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# Using an extended 2D hydrodynamic model for evaluating damage risk caused by extreme rain events: Flash-Flood-Risk-Map (FFRM) Upper Austria

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Considering the increase in flash flood events causing massive damage during the last years in urban but also rural areas [1-4], the requirement for hydrodynamic calculation of flash flood prone areas and possible countermeasures has arisen to many municipalities and local governments. Besides the German based URBAS project [1], also the EU-funded FP7 research project "SWITCH-ON" [5] addresses the damage risk caused by flash floods in the sub-project "FFRM" (Flash Flood Risk Map Upper Austria) by calculating damage risk for buildings and vulnerable infrastructure like schools and hospitals caused by flash-flood driven inundation.

While danger zones in riverine flooding are established as an integral part of spatial planning, flash floods caused by overland runoff from extreme rain events have been for long an underrated safety hazard not only for buildings and infrastructure, but man and animals as well. Based on the widespread 2D-model "hydro_as-2D", an extension was developed, which calculates the runoff formation from a spatially and temporally variable precipitation and determines two dimensionally the land surface area runoff and its concentration.

The conception of the model is to preprocess the precipitation data and calculate the effective runoff-volume for a short time step of e.g. five minutes. This volume is applied to the nodes of the 2D-model and the calculation of the hydrodynamic model is started. At the end of each time step, the model run is stopped, the preprocessing step is repeated and the hydraulic model calculation is continued.
In view of the later use for the whole of Upper Austria (12.000 $km^2$) a model grid of 25x25 $m^2$ was established using digital elevation data. Model parameters could be estimated for the small catchment of river Ach, which was hit by an intense rain event with up to 109 mm per hour at 20th of June 2012, based on open data sources of geology, soil and land use.

The aim of FFRM is to provide an estimation of the damage risk caused by flash-floods for the whole of Upper Austria. To address the hazard, inundation depths were calculated with the extended 2D-model using design rains with an 100-year return period provided by the Environmental Ministry [7]. The potential damage was calculated using damage functions, which were derived from our experience from damage surveys of past events in Austria and according to guidelines for determination of cost-benefit-ratios for flood protection measures [8].

The greatest difficulty was to get appropriate data for the distribution of houses and industrial plants. Zoning plans provide good information on spatial distribution of residential, commercial and industrial areas, but does not contain information on the kind of industry, which is essential for estimating absolute damage values. To get a first idea detailed information from surveyed areas was intersected with the zoning plan, which provides an average damage in the respective zones. The first results can be found on www.waterviewer.com and will be updated with the further development of the project.

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[2] Società Meteorologica Italiana (SMI), http://www.nimbus.it/eventi/2013/130624flashfloodRimini.pdf, prompted on 13th of November 2014

[3]Newspaper “Österreich”, http://www.oe24.at/oesterreich/chronik/Sturzflut-Regen-legt-Ost-Oesterreich-lahm/1509113, prompted on 13th of November 2014
[4] Newspaper „Oberösterreichische Nachrichten“, http://www.nachrichten.at/oberoesterreich/Unwetter-Mure-riss-Strasse-mit-Wohnhaus-in-Gosau-gefaehrdet;art4,911288 , prompted on 13th of November 2014
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[7] http://ehyd.gv.at
[8] Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management: „Kosten-Nutzen-Untersuchungen im Schutzwaserbau“, July 2009