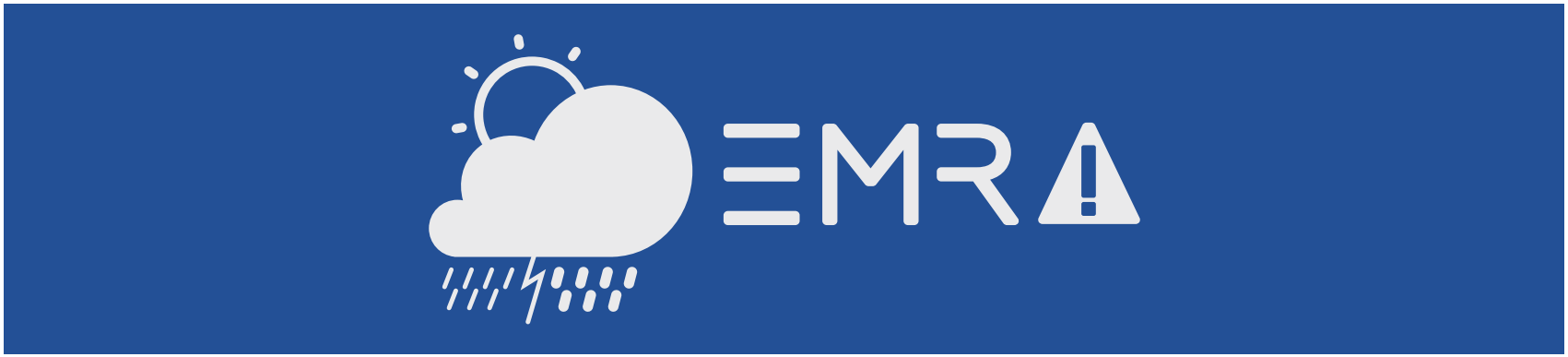
Spatio-temporal Modeling And Monitoring Of Extreme Weather Events And Conditions

Markus Möller, Sandra Krengel, Detlef Deumlich, Rolf Lessing & Burkhard Golla



Gliederung

1. Motivation and objectives
2. Geodata integration approach
   - Phenological Modelling
   - Localization of extreme weather events
3. Conclusion

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 ⇒ damages to tissue and reproductive organs, significant reduction of photosynthesis up to irreversible tissue damages due to water deficit

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

Mäkinen, H., Kaseva, J., Trnka, M., Balek, J., Kersebaum, K.C., Nendel, C., Gobin, A., Olesen, J.E., Bindi, M., Ferrise, R., Moriondo, M., Rodr'ıguez, A., Ruiz-Ramos, M., Takáč, J., Bezák, P., Ventrella, D., Ruget, F., Capellades, G. & Kahiluoto, H. (2018): Sensitivity of European wheat to extreme weather. Field Crops Research 222, 209-217.

EMRA project objectives

Practical decision support system ...

- ... for farmes and agricultural advisers
- ... enabling a risk assessment of reference units (e.g., parcels) regarding extreme weather

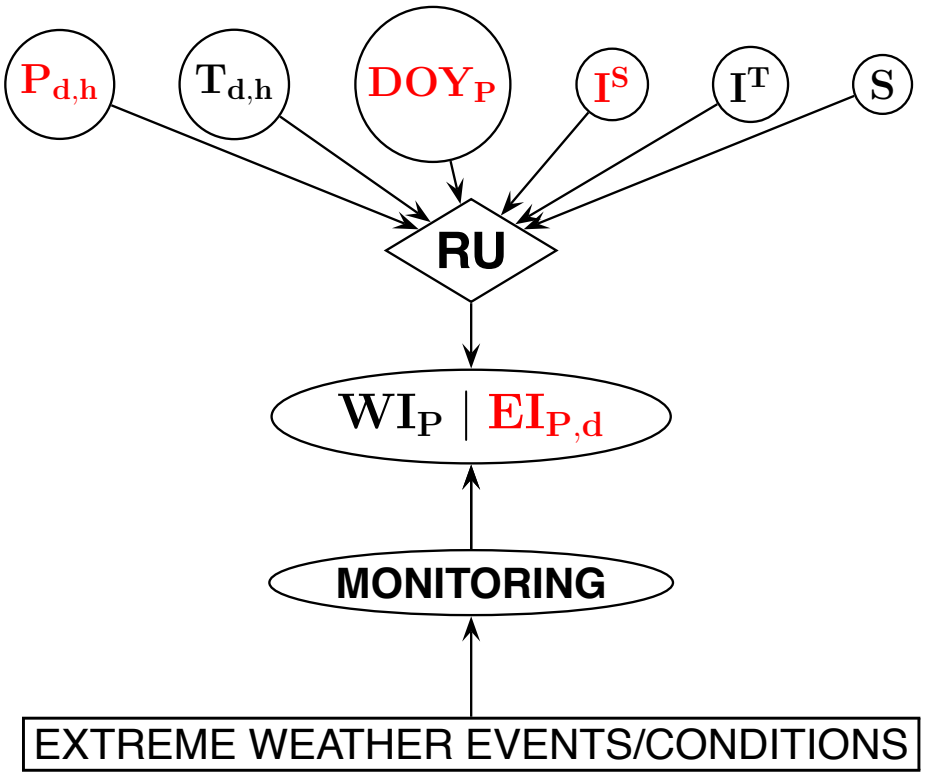
Agricultural crop types and test sites

- 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/EI calculation

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

Möller, M., Doms, J., Gerstmann, H., Feike, T., 2018. A framework for standardized weather index calculation in Germany. Theoretical and Applied Climatology. URL https://link.springer.com/article/10.1007/s00704-018-2473-x

$P_{d,h}$ – daily and hourly precipitation | **T_d** – daily mean temperature | **DOY^P** – DOY of begining phenological phases | **I^S** – spectral index | **I^T** – terrain index | **S** – soil data | **RU** – Reference unit | **WI_P** – Weather Index | **$EI_{P,d,h}$** – Erosion Index

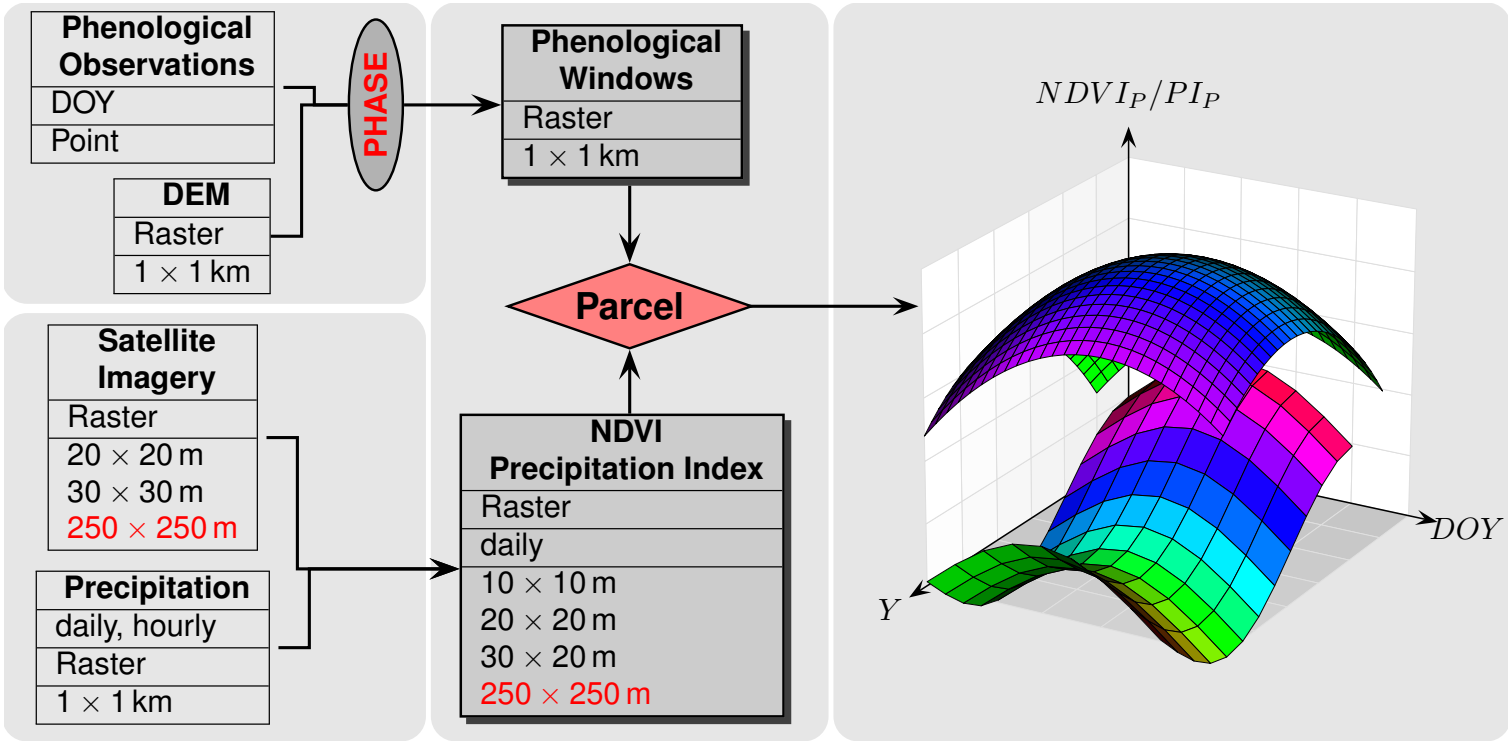
Geodata integration approach

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.

Geodata integration approach

Parcel-specific time series of phenological soil cover and precipitation

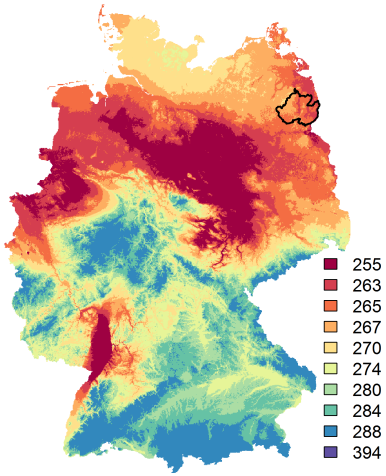


Gerstmann, H., Doktor, D., Gläßer, C. & Möller, M. (2016): PHASE: A geostatistical model for the Kriging-based spatial prediction of crop phenology using public phenological and climatological observations. *Computers and Electronics in Agriculture* 127, 726–738.

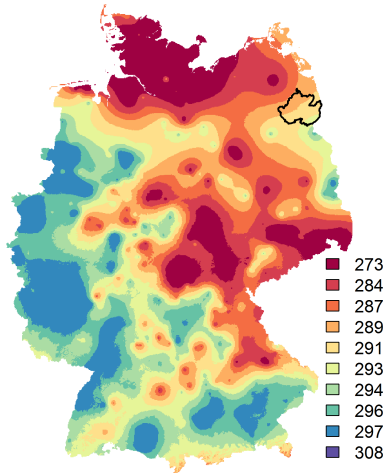
Möller, M., Gerstmann, H., Dahms, T.C., Gao, F. & Förster, M. (2017): Coupling of phenological information and simulated vegetation index time series: Limitations and potentials for the assessment and monitoring of soil erosion risk. *CATENA* 150, 192–205.

Interpolation of phenological observations

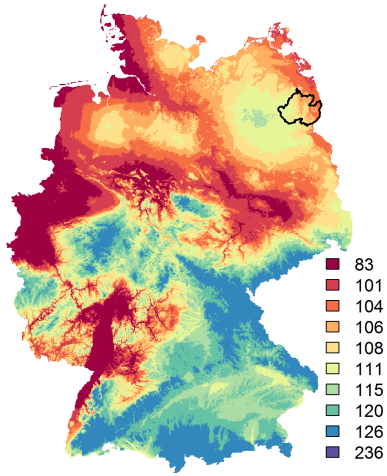
Beginning phenological phases (Winter Wheat, 2016)



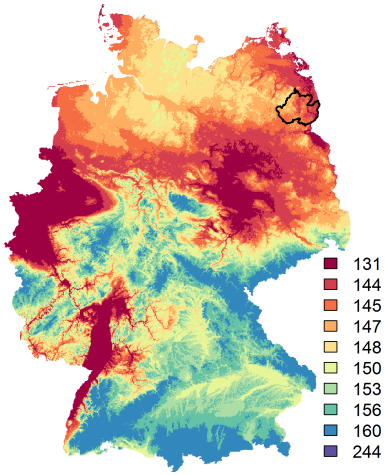
tilling



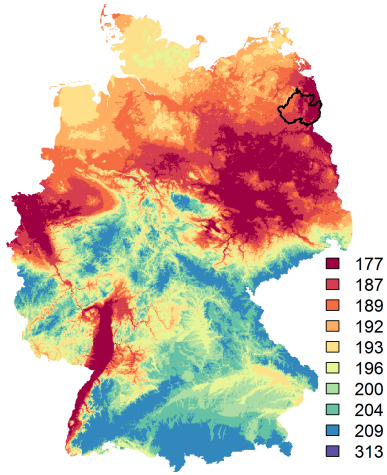
emerging



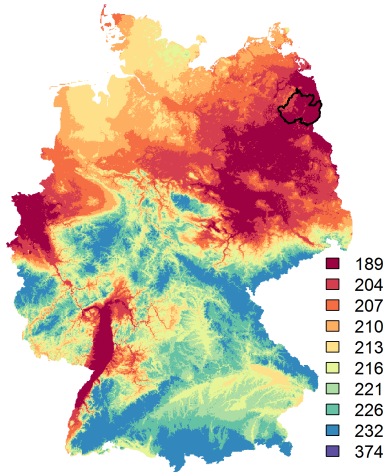
shooting



ear



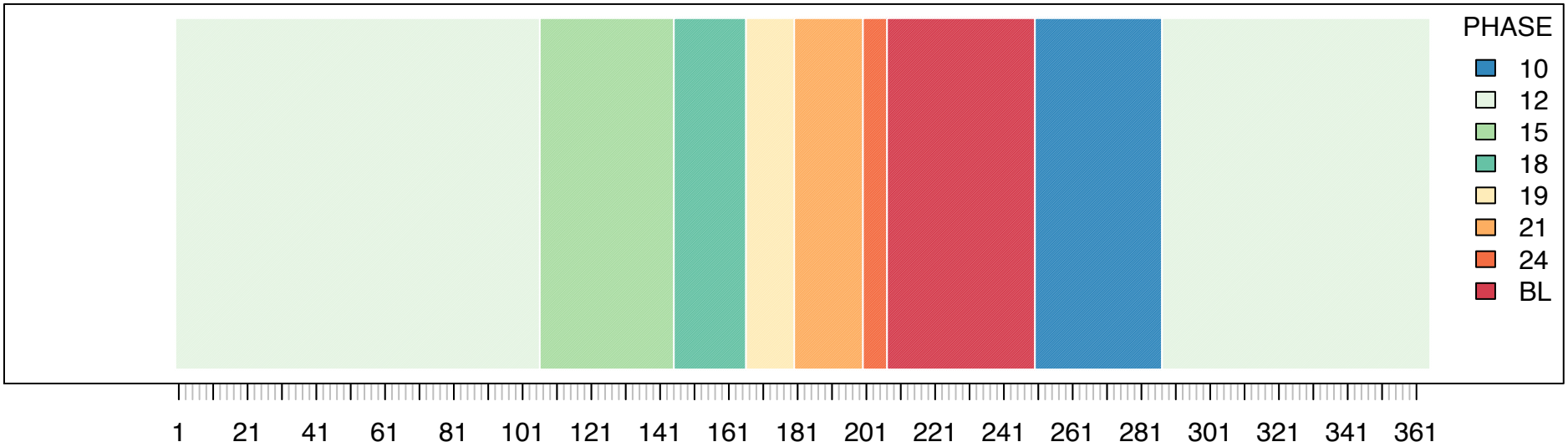
yellow ripeness



harvest

Crop-specific phenological windows

Winter Wheat in the distric of Uckermark (2016)

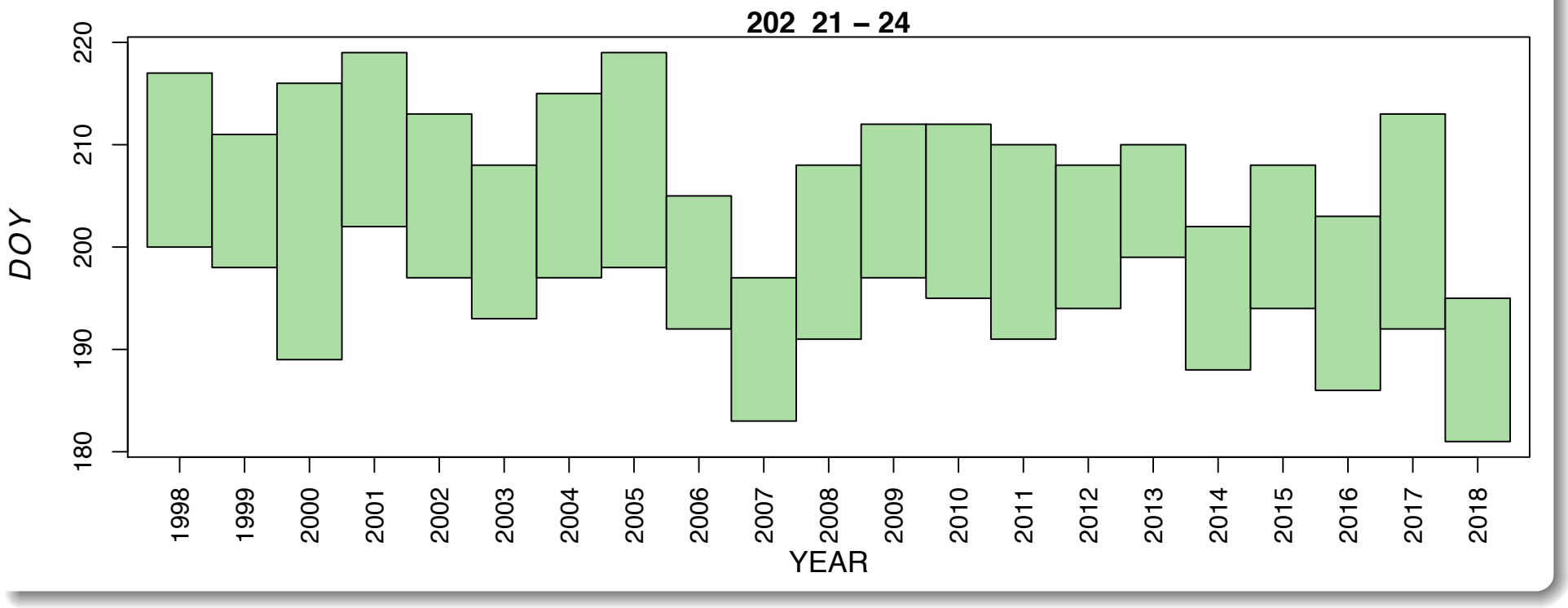


10 – tiling | 12 – emerging | 15 – shooting | 18 – beginning of ear | 19 – milk ripeness | 21 – yellow ripeness | 24 – harvest

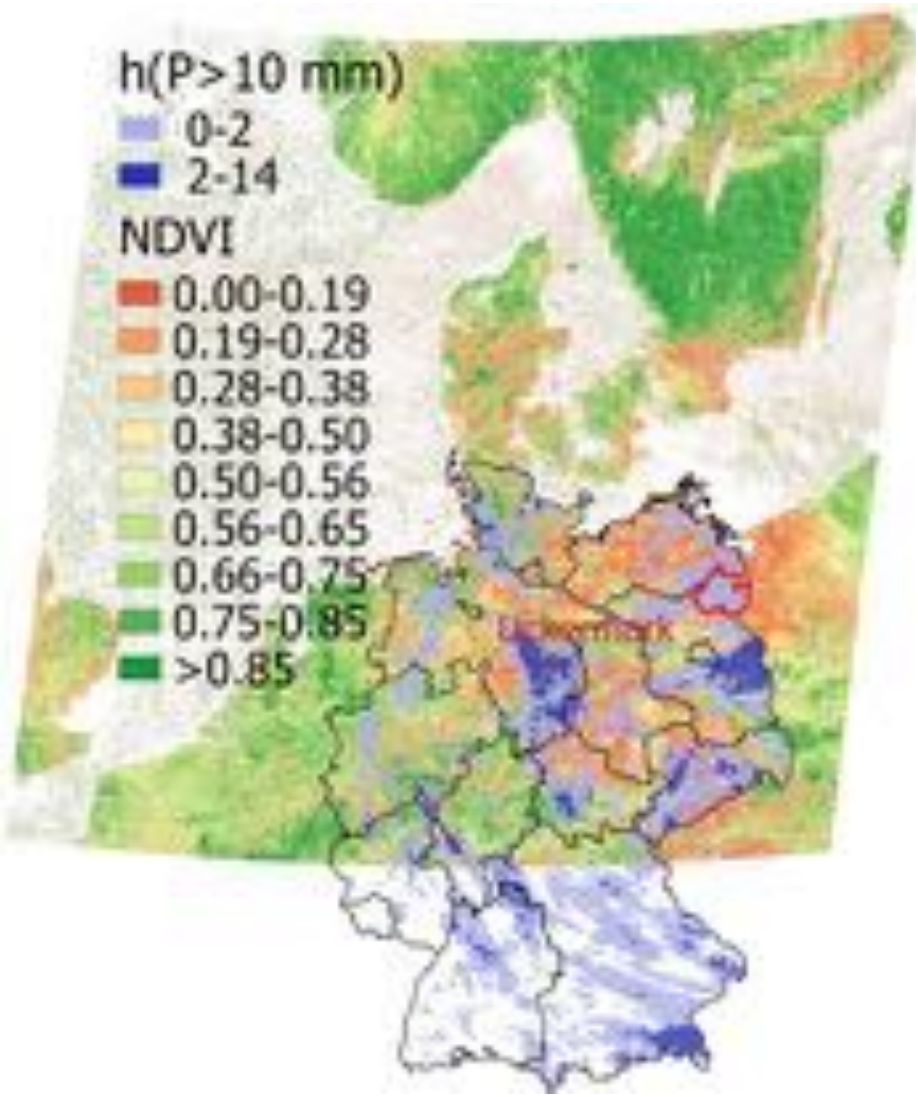
Möller, M., Gerstmann, H., Dahms, T.C., Gao, F. & Förster, M. (2017): Coupling of phenological information and simulated vegetation index time series: Limitations and potentials for the assessment and monitoring of soil erosion risk. *CATENA* 150, 192–205.

Crop-specific phenological windows

Winter Wheat in the distric of Uckermark: Periods between *beginning of yellow ripeness* and *harvest* from 1998 to 2018



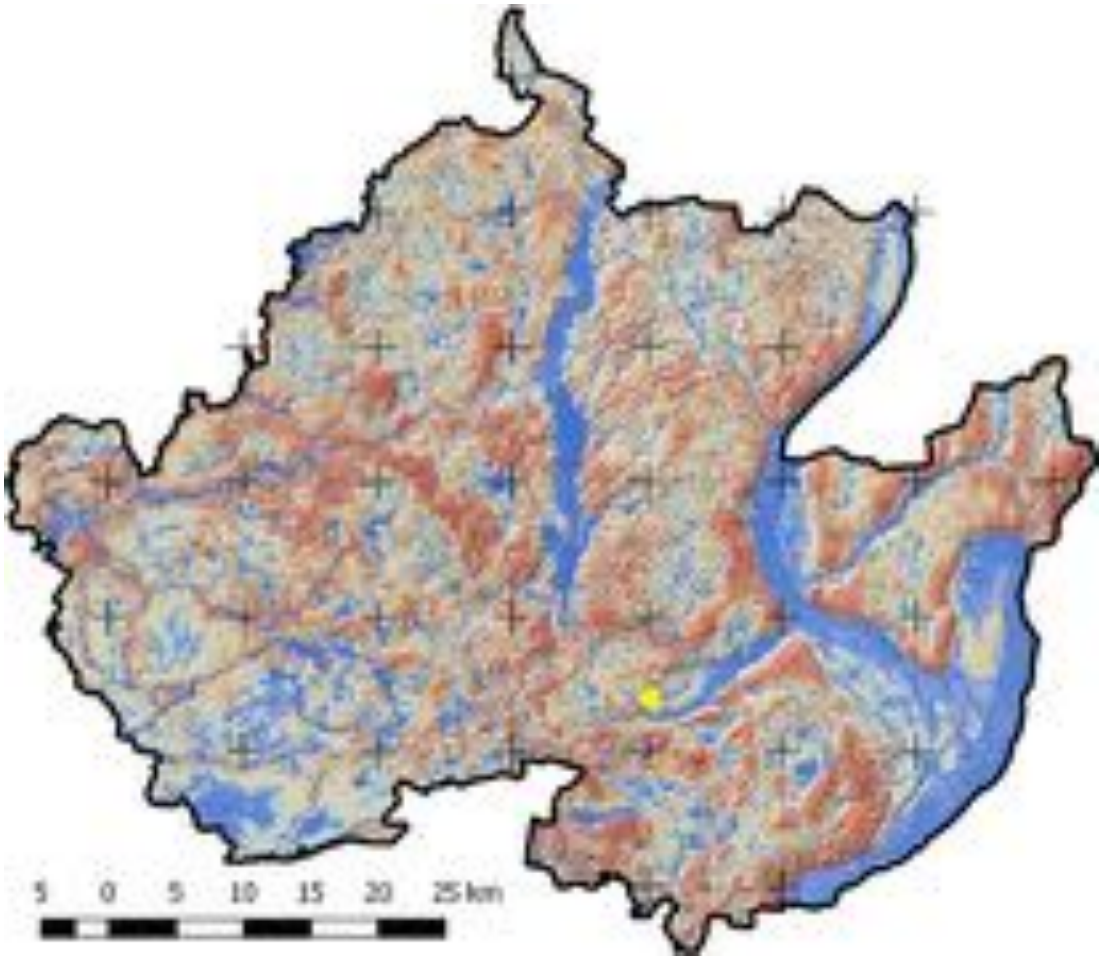
Satellite and precipitation data



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

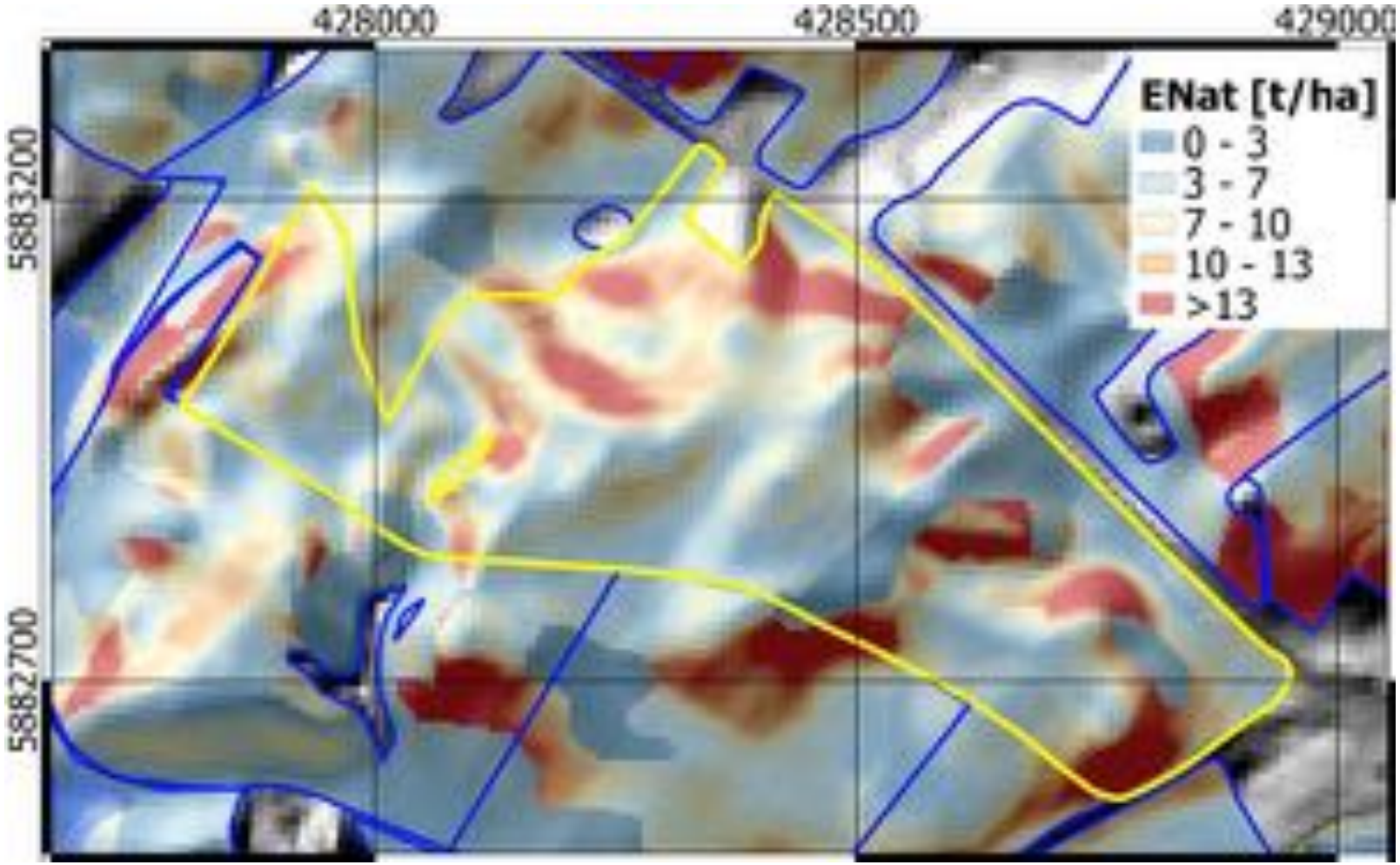


Regional geodata

- DEM & soil erodibility
  - 10×10 m
  - © Soil survey of Brandenburg (`https://lbgr.brandenburg.de`)

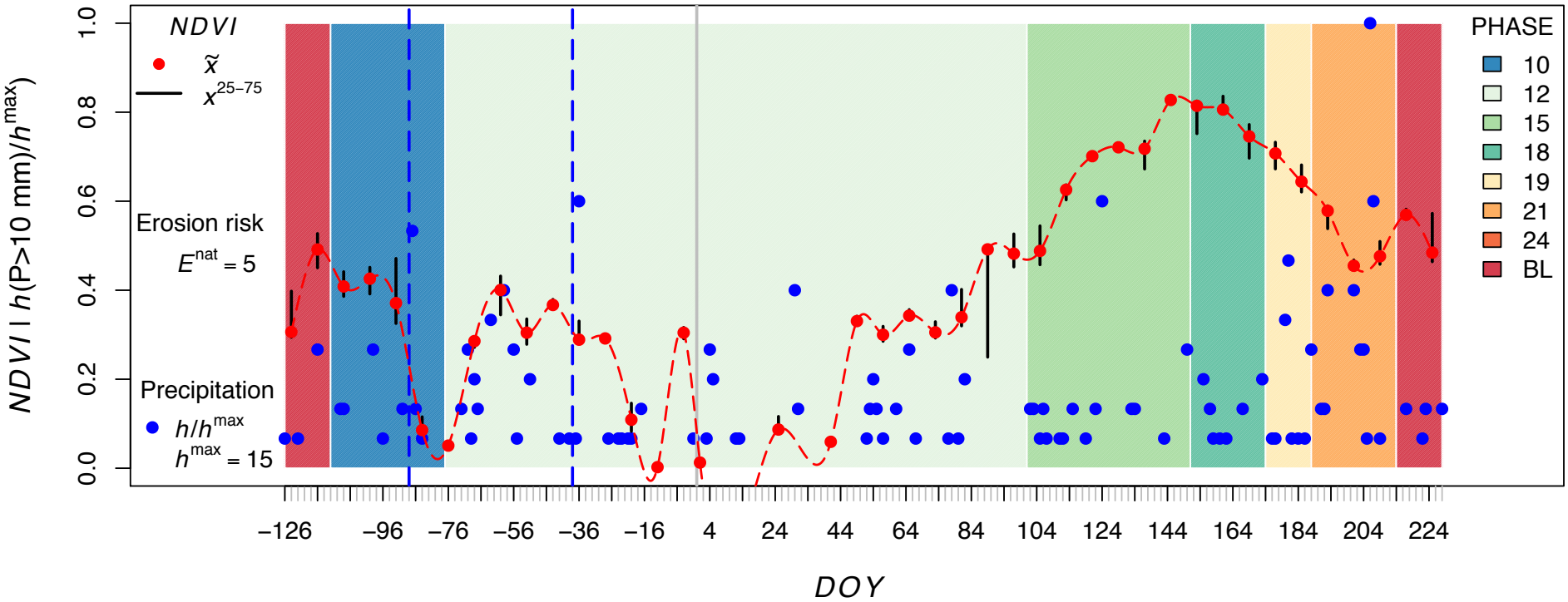
Parcel and event-specific soil erosion assessment

Parcel DEBBLI0373300339-3901: Winter Wheat in 2017 | 32 ha



Parcel and event-specific soil erosion assessment

Parcel DEBBLI0373300339-3901



10 – tiling | 12 – emerging | 15 – shooting | 18 – beginning of ear | 19 – milk ripeness | 21 – yellow ripeness | 24 – harvest

- *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

Questions?

Contact Markus Möller · Federal Research Centre for Cultivated Plants · Institute for Strategies and Technology Assessment · Stahnsdorfer Damm 81 · 14532 Kleinmachnow (Germany) · Email: markus.moeller@julius-kuehn.de · URL: http://emra.julius-kuehn.de

http://emra.julius-kuehn.de

Joint project partners

Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment · Stahnsdorfer Damm 81 · 14532 Kleinmachnow (Germany)
German Weather Service (Deutscher Wetterdienst DWD) · Centre for Agrarmeteorological Research · Bundesallee 50 · 38116 Braunschweig (Germany)
Leibniz Centre for Agricultural Landscape Research (ZALF) · Eberswalder Straße 84 · 15374 Müncheberg (Germany)
DELPHI IMM GmbH · Eisenhartstraße 2 · 14469 Potsdam
proPlant Agrar-und Umweltinformatik GmbH · Nevinghoff 40 · 48147 Münster
Obstbauversuchsring des Alten Landes e.V. (OVR) · ESTEBURG – Obstbauzentrum Jork · Moorende 53 · 21635 Jork
Landesamt für Ländliche Entwicklung, Landwirtschaft und Flurneuordnung (LELF) · Pflanzenschutzdienst ·FGL Risiko- und Kontrollmanagement · Müllroser Chaussee 54 · 15306 Frankfurt (Oder)