Incorporating climate change projections into operational debris flow hazard mapping: Initial insights from the Toverino River Basin in South Tyrol (Eastern Italian Alps).

Laura Bozzoli (a), Alice Crespi (a), Stefan Steger (b), Mateo Moreno (a,c)
(a) Center for Climate Change and Transformation, Eurac Research, Bolzano, Italy
(b) GeoSphere Austria, Vienna, Austria
(c) Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, The Netherlands

INTRODUCTION

- Debris flows are rainfall-induced phenomena, triggered by high intensity and short duration rainfall. [Martinengo et al., 2023; Turkington et al., 2016]
- Changes in intensity and/or frequency of heavy precipitation are likely to cause changes in debris flows occurrence.
- Debris flow hazard maps build upon simulations relying on rainfall statistics, i.e. Intensity-Duration-Frequency (IDF) curves.
- Accounting for non-stationarity of precipitation conditions may be an important step towards a further improvement of managing future debris flow risk.
- The aim of this work is to assess potential changes in the definition of hazard areas by including the projected changes in the intensity and frequency of triggering precipitation.

THE X-RISK-CC PROJECT

The X-RISK-CC („How to adapt to changing weather eXtremes and associated compound RISKs in the context of Climate Change") is an EU-funded project aiming to support risk managers and policy makers across the Alpine Space in addressing the compound risks of climate change extremes by developing new knowledge, local risk management actions and transnational guidelines.

STUDY AREA

- Toverino River catchment, municipality of Brennero – Brenner, South Tyrol (North-Eastern Italy).
- Catchment area: 7.6 km2. Elevation range: 1175 m a.s.l. - 2705 m a.s.l..
- On 16th August 2021 a heavy rainfall event caused a widespread erosion in the upper catchment, triggering a debris flow at the confluence with the Fleres valley.
- The accumulated debris cused the blockage and consequent flooding of the Fleres river, with damages to buildings and infrastructures [Autonome Provinz Bozen – Südtirol Provincia Autonoma di Bolzano - Alto Adige, 2021].

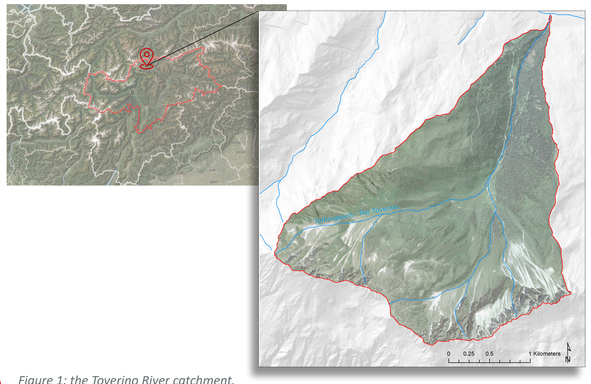

Figure 1: the Toverino River catchment.

METHODS

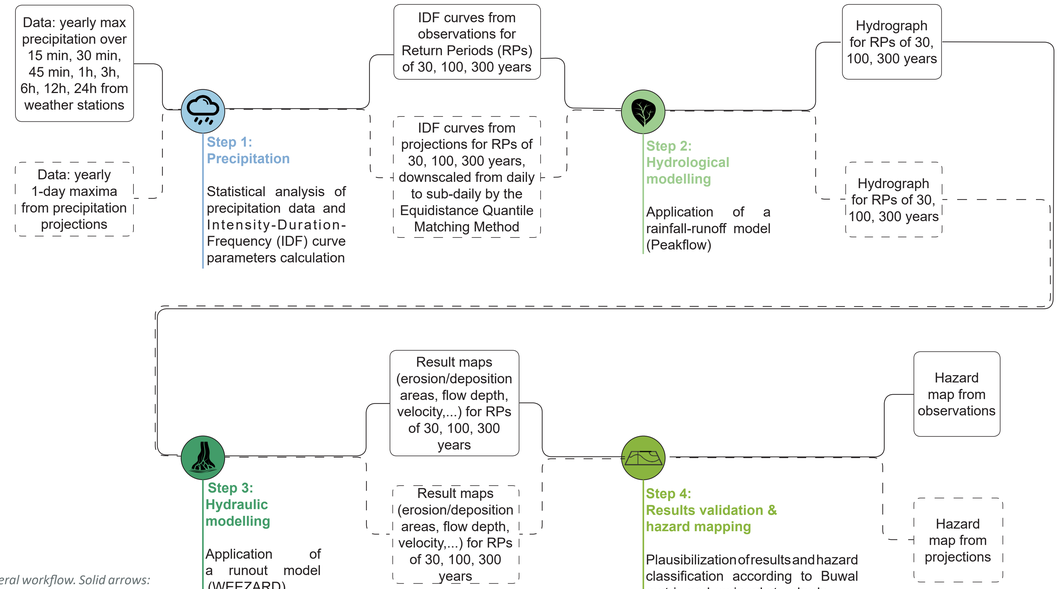

Figure 2: the general workflow. Solid arrows: observations; Dashed arrows: projections.

FIRST RESULTS

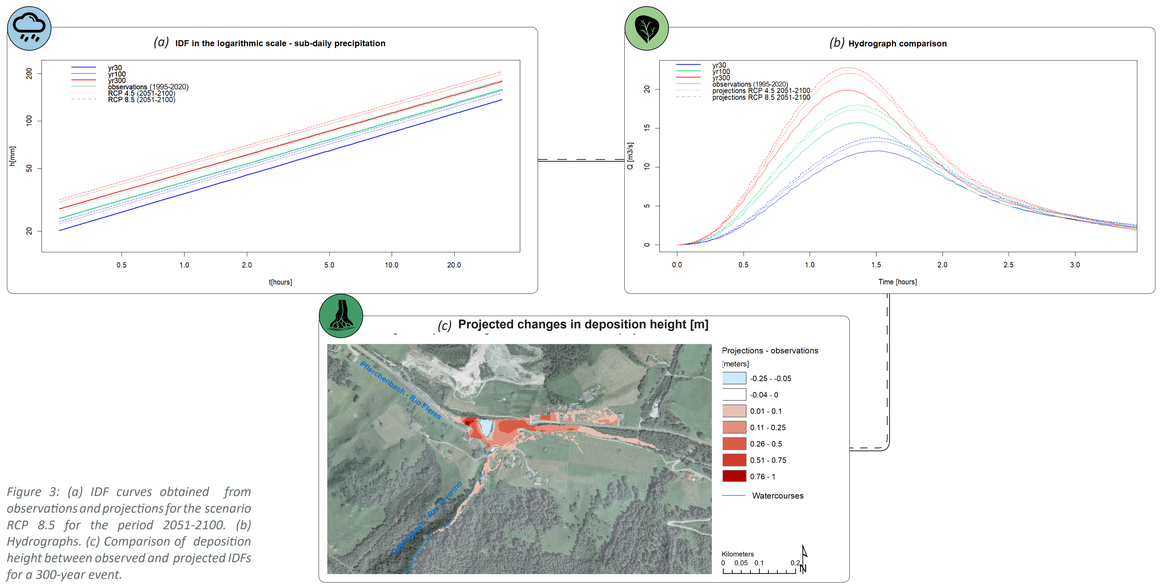

Figure 3: (a) IDF curves obtained from observations and projections for the scenario RCP 8.5 for the period 2051-2100. (b) Hydrographs. (c) Comparison of deposition height between observed and projected IDFs for a 300-year event.

DISCUSSION

- This research tests a modelling workflow to incorporate changes in the intensity and frequency of heavy rainfall into official hazard assessment procedures and to evaluate modifications of the current zonation patterns. The basic assumption is that all non-climatic factors potentially influencing the steps of the workflow (e.g., vegetation cover, land use, availability of solid material, river transport capacity, and many others) remain stable.
- Possible changes in the IDF curves are derived from observations and climate model projections. The shift (Figure 3a) means that, given the recurrence interval, the expected precipitation height could be potentially higher.
- The hydrographs (Figure 3b) show an amplification of the peak discharge considering projected IDFs and consequently a bigger runoff volume.
- Figure 3c represent the difference in the deposition height for a 300-year event based on projected and observed IDFs suggesting an overall increase of the deposited material and extent of affected area.
- All steps of the workflow are affected by uncertainties which have to be carefully considered and investigated further.

CONCLUSIONS AND OUTLOOK

- The results show that projected changes in the rainfall statistics can lead to meaningful changes in the hydrological and hydraulic response of the catchment, potentially affecting the hazard zonation.
- The workflow will be finalized and applied to derive an overall evaluation of projected changes in the hazard zonation in the Toverino river catchment.
- A throughout evaluation of the model components will be performed by simulating past events and comparing model outcomes with collected observations and local impact reports.
- The approach can be extended to include other types of climate-related hazards.

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