

Flood risk in the Alps: Implications of rainfall and temperature variations on hydrological extremes

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Flood risk in the Alps: Implications of rainfall and temperature variations on hydrological extremes / Evangelista, Giulia; Demateis Raveri, Marco; Monforte, Irene; Claps, Pierluigi. - ELETTRONICO. - (2023). (Intervento presentato al convegno SISC23: Mission Adaptation! 11th Annual Conference of the Italian Society for Climate Sciences tenutosi a Milano nel 22-24 Novembre 2023).

*Availability:*

This version is available at: 11583/2985304 since: 2024-01-22T10:01:36Z

*Publisher:*

SISC - Società Italiana per le Scienze del Clima

*Published*

DOI:

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# Flood risk in the Alps: implications of rainfall and temperature variations on hydrological extremes

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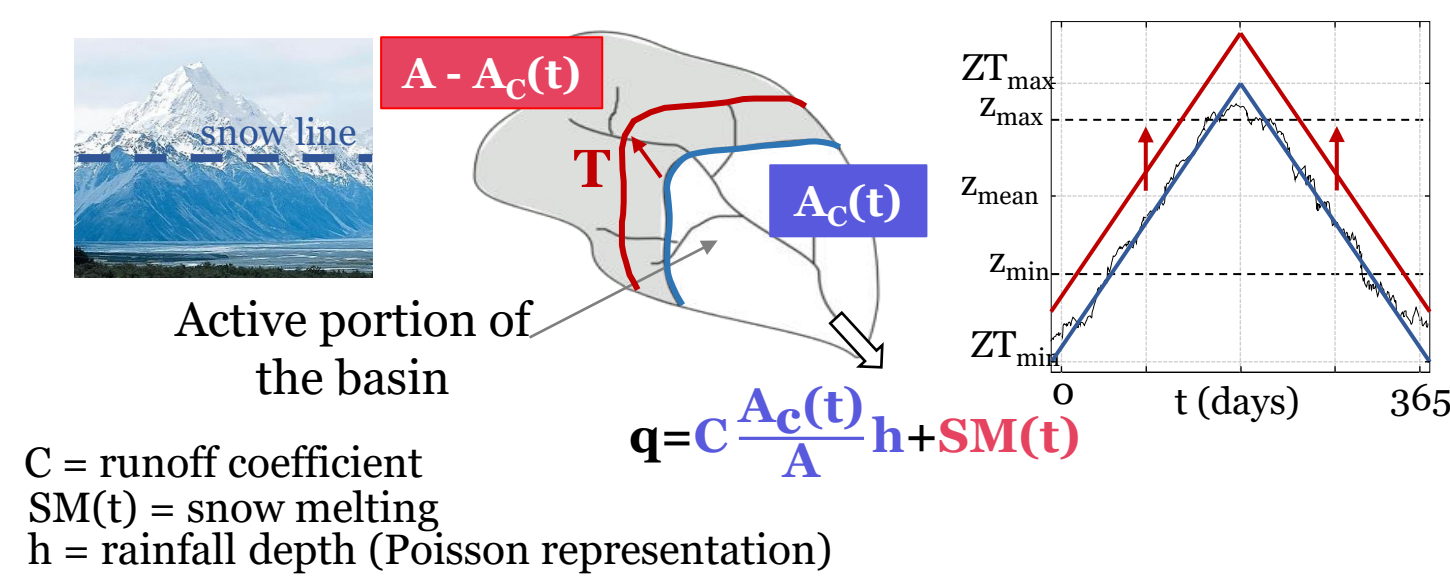


## The context

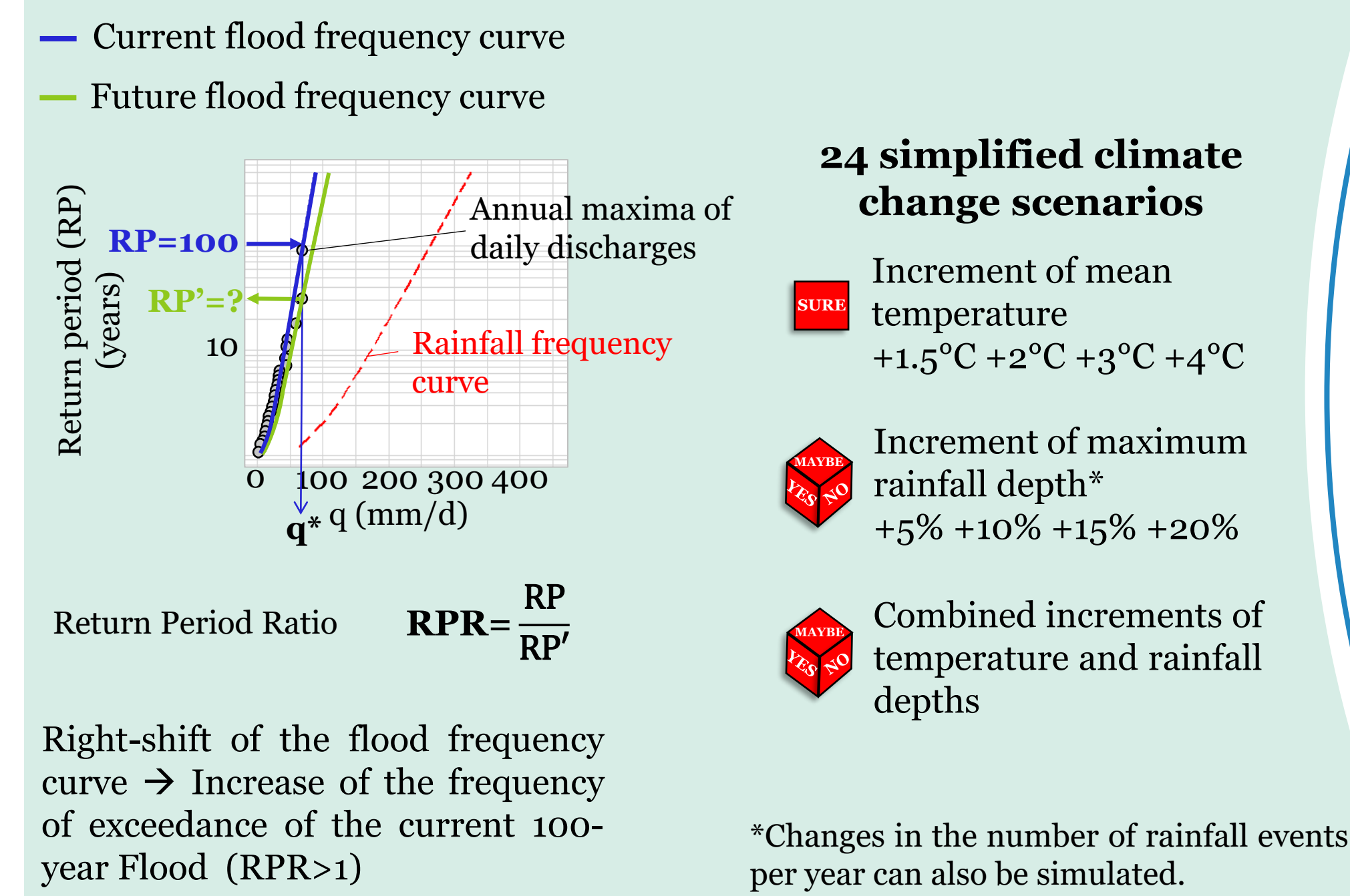
- Knowing how a mountain basin will respond following a precipitation event is important for the purposes of flood risk management and mitigation.
- The response of mountain basins is closely linked to the conformation of the catchment area and to the fluctuation of snow depth over months or years.
- Rising temperatures that have occurred in recent decades and are expected to increase further will affect the formation and magnitude of floods in the mountains.

## The model

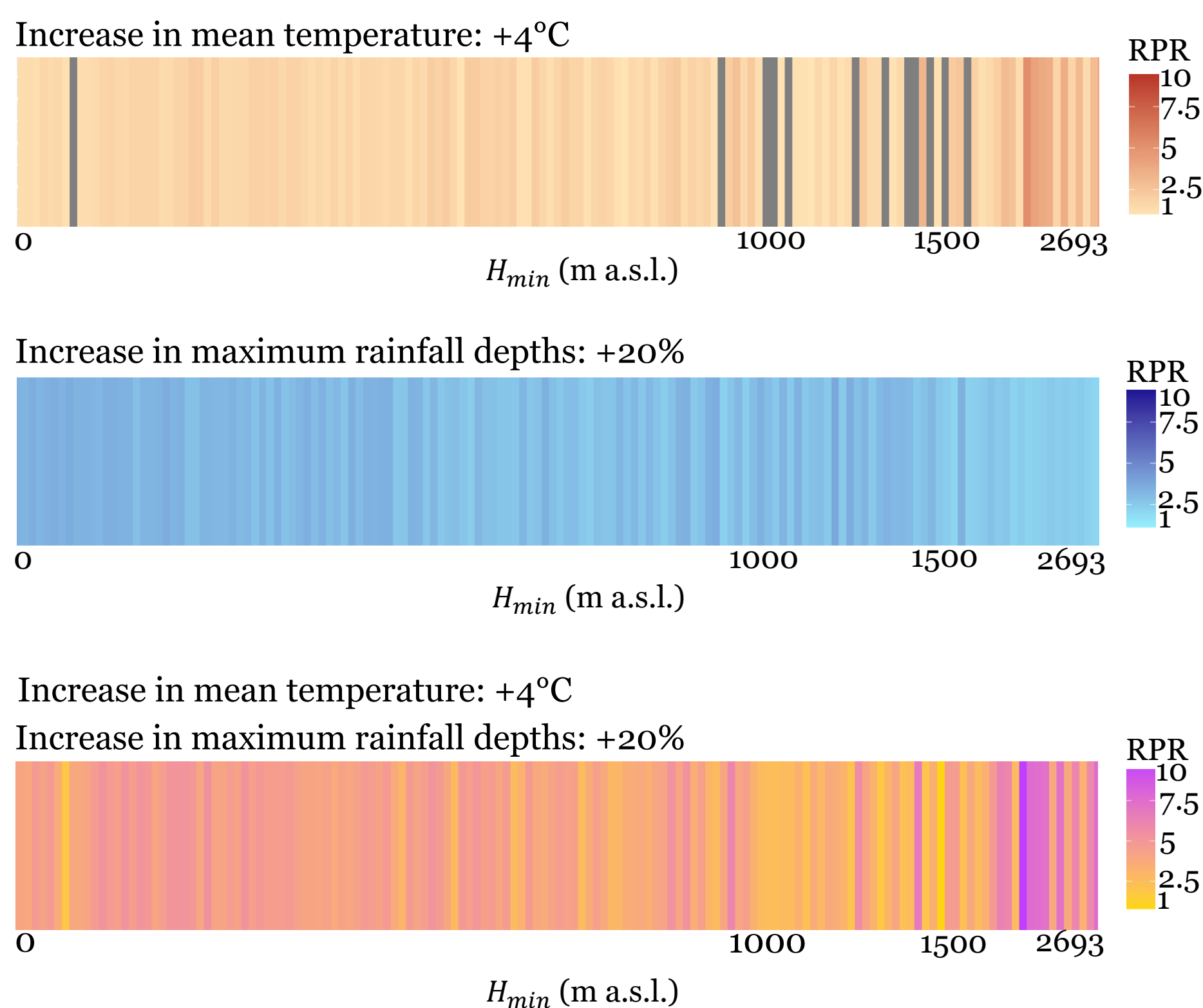
The FloodAlp model [1], based on the derived distribution approach, produces a **simplified flood frequency curve** as a function of the annual variation of the snow-covered portion of the basin, based on how **the seasonal variation of the snow line** affects the **distribution of elevations in the basin**.



## Computation of the future flood frequency curve



## Variability of the potential increase of flood frequency in the Alpine basins



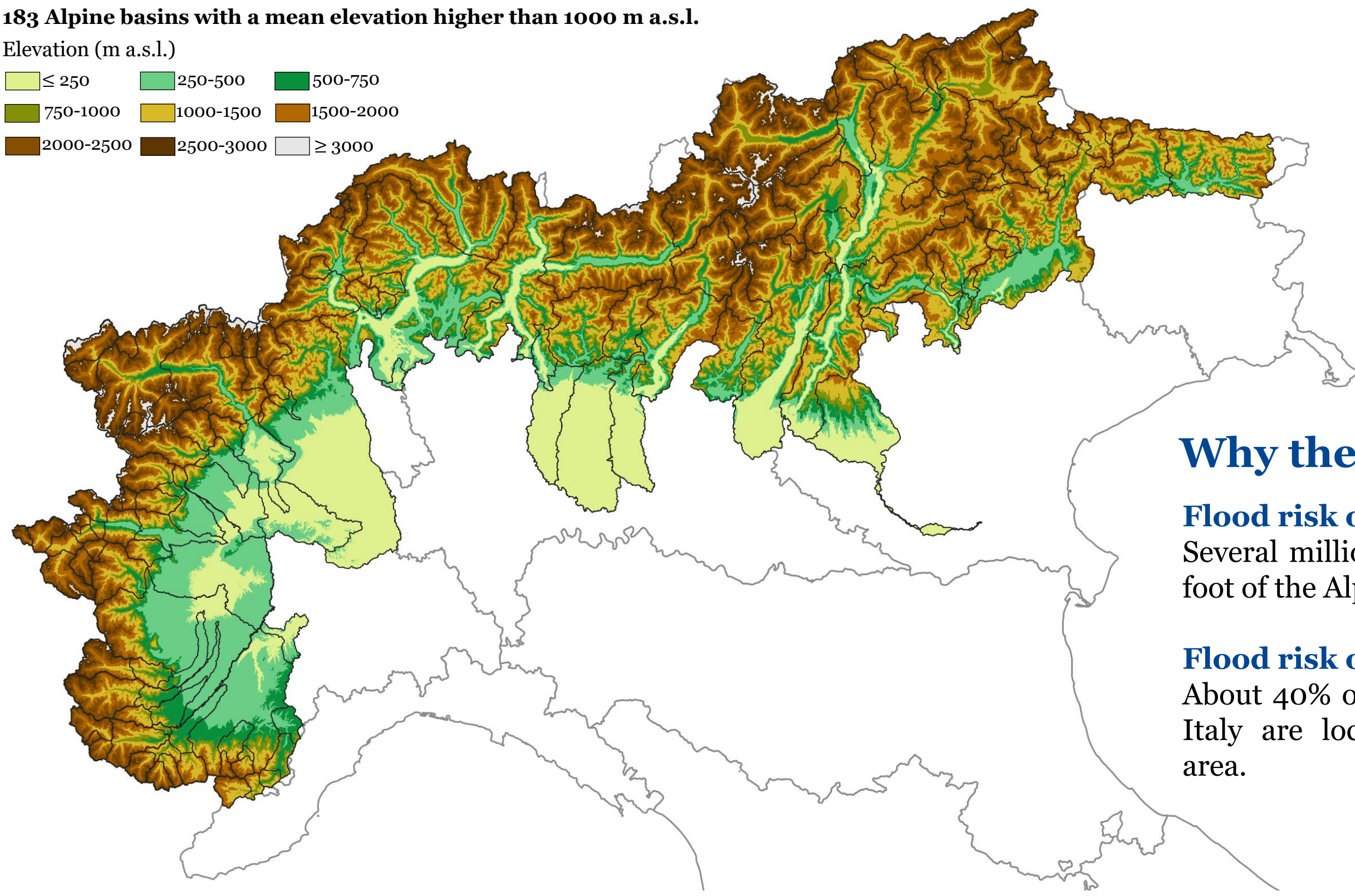
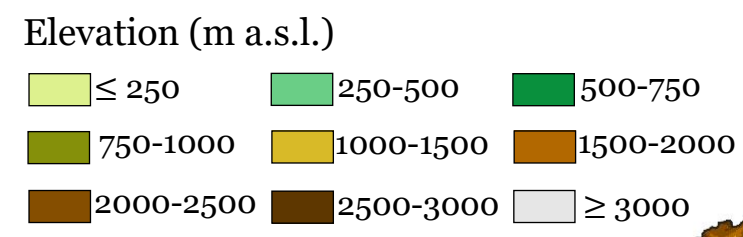
## References

- [1] Allamano, P.; Claps, P.; Laio, F. An analytical model of the effects of catchment elevation on the flood frequency distribution, *Water Resour. Res.* 2009, 45, W01402.  
[2] Monforte, I., Evangelista, G., Claps, P. Flooding risk from global warming in Alpine basins: an estimate along stream network. Presented at the 5th EWAS (Efficient Water Systems) International Conference, Naples, 12-15 July 2022.

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183 Alpine basins with a mean elevation higher than 1000 m a.s.l.



## Why the Alps?

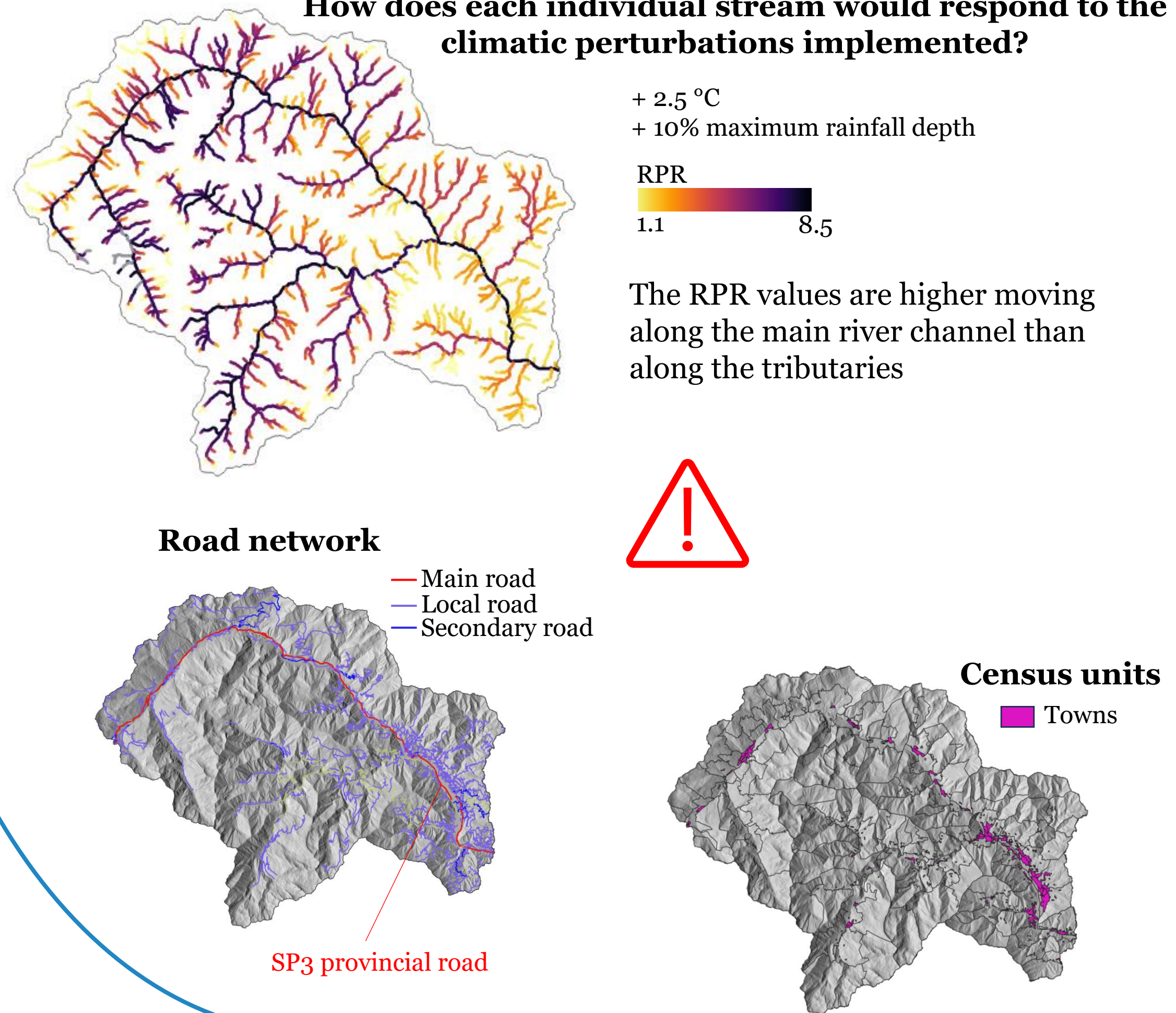
**Flood risk on people**  
Several million people live at the foot of the Alps.

**Flood risk on infrastructures**  
About 40% of the Large Dams in Italy are located in the Alpine area.

## High-resolution zoom on the Chisone basin (North-Western Alps) [2]

Analysis performed over **12.000 sub-basins** extracted from a DEM at a **50 m spatial resolution**, following the streams every 50 m.

## How does each individual stream would respond to the climatic perturbations implemented?



## Summary

- The increased frequency of flooding due to changes in temperature and rainfall characteristics can have serious implications for infrastructure and human safety in the Alps.
- In absolute terms, alterations in temperature have a more pronounced effect on reducing the return period of the current 100-year flood compared to changes in precipitation intensity.
- High sensitivity of the Alpine basins to rising temperatures at elevations above 1500 m a.s.l. Lower regions, as expected, are however highly vulnerable to intensified precipitation.
- Due to a combined hypothetical increase of 4°C in mean temperature and 20% in maximum rainfall depth **the current 100-year flood may become up to 9 times more frequent.**