ABSTRACT: Within the research project RIMES (Climate Change and Natural Hazard Risk Management in Energy Systems) the primary focus was put on the development of a methodical risk management procedure for energy generation facilities in an alpine environment, that explicitly considers uncertainty and climate change aspects. The project started in 2009 and terminated in August 2013. In this paper we will highlight few basic findings of the project, regarding avalanche hazard.

In order to assess the influence of natural hazards on hydropower generation facilities, the problem is approached at object-level (e.g. pylons, water intakes, reservoirs). In a first step the relevance of the considered hazard processes is evaluated based on a pre-assessment for every object, employing a GIS-based analysis and a preliminary estimation of the hazard situation onsite. In order to introduce climate change aspects in future risk management decisions, climate scenarios based on regional climate studies and time series analysis of local weather stations have been developed for the study area. Subsequently, the sensitivity of avalanches to the assumed changes was assessed at catchment-level. The results indicate that the assumed changes in climatic variables will affect the considered avalanche hazard processes differently, but have a clear link to elevation.

KEYWORDS: avalanche, climate change

1 INTRODUCTION

The research project RIMES aimed at the optimisation of risk management procedures by addressing uncertainties of various domains (climate change, natural hazards, economical losses) and the standardisation of a method to determine the vulnerability of an energy system.

In the field avalanches detailed analysis on climate change impacts is still limited. In the past years some studies have addressed the influence of climate change on avalanche activity (e.g. Glazovskaya 1998, Martin et al. 2001, Latemser and Schneebeli 2002, Eckert et al. 2010a,b). However, most studies focused on the number of avalanches or the run-out distance without distinguishing between wet and dry snow avalanches. Anyhow, a well-accepted assumption is that climate change will have an impact on the type of avalanche, especially in lower elevations. In this paper we present a summary of results of the analysis on the impact of climate change on avalanche activity on the example of the Kapruner valley in Austria. This paper is a summary of partial results that have been presented before.

2 STUDY AREA

The two study areas in the project RIMES are located in western Austria, one in the province of Salzburg, the Kapruner valley, and the second in the province of Tyrol, the Zillertal (Figure 1). Here we only present the results from Kaprun.

Figure 1: Location of the two study areas, Kaprun (blue star) and Zillertal (red star).

3 DATA

In the Kapruner valley the historical data on avalanche activity are available from the winter 1943 until 2012. In total 2973 events are registered from which 2676 are related to a specific
avalanche path. On 297 days more than one avalanche was observed, however a local reference was not made in the cadastre. The database contains 42 avalanche paths for which a minimum of 10 avalanches were recorded over the observation time. The maximum of avalanches recorded in one path are 166 events. Of the 2676 avalanches 1611 were recorded as wet snow and 1003 as dry snow avalanches; for 12 events the type was unknown

4 METHODS

A reliable quantification of the trend of the ratio of wet to dry snow avalanches is not possible as the dataset is subject to great uncertainties. Therefore we choose a more descriptive approach to understand the impact of climate change on avalanche activity. Uncertainties in the avalanche data are due to:

- The quality of recordings
- Bias towards larger events that were relevant to the hydro power company
- Time lag in recordings e.g. due to visibility, none recordings, when no damages occurred, ignorance of events, inexactness of observation or poor accessibility
- Unexpected data gaps, e.g., although the winters 1951/52 and 1953/54 were pronounced avalanche winters in the Alps, no avalanches were recorded
- The reliability or the completeness
- The type of avalanches is subject to subjective opinions

5 OVERVIEW OF RESULTS

Figure 4 shows the ratio of dry to wet snow avalanches as recorded in the cadaster for three elevation classes. In general more wet snow avalanches than dry snow avalanches were observed. For the elevation class between 1400 and 1800 m a.s.l. 70% wet and 30% dry snow avalanches, for elevations between 1800 and 2300 m a.s.l. 64% and 36% and above 2300 m a.s.l. 55% to 44%. It seems that at middle and higher elevations the portion of wet snow avalanches is further increasing; although there are winters with only dry snow avalanches recorded in all elevation classes.

6 OUTLOOK

The formal analysis of the results will be published in a paper that is in preparation.

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8 REFERENCES


