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A Review of Environmental Effects of Surface Water Pollution

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Abstract*—Water is life without pollution, but death when it is polluted. The objective of this study is to conduct a literature review of environmental effects of surface water pollution. The method used for this study is a review of academic journal articles, internet materials, textbooks, bulletins, conference papers, project reports and publicly available materials on the environmental effects of surface water pollution. All previous authors whose works were reviewed agreed that anthropogenic activities greatly contributed to surface water pollution and spatial variation of physicochemical parameters over time and location more than other sources in terms of both chemical and physical water pollutants that indicated elevated values of major chemical parameters (lead, cadmium, chromium, copper and some anions) beyond the permissible/threshold limits set by regulatory bodies. They also had a unity of opinion that the parameters have adverse effects on human plants, aquatic and physical environment. From the review and based on the results of the previous studies, this study concludes that most surface waters across the globe are polluted and as such must be treated before use both for domestic and industrial purposes to avoid the spread of epidemics that can lead to deaths of humans who are the most precious of all creatures. Recommendations of the study include: (1) regular review of environmental effects of surface water pollution by researchers to indicate the trend in pollutional loads of rivers and streams across the globe; (2) strict enforcement of regulations water quality standards and (3) regular monitoring of the environments of water bodies by regulators and the locals.*

Keywords*— *Surface Water, Pollution, Water Quality, Physicochemical Parameter, Review, Sustainable Water Management.

I. INTRODUCTION

Water occupies about 71% of the earth's surface and yet it is one of the scarcest commodities especially in the developing countries of the world (Karikari and Ansa, 2006). They also stated that water is one of the most demanded of all urban and rural amenities and it is indispensable for man's activities. Oketola, Adekolurejo and Osibanjo (2010) noted that water is abundant on the planet Earth as a whole, but fresh potable water is not always available at the right time or the right place for human or ecosystem use and water is undoubtedly the most precious natural resource vital to life. Furthermore, they opined that water is distributed in nature as surface and ground water in different forms and sources which are oceans, seas, rivers, streams, lakes, ponds, wells, boreholes and springs. Rivers are among the oldest water bodies in the world (Higler, 2012). He also noted that in most urban-rural communities in the developing countries especially the Sub-Saharan Africa, surface waters (rivers, streams, and lakes) have been the most available sources of water used for domestic purposes. The water from these sources is contaminated with domestic, agricultural, and industrial wastes and is likely to cause water related diseases (Ojekunle, 2012; Ayeni, 2014).

Water is a resource that has many uses, including recreation, transportation, hydroelectric power and domestic, industrial and commercial uses (Kumar, 2007). He also asserted that water also supports all forms of life and affects our health, lifestyle, and economic well- being. Although more than three quarters of the Earth's surface is made up of water, only 2.8 percent of the Earth's water is available for human consumption (Iskandar, 2010). At present, approximately one-third of the world's people live in countries with moderate to high water stress and the worldwide freshwater consumption increases six fold between the years 1900 and 1995 more than twice the rate of population growth, thus, many parts of the world are facing water scarcity problem due to limitation of water resources coinciding with growing population (United Nations Environmental Programme, UNEP, 2002). Filkersilasie (2011) opined that the role of the river is not primarily to carry industrial wastes but their ability to do so is hugely exploited. He also reported that there has been significant impairment of rivers with pollutants, rendering the water unsuitable for beneficial purposes.

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Rivers provide a variety of services for human populations, including water for drinking and irrigation, recreational opportunities, and habitat for economically important fisheries (Leroy, 2002). The growing problem of pollution of river ecosystem has necessitated the monitoring of water quality (Ravindra, 2003). Fresh water is a finite resource, essential for agriculture, industry and even human existence, without fresh water of adequate quantity and quality, sustainable development will not be possible (Kumar, 2007). Rivers play a major role in assimilation or carrying off of municipal and industrial wastewater and runoff from agricultural land, the former constitutes of constant polluting non- point sources whereas the later is a seasonal phenomenon (Muduli and Panda, 2010). With the rapid development in agriculture, mining, urbanization, and industrialization activities, the river water contamination with hazardous wastes and wastewater is becoming a common phenomenon (Ali, 2012).

Rapu (2003) reported that in South Africa, over 15% of rural dwellers depend on polluted river waters for their domestic needs. Khalil (2005) claimed that over 70% of people in Sudan get their water supply from surface waters, which in most cases are polluted by agricultural chemicals and industrial effluents. Shuaib (2007) was of the opinion that over 40% of Nigerians depend on either polluted surface waters or wells for their domestic activities. He also argued that the constant use of heavily polluted water for a long time usually results in health problems. Researchers in different parts of the world have reported health problems associated with prolong time use of polluted river water, which range from dysentery, diarrhea, abortion, premature birth, viral hepatitis and gastric and duodenal ulcers amongst others (Oguzie and Okhagbuzo, 2010; Purnamitta, 2011).This study is therefore focused on a review of environmental effects of surface water pollution.

1.1 Statement of the Problem

The need for good water quality has been of growing concern in Nigeria and worldwide as anthropogenic activities are fast degrading most water bodies, these activities which are agricultural practices, human domestic activities and dredging, all result in pollution of the natural habitats of aquatic organisms (Adeloye, 2004). Rivers serve as sinks to most wastes that result from these anthropogenic activities (Onyegeme and Ogunka, 2015). They further opined that as human population increases, more pressure is put on available water resources in meeting human water needs and for waste disposal.

Adeyemi, Adikwu, Akombu and Iyua (2009) stated that people residing close to rivers are predominantly farmers and occasional dredgers (sand miners). They use poultry droppings as well as chemical fertilizers to enrich their farmlands; these constitute pollutants which drain into the river through run-offs. Furthermore, they were of the opinion that most Rivers in Nigeria had in recent times come under stress as a result of rapid urbanization. All the domestic and industrial wastes as well as sewage from all parts of Port Harcourt are washed into the river during run-off (Olorode, Bamigbola, and Ogba, 2015). They further statedthat the topography of the town slopes into the river and drainage channels are constructed emptying into the river. This situation may eventually lead to pollution of the river which might have dire consequences on the ecosystem. The physicochemical and biological parameters of rivers vary temporally and spatially depending on the nature and quantity of effluents they receive seasonally and at points along their courses (Howard, 2011). Rivers may show the same trend making the water hazardous for use at some points or times (Olorode*et al*, 2015).

1.2 Objective of the Study

The objective of this research is to conduct a review of environmental effects of surface water pollution.

II. CONCEPTUAL FRAMEWORK: SUSTAINABLE WATER MANAGEMENT (SWM)

This research is based on the concept of sustainable water management (SWM). SWM is a critical component of sustainable development, and accounts for similar issues as sustainability. Mays (2006) defined SWM as meeting current water demand for all water users without impairing future supply. More specifically, SWM should contribute to the objectives of society and maintain ecological, environmental, and hydrologic integrity (Loucks and Gladwell, 2002). A more holistic objective of water management is provided in Agenda 21 (United Nations Conference on Environment and Development, Rio de Janero, Brazil, 3–14 June, 1992) which ensures that adequate supplies of water of good quality are maintained for the entire population of the planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and to combat vectors of water-related diseases.

III. METHOD

This research made use of a review of academic / journal articles, conference papers, internet, and textbooks. The researcher assembled twenty-five (25) materials for this research but was able to use fifteen (15) which addressed

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environmental effects of surface water pollution. This enabled the researcher to make a synthesis of various researchers' views on environmental effects of surface water pollution.

IV. LITERATURE REVIEW

Enetimi, Angaye and Okogbue (2016) conducted field research on physio-chemical quality assessment of river Orashi in Eastern Niger Delta of Nigeria and asserted that river quality assessment is essential to the sustenance of aquatic biodiversity, the environment and public health. They also indicated that mild anthropogenic activities have caused changes in parameters assessed such as iron, PH, magnesium, calcium with increase in total dissolved solids. Furthermore, they were of the opinion that if mitigation measures are not put in place, anthropogenic effects could rise beyond tolerant or permissive limits, which could affect the sustenance of the river.Bellingham (2012), in his study on physicochemical parameters of natural waters opined that the concentration levels of Pb, Cd, Fe and Mn were in surplus because fertilizers and pesticides used for agricultural activities, manufacturing land-use along the watershed area and other anthropogenic activities were the major causes for the elevated concentrations of the metals in rivers.

Tajuddin, Masaom, Yustiawati, Suhaemi, Syawal, Takeshi, Shunitz and Masaaki (2012) conducted field research on comparative assessment of water quality in the major rivers of Dhaka and West Java, asserted that Bangladesh have been considerably contaminated by heavy metals, physio-chemical and biological pollutants. In addition, they opined that biological pollution indicates anthropogenic sources caused by poor sewerage system whereas the heavy metals and physiochemical pollution indicate industrial sources.Ugwu and Wakawa (2012) conducted field analysis on seasonal physio-chemical parameters in River Usman and reported that there is adverse effect of the monsoon as well as diverse anthropogenic activities on the bacterial population of water bodies which has led to decrease in bacterial calculations in the heavy rain period owing to flushing effect. Kumar (2006) conducted field research on view of freshwater environment and revealed that high saturation levels of dissolved oxygen and low concentrations of phosphates nitrate, sodium and potassium in surface waters varies as a result of season of the year.

Onyegeme Okerenta and Ogunka Nnoka (2017)conducted field research on seasonal variations in physicochemical and bacteriological parameters of Ulasi River, Okija, Anambra State and stated that high value of biological oxygen demand (BOD) and Coliform count in dry season indicated deterioration of water quality which was due to the effluents which showed thatfor drinking purposes, the water is not of an ample quality in the absence of any purification; but for other leisure activities like swimming and industrial use, the river water was still of an adequate quality. Agbabiaka and Oyeyiola (2012) carried out field analysis on microbial assessments of soil sediments of Foma River, Ita-Nmo, Ilorin, Nigeria and reported that turbidity and BOD of surface water bodies were as a result of mining of dolomite and soil wearing away. Onyegeme and Ogunka (2017)conducted field study on physicochemical properties of water quality of Imeh, Edegelem and Chokocho communities located along Otamiri-Oche River in Etche ethnic nationality of Rivers State, Nigeria and claimed that parameters such as the pH, total dissolved solids (TDS), dissolved oxygen (DO), BOD and chemical oxygen demand (COD), alkalinity, hardness, chloride, nitrate-nitrite were found to be abnormal due to large amount of oxygen demanding wastes entering into the river from domestic sources.

Iyama. and Edori (2014) undertook analysis of the water quality of Imonite Creek in Ndoni, Rivers State, Nigeria and claimed that the quality of a given water body is governed by the physical, chemical and biological factors all of which interact with one another and greatly influence its productivity, bio monitoring in conjunction with physical and chemical observation of water quality is potentially useful in assessing water bodies. Rajiv, Hasna, Abdulsalam, Kamaraand Sankar, (2012) conducted field analysis of physicochemical and microbial different river waters in Western Tamil Nadu, India and claimed that in order to mitigate the impact human societies have on natural waters, it is becoming increasingly important to implement comprehensive monitoring regimes. He further highlighted that monitoring water resources will quantify water quality, identify impairments and help policy makers make land use decisions that will not only preserve natural areas, but improve the quality of life.

Meligaand Salifu (2014) carried out field research on assessment of physicochemical and biological parameters of Imaboro River, Oyo State, Ibadan, Nigeria and opined that the pH, DO, BOD, chlorides, phosphates and nitrates has changeable levels of pollution from unpolluted to exceptionally-polluted levels depending on the pragmatic seasons of the year which have a posturing danger to the fish health and biodiversity. Dimowo, Benjamin and Onozey (2013) conducted field research on assessment of some physicochemical parameters of River Ogun (Abeokuta, Ogun State, Southwestern Nigeria) in Comparison With National and International Standards and asserted that water surface such as faecal coliform bacteria,

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in the satisfactory limit set by the World Health Organization (WHO) for drinking water, metals such as lead and iron and physical characteristics such as turbidity and oil and grease, had been surpassed at all the sites they studied leading to extremely contaminated/poor condition for drinking or domestic use.

Cosmas, Ahamefula, Ahiarakwem, Samuel and Onyekuru (2015) conducted research on comparative assessment of the physicochemical and microbial trends in Njaba River, Niger Delta Basin, Southeastern Nigeria and reported that industrial activity and its effluent have contaminated surface water with large amount of heavy metals (Mn,Cr, Cd, Ni, Zn and Fe) ,Ca, chlorides and total hardness were in high levels. Raja and Venkatesan (2010) carried out field research on assessment of surface water pollution and its impact in and around Punnam area of Karur district, Tamilnadu, India and reported that there was variation in the parameters like total hardness, total alkalinity, dissolved oxygen, conductivity, and pH of surface water bodies. They founded that dissolved oxygen was maximum during wintry weather which was deducted as a factor of cool atmospheric temperature. According to them, however, during the summer season, conductivity, total hardness and total alkalinity were found to be at upper limits. Additionally, they reported that most of the parameters were high in summer which might be as a result of hot temperature, high loss and small water level and lowest in wintry weather due to improved water level.

Table.1: Summary of Characteristics of some of the Studies on Pollution of Surface Water

S/	Auth	Topic of the	Method(s	Results	Recommendation(s)	Conclusion
1.	Rajiv, Hasna, Abdulsalam, Kamara and	Physicochemical and Microbial Analysis of Different River Waters in Western Tamil Nadu, India.	Laboratory analysis and questionnaire	Turbidity and BOD showed elevated values compared to limits. Maximum values of magnesium and calcium may be credited to the mining of dolomite and soil wearing away.	This study would help to create and develop awareness among the people to maintain the quality of the river waters. Water quality monitoring and management should be in place in order to	Results obtained showed slight variations between water qualities of the rivers. The comparative analysis suggests the distinct nature of different river water and it depends on geographical location, time zone and geological foundation.
2.	Dimowo, (2013).	Assessment of Some Physicochemical Parameters of River Ogun	Laboratory analysis and questionnaire	The result showed that dissolved oxygen, hydrogen ion concentration, total hardness and nitrate were above the maximum permissible	To prevent mass extinction of aquatic organisms due to anoxic conditions, proper regulations should be implemented to reduce	Since most of the parameters measured were above the maximum permissible limits of the national and international standards, it can be concluded that the water is unfit for domestic uses,
3.	Melig a, Salifu (2014)	Assessment of Physicochemical and Biological Parameters of Imaboro	Laboratory analysis and questionnaire	The mean observations for the various water quality parameters in the sampled months of June	People should be sensitized on the danger of dumping refuse inside the river, molecular techniques be adopted for accurate identification	Most physicochemical parameters of Imaboro river fall within permissible limits. However, the water showed evidence of pollution.
4.	Iyama. and Edori (2014)	Analysis of the Water Quality of Imonite Creek in Ndoni, Rivers State, Nigeria	Physical observation, laboratory analysis	The mean observations for the various water quality parameters in the sampled months of June, September, November and January respectively are BOD, mg/l (0.27, 0.28, 0.33, 0.33), DO mg/l (3.8, 3.78, 2.72, 2.73), pH (7.43, 7.53,	The local authorities should make provisions for task forces to ensure strict compliance by the natives on water quality standard.	The relatively lower concentrations of heavy metals and TDS indicated that the Imonite Creek was not polluted by the organic and inorganic contaminants entering the water body around Ndoni in the Niger Delta of Nigeria.

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5.	Cosmas, Ahamefula, Ahiarakwem, Samuel and Onye	A Comparative Assessment of the Physicochemical and Microbial Trends in Njaba River, Niger Delta	Laboratory analysis and questionnaire	Results of the analyses indicated that average pH, electrical conductivity and the Total Dissolved Solids (TDS) of the Njaba River in 2003 were 6.3, 22 µS/cm and 13.5 mg/l, respectively. Mean values in 2008 for the	The pH can be corrected (raised) using sodium bicarbonate (soda ash) while the microbial assay can be improved upon by boiling and subjection to treatment using chlorine	The physical and bio-chemical properties of the Njaba River water samples within the period (2003 to 2008) under investigation indicated an increase (at a slow rate) of contaminant loads. The trend indicated some environmental problems (low pH, poor
6.	Onyegeme Okerenta and Ogunka Nnoka (2017	Seasonal Variations in Physicochemical and Bacteriological Parameters of Ulasi River, Okija, Anambra	Water sampling and laboratory analysis.	Results obtained for turbidity are 205 ± 0.70 (downstream), 25.70 ± 0.00 (upstream) for wet season and 138 ±0.60 (downstream).	A management plan to restrict the dumping of wastes into Ulasi River is needed. Educating the people was also recommended and strict enforcement of laws.	This study demonstrates the influence of rural land use and seasonal effect on water quality in Ulasi River. The data clearly shows that the downstream is more polluted than upstream.
7.	Agbabiaka and Oyeyiola (2012)	Microbial Assessments of Soil Sediments of Foma River, Ita-Nmo, Ilorin, Nigeria.	Water sampling and laboratory analysis.	pH values were generally in the optimal range of 6.14 - 7.97; Dissolved solids values expressed in mg/l were generally high throughout the months with a range of120 – 7800 mg/l and Temperature values	The local authorities should make provisions for task forces to ensure strict compliance by the natives on water quality standard.	Pollution of surface water occurs when too much of an undesirable or harmful substance flows into a body of water, exceeding the natural ability of that water body to remove the undesirable material, dilute it to a harmless concentration, or convert it to a harmless
8.	Enetimi, Angaye and Okogbue (2016)	Physicochemical quality assessment of river Orashi in Eastern Niger Delta of Nigeria	Laboratory analysis and field observation	Results of sampling showed that temperature of the river ranged from 26.77 - 28.07 and 26.37 - 27.13oC in dry and wet seasons respectively. The pH of the sampling stations in this study, was lower in dry season (6.21 - 6.52) and higher	Sensitization of people residing around the river and government Intervention aimed at cushioning anthropogenic activities around the river.	River quality assessment is essential to the sustenance of biodiversity, the environment and public health. Our results showed that the river quality assessment of Orashi river indicated mild anthropogenic activities in terms of parameters assessed. However, if mitigation
9.	RajaandVenkatesan (2010).	Assessment of surface water Pollution and itsImpact in and around Punnam Area ofKarur	Laboratory analysis and review of related literature	The pH values of all the sample shows in the range of pH 7.3 to 8.7, which indicates they were within the desirable limit except sample 6. The mild alkalinity may be due to the bi-carbonates. The alkalinity of the samples	It is suggested to exercise all the necessary precaution before the water is used for drinking and irrigation. Otherwise, it may lead to much adverse health effect.	The water quality parameter of the various areas around Punnam clearly indicates that the water samples are highly polluted. It is observed that the water taken from PasupathipalayamKulathur, Chathiram are alarmingly get polluted followed by Kuttakadai. These are as

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10.	Tajuddin, Masaom, Yustiawati, Suhaemi, Syawal,	Comparative Assessment of Water Quality in the Major Rivers of Dhaka and West Java	Water sampling and laboratory analysis	The pH value was ranging from 7.1–8.4 for the sampling points in both countries. It can be seen that the ionic environment in rivers are identical and lies within the standard range recommended by the WHO. Conductivity is a	The result of the study suggests there is urgent need for systematic monitoring along with remediation to reduce pollutant inputs and by developing functional sewage treatment plant.	It is concluded from the present study that the rivers in West Java, Indonesia and Dhaka, Bangladesh have been considerably contaminated by heavy metals, physiochemical and biological pollutants. The biological pollution indicates anthropogenic sources caused by poor sewerage system

Source: Researchers' design, 2017

V. RESULTS AND DISCUSSION

Water is a key component of the environment which its quality must be maintained and free from pollution. From Table 1, all the topics reviewed are relevant to environmental effects of surface water pollution. The researchers (eg. Dimowo, 2013; Enetimi, Angaye and Okogbue, 2016; and Iyama. and Edori, 2014) made use of standard method including questionnaire, review of related literature, sampling and laboratory analysis for obtaining data and information from the field. Previous studies by authors showed that surface water pollution arises from anthropogenic activities by transporting sediments from different land uses into nearby surface water bodies. Various authors were of convergent view that surface water parameters such as PH, BOD, COD, TDS and turbidity varies with season of the year (i.e.) dry and rainy season.

Iyama. and Edori (2014) and Dimowo (2013) had similar view that BOD and COD of surface water has reduce because of the quantum on organic and inorganic wastes deposited inside rivers. Authors such as Meliga and Salifu (2014) and Enetimi, Angaye and Okogbue, (2016) have unity of opinion that sensitizing people on the dangers of dumping refuse inside the river should be adopted for to reduce the level of pollution and contamination in surface water bodies while others (Agbabiaka and Oyeyiola, 2012; and Onyegeme Okerenta and Ogunka Nnoka, 2017) were of the view that task forces should be employed to ensure strict compliance by the natives to maintain water quality standard.

Generally, it is of common knowledge that regions with high human population and high rate of urbanization tends to suffer more of surface water pollution because individuals and industries has a mindset that surface water bodies are dumpsite for disposing off their waste. This is because, in global context, many people see water body as industrial dustbin since they channel out their industrial effluents in them for easier waste discharge which is of great environmental cost.

VI. RECOMMENDATIONS

From the reviewed literatures and based on the results the following recommendations are made not only to enhance the water quality and the environment, but also to protect the health of the people who depend on these surface water bodies for their living:

1. Management plan to restrict the dumping of wastes into surface water bodies is needed in order to reduce the impact on water quality and pollution related health problems. This can be achieved through effective waste management strategy and provision of reliable public water supply.
2. Regular monitoring exercises should be carried out by enforcement agencies and the locals on the activities along the river bank in order to ensure those effluents standards and other sanitary conditions are complied with.
3. Regulators of environmental and public health standards should put in place functional measures to enforce the already established standards not just only by punishing offenders, but also by rewarding/acknowledging compliance.
4. Regular review of environmental effects of surface water pollution should be conducted by researchers to indicate the trend in pollutional loads of rivers, stream and lakes across the globe.

VII. CONCLUSION

This paper discussed the environmental effects and physicochemical characteristics of surface water pollution through a review of works of previous authors. Previous authors viewed water pollution as a threat to the survival of the environment and mankind. They argued that anthropogenic activities are the major factor of water

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pollution. River quality assessment is essential to the sustenance of biodiversity, the environment and public health. Results of the quality assessment of rivers indicated mild anthropogenic activities in terms of parameters assessed. However, if mitigation measures are not put in place, anthropogenic effects could rise beyond tolerant or permissive limits, which could affect the biodiversity

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