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To cite this article: G A Adeyemi et al 2019 IOP Conf. Ser.: Mater. Sci. Eng. 640 012108

View the article online for updates and enhancements.
The place of geoinformatics in waste management, sanitation and health risks prevention in Ado-odo/Ota local government area

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Abstract: Increasing population growth, lack of suitable waste treatment and disposal sites, in addition to inadequate equipment for waste recycling, poor town planning, accumulation of waste beside the roads and canals caused by inadequate waste collection and lack of enough data and information on waste generation could be observed as palpable causes of inadequate waste management in our societies, as well as sources of environmental pollution. This paper considered the applications of Geographic Information Systems in the selection of suitable landfill sites in Ado-Odo/Ota LGA. Geospatial data of the study area were obtained, buffer, overlay and intersection analysis were carried out to exclude non-suitable locations and identification of suitable sites. The suitable locations for landfill were selected, and we concluded that GIS is a veritable tool in qualitative decision making in environmental management and sustainable development.

Keywords: Waste management, Health, Risks GIS

1.0 Introduction:
Increasing population growth in addition to increasing per capital income have culminated in the generation of huge municipal solid waste (MSW), posing a significant threat to human health and environmental quality if not properly managed. Landfill site selection is equally increasingly becoming harder because of the increasing environmental and public health concerns, increasing scarcity of land for landfill construction and cost. Rapid urbanization caused by rural-urban drift has inevitably added pressure on urban infrastructures and services that need attention in the first instance especially in less developed countries. Sustainable waste generation, effective waste collection, organized disposal systems and management would prevent environmental degradation, e.g. air pollution through noxious smell, surface and underground water pollution through percolation. According to [1], rising population densities, public health challenges and inadequate availability of lands for landfill construction are the main obstacles to overcome in selecting a suitable landfill site.

The amount of solid waste generated and disposed worldwide has skyrocketed as a result of changes in our ways of lives (eating, work habits, urbanization, transportation etc.). Landfilling is an economical waste management process that is used to properly dispose solid waste, with benefits such as less adverse health risks or hazards to both humans and the ecosystem. Lack of waste treatment and disposal sites, inadequate facilities for waste recycling, poor town planning, accumulation of waste beside the roads and canals- caused by inadequate waste collection- and lack of adequate data on waste generation could be observed as palpable causes of poor waste management in less developed countries. Present day estimates in Nigeria reveal an annual solid waste...
generation of 36 million tons. The increasing rate of globalization has led to an upsurge in the volume of solid waste being generated in our cities daily which have made the management of solid waste a major environmental and public health concern for governments of developing countries. The rate at which municipal solid waste are being generated in the Ado-Odo LGA, in Ogun State, Nigeria which is rapidly becoming an urban locale, has been increasing tremendously over the past years [2].

Most emerging nations, including Nigeria, have significantly heavier, wetter, more hazardous and corrosive wastes. These pose significant challenges to existing waste management techniques [3].

Chang and Breden, 2008[4] opined that landfill siting is a difficult, sophisticated, stressful, and protracted process requiring evaluation of several criteria, considering social, environmental, technical and financial factors. These are very crucial because the landfills may have a direct impact on the ecology and biophysical environment of the area.

Urban solid waste management is one of the most pressing environmental challenges facing authorities in less developed countries. Also, the methods of dealing with waste management practices varies from one country to another. Methods and procedures of wastes handling are equally different. Hazardous wastes would be handled with more care, by professionals and experts because of its immediate and long term effects e.g nuclear waste. Hence, wastes handling, treatment and disposal are very important because wrong handling and disposal methods could lead to environmental pollution, contribute to public health issues and affect lives generally. Industries and households generate wastes and they should be treated with care.

Baban and Flannagan [5] concluded that two major issues are of utmost importance in siting a landfill: (1) approval of the local population, which is driven by social and political considerations, economic incentives, and (2) engineering and technical protocols for planning and protection of the physical environment. Therefore, suitable sites cannot just be ‘anywhere’; landfills are environmentally sensitive in nature and cannot be situated just anywhere. Hence, landfill sites should be selected carefully with adherence to all necessary criteria.

2.0 The need for Geographical Information Systems in landfill site selection

Geographic Information Systems (GIS) efficacies in performing integrated analysis of data sets to aid decision making on environmental management, facilities siting and infrastructural development are enormous. Its vital roles as a decision support tool are therefore critical in pollution control and nature conservation. GIS could simply be defined as organized collection of computer hardware, software and spatially referenced data, personnel and procedure effectively combined to collect, analyse, store, manipulate, and display spatially reference data.

GIS is an economically viable and time saving method of selecting suitable landfill sanitary site, since the manual methods can be really difficult and tasking. Integrated analysis of GIS and remote sensing have proven to be a veritable tool in solving environmental problems and a solution bearer in making qualitative decision. Selecting suitable site for landfill requires multi-criteria analysis of datasets, which may come from different sources, scales and time. Effective methods of handling these high volumes of data are therefore very important.

GIS is an efficacious tool for the management and analysis of data required for any land development activity [6]. It has the ability to manage and model the important environmental, social, economic, political and technical issues. Majority of the components involved in the process of site selection for sanitary landfill involve spatial representation and analysis, which in the past has encouraged the utilization of geographical approaches that promotes the integration of multiple data layers using GIS and Remote sensing [7], [8] and [9].

Areas around or in proximity to significant recharge areas, e.g. public lands or airports, highly permeable soils, steep slopes, wetlands, floodplains, urban areas, and public water supply, wells and other land features are all considered as potentially unsuitable for siting a sanitary landfill. These areas could be identified, referenced and excluded in order to obtain the suitable areas for landfill. This may be a lot more complicated using the traditional and manual methods, hence, the need for GIS and remote sensing applications. [10] concluded that organized disposal systems and management would prevent environmental degradation. [11] described noise mapping as a graphical representation of the sound level distribution existing in a given region, so also the benefits of waste mapping as they exist in a certain location.
3.0 Methods
Secondary spatial data on the hydrology, soil, vegetation, settlements, road network and slope were obtained for the study area. Buffer operations were carried out using ArcGIS 5.5 in order to select the suitable locations that are able to meet the criteria for proximity to road, appreciable distance from water bodies, the areas outside the limits of economic trees plantation, areas that are not sandy in nature as well as locations that are outside residential areas. Buffer zones of 3km were created around the major road network. Generally, areas within this zone are considered suitable due to the proximity to the roads. However, other land uses within the buffer were also considered before arriving at a suitable site. These considerations include considerably safe distances of the proposed site from residential areas, water bodies and forest resources. These land use layers were combined by overlay operation to perform integrated analysis of the datasets. The final suitable sites were obtained as being within 3km of major roads and 1km away from the other land use categories. These locations could subsequently be subjected to ranking considering their sizes, locations and proximity to other considerations that may be factors of interest.

4.0 Result
The maps below show the locations that could be used for land fill in relation to existing land uses such as roads, agricultural lands and forest resources. The buffer areas take the locations of these land uses into consideration and isolate areas with the least environmental concerns in relation to the land use categories without creating environmental concerns in terms of surface or underground water pollution. The location that is not too far from the main road for cost effectiveness, areas that are not within the residential areas to prevent foul odour, the locations that are not within economic trees plantation.

![Buffer zones showing areas suitable for siting a landfill.](image_url)
Fig. 2:
An extract of the buffer zones suitable for siting a landfill.

5.0 Conclusion
Geographic Information Systems and computer-based spatial analytics have continually played a huge role criteria assessment and policy-making. Before the advent of GIS, an operation of this nature would require the analysts to physically be on ground to take manual measurements. This would be both labor-intensive and time-consuming. Accessibility and navigability around the site is usually another common challenge associated with the traditional methods. Hence, geoinformatics has become a viable tool in effective planning and qualitative decision-making.

Acknowledgement: The authors appreciate the financial support of Covenant University in the process of execution of this project.
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