A NEW APPROACH TO MODEL OVERLAND FLOW

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INTRODUCTION

Overland flow is defined as the part of the precipitation that flows over the land surface directly towards a watercourse. In recent years, storm events caused overland flow that led to major damage in Switzerland. Although this process normally does not endanger people, it often causes damages to buildings and infrastructure. Furthermore, people can be at risk in basements or cellars inside of buildings. Today, the risk of flood-related damage is specifically reduced by flood protection measures along watercourses. In many cases, however, the danger of overland flow occurs from a different flow direction and can therefore affect other, maybe unprotected, parts of buildings. According to current studies, up to 50 % of the cases of damage related to water hazards are caused by overland flow. Nevertheless, in Switzerland overland flow is hardly integrated in the hazard assessment process. In addition, the implementation varies considerably among the different Cantons. To fill this gap, a new method has been developed to model overland flow over large areas in a consistent manner. The application bases upon the software package FloodArea and identifies sites potentially endangered by overland flow. In this paper, the elaborated method is presented and the results of two case studies are shown.

MODEL REQUIREMENTS

The most important requirement is a very accurate digital terrain model (DTM) that represents even small terrain structures. In Switzerland, the LiDAR-based DTM-AV (2m resolution) is used for this purpose. Besides the DTM, a precipitation curve is required. Based on this curve, each cell of the DTM is fed with precipitation. Thereby, the precipitation curve can be adapted for each cell individually. Knowledge about the surface cover is further required to incorporate the storage capacity of the soil. The integration of information about the type and the roughness of the terrain finally allows for modeling realistic outputs.

METHODOLOGY

The following list sketches the approach used to perform the overland flow modeling:

1. Adaptation of the high resolution DTM. To achieve good results, various adjustments of the terrain model are necessary. These adjustments include, amongst others, the integration of buildings, traffic infrastructure, watercourses and further important structures.
2. Specification of the precipitation graph (intensity and duration).
3. Weighted classification of the surface cover on the basis of the cadastral survey into six classes (buildings, sealed areas, agricultural land, garden, watercourses and forests).
4. Determination of the storage capacity by taking into account surface cover and slope conditions.
5. Determination of the roughness of the terrain.
6. Performing of the modeling process.
7. Generalization and verification of the result.

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STUDY AREAS AND RESULTS

So far, the approach was applied to model overland flow of two Swiss test sites. On the one hand, it was used in the municipality of Langnau am Albis (ZH) on behalf of the building insurance of the Canton of Zurich. Langnau am Albis comprises a wide range of terrain types, reaching from densely populated to rural areas. Fig. 1 provides an example of the model output. On the other hand, an evaluation was carried out in the region of Lyss (BE) on behalf of the Federal Office for the Environment. The latter site has an area of about 120 km^2. Fig. 2 shows an example of this modeling effort in the Winterswil area. Note that there are no watercourses in the section of the map shown.

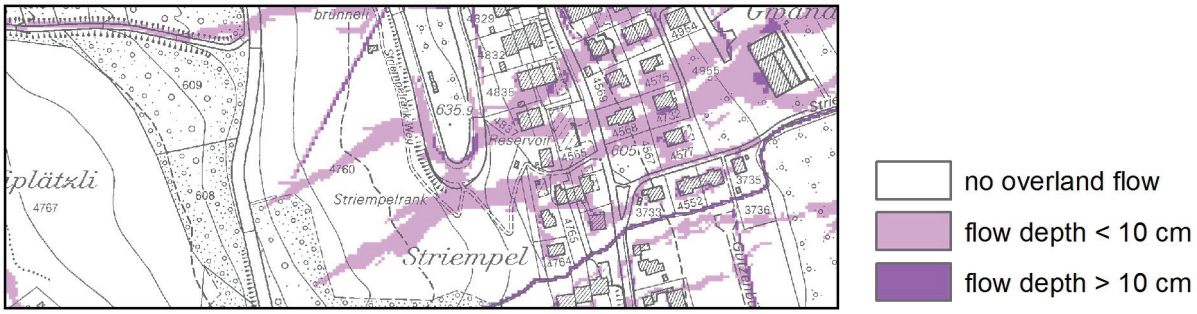

Fig. 1 Modeling of overland flow in Langnau am Albis (Canton of Zurich, Switzerland) (Source: geo7 AG (2009). Source of map layer: © Amt für Raumentwicklung des Kantons Zürich)

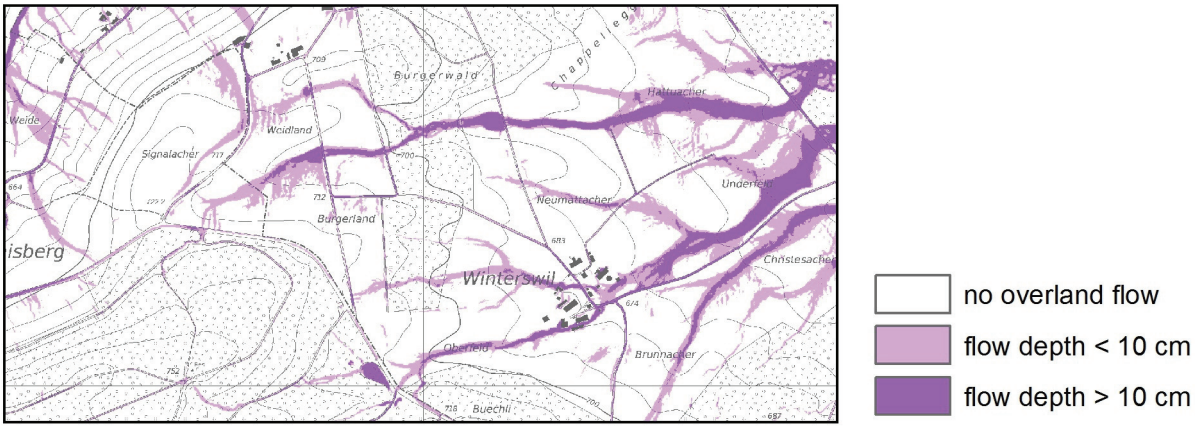

Fig. 2 Modeling of overland flow in the Winterswil area (Canton of Berne, Switzerland) (Source: geo7 AG (2010). Source of map layer: UP5 © Amt für Geoinformation des Kantons Bern)

CONCLUSIONS

The comparison of the modeled results to documented events showed a good consistency at the borders of settlements as well as in agricultural areas. Based on the approach introduced above, potentially endangered buildings or sites were easily identified. Within dense settlements the results were less satisfactory, therefore, further studies are in progress. The focus of those studies is on improving the limited accuracy of the DTM and on integrating additional structures (such as small construction works), which can influence the flow direction considerably. All in all, the results are well suited to complement the already existing hazard maps (either as an addition to flood hazard maps or as a flood-proofing map) and to support effective measures to reduce future damage.

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