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Trend Analysis of Waste Disposal in an Afrotropical Urban River Water Body

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Abstract Urban rivers play important roles in providing water resources for human, and ecosystem survival. Urban river water quality is therefore an important parameter that must be monitored. The lack of appropriate basic urban infrastructures, coupled to the rapidly increasing human populations in tropical cities, has led to an advanced state of pollution of these cities. The aim of this study was to assess the water quality of an urban river water body of the metropolitan city of Douala. We collected water samples both upstream, and downstream of a major saop manufacturing industry. We determined the water quality index (WQI), and tested for an association of this water pollutants with waterborne diseases in the area. The river was highly polluted, and the concentrations of pollutants (WQI usptream = 16.2; downstream =11.9) were very much higher than the standards recommended by the World Health Organization (WQI = 99.2). There was a very significant association between the polluted water, and waterborne diseases. We advocate taugher pollution control measures to stop the deterioration as cumulitive effects of environmental degredation are extremely difficult to reverse.

Keywords: *poor urban infrastructure, polluted urban river, waterborne diseases, Douala*

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1. Introduction

The poor management of urban environments in tropical areas has become a serious development issue [7,12,13]. The United Nations industrial development organization (UNIDO) reported in 1999 that, industries located along the coast line in the Gulf of Guinea in West Africa, produce some 500 million tons of waste annually, most of which is discharged in city water bodies. This huge waste discharge is as a result of poor urban management [7,9] and, its impacts on both the natural environment and local economies, is a complex one. These impacts, apart from causing public health hazards, can distabilize the entire marine ecosystem along the Atlantic coast line in the Gulf of Guinea. This coast line is part of the migratory route for many aquatic species like Humpback Whales [16].

Population and water need in the tropics rise rapidly, whereas, water availability is decreasing due to inefficient management and deterioration [7,8]. The rapid unplanned urbanization of tropical cities especially in Sub-Saharan Africa, has had great negative impacts on natural ecosystems, and is considered to have favoured many water related diseases [6]. These water related diseases (e.g. malaria, typhoid, cholera) usually lead to a high morbidity of the local population which affects economic development of these areas [2].

The tropical metropolitan city of Douala in Cameroon, is one such tropical city with a chronic urban pollution problem. This is due to an inefficient government machinery in solving problems related to water supply and waste disposal. In addition, the increasing urban population is worsening the situation as life becomes more inhospitable. In this study, our goal was to assess the impacts of waste discharge into an urban river water body used for domestic consumption in the metropolitan city of Douala. Specifically, we aimed to: (i) determine the level of deterioration in water quality, and the main water pollutants from a major soap manufacturing industry along the Ngoua river water body, (ii) determine waterborne diseases in the area, and find if these were associated to the pollution of this water body, and (iii) determine the degree of deviation of this polluted water body from the World Health Organization (WHO) guidelines.

2. Materials and Methods

2.1. Study Site

The metropolitan city of Douala (3^o 48'N 10^o 08'E) is one of the largest cities in the Central African sub-region. It is situated within the Congo-Guinean phytogeographic zone near the Atlantic coast 1 m above sea level, and is home to the largest sea port in the sub-region. As of 2010, the city of Douala and its surrounding area, had an estimated population that surpassed 3 million inhabitants [5]. Its climate is a tropical monsoon climate with relatively constant temperatures throughout the year. The city typically features warm, and humid conditions with an average annual temperature of 27°C, and an average humidity of 85% [17]. Douala experiences on average roughly 3,500 mm of rainfall annually. The city sits on a coastal lagoon complex on the estuary of the Wouri River, and includes several water bodies, such as the Ngoua River from which samples were collected for this study (Figure 1).

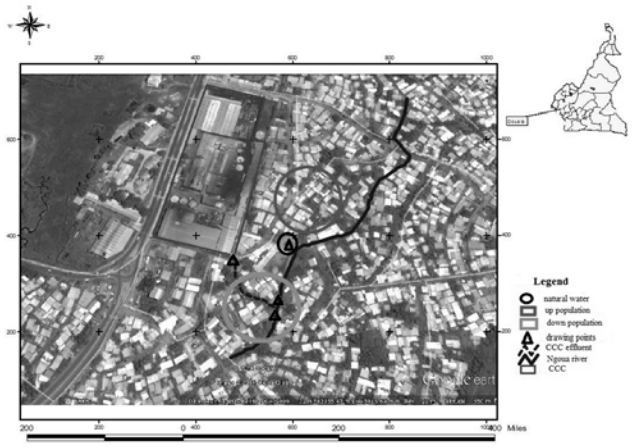

Figure 1. Ngoua water body showing selected sampling sites. The dotted line shows discharge from a soap manufacturing company

The Douala lagoon system describes a major consequence of the Tertiary to early Quaternary periods, particularly of the Holocene marine transgressions, which witnessed the drowning of the estuarine system of the River Wouri [4].

2.2. Data Collection

We collected water samples along the Ngoua water body in 2011 and 2012, using polyethylene bottles from two points (upstream and downstream) during production, and cleaning of residual products by a major soap industry in the city, which is the biggest in the country (Figure 2, Figure 3, Figure 4).

Figure 2. Upstream collection site

Figure 3. Downstream site

Figure 4. Local inhabitants fetching water for domestic consumption

This Ngoua river is the main water body in the industrial part of the city of Douala. The upstream collection site was located before the soap industry, while downstream site was located after the soap industry. Water samples were stored at temperatures between 0° C and 4°C in the dark before laboratory analyses. Measurements of physico-chemical characteristics of the river water, were recorded using a Visocolor ECO^2 Kit supplied by MACHEREY-NAGEL Gmbh and Co.KG. Parameters measured were temperature (°C), conductivity expressed in micro Siemens per cm (μs/cm), suspended solids (SS), dissolved Oxygen (DO), biochemical oxygen demand (BOD), nitrates ($NO3^-$), nitrites ($NO2^-$), ammonia ($NH4^+$), and total hardness of the water. Concentrations are all expressed in mg/L. We carried out qualitative and quantitaive analyses of bacterial colonies as indicators of organic pollutions. We used a structured questionaire to sample households, and health facilities along the river to gather information on the use of the river water by the inhabitants, and all water related diseases.

2.3. Data Analyses

We assessed the overall river water quality status by calculating the water quality index (WQI). This index provides an overall picture of the quality of a body of water, and allows for spatial assessment of water quality to be undertaken [3,14]. The index allows measurements of the frequency, and extent to which parameters exceed WHO guidelines at each sampling site, and reflects the

quality of water for both health, and acceptability, as set by the WHO. The equation for calculating WQI is:

$$WQI = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \right) \quad (1)$$

where;

F1 = is the Scope, and is the percentage of parameters that exceed WHO guidelines, F2 = is the Frequency, and is percentage of each individual test within each catagory that exceed WHO guidelines; F3 = is the Amplitude, and is the extent to which the failed test exceeds WHO guidelines. The values for WQI range from 0 to 100. All WQI values < 12 imply highly polluted water, WQI < 50 implies the water is slightly polluted and not fit for human consumption, WQI between 51 – 80 implies, the water is moderately polluted but fit for human consumption, WQI > 80 implies the pollutants are within the prescribed standard. We used chi square tests to find if the degree of water pollution was associated to the number of people with water related diseases both upstream and downstream. We tested for significant differences between upstream and downstream collection sites in the number of people infected with the same water related diseases with a paired t-test. Values of $P<0.05$ were considered significant. Analyses were done using STATISTICA 6.0 (StatSoft 2001).

3. Results

Analysis of the Ngoua urban water body revealed that it was highly polluted both upstream and downstream, and that the pollution was not mainly due to the soap industry. Downstream was more polluted than upstream (Figure 5) because the soap industry increased pollution levels, but the pollution level was not significantly different between both collection sites ($\chi^2 = 13.4$, $P = 0.2$).

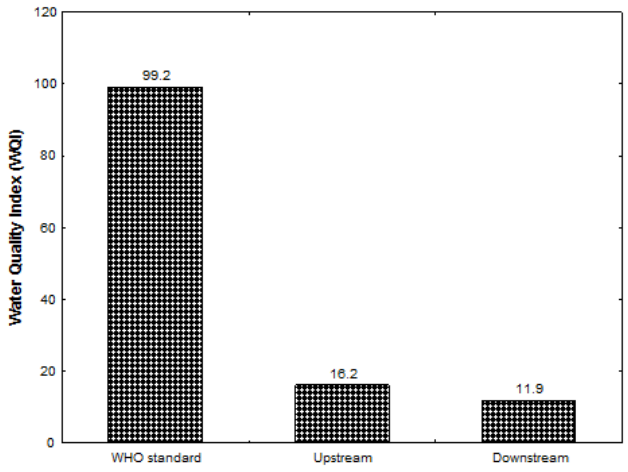

Figure 5. Water quality index (WQI) of the sampling sites compared to the water quality index calculated from WHO guidelines. On each bar is the value for each site

This revealed that this water should not be used for domestic consumption as almost all parameters measured far exceeded the standards set by WHO (Table 1). We also observed high levels of faecal coliform contamination of the water body (Table 1). There was a significant association both upstream (χ^2 =70.95, $P<0.001$) and downstream (χ^2 =79.8, $P<0.001$) between the pollutants in the water, and diseases related to water, with the most frequent diseases being typhoid, cholera, malaria, and skin affections. The number of people affected by these diseases did not differ at both collection sites (paired t-test, t= -2.04, P = 0.13). This indicated that the polluted water greatly favoured waterborne diseases in this area.

Table 1. Different paramaeters measured along the Ngoua river water body with WHO standards in the Metropolitan city of Douala

Parameter	Ngoua water body		WHO guideline
	Upstream	Downstream	
Faecal coliform (MPN/100mL)	34000	53000	0
DO (mgL^{-1})	7	12	10
BOD (mgL^{-1})	8	17	6
Ammonia (mgL^{-1})	0.7	3	1.5
Suspended solids (mgL^{-1})	30	70	< 20
Temperature °C	24	28	30
pH	6.5	9	8
$NO3^-$ (mgL^{-1})	5	1	1.5
$NO2^-$ (mgL^{-1})	0.5	0	3
Hardness ($mmolL^{-1}$)	0.54	1.07	-

4. Discussion

The results of this study confirm the assertion that, there is a chronic pollution problem in the metropolitan city of Douala as revealed by the Ngoua river water. This is a serious health problem that may likely affect the local economy. There is an urgent need for an effective management of the local environment, especially the urban river water bodies in rapidly growing cities like Douala, if a satifactory growth of the city has to be achieved. Moreover, these water bodies, like the Ngoua river, empty their contents into the Atlantic ocean which only exacerbates the problem.

Reference [7] reported that some basic requirements in general have to be fulfilled for the satisfactory growth of a city, especially in the tropics. These are: the maintenance of a healthy and productive internal environment, the handling in an environmentally friendly manner of waste products, the capacity of institutions within the city to manage effects due to natural hazards, and the maintenance of infrastructures such as sewage treatment plants, and efficient drainage systems. Failure to meet these requirements can put a city on a downhill path that can lead to economic stagnation, physical decay and social dysfunction. The city of Douala seems to be taking this path.

The observation of high faecal coliform bacterial infection, and suspended solids, present in the Ngoua river water body both upstream and downstream, was an indication that the contamination of this urban water body was not mainly due to industrial activities, but also to municipal and agricultural activities, along with improper disposal of domestic solid waste. This is an alarm for the safety of public health, and the aquatic environment in this area. There appears to be a tendency of an ever increasing urbanization, industrialization and agriculture of tropical coastal cities that cause microbial [1,10], as well as physico-chemical contamination of natural water sources

[12]. Most tropical cities located on the banks of an urban river water body, use raw water from the river for domestic consumption [8], and also tend to discharge sewage into it [12]. Sewage contaminated drinking water is the major source of several water related diseases [11]. Uncontaminated water in cities, is essential not only for human health, but also for urban ecosystems, because many urban species rely on it for their survival.

In conclusion, the findings of this study constitute a call for more efficient government machineries in the management, and control of waste discharge into urban water bodies in tropical cities, especially in Cameroon. The increasing human population in the metropolitan city of Douala, has led to an increase in agricultural, and industrial activities in this area. Therefore, a better distribution system, effluent discharge, and municipal waste management for the safety of public health and environment in Douala, is imperitive. The trend of Douala city water bodies is therefore one that is rapidly degrading. More studies are required based on seasonal variations and anthropogenic activities to better understand the extent of the problem not only in Cameroon, but also in other Sub-Saharan African cities. As environmental deterioration is a slow process of degradation, the cumulative effects toward the attainment of a state of disaster also come unnoticed, and is usually extremely difficult to reverse.

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References

[1] Ashbolt, N.J. Microbial contamination of drinking water and disease outcomes in developing regions. Toxicology 198(1): 229-238, 2004.

[2] Awolola, T.S., Oduola, A.O., Obansa, J.B., Chukwurar, N.J. & Unyimadu, J. P. "Anopheles gambiae s.s. breeding in polluted water bodies in urban Lagos, southwestern Nigeria," J. of Vector Borne Dis., 44(4): 241-244, 2007.

[3] CCME. Canadian water quality guidelines for the protection of aquatic life: CCME Water Quality Index 1.0, User's manual. In: Canadian Environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg, Manitoba, pp. 15-16, 2001.

[4] Chappell, J. Coastal change: Determination of historic and Holocene trends, as a basis for assessing human impacts. In E. Duursman (ed.) In Intergovernmental Oceanographic Commission. Workshop Report, pp. 79-91, 1995.

[5] Diwouta-Kotto, D. Suites architecturales: Kinshasa, Douala, Dakar. Épinal: Association VAA, p. 42, 2010.

[6] Djouaka, R.F., Bakare, A.A., Bankole, H.S., et al. "Does the spillage of petroleum products in Anopheles breeding sites have an impact on the pyrethroid resistance?" Malaria J., 6:159.

[7] Gladwell, S.J. & Low,S. K. Tropical cities: Managing their water. Report for UNESCO, pp. 1-4, 1993.

[8] Jacobsen, M., Webster, M. & Vairavamoorthy, K. The Future of Water in African Cities: Why Waste Water? Directions in Development. Washington, DC: World Bank. p. 226, 2012.

[9] Kessides, C. The Urban Transition in Sub-Saharan Africa: Implications for Economic Growth and Poverty Reduction. Africa Region Working Paper for the World Bank Series No. 97, 2005.

[10] Lundin, C.G. & Lindén, O. Coastal Ecosystems: Attempts to manage a threatened resource. Ambio, 22 (7): 468-473, 1993.

[11] McMichael, A.J. The urban environment and health in a world of increasing globalization: issues for developing countries. Bull. of the World Health Organization, 78 (9), 2000.

[12] Mudiam, M.K.R., Pathak, S. P., Gopal, K. & Murthy, R.C. Studies on urban drinking water quality in a tropical zone. Environ. Monit. Assess. 184 (1): 461-469, 2012.

[13] Nair, S. Challenges in urban water management in a changing environment – case study from a growing tropical city in: NOVATECH, 7th International Conference on Sustainable Techniques and Strategies in Urban Water Management, Lyon, France, 2010.

[14] Padmanabha, B. & Belagali, S.L. Comparative study on the water quality index of four lakes in the Mysore city. Indian J. of Environ. Protect. 25 (10): 873-876, 2005.

[15] UNIDO. Rapport de l'ONUDI sur la dimension industrielle du développement durable au Cameroun. ONUDI, Yaoundé, Cameroun, 49p, 1999.

[16] Rosenbaum, H.C., Maxwell, S. M., Kershaw, F. & Mate, B. Long-Range Movement of Humpback Whales and Their Overlap with Anthropogenic Activity in the South Atlantic Ocean. Conserv. Biol. 00(0): 1-12, 2014.

[17] World Weather Information Service (WWIS), Douala. World Metoerological Organization, 2012.