

PHYSICOCHEMICAL ANALYSIS OF WATER RESOURCES IN SELECTED PART OF OJI RIVER, ENUGU STATE SOUTH EASTERN NIGERIA

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ABSTRACT: Oji River and its environs is located few kilometres from Enugu, the capital city of Enugu state. Geographically, the study area is bounded by latitudes $6^{\circ}14'N-6^{\circ}17'N$ and longitudes $7^{\circ}17'E-7^{\circ}19'E$. The study area is underlain by the Ajali Sandstone and Nsukka Formation. The area has abundant water resources. A total of ten (10) water samples were collected at various locations for hydrochemical analysis. The result shows that the water resources for (WS 2, 4-10) are safe for domestic, industrial and agricultural uses as the chemical constituents are below (WHO, 2011) permissible limit. Except for WS 1-Oji wonderful river where nitrite (NO_2^{2-}) and Fluoride (F) value were observed to be higher than (WHO, 2011) permissible limit (8.2 and 2.5mg/l) respectively. This indicate that nitrite and fluoride treatment is required for WS 1-Oji wonderful river while for WS3-Ogba spring were copper value (11.0mg/l) were observed to also be higher than (WHO, 2011) permissible and as such requires copper treatment.

KEYWORDS: Groundwater, Surface water, Physical parameters, Chemical parameter, domestic purpose.

1 INTRODUCTION

The study area is located in Enugu State, south eastern Nigeria, the Villages in the area include; Ojinator, Ugwuoba, Achi, Egbagu, Upkata and Agbalengi. Since water is necessary for the daily activities of plants, animals and humans. Moreso, increase in population has led to increase in demand for portable water, inhabitants of the area depend solely on surface and groundwater for domestic, agriculture and other uses. The presence of objectionable tastes, odour, colour as well as harmful substances in such water no matter how abundant it is, renders it unsuitable for domestic, industrial and agricultural uses [11]. The physical and chemical characteristics of water are important parameters as they may directly or indirectly affect its quality. Suitability of groundwater for domestic use is determined by its geochemistry. Geochemical data also gives important clues to the geologic history of rocks and indications of groundwater recharge, movement and storage [17]. Water quality depends on number of factors, such as general geology, degree of chemical weathering of prevailing lithology, quality of recharge water and inputs from sources other than water-rock interaction [1], [13], [4], [5]. [9] noted that agricultural inputs and wastes, domestic and industrial wastes commonly find their way into groundwater as leachates through the soil. All these affect the quality of water resources in the area. Most houses and industries channel their waste directly to the river channels.

Hence, the need to access the physical and chemical constituents of water resources from available surface water and groundwater sources in Oji River and environs. This work seeks to compare result of hydrochemical analysis with the World Health Organization [16] standard for drinking water. It will also proffer recommendations on the best option on management/utilization of water resources in the area.

2 PHYSIOGRAPHY, CLIMATE AND VEGETATION

The study area is characterized by gently sloping topography, the nature and slope of the area makes it vulnerable to erosion. The total annual rainfall ranges from 1600mm to more than 2000mm, the inversion in the tropical air mass causes convectional rainfall. The area falls within the tropical rainforest belt of Nigeria with temperature ranges from 30°C to 32°C as shown in Figure 1. It is characterized by two seasons, the dry and rainy season. The climate is favourable for farming. The dry season is usually from (November-March), it is marked by an average rainfall of about 60mm. The highest annual rainfall in south eastern Nigeria is received around the eastern highlands due to the convectional and orographic nature of the rains received [7]. According to Monanu [7], variations in the amount, seasonal distribution and annual rainfall variability affect peasant farming within communities adversely. The rainfall pattern which is controlled by the movement of the Inter-tropical Convergence Zone (ITCZ) is characterised by a long wet season from April to July, with a short dry season in August, followed by a short wet season from September to October [7].

The vegetation is characterised by grassland though some plant species of low land rainforest such as (*Elacies geineenus*) oil palm tree is found, the area is composed of short and tall grasses and shrubs that are found on the highland and for the forest area in lowland along the stream channels. The change in vegetation is due to lithological variation with the study areas.

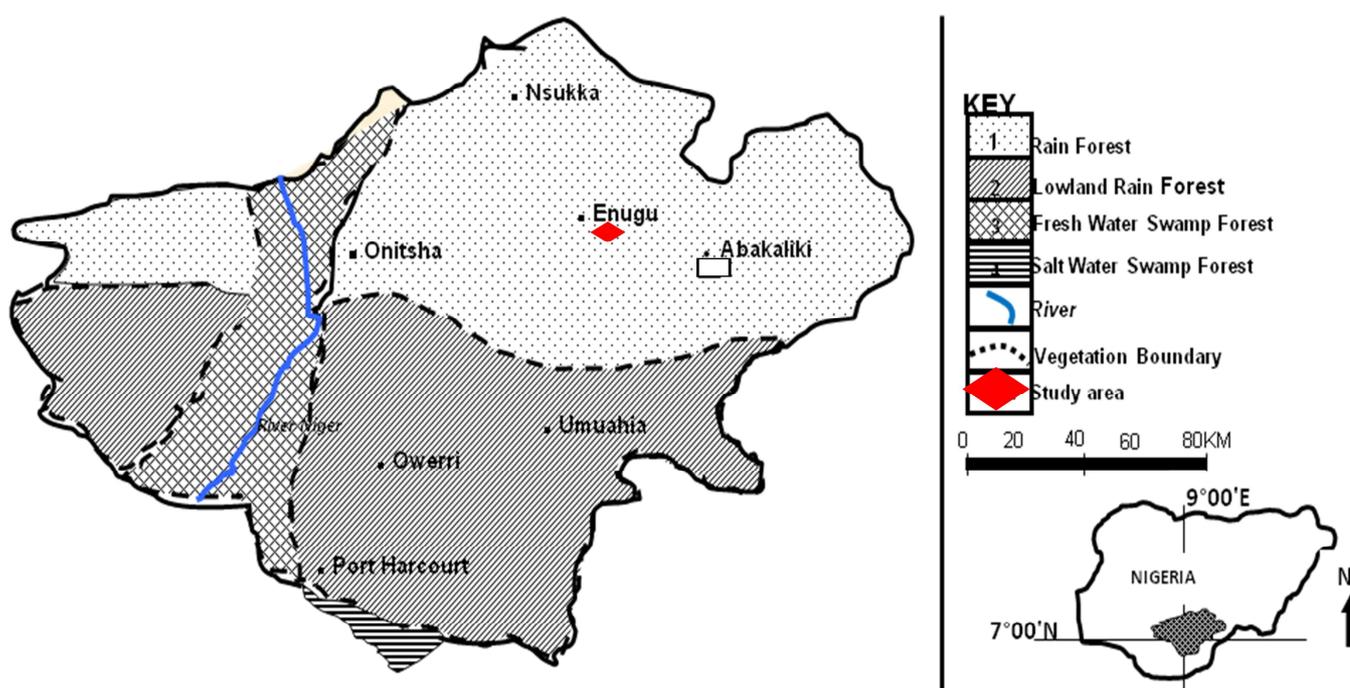


Figure 1: Map Showing Climate and Vegetative Zones of Southeastern Nigeria (Modified after) [6].

3 GEOLOGY OF THE STUDY AREA

The study area lies across two geological formation; Ajali Formation and Nsukka Formation. The Nsukka Formation (Upper Maastrichtian) covers 25% of the study area. It lies conformably on top of the Ajali Sandstone (Maastrichtian), covers a total of 65% of the study area. The Ajali formation has a thickness of about 45-50meters and consists of thin band of white mudstone and shale occurring at interval and increasing in number toward the base. The Nsukka Formation was first describe by [14] as the 'upper coal measure' it consist of intense ferroginisation of well bedded blue clays, carbonaceous shale and thin band of limestone resulted in ironstone which exist in formation. [8] used sedimentological evidence to suggest that the Nsukka Formation represented a phase of fluvio-deltaic sedimentation that began close to the end of the maastrichtian and continued during the Paleocene.

4 HYDROGEOLOGY OF THE STUDY AREA

The study area is with springs, streams and rivers. This includes the popular Oji wonderful river, Dodo River, Ezu River and Ozom River while the streams are Nwangele and Izele stream.

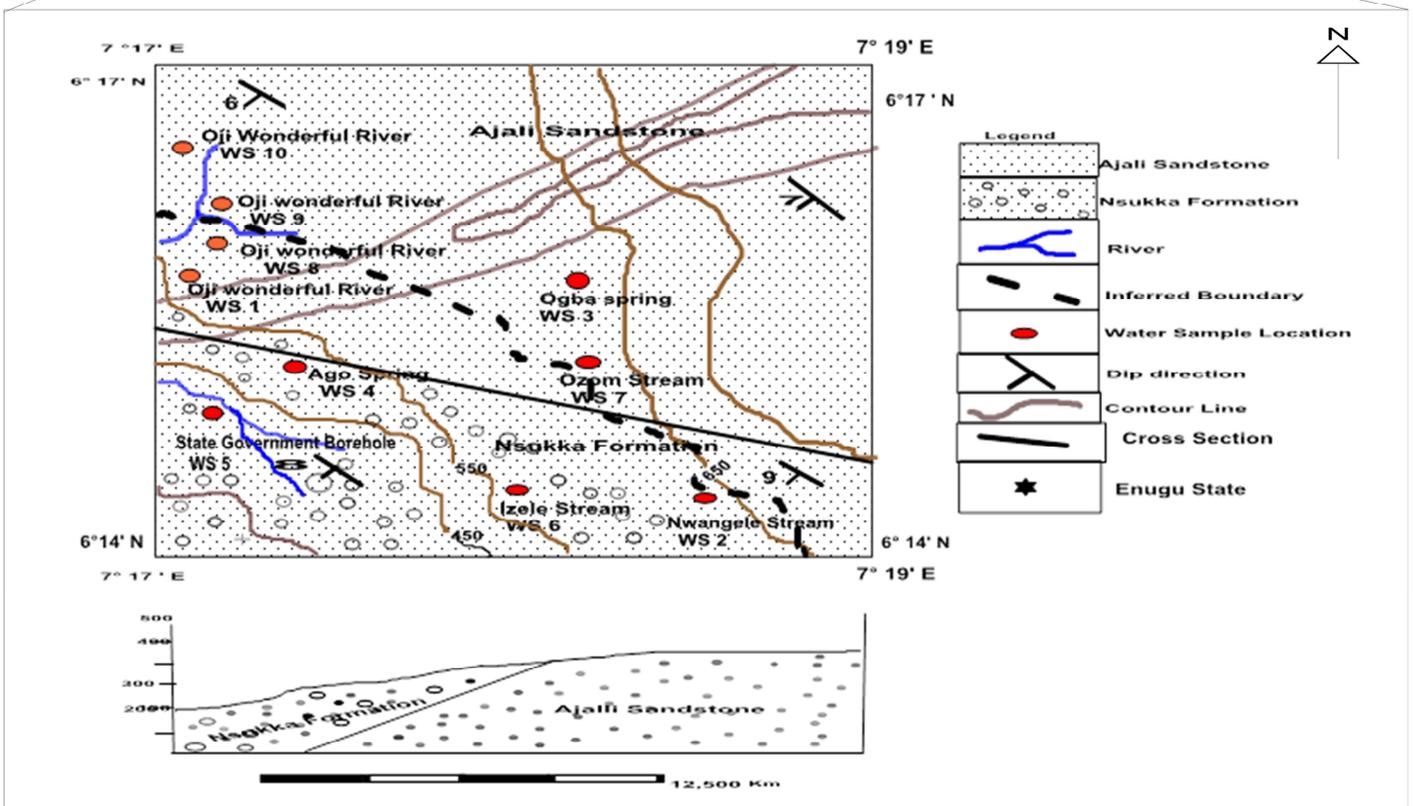


Figure 2: Geological Map and Water Samples Collection Sites.

5 METHODOLOGY

Ten water samples were collected from different rivers traversing different communities in the study area as shown in a Figure 2. In-situ measurements of temperature (°C), electrical conductivity (EC), and total dissolved solids (TDS) were carried out in the field while samples were collected in clean new white plastic bottles (1.5 L) which were first rinsed with part of the water samples to avoid contamination. While Conductivity Meter Bridge was used for turbidity measurement and pH meter used to determine the acidity of the water samples. Total dissolved solids were determined by evaporation; weighing 100 ml

of water sample and then subtracting the weight of the residue from the weight of water before evaporation. The EC was measured using a WPACMD 400 m which can measure conductivity over the range of 10⁻² to 10⁻⁶ μ Siemens/cm² with an accuracy of 0.1 μ S/cm². The coordinates (longitude, latitude and elevation/altitude) of each sample location in the study area was taken using the GARMIN GPSmap76CSx. These samples were labelled WS I- 10 (Table 1). All the water samples were preserved in a refrigerator to exclude microbial activity and unwanted chemical reaction. The determinations of other physicochemical properties of the water samples were performed within 2 days of sampling. HACH DR 2800 Spectrophotometer was used in the determination of different hydro geochemical properties such as Na⁺, K⁺, HCO₃⁻, Cl⁻, NO₂⁻, SO₄⁻, Fe⁺, Mn²⁺, NO₃⁻, SO₄²⁻, NaCl, Mg²⁺ CO₃²⁻, Mn, Ca²⁺, PO₄²⁻, Cu²⁺. Analytical water test tablets prescribed for HACH DR Spectrophotometer 2800 using procedures 2 outlined in the HACH DR 2800 Spectrophotometer manual were used for the examination of the water quality. Other analyses such as the determination of Mg and Ca concentrations were done by complexometric titration method.

6 RESULTS AND DISCUSSION

From the physicochemical analysis carried out for carbonate, total hardness, salinity (NaCl), silica (SiO₂), total alkalinity, total dissolved solid (TDS) their values ranges from (9.6-41.5mg/l, 0.0-21.6, 0.0-11.3, 0.0-28.0, 0.0-1.5, 22.4-28.2mg/l) respectively, for carbonate, total hardness, salinity and total dissolved solid their values falls below the [16] permissible water quality limit. While silica (SiO₂) and total alkalinity has no WHO guideline, they occur in drinking-water at concentrations well below those at which toxic effect. [18]

For the parameters like pH, turbidity and conductivity their values ranges from (6.0-6.9, 1.3-2.0, 0.5-2.9NTU, 34.7-60.2μs), respectively their value falls below the [16] permissible water quality limit. For the cations calcium (Ca⁺), magnesium (Mg), sodium (Na) and potassium (K) their value ranges from (4.2-12.3, 1.2-3.5, 0 - 0.3 and 0.9-2.1mg/l) respectively. Their values falls below the [16] permissible water quality limit as shown in Figure 3. While that of anions nitrite (NO₂⁻), Nitrate (NO₃⁻), phosphate (PO₄³⁻). Sulphate (SO₄²⁻), bicarbonate (HCO₃⁻) and chlorine (Cl) their values ranges from (0.0-8.2, 0.0-26.0, 0.0-0.1, 2.1-12.2, 1.4-17.6, 30.8-66.7 and 1.4 – 17.6 mg/l) respectively. As for nitrate, sulphate, bicarbonate and phosphate their values fall within below the [16] permissible water quality limit as shown in Figure. 4. Except for nitrite (NO₂⁻) which its value (8.2mg/l) was observed to be above the [16], permissible water quality limit at WS1 Oji wonderful river. Nitrite infiltrates into water bodies from fertilizers and manure [8]. Nitrite is source for concern in infants under six months of age as it causes methemoglobinemia. In general, the most important source of human exposure to nitrate and nitrite is through vegetables (nitrite and nitrate) and through meat in the diet. Nitrite is used as a preservative in many cured meats, [15]. And fluoride value (2.5mg/l) is above the [16] guideline value at WS1 Oji wonderful river which is as a result of natural system "weathering and rain water"[2], these implies that WS1 require treatment. Fluoride dissolved into groundwater as it moves through pore spaces between rocks. It also infiltrate into groundwater through discharge from fertilizer or aluminium factories as shown in Figure 4.

For trace element iron (Fe), manganese (Mn) and copper (Cu) their values ranges from (0.0-0.1, 0.0-0.0 and 0.0-11.0mg/l) respectively as shown in Fig.5. Their values fall below the [16], permissible limit. Except copper(Cu) its value (11.0mg/l) for WS3 Ogba spring the value of copper is above the of [16], guideline value .The sources of copper in both surface and groundwater is from industrial waste and domestic waste and mining activities within the study area. Copper is essential trace element but toxic to plants and algae at moderate levels. Copper can cause stomach and intestinal distress, liver and kidney damage. In high doses, it results in bad taste and significant staining in cloths fixtures.

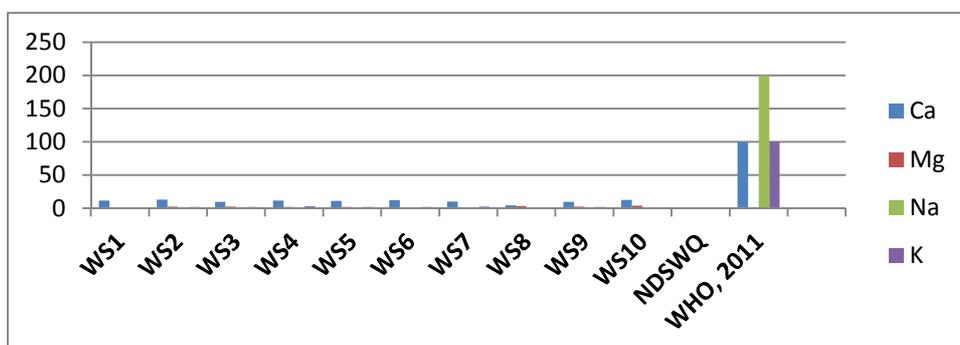


Figure 3. Major Cations in the analyzed samples expressed as a bar chart.

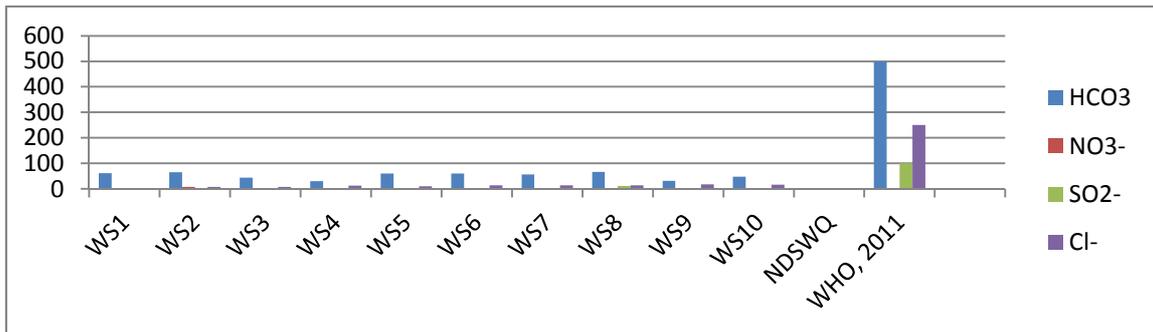


Figure. 4. Major Anions in the analyzed samples expressed as a bar chart

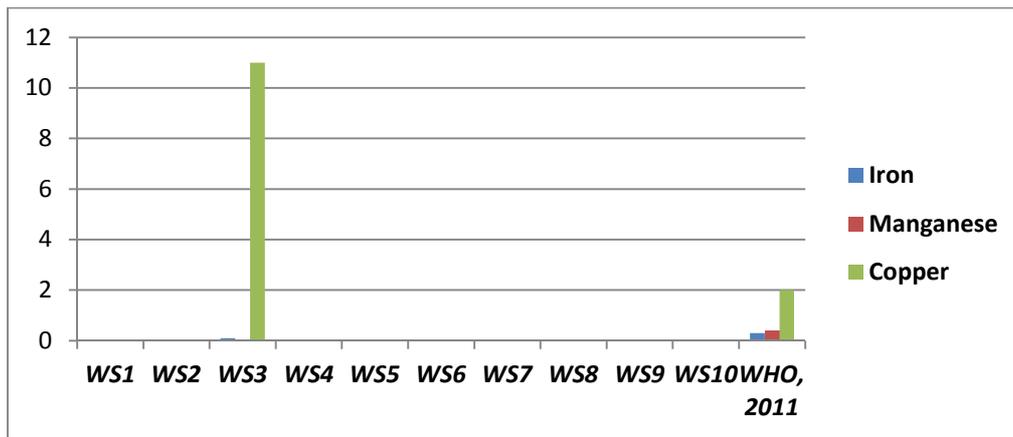


Figure.5. Trace Elements expressed in barchart

Table 1. Result of physiochemical analysis of water sample of Oji River compared with [16] standard

Constitutes	W.H.O Standard 2011	WS1 Oji wonderfulRiver	WS2 Nwangele Stream	WS3 OgbaSpring	WS4 Ago Spring	WS5 State Government Borehole	WS6 Izele Stream	WS7 Ozom Stream	WS8 Oji wonderful River	WS9 Oji wonderful River	WS10 Oji Wonderful River
p ^H	6.5-8.5	6	6.4	6.4	6.5	6.5	6.3	6.9	6.0	6.2	6.0
Temp °C	24	25	24	27	24	28	24	29	27	23	24
Apperance		Cloudy	Cloudy	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Colour (units AP.CO Std)	15	2.0	1.6	1.8	4.6	1.9	1.6	1.7	1.5	1.3	1.3
Turbidity (NTU)	5	2.0	0.9	0.9	0.8	0.9	0.8	0.5	1.5	2.3	2.9
ConductivityµS	1000	56.0	43.8	50.2	43.8	46.5	52.5	49.1	52.4	60.2	34.7
Calcium mg/l ca ²⁺	75	11.3	12.6	9.6	11.2	10.8	11.7	10.1	4.2	9.6	12.3
Magnesium mg/Lmg ⁺	250	1.2	2.0	2.0	1.6	1.5	1.3	1.3	3.2	2.4	3.5
Sodium mg/l Na ⁺	200	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Potassium mg/l Na ⁺	200	1.3	1.6	1.9	2.6	1.9	1.7	2.1	1.4	1.9	0.9
Sulphate mg/l So ²⁻	250	2.4	2.4	2.4	2.1	2.2	2.7	2.4	12.2	2.1	2.5
Chloride mg/l Cl	250	1.4	8.6	8.5	12.5	10.8	14.3	13.7	14.6	17.6	16.6
Bicarbonate mg/L HCO ₃	500	62.0	65.0	44.0	30.8	60.0	60.0	56.4	66.7	32.4	48.3
Carbonate mg/l CO ₃ ²⁻	500	12.0	16.0	16.0	9.6	20.0	33.2	41.5	17.2	22.6	19.3
Nitrate mg/l NO ₂ ⁻	50	26.0	0.0	0.0	0.0	0.4	1.8	0.9	0.6	0.	0.0
Nitrite mg/l NO ₃ ⁻	3	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.6
Phosphate mg/l PO ₄ ²⁻	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Fluoride mg/l	1.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3
Free Chlorine mg/l Cl	5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Iron mg/l	0.3	0.00	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manganese mg/L Mn ²⁺	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper mg/ L Cu ²⁺	2	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Hardness mg/l CaCo ₃	500	0.0	14.6	11.6	12.8	12.3	19.5	21.6	21.6	24.3	19.2
Salinity mg/l Nacl	600	11.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.6
Total Dissolved Solid Mg/l	500	28.0	26.9	25.1	24.2	23.3	28.3	31.6	28.2	22.4	31.5
Total alkalinity mg/l		1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.3

7 CONCLUSION

From the physiochemical analysis carried out for both the surface and groundwater are in compliance with [16] guideline value for locations (WS 2, 4-10). Except for WS1 (Oji wonderful river) where fluoride and nitrite content tend to be higher than the permissible limit of [16] water standard. While for (WS3-Ogba spring) copper has the value of (11.0mg/l) which shows that the higher than the permissible limit of [16] water quality standard. This result implies that fluorine and nitrite treatment is needed for WS1 (Oji wonderful river), while for (WS3-Ogba spring) require copper treatment as shown in Figure 6.

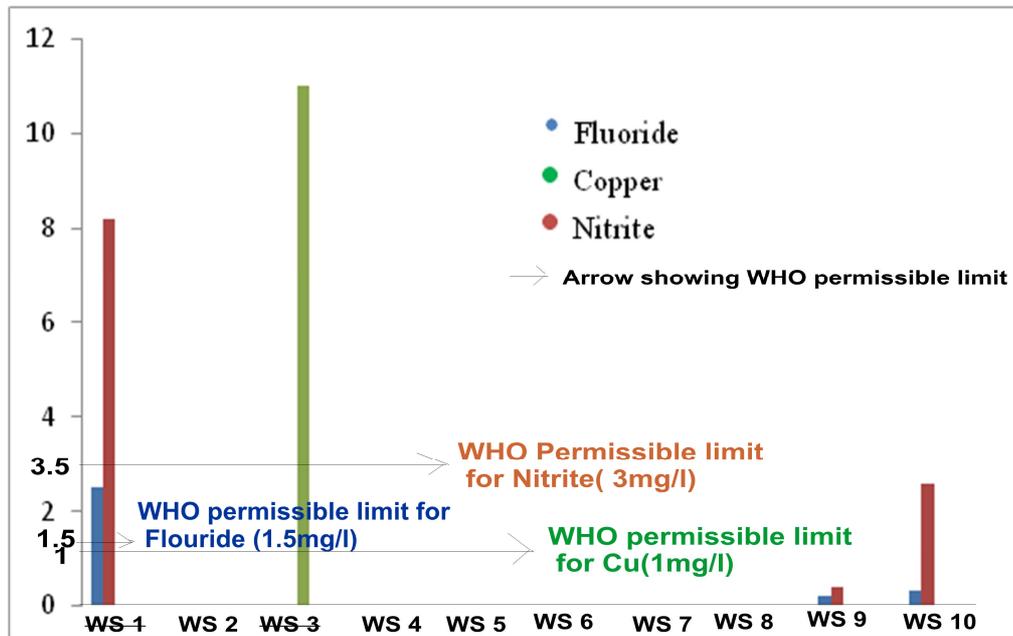


Figure.6 Showing Fluoride (F), Copper(Cu) and Nitrite(NO₂) values above the permissible limit of [16] for each of the locations WS(1-10).

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