AN EVALUATION OF RIVER SAKI-JIKI STREAM WATER QUALITY IN BATSARI KATSINA STATE NIGERIA

Adamu G. K
Aliyu I. Kankara
Rabi'u Tukur
Ibrahim Abdulrashid
Department of Geography and Regional Planning,
Federal University Dutsin-ma, Katsina State, Nigeria

Abstract

Environmental hydrogeo-chemistry is unique in focusing directly on the presence of dissolved salts and other contaminants observed in the surface and ground water sources, resulting in intriguing fall in the productivity of public health issues related to environment. This is mostly brought by Intensive human and agricultural activity. Trace elements, normally present in minute quantities in the stream water are a major influence on health. Chemical data itself can be used to obtain information about geological processes. Spectro-photometric methods and procedures for the evaluation of water samples were use to obtain values of concentrations of a selected number of alkaline elements and their compounds, in addition to other water condition indicators. These were sampled and evaluated. The result of the research shows that, all the parameters tested show variations when compared with the control site, but the concentration is not severe to the level it makes the water not suitable for either domestic or agricultural use. The study therefore, recommended for frequent monitoring of the soil, sand, water conditions in order to detect early signs of hazards.

Keywords: Trace elements, Hydro-geochemistry, Environment, River Saki Jiki, Geological process, Spectro-photometric

Introduction

The source of water for the irrigation and other domestic uses in the study area is River Saki Jiki that stretches in the north south direction of Jibia, thereby draining into Jibia Dam in the north. Shallow hand-dug wells are constructed along river channels in the dry period to irrigate farm plots as well used for domestic water supply. In a study on the hydrological properties of River Tagwai and its tributaries conducted by Muhammad (2000) the results from two hydrological stations; one at Ajiwa dam site and another at Makurda bridge indicated that, at the Ajiwa station, the average days of discharge were 99 days, with an average discharge of twenty five (25) million cm^3 and the other at the Tagwai/Makurda station with a catchment area of $1900km^2$ has a discharge of twenty (20) million cm^3. The Saki Jiki River and its tributaries provide a dense hydrological network which provides high potentials for irrigation and other domestic uses in the area; as such the hydrology of the area can sustain regional surface and ground water development.

The hydrometeorological data obtained from Katsina airport meteorological station exhibits good values of precipitation in Katsina state of about 780mm per annum on the average. Infiltration value is also high owing to the gently undulating topography and the absorptive topsoil made up of composites of sand and sandy lateritic formation which discourage excess run off. Hence the recharge of the sub-surface water bearing formations is encouraging (Innocent, 1998). On the basis of land use, the Saki Jiki valley may be put into use, for the flood plains be put under intensive cultivation. The grass lands of Saki jiki area was left fallow for many years while the uplands farmlands are intensively cultivated essentially available only for rain fed cultivation (Danjuma, 2008). This has made the lowland area becoming more fertile and fully becoming a land suitable for agricultural productions.

Saki-jiki is a village few kilometers away from Batsari town, but the location of the river made it agrarian communities particularly dry season farming. The river brings potentials for agricultural development which made the area to attract migrant farmers. River Saki-jiki is the major source of water for both dry season farming and domestic uses in the area. Use of chemical fertilizer has to some extent show a sign of contamination of both ground and surface water in the area. The study therefore, intends to investigate the level of contamination of the water in the area.

Sampling and Laboratory Analysis

Sampling methods and procedures used in this work were those described by Johnson (1975), Franson (1985) and FEPA (1990) Nigeria water quality tests and means of measurement. The procedures used in the analysis of the samples were those described in the standard methods for the analysis of liquid samples explained in Johnson (1975), Franson (1985) and in Hach (1997) in respect of Temperature, pH, Calcium, Phosphates, Nitrates and Electrical Conductivity. A one-liter quantity of sample was obtained monthly for a period of three months between February to April, 2000, from each of the sample collection points analyzed the selected parameters. In order to avoid post-sampling contamination, sample bottles were treated by rinsing thoroughly with de-ionized water and air-dried in a glass sealed drying cabinet to avoid contamination by sediments. Because changes that continue after sample collection may change the amount of chemical species available for analysis, preservation by refrigeration was introduced with the aim of slowing down the chemical and biological changes that may occur. Samples were analyzed as quickly as possible (a few hours after collection) in the laboratory. A DRJ20 I0 IR spectrophotometer was used in the determination of nitrates, calcium and phosphates. While a mercury thermometer was used in the determination of sample temperatures, pH and electrical conductivity were determined using a portable pH meter and an SC-120 portable conductivity meter. For the laboratory procedures, samples were always allowed after preservation to warm up to attain temperatures of between 20°C and 25°C as outlined by Hach (1997), before the commencement of analysis, in order to obtain best results. Nitrates have been determined by the Cadmium reduction method as outlined by Hach (1997). Phosphates were determined according to the methods in Franson (1985) and as outlined by Hach (1997), while calcium was determined by the methods proposed by Gotterman et, at (1987). For the analysis of data generated in the laboratory evaluation of the samples, a set of descriptive statistical techniques (percentiles and averages) were used to summarize the results. Observations for each of the parameters were averaged to obtain their mean concentrations. For the statistical evaluation, the student test, a much stronger statistical technique for the statistical comparison of means was used to test the significance of the differences between the different sampling points in this study.

Results Presentation and Discussion

Table: 1 Mean Water Properties for Three Months Period from the Two Study Sites

PARAMETER	IRRIGATION SITE	CONTROL SIDE
Temperature ^{0}C	28	28.2
Nitrates mg/l	10.5	7.3
Calcium mg/l	20.84	8.74
Phosphorus mg/l	4.4	0.99
PH	6.78	5.79
EC ms/cm	2.05	1.66

Laboratory Analysis: 2013

Generally, from the table above it can be observ highest monthly mean temperature of 28.5^{0}C was recorded in the month of March on irrigated sites and continued to drop down through April, May and June with the lowest monthly mean of 27.1 °C for the Month of July. This shows a general range of 1.4^0C. On other non-irrigated control sites, however, highest temperatures were recorded as well in the Month of March with mean monthly value of 28.2 °C and this continued to drop down at a rate of 0.2°C, with the lowest recorded mean of 27.2 °C in the month of July. This in general shows a slight variation among the irrigated and the control

A total of 315 measurements were made out of which 105 each for nitrates, calcium and phosphates were recorded for the period. Out of this number, 60 were for nitrates, phosphates and calcium from the control site for the months of March, April, May, June and July 2004. The remaining 255 records were from the irrigated sites. The tables below represent the mean monthly concentrations of each of the parameters from the irrigated and the control sites.

In general, significant variations have been observed in the temperatures of the water sources both between the irrigated and the non irrigated control sites themselves. Highest monthly means of 28.5°C and 28.2°C were obtained in the month of March for the irrigated and the control sites respectively. A mean monthly range of 2.0°C was obtained. This, however, is a little more conservative compared with a range of 3.6°C observed by Ogbalor (1991) and 4.0°C as observed by Essiet and Ajayi (1995) in a downstream well around Jakara river in Kano state and shallow boreholes in the Hadejia valley in Jigawa state. This low range may have been due to the fact that the sampling period did not include the period between November to January, when the temperature in the region is generally low and the winds impose significant impacts.

Reference to the mean values of pH in the irrigated and the Control sites, it could be seen that the groundwater sources of the Irrigation site as at the time of samples collection (March to July, 2013) was about neutral with pH values ranging between 6.78 to 6.95, giving a mean of 6.87. On the other hand, the ground water sources at the Control site were slightly acidic with values between 5.97 to 6.15 and a mean of 6.04. This shows a slight variation of 0.83 between the Irrigated and the Control sites. In general, this falls within the range of 6.4 to 8.5 recommended for irrigation. Even though pH is not an accepted criterion of water quality as reported by Shainberg and Oster (1978) in Essiet and A jayi (1995) because it tends to be buffered by the soil and, most crops tolerate a wide range of pH levels.

For Electrical conductivity, mean monthly values of 2.05 ms/cm and 1.66 ms/cm were obtained from the Irrigated and the control sites respectively. This shows a difference of 0.39 ms/cm. Mean monthly concentrations of calcium, nitrates and phosphates were presented in table 1 between the Irrigated and the control sites. The reason for this is because, chemical concentrations are affected by dilution effect, most monthly parameter quality indices are highest in summer and autumn when the water discharge is typically lowest and are therefore lower in winter as observed by Norman and Stephen (1999). The monthly concentrations of calcium in the Irrigated site ranged between 13.73 mg/l to 28.34 mg/l and 7.61 mg/l to 13.86 mg/l in the Control sites. This shows a range of 14.61 mg/l and 6.25 mg/l in the Irrigated and the control sites respectively. A significant difference was observed in the mean concentrations of calcium between the two sites with a value of 10.72 mg/l. This provided the highest variation among the parameters studied among the two sites. Monthly concentrations of nitrates in the irrigated site ranged between 0.78 mg/l to 20.3 mg/l and 6.4 mg/l to 8.1 mg/l in the control site. There is therefore, a wider range in the concentration of this parameter in the Irrigated than in the control site. A mean monthly concentration of 14.8 mg/l was obtained in the Irrigated site and 7.0 mg /l in the control site also showing a huge difference in the concentration of nitrates of 7.8 mg/l between the two sites. Phosphates exhibited comparatively a narrow range of 3.46 mg/l with a lowest mean concentration of 5.34 mg/l in the Irrigated site. The Monthly concentration of this Parameter in the control ranged between 0.93 mg/l to 1.05 mg/l and a monthly variation of 1.05 mg/l. This provided a difference of 2.23 mg/l in the concentration between the irrigated and the control sites. In general, the concentrations of calcium, nitrates and phosphates appeared to be higher than other parameters studied in the two sites and exhibited much more significant differences between the irrigated and the Control sites. PH and Electrical Conductivity at the irrigation site have shown significant relationship in their nature with respect to their monthly distributions. Highest values were recorded in May at the onset of the rainy season through a gradual build up and continue to fall regularly in the month of June and July. On the other hand, no significant variation was observed in the value of electrical conductivity between these Months in the Control site. This shows a direct relationship with the nature of salt concentrations resulting from rushed infiltration of compound fertilizer solutions on the Irrigated site. The levels of some of these compounds however are comparatively similar to those reported elsewhere (pH and electrical conductivity: in Essiet and Ajayi (1995) while the levels of others (calcium, nitrates and temperature) are comparatively higher than the concentrations observed by Essiet and Ajayi (1995) in a similar environment. Year round deposition of phosphates and nitrates and other salt based compound in either solid or liquid forms from fertilizer applications have been a major cause of land and water acidification on many irrigation sites. Where buffering from soils is inadequate, these levels may become toxic not only to aquatic, but also to plant and human life.

Conclusion and Recommendations

Many studies conducted elsewhere around the world (Essiet and Ajayi, 1995; Gupta 1998) have shown that human activities, particularly agriculture, over time have had profound impacts on the environment. The analysis of a selected number of parameters in the Tagwai valley may as well provide a basis for another scientific conclusion. From the study results therefore, it could be seen that the values/concentrations of temperature, pH and electrical conductivity of the irrigated and the control sites as at the time of the study showed little or no significant variations, whereas those of calcium, nitrates and phosphate showed statistically significant variations. The higher concentrations on the Irrigated sites of the alkaline earth elements or their compounds indicated a probable influence of compound fertilizer (N.P.K and Urea) and other chemical inputs (herbicides and pesticides) extensively used by farmers in the area in soil and crop treatments. Continued uncontrolled treatment of soil and crops with chemical agricultural inputs in the upland and flood plains of the Tagwai basin poses a serious salinity hazard due to increased concentrations of these alkaline earth elements or their compounds in the soils and water systems of the area. In order to salvage the current situations, and for the communities to continue to derive sustainable benefits from the land and the underlying water sources, a simple but dynamic management system must be established incorporating not only legal regulatory frameworks, but also the following:

I. The introduction of simple water testing technique or techniques similar to those recommended by Essiet and Ajayi (1995) in a similar environment.

2. Frequent monitoring of the soil, sand, water conditions in order to detect early signs of hazards.

3. Introduction of a method of regulated application of chemical fertilizers and other agricultural inputs with particular attention to nitrate fertilizers.

4. Conjunctive use of surface and ground water sources should be encouraged where possible in order to improve the concentration balance between the two sources.

5. Provision of improved drainage systems in order to encourage the leaching of excess salts deposited in the soil from the surface and the ground water through adsorption and desorption.

6. A program should be commissioned in the area to produce a data base that will provide a foundation for future research and studies on environmental interactions in the area.

References:

Essiet, E. U. and Ajayi, A. O. (1995) An evaluation of ground water quality of shallow boreholes used for small scale Jadama irrigation in Hadejia valley project (phase I) area, Jigawa state. In FaIola J. et al (1995). Issues in Land Administration and Development in Northern Nigeria Journal, Department of Geography, Bayero University Kano, Nigeria.

FEPA (1990). Proposed National Effluent limitation, Gaseous and hazardous solid wastes management for industries in Nigeria. Lagos

Franson, M. A. H. (ed) (1985) Standard methods for the examination of water and wastewater. American Public Health Association, Washington D. C.

Gotterman, et al (1987 L Methods for physical and chemical analysis oj fresh waters. An lBP Hand book, No.8, Black well scientific publications.

Gupta D. A.(1998) Ground water and the environment,. in Asit K B. (1998).Water resources, Environmental planning and management, Tata McGraw-Hili, New York.

Hach (1997) Manual/ procedures for the DR/20tO spectrophotometer, Hach company, U.S.A.

Innocent,C. O. (1998) "Techniques in ground water development in Katsina state". Paper presented at the seminar; Building of a new Katsina state; the role of science and technology. Organised by the College of Science and Technology, Hassan Usman Katsina Polytechnic, September 1998.

Johnson, C. G. (1975) Manual of methods in aquatic research. part I. Methods for detection. measurement and monitoring of water pollution. F AO fishery technical paper, No. 137.

Lagas, P., Verdram, B. and Loch, lP.G. (1989), Threat to ground water quality by pesticides in Netherlands. In ground water management; Quality and quantity. IAHS publication No. 188, IAHS Press, Wellingford, U. K. Pp. 171-180 .

Muhammad, N. D. (2000) "Study of irrigation potentials of tube wells in Fadama areas of Katsina State". A research project submitted to the National Water Resources Institute, Mando, Kaduna in partial fulfillment of the requirements for the award on higher national diploma in Civil Engineering .

Norman E.P.and Stephen, J. K. (1999). "An evaluation of stream water quality in Atlanta, Georgia and the surrounding region",(U.S.A.). Paper presented at the IUGG symposium, Birmingham.

Ogbalor, B. (1991)."An Evaluation of domestic wastewater quality for irrigation of vegetable crops along the Jakara stream, Kano State.". An unpublished M.Sc Thesis, Bayero University,Kano.

Hainberg and Oster, (1978) Quality of Irrigation Water. Mc Publications No.2, Canada. In Essiet, E. U. and Ajayi A. O. (1995).An Evaluation of ground water quality of shallow boreholes used for small scale Fadama irrigation in Hadejia valley project (Phase 1) area, Jigawa state. A paper presented at the third national workshop on land administration and development in northern Nigeria, held at Bayero University, Kano, Nigeria, March 1995.