FACTSHEET RISK ASSESSMENT AND MAPPING ACTIVITIES

Heavy rain hazard map: Flow pathway analysis

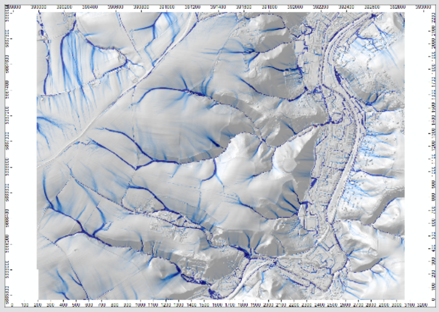
Where was it implemented?

Germany, Saxony, Meißen

Problem/background

Parts of the city of Meißen were affected by an intensive heavy rainfall event on May 27th 2014 that caused damages in the range of more than 4 million €. Future events of a comparable intensity in other parts of the city are possible. Currently there exist no information on the spatial distribution of water levels and flow velocities resulting from a heavy rain event. To help especially the city planning department when dealing with new developments, hazard maps are recognised as useful tools during the planning process.

Map example:



Description of methodological background and outcomes

The flow pathway analysis method uses a digital elevation model in raster representation and calculates where a unit of water from each cell might flow to. It is a kind of neighbourhood analysis that looks from each cell to the lower neighbours and distributes the potential flow based on different algorithms. The simplest version "Deterministic 8" puts everything to the neighbouring cell with the steepest slope, what causes a very strong concentration with one cell wide flow pathways. More realistic algorithms take into account that the other lower lying cells also receive runoff, e.g. Rho 8, deterministic infinity or multiple flow direction. All these methods can be found in the free geoinformation software SAGA-GIS or QGIS.

Area and event characterisation

Area type Rural and urban	**Topography** Hilly
Land cover/land use distribution 30% forest, 30% cropland, 40% built-up	**Event** No event
Receptors Buildings and streets visualised in map	**Flood type** Flash flood with mud/debris component

Specifications of method/measure and data demands and outputs

Level of complexity	2
Addressed SPRC element	P
Method group	Process-based approach
Spatial scale(s) of application	Raster width 1 to 5 meters, total area limited only by computer memory
Time scale/resolution	No timely dynamics
Input datasets (type and scale/resolution)	Digital Terrain Model DTM (raster, 2 m)
Output datasets (type and scale/resolution)	Flow accumulation (=contributing catchment area of each pixel, raster, 2 m)

Description of implementation	
Implementation • 3/2018 to 6/2019	**Users (reported/designated)** • City planning department
Initiator/responsible • IOER/RAINMAN	**Involved stakeholders** • City planning department • Civil security department • Building department

Lessons-learned	
Main success factor: • Very fast calculation and low data demands. • Available in free GIS software such as SAGA-GIS and QGIS. • Low costs.	**Main challenge:** • The method needs a depressionless DTM with a continuous slope. Changes to the original DTM are needed that might artificially change the flow pathway structure, e.g. in the areas of filled sinks.
Synergies/beneficial aspects: • Screening analysis for further in-depth methods such as hydrodynamic modelling. • No information about rainfall characteristics required.	**Conflicts/Constraints:** • The method gives no direct information about resulting water levels and flow velocities. • The method is not able to integrate the impact of potential hazard reduction measures. • Effects of different rainfalls cannot be modelled.

Key message to others starting with a similar task	Contact
„Use this method to get a fast and cheap impression of your potential flow patterns to identify potentially threatened areas and objects as a starting point for further in-depth analysis."	Dr. Axel Sauer Leibniz Institute of Ecological Urban and Regional Development (IOER) a.sauer@ioer.de

References

O'Callaghan, J.F.; Mark, D.M. (1984) The extraction of drainage networks from digital elevation data. Computer Vision, Graphics and Image Processing 28, 323-344.

Fairfield, J.; Leymarie, P. (1991) Drainage networks from grid digital elevation models. Water Resources Research 27, 709-717.

Bauer, J.; Rohdenburg, H.; Bork, H.-R. (1985) Ein Digitales Reliefmodell als Voraussetzung für ein deterministisches Modell der Wasser- und Stoff-Flüsse. In: Bork, H.-R.; Rohdenburg, H. (Eds.) Parameteraufbereitung für deterministische Gebiets-Wassermodelle. Grundlagenarbeiten zu Analyse von Agrar-Ökosystemen. Landschaftsgenese und Landschaftsökologie 10, 1-15.

Tarboton, D.G. (1997) A new method for the determination of flow directions and upslope areas in grid digital elevation models. Water Resources Research 33(2), 309-319.

Freeman, G.T. (1991) Calculating catchment area with divergent flow based on a regular grid. Computers and Geosciences 17, 413-422.

Quinn, P.F.; Beven, K.J.; Chevallier, P.; Planchon, O. (1991) The prediction of hillslope flow paths for distributed hydrological modelling using digital terrain models. Hydrological Processes 5, 59-79.

Seibert, J.; McGlynn, B. (2007) A new triangular multiple flow direction algorithm for computing upslope areas from gridded digital elevation models. Water Resources Research 43, W04501.

Qin, C.Z.; Zhu, A.X.; Pei, T.; Li, B.L.; Scholten, T.; Behrens, T.; Zhou, C.H. (2011) An approach to computing topographic wetness index based on maximum downslope gradient. Precision Agriculture 12(1), 32-43.