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Research Article

TRACE METAL INDICES IN THE CHARACTERIZATION OF HYDROGEOCHEMICAL CONDITION OF SURFACE WATER ALONG ASA RIVER, ILORIN, KWARA STATE, NIGERIA

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ABSTRACT
The effects of industrial, agriculture and domestic discharges on the quality of water along ASA River located in Ilorin were investigated using trace metals in April 2012 when the water level along ASA River was low. The choice of sample locations was based on the land use pattern along the ASA River with a view to determine the impact of such activities on the various levels of metal pollution. Seven locations along the river bank were selected particularly areas that receives effluents into the river. The results of trace metals such Cd, Cr, Mn, Ni, Fe, Co, Cu, Pb and Zn in surface water along ASA River reveal a general high contamination when compared with World Health Organization (WHO) and Federal Environmental Protection Agency (FEPA) standards and the source of these pollutants could be diverse ranging from industrial to agricultural and domestic sources. Regular monitoring of surface water of ASA River should be carried out as there is notable increase in the level of human and industrial activities along the course of the river.

Key Words: *ASA River, Trace Metals, Contamination, Industrial, Agriculture and Domestic Sources*

INTRODUCTION
Monitoring of the river water quality is necessary in present day society, especially for rivers affected by urban effluents (Amadi *et al*., 2010). However, changes in the water chemistry of the river and drainages can be the results of domestic, industrial or agricultural discharges which may in turn lead to aquatic ecosystem degradation (Pereira *et al*., 2007) such as deterioration of water quality in rivers and drainages. Rapid urbanization and increased agricultural activities have resulted in the degradation of the water quality (Ige *et al*., 2010). Used and unused fertilizers, pesticides, effluents discharged from industries and sewage water are the main contaminants of the groundwater in the vicinity of rivers that flows through populated areas (Chandu *et al*., 2008).
ASA River supplies the basic water needs of the Ilorin city and its environs after treatment at ASA Dam treatment plant. Shortage of sufficient potable water has led many people to depend on this river not only for drinking but also, for other domestic and industrial uses, therefore, its pollution status is thus of serious concerns that worth investigation and assessment. Some geochemical studies have been carried in the last few years on the geochemistry of water and sediments of ASA River (Alao and Ige 2003, Eletal *et al*., 2005). The present study deals with the heavy metal pollution in surface water along ASA River in Ilorin.

MATERIALS AND METHODS
Study Area, Nature and Geological Background of ASA River
ASA River originate from Oyo state and flows through Ilorin in a South-North direction forming a dividing boundary between Eastern and Western Ilorin. The ASA River flowing almost South- North divides the city of Ilorin almost to two equal halves (Figure1). The river and its banks have been turned in

to refuse/waste dump sites by the inhabitants of the flood plain (Ige and Alao 2003).The tributaries of ASA in Ilorin Include River Agba, Aluko, Atikeke, Mitile, Odota, Okun, and Osere.

The study area is situated on the Precambrian Basement Complex rocks that include granite, granitic gneiss and migmatites (Annor *et al*., 1996). The rock form part of regional North –Western Island running northwest-southeast parallel to the river Niger (Offodile, 1987 and Annor *et al*., 1996). These represent the deeper fractured aquifer which is partly overlain by a shallow porous aquifer within the lateritic soil cover (Alao 1983).

Sampling Methods

A 20-km long stretch of the ASA River was selected for the present study. The choice of sample locations was based on the land use pattern along the ASA River with a view to determining the impact of such activities on the various levels of metal pollution. Seven (7) locations along the river bank have been selected particularly areas that receives effluents into the river (Table 1). The water samples were collected at each site. All samples were collected in April 2012 when water level of the ASA River was low. Water samples were collected into $2^1/_2$ litre plastic containers. Before sampling, sample containers were washed by soaking them in detergent for 24hours, followed by rinsing with tap water and then rinsed with 5% nitric acid and lastly with doubly distilled water.

Figure1: Heap of refuse dumped at the Bank of ASA River in Amilegbe Bridge, Ilorin.

Figure 2: Refuse dumpsite, under the Bridge at Railway station, Ilorin.

Figure 3: Effluent of Soap and Detergent Industries at ASA Dam.

Samples Preparation and Analysis

Sediment samples were air-dried in the laboratory for about seven days to avoid loss of volatile substances that may accompany drying in the oven. The sediment samples were digested in a mixture of perchloric nitric and hydrochloric acids. All chemicals used were of reagent grades. The digested solutions were then analysed for Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, and Zn by Atomic Absorption Spectrophotometric technique.

Table 1: Description of the Sampling Locations

S/N	Description	Coordinate
1	Afon water treatment station in ASA Local Government Area of Kwara State. Taken as control being the closest accessible site to the source and also as a result of low level of human activities in the area.	N08^0 20' 18.8" E004^0 31' 28.0"
2	Laduba Village where farming activities are taken place.	N08^0 23' 0.82" E004^0 33' 23.0"
3	Behind a soap and detergent company around ASA Dam in Ilorin.	N08^0 26' 15.3" E004^0 33' 40.5"
4	Behind a pharmaceutical company in Ilorin.	N08^0 27' 41.6" E004^0 33' 30.6"
5	Behind a bottling company around Unity road, Ilorin.	N08^0 28' 01.8" E004^0 33' 28.9"
6	Receives effluents from a major hospital and a huge dump site beside it with a busy road across the river.	N08^0 29' 48.7" E004^0 34' 02.4"
7	Sobi along Shao in Moro Local Government Area of Kwara state. It is far from the activities of Ilorin but also involves some farming activities.	N08^0 32' 10.7" E004^0 34' 05.9"

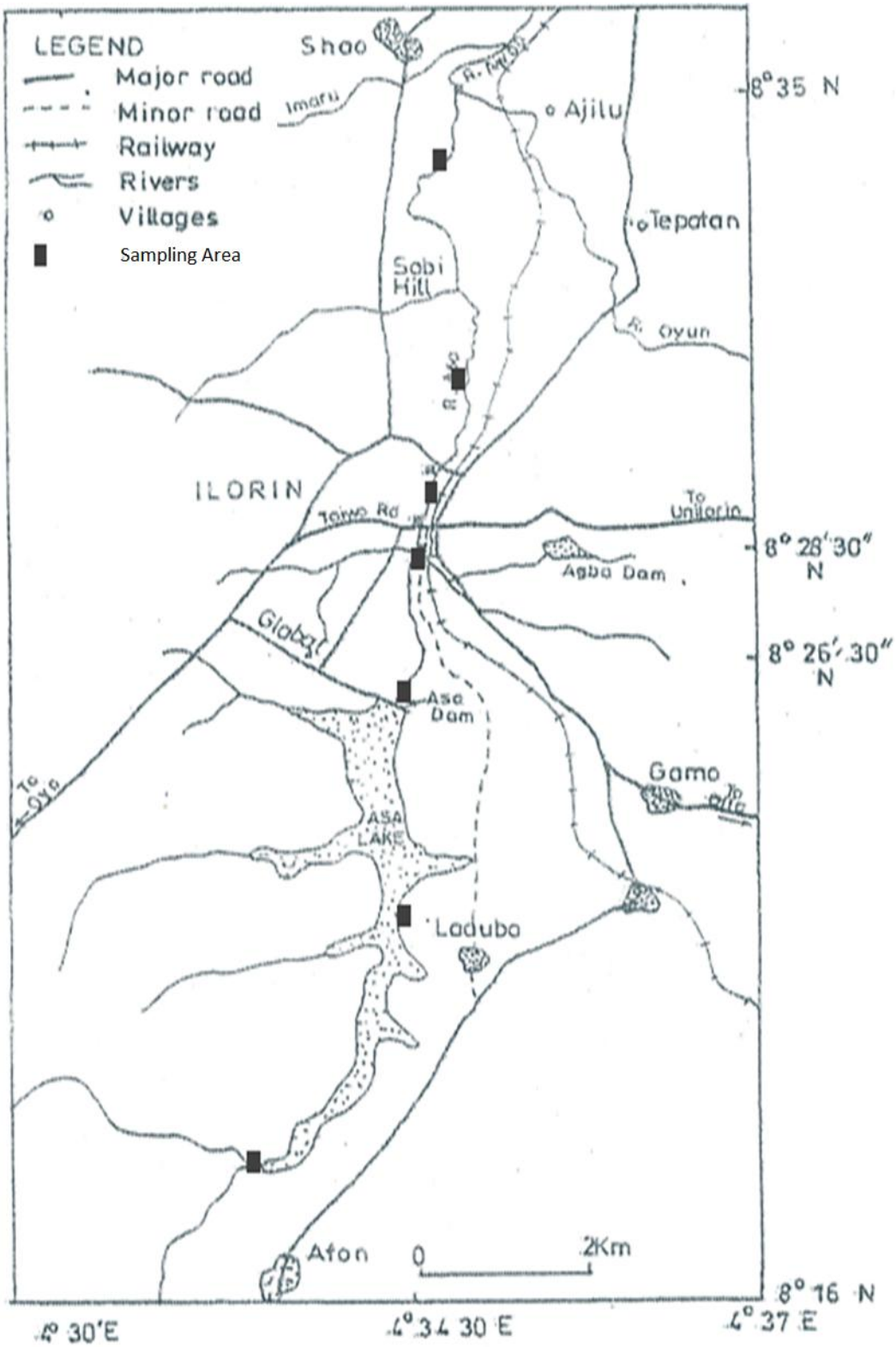

Figure 4: Map of Ilorin and environs showing flow of ASA River and sampling locations (Modified from Eleta *et al*., 2005)

RESULTS AND DISCUSSION

Trace Metals in Water

The result of trace metals (Cd, Cr, Mn, Fe, Ni, Pb, Zn, Co, Cu) pollution determined in surface water samples from ASA River are shown in Table 2. The trace metal concentrations are higher in all the locations and found to be far above the World Health Organization (WHO) and Federal Environmental Protection Agency (FEPA) recommended level in water. Generally, the source of these pollutants could be ranging from industrial to agricultural and domestic sources. The presence of trace metals and other inorganic elements in relatively high concentrations in water from ASA River is not unusual as presence of some chemical elements such as phosphate and nitrate in higher concentrations above World Health Organization (WHO) recommended level have been reported by Eleta *et al*., 2005. The abnormally high levels of heavy metals in the surface water of ASA River is of great concern and calls for urgent attention if the inhabitants are to be protected against the chronic effects of the abnormal levels of the chemicals.

Table 2: Concentration of Trace metals (ppm) in surface water along ASA River

Heavy Metal	L_1	L_2	L_3	L_4	L_5	L_6	L_7	WHO Acceptable Limit (mg/l) (2003)	FEPA Acceptable Limit (mg/l) (1991)
Cd	0.07	0.12	0.03	2.31	0.38	0.13	0.12	0.003	0.01
Cr	1.00	1.80	0.70	3.10	0.10	0.40	0.31	0.05	0.05
Zn	0.13	0.08	0.93	0.04	0.56	5.70	0.06	3.00	-
Pb	0.10	15.6	8.90	4.60	10.8	50.5	1.45	0.01	0.05
Fe	79.0	42.1	48.0	52.0	11.0	36.0	13.0	NH	0.30
Ni	0.10	0.20	1.00	5.10	0.40	2.01	0.03	0.02	-
Mn	4.00	2.00	18.0	35.0	3.00	88.0	25.0	0.40	-
Cu	56.0	77.0	5.30	8.80	37.0	105.0	73.0	2.00	1.00
Co	10.4	3.50	7.75	0.38	0.11	2.30	4.13	NG	-

Key: NG = Not mentioned in the WHO Guideline
NH = Not of health concern at levels found in drinking water

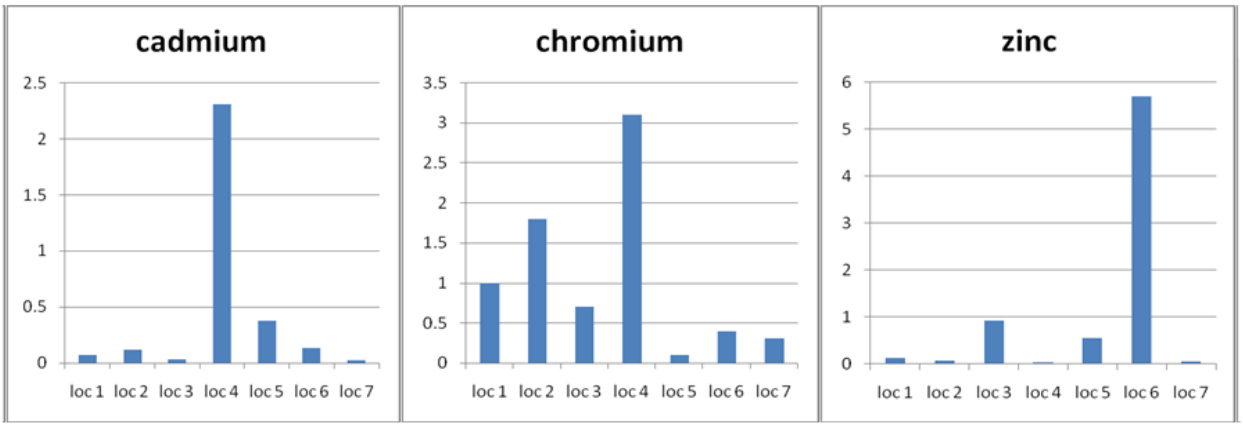

Figure 2.1 Concentration of Trace metals across Locations.

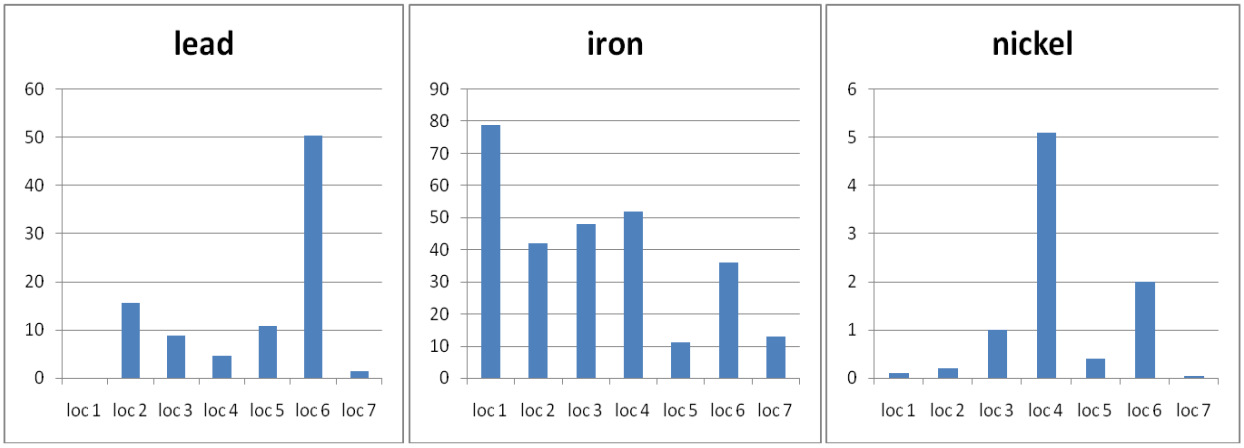

Figure 2.2: Concentration of Trace metals across Locations.

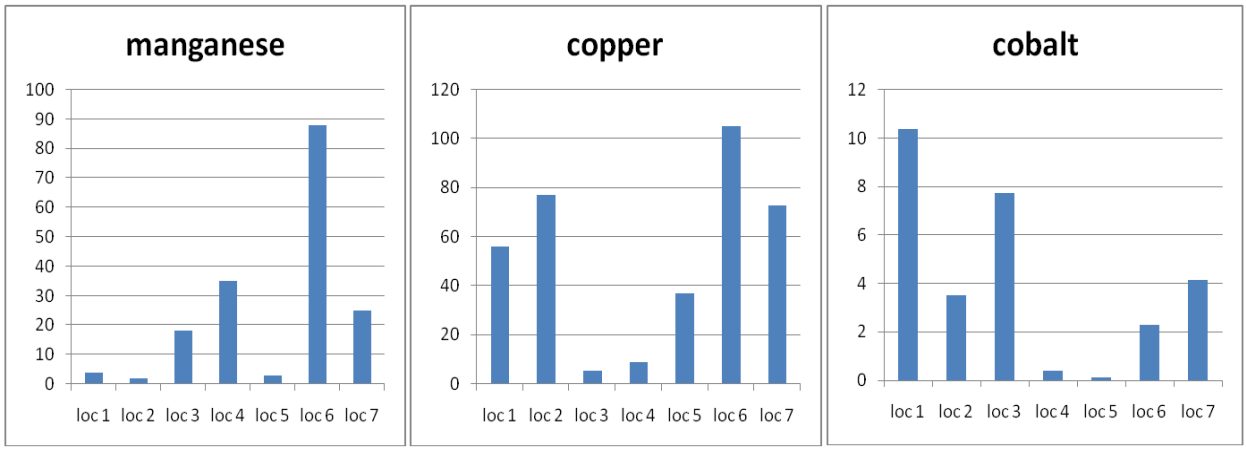

Figure 2.3: Concentration of Trace metals across Locations.

Conclusion

Analysis of surface water samples along the ASA River within Ilorin metropolis has revealed that the surface water has been highly contaminated in the localities selected for this study. The river which unlawfully has become the refuse dumpsite for the inhabitants of the ancient city produces foods (fishes, vegetables, tomatoes e.t.c.) directly or indirectly for the people of the city. The surface water samples said to be polluted with lead, zinc, manganese, cadmium, chromium, iron, nickel, copper and cobalt and that the soap and detergent industries, bottling companies and heaps of refuse dump into/ along the river are the capital source of pollution. Also, indiscriminate use of fertilizers by the river side farmers also facilitates pollution.

Recommendations

The state government is advised to organize a health team which shall monitor and ensure that industrial effluents from industries concerned are seriously pre-disinfected, tested and certified by this "on-compromising" team if fish and other aqua-products from the river are to be dependable for consumption. It is also recommended that dumping of refuse along the river channel should be forcefully discouraged and that the government should help in providing household disposal sites for the inhabitants of the town. Finally, it is also recommended that regular monitoring of the water of the ASA River be carried out as there is notable increase in the level of human and industrial activities along the course of the river.

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