DOCTORAL PROGRAMME CLIMATE CHANGE

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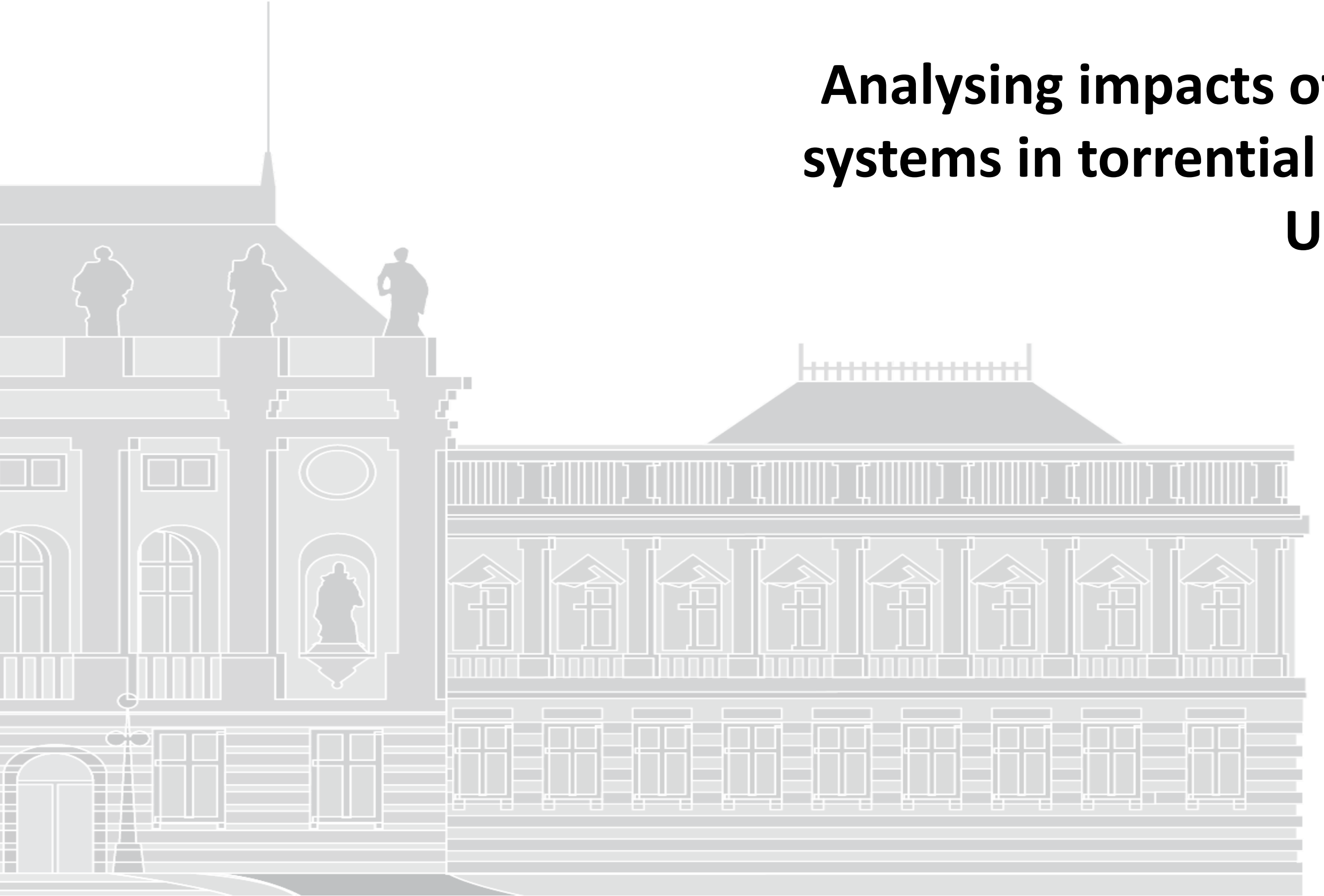

Analysing impacts of extreme precipitation on geomorphic systems in torrential catchments - a comparative study from Upper Styria (Austria)

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1. Background

- Sediment-laden torrential flooding events are among the most frequent geo-hazards in Austria and lead to costs of several millions (€) every year.

- The analysis of pre- and post-event high-resolution topographic data is important for the understanding of sediment dynamics and changes in channel morphology.

- Aim of this study is to investigate the hydro-geomorphic response and the amount of mobilised sediment in three different torrential catchments during extreme precipitation- and runoff events.

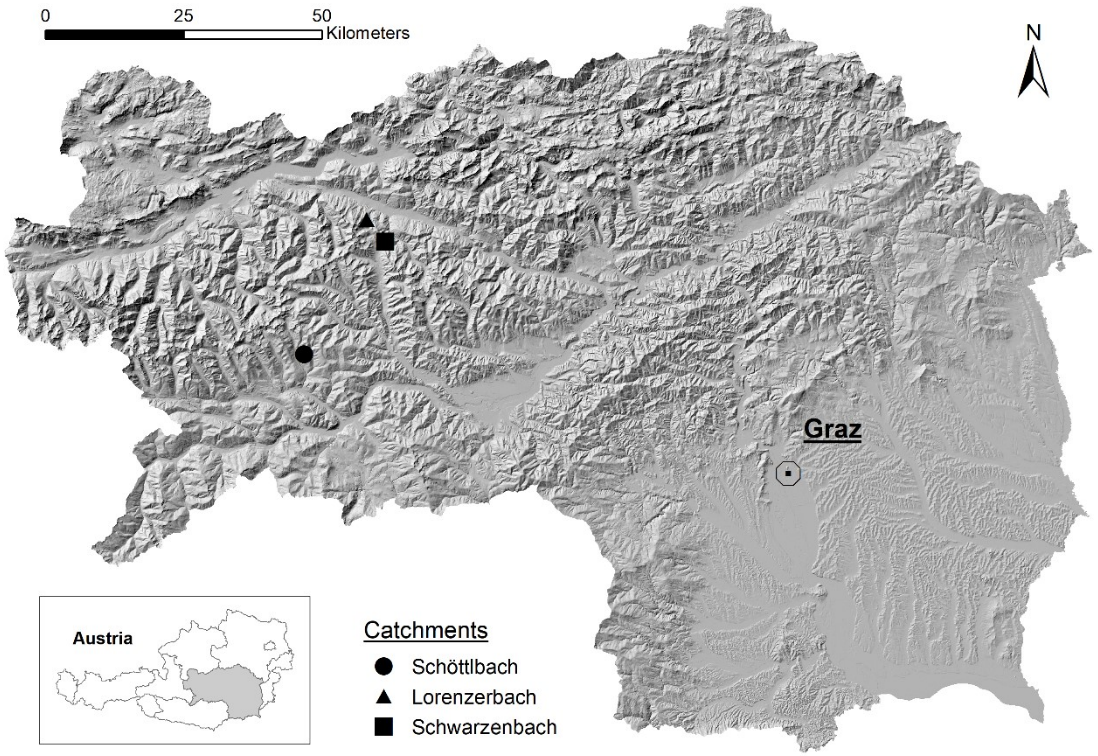

Figure 1: Location of the investigated torrential chatchments in Styria (grey) - Source: GIS Steiermark.

	Schoettlbach	Lorenzerbach	Schwarzenbach
Catchment area [km²]	70.5	5.5	11.3
Sea level of the estuary [m a.s.l.]	815.0	688.2	693.5
Sea level of the spring [m a.s.l.]	1801.0	1864.1	1948.2
Main channel length [km]	16.8	6.4	8.4
Average channel bed inclination [%]	5.9	18.3	14.9
Mean aspect	SW	NE	NE
Mean annual precipitation [mm/d]	737	1172	1172
Discharge 150 year event [m³/s] (Wundt)	165.0	34.1	40,4
$\boxed{\text{Sediment load 150 year event [m³] (Zedlacher)}}$	74 000	18 000	30 000
Buildings in red and yellow hazard zones	156	49	120

Table 1: Comparison of the geographical catchment properties

2. Methods

2.1 Hydro-meteorological Analysis

With combining station data and data from the Integrated Nowcasting through Comprehensive Analysis System (INCA) we aim at analysing location, pattern and intensity of extreme precipitation events. To identify precipitation- and discharge thresholds for each catchment historical data will be included into the analysis.

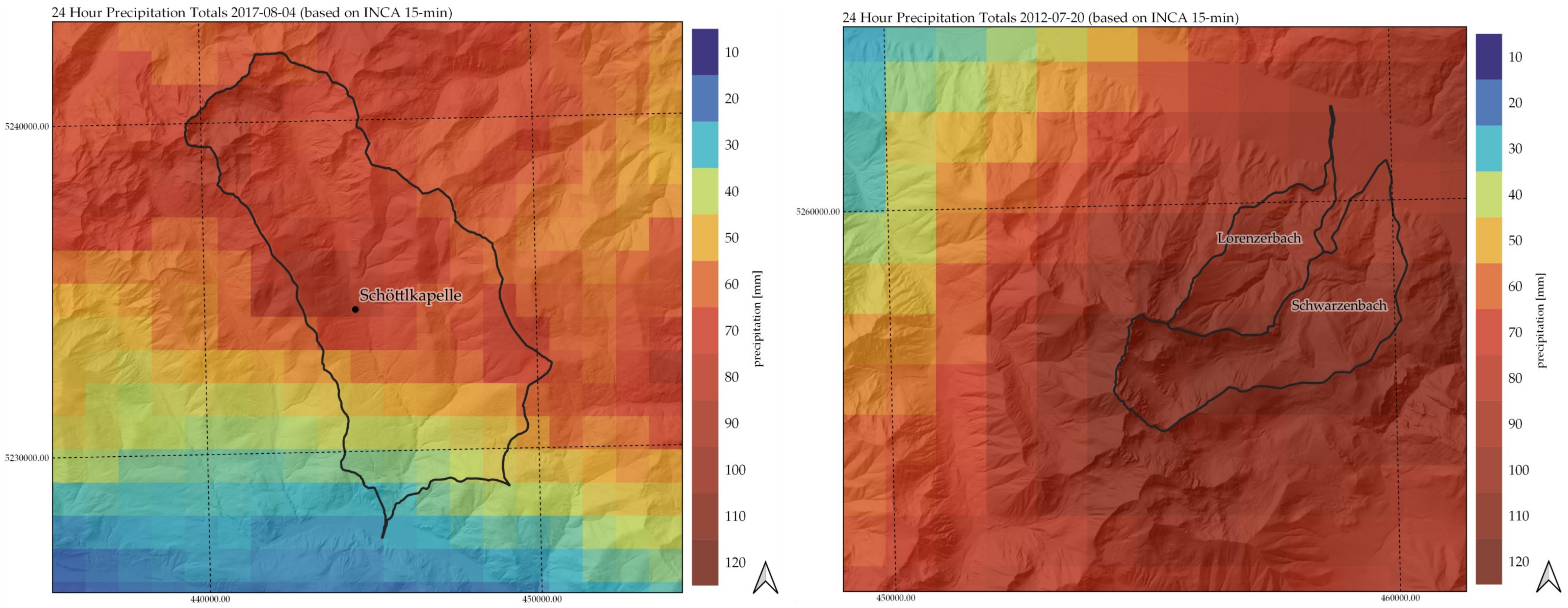

Figure 2: (a) 24h precipitation sum [mm] - Schöttlbach catchment (2017/08 /04); (b) 24h precipitation sum [mm] - Lorenzer- and Schwarzenbach catchment (2012/07/20) (Source: ZAMG - based on 15min dataset)

2. Methods

2.2 DTM Uncertainty and Comparability Assessment

The complex channel morphology, dense vegetation covers, steep slopes, and the heterogeneous quality and accuracy of DTMs in torrential catchments complicate erosion and deposition volume calculations. Therefore, quality parameters (see Figure 3) are checked to evaluate DTM uncertainties and to distinguish between actual surface change and inherent noise.

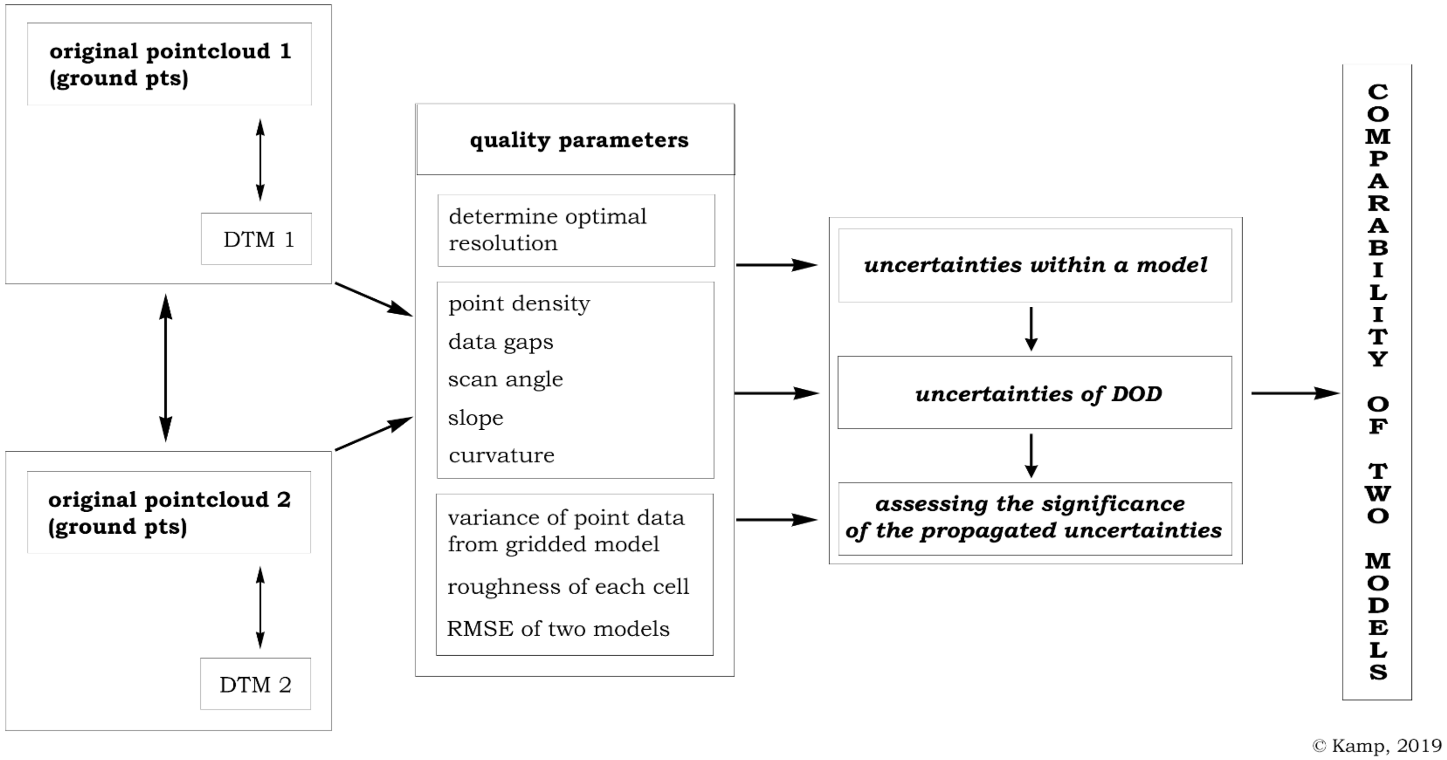

Figure 3: Worklflow for DTM uncertainty and comparability assessment (Kamp et al., in prep.)

2. Methods

2.3 Geomorphic Change Detection (GCD) vs. Sediment Output Estimations after Zedlacher (1986)

The empirical approach after Zedlacher (1986) aims at estimating sediment output of Styrian torrential catchments for extreme events with a 150-year return period.

(1) $$V_{G_{150}} = 178 * A_E * J$$

$V_{G\,150}$	sediment load [m³]
A_E	catchment area [km²]
J	gradient of the main channel [%]

DoD based calculations reflect the volume mobilized by an extreme event. These results are used to evaluate the Zedlacher (1986) approach with the aim to `update' and consider other key parameters, such as sediment availability and/or vegetation cover.

3. Case Study – Schöttlbach

- Two exceptional rainfall events (2011 & 2017)

- 2011 – 50-year flood up 100 m³/s discharge
→ sediment output = 90 000 m³ (Hübel et al., 2011)

- 2017 – 40-year flood up 85 m³/s discharge
→ Sediment output 110 000 m³ (Krenn et al., 2019)

Using the Zedlacher (1986) approach, sediment output is estimated at 73 000 m³ for a 150-year event. Hence, GCD results show that sediment yield is significantly underestimated, given that comparably smaller events could mobilize higher sediment volumes in 2011 and 2017.

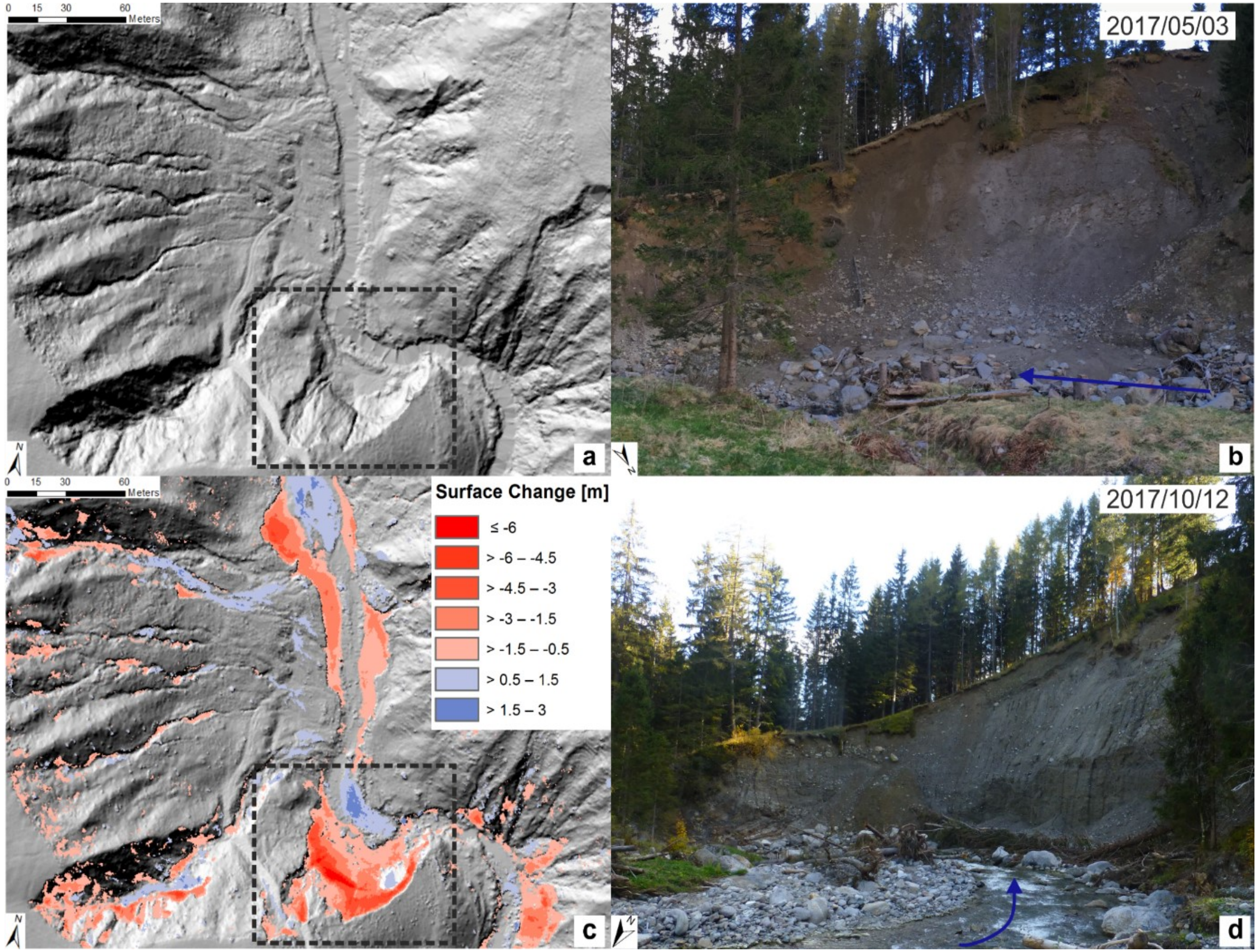

Figure 3: Pre- and post event situation 2017 - AOI Amphitheatre - Schöttlbach (Source: Krenn et al., in prep.)

4. Outlook and future work

The goal of this study is to collect data and information about sediment volumes mobilized by extreme precipitation and discharge events in torrential catchments in Styria. First results have shown that analysing multi-temporal LiDAR data is crucial for the understanding of geomorphic processes. By using a GIS-supported statistical-empirical modelling approach we aim at adapting / updating the Zedlacher (1986) approach for more accurate sediment output estimations. The updated approach will then be transferred and to other torrent catchments in Styria.

References

[1] Hübl, J., Eisel, J., Hohl, D., Kogelnig, B. und F. Mühlböck (2011): Ereignisdokumentation und Ereignisanalyse Wölzerbach; IAN Report 143, Band I.

[2] Kamp, N.; Krenn, P.; Avian, M. (in prep.): Comparability of Multi-Temporal DTMs derived from Airborne and UAV-borne Laser Scanning Point Clouds and their Quality Characteristics and Uncertainties in the Field of Geomorphic Impact Analysis.

[3] Krenn, P.; Peßenteiner, S.; Kamp, N. (2019): Das Wildbachereignis von 2017 im Schöttlbach, Oberwölz – eine geomorphologische Bestandsaufnahme mittels UAV-based laser scanning (ULS). In: *Zeitschrift für Wildbach-, Lawinen, Erosions- und Steinschlagschutz* (184). (in german)

[4] Krenn, P.; Kamp, N.; Peßenteiner, S.; Sass, O. (in prep.): Analysing geomorphic impacts of extreme precipitation event on a torrential catchment in Upper Styria (Austria) using UAV-borne laser scanning (ULS)

[5] Zedlacher, D. (1986). Extreme Wildbach-Feststofffrachten in der Steiermark. Wildbach- und Lawinenverbau, 50. Jg, Heft 103, PP 5-13. (in german)

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