FACTSHEET RISK ASSESSMENT AND MAPPING ACTIVITIES

Integrated heavy rainfall risk maps for the City of Graz – Catchment Annabach

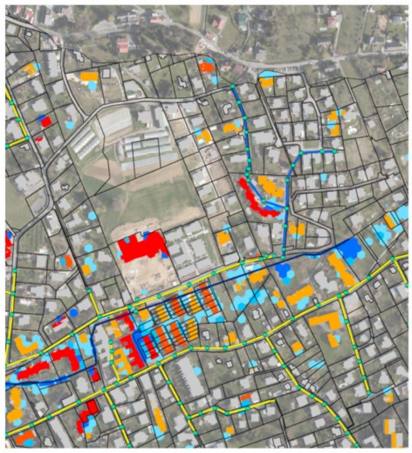
Where was it implemented?

Austria, Steiermark, Graz, catchment Annabach

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 centre causing flooding of underpasses, cellars, underground garages and of a shopping centre. 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 sewer system. Hazard and risk maps, considering the subsystems hillside location, urban steams and urban space, will support in particular the city planning department, as well as the department for civil protection to develop appropriate measures.

Map example:



Source: TU Graz

Description of methodological background and outcomes

A highly integrated model (PCSWMM2D) was used to simulate the defined heavy storm events scenarios. The model integrated three types of models (hydrology (conceptional), surface-runoff (hydrodynamic), and sewer-transport model (hydrodynamic)).

The model solves the full Saint-Venant-Equation with a finite difference method to calculate the water depth and the flow velocity on the surface. The theoretical background is showed in Rossman (2017). The input data for the hydrodynamic models are the effective precipitation coming from the hydrological model, which is a raster-based model. Each raster-cell is combined with the land-use data to define all hydrological parameters (roughness, depression storage, infiltration parameters, …). The interactions with the sewer transport model was solved with a orifice based on the Torecelli-equation (Rossman, 2015) on each manhole of the sewer system.

The detailed method for the model creation is described in Leitner et al. (2018).

Area and event characterisation

Area type Urban	**Topography** Hilly
Land cover/land use distribution Farmer land: 4 %, Buildings: 16 %, Greenland: 41 %, Bushland: 9 %, Impervious: 22 %, Forest: 7 %, Water: <1% Classifications come from the land use data.	**Event** Observed events (06.05.2013, 18.07.2019), Synthetic/design events (Euler model rain 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
Addressed SPRC element	Source, pathway, receptor, consequence
Method group	Process-based approach for hazard, empirical/statistical for vulnerability

Spatial scale(s) of application	Local. Raster with 10 m^2 on flat land and approx. 40 m^2 on the hillside (depending on the mesh resolution)
Time scale/resolution	The time step (explicit solver) based on a sensitivity analysis of the used mesh resolution: current time step is 0.08 sec. This time step resulted in a simulation time of about 3 hours, compared to an event duration of about 5 hours
Input datasets (type and scale/resolution)	Digital Elevation Model (raster, 0.5 m) Digital Surface Model (raster, 0.2 m) Land use data (raster, 0.2 m) Soil data (raster, 0.25 m) Buildings (Digital Land Register/Cadastre) (vector: polygon) River geometry (vector: line) Sewer system data (vector: line, point) Event documentation (insurance data, operation protocols of fire departments, social media) (vector: point; texts, videos, images)
Output datasets (type and scale/resolution)	Water levels, flow velocities as an output-time series along the event duration in each raster cell
Description of implementation	
Implementation • 12/17 – 01/19	**Users (reported/designated)** • City of Graz, Building Department, Department Green Space and Waters, Department Civil Protection
Initiator/responsible • Land Stmk/RAINMAN • External Contractor: Graz University of Technology	**Involved stakeholders** • City of Graz, Building Department • City of Graz, Department Green Space and Waters • City of Graz, Department Civil Protection
Lessons-learned	
Main success factor: • Good matching between observed and simulated flood areas based on the damage data coming from the fire department. • Integration between a raster based hydrological model with a hydrodynamic sewer and surface runoff model.	**Main challenge:** • Quantitative or qualitative measurements or damage data are required to calibrate integrated urban flood models.
Synergies/beneficial aspects: • The used approach contains all relevant models in one integrated flood model (sewer, hydrology, surface runoff). • Due to the explicit solver method, the simulation time is very short. • The model is very flexible to structural changes (storages, measures are easy to integrate).	**Conflicts/Constraints:** • The time step is depending on the spatial resolution and the simulated heavy rain event

Key message to others starting with a similar task	Contact
"A hydrological model and sewer model must be integrated in an urban flood model to know the whole dynamic during a heavy storm event!" "Real storm events must be simulated, to verify such models with qualitative damage data from different sources!"	Office of the Styrian Government, Department 14 Water Management, Resources and Sustainability, abteilung14@stmk.gv.at Graz University of Technology, Institute of Urban Water Management and Landscape Water Engineering, office.sww@tugraz.at

References

Leitner, S.; Maier, R.; Sauer, A.; Jöbstl, C.; Ortlepp, R.; Hornich, R.; Muschalla, D. (2018) Integrated urban flash flood risk assessment. In: Mannina, G. (Ed.) Proceedings of 11th International Conference on Urban Drainage Modelling, Sep. 23-26, 2018, Palermo, Italy.

Rossman, L.A. (2015) Storm Water Management Model User's Manual Version 5.1. EPA/600/R-14/413b. Cincinnati, Ohio, USA. US EPA National Risk Management Research Laboratory.

EPA (2017) Storm Water Management Model Reference Manual Volume II – Hydraulics. EPA/600/R-17/111. Cincinnati, Ohio, USA. US EPA National Risk Management Research Laboratory.