EFFECT OF AGRICULTURAL ACTIVITIES ON WATER QUALITY AT THE SULEJA DAM, NIGER STATE, NIGERIA

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Abstract

Problems associated with water quality in the study area are commonly attributed to nutrient, chemical and pathogen loadings into Suleja Dam as a result of point source and non-point source activities. Therefore, it was imperative to evaluate the effects of agricultural activities on water quality in Suleja dam, Niger State, Nigeria. The materials and methods utilised for this study were water samples, field observations, photographs and questionnaire administration. Data were analysed using statistical techniques such as the mean, frequency percentage and Analysis of Variance. The result revealed that the nitrate for the study area during the rainy season were very high above the permitted level (50mg/l) except sample X^3 (23.8mg/l). The finding shows that fluoride was present in all sample points and two samples (X^5 and X^6) exceeded the acceptable limit of 1.5mg/l. The highest E.Coli value was located in sample point Y^4 with value of 74cfu in dry season and the least was located in sample point X^6 with value of 5cfu in rainy season. The result also revealed that there were presents of bacteria (Coliform and E.Coli) in all the sample points during the wet season which was as a result of human and animal faeces contamination. Incidence of health challenges in Suleja Metropolis showed cholera, diarrhea and typhoid are on the increase and this is attributed to poor drinking water quality from Suleja dam that has E.Coli of 74cfu which is greater than the accepted level. Year 2015 has the highest Diarrhea occurrence in the study area with 1,283 occurrence, 2014 has the highest Cholera occurrence with 198 and 2018 has the highest Typhoid occurrence with 273 in the study area. As revealed in the study, awareness against the high usage of fertilizer and pesticide around the dam ranked the highest with 173 (53.9%) respondents, disallowing the dumping of fish and poultry waste water in the dam ranked second with 69 (21.5%) respondents and the least was the enforcement on the Reduction of fertilizer usage around the dam with 39 (12.1%) respondents. This implies that were good preventive measures against the effect of agricultural activities on water quality in the study area. In conclusion, agricultural activities has both direct and indirect effects on the quality of Suleja dam and is among the leading causes of water quality degradation, mainly as a result of the excessive use of agrochemicals.

Its therefore recommended that the conditions of Suleja dam can fluctuate periodically, so water quality of this dam must be measured regularly to observe trends.

Keywords: *Suleja dam, Water quality, and Agricultural activities*

Introduction

Water is a key natural resource which is vital for the survival of all ecosystems on the planet. However, less than 1% of the earth's water resources are accessible to humans as fresh water, in the form of either surface or ground water (Krchnak, 2012, UNESCO, 2010). Agrochemical is a common term encompassing various chemical products that are used in agricultural activities. In most cases, it refers to the wide range of pesticides including insecticides, herbicides, and fungicides. It may also include synthetic fertilizers, hormones and other chemical growth agents as well as concentrated stores of raw animal manure (Moss, 2015).

Surface water contamination in a catchment (dam) is mainly attributed to outdated farm management practices. These include excessive use of fertilizers for high product yields, traditional irrigation practices, use of pesticides and herbicides and poorly managed animal farming operations (Moss, 2015, EPA, 2009). Other sources include fracking, deforestation, atmospheric deposits by rainfall and untreated sewage waste. However, this study focuses on the effect of agricultural activities on water quality degradation in Suleja Dam, Niger State, Nigeria.

The impacts of agricultural practices on surface water quality is given special attention currently since the safe and ample supply of freshwater is fundamental to humans and for the sustainability of ecosystem function. Intensive agricultural practices around Suleja dam often pose a threat to the ecological integrity of dam ecosystems.

Statement of the Research Problem

Several researchers have studied the effects of agricultural activities on water quality both nationally and internationally and they include Mohamed (2015); Shuuya (2014); Singh, Choudhary and Singh (2013); Mobeen, Shahid, Salma and Tayyaba (2012); Marouane *et al.*, (2014); Ayobahan *et al.*, (2014); Juan *et al.*, (2013); Huma *et al.*, (2017); and Randall (2012). Based on the published thesis and journals, few study has evaluated the effects of agricultural activities on water quality in Nigerian dams but not in Suleja dam, Niger State, Nigeria and this have created a paucity of knowledge about the study area which this study intend to fill. Problems associated with water quality in the study area are commonly attributed to nutrient, chemical and pathogen loadings into Suleja Dam as a result of point source and non-point source activities.

Non-point source fluxes in the study area are coming from diffused sources/activities with no direct source of entry and they include animal farming (poultry and fish farming) and crop production. The crop production in the study area may contaminate Suleja dam with agrochemical and fertilizer application. Therefore, it was imperative to evaluate the effects of agricultural activities on water quality in Suleja dam, Niger State, Nigeria and propose strategies which can be used to reduce the threat to the people and aquatic organisms.

The Study Area

Suleja Dam lies between latitude 9º13'10'' and 9º14'64'' north of the equator and longitude 7º14'38" and 7º14'67'' east of Greenwich Meridians as indicated in Figure 1 of this study. It has a surface area of 7.4km^2.

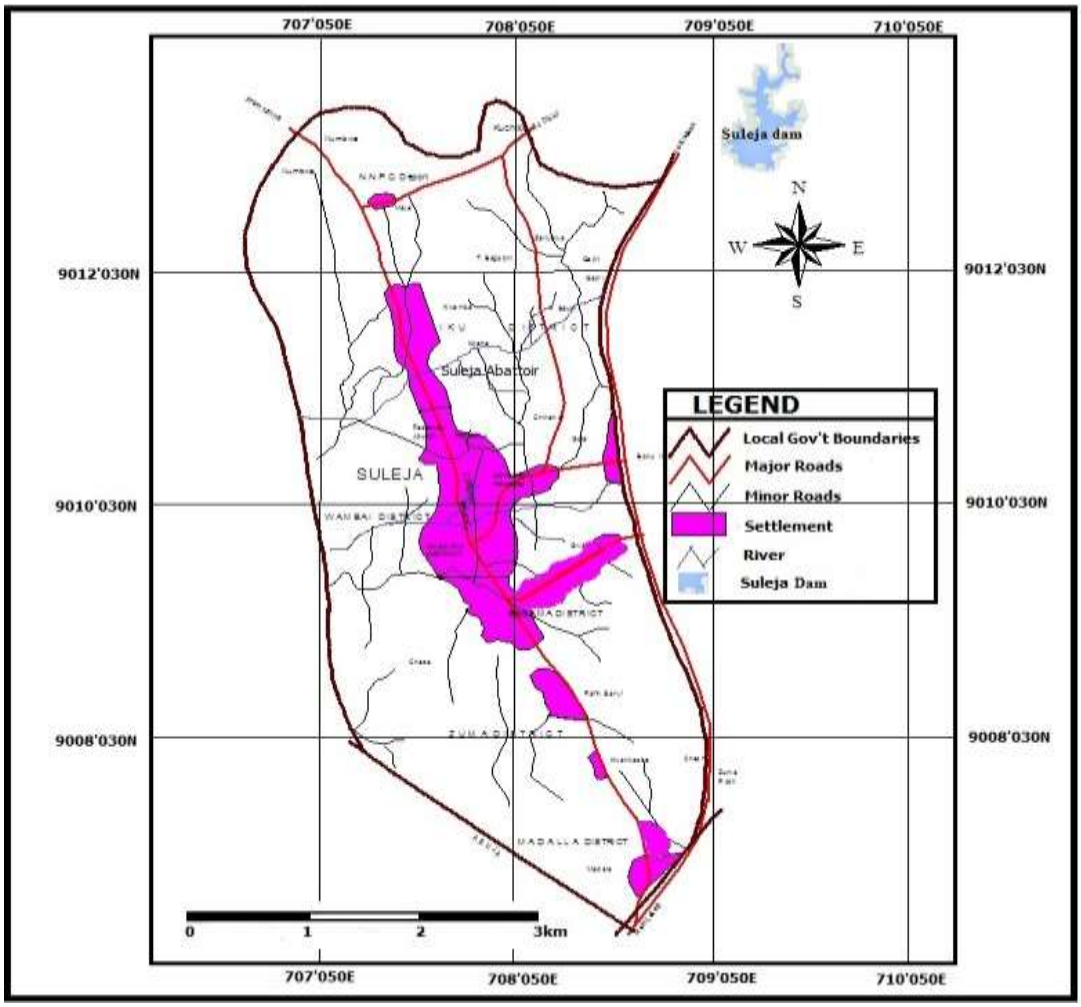

Figure 1: Location of Suleja Dam
Source: Niger State Geographic Information System (2018)

Research Methodology

The primary data sources include collection of water samples from the six sample points, questionnaire administration and field survey. Sites were selected to encompass a variety of land uses based on near-stream land use activities. These sites were chosen across the entire South Eastern part of the dam, so that results would not be as tied to local characteristics. Water samples were collected 0.5m below the water surface and at least 3m from the dam-bank and a GPS receiver was used to locate appropriate sampling points.

The secondary data sources include information from relevant maps, dissertations, textbooks, newspapers, journals, unpublished texts, published texts, collection of e-books and the internet that are relevant to this thesis. Other secondary data include collection of data on the occurrence of water borne diseases especially typhoid, diarrhea and cholera in the study area from the Department of Primary Health Care and Disease Control of the Niger State Ministry of Health and Primary health Care Services in the study area. Water-borne diseases occurrence precisely Cholera, Diarrhea and Typhoid were collected from General Hospital Suleja which was used to achieve objective two of the study.

In order to examine the chemical and bacteriological characteristics of water in Suleja dam, six sampling points were identified along the South Eastern part of upstream and dam site location for rainy season and six sampling points were also identified during the dry season. Analysis of Variance (ANOVA) Inter sample comparisons was carried out to test for significant differences in the chemical and bacteriological conditions using parametric ANOVA.

Diseases occurrence data obtained were on monthly basis for a period of 10 years (2009 to 2018) and this was converted into mean annual value using the mean statistical technique.

Results and Discussions

Examine the Chemical and Bacteriological Characteristics of the Water in the Dam

Table1 shows the chemical and bacteriological water quality result.

Table 1: Chemical and Bacteriological Water Quality Result

SN	PARAMETERS	X^1	X^2	X^3	X^4	X^5	X^6	NSDWQ
1.	Temperature (^{0}C)	25.2	25.3	25.5	25.3	25.3	25.1	30^{0}C
2.	Colour (PtCo)	0	0	0	0	17	550	15TCU
3.	Odour	UO	UO	UO	UO	UO	UO	UO
4.	pH	7.69	7.85	7.93	7.73	8.25	8.34	6.5-8.5

5.	Ferrous Iron (mg/L)	0.01	0.03	0.01	0.40	0.04	0.07	0.3
6.	Total Hardness (mg/L)	161.0	339.0	122.0	73.0	201.0	227.0	500mg/1
7.	Total Dissolved Solid (mg/l)	200	565	144	65	154	155	1500mg/1
8.	Nitrate (mg/L)	50.3	57.9	23.8	158.2	115.8	329.4	50mg/l
9.	Turbidity (NTU)	0	13	0	41	6	61	5NTU
10.	Manganese (mg/L)	0.20	0.80	0.10	0.50	0.30	4.0	0.2mg/l
11.	Electrical Conductivity	405	113.7	288	132.2	309	311	1250mg/l
12.	Phosphate (mg/L)	2.0	0.5	0.0	1.7	0.9	1.0	6.5mg/l
13.	Sulphate (mg/L)	10.0	8.0	7.0	14.0	26.8	7.0	400mg/l
14.	Chloride (mg/L)	89.2	103.1	65.9	79.8	109.2	115.3	250mg/l
15.	Total Alkalinity (mg/L)	31.5	32.8	45.3	45.0	64.3	92.1	100mg/l
16.	Residual Chlorine (mg/L)	0.01	0.03	0.00	0.02	0.13	88.0	0.2mg/l
17.	Fluoride (mg/L)	0.03	1.05	0.02	0.39	1.87	2.20	1.5mg/l
18.	Zinc (mg/L)	0.35	0.34	0.28	1.10	0.78	0.84	3mg/l
19.	Total Coliform (cfu/100ml)	1	7	3	16	13	21	No coliform
20	E. Coli (cfu/100ml)	9	13	21	34	13	5	No E.Coli

UO-Unobjectionable

Source: Federal Ministry of Water Resources in Minna, Nigeria (2019)

As revealed in Table 1, zinc was present in all the sample points and they were within the acceptable limit of 3mg/l. Contamination of zinc above this level will leads to deterioration of human health like vomiting, nausea, and stomach cramps. As indicated in Table 1, fluoride was present in all sample points and two samples (X^5 and X^6) exceeded the acceptable limit of 1.5mg/l. The health benefit of fluoride within the acceptable limit prevent dental carries. The health implication of fluoride above the acceptable limit increases dental and bones challenges like skeletal fluorosis. Plate I shows collection of water sample from Suleja dam.

As shown in Table 4.1, manganese was present in all the sample points except sample X^4 and sample point X^2, X^5 and X^6 were above the accepted limit (0.2mg/l). In concentrations higher than 0.2mg/l, the manganese may become noticeable by impairing color, odor, or taste to the water. However, according to Nigerian Standards for Drinking Water Quality health effects are not a concern until concentrations are approximately 10 times higher. Manganese can be consumed from our diet and in our drinking water on daily basis.

As revealed in Table 1, only sample X^6 ferrous iron exceed the accepted level with 0.40mg/l. There were no health challenges attributed to ferrous iron since people are expected to consume between 20-50mg/day. As indicated in Table 1, the nitrate for the study area during the rainy season were very high above the permitted level (50mg/l) except sample X^3 (23.8mg/l). It was noticed that the excessive use of nitrogen fertilizers was very common in the production of vegetables, fruits and other crops. Many farmers applied much more nitrogen than the mean value. Fertilizer applications were so high making the amount of non-absorbed nitrogen even higher. Agricultural surface water pollution by nitrate is a serious problem that has a negative impact on both environment and human health. This result agreed with work of Tits, Elsen, Devenyns, Laeremans and Elsen, (2014); Tirivashe, Adelaide and Tavengwa, (2012); and Singh, Choudhary and Singh, (2013).

As revealed in Table 1, there were presents of bacteria (Coliform and E.Coli) in all the sample points during the wet season which was as a result of human and animal faeces contamination. Chlorination which is the only treatment done by the water board of the study area cannot reliably kill organisms with a lifecycle phase that includes a protective cyst such as Coliform and E.Coli, so drinking water catchments need to be protected from these by excluding human and animal faeces contamination.

Assess the Health Challenges Associated with the Consumption of the Water in Suleja Dam

This objective was dissected into two sets and the analysis was based on the dissection which were both annual and monthly incidence of the selected diseases in the study area. The health challenges associated with the consumption of the water in Suleja dam assessed in this study include incidence of cholera, diarrhea and typhoid by the residents of Suleja metropolis as indicated in Table 2. As revealed in Table 2, health challenges is on the increase despite some fluctuation in some years.

Table 2: Incidence of Cholera, Diarrhea and Typhoid in Suleja Metropolis

Year	Cholera	Diarrhea	Typhoid
2009	8	465	53
2010	2	523	65
2011	1	483	73
2012	5	546	175

2013	26	467	73
2014	198	97	55
2015	35	1,283	92
2016	21	535	45
2017	66	655	204
2018	89	773	273
Total	451	5827	1108

Source: General Hospital Suleja, 2019

Incidence of health challenges in Suleja Metropolis showed cholera, diarrhea and typhoid are on the increase and this is attributed to poor drinking water quality from Suleja dam that has a E.Coli of 75cfu which is greater than the accepted level. Year 2015 has the highest Diarrhea occurrence in the study area with 1,283 occurrence, 2014 has the highest Cholera occurrence with 198 and 2018 has the highest Typhoid occurrence with 273 in the study area.

As revealed in Table 2, year 2014 ranked the highest with 198 cases of cholera followed by year 2018 with 89 cases and the least year was 2011 with one case of cholera. This implies that cholera incidence is on the increase despite some fluctuation in some years (2010 to 2012). Though these cases are not attributed to consumption of water from Suleja dam alone but also associated with other sources of water in the study area. The principal mode of transmition of cholera remains ingestion of contaminated water or food. This result is in consistence with work of Lawoyin *et al.*, (2009).

As revealed in Table 2, year 2015 ranked the highest with 1,283 cases of diarrhea followed by year 2018 with 773 cases and the least year was 2014 with 97 cases of diarrhea. This implies that diarrhea cases is on the increase despite some fluctuation in some years (2013 to 2014). Though these cases are not attributed to consumption of water from Suleja dam alone but also associated with other sources of water in the study area.

As revealed in Table 2, year 2018 ranked the highest with 273 cases of typhoid followed by year 2017 with 204 cases and the least year was 2016 with 45 cases of typhoid. This implies that typhoid cases is on the increase despite fluctuation in some years (2013 to 2014). Though these cases are not attributed to consumption of water from Suleja dam alone but also associated with other sources of water in the study area. This result is in consistence with work of Gana *et al.,* (2015); Naveen, Ronald, Edward, Joshua and Allen (2011) and Ayivor and Gordon (2012).

Conclusion

Freshwater is our richest and most natural resources in Suleja metropolis which is been polluted. Since water quality problem due to agricultural activities can be prevented, it is necessary and imperative to protect Suleja dam and the environment in general from pollution through appropriate legislation and guidelines.

In conclusion, agricultural activities has both direct and indirect effects on the quality of Suleja dam and is among the leading causes of water quality degradation, mainly as a result of the excessive use of agrochemicals. The outcome of this study links the concentrations of chemical and bacteriological variables to agricultural practice and local geomorphology. Seasonal patterns in the concentration of chemical and bacteriological variables occur, as agricultural activities change seasonally, and these concentrations were therefore determined periodically. The higher levels of studied parameters can be attributed to farming activities along the bank of the study area. To maintain yield increase of agricultural production and minimize environmental pollution of Suleja dam, management practices for N-fertilizer should be disseminated and applied an excessive fertilizer application prevented.

References

Ayivor, F. and Gordon, P. (2012). Endosulpfan residues in Brazilian tomatoes and their impact on public health and the environment. *Bulletin of Environmental Contamination and Toxicology*, 62, 671-676.

Ayobahan, S.U., Ezenwa, I.M., Orogun, E.E., Uriri, J.E. and Wemimo, I.J. (2014). Assessment of Anthropogenic Activities on Water Quality of Benin River. *Journal of Applied Sciences and Environmental Management,* 18(4), 629-636.

Environmental Protection Agency (2009). National Water Quality Inventory: Report to Congress; 2009 Reporting Cycle. Washington, DC: United States Environmental Protection Agency.

Gana, D. N. and Emigilati, A. M. (2015). Effect of abattoir waste on water quality in Kwata Suleja Area of Niger State, Nigeria. Retrieved from www.ejir.au.edu

Huma, Z., Nick, R, H., Geoff, V. M., Mark, R. and Neil C. (2017). The Impact of Agricultural Activities on Water Quality: A Case for Collaborative Catchment-Scale Management using Integrated Wireless Sensor Networks. *Journal of Computers and Electronics in Agriculture,* 3, 1-20.

Juan, H., Jinyan, Z., Haiming, Y., Feng, W. and Xiangzheng, D. (2013). Evaluation of the impacts of land use on water quality: A case study in the Chaohu Lake Basin. *The Scientific World Journal,* 1, 1-7.

Krchnak, K. (2012). *Human population and freshwater resources: US cases and international perspectives*. California: Yale University Press.

Lawoyin, T. O., Ogunbodede, N. A., Olumide, E. A. A. and Onadeko, M. O. (2009). Outbreak of cholera in Ibadan, Nigeria. *European journal of epidemiology*, 15(4), 367-370.

Marouane, B., Belhsain, K., Jahdi, M., El-Hajjaji, S. Dousset, S. and Satrallah, A. (2014). Impact of agricultural practices on groundwater quality: Case of Gharb region-Morocco. *Journal of Material and Environmental Science,* 5(1), 2151-2155.

Mobeen, G., Shahid, I., Salma, K. and Tayyaba, P. (2012). The relationship of land use practices to surface water quality in the Upper Oconee Watershed of Georgia. *Journal for Ecological Management*, 128(1-2), 39-48.

Mohamed, H. (2015). Treatment of seasonal pesticides in surface waters. *American Water Works Journal,* 81(1), 43-52.

Moss, B. (2015). Water pollution by agriculture. *Philosophical Transactions of the Royal Society B: Biological Sciences,* 363, 659-666.

Naveen, C. A., Ronald, D. L., Edward, M. R., Joshua, D. W. and Allen, W. S. (2011). Effect of Agricultural Activity on River Water Quality: A Case Study for the Lower Colorado River Basin. *Journal of Hydrology*, 387(3), 343-355.

Randall, F.K. (2012). Agricultural practices and water quality in Saskatchewan: The social ecology of resource management. A thesis Submitted to the College of Graduate Studies and Research in Partial Fulfillment of the Requirements for the Degree of Master of Sociology of Agriculture and Development in the Department of Sociology, University of Saskatchewan, Saskatoon.

Shuuya, Y. (2014). Headwater Influences on Downstream Water Quality. Journal of *Environmental Management, 41*, 367–377.

Singh, T., Choudhary, P. and Singh, U. (2013). Relationships between land use patterns and water quality in the Taizi River basin, China. Journal of *Ecological Indication*, 41, 187–197.

Tirivashe, P.M., Adelaide, M. and Tavengwa, C. (2012). Assessment of human impact on water quality along Manyame River. *International Journal of Development and Sustainability,* 1(3), 754-765.

Tits, M., Elsen, F., Devenyns, D., Laeremans, J. and Elsen, A. (2014). Impact of agricultural practices on surface water quality: A case study in the problem area of the Horstgaterbeek in North Limburg, Flanders, Belgium. Retrieved from *info@bdb.be*

United Nations Educational, Scientific and Cultural Organisation (2010). Global Hydrology and Water Resources. Water: a shared responsibility. John Wiley and Sons, New York, p. 163-209.