INTERPRAEVENT
2024 - Vienna, Austria

June 10th – 13th, 2024

Rainfall-induced landslide types during the Rainstorm in August 2023 in Carinthia (Austria)

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Abstract

Hundreds of gravitational mass movements were triggered in Carinthia (Austria) in the course of a four-day heavy precipitation event. This extreme precipitation event were preceded by a period of rainfall over several weeks, which led to a high degree of soil soaking. In addition to floods and mudflows, the dominant gravitational mass movements were landslides and soil flows, some of which caused extensive damage.

Event description

In the first week of August 2023, an area of low pressure moved from northern Italy to Eastern Europe (depression Zacharias) and brought large amounts of rain to the southern and northern sides of the Alps in a short period of time (Fig. 1). In Figure 1 shows the precipitation sum for five days created on 7 August (1 A) and monthly sums in July 2023 with respect to two periods (1B and 1C).

Table 1: Monthly sums of precipitation (mm) of **July** in the reference period 1991-2020 and 1961-1990 compared to 2023 recorded in several stations in Southern Carinthia (Source GeoSphere Austria).

	1961 - 1991	1991 - 2020	2023
Bad Eisenkappel	150 mm	139 mm	331 mm
Loibl	193 mm	181	430 mm
Ferlach	137 mm	137 mm	264 mm
Feistritz ob Bleiburg	136 mm	127 mm	239 mm

Process types

Hundreds of gravitational mass movements were triggered during the storm and flood event (fig. 2 and 3). A systematic survey of all gravitational mass movements could not be carried out due to the large number of processes and limited human resources. Only those gravitational mass movements that occurred directly in the settlement area and/or caused damage were documented.

Figure 4: A large earth flow caused severe damage on several houses (by F. Goldschmidt).

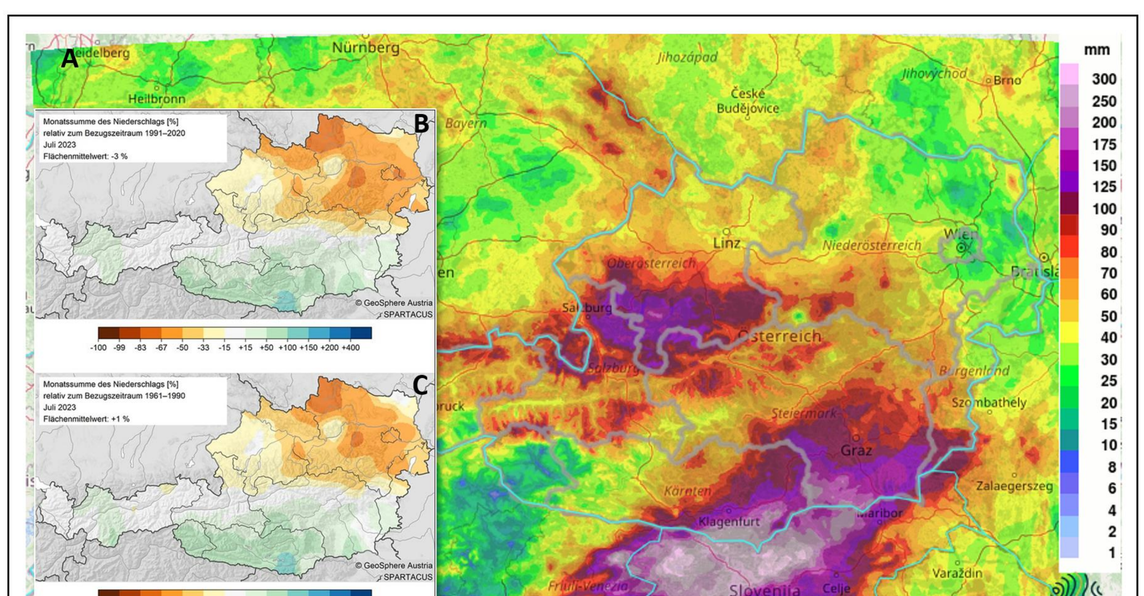

Figure 1: The precipitation sum for five days in August, created on 7 August 2023 (A) and monthly sums of precipitation (mm) of July for the reference period 1991-2020 (B) and 1961-1990 (C) (Source: GeoSphere Austria).

These extreme precipitation events were preceded by a rainy July, with monthly average precipitation 50-200 % higher than in the last 60 years (Tab.1). The first mudslides and floods occurred on 4 August. In correlation with the distribution of precipitation, the Lower Carinthian region, especially the municipalities of Eisenkappel and Voelkermarkt, were most affected by landslides during the Zacharias depression. However, numerous landslides and floods were also recorded in Diex, Brueckl, Ebenthal and Klagenfurt and some municipalities in the Lavanttal valley.

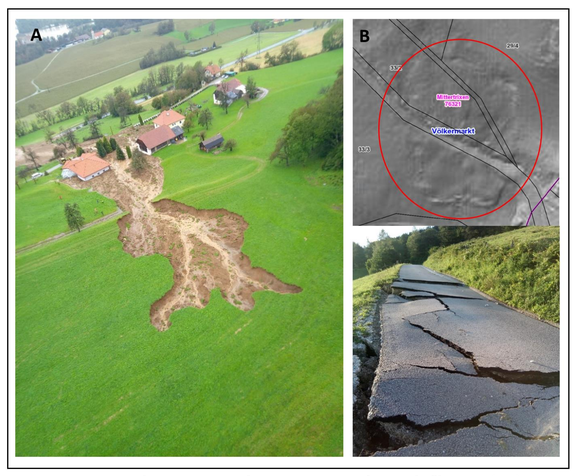

Figure 2: Slope explosion and soil flow (A) and reactivation of landslide (B) (by F. Goldschmidt)

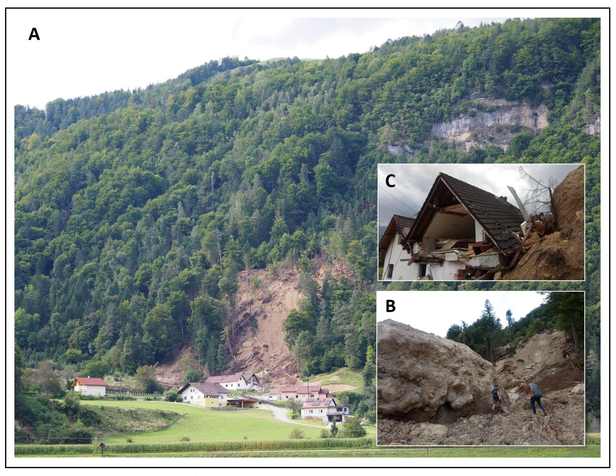

Figure 3: Landslide and erosion triggered a rockfall destroying a house (by S. Melzner).

The field mapping and documentations revealed that the dominant gravitational mass movement types in the disaster were landslides, soil flows and slope explosions (fig. 2 to 4). In the course of the heavy precipitation event, many landslides turned into flow processes depending on the material.

The landslides and soil flows led to the silting up of agricultural land, the relocation of road sections and, in some cases, the destruction of buildings (Fig. 3 and Fig. 4).

Outlook

In future, the increase in extreme weather events and the potential triggering of hundreds of gravitational mass movements will require a collective rethink and the application and development of innovative methods for the rapid documentation of processes and damage and the assessment of hazards in the event of a disaster. Automated damage and event/process reporting using an app, the provision of financial and human resources for a systematic survey of all gravitational mass movements (Melzner et al., 2015) will also be necessary in the future with regard to a reliable data basis for preventive spatial planning.

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