DOWNSTREAM VARIATION IN WATER QUALITY OF ORLE RIVER, EDO STATE, NIGERIA

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Abstract

The downstream variation in water quality of Orle River draining the Northern portion of Edo State, Nigeria was investigated. The aim was to ascertain if there were any observed differences in the quality of the water in the downstream direction of the river from source to mouth under different environmental conditions. The Orle River rises from the northern basement complex rock of the state, flows through the cretaceous sedimentary in the middle of the study area where it is joined by Ojo and Edion Rivers before it enters the Niger River in the Tertiary sedimentary rock formation. This paper has examined some physio-chemical parameters of the river. It was found that some of the parameters vary in the downstream direction. While the source in the basement complex environment resulted in a tendency towards alkalinity in pH, the downstream location in geology change resulted in a rise in the mean water temperature and true colour and the effect of mixing at the confluences, resulted generally in a reduced pH, total solids and true colour. The pattern of variation can be explained by the fact that rivers at high stage are less concentrated than rivers at low stage.

Introduction

Water quality is a term that relates to the composition of water as affected by natural processes and cultural activities (Chesters and Schierow, 1985).It is usually measured in the concentrations of constituents and classified relative to the intended use. In Orle River basin from the .source to the downstream direction, the water is useful for domestic, agricultural and for local craft industry. All uses of water must be subordinated to man's need for a healthy fluid for his consumption, (Ohagi. 1985, Akhionbare, 1998).The minerals from the environment which are released to surface water include those very mobile minerals and non-mobile and stable substances. These minerals are usually the results of intense chemical alteration of rocks, land use and vegetation activities in the environment. Livingstone (1963), Eborge el a! (3979) and others hold that the dissolved matter of river water tends to influence the quality of the water. River water is extremely variable in chemical composition due to the nature of the elements present in the surface runoff or groundwater, When rainfall is heavy and concentrated in short periods of time, the nourishment of swollen streams in terms of elements is from surface runoff. Some elements are also leached down the soil horizon and these are later re-discharged to the surface stream as groundwater contribution. This groundwater is usually more concentrated in elements because of its long-standing intimate contact with rocks and mineral soil under conditions of oxygen and carbon dioxide tension that are particularly favourable to the solution of many mineral components. The concentration of river water therefore bears an inverse relation to discharge. Thus rivers at high stage are less concentrated than rivers at low stage. This paper therefore investigated the effects of the stages of the river vis-a-vis the environmental conditions on the water chemistry of Orle River in Edo State, Nigeria.

The Study Area

The study area is located in the northern portion of Edo State (6°45'N to 7°15'N and 6° OO'E to (V'45'E, Figure l).It covers an area of 1 16km^2.The area is well drained with an average slope of 0-5%. The geology of the area can be divided into four parts: (the crystalline rocks, the cretaceous sedimentary, the tertiary sedimentary and alluvial sands). This geologic background provides abundant weather able materials which are intensively weathered and find their way into the local streams channels. The soils are mainly utisols with some oxisols in the southern parts of the basin. The hydrology is a reflection of the geology and is dominated by the extensive River Niger floodplain in the East and other rivers such as Edion, Orle, Ojo and Obe. Some of these streams are ephemeral, particularly at the headwaters of these rivers. Here the groundwater contribution to the surface stream is low. Others are perennial though they reduce in volume and some parts may even dry up during the dry months. The corrosive and cavitating activities of these streams are observable. Loose grains are seen to move along the vortex current. The rivers flow very fast in some locations and very slow in others. The water appears to be very turbid. Their flow patterns are similar: minimum flows occur in March/April and the maximum flows occur in September/October. There is close correlation between topography and parent materials, soils and vegetation (gallery forest and guinea savanna) in this area.

Methods of Study

Sampling Design and Analysis

The concentration in the river water of the following elements were carried out in water and air temperatures, true colour, taste, potential for hydrogen (pH) and total solids. In a study of water quality in any river of this nature, the WHO (1971) recommends that information should be gathered and the quality monitored for at least six consecutive months. Water samples were accordingly collected from the fields in location 1-4 (Figure 2) in the downstream location. The water samples were collected in the middle of the river close to the bottom in the upstream direction. At locations where the rivers are deep, the samples were collected with the aid of a water sampler. The water samples were collected fortnightly for eight (8) months beginning from November 1987 to June 1988.A comparative study of other works carried out in 2000 was also made alongside this report. Air and surface water temperatures were measured in the field with the mercury-in-glass thermometers. The water pH was measured in situ using Graffin battery operated meter. The water samples for total solids were collected with a colourless four-litre plastic bottle fitted with a plastic stopper. The bottles were previously washed with Teepol solution and rinsed many times with distilled water in the laboratory. The quantity of water was sufficient to determine the various parameters investigated in the study. The water samples for total solids (TS) were evaporated and dried in weighed dishes at 105°C to constant weight. The increase in weight over the empty dish represented the total solid content. One hundred ml of the samples were used and the evaporating dishes were left to cool in a dessicator while weighings were done. The results were expressed in milligram total solids per litre of sample.

The colour of the water samples were observed after filling matched Nessler tubes with the water samples to the 50ml mark and comparing them with the standard disc, NSA, using a Nessleriser. The colours were read out from the disc directly in Hazen units. Where the colour exceeded 70 units, the sample was diluted with distilled water until the colour was within the range of the standards in the disc. The values so obtained were multiplied by the dilution factor and results expressed in Hazen units (Platinum-Cobalt Scale). The taste was determined by actually tasting a little quantity of the water. Data generated were analysed using simple statistics such as the arithmetic mean. These statistics helped to depict their variational patterns. Results are presented in Tables 1 - 2.

Results and Discussion

The results of the physical quality parameters are presented in Table 1.

Table I: Summary of Some Physical Quality Parameters in the Downstream Direction

Parameters	Downstream Locations in Orle River											
	Orle at Source			Geology Change			First Confluence			Second Confluence		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Water Temp (°C)	23.0	30.0	27.58	25.0	33.0	28.50	22.0	30.5	27.86	25.0	33.0	27.58
Air Temp (°C)	30.0	36.1	33.08	31.0	35.2	33.13	29.5	38.45	33.98	30.0	35.1	32.83
True Colour (Hazen Unit)	5	80	27.50	5	120	53.85	5	60	38.47	5	100	38.44
Taste	Highly Objectionable											

Source: Ikhile (1990).

Air Temperature

There was a slight variation in the air temperature of Orle river basin in the downstream direction (Table 1) (32.83°C - 33.98°C). Due to the fact that the drainage basin is within the tropical continental climatic belt, variation in the air temperature is therefore minimal. The lowest air temperature recorded at this time was 29.5°C at the first confluence and the highest was 38.5°C at the same first confluence. This could also be due to expose of the area at the point of sampling (Ikhile, 1990; Ikhile and Akhionbare, 2002a).

Water Temperature

There was a similar slight variation in the water temperature of Orle River in the downstream direction (Table 1). The mean water temperature was highest at the geology change (28.5°C), range (25.0°C - 33.0^{D}C) followed by the first confluence (27.86°C), (range, 22.0°C - 30.5°C). The differences observed could be due to the type of vegetation at that particular point of sampling. At the source and second confluence, there was the gallery forest with thick canopy which acted as a shield for the water. But at the first confluence and geology change, there was the savanna grassland which is more open hence slightly higher water temperatures were observed at these locations. Moreover, Ogbeibu and Ezeunara (2002) observed for the Ikpoba river a rise in water temperature due to the amount of substances present in the river which have the capacity of increasing the water temperature. Higher turbidity (53.85 hazen unit) at the geology change and suspended solids are known to increase water temperatures as well (Egborge, 1979). This point of geology change to sedimentary rocks could be experiencing more suspended solids.

True Colour

There is a wide range in the variation in colour of the water in the downstream direction (Table 1). The water tended to be turbid throughout the whole basin. This is highest in the area of change in geology where it ranged from 5-120 Hazen units. This is not surprising since there is evidence of ironstone in this area which probably increased the value of the true colour. At the source, the true colour ranged between 5-80 hazen units, while it was between 5-60 hazen units at the first confluence and 5-100 hazen units at the second confluence. The quality parameters of the river at the first confluence was generally low compared with other locations. The stage of the river here is high, having received contribution from Edion and other smaller rivers at this junction. At the source from the rocks, the water tended to have the least mean colour 27.50 hazen units. This is in line with Egborge, and Fugade (1979) who hold that rivers originating from fresh crystalline rocks have less suspended and dissolved solids which contributes to their colour.

Taste

The taste of the water in the downstream direction is highly objectionable. This unpalatable state of the water according to Ikhile and Akhionbare 2002(b) may be due to vegetational decay which is abundant in the study area and also due to microbial activities (Ekelemu et al, 1999). The measurement of colour is an important determinant of the aesthetic acceptability of drinking water (Lamb, 1993).

Table 2: Summary of Some Chemical Quality Parameters in the Downstream Direction

Parameters	Downstream Locations in Orle River											
	Orle at Source			Geology Change			First Confluence			Second Confluence		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
PH	7.30	8.10	7.68	5.00	7.50 '	6.76	4.80	7.50	5.78	S.I	8.2	6.70
Total Solids (Mg/L)	150	800	391.67	50	700	340.63	50	900	326.88	50	750	329.13

Source: Ikhile (1990).

Hydrogen - Ion Concentration (pH)

There is slight variation in pH in the downstream direction of the drainage basin (Table 2).

The variation ranged between 4.8 - 8.2 in the downstream direction of the basin. It tended towards acidity

in some locations, especially at the first confluence and towards alkalinity at the source and mouth of Orle river. At the source, the geological background seemed to exert alkaline effect on the water (7.3 - 8.1) with the highest mean value of 7.68. At the change in geology, it ranged between (5.0 - 7.50) with a mean of 6.76. The first confluence recorded the lowest (4.8 - 7.5) with a mean value of 5.78. At the source, there seemed to be an increase (5.1 - 8.2) with a mean of 6.7. The effect of limestone reported in this formation most have impacted on the water quality (Obakpolor, 1984).

Total Solids

Generally in the downstream direction, the total solids vary between 50mg/l and 900mg/l being more abundant at the source. There is a decrease in the total solid content from source to the first confluence and then a slight decrease in the second confluence. The first confluence recorded the lowest mean value (326.88mg/l) sometimes, although it had the widest variation. The second confluence equally recorded a wide variation. This variation pattern also exhibits the effect of stage of the river. For sometimes in all the locations in the downstream direction of the basin, the total solid content exceeded the WHO maximum acceptable concentration of 500mg/l. This was more so at the source where at all the time of sampling in the dry season, the values recorded were 500mg/l and above.

Summary and Conclusion

This study has examined the downstream variation in water quality of Orle River with the aim of establishing the degree of pollution from the source of River Orle to the mouth. A measure of the quality of the river was established. While some quality parameters increased downstream, others decreased downstream while most of them exhibited the effect of stage/reach in the basin. The Orle River can be said to be "naturally" polluted based on Ajayi and Osibanjo (1981) classification of natural waters. The water needs to be purified for domestic agricultural and industrial purposes.

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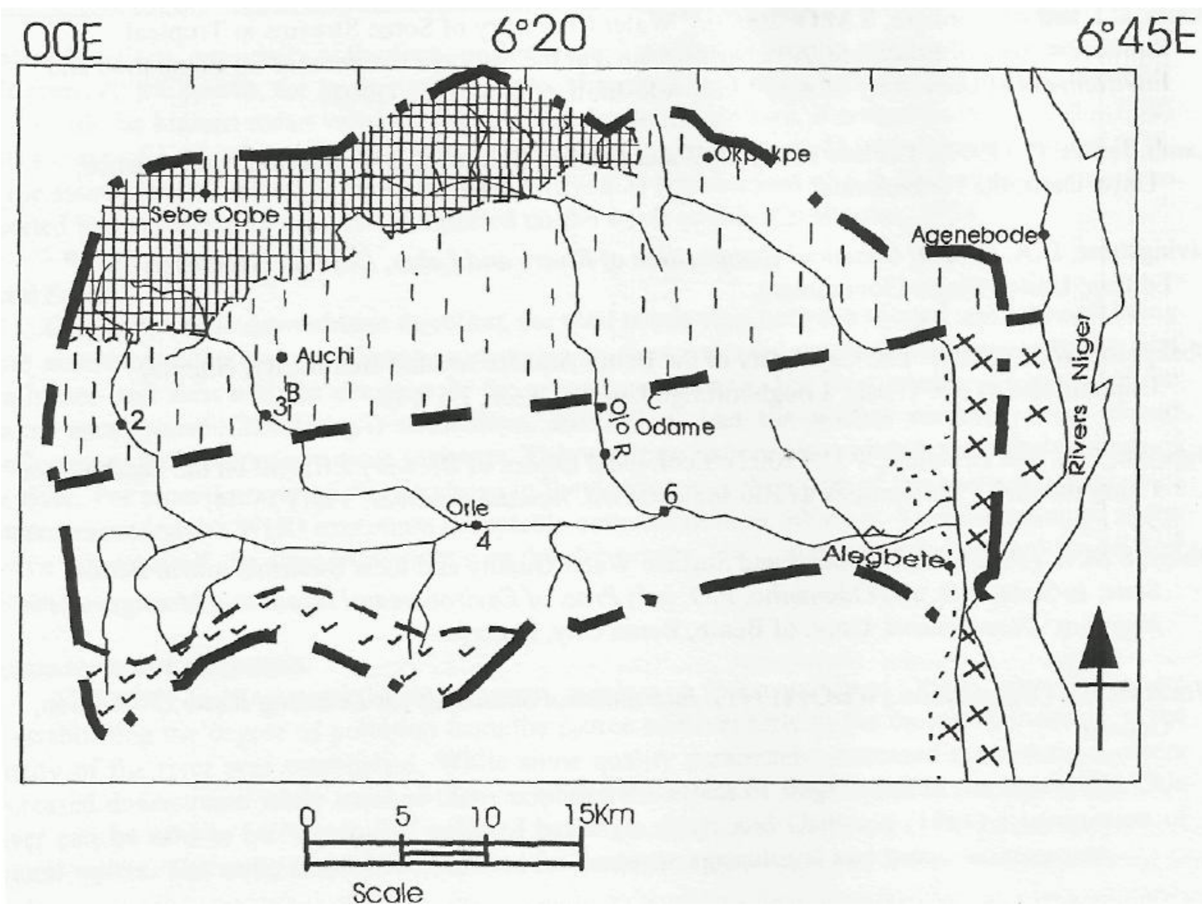

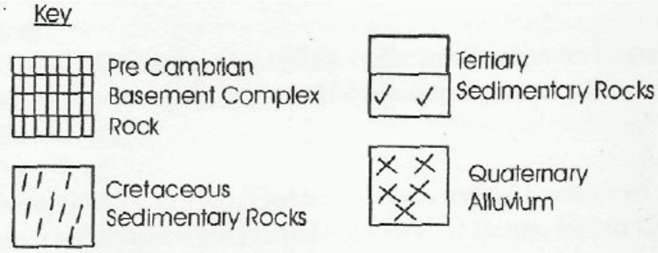

1.6. Sample location for Water Samples