Integrated assessment and evaluation of flood protection projects: Long-term risk evolution and cost-benefit analysis.

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INTRODUCTION

In Switzerland wide areas are threatened by single or multi-hazards. The risk of such a natural hazard depends on the probability of the event and its intensity as well as, on the other side, on the presence probability and the vulnerability of the affected objects, i.e. the values (Kienholz 2005). Observations over the years lead to the assumption that the extent of damage caused by natural events is constantly increasing (PLANAT 2004). Höppe (2008) indicates various reasons for this phenomenon. He lists population growth, rising living standards, concentration of population and values in metropolitan areas, colonization and industrialization of exposed regions, susceptibility of modern societies and their technologies and finally the rising insurance density. Yet, detailed analysis of drivers for possible trends in risk evolution are limited (de Moel et al. 2011, Fuchs et al. 2013), especially if flood protection is also considered. Thus, this study focuses on an evaluation of preventive measures in flood protection. In times of limited financial resources most policies use cost-benefit analysis for a prioritisation of flood protection projects. Meyer et al. (2013) provides several cost assessment approaches, less attention receives the discussion on what is a benefit and consequently the benefit analysis. An objective of this study is to present a tool for measuring benefit in a more comprehensive way than only focusing on monetisation of direct benefits by risk reduction.

There are two research aspects. The first one concerns the effect of hazard control facilities on long-term flood risk evolution. The study presents a survey of the changing of land-use, the spatial planning and the development of risk trends in the domain of a flood control facility. In a second part, the study concentrates on the beneficiaries of the flood control facilities. There will be a comparison of the groups of beneficiaries according to our comprehensive model with the actual cost sharing method applied to finance the analysed flood control facilities.

METHOD

Out of 72 projects, financed by the insurance company Swiss Mobiliar in addition to the standard financing bodies (i.e. Federation, canton and municipality), four flood protection projects were selected. The selection is based on different categories, such as time of implementation, type of flood measure, type of hazard and the size of the domain of the flood control facility. All the research questions are evaluated in all four study sites in order to provide a valuable empirical database of high quality.

In a next step, scenarios for the risk situation before and after the construction of the flood measure and for a hypothetical maximum development expansion in the affected area are illustrated using GIS. The tool „EconoMe“ (BAFU 2015) allows to calculate the damage potential, depending on the intensity of the event. The EconoMe tool provides, in addition to information on the damage potential for a defined area, a cost-benefit factor. This cost-benefit factor reflects the profitability of a project (BAFU 2015).

To complement the purely monetary benefits in the form of prevented financial losses, semi-structured expert interviews will be conducted to build further, non-monetary benefit criteria. In a next step, stakeholders weight these criteria. Stakeholders are the inhabitants in the area affected by the selected flood protection facilities. The weighting will be included in the multi-criteria analysis (Gamper et al. 2006; Shreve and Kelman 2014). This method allows a subjective assessment of non-monetary factors. Figure 1 shows the multi-criteria analysis for Weinfelden-Bürglen (based on Hostmann et al. 2005) enhanced by the authors with the weighting

procedure (as explained above). The example shows that due to the weighting of the criteria, the ranking of the different project options changes and could thus lead to an alternative prioritization.

FIRST RESULTS AND CONCLUSION

The empirical study of selected flood protection projects in Switzerland allows gaining a deeper, more comprehensive insight into the long-term impacts of flood prevention projects. A flood control project that protects an area with high expansion potential often results in an increase of the risk. Such an analysis of risk with an emphasis on the development of the damage potential may provide new inputs for project prioritization. An extended analysis of the beneficiaries (both from a monetary as well as non-monetary perspective) of a flood protection facility may lead to a new method of allocating the costs of flood control facilities to all beneficiaries in the future. Currently, the flood risk evolution analysis is ongoing and will be finished by August 2015. Stakeholders are identified for the semi-structured interviews and will be conducted in September 2015. The analysis will be finalized by November 2015.

Table 1. Multi-criteria analysis for different flood prevention project options in Weinfelden-Bürgeln. The figure shows tree benefit criteria. Those three as well as four additional ones (not shown in this figure) were assessed by experts (based on Hostmann et al. 2005). This assessment is ranked by the authors in the column labeled „Rank“ (best 5, worst 1). In a next step the ranking is multiplied with one and the weight of the criteria, as given by the stakeholders (Rank*(1+Weight)), resulting in a weighted rank. The final quarter shows the sum of the ranks from all seven criteria, for each of the options. This final ranking (best 1, worst 5) for the project prioritization is done for the expert assessment (yellow) and in form of a weighted expert rank, including stakeholders criteria bias (green).

Criteria	Damage potential Weight: 20%			Ecology Weight: 27%			Recreation use Weight: 7%			∑ (Rank)	Rank [1-5]	∑ (Rank * [1+Weight])	Weighted Rank [1-5]
Assessment / Project Options	Expert assessment [10^6 CHF]	Rank [5-1]	Rank * [1+Weight]	Expert assessment [Scale 1-5]	Rank [5-1]	Rank * [1+Weight]	Expert assessment [ha]	Rank [5-1]	Rank * [1+Weight]				
As-is state	370	3	3.6	1.5	1	1.27	15	1	1.07	21	3	21.93	5
Version Canton	12.3	5	6	3.4	4	5.07	55	5	5.33	24	1	26.40	1
Nature reserve	370	3	3.6	4.7	5	6.33	31.4	4	4.27	20	5	22.20	4
Minimal version	370	3	3.6	2.5	2	2.53	28.6	3	3.20	21	3	22.33	3
Combination version	113.5	4	4.8	2.9	3	3.80	26.8	2	2.13	22	2	23.73	2

KEYWORDS

evaluation of flood protection projects; Long-term risk evaluation; cost-benefit analysis; group of beneficiaries

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