NOMOS - HIGH DEFINITION 2D MODEL FOR FLOODING HAZARD ASSESSEMENT

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INTRODUCTION

The Swiss Federal Office of the Environment (FOEN) requests all communities to establish risk assessment maps. The community of Bagnes made the experience that the existing flooding hazard map, based on 1D computation and site inspections, was not detailed enough to settle on local construction projects in the famous mountain village Verbier. Therefore, the technical service of Bagnes decided to establish a new flooding hazard map based on a high definition terrain model and a 2D hydraulic model. This study was called NOMOS, which is generally traduced by “the law” and was used to name the very first survey, basis of all division and repartition of the land.

HIGH DEFINITION TERRAIN MODEL

In an urban environment many small structures, as streets, footpaths and small garden walls might influence water flow. Such structures are especially important in a steep topography as the flow is shallow and at high velocity.
For this reason a high precision photogrammetric survey has been chosen as basis for the digital terrain model. The precision of the survey was of ± 0.1 m and it contains a collection of points and the break lines of the above mentioned structures. Finally, the digital terrain model includes polygons representing all buildings.

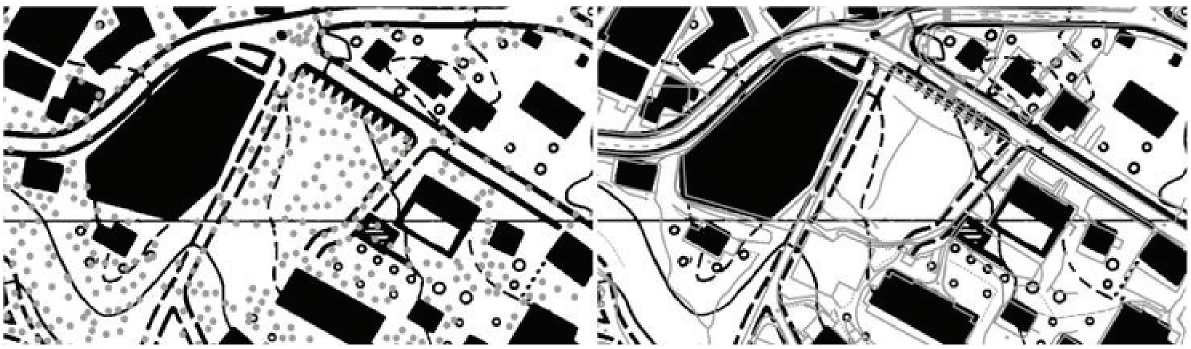

Fig. 1 Results of the photogrammetric survey. Left the base points and on the right the break-lines.

Based on these data sets, a triangulated terrain model was established. In this model, a regular grid of square cells has been interpolated which was finally the computational mesh for the 2D hydraulic model. Building have been integrated into the computational mesh as holes (blank areas), since no water can flow through.

NUMERICAL HYDRAULIC MODEL

The numerical model was implemented with the code Dunamic 2D developed by HydroCosmos SA. The code solves the complete equation of St-Venant by the finite volume method. The special form of the source terms allows simulation of all bi-dimensional non-stationary flows on real topography. The numerical scheme handles sub-critical and super-critical flows and allows automatical positioning of hydraulic jumps. It also manages wave propagation on dry surfaces.

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Beside the topography, represented by the terrain model described above, the model needs initial and boundary conditions. The initial condition is the dry topography. Boundary conditions are "waterproof" walls around the buildings and at the upstream end of the model. A critical flow was chosen for the downstream boundary conditions as the topography is rather steep and the flow mainly super-critical.
The flow is introduced as a source in the river bed of the mountain torrents. In order to cover the entire domain of Verbier, many different flooding scenarios have been investigated.

RESULTS

The results of the simulations of all flooding scenarios have been superposed, choosing in each computation cell the maximum water depth or unit flow of all scenarios. The flooding hazard is the maximum of the two parameters (water depth, unit flow) classified into three categories (weak, mean and severe) according to probable damage caused by the flow. The probability of occurrence is also considered for the classification.
In general, the new established flooding hazard map shows that the finally affected surfaces are much smaller than in the original map based on more traditional methods.

Fig. 2 Comparison between the NOMOS flood risk assessment (on the right) and the original map (on the left).

Furthermore, the results show some particular phenomena that should be considered for constructions in flood risk zones. Buildings, infrastructures and landscape design influence the flow. Two buildings close to each other reduce the available flow surface. The concentrated flow between the buildings generates a high risk zone either because of the flow depth or because of the flow velocity (left circle on figure 3). A building also can constitute an obstacle to the flow. The water stops and its depth increases resulting in a high risk (right circle on figure 3).

Fig. 3 Influence of buildings on flow and hazard assessment. Flow depth on the right, hazard on the left.

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