Klausbach torrent - hydrological modelling of complex catchment features by simple engineering practice

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OBJECTIVE

To implement a certain quality of hazard analysis, standard methods are required. A standard method, in the same time is limiting the engineer's flexibility. In the following, an example of using a standard method and complemented it with engineering practice is shown.
The issue was to determine hydrological parameters for the Klausbach torrent for design purposes.
A simple hydrologic model (unit hydrograph) was not able to model the complex catchment features. Preferably feasible solutions were integrated into the hydrologic model to consider those phenomena.

SITUATION

Due to an artificial locally changed river bed, the hydrological conditions were completely changed in the Klausbach catchment. Originally, the Klausbach torrent entered into the Hintersee Lake. The lake was built by the impoundment of the torrent for timber transport reasons. Probably since 1884, the course of the torrent was artificially relocated into a new channel which bypasses the Hintersee lake. That measure divided the catchment into two hydrological regimes, the Hintersee with its remaining tributaries and the Klausbach catchment. Since the artificial riverbed was designed too small, the torrent inundates its banks frequently (from about a 25 years flood).
If a flood occurs within the artificial reach, the discharge finds its way over the bottom of the valley into the lake. The bottom of the valley is filled by sediments. Extensively infiltration into the porous sediment deposits takes place while the water runs over the flat and wide area. Finally it reaches the Hintersee Lake's, where the water level rises dangerously.
The heavy rainfall of June 2013 produced a flood situation with serious risks which emerged due to the prevail situation. The dam of the artificial Klausbach channel was overflown and eroded. Huge amounts of water overflew the valley bottom and finally reached the lake. The water level raised two meters higher than its annual average. Thereby the buildings on the lakeside were exposed and the weir at the outlet of the lake was destroyed.
A further catchment feature with significant hydrological effects is a large deposition area of block fall events in the middle part of the catchment (compare figure 1). The material of the block falls causes a very special petrology and influence the runoff formation. The big range of grain sizes causes a strong infiltration and as consequence a decrease of the surface runoff in favor of a higher interflow.

METHODS

The basis of the calculation was a relatively simple precipitation/runoff model (SCS unit hydrograph). This model provides a one stream flood routing only. To consider the effects of a bank bursting scenario, the hydrograph needs to be divided into two streams at the position where the dam is overflown. For this purpose a module was added which splits the hydrograph after reaching a variable threshold value. Thus two parallel reaches could be described by the model:

- reach A: discharge over the valley bottom into the lake
- reach B: discharge of the (artificial) Klausbach riverbed

Another module for considering the infiltration which occurs at the bottom of the valley (reach A) and happens within the block fall affected reach was used. It was parameterized by infiltration area (km^2) and infiltration rate (mm/h). The retention behavior of the Hintersee lake was described by a hydraulic calculated volume discharge relationship.

RESULTS

The model was implemented in Excel. The calculations showed satisfying results. As a reference, measurements of a gauge, situated shortly below the outlet of the lake flows into Klausbach, were used.

OUTLOOK

In many cases the individuality of torrent catchments is elusive for modelling. Nevertheless, already simple descriptions of complex phenomena can be valuable to understand the processes and use the calculation as a decision-making basis. Flexible and modular model tools offer the opportunity to on the one hand provide a basic standard but on the other hand adjust and expand to special boundary conditions.

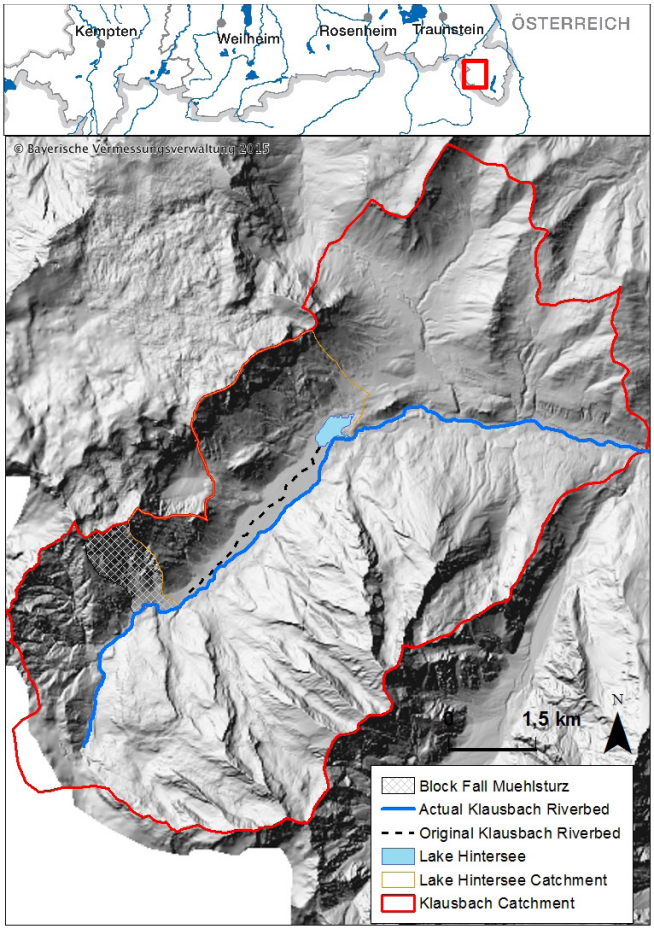

Figure 1. Situation of the Klausbach catchment

KEYWORDS

hydrology, precipitation/runoff model, alpine catchment

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