Distance from roads: Landfill location must be close to roads network for accessibility and ease of transportation, consequently reducing relative costs. Minimum and maximum distance from road network for this study was set after summarizing different literatures. Figure 6 shows multiple ring buffers that we used to delineate exclusionary areas. Most studies suggest that landfills should be located within a 1 km buffer from the roads and other transportation facilities [6]. For this study a distance of greater than 1000 m from road network is considered as the best distance for siting process.

Distance from rivers: In order to reduce vulnerability to ground and surface water pollution from contamination, landfills should not be located near streams and river. Figure 7 shows multiple ring buffers were used to prepare multiple polygons around each streams and rivers within the following distances: 0-300,300-500,500-1000, >1000m. 300 to 500 m buffer areas were excluded from siting process. [12]

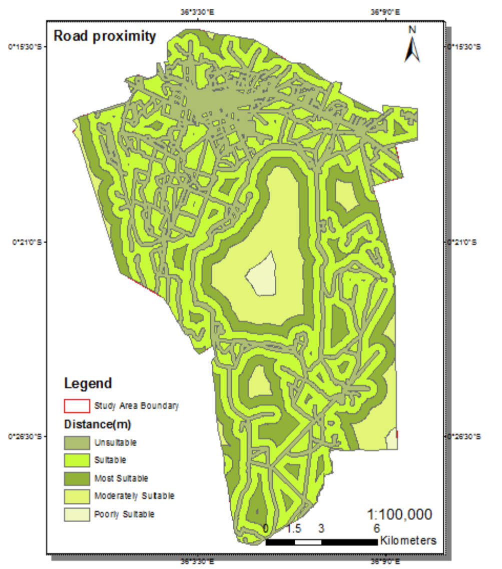

Figure 6: Road proximity suitability map showing suitable and unsuitable areas for landfill siting

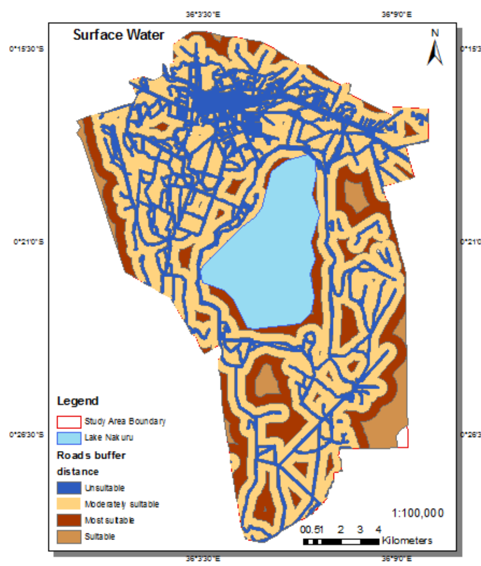

Figure 7: Rivers and streams suitability map of the study area

Land use/land cover:

Land use/ land cover of the study area was mapped from satellite image LANDSAT 8. Image classification was done to categorize the image to different classes through supervised classification. General land cover of the area was derived and five land cover classes were identified namely: water, urban, rangeland, forest and bare/agricultural land. Solid waste disposal site should not be placed too close to settlement areas and recreation centers. Land use types such as grassland, forests, agricultural land, wet land, bush lands would be considered and assigned an appropriate index of land use suitability.

Table 1: Land use/ Land cover

	Land use / Land cover	*Area(Km^2)*	*%*
1.	Water	39.32	13.5
2.	Urban	42.12	14.4
3.	Range land	110.80	38
4.	Forest	18.02	6.2
5.	Bare/ Agricultural land	81.04	27.8
		291.66	100

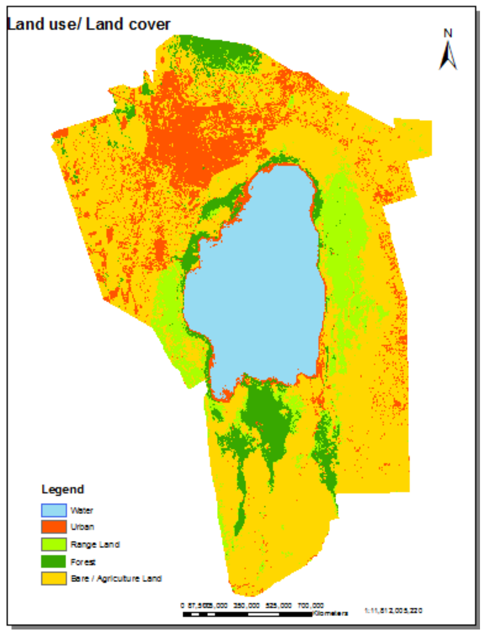

Figure 8: Map showing land use/ Land cover of the study area

3. Results and Discussion

Evaluation of Weighting Criteria

A component of MCDA is assigning weights for all factor maps used. Weights were used as a measure value assigned to each evaluation criteria. This weighting process was adopted in this study to express the importance of each factor relative to the other. Table 2 shows pair wise comparison that was adopted for calculating weight for all criteria. Based on our expert judgments, two criteria had to be considered at a time and for each comparison it was decided which of the two criteria was most important, and then assigned score was given to show how much more important it is.

A comparison matrix among the criteria was developed, indicating the relative importance of the criterion in the columns compared to the criterion in the rows which was subsequently used to compute an Eigen vector, which ultimately represented the ranking of the criteria.

Table 2: A Pairwise Comparison matrix, λ max=7.1562, CI=0.026 CR = 0.04 ≥0.01

	Eigen Vector Weight	*Percentage %*
LU	0.32	32
PPA	0.28	28
SL	0.16	16
S	0.11	11
G/L	0.07	7
PR	0.03	3
P.rd	0.03	3

Table 3: Derived weights and their percentage

	LU	PPA	SL	S	G/L	PR	P.rd
LU	1	2	2	3	4	9	7
PPA	0.5	1	3	3	4	9	7
SL	0.5	0.33	1	2	3	5	4
S	0.33	0.33	0.5	1	2	5	4
G/L	0.25	0.25	0.33	0.5	1	4	2
PR	0.11	0.11	0.2	0.2	0.25	1	2
P.rd	0.14	0.14	0.25	0.25	0.5	0.5	1

PR- Proximity to rivers, PPA- Proximity to protected areas, LU-land use/ Land cover, S- soil, G/L-geology, SL-slope, P.rd- proximity to roads

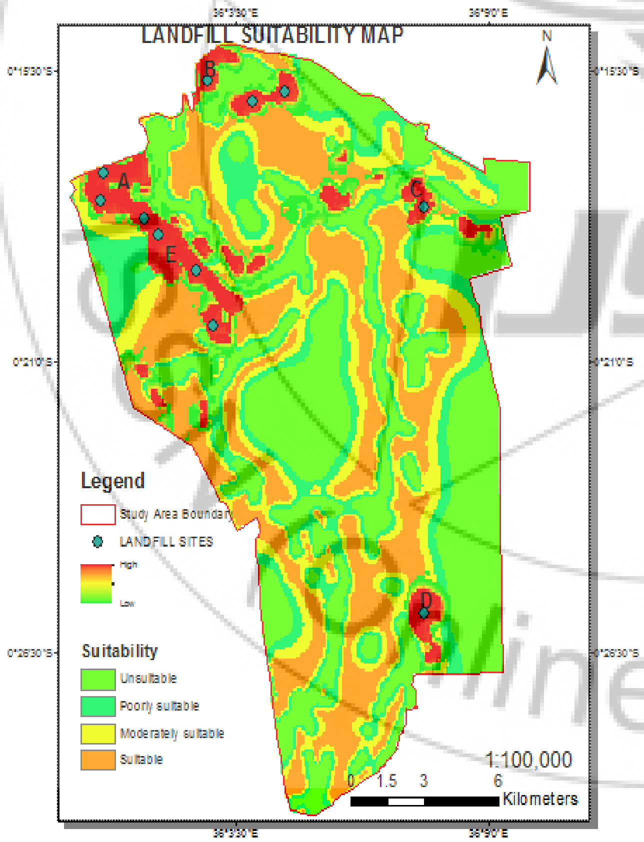

Figure 9: Landfill suitability Map

Landfill suitability analysis is based on different environmental and social factors. The seven factor maps were combined according to their importance, land use and land cover carried the most importance to the overall suitability map. The analysis of the weight assignment shows that land use / land cover related factors; slope and soils are more influential than the other factors

Protected areas had an overall percentage weight of 28%. Slope, soil, geology had 16%, 11% and 7% respectively. Both proximity from rivers and roads had equal importance. Accordingly, 11 candidate landfill sites each with an area greater than 0.5km^2 were selected. The result of the final suitability map (Figure 9) showed that there are some discontinuous small area sites as suitable areas for landfill location. However, 62.8% of the area was unsuitable for landfill siting, 0.76% poorly suitable. Out of the remaining area, 5.52 % of the area was most suitable, these areas are preferable for landfill because of their minimum effect on environment, public health and cost effective than other parts of the study area. 11.24% was found to be moderately suitable, while 19.32% was suitable. Field verification exercise was carried out to determine the accuracy and suitability of the candidate sites.

4. Conclusion

Gioto open dumping site has been posing negative impacts on the environment and public health like downstream water pollution, soil pollution and health problems to the surrounding community. The problems resulted due to not considering key factors necessary in landfill siting. The seven factor maps were combined according to their importance, land use and land cover carried the most importance to the overall suitability map. Protected areas had an overall percentage weight of 28%. Slope, soil, geology had 16%, 11% and 7% respectively. Both proximity from rivers and roads had equal importance.

Final suitability map was created showing 11 candidate sites, Site A found on the north eastern part of Nakuru town being the most suitable, followed by sites Band C.

The findings from this study can be a significant basis for replication in other towns as a step in to an efficient and effective practice of waste management and disposal.

Integrating GIS and MCDA in the site selection process can greatly improve waste management sector in Nakuru town. This can be done by establishing a landfill facility to serve the town and its environs.

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