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Development of a methodology for extreme flood estimation

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1. Introduction

The development of a methodology for **extreme flood** estimation is the aim of the project CRUEX++. This project follows the CRUEX project which aimed at the development of a PMP-PMF methodology (PMP=Probable Maximum precipitation, PMF=Probable Maximum Flood). Numerous tools, models and methods have been developed during the last years. The goal of the CRUEX++ project is to combine and enrich these elements leading to a methodology for extreme flood estimations in order to verify dam safety. A PhD thesis has been initiated in 2012 to lead this project and to conclude on a final methodology.

2. Approaches

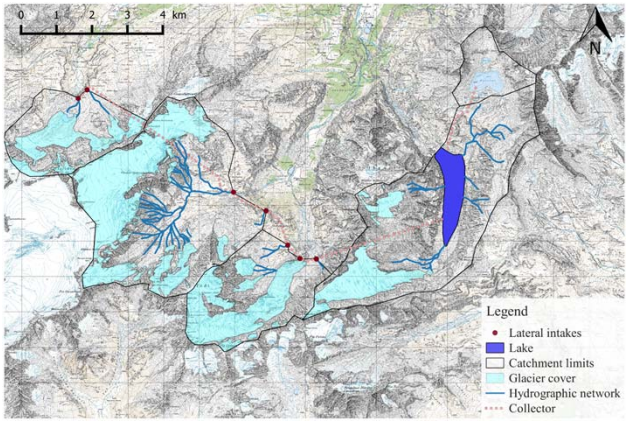
The 2 main families of approaches taken into account are the statistically based methods and the simulation based methods.

In the context of the **statistically based methods**, the theory of extremes, englobing the General Extreme Value Distribution (GEV) and the Peak Over Threshold Method (POT), as well as the GRADEX method are included.

In the domain of the **simulation based methods**, the semi-distributed conceptual hydrological model GSM-Socont is used in a modified version. This model allows Precipitation-Discharge simulations, respecting the contributions of snow fall, surface runoff, infiltration as well as snow and glacier melt.

The **PMP-PMF approach** based on PMP maps, elaborated during the CRUEX project is also considered as part of the simulation based methods

3. Case study of Limmernboden

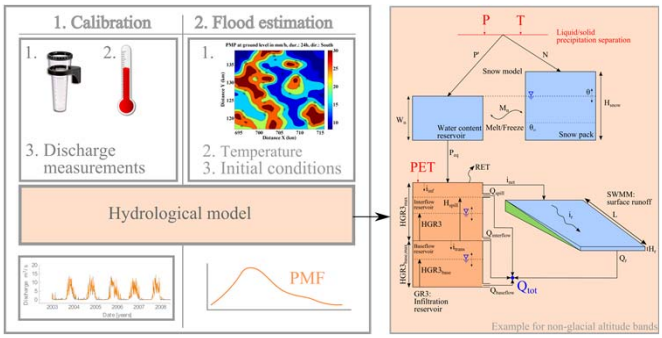


- Northern Swiss Alps
- Area: 17.8 km^2
- 7 lateral intakes
- Additional catchment: 31.8 km^2
- Total glacier cover: 17.5 km^2
- Altitude range: 1858-3614 masl
- Karstic behaviour

- A detailed description of the case study has been presented at IUGG 2015 and can be consulted by scanning the following QR code

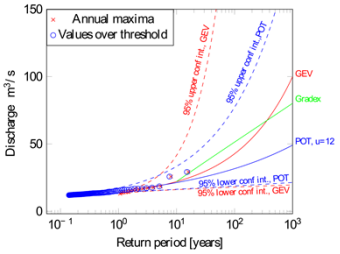
- 2 approaches are applied
  1. Statistically based methods
  2. Simulation based PMP-PMF method
- The results are compared and discussed

4. PMP-PMF simulation approach



5. Results and discussion

- Statistical extrapolations using GEV, POT and Gradex

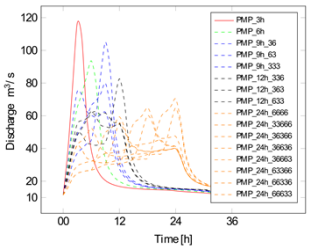


- Daily to hourly: $Q_{hourly}=1,7 \cdot Q_{daily}$

  The factor of 1,7 has been determined by hourly and daily simulations over the whole period from 1997 to 2009.

- Safety flood: $Q_{safety}=1.5 \cdot Q_{hourly}$

- PMP-PMF simulations for different precipitation durations



- Critical PMF from 3h-PMP
- Comparison between the PMF and the statistical estimation by ratio R defined below:

$$R = \frac{Q_{PMF}}{Q_{stat}}$$

R	Q_{GEV}=255 m^3/s	Q_{POT}=126 m^3/s	Q_{Gradex}=204 m^3/s
$Q_{PMF,3h}$=116 m^3/s	0.45	0.92	0.57

The results show that the statistical estimates are higher than the PMF. Different reasons can be stated:

- PMP data (maps) with limited choice of precipitation duration.
- Not enough data for reliable GEV or Gradex extrapolation.
- Gradex ignores the karstic effect.
- POT returns the closest estimation compared to PMF.

6. Conclusions

- The PMP-PMF method may not always overestimate extreme flood.
- Statistical methods can lead to very high estimates (>2 · Q_{PMF}).
- Statistical methods are not recommended as standalone for extreme flood estimations based in short time series.
- Importance of using different estimation methods in order to compare the results.

7. Present research

- Determination of the **temperature** to be considered for event based extreme flood estimations.
- Research on the initial conditions in terms of **soil saturation** and **snow height** to initialize the simulation model for extreme flood estimations.
- **Comparison** between the results arisen from the two main method families (statistics and simulation).
- Determination of the application **limit of PMP maps.**

Acknowledgements
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