Determination of Solid Waste Collection Points in Thika Municipality Using GIS

Boniface Mwenda Ntarangwi and Patroba Achola Odera

Department of Geomatic Engineering and Geospatial Information Systems, Jomo Kenyatta University of Agriculture and Technology
INTRODUCTION

Geospatial Information Systems (GIS) refers to a set of tools that are used for collection, storage, manipulation, analysis and visualisation of spatial data.

Solid waste refers to non-liquid waste materials arising from domestic, trade, commercial, agricultural, industrial activities and from public services.

Solid waste management refers to the collection, transportation, processing and disposal of solid waste.

In the modern world, solid waste management has become an important factor that must be considered during the formulation of urban development plans.
• Using GIS, solid waste collectors can solve fundamental problems in solid waste management such as determining the distribution of waste generation in an area and the optimal route for disposal.

• This can be achieved by considering factors that affect selection of disposal sites such as topography, geology, settlements, land use, water bodies and road networks.

• GIS has capabilities that allow overlay of these different factors and create models that can be analysed to come up with the most suitable location for solid waste collection sites.
PROBLEM STATEMENT

In Kenya, the general state of solid waste management is poor. For example; in Nairobi, solid waste management is characterized by low coverage of solid waste collection, uncontrolled dumping of solid waste, inefficient public services and poor infrastructure.

It is estimated that in Kenya, 30-40% of waste generated in urban areas goes unpicked and less than 50% of the population is served.

This leads to uncontrolled disposal of solid waste, usually at undesignated areas like street corners and at the road side. This causes environmental degradation through air, soil and water pollution.
EXAMPLES OF UNCONTROLLED DISPOSAL OF SOLID WASTE
OBJECTIVES

- To map the existing solid waste management facilities in Thika town. (Road network, collection and disposal points)

- To propose new collection points for solid waste disposal
DETERMINATION OF PROPOSED COLLECTION POINTS

1. Determination of suitable areas for location of proposed points
2. Determination of number of points required to serve the whole population
3. Mapping of demand points
4. Solving the location-allocation problem
DETERMINATION OF SUITABLE AREA

✓ This was done to avoid situations where a collection point generated would not be viable due to constraints such as legal or environmental.

✓ Physical features such as rivers, dams and plantations were mapped. The areas were merged to create a polygon that represented the exclusion zone.

✓ The exclusion zone was excluded from the area of study, resulting in a region suitable for placing collection points.
SUISIBLE AREA

Legend

- Thika_Municipality
- Suitable_areas

Coordinate System: Arc 1960 UTM Zone 37S
Projection: Transverse Mercator
DETERMINATION OF NUMBER OF COLLECTION POINTS

- This was based on the population of each sub-location and the capacity of each collection point.
- The capacity of each point was taken to be 400 kilograms. This is the average capacity of a front end loader (FEL) container.
- Using rate of waste generation in the municipality (0.55kg/person/day), number of points was given by:

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n = \frac{\text{rate of waste generation} \times \text{population of sublocation}}{400}
\]
SOLVING THE ALLOCATION PROBLEM

- This is a problem that involves determining the best location of facilities based on criteria like optimum distance, capacity of facility, population density, optimal cost and so on.

- In this case, the demand points (households) and the proposed points were used for analysis. The result was a spatially balanced set of points that could adequately serve the whole population.
Location-Allocation Parameters (ArcGIS)

This option solves the location problem where facilities have a finite capacity. It chooses facilities such that all or the greatest amount of demand can be served without exceeding the capacity of any facility. In addition to honoring capacity, it selects facilities such that the total sum of weighted impedance (demand allocated to a facility multiplied by the impedance to or from the facility) is minimized.
CONCLUSIONS

- The proposed points offer better spatial coverage, thus more residents of Thika sub-county can be served as compared to the existing system.
- More so, since the proposed points are all known, it is possible to perform more spatial analysis such as service area coverage. This would be necessary in future after the town has expanded, and new settlements have come up.
- The proposed collection points have the capacity to serve 93,056 residents, which represents 67% of the population. The existing collection points are estimated to serve 33% of the residents. Therefore, it is possible to achieve an improvement by 34% if the proposed collection points are implemented.
THANK YOU