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# Hydro-Meteorological Triggering Pollution Due To Debris Flows

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**Abstract**

Hydro-meteorological trigger conditions, which are expected to alter in a future climate, have a significant impact on debris flow activity. In order to evaluate changes in the frequency of critical trigger conditions for various trigger types-long-lasting rainfall, short-duration storm, snow-melt, and rain-on-snow-in six regions of the Austrian Alps, we connect a regional hydro-meteorological susceptibility model for debris flows with climate projections until 2100. When the number of days necessary for debris-flow initiation is averaged across all regions, there are few annual changes, but there are distinct changes when hydro-meteorological trigger types and the study region are separated. At the monthly and seasonal scales, changes become more apparent, with a general pattern of critical debris-flow trigger conditions earlier in the year. The findings of this study can be used as a foundation for future risk management adaptation strategies.

**Keywords:** Pollution; Atmosphere; Debris

## Introduction

According to Brunetti et al., the study regions' climatic conditions are dominated by oceanic climate in the west, Mediterranean climate in the south, and continental climate in the east. The distribution of precipitation reflects these influences, with the highest annual sums in the westernmost region, Montafon, at 1548 millimeters per year and the lowest in the easternmost region, Feistritztal, at 910 millimeters per year. From west to east, long-term average runoff coefficients also decrease. The easternmost Feistriztal has the lowest runoff coefficient, with less than 40%, while the Montafon, Pitztal, and Defereggental release more than 80% of their precipitation as stream flow. The loss of bare rock and sparsely vegetated areas in high-alpine regions at the expense of forests and grasslands, which improve retention capacities in lower-alpine regions, is the cause of this declining trend. The region of Montafon had the most days with debris-flow activity (43 days between 1953 and 2013), while the region of Feistritztal had the fewest (three days between 1975 and 2013).

Regional climate simulations from the EURO-CORDEX initiative were used to generate the projected station data. Europe's global climate projections from the Coupled Model Intercomparison Project Phase 5 are dynamically downscaled in these EURO-CORDEX simulations. For the European continent, climate projections are downscaled from the original global climate models' (GCM) resolution to a common grid size resolution of 12.5 km. When attempting to use bias adjustment as a straightforward statistical downscaling, recent research has revealed significant artifacts. As a result, we employ a novel strategy that separates the downscaling from the adjustment: The local EURO-CORDEX projections were first inclination changed against gridded reference perceptions and afterward further downscaled to the weather conditions checking stations by a spatial stochastic downscaling model utilizing day to day observational estimation information from the particular stations. SDM is used to adjust for bias. Based on a transformed truncated Gaussian model, the stochastic downscaling method separately models the marginal distribution and spatial correlation of all nearby weather stations for each study region. This made sure that a weather station's projected data on any given day was the same as that of other stations in the same area. For moderate and extreme precipitation, the model performs well in a variety of diagnostics that represent marginal, temporal, and spatial aspects. Switanek et al. provide a comprehensive evaluation and methodological details about the stochastic downscaling method. 2022. For the catchments that were the subject of the study at hand, that study demonstrated good performance in simulating mean and intense precipitation, dry-day and wet-day probabilities, spatial correlations, and spatial dependence of extreme rainfall [1-5].

## Discussion

Estimates of water storage and flux in various compartments of the study regions' hydrological systems are made possible by the process-based hydrological model's operation on a precipitation zone scale, which ensures that precipitation data are processed at the highest spatial level possible. Based on where the available rain gauges are located, we use Thiessen polygon decomposition. Temperature information is the same. According to Gao et al.'s suggestion, various hydrological response units (HRU) take into account hydrological heterogeneity. 2014). We distinguish between riparian zones, forest, grassland, and areas with no vegetation or bare rock. Based on the approaches of Sevruk (1997) and Rolland (2003), respectively, the elevation range of each HRU was discretized into elevation bands of 100 meters to account for elevation gradients in temperature and precipitation. It was assumed that glaciers only existed in bare rock domains in two of the six regions, and they were simplistically modeled with an unlimited supply of water for their area fraction in an elevation zone.

For the arrangement of the hydrological model a computerized rise model (DEM) with a network size of 10 by 10 m (vogis.cnv.at), a Level Above Closest Waste guide, a glacier distribution map, the CORINE land-cover dataset from 1990 (https://www.eea.europa.eu), and the DEM were utilized.

Precipitation and temperature data from the Austrian Central Institute for Meteorology and Geodynamics (ZAMG) were used to force the model, which was then calibrated using stream flow data from the Hydrographic Service Austria (HD) and the hydropower companies Illwerke and TIWAG. We obtained posterior parameter distributions

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by employing the "DREAM" algorithm for model calibration. DREAM was run using the computational resources of the Vienna Scientific Cluster (VSC) for 20,000 generations for each study region. Validation times ranged from one to two years, while calibration times ranged from four to 35 years. Post-adjustment model assessment utilizing different execution measurements exhibited the model's capacity to at the same time duplicate numerous hydrological marks. Supplement 1 and Prenner et al. provide comprehensive performance metrics, 2019. Based on these findings, it seems likely that the model accurately depicts the underlying processes.

The hydrologic model's uncertainties were taken into account by sampling 25 distinct sets of the parameter's posterior distributions. Each of the 28 anticipated precipitation and temperature station series was used to run the hydrological simulation with the appropriate model parameters set. As a result, all regions had access to a total of 700 (=25 28) projected future catchment state time series for each precipitation zone, allowing for an evaluation of trigger conditions' changes and uncertainties. Hanus et al. performed a validation of the hydrological model using the modelled past climate for the years 1981–2010 (2021) demonstrated that the seasonality of runoff and the timing of extreme events are generally accurately captured, but that the magnitude of high flows is somewhat underrepresented, primarily as a result of an inadequate representation of localized, high-intensity rainfall events as input data. Since a combination of hydro-meteorological criteria is used in the regional susceptibility model for debris flows (Section 3.4), we assume that these flaws have little effect on the model's performance. We focus solely on the impact of climate change, ignoring other anthropogenic factors like changes in land use or engineering measures to prevent debris flows. Between 1970 and 2100, projected climate data are used in the hydrological simulation [6-10].

## Conclusion

The Wilcoxon Rank Sum test (Wilcoxon, 1945) was used to compare the value distributions of either the future period (2021–2050) or the historical reference period (1971–2000) to determine the statistical significance of identified changes. This test was done for every precipitation zone of a district which includes 700 time-series of projected hydro-climatological catchment states. When at least 50% of the realized Wilcoxon tests for a region were significant at a 5% significance level, it was assumed that the hydrological regime had changed significantly. According to our definition, a change that was significant, either positive or negative, occurred when at least 80% of the significant samples displayed deviations in the appropriate direction. Otherwise, it was assumed that the uncertainty was too high to identify a clear trend when the significant samples did not demonstrate a distinct direction (below the 80% threshold). This method was rehashed for every one of the two discharge situations.

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