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Impact of the Physicochemical Characteristics of the River Nyong Waters at Mbalmayo on the Health of Riverside Population

Impact sur la santé des populations riveraines des caractéristiques physicochimiques des eaux du fleuve Nyong à Mbalmayo

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ABSTRACT

Background and aim. The Nyong is one of the main sources of drinking water supply in Cameroon. The protection of its integrity is very important. A prospective study was conducted from January to March 2012. The objective was to assess the physicochemical quality of the Nyong waters. **Materials and Methods**. Physicochemical parameters (colour, temperature, suspended solids, pH, electrical conductivity, dissolved oxygen, nitrates and orthophosphates) were measured according to the usual techniques. **Results**. Three physicochemical parameters (electrical conductivity, oxygen and nitrate concentrations) were in compliance with water quality standards, two were non-compliant (colour and orthophosphate concentration) and three varied in space and time (temperature, pH, concentration of suspended solids). **Conclusion**. The Nyong water is not recommended for drinking water purposes. However, it was found to be generally of good quality for bathing (class A) and for the production of water for human consumption (class A1). Moreover, an association could be established between the physicochemical of this water and complaints of itching expressed by some residents.

RÉSUMÉ

Introduction. Le Nyong est l'une des principales sources d'approvisionnement en eau potable du Cameroun. La préservation de son intégrité est du plus haut intérêt. Une étude prospective a été conduite de Janvier à Mars 2012. Elle a consisté à évaluer la qualité physico chimique des eaux du Nyong. **Matériel et Méthodes**. Les paramètres physico-chimiques (couleur, température, matières en suspension, pH, conductivité électrique, oxygène dissous, nitrates et ortho phosphates) ont été mesurés suivant les techniques usuelles. **Résultats.** Trois paramètres physicochimiques (conductivité électrique, concentrations en oxygène et en nitrates) ont été conformes aux normes relatives à la qualité de l'eau, deux ont été non conformes (couleur et concentration en ortho phosphates) et trois ont varié dans l'espace et le temps (température, pH, concentration en matières en suspension). **Discussion**. L'eau du Nyong est non recommandable comme eau de boisson. En revanche, elle serait de bonne qualité pour la baignade (classe A) et la production de l'eau destinée à la consommation humaine (classe A1). Par ailleurs, une association a pu être établie entre les caractéristiques physico chimiques de cette eau et les plaintes de démangeaisons, formulées par certains riverains.

INTRODUCTION

The Nyong begins its course at the East Region of the country about 690m above sea level, in Lomié (east of Abong Mbang, in the large equatorial forest and at a longitude of 13°30'). The river winds through about 690 km, in a global direction oriented ENE-WSW, to the Atlantic Ocean (Olivry, 1986; Nkoue Ndondo, 2008). It is of major socio-economic importance. Indeed, it is an important source of supply for the national water distribution system of cities. In addition, riverside population use its waters for various activities such as household, drinking, recreation, fishing, navigation and agriculture (Ateba, 2012). In order to contribute to the protection of aquatic ecosystems, a prospective study was conducted to measure physicochemical parameters of the Nyong to Mbalmayo.

MATERIALS AND METHODS

Water samples collected at selected sites on the River Nyong were subjected to physicochemical analysis, from January to March 2012. A questionnaire survey was carried out among riverside population.

Sampling sites (Figure 1)

Four sampling stations were selected to obtain a good representation of the natural environment of the River Nyong. Half of these stations were in semi-rural, sparsely populated areas, while the rest were located in the centre of the densely populated town of Mbalmayo. The selection criteria were accessibility and the existence of human activities near the sites. *Station 1* was located at a place called "Akomnyada", north of the city at the entrance to Mbalmayo, about 15m upstream from the catchment area by the firm "Camerounaise des Eaux" (CDE). It had sparse human activities. No industry or agricultural activity was observed during the study period. The nearest houses were located at about 200 m. Local riverside population used water from the river for fishing, domestic activities and consumption. These uses were universal. *Station 2*, located at a place called "Nouveau pont", was located in the city, about 20 km from the first. Human pressure appeared to be quite high, with up to 25m upstream, a few maize fields with irregular cattle stays, 100m there were houses, and 200 m upstream a steep rock used as a quarry whose materials were directly dumped into the river. According to local residents, in times of flooding, faeces were sometimes dumped in the bed of the river following the flooding of toilets. *Station 3*, also known as "*ancien pont*", was also located in the city, about 200m from station, 2.50 m downstream from "marché Japon". The human pressure seemed very intense. Indeed, urban waste was being dumped in abundance in the waters. Houses were located about 15m. No agricultural or livestock activities had been observed. *Station 4*, called "Nsenlong", was located outside the city centre, towards the south exit of the town, in a sparsely populated village. The houses were located 200m as well as a large cocoa farm.

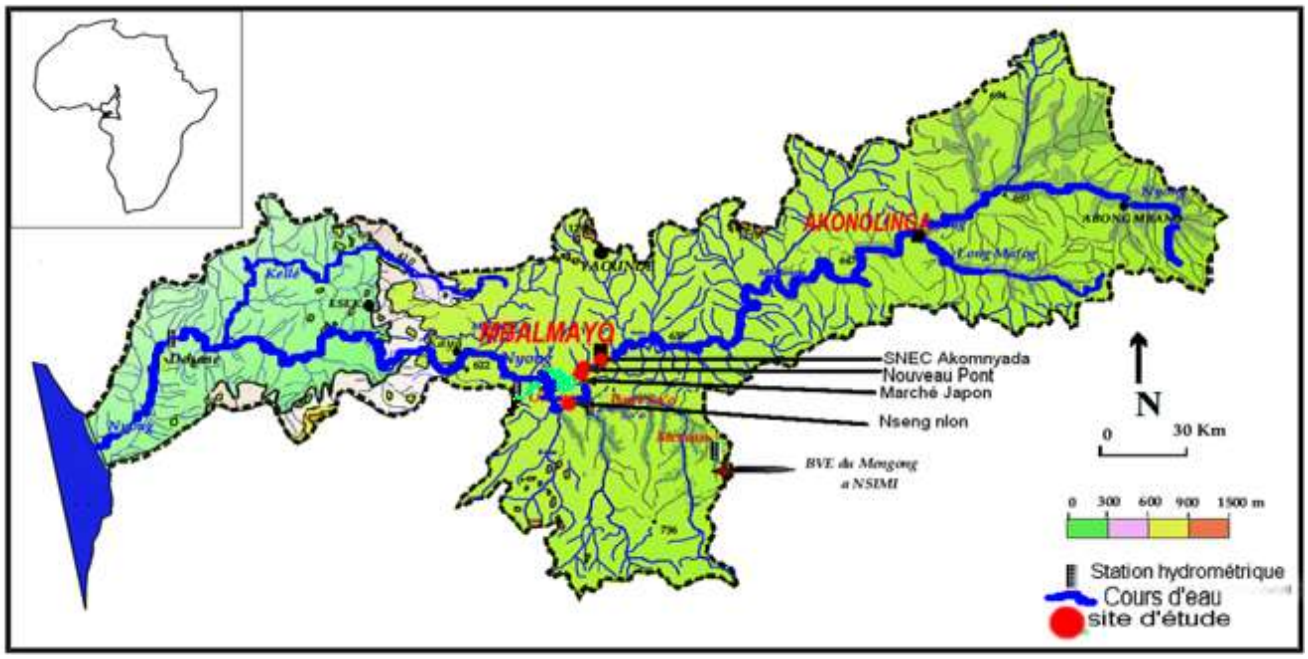

Figure 1: Modified map of the Nyong catchment area showing the different sampling stations

Sample collection

Four water samples were collected per month and per station. Two on the shore and two in the middle of the river. 500 ml vials were used. They were made of polyethylene. The tightly closed vials were immersed 30 cm from the surface of the water. Then, the vial was opened in the opposite direction to the flow for filling and re-closed before removal. The samples were transported in a refrigerated cooler at $4^{o}C \pm 1^{o}C$. Analyses were conducted the same day.

Physicochemical analysis

Physicochemical parameters (colour, temperature, suspended solids, pH, electrical conductivity, dissolved oxygen, nitrates and orthophosphates) were measured according to the techniques described by APHA (1998), Rodier (2005) and Rodier (2009). The results were interpreted according to Rodier (1996), MINEPDED (2010) and Simwotchou (2011)

Survey

A questionnaire was administered to 25 riverside inhabitants per station to identify water uses and the epidemiology of water-borne diseases in the locality.

Statistical analysis

The various results obtained were analyzed using SPSS software version 16.0. Kruskal-Walis test and Spearman's rank correlation coefficient were applied.

RESULTS

For a given station, the measured values for the bank and the current were roughly similar.

Colour

For all stations, the lowest value (178Pt/Co) was observed in January and the highest (310Pt/Co) in February. Both values were respectively 4 to 8 times higher than the required value (40Pt/Co) for the production of water for human consumption and recreational activities; 2 to 4 times higher than the maximum (80Pt/Co) recommended for navigation and irrigation.

Temperature

For all stations, values ranged between 20°C and 25°C during the months of January and February, i.e. they were consistent for the production of water for human consumption and recreational activities. In March, temperatures ranged from 25.5°C to 30°C, making River Nyong suitable for irrigation and navigation.

Suspended Solids (SS)

In January and February, for almost all stations, SS complied with the standards (<25 mg/L). Generally, the bank and current had similar values except for station 3. In March, SS levels were higher than those observed in other months for all stations (8 <SS <24mg/L). However, water quality was satisfactory for this parameter with the exception of the middle of Station 3 (26 mg/L). The bank and current had similar values for stations 1 and 4 while the current had higher concentrations than the bank for stations 2 and 3.

pH

Generally, the Nyong water turned out to be acidic. For all stations, the lowest values (<6.5) were measured in January and March, while the highest values (6.8 <pH <6.9) were observed in February.

Electrical conductivity

All measured values were less than 100 µS/cm. The lowest concentrations were in January and the highest in February.

Dissolved O2

The percentage of dissolved oxygen in the River Nyong ranged from 81.1 to 99%. For most stations, the highest values were observed in February and the lowest in March.

Nitrates

At all stations nitrate concentrations were less than 50 mg/L. The most significant values were recorded in February. They were higher in currents. However, in March for all stations, the levels in this parameter were undetectable.

Orthophosphates

The results obtained for this parameter were very diverse. Concentrations measured on the banks were well above 0.2 mg/L for stations 1, 2 and 4 in January, while in the currents they ranged between 0.1 and 0.2 mg/L. Moreover, for station 3, the values of this parameter, for the bank and the current were located in this last range. In February, concentrations of orthophosphate were 10-fold greater than 0.2 mg/L for all stations. The values obtained on the banks and currents were similar for stations 1 and 2. In March, bank concentrations for station 2, bank and current concentrations for Station 3 and the bank concentrations for station 4 were between 0.1 and 0.2 mg/L. The other stations were 2 to 3 times greater than 0.2 mg/L.

DISCUSSION

The colour of the Nyong water was found to be inadequate for human consumption, bathing and recreational activities. This may be the result of the soil structure of the river bed. Indeed, the presence of clay materials such as yellow goethite and kaolinite associated with iron oxides would play an important role in this dyeing (Braun et *al*. 1998). The temperature of the river water was appropriate for human consumption in January and February ($22 < T (^{o}C) < 25$). On the other hand, in March, the temperatures were higher ($27 < T (^{o}C) < 28$). In January and February, the SS content of the water met the quality standards. According to Braun et *al*. (1998), who had similar results, the forest cover preserved from the drained areas and the extension of the swampy area between Abong-Mbang and Mbalmayo would limit the transport of matter, whether solid or dissolved, to the river. Moreover, the high levels of SS observed in March, in particular at the level of the first

three stations, could be justified by permanent sand dredging activities carried out during this period. In general, the pH of the Nyong water was acidic. This acidity may be due to the nature of the soil crossed, as noted in 1998 for this same river by Braun *et al*. In February, the values were slightly higher, the water was of satisfactory quality in terms of this parameter. This pH increase could have been generated by the rainwater drainage of limestone ions from the carbonate rocks of the slopes, described by Nkoue Ndondo in 2008. The conductivity of the Nyong water was very low. Oxygen was in satisfactory quantity.

The number of people per station complaining of the various conditions is high, it would be possible to infer that the Nyong water could be associated with it. Localized skin diseases may be related to physicochemical properties. Orthophosphates and pH are sometimes associated, in particular, with the irritations of the skin.

We conclude that **t**he Nyong water appeared to be highly coloured, acidic, low mineral content, rich in phosphate ions and having satisfactory concentrations of SS, oxygen and nitrates. Its temperature varied in space and time. With such properties, water from the Nyong to Mbalmayo would not be recommended for drinking water purposes, but compliant for swimming and food water production. It may be associated with complaints of itching, emitted by some residents

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Tableau I: Values of the physicochemical parameters of the river Nyong waters

		Akomnyada		Nouveau pont		Ancien pont		Nsenlong	
Parameters	Month	Bank	Current	Bank	Current	Bank	Current	Bank	Current
Colour (Pt/Co)	January	196	180	193	201	278	222	233	178
	February	310	260	270	260	270	290	290	280
	March	254	279	238	265	284	287	232	229
Temperature (°C)	January	24	24	25	25	25	25	25	24
	February	22	22	23	23	23	23	25	25
	March	28	28	28	28	28	28	27	27
Suspended Solids Mg/L	January	0	0	2	0	1	1	6	0
	February	2	0	1	0	4	8	0	3
	March	12	14	8	24	14	26	13	13
pH	January	6,36	6,21	6,11	5,98	6,02	6,94	6,32	6,46
	February	6,86	6,86	6,87	6,81	6,86	6,81	6,9	6,91
	March	6,26	6,40	6,16	6,34	6,10	6,23	5,96	6,16
Electrical conductivity (µS/cm)	January	39,2	25	33,1	31,8	31,6	44,9	23,6	34,7
	February	45,5	48,3	51,5	51,5	52,4	51,2	57,6	68,6
	March	42,8	37,6	41,2	36,8	40,2	38,2	40,4	41,2
Dissolved O_2 (% de saturation)	January	92,8	97,5	94,9	89,9	96,3	97,1	98,5	98,2
	February	97,3	94,6	98	95,6	97,3	97,3	99	99
	March	93,5	79,4	83,8	83,8	85,3	81,1	84,1	90,6
Nitrates (mg/L)	January	0	0,12	0,17	0,01	0,10	0	0	0,06
	February	3,7	12,8	4,1	6,4	6,6	13,6	9	16,4
	March	0	0	0	0	0	0	0	0
Orthophosphates (mg/L)	January	1,29	0,11	1 ,95	0,11	0,19	0,11	2,35	0,17
	February	3,3	3,8	3,9	3,8	3,8	7,8	2,8	7,4
	March	0,69	0,65	0,48	0,08	0,17	0,18	0,2	0,69