Remote sensing application for wetland/peat fire monitoring: a case study of Molopo peatland

By

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Agricultural Research Council-Soil, Climate & Water

Space for National Development

OUTLINES

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- → Material & Methods
- → Results & Discussion
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Introduction

- Wetlands and specifically peatlands, are valuable natural resources that needs to be monitored and managed wisely.

- Peatlands are important for carbon sequestration, water storage and biodiversity.

- Peatlands are groundwater dependent, making these ecosystems special.

- Peatlands are under increasing threat from agriculture, mining and infrastructure developments.

Introduction

- Degradation of peatlands is a major and growing source of anthropogenic greenhouse gas emissions.

- Carbon dioxide emissions from peatland fires jeopardize the health and livelihoods.

- Peat fires were reported in the North West Province at Bodibe 2004 (water abstraction for agriculture); Molopo 2016 which was directly related to water abstraction for municipal use (Mahikeng City).

Introduction

- Water abstraction for different mining activity also negatively impact the peatlands of Molopo, Bodibe and Molemani.

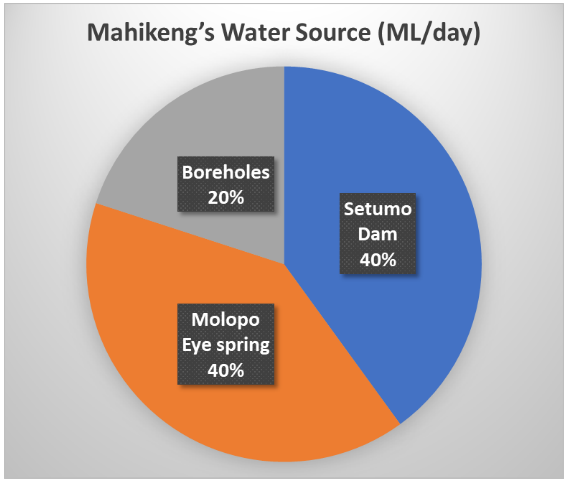
- Peat fire detection is a challenge. One of the major cause of dryness in the peat areas is the lowering the level of ground water due to several reason depends on the hydrological setup.

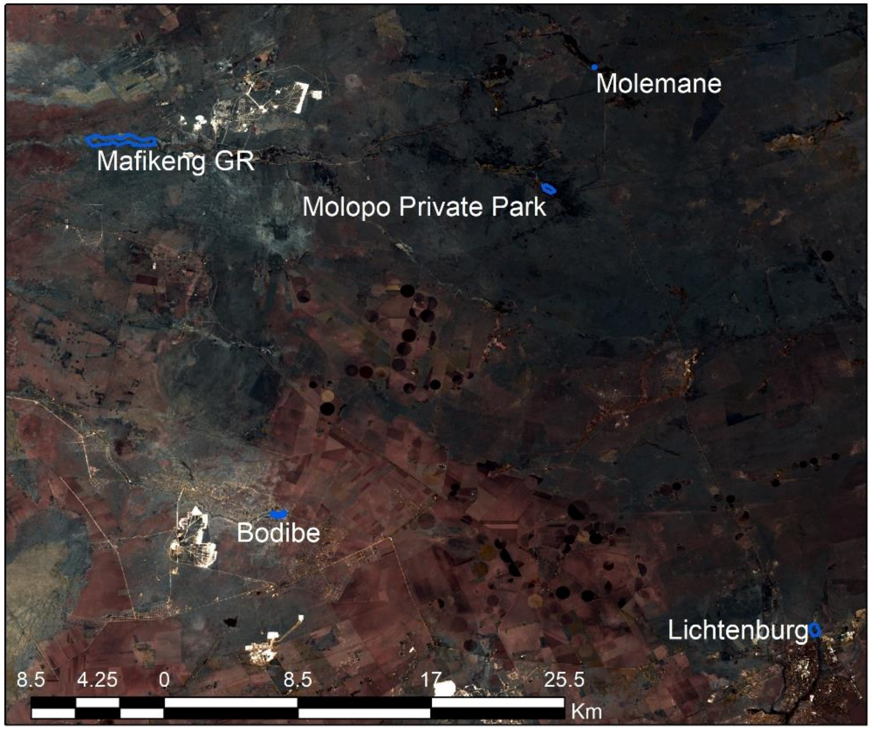
Introduction

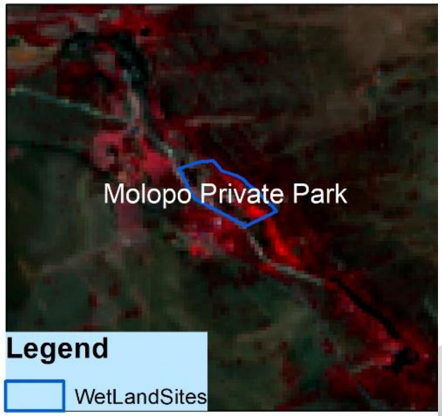
- The aim of this paper is investigate the potential of different remote sensing products and indices for peat fire detections and peatland monitoring considering the Molopo peatland as one of pilot study areas

Material & Methods Study area

The Molopo Peatland boundary with area of approximately 186,300 m2 and number of pixels 207







Material & Methods

Data used

- Three hundred thirty three Landsat 7 images were downloaded from the available archives and analyzed for the study area to assess the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Water Index (NDWI) . The thermal Landsat data is also processed to calculate the LST. The Landsat data cover the time span of 1999 up to April 2018.

Material & Methods

Image preprocessing

- The first step in the analysis was to select cloud free images which resulted in 216 cloud free images (less than 5% cloud cover)

- Images radiometric & atmospheric correction were carried out using the dark object subtraction according to Chavez (1996).

- Image Layer Stacking and study area clipping

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	No.	File Name	PATH	ROW	CLOUD_COVER	DATE_ACQUIRED	SENSOR_ID	IMAGE_QUALITY	SPACECRAFT_ID	SUN_AZIMUTH	SUN_ELEVATION	EARTH_SUN_DISTANCE
2	322	LM05_L1TP_172078_19840519_20180409_01_T	172	78	0	1984-05-19	"MSS"	5	"LANDSAT_5"	42.69236184	31.09895544	1.0118498
3	324	LM05_L1TP_172078_19840706_20180410_01_T	172	78	0	1984-07-06	"MSS"	5	"LANDSAT_5"	42.10343549	27.81492558	1.0167077
4	325	LM05_L1TP_172078_19840722_20180410_01_T	172	78	0	1984-07-22	"MSS"	5	"LANDSAT_5"	44.22895863	29.4311179	1.0159623
5	328	LM05_L1TP_172078_19870104_20180327_01_T	172	78	0	1987-01-04	"MSS"	5	"LANDSAT_5"	94.51761259	51.47901979	0.9832866
6	38	LE07_L1TP_172078_20000507_20170212_01_T	172	78	0	2000-05-07	"ETM"	9	"LANDSAT_7"	39.42048609	36.9630396	1.0091814
7	39	LE07_L1TP_172078_20000811_20170210_01_T	172	78	0	2000-08-11	"ETM"	9	"LANDSAT_7"	43.09122801	36.9475687	1.0134176
8	43	LE07_L1TP_172078_20010307_20170206_01_T	172	78	0	2001-03-07	"ETM"	9	"LANDSAT_7"	65.22552398	49.70231857	0.9924166
9	44	LE07_L1TP_172078_20010526_20170205_01_T	172	78	0	2001-05-26	"ETM"	9	"LANDSAT_7"	37.06426987	33.14123031	1.0130938
10	45	LE07_L1TP_172078_20010729_20170204_01_T	172	78	0	2001-07-29	"ETM"	9	"LANDSAT_7"	41.11100998	33.66621868	1.0152996
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13	51	LE07_L1TP_172078_20011220_20170201_01_T	172	78	0	2001-12-20	"ETM"	9	"LANDSAT_7"	92.38467421	59.80554584	0.9838043
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Material & Methods Image processing

- NDVI calculation: NDVI is calculated according to the following equation:

$$NDVI=(NIR - R) / (NIR + R)$$

NDVI values range from +1.0 to -1.0. Areas of barren rock, sand, or snow usually show very low NDVI values (for example, 0.1 or less). Sparse vegetation such as shrubs and grasslands or senescing crops may result in moderate NDVI values (approximately 0.2 to 0.5). High NDVI values (approximately 0.6 to 0.9) correspond to dense vegetation

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Material & Methods Image processing

- NDWI calculation: NDWI is calculated according to the following equation:

$$NDWI = (NIR - SWIR) / (NIR + SWIR)$$

NDWI values range from +1.0 to -1.0. The combination of the NIR with the SWIR removes variations induced by leaf Internal structure and leaf dry matter content, improving the accuracy in retrieving the vegetation water content (Ceccato et al. 2001).

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Material & Methods Image processing

- LST calculation: LST is calculated according to the following equation:

Conversion of the Digital Number (DN) to Spectral Radiance

$$L_\lambda = L_{\lambda\min} + (L_{\lambda\max} - L_{\lambda\min}) \times (Q_{\lambda DN} - Q_{\lambda\min}) / (Q_{\lambda\max} - Q_{\lambda\min})$$

Where L_λ is the at-sensor spectral radiance (watts/(meter squared × ster × μm)); $L_{\lambda max}$ is the maximum at-sensor spectral radiance; $L_{\lambda min}$ is the minimum at-sensor spectral radiance

Conversion of Spectral Radiance to at-Sensor Temperature (T_i)

$$T_i = \frac{K_2}{\ln\left(\frac{K_1}{L_\lambda} + 1\right)}$$

Where i T is the at sensor temperature in Kelvin, K1 and K2 are pre-launch calibration constants and Lλ is the spectral radiance in watts/(meter squared × ster × μm).

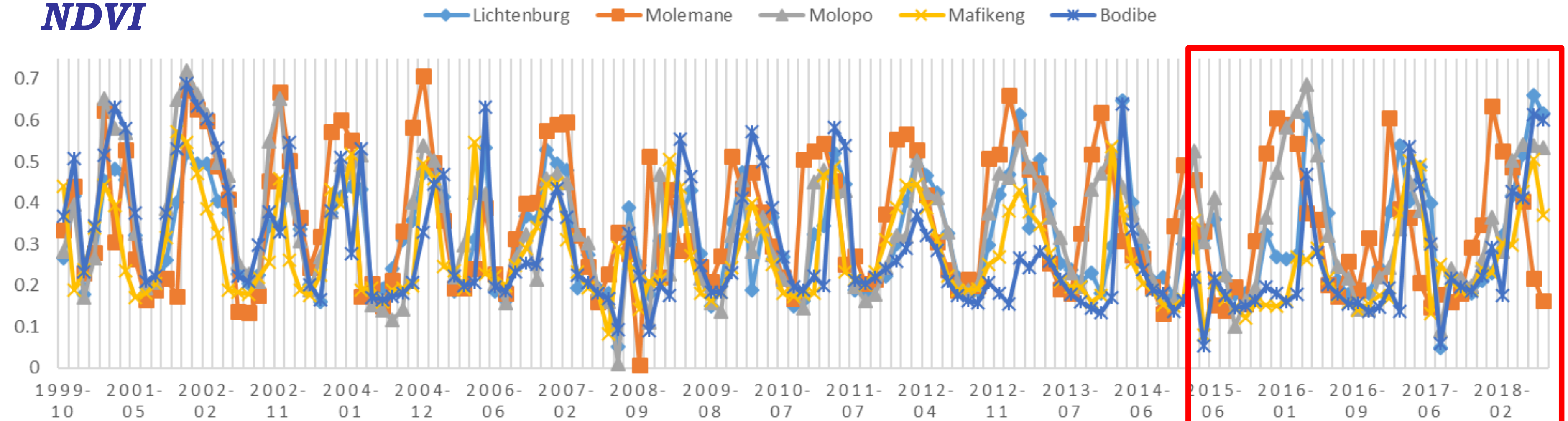
Image analysis

- Zonal Statistical analysis were carried out for all processed 216 images using the boundary of the Molopo peatland.

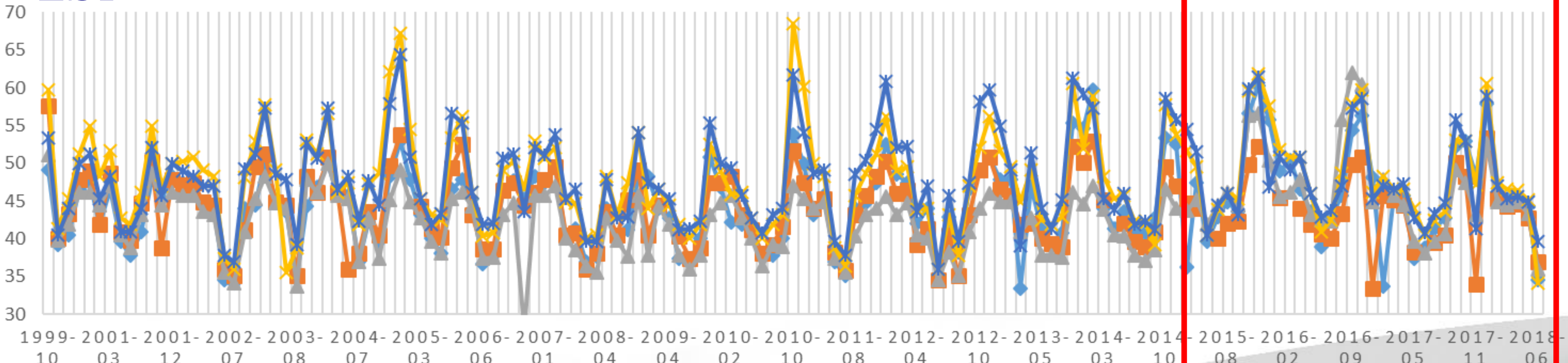
- The mean, median, minimum, maximum, 1st quantile and 3rd quantile were calculated and plotted against time to illustrate the temporal characteristics of the study area during the past twenty years.

Results & Discussion

NDVI



LST



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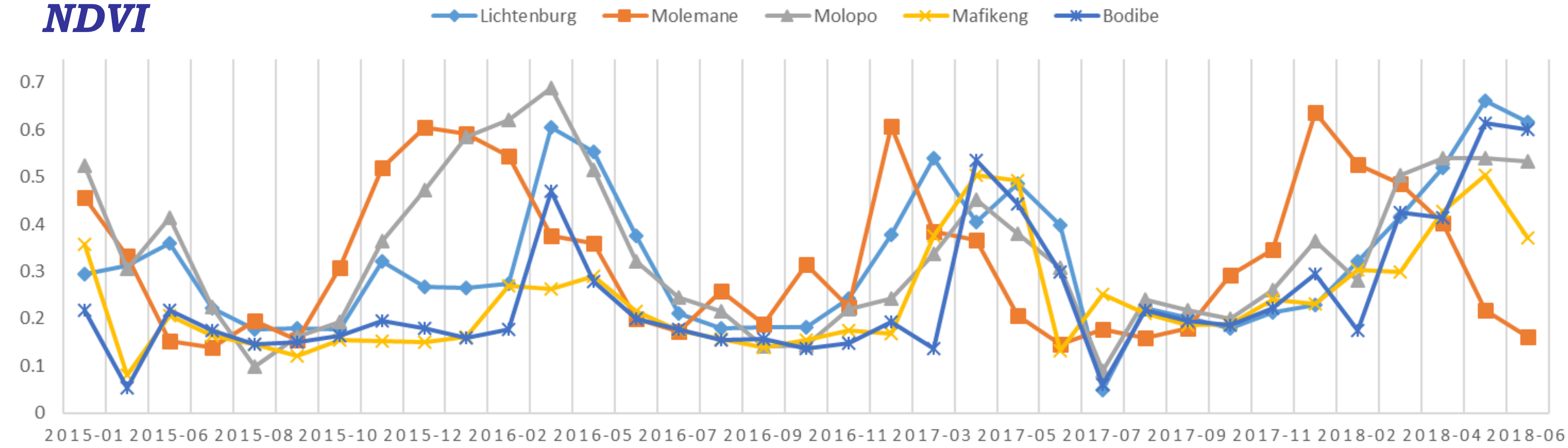
Results & Discussion

NDVI



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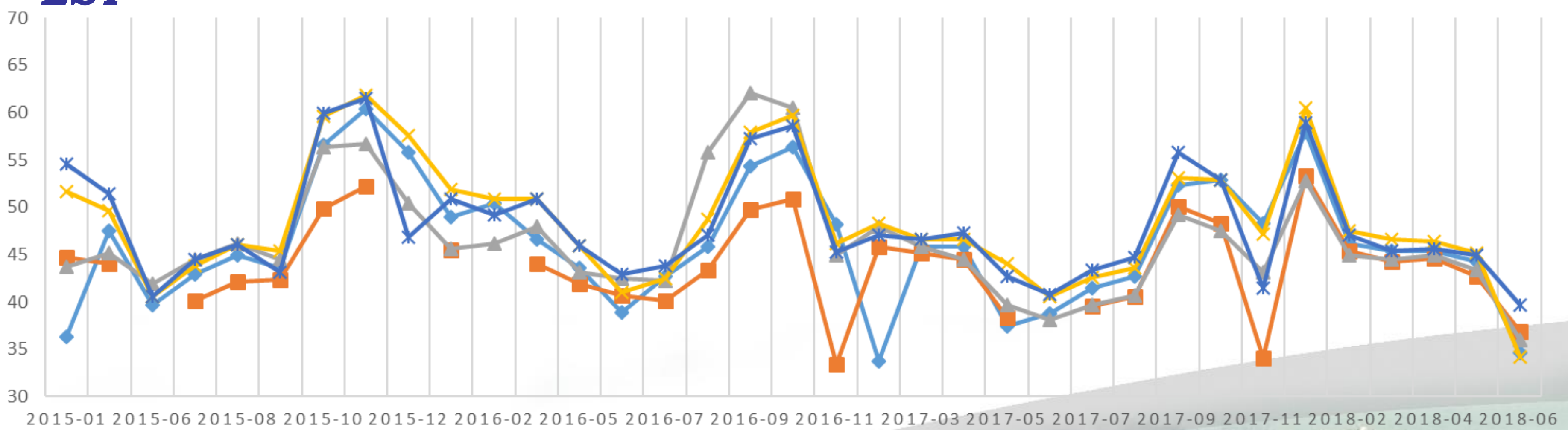
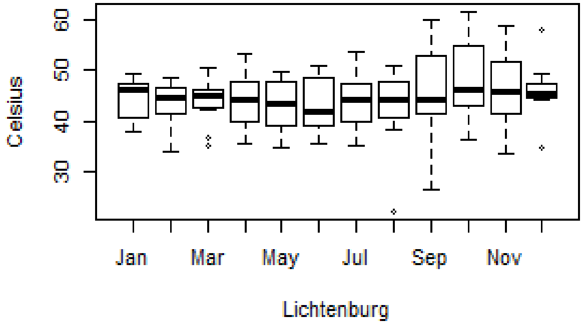
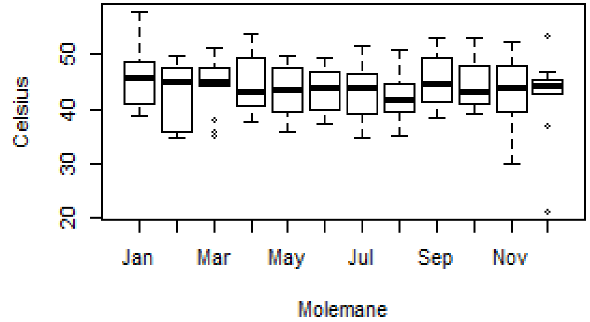
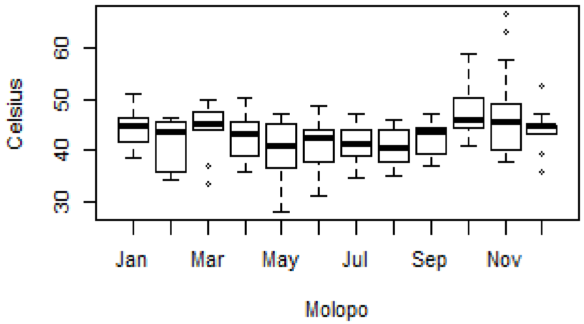
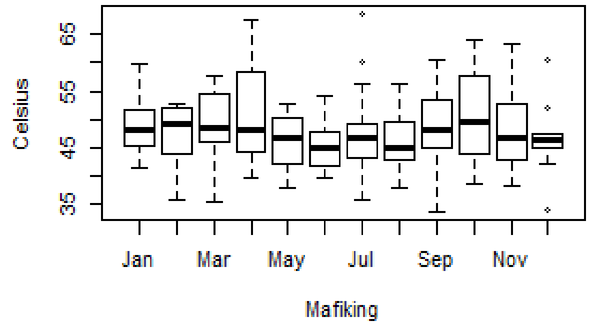


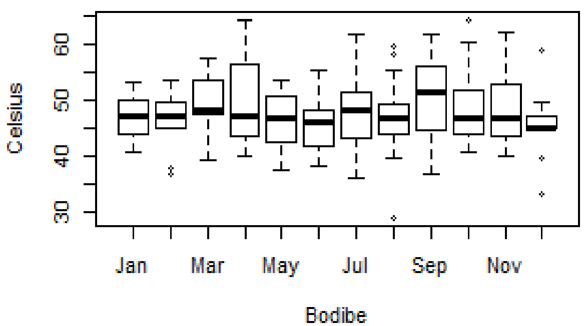
Results & Discussion



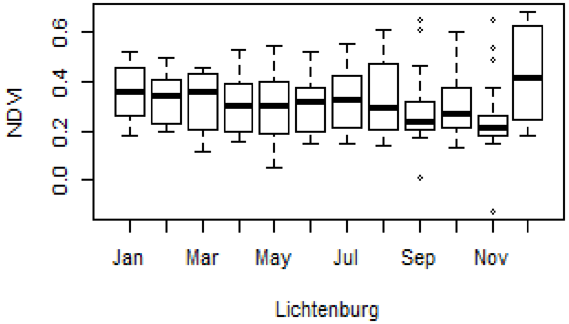


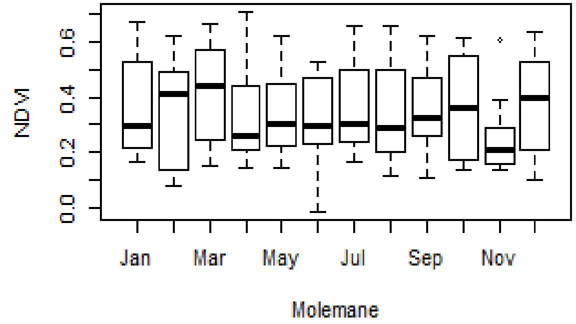


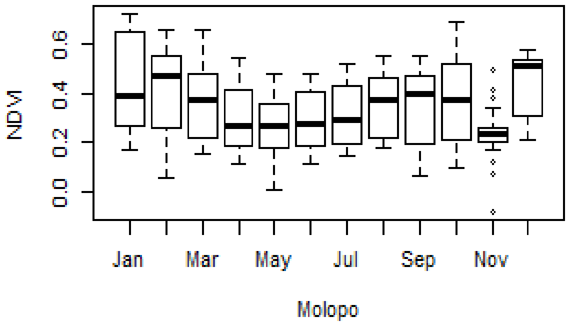


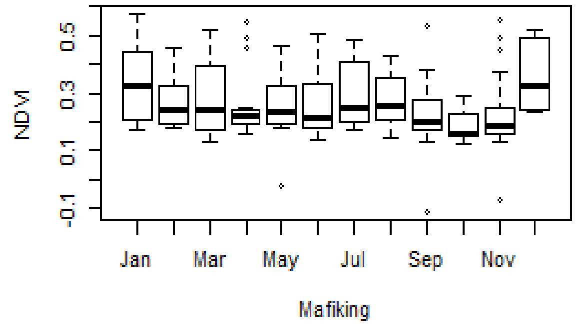


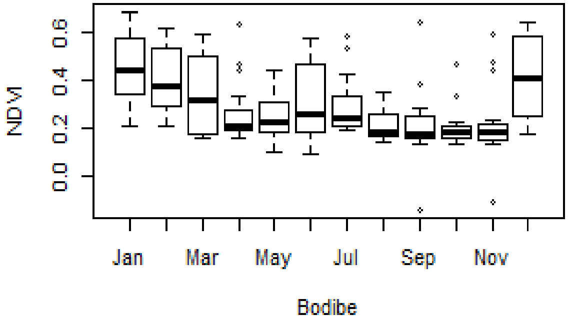
Results & Discussion



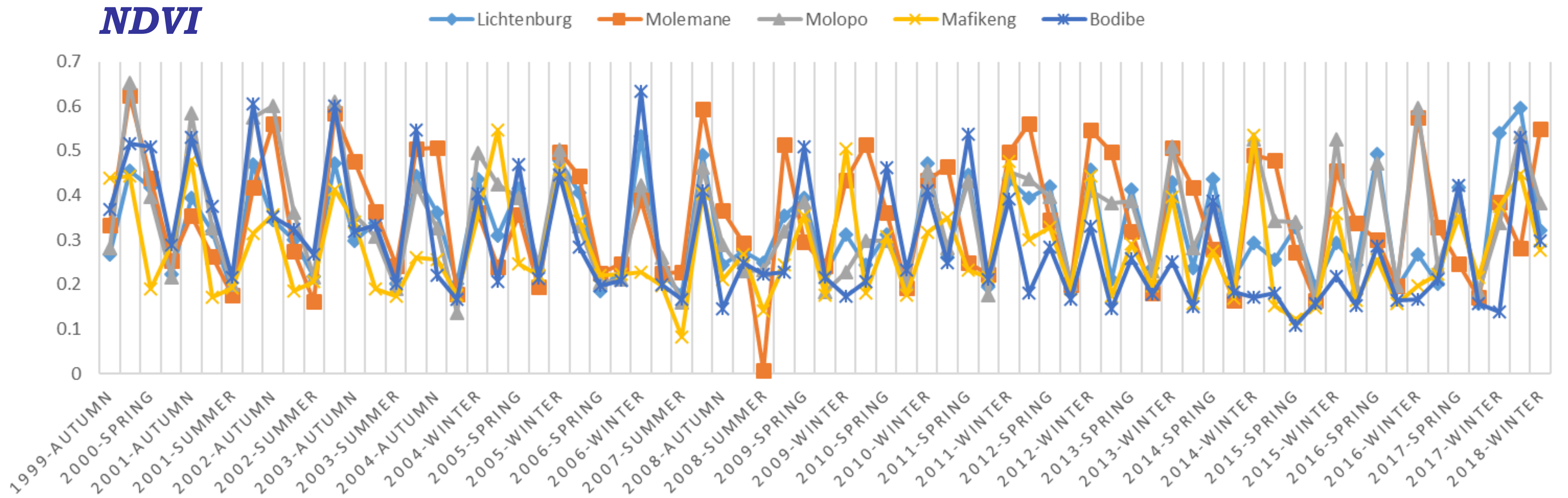


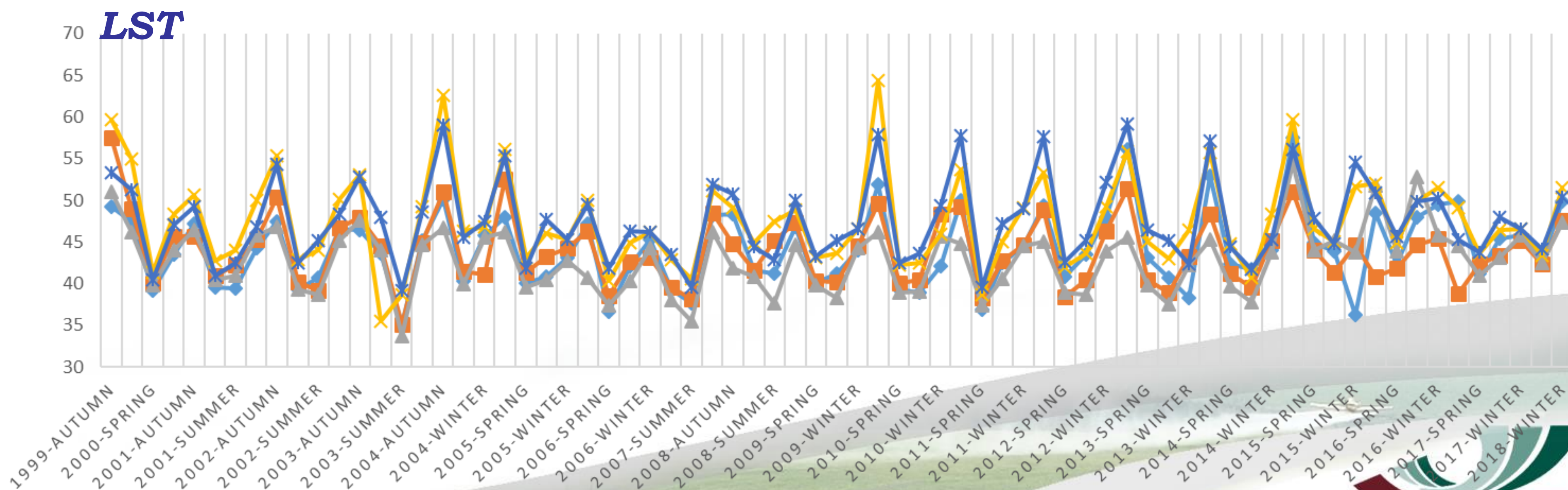






Results & Discussion





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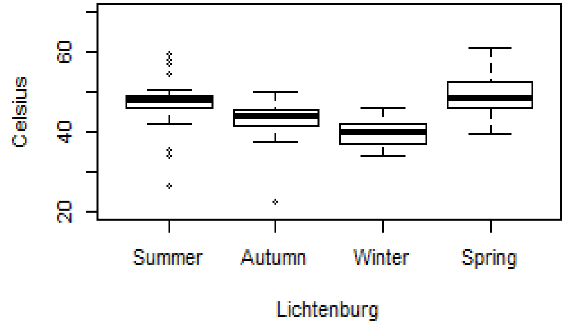

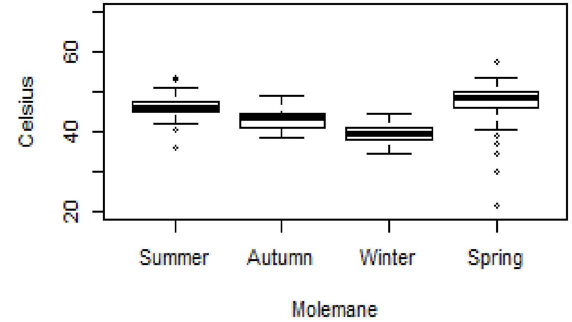

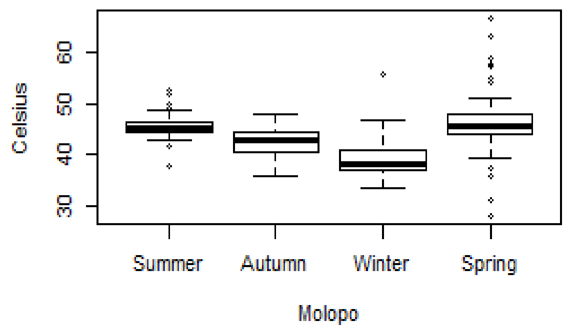

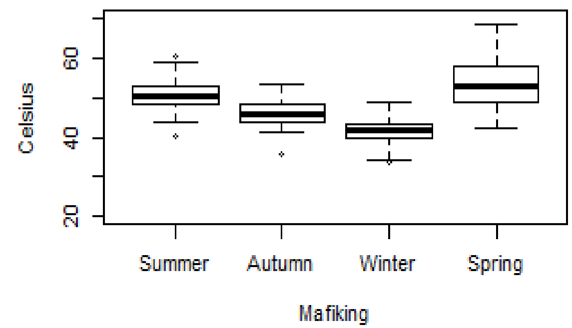

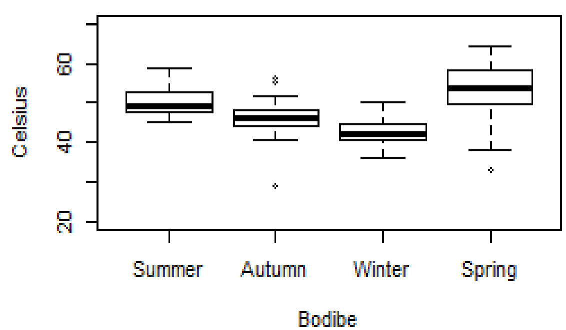

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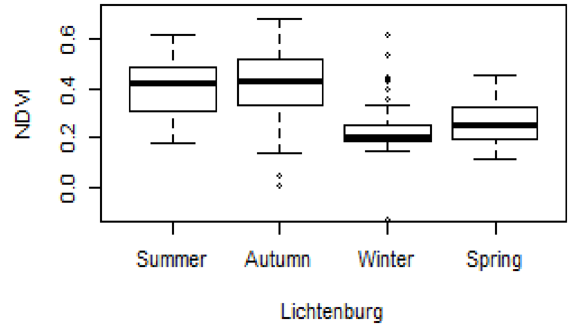
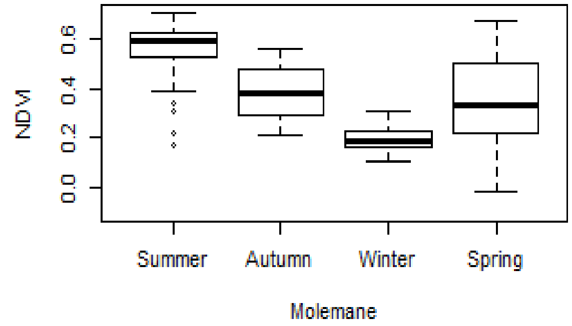
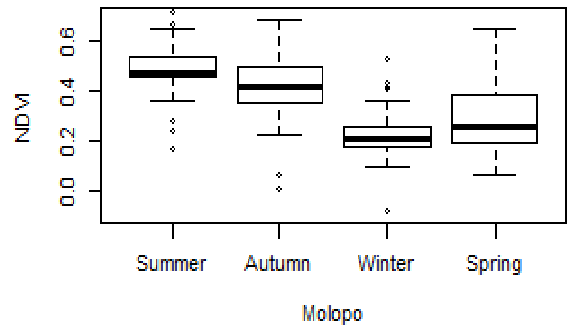
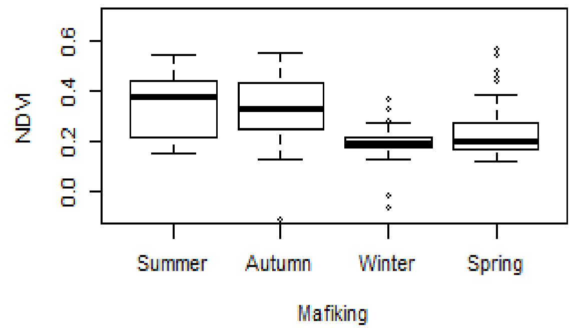
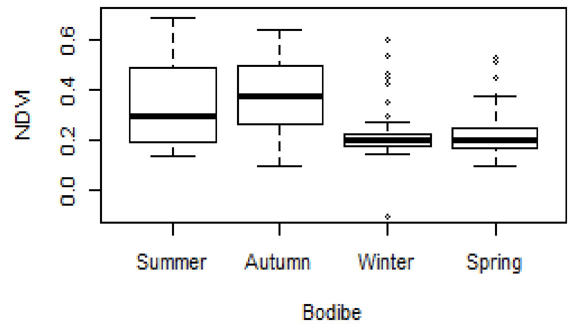




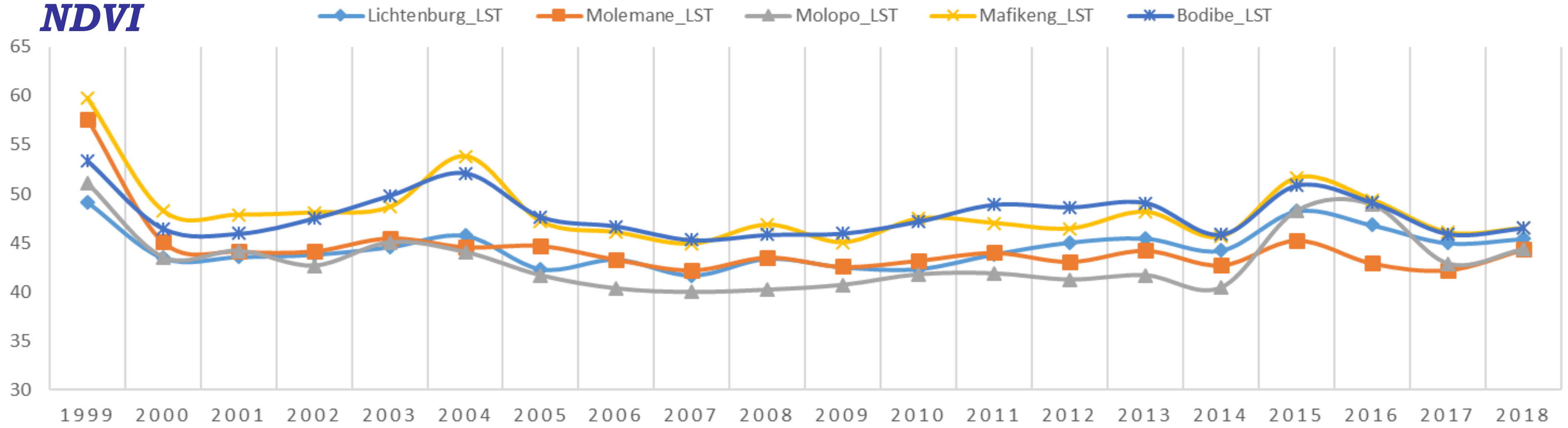




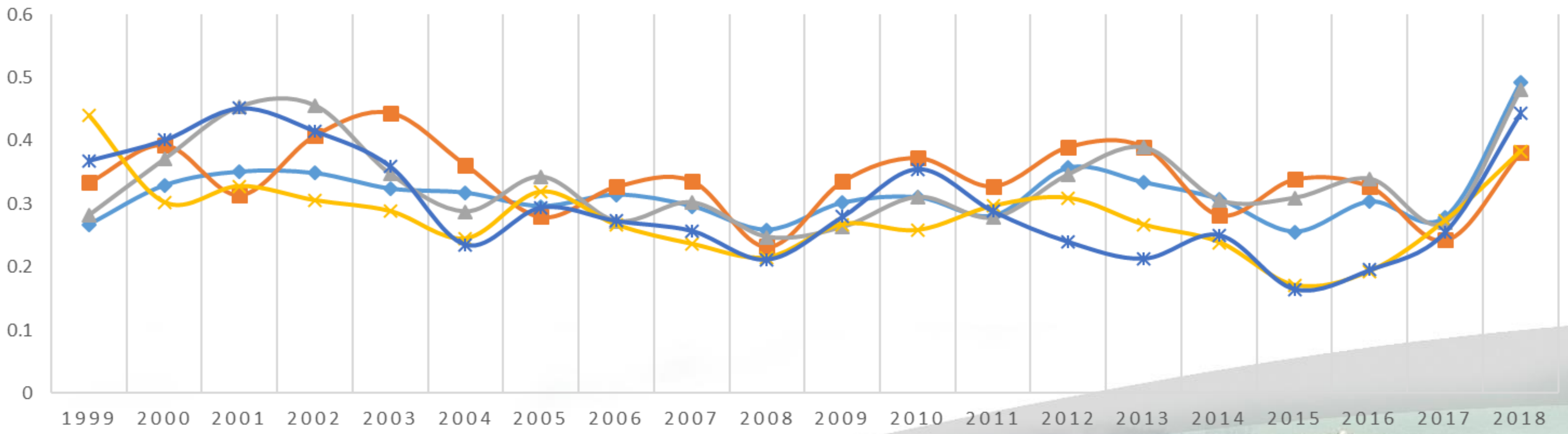


Results & Discussion

NDVI



LST



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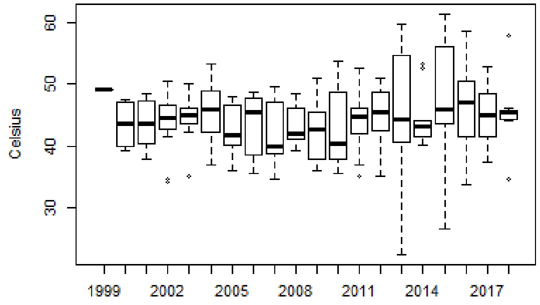
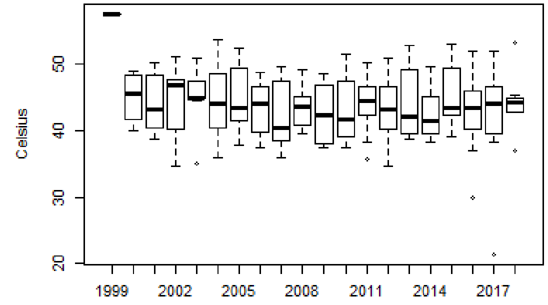
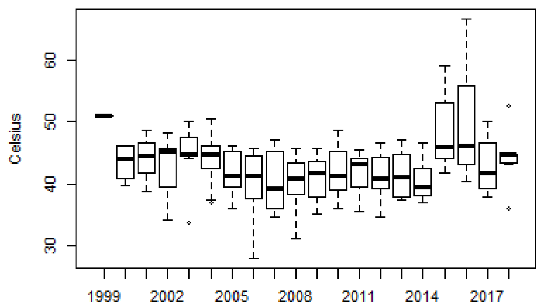
Results & Discussion



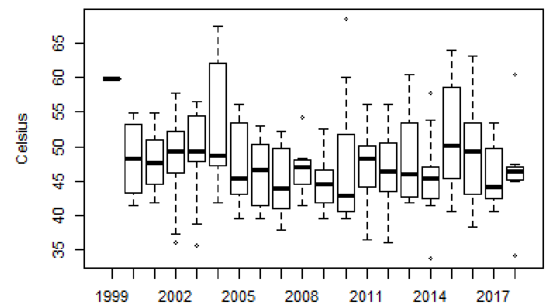
Lichtenburg



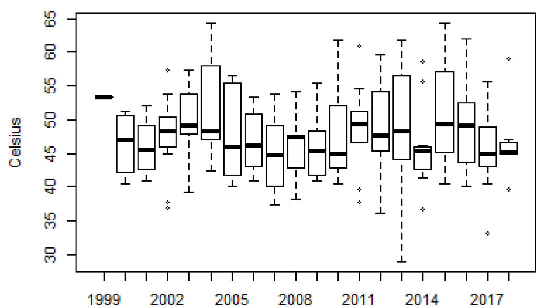
Molemane



Molopo

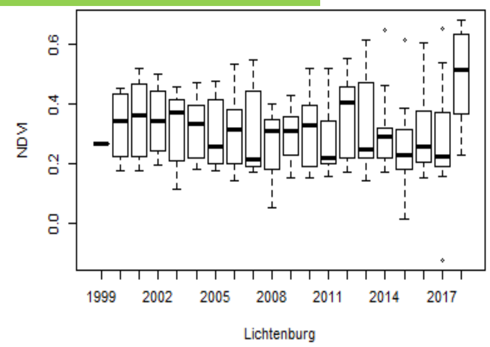


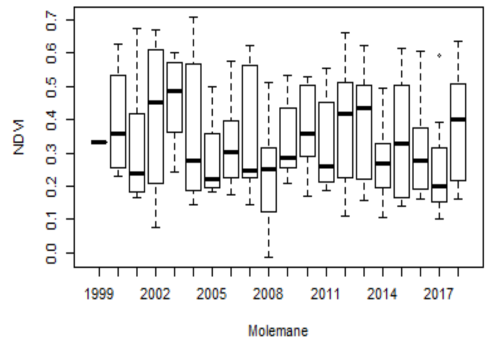
Mafiking

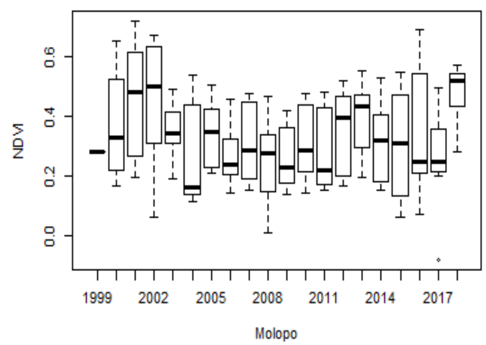


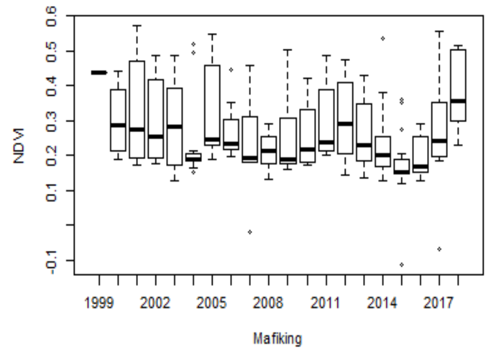
Bodibe

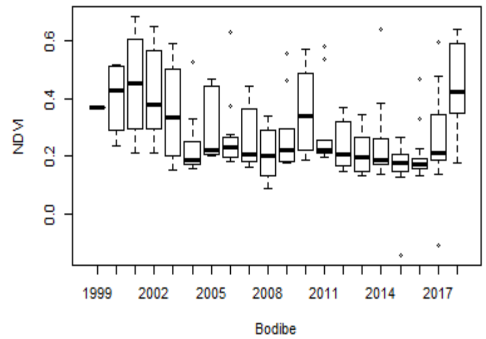
Results & Discussion











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Recommendation

- Time series analysis is required and seasonal characteristics of the peatland

- Consider more peatland

- Of course not to forget to double check the peatland boundary and the peat fire events.

- Most importantly addressing the comments and notes from the audience.

Acknowledgment

Water Research Commission

Project #: **K5/2836**

Multi-platform remote sensing tools for peat fire detection and monitoring

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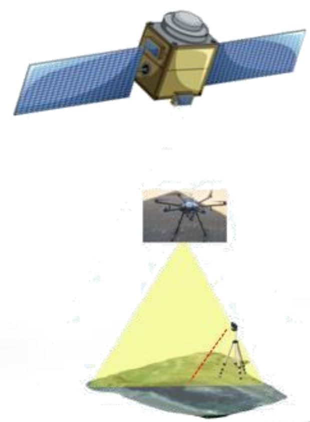

THANK YOU

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