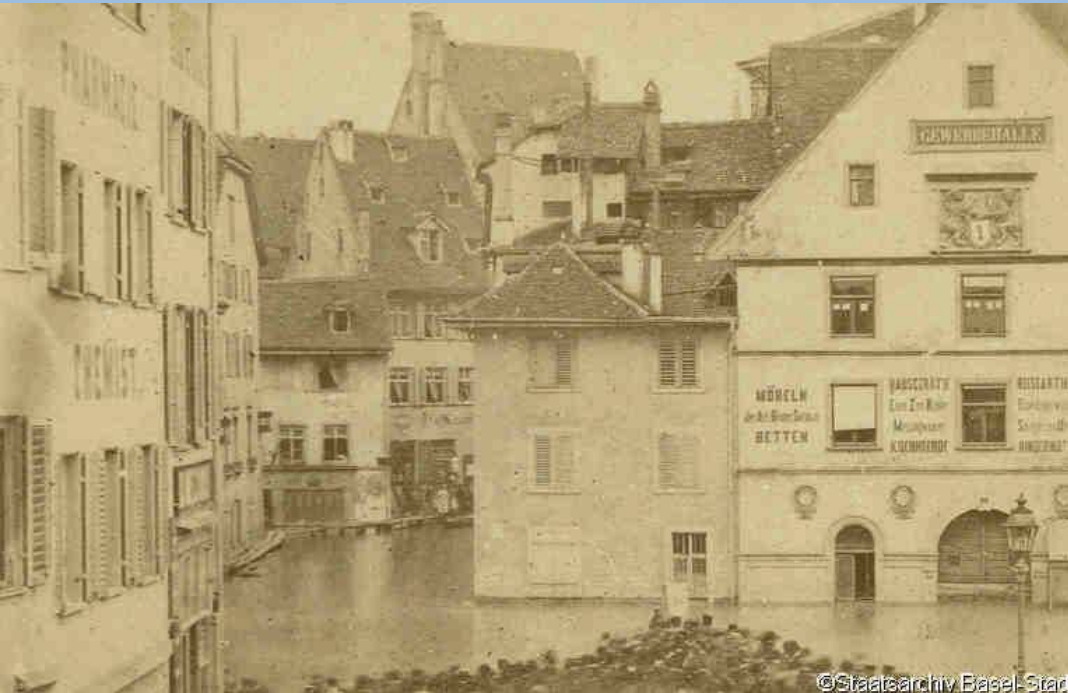


# HISTORICAL FLOODS IN SWITZERLAND

## Prerequisites, new trends in research



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and  
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University of Bern

Bonn, 9 November 2023

# Outline

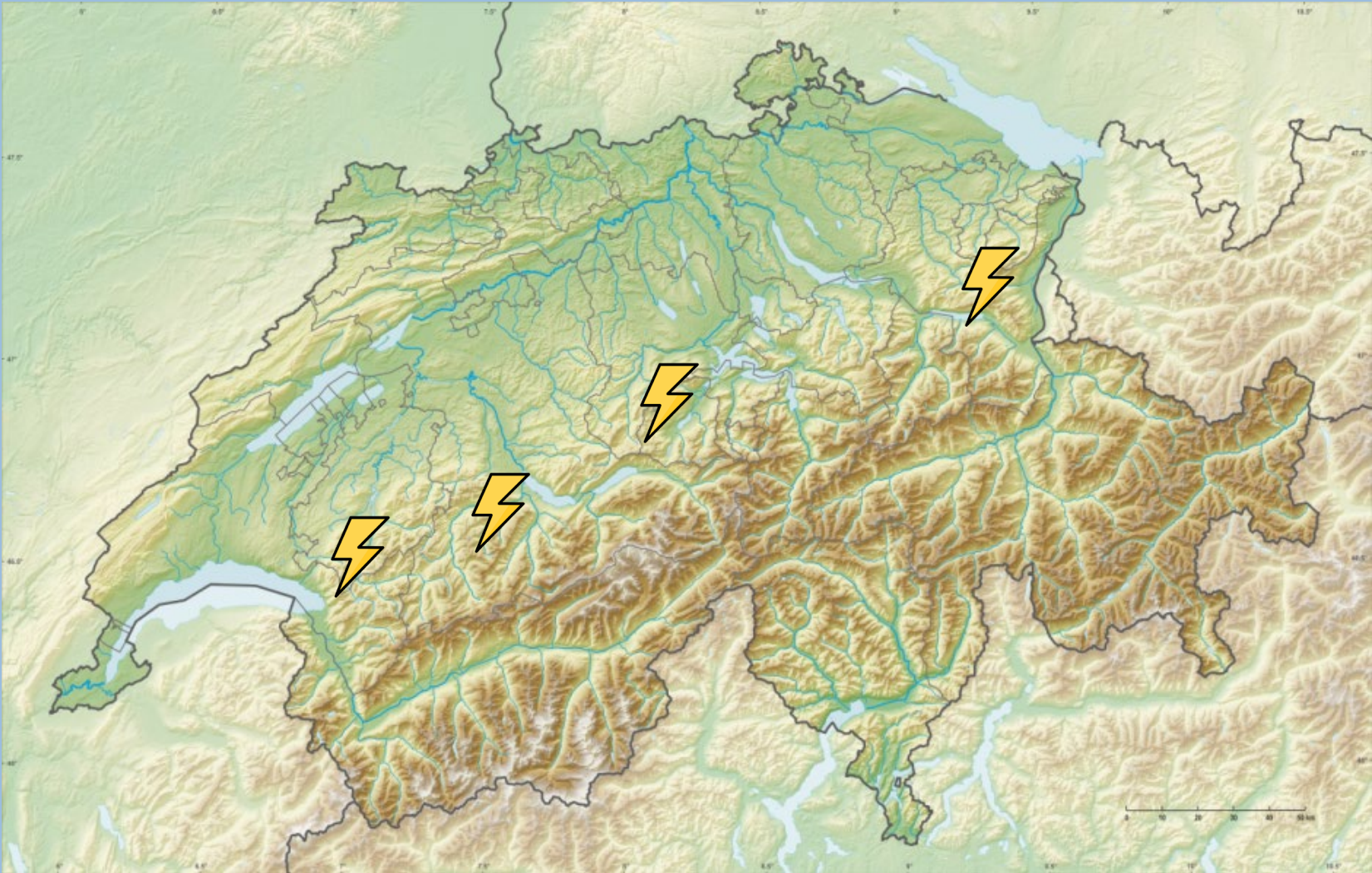
- Switzerland as the “water castle of Europe”
  - Catchment areas
  - Seasonal precipitation
- New trends in flood and drought research
  - Starting point: the state of the art 10 years ago
  - Worst-case scenarios: the extreme drought of 1540
  - Discovering the regional scale
  - New historical sources for the reconstruction of pre-modern and modern floods
  - New interdisciplinary studies related to anniversaries
    - 1868
    - 1947
  - New approaches from unusual perspectives
    - Historical floods and droughts related to nuclear power plants

# Switzerland as the “water castle of Europe”

- Numerous river systems in Central Europe with headwaters in Switzerland
  - Rhine (1232 km, of which 375 km in Switzerland)
  - Rhone (812 km, of which 264 km in Switzerland)
  - Inn (517/520 km, of which 104 km in Switzerland)
  - Ticino (248 km, of which 91 km in Switzerland)
- Rain and snowmelt
  - Heaviest rainfall in the summer months
  - Snowmelt mainly from April to July
- Extreme weather conditions
  - Humid, and rather mild winters (risk of avalanches)
  - (Late) spring rain and meltwater (floods)
  - Summer low-pressure systems from the northern Mediterranean
  - Thunderstorm activity on the edge of the Alps (Moleson, Pilatus, Säntis, etc.)

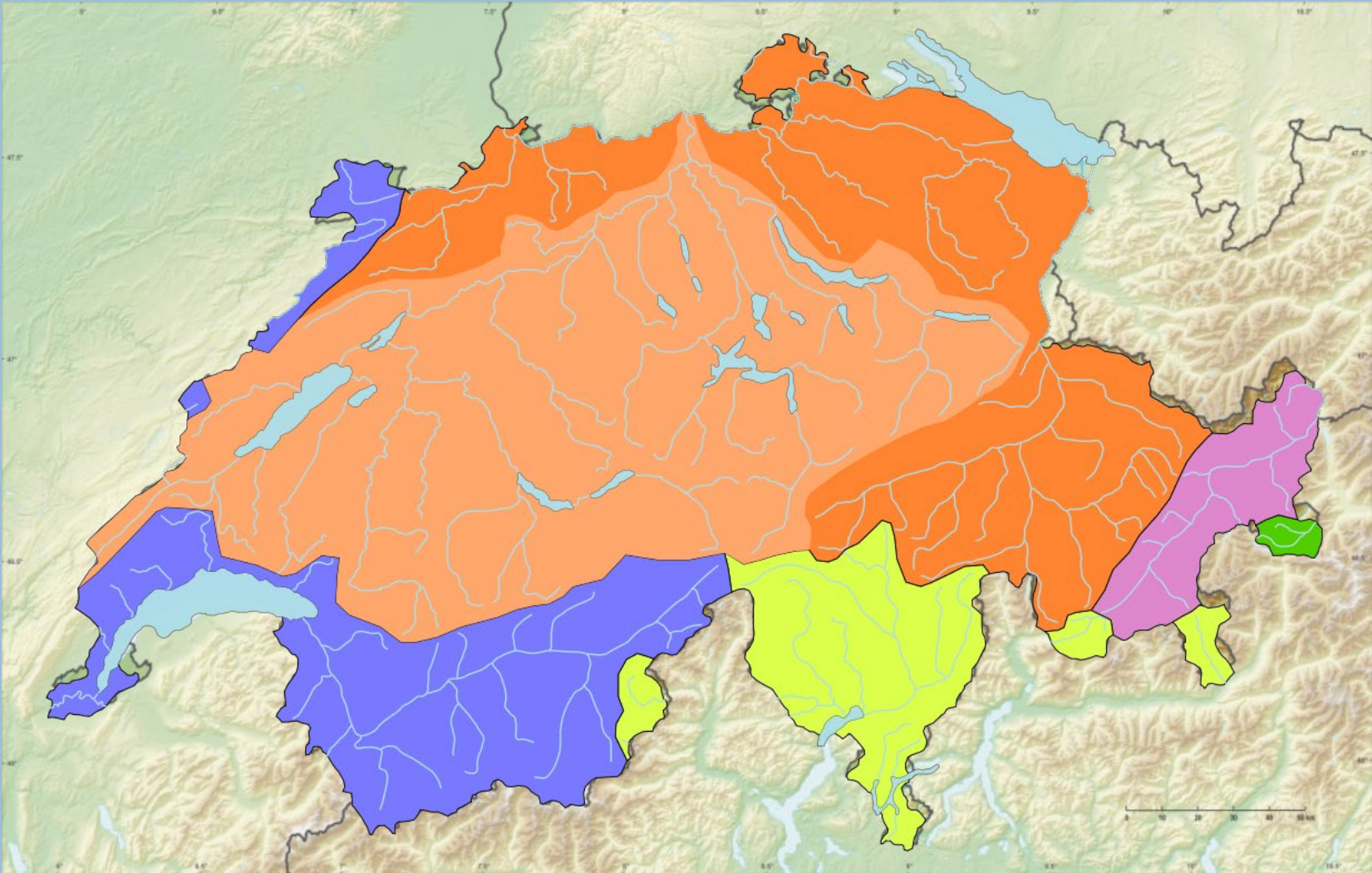
# Switzerland as the “water castle of Europe”

## Physical-topographical map of Switzerland



# Switzerland as the “water castle of Europe”

## Catchment area of the major Swiss rivers



# Switzerland as the “water castle of Europe”

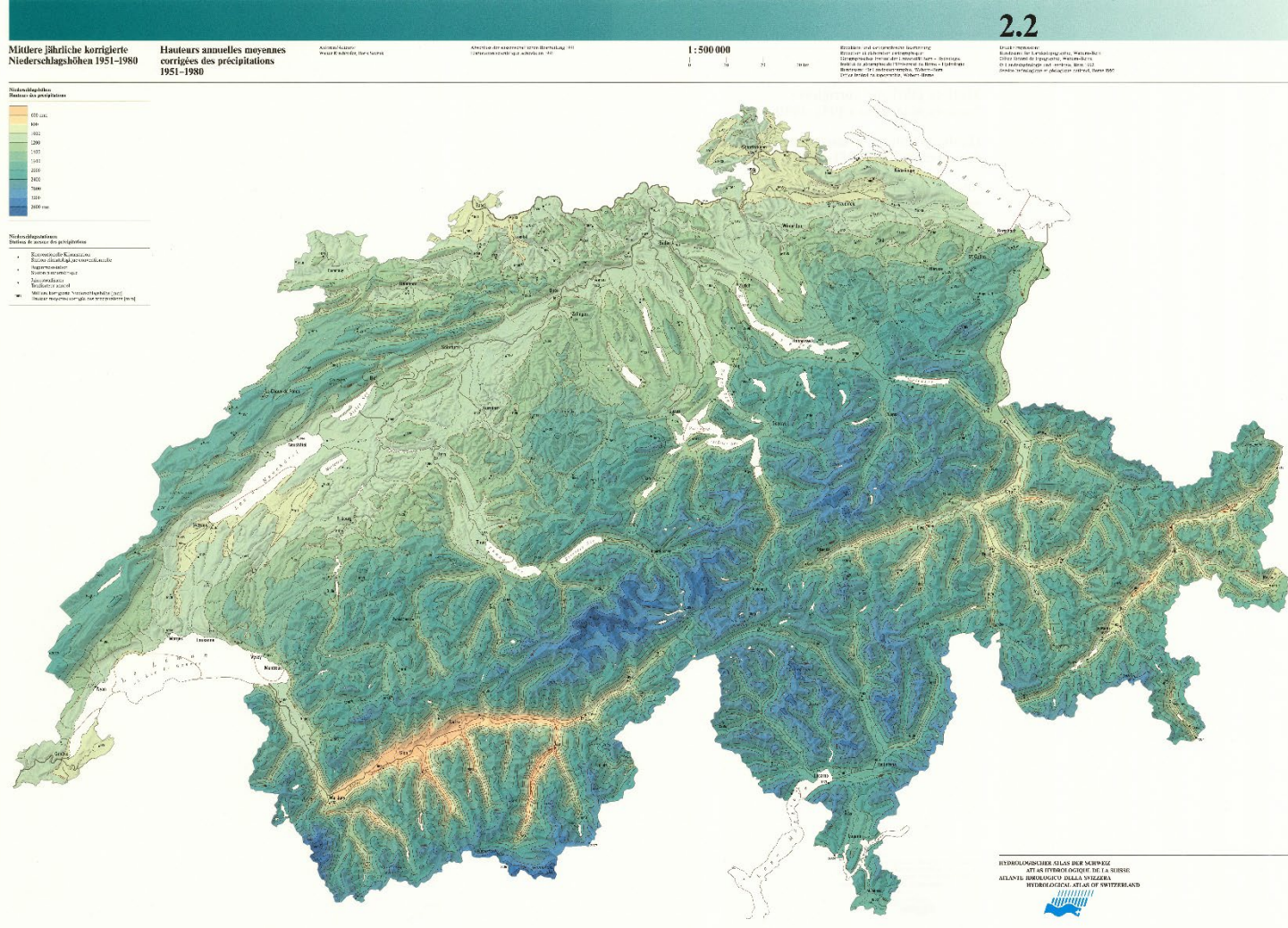
## Catchment area of the Rhine River and its tributaries



Source:  
University of  
Bern, Institute of  
Geography,  
Hydrology Unit /  
swisstopo

# Switzerland as the "water castle of Europe"

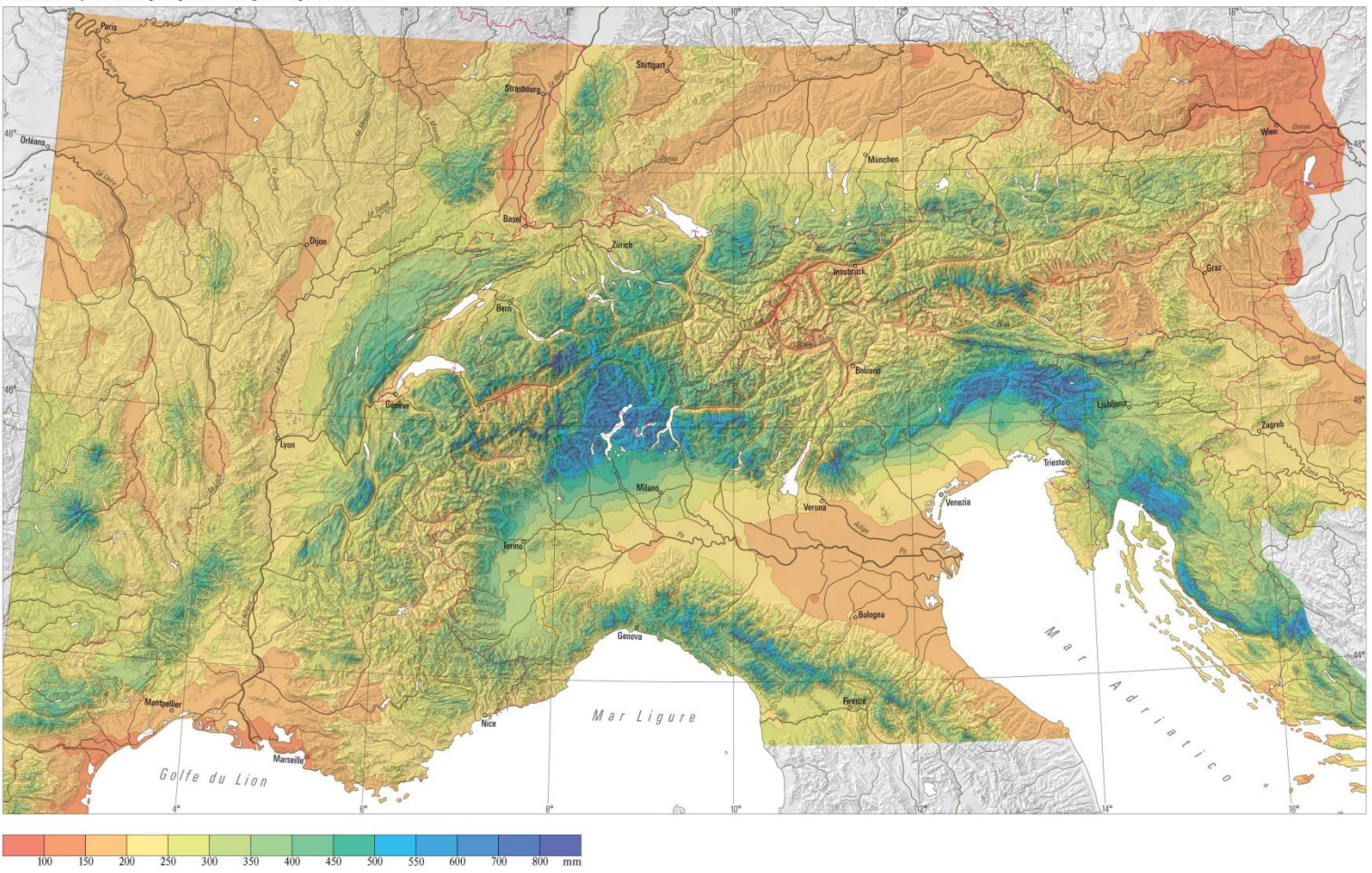
## Average precipitation, 1951-1980



Source:  
Hydrologi-  
scher Atlas  
der Schweiz

# Switzerland as the “water castle of Europe” Precipitation in the Alps by season, 1971-1990 Spring (March to May)

Mittlere Niederschlagshöhen im Frühling (März-Mai)  
Hauteurs moyennes des précipitations en printemps (mars-mai)



Flächentreue Azimutalprojektion, Kartengrundlage: PK 1000, © Bundesamt für Landestopographie  
Projection azimutale équivalente, base de la carte: PK 1000, © Office fédéral de topographie

Source:  
Hydrologischer Atlas  
der Schweiz

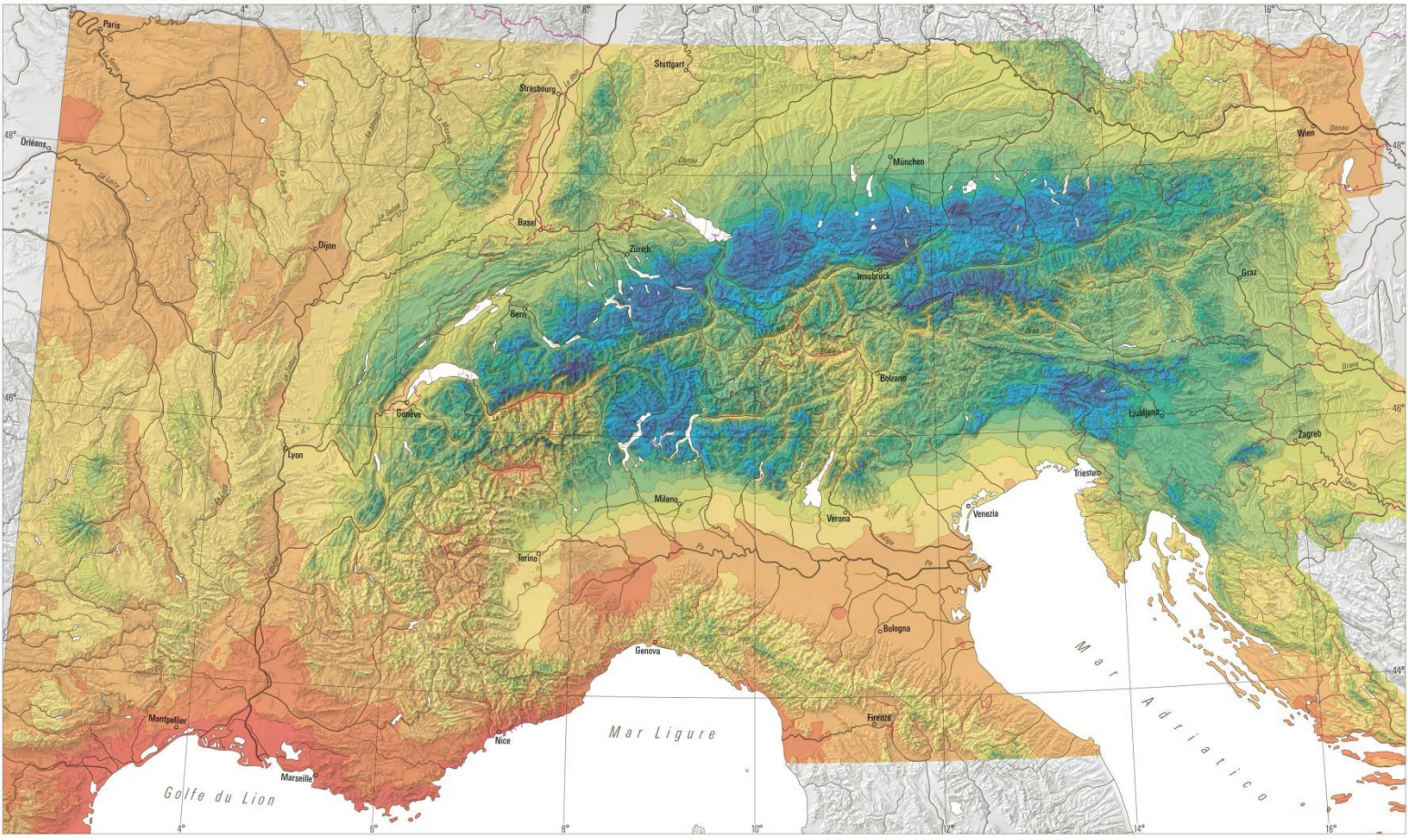


# Switzerland as the “water castle of Europe”

## Precipitation in the Alps by season, 1971-1990

### Summer (June to August)

Mittlere Niederschlagshöhen im Sommer (Juni-August)  
Hauteurs moyennes des précipitations en été (juin-août)



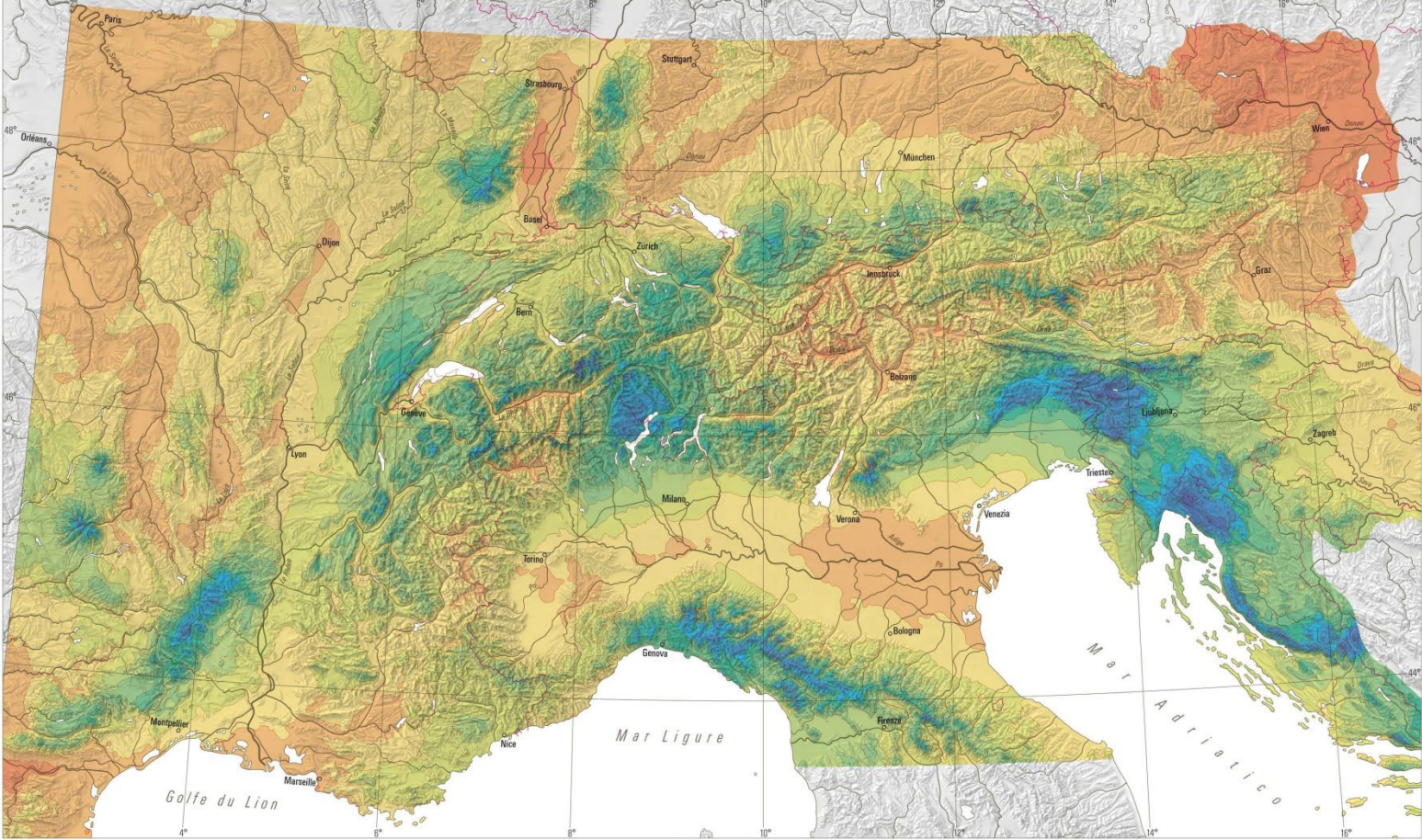
Source:  
Hydrologischer Atlas  
der Schweiz

# Switzerland as the “water castle of Europe”

## Precipitation in the Alps by season, 1971-1990

### Autumn (September to November)

Mittlere Niederschlagshöhen im Herbst (September–November)  
Hauteurs moyennes des précipitations en automne (septembre–novembre)

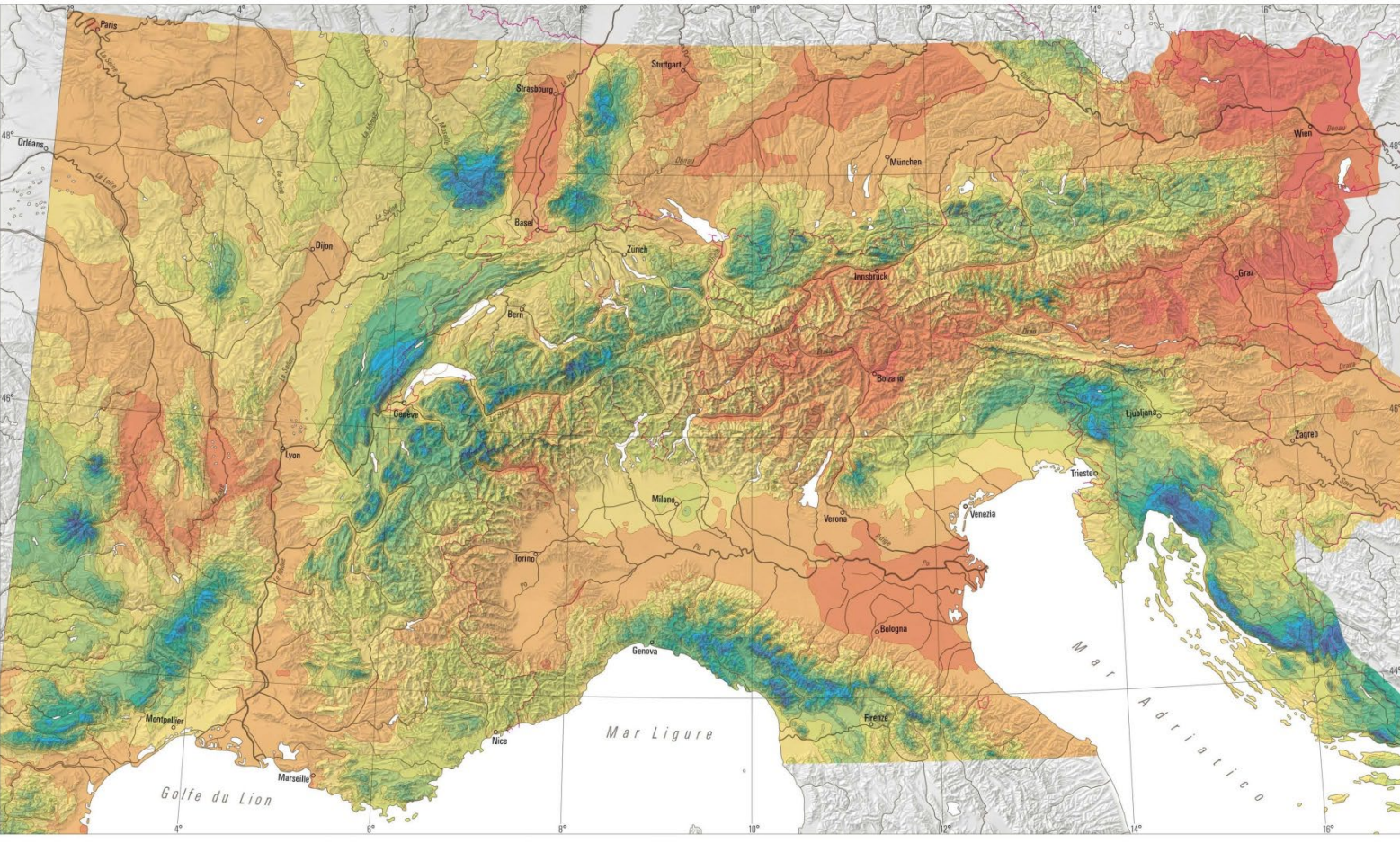


HYDROLOGISCHER ATLAS DER SCHWEIZ

Source:  
Hydrologischer Atlas  
der Schweiz

# Switzerland as the “water castle of Europe” Precipitation in the Alps by season, 1971-1990 Winter (December to February)

Mittlere Niederschlagshöhen im Winter (Dezember-Februar)  
Hauteurs moyennes des précipitations en hiver (décembre-février)



Quelle:  
Hydrologischer Atlas  
der Schweiz

# Flood frequency and flood risk in Switzerland

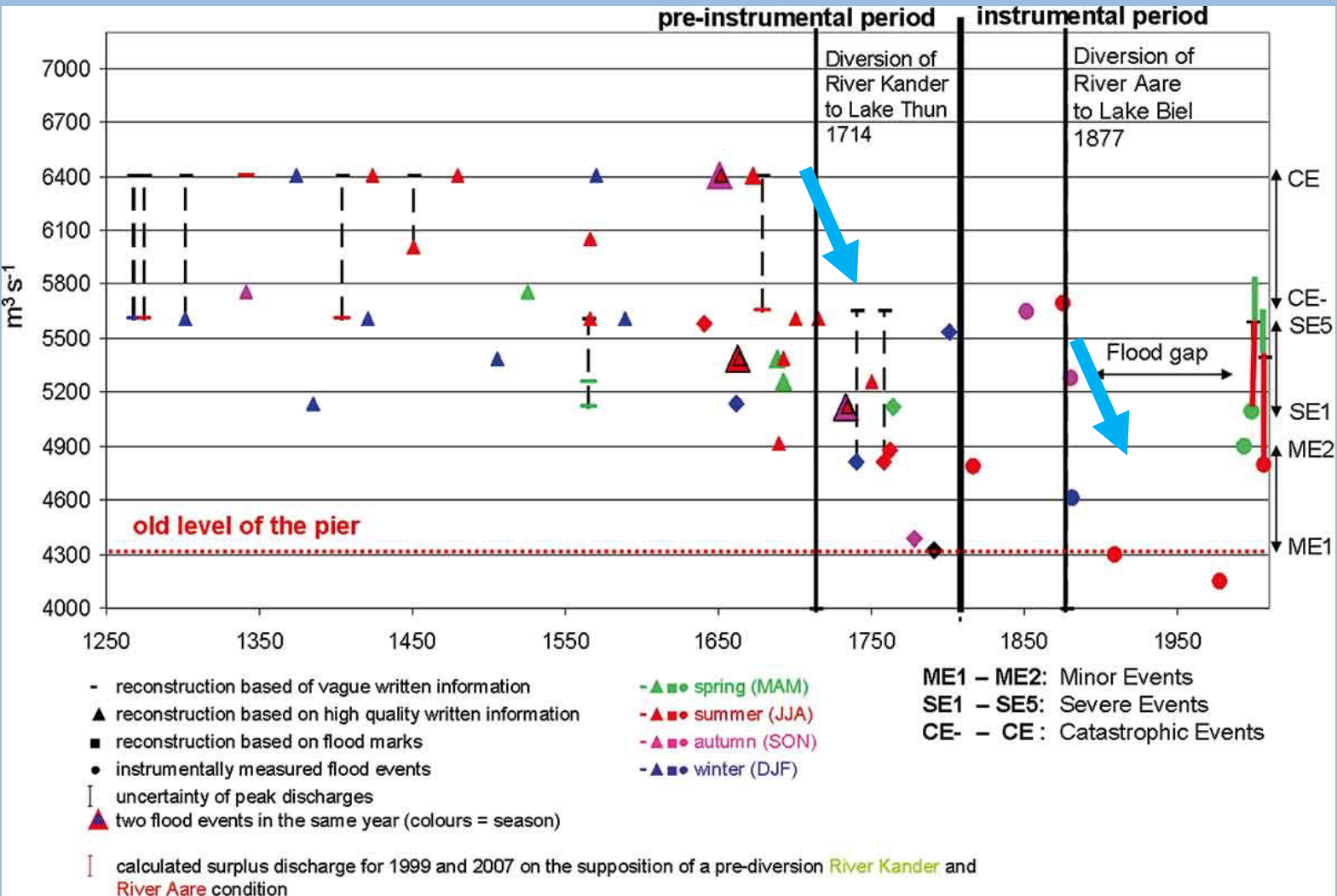
- First major river rectifications and deviations from the 18th century onwards
  - Kander breakthrough (1711-1714)
  - Linth canal (1800s)
  - Jura lakes melioration project (1868-1891)
- Intensity of floods decreases noticeably due to corrections
- Floods of 1868 as “worst-case scenario”
  - Trigger for a change to federal flood management legislation
  - Predominating technical flood protection
- “Disaster gap” (Christian Pfister) between 1910 and 1987
  - Hypothesis only applicable on a large-scale level
- New series of floods since 1987
  - Implementation of an integral flood protection since the 1980s
  - Large number of studies on flooding after the events of 2005 and 2007

# New research trends

## State of the art 10 years ago

- Large number of studies on flooding after the events of 2005 and 2007
- Approaches
  - Reist et al. 2002; Weingartner, Reist 2004  
Hydrological reconstruction of regional events, e.g. the flash flood of the Emme river in 1837 according to Jeremias Gotthelf's report
  - Schmocker-Fackel, Naef 2010  
Flood frequencies for Switzerland during the last 500 years
  - Wetter et al. 2011  
Flood frequency of the Rhine river in Basel since 1268
  - Summermatter 2012/2017  
Political activities for the prevention of floods in Switzerland (1868-1987)

# Frequency of floods in the city of Basel



Source:  
Wetter et al.  
2011: 745.

# New research trends

## Worst-case scenarios: the extreme drought of 1540

- Wetter et al. 2014: “The Year-Long Unprecedented European Heat and Drought of 1540 – a Worst Case”
  - Large international study on the millennium summer of 1540
  - More than 300 contemporary sources from human archives used
- Reception
  - Büntgen et al. 2015  
Critique by the dendrochronology community: no remarkable signal in tree-ring data
  - Response by Pfister et al. 2015: “Tree-Rings and People – Different Views on the 1540 Megadrought. Reply to Büntgen et al. 2015”  
Resolution of anthropogenic sources higher than any natural archive
  - Reference study for the understanding of the hot and dry summers from 2003 onwards

# New research trends

## Discovering the regional scale

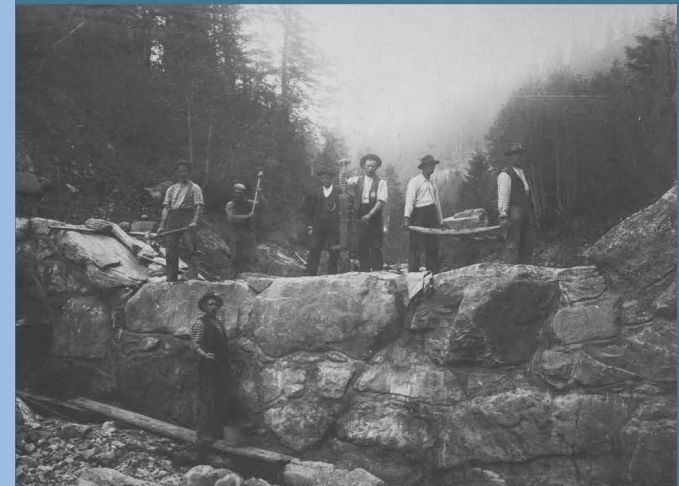
- Challenge of Christian Pfister's concept of a "disaster gap"
  - Not applicable on a regional and local level (?)
- Salvisberg 2017
  - Flood protection along the Gürbe river (canton of Bern)
  - "The most expensive torrent of Switzerland"
  - High-resolution reconstruction of regional flood regimes
  - Definitely no "disaster gap" there
- Heinzmann 2019
  - Flood protection and management along the lower Emme river

Melanie Salvisberg



### Der Hochwasserschutz an der Gürbe

Eine Herausforderung für Generationen (1855–2010)



Schwabe



# New research trends


## New historical sources for the reconstruction of pre-modern and modern floods

- Various studies at the Institute of History, University of Bern
  - Partly related to the SNSF project “Reconstruction of the genesis, process and impact of major pre-instrumental flood events of major Swiss rivers including a peak discharge quantification”
- Sources
  - Urban account books with weekly expenditures on
    - Repairs for bridges
    - Maintenance of protective buildings
  - Pictorial evidence for flood reconstruction
- Publications
  - Rohr 2014: Serial iconography to evaluate early disaster photography
  - *Berner Studien zur Geschichte* open access series
    - Longoni 2019: Fribourg, 14th to 16th centuries
    - Spycher 2022: Basel, 1600-1650
    - Ineichen 2024 (forthcoming): Solothurn, 15th century

# New research trends

## New interdisciplinary studies related to anniversaries

- 150th anniversary of this “centennial flood” in 2018
- Contributing disciplines
  - Climatology
  - Hydrology
  - Forestry studies
  - Geology
  - Environmental and climate history
  - Political science
- Publication for a wider audience (*Geographica Bernensia* series)
  - Print and open access
  - German, English, French, and Italian version




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GESCHIEHEN CENTRE  
CLIMATE CHANGE RESEARCH

**1868 – the flood  
that changed Switzerland:**  
Causes, consequences and lessons for the future



GEOGRAPHICA BERNENSIA

# New research trends

## New interdisciplinary studies related to anniversaries

- 75th anniversary of the extremely dry summer of 1947
  - Recent hot summers as additional trigger
- Various contributing disciplines
- Publication for a wider audience (*Geographica Bernensia* series)
  - Print and open access
  - German, English, and French version



b  
UNIVERSITÄT  
BERN  
DESCHER CENTRE  
CLIMATE CHANGE RESEARCH



### Hot and dry summers in Switzerland

Causes and impacts of the record summers  
1947, 2003, and 2018



GEOGRAPHICA BERNENSIA

**Thank you for your attention!**

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