FACTSHEET RISK ASSESSMENT AND MAPPING ACTIVITIES

Integrated heavy rainfall risk maps for the City of Graz – Catchment Stufenbach and Stiftingbach

Where was it implemented?

Austria, Steiermark, Graz, Stufenbach catchment and part of the lower Stiftingbach catchment

Problem/background

Parts of the City of Graz were frequently affected by heavy rain events. On 16th April 2018 a major event has hit the southwestern part of city center causing flooding of underpasses, cellars, underground garages and of a shopping center. Future events of a comparable intensity in other parts of the city are possible. Currently only flow path maps are available as indication of a possible threat. Moreover, in case of a heavy rain event the city is facing the challenge of a combined flooding from slope water, streams and the sewer system. Hazard and risk maps, considering the subsystems hillside location, urban streams, and urban space will support the city planning department and the department for civil protection to develop appropriate measures.

Map example:

Source: RIOCOM

Description of methodological background and outcomes

An interactive decision support system (Visdom, http://visdom.at/) was used to simulate and visually analyze numerous, alternative heavy storm scenarios. The model integrates and couples state-of-the-art components for hydrology, surface runoff, and sewer transport.

The model solves the 2D Saint-Venant-Equation with a finite difference method to calculate the water depth and the flow velocity on the surface.The theoretical background is shown in the openly accessible publications of Buttinger-Kreuzhuber et al. (2019) and Horváth et al. (2020) Hydrological rainfall-runoff components such as interception and soil infiltration are tightly integrated into the raster-based solver. The raster cell parameters for roughness, infiltration and interception are derived from land use and soil data. The hydrodynamic sewer transport model is coupled with the surface simulation at each storm drain or manhole of the sewer system. The fast GPU-based solvers enable the detailed simulation of large parameter variations within a few hours to calibrate them according to historical measurements.

Area and event characterisation

Area type	**Topography**
Urban/semi-urban to rural	Hilly to lowland (Stufenbach); Hilly (Stiftingbach)
Land cover/land use distribution	**Event**
Stufenbach: Farmer land: 17 %, Buildings: 8 %, Bushland: 2 %, Impervious: 11 %, Forest: 34 %, Water: <1 % **Stiftingbach:** Farmer land: 17 %, Buildings: 11 %, Bushland: 1 %, Impervious: 22 %, Forest: 28 %, Water: <1 % Classifications comes from the land use data.	Observed event (06.05.2013), Synthetic/design events (Model rain 30, 45, and 60 min T10, T30, T50, T100)

Receptors Buildings, technical infrastructure	**Flood type** Complex flooding (flash, pluvial and sewer)
Specifications of method/measure and data demands and outputs	
Level of complexity	3
Adressed SPRC element	Source, pathway, receptor, consequence
Method group	Process-based approach for hazard, empirical for vulnerability
Spatial scale(s) of application	Raster width 0.5 meters, total area limited only by the total number of raster cells
Time scale/resolution	Calculation timesteps: flexible/automatic, output timesteps: flexible, minutes to hours
Input datasets (type and scale/resolution)	Digital Elevation Model (raster: 0.5 m) Land use data (vector: polygon) Soil data (vector: polygon) Buildings (3D-City-Model) (3D-Objects) River and retention basin geometry (vector: line) Sewer system data (vector: line, point, polygon) Event documentation (operation protocols of fire departments, documentation by affected citizens) (vector: point; texts, images) Measured precipitation Design precipitation values
Output datasets (type and scale/resolution)	Water levels and flow velocities as an output-timeseries along the event duration in each raster cell, 3D
Description of implementation	
Implementation • 04/19 – 11/19	**Users (reported/designated)** • City of Graz, Building Department, Department Green Space and Waters, Departement Civil Protection
Initiator/responsible • Office of the Styrian Government, Department 14 Water Management, Resources and Sustainability • External Contractor: RIOCOM - Ingenieurbüro für KTWW Handelskai 92 1200 Wien www.riocom.at • Co-Contractor: VRVis Zentrum für Virtual Reality und Visualisierung Forschungs-GmbH Donau-City-Straße 11 1220 Wien www.vrvis.at	**Involved stakeholders** • City of Graz, Building Department • City of Graz, Department Green Space and Waters • City of Graz, Departement Civil Protection

Lessons-learned

Main success factor:

- Good agreement between observed and simulated flood areas based on the damage data provided by the fire department and a detailed event documentation of the 2013 event provided by the City of Graz.
- Coupling of a fast raster based hydrological model with a hydrodynamic sewer and surface runoff model.

Main challenge:

- Plausibilisations of surface runoff models rely mainly on observations, hence documentation of events and damages is essential.
- Reliable parameters need to be evaluated.

Synergies/beneficial aspects:

- The used modelling software (Visdom) contains all relevant models in one highly integrated flood model (sewer, hydrology, surface runoff).
- Due to the explicite solver method and GPU-based implementation, the simulation time is very short.
- The model is very flexibel to structural changes (storages and protection measures are easily added).

Conflicts/Constraints:

- The model results have a strong dependency on the up-to-dateness of the surface data.
- Future events will differ from the historic as well as from the synthetic events.

Key message to others starting with a similar task

"Integrating a sewer model into an urban flood model shows the most significant impact where sewer overflows occour."

"Real storm events must be simulated to verify models with respect to qualitative damage data from different sources. Hence event documentation is very valuable for the evaluation of the model outputs."

"The quality of the Digital Elevation Model (DEM) has the greatest influence on the results. Hence, verification of the DEM data needs to be accomplished."

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References

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