Spatio-temporal Modeling And Monitoring Of Extreme Weather Events And Conditions

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Gliederung

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   - Localization of extreme weather events

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Motivation and objectives

Extreme weather in Europe

Situation
Global climate change leads to increasing occurrence of extreme weather, which can have an impact on crop yield levels and yield stability.

Phenomena and impacts

**Conditions**
heat, frost, drought $\Rightarrow$ damages to tissue and reproductive organs, significant reduction of photosynthesis up to irreversible tissue damages due to water deficit

**Events**
heavy rainfall, hail $\Rightarrow$ root damages from oxygen deficit as a consequence of soil water logging, soil erosion and nutrient leaching

EMRA project objectives

Practical decision support system . . .
- . . . for farmers and agricultural advisers
- . . . enabling a risk assessment of reference units (e.g., parcels) regarding extreme weather

Agricultural crop types and test sites
- Winter Wheat in the district of Uckermark
- Apple in Altes Land region (district of Stade)

Components
- geodata integration
- dynamic risk assessment
- monitoring
Geodata integration approach

**Dynamic WI/El calculation**

The impact of extreme weather events/conditions is related to phenological development stages/phases of crops.

\[ P_{d,h} \] – daily and hourly precipitation  |  \[ T_d \] – daily mean temperature  |  \[ \text{DOY}^P \] – DOY of begining phenological phases  |  \[ I^S \] – spectral index  |  \[ I^T \] – terrain index  |  \[ S \] – soil data  
\[ \text{RU} \] – Reference unit  |  \[ \text{WI}_P \] – Weather Index  |  \[ \text{EI}_{P,d,h} \] – Erosion Index

Motivation and objectives

Geodata integration approach

Localization of soil erosion events

- Soil erosion occurs when a heavy rain event coincides with no or sparse vegetation cover on parcels.
- Event-specific information about parcel-specific crop coverage and precipitation on particular development stages/phases are needed.
Phenological Modelling

Geodata integration approach

Parcel-specific time series of phenological soil cover and precipitation

Phenological Observations
- DOY
- Point

DEM
- Raster
- 1 x 1 km

Satellite Imagery
- Raster
- 20 x 20 m
- 30 x 30 m
- 250 x 250 m

Precipitation
- daily, hourly
- Raster
- 1 x 1 km

Phenological Windows
- Raster
- 1 x 1 km

Parcel

NDVI Precipitation Index
- Raster
- daily
- 10 x 10 m
- 20 x 20 m
- 30 x 20 m
- 250 x 250 m


Interpolation of phenological observations

Beginning phenological phases (Winter Wheat, 2016)
Crop-specific phenological windows

Winter Wheat in the district of Uckermark (2016)

Crop-specific phenological windows

Winter Wheat in the district of Uckermark: Periods between \textit{beginning of yellow ripeness} and \textit{harvest} from 1998 to 2018

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{phenological_windows.png}
\caption{Crop-specific phenological windows for Winter Wheat in the Uckermark district from 1998 to 2018. The x-axis represents the years, and the y-axis represents the DOY (Day of Year) values.}
\end{figure}
Satellite and precipitation data

Germany-wide geodata sets

- MODIS (7th Oct 2016)
  - Terra Surface Reflectance
  - 8-Day L3 Global 250 m SIN Grid V006 (MOD09Q1; © USGS)
  - NDVI/SAVI
  - 250 × 250 m

- Precipitation (3rd Oct 2016)
  - highly resolved (5 min) and adjusted radar rain data (RADOLAN, © DWD)
  - aggregated to hours per day exceeding a threshold of $P > 10$ mm
  - 1 × 1 km
Parcel and event-specific soil erosion assessment

Regional geodata
- DEM & soil erodibility
  - 10 × 10 m
  - © Soil survey of Brandenburg
    (https://lbgr.brandenburg.de)
Parcel and event-specific soil erosion assessment

Parcel DEBBLI0373300339-3901: Winter Wheat in 2017 | 32 ha
Parcel and event-specific soil erosion assessment

Parcel DEBBLI0373300339-3901

- NDVI and Precipitation Index profile for Winter Wheat in 2016/2017
Summary

Scale-specific geodata integration of current and historical geodata for the assessment of extreme weather

- phenological information
- daily weather data
- satellite imagery

⇒ Parcel-specific localization of historical/up-to-date soil erosion events of high probability

Challenges

- Applying ML techniques to detect Germany-wide pattern of extreme weather risk
- Integration and visualization of spatio-temporal data qualities/inaccuracies
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