RADOLAN - a radar-based tool for the retrospective analysis of extreme erosion events

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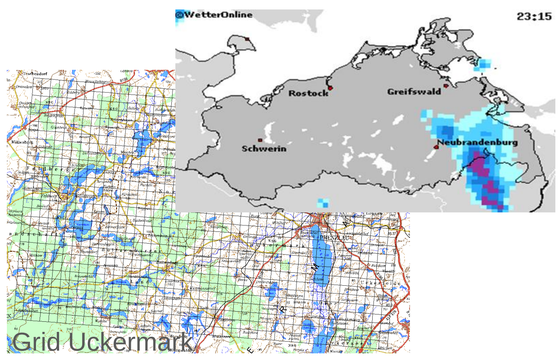
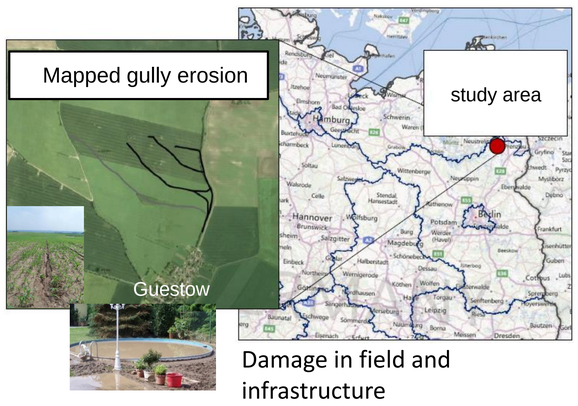
Inducement

Frequently occurring rainstorm events can cause erosion damages, not only in hilly regions but also in areas of relatively low relief energy. In addition, effects of rain drop impact on the soil surface properties foster subsequent erosion. Such changes of the soil surface can be detected from aerial photographs and by comparing terrain surfaces before and after rainfall events using high resolution DEM. The aim of this study was to identify factors of site and rainfall condition and to understand their combined effects on erosion. We analyzed past erosion events by considering soil properties, relief, rainfall, and soil management. For estimating duration, amount and intensity of rainfall the "radar-assisted analyses of precipitation in real time for Germany (RADOLAN)" was used in cases where data of meteorological stations were not available. Erosion-3D was carried out for retrospective analysis of soil erosion

Extreme event | Uckermark 5 June 2007

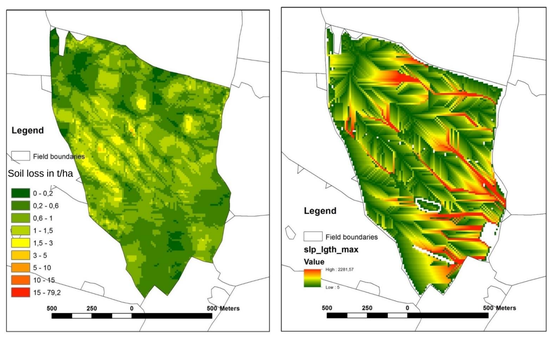




Damage in field and infrastructure

Data Analysis and Results

Risk of water erosion according to DIN 19708 „USLE“

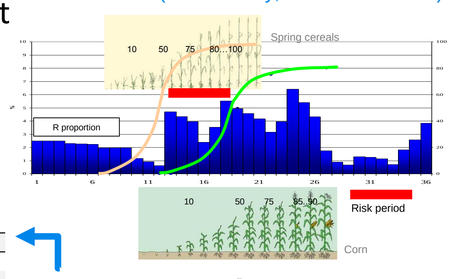


„Stable“ site factors: Soil, relief

flow path length, erosion risk

Crop, soil cover and management practices
→ deriving risk periods

erosion risk = f(rain erosivity, soil surface cover)



Y,M,D,H,M, 0.00000000000000E+0000
Y,M,D,H,M,Ded_05062
007

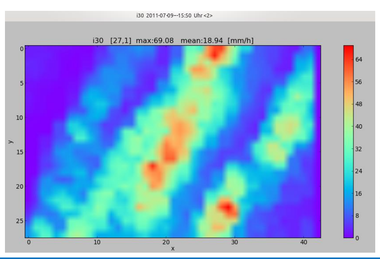
2007,6,5	0	0.29
2007,6,5	10	0.41
2007,6,5	20	0.63
2007,6,5	30	0.17
2007,6,5	40	0.03
2007,6,5	50	0
2007,6,5	0	0
2007,6,5	10	0
2007,6,5	20	0
2007,6,5	30	0
2007,6,5	40	0
2007,6,5	50	0.02
2007,6,5	0	0
2007,6,5	10	0

Annuality	EI_{30} [N h^{-1}]	I_{30} [mm h^{-1}]	P [mm]	Duration [min]
2	40.6	42.0	42.3	320
20	28.1	42.4	24.0	110
100	146.6	92.6	60.8	160
Day				
5 June 2007	408	102.4	148	1100

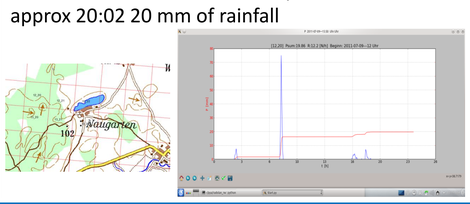
precipitation → main component as a trigger in water erosion

RADOLAN

- Improving the view of erosion research
- Providing spatially and temporally distributed rainfall data
- Regional erosion events detectable, e.g. in sparsely populated areas
- Almost full coverage with high operability
- Providing retrospective statements on erosivity
- Efficiency of data analysis increases
- Interactive tool



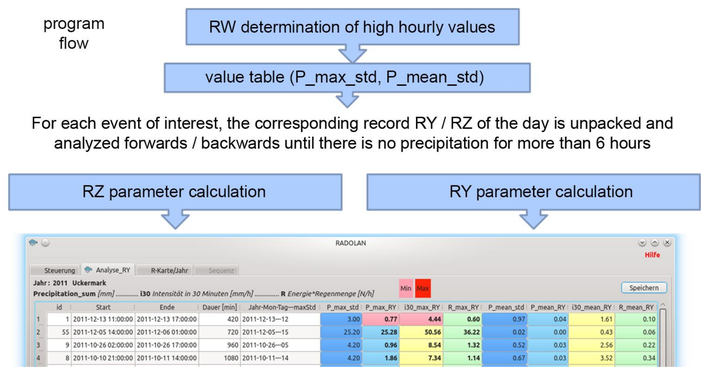
Naugarten 9 July 2011
Residents info: vortex and heavy rainfall
approx 20:02 20 mm of rainfall



Method

DWD radar system RADOLAN

- Development of an open source application for RADOLAN data evaluation for R-factor calculation
- LINUX application (using ORACLE's VirtualBox for WINDOWS users)
- Download of hourly precipitation data (RW product, free data)
- Provision of 5-minute precipitation data (RY/RZ product) by DWD
- Start Python:



- Calculation of rain erosivity according to DIN19708:

$$EI_{30} = \sum(E_i) * I_{30} \text{ in [N/h]} \quad (1)$$

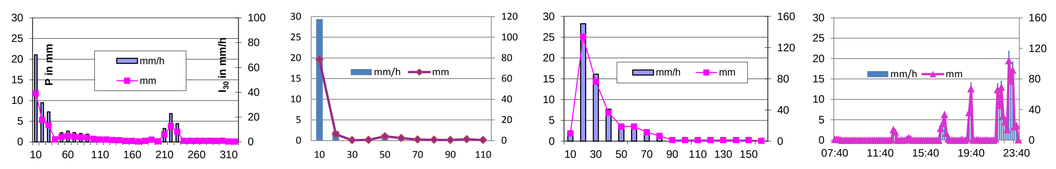
$$E_i = (11.89 + 8{,}73 \log I_i) * N_i \quad \text{in [J/m²] for } I_i \geq 0.05 \text{ mm/h}$$

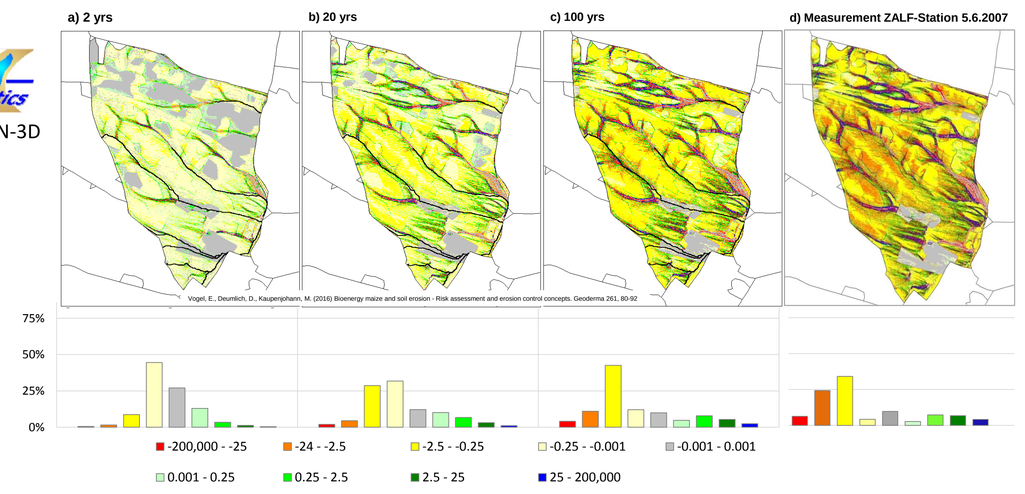
$$E_i = 0 \text{ J/m² for } I_i < 0.05 \text{ mm/h}$$

$$E_i = 28.33\ N_i \text{ J/m² for } I_i > 76.2 \text{ mm/h} \quad (2)$$

- Output of tables and graphs (threshold > 0.5 N / h)
- Results from the event ... year, long-term mean of erosivity

Usage of water erosion models for planning and damage analysis



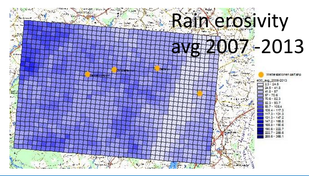


Geo Gnostics
EROSION-3D

6.1	19.4	Soil erosion [t/ha]	64.7	177.9
0.4	1.3	Soil loss [mm]	4.3	11.9
4	9	Surface runoff [mm]	30	84
9	39	Runoff coefficient	49	57
				Assessed catchment area: 118 ha

Conclusion and Prospect

- Further analysis is used to determine parameters of heavy rain and its application to erosion phenomena in the area of the Uckermark
- Contribution to the R-factor map of Germany in a 1 km x 1 km grid
- Improvement of GIS operability (site selection via OpenStreetMap and result visualization)
- Both RZ and RY are of interest for erosion phenomena
- Automatic data quality control



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