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Water Quality Monitoring and Assessment in a Developing Country

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1. Introduction

Water is very essential for man and, it is being increasingly stressed through the action or inaction of man leading to either a temporary or permanent impairment of water quality. Impairment resulting from the presence of foreign substances (organic, inorganic, bacteriological or radiological) tends to degrade the quality of water. It is needed for virtually all of man's major/ routine activities. Water can be useful for industrial, domestic and recreational purposes (Yerima *et al*, 2008).

Apart from water supplied by the utility board, many have dug either boreholes or wells in their homes and industries in order to have adequate supply of clean and fresh water (Spalding and Exner, 1993). River constitutes the bulk of water being used in Cities and its environs either treated or otherwise. River banks could be very busy with varied activities ranging from farming to industrial activities and a lot more.

Water in shallow wells is closer to the surface and to potential sources of contamination. River on its own has the open abuse of being eroded and abused by many if not all in this part of the World as, waste are dumped in the river without recluse to its effect on the ecosystem.

High loads of nitrate in rivers have been responsible for the eutrophication of rivers. This leads to the depletion of oxygen in the water and, leads to an imbalance in the ecosystem. A River would mean different things to different people. To some, it is used for laundry and recreation purposes, to some industries it is a good supply of cooling water and to others, the river is a convenient point of waste discharge from both the home and industries.

Water could be available through precipitation (rain), surface and ground water sources. In the past, the general belief was that, rain water was the purest of these. However, with the advent of industries and many of the activities of man, this source of water supply has suffered its share of pollution. Particulates left in the air, resulting from the activities of man have been washed into water collections during rains besides, collection of water from roof tops have also suffered some level of pollution as the material used in making the roofing sheets have been eroded and washed into the water collection.

Surface water such as rivers and streams have suffered immeasurable contamination resulting from the activities of man. Many industries and workshops are sited along the

bank of rivers with one of the purpose being, to have ease of waste disposal as effluents sometimes in their untreated state are emptied into the water bodies. Individuals have been known to leave their residence just to empty their waste into the streams and rivers nearby.

The waste of those upstream becomes source for those downstream. Many drink water from the taps, rains, wells, borehole and even rivers and streams with little or no treatment.

The physico – chemical parameters useful for water quality assessment are determined by the presence of both organic and inorganic compounds that are either suspended or dissolved in it. While some of these compounds are toxic to the ecosystems, others constitutes nutrients to aquatic organisms and others are responsible for the aesthetics of the water body (Olajire and Impekperia, 2000).

The pH of water determines the solubility and bioavailability of chemical constituents such as nutrients and heavy metals. Metals tend to be more toxic at lower pH as they are more soluble. Though an increase in pH may have no direct impact on the aquatic life, they greatly influence the availability and solubility of all chemical forms in the water and this might aggravate nutrient problems leading to a destabilization of the ecosystem.

The prevalent problem in a country resulting from inadequate water supply for use that has turned every man in the country into a local government is responsible for this study. This becomes necessary when you realize that very little can be achieved without water. Three of the sources open to man are being investigated in this study.

Nitrate has been found in wells and in some cases, shallow bore holes. Location of these have been implicated in the concentration discovered. Studies have shown that excess nitrate is responsible for the blue baby syndrome amongst other diseases.

There is so much water on the surface of the earth and yet, insufficient to meet the needs of man as, most of this resides in the ocean which limits its direct use without prior treatment / improvement

The physical and chemical parameters useful for water quality assessment are determined by the presence of both organic and inorganic compounds that are either suspended or dissolved in it. While some of the compounds are toxic to the ecosystem, some constitutes nutrients to aquatic organisms and others are responsible for aesthetics of the water body (Eletta and Adekola, 2005)

The measure of the hydrogen ion concentration determines the mobility/ bioavailabiity of chemical constituents such as nutrients and heavy metals. Metals tend to be more toxic at lower pH since they are more soluble. Though an increase in pH level may not have direct impact on the aquatic life, they greatly influence the availability and solubility of all chemical forms in the water and this might aggravate nutrient problem leading to a destabilization of the ecosystem. Contaminants such as hydrocarbon, heavy metals and pesticides have been known to have direct toxic effect when released into the aquatic environment and, the sediment constitutes a sink for these pollutants. (Fleeger *et al*, 2003)

The cause of pollution typically lies with man while the spread is generally driven by natural means hence the study looking into the impact of man's activity on water quality.

In the urban environment, sewage discharges are a major component of water pollution. This contributes to the oxygen demand and nutrient loading thereby promoting growth of toxic algae and other aquatic plant hence the destabilization of the ecosystem (Olajire and Imepekperia, 2000).

2. Rain water

Rain water is a form of precipitation in which liquid water falls to the earth surface. Rain water harvesting is a common sight in developing countries. This is a major source of water during the raining season as harvesting is done mainly via roof tops without recluse to the effect of the make of the roof sheet, ware on roof sheets with age and erosion of sheet material. Emissions into the air through vehicular exhaust, industrial discharges amongst others get washed down from the sky during rains. Unfortunately, because of the unavailability of sufficient portable water in many of these areas, rain water harvesting is done and, with little or no processing, consumed domestically.

3. Well/boreholes

In many developing countries wells are sited in homes due to the inadequacy of portable water supply. Boreholes are not readily available in many cases and, the siting of wells are not well monitored. Transport of waste through leaching into shallow wells have resulted in pollution.

Studies have shown that water pollution arising from the presence of foreign substances (inorganic, bacteriological or radiological which tends to degrade the quality of water has become a serious concern today (Ibe et al, 2002, Salami A.W., 2003, Yerima et al, 2008).

Environmental scientists are increasingly aware of the need for reliable methods that can determine the chemical forms of toxic trace metals especially the toxic heavy metals in natural water.

In water, the free and hydrated metal ions are considered to be the most toxic form followed by strong metal complexes, and metal species associated with colloidal particles which are least toxic.

In a developing country, the search for water are explored to complement the limited amount of water available for use for domestic, agricultural, recreational and industrial uses. The biodegradable wastes emptied into the water body leads to eutrophication of the water body, depletion of oxygen in the water and extinction of aquatic animal.

Studies have revealed that the waste of one man eventually flows into the areas downstream and becomes the source for the man living downstream of discharge. Hence the need for a proper monitoring of activities capable of leading to changes in water quality.

4. Surface water

In many of the villages in developing countries, the people adopt the streams and rivers as their means of water supply for all the water need. Unfortunately, many see the river as a good point to empty their wastes. Wastes are indiscriminately dumped along the water course when there is rains with the river as the target to empty such waste (Boukori *et al*, 1999, Adeyemi, 2003).

5. Waste disposal

Many see the river as a good location to empty waste from homes and industry such that, the quality of water at a time might be lowered as a result of closeness to residential areas and industries. Indiscriminate location of dumpsite is another avenue of getting pollutants into the water body. During rains, wastes are leached into the surface and ground water sources. The location of septic tank indiscriminately also gives rise to surface and ground water pollution.

Fig. 1. Fishing and recreation

Fig. 2. The young catching fun in water

6. Recreation

Unregulated, recreational activities also leads to lowering of surface water quality. Washing of clothes and other items in the water, bathing and other such activities have a negative impact on the water quality.

7. Industrial

Many industries located close to water sources are in the habit of disposing their waste into surface water aside from the primary use of the water for industrial purposes. For the small to medium scale industries especially that are barely trying to stand, waste treatment is the least of their concern. In a study carried out in 2005 by Eletta *et al* on, the effect of waste discharges from a beverage industry, it was discovered that the nitrate levels were present in quantities above the standards laid down by the World Health Organization (WHO). The concentration of zinc (Zn) was also found to be high in the discharges. The aquatic toxicity of Zn and especially the toxicity in fishes have been reviewed and, it has been concluded that, it has a high toxicity on fish even though the effect on man is not as lethal (Fatoki et al, 2002, Fadiran and Mamba, 2005).

8. Rain water run off

A study on the rain water runoff from paved roads in two cities by Adekola et al, 2001 showed clearly that trace metals were present in significant amounts in the runoffs which eventually are discharged into water bodies. In fact many use opportunity of such run off. Over the time, accumulation of these has a negative effect on the water quality.

9. AIM

This chapter aims at identifying the various sources of water, Some pollutants and suggestion of some form of regulation of activities that impair the quality of water sources.

Fig. 3. A place to empty waste

Fig. 4. Metal works along river bank

Fig. 5. Rainwater harvesting

10. Methodology

Samples were collected and after prior treatment, analysed following standard methods from literature for some trace metals and nutrient loading.

11. Result

The reconstruction of historical inputs of anthropogenic pollutants is important for improving management strategies and evaluating the success of recent pollution control measures (Santschi *et al*, 2001).

There is a need to identify in relation to a particular water body the possible sources of pollution and, give necessary assessment and evaluation of the water based on the activity along/ around it and, where the need arises, education on impact of such activities and in consultation with necessary enforcement agencies, there might be a need to put some measures in place to make sure that right practices are on there.

Three main sources of water available for man's use (ground, surface and rainwater) are randomly investigated for some trace metal and nutrient loading with a view to monitor the impact of man's activities on the quality of water available for man's use.

12. Discussion

The study carried out on randomly selected locations confirmed the impact of some of the activities carried out along the course of the river on the concentration of some of the identified pollutants in the various water bodies.

Concentration of copper (Cu) in the water samples across samples and locations were found to be within allowable concentration levels by the World Health Organization (WHO).

Concentration of lead (Pb) in the rain and surface water samples were determined across locations. There was visibly, no significant changes in the Pb concentrations from the two sources. Figure of 0.08 mg /l was recorded at location 4 which has a metal workshop along the bank of the river under study as shown in fig 4.

Concentration of iron (Fe) in the ground water sample was found to be below detection limit. However for the surface water samples, concentration was found above the WHO allowable limits in locations 3 and 5 with average concentrations of 3.08 and 3.6 mg/l respectively with. Location 3 has a soap and detergent company emptying its waste into the water at this point. It was discovered that, the company treats its waste using ferric chloride and, the high concentration observed will not be unconnected with the input into the river at this point. Location 5 has a metal fabricating industry sited just at the bank of the river as shown in the picture above. Fig 5, shows a rusted corrugated iron roof which is a common sight considering it is the cheapest and readily available roofing material to many. However, because of the inadequacy of water for the use of man, rain harvesting is carried out by many during the rains. As the rain impinges on the roof top, there is the eroding of the materials used in the manufacture of the sheet into water collected. The concentration of Fe in roof tops with longer age of use have been found to be higher than newly installed sheets.

Concentration of nitrate was determined in the surface and the ground water. From the data collected, it was found that, the activities around the sampling points had direct influence on the nutrient loading. Location 4 which had an average concentration of 15.41 mg/l has extensive farming activities going on along the bank of the river and a beverage industry empties its waste into the river at this point. Locations 5 and 6 has average concentrations of 9.74 and 10.45 mg/l respectively also has farm activities and refuse dumps along the bank. Location 7 with an average concentration of 7.81 mg/l has extensive irrigation farming along the bank of the river. The surface of the river is covered with sea weed along these areas and when these die off, there is biodegradation and oxygen is used up and this results in the destabilization of the ecosystem. Fishing activities have been greatly reduced along this stretch of the river. In rain water harvesting, the state of the roof tops is often not taken into account. Water is collected from sheets in deplorable conditions as depicted in fig 5.

The average nitrate concentration of 7.89 and 7.35close to mg/ l observed in locations 5 and 6 in the ground water samples could be traced to the improper location of the wells. These two wells are located close to soakaways that are situated uphill of the wells.

13. Recommendations

13.1 Rainwater

Pollution of this source can come from washing down of particulates in the atmosphere during rains in which case, there is a need to monitor discharges in the form of particulates from industrial wastes and vehicular discharges. Trapping of gaseous wastes from industries and proper treatment and discharge will go a long way in reducing the chances of their reacting with water during precipitation. The trace metal pollutants resulting from impinging on the roof tops can be reduced by enforcing that aged roofing sheets be changed after a stipulated length of years after carrying out an intensive study to ascertain the period when optimum leaching is done.

13.2 Surface water

There are several inputs that goes to pollute the surface water. Animals crossing a river and discharges its waste as it crosses a river at shallow ends, man would swim (fig 2), wash and even empty the waste generated in the homes (fig 2) into the river in other to have it washed downstream aside from the washings into the water bodies from gutters and roads after each rain.

For all of these, there is a need for the government to enforce proper conduct with respect to rivers which mean different thing to different people depending on the point of contact. Farm practices along the bed of rivers should only be encouraged at safe distances from the river. A ban on animals wading through rivers should be put in place and the nomadic should be encouraged to wash their animals from puddles or they should be made to have a ranch where the animals are properly monitored.

Ground water pollution is mainly through leaching. There is a need to educate the builders such that wells are not located in areas where wastes cab be washed in easily.

All that constitutes pollution of water can all be addressed with putting laws in place and ensuring that the laws are followed strictly.

Location	Cu_R	Cu_S	Cu_g
1	0.13	0.06	0.04
2	0.1	0.07	0.02
3	0.08	0.06	0.03
4	0.17	0.05	0.02
5	0.13	0.04	0.02
6	0.1	0.06	0.03
7	0.17	0.07	0.02
8	0.12	0.07	0.03

Table 1. Average concentration of Cu in selected rain surface and groundwater samples (mg/l)

Location	Pbavg®	Pbavg(s)
1	0.03	0.04
2	0.03	0.05
3	0.05	0.06
4	0.03	0.08
5	0.04	0.05
6	0.04	0.04
7	0.06	0.05
8	0.05	0.05

Table 2. Average concentration of Pb in selected rain and surface water samples (mg/l)

Location	Feavg®	Feavg(s)
1	1.77	0.54
2	1.59	0.6
3	2.04	3.08
4	1.35	1.37
5	1.41	3.6
6	2.55	2.09
7	2.03	1.66
8	1.56	1.63

Table 3. Average concentration of Fe in selected rain and surface water samples (mg/l)

Location	NO_3s	NO_3g
1	3.74	0.89
2	3.147	0.68
3	5.277	1.1
4	15.41	0.5
5	9.743	7.89
6	10.45	7.35
7	7.81	1.83
8	1.843	0.4

Table 4. Average concentration of NO_3 in selected ground and surface water samples (mg/l)

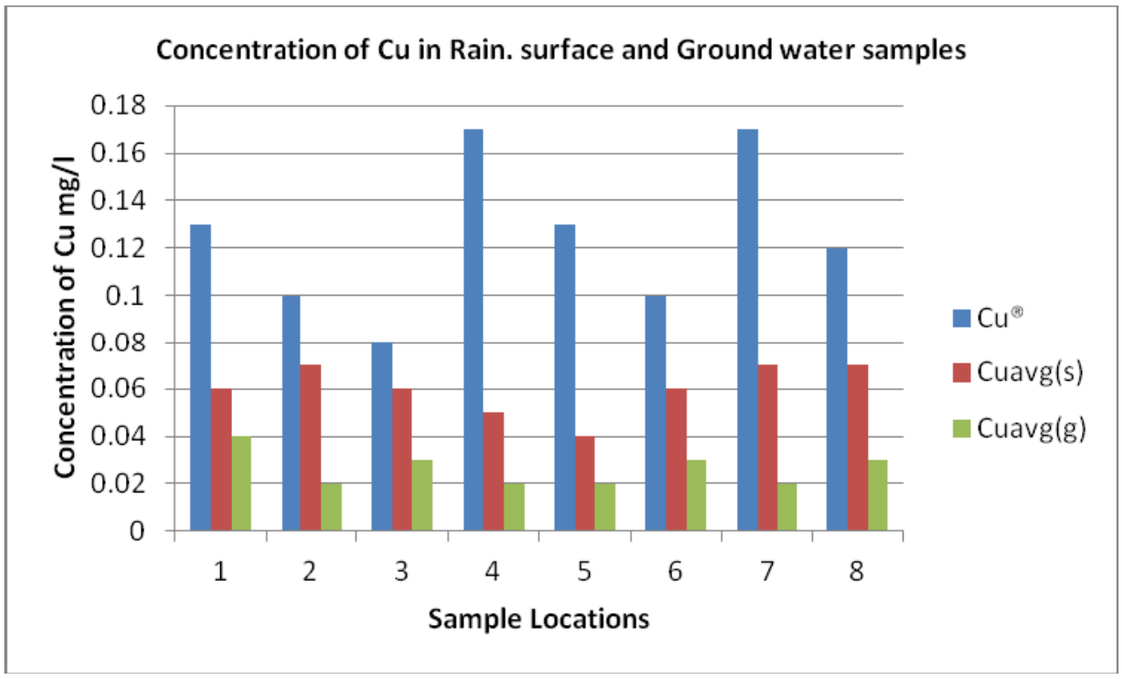


Fig. 6. Average Cu concentration across locations in rain, surface and ground water samples

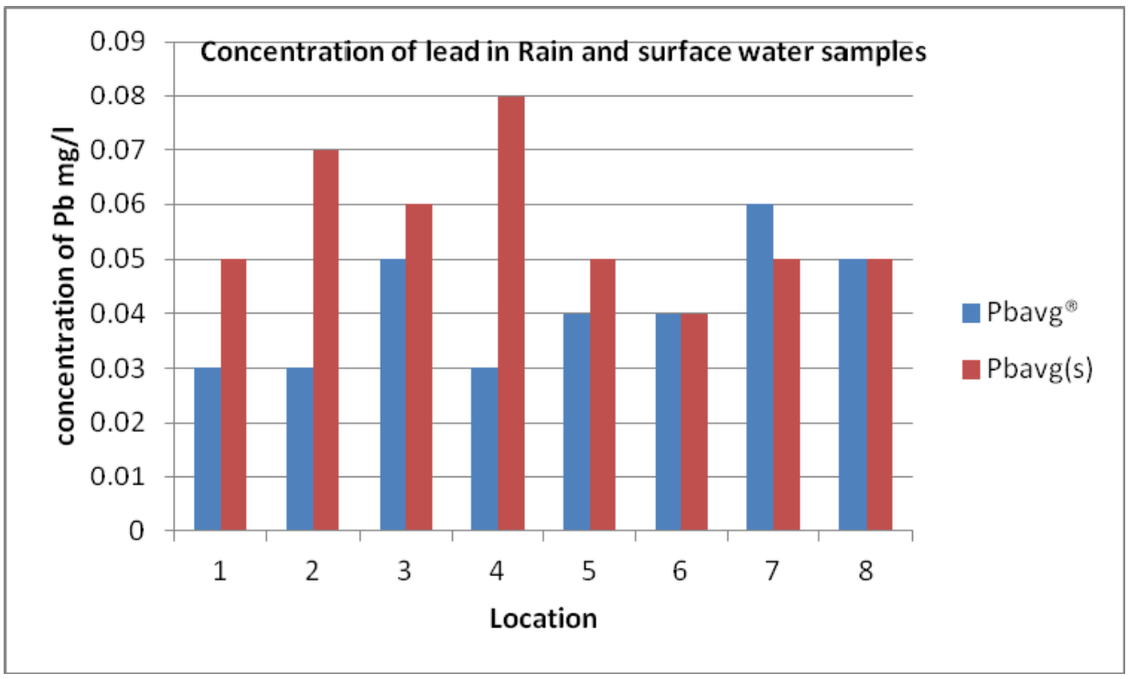


Fig. 7. Average Pb concentration across locations in rain and surface water samples

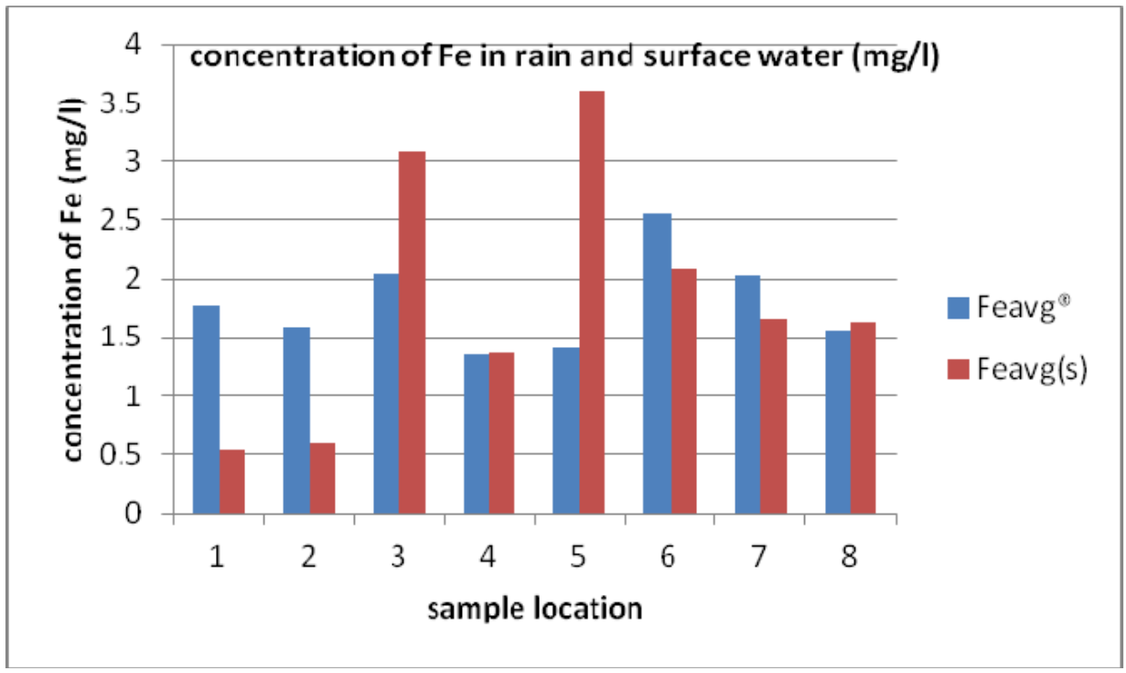


Fig. 8. Average Fe concentration across locations in rain and surface water samples

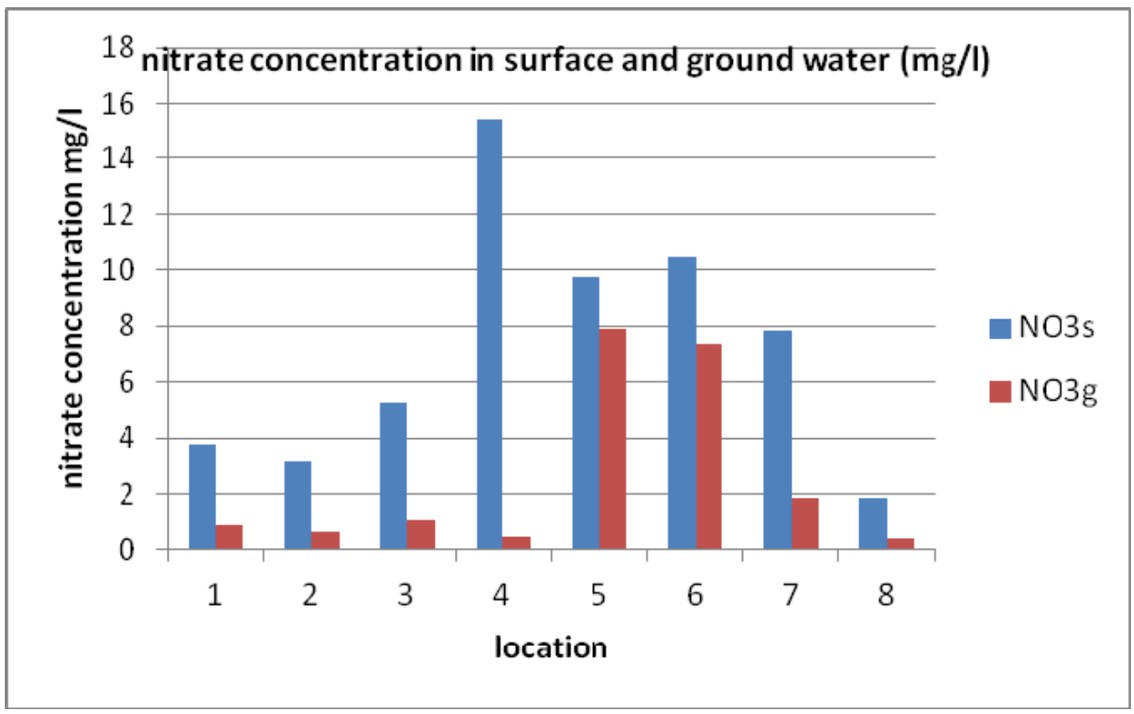
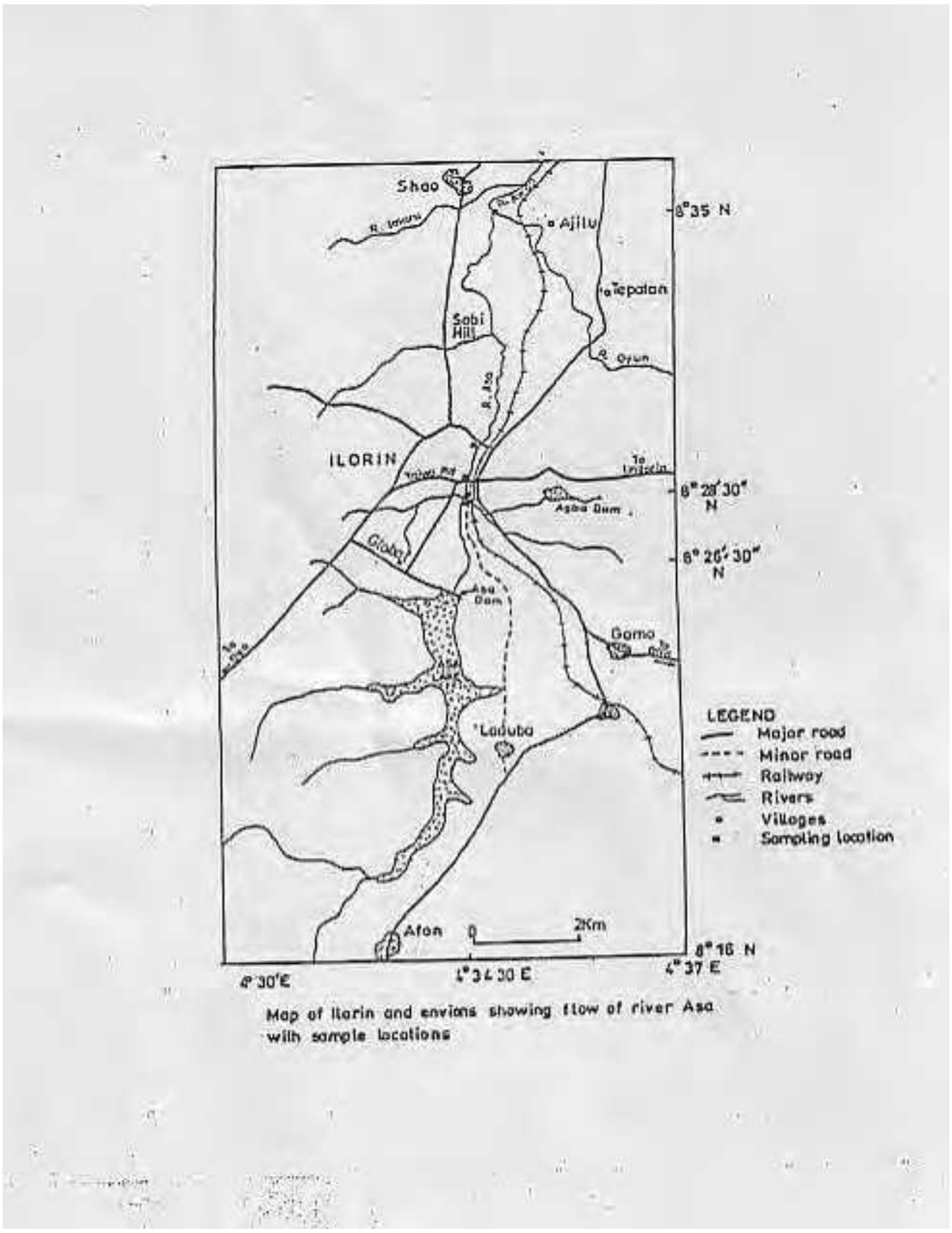


Fig. 9. Average nitrate concentration across locations in surface and ground water samples

14. Appendix



Map of Ilorin and environs showing flow of river Asa with sample locations

Fig. 10.

15. References

[1] Adekola F.A., Eletta O.A.A. and Atanda S.A., 2001, "*Some heavy metals concentration in rain water runoff on paved roads in Lagos and Ilorin Cities, Nigeria*", Academy Journal of Science and Engineering, 1, 88-96

[2] Adeyemi O.K, 2003, "*Consequences of pollution of Nigerian Aquatic Environment on fisheries resources*" 23(4), 297 – 306

[3] Boukori Y, Bawa I.M., Djareye – Boundjou G., 1999, "*Characterization of some Togo Surface Waters*" *Bull. Chem. Soc. Ethiopia*. 13(1): 11 - 21

[4] Eletta O.A.A. and Adekola F.A., 2005, "*Studies of the physical and chemical properties of Asa river water, Kwara State, Nigeria*" , Science Focus 10(1), 72-76

[5] Eletta O.A.A., Adekola F.A., and Aderanti M.A., 2005, " *Effect of waste discharge from soft drink plant into Asa river, Ilorin, Nigeria*" J. Appl. Sci. Envron. Mgt. 9(1), 187 -190

[6] Fadiran A.O and Mamba S.M, 2005, "*Analysis Of Nitrates And Nitrites In Some Water And Factory Effluent Samples From Some Cities In Swaziland*", Bull. Che. Soc. Ethiopia 19(1) 35-44

[7] Fatoki O.S., Lujiza N. and Ogunfowokan A.O, 2002, "*Trace metal Pollution in Umtata River*" water South Africa 28(2), 183 -187

[8] Fleeger J.W., Carmana K.R., and Nisbeth R.M., 2003, " *Indirect effects of contaminants in aquatic ecosystem*" The Science of Total Environ., 317 (1-3), 207 – 233

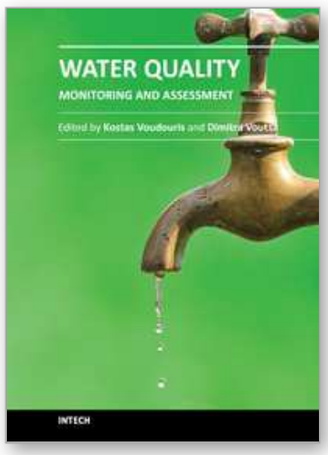
[9] Ibe K.M., Egereonu U.U and Sowa A.H.O., 2002 " T*he impact of hand pump corrosion on water quality in rural areas of west African Sub – Region*" J. Environmental Monitoring and Assessment, 78, 31 -43

[10] Olajire A.A. and F.E. Imepekperia, 2000, " *A study of water quality of the Osun River; metal monitoring and Geochemistry*" Bull. Chem Soc. Ethop 14(1), 1-18

[11] Salami A.W., 2003, " *Assessment of the level of water pollution along Asa River Channel, Ilorin, Kwara State, Nigeria*" Nig. J. Pure Appl. Sci. 18: 1423 -1429

[12] Santschi P.H., Presleyb B.J., Wadec T.L., Garcia – Romeroe B., and Baskaran M., 2001, " *Historical contamination of PAHs, PCBs, DDTs and heavy metals in Missisipi River Delta, Galveeston Bay sediment cores*" Marine Environmental Research, 2, 387 -392

[13] Yerima F.A.K., Daura M.R and Gambo B.A., 2008, "*Assessment of groundwater quality of Bama town, Nigeria*" J. of Sustainable Development in Agriculture and Environment 3(2) 128 -137



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The book attempts to covers the main fields of water quality issues presenting case studies in various countries concerning the physicochemical characteristics of surface and groundwaters and possible pollution sources as well as methods and tools for the evaluation of water quality status. This book is divided into two sections: Statistical Analysis of Water Quality Data;Water Quality Monitoring Studies.

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