Satellite-Derived Assessment of Rangeland Productivity in Blouberg Local Municipality in a Changing Climate

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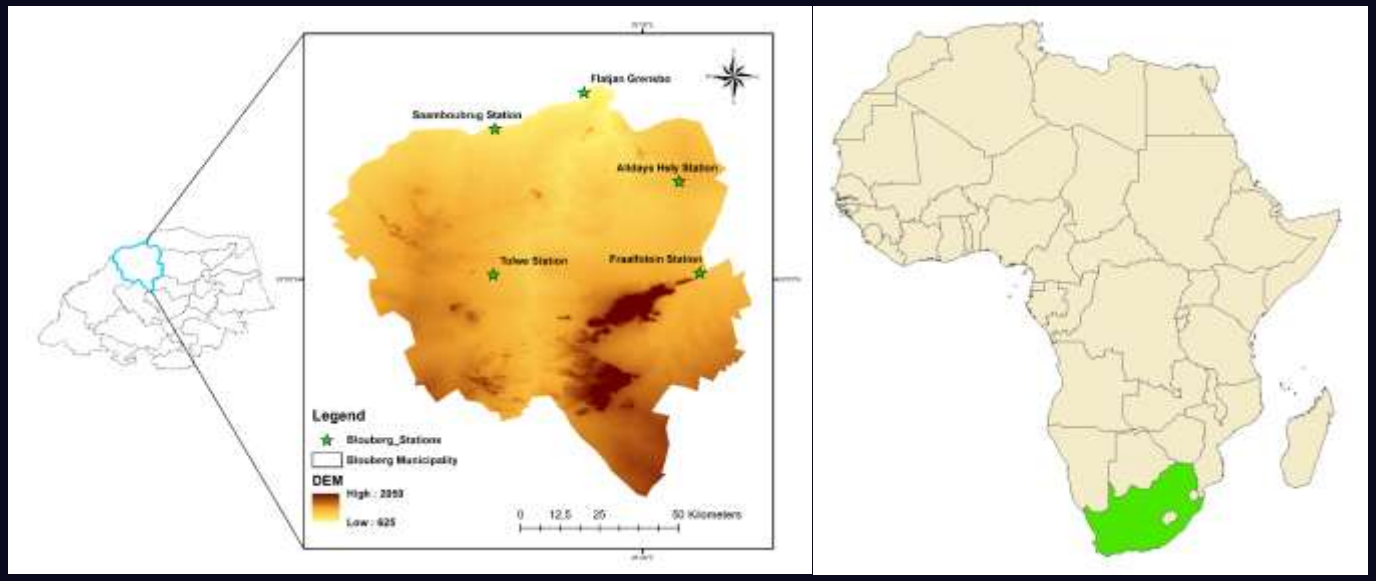
Introduction

- Rangelands constitute essential ecosystems that support biodiversity, sustain rural livelihoods, and contribute significantly to global food security (Vetter, 2020).
- The intricate balance of these landscapes, however, is increasingly challenged by the omnipresent forces of climate change (IPCC, 2019).
- Farmers use rangelands as a vital component for livestock grazing.
- This work examined the dynamics of rangelands (productivity and sustainability) in Blouberg Municipality within the context of the changing climate.

Purpose

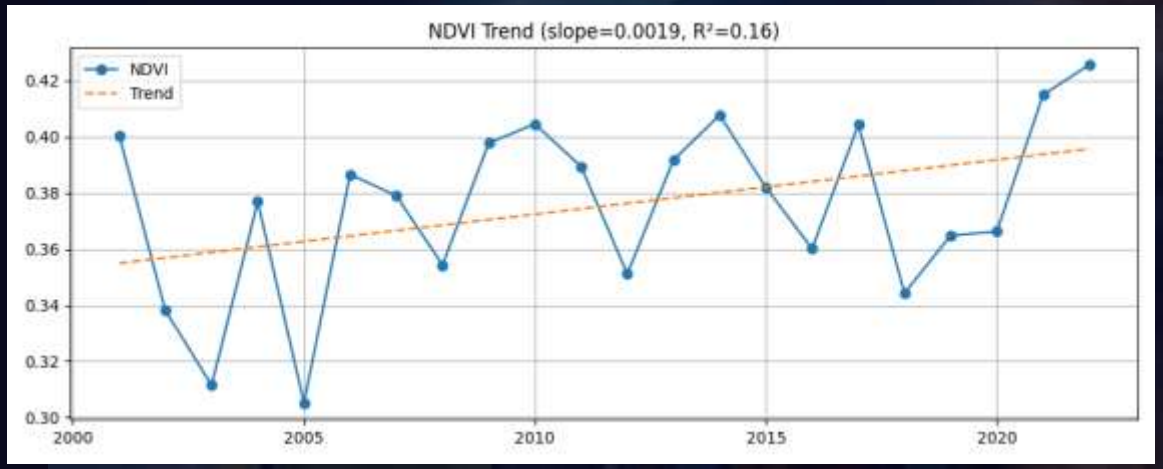
- Characterize the state of rangelands in terms of their productivity.
- Assess the resilience of rangelands to climate dynamics.
- Highlight areas vulnerable to degradation.

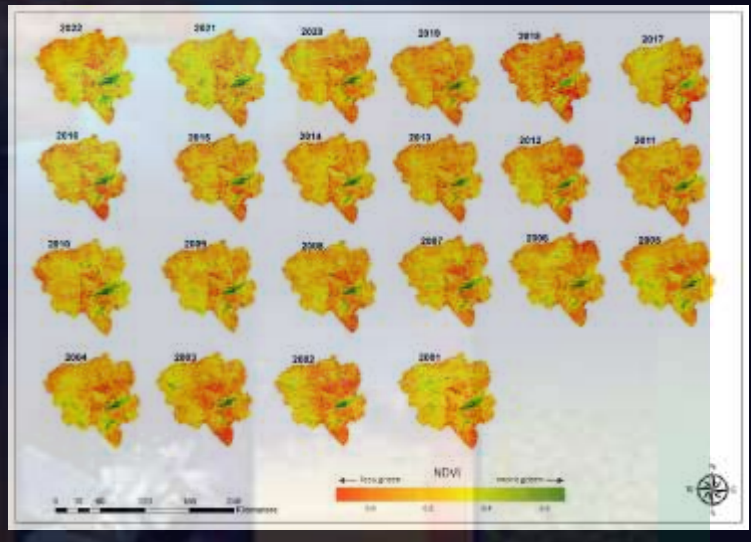
Study Area/Approach

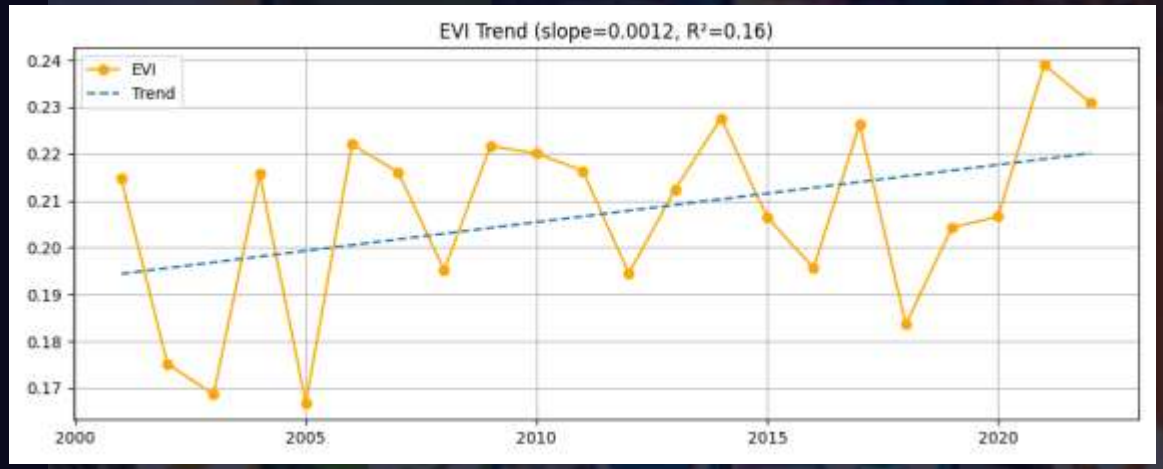


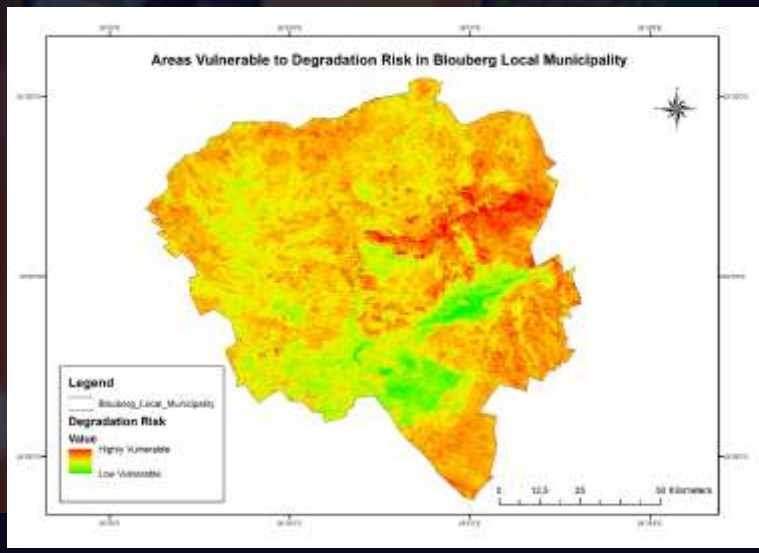
- Used MODIS NDVI and EVI from 2001 to 2022
- Integrated climatic variables (rainfall and temperature) to observe their impact on vegetation dynamics.
- Processed data using Google Earth Engine.

Results

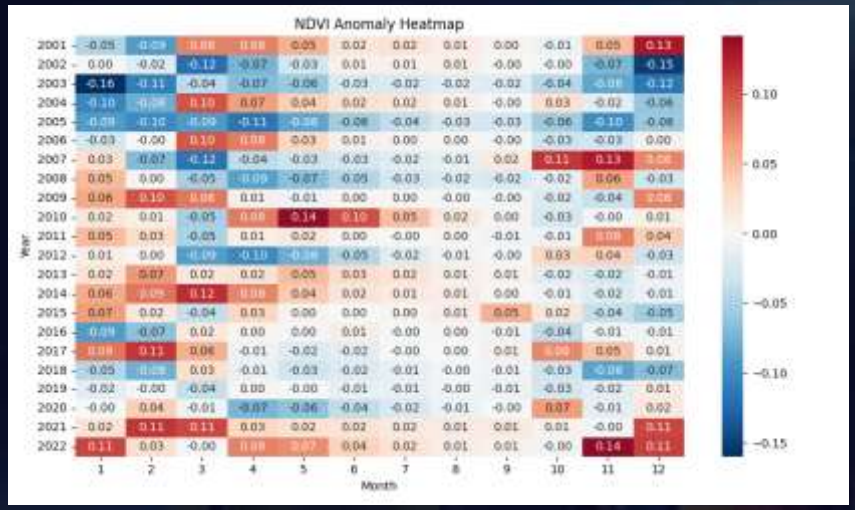

NDVI Trend (slope=0.0019, R²=0.16)
NDVI
Trend
0.42
0.40
0.38
0.36
0.34
0.32
0.30
2000
2005
2010
2015
2020

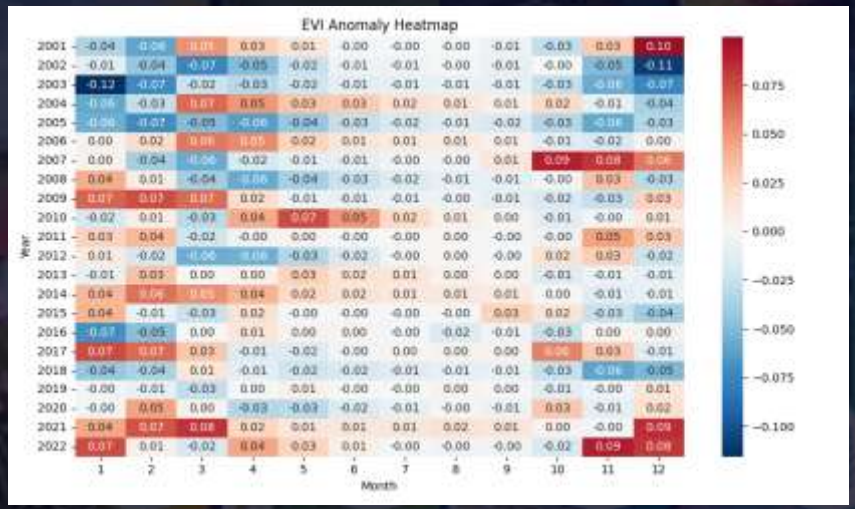

NDVI


EVI Trend (slope=0.0012, R²=0.16)
EVI
Trend
0.24
0.23
0.22
0.21
0.20
0.19
0.18
0.17
2000
2005
2010
2015
2020


Areas Vulnerable to Degradation Risk in Blouberg Local Municipality
Legend
Degradation Risk
Value
Highly Vulnerable
Low Vulnerable

Results…





- **Negative anomalies (blue)** = vegetation stress/drought.
- **Positive anomalies (red)** = above-normal vegetation growth.
- **Major patterns:**

2003 & 2016: Strong negative anomalies → severe drought years

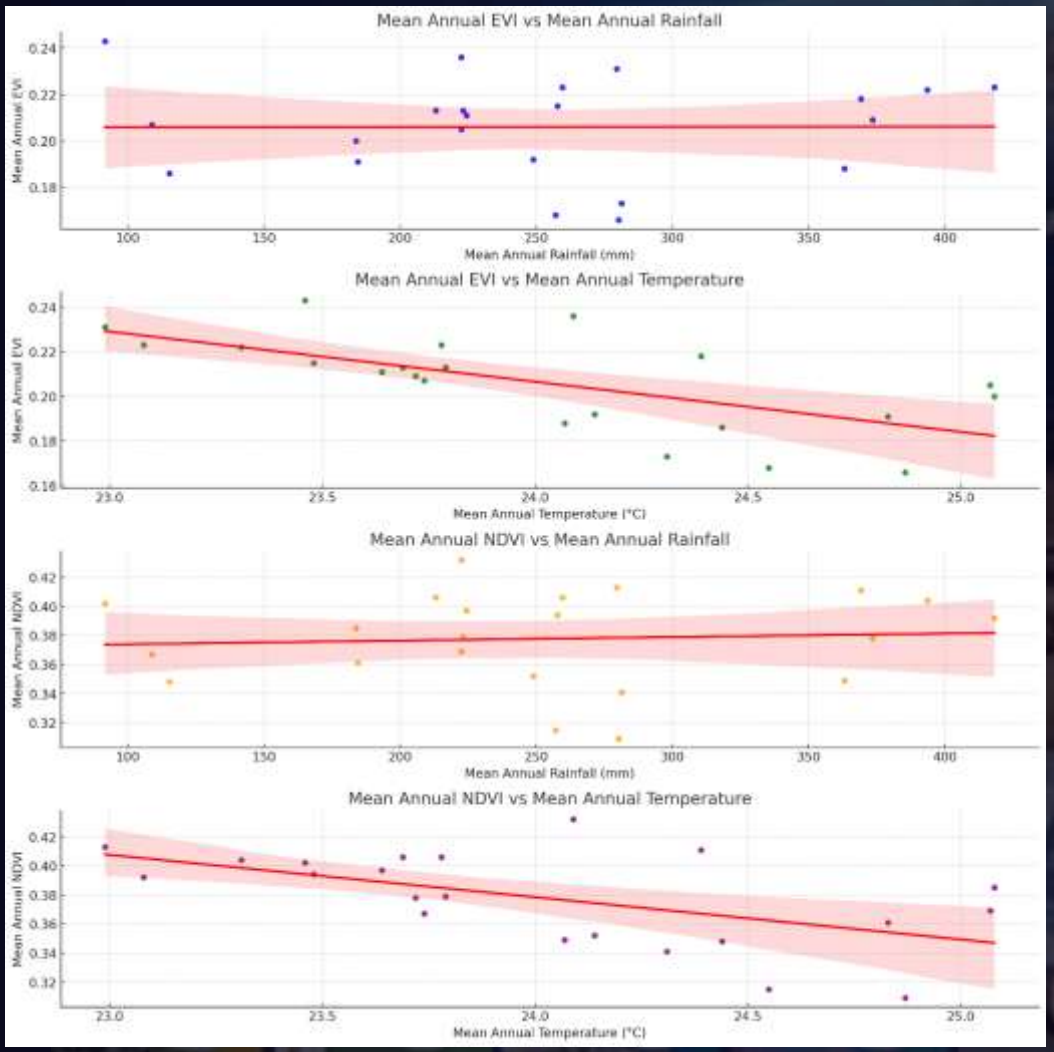
2010 & 2015: Strong greening phases → good vegetation recovery

2021–2022: Widespread positive anomalies → exceptional vegetation growth(Insert both heatmaps side by side for visual impact)

- Both indices agree on drought (2003, 2016) and greening (2010, 2015, 2021–2022).
- EVI → highlights canopy structure & recovery trends.
- NDVI → stronger response to extreme events & greenness shifts.
- Combined, they provide robust vegetation monitoring.

Results…

Vegetation Indices vs Climate Variables (2001-2022)

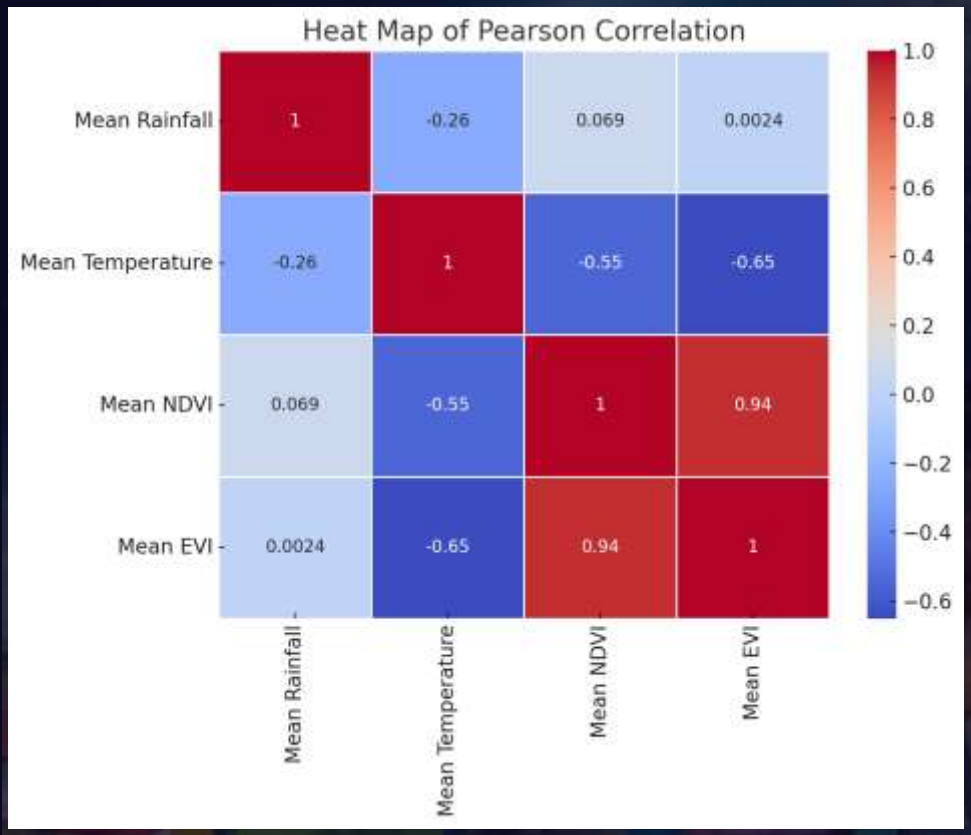


- **EVI vs Rainfall:** Weak positive association; EVI remains relatively stable across rainfall gradients.
- **NDVI vs Rainfall:** Slight positive trend, but variability is high → rainfall alone does not strongly explain vegetation greenness.
- **Implication:** Rainfall has limited influence on vegetation dynamics in this dataset; other factors likely contribute.

- **EVI vs Temperature:** Clear negative trend — higher temperatures reduce vegetation greenness (EVI).
- **NDVI vs Temperature:** Also shows a negative trend, consistent with EVI.
- **Implication:** Temperature is a stronger driver of vegetation changes compared to rainfall, suggesting heat stress reduces vegetation productivity.

Results

Relationship between Vegetation Indices and Climate Variables (2001-2022)



NDVI & EVI:

- Strong positive correlation (0.94) → indices closely related but differ in sensitivity to soil/atmosphere.

Temperature vs Vegetation:

- **NDVI:** -0.55, EVI: -0.65
- Higher temperatures → negative effect on vegetation (heat stress, evapotranspiration, reduced soil moisture).

Rainfall vs Vegetation:

- NDVI: 0.069, EVI: 0.0024 (weak correlations).
- Rainfall alone is not a strong predictor of vegetation health → influenced by timing, distribution, soil, and management factors.

Rainfall vs Temperature: Moderate negative correlation (-0.26) → warmer periods coincide with reduced rainfall.

Summary

- Both NDVI and EVI show weak but positive greening trends (2001–2022), though not statistically significant.
- Severe droughts (2003, 2016) and greening phases (2010, 2015, 2021–2022) were consistently detected by both indices.
- Temperature has a stronger negative impact on vegetation than rainfall, highlighting heat stress as a key driver of productivity loss.
- Rainfall alone is a poor predictor of vegetation dynamics; timing, distribution, and land management matter more.
- NDVI & EVI strongly correlated (0.94) → complementary indicators for monitoring rangeland dynamics.

Implications

- Areas that are highly vulnerable to land degradation highlighted.
- Demonstrate the critical need for adaptive land management strategies to sustain rangeland ecosystems in the face of climate variability.
- Vegetation-climate interactions highlights significance of short-term climatic impacts.

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DATE: 20 – 22 August 2025

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