ADDRESSING NATIONAL CHALLENGES THROUGH GEOSPATIAL MODELING

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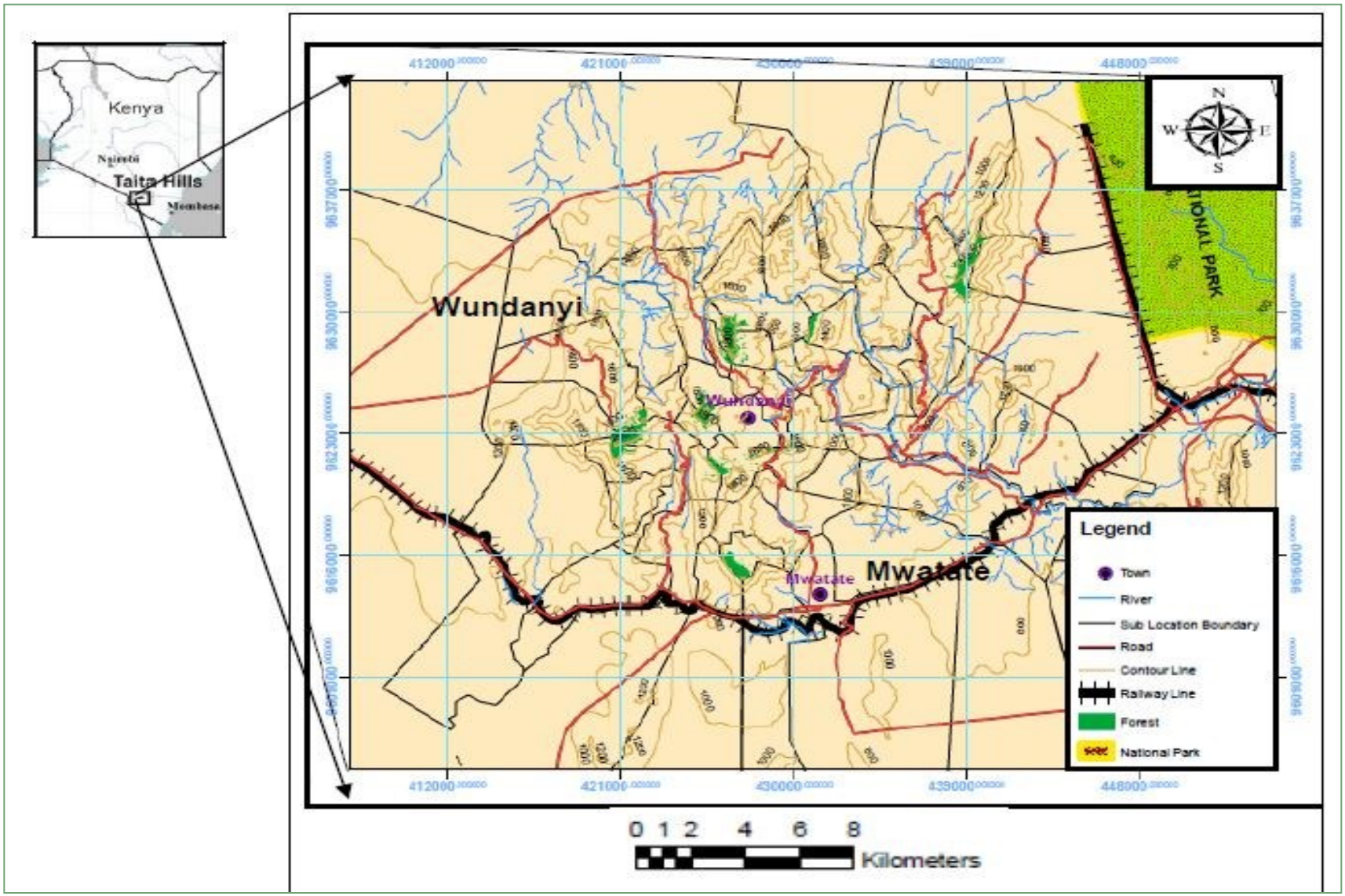
Geospatial Modeling for Cropland Assessment and Modeling Agro Ecological Zones.

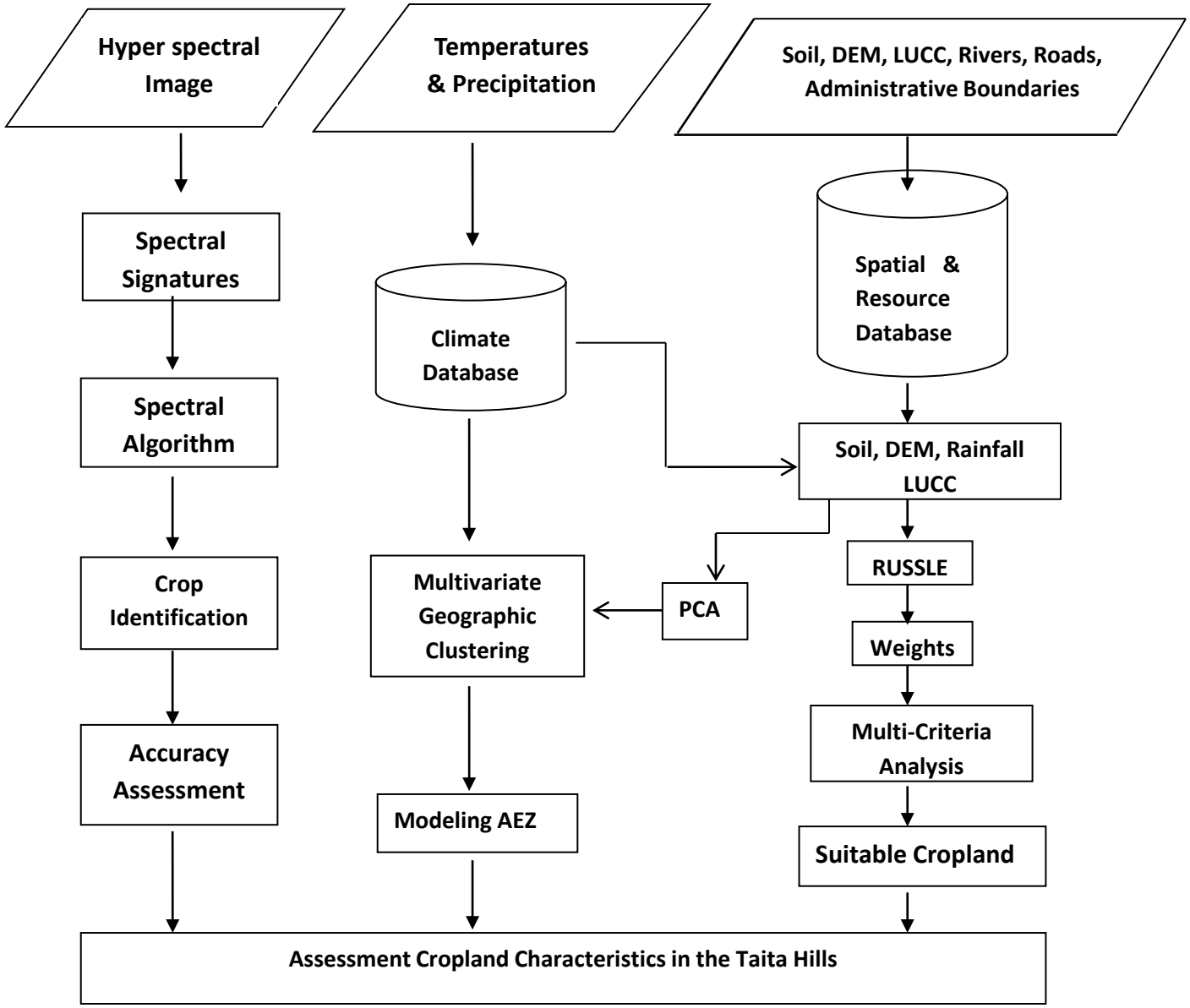
Case of Taita Hills, Coastal Kenya



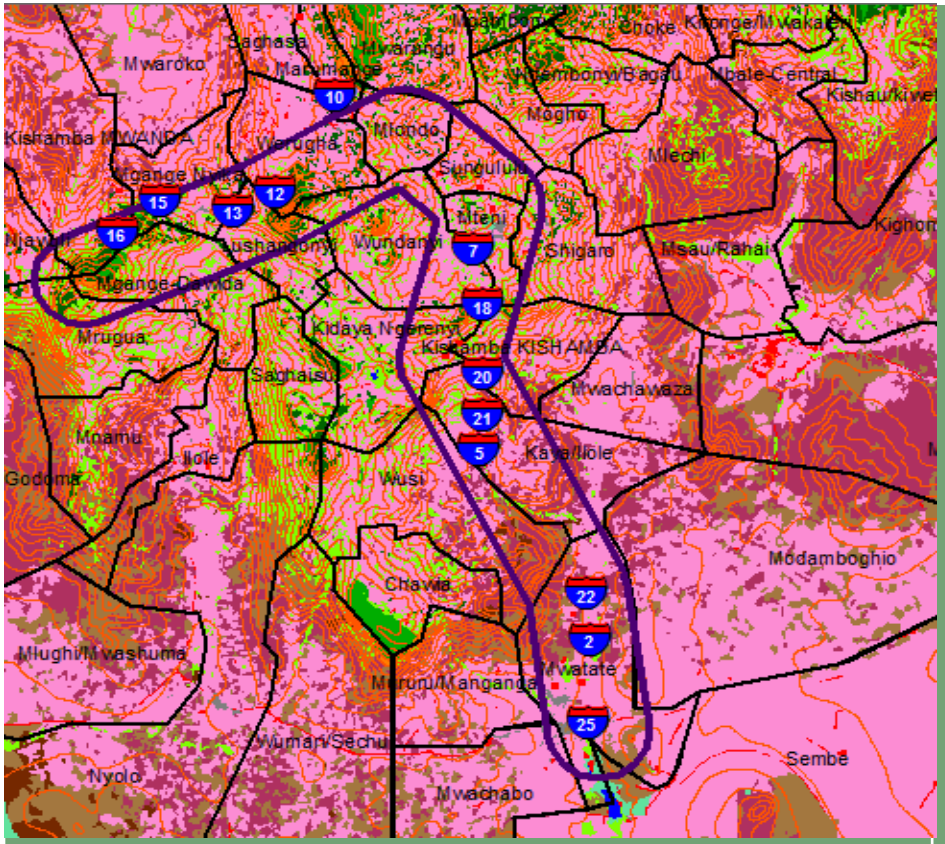
DATASETS

Data	Description
Hyper spectral images (AISA Eagle Imagery)	January 2012,
Aerial Images (NIKON D3X)	Provided mosaic imagery
Satellite image (SPOT 5)	Basis for land use and land cover mapping
Existing GIS data	Available datasets
Climate data sets	WorldClim data of FAO for 1960-2010 plus projections. Weather station data for 2009-2012.
Soils of Kenya	ILRI databases, Kenya
GPS measurements	Crops mapping

Modeling Approach



Transect – Taita Hills



DESCRIPTION

Points in blue randomly selected on the transect.

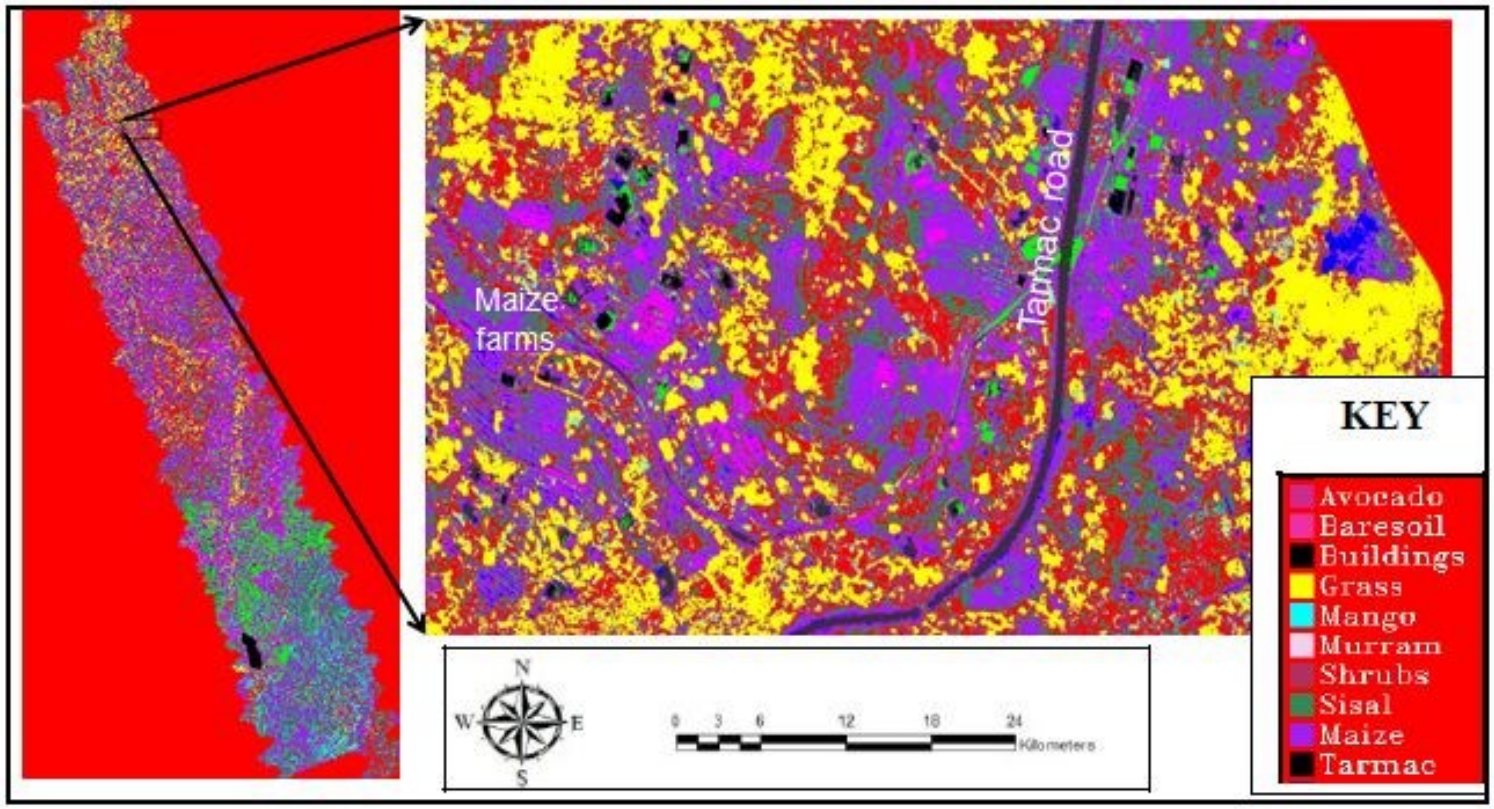
Majorly crops - maize, bananas, sorghum, beans, potatoes, cassavas among others.

Fruits included mangoes, avocadoes, pawpaw, citrus, oranges

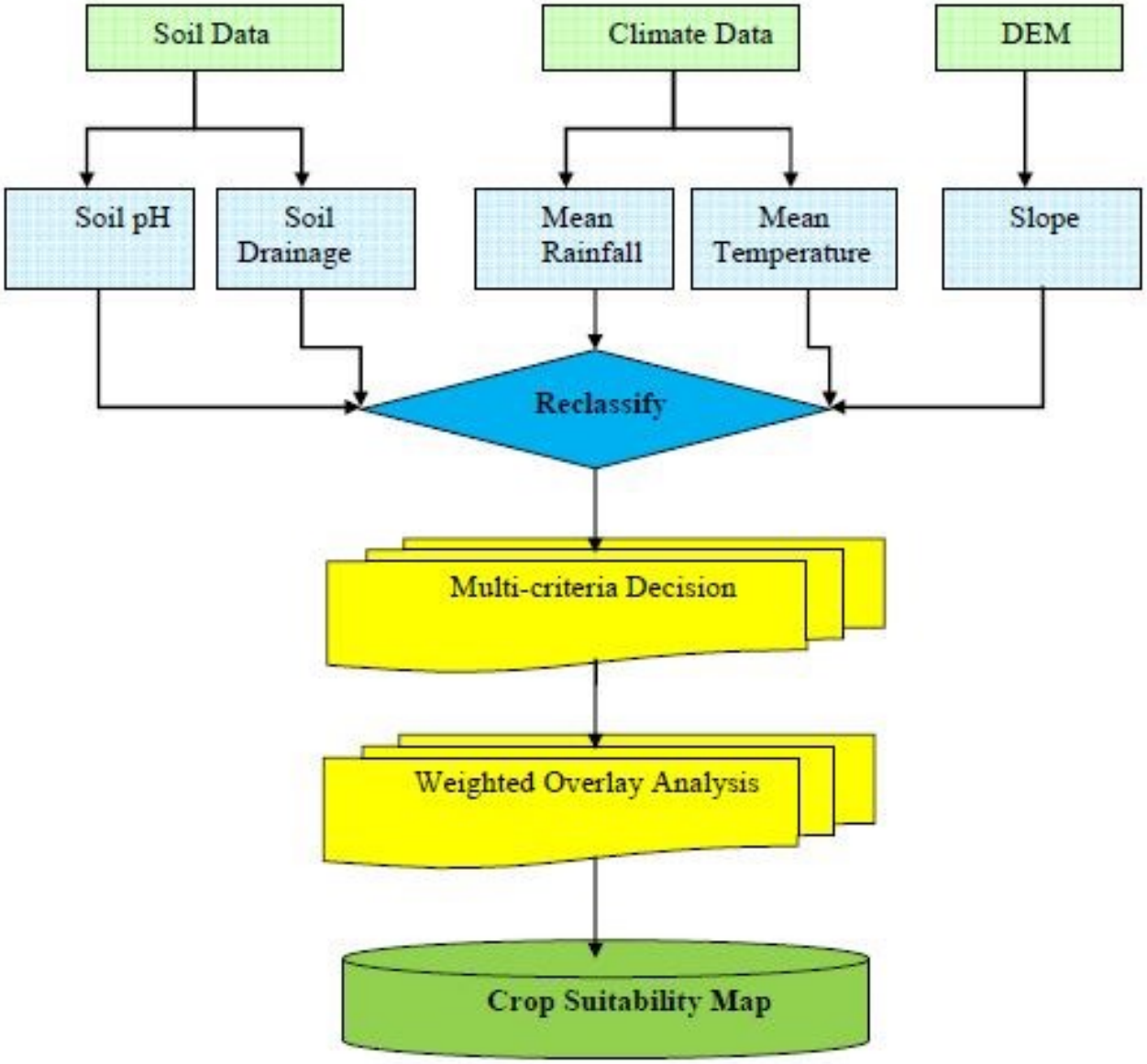
Dark-blue line is the transect line at 1 km buffer.

Plots selected for climate analysis along a 1km buffer transect.

Land Cover

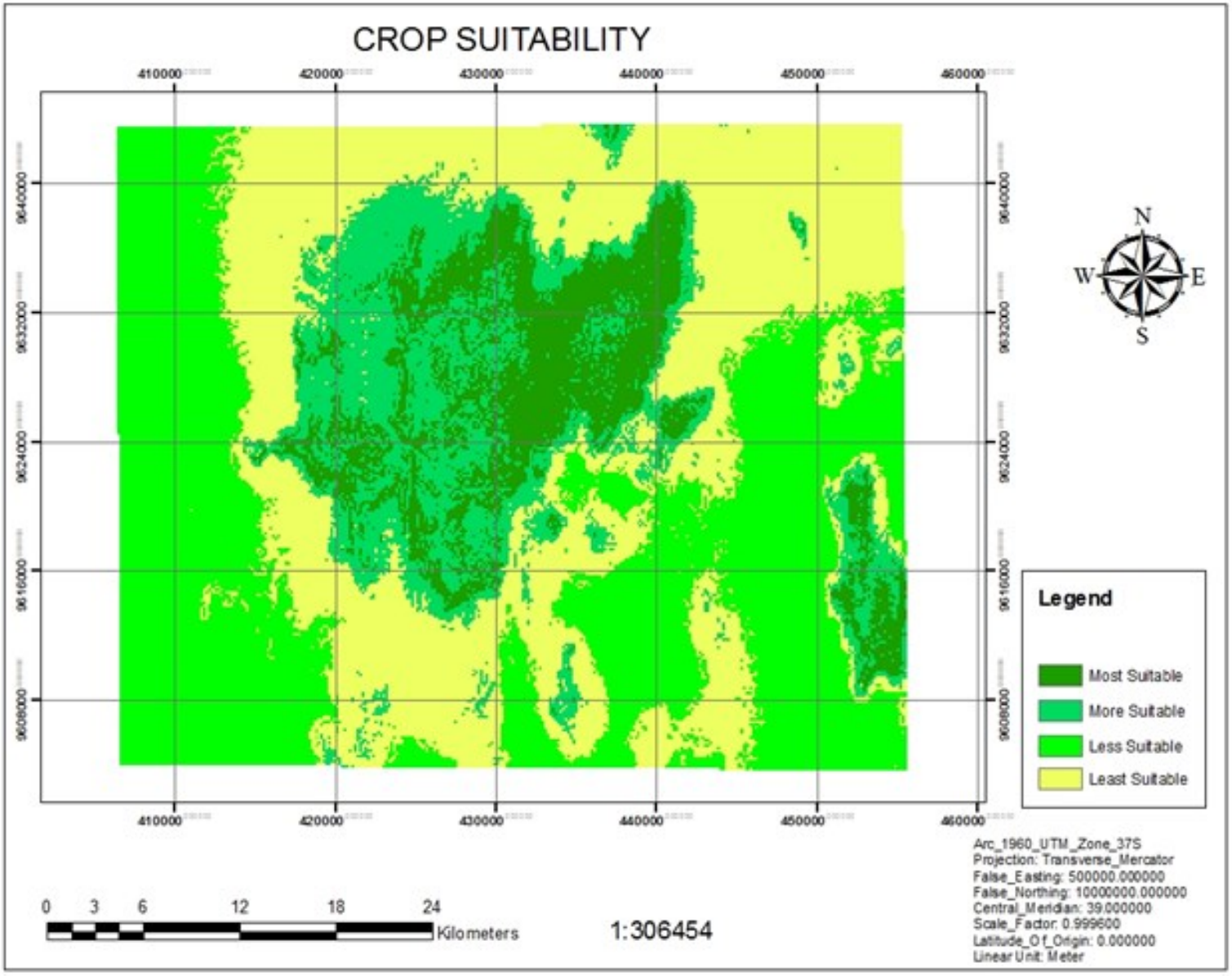

Maize farms
Tarmac road
KEY
Avocado
Baresoil
Buildings
Grass
Mango
Murram
Shrubs
Sisal
Maize
Tarmac
N
W
E
S
0 3 6 12 18 24
Kilometers

Land Suitability Modeling

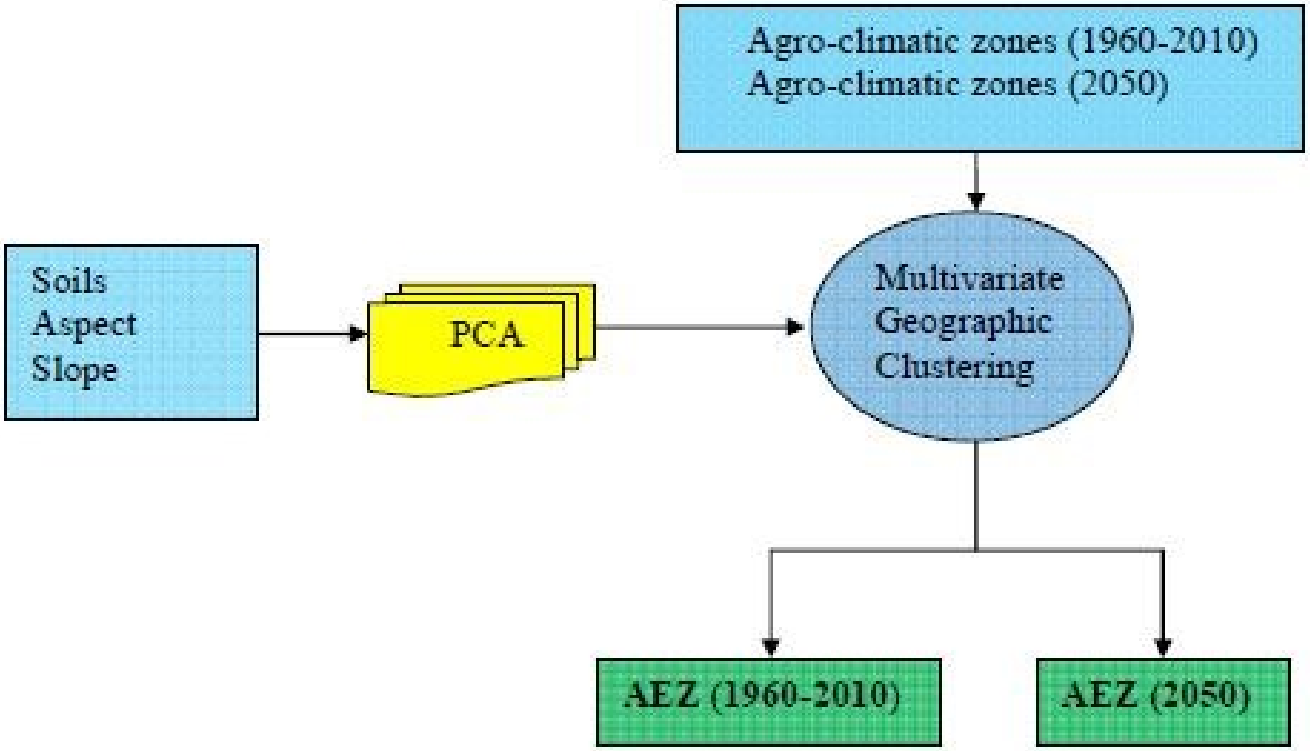


Parameter Weighting

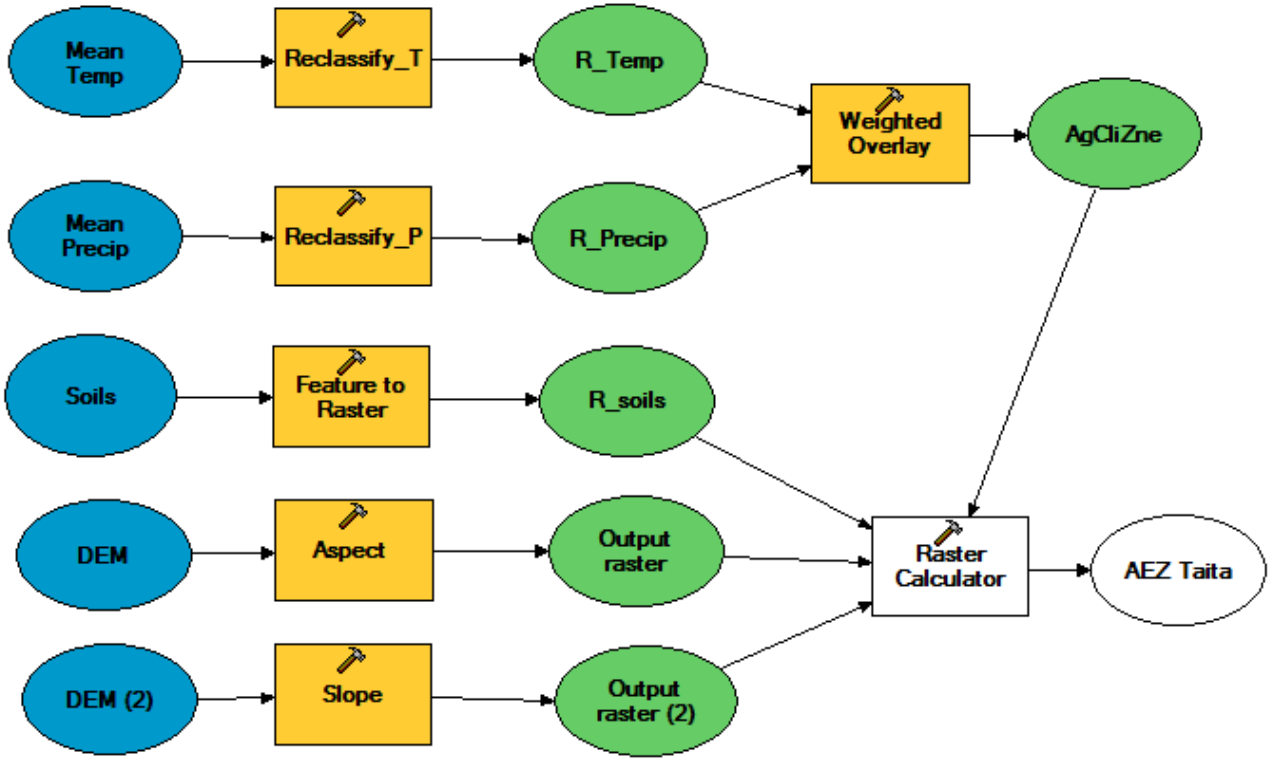
Erosion Parameters	Sub-class Parameters	Rank
1.Rainfall	More than – 1400 mm	3
	1201 mm – 1400 mm	2
	1000 mm – 1200 mm	1
2. Temperature	Less than 15°C	5
	15°C to 17°C	4
	17°C to 19°C	3
	19°C to 22°C	2
	More than 22°C	1
3. Soil type / pH levels	Low PH (shallow & loamy)	3
	Moderate pH (loamy sand to sandy loam)	2
	High pH (sandy loam to clayey loam)	1
4. Slope	Very Steep (>40%)	5
	Steep (30.1-40%)	4
	Moderate (20.1-30%)	3
	Gentle (10.1-20%)	2
	Very Gentle (<10%)	1
5. Drainage density	>6	5
	5.1-6.0	4
	4.1-5.0	3
	2.1-4.0	2
	<2	1
6.Land use and land cover	Agricultur	5
	Sparse	4
	Forest	3
	Water	2
	Built-up	1


CROP SUITABILITY
410000
420000
430000
440000
450000
460000
9640000
9632000
9624000
9616000
9608000
N
W
E
S
Legend
Most Suitable
More Suitable
Less Suitable
Least Suitable
0 3 6 12 18 24
Kilometers
1:306454
Arc_1960_UTM_Zone_37S
Projection: Transverse_Mercator
False_Easting: 500000.000000
False_Northing: 10000000.000000
Central_Meridian: 39.000000
Scale_Factor: 0.999600
Latitude_Of_Origin: 0.000000
Linear Unit: Meter

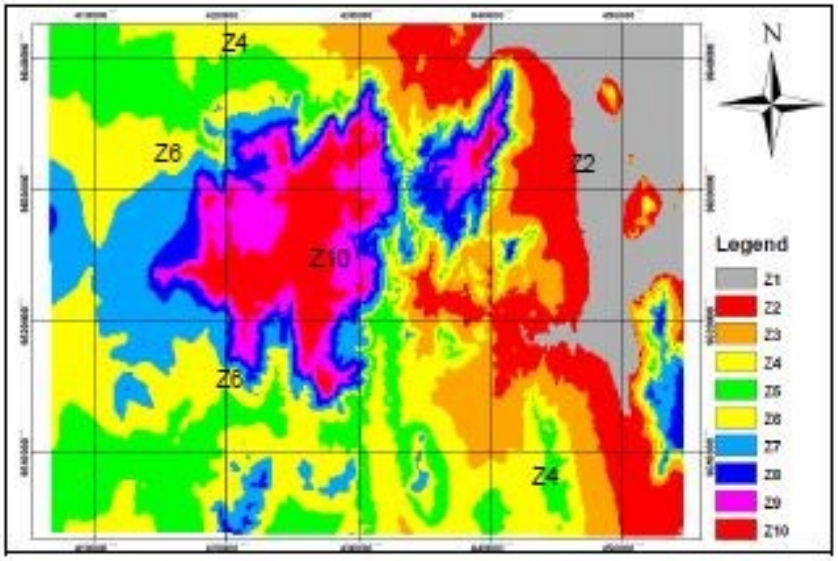
Modeling Agro Ecological Zones



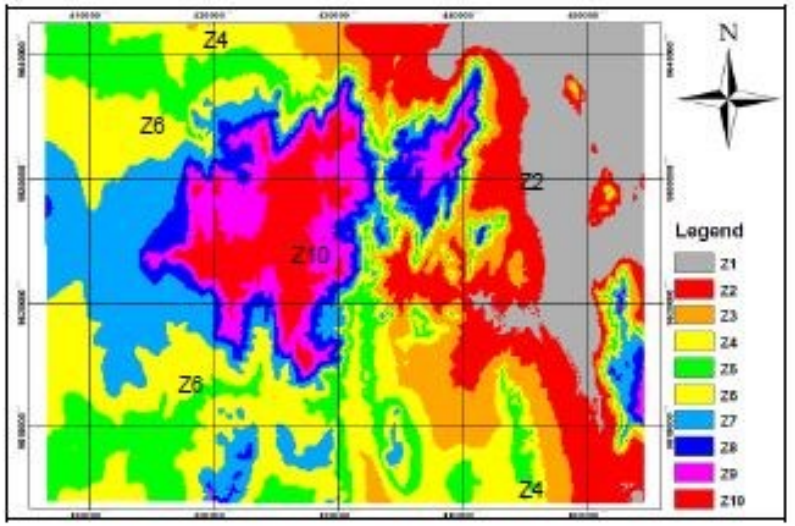
Geospatial Model



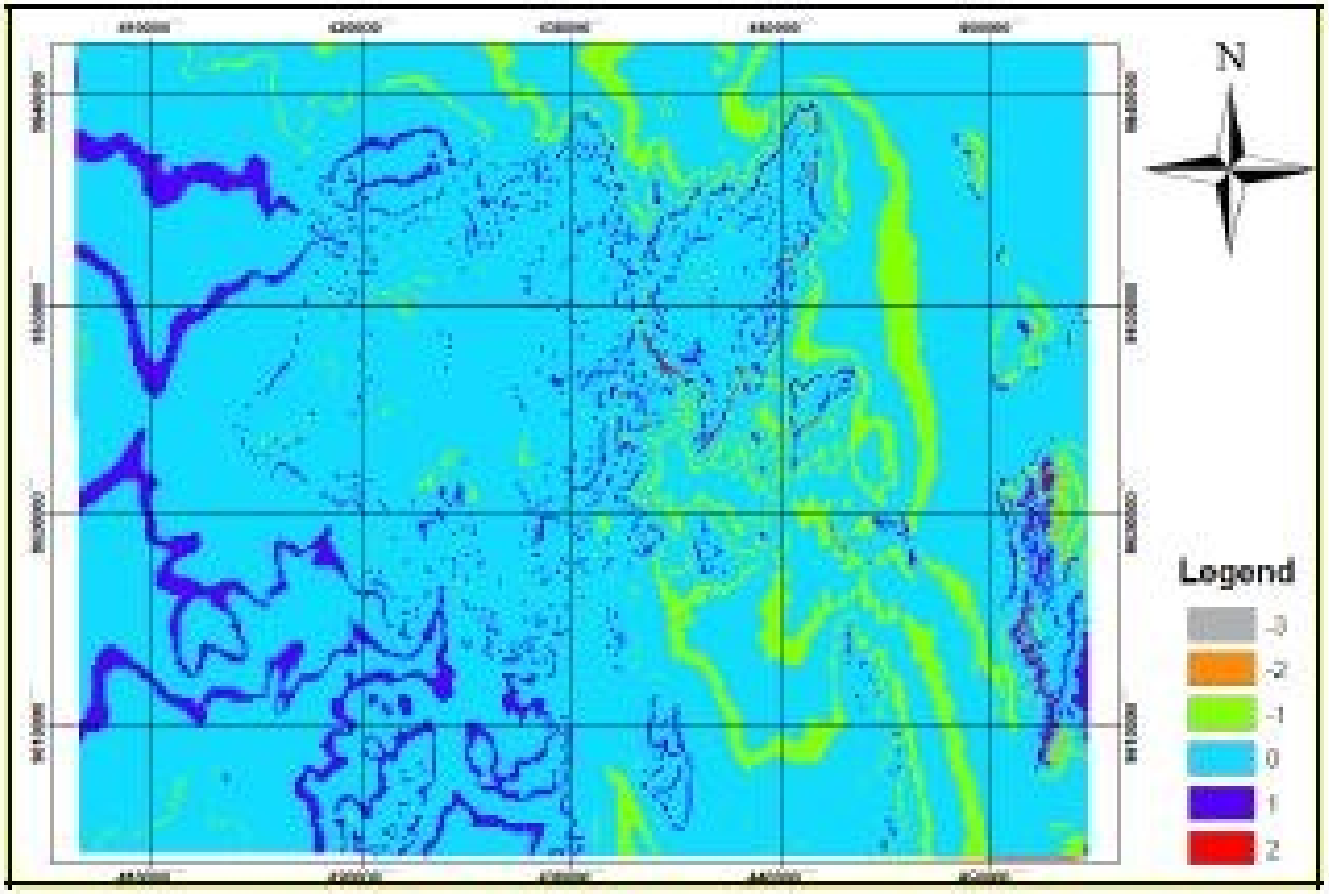
AEZ Map of 1960-1990



Projected AEZ for 2050

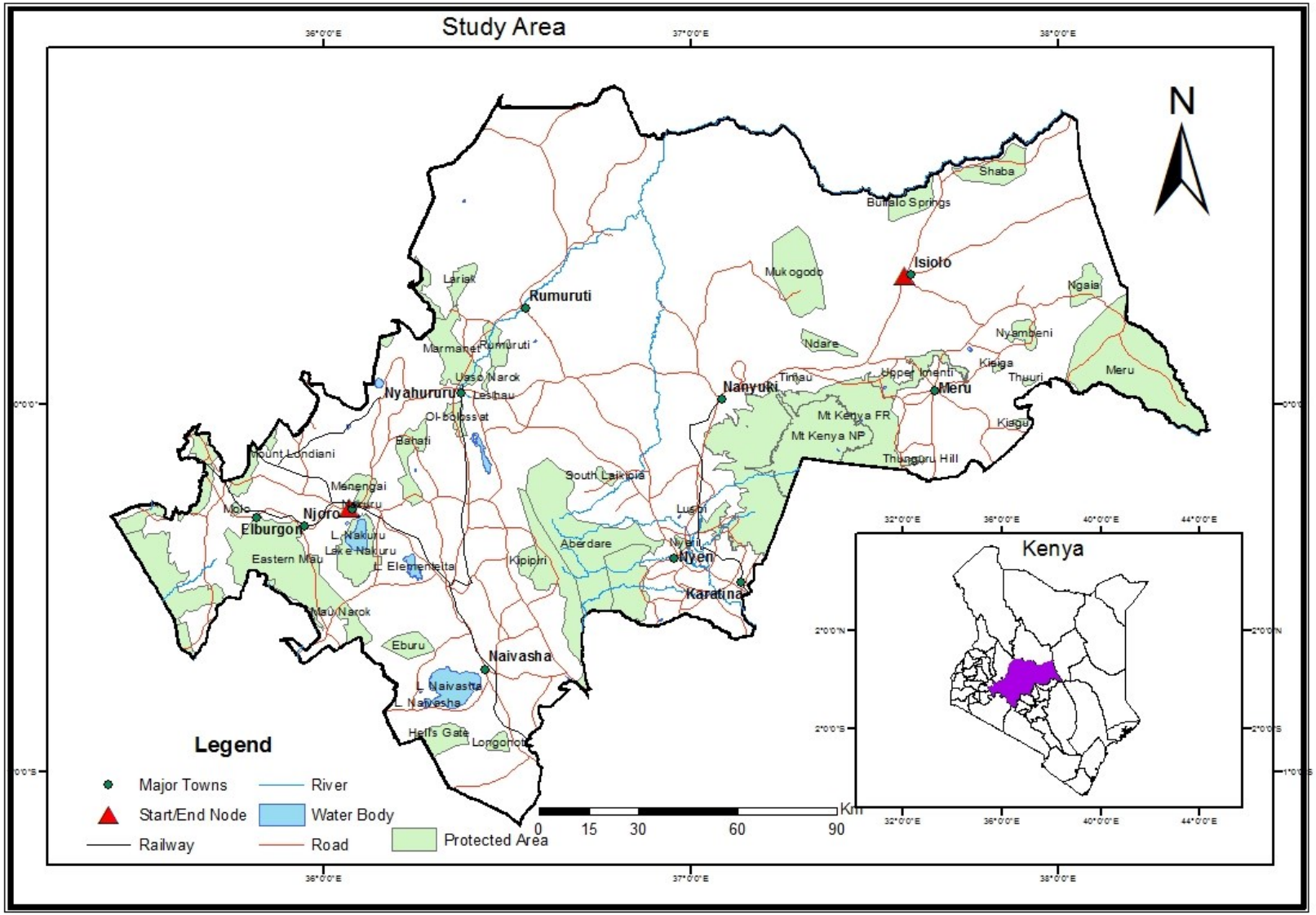


Zone differencing map



GIS Analysis and Spatial Modeling for Optimal Oil Pipeline Route Location

Proposed Isiolo Nakuru Pipeline Route In Kenya

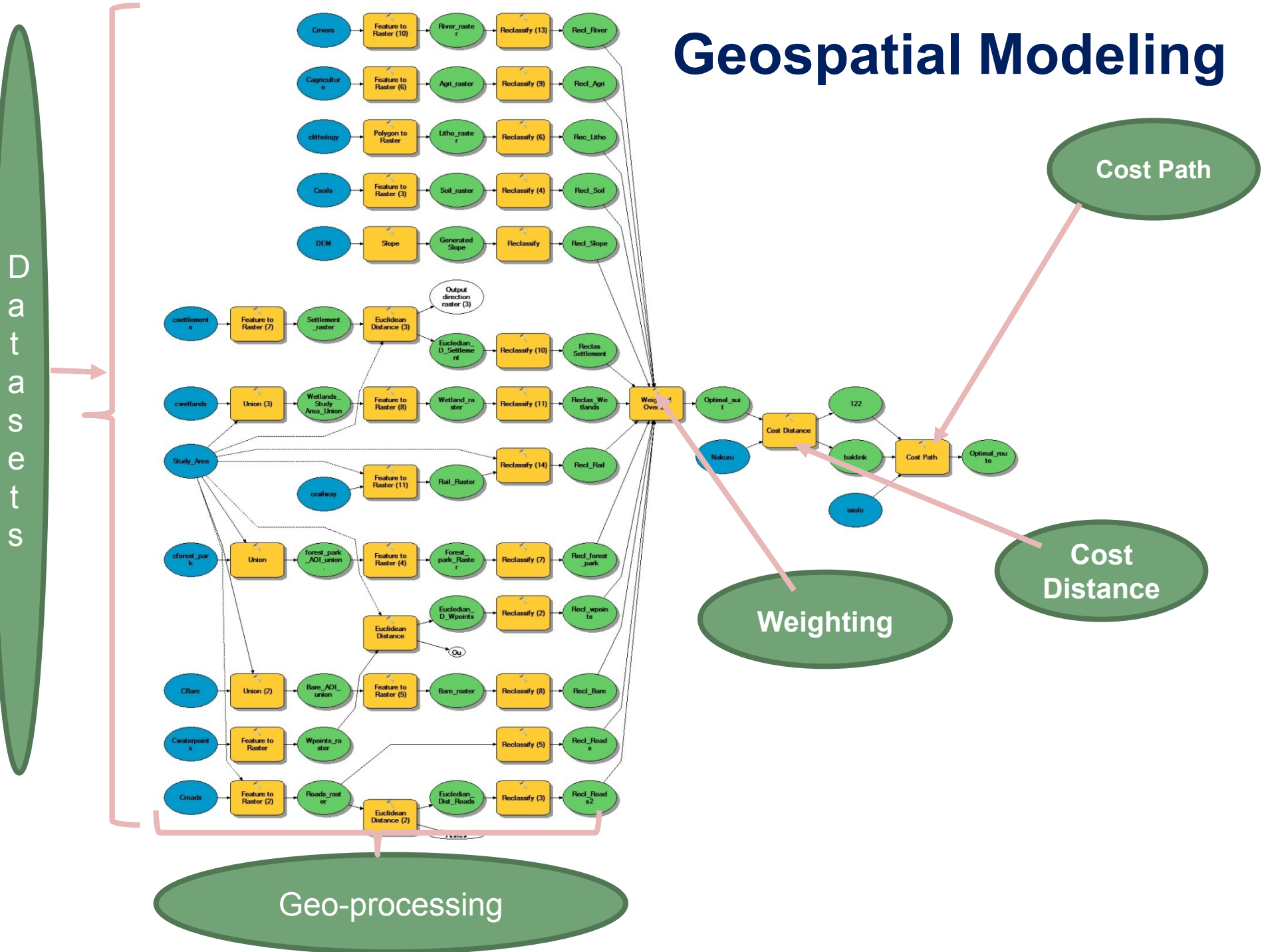


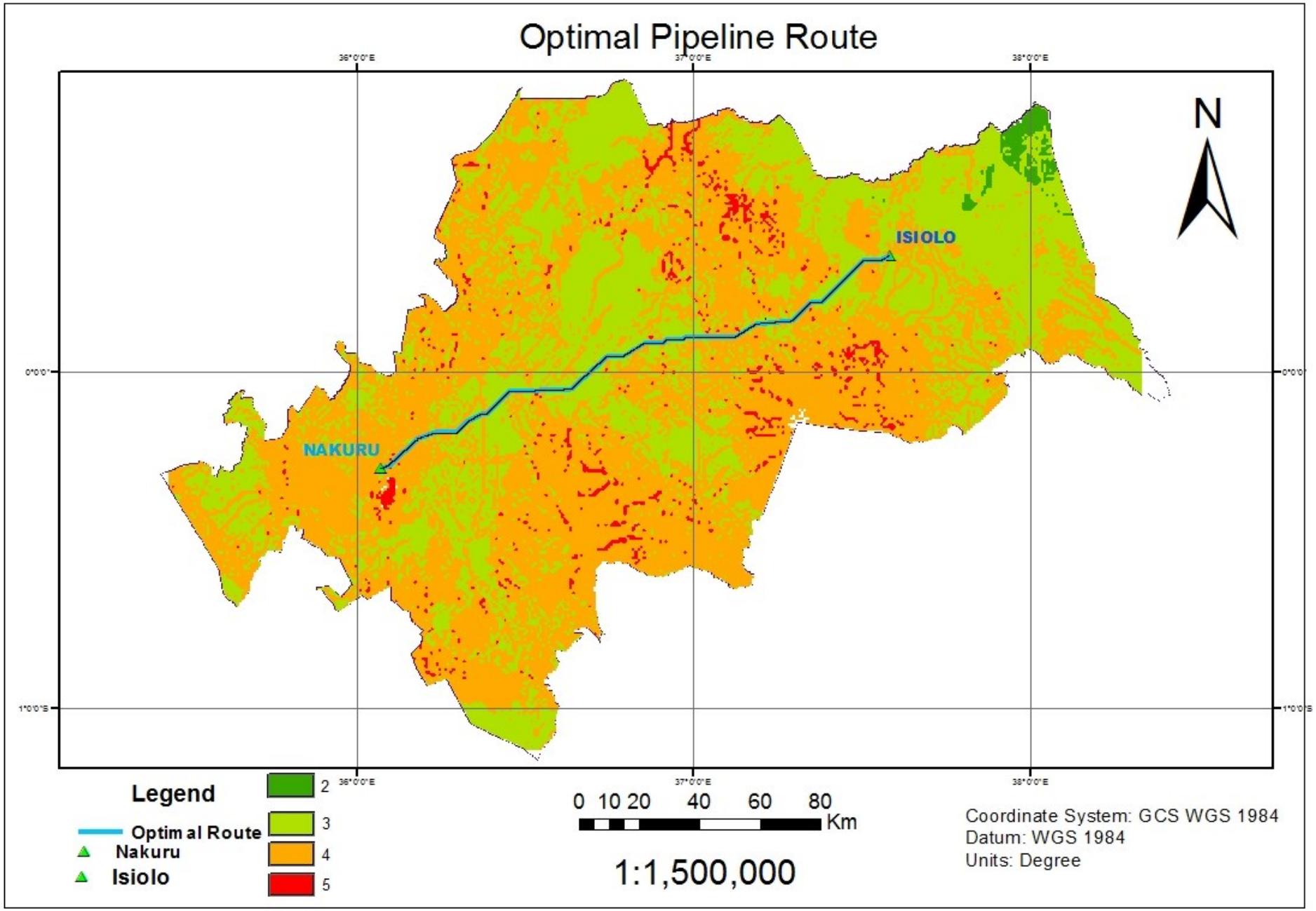
Datasets

	RESOLUTION/SCALE	SOURCE
Roads	1:500,000	NEMA
Railway	1:500,000	NEMA
Soil	1:500,000	ILRI website
Geology	1:500,000	NEMA
settlements	1:500000	NEMA, DSRS
River	1:500,000	ILRI website
Game parks/reserves/	1:500,000	NEMA
Wetlands and lakes	1:500,000	NEMA
DEM	30m	Aster Website
Agricultural Land	1:500,000	NEMA
Ground water sites	1:500000	ILRI website
forest	1:10000	KFS

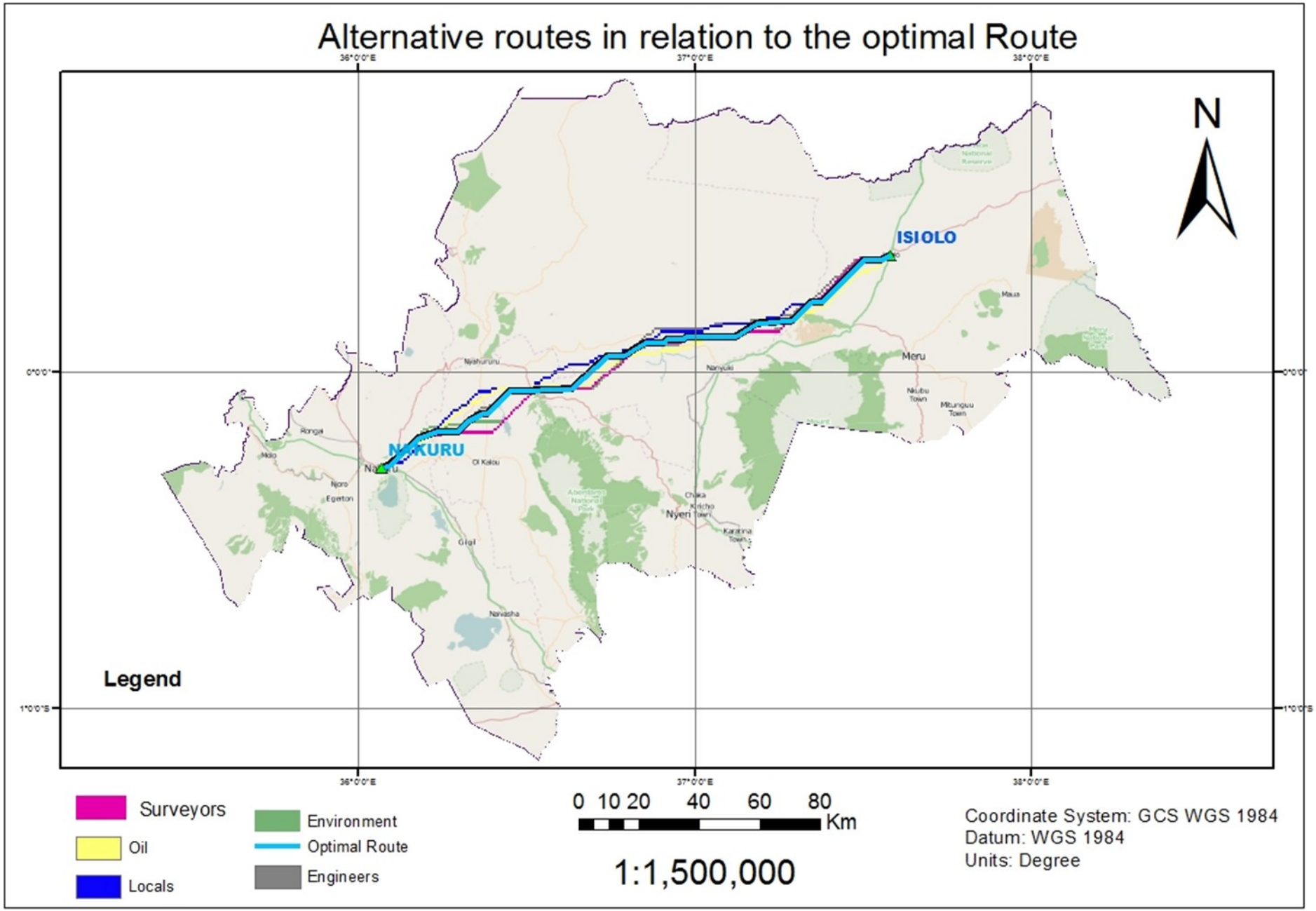
VARIABLE	CRITERIA
Proximity to roads	Capitalize on existing linear disturbance
Road crossing	Minimize road crossing
Railway Crossing	Minimize railway crossing
Soil type	Avoid clay soil type
Geology	minimize hard rocky areas
Proximity to settlements	Avoid populated areas
River crossing	Minimize river crossing
Game parks/reserves/forest	Minimize crossing Game parks/
Wetlands and lakes	Avoid crossing wetlands
Slope	Utilize fairly flat areas
Agricultural Land	Avoid sensitive land areas
Ground water sites	Route away from ground water sites

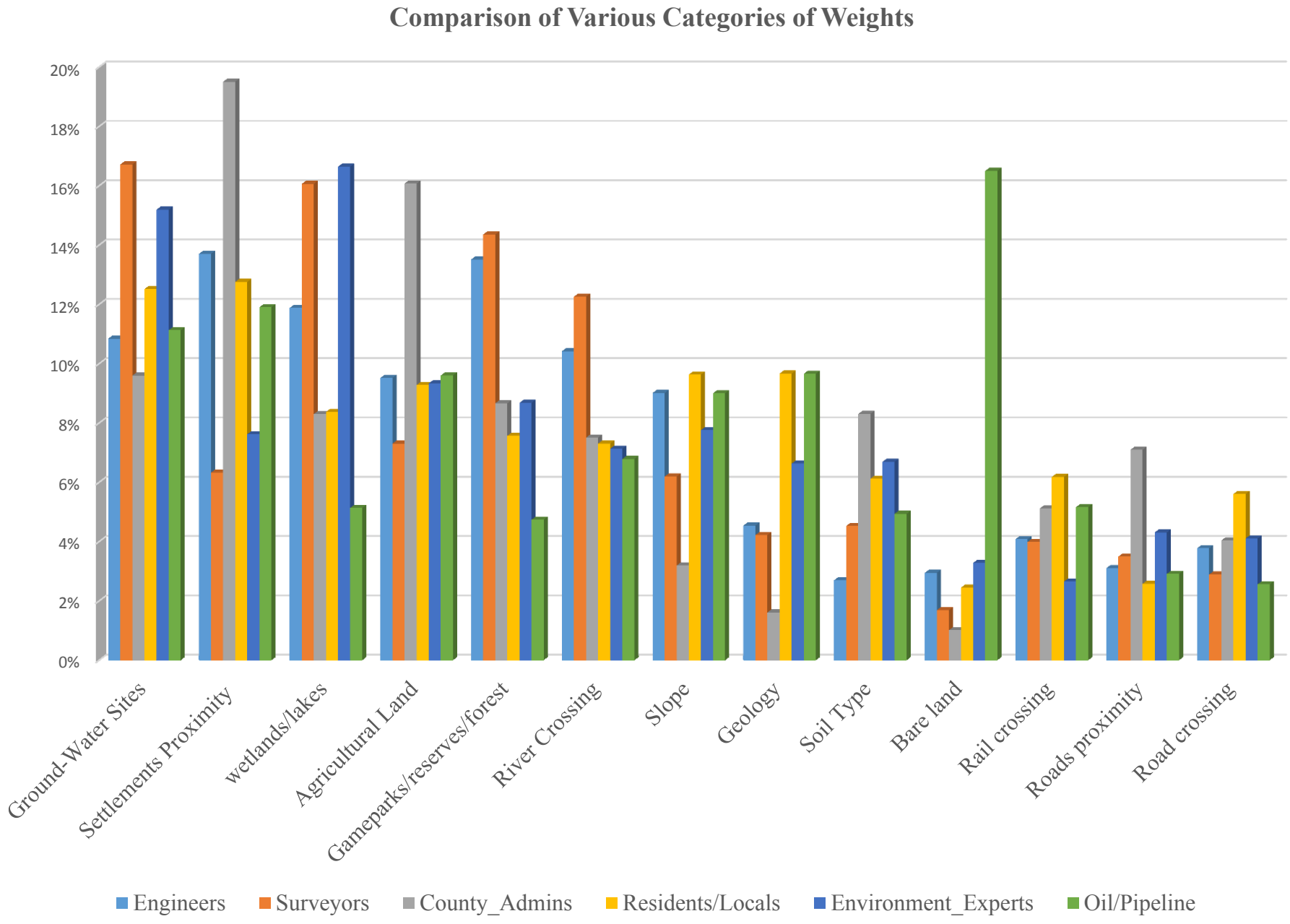
Geospatial Modeling



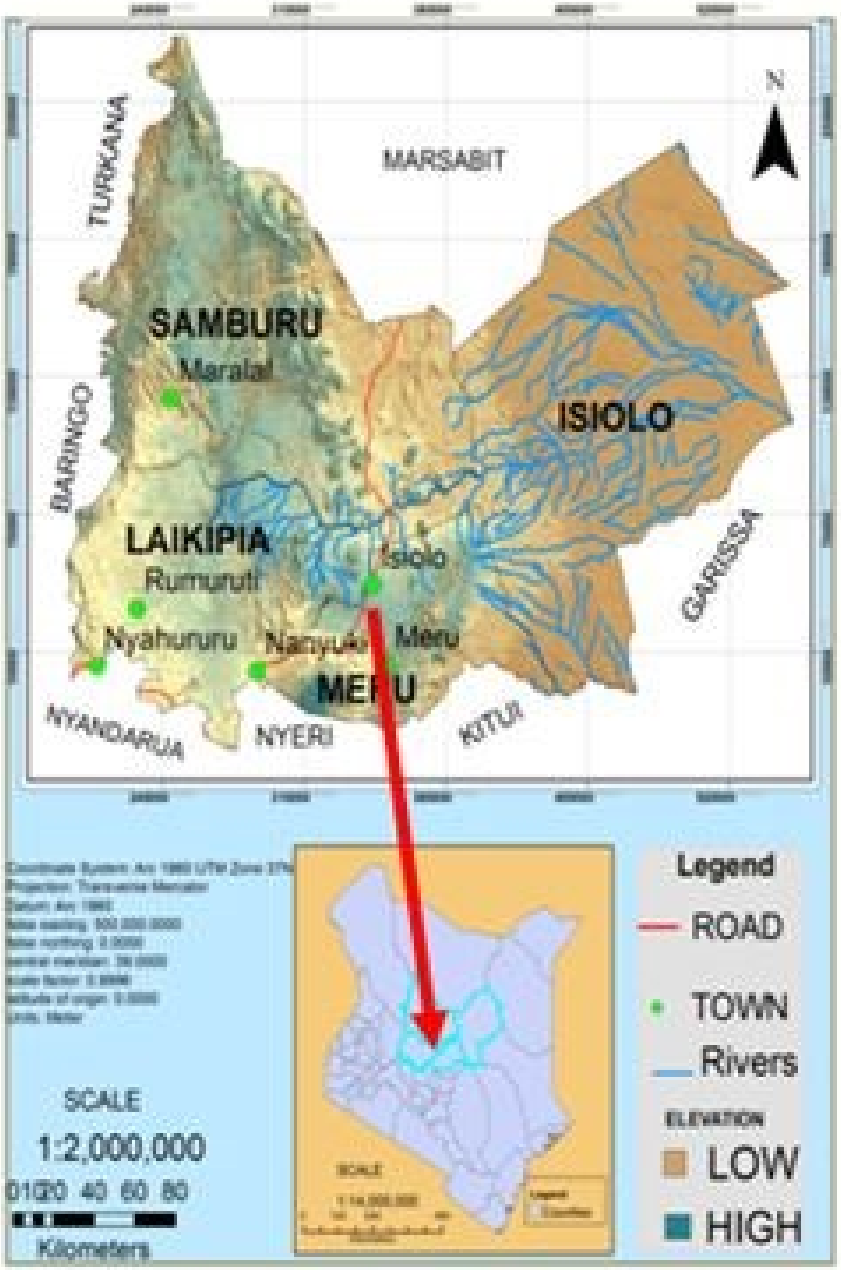

Optimal Pipeline Route
36°0'0"E
37°0'0"E
38°0'0"E
0°0'0"
1°0'0"S
N
ISIOLO
NAKURU
Legend
Optimal Route
Nakuru
Isiolo
2
3
4
5
0 10 20 40 60 80
Km
1:1,500,000
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

Alternative routes in relation to the optimal Route




Comparison of Various Categories of Weights
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Ground-Water Sites
Settlements Proximity
wetlands/lakes
Agricultural Land
Gameparks/reserves/forest
River Crossing
Slope
Geology
Soil Type
Bare land
Rail crossing
Roads proximity
Road crossing
Engineers
Surveyors
County_Admins
Residents/Locals
Environment_Experts
Oil/Pipeline

Spatial Modeling for Environment Impact Assessment

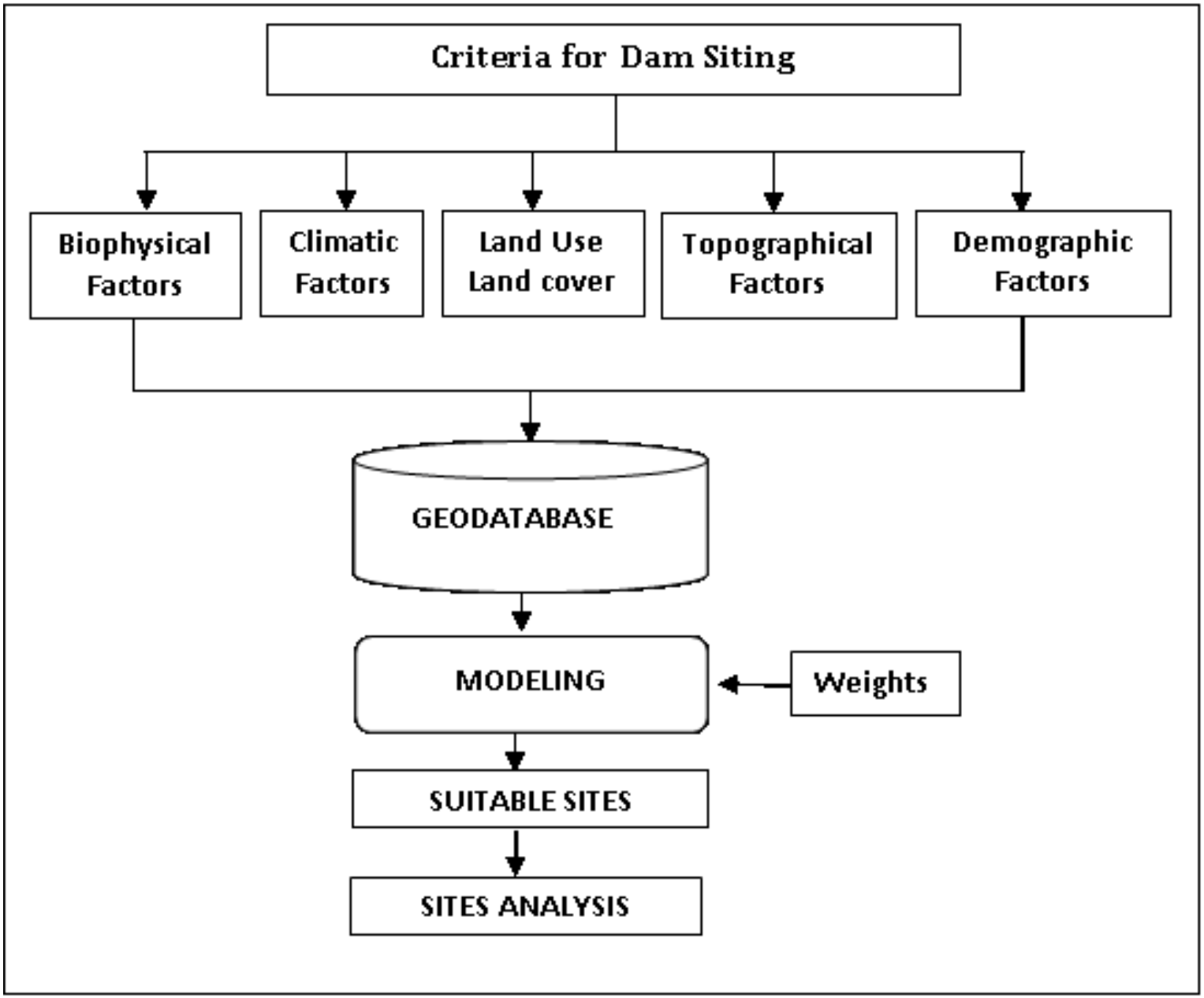


Study Area

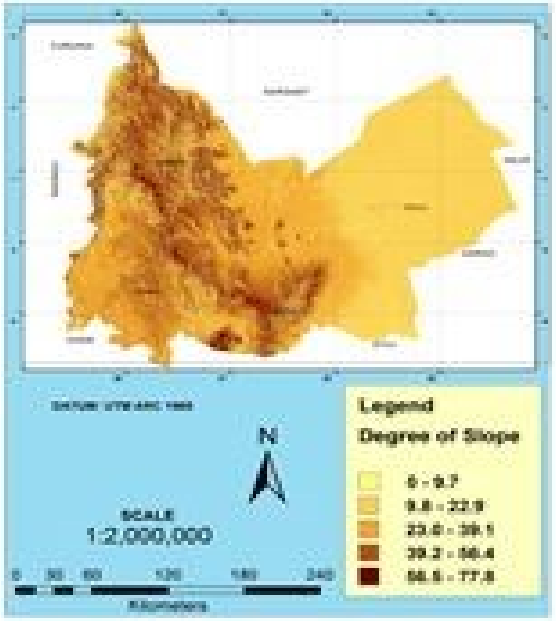
- Rift Valley & Upper eastern regions comprising of Isiolo, Meru, Laikipia, and Samburu counties.

- Covering an area of 25 336.1 Km2

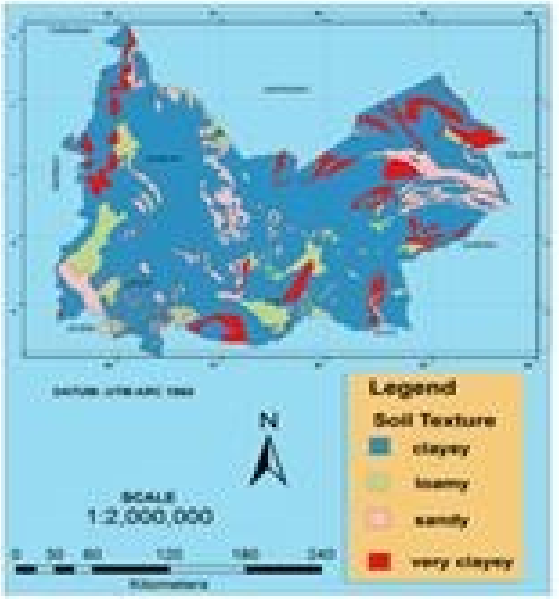
MODELLING APPROACH



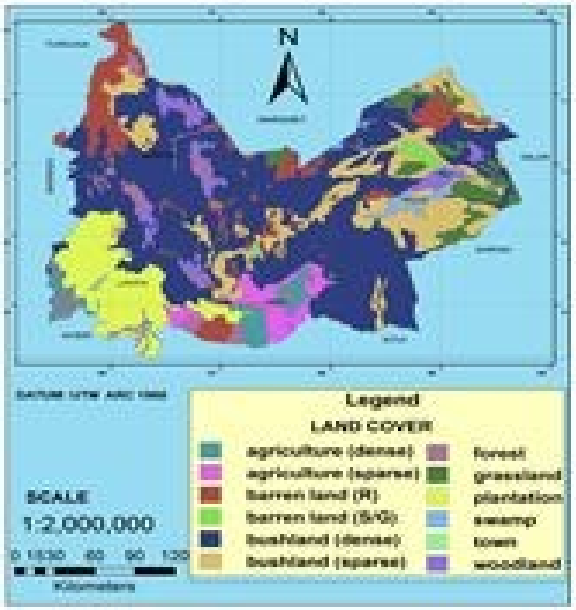
Modeling Variables



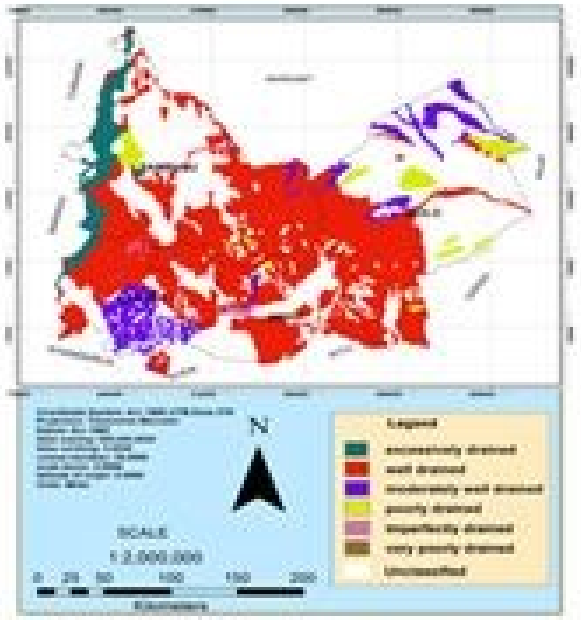
Slope



Soils

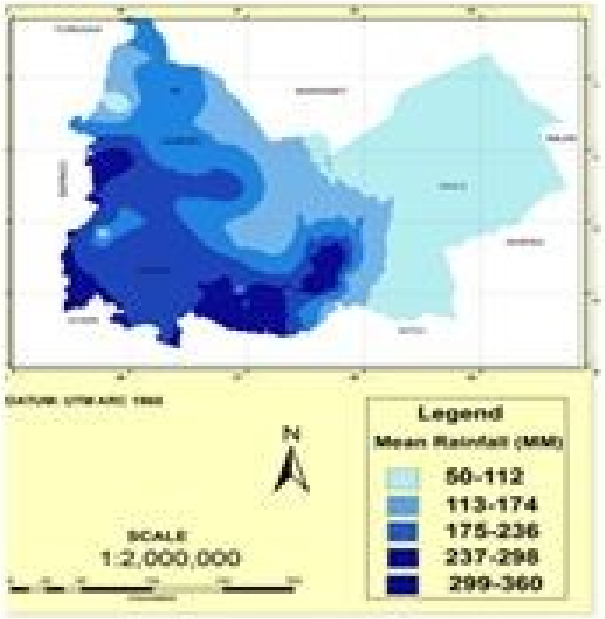


Land cover

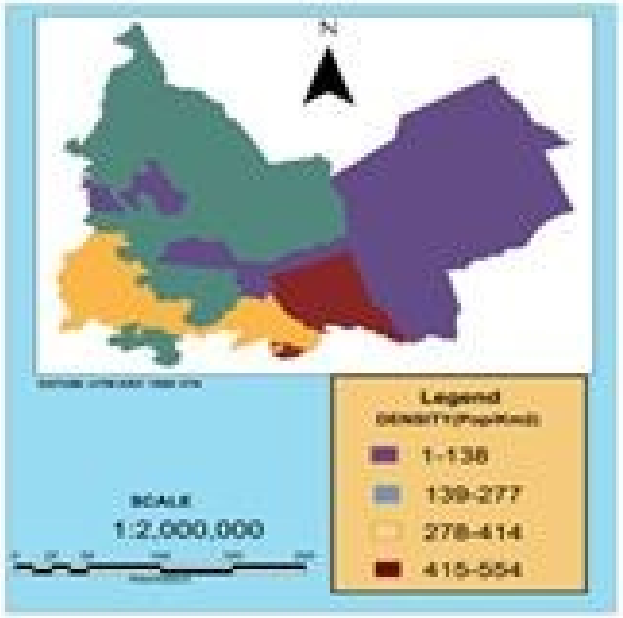


Drainage map

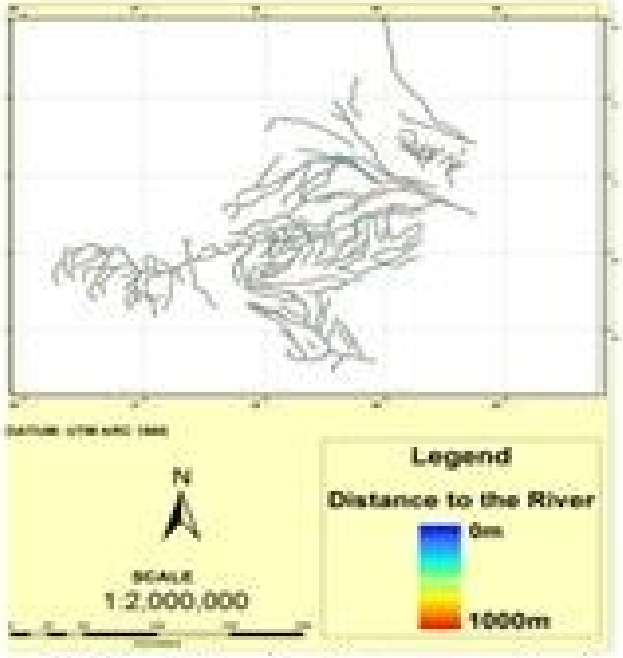
Modeling Variables



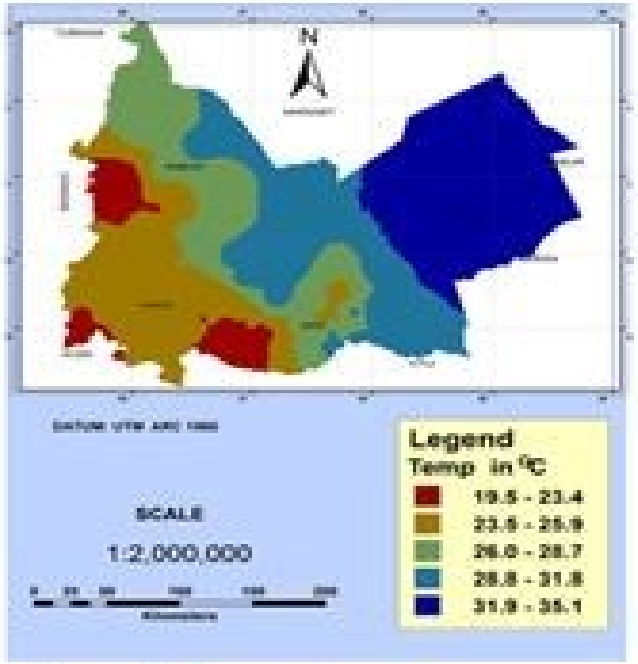
Rainfal



Population Density

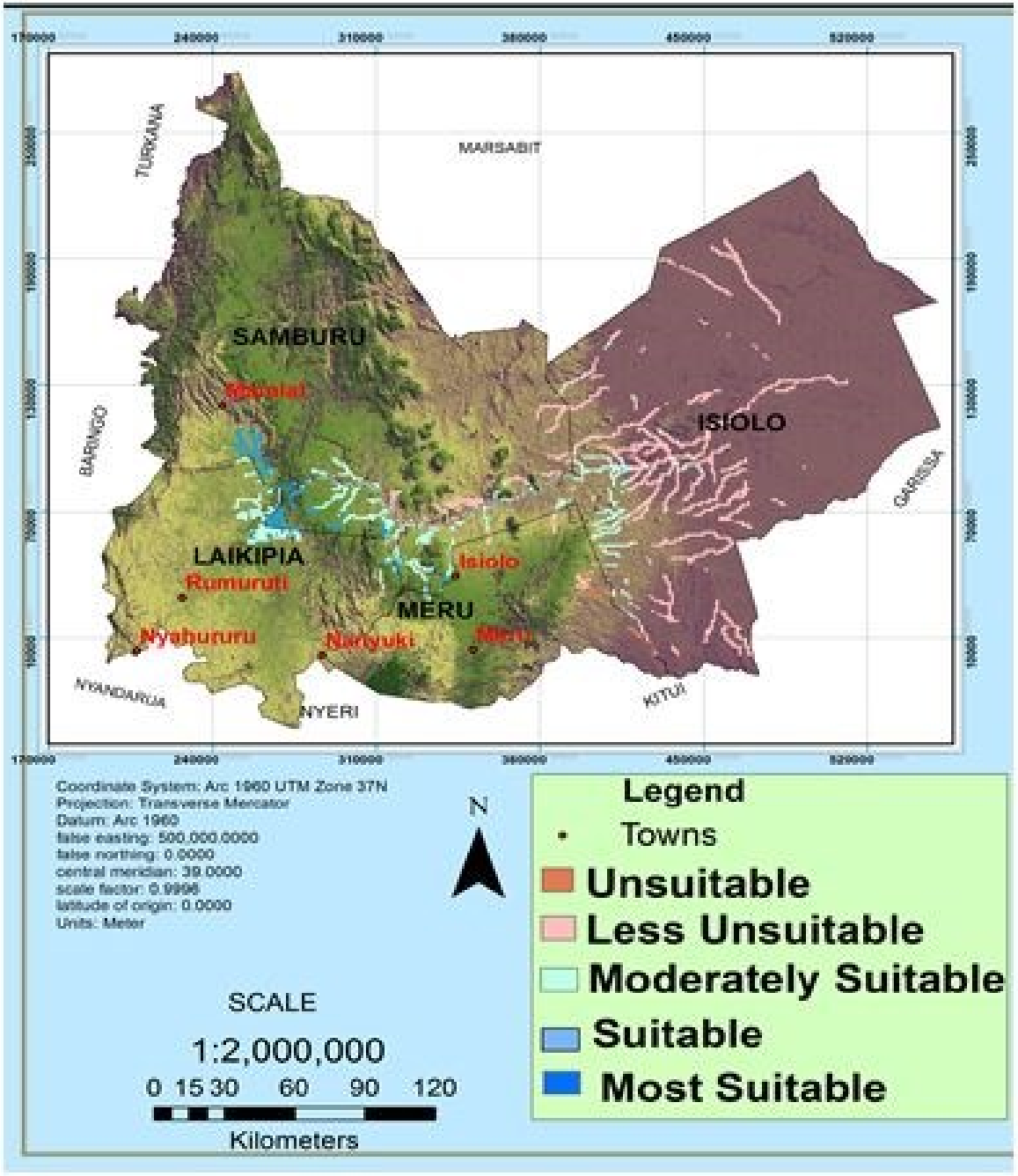


Rivers

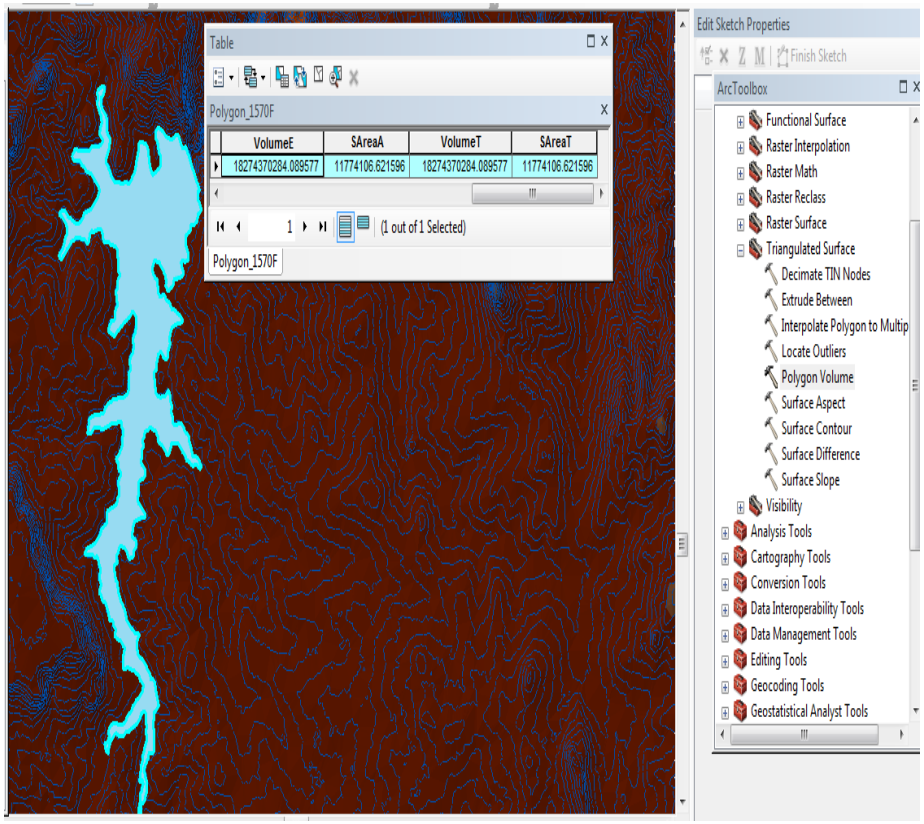


Temperatures

	Weights	%
Population	0.23	23%
Soil Texture	0.21	21%
Slope	0.15	15%
Temperatures	0.10	10%
Rainfall	0.05	5%
Land Cover	0.01	2%
Drainage	0.22	22%
River	0.02	2%
Total	1	100

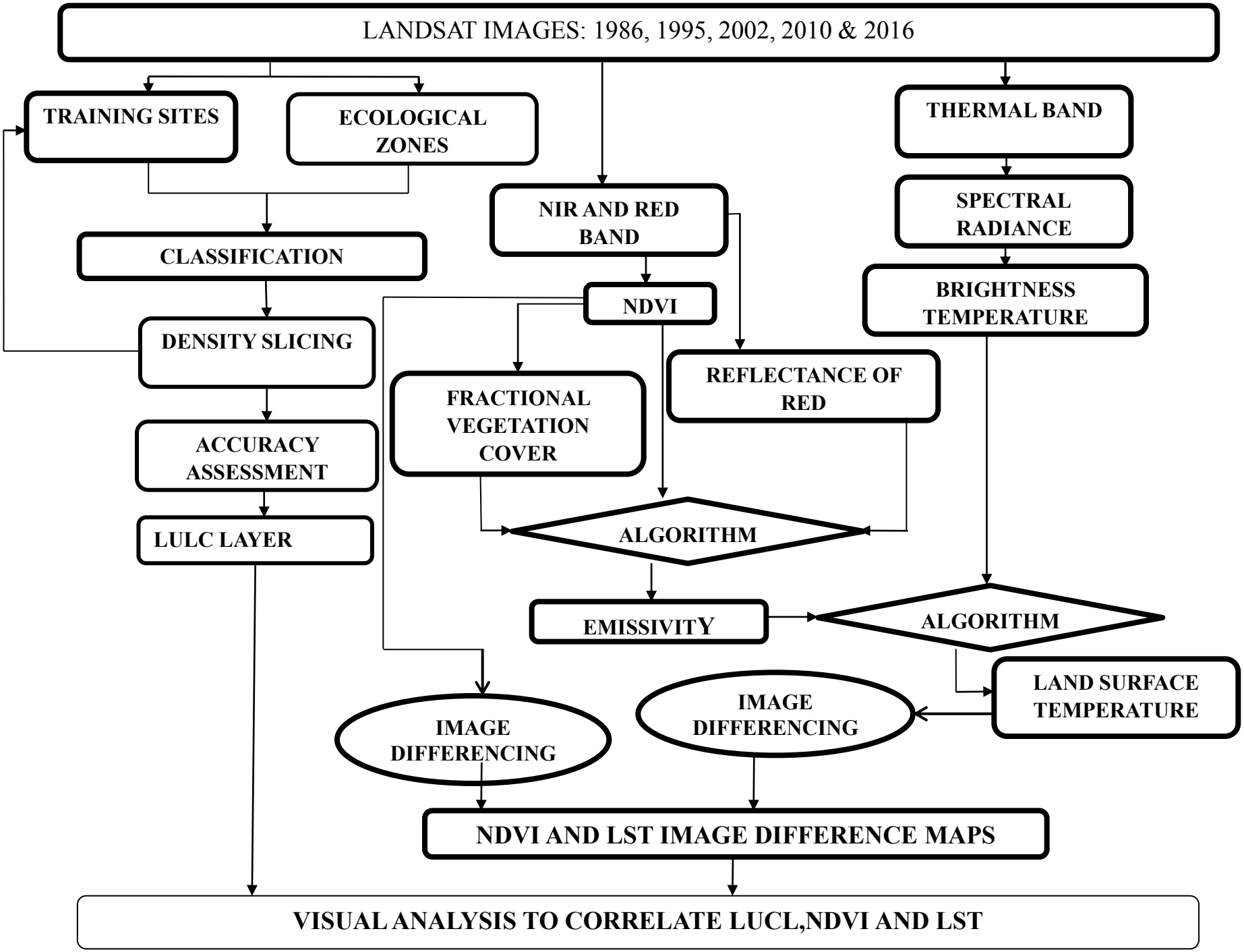


MODEL RESULTS

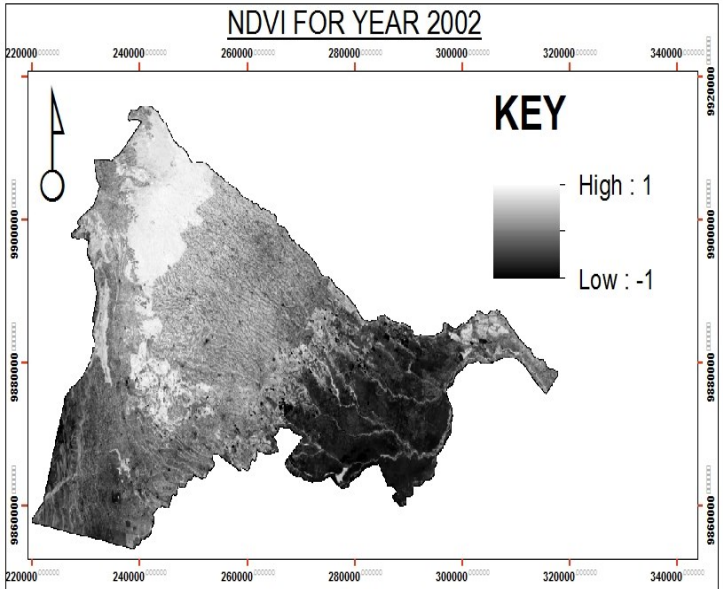


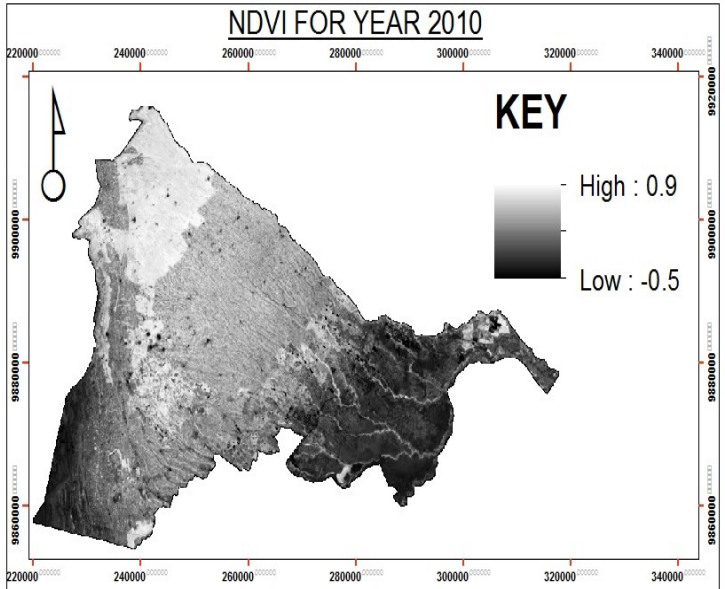
Volume calculation on the reservoir

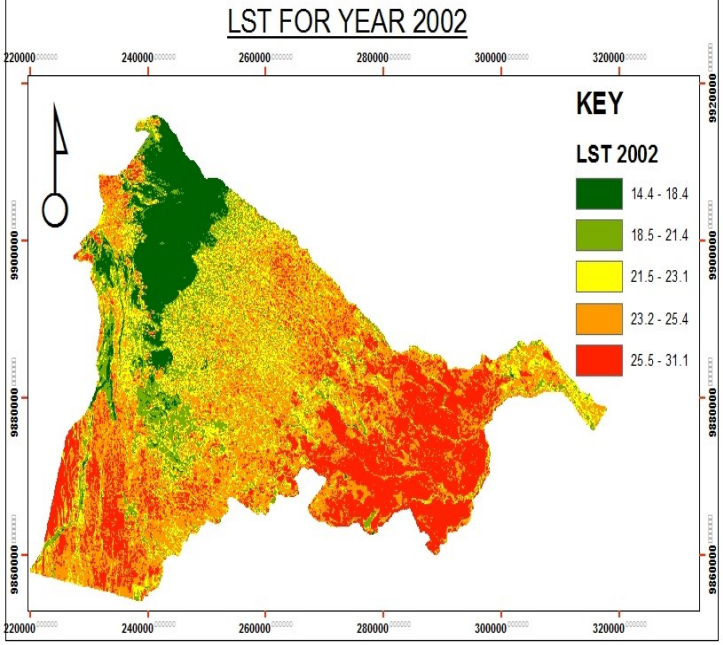
Spatial Modeling for Climate Change Analyses in Central Kenya

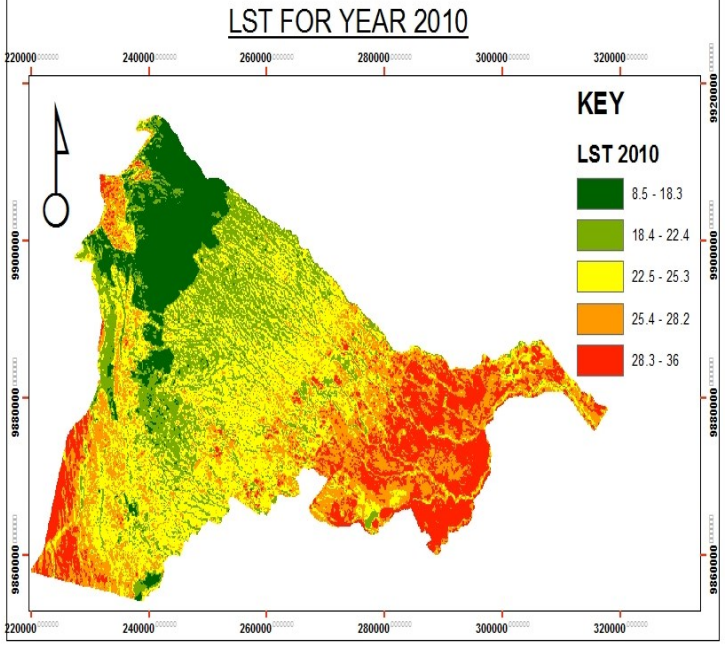

LANDSAT IMAGES: 1986, 1995, 2002, 2010 & 2016
TRAINING SITES
ECOLOGICAL ZONES
THERMAL BAND
NIR AND RED BAND
SPECTRAL RADIANCE
CLASSIFICATION
BRIGHTNESS TEMPERATURE
NDVI
DENSITY SLICING
REFLECTANCE OF RED
FRACTIONAL VEGETATION COVER
ACCURACY ASSESSMENT
ALGORITHM
LULC LAYER
EMISSIVITY
ALGORITHM
LAND SURFACE TEMPERATURE
IMAGE DIFFERENCING
IMAGE DIFFERENCING
NDVI AND LST IMAGE DIFFERENCE MAPS
VISUAL ANALYSIS TO CORRELATE LUCL,NDVI AND LST

NDVI & LST For 2002 and 2010

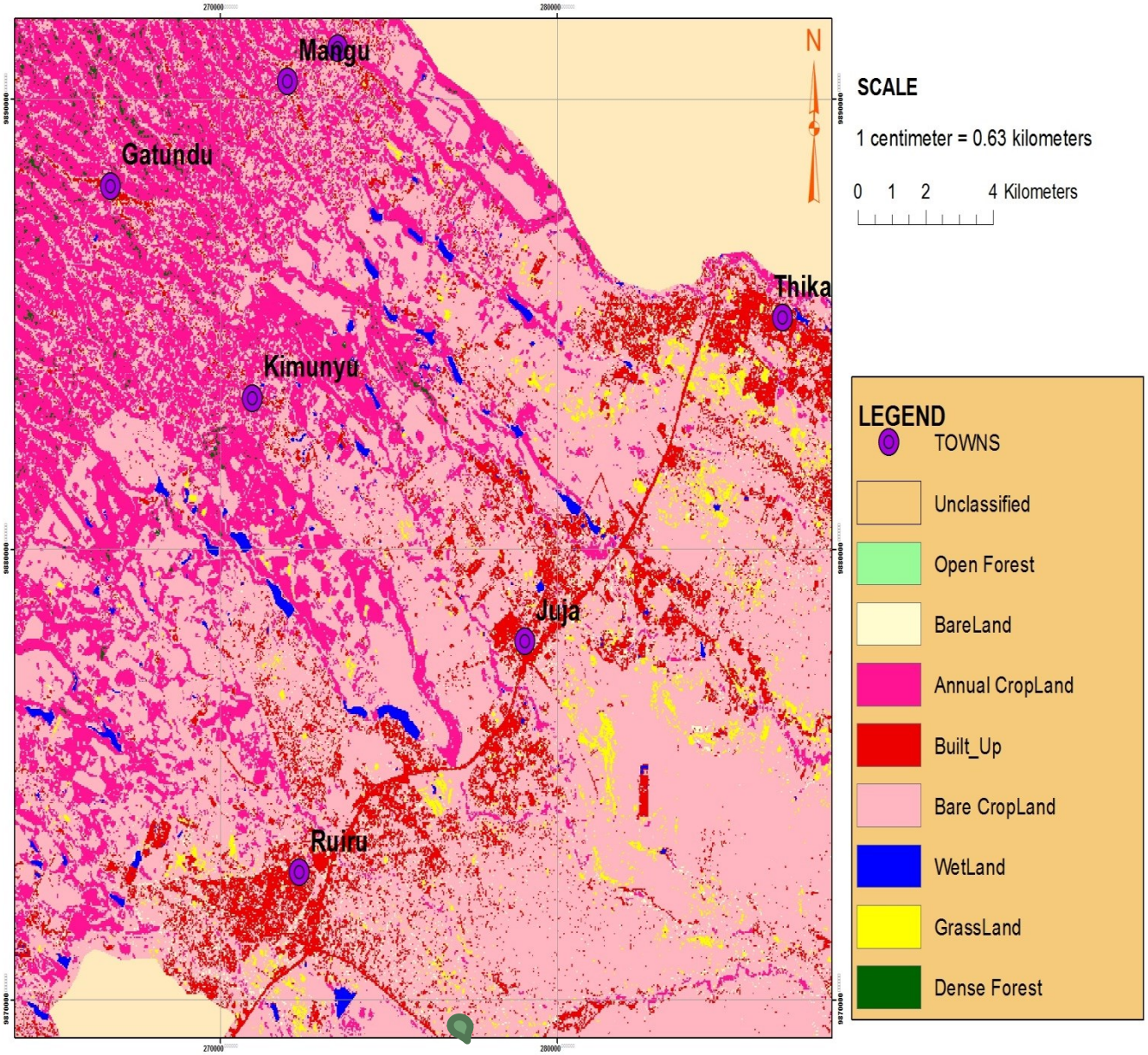


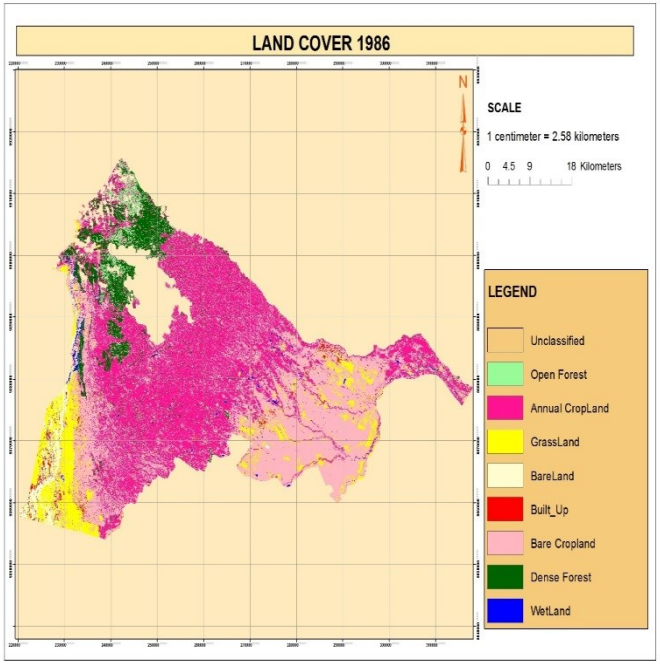


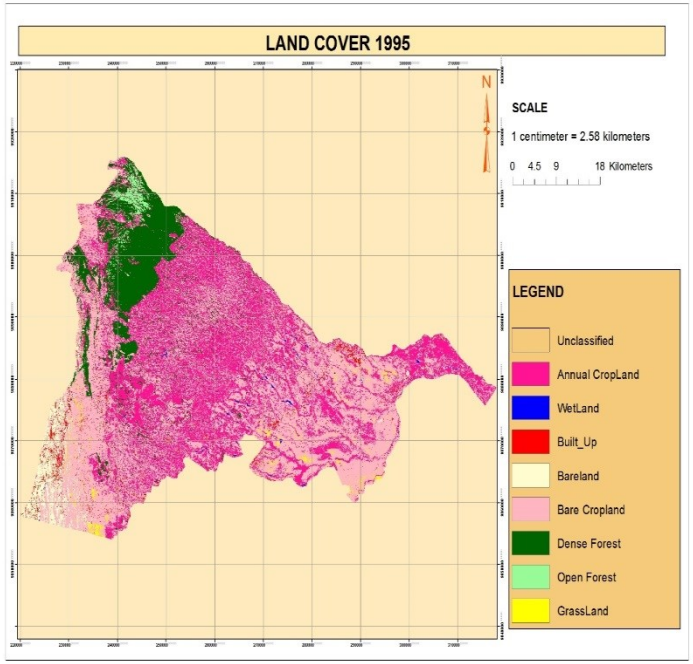


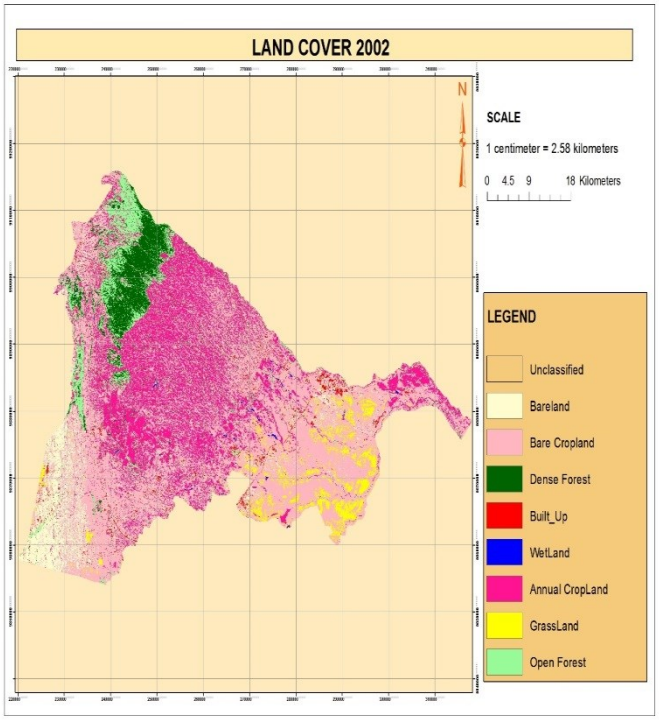


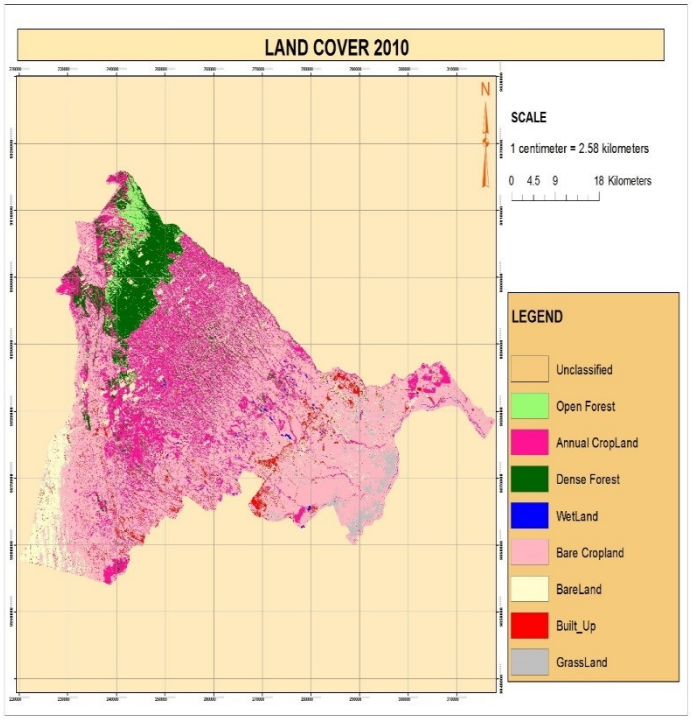
LAND COVER 2016

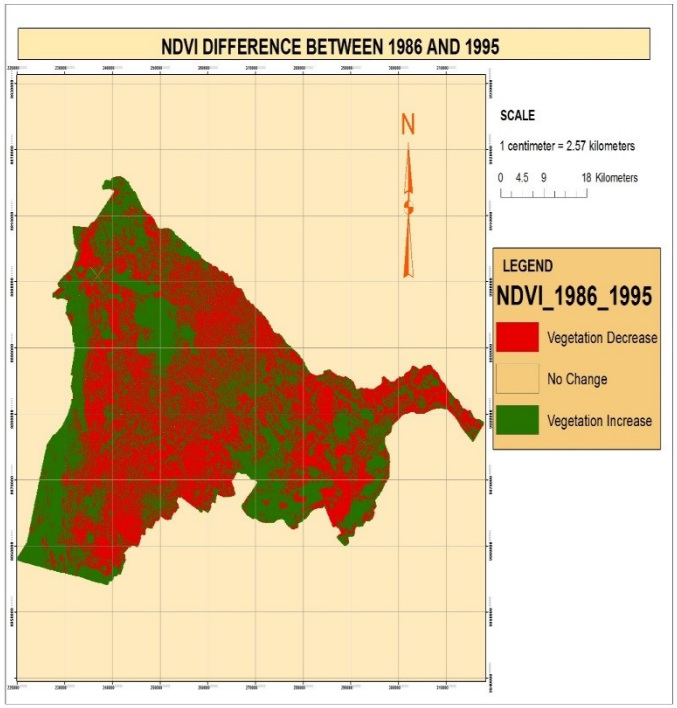


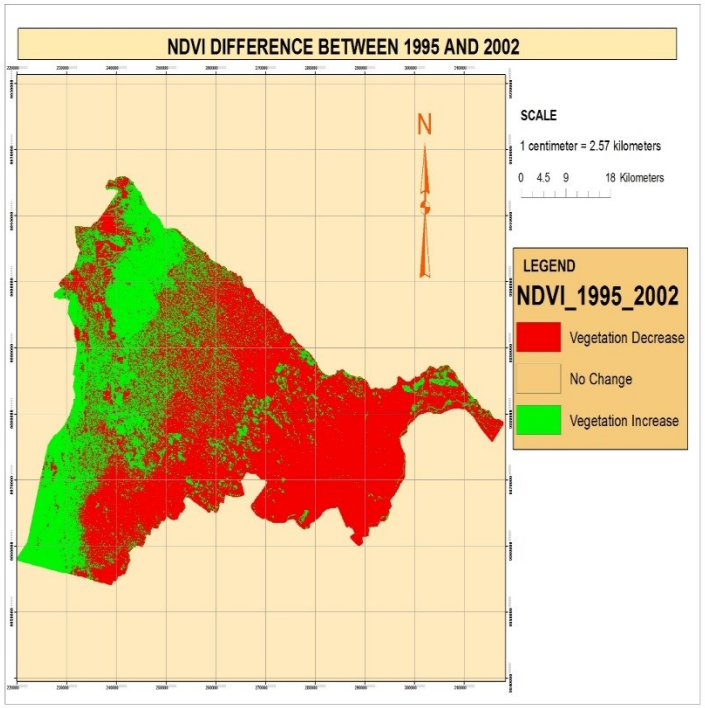

LAND COVER 1986
N
SCALE
1 centimeter = 2.58 kilometers
0 4.5 9 18 Kilometers
LEGEND
Unclassified
Open Forest
Annual CropLand
GrassLand
BareLand
Built_Up
Bare Cropland
Dense Forest
WetLand

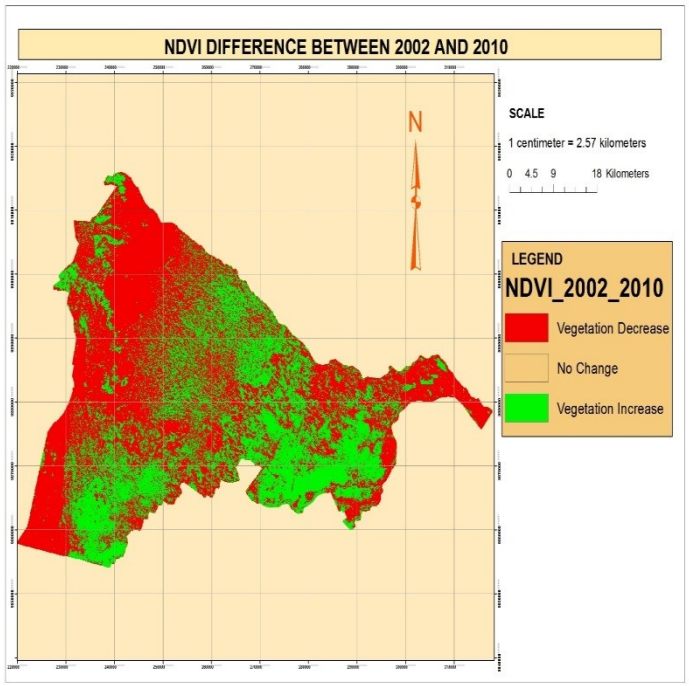

LAND COVER 1995
N
SCALE
1 centimeter = 2.58 kilometers
0 4.5 9 18 Kilometers
LEGEND
Unclassified
Annual CropLand
WetLand
Built_Up
Bareland
Bare Cropland
Dense Forest
Open Forest
GrassLand

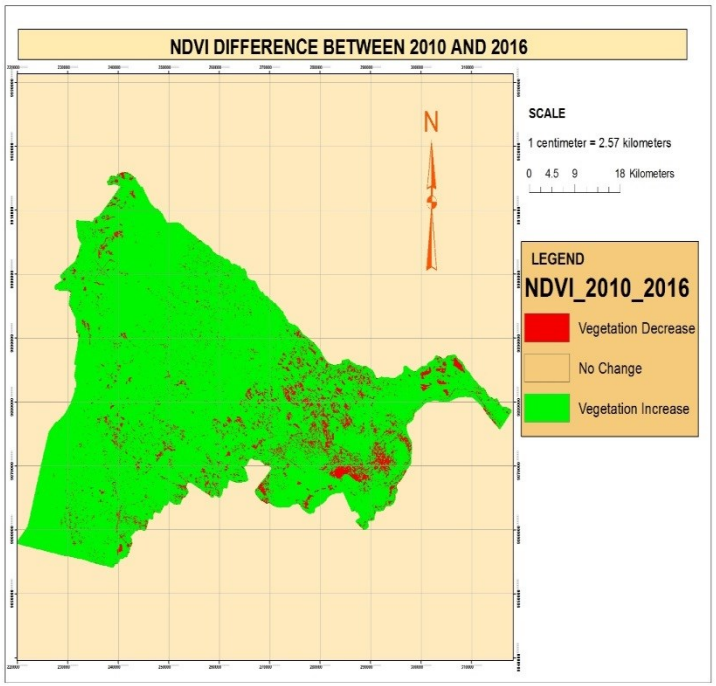

LAND COVER 2002
N
SCALE
1 centimeter = 2.58 kilometers
0 4.5 9 18 Kilometers
LEGEND
Unclassified
Bareland
Bare Cropland
Dense Forest
Built_Up
WetLand
Annual CropLand
GrassLand
Open Forest

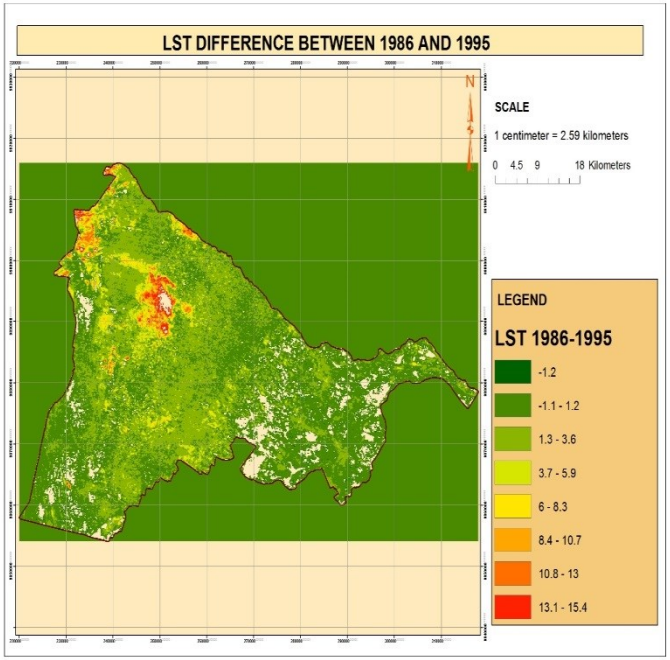

LAND COVER 2010
N
SCALE
1 centimeter = 2.58 kilometers
0 4.5 9 18 Kilometers
LEGEND
Unclassified
Open Forest
Annual CropLand
Dense Forest
WetLand
Bare Cropland
BareLand
Built_Up
GrassLand

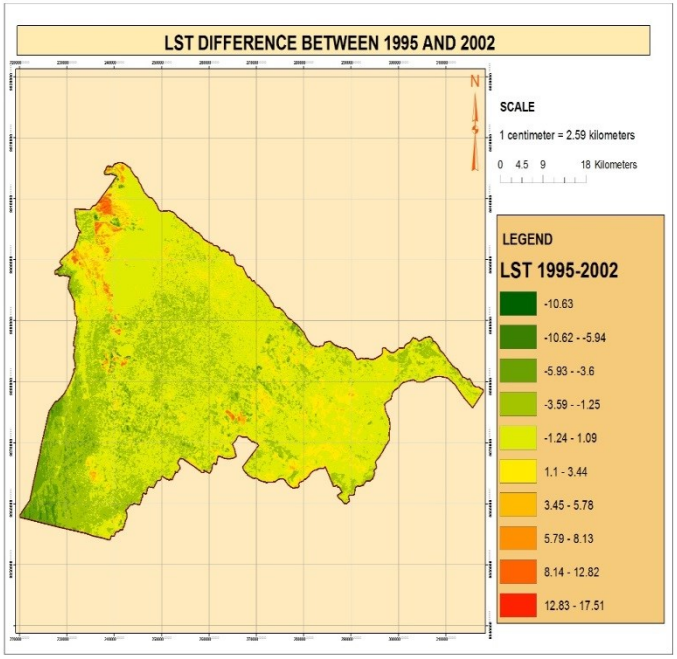

NDVI DIFFERENCE BETWEEN 1986 AND 1995
N
SCALE
1 centimeter = 2.57 kilometers
0 4.5 9 18 Kilometers
LEGEND
NDVI_1986_1995
Vegetation Decrease
No Change
Vegetation Increase

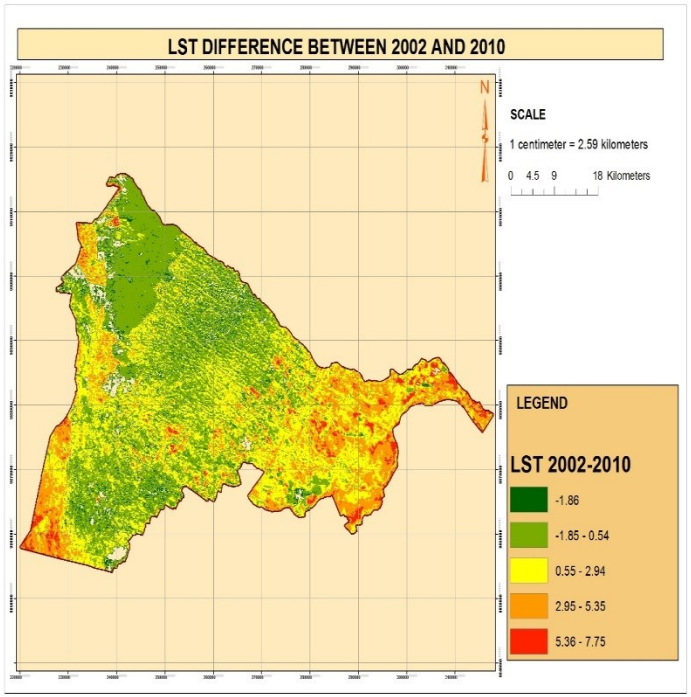

NDVI DIFFERENCE BETWEEN 1995 AND 2002
N
SCALE
1 centimeter = 2.57 kilometers
0 4.5 9 18 Kilometers
LEGEND
NDVI_1995_2002
Vegetation Decrease
No Change
Vegetation Increase

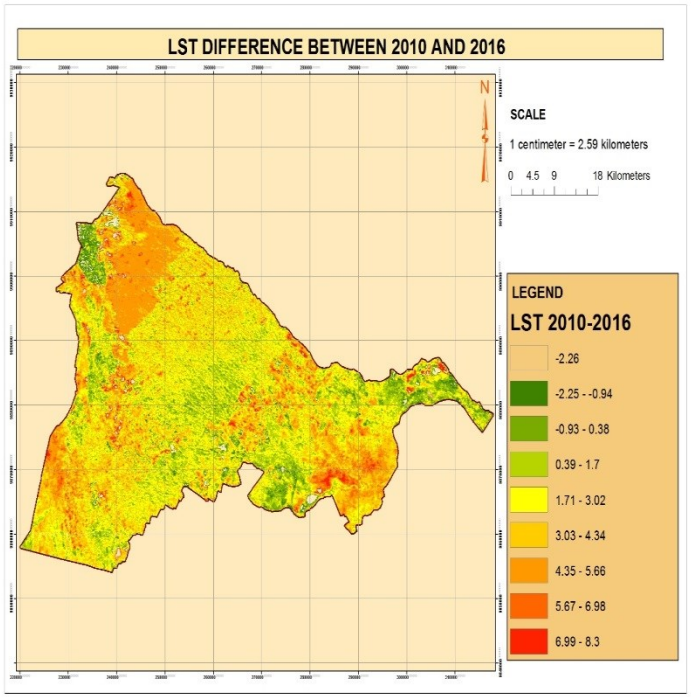

NDVI DIFFERENCE BETWEEN 2002 AND 2010
N
SCALE
1 centimeter = 2.57 kilometers
0 4.5 9 18 Kilometers
LEGEND
NDVI_2002_2010
Vegetation Decrease
No Change
Vegetation Increase


NDVI DIFFERENCE BETWEEN 2010 AND 2016
N
SCALE
1 centimeter = 2.57 kilometers
0 4.5 9 18 Kilometers
LEGEND
NDVI_2010_2016
Vegetation Decrease
No Change
Vegetation Increase


LST DIFFERENCE BETWEEN 1986 AND 1995
N
SCALE
1 centimeter = 2.59 kilometers
0 4.5 9 18 Kilometers
LEGEND
LST 1986-1995
-1.2
-1.1 - 1.2
1.3 - 3.6
3.7 - 5.9
6 - 8.3
8.4 - 10.7
10.8 - 13
13.1 - 15.4

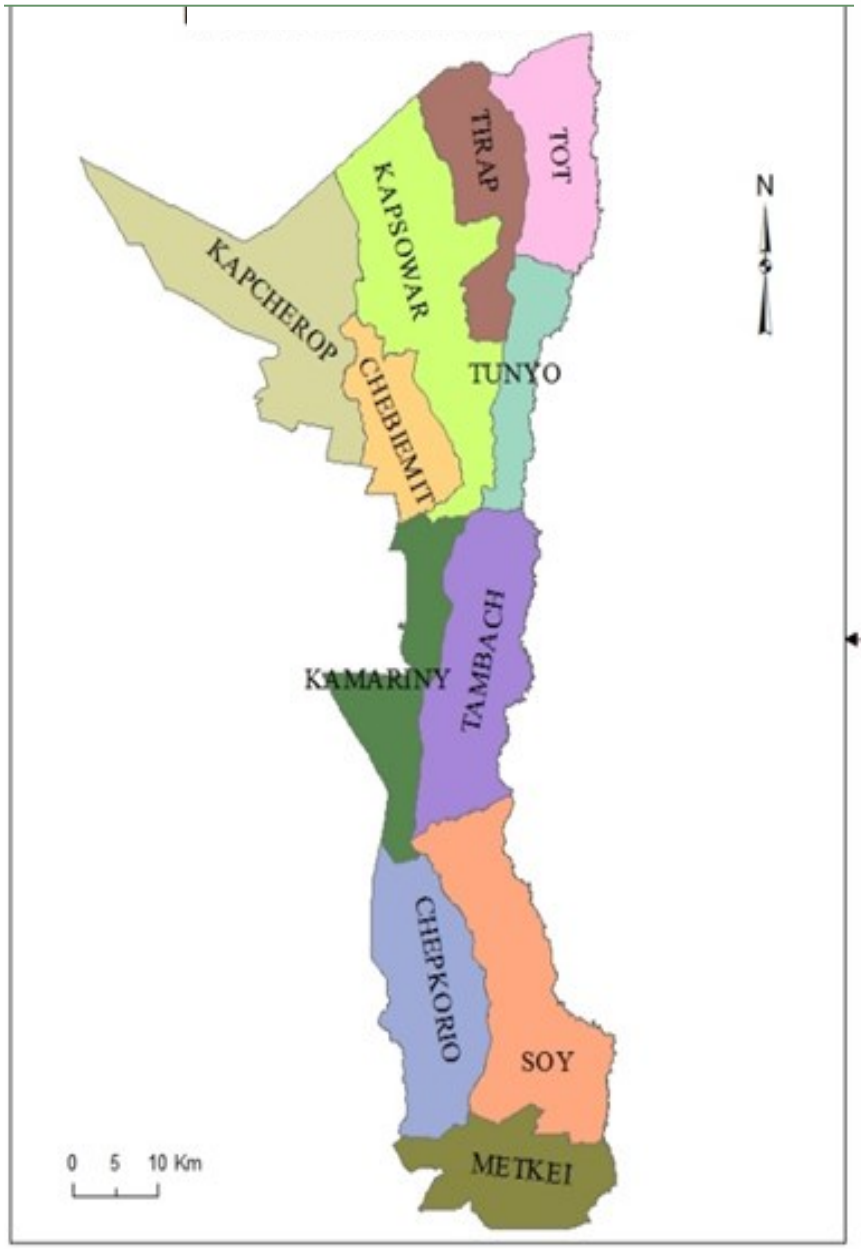

LST DIFFERENCE BETWEEN 1995 AND 2002
N
SCALE
1 centimeter = 2.59 kilometers
0 4.5 9 18 Kilometers
LEGEND
LST 1995-2002
-10.63
-10.62 - -5.94
-5.93 - -3.6
-3.59 - -1.25
-1.24 - 1.09
1.1 - 3.44
3.45 - 5.78
5.79 - 8.13
8.14 - 12.82
12.83 - 17.51


LST DIFFERENCE BETWEEN 2002 AND 2010
N
SCALE
1 centimeter = 2.59 kilometers
0 4.5 9 18 Kilometers
LEGEND
LST 2002-2010
-1.86
-1.85 - 0.54
0.55 - 2.94
2.95 - 5.35
5.36 - 7.75


LST DIFFERENCE BETWEEN 2010 AND 2016
N
SCALE
1 centimeter = 2.59 kilometers
0 4.5 9 18 Kilometers
LEGEND
LST 2010-2016
-2.26
-2.25 - -0.94
-0.93 - 0.38
0.39 - 1.7
1.71 - 3.02
3.03 - 4.34
4.35 - 5.66
5.67 - 6.98
6.99 - 8.3

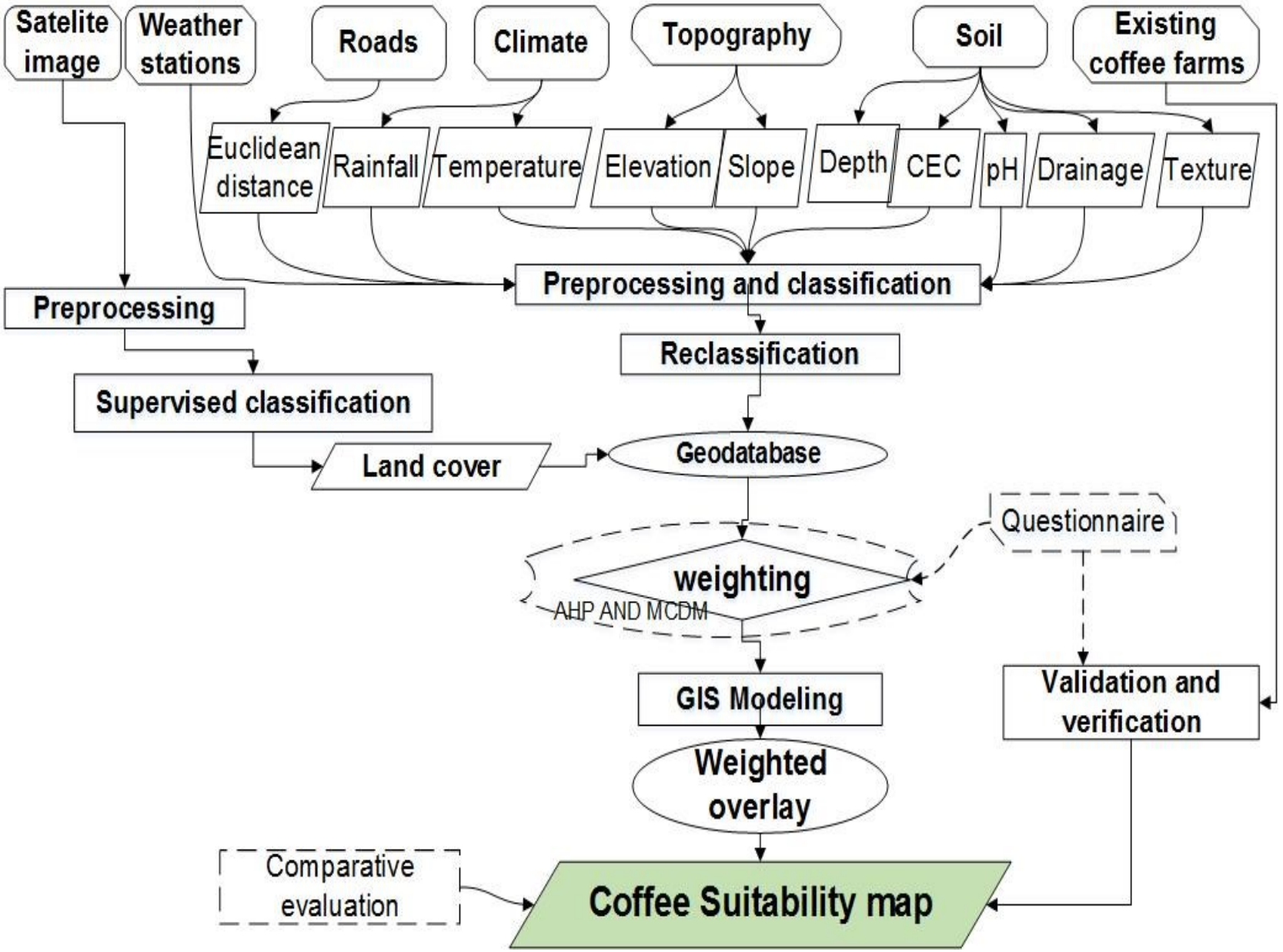
Spatial Modeling to Enhance Food Security

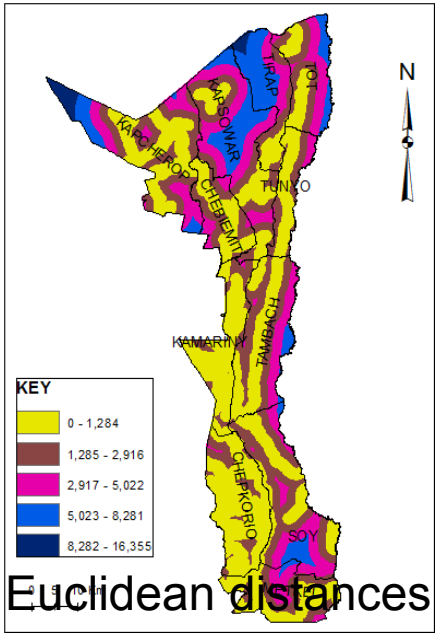
Case of Elgeyo - Marakwet County



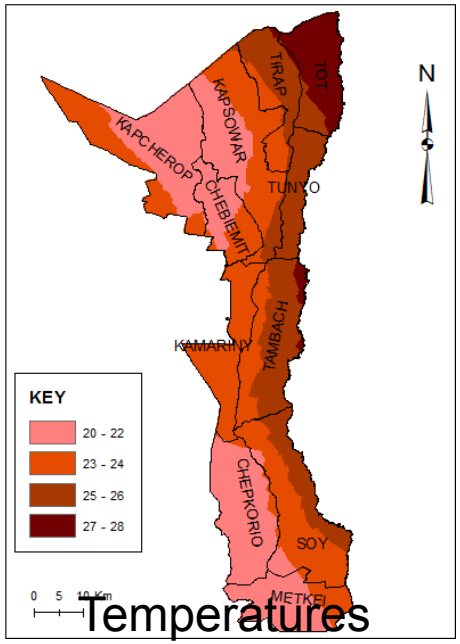
Dataset	Source/ Description
Satellite image	USGS, resolution 1-arc-second
Roads	National Bureau of Statistics (KNBS), 2001, scale 1:50,000
Climate (rainfall, temperature) and weather stations	Kenya Meteorological Department (KMD), year 1980-2014,
Topography (Elevation and slope)	USGS, Oct. 2011, resolution 1-arc-second
Soil depth, drainage, texture, PH, CEC	Kenya Soil Surveys, year 2015
Existing coffee farm	GPS measurements, Questionnaire, July 2015
Model weights, AHP ratings	Questionnaire, June 2015
Training sites	GPS mapping, July 2015, 10m resolution
Administrative boundaries	Shapefile, Survey of Kenya, 1992, 1:250,000

Modeling approach

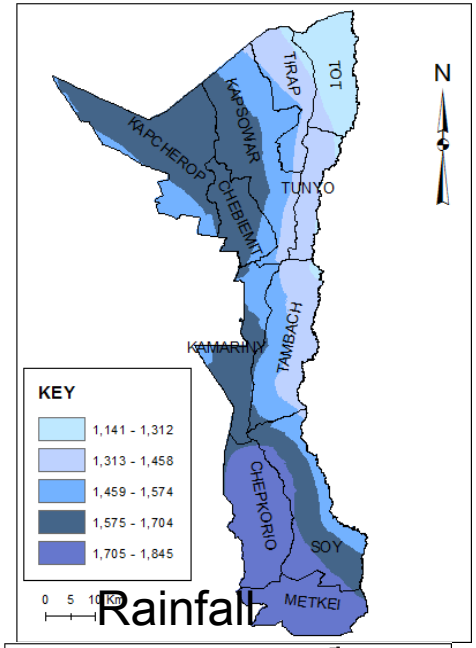




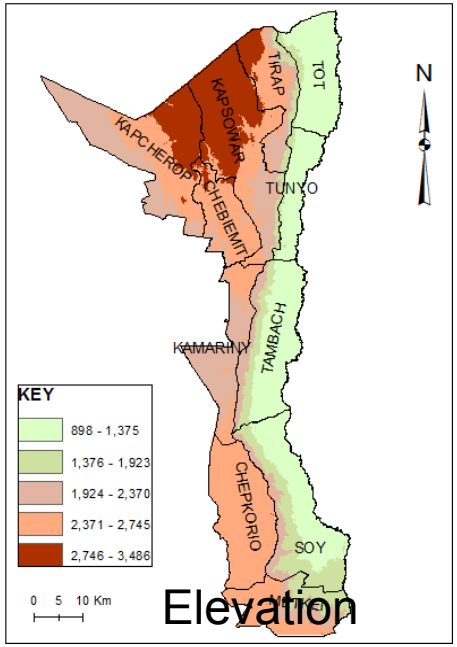
Euclidean distances



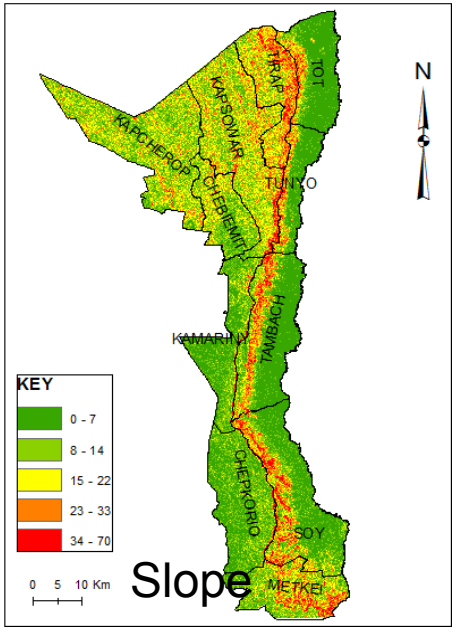
Temperatures



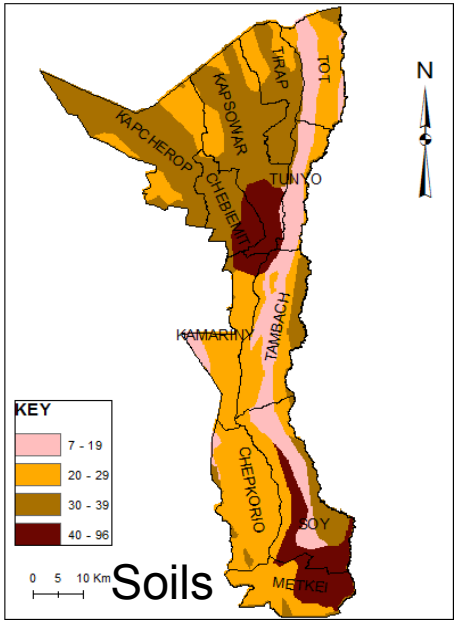
Rainfall



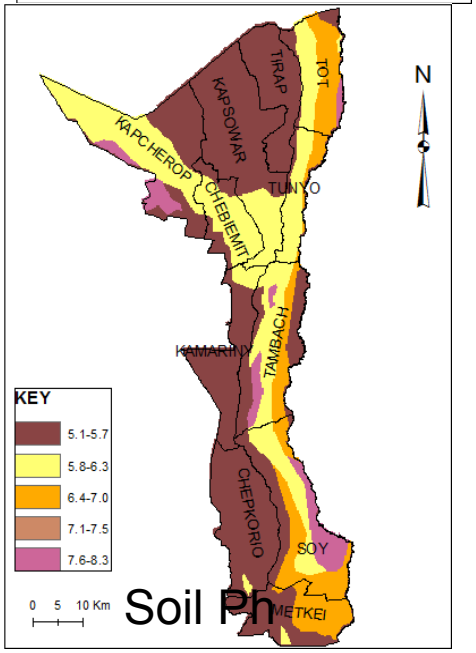
Elevation



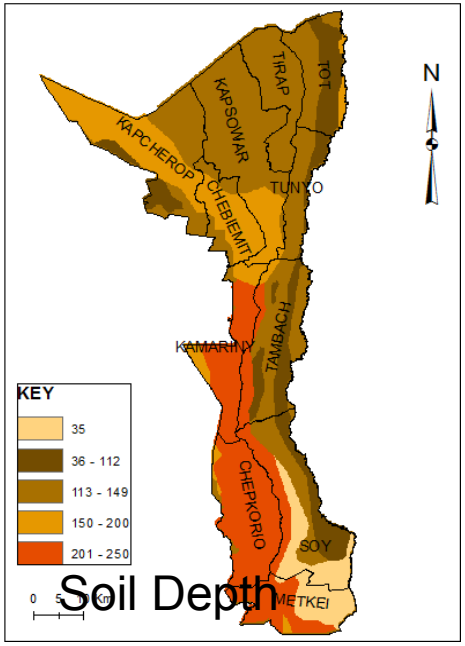
Slope



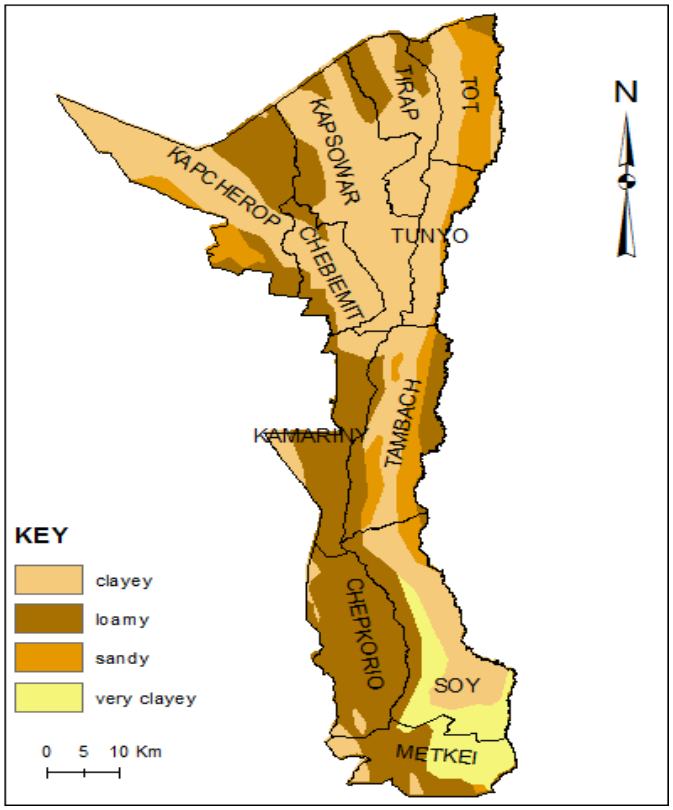
Soils



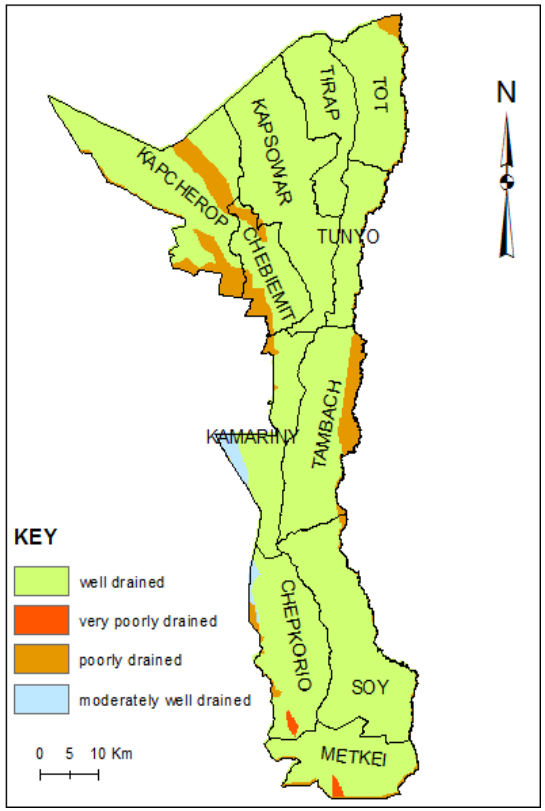
Soil Ph



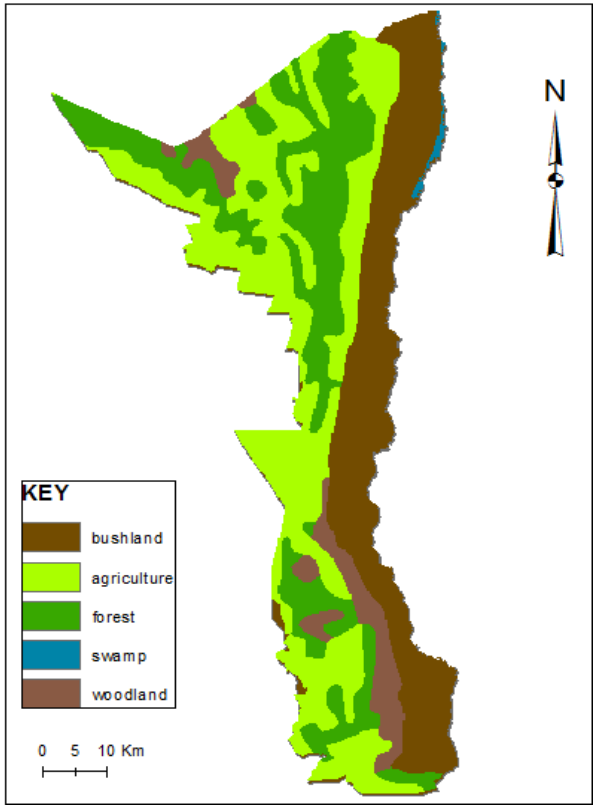
Soil Depth



Soil texture

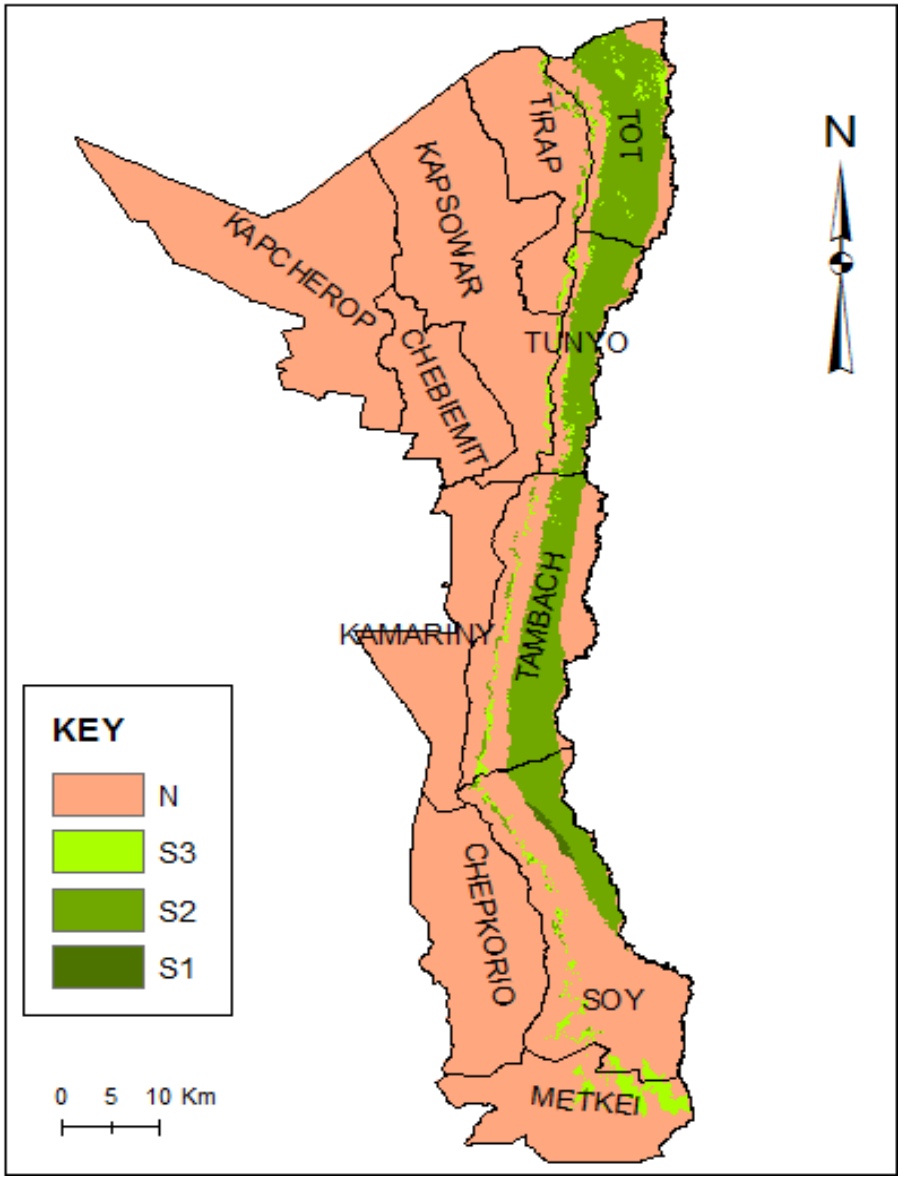


Soil Drainage

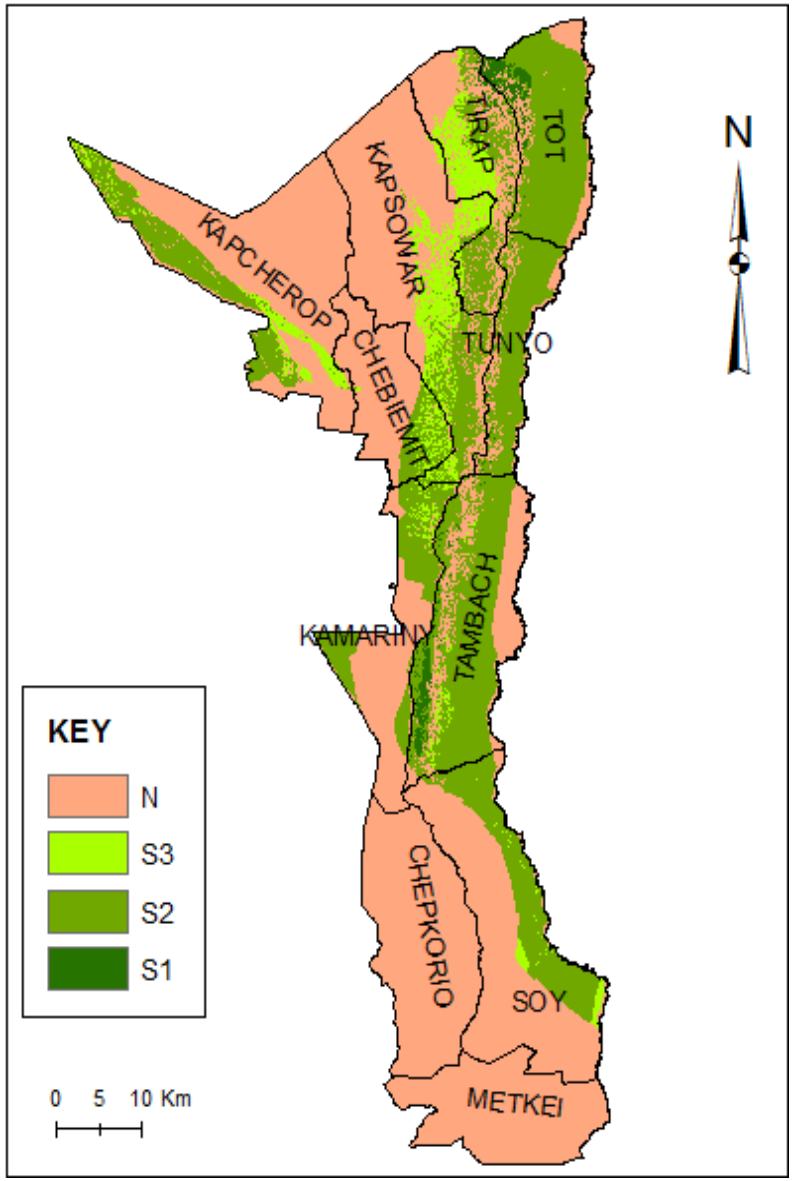


Land Cover

Criteria	w_1	Sub-criteria	w_2	Product weight	Normalized weight	Weight (%)
Climate	0.434	Rainfall	0.186	0.0807	0.252	25.2
		Temperature	0.270	0.1172	0.366	36.6
Topography	0.078	Elevation	0.114	0.0089	0.028	2.8
		Slope	0.082	0.0064	0.020	2.0
Soil	0.266	Depth	0.073	0.0194	0.061	6.1
		CEC	0.053	0.0141	0.044	4.4
		Drainage	0.061	0.0162	0.051	5.1
		Texture	0.059	0.0157	0.049	4.9
		pH	0.036	0.0096	0.030	3.0
Roads	0.047	Roads	0.034	0.0016	0.005	0.5
Land cover	0.175		0.175	0.0306	0.096	9.6
TOTAL				0.3204	1.000	100.0

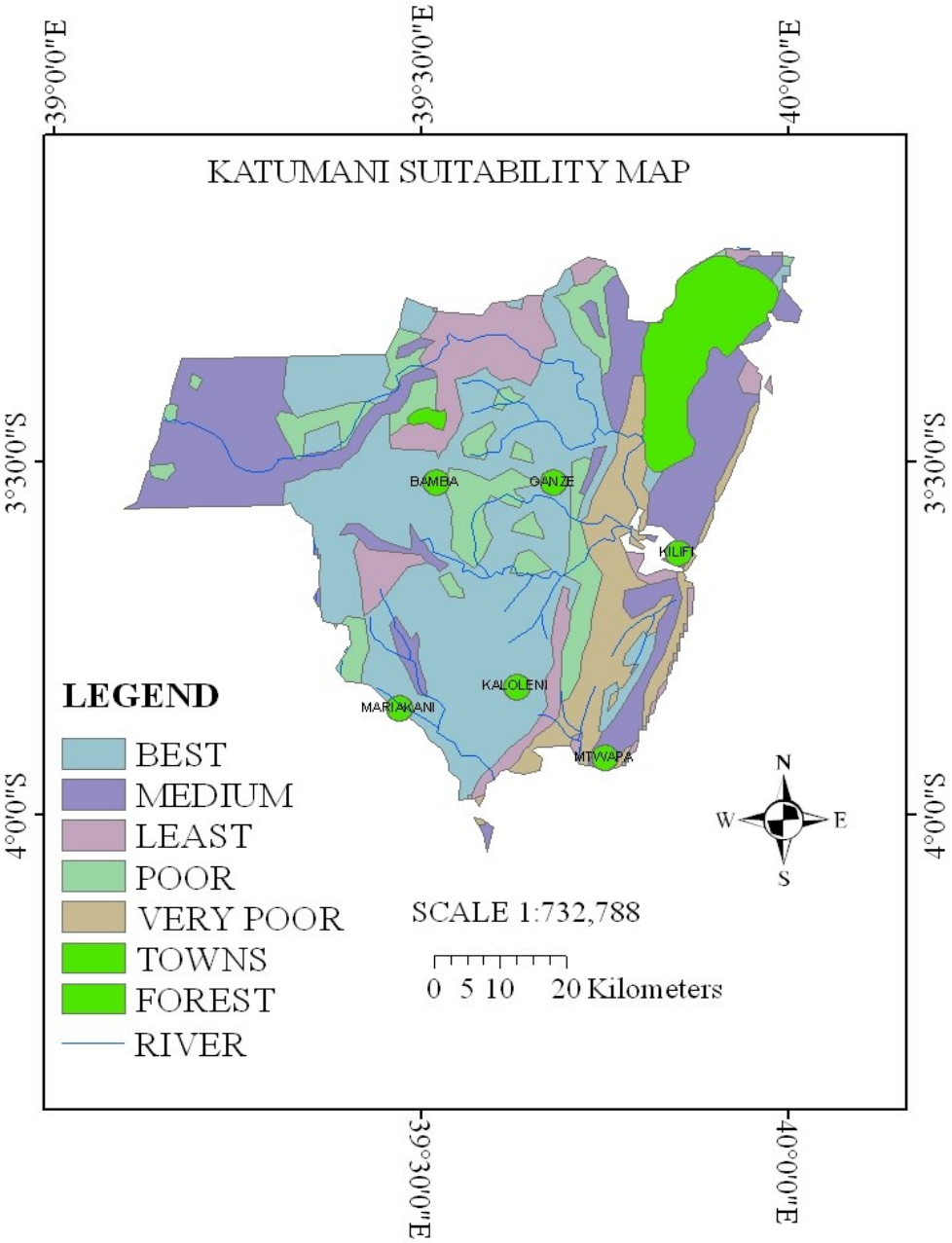


Suitability map for Arabica coffee



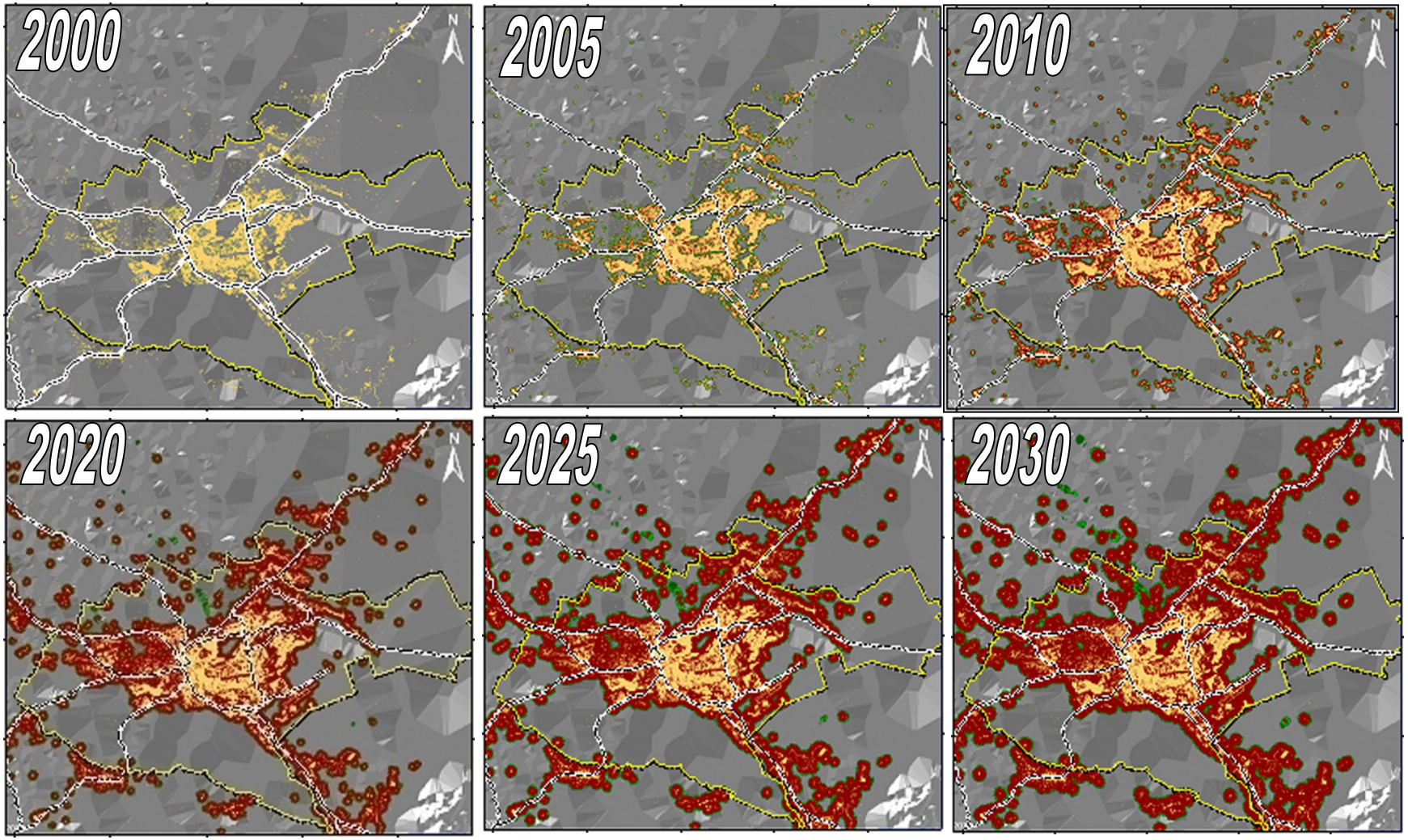
Suitability map for Robusta coffee

Maize Crop Suitability Modeling



Soil texture,
Soil pH,
Surface drainage
Permeability.
Rainfall
Temperatures
Slope
Land use
Agro ecological Conditions

Geospatial Modeling for Planning Urban Scenarios



Conclusion

Crucial role of Geospatial modeling

- studying and simulating spatial objects/ phenomena to facilitate problem solving and planning

- Finding associations based on event and geospatial data
- Making predictions using time series and geospatial data

Thank you

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