Table 2: Routes Comparison

Variable	Optimal	HC	Envi	Oil	Eng.	Geo	CoA
Length	194	194.8	195.7	193.8	194.7	196.1	194
Wetlands C.	1	1	1	1	1	1	1
Rivers C.	15	14	4	16	14	14	114
Roads C.	43	50	43	51	44	60	62
Rail line C.	2	2	2	2	2	2	2
Settlements within 100m	3	1	1	1	0	2	2
AA C.	400.5	387.3	466	424.8	357.6	451.3	448
GWP within 250m	0	1	0	0	0	0	0
Forest Area C.	123.4	127.9	96	191.5	108.5	110.9	214.6

Length in Kilometers, Area in Hectares, Areas taken with a 25 meter Buffer

GWP = ground water points, C. Crossed, AA = Agricultural Area, Eng. = Engineers; Geo = Geoscientists, CoA = County Administrators, HC = Host Community, Envi = Environmentalists, Oil = Oil and Pipeline Industry.

Within a 25m buffer, the geology area covered by the routes indicated that optimal route was the third best in terms traversing soft rocks. Similarly in terms of soil type's coverage, optimal route was the second best in traversing sand soils rather than clay soil.

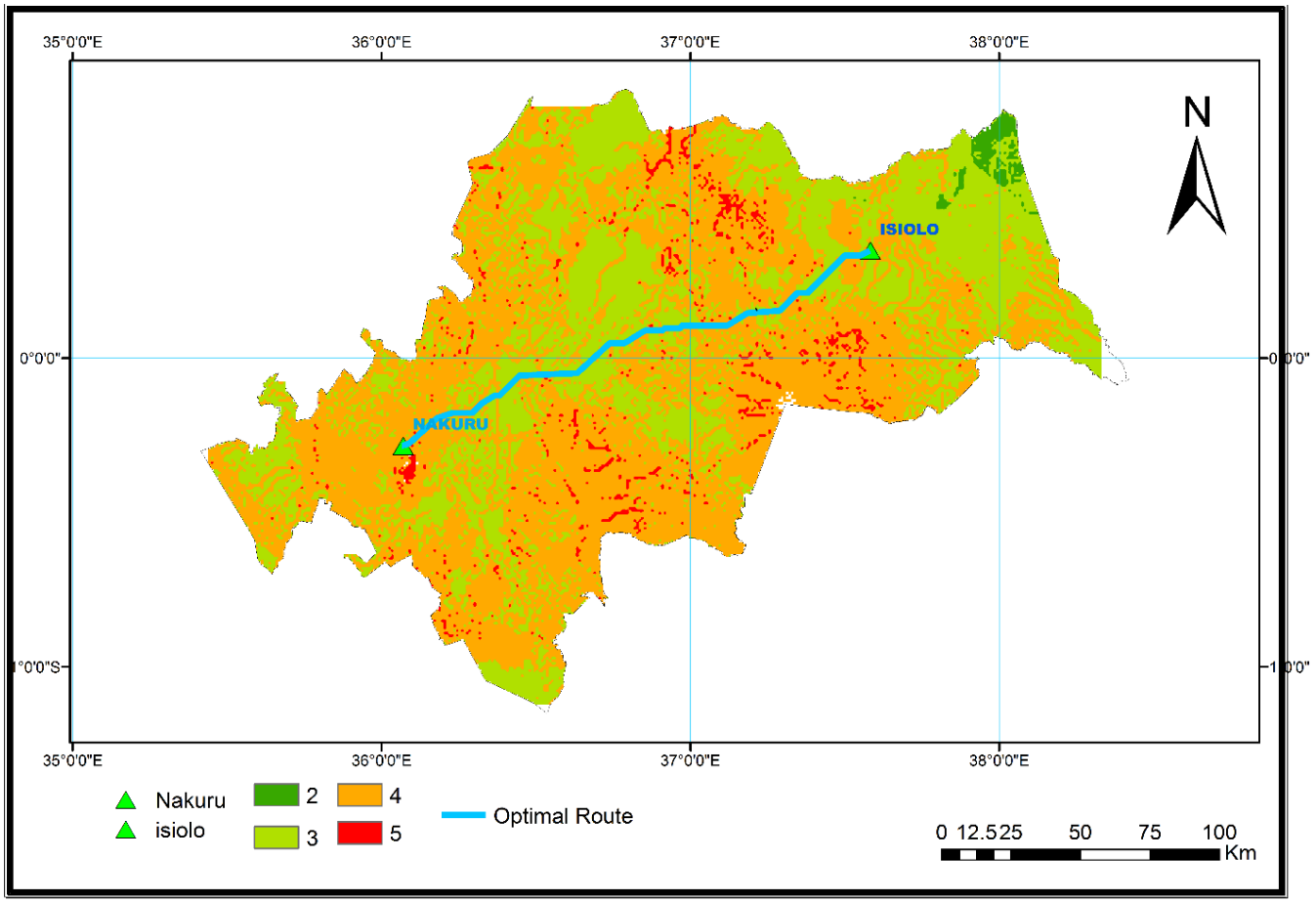

Figure 3: A Map of the suitability layer and the Optimal Route

5. Conclusion

An optimal oil pipeline route was generated using GIS analysis and spatial modelling incorporating multicriteria decision with environmental, engineering, technical and social factors being the key criteria. The model developed incorporated 13 variables. The results of weighting showed very high preference for ground water sites, agriculture land, rivers, settlements and game parks/reserves and or forests. Slope, geology and soil types were the engineering factors that are hard to navigate. Bare land, rail crossing, roads proximity and road crossing ranged were weighted low. There were high standard deviations observed from respondents within the same category. The CR used was 0.5 as opposed to the conventional 0.1, due to the high number of variables and lack of clear criteria on what CR should be used for how many variables. The route profile generated had a peak of 2780 and the lowest with about 1110 msl as opposed to the highest point in the study area with 5000msl, a reduction in elevation given the weight.

Results from weights indicated the importance environment conservation and protection of human life pipeline routing while engineering factors can be navigated using technology. The optimal route was generated using the mean weights and by use of standard deviation alternatives were given. The suitability layer indicated the study area was a fair routing area. The model developed can be used for modelling different types of linear structures in Kenya. This study presented the dynamics in pipeline routing and demonstrated the interrelationship among engineering, environmental and social factors in routing a pipeline.

Several ground realities that affect the route were not considered, they can be ascertained after a ground survey. Adoption of GIS techniques for routing of linear structures in Kenya, considering land ownership and developing an independent interface for non GIS professionals can be taken up to utilize the findings of this research and further them .

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