# Landfill Suitability Mapping of Lagos State, Nigeria: Analytic Hierarchy Process (AHP) and GIS Approach


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## Problem Statement & Case Study

As one of the fastest growing cities in the world, Lagos continues to grow in leaps and bounds with encroachment and inundation of landfill sites, that were hitherto considered distant from residential areas, as common phenomena. These landfill sights have now become a threat and menace to the city and its dwellers. Government's recent effort has been geared towards decommissioning some of these sites that have indeed become an eyesore while establishing new sites. A question that might arise is "where best could a landfill be sited?" The various considerations might be distance from roads and residential areas, clearance from water bodies etc. In this study we have attempted to combine various factors that may be of interest in the determination of potential landfill sites using a combined approach of Analytic Hierarchy Process (AHP), developed by Thomas Saaty (1980), and Geographical Information System (GIS) to obtain a landfill suitability map of Lagos state.

## Study Objectives

- Combine and analyze various variables of importance in the assessment of landfill site suitability in Lagos state using AHP and ArcMap
- Estimate area of potential landfill sites in order to categorize them on the basis of maximum volume of waste they can hold.

## Approach for Solution

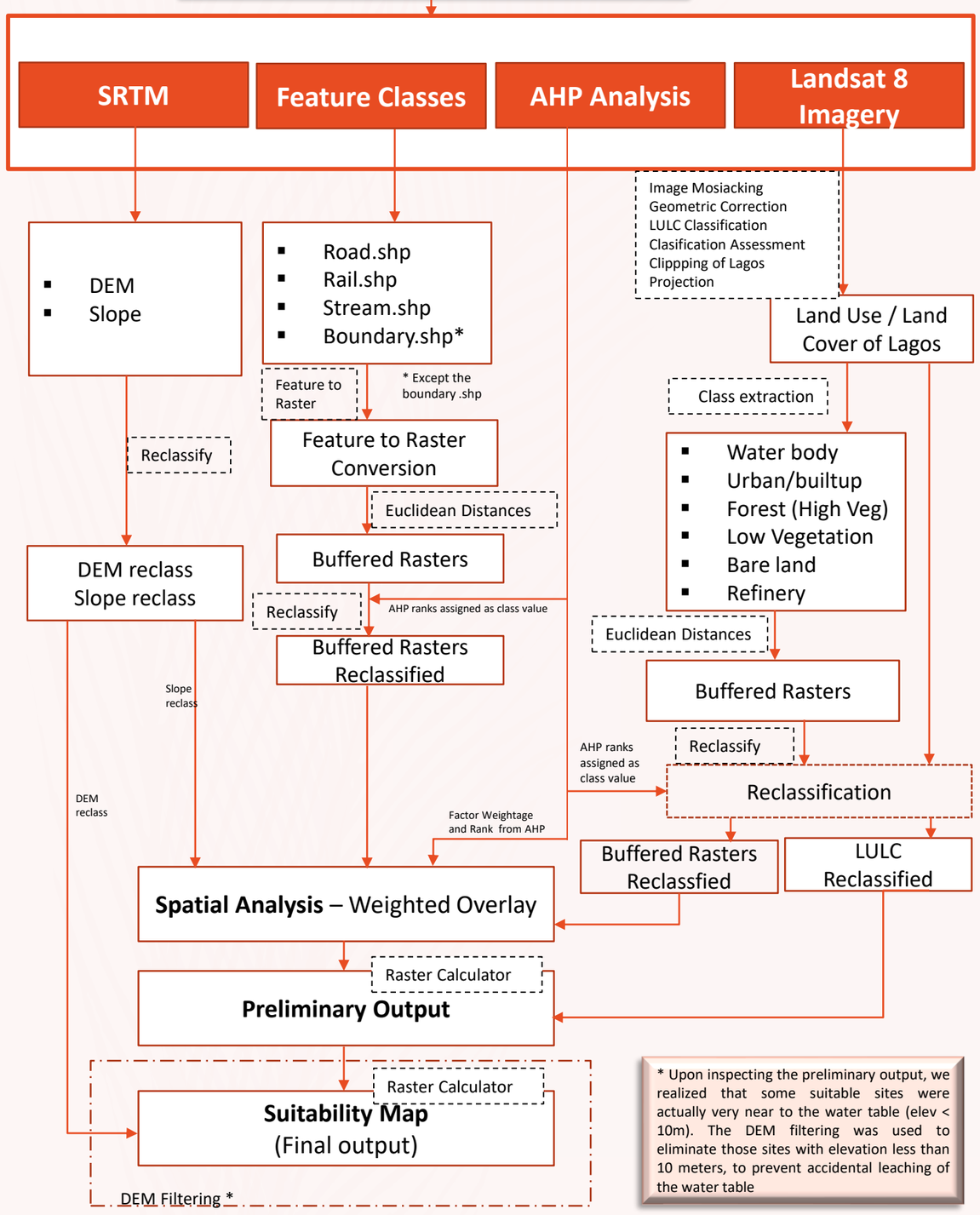


**Figure 1**: Flowchart of analysis

We have used pairwise comparison matrix computation in AHP to arrive at weightages of factors in this study. These weightages and standard suitability/priority ranking in AHP (1-9) have been used for class values(in reclassification) and ranks in weighted overlay analysis. The factors are as follows: low vegetation/bare land (1), roads(2), railway(3), urban(4), forest(5), slope(6), stream(7), waterbody(8). The suitability map generated from this process is an important first point of call document when landfill site


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**Reference**

Saaty, T.L. Multicriteria Decision making: The Analytic Hierarchy Process. McGrawHill: New York, NY, USA, 1980.


## Results & Benefits

### AHP Outputs

**Table 1:** Weightage of the various factors derived from AHP pairwise comparison matrix computation

| Factors | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Weightage (%) | 32.9 | 22.86 | 15.76 | 10.82 | 7.38 | 5.01 | 3.03 | 2.21 |

**Table 2**: Results from AHP pairwise comparison matrix

| S/No | Result of AHP Matrix | Values |
|---|---|---|
| 1 | No of factors (N) | 8 |
| 2 | Max. Principal Eigene Vector (λmax) | 8.38 |
| 3 | Consistency Index | 0.0110 |
| 4 | Relative Index | 1.41 |
| 5 | Consistency Ratio | 0.00783 |

**Table 3:** Class and rank coding

| Ranking | Suitability |
|---|---|
| 0 (Restricted) | Not Suitable |
| 3 | Less Suitable |
| 5 | Suitable |
| 7 | Most Suitable |

### GIS Analysis Outputs

Esri's ArcMap 10.5

Tools

*Maximum likelihood classifier, Feature to Raster, Reclassify, Euclidean distance, Weighted Overlay, Raster Calculator etc*

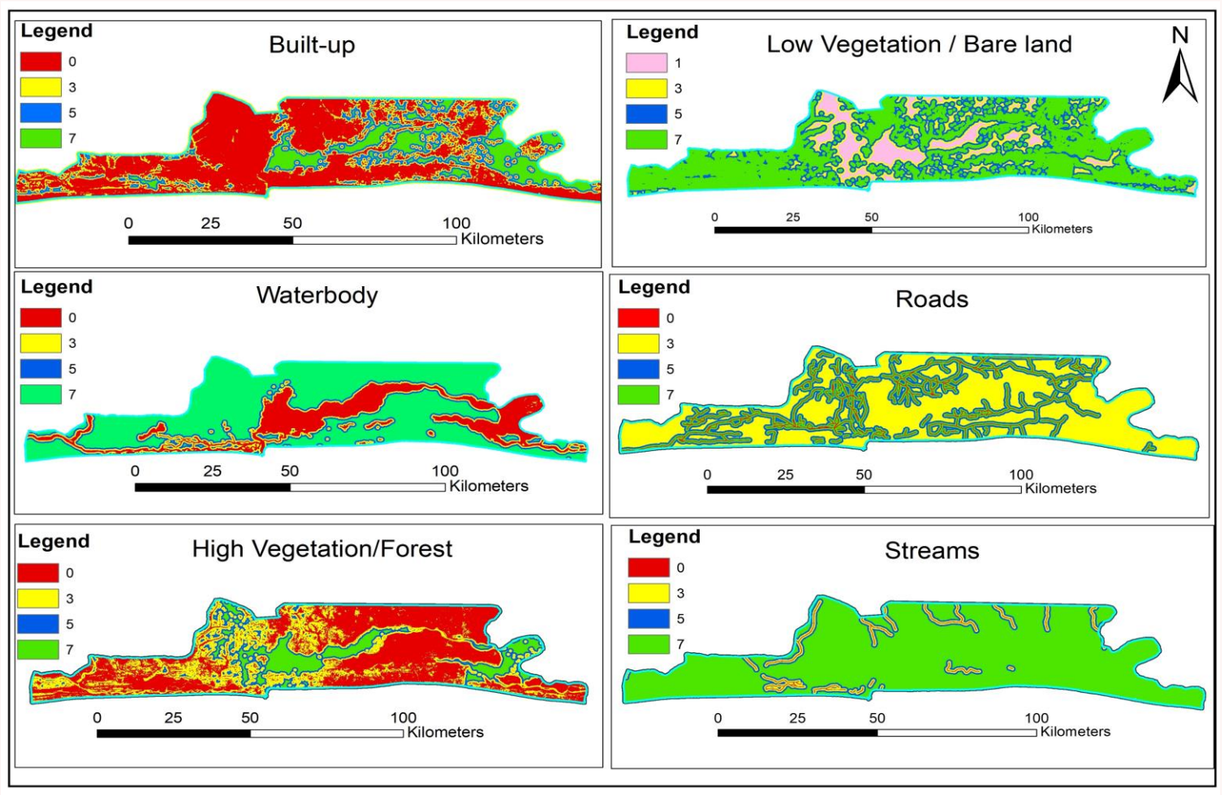


**Figure 2**: Reclassified Euclidean distances raster of some of the factors (not included are rail and slope rasters)

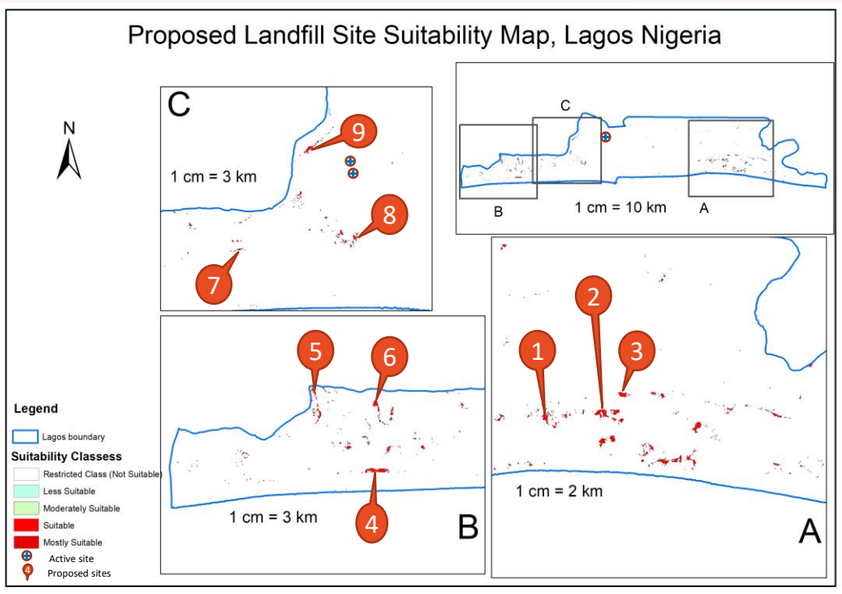


**Figure 3**: Final output showing some selected proposed sites as well as active landfill sites.

**Table 4**: Area of some proposed sites

| Sites | Area ($m^2$) |
|---|---|
| 1 | 420132.392 |
| 2 | 729096.215 |
| 3 | 394511.536 |
| 4 | 1140409.241 |
| 5 | 240915.378 |
| 6 | 465582.065 |
| 7 | 109322.387 |
| 8 | 189153.227 |
| 9 | 339149.078 |

## Benefits

With this outcome, the state government and policy makers are better equipped to make informed decisions with regards to location of landfill sites to save the city dwellers from the present environmental eyesore currently constituted by the present sites. Furthermore, the sample suitable sites area information shown in table 4 clearly indicates that planning and decision making can be further enhanced by knowing the size of landfill to be situated and its maximum operational or allowable capacity.

## Future Road Map & Conclusion

We have been able to demonstrate an integrated approach of AHP and GIS in landfill site selection using various factors known to be influencing the site selection process either directly or indirectly. Also shown, is estimated area of some proposed sites which is important in planning the actual situation of the landfill site. Our work also comes handy while making future planning as it affects the peculiarity of Lagos being a fast growing city.