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USING OF WATER QUALITY INDEX (WQI) IN DETERMINING THE QUALITY OF DOMESTIC SURFACE WATER IN CÔTE D'IVOIRE: THE CASE OF LOBO RIVER IN THE DEPARTMENT OF DALOA

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ABSTRACT

The present study aims at assessing the water quality index (WQI) in the surface water of Lobo river in the department of Daloa (Côte d'Ivoire). The surface water samples were subjected to comprehensive physico-chemical analysis involving major cations, anions and heavy metal.A total of sixteen physico-chemical parameters including temperature, hardness, alkalinity, dissolved oxygen, conductivity, pH, calcium, magnesium, chlorides, nitrates, sulphates and fluoride were recorded during 2012 and 2016. The study shows that water from Lobo river is acid. The pH values range from 6.6 to 6.9, with a mean 6.8. The surface water is fresh with electric conductivity about 192.3 µS/cm to 316 µS/cm. Water Quality Index (WQI) calculated based on these parameters range from 47.04 to 93.1. These values also revealed the excellent quality of Lobo river water and its suitablity of domestics purposes.

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INTRODUCTION

Long regarded as an inexhaustible natural resource, water consumption is not less limited. Indeed, faced with waste and the illusion of abundance, water scarcity is beginning to be felt in all countries. In the world, one of the problems facing governments in all states is access to drinking water (Soro, 2002). For the United Nations Development Program (UNDP), the right to drinking water must be recognized as a human right (UNDP, 2006). Access to drinking water has always been at the center of development projects, because people can not live without fresh water. Groundwater is often accumulated in the upper layers and generaly flows along privileged channels, which are essentially fissures or faults. According to Reiss (1980) this water has good quality compared to surface water (rivers, lakes, ponds). For the drinking water supply of the population of the study area, the Water Distribution Company in Côte d'Ivoire (SODECI) of Daloa uses surface water from Lobo river.

The mineralisation of surface water depends natural processes but also on anthropogenics activities. The quality of this water is often poor, and the bacteriological condition is inevitably disastrous (Lasm, 2000).In fact some works have been done on different aspects of water resource from Daloa (Koffi, 2015, Labé, 2014), but any study is about the quality of Lobo river. The goal of this study is to envisage the water quality status of Lobo river using the water quality index. Then periodic monitoring and assessment of water quality helps to develop management strategies to control surface water pollution (Shuchun *et al*. 2010) in spite of increasing urbanization and anthropogenic pressure on them. The method of Water quality index (WQI) is one of the most effective tools (Ravikumar *et al*., 2013) to communicate information on the quality of water to the concerned citizens and policy makers as it is an important parameter for the assessment and management of surface/ground waters. This study was carried out in the departement of Daloa to evaluate the Lobo river water quality analyzing physico-chemical parameters and by estimating WQI.

Study area

Geographical location: Daloa is the important and biggest city in the center-western part of Côte d'Ivoire. This city is the capital of the region of Upper Sassandra. The study area is located between 7 °20 and 5 ° 45 West latitudes and 7 ° 15 and 6 ° 30 North longitudes (figure 1). Daloa covers a total landmass of about 5 450 km^2 which is nearly 28% of the total geographical area of the region. The population is about 591633of persons, with an average annual growth rate 1,95% (RGPH, 2014). The geomorphology of the area widely can be categorised as a peneplain whose altitude varies from 160 m to 480 m. The plains and plateaus are the two major types of relief that are present in the department. In the area, agriculture is the main income-generating activity of the population. It is an extensive, anarchic, rain-fed and manual agriculture, which compensates for its weaknesses by the permanent conquest of new lands (Noufou, 1998). The agriculture is less modernized. The production system is dominated by the coffee-cocoa sector. Apart from growing coffee and cocoa, there are some wood processing units. The drinking water supply of the populations is ensured from a catchment made on the river Lobo. This river is a tributary of the Sassandra River, located 25 km from the city in the locality of Zébra.

The climatic regime of the region is divided into four (4) seasons :- december to march (long dry season);-july to august (short dry season);- - september to november (long rainy season);-april to june (short rainy season).

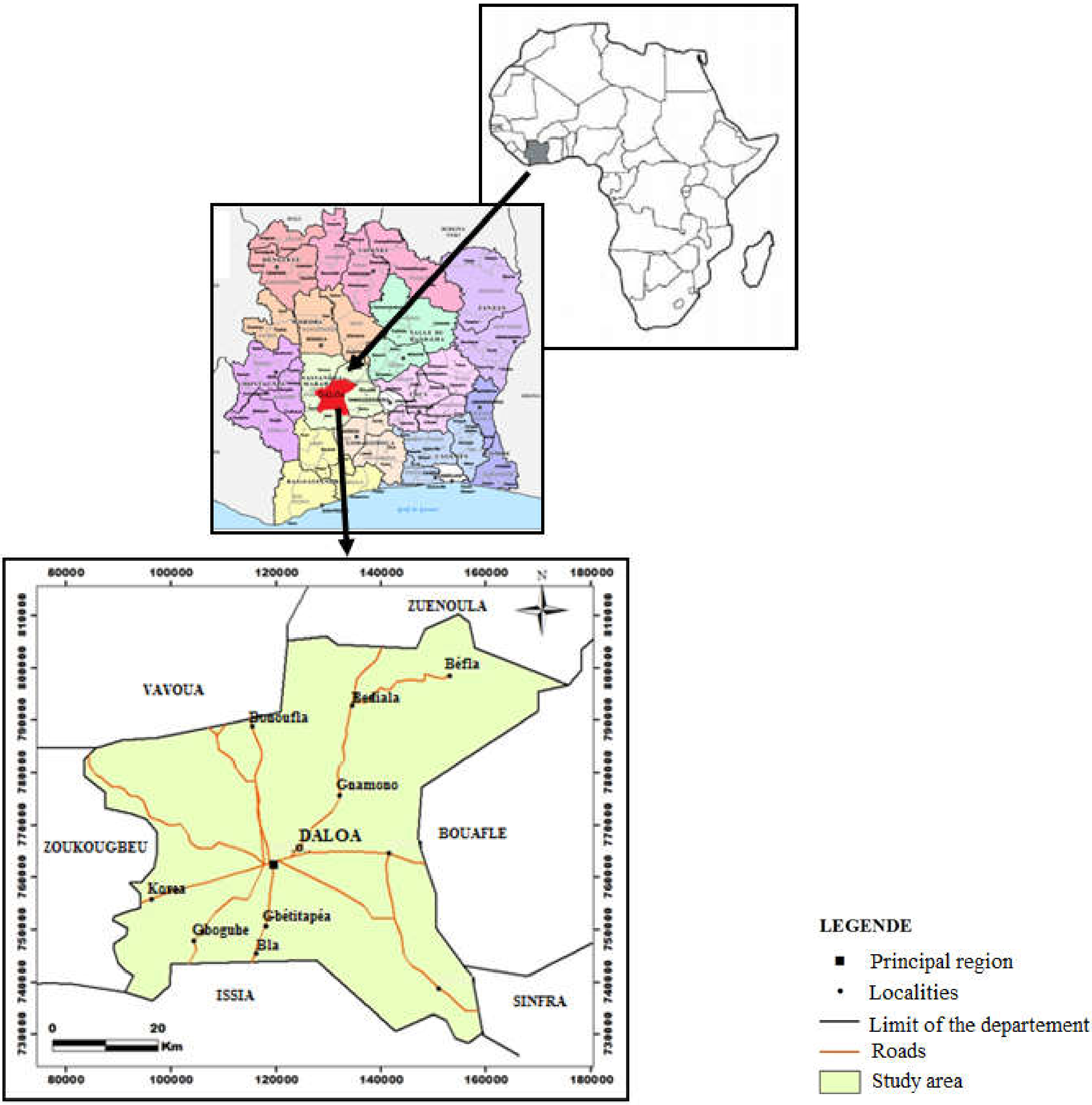

Figure 1. Map of the study area

Geological context: The study area is underlain by igneous and metamorphic rocks of Precambrian age which are nearly 97,5% of the of the total area of Côte d'Ivoire. From a geological point of view, the distribution of the major rock units in the study area is presented by the work of Ahimon (1990) and Delor *et al*. (1995). According to this study, the Daloa region belongs mainly to the Precambrian basement (Middle Precambrian). It is grouped into two large entities that are magmatic rocks and metamorphic rocks. The magmatic rocks encountered are of the types: plutonic and volcanic. The metamorphic rocks are migmatite and schistous type in which is underlain the Lobo River.

Hydrogéological context: In the study area, there are generally two types of aquifers: the aquifer of alterites (superficial) and the fractured aquifers (deeper). Alterite aquifers are the first groundwater reservoir in the crystalline and crystallophyllian basement zone. These are surface formations resulting from the processes of physico-chemical alteration and erosion of the basement. They develop in the sandy-clay formations of the alteration layer whose thickness generally varies between 10 and 30 m but can sometimes reach 40 m (Lasm, 2000). These alterites constitute an important surface reservoir directly fed by the infiltration of rainwater. They are characterized by a piezometric level close to the surface, which makes them vulnerable to pollution because of anthropogenic activities. The cracks aquifers are below the aquifer of alterites. They are much larger reservoirs. These aquifers are usually created as a result of tectonic events that affect the upper and middle levels of the Earth's crust (Savadogo 1984). They extend on average over a thickness of 50 m (Maréchal *et al*., 2003) in the basement and develop a productivity superior to that of the alterites. Crack aquifers are protected from seasonal fluctuations and most types of pollution.

MATERIALS AND METHODS

Methodology of surface water sampling and analysis: For this study, water from Lobo river were sampling from 2012 to 2016. In fact, the samples were taking during the dry season for each year. During the sampling, water were collected in polyéthynlenes bottles in 500 ml and 1 litre sterilized polythene bottle. For all samples collected, parameters such as electrical conductivity (EC), temperature (T) and pH values were measured in the field. On site testing was necessary for these parameters since they are likely to change during transport. These variables were measured using the pH-meter WTW 3110 and conductmeter WTW 3110. The samples bottles were stored at 4°C until analysed to minimize physico-chemical changes. The samples were transported in the laboratory foranalysis. In surface water the parameters analyzed include major cations (Ca^{2+}, Mg^{2+}, Na^+, K^+, Al^{3+}), anions (HCO_3^-, Cl^-, SO_4^{2-}, NO_3^-, NO2-, NH_4^+andF^-) in milligram per liter (mg/L), besides general parameters (P, TAC, TH total and TH calcique). Heavy metals were also analysed and composed of iron (Fe), manganese (Mn), zinc (Zn), cadmium (Cd) and copper (Cu) were measured in the water. Those analysis were determined by the spectrometric method using a spectrophotometer (HACH/DR 2500) and the turbidimeter 210 Q. The standard analytical procedures for analysis methods recommended by Rodier *et al*. (1996) were employed in the present study.

Water quality index method: The Water Quality Index (WQI) provides a comprehensive picture of the quality of surface/ground water for most domestic uses (Ravikumar *et al*., 2013). WQI is defined as a rating that reflects the composite influence of different water quality parameters (Sahu and Sikdar 2008). For calculating the WQI in this study study, 16 parameters namely, pH, Turbidity, electrical conductivity, calcium, magnesium, potassium, bicarbonate, sulphate, chloride, nitrate, ammonium, oxydability, fluoride, copper, zinc and iron have been considered. There were the three steps of calculation of the WQE of a water sample.

First step: weight assignment (wi): Each of the chemical parameters was assigned a weight (wi) based on their perceived effects on primary health/their relative importance in the overall quality of water for drinking purposes. The highest weight of 5 was assigned to parameters which have the major effects on water quality and their importance in quality (NO_3^- and F^-). A minimum valor 2 was assigned to parameters which are considered as notharmful to water quality like Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Potassium (K^+) and iron (Fe). The weight of 3 was attribuated to the others parameters.

Second step: calculation of the relative weight (W_i): The relative weight W_i is equal to the ratio between the weight (w_i) of every chemical parameters and the total of the weight of all the parameters (equation 1).

$$W_i = \frac{wi}{\sum_{n=1}^{n} wi} \quad (1)$$

where Wi : is the relative weight, wiis the weight of each parameter and nis the number of parameters.

Third step: counting of the Water Quality Index (WQI): A quality rating scale (qi) for all the parameters was assigned by dividing its concentration in each water sample by its respective standard according to the drinking water guidelines recommended by the WHO, the result was then multiplied by 100 (equation 2).

$$qi = \frac{Ci - Vio}{Si - Vio} \times 100 \quad (2)$$

where, qi = the quality rating, Ci= value of the water quality parameter obtained from the laboratory analysis,
Si= value of the water quality parameter obtained from recommended WHO, and Vio= the ideal value which is considered as 7.0 for pH and 14.6 mg/l for DO.

Then, the Sub-Index or Second-index (SI_i) of water quality for each chemical parameter is assigned by multiplication of the weight (Wi) by the estimate quality (qi) according to the equation 3.

Finally, the Water Quality Index (WQI) is obtained with the following equation (equation 4).

$$SI = Wi \times qi \quad (3)$$

$$WQI = \sum_{i=1}^{n} SIi \quad (4)$$

where SIi is the sub-index of ith parameter ; qi is the rating based on concentration of ith parameter and n is thenumber of parameters. The computing WQI values could be classified according the following tableau (Ramakrishnaiah *et al*. 2009; Alobaidy *et al*., 2010; Ravikumar *et al*., 2013).

RESULTATS AND DISCUSSION

Physico-chemicals caracteristics of water from river Lobo: The samples were collected from each of the different sites within the Lobo river. The minimum, maximum and mean analytical results for each parameter for each period of analysis are summarized in Tables 2.

Tableau 1. Level of Water Quality Index (WQI)

Water quality statut	Water quality level
0 < WQI< 50	Excellent water
50 < WQI< 100	Good water
100 < WQI< 200	Poorwater
200 < WQI< 300	Very poor water
WQI> 300	Unsuitable water

Tableau 2. Physico-chimical data of Lobo river from 2012 to 2016

Stations	Pss12	Psp12	Pss13	Psp13	Pss14	Pss15	Pss16	Min	Max	Mean	Standard deviation
Turbidity (NTU)	4.9	6.4	4.47	7.2	4.2	9.86	5.73	4.2	9.86	6.11	2.08
pH	6.7	6.6	6.7	6.6	6.8	6.9	6.8	6.6	6.9	6.73	0.12
Conductivity (µS.cm^{-1})	248	252	247	308	316	229	192.3	192.3	316	256.04	47.28
Chlorures	19.8	23.4	22.3	14.5	12.4	10.7	21.4	10.7	23.4	17.79	5.56
Sulfates	0	8.2	16	0	0	0	0	0	16	3.46	6.72
Bicarbonates	51.24	64.66	81.74	39.04	39.04	39.04	45.14	39.04	81.74	51.41	17.85
Nitrates	8.8	4.1	0.04	6.2	3.6	3.7	1.6	0.04	8.8	4.01	2.13
Potassium	10.8	10.4	10	9.82	10.9	7.2	4.2	4.2	10.9	9.05	2.58
Calcium	24.84	24.84	25.65	27.25	28.05	26.45	30.46	24.84	30.46	26.79	1.99
Magnesium	25.22	35.66	34.21	25.53	19.58	21.18	17.17	17.17	35.66	25.51	7.77
Ammonium	0.43	0.37	0.35	0.66	0.32	0.4	0.4	0.32	0.66	0.42	0.12
Iron	0.92	1.24	1.12	2.34	2.09	0.2	2.2	0.2	2.34	1.44	0.83
Manganese	0.065	0.22	0.022	0.21	0.18	0.3	0.491	0.022	0.491	0.21	0.15
Oxydability	15.9	14.7	14.75	17.04	15.7	14.5	14.5	14.5	17.04	15.30	1.01
Copper	0.03	0.19	0.79	0.16	0.03	0.03	0.1	0.03	0.79	0.19	0.29
Zinc	0.12	0.06	0.07	0.06	0.02	0.02	1.04	0.02	1.04	0.20	0.41
Fluorine	1.06	0.44	0.44	0	0	0	0.27	0	1.06	0.32	0.22

Tableau 3. Results of Water Quality Index from the station Pss12

	WHO values (Si)	Values Surv. (Vi)	Weight (wi)	Relative Weight (Wi)	Quality (qi)	Sub-Index (SI)
Turbidity	5	4.9	3	0.06	98.00	6.00
pH	8.5	6.79	3	0.06	-14.00	-0.86
Conductivity	400	248	3	0.06	62.00	3.80
Chlorures	250	19.8	3	0.06	7.92	0.48
Sulfates	250	0	3	0.06	0.00	0.00
Total Hardness (TH)	200	50.07	2	0.04	25.04	1.02
Total Alkalinity Complete (TAC)	500	51.24	3	0.06	10.25	0.63
Ammonium	1.5	0.43	3	0.06	28.67	1.76
Iron	0.3	0.92	2	0.04	306.67	12.52
Manganese	0.4	0.065	3	0.06	16.25	0.99
Nitrates	50	8.8	5	0.10	17.60	1.80
Oxydability	5	15.9	3	0.06	318.00	19.47
Cooper	2	0.03	3	0.06	1.50	0.09
Zinc	3	0.12	3	0.06	4.00	0.24
Fluorine	1.5	1.06	5	0.10	70.67	7.21
Potassium	12	10.8	2	0.04	90.00	3.67
		Total	49	1.00	1042.55	58.83
					WQI = 58.83	

The pH is a numerical expression that indicates the degree to which water is acidic or alkaline, with the lower pH value tends to make water corrosive and higher pH provides taste complaint and negative impact on skin and eyes. The pH of the samples water is acid and the values range from 6.6 to 6.9, with and average value 6.8. During the wait saison, the pH of the surface water range from 6.7 to 6.9, with and average value 6.8. However, in the dry saison, the pH is about 6.6 to 6.8 with a mean 6.65. The pH values of river Lobo is acid during the raining saison and neutre during the dry saison. In the dry season, the electic conductivity of water Lobo river range from 192.3 µS.cm^{-1}at the station Pss16 to 316 µScm^{-1}at the station Pss14, with an average value 246,46 µS.cm^{-1}.During the raining season, the values of eclectric condictivity are about 252 µS.m^{-1}at the station Psp12 (bis) and 328 µS.cm^{-1}at the station Psp12, with and average 303 µScm^{-1}. In fact the analysis show that water from Lobo river is fresh with low electric conductivity.

Characteristics of Water Quality Index (WQI)

Seasonal Characteristics of Water Quality Index (WQI): The analytical results of seasonal coumpting of Water Quality Index (WQI) from Lobo river during the period 2012 to 2016 are summarized in Table 2.

Dry season: During the dry season, the values of Water Quality Index are summarized in Tables 3 to 7. The WQI values in the dry season range from 47.04 at the station Pss15 to 74.21 at the station Pss16, with a mean value of 60.52 (Table 2). The differentes variation of the QWI values during the dry season in the study area is shown by the figure 7. All the WQI values are under than 40.

Tableau 4. Results of Water Quality Index from the station Pss13

Parameters	WHO values (Si)	Valeurs surv. (Vi)	Weight (wi)	Relative Weight (Wi)	Quality (qi)	Sub-Index (SI)
Turbidity	5	4.47	3	0.06	89.40	5.47
pH	8.5	6.71	3	0.06	-19.33	-1.18
Conductivity	400	247	3	0.06	61.75	3.78
Chlorures	250	22.3	3	0.06	8.92	0.55
Sulfates	250	16	3	0.06	6.40	0.39
Total Hardness (TH)	200	59.87	2	0.04	29.94	1.22
Total Alkalinity Complete (TAC))	500	81.74	3	0.06	16.35	1.00
Ammonium	1.5	0.35	3	0.06	23.33	1.43
Fer total	0.3	1.12	2	0.04	373.33	15.24
Manganèse	0.4	0.022	3	0.06	5.50	0.34
Nitrates	50	0.04	5	0.10	0.08	0.01
Oxydability	5	14.75	3	0.06	295.00	18.06
Cuivre	2	0.79	3	0.06	39.50	2.42
Zinc	3	0.07	3	0.06	2.33	0.14
Fluorine	1.5	0.44	5	0.10	29.33	2.99
Potassium	12	10	2	0.04	83.33	3.40
		Total	49	1.00	1045.17	55.26
					IQE = 55.26	

Tableau 5. Results of Water Quality Index from the station Pss14

Parameters	WHO values (Si)	Values surv. (Vi)	Weight (wi)	Relative Weight (Wi)	Quality (qi)	Sub-Index (SI)
Turbidity	5	4.2	3	0.06	84.00	5.14
pH	8.5	6.82	3	0.06	-12.00	-0.73
Conductivity	400	316	3	0.06	79.00	4.84
Chlorures	250	12.4	3	0.06	4.96	0.30
Sulfates	250	0	3	0.06	0.00	0.00
Total Hardness (TH)	200	47.64	2	0.04	23.82	0.97
Total Alkalinity Complete (TAC)	500	39.04	3	0.06	7.81	0.48
Ammonium	1.5	0.32	3	0.06	21.33	1.31
Iron	0.3	2.09	2	0.04	696.67	28.44
Manganese	0.4	0.18	3	0.06	45.00	2.76
Nitrates	50	3.6	5	0.10	7.20	0.73
Oxydability	5	15.7	3	0.06	314.00	19.22
Cooper	2	0.03	3	0.06	1.50	0.09
Zinc	3	0.02	3	0.06	0.67	0.04
Fluorine	1.5	0	5	0.10	0.00	0.00
Potassium	12	10.9	2	0.04	90.83	3.71
		Total	49	1.00	1364.79	67.29
					WQI = 67.29	

Tableau 6. Results of Water Quality Index of sample Pss15

Parameters	WHO values (Si)	Values surv. (Vi)	Weight (wi)	Relative weight (Wi)	Quality (qi)	Sub-Index (SI)
Turbidity	5	9.86	3	0.06	197.20	12.07
pH	8.5	6.93	3	0.06	-4.67	-0.29
Conductivity	400	229	3	0.06	57.25	3.51
Chlorures	250	10.7	3	0.06	4.28	0.26
Sulfates	250	0	3	0.06	0.00	0.00
Total Hardness (TH)	200	47.64	2	0.04	23.82	0.97
Total Alkalinity Complete (TAC)	500	39.04	3	0.06	7.81	0.48
Ammonium	1.5	0.4	3	0.06	26.67	1.63
Iron	0.3	0.2	2	0.04	66.67	2.72
Manganèse	0.4	0.3	3	0.06	75.00	4.59
Nitrates	50	3.7	5	0.10	7.40	0.76
Oxydability	5	14.5	3	0.06	290.00	17.76
Cooper	2	0.03	3	0.06	1.50	0.09
Zinc	3	0.02	3	0.06	0.67	0.04
Fluoride	1.5	0	5	0.10	0.00	0.00
Potassium	12	7.2	2	0.04	60.00	2.45
	Total		49	1.00	813.59	47.04
			WQI = 47.04			

Rainy season

Tables 8 and 9 show the WQI values during the rainy season. During the rainy saeason, the values of WQI range from 61,05 at the station Psp12 (bis) to 93,1 at the station Psp12, with a mean of 78,74 (Figure 3).

The seasonal variation of the WQI of the Lobo river in the departement of Daloa is shown by the Tables 10.

Annual characteristics of the Water Quality Index: The Water Quality Index (WQI) values computed could be classified as five (5) types: execellent (WQI < 50), good

Tableau 7. Results of Water Quality Index from the station Pss16

Parameters	WHO values (Si)	Values surv. (Vi)	Weight (wi)	Relative weight (Wi)	Quality (qi)	Sub-Index (SI)
Turbidity	5	5.73	3	0.06	114.60	7.02
pH	8.5	6.84	3	0.06	-10.67	-0.65
Conductivity	400	192.3	3	0.06	48.08	2.94
Chlorures	250	21.4	3	0.06	8.56	0.52
Sulfates	250	0	3	0.06	0.00	0.00
Total Hardness (TH)	200	47.64	2	0.04	23.82	0.97
Total Alkalinity	500	45.14	3	0.06	9.03	0.55
Ammonium	1.5	0.4	3	0.06	26.67	1.63
Iron	0.3	2.2	2	0.04	733.33	29.93
Manganese	0.4	0.491	3	0.06	122.75	7.52
Nitrates	50	1.6	5	0.10	3.20	0.33
Oxydability	5	14.5	3	0.06	290.00	17.76
Cooper	2	0.1	3	0.06	5.00	0.31
Zinc	3	1.04	3	0.06	34.67	2.12
Fluorine	1.5	0.27	5	0.10	18.00	1.84
Potassium	12	4.2	2	0.04	35.00	1.43
	Total		49	1.00	1462.03	74.21
			WQI = 74.21			

Tableau 8. Results of Water Quality Index from the Psp12 (bis)

Parameters	WHO values (Si)	Values surv. (Vi)	Weight (wi)	Relative weight (Wi)	Quality (qi)	Sub-Index (SI)
Turbidity	5	6.4	3	0.06	128.00	7.84
pH	8.5	6.69	3	0.06	-20.67	-1.27
Conductivity	400	252	3	0.06	63.00	3.86
Chlorures	250	23.4	3	0.06	9.36	0.57
Sulfates	250	8.2	3	0.06	3.28	0.20
Total Hardness (TH)	200	60.51	2	0.04	30.26	1.23
Total Alkalinity Complete (TAC)	500	64.66	3	0.06	12.93	0.79
Ammonium	1.5	0.37	3	0.06	24.67	1.51
Iron	0.3	1.24	2	0.04	413.33	16.87
Manganese	0.4	0.22	3	0.06	55.00	3.37
Nitrates	50	4.1	5	0.10	8.20	0.84
Oxydability	5	14.7	3	0.06	294.00	18.00
Cooper	2	0.19	3	0.06	9.50	0.58
Zinc	3	0.06	3	0.06	2.00	0.12
Fluorine	1.5	0.44	5	0.10	29.33	2.99
Potassium	12	10.4	2	0.04	86.67	3.54
	Total		49	1.00	1148.86	61.05
			WQI = 61.05			

Tableau 9. Results of Water Quality Index from the station Psp13

Parameters	WHO values (Si)	Values surv. (Vi)	Weight (wi)	Relative weight (Wi)	Quality (qi)	Sub-Index (SI)
Turbidity	5	8.51	3	0.06	170.20	10.42
pH	8.5	6.64	3	0.06	-24.00	-1.47
Conductivity	400	324	3	0.06	81.00	4.96
Chlorures	250	17.8	3	0.06	7.12	0.44
Sulfates	250	0	3	0.06	0.00	0.00
Total Hardness (TH)	200	81.11	2	0.04	40.56	1.66
Total Alkalinity Complete (TAC)	500	41.48	3	0.06	8.30	0.51
Ammonium	1.5	0.84	3	0.06	56.00	3.43
Iron	0.3	2.08	2	0.04	693.33	28.30
Manganese	0.4	0.221	3	0.06	55.25	3.38
Nitrates	50	7.4	5	0.10	14.80	1.51
Oxydability	5	18.1	3	0.06	362.00	22.16
Cooper	2	0.37	3	0.06	18.50	1.13
Zinc	3	1.23	3	0.06	41.00	2.51
Fluorine	1.5	0	5	0.10	0.00	0.00
Potassium	12	12.2	2	0.04	101.67	4.15
	Total		49	1.00	1625.72	83.09
			WQI = 83.09			

quality (50 < WQI < 100), poor quality (100 < WQI < 200), very poor quality (200 <WQI < 300); Unsuitable (IQE > 300) (Alobaidy *et al*. 2010). The annual computed values of water quality index from Lobo river in the study area are shown by the following Table 11. The mean annual value is computed for the dry season and the rainy season. The annual WQI values range from 50 to 100. It show that surface water is good quality (50 < IQE < 100).

However, the computed resultats of WQI at the station Pss15 is less than 50. The quality of surface water from the study area is excellent (Figure 4).

DISCUSSION

The water quality index (WQI) values computer for the Lobo river in the study area are less than 100. Those values show that surface water of the department of Daloa has range good quality (Alobaidy *et al*., 2010).

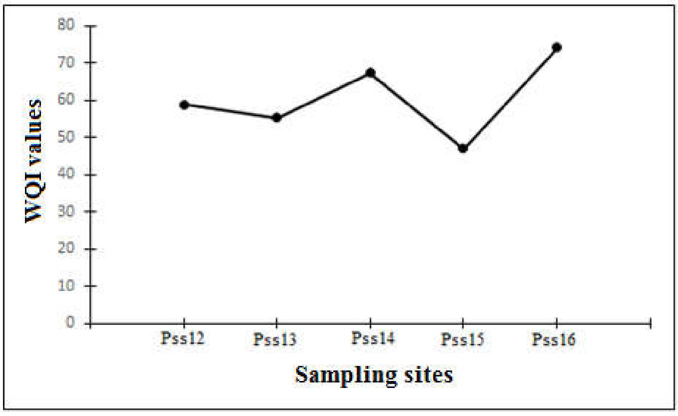

Figure 7. Water Quality Index of the Lobo river in the dry season

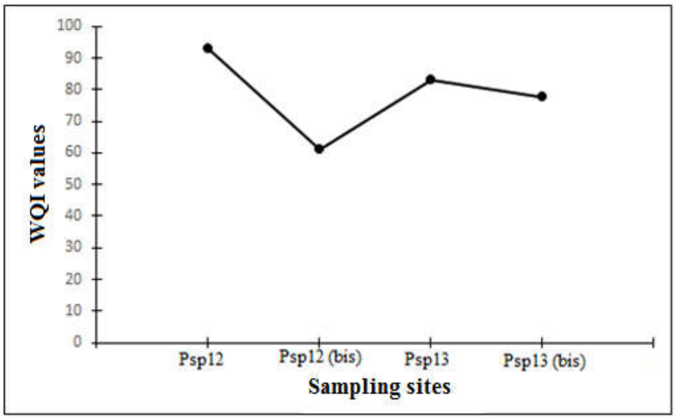

Figure 8. Water Quality Index of the Lobo river during the rainy season

Tableau 8. Summary of the seasonal variation of the WQI

	Dry season					Rainy season	
Stations	Pss12	Pss13	Pss14	Pss15	Pss16	Psp12	Psp13
WQI	58.83	55.26	67.29	47.04	74.21	61.05	77.72
Observations	Good	Good	Good	Excellent	Good	Good	Good
Mean	60.52					78.74	

Tableau 9. Summary of the water quality index values from 2012 to 2016

	2012	2013	2014	2015	2016
WQI Mean	61.05	66.49	67.29	47.04	74.21
Observations	Good	Good	Good	Excellent	Good

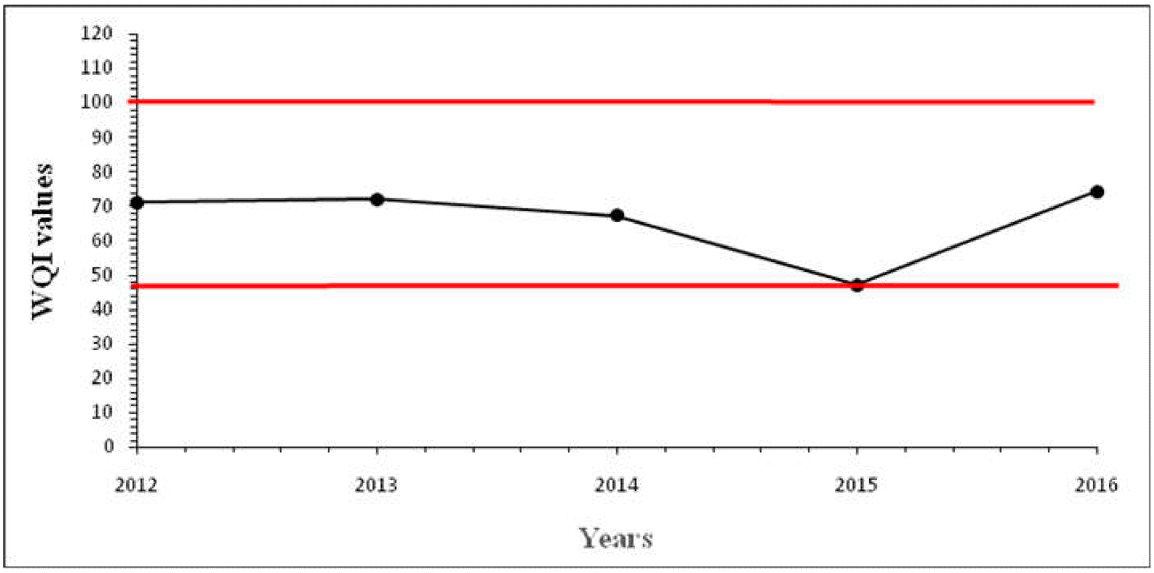

Figure 6. Temporal variation of the water quality index of Lobo river from 2012 to 2016

This water is suitable for domestic activities. Les valeurs de l'IQE calculées à tous les prélèvements de l'eau de la zone d'étude sont inférieures à 100, et que 100 étant la valeur limite d'une bonne eau, indiquant que l'eau est appropriée à l'usage domestique. At the station Pss15 in 2015, the water quality index (WQI) value is about 47.04. This value shows that water is excellent quality. In 2012, at the station show at the station Psp12 the WQI value is about 93.1 and shows that water is fresh and good quality. In the departement of Daloa, there is an increase in humidity during the rainy season (April to June and September to November) and a decrease in humidity during the dry season (December to March and July to August). The hight values of water quality index (WQI) during the year 2012 came from rain. In fact runoff water erodes chemical substances during their flow to deposit the streams in the surface water (Guillemin and Roux, 1992). This is the principal way to increase chemical mineralisation of surface water. This study show that during 2015, the WQI values are less than 50. In fact, this year was This year was the driest. Then the WQI values were influenced by the drought. In the study area, the mineralization of surface water is conducted by the season. Runoff provides surface water with chemical elements and sediment which are responsable of water mineralization and impact it quality.

Conclusion

The present study was about the quality of surface water from Lobo river in the department Daloa in the center-western part of Côte d'Ivoire. The study showes the characteristics of surface water. The hydrochemical study from surface water of Lobo river shows the following caracteristics. Lobo river water has a low mineralization. The electrical conductivity which ranges from Il 192.3 µS/cm to 316 µS/cm. Surface water is acid with a pH values between 6.65 and 6.93. In this study, the water quality index (WQI) values computer for the Lobo river is less than 100,limit value of a good water. Lobo river water is fresh and the quality ranges from excellent to good during the rainy season and the dry season in the period of study. In the departement of Daloa, this surface water is suitable for domestic activities.

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