Geospatial Modelling of Landfill Suitability Using Geophysical and Remote Sensing Data in a Basement Complex Area

[1]Kehinde Anthony Mogaji, [2]Soliu Ademola Mudashiru, *[3]Sodiq Solagbade Oguntade, [4]Mariam Yetunde Toyib

[1,2,4]Department of Applied Geophysics, Federal University of Technology Akure, Ondo State, Nigeria

[3]School of Natural and Built Environment, Queen's University Belfast, Belfast, United Kingdom

Email: soguntade01@qub.ac.uk

Authors ORCID IDs: [1]https://orcid.org/0000-0001-7069-1319, [2]https://orcid.org/0009-0003-2305-9646, [3]https://orcid.org/0000-0002-6247-1284, [4]https://orcid.org/0009-0000-5796-2348

Abstract

Sustainable waste management solutions, such as optimal landfill siting, are important due to the significant increase in solid waste generation. This research employed a geospatial framework to model seven (7) landfill suitability assessment factors (LSAFs) sourced from geophysical and remote sensing datasets, leveraging on Entropy (En), Analytical Hierarchical Process (AHP) and Grey Relational Analysis (GRA) models within the basement complex area of Nigeria. The seven Landfill Suitability Assessment Factors (LSAFs): slope, lineament density, drainage density, overburden thickness, hydraulic conductivity, depth to basement, and reflection coefficient, were systematically analysed using the aforementioned models to create landfill suitability assessment maps (LSAMs) of the study area employing ArcGIS 10.7 software. The result of the En-LSAM model revealed that 65% (288m^2), 32% (153m^2), 9% (43m^2) while that of AHP modeled LSAM showed that, 35% (169m^2), 49% (238m^2), 16% (77m^2) whereas GRA modelled LSAM showed that 38% (185m^2), 47% (228m^2), 15% (71m^2) of the study area fall into low, moderate and high landfill suitability respectively. The proxy validation technique, employing qualitative validation with the longitudinal conductance data of the study area, demonstrated accuracies of 71%, 64% and 70% for the Entropy, AHP and GRA models, respectively. The accuracies reveal the superiority of the entropy and GRA models, which are data-driven weighted approaches, over the expertly weighted AHP model in dividing the landfill suitability regions within the study area. This research presents an approach of integrating remote sensing and geophysical parameters for landfill suitability modelling in regions falling within the basement geologic settings. The findings from this research not only provide actionable insights for informed decision-making but also contribute to the advancement of geophysical knowledge and sustainable environmental management.

Keywords: Waste management, Landfill, Geophysics, Remote sensing, Geospatial analysis, Entropy