Assessment of Environmental Sensitivity to Desertification in Katsina State, Nigeria

by

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Outline

- Introduction
- Study area
- Aim and objectives
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- Method
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Introduction

- The Nigeria 2018 report on Land Degradation Neutrality (LDN) Target Setting Program provides a summary of the LDN target setting process in Nigeria. The country has a total land area of 923,786 Km2 with a population of about 180 million people, currently less than 10% of the total land area is classified as forest. Land degradation is growing at an alarming rate across all the ecological zones.

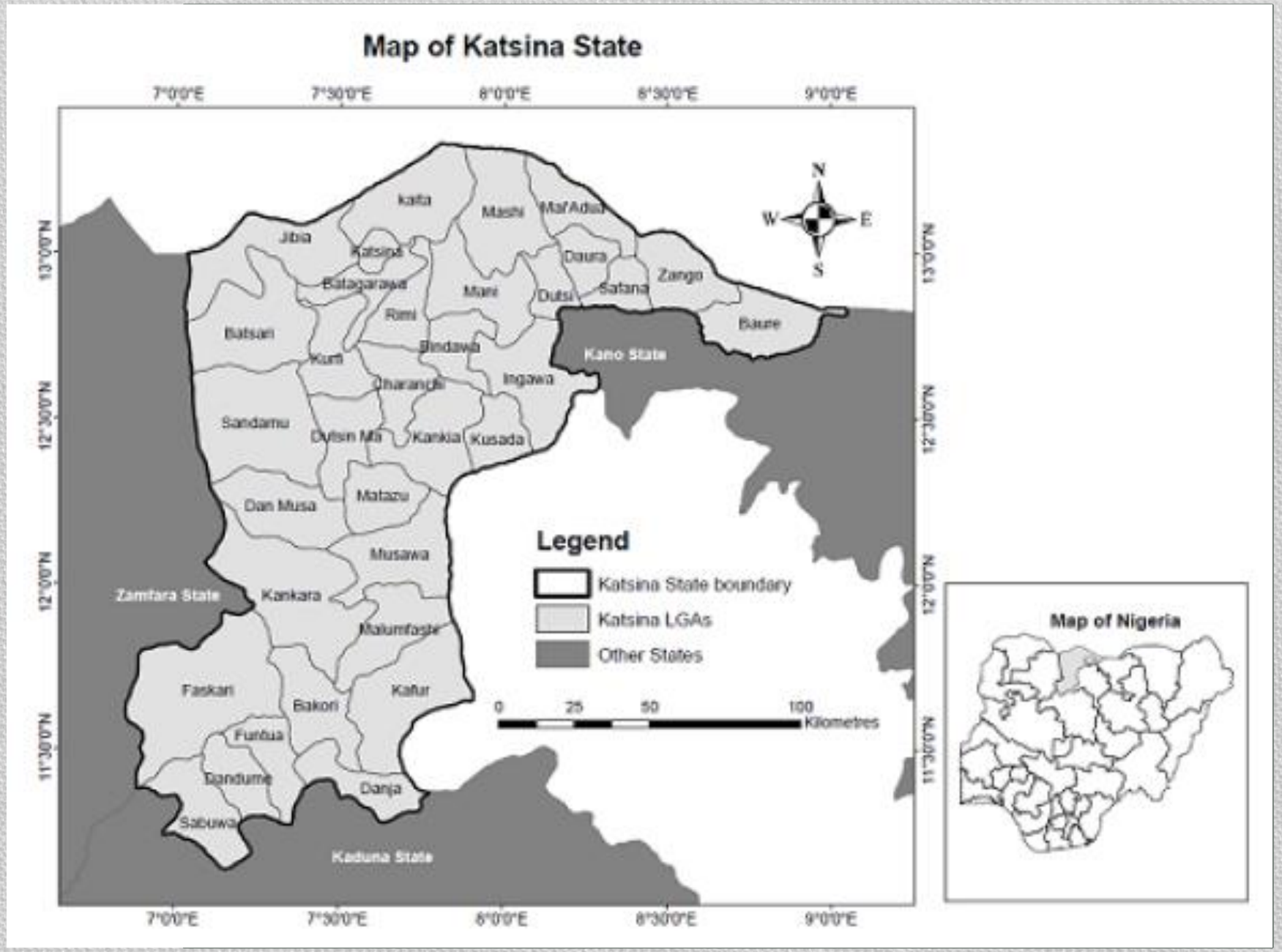
- Target 15.3 combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world", therefore has becomes vehicle for driving the implementation of United Nations Convention to Combat Desertification (UNCCD),

- Nigeria joined the LDN program having understood the benefits and links with other SDGs in addressing food security, unemployment, degraded land, water and climate change.

Contributions to other SDGs, including those relating to climate change mitigation and adaptation, biodiversity conservation, ecosystem restoration, food and water security, disaster risk reduction, and poverty (The Global Mechanism of UNCCD, 2016).

Study area

This study is focused on Katsina State. The state was created in 1987 from the defunct Kaduna State and is located between latitude 110 08' North and 130 22' North and longitude 60 52' East and 90 20' East. It covers a total area of approximately 23,983sq km. The state is bounded in the East by Kano State, in the West by Zamfara State, in the South by Kaduna State and in the North by the Niger Republic.



Aim and Objectives

- The aim of this study is to assess the sensitivity of the environment to desertification in Katsina State.

Objectives

- Acquisition of Satellite Images (NigeriaSat-1 and Landsat images).
- Extraction of informational classes from the satellite images.
- Determination of the soil and climatic quality index.
- Estimation of the vegetation quality index.
- Implementation of the environmental sensitivity index for desertification.

Data

- The dataset used for the research, its format and the source are shown in Table. However, ancillary datasets were collected from the field to interpret the satellite images acquired for the research.

- The interpreted images were used as input for Vegetation Quality Index (VQI). Moreover, the field visit provided a better understanding for the interpretation of the environmental sensitivity index.

Data	Format	Date	Source
Soil Grid Data	Raster	08-02-2015	The International Soil Reference and Information Centre (ISRIC) (www.isric.org/content/african-soilgrids-t250m-geotiffs)
Standard Soil Depth	150m Raster	08-02-2015	The International Soil Reference and Information Centre (ISRIC) (www.isric.org/content/african-soilgrids-t250m-geotiffs)
DEM	30m ASTER	17-10-2011	Earth Explorer website (https://earthexplorer.usgs.gov)
Precipitation Dataset	2.5 degrees	14-11-2016	Version-2 global precipitation climatology project (GPCP)
Annual Mean Temperature	Degree Celsius	16-11-2016	Giovanni NASA (http://giovanni.gsfc.nasa.gov/giovanni/)
Landsat 8 Satellite Image	Raster	18-10-2016	Earth Explorer (http://earthexplorer.usgs.gov/)
NigeriaSat-1	Raster	03-10-2006	NASRDA Archival dataset (three spectral bands are provided in the ranges: 0.52-0.62 µm (green), 0.63-0.69 µm (red), and 0.76-0.9 µm (NIR)).
Katsina State Boundary	Shapefile	28-09-2006	Office of the Surveyor General of the Federation (OSGOF) through Second Administrative Level Boundaries (SALB) dataset project.

Method

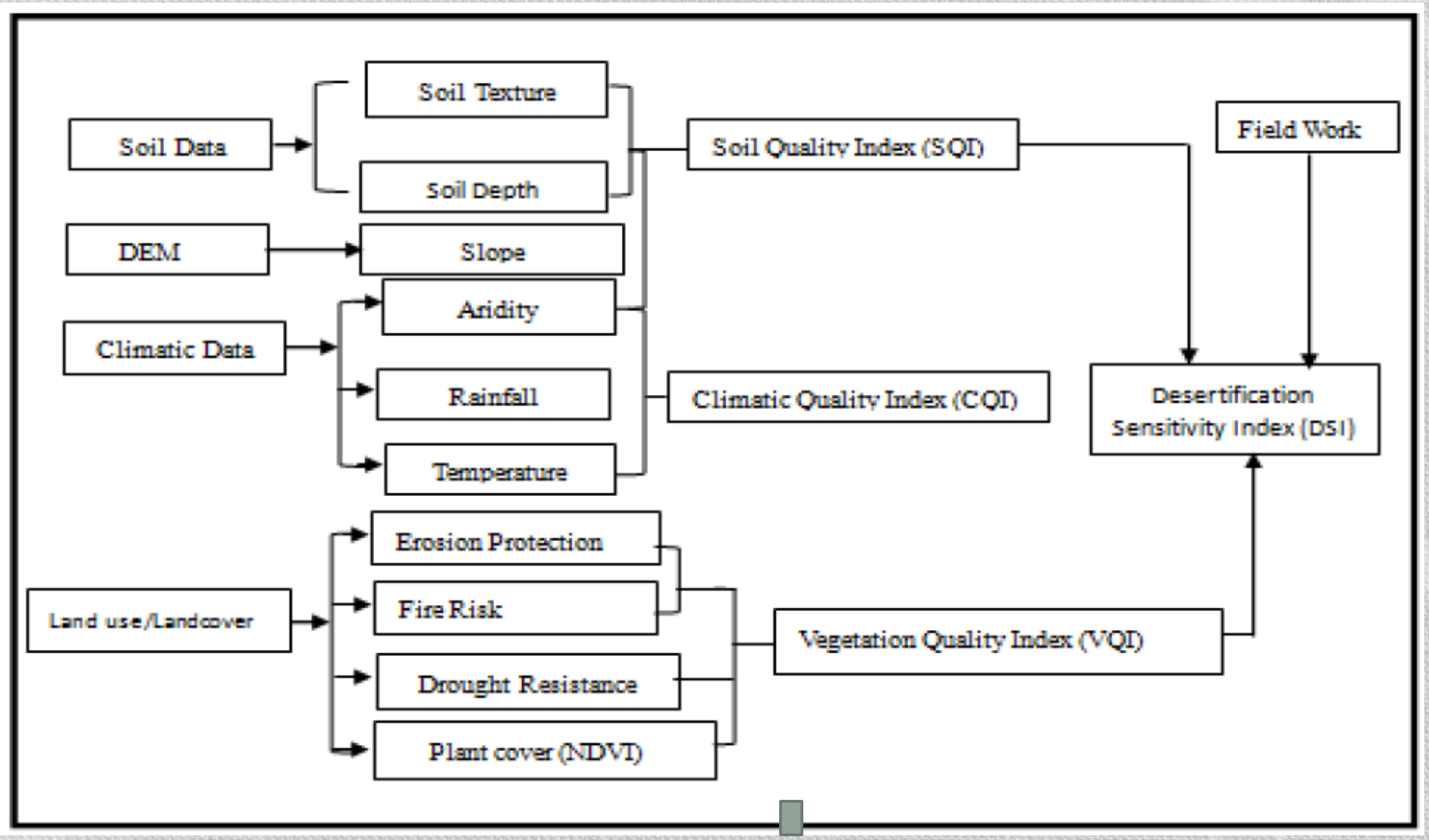
- **Mediterranean Desertification And Land Use (MEDALUS) model**

- The MEDALUS (Mediterranean Desertification and Land Use) approach was developed by the European Commission and aims at assessing environmental sensitivity to desertification (EC 1999, Basso et al. 2000).

- The areas sensitive to desertification are identified by the combination of 5 quality indicators: Soil Quality Index (SQI), Climate Quality Index (CQI), Vegetation Quality Index (VQI), Water Quality Index (WQI), and Land Management Index (LMI).

- The MEDALUS model is based on the classification of the Environmental Sensitivity to Desertification Index (ESDI) obtained as the geometric mean of the available environmental and anthropogenic quantitative indices.

Flow chat


Soil Data
Soil Texture
Soil Depth
Soil Quality Index (SQI)
Field Work
DEM
Slope
Climatic Data
Aridity
Rainfall
Temperature
Climatic Quality Index (CQI)
Desertification Sensitivity Index (DSI)
Land use/Landcover
Erosion Protection
Fire Risk
Drought Resistance
Plant cover (NDVI)
Vegetation Quality Index (VQI)

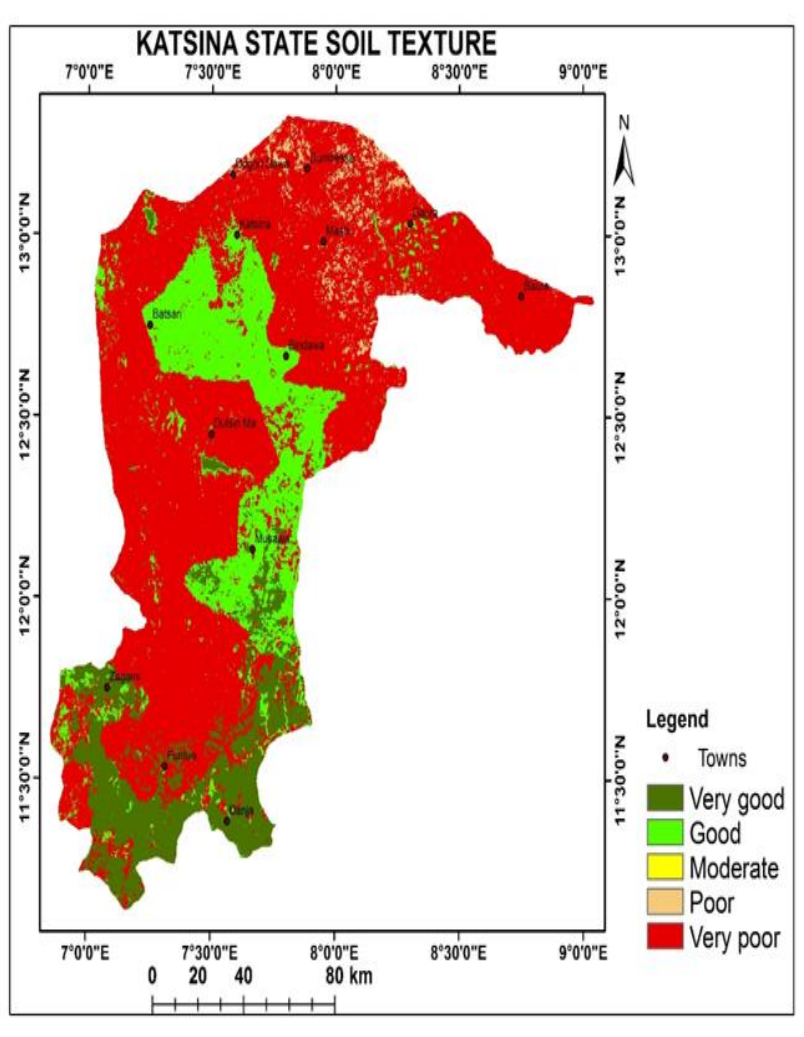
Environmental Sensitivity index

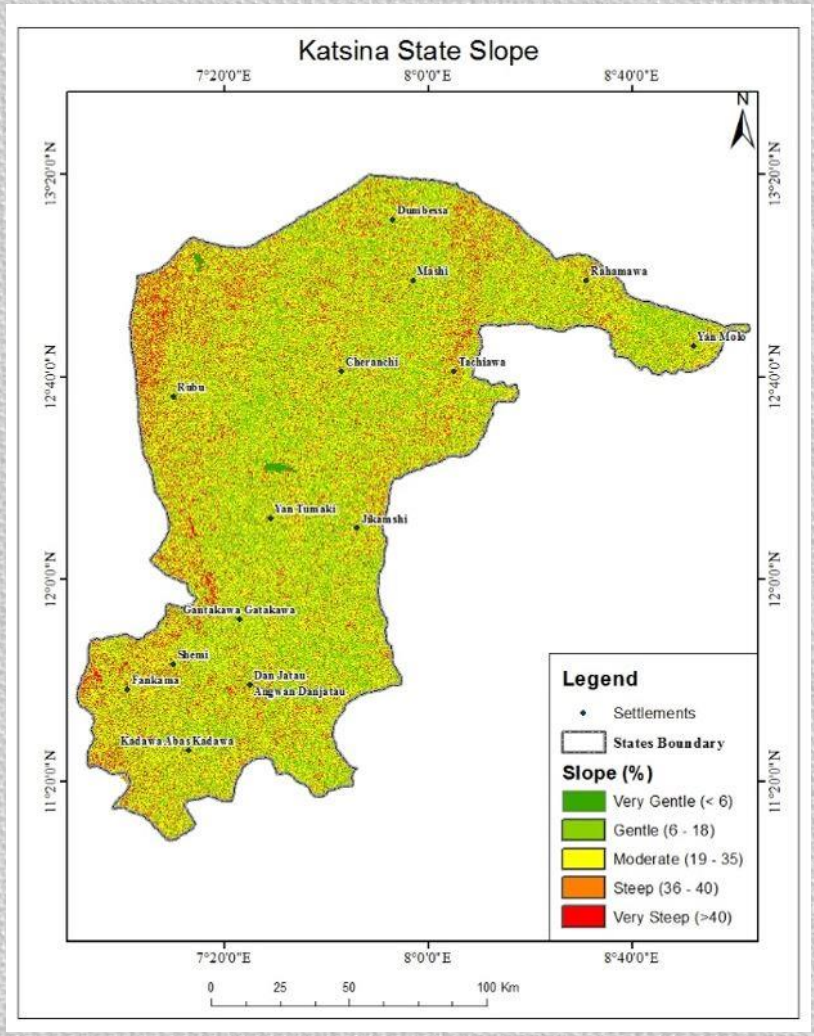
- **The Evaluation of the Environmental Sensitivity to desertification Index**

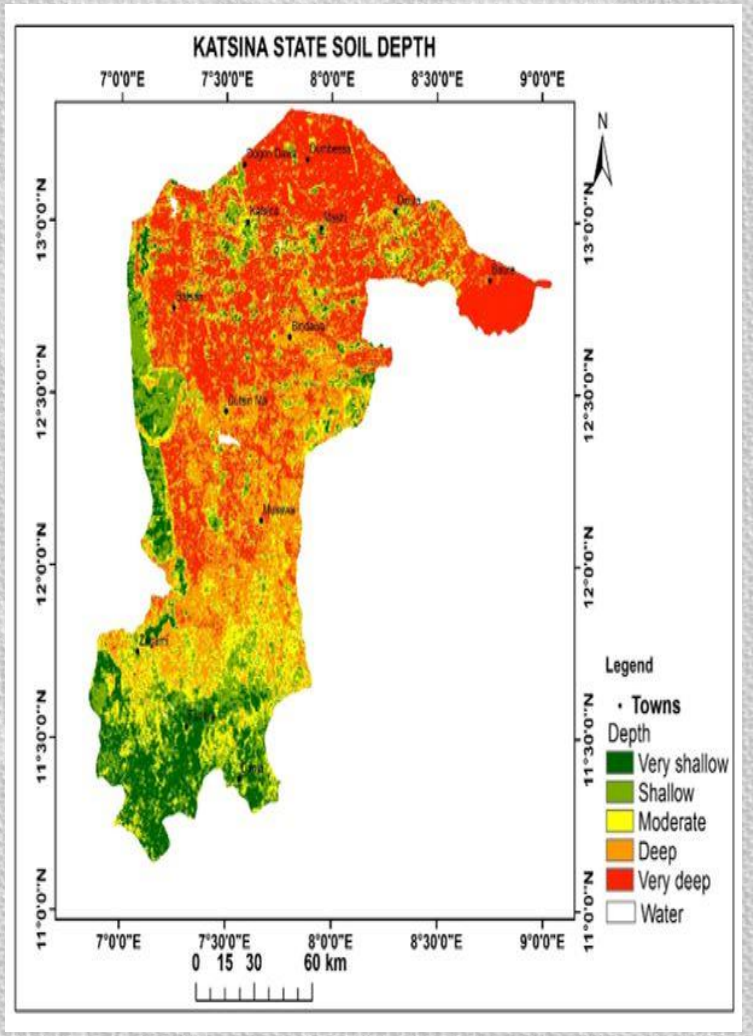
The formula for evaluating the environmental sensitivity to desertification is presented in Equation. (ESDI = (SQI * CQI * VQI)1\3)

The SQI, CQI, and VQI were evaluated. The thematic maps from these sections were thereafter substituted in Equation, using the raster calculator routine in ArcGIS. The resulting thematic map was divided in three segment based on the natural break criteria. The three segment areas include: non-sensitive area, moderate sensitive area and very sensitive area.

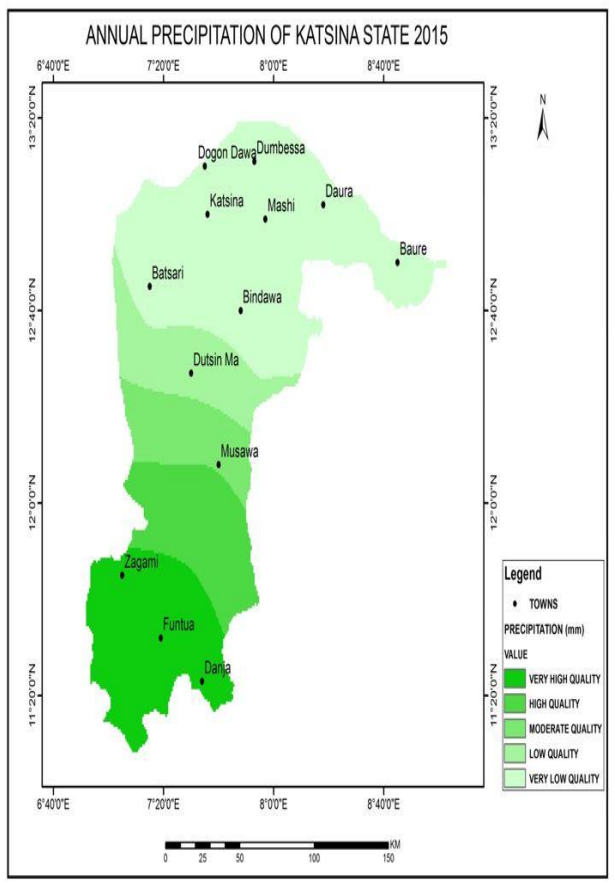
Analysis

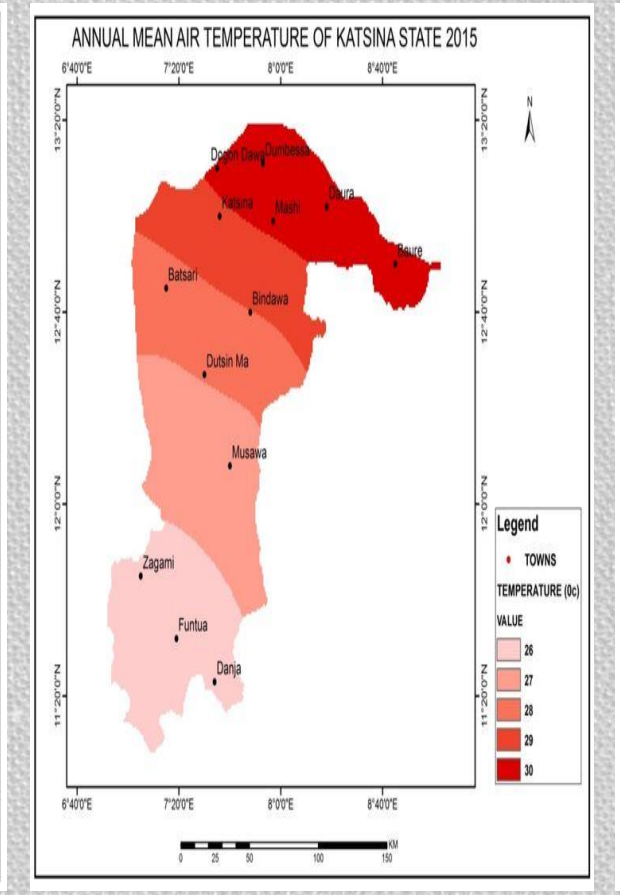

KATSINA STATE SOIL TEXTURE
7°0'0"E
7°30'0"E
8°0'0"E
8°30'0"E
9°0'0"E
13°0'0"N
12°30'0"N
12°0'0"N
11°30'0"N
N
Legend
Towns
Very good
Good
Moderate
Poor
Very poor
0 20 40 80 km


Katsina State Slope
7°20'0"E
8°0'0"E
8°40'0"E
13°20'0"N
12°40'0"N
12°0'0"N
11°20'0"N
N
Dumbessa
Mashi
Rahamawa
Yan Mako
Cheranchi
Tachiawa
Rubu
Yan Tumaki
Jikamshi
Gantakawa Gatakawa
Shemi
Fankama
Dan Jatau
Angwan Danjatau
Kadawa Abas Kadawa
Legend
Settlements
States Boundary
Slope (%)
Very Gentle (< 6)
Gentle (6 - 18)
Moderate (19 - 35)
Steep (36 - 40)
Very Steep (>40)
0 25 50 100 Km

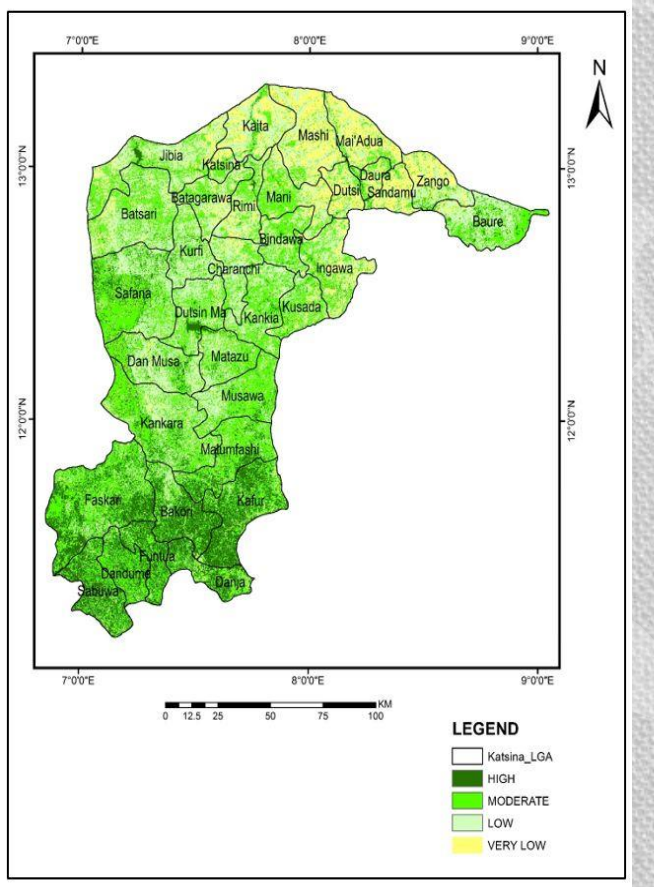

KATSINA STATE SOIL DEPTH
7°0'0"E
7°30'0"E
8°0'0"E
8°30'0"E
9°0'0"E
13°0'0"N
12°30'0"N
12°0'0"N
11°30'0"N
11°0'0"N
N
Legend
Towns
Depth
Very shallow
Shallow
Moderate
Deep
Very deep
Water
0 15 30 60 km

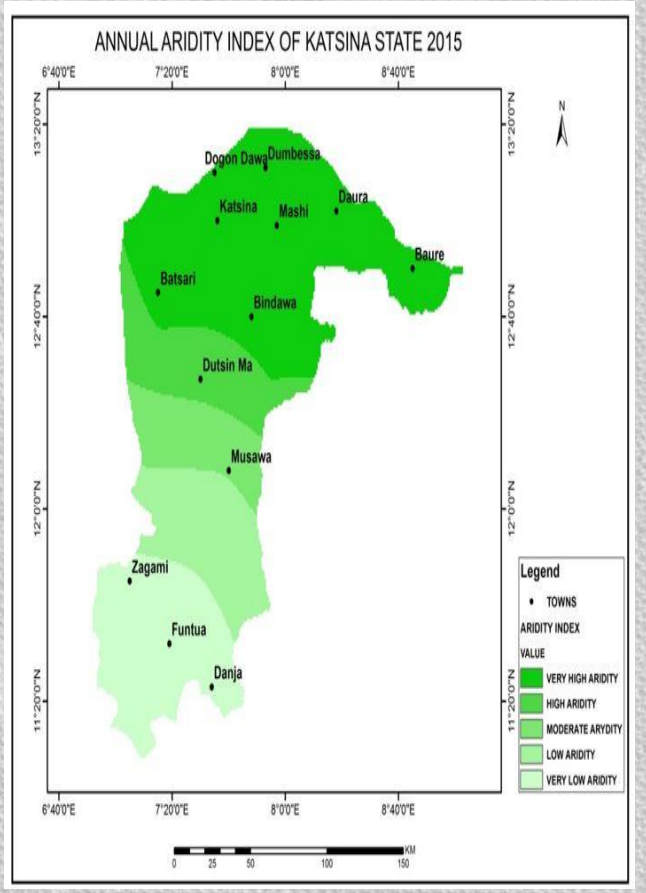
Analysis



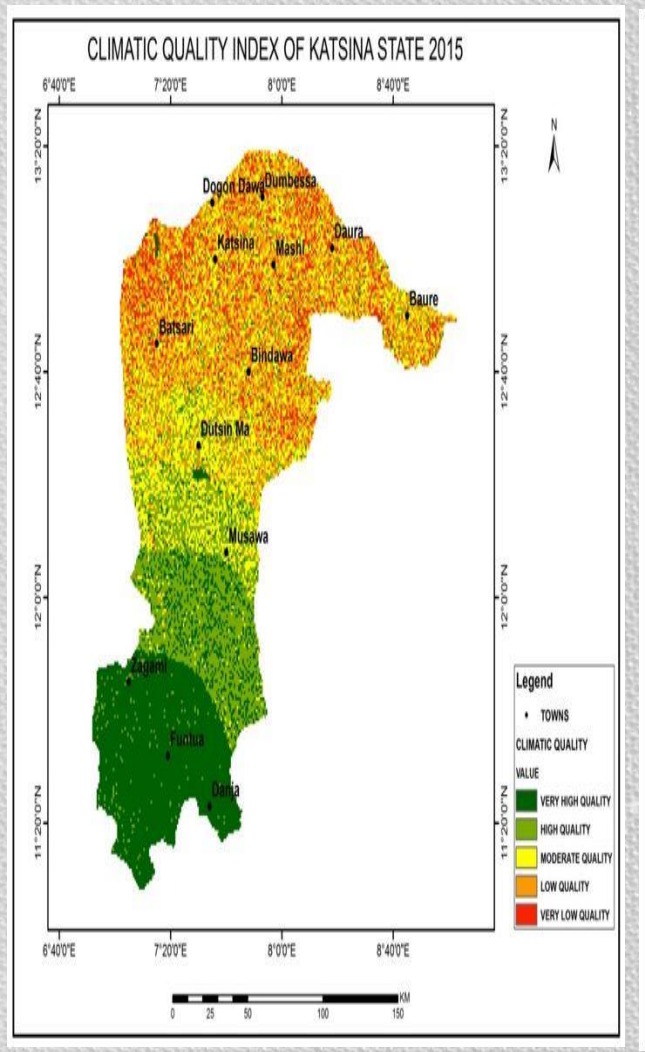


Vegetation cover map

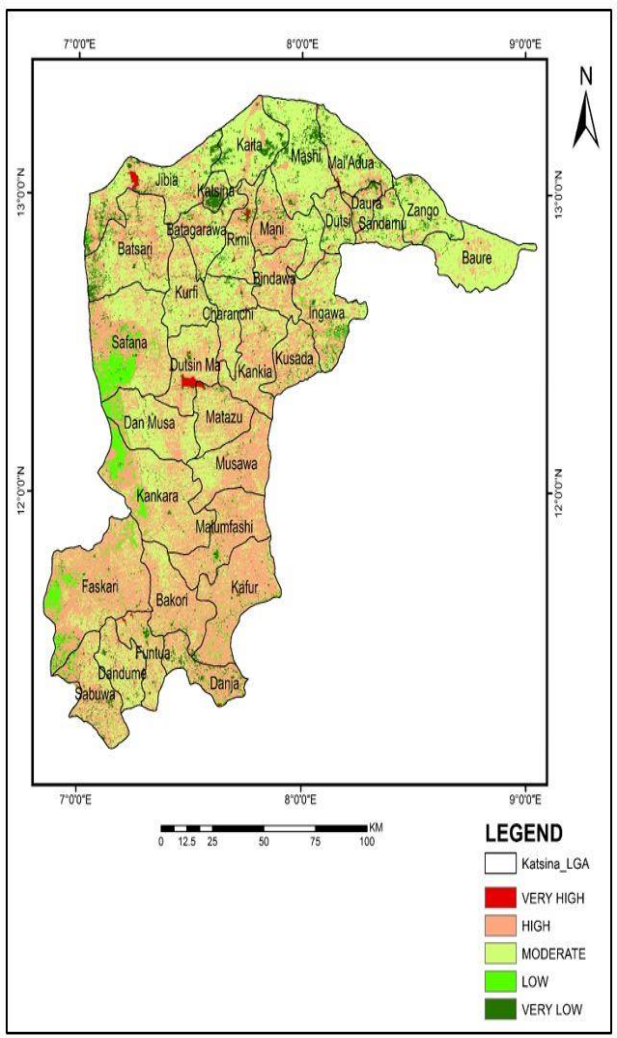




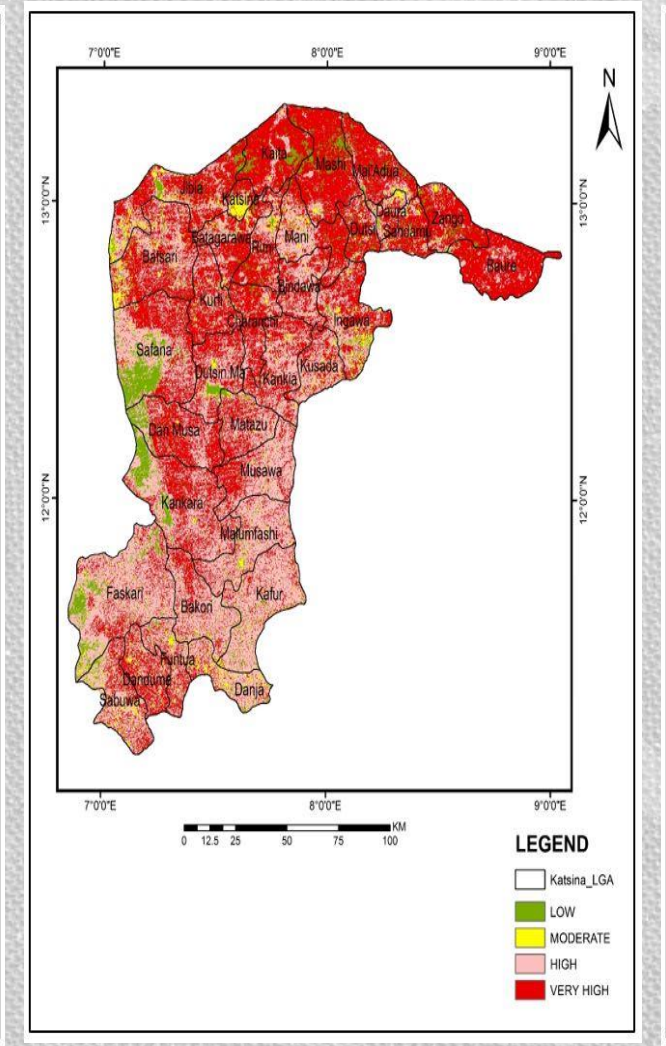
Analysis



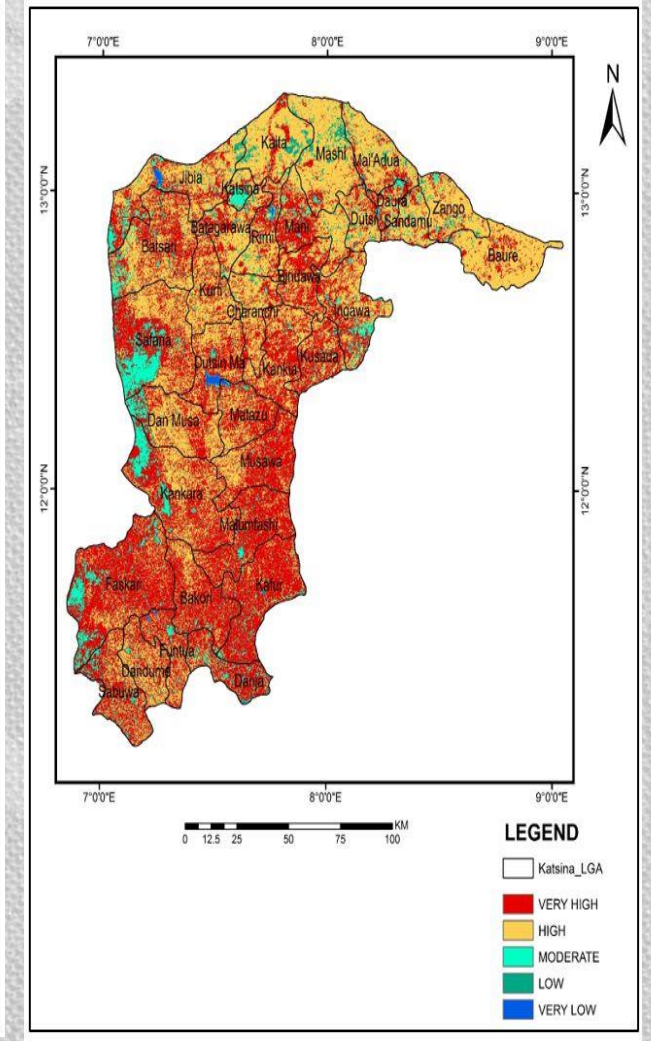
Drought resistance map



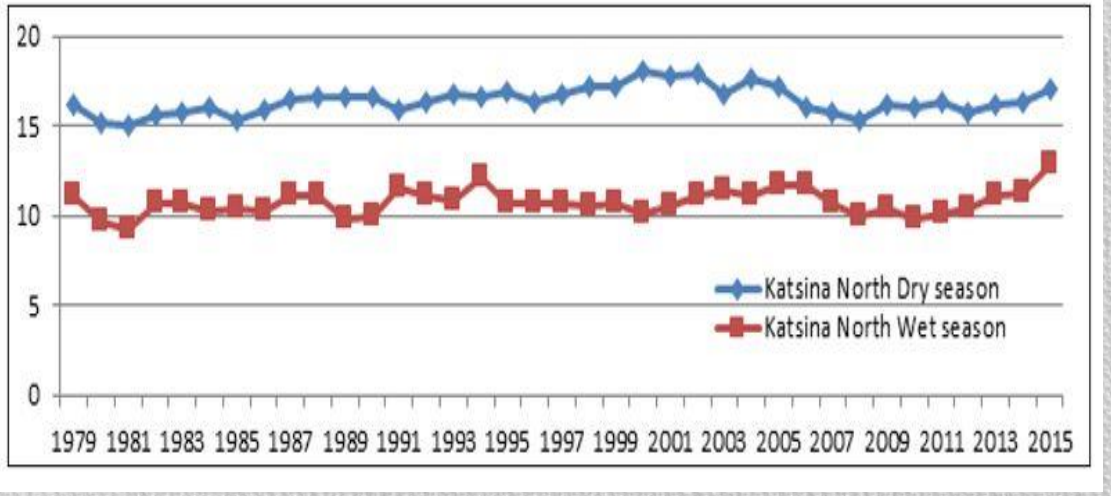
fire resistance map



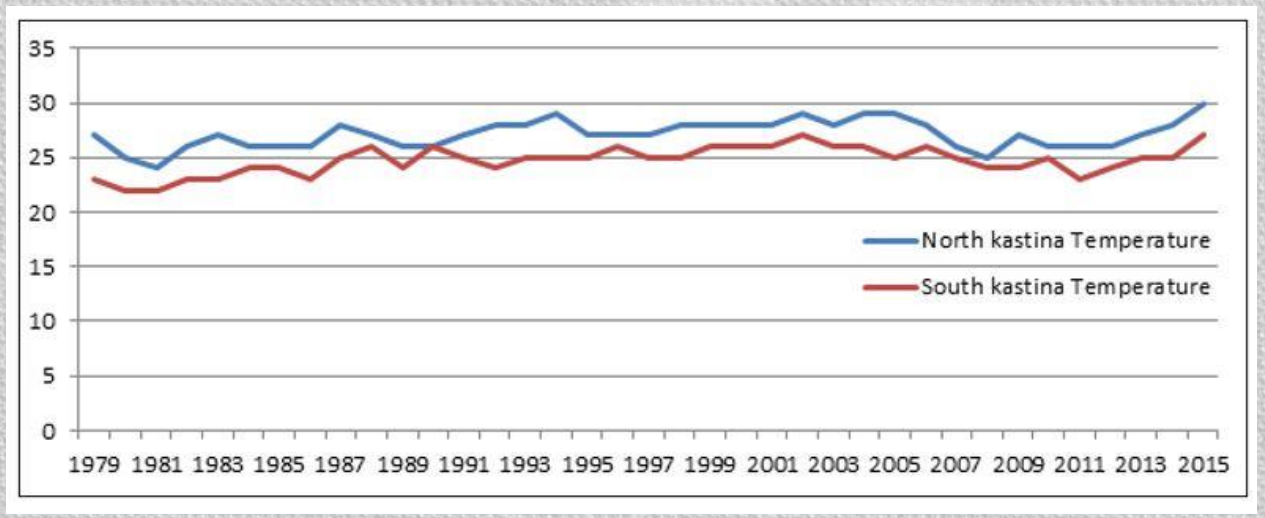
Erosion resistance map



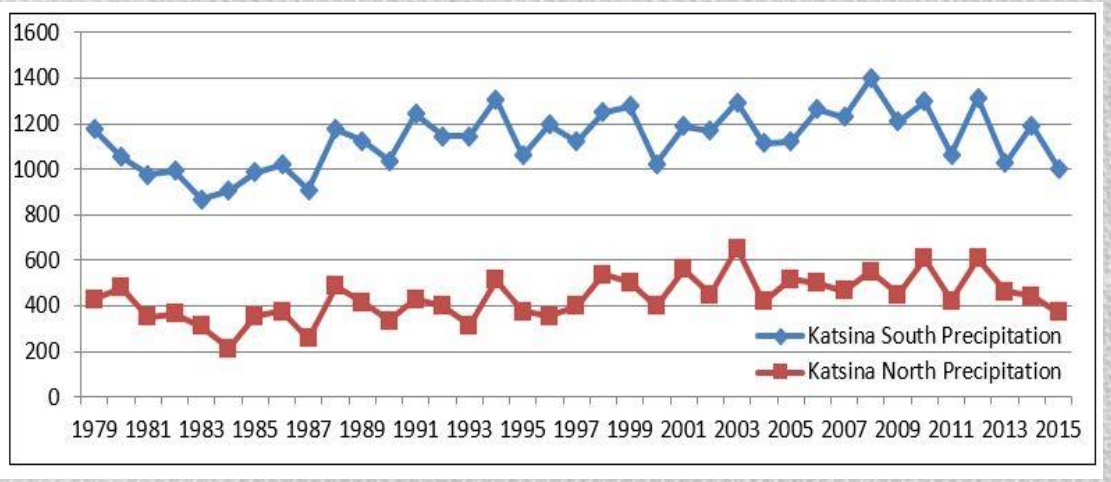
Analysis



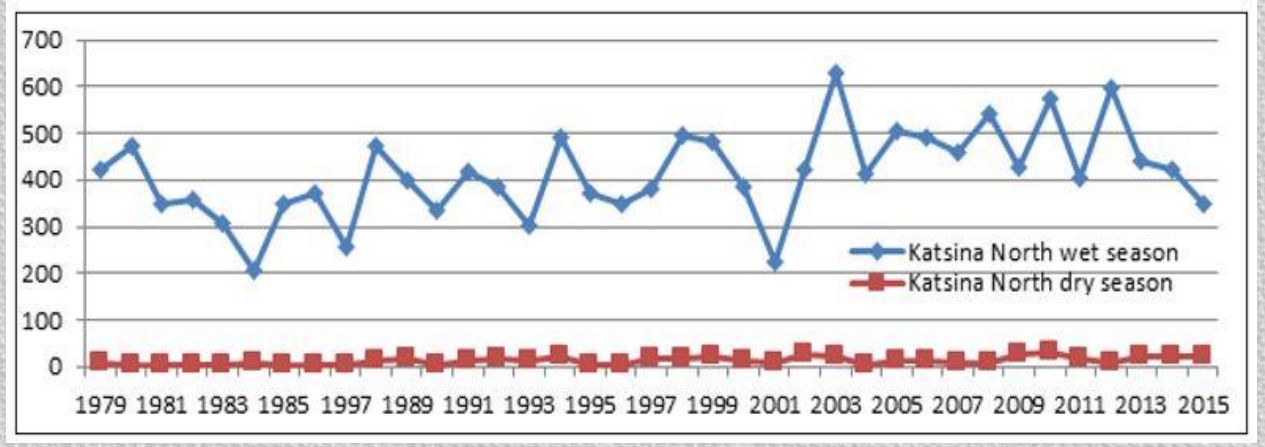
Mean annual Temp for dry and wet seasons for northern Katsina state



Annual mean temp for north & southern segments of Katsina state



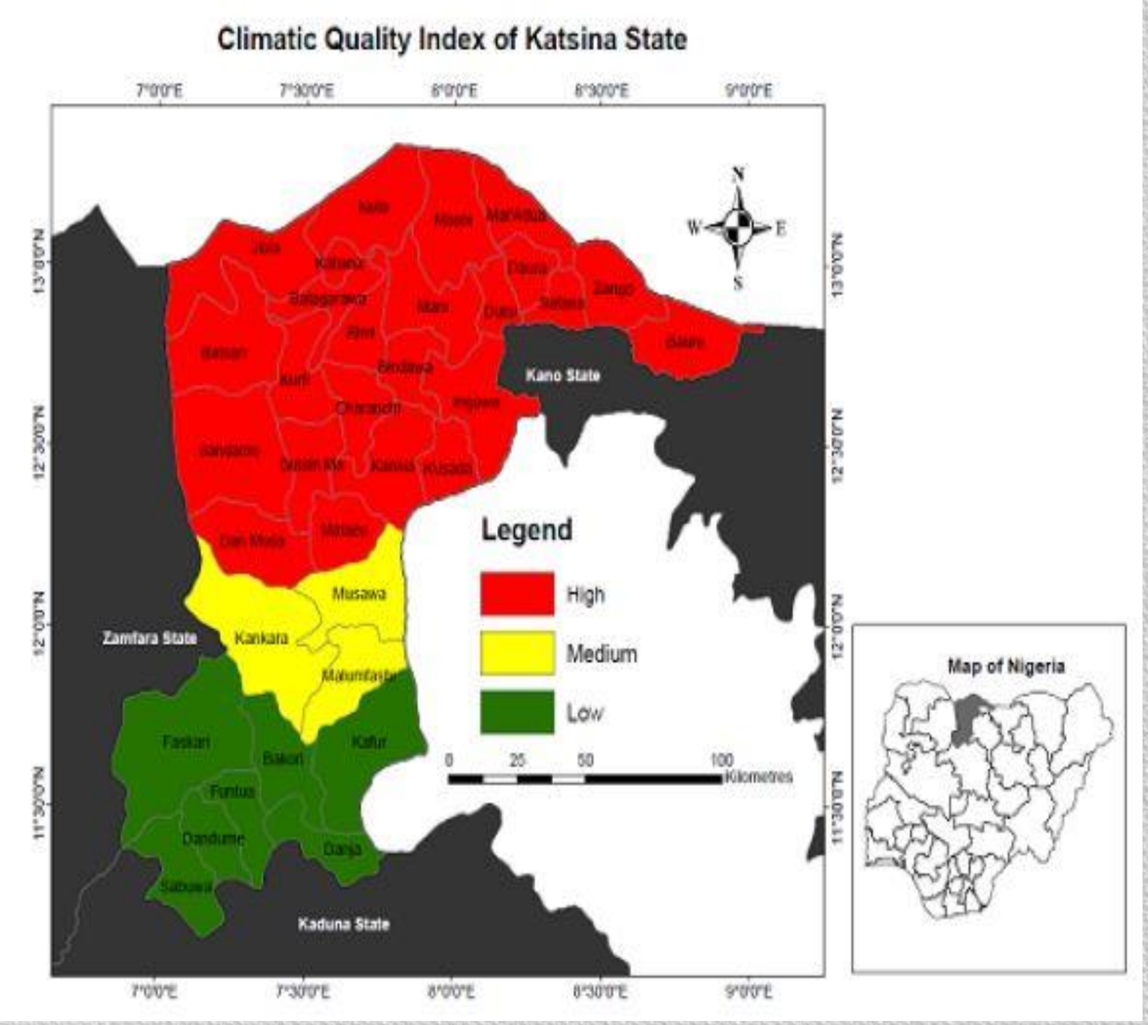
Annual ppt for southern part Katsina state

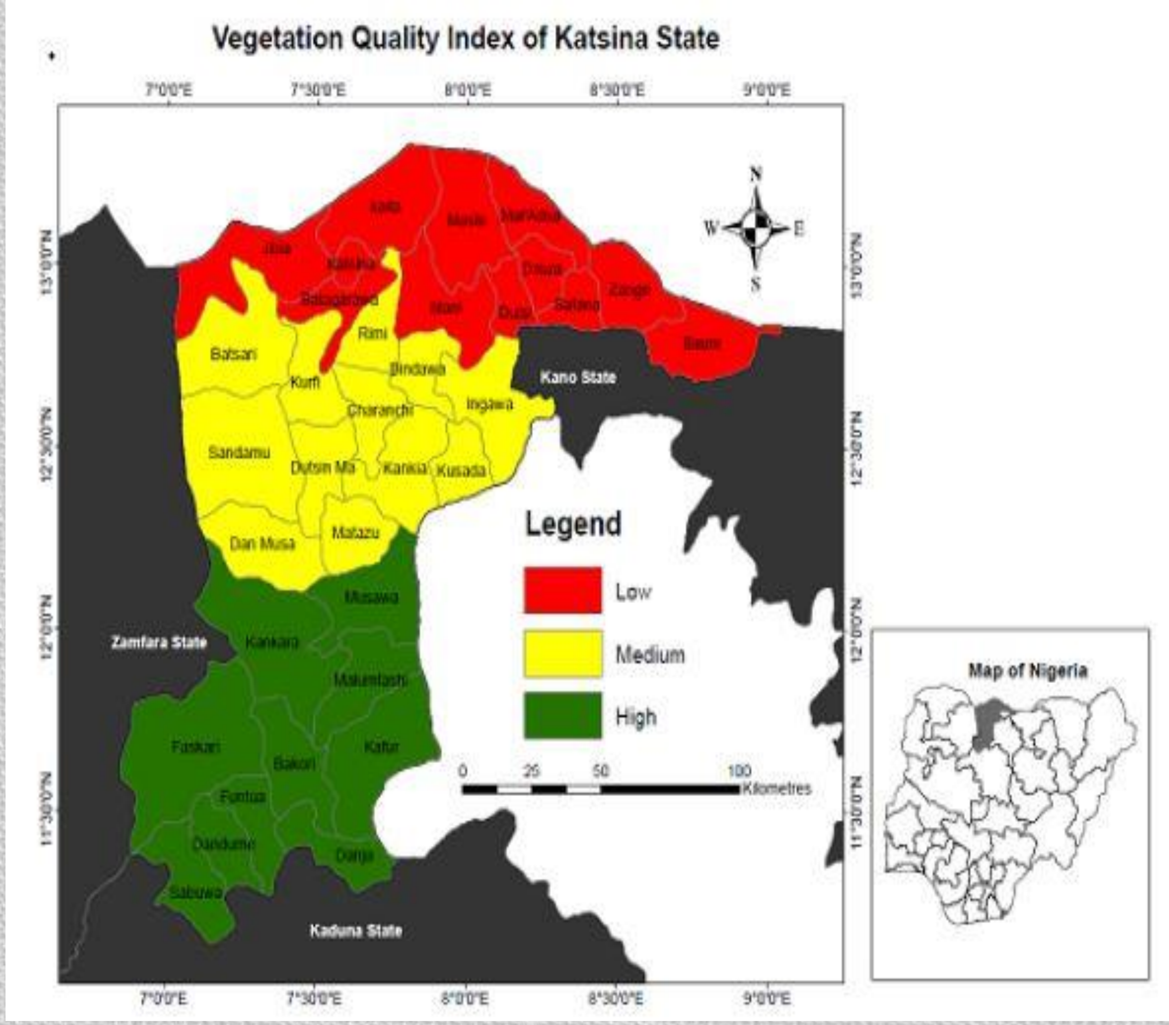


Annual Precipitation for Northern Segment of Katsina in dry and wet seasons

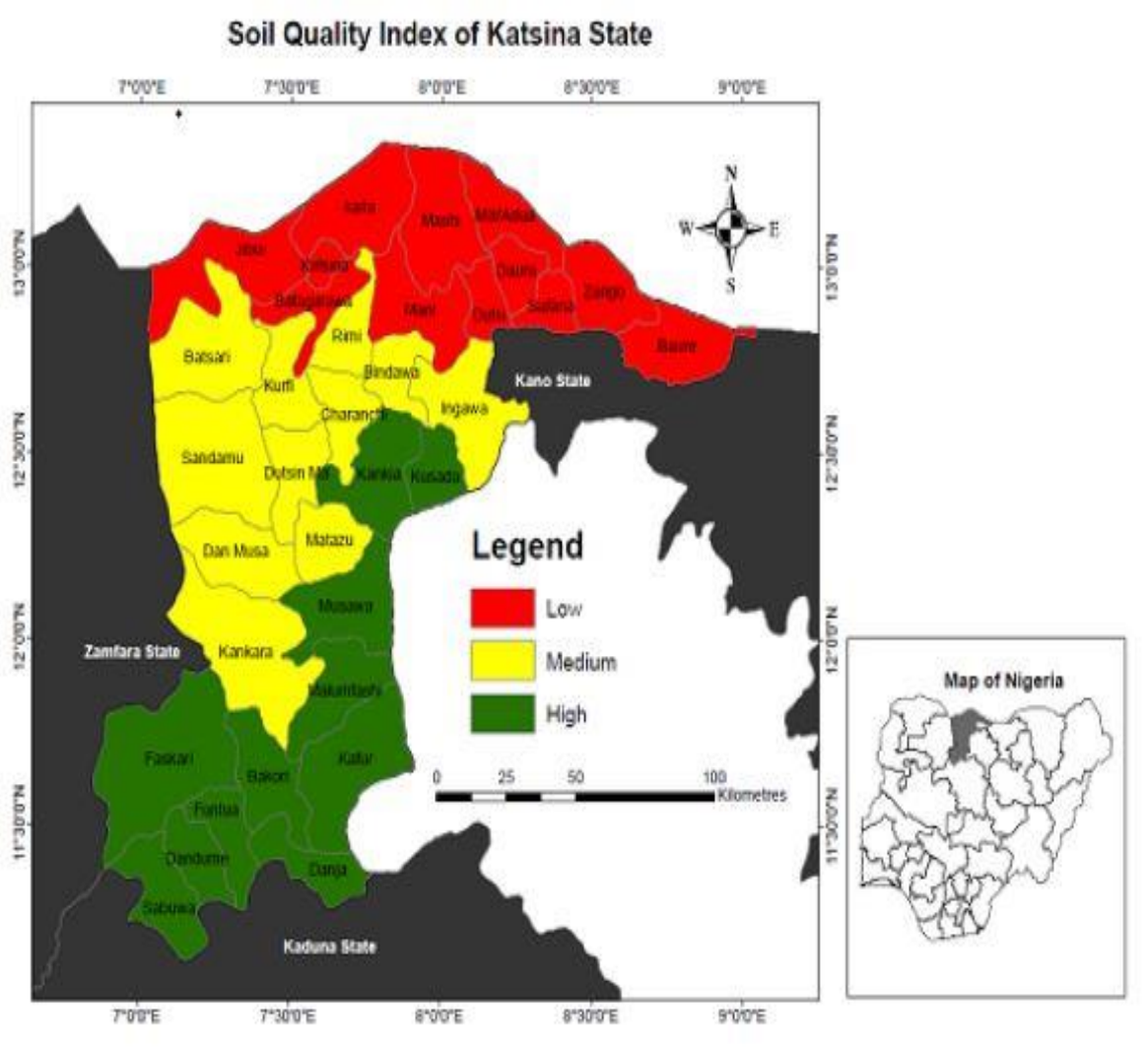
Data Source: Giovanni NASA 2017

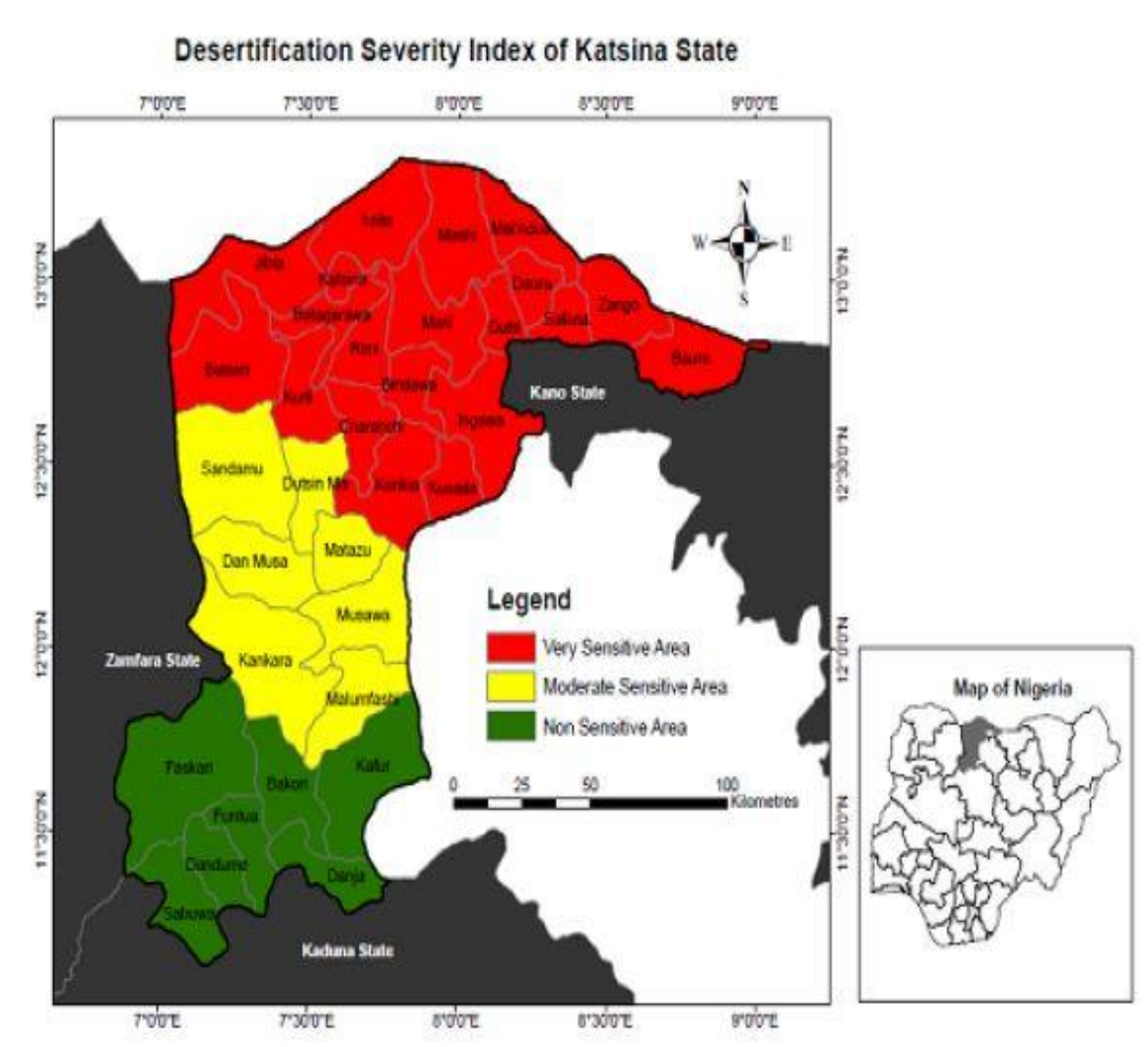
Results


Climatic Quality Index of Katsina State
Kano State
Zamfara State
Kaduna State
Legend
High
Medium
Low
0 25 50 100
Kilometres
Map of Nigeria


Vegetation Quality Index of Katsina State
Kano State
Zamfara State
Kaduna State
Legend
Low
Medium
High
0 25 50 100
Kilometres
Map of Nigeria

Results


Soil Quality Index of Katsina State
Legend
Low
Medium
High
Kano State
Zamfara State
Kaduna State
Map of Nigeria


Desertification Severity Index of Katsina State
Legend
Very Sensitive Area
Moderate Sensitive Area
Non Sensitive Area
Kano State
Zamfara State
Kaduna State
Map of Nigeria

Findings

- The variability between the northern and southern segments of Katsina State. This is clearly shown in the variability of precipitation and temperature for the northern and southern Katsina, respectively.

- Rainfall in 2015, the southern parts of the state received a total of over 800 mm of rainfall while the northern parts received a total of less than 497 mm. Similarly, the mean temperature for the northern part of Katsina was 30 oc while that of the southern part was 27 oC. These results are consistent with the ESDI for Katsina State.

- The (ESDI) analysis revealed that about 917,872.74ha representing about 38.31% of total area of katsina state is highly sensitive to desertification, while about 814,291.57ha representing 33.99% is moderately sensitive and 663,628.05ha which also represent 27.70% is Non sensitive to desertification

- The implications of the findings in this research are numerous. First, the northern part of Katsina State is highly vulnerable to desertification process. The local government areas affected include: Katsina, Kurfi, Kankia, Batagarawa, Kusada, Charanchi, Jibia, Batsari, Mai-adua, Mashi, Kaita, Mani, Dutsi, Daura, Sandamu, Zango, Baure, Ingawa, Bindawa, and Rimi local. The livelihood of the communities in these local government areas have been large limited due to high vulnerability to desertification process. As a result there is constant migration down to southern Katsina and southern Nigeria. This migration is responsible for the clash between the herdsmen and farmers with the loss of lives and properties.

Some plates from field work

Findings cont'd

Sandy soil in Mai'adua LGA

Sparse vegetation in Baure LGA

Conclusion

- Land degradation and desertification (LDD) are critical issues facing most states in northern Nigeria, with severe consequences for national food security. Land degradation refers to the deterioration or total loss of the productive capacity of the soils for present and future use (FAO, 1980).

- The Environmental Sensitivity to Desertification Index (ESDI) is the most frequently applied indicator-based system for accessing Land Degradation and Desertification. The research reported here adopted the MEDALUS (Mediterranean Desertification and Land Use) approach for identifying environmentally sensitive areas (ESA) to desertification in Katsina State, Nigeria. Three indicators; SQI, CQI and VQI were used to estimate ESDI for Katsina State.

- Space base technology have been efficiently applied to solve environmental problems such as NDVI, VCI, EVI, SPI, TGSI and other machine learning similar to classification and regression Tree Decision Tree, CART-DT, Random Forest, RF; Convolutional Neural network, CNN which are often combine to analyze spatial data for monitoring and decision support relating to climate change, Land degradation and desertification within environmental domain.

Recommendations

- The need to effectively enforce existing environmental laws. One of such environmental laws is the prohibition of the unsustainable logging for fuel wood. It was discovered during the field visit to Katsina State by this research team that Niger and Nigeria have similar laws on the prohibition of unsustainable logging practices. While the law is strictly enforced in Niger, with resultant existing of many shrubs in the country, the story is different for Nigeria. The lack of adequate enforcement on the Nigerian side means that communities on the Niger side of the border cross into the Nigerian side and harvest fuel wood.

- The need for sustainable tree planting programs. There are currently efforts by the Great Greenwall Development Agency, European Union and other supporters. However, it was observed during the field visit to Katsina (as part of this research) that some of these programs do not elicit the participation of the communities where these tree planting programs are domicile.

- Focus intervention in the northern part of the State given the high sensitivity of the area to desert conditions. The focus should be on sustaining the environment as well as the livelihood of the communities in the local government areas. Given that the predominant source of livelihood are rain fed agriculture and herding, drought resistant seedlings as well as organic manure should be given to the farmers for the planting seasons.

Thank you for Listening

Our future is in our hands

The strength is in our heads,
when we think alike

The environment is a global envelop
and team work is ……