Desert Encroachment Monitoring in North-Eastern Nigeria

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In a session aimed to showcase how Nigeria is using space applications to support its policy development against Climate Change and the concrete implementation of innovative projects using space applications.

Talking Points

- Desert Encroachment
- The Role of Satellite Monitoring of Desert Encroachment in Northeastern Nigeria
- Ongoing National Efforts

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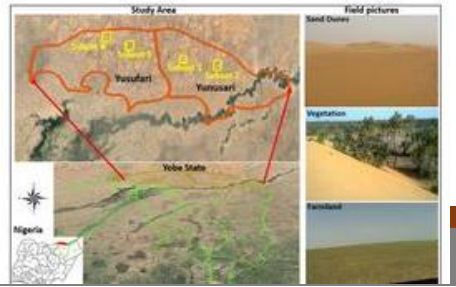

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Abstract

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Desertification in the Sahel Region: A Product of Climate Change or Human Activities? A Case of Desert Encroachment Monitoring in North-Eastern Nigeria Using Remote Sensing Techniques

by Esther Shupel Ibrahim [1,2,3,*], Bello Ahmed [4], Oludunsin Tunrayo Arodudu [5], Jibril Babayo Abubakar [3], Bitrus Akila Dang [3], Mahmoud Ibrahim Mahmoud [6], Halilu Ahmad Shaba [7] and Sanusi Bello Shamaki [8]

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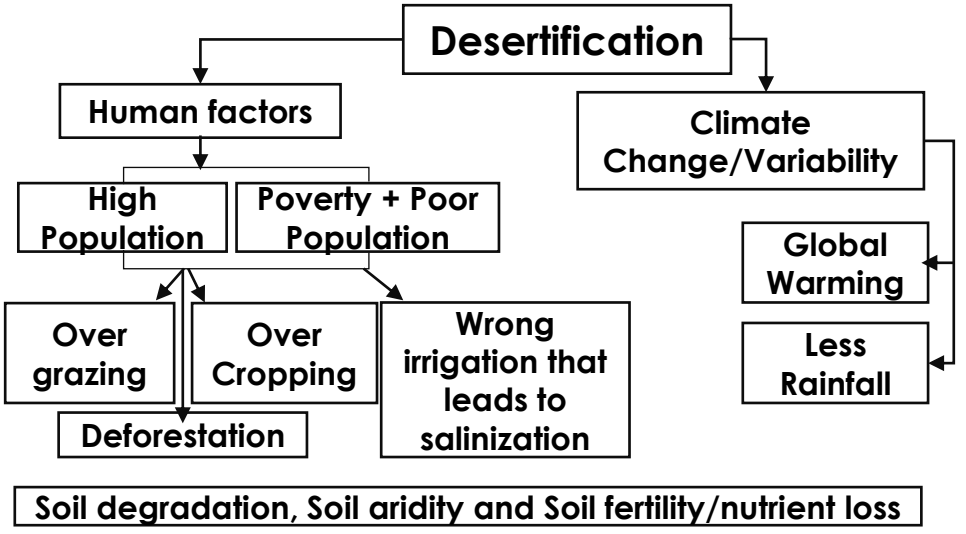
Introduction

Desertification:

- Is simply the progress of ecological degradation on land that leads to the loss of fertile, productive soil and other soil productivity components.
- It is a land degradation process in arid and semi-arid areas.
- The desert land progressively becomes drier such that it is unable to support any plant growth for food production and life habitation.
- It occurs due to various factors including climatic variation and human activities.



Overview of Desertification in Nigeria

- **Nigeria has experienced many unexpected droughts that affected northern states from low to high rates.**
- **~64% of Nigeria has been low in vegetation cover due to high rate of desertification.**

THE JUSIFICATION FOR MONITORING DESERTIFICATION IN NIGERIA

Facts

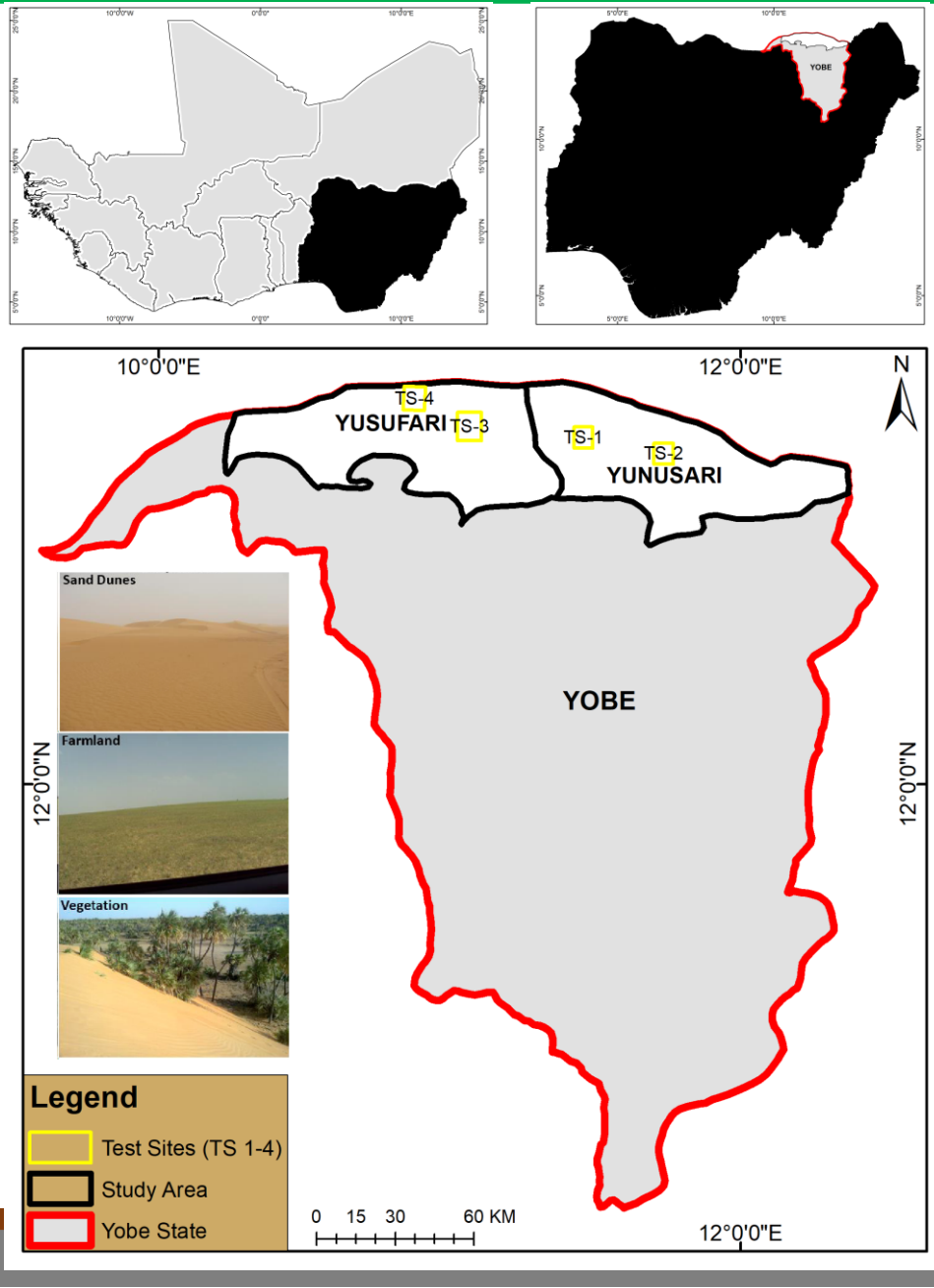
- Persistence of desertification in Nigeria has continued to threaten the attainment of food security and other important sustainable development goals in the affected states.
- Desert features now account for approximately 580, 841 km^2 of Nigeria's landmass and accounting for up to 63.8% of the country's landmass.
- Nationally, desertification effects are trending down towards the Southern parts of Nigeria at a rate of 0.6 km per annum, engulfing about 351,000 ha of cropland and rangeland annually.
- About 30 million people (17% of the national population, and 15 out of 36 States of the Nigerian Federation) are affected by desertification in Nigeria.
- The affected states share a border with the Sahelian-Saharan zone of the Niger Republic, which is one of the world's most sensitive ecosystems.

This has resulted in catastrophic consequences that affects human, animal and plant populations in a variety of ways such as:

- **Forcing human migrations.**
- **Increased erosion.**
- **Alteration of geochemical composition of soils.**
- **Surface and groundwater depletion.**
- **Biodiversity loss and species extinction.**
- **Reduced agricultural yields.**
- **Higher unemployment.**
- **Rural poverty rates**

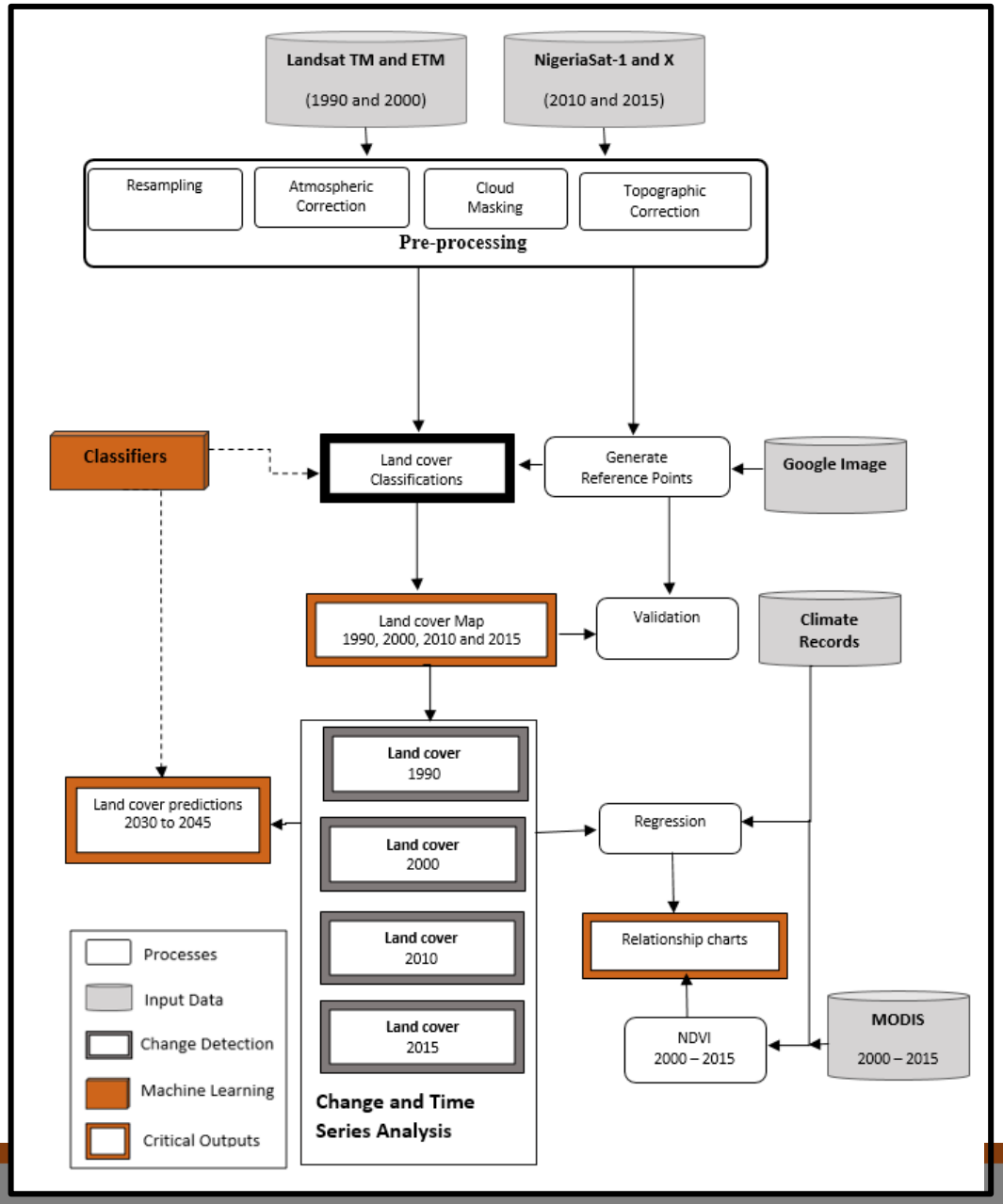
As well as a rise in social vices and civil conflicts (e.g., banditry, kidnapping, armed robbery, religious extremism, insurgency, land/territory grabbing, etc).

MONITORING SITE



- Our **desertification monitoring site** is situated in the northernmost part of Yobe State in the North-Eastern region of Nigeria and is one of the areas most affected by desertification in Nigeria.
- The area covers **Yunusari** and **Yusufari** local government areas (LGAs) in Yobe State.
- Yobe State shares local boundaries with the Borno, Jigawa, Bauchi and Gombe states, as well as an international border with the Republic of Niger to the North.
- All its neighbouring states are very active desertification sites, except Bauchi State, with minor desertification influence. Yobe State has 17 LGAs which are all associated with severe cases of dune formation.
- The most severe cases are found in the northernmost parts of Yobe State in the Yunusari and Yusufari LGA, hence our choice of the two LGAs as desertification monitoring site.

OUR METHODOLOGY

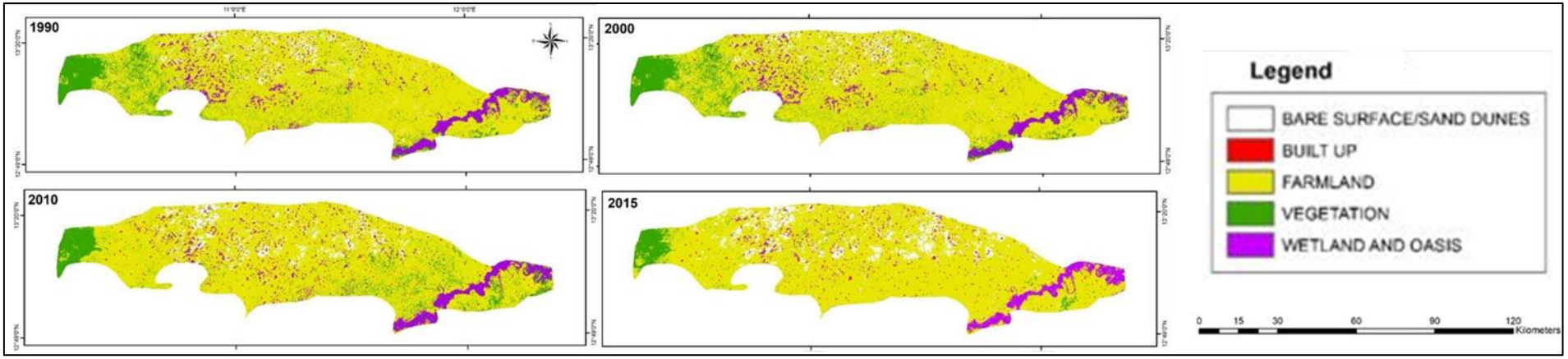


- Data and Pre-Processing.
- The Generation of Reference Data.
- Land Cover Mapping and Accuracy Assessment.
- Time Series Assessments and Projections.
- Climate Change and Land Cover Conversions.

		Reference (Field Data)							
	Land Cover	Bare Surface/Sand Dunes	Built-Up	Farmland	Vegetation	Oasis/ Wetlands	Total	User's Accuracy	Commission Error
Classified Image (Map)	Bare surface / sand dunes	51	4	5	0	0	60	0.85	0.15
	Built-up	0	34	1	0	0	35	0.97	0.03
	Farmland	4	2	94	2	2	104	0.90	0.10
	Vegetation	0	1	2	41	4	48	0.85	0.15
	Oasis/ Wetlands	1	1	2	4	53	61	0.87	0.13
	Producer's accuracy	0.75	0.94	0.84	0.76	0.87	-	-	-
	Omission Error	0.25	0.06	0.16	0.24	0.13	-	-	-
	Overall accuracy	0.81 (81%)	-	-	-	-	-	-	-

RESULTS-1

Land-use/Land-cover (LULC) Classification of Yusufari & Yunusari LGAs (1990, 2000, 2010 & 2015)

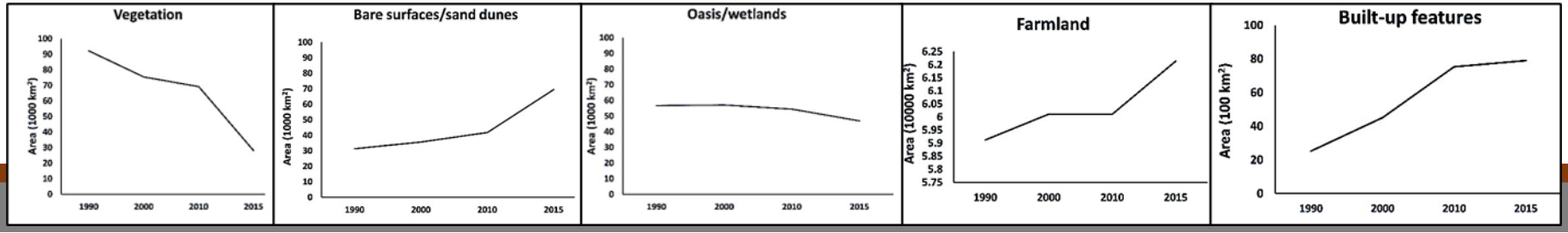


Analysis of Changes in LULC (1990 - 2015)

Land Cover	1990 (ha)	%	2000 (ha)	%	2010 (ha)	%	2015 (ha)	%	
Bare Surface/ sand dunes	31,369	4.1	35,663	4.6	41,732	5.4	69,462	9	4.9%
Built-up	2519.8	0.3	4512.4	0.6	7527	1	7893	1	
Farmland	591,175	76.4	601,112	77.7	601,048	77.7	621,411	80.3	
Vegetation	92,126	11.9	75,409	9.7	69,120	8.9	28,143	3.6	-8.3%
Oasis/wetlands	56,563	7.3	57,110	7.4	54,330	7	46,857	6.1	-1.2%
Total	773,752	100	773,806	100	773,757	100	773,766	100	

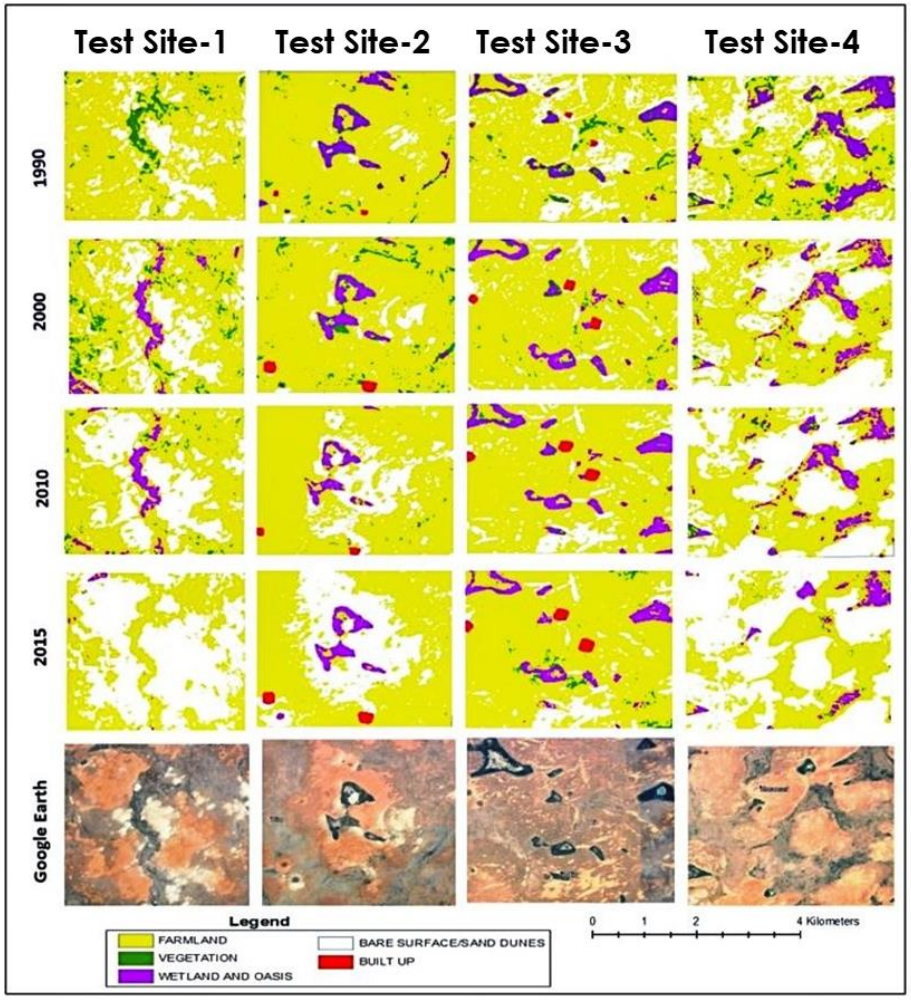
This table provides a summary of land cover maps produced from 1990 to 2015, providing the distribution of land cover types in hectares and percentage of each land cover class for each time slice.

LULC Change trend from 1990 to 2015



RESULTS-2

Explicit Test Sites of sand dune progression in Yusufari and Yunusari LGAs over a 25-year period



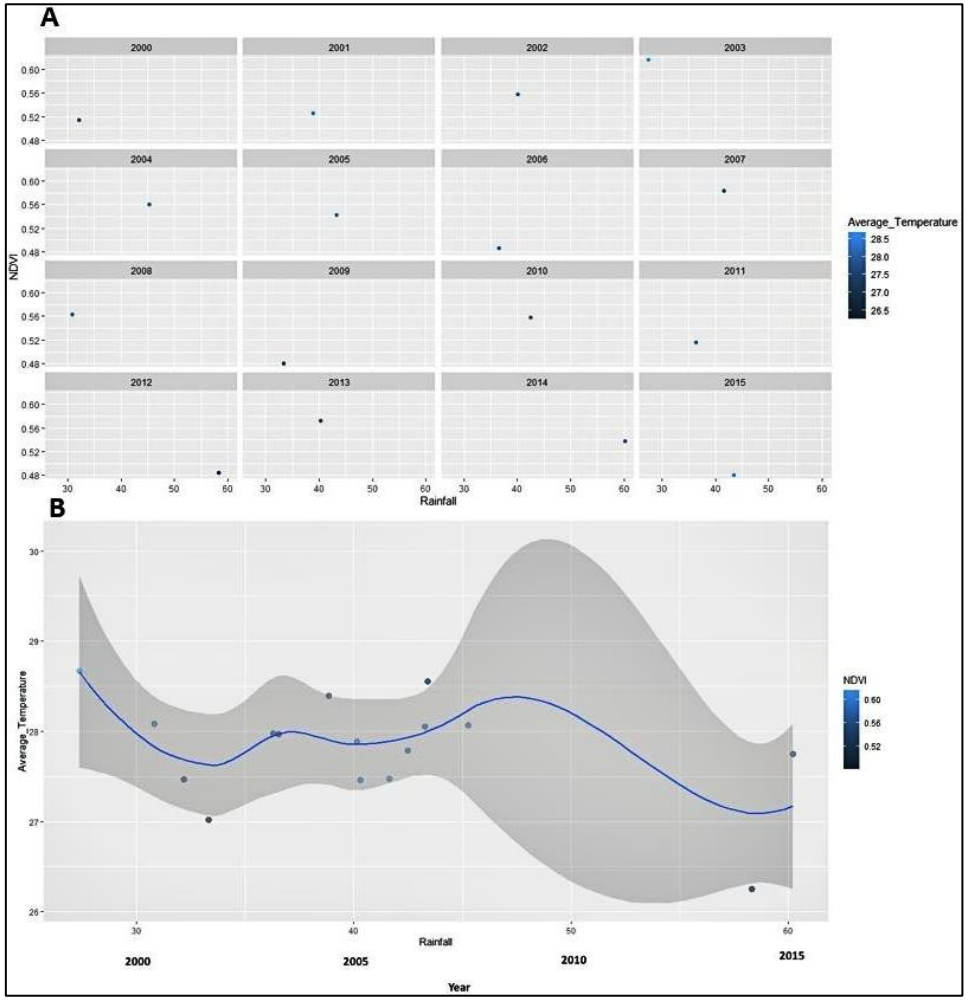
Land Cover Conversions	Area (ha)
* Vegetation to Farmland	62,411
Vegetation to Wetland and Oasis	6432
Vegetation Unchanged	21,783
* Vegetation to Bare/Sand dunes	1013
* Vegetation to Built-Up	394
Wetland and Oasis to Farmland	21,922
Wetland and Oasis Unchanged	33,142
Wetland and Oasis to Vegetation	996
* Wetland and Oasis to Bare/Sand dunes	309
Wetland and Oasis to Built-Up	163
Farmland Unchanged	519,371
Farmland to Wetland and Oasis	7143
Farmland to Vegetation	5265
* Farmland to Bare/Sand dunes	54,455
Farmland to Built-Up	4624
Bare/Sand dunes to Farmland	17,270
Bare/Sand dunes to Wetland and Oasis	69
Bare/Sand dunes to Vegetation	72
Bare/Sand Dunes Unchanged	13,656
Bare/Sand Dunes to Built-Up	291
Built Up to farmland	61
Built Up to Wetland and Oasis	39
Built Up to Bare/Sand dunes	0.2
Built Up Unchanged	2419
Total	773,298

* Conversions significant to desertification. This table provides a summary of land cover conversions in hectares from 1990 to 2015, providing insights to desertification indicators and drivers.

- The largest conversion of land cover within the 25-year period was from **vegetated land to farmlands** (about 62,411 ha).
- Mainstreaming Remote Sensing for systematic and routine desertification encroachment and improved land management strategies is practical.

RESULTS-3

Relationship of Land Cover Conversions and Climate Parameters between 1990 and 2015



- The distributions of the mean NDVI values peaks showed a graduating decrease, especially from 2008 to 2015.
- Observed increase in rainfall did not reflect in a steady increase in NDVI peak values, hence revealed a disassociation between mean rainfall, temperature and NDVI peaks (vegetated surfaces).
- The decrease in vegetated areas and increase in bare surfaces cannot, therefore, be attributed to weather variables.
- Although the results of our NDVI trajectory pattern agree with our land cover analysis and statistical results. **This finding corresponds with results from other studies that particularly asserted that intensified agricultural activities are the major factor influencing and aggravating desertification in the study area**.
- Our results demonstrate that sand dunes and bare areas over the 25 years study period have more than doubled from the start year. At this rate, it can be inferred that sand dunes may cover about 20% of the landmass by the year **2040 based on our Probabilistic projections**.
- This implies that up to **130,000 ha of land might become desert** if socioeconomic activities and management practices remain the same and if the current no-policy framework persists.

SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT ANALYSIS OF DESERT ENCROACHMENT MONITORING IN NORTH-EASTERN NIGERIA

Our approach to desert encroachment monitoring reveal that the sand dune is progressing at a mean annual rate of about **15.2 km^2** in the study area.

Socio-Economic Impacts of Desert Encroachment	Environmental Sustainability Impacts of Desert Encroachment
Land Use Conflicts.	Serious land degradation due to over-exploitation of natural resources.
Social vices and civil conflicts (e.g., banditry, kidnapping, armed robbery, religious extremism, insurgency, land/territory grabbing, etc).	Increased erosion and Reduced agricultural yields
Rural Poverty and Forcing of Rural-Urban Human Migration	Surface and groundwater depletion.
Food, Water, Nature and Energy Crises	Biodiversity loss and species extinction.
Food Insecurity, and Higher unemployment	Alteration of geochemical composition of soils

As we see in Nigeria lately.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

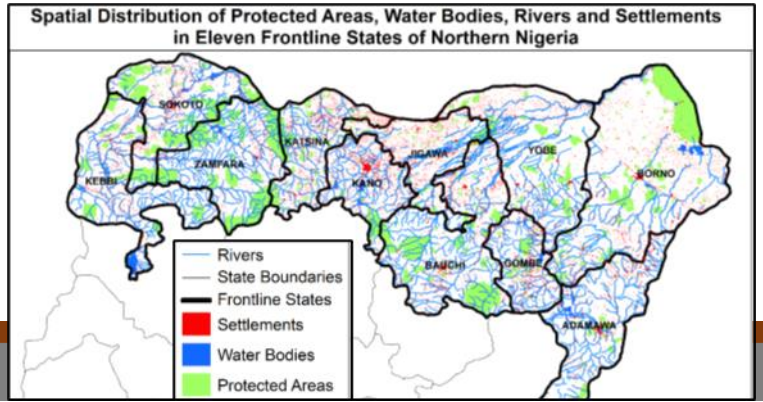
- We infer that desertification in Nigeria is less a function of climate change.
- Desert encroachment is more a product of human activities driven by poverty, population growth and failed government policies based on our land cover change, trend and conversion assessment, visual reconciliation of climate records of land cover data, statistical analysis, observations from ground-truthing, as well as previous literature.
- Further projections by this study also reveal a high probability of more farmlands being converted to sand dunes by the years 2030 and 2045 if current practices prevail.

RECOMMENDATIONS

- ✓ The Federal Government of Nigeria should consolidate its effort on combating desertification of the country's landscape by ensuring intra and inter Ministries Departments and Agencies Collaboration having established the National Climate Council 2022, achieved the passing of Climate Act 2021, and the establishment of the National Agency for the Great Green Wall (NAGGW).

RECOMMENDATIONS CONT'D

- ✓ **The National Agency for the Great Green Wall should**:
  - Incorporate the use of Geospatial Information Technologies such as Satellite Remote Sensing in monitoring the frontline states to generate credible information and guide decision making to achieve sustainable national, regional and local development.
  - Commission and Promote site specific research work such as our study that focused on state and local government scale to generate evidence-based information for smart national desert encroachment amelioration action plan.
  - Create policy frameworks that promote the adoption of Sustainable Land Management (SLM) solutions as its contribution to addressing desertification as well as mitigating and adapting to climate change, with co-benefits for poverty eradication and food security among dryland populations.
  - Collaborate and invest in SLM, land restoration and rehabilitation in dryland areas to achieve positive economic returns.
  - Develop and implement Land Degradation Neutrality policies that allows populations to avoid, reduce and reverse desertification, thus contributing to climate change adaptation with mitigation co-benefits.
  - Develop and promote environmental conservation programmes that involves people at grassroots level, particularly pastoralists and the dominant peasants in rural areas.



Thank You!
Questions?

Find Findings Here