

**USE OF *DEPTH TO WATERTABLE,*
SOIL AND TOPOGRAPHY IN
MODELLING VULNERABILITY
OF GROUNDWATER TO
POLLUTION IN NAIVASHA-
ELEMENTAITA-NAKURU
WATERSHED; KENYA RIFT.**

BY

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Background

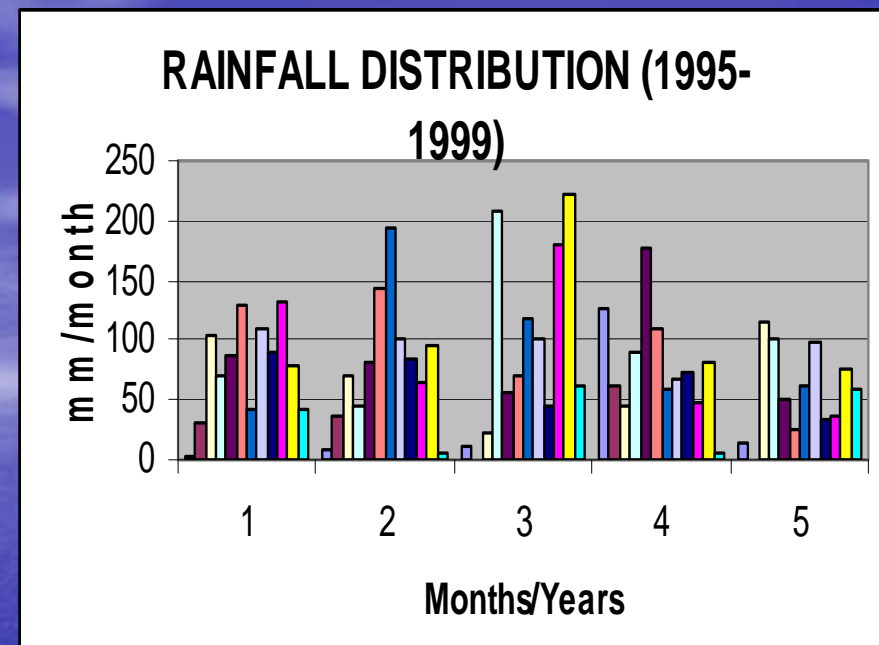
- Population increase and urbanization, 38,181 in 1962, 289,385 in 2000 in Nakuru. 25,000 in 1987, 250,000 in 2002 in Naivasha.
- Change in land use. From stock rearing, ranching to horticulture.
- Intrinsic characteristics of the rift aquifers.

Review

- Vulnerability.-the sensitivity of groundwater quality to an imposed contaminant load, which is determined by the intrinsic characteristics of the aquifers.
- DRASTIC.-system which involves delineation of hydrogeologic settings and data analysis to develop a single index number which represents the sensitivity of that setting to groundwater pollution.

Importance

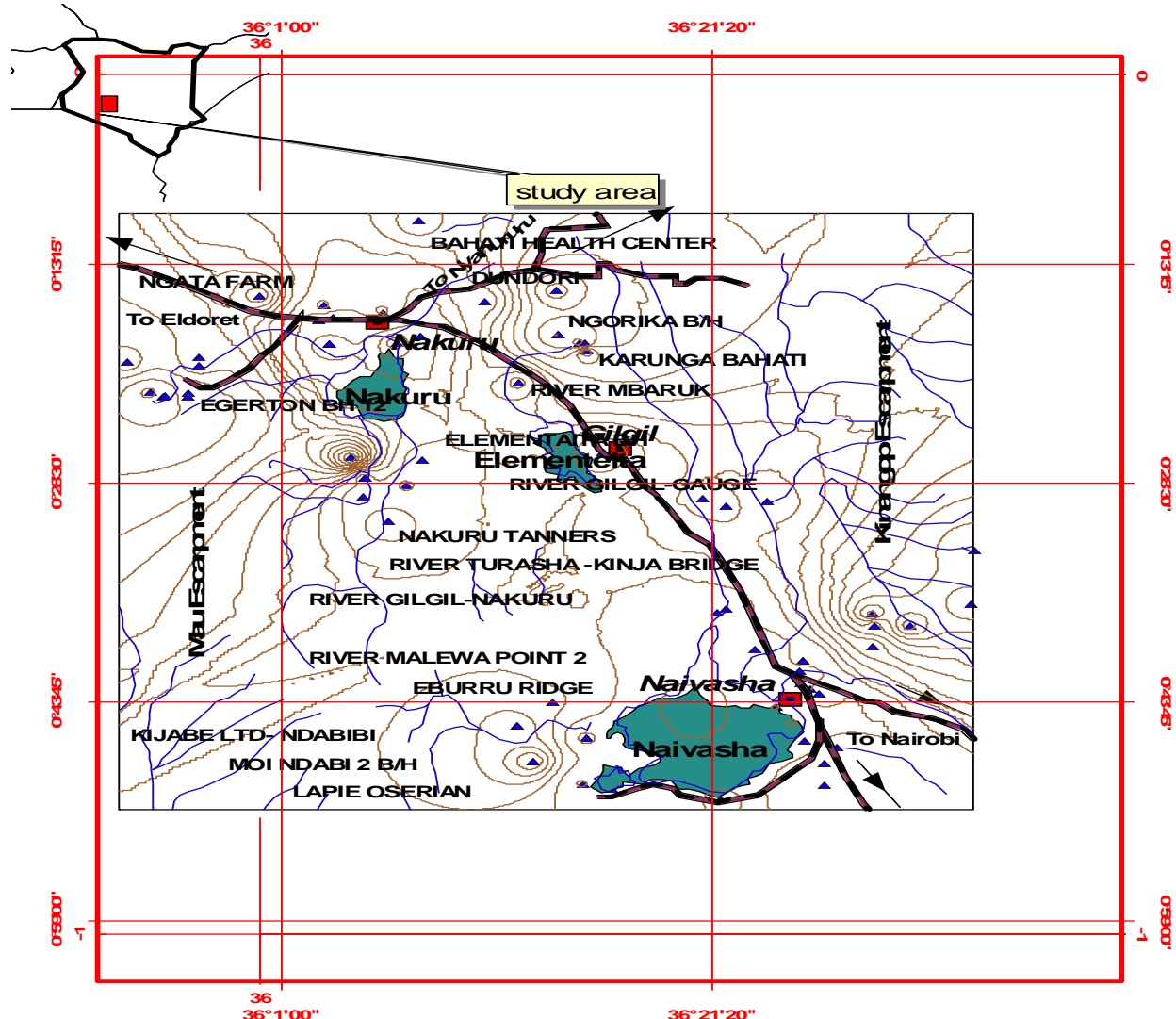
- Insufficient supply of water.
- poor waste management in urban areas.
- Unreliable and unpredictable rainfall patterns. (see graph)



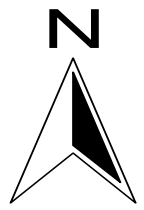
Objectives

- Identify potential aquifers for future development
- Identify less vulnerable zones to delineate areas that can be exploited optimally for groundwater.
- Assess the combined effect of depth to water table, topography and soil in groundwater vulnerability index.

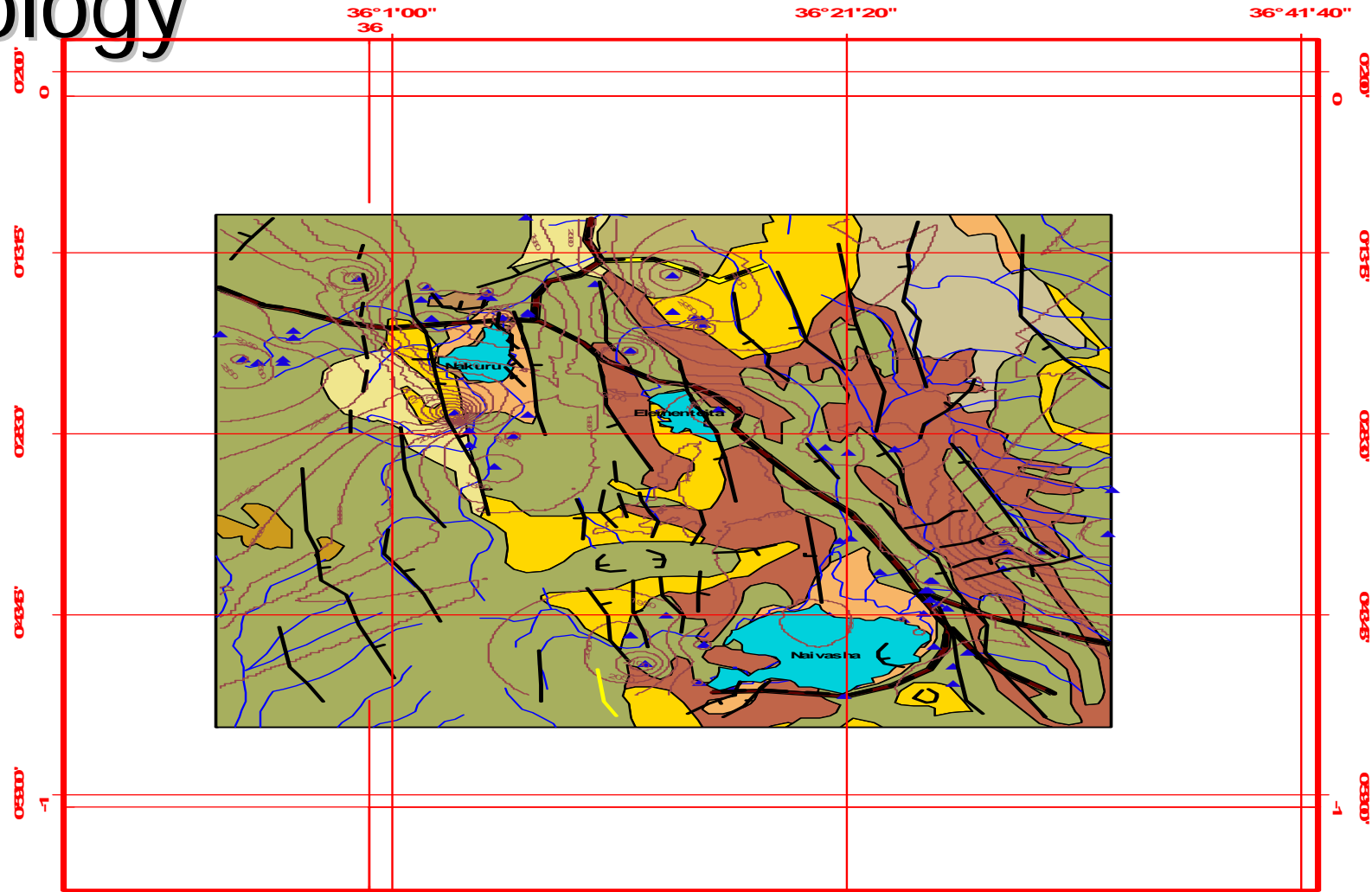
Study area



- LEGEND**
-  Rivers and streams
 -  Major roads
 -  Contours
 -  Lakes
 -  Towns
 -  sampled boreholes











geology



LEGEND



geology

-  Andesite, trachyte, phonolite
-  Basalt
-  Basic igneous rock
-  Eolian unconsolidated rock
-  Fluvial
-  Igneous rock
-  Organic unconsolidated rock
-  Pyroclastic unconsolidated rock

-  Faults
-  Contours of Results hse.dbf
-  Kenya_Lakes.shp
-  Results hse.dbf
-  major roads
-  rivers

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Methods used

- Desktop review of maps, reports & literature.
- Field measurements.
- Data conversion and plotting:-
- Depth to water table
- Topographic calculation from altitude.
- Digitizing the soil map while making reference to DRASTIC ratings.

Assumptions in DRASTIC

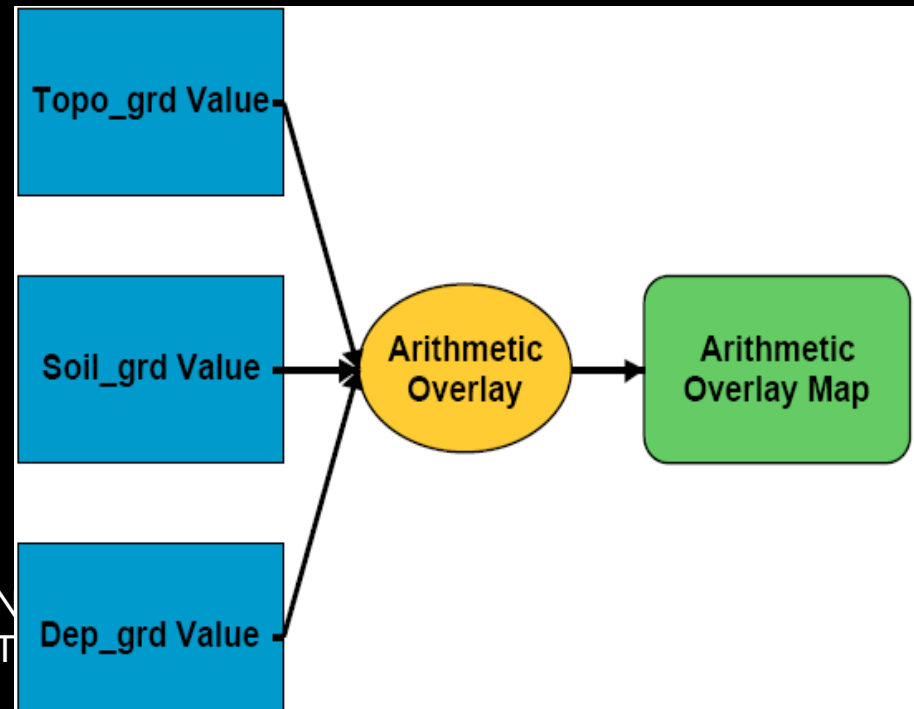
- the pollutant is introduced at the ground surface.
- The pollutant is flushed into the groundwater by precipitation.
- The pollutant has the mobility of water.
- The area evaluated using DRASTIC is 100 acres or larger.

Tables used

Depth(m)	rating
19-34	7
34-48	5
48-63	3
63-78	2
78-92	1

Soil type	Locality	Rating
solonetz	Naivasha Nakuru	9
phaeozems	SoysambuPa nda farmOserian farmBahati	8
andosols.	Eburru Mau Escarpment	7
cambisols	Kinangop,Oi kalao,Gilgil,N jorowa gorge	9
lava	ElementaitaN	6

Altitude	index
2316-2438	2
2194-2316	3
2072-2194	4
1950-2072	5
1828-1950	6

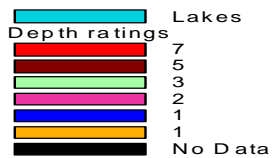


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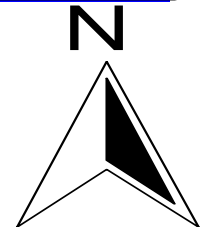
Outcome-Depth rating



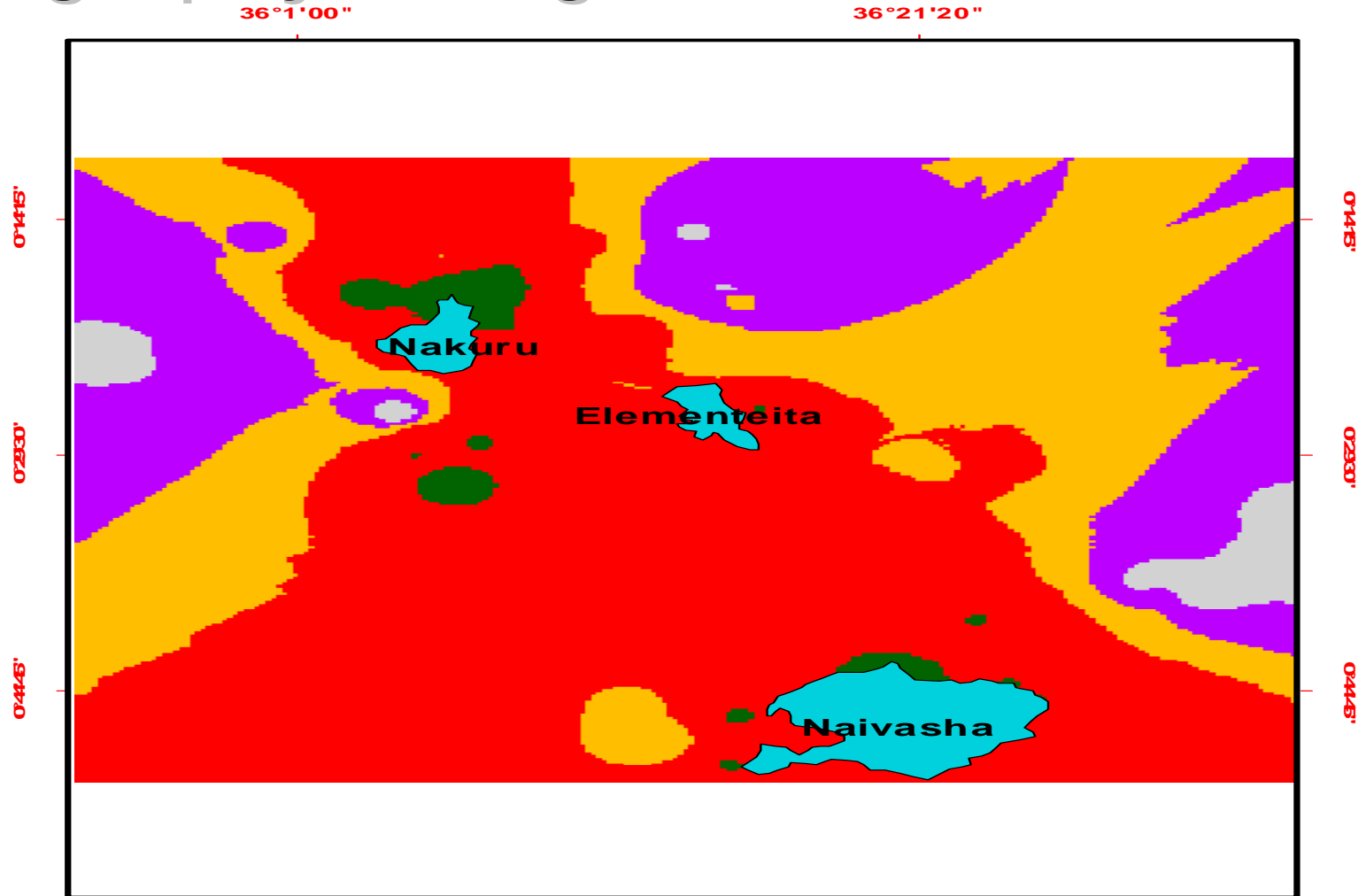
LEGEND



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Topography rating

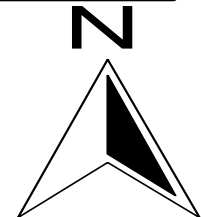


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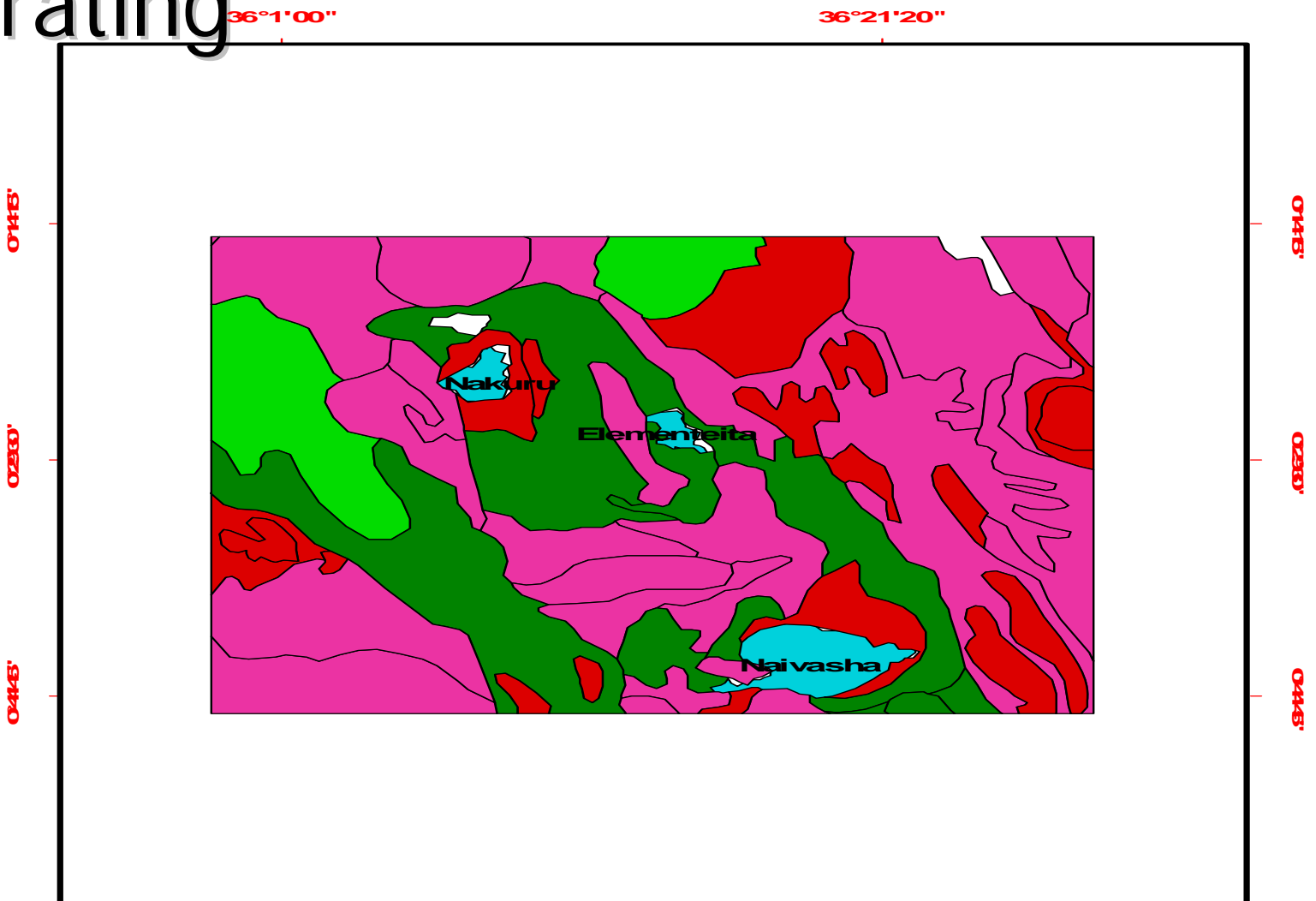
- Lakes
- Topography ratings
- 6
- 5
- 4
- 3
- 2
- No Data

7 0 7 14 Kilometers

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Soil rating



LEGEND

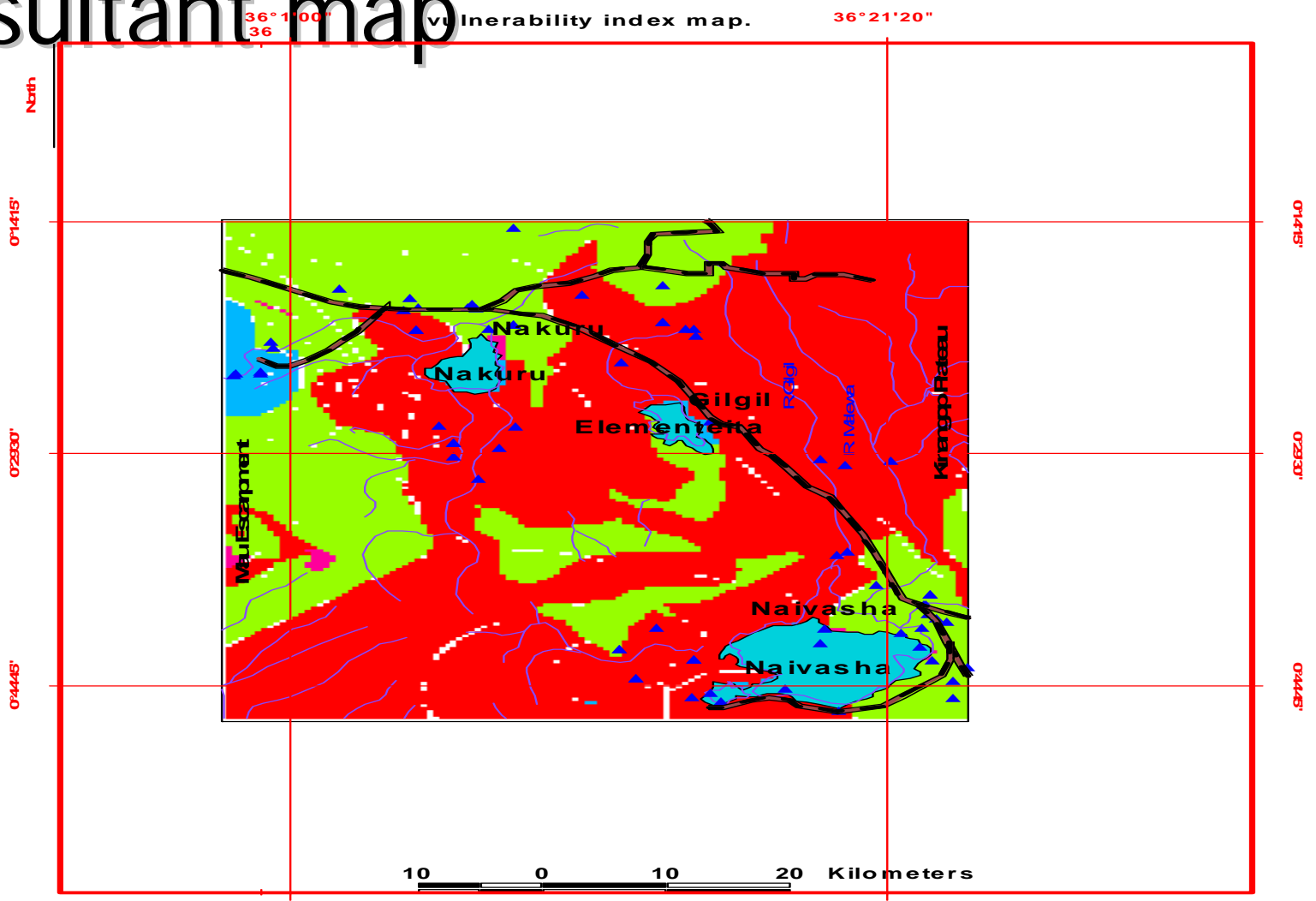
Soils and ratings	
	Solonetz = 9
	Cambisols = 10
	Phaeozems = 8
	Andosols = 7
	Lava = 6
	Lakes








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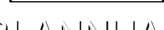
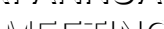
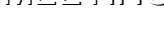
Resultant map

vulnerability index map.



LEGEND

-  Major roads
-  sampled boreholes
-  Rivers and streams
-  Lakes
-  Towns

- Arithmetic Overlay Map**
-  Low
 -  Moderate
 -  High
 -  Very high
 -  No Data

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Discussion

- Depth to watertable results indicate that over 70% of the area is less vulnerable->100m.
- Topography results indicate that Akira and Ndabibi plains are highly vulnerable. The results also conform to what is expected of a rift. Floor is generally susceptible.
- Soil parameter indicates that thin-layered soils, *cambisols* are the most vulnerable.
- Physico-chemical results are below WHO standard save for fluoride. But high levels of *coliforms bacteria* is an indication of poor sanitation.

conclusion

- fluvial and pyroclastics sediment aquifers are highly vulnerable when the parameter of slope is considered.
- The same aquifers are equally vulnerable when depth to water table is considered.
- The parameter of topography as modeled here indicates the reliability of this model. This is because of conformity shown in depicting the rift morphology.
- We can therefore conclude that this model is practical when assessing vulnerability of groundwater to pollution when other factors are kept constant.

recommendations

- Little improvement in the well-log data from the Ministry of Water and Irrigation could go along way in improving future model.
- Studies should also be carried in form of experiments to actually measure the response of these aquifers to ascertain their properties.
- Modification to include structures i.e. faults should also be considered.



MAWARI KENYA TEAM