RIVER AND STREAM WATER QUALITY MONITORING IN NORTH CENTRAL ZONE - NIGERIA: CHALLENGES AND SOLUTIONS

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1.0   INTRODUCTION

Every living thing on earth needs water to survive and without any doubt, inadequate quantity and quality of water have serious impact on sustainable development (Taiwo et al, 2012).Water is not only one of the most essential commodities of our day-to-day life, but the development of this naturalresource also plays a crucial role in economic and social development processes. While the total amount of water available in the world is constant and is generally said to be adequate to meet all the demands of mankind, its quality and distribution over different regions of the world is uneven and causes problems of scarcity and suitability (Mauskar, 2008). Water is a vast network of branching rivers, springs, creeks, swamps. estuaries. wetlands, lakes, bays, etc (Water Monitoring, 2013).

The National Bureau of Statistics in 2009revealed that, at least 27% of Nigerians, most of who live in the North Central and the far North of Nigeria, depended absolutely on streams, ponds. rivers. dams and rainwater as their drinking water source (Taiwo et al, 2012). Research has shown high prevalence of waterborne diseases such as cholera, diarrhea, dysentery. hepatitis in these regions, with hundreds and thousands of children and even adults dying every year (Oguntoke et al., 2009; Raji and Ibrahim, 2011). Water quality monitoring is therefore paramount especially in these parts of the country to safeguard the public health and also to protect the water resource in the area. Water quality monitoring is a fundamental tool necessary for the management of freshwater resources, particularly rivers and streams which are often than not. the main sources of drinking water in the rural and some urban areas (Adah&Abok. 2013).

Rivers and streams supply our drinking water, irrigate our crops, power our cities with hydroelectricity, support fish and other aquatic species and provide countless recreational and commercial opportunities (Rivers & Streams, 2013).

2.0   WATER QUALITY: Why Monitoring?

Water quality is a complex subject, which involves physical, chemical, hydrological and biological characteristics of water and their complex and delicate relations. From the user's point of view, the term "water quality" is defined as "those physical, chemical and biological characteristics of water by which the user evaluates the acceptability of water" (Mauskar, 2008).The quality of any body of surface or ground water is a function of either or both natural influences and human activities. Without human influences, water quality would be determined by the weathering of bedrock minerals, atmospheric processes of evapotranspiration, and the deposition of dust and salt by wind. Other water quality concerns include, the natural leaching of organic matter and nutrients from soil, hydrological factors that lead to runoff, and by biological processes within the aquatic environment that can alter the physical and chemical composition of water (UNEP. 2006). With increasing human activities around natural sources of domestic water supply and its attendant effects, it becomes more pertinent to invest in monitoring of our rivers and streams

2.1   Water Quality Monitoring

Monitoring as defined by the International Organization for Standardization (ISO) is "the programmed process of sampling, measurement and subsequent recording or signaling, or both, of various water characteristics, often with the aim of assessing conformity to specified objectives" (Milicevic, 2013). This general definition can be differentiated into three types of monitoring activities that distinguish between long-term, short-term and continuous monitoring programs as follows:

1. **Monitoring** is the long-term, standardised measurement and observation of the aquatic

environment in order to define status and trends.

2. **Surveys** are finite duration, intensive programmes to measure and observe the quality of

the aquatic environment for a specific purpose.

3. **Surveillance** is continuous, specific measurement and observation for the purpose of water quality management and operational activities.

Water quality monitoring can provide future management strategy that can be adopted by anyauthority. Information concerning the water quality of our rivers and streams will provide a useful instrument for policy makers to formulate management strategy for control and abatement of water pollution.To make better pollution control decisions, data on water quality of a particular water body is needed and such reliable data can only be obtained through monitoring. Without data, we simply cannot know where pollution problems exist, where we need to focus our pollution control energies, or where we've made progress or otherwise (EPA, 2012).

The monitoring of water quality is so important that in 1977, the World Health Organization (WHO), United Nations Environment Program (UNEP), United Nations Educational, Scientific and CulturalOrganization (UNESCO) and World Meteorological Organization(WMO) jointly launched a water monitoring program to collect detailed information on the quality of global ground and surface water (Taiwo et al, 2012). Since then, significant progress has been made by some countries like Germany, USAand Japan, to build on this effort to safe guard the quality of the water bodies within their territories from deteriorating. Nigeria and some part of the developing world are just transiting from survey to surveillance.

It is worthy of noting that the water quality of rivers and streams also depends on the quantity of the flow (discharge)The quantity of flow is an important factor in determining water quality and, thus, in interpreting water quality data (Erwin & Hamilton, 2005). The potential effects of contaminants on drinking-water supplies and aquatic habitats depend largely on the amount of water flowing in rivers and streams. We may be familiar with the outdated adage that "dilution is the solution to pollution." More flow, however, usually means that rivers and streams are carrying a greater magnitude of contaminants and sediment, in part because of overland runoff. When waters carrying these increased loads reach gulfs and bays, aquatic plants and animals can be greatly affected, particularly if this occurs during the critical life cycles of these organisms.

2.2   Monitoring Objectives

Monitoring can be conducted for many purposes:

i.   To characterize waters and identify changes or trends in water quality over time;
ii. To identify specific existing or emerging water quality problems;
iii. To gather information to design specific pollution prevention or remediation programmes;
iv. To determine whether program goals such as compliance with pollution regulations or implementation of effective pollution control actions are being met; and
v.   To respond to emergencies, such as spills and floods.

2.3   Strategic Monitoring Design

The 2007/2008 guidelines for water quality monitoring laid down eight (8) important steps involved in water quality monitoring (Mauskar, 2008). These are design model steps that must be strategically followed in order to achieve the monitoring objectives.

Step-1 Setting Water Quality Monitoring Objectives
    The monitoring objectives must be set without which the monitoring would be baseless.

Step-2 Assessment of Resources Availability
    i. Laboratory facilities and competence
    ii. Transport and power
    iii. Human resource –adequate number and competence

Step-3 Reconnaissance Survey
    i. Map of the area
    ii. Background information
    iii. Human activities
    iv. Potential polluting sources
    v. Water abstractions and uses
    vi. Hydrological information
    Vii.Water regulation

Step-4 Network Design
    i. Selection of sampling locations
    ii. Optimum number of locations
    iii. Parameters to be measured
    iv. Frequency of sampling
    V.Component to be samples – water, sediment or biota

Step-5 Sampling
    i. Representative sampling
    ii. Field testing
    iii. Sample preservation and transport

Step-6 Laboratory Work
    i. Laboratory procedures
    ii. Physical and chemical analysis
    iii. Microbiological and biological analysis

Step-7 Data Management
    i. Storage
    ii. Statistical analysis
    iii. Presentation
    iv. Interpretation
    v. Reporting

Step-8 Quality Assurance
  i. Production of reliable data
  ii. Quality control
  iii. Internal Assurance Quality Control
  iv. External Assurance Quality Control

3.0 WATER QUALITY SURVEILLANCE IN NIGERIA

The space occupied by inland water bodies in Nigeria is estimated at 900 km^2 representing 0.1 % of the total land mass while the coastal area stretched up to 853 km (Ekiye and Zejiao, 2010). Nigeria has abundant water resources covering an enormous and diverse landscape, although they are unevenly distributed over the country (WHO/UNEP, 1997).

Nigeria is well drained with a close network of rivers and streams(Water profile, 2010) with four principal surface water basins as follows;

1. The Niger Basin has an area of 584,193 km^2 within the country, which is 63 percent of the total area of the country. The most important rivers in the basin are the Niger and its tributaries, Benue, Sokoto and Kaduna.
2. The Lake Chad Basin in the Northeast with an area of 179,282 km^2, or 20 percent of the total area of the country. Important rivers are the KomadougouYobe and its tributaries, Hadejia, Jama'are, and KomadougouGena.
3. The South western littoral basins have an area of 101,802 km^2, which is 11 percent of the total area of the country. The rivers originate in the hilly areas to the south and west of the Niger River.
4. The South eastern littoral basins, with the major watercourses being the Cross and Imo Rivers, have an area of 58,493 km^2, which is 6 percent of the total area of the country, and receive much of their runoff from the plateau and mountain areas along the Cameroon border.

Nigeria also has extensive groundwater resources, located in eight recognized hydrogeological areas together with local groundwater in shallow alluvial (fadama) aquifers adjacent to major rivers.

As far as the definitions of monitoring, survey and surveillanceare concerned, Nigeria can be said to be in a stage of transition from 'survey to surveillance'. The Nigerian Constitution places responsibility for Water Supply on the three tiers of Government which include the Federal, State and Local Governments (NWRI, 2012). The Water Resources Decree 101 is vested with the role of coordinating all activities that are involved with the development and management of water resources in the Country. The Federal Ministry of Water Resources and Rural Development wasestablished in 1984 to among other functions, safeguard the water resource of the nation through periodic monitoring (NWRI, 2012).

The Federal Environmental Protection Agency – FEPA (established in 1988) which later transformed to the Federal Ministry of Environment, also had the mandate of monitoring the environment. The functions of FEPA also included regulation of effluents discharge by industries and several other Institutions. Statutory power was given to the Agency to prosecute any offender. The essence of this is to protect the water resource of Nigeria from pollution (NWRI, 2012). But the effects of these efforts are yet to be felt.

The Federal Ministry of Water Resources in conjunction with UNICEF and WHO have carried out Rapid Assessment of Drinking Water Quality in various parts of the country

during which poor drinking water quality situation was identified in some parts of the country (Ikelionwu, 2012). In pursuant of the demand to protect the water resources, the Federal Ministry of WaterResources also started some projects/programmes, some of which are the Reference andRegional Water and Monitoring Network Programme, the RapidAssessment of Drinking Water Quality (RADWQ) Project, the Water Quality SurveillanceProject and the development of the Nigerian Drinking Water Quality Standards (Ikelionwu, 2012). The Ministry and UNICEF have conducted water quality surveillance in only four focus states with the help of a consultant. Four focus states namely Benue, Ekiti, Enugu and Jigawa were involved in this exercise.

As at present,available information indicates that there are only six (6) Regional Water Monitoring laboratories in Nigeria. This number is grossly inadequate for effective monitoring the water quality of our streams and rivers, from which the vast majority of Nigerian source for their domestic water needs.This inadequacy has prompted the Federal Ministry of Water Resources to embark on the construction of six new Water Quality Monitoring laboratories in various parts of the country. According to the Director, Water Quality Control and Sanitation, Samuel Ome, "the six existing laboratories are inadequate due to the country's large population, and so we are building additional six now; our target is that each state will have one, so that overall we will have 37 laboratories in the whole federation" (Ome, 2013). It is hoped that this will come to pass in no time.

Recently the Minister for Water Resources had cause to assure Nigerians that the implementation of the Nigerian Standard for Drinking Water Quality would support and safeguard public health (Ochekpe (2013). Even though the National Standard for Drinking Water Quality was approved in April, 2007, to regulate drinking water quality in the country, the number of deaths due to water related diseases has continue to increase (Lohdip, 2011).

4.0   NORTH CENTRAL ZONE SITUATION-CHALLENGES
Most streams and rivers in the North Central Nigeria have been surveyed by academic researchers within the region, the results of which only few have been published. Anthropogenic interference in the hydrologic cycle and point source which are mostly related to agricultural runoffs, domestic and industrial discharges and mining activities within the areas are majorly the pollution sources of these streams and rivers within the region. For instance, analysis of Chanchaga river in Niger state by Amadi et al (2012) using Metal Pollution Index (MPI) indicated that the river is slightly affected with respect to heavy metal pollution, which can be attributed to the gold mineralization and mining along the river course. The levels of heavy metals in water and fishes from the River Niger were studied by Oboh and Edema (2007) with most values above tolerable limits. Speciation studies of trace elements levels in sediments from Zarmaganda Stream in Jos, Plateau State, North Central Nigeria, was carried out by Abehet. al., (2007),and the results were found to be above the tolerable limits.

Summary of the assessment of streams, rivers and surfacedams by Lohdip and his co-researchers within Plateau and Nasarawa states over the years revealed that most of the water bodies have high turbidity, heavy metals, hardness, suspended solids,nutrients and organic matter, soluble ions, oil and grease and microbial loads (Gongden&Lohdip, 2009; Lohdip, 2011; Lohdip, 2012; Gongden & Lohdip, 2012; Lawal&Lohdip, 2012; Lohdip & Gongden, 2012; Lohdip, et. al., 2012;Lohdip&Gongden; 2013).However, the water quality status of these water bodies in the region can not be conclusive due to several challenges which hampered the continuous monitoring of these streams, rivers and dams as expected.

The outcome of the survey by the UNICEF procured consultants on water quality surveillance in the four states including Benue, stated earlier, had identified some problems/challenges affecting the systematic water quality monitoring programme in the North Central zone of Nigeria. The outcome of the investigations of our research group at the University of Jos has also suggested similar challenges (Lawal&Lohdip, 2012; Lohdip, 2011; Lohdip et. al., 2012A; Lohdip&Gongden, 2013). Some of the challenges include and not limited to the following;

1. Inadequate standard laboratories – presently there are only six (6) Regional Water Monitoring laboratories in Nigeria. This means that there is only one of such laboratories in the North central regionis grossly inadequate for effective monitoring the water quality of our streams and rivers.
2. Inadequate funding of water resources and non-judicious application of the funds allocated.
3. Lack of equipment and poor maintenance/calibration of equipment – because the Federal Government is not able to put in place the required laboratories, some State governments in the zone make do with poorly equipped facilities at their disposal.
4. Lack of reagents to work with in such laboratories where they exist in the States.
5. Insufficient relevant and poorly trained human resource to manage the laboratories.
6. Non-availability of Water Quality monitoring system (body) in the rural areas which rely basically on rivers and streams for their day-to-day uses.
7. Non provision of Hand Testing equipment on the spot monitoring of the streams and rivers.
8. Poor power supply to the laboratories
9. Poor sanitary conditions in the laboratories
10. Security challenges

5.0   THE WAY FORWARD

It is understood that rivers and streams in the North Central Zone of Nigeria are the major sources of domestic water supply and effective monitoring of such sources are the panacea for good health. However, continuous monitoring of the rivers and streams to ascertain their water quality is facing serious challenges due to numerous factors. The following are therefore some of the strategies considered to ensure potable water for the people within this zone;

Funding is key in order to achieve the objectives of any water quality monitoring programme. Government and its agencies must ensure adequate funding of water resources and judicious application of the funds allocated and funds secured from donor agencies. Transparent management of donor funds will encourage such donors to do more.

When funds are available and properly managed, standard laboratories could be set up in every state and institution to effectively monitor our rivers and streams. Adequate funding is also needed for staff training for effective management of the facilities and processes.

Volunteers and NGO should be encouraged through funding to monitor and carry out water quality assessment within their localities. For example, a Directory of Environmental Monitoring Volunteers should be introduced using fresh graduates from the sciences who are searching for jobs.

The responsibility to monitor water quality rests with many different agencies. Interstate commissions, like States, Local Governments and Communities, may also receive grants and start monitoring programmes.

The States can start their own water quality-monitoring programmes and ensure that it covers the entire state. The networks can supplement the national network. Data generated can be transferred to the Central Data Bank under the Water Quality Laboratories and Monitoring Network.

Regional Water Quality Laboratories and Monitoring Network Programme, as well as the Rapid Assessment of Drinking Water Quality (RADWQ) project should be expanded to cover all the other states within the Central zone.

Concerted effort should be made to strengthening coordination between the three layers of government. For example, the Local Governments should be given specific mandate to manage water resources at that level. Of course this level of government is closer to the rural dwellers and in better positioned to identify and solve the water challenges. With the appropriate legislation and adequate fund allocation, the local governments will be in better position to fulfill their water and sanitation responsibilities. Local governments can set up water monitoring laboratories at the various environmental offices to conduct water quality monitoring within their boundaries.

There is the need to control and limit pollution of our surface and ground waters.Industrial and agricultural sectors should also be compelled to treat their wastes before discharge into the water bodies. Catchment protective demarcation facilities should be put in place to control contamination of our water bodies. The National Environmental and Sanitation Regulatory Agency (NESREA) should be seen to be active in its operation of protecting and regulating our water sources and the general environment.
The need to protect our rivers and streams is a clarion call to all as millions of the populace relies on it for their daily water supply. We must not lose sight of our responsibilities as individuals in securing our water resources. "Do not put pollutants into our rivers and streams".

6.0   CONCLUSION
Streams and rivers provide drinking water for the vast majority of the populace in the North Central Zone of Nigeria. These sources need to be periodically monitored to ascertain the water quality in order to prevent the menace of water related diseases. However, no or little attention has been given to this process. The way forward is for government to provide adequate funding to address the provision of water quality laboratories and trained personnel. There is the need to strengthen the coordination between the three layers of government in water issues.Water Quality Laboratories, Monitoring Network Programme and the Rapid Assessment of Drinking Water Quality (RADWQ) project should be expanded and sustained, to cover all the other states within the Central zone. The National Environmental and Sanitation Regulatory Agency (NESREA) should be active in its operation of protecting and regulating our water sources and the general environment. Individuals should also take responsibility in securing our streams and rivers by not polluting them.

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