DISTINGUISHING BETWEEN HUMAN-INDUCED LAND DEGRADATION FROM EFFECTS OF RAINFALL: CASE OF THE GREATER SEKHUKHUNE DISTRICT MUNICIPALITY, SOUTH AFRICA

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Introduction 1 of 2

- Land Degradation (LD) -affects sustainability and livelihoods of +/-1.5 billion people globally

- Complex environmental and socioeconomic issue in arid and semi-arid regions

- Climate variability and poor land practices in semi-arid regions i.e., >70% of land in South Africa intensively degraded.

- Distinguishing between human-induced degradation and climatic factors

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- Lack of robust data and methods to monitor and assess LD

- Studies end in discussion about degree or reality of degradation.

- Spatial monitoring systems

- RESTREND method- spatial patterns of factors driving LD at cell resolution

- Based on condition that water is the limiting factor to vegetation productivity

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Objective

To distinguish human-induced land degradation from rainfall using the RESTREND method from 1990 to 2019 in The Greater Sekhukhune District Municipality

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Study Area

- **Semi-arid environment** avg annual rainfall ±560 mm

- **Dominating Geology**: ultramafic substrates - low nutrient availability

- **Agriculture dominates land use** -70% subsistence farmers engaged in livestock and crop farming

High climatic variability & change and climate extremes that alter the environment and threatening livelihoods.

Future agricultural concerns:
  – water scarcity
  – land conflicts
  – inappropriate LU
  – poor infrastructure and services
  – uncontrolled grazing

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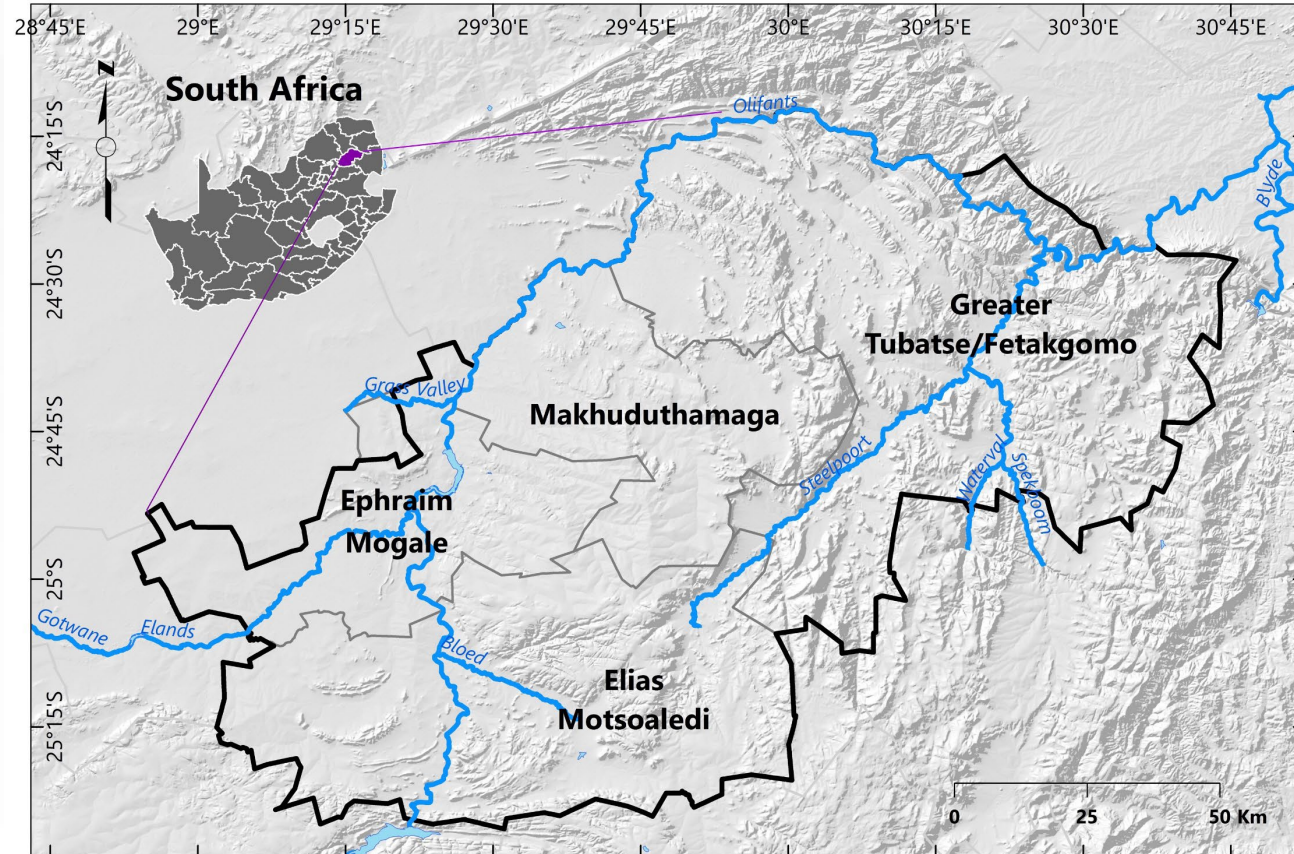
Methodology

Methodology

- Residual trend (RESTREND) method: Spatial patterns of factors driving LD at cell resolution.
- ArcGIS, QGIS and R Studio used to assess Rainfall and NDVI trends at both spatial and temporal levels using averaged daily wet season data.
- LD indicator: Key informant interviews- LULCC Influence on LD

Data Collection

- NDVI (NOAA-AVHRR sensors): LD proxy and strongly correlated above-ground net primary productivity
- Rainfall (PERSIANN-CDR): Satellite-derived and climatic factor influencing vegetation production and closely correlates with NDVI in semi-arid
- Key informant-Semi-structured interviews

Data Analysis

- RESTREND: (1) pixelwise OLS regression -wet season observed NDVI and rainfall per pixel, (2) difference of residuals- observed predicted sum of NDVI (predicted by rainfall) from the linear model, and (3) a new OLS regression -residuals against time, representing residual trend (RESTREND).
- Mann-Kendall trend and residuals
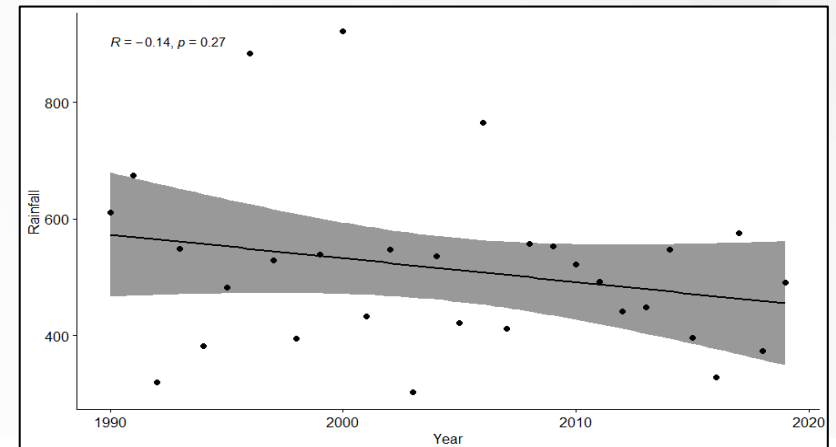
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Results: Temporal RESTREND
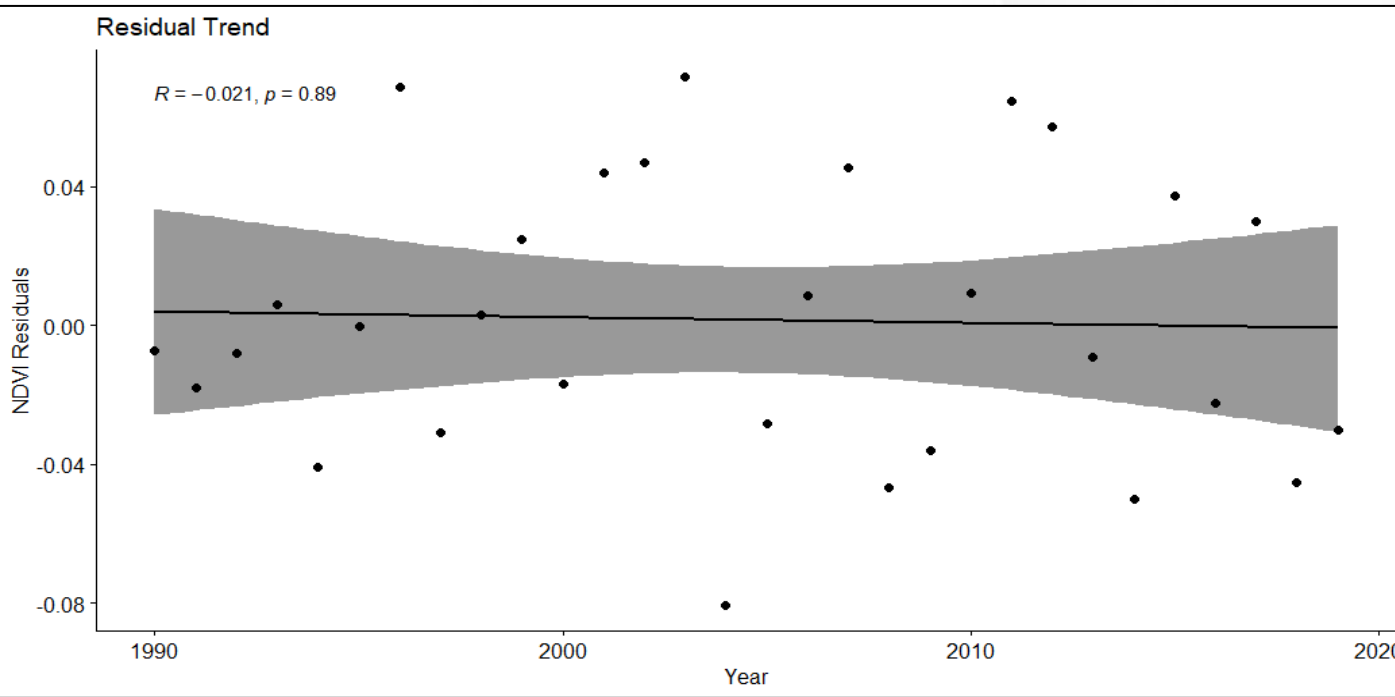
Temporal RESTREND of NDVI residuals between 1990 to 2019 averaged over all pixels in the study region, adjusted for rainfall.
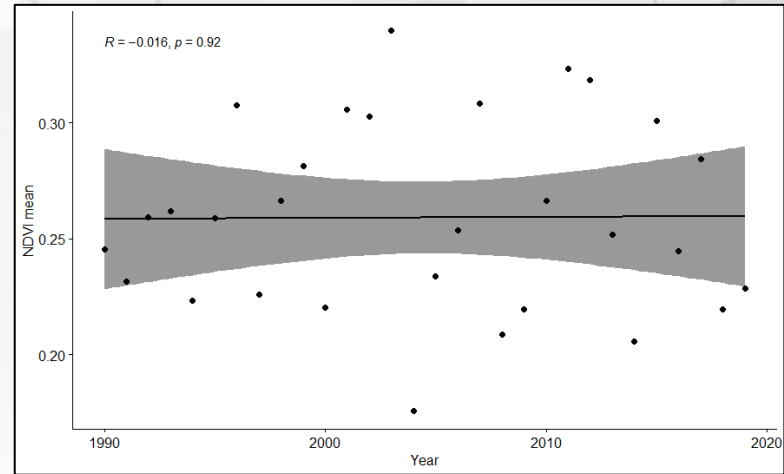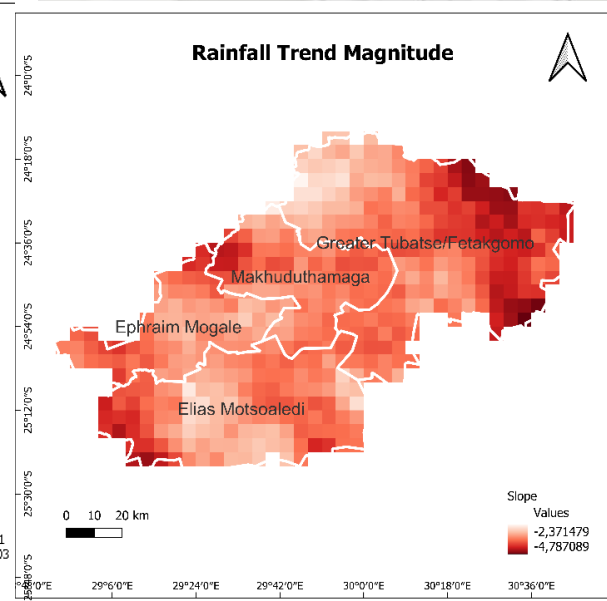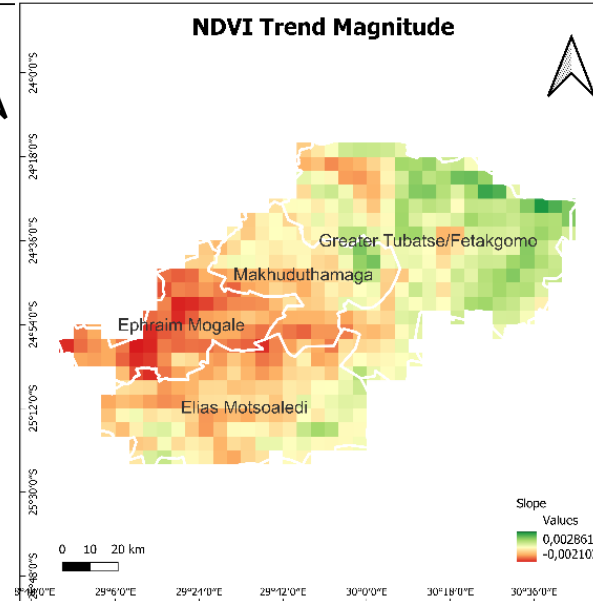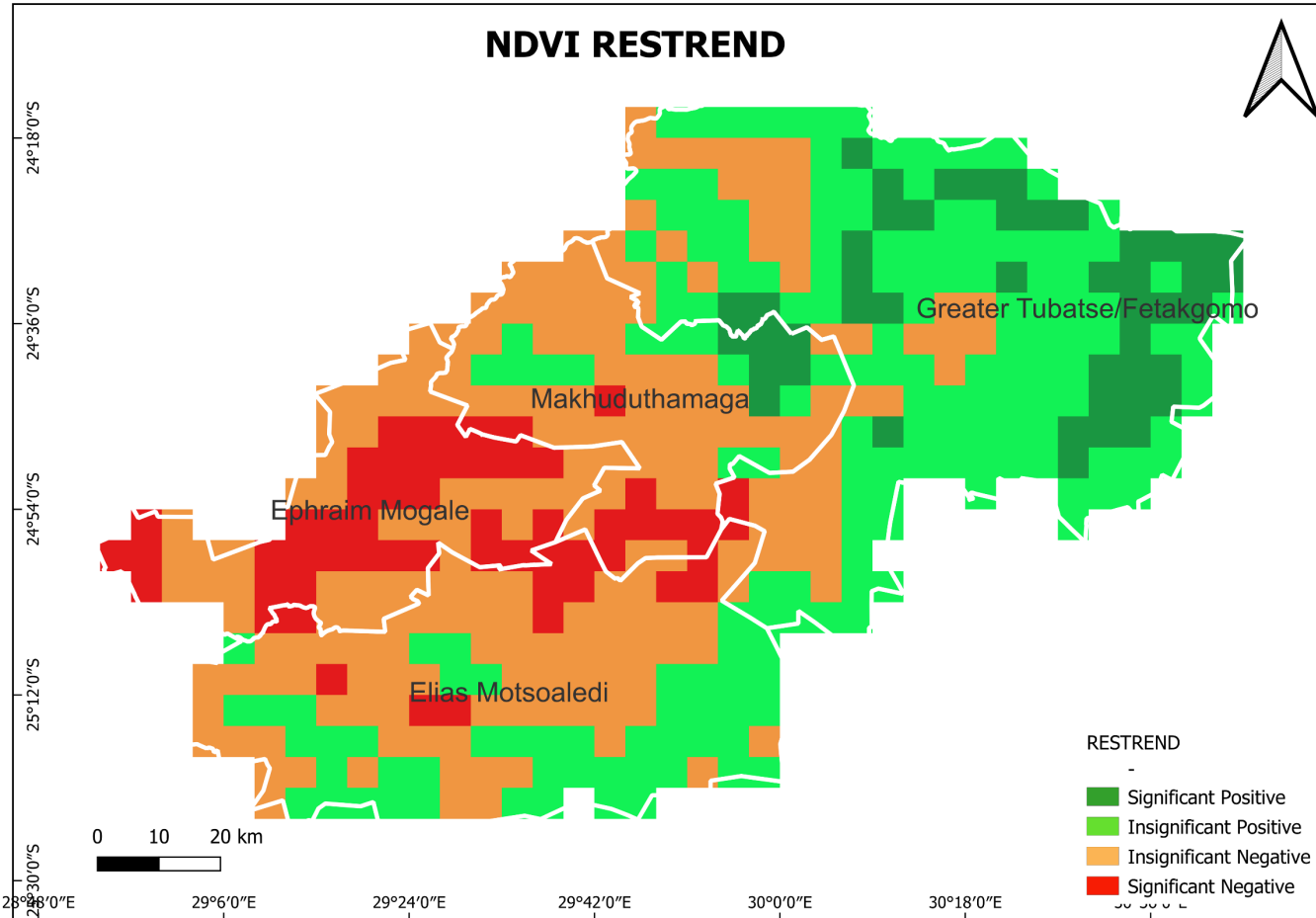

MK NDVI trend magnitude (Sen's Slope)

MK Rainfall trend magnitude (Sen's Slope)

Results: Spatial RESTREND

NDVI RESTREND

RESTREND
-
■ Significant Positive
■ Insignificant Positive
■ Insignificant Negative
■ Significant Negative

NDVI Trend Magnitude

Slope
Values
0,002861
-0,002103

Rainfall Trend Magnitude

Slope
Values
-2,371479
-4,787089

MK NDVI RESTREND	RESTREND Slope (Magnitude)			Significance of Residual Trend (Anthropogenic)		Insignificance of Residual Trend (Climatic)	
	Pos	Neg	Stable	Sign Neg (LD)	Sign pos	Insign Neg (LD)	Insign pos
%	40.99	53.00	6.01	11.59	9.52	41.41	37.27

8 Spatial RESTREND of NDVI residuals between 1990 to 2019 averaged over all pixels in the study region, adjusted for rainfall.

Results: Potential Driving Factors of LD

Degradation due to Rainfall: Majority of the district (41.41%) LD due to rainfall decline

- Rainfall Variability and Drought impacts- soil erosion & sedimentation during flash floods, increase in bare soil

- Severe droughts in 2002-2004, 1992 and 2015

Degradation due to anthropogenic activities

- Settlement encroachment into productive cropping land,

- Land tenure conflicts

- Excessive wood harvesting, Overstocking & Overgrazing

- Cropland abandonment and Bush encroachment (improvement of NDVI RESTREND)

Conclusion

- RESTREND- Effective tool of analysis of correlation between climate factors (i.e., rainfall) and NDVI to reveal productivity change

- Synergistic impact of climate variability and extreme weather events.

- Efforts made to address LD -challenges to address this included high speed of flash floods that removed erosion structures, inappropriate measures to manage rangelands, and sedimentation in water sources.

- RESTREND reveals cell level sustainable land management interventions to address LD from the source

Key informants highlight Integrated and coordinated approach:

➢ Need for **sense of urgency** from (1) **government**, (2) **tribal authority as custodians of natural resources** and **(3) land users.**

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Thank you