448 years after the event:

Quantifying the local-scale effects of a Vb cyclone hitting Central Europe in 1572 using a detailed historical damage inventory

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The central European flood of 1572 and its local-scale effects as revealed by a damage inventory

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ABSTRACT

A cyclone in July 1572 caused a catastrophic flood in the catchments of the Upper Danube and Vltava rivers. A previously unpublished inventory dating to 1574 enabled local-scale insight into the effects of the cyclone. The degree of destruction was inventoried for 355 subjects of the Benedictine Abbey of Admont, Austria. The location of 150 damaged buildings was possible due to registers, cadastres and other geographical sources. Spatial analysis revealed that most of the properties damaged were located near watercourses at alluvial fans. A significantly greater amount of damage was revealed for properties, which would be nowadays located in moderate- and high-risk hazard zones. Only 18.7% of the properties damaged in 1572 were located inside modern hazard zones. By using methodological approaches of history, environmental history and geography, we show that it is possible at local scale to reconstruct the spatial pattern, magnitude and intensity of a cyclone ca. 450 years after the event.

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Introduction

Reconstructing the effects of natural processes on the landscape that happened several centuries ago and which might have been perceived as disasters by contemporaries is widely considered to be difficult (e.g. Hammerl 1992, Glaser 2001, Rohr 2007). Quantifying, for instance, the effects of a regional-scale flood event in terms of the area affected and the degree of devastation is normally outright impossible due to sparse or missing data. Floods in Austria, as an example, which occurred in Medieval or Early Modern Times have hardly been studied in detail apart from individual studies or general overviews of past disasters provoked by nature (e.g. Rohr 2005, Hohensinner 2015a). Quantifying the effects of an extreme meteorological event helps to heighten understanding of the human–nature relationship in a period when manmade, modern changes of riverbeds and protection structures against floods, debris flows, rock falls or avalanches did not exist or did so only to a very limited extent. Furthermore, the reconstruction of historical floods is highly important for frequency-magnitude considerations of natural hazards and in relation to possible climate change impacts (e.g. Cœur and Lang 2017). The conversion of historical information about flood-water levels into quantitative values of water discharge is a complex process where complementary information must be collected and analysed (e.g. Barriendos *et al.* 2003, Brázdil *et al.* 2006). However, there is considerable potential for improving the reliability of the current flood risk assessments by using the valuable information on past extreme events (Kjeldsen *et al.* 2014). Barnikel (2004), for instance, used historical data of small mountain torrents to show that modern hazard zone maps in Germany fail to sufficiently consider historic events. Finally, reconstructions of past damaging events also help to understand what might happen, if protection structures did not exist during similar extreme meteorological events.

However, the questions arise: What kind of processes were perceived as hazards and what events were seen as a disaster for the contemporary in early Modern Times? In natural hazard usage, the term "hazard" features two different definitions. It can be understood as an actual physical process or a situation that has the potential to cause damage. The other option is to comprehend it as a threatening condition provoked by the behaviour of a given process. The severity of the natural hazard is, in that case, expressed as the probability of the occurrence of a damaging process (Crozier and Glade 2004). Here, we follow the former definition that a natural hazard is associated with natural or geophysical processes and involves the potential for complete loss or human injury or damage to infrastructure (e.g. Stillwell 1992, Dikau and Weichselgartner 2005). A natural hazard event can become a disaster or a catastrophe in the perception of people, particularly if external help is indispensable for coping with the effects of the respective event (Felgentreff and Glade 2008). This is especially the case when the unexpectedness in terms of timing or magnitude can create a catastrophic feeling (Rohr 2007). The storytelling and collective memory of its effects are ways of coping with the situation as well. The passing on of this information over generations can be used to overcome similar events by providing the chance of comparison. Of course, exaggeration of events cannot be ruled out in many of such

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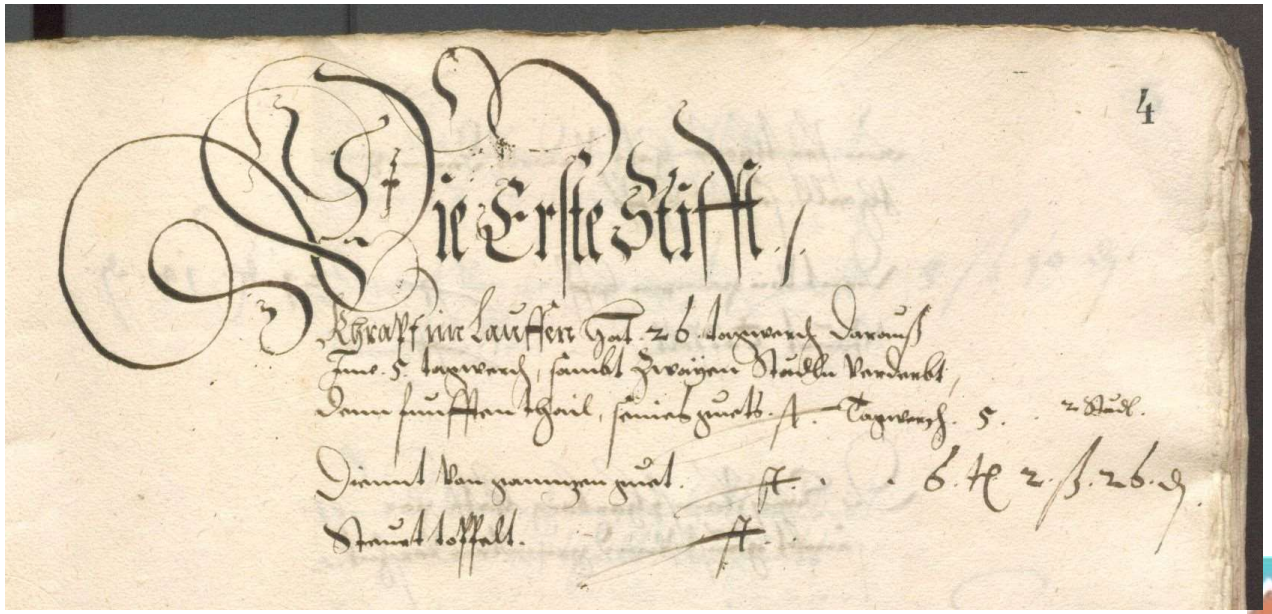
Introduction

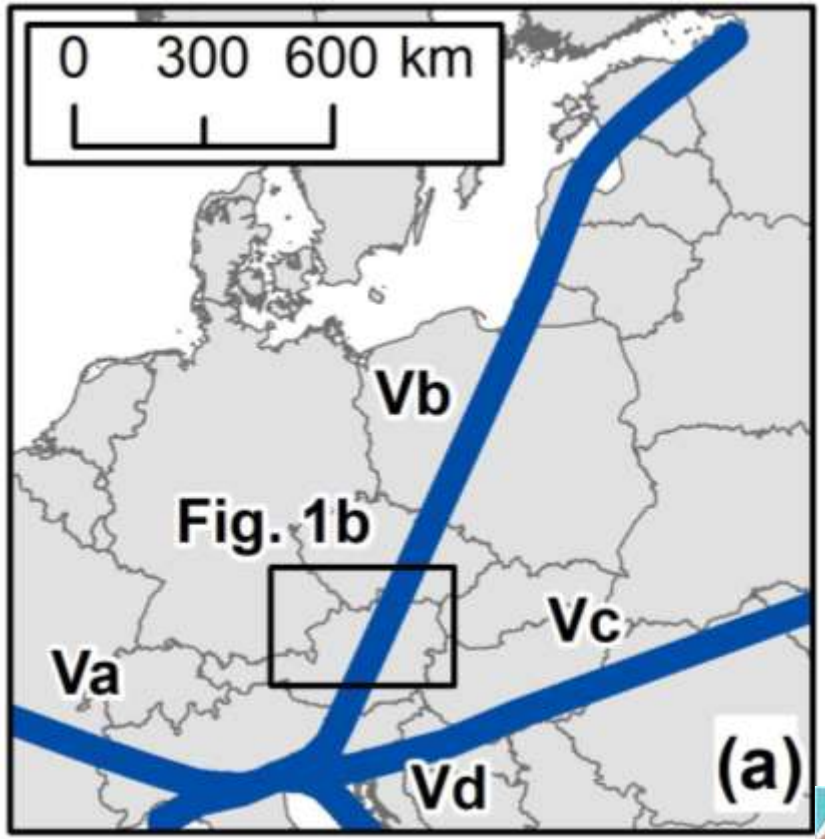
- The modern quantification of the effects of such extreme event helps to increase the understanding of the human-nature relationship in a period when manmade, modern changes of riverbeds and protection structures against floods or debris flows did not exist or did so only to a very limited extent.
- However, quantifying the effects of a historical regional-scale flood event in terms of degree of devastation at local-sale is normally outright impossible due to lack of detailed data.



Historical document dating to 1574 used in this study (taken from Eulenstein & Kellerer-Pirklbauer 2020)

Introduction

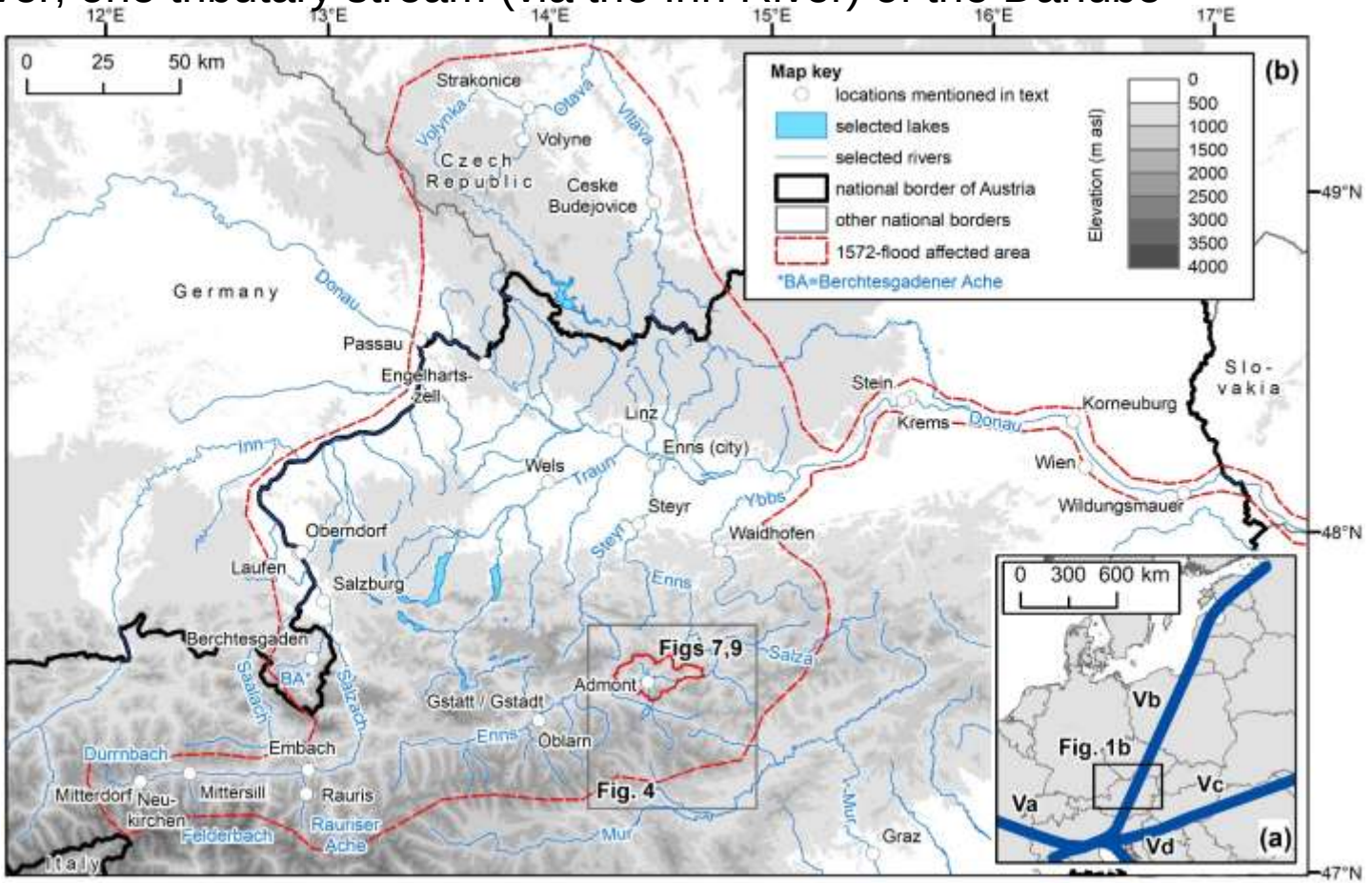
- One of the most severe floods that has ever been registered in the catchment of the Upper Danube River in Central Europe is the one that took place in June/July 1572.
- This flood was caused by a prolonged precipitation event related to a so-called Vb cyclone.
- Vb cyclones bring extreme weather conditions with sustained precipitation over the northern side of the European Alps and Central Europe.



Typcial Vb-cyclone trajectory (taken from Eulenstein & Kellerer-Pirklbauer 2020)

Regional-scale impact

- The impacts of the Vb cyclone in 1572 severely affected transport routes and local economies as indicated for instance by salt transport data from the Salzach River, one tributary stream (via the Inn River) of the Danube River.



Regional-scale map with flood-affected area (taken from Eulenstein & Kellerer-Pirklbauer 2020)

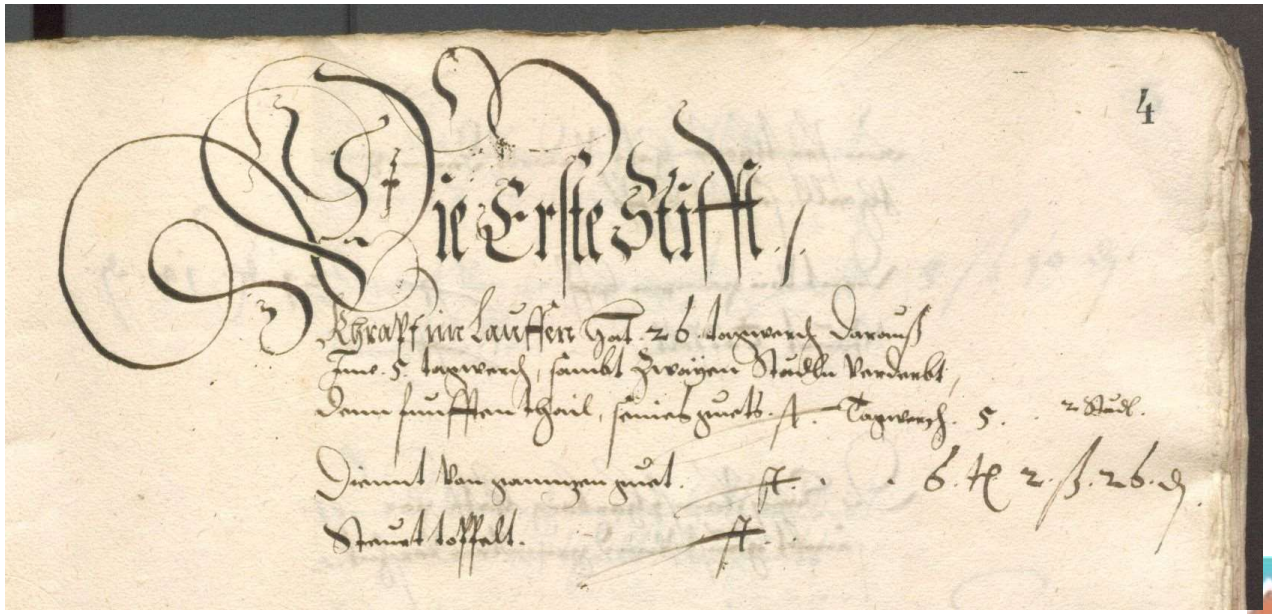
Regional-scale impact

- Different means of remembrance as historical flood level markers or memorial stones at several cities in Central Europe suggest that contemporaries considered the outcome of the cyclone as catastrophic.

The July 1572 flood – means of historical remembrance in Salzburg (upper left) and Steyr (right and lower left) – both in Austria (taken from Eulenstein & Kellerer-Pirklbauer 2020)

Local-scale impact

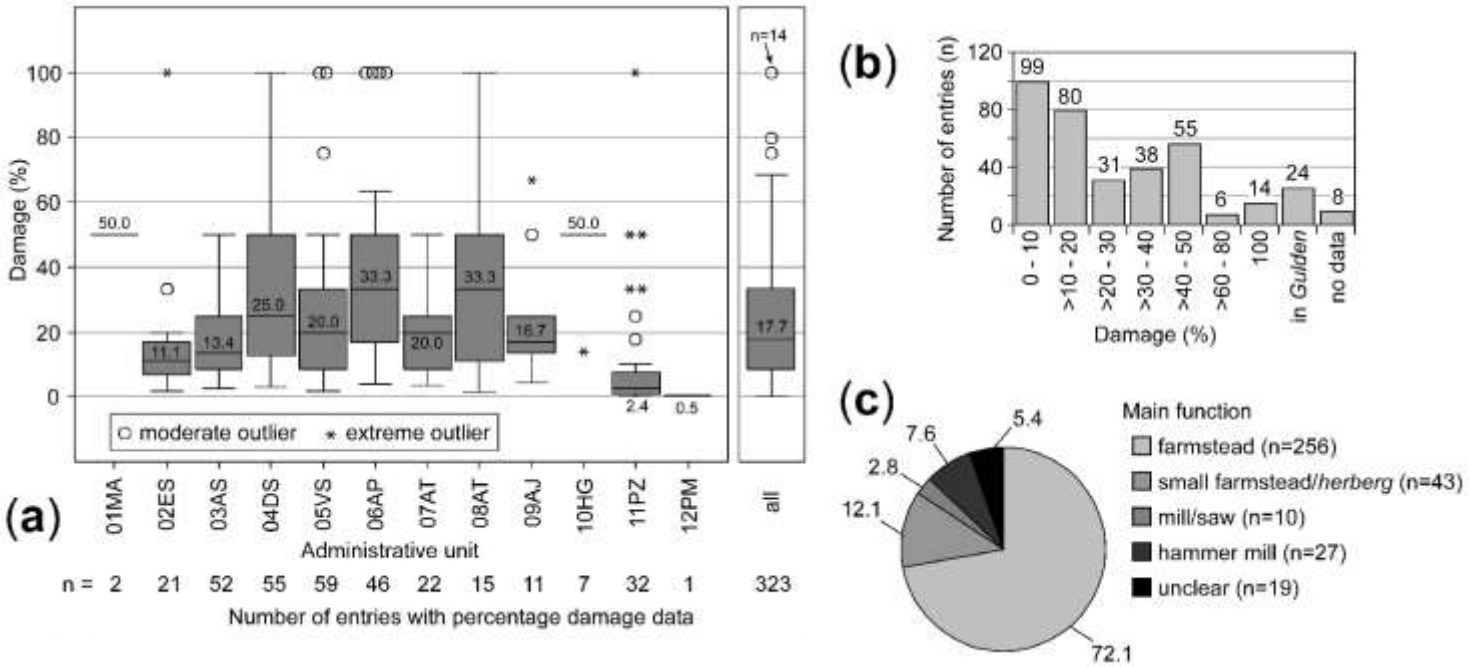
- A detailed damage inventory referring to the cyclone of 1572 was analysed.
- The purpose of the inventory was to reduce taxes for the Benedictine Abbey of Admont.
- The interdisciplinary analysis (historian, geographer) of the source enabled a local-scale insight into the effects of the cyclone at Admont.



Historical document dating to 1574 used in this study (taken from Eulenstein & Kellerer-Pirklbauer 2020)

Local-scale impact

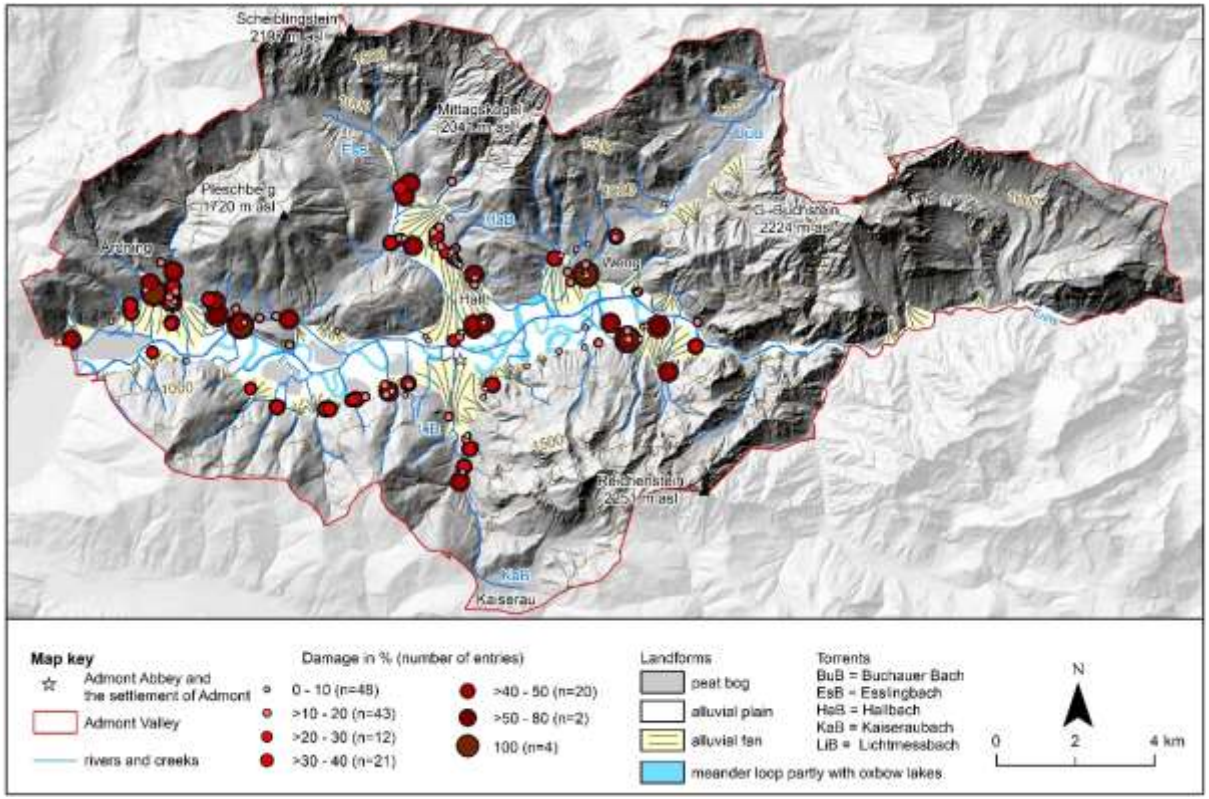
- The inventory contains a list of 355 subjects of the abbey distributed over 12 administrative units that suffered minor to severe (complete destruction) damage related to flooding (main river or tributary creeks), debris-flows or landslides.



Degree of damage caused by the 1572 event and contemporary economic conditions at the 12 administrative units of the Benedictine Abbey of Admont: statistical distributions of (a) the degree of damage for each administrative unit and (b) for different damage classes; (c) main function of the 355 inventory entries (taken from Eulenstein & Kellerer-Pirklbauer 2020)

Local-scale impact

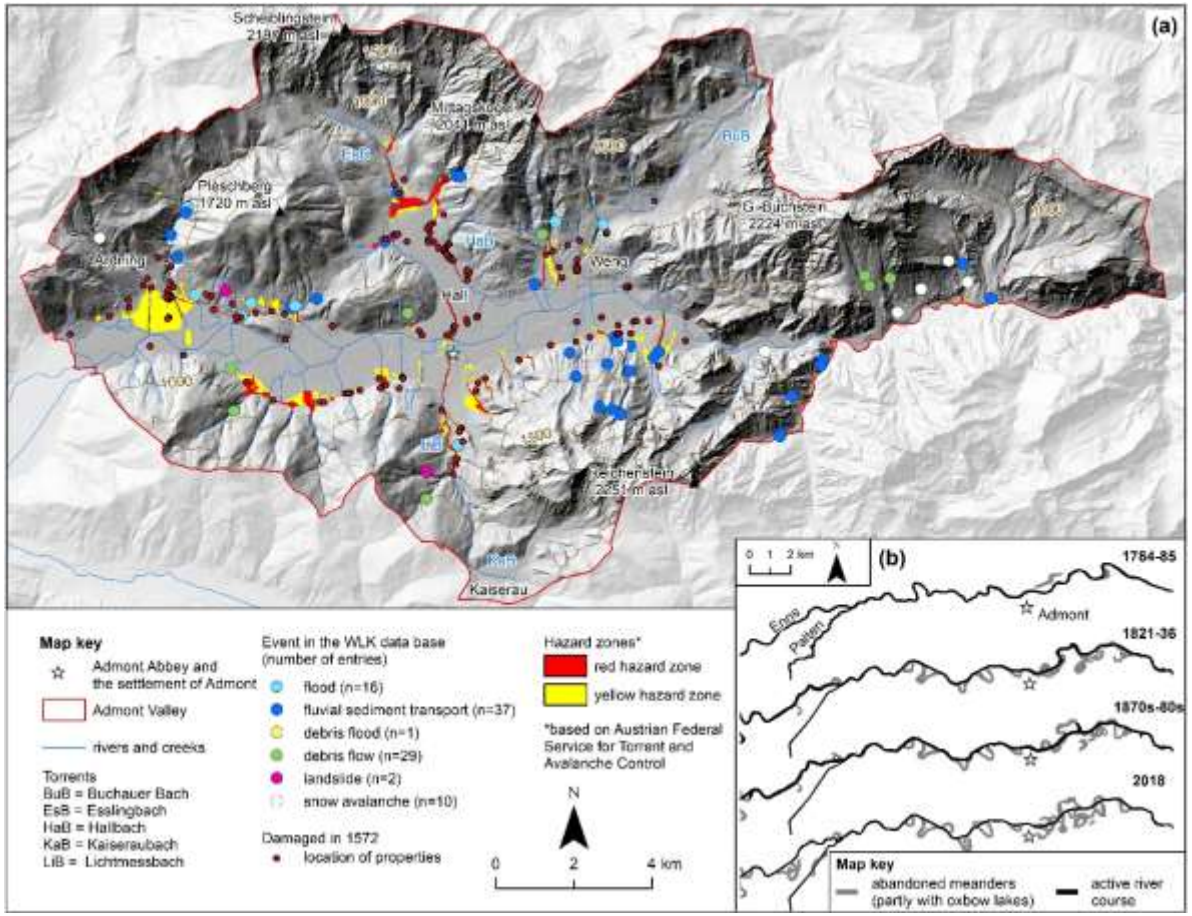
- Further historical sources and geographical data such as land registers and cadastres allowed the localization of 150 damaged buildings at cadastral scale in the valley surrounding the abbey.



The Admont Valley with the spatial distribution of the 150 localized subjects hit by the heavy precipitation event in July 1572. The degree of damage (classified), the number of entries per percentage class, and relevant landforms are indicated (taken from Eulenstein & Kellerer-Pirklbauer 2020)

Local-scale impact

- Our analyses show that most of the properties were located near watercourses at alluvial fans or at slopes above the Enns valley bottom.
- A significantly greater amount of damage was revealed for properties, which would be nowadays located in moderate- and high-risk hazard zones.



Relationship between the 150 localized properties in the Admont Valley harmed in 1572 and the damaging events (n = 95) documented in the period 1851–2017, as well as the spatial extent of yellow and red hazard zones along torrents as defined by the hazard zone maps of the Austrian Federal Service for Torrent and Avalanche Control (taken from Eulenstein & Kellerer-Pirklbauer 2020)

Conclusions

- Modern hazard zone maps are commonly based on runoff modelling using design flood events.
- Our analysis suggests, nevertheless, that previously undetected or unconsidered sources might contribute substantially to the understanding of the spatial pattern of potential damage in an entire valley region during an exceptional cyclone at a local and even cadastre scale.
- This achievement is possible despite obvious changes in geomorphological, hydrographical, building structure and protective measure conditions since 1572.

(taken from Eulenstein & Kellerer-Pirklbauer 2020)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