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Geophysics Techniques in the Appraisal of the Integrity of Dumpsite and Groundwater Contamination

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ABSTRACT

This paper attempted to bring to light the hazards associated with the indiscriminate dumping of refuse in towns and cities and the concomitant pollution of groundwater which accounts for over 70% of the domestic use of water. The paper took a critical look at the menace of groundwater contamination resulting from the linkage of leachate from dumpsites and other sources among which are Kaduna, Lokoja, Lagos and China (Carpentel,Ding, and Cheng,2012; Abdullahi,Osazuwa And Sule, 2011; Abdul-Salam, Ibrahim, and Fatoyinbo, 2011; Longe, and Balogun, 2010). The paper recommends among other things that government, its agencies and the general public should employ the services of geophysicists and waste management agencies/experts before establishing a dumpsites/landfills and put in place appropriate monitoring/supervision systems. Finally, the paper concludes by suggesting the use of Geo-electrical survey other than Seismic refraction, magnetic, chemical and microbial as a very convenient method of detecting groundwater contamination without uttering the physical and other properties of the Dumpsites.
Keywords: Groundwater Contamination, Dumpsites, Waste Management.

1. INTRODUCTION

The prevalence use of groundwater for domestic purposes in the world and particularly in the developing countries can not be over emphasised. While the developed countries have to a large extent evolved an effective waste disposal management system, the developing nations have found it covenient to dump theirs waste indiscriminately, thereby, exposing the nation citizenry to many health hazards as a result of the concormitant contamination/pollusion of groundwater (Alimba, Bakare, and Latunji,2006).

1.1 Importance of Groundwater

Abdullahi,Osazuwa, And Sule, (2011), stated that groundwater is favuoured for domestic purposes because is of high quality and requires little treatment because any present of fungi, bacteria and other biological pollutants are naturally filtered and diluted as the water perculates through the soil. Groundwater is an important source of drinking water for humankind and it contains over 90% of the fresh water resources and is an important reserve of good quality water (Al Sabahi , Abdul, Wan, Al Nozaily, Alshaebi, 2009). The provision of potable drinking water by State Water Corporations in Nigerian cities and in many other parts of the world have not been able to meet the growing need of a large number of the world population, hence a large number of people relied very much on groundwater resource from hand-dug wells and boreholes. The situation has been further worsen by the epileptic supply of power with the consequent shortage in daily water production by the water supply scheme.

1.2 Causes of Groundwater Pollution

In Nigeria, inadequate supply of pipe borne water occasioned by an increasing urban population, poor maintanace culture and the epileptic supply of power is a major concern; hence many homes have wells and boreholes as source of water for household uses. Therefore, the pressure on groundwater exploitation had increased (Gbadebo and Taiwo, 2011).The rate of urbanization in Nigeria is alarming and the major cities areas are growing at rates between 10-15% per annum (Yusuf, 2007) and thus, human activities including soil fertility remediation, indiscriminate refuse and waste disposal, and the use of septic tanks, soak-away pits and pit

latrines are on the increase(Adetunji and Odetokun,2011). The mis-management and/or improper disposal of these hazardous materials, will lead to decreased of fresh groundwater supply due to contamination.

1.3 Dumpsite Pollution

Solid waste disposed in landfills is usually subjected to series of complex biochemical and physical processes, which lead to the production of both leachate and gaseous emissions. Also disposal of waste water (septic waste water) inside landfills which is practiced in most municipal dumpsites in Nigeria cities increased the leachate production significantly and should be considered as a major source of leachate generation.When leachate leaves the landfill and reaches water resources, it may cause surface water and ground water pollution (Kängsepp and Mathiasson,2009; Abbas. Jingsong, Ping, Ya, Al-Rekabi ,2009; Lou , Chai, Niu, Ou, Zhao, 2009; Olsson , Gustafsson, Berggren, Bendz, Persson, 2009).

1.4 Process of Groundwater Contamination from Dumpsites

Groundwater contamination from landfills typically forms a 'plume' that moves outward and downward into surrounding and underlying aquifers. This plume may contain dissolved carcinogens such as heavy metals (e.g lead,mercury, chromium,cadium, arsenic,etc.),volatile organic compounds (VOCs), (benzene,ethylbenzene,toluene,etc.) and less harmful ions (sodium,calcium, iron,surfate,chloride,etc). Early detection of this process is of ought most important for any nation.

1.5 Menace of Groundwater Pollution and Dumpsite

Industrialization, population growth and un-planned urbanisation have partially or totally turned our environment to dumping sites for waste materials (Alimba, Bakare, and Latunji,2006). Dumpsite is where waste materials are disposed and is the oldest form of waste treatment. Historically, dumpsites have been the most common method of un-organized waste disposal and remain so in many places around the world. Most dumpsites are located within the vicinity of living communities and wetlands.The dumpsites are often not lined nor basement prepared for selective adsorption of toxic substances.Therefore it is prone to release pollutants to nearby water and to the air through leachates and dumpsite gases respectively (Abdus-Salam, Ibrahim and Fatoyinbo,2011). Indiscriminate disposal of solid waste in unauthorized places has become an increasing problem for most cities in Nigeria. Many cities in Nigerian are experiencing the problem of solid waste management despite the best attempt of waste avoidance, reduction, reuse and recovery. Use of dumpsites is still the ultimate disposal method of domestic and industrial wastes in Nigeria (Aiyesanmi and Imoisi, 2011). Demographic expansion and increased industrial and commercial activities have caused an astronomical increase in the volume and diversity of solids wastes generated in most cities in Nigeria (Aluko, 2003). In Nigeria, most people are not aware of the health implication of living close to dumpsite, planting close to dumpsite and eating fruits and vegetable from dumpsite Alimba, C.G, Bakare, A.A. and Latunji, C.A. (2006). Many water resources have been rendered unwholesome and hazardous to man and other living systems as a result of indiscriminate dumping of refuse (Bakare, Mosuro, and Osibanjo, 2005). Groundwater pollution has been attributed to the process of industrialization and urbanization that has progressively developed over time without any regard for environmental consequences (Longe and Balogun, 2010) which eventually results in the deterioration of physical, chemical and biological properties of water (Isikwe , Iorver, Onoja, 2011). Environmental pollution due to indiscreminate siting of municipal waste dump has been of grave concern to Earth scientists and other researcher from other relative field of study.In urban areas, where massive toxic solid waste are produced due to industralization and urbanization and are usually disposed off inadequately on land surface, shallow excavation, rivers and stream channels surely poses a threat to both groundwater and downsream surface water.Municipal solid waste did not pose a significant problem until humans established settlements. Prior to that time, the types and quantities of waste were readily degraded or consumed by animals or naturally degraded without causing significant impact to the environment (Longe and Balogun,2010), but present realities have proved the contrary. Soil hydrological system is significantly affected by solid waste landfills/dumps, hence the need to put proper measures in place to check this menace.

2. GEOPHYSICAL ELECTRICAL METHODS

Electrical methods comprise a multiplicity of separate techniques that employ differing instruments and procedures, have variable exploration depth and lateral resolution, and are known by a large lexicon of names and acronyms describing techniques and their variants. Electrical methods can be described in five classes: namely
(i) direct current resistivity, (ii) electromagnetic, (iii) mise-a-la-masse, (iv) induced polarization, and (v) self potential. In spite of all the variants, measurements fundamentally are of the Earth's electrical impedance or relate to changes in impedance.
Electrical methods have broad application to mineral and geoenvironmental problems: they may be used to identify sulfide minerals, are directly applicable to hydrologic investigations, and can be used to identify structures and lithologies.

2.1 Role of Geophysical survey in the detection of Groundwater Pollution

A high concentration chlorine ions in solution (referred to as chloride) in particular makes landfill leachate electrically conductive. Acids dissolved in water (indicated by high pH values less than 7) release hydrogen ions into solution which also enhances electrical conductivity (Carpentel,Ding, and Cheng,2012). Ge-oelectric and electromagnetic methods have been found

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to be usefull in the detection and the location of the extent of contamination by leachate of groundwater(Abdullahi,Osazuwa And Sule, 2011).These methods are found to be very suitable because ionic concentration of landfill leachate is higher than that of groundwater, so when leachate enters an aquifer, it results in a large contrast in electrical properties, and these methods can identify these zones as an anomally , hence the detection and location of Leachate plume(Carpentel,Ding, and Cheng,2012; Abdullahi,Osazuwa And Sule, 2011). The application of electrical geophysical survey to dumpsites/landfills studies are well documented (Abdullahi,OsazuwAnd Sule, 2011; Alisiobi and Ako,2012; Amadi, Nwankwoala, Olasehinde, Okoye, Okunlola, Alkali, (2012); Sunmonu, et al (2012); Osazuwa, and Abdullahi,2008a; Osazuwa, I.B. And Abdullahi, N.K.,2008.). Another reason why geo-electrical survey is of significant in the detection of groundwater contamination is that its application does not significantly distort or affects the dumpsites or Landfills under investigation. Other methods do.

2.2 Importance of Geophysical Surveys

In Nigeria, it is generally believed that individuals, government and environmental agencies pay little or no attention to the environmental impact of the waste disposal and management, even when it is a statutory responsibility of the parties concerned. Agencies like the Federal Environmental Protection Agency (FEPA), Ministry of Environment, and even local authorities are responsible for planning a defined line of action for the disposal and management of wastes generated on daily basis in our society (Abdus-Salam,Ibrahim and Fatoyinbo,2011). Presently, Landfills in the developed countries are built only after carrying out detailed geophysical surveys in order to ensure the presence of the right subsurface features that can subtain/enhance its integrety (i.e. prevent the contamination of groundwater by Leachate from landfills). This appraisal is an attempt to bring about a national awreness of the potentail health risks posed by groundwater contamination by Leachate and the need for a quick intervention through the use of geophysical survey, thereby preventing the waste of public funds and enhance the economic growth of the nation.

3. CONCLUSION

The general belief that wastes are sometimes hazardous to health cannot be overemphasized. Hazardous waste can cause and has caused pollution, damage to health and even death. Exposure to multiple chemical combinations in populations living near waste dump sites has led to series of human health disorders. Geo-electrical method can effectively detect the contamination of groundwater by leachate from dumpsites/Landfills without compromising the integrity of such sites unlike seismic, Chemical and microbial methods.

Recommendation

The health of the citizens of a nation has positive impact on the economic and technological development of a nation. In view of the above the following recommendations are pertinent:

1. The government, its agencies and the general public should employ the services of geophysicists and waste management agencies/experts before establishing a dumpsites/landfills
2. Laws prohibiting the indiscriminate dumping of refuse in the environment other than those area designated by law should be enacted.
3. Dumpsites/Landfills should be sited at safe and reasonable distance away from residential buildings and others facilities that can be compromised by pollutants from them.
4. Where dumpsites/landfills are located there is need for periodic monitoring and maintenance of such sites and environs in order to ensure the integrity of the sites and decide when they can be shut down if they are likely to cause any health hazard.
5. The proper education of the general public on the important of water sanitation and good waste disposal methods, establishment of water treatment plants and good regulatory strategies.

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