Understanding Paleofloods for Estimating Damage Loss Potential in the Future

Tina Swierczynski[1], Franz Prettenthaler[2], Michael Hofstätter[3], Hansjörg Albrecher[4], Dominik Kortschak[2], Judith Köberl[2], Annemarie Lexer[3]

[1] *Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Potsdam, DE;*
[2] *JOANNEUM RESEARCH Forschungsgesellschaft mbH (incl. project coordination), Graz, AT;*
[3] *Zentralanstalt für Meteorologie und Geodynamik, Vienna, AT;*
[4] *Université de Lausanne, CH*

Motivation

The summer floods of 1997, 2002 and 2013 rank among the most severe events in Austria according to related damage losses. Usually, estimations of damage potentials and the resulting calculations of insurance premiums are based on damage experience and floods comprising comparatively short time periods and few data points, often covering a few decades only.

In the FloodRisk-7000 project (https://floodrisk.joanneum.at/), we aim at providing improved estimations on flood damage potential in Northern Austria for past, current and future climatic conditions by making use of and merging different kinds of data sets:

(1) Paleofloods 7000 years,
(2) Cyclone tracks & extreme precipiation,
(3) Damage loss (municipalities)

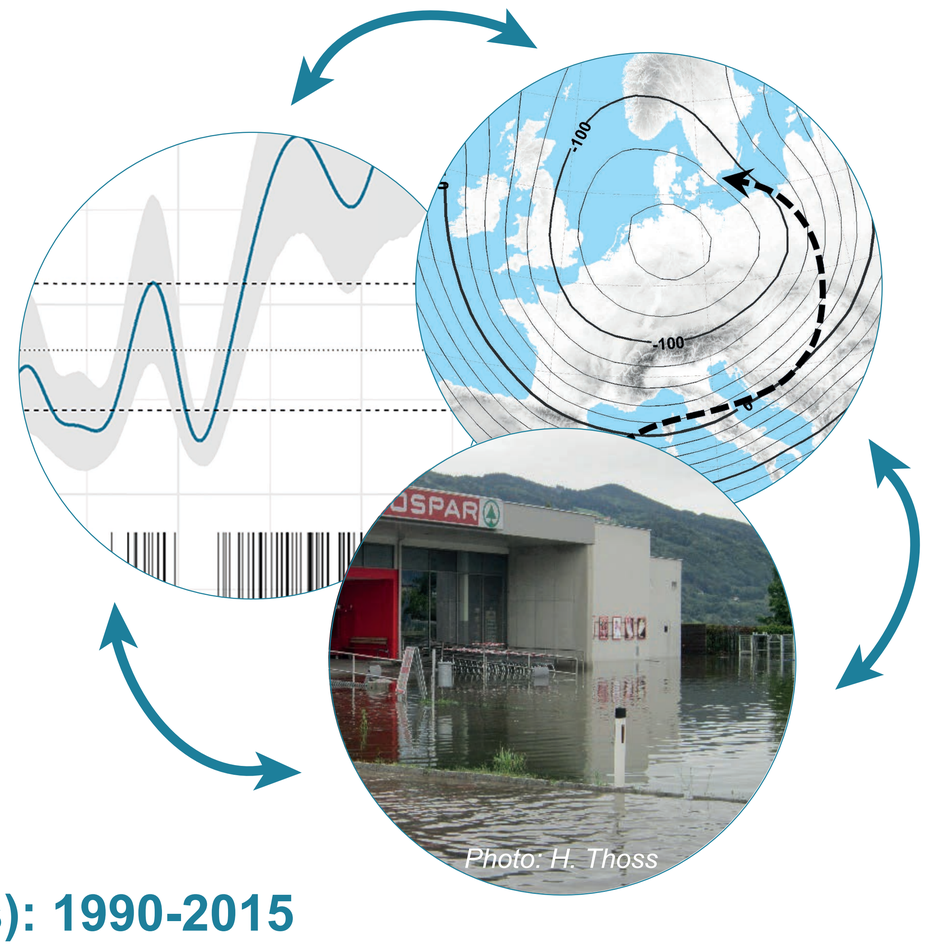
Data & Challenges

Paleofloods: 7000 years

Lake Mondsee sediments (NE Alps/Upper Austria) reveal a spring/summer flood record (75% floods > 80 m^3/s). Interestingly, floods occurred in 30-50 years episodes with higher frequency during climate transitions, in particular to cooling phases (e.g. little Ice Age: 1300-1500 AD). *Swierczynski et al., 2013, Quat. Sc. Rev.*

Extract relevant paleoflood information for model implementation:

- Statistical properties of sedimental flood records (stationarity, trends, inherent dependence patterns)
- Quantification of dating uncertainties to make use of it for modelling practices.



Cyclone track catalogue: 1959-2015

The European Alps are affected by different storm tracks leading to extreme precipitation events, resulting in flood events.

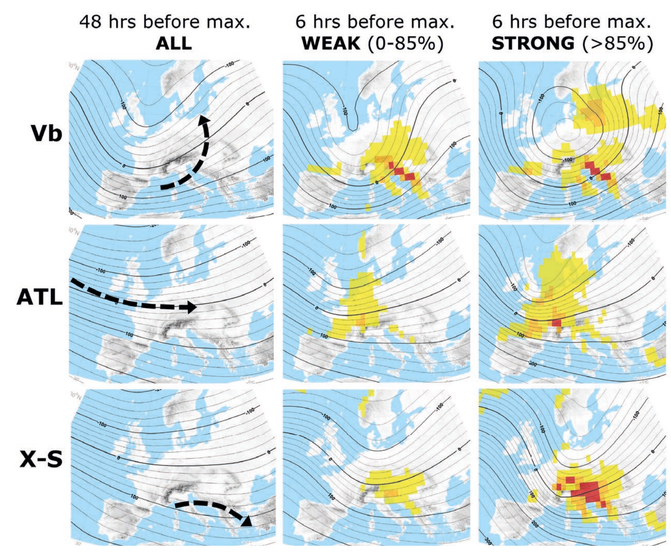


Fig 1. From: Hofstätter, M., Lexer, A., Homan, M. and G. Blöschl (2017). Heavy precipitation over Central Europe and the role of cyclone track types, Int. J. Climat., in review 2017.

Stormtracks at Lake Mondsee catchment will be evaluated:

- Attribution of highest 24h precipitation events to flood sediment record
- Future development of cyclone tracks and precipitation totals (GCM ECHAM6), 2015-2100
- Relating cyclone tracks to precipitation events

Damage loss (municipalities): 1990-2015

Flood loss data: Residential buildings, annual resolution, municipal resolution, Flood risk zones, building stock values (annual resolution, inflation-adjusted).

- Implementing paleoflood characteristics in data in flood risk model (cluster, uncertainty of data,...)
- Conducting an Extreme Value Analysis on loss data
- Calibrating a flood damage model for Austria using the spatial dependence structure (Neighborhood Relationship Flood Risk Model: $NeRF_{HORA}$)

$NeRF_{HORA}$ according to Prettenthaler, F., Kortschak, D., et al. (2015): Catastrophe Management: Riverine Flooding, in Steininger, K. et al. (ed.) Economic Evaluation of Climate Change Impacts: Development of a Cross-Sectoral Framework and Results for Austria, Springer.

Discussion & Outlook

Paleoflood analysis

Change Point Analysis based on inter-event occurrence time indicates four change points thus revealing different hydro-climatological regimes : 1582 BC, 1308 BC, 81 BC, and 1489 AD (see Fig. 2)

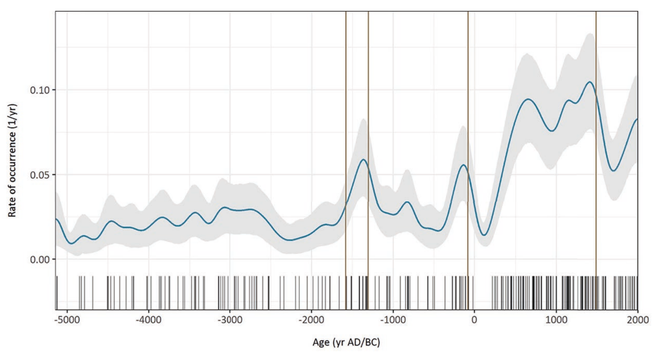


Fig 2. Paleofloods at Lake Mondsee (data from Swierczynski et al, 2013, Quat. Sc. Rev.): discrete flood layers, 100 year kernel regression incl. 5% uncertainty bands and change points)

Cyclone tracks & extreme precipitation

1959-2015: Cyclone tracks Vb, EA, X-N, X-S show a high probability for an RR95-heavy-precipitation-event in the region Nordstau (including the Mondsee's catchment area) within the summer half-year.

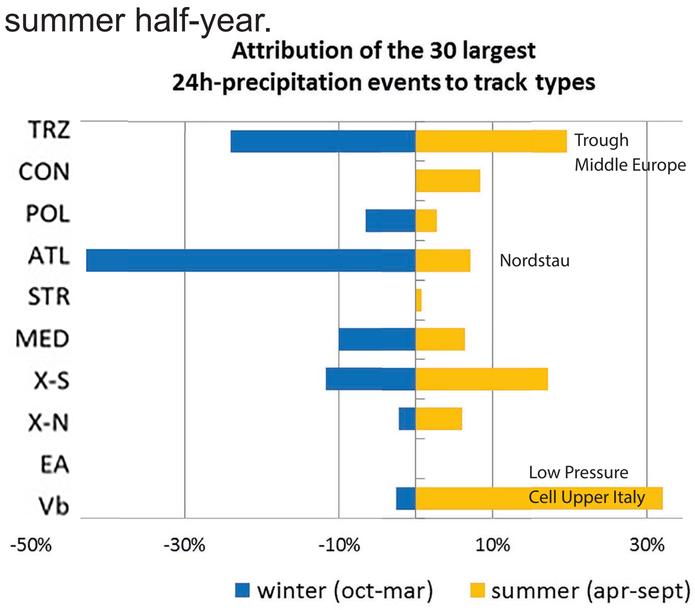


Fig 3. Track types according to: Hofstätter, M., Chimani, B., Lexer, A. and Blöschl, G. (2016). A new classification scheme of European cyclone tracks with relevance to precipitation, Water Resour. Res.,

Damage loss potential

Modelling of damage loss potential will include a probabilistic procedure to relate sediment data to flood loss data, assuming that high probability of discharge > 80m^3/s will cause damage in the catchment.

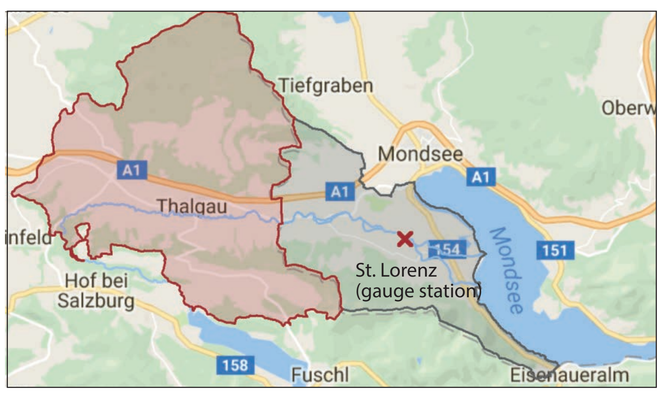


Fig. 4: River sub-/catchments most affected by floods at Lake Mondsee

Next: Relationship flood frequency variability (sediment records) & climate → **Modelling future flood damage potentials incl. Uncertainty analysis throughout the modelling chain**