

Spatio-temporal detection of agricultural parcels affected by soil erosion

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- 1 Motivation
- 2 Dynamic geodata integration approach
 - Phenological development of crops
 - 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 $\Rightarrow$ 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



Mäkinen, H., Kaseva, J., Trnka, M., Balek, J., Kersebaum, K.C., Nendel, C., Gobin, A., Olesen, J.E., Bindi, M., Ferrise, R., Moriondo, M., Rodríguez, 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 (<https://emra.julius-kuehn.de>)

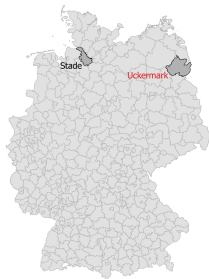


Extreme Weather Monitoring and Risk Assessment
(Friday 15:00–15:15 | EGU2019-12558 | Room L1)



Practical decision support system ...

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



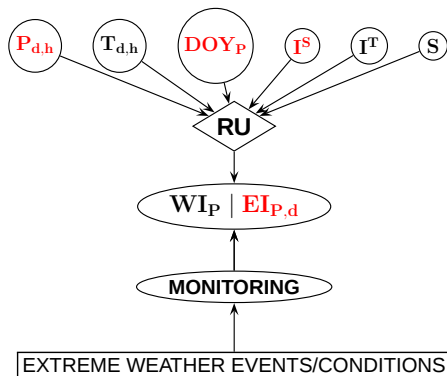
Agricultural crop types and test sites

- Winter Wheat in the district of Uckermark
- Apple in Altes Land region (district of Stade)

Components

- dynamic geodata integration and risk assessment
- monitoring

Dynamic 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 beginning 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

Dynamic geodata integration approach



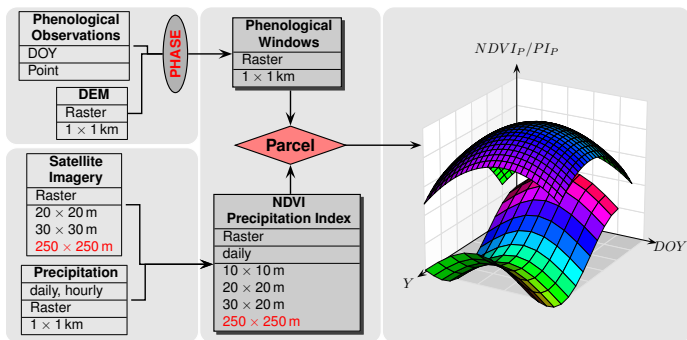
Spatio-temporal detection of of agrcultural parcels affected by soil erosion



- 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.

Dynamic geodata integration approach

Parcel-specific time series of phenological soil cover and precipitation



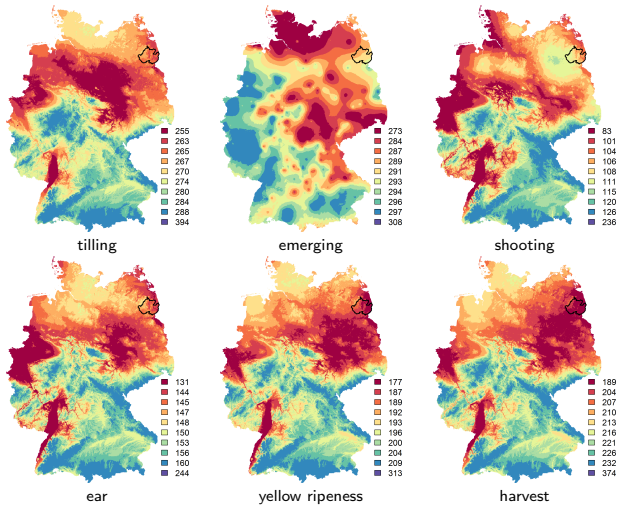
Gerstmann, H., Doktor, D., Gläßer, C. & Möller, M. (2016): PHASE: A geostatistical model for the Kriging-based spatial prediction of crop phenology using public phenological and climatological observations. *Computers and Electronics in Agriculture* 127, 726–738.



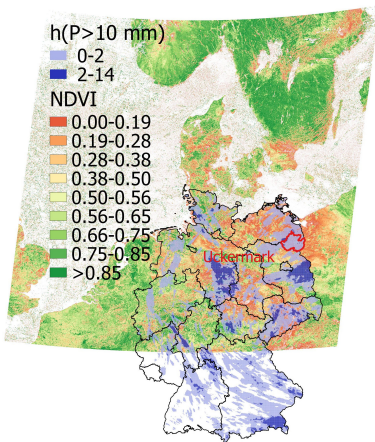
Möller, M., Gerstmann, H., Dahms, T.C., Gao, F. & Förster, M. (2017): Coupling of phenological information and simulated vegetation index time series: Limitations and potentials for the assessment and monitoring of soil erosion risk. *CATENA* 150, 192–205.

Interpolation of phenological observations

Beginning phenological phases (Winter Wheat, 2016)



Germany-wide satellite and precipitation data



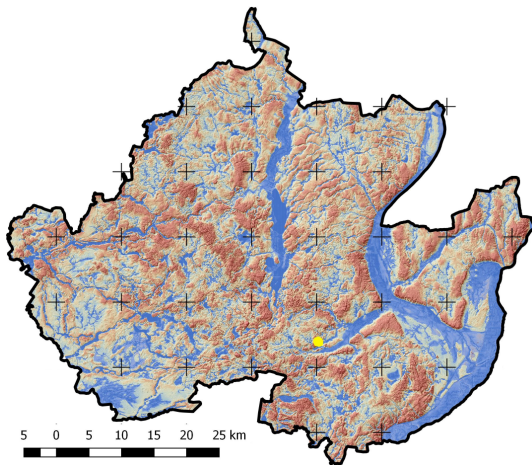
Soil coverage index (7th Oct 2016)

- MODIS Terra Surface Reflectance
8-Day L3 Global 250 m SIN Grid V006
(MOD09Q1; © USGS)
- NDVI
- 250×250 m

Precipitation index (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



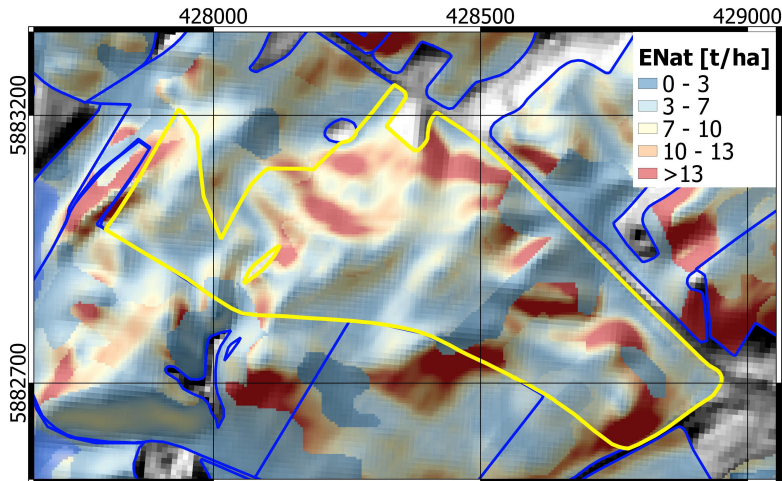
Regional geodata

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

Parcel and event-specific soil erosion assessment

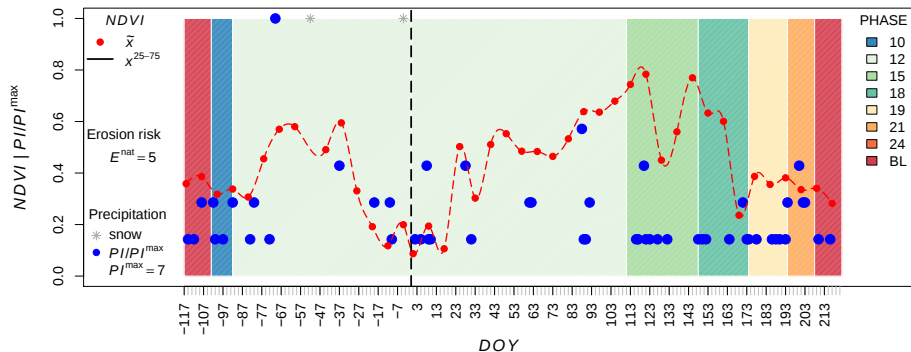


Parcel DEBBLI0373300339-3901 (32 ha)



Parcel and event-specific soil erosion assessment

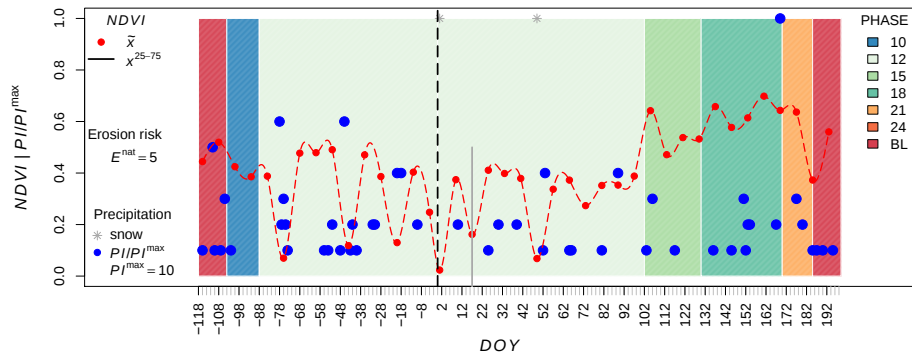
Parcel DEBBLI0373300339-3901: *NDVI* and Precipitation Index profiles for Winter Wheat in 2014/2015



10 – tilling | 12 – emerging | 15 – shooting | 18 – beginning of ear | 19 – milk ripeness | 21 – yellow ripeness | 24 – harvest | BL – bare land

Parcel and event-specific soil erosion assessment

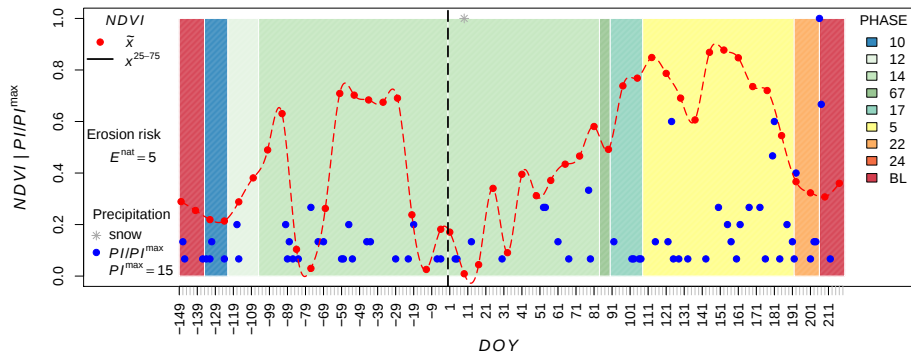
Parcel DEBBLI0373300339-3901: *NDVI* and Precipitation Index profiles for Winter Barley in 2015/2016



10 – tilling | 12 – emerging | 15 – shooting | 18 – beginning of ear | 21 – yellow ripeness | 24 – harvest | BL – bare land

Parcel and event-specific soil erosion assessment

Parcel DEBBLI0373300339-3901: *NDVI* and Precipitation Index profiles for Winter Rapeseed in 2016/2017



10 – tilling | 12 – emerging | 14 – rosette formation | 67 – shooting | 17 – bud formation | 5 – flowering | 22 – full ripening | 24 – harvest | BL – bare land

Summary



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

Next steps

- Integration of other explaining dynamic variables (e.g., soil moisture)
- Applying ML techniques to detect pattern of extreme weather risk

⇒ We are looking for mapped historical soil erosion events (happened in Germany)



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