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Risk assessment and rehabilitation potential of a millennium city dumpsite in Sub-Saharan Africa

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ABSTRACT

Management of the ever-increasing generated solid waste had been a difficulty for state governments in Nigeria. The high costs connected to this waste management which had encumbered the state budget, ignorance or lack of understanding of resourceful waste management and insensitivity to environmental concerns may have led to partial neglect of this sector. This research paper is aimed at evaluating the rehabilitation potential and the risk level of Igbatoro dumpsite, an Ondo state-managed waste dumpsite which predominantly receives the waste of Akure and its environs. In determining rehabilitation/reconstruction potentials and assessing the risk of the dumpsite, an Integrated Risk Based Approach (IRBA) was considered. The Risk Index (RI) was calculated from the addition of the sensitivity index output with the attribute weightage of the twenty-seven (27) parameters studied. A total risk index of 571.58 was obtained for Igbatoro dumpsite indicating moderate hazard evaluation. Questionnaires distributed to dwellers around the dumpsite also showed that 83.6% of those interviewed agreed that the present management of the dumpsite is poor while 81.8% supported rehabilitation of the dumpsite. Hence, reconstruction of the Igbatoro dumpsite to an endurable and controlled landfill is hereby recommended.

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1. Introduction

An arduous environmental challenge facing local authorities in many countries (most especially the developing ones) all over the world is the management of the ever-increasing and diverse municipal solid wastes (MSW). Among factors contributing to increase in MSW in developing countries are increment in population levels, swift urbanization, flourishing economy and improvement in living standards (Ağdağ, 2009; Minghua et al., 2009; Turan et al., 2009). The state/local governments in Nigeria are usually responsible for provision of effective and efficient waste management system in their cities to inhabitants. However, they face challenges in providing such (Sujauddin et al., 2008) mainly due to lack of organization, system multi dimensionality and complexity (Burnley, 2007; Guerrero et al., 2013). In developing countries additional factors challenging waste management include ignorance, dearth of sufficient policies and empowered legislation, political interference, lack of man, machine and money power (Agunwamba, 1998; Al-Khatib et al., 2015; Henry et al., 2006).

Apart from disposal into flowing water and incineration, a common method of eliminating MSW in developing countries is disposal in open dumpsites (Ali et al., 2014; Nnaji, 2015; Solomon, 2009). Wastes in dumpsites are exposed and uncontrolled owing to lack of daily cover. Environmental deterioration, public health risks and other socio-economic problems are obvious consequences of mismanaging dumpsites in Nigeria (Abah and Ohimain, 2010). Besides groundwater pollution (Akinbile and Yusoff, 2011; Longe and Balogun, 2010; Oyelami et al., 2013), dumpsites are anthropogenic sources of heavy metals contamination in soil (Odai et al., 2008; Ojuri et al., 2016). All these have a negative effect on environmental quality (Biswas et al., 2010; Calvo et al., 2005; Oluwatuyi and Ojuri, 2017). Presently various countries have noticed that their waste management method do not suit sustainable development goals. Hence the need to depart from options of traditional waste management to integrated approaches of waste management (Abu Qdais, 2007). An integrated approach to waste management would overcome the challenges in developing countries. It will also reduce mortality rates and promote environmental health.

A first step to this integrated approach is the rehabilitation of dumpsites (especially those with high rehabilitation potential),

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dumpsite rehabilitation is the restoration of an uncontrolled dumpsite to a controlled dumpsite for the remaining of its operational lifetime. The rehabilitation of El Yahoudia dumping site in Tunisia is a vivid example of a rehabilitated dumpsite in a developing country (Zaïri et al., 2004). While Nas and Bayram (2008) was of the opinion that rehabilitating and closing down of the dumpsite in Gumushane province in Turkey was difficult and costly, economic benefits of rehabilitation are more than the cost incurred (Ayalon et al., 2006). Study had also shown that phytoremediation could be used as form of rehabilitation to dumpsites (Nagendran et al., 2006). In planning and initiation of dumpsite rehabilitation, evaluation of the relative health and environment hazards associated with the existing dumpsite should be adequately carried out, as it is key in recommending a suitable methodology. The objective of this paper is to evaluate the pollution risks and rehabilitation potential of the Igbatoro dumpsite using the Integrated Risk Based Approach (IRBA) suggested by Kurian et al. (2005). Steps for further improvement of the dumpsite were recommended.

2. Study area (Igbatoro dumpsite)

The study area is the open dumpsite of Ondo State Waste Management Authority (OSWMA) Yard situated in Igbatoro Road, Akure, Ondo State, South-western Nigeria. The dumpsite is about 4.5 km from the Old Owena motel (now Shoprite) with the nearest village (called Imafon) located in the upwind direction of the site about 1.6 km from the dumpsite. The underlying soil of the dumpsite are predominantly sand with silty content. The dumpsite receives more than 100,000 metric tons of wastes per year. It is the most active dumpsite in the state, as it receives wastes from the city of Akure and its environs. Akure is located on latitude 7°58′0″N and Longitude 5°18′0″E with a tropical humid climate and two distinct seasons (rain and dry), while its average annual rainfall ranges between 1405 mm and 2400 mm. The main parent material of the soil is crystalline basement complex rocks, it is made up of ferruginous tropical soils. A sandy surface horizon underlain by a weakly developed clayey, mottled and occasionally concretionary sub-soil are main features of soil from the study area. The study area map is shown in Fig. 1 and a pictorial view of the dumpsite is shown in Fig. 2.

3. Materials and method

3.1. Soil sampling and testing methods

Soil samples were obtained randomly within the dumpsite at six (6) different locations as shown in Fig. 1(b). The method used for the sample collection is the trial pit method. Each pit was sunk by hand excavation with the aid of digger and shovel. Disturbed and relatively undisturbed samples were collected from the 1.2 m × 1.2 m pit at varying depths of 0.5 m, 1.0 m and 1.5 m. Soil were sampled at all three depths for each of the six locations except for two locations (location 5 and 6) where soil was not sampled at depth 1.5 m because of the rock present.

Basic geotechnical tests namely specific gravity, particle size distribution, Atterberg limits were performed on the soil samples in accordance to BS 1377(1990). Classification of the collected samples were done according to the American Association of State Highway and Transportation Officials (AASHTO) and Unified Soil Classification System (USCS). Permeability test was also conducted on the relatively undisturbed soil samples in accordance to the method described by Das (2002). The laboratory tests were conducted at the Soil Mechanics laboratory of The Federal Polytechnic Ado-Ekiti, Nigeria.

3.2. Water sampling and analytical methods

Three (3) existing hand-dug wells with approximate depths of 5.7 m, 7.65 m and 8.35 m in basement formation located within approximate distance of 12.4 m, 11.4 m and 9.6 m respectively away from the perimeter boundary of the dumpsite were used as sampling points for groundwater quality. The analyses carried out at the Quality Control laboratory of the Ondo State Water Corporation covered the physical, chemical and microbiological parameters of water samples. The physical parameters tested included appearance, color, taste, odour, turbidity, conductivity and temperature. The chemical parameters tested were pH, Total

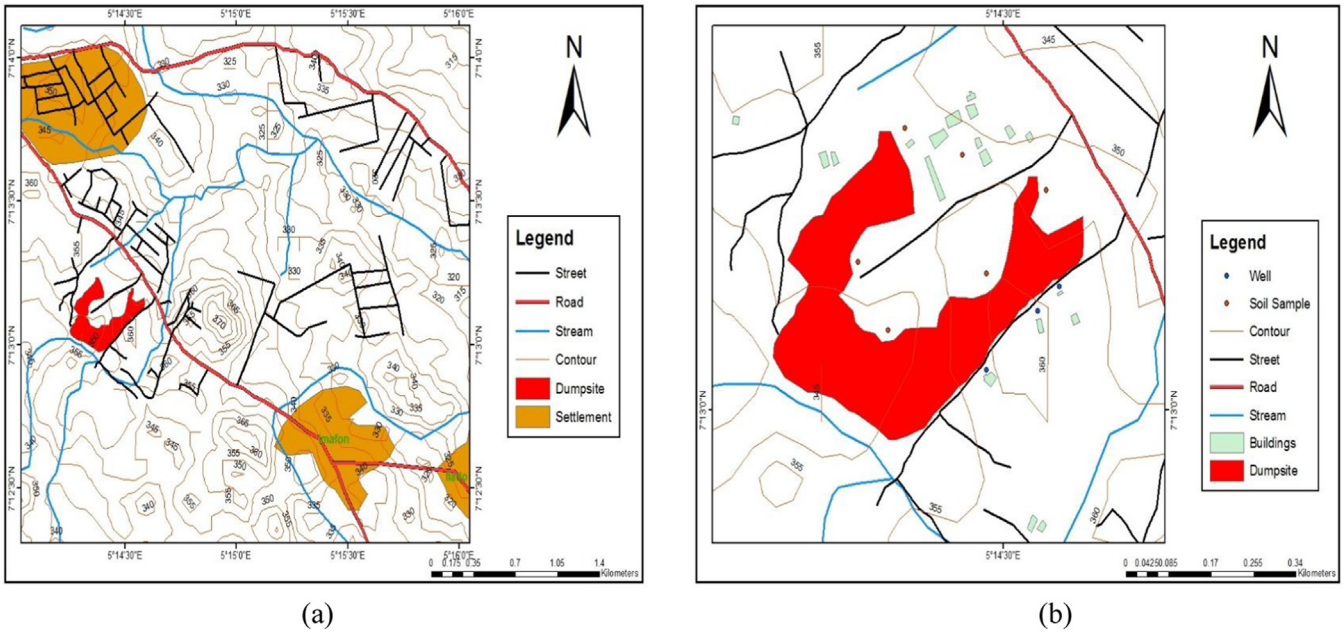

Fig. 1. Map showing (a) the existing open dumpsite and (b) existing dumpsite and sampling points.

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