

Flood protection of the alpine village of Verbier (Switzerland)

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INTRODUCTION

The village of Verbier is situated in the Val de Bagnes in the Swiss Alps. It is among the most famous skiing regions of Switzerland. Therefore the building activity has been very important in the last decades and the settlement still keeps growing and space is precious. Often torrents had to make place for roads, infrastructure or buildings and were displaced or put underground.

As Verbier is situated on a terrace among steep mountains, avalanche hazard is well known and has always been considered for building projects. But nobody worried about flooding hazard before the flood events of the region in October 2000 and June 2001. The first flood risk study of the Val de Bagnes in 1999 did even not include the torrents of Verbier, as nobody was conscious of their danger.

As a consequence of the damage of the events in 2000 and 2001, the community of Bagnes, to which the village of Verbier belongs to, started to establish a hazard map for flooding. It was affirmed in 2011 as reported at the Interpraevent Congress in 2012 (Dubois et al., 2012).

This study fixed the peak discharges of a hundred year flood and an extreme event for all torrents of the village of Verbier and evidenced the important danger they represent. The study also pointed out that a calibration of hydrological models is very difficult in the zone: a part of the watershed is karstic, other areas are rather swampy.

FLOOD PROTECTION

The community of Bagnes then mandated a group of engineering offices to elaborate a flood protection project for the village of Verbier. It showed up very quickly that a major enlargement of the torrents in the settlement area is nearly impossible due to lack of space. Often torrents are nowadays crossing buildings and streets underground.

Therefore protection measures must be placed upstream of the housing development area. Considering the important estimated peak discharges and the steep topography, retention is not feasible and deviation of the four major torrents around the whole village is very expensive.

So it was discussed to reduce the design flood from the hundred year flood to a more frequently occurring discharge. This idea was confirmed by comparing the peak discharges of the 2000 and 2001 events to the peak discharges proposed by the hazard assessment: the major torrent, the Grand Torrent (big torrent), had a discharge of about 5 to 6 m³/s in October 2000. The hundred years flood peak discharge has been estimated with 45 m³/s. In general, Verbier does not have frequent damaging flood events.

TOWARDS A DESIGN DISCHARGE

But how to choose the value of the design discharge? The choice should be consistent, suitable and fair over the whole area.

The idea was that beyond a limit discharge the cost of protection works grow disproportionately to the gain in capacity. This limit discharge would be the optimum design discharge.

In a first step, all torrents of Verbier were registered in a geographical information system (GIS). They were subdivided into reaches with the same hydrology (the same peak discharge for a hundred years flood) for further analysis.

Each reach was split into small sections with uniform capacity computed based on topographic survey data. This analysis is very detailed: some sections have the length of the bridge that limits its capacity. For different design discharges, the total length of all sections to enlarge to obtain this discharge as capacity of the reach is computed. The length to enlarge is assumed proportional to the costs of protection works, as the torrents have rather supercritical flow. A more detailed cost

calculation would be too onerous for this global study over the whole area with about ten torrents. The analysis shows, as it is represented on figure 1, that there is in fact a break point beyond which the costs grow disproportionately to the gain in capacity. Additionally, this discharge should be at least twice the minimal capacity of the reach. It was not intended to assign a return period to the design discharge. But considering the few weak points with frequent inundation problems, the above defined design discharge has a return period of between 30 to 50 years (once in a generation).

CONCLUSIONS

Verbier will not be protected against a hundred year flood, but by considering systematically the design discharges for each restoration work on a torrent the safety level will be substantially enhanced with bearable costs.

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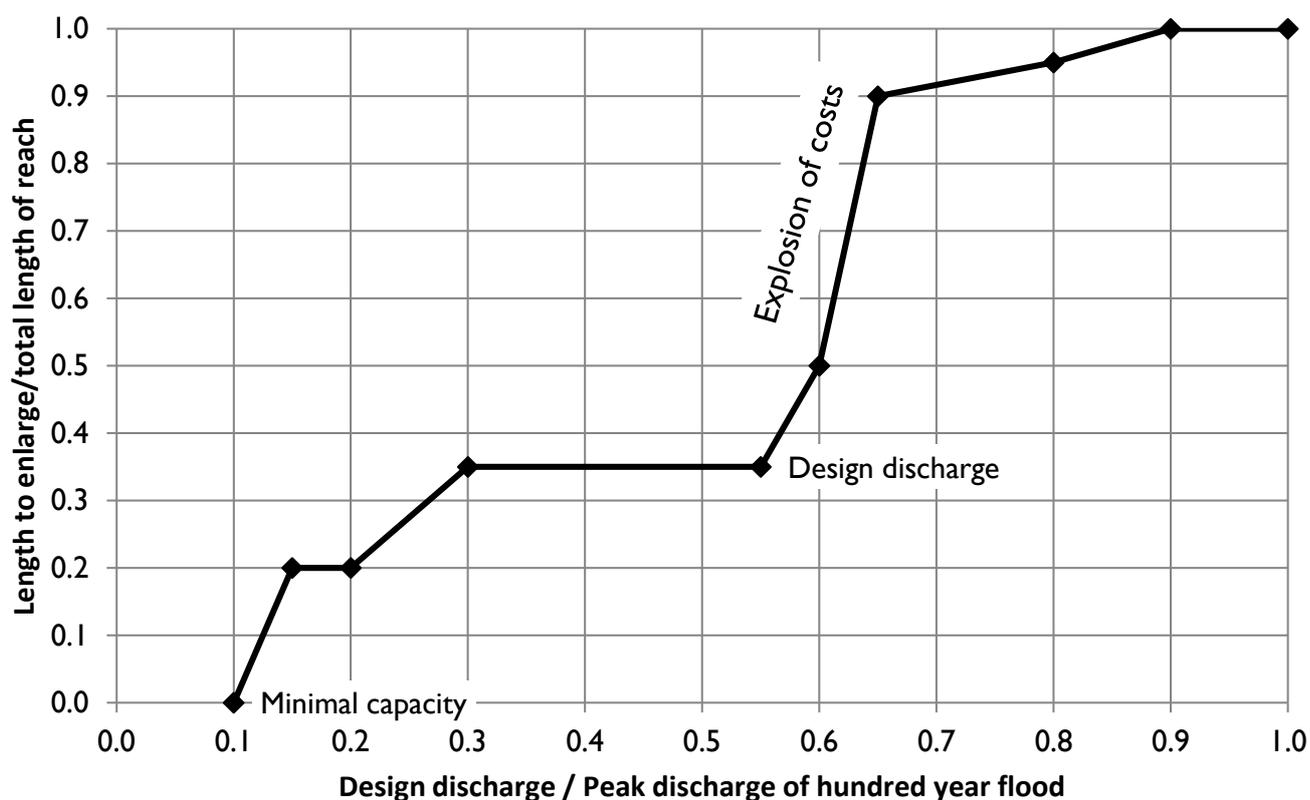


Figure 1. Length to enlarge versus design discharge.

KEYWORDS

flood protection, design discharge, mountain village

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