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Chair of Geoinformatics

Vegetation dynamics on the former military training area Königsbrücker Heide

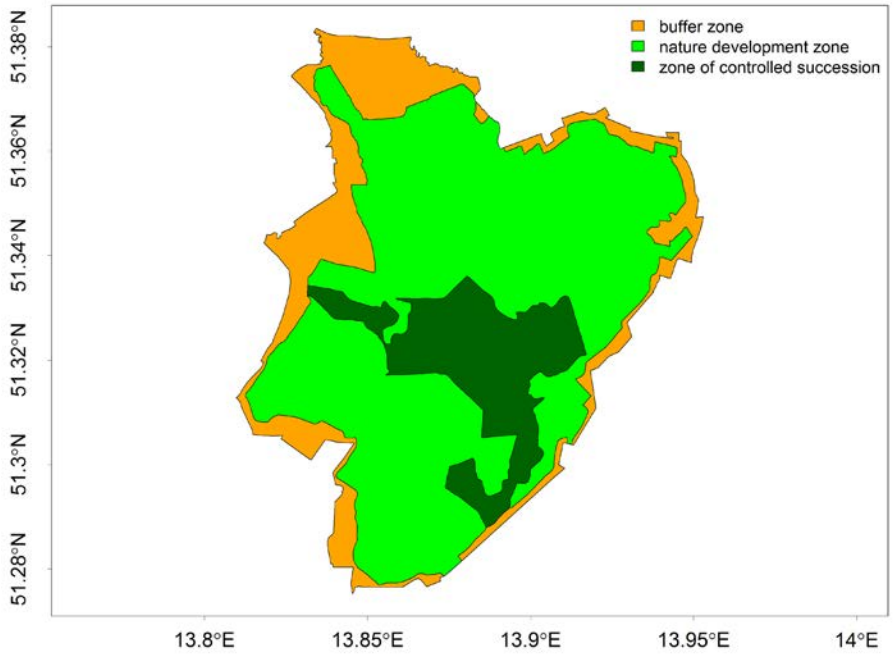
INCREaSE - GEOWorkshop
Wroclaw, 13. September 2018

Chair of Geoinformatics

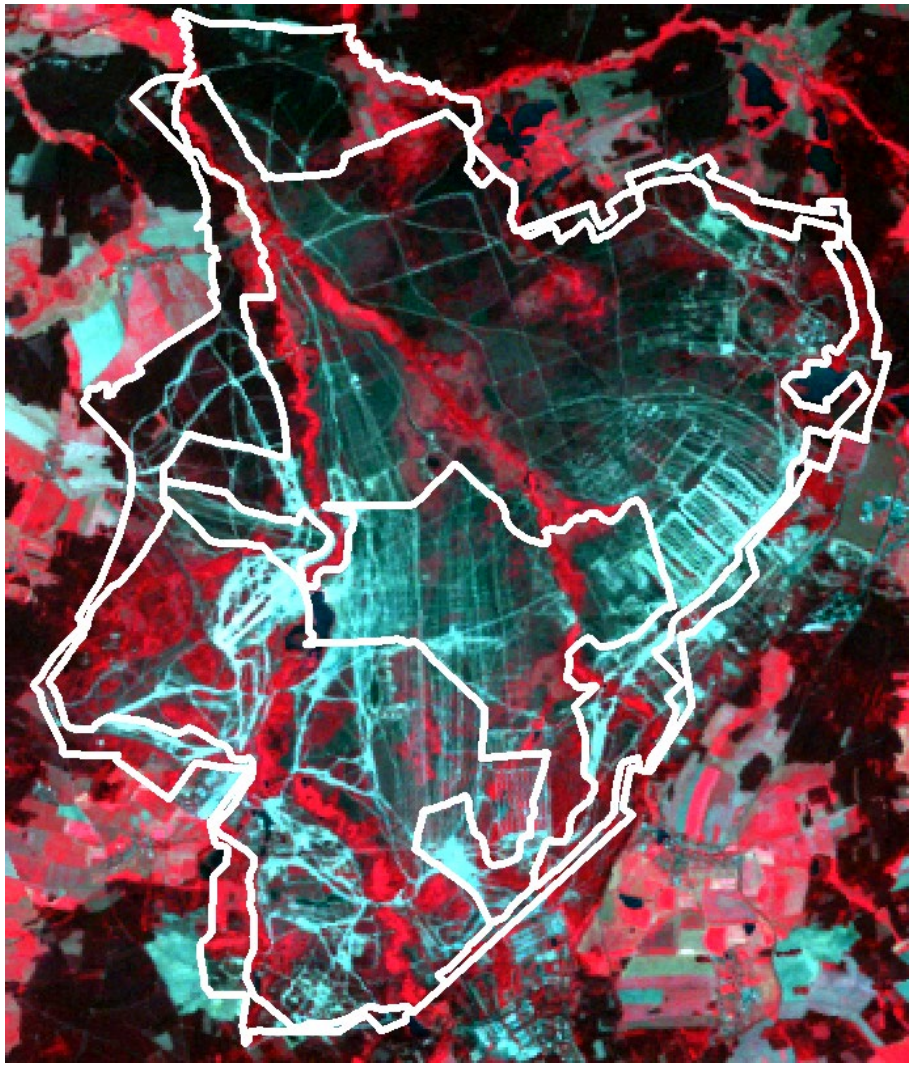
- Since 2007; ~ 10 Postdocs and Phd. Students
- development of open, interoperable, service based Geographic Information Systems
- setting up of Spatial Data Infrastructure (regional, national, international)
- architectural design and methods for distributed and efficient geoprocessing and spatial data integration
- interoperable & interdisciplinary spatio-temporal simulation modelling
- Remote Sensing

Study Area – Königsbrücker Heide

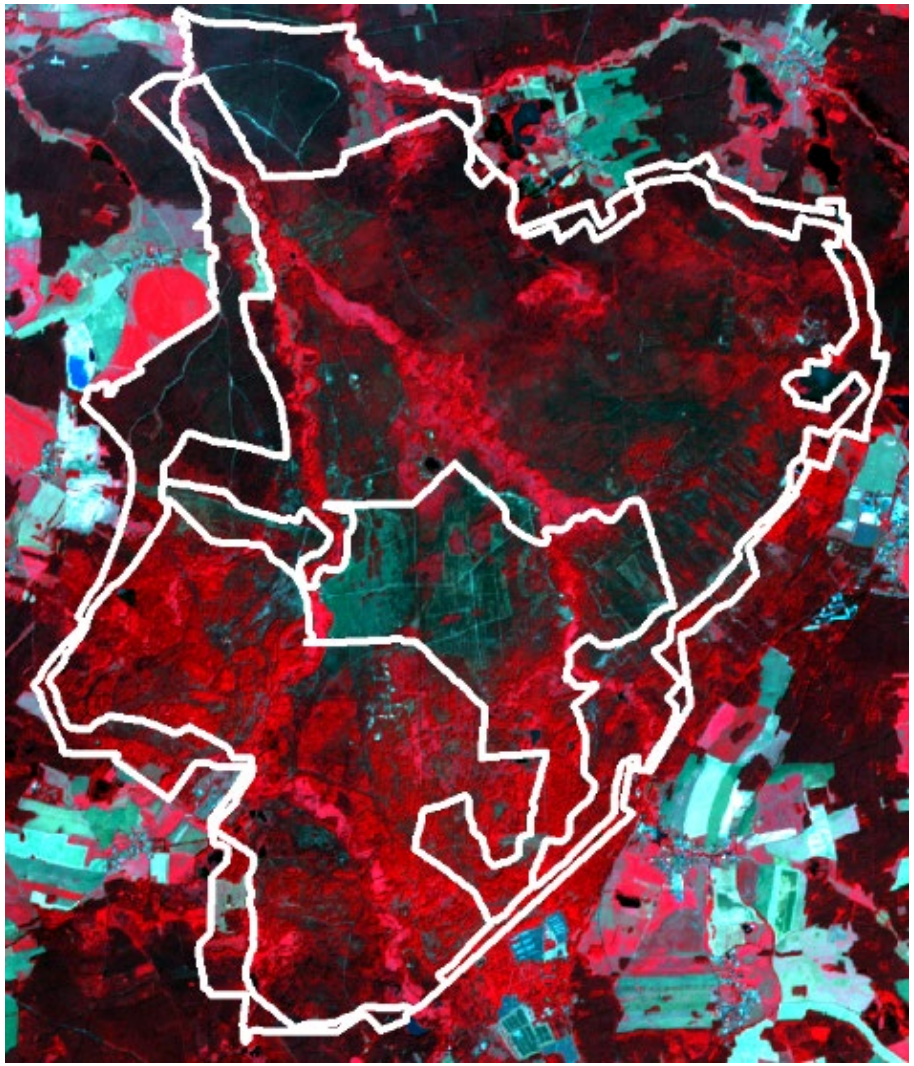
- ~30 km north of Saxony´s capital Dresden
- long military history since 1906
  - Royal Saxon Army
  - Wehrmacht
  - Soviet armed forces (Red Army) till 1992
- area for nuclear weapons
- since 1996 declared as nature reserve (NSG) “Königsbrücker Heide”
  - nature development zone
  - zone of controlled succession
  - buffer zone



Study Area – Königsbrücker Heide



1992 (end of military use)

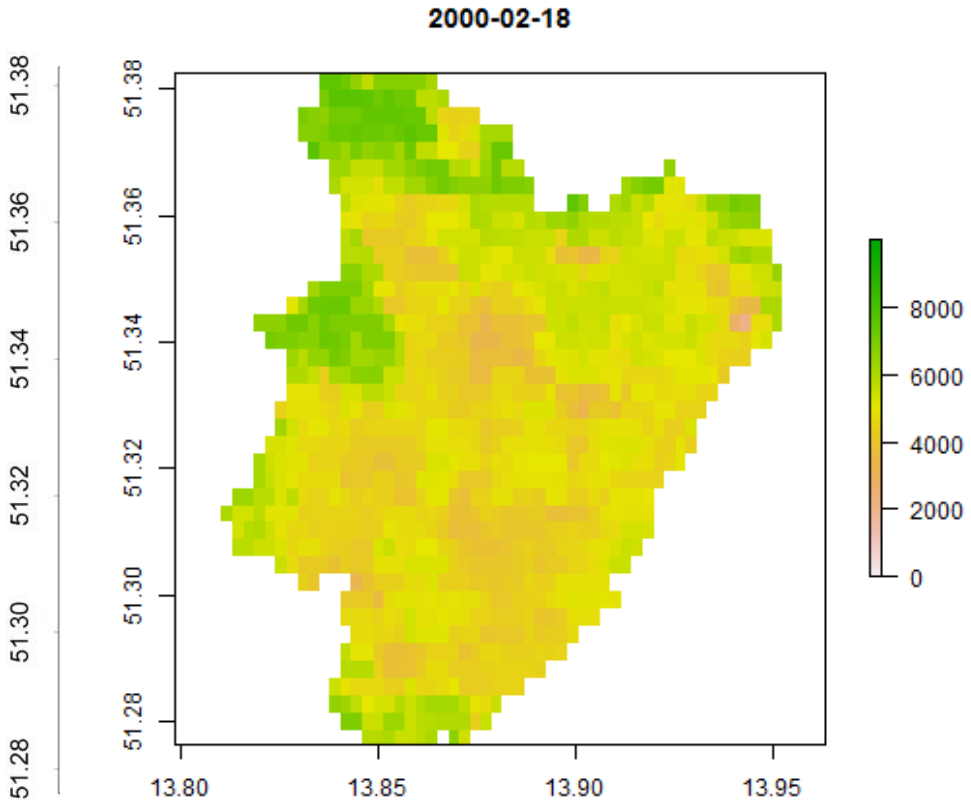


2015 (end of MODIS time series)

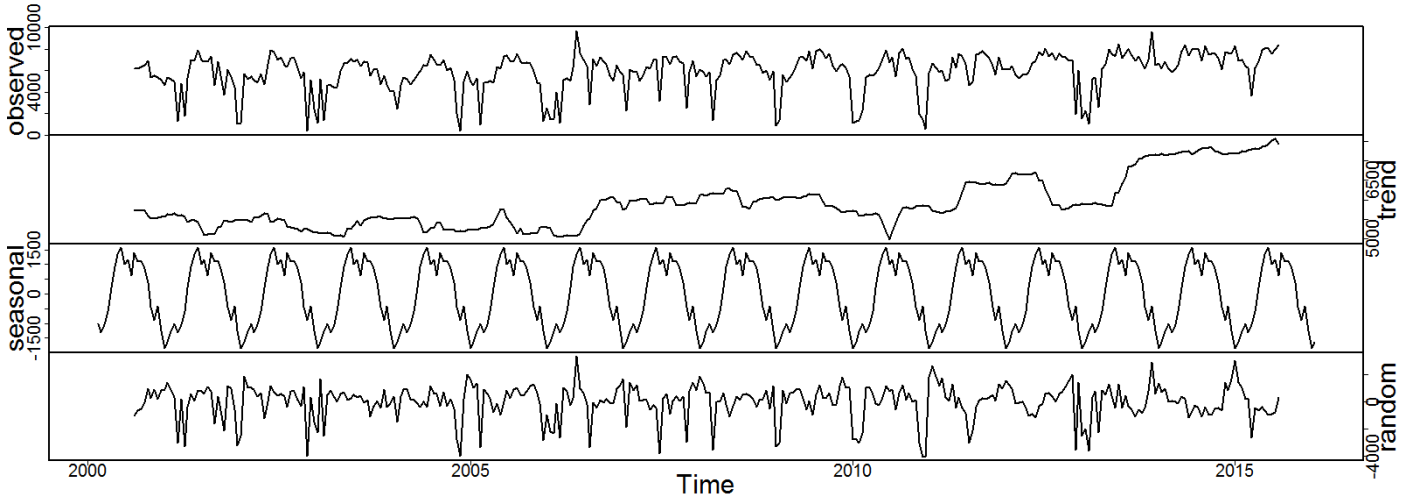
Methods & Materials

MODIS NDVI time series

- product: MOD13Q1 V6
- spatial resolution: 250m
- repetition rate: 16 days
- observation period:
  Feb. 2000 – Jan. 2016
- 367 observations
- interpolation of data gaps using seasonal Kalman filter

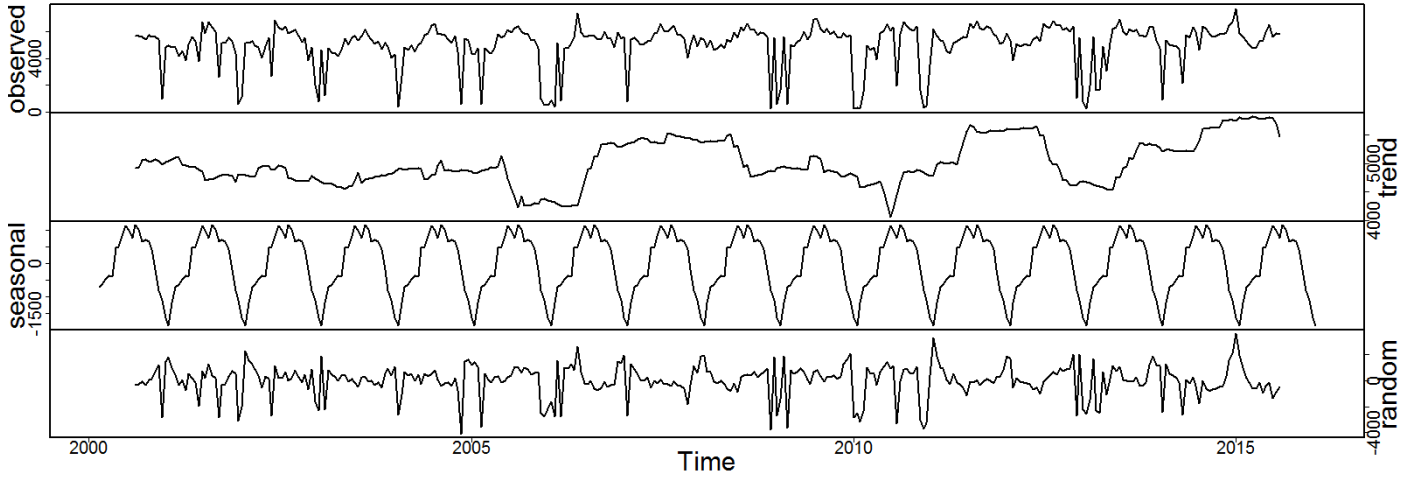


Trend Dynamics



Nature Development Zone

- Decomposition of Time Series
- Positive Long Term Trend



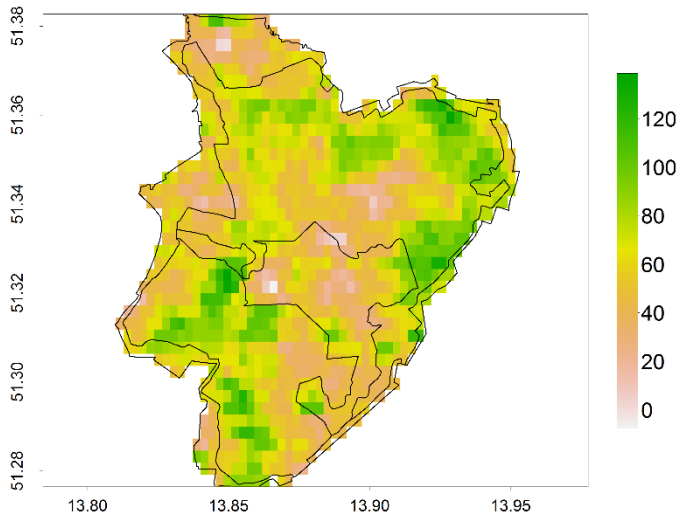
Zone of Controlled Succession

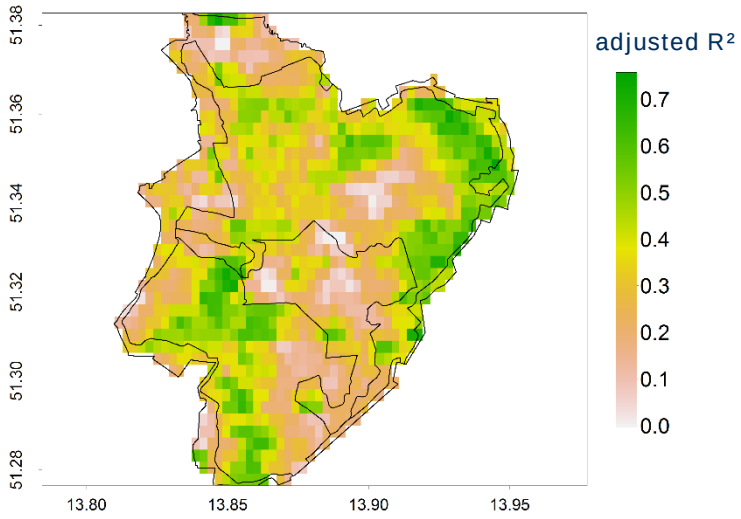
- Decomposition of Time Series
- Structural Breaks in Vegetation Trend

Trend Dynamics

OLS Regression

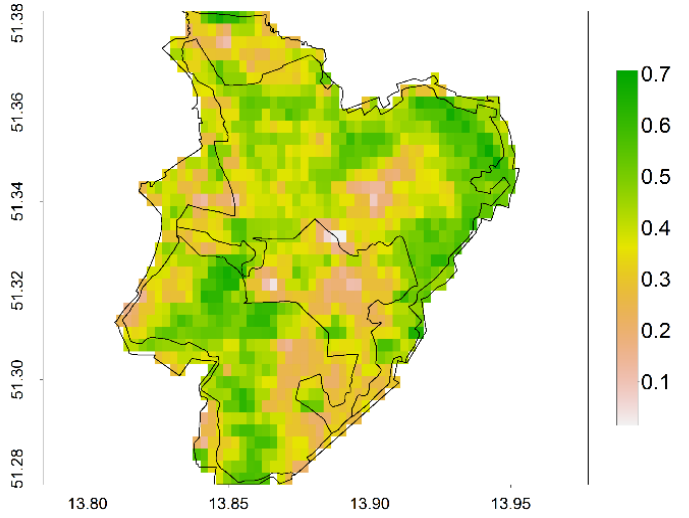
- No uniform trend over the whole study area
- Positive Trend over the whole Study Area
- High slopes of the linear trend occurs mainly in the nature development zone

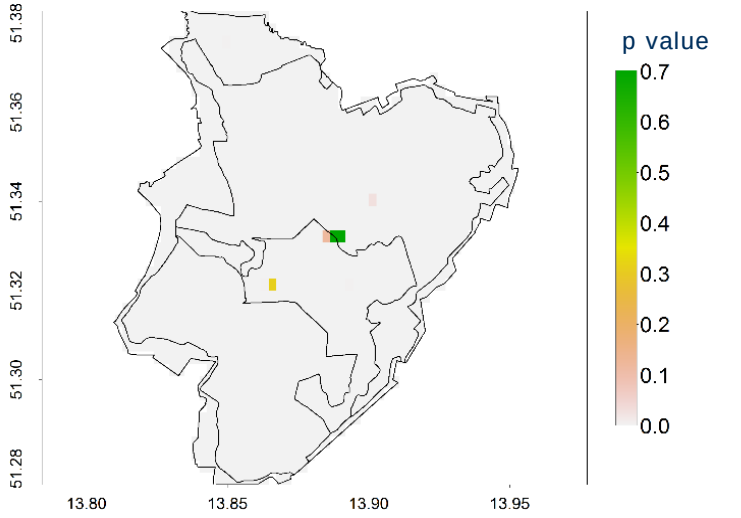




Kendall's tau

- Non-parametric test
- robust to outliers
- tau-value can be interpreted as an indicator of the strength of a trend signal

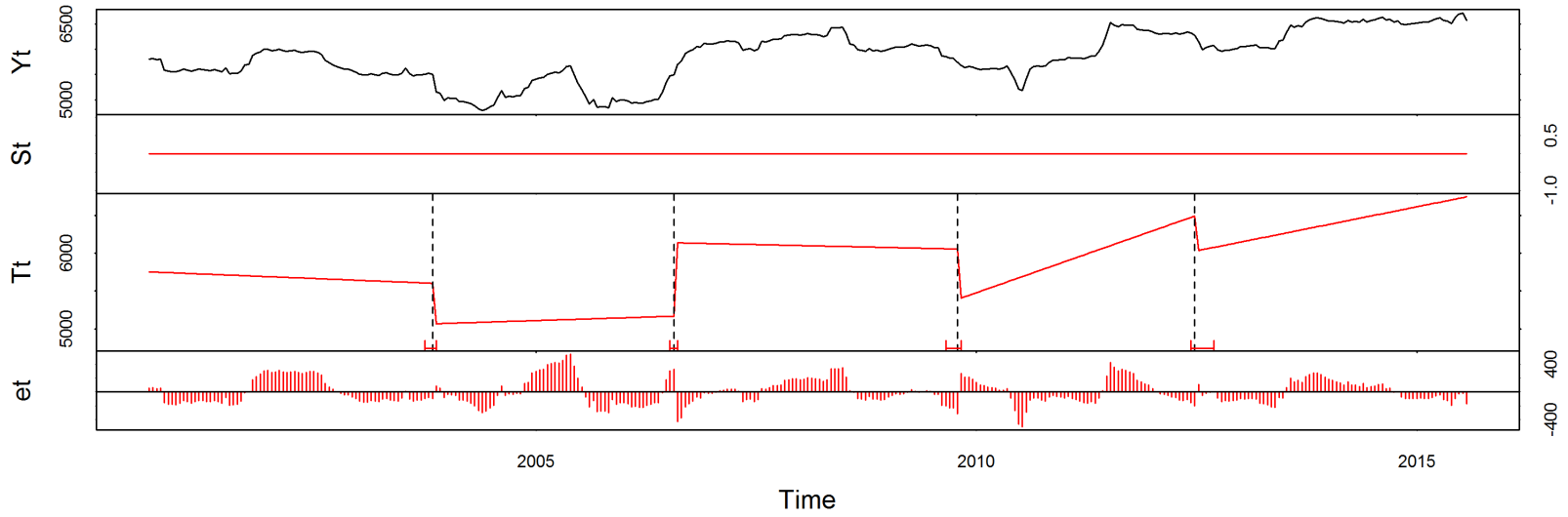


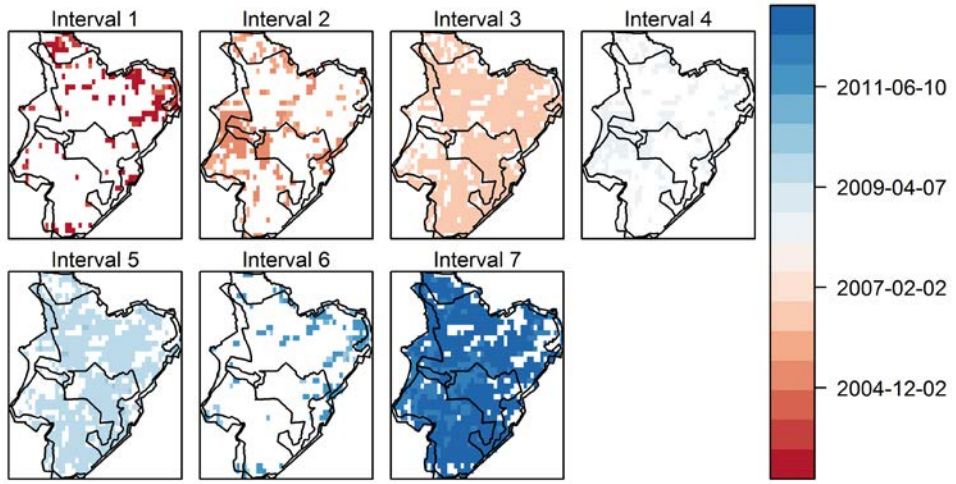


Trend Dynamics

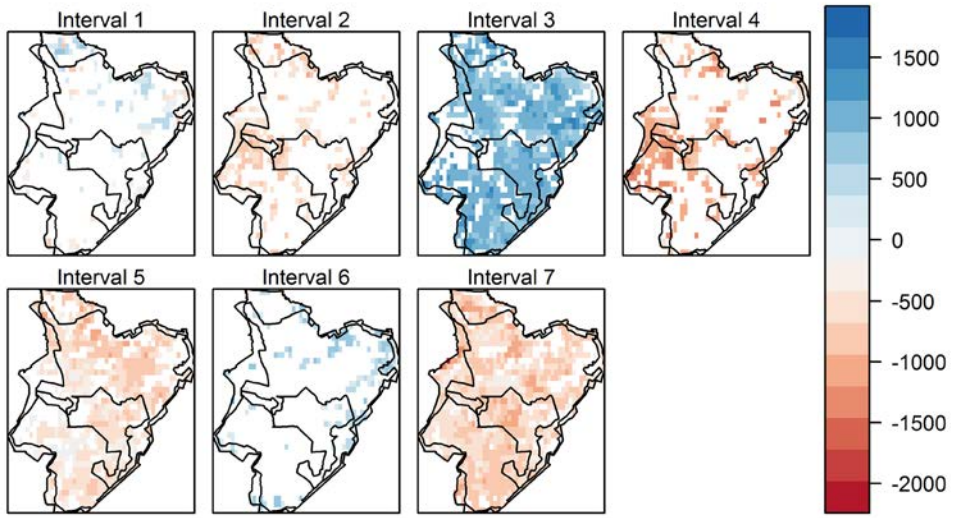
Breakpoint Detection

- Break Dates
- Magnitudes
- Confidence Intervalls





Break Date

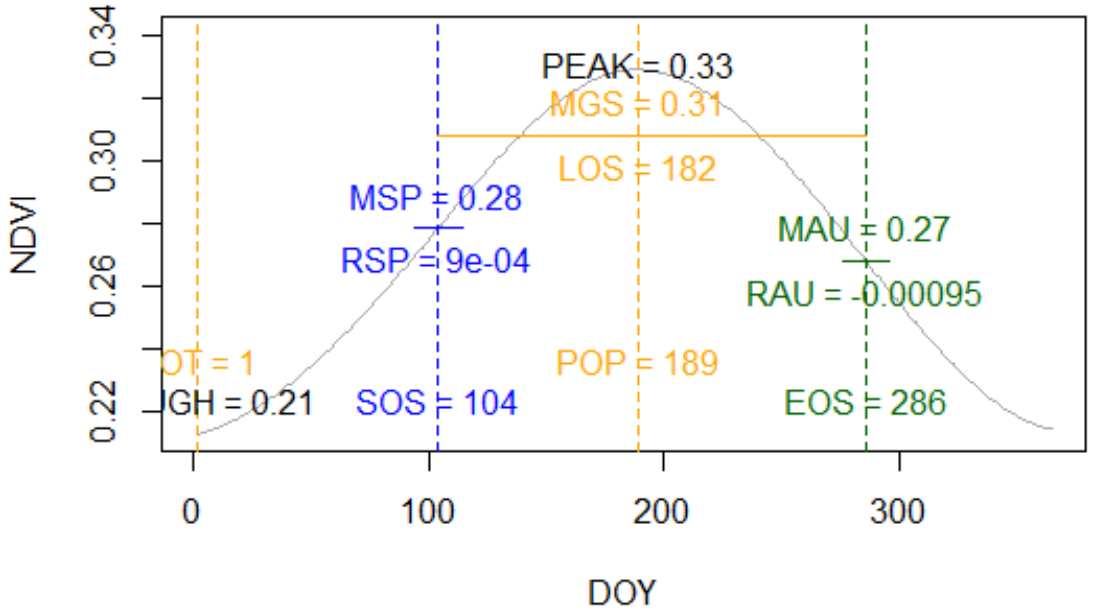


Break Magnitude

Dynamics of Seasonality

Definition of phenology and greenness metrics

- Start of season (SOS): mid-point of spring greenup
- End of season (EOS): mid-point of autumn senescence
- Length of season (LOS): difference between EOS and SOS
- mean growing season (MGS): mean value between the SOS and EOS
- The Position of Peak (POP) and the peak value (PEAK): indicators for the time and level of photosynthetic activity

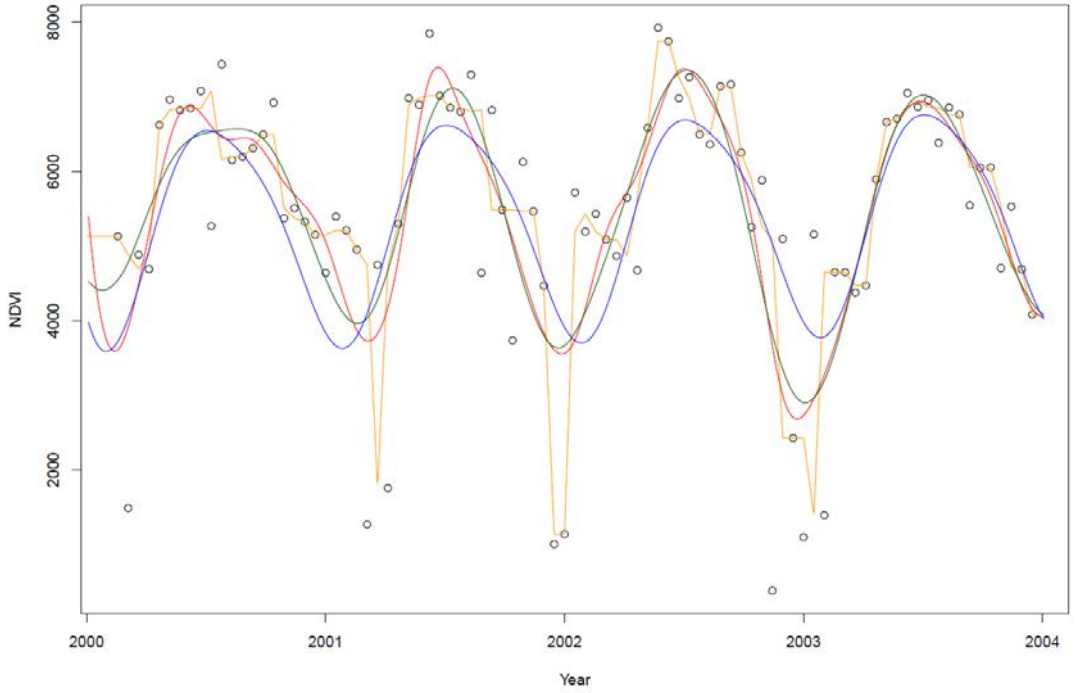


Source: http://greenbrown.r-forge.r-project.org/fig_PhenoDeriv.png

Dynamics of Seasonality

1. Temporal interpolation to daily resolution

   - Singular Spectrum Analysis
   - linear interpolation
   - spline interpolation
   - STM-interpolation



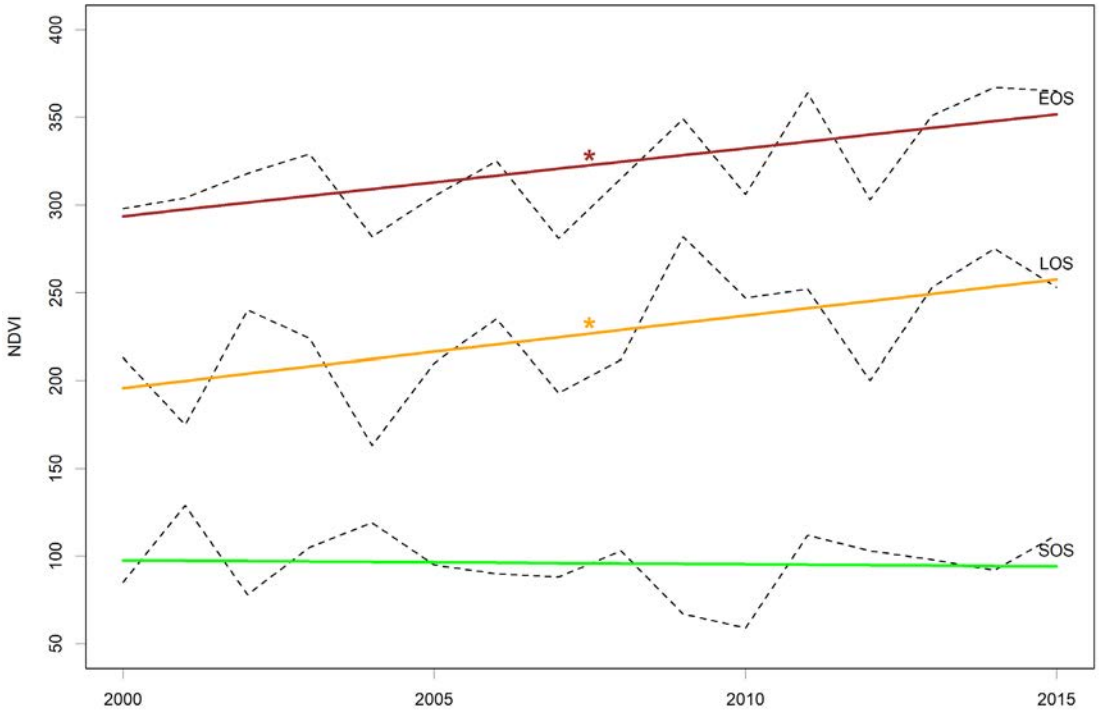
2. Calculation of phenology and greenness metrics (PGM)

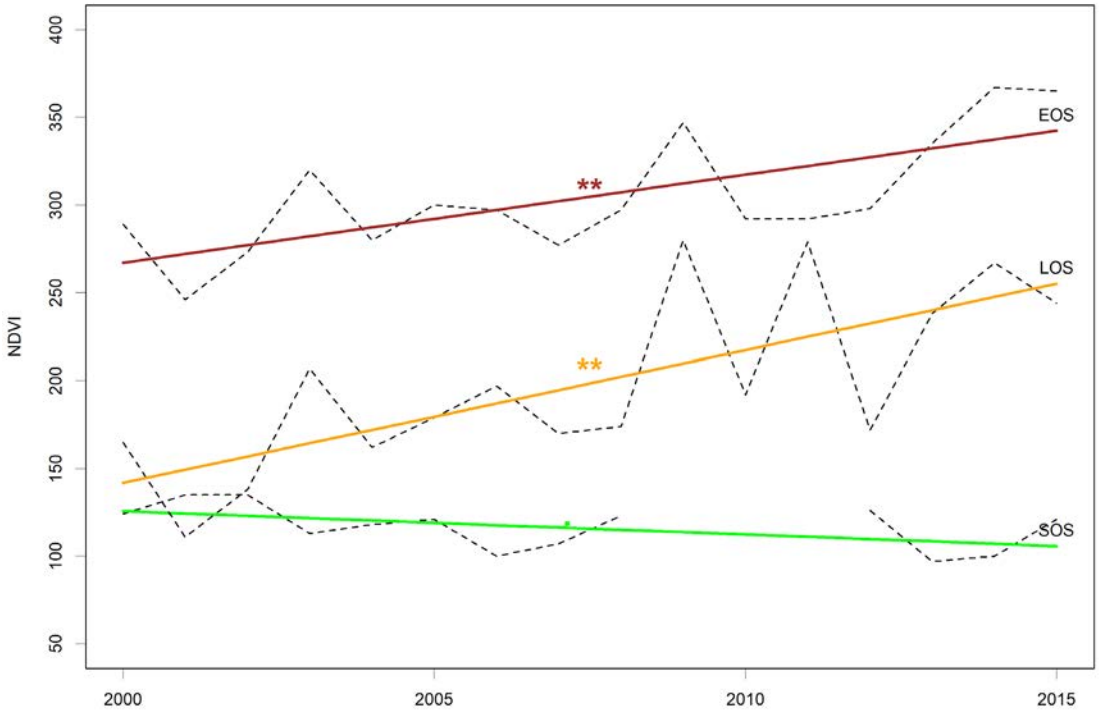
   - TRS approach: simple threshold based on the amplitude of the series
   - White approach: the 50% level of the greenness curve in spring and in autumn
   - Deriv approach: derivative of the seasonal curve

3. Trend analysis for selected phenology and greenness metrics

Dynamics of Seasonality – PGM (SOS, EOS, LOS)

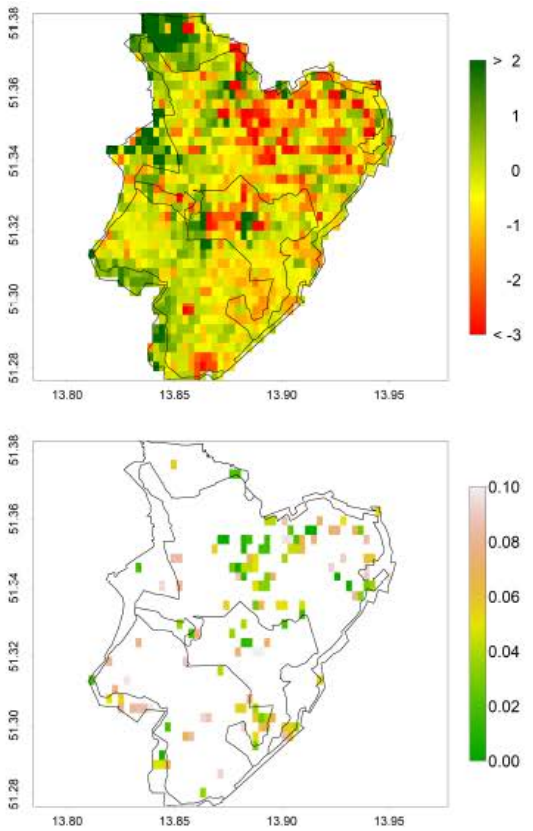
Spline Interpolation, Deriv Approach, Selected Locations





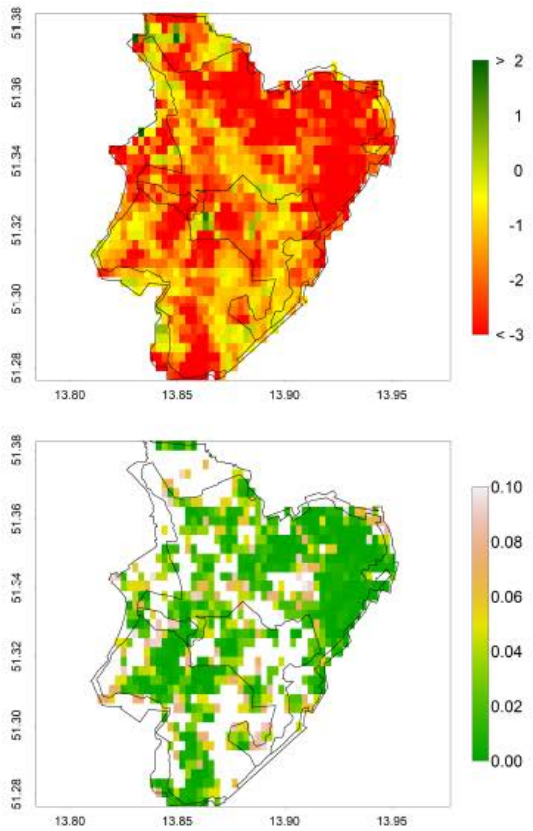
Dynamics of Seasonality – Linear Regression for Start of Season (SOS)

Spline & White approach



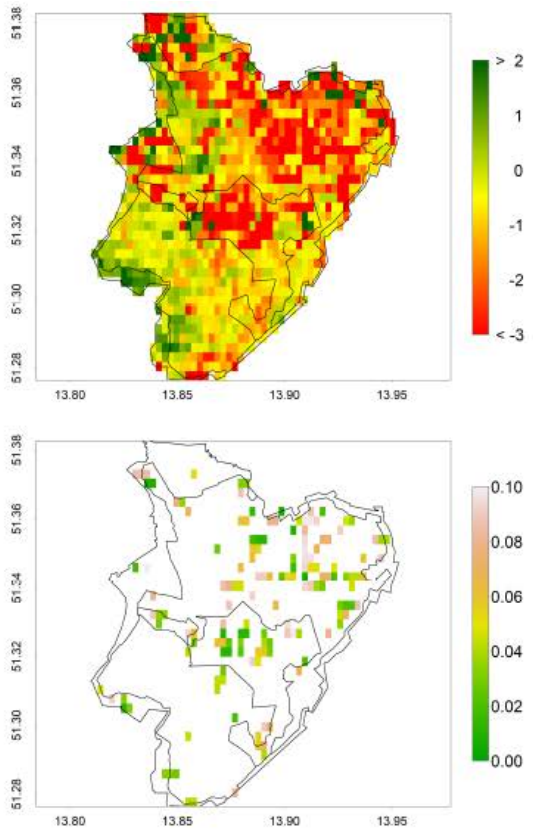
p-value < 0.05: 60 (5.0 %)

Spline & TRS approach



p-value < 0.05: 610 (50.6 %)

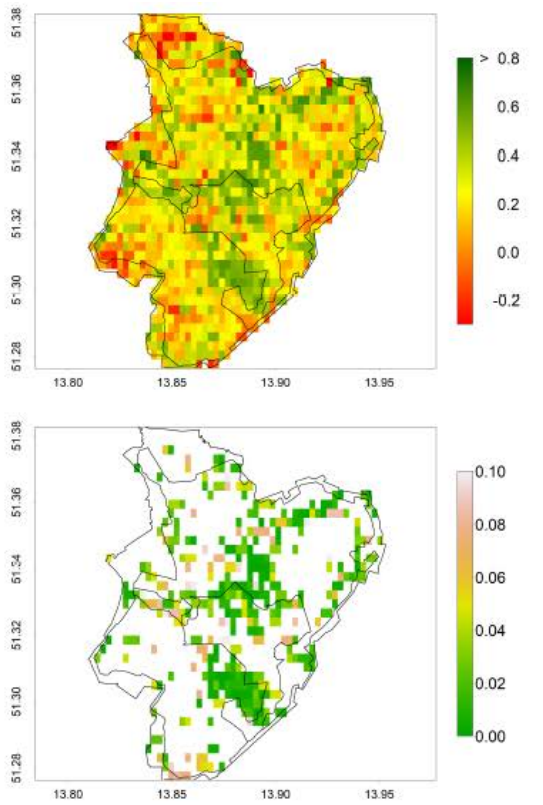
Spline & Deriv approach



p-value < 0.05: 75 (6.2 %)

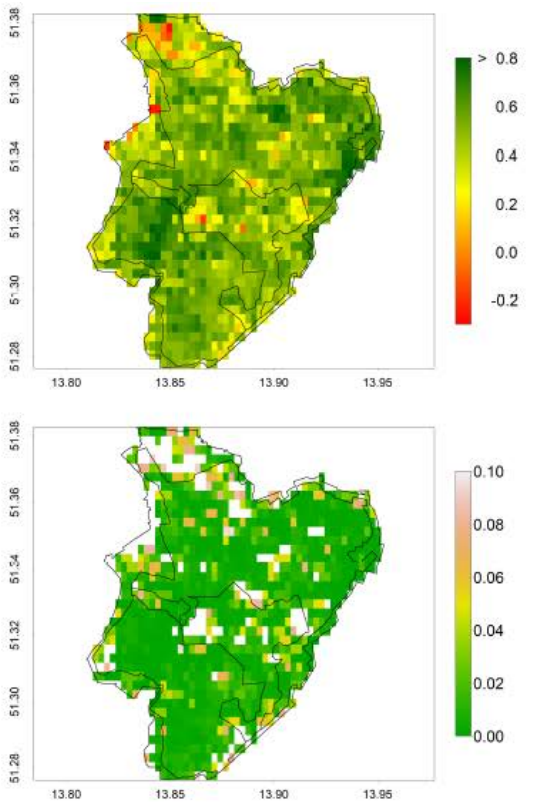
Dynamics of Seasonality – Mann -Kendall T rend Test for Length of Season (LOS)

Spline & White approach



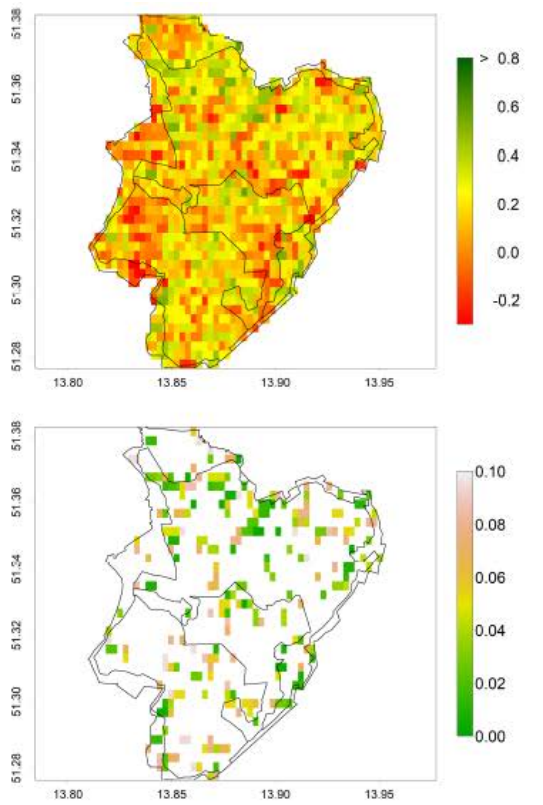
p-value < 0.05: 292 (24.2 %)

Spline & TRS approach



p-value < 0.05: 973 (80.7 %)

Spline & Deriv approach

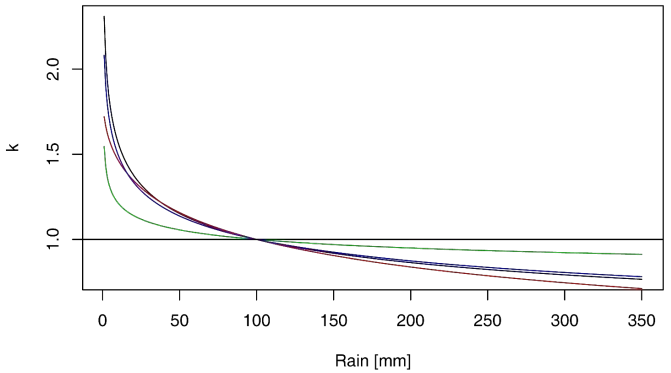


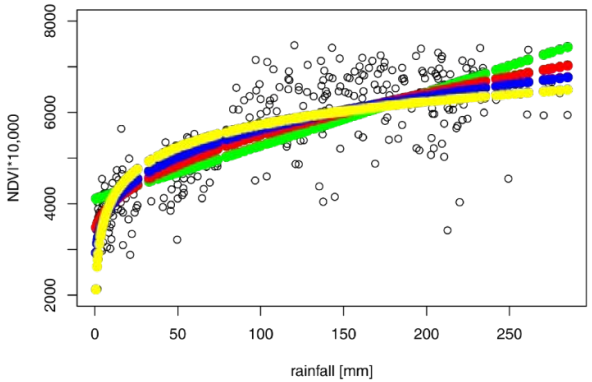
p-value < 0.05: 135 (11.2 %)

Further Research

Wessollek, Christine ; Karrasch, Pierre ; Osunmadewa, Babatunde A.: Introducing a rain-adjusted vegetation index (RAVI) for improvement of long-term trend analyses in vegetation dynamics. Proc. SPIE 9644, Earth Resources and Environmental Remote Sensing/GIS Applications VI, doi:10.1117/12.2192821.

- More detailed Information of Precipitation (RAVI)





- Implementation of Low Cost Meteorological Stations

EXTRUSO

SMARTrain

Picture: Landeshauptstadt Dresden
https://smart-rain.de

- Temporal high resolution data acquisition using UAV technology

DFG Deutsche Forschungsgemeinschaft

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1. Wessollek, Christine ; Karrasch, Pierre: **Monitoring structural breaks in vegetation dynamics of the nature reserve Königsbrücker Heide.** In: Proc.SPIE, , Earth Resources and Environmental Remote Sensing/GIS Applications VIII,10428, 2017. pp. 10428 – 10428 – 17. doi:10.1117/12.2278202

2. Wessollek, Christine ; Karrasch, Pierre: **Monitoring of vegetation dynamics on the former military training area Königsbrücker Heide using remote sensing time series .** *Proc. SPIE* 10005, Earth Resources and Environmental Remote Sensing/GIS Applications VII, 100050Q (October 18, 2016); doi:10.1117/12.2239944

3. Karrasch, Pierre ; Wessollek, Christine: **Evaluation of MODIS-NDVI based phenology indicators for the analysis of vegetation dynamics in the nature reserve Königsbrücker Heide.** Proc. SPIE, Earth Resources and Environmental Remote Sensing/GIS Applications, 10790, 2018

SPIE. REMOTE SENSING

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