A SEASONALITY ANALYSIS OF FLOOD PEAKS AS BASIS FOR FLOOD RISK ANALYSES IN TWO ALPINE REGIONS

Klaus Schneeberger[1,2], Matthias Huttenlau[1] and Johann Stötter[1,2]
[1] alpS - Centre for Climate Change Adaptation Technologies, Innsbruck, Austria (schneeberger@alps-gmbh.com)
[2] Institute of Geography, University of Innsbruck, Innsbruck, Austria

Motivation

Several serious flood events occurred in Alpine regions within the last decades. In order to analyse potential consequences of future flood events in two regional scale study areas a flood risk project was initiated. The framework of the overall project follows the risk concept of managing natural hazards, where risk is defined as a product of hazard, elements at risk and vulnerability. The project is structured into (i) analysing and generating flood scenario, (ii) flood inundation assessment and (iii) consequence analysis (loss simulation). By the combination of the flood scenarios and the consequence analyses we consider a wide range of potential damaging flood events in an entire region.

The comprehensive data catalogue which comprises the flood scenarios is based on historical- and synthetic data. Since documented loss events are comparatively rare, an ancillary database of synthetic flood footprints will be created using Monte Carlo (MC) Simulations.

A broad understanding and diligent analysis of the flood hazard is prerequisite for an adequate assessment of flood risks. Therefore, the seasonality of extreme river discharges is analysed and compared within the study areas to understand the flood occurrence. The presented study contributes to a better understanding of flood generating processes within the study areas.

Characteristics of the study areas

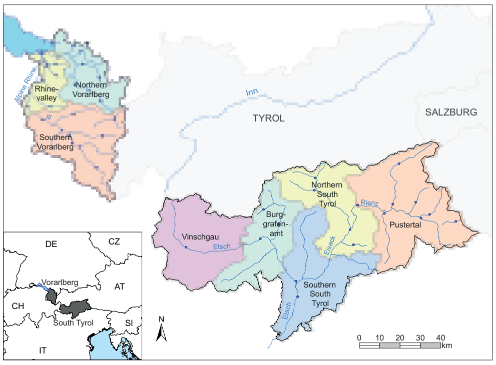

Figure 1: Study areas Vorarlberg and South Tyrol

The study areas are Vorarlberg (2600 km²) and South Tyrol (7400 km²), two typical Alpine regions located in the Eastern Alps (Figure 1). Regarding to their hydrological behaviour, two significant differences of the regions are the locations concerning the Alpine divide (Vorarlberg is located northwards and South Tyrol southwards) and the main precipitation patterns (Vorarlberg is mainly influenced by westerly circulation patterns and South Tyrol by Mediterranean lows).

For a better overview of the regional patterns of the flood frequency within the study areas the standardised specific flood discharges (Q) are shown in Figure (2). The standardisation was done by using a hypothetical watershed with 100 km² and applying $Q = Q_A \cdot A^{0.25} \cdot 100^{-0.25}$, where Q_A is the calculated specific discharge of a certain watershed (A). The flood information is assigned from the downstream gauging station and in a first step no regionalisation approach was applied.

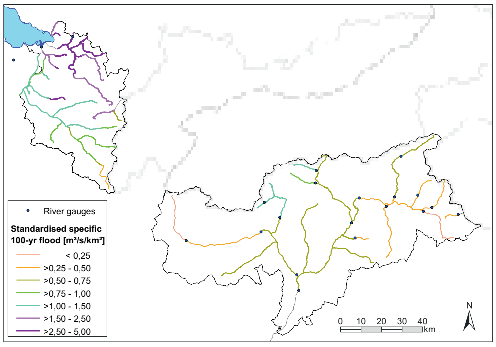

Figure 2: Standardised specific 100-year flood

Seasonality of extreme river discharges

The seasonality analysis of the maximum annual floods is a common method to show the average occurrence date of the extremes. Therefore, a directional statistics was applied, where the maximum annual discharge peaks are displayed in a polar plot. The direction of the arrows indicates the occurrence date of the mean annual floods and the length of the arrows shows the variability of the extremes (Figure 3). The colour of the several watersheds indicates the ratio of the 100-year flood based on summer and winter series and points out the distribution of flood peaks around the year. Light green indicates small ratios (floods are uniformly distributed) and green shows watersheds with large ratios (summer floods are dominant).

The common approach to characterise the seasonality of the flood peaks, however, does not consider the magnitude of the flood events. In order to address this issue we applied a directional statistic, where the magnitudes of several peaks are visualised within polar plots (Figure 4). The distance from the centre of the polar plot correlates with the discharge of the considered flood peak.

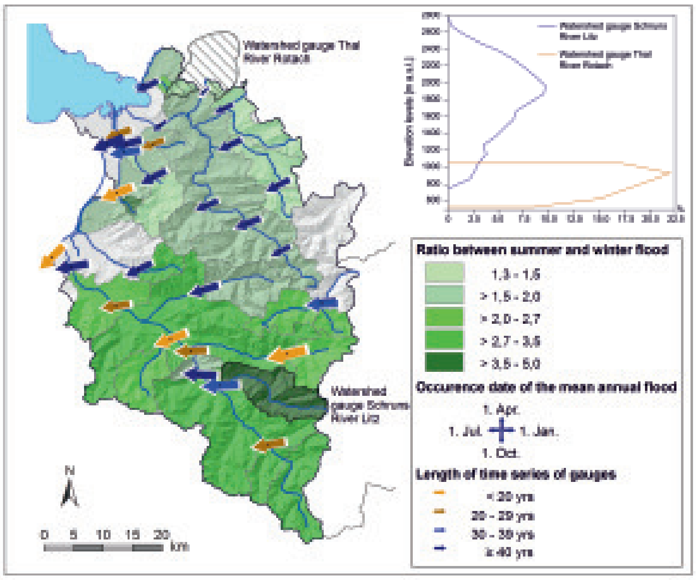

Figure 3: Seasonality of annual maximum floods (Vorarlberg): The direction of the arrows indicate the occurence date of the mean annual floods and their length indicates the variability of the annual discharge maxima.

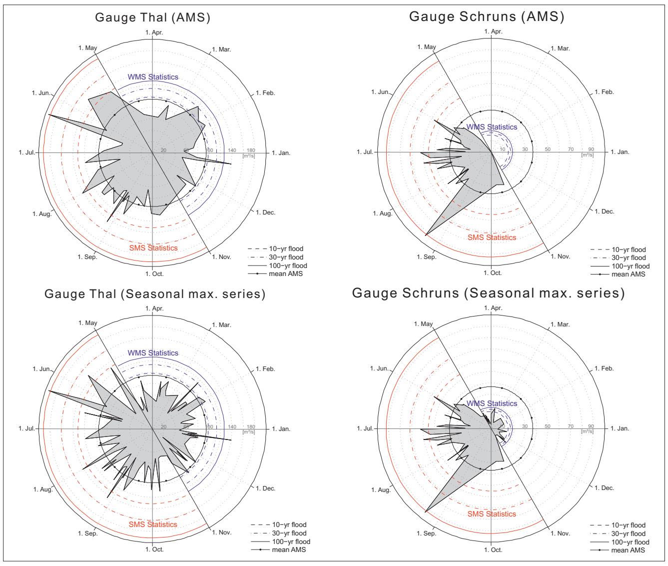

Figure 4: Directional statistics: Gauge Thal and Schruns

The two hatched areas in Figure 3 show the watershed of gauge Thal in the north of Vorarlberg and Schruns in the south, which are representative watersheds. These two data sets are also used for the polar plots in Figure 4. The flood peaks tend to be more uniformly distributed around the year in the northern region of the study area. This correspond to the lower altitude and the high precipitation throughout a year. In the Alpine catchment (Schruns with elevation ranging up to 3312 m a.s.l.) the gap between summer and winter floods is larger.

Conclusion and Outlook

The presented study helps to understand the seasonality of flood peaks. We could show that the occurrence date and the variability of the mean annual peak tends to have a regional pattern within Vorarlberg. In the lower regions in the north of the province the flood events are distributed around the year (with a high variability) and in the higher alpine regions towards the Alpine divide in the south the flood peaks occur mainly in early summer (events are dominated by snow melt and rain on snow events). These findings contribute to subsequent flood risk analyses and the acquired knowledge helps when carrying out the following steps: generating of a comprehensive data catalogue and regionalisation.

Project partners

COMET
Fachhochschule Vorarlberg University of Applied Sciences
VORARLBERGER LANDES-VERSICHERUNG VLV Im Ländle sicher besser
tiroler VERSICHERUNG
Vorarlberg unser Land
AUTONOME PROVINZ BOZEN SÜDTIROL
PROVINCIA AUTONOMA DI BOLZANO ALTO ADIGE