INTERPRAEVENT
2021 – Norway

14th Congress

INTERPRAEVENT 2021

May 31st to June 2nd 2021
Virtual Congress, Norway
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Natural hazards in a changing world

INTERPRAEVENT 2021 – Norway

14th Congress INTERPRAEVENT 2021
Norway – Extended Abstract
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Implications of different pluvial flood models for comprehensive flood risk management in Austria

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Keywords: pluvial flood; Hazard Maps; flood modelling; flood risk management; spatial planning, flood awareness

Introduction

Pluvial floods became a severe threat in Austria over the last decade due to an increase of exposure and heavy rainfall events. An increasing proportion of the inventoried damage events caused by flooding fall on pluvial floods and surface runoff without a link to the water network. Although these events, due to comparatively low process intensities, constitute no major hazard for human lives, significant property damage arises. For fluvial floods a sound basis for planning and comprehensive flood risk management strategies were established in Austria, especially since the Danube flood in 2002. For pluvial flood risks such management approaches are relatively new or even missing in some cases and sectors. A crucial factor that hampered the mitigation of and adaptation to pluvial flood hazards was the missing availability of pluvial flood hazard and risk maps. In the more recent past this gap started closing as different Austrian administrative bodies published such maps. Due to a lack of standardization a variety of methodologies and maps with different scales evolved within the country. This paper compares the existing approaches, applies them to a region in Carinthia (an Austrian state) and discusses the implications for the selection of measurements and relevant sectors such as spatial planning.

Methods

As a first step, an inventory was made of different approaches for the assessment of pluvial hazards that exist in Austria. Based on the different model assumptions and the characteristics of their results such as scale, accuracy and purpose of use, one nationwide approach, two regional maps that cover the area of a state and three local maps that focus on municipalities are compared. The different methods are then applied to a heterogeneous river basin (approx. 55 km²) in the alpine foreland, where the density of observed pluvial events is high due to its topographical and meteorological situation. Based on the simulation results different hazard maps can be produced and analysed. The overlay with

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data from other sectors, such as a zoning plan, or with data on elements at risk can further help in developing the understanding of the different model results. Based on this comparison, and the experiences with and the public response to the different methods/maps so far, assets and drawbacks can be evaluated.

Results and discussion

Pluvial hazards maps can fulfil two main purposes: (1) they inform the potentially affected inhabitants to foster individual protection and adaptation measures and (2) they provide preliminary information for a sustainable spatial planning and construction development.
However, the level of detail provided by the different methods for the assessment of pluvial hazards varies considerably. In general, two groups of methods can be distinguished: Firstly, topographic methods (ArcGIS, QGIS/GRASS GIS and Global Mapper are compared), in most cases based on an D8-algorithm, provide an overview of pluvial flow paths and their basins. The comparison of the three software packages shows that the output of topographic methods is rather dependent on the manipulation of the DEM and the model parameters such as flow accumulation than on the used software. An intersection with the settlement space can further help to indicate entry points of the surface flow into inhabited areas. As these models do not consider flow properties, they cannot provide realistic assessments within settlements. Secondly, hydrodynamic models (FloodArea, HEC RAS 2D and BASEMENT are compared; the selection of these models is based on already existing approaches in Austria and focuses on freeware) close this gap and are, moreover, capable of assessing the likelihood of an event. They additionally complement the results with detailed flood extents, water depths and flow velocities for a specific rainfall event. For the comparison, a homogeneous 100-year block rain with a duration of 30 min was used. As first tests have shown that other variables have a more significant influence on the results, no variation of rainfall was included. However, as the compared hydrodynamic models use different solvers, some differences in their output and the influence of input data (e.g. roughness or runoff coefficient) can be outlined. Although the more detailed information resulting from hydrodynamic models is preferable, a nationwide coverage is hampered by high requirements of input data and extensive processing efforts. Additionally, the communication of the results to the public is a challenge, because the calculation is based on likelihood, and accuracy issues must be addressed in greater detail.

Conclusions

Crosschecking the maps with observed pluvial events shows that both topographic methods and hydrodynamic models produce sound output. While using the derived maps for informing the public, it is found that both kinds of maps can help raise awareness about pluvial flood risks. They can also be used as a basis for spatial planning, where the benefits of a plot-accurate hydrodynamic model are essential. But, nonetheless, expert judgements must supplement this information, whenever an in-depth assessment is necessary due to legal requirements. The study lays the foundation for planning and distributing a more detailed nationwide pluvial flood hazard map in Austria.