Geophysical Research Abstracts
Vol. 21, EGU2019-15424, 2019
EGU General Assembly 2019

Sensitivity of Alpine Geosystems to Climate Change since 1850: Introducing the SEHAG research unit

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In recent years, a multitude of scientific studies has succeeded in verifying the existence of significant climate changes, in particular since the end of the Little Ice Age (c. 1850) and during the last fifty years. Mountain regions are disproportionately affected by global warming and changing precipitation conditions; temperatures in the Alps, for example, have increased by more than twice the global average in recent decades. While some consequences of changing hydrometeorological conditions are clearly visible (the demise of Alpine glaciers has become an emblematic manifestation of climatic change in public perception), others are not well documented and understood. Debris flows, for example, have been shown to react to permafrost degradation, increasing frequency of heavy rain, or to declining debris production in different studies. Together with contingent factors, system-internal dynamics and the interaction of hydrological and geomorphic processes further complicate the investigation of the reaction of geosystem components to climate change. Finally, it is unclear to what extent changes in system components (glaciers, permafrost, surface runoff and river discharge, geomorphic processes on hillslopes, etc.) will propagate through the geosystem to form a catchment-scale response.

These research problems are tackled by the SEHAG (SEnsitivity of High Alpine Geosystems to climatic change since c. 1850; funded by DFG and FWF) research unit in three Central Alpine catchments (Kaunertal/Austria, Horlachtal/Austria and Martelltal/Italy). The SEHAG consortium and its collaborators aim to make use of existing hydrometeorological data and dynamically downscaled reanalysis data to better characterise local climatic change, e.g. changes in the magnitude and frequency of hydrometorological events. These data will drive models that reconstruct glacier dynamics and extent, surface runoff and river discharge within three time slices (1850-1920, 1920-1980, 1980-present). Geomorphic and vegetational changes will be reconstructed using historical aerial and terrestrial photographs by means of stereo- and monophotogrammetric techniques. Such photographs are being retrieved from different historical archives; the first time slice coincides with the emergence of both photography and Alpine tourism. During the project period, present-day rates of hydrological and geomorphic processes, vegetation colonisation and development will be measured in the field, partially continuing existing data series. Results will inform historical geomorphological and landcover maps, quantify changing rates of geomorphic processes, sediment yield and delivery, and assess sediment connectivity. Finally, we will combine information on geomorphic activity, sensitivity to climate change, and connectivity: Where and when active and/or sensitive parts of the catchment are coupled to the channels, we expect a (more) pronounced response related to sediment transfer within the valley, and sediment yield; conversely, a lack of connectivity might buffer the propagation of changes and mitigate the catchment scale response.

The understanding of changes and their propagation in the past will help to better estimate the consequences of future changes. A second project phase will be dedicated to the prediction of system trajectories in the decades to come.