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Water quality evaluation from Lomé's lagoon: Effects on heavy metals contamination on fishes.

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ABSTRACT: The relevance of this study shows that in general, water of lake of Lome has a strong alkalinity (pH raging from 8.8-9.2) and a strong salinity revealed by the high value of the electric conductivity (2800-3200 $\mu s.cm^{-1}$). An impressive algae colony is composing the essential suspended matter (60-70 $mg.l^{-1}$). The water turbidity was about 80-90 NTU. We also determined that in some places of the lake, the high concentration of nitrogen compounds appeared to be the major causing pollution since the NTK (total nitrogen) ranged from 20-22 $mgN.l^{-1}$. In contrast, the COD (chemical oxygen demand) and the BOD (biochemical oxygen demand) values were low (110 $mgO_2.l^{-1}$ and 40 $mgO_2.l^{-1}$ respectively). In the case of metallic elements, cadmium contents was very low in water, sediments and fishes. Copper, lead, zinc and mercury concentrations in water were respectively 3.6; 8.0; 7.0 and 14.0$\mu g.l^{-1}$. In fishes, the following measured values of the same elements were 5.0; 2.8; 20.2 and 5.5 $\mu g.l^{-1}$ respectively. @JASEM

Lakes and lagoons of African cities have been in last decades, exposed to serious pollution risks due to the growing number of inhabitants and to the intensification of industrial and art activities. Waters from runoff are drastically polluted. Industrial and domestic wastes and all kind of effluents contribute to the pollution of the aquatic mediums. Particularly lakes and lagoons are the principal targeted sites in urban areas. Recently, for example, a research has shown that effluents charged with about 500 $mg.l^{-1}$ of suspended matter, 1400 $mg.l^{-1}$ of COD, 600 $mg.l^{-1}$ of BOD and about 40 $mg.l^{-1}$ of NTK were discarded into a lagoon of Abidjan Côte d'Ivoire (Brigton Bi. et al, 2006).
Heavy metals carried down by effluents are usually mentioned. Table 1 indicates the contents of some elements in water, sediment an in fishes from different lakes and lagoons, showing the different degrees of pollution. Specially, this type of pollution from metal has been the major threats for Europe and becomes now a serious issue for African countries as well.
In the present study we emphasize on the situation of the pollution of the lagoon of Lome and the effects on the contamination of fishing products.

Table 1. Heavy metals contents in water, sediment and fish from different lakes.

Locations	Mediums	Cd	Cu	Hg	Pb	Zn	References
Odo-Iyaalaro (tributary of Lagos lagoon)	Water mgl^{-1}	1.9	22	-	25	64.5	Oyeyiola et al,
	Sediments mgl^{-1}	42.1	94.5	-	108.3	805	2006
Urban lakes in Yaoudé, Cameroon	Water μgl^{-1}	-	-	-	20.1	90.2	Demanou, J; Brummett RE., 2003
Lake Victoria, Tanzania	Sediment mgg^{-1}	< 1.9	32.6	-	58.1	101.9	Machiwa, JF, 2003
	Fish mgg^{-1}	4.67	07	-	0.13	8.8	
Fouarat lake, Marocco	Sediment μgg^{-1}	0.9	75	-	110	400	Bouih, BH. et al., 2005
Lakes Awassa, Ziway, Ethiopia	Fish $mgkg^{-1}$	4.9	797		42.3	115.9	Aweke, K; Tadesse, W 2004
Santa Gilla lagoon, Italy	Sediment ppm	-	33	6.28	172	209	Degetto, S; et al., 1997
Marano lagoon, Italy	Sediment μgg^{-1}	-	-	6.6	-	-	Piani, R;. et al., 2005
Lakes Killarney Park, Canada	Sediment $mgkg^{-1}$	12	189	-	253	1132	Belzile, N; et al., 2004

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MATERIALS AND METHODS

Solutions used for the studies were prepared from analytical grade chemicals, in bidistilled water or in high purity organic solvents. Water samples were taken in glass flasks or in plastic bottles (about 20 cm profounder), temperature and pH were measured before the samples were brought in the laboratory in a cooler. Dissolved oxygen is trapped on the site, sediments and fishes were taken in the glass flaks.

The analytical methods used for the study were from the french normalisation association (AFNOR 1990). Turbidimeter HF Inst. DRT 100B, conductimeter Tacussel CD7N and pH-meter, pH.330i/set were used to measure water turbidity, electric conductivity and pH.

Spectrophotometer analyses were performed on Shimadzu spectrophotometer UV 120-02. Prior the analysis, metallic elements were concentrated according to the method of Per and Johan (1991) described as follow : Aqueous solutions of magnesium sulphate 0.32M (10 ml) and sodium hydroxide 0.5M (10 ml) were added to 1000 ml of water and stirred thoroughly, then the suspension allowed to stand for 24 hr. The supernatant was removed. The residue was centrifuged and nitric acid 5M (5 ml) was added to the sediment in the tube. Some drops of hydrogen peroxide 30% was added to oxidise organic matter. The mixture was warmed at 95°C on water bath for 2 hr to completely dissolve the suspension and then poured in 25 ml flask and brought to 25 ml with distilled water.

Sediments were dried prior at room temperature then at 80°C in an oven; The mineralization was carried out with acids mixture composed by: 25% $HClO_4$; 37.5% HF and 37.5% HNO_3 (in volume). 2.5g of dried sediments in Teflon container was slightly wetted before 25 ml of acids mixture was added, the reaction mixture left to proceed overnight and warmed on heating sand for 2 hr. On cooling to room temperature, 2.0 ml of nitric acid (16N) and water 25 ml were added, followed by filtration through wattman paper, the filtrate was poured in 100 ml flask and brought to 100 ml with distilled water.

Fish was thoroughly grounded prior the mineralization was done as follow: In a tube containing 10 ml of nitric acid (16N), 5g of grounded fish was added and the mixture left to react for 24 hr. The suspension was warmed at 90°C for 3 hr in a water bath; the mixture was poured in a 50 ml flask and completed at 50 ml with distilled water.

Cadmium, copper, lead and zinc were analysed on a Perkin-Elmer 2380 flame atomic absorption spectrophotometer. Mercury concentration was determined by method with dithizone in the presence of EDTA (Charlot 1974).

RESULTS

Samples were taken from sites in two natural lagoons of Lome (eastern lake and lake of Bê). The depth average was about 0.5-3.5 m. Water in the lagoons comes especially from run off and domestic effluents.

To evaluate water quality, sediments and water physicochemical parameters were measured. Heavy metals in waters, sediments and fishes were analyzed. Some of the waters and sediments physicochemical parameters are listed in table 2.

Table 2. Values of water parameters.

Parameter	Unit	Est lake	Lake of Bê
Température	°C	28.3 – 28.6	28.4 – 28.5
pH	-	8.8 – 9.0	9.1 – 9.3
Electric conductivity	$\mu s.cm^{-1}$	3180 - 3200	2810 - 2870
Turbidity	NTU	80 - 90	70 - 80
Ammonia (NH_4^+)	$mg.l^{-1}$	0.7 – 1.4	0.3 – 0.5
Total nitrogen (NTK)	$mgN.l^{-1}$	20.0 – 22.0	4.0- 6.0
Dissolved oxygène	$mg.l^{-1}$	6.8 – 7.1	6.2 – 7.5
Oxidizability ($KMnO_4$)	$mgO_2.l^{-1}$	10 - 12	6 - 8
COD	$mgO_2.l^{-1}$	100 - 105	103 - 110
BOD	$mgO_2.l^{-1}$	20 - 30	30 - 40

Lake of Bê had high pH (9.1-9.3) and the eastern lake pH ranged 8.8-9.0. This alkalinity is the direct consequence of intense photosynthesis activity. Indeed a massive presence of algea gave a green colour aspect to the lagoons. Concentrations of suspended matter greatly composed of algae ranged from 60-70 $mg.l^{-1}$. The water turbidity was about 80-90 NTU. Similar high pH values (9.0-9.2) were measured in water from lake of Merja Fouarate in Morocco (Nassali et al. 2005). Electric conductivity values were in general elevated (2800-3200 $\mu s.cm^{-1}$) caused by a strong salinity due to the sea water intrusion witch was proven by the chloride ions concentrations in the lagoon (1200-1300 mgl^{-1}). COD and BOD values showed that organic matters contents were low, extreme values of COD (110 $mgO_2.l^{-1}$) and BOD (40 $mgO_2.l^{-1}$) from lake of Bê, indicate that biodegradable charge does not exceed 40%. Dissolved oxygen value (6.5-7.5 $mg.l^{-1}$) indicated a good aeration of water probably because of the algea intense photosynthesis activities. In the case of nitrogen elements, we measured high NTK values (20-22 $mgN.l^{-1}$) and ammonium ions (0.7-1.4 $mg.l^{-1}$), this nitrogen polluting source comes from dumping of effluents in the lagoon and from all kind of liquid and solid wastes. In addition, this late assessment is supported by a recent study showing that domestic effluents could contain up to 40 $mgN.l^{-1}$ of NTK (Briton Bi et al. 2006).

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Table 3. Heavy metals contents in water.

Element	Unit	Est lake	Lake of Bê
Cd	µgCd.l^{-1}	< 0.5	< 0.5
Cu	µgCu.l^{-1}	1.5 – 3.4	2.0 – 3.6
Hg	µgHg.l^{-1}	10.0 – 12.0	12.0 – 14.0
Pb	µgPb.l^{-1}	1.5 – 3.6	5.0 – 8.0
Zn	µgZn.l^{-1}	4.0 – 7.0	3.0 – 6.0

We also have been interested to the presence of metallic elements in water (table 3). Therefore, in water cadmium (Cd) concentration was vary low (<0.5 mg.l^{-1}), mercury (Hg) had 12-14 mg.l^{-1} other metallic elements (Cu, Pb, Zn) contents did not exceed 10 mg.l^{-1} showing that the values were lower compared to those usually mentioned from literature (table 1).

In order to elucidate the evidence of the pollution effects, we performed qualitative and quantitative studies for metallic elements in sediments and their determination in fishes from the lake of Bê. Cadmium was not detected in the sediments and fishes (table 4), mercury content is about 50-60 µg.g^{-1} in sediments and 2.5-4.5 µg.g^{-1} in fishes. WHO's datas tolerate mercury weekly toxic doses witch are 5.0 µg.kg^{-1} and 1.6 µg.kg^{-1} for methylmercury (INERIS 2005). Clearly, it appears from this study results that, mercury content values are beyond WHO's, therefore consuming fishes from the lagoons of Lome is not seriously recommended. In addition tolerated weekly doses of WHO for cadmium is 7 µg.kg^{-1} and 25 µg.kg^{-1} for lead. In other parts of Africa from lake Victoria in Tanzania (Machiwa 2003), low concentration values of metallic elements have been found in fishes, the similar low datas were obtained in fishes of the sea water from Lomé beaches where cadmium and mercury concentrations in fishes are <1 µg.g^{-1} (Bawa et al. 2006). In contrast high concentrations of some metallic elements have been measured in the lake Awassa in Ethiopia (Aweke and Taddesse 2004), however, authors mentioned the variation of the concentration in different fish organs

Table 4. Heavy metals contents in sediment and fish (lake of Bê).

Elements	Sediment µg.g^{-1} (dried matter)	Fish µg.g^{-1} (wet matter)
Cd	< 0.05	< 0.05
Cu	20 – 36	1.0 – 5.0
Hg	50 – 60	2.5 – 4.5
Pb	70 – 80	0.6 – 2.8
Zn	160 – 180	15.4 – 20.2

The over all conclusion indicates that wastes and effluents from different sources contribute to the pollution of the aquatic mediums. The pollution was particularly caused by high contents of nitrogen elements. Mercury was found in fishes, so their consuming should not be recommended. Strong rules against wild dumping wastes are needed from the government to slow down and control the pollution activities in the lagoon of Lome.

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