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ÖAW IGF

Flood Flow in a Proglacial Outwash Plain – Quantifying Spatial Extent and Frequency of Inundation from Time-Lapse Imagery

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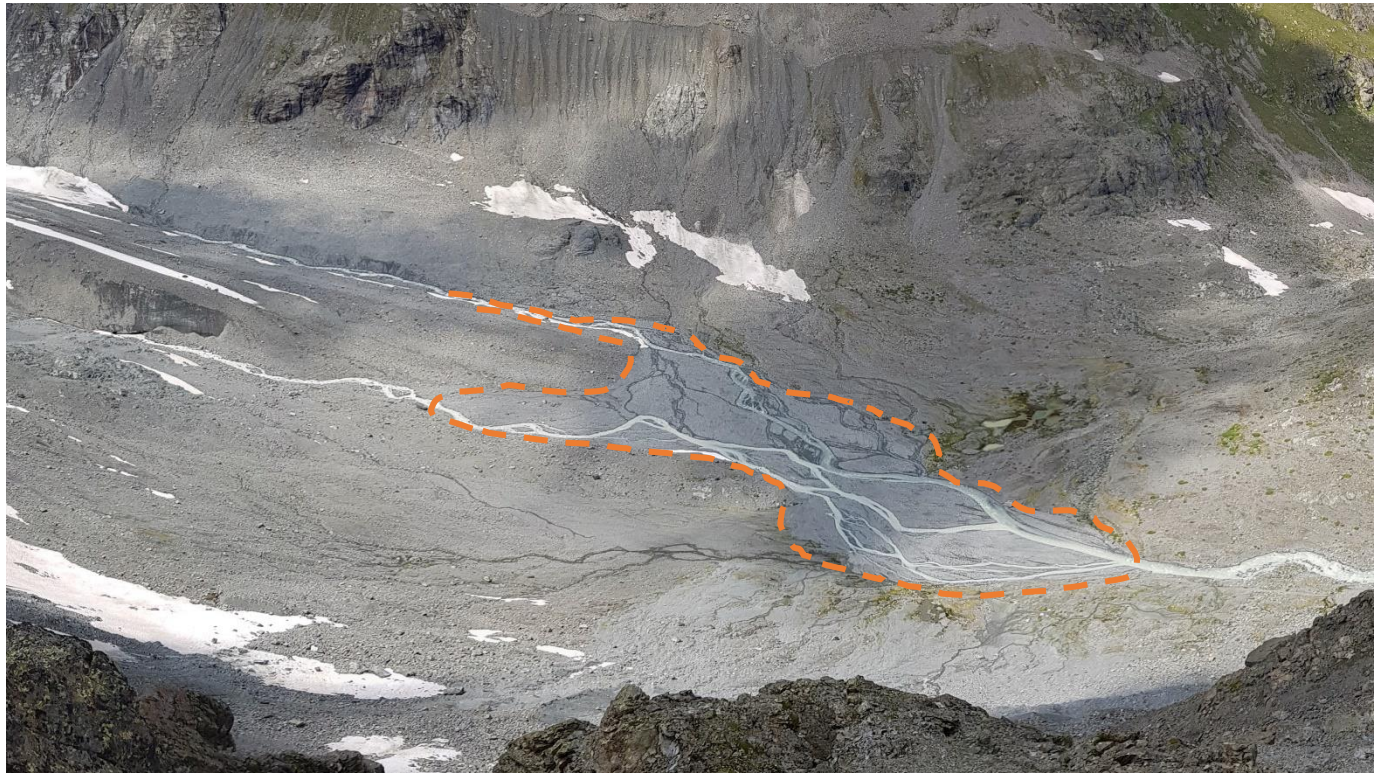
Proglacial Outwash Plain

- Highly dynamic braided channel network
- Linking glacial sediments with lower stream sections
- Area of sediment re-deposition



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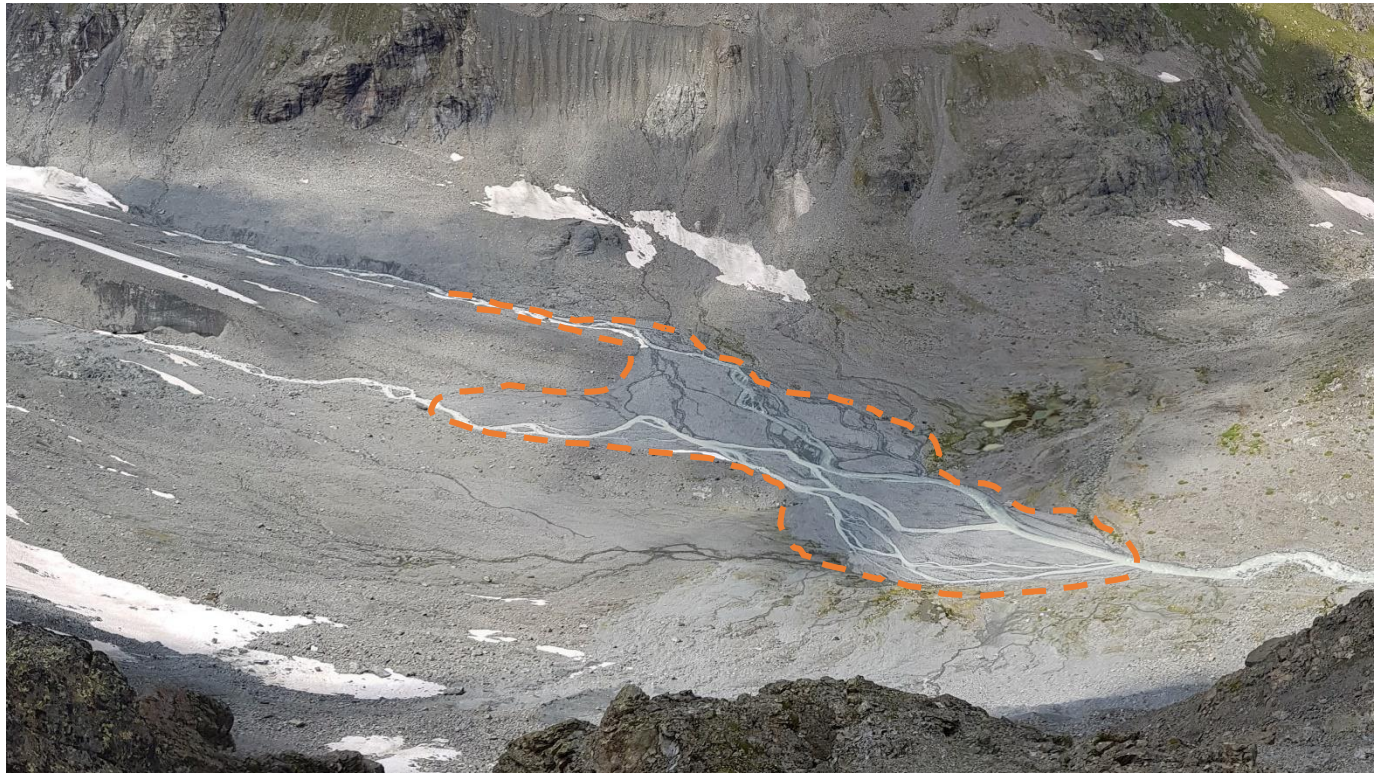
- Discharge and flood patterns are challenging to quantify:
  - Paraglacial transition zone with rapidly changing topography and channel network
  - Natural hazards (avalanches, rockfall)
  - Remote location



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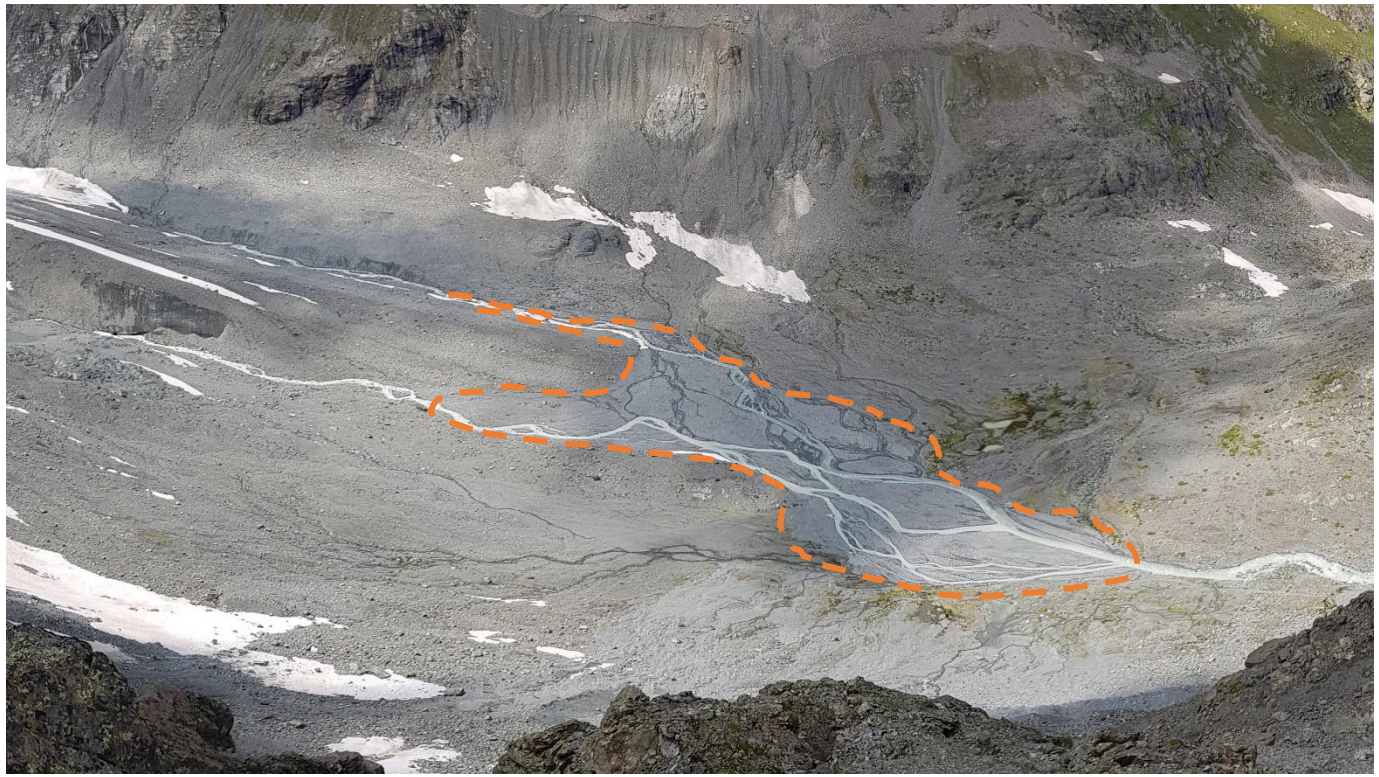
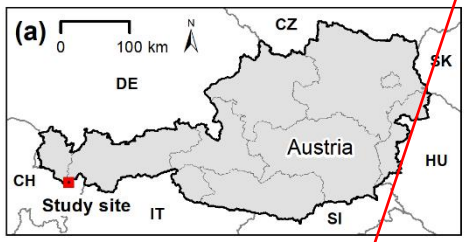
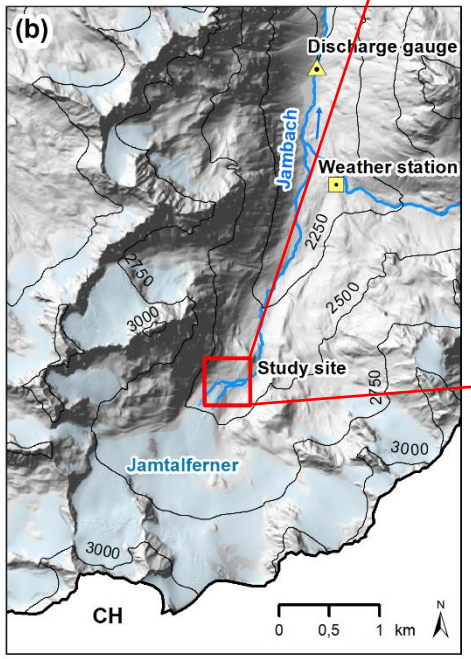


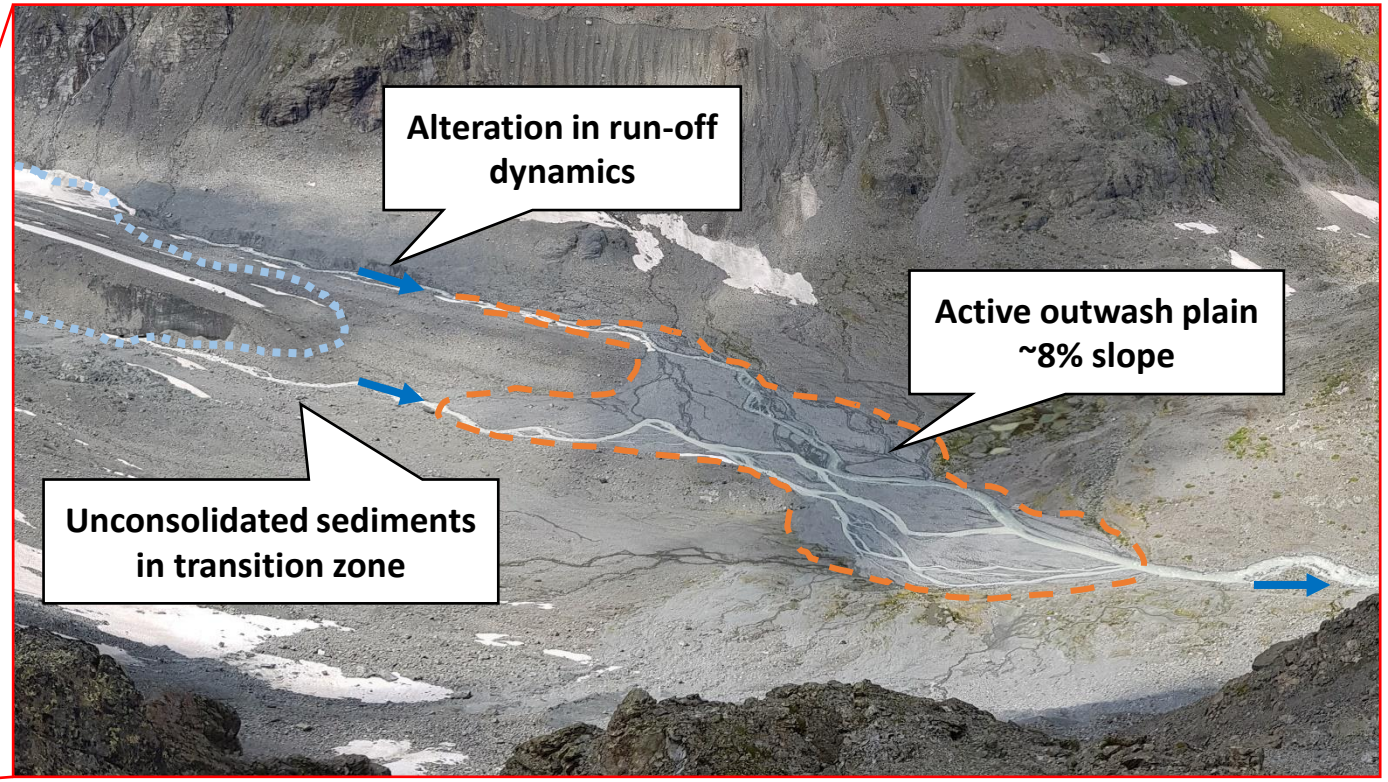
- Yet, **need for quantification of surface run-off**, e.g. as boundary condition for numerical modelling of bedload transport!

Jamtal Valley

- Western Tyrol, Austria
- OWP at ~2410 m a.s.l.
- Retreating glacier with debris-covered tongue
- 2 glacier gates –> OWP –> 1 confluence



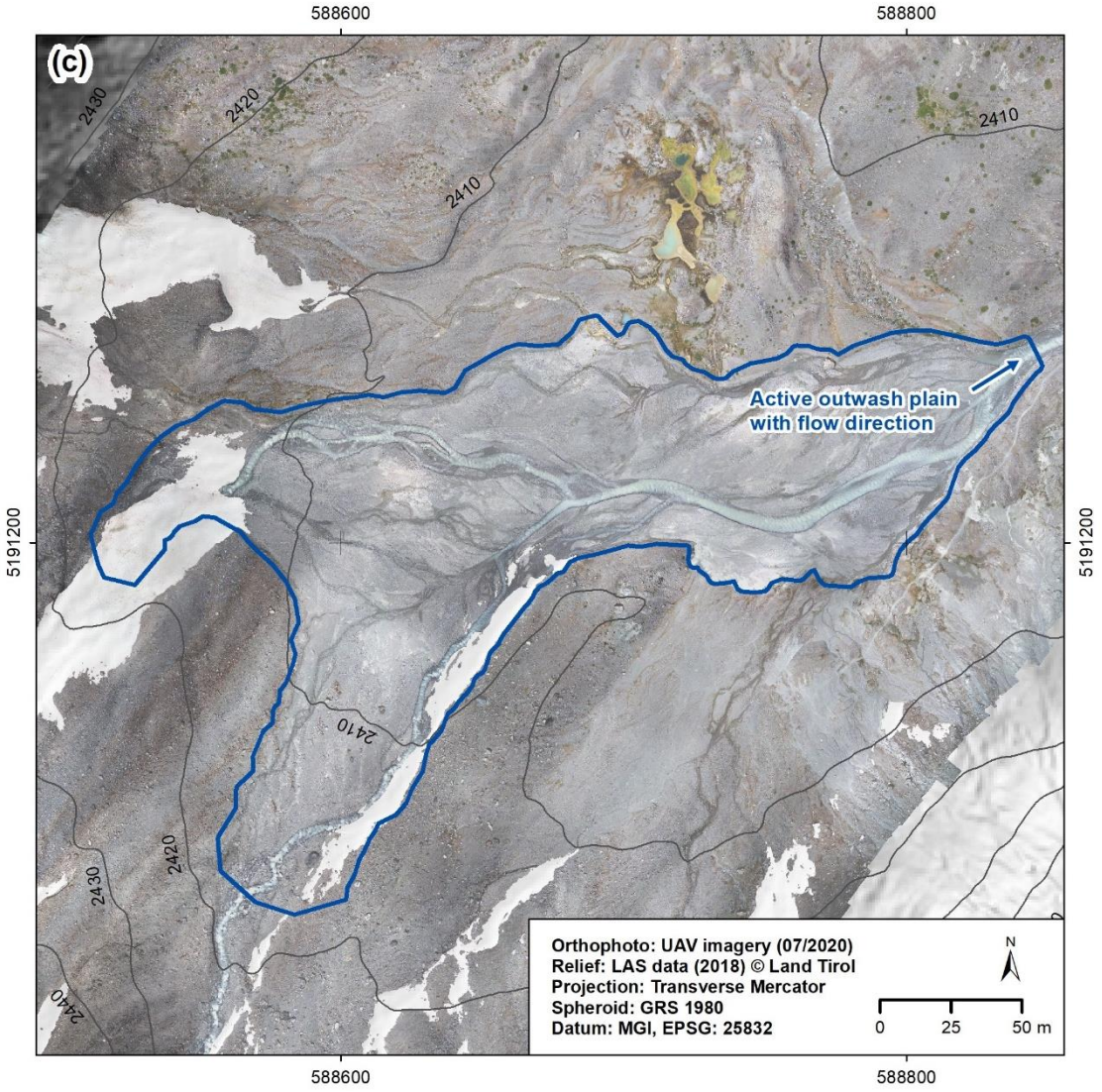




- **Is it possible to capture the inundation area and dynamic during high run-off events?**

Jamtal Valley

- **LTER**-site (Long-Term Ecosystem Research Network)
- **Hidden.Ice** – Changing debris cover on Eastern Alpine glaciers: Quantification and hydrological impacts
- **Black.Ice** – Albedo effects of in-/organic particles on glacier ice
- Synergies?



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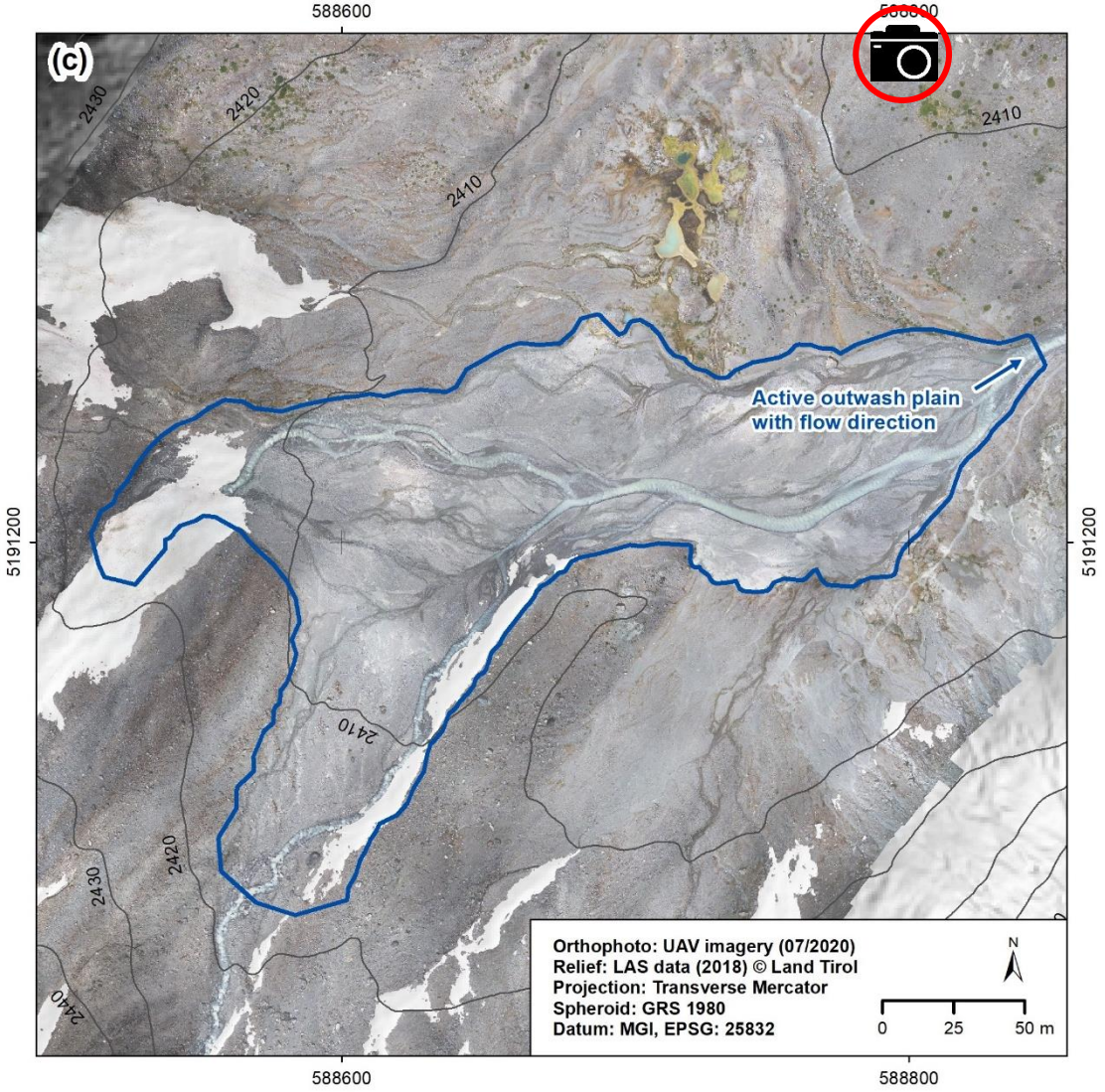
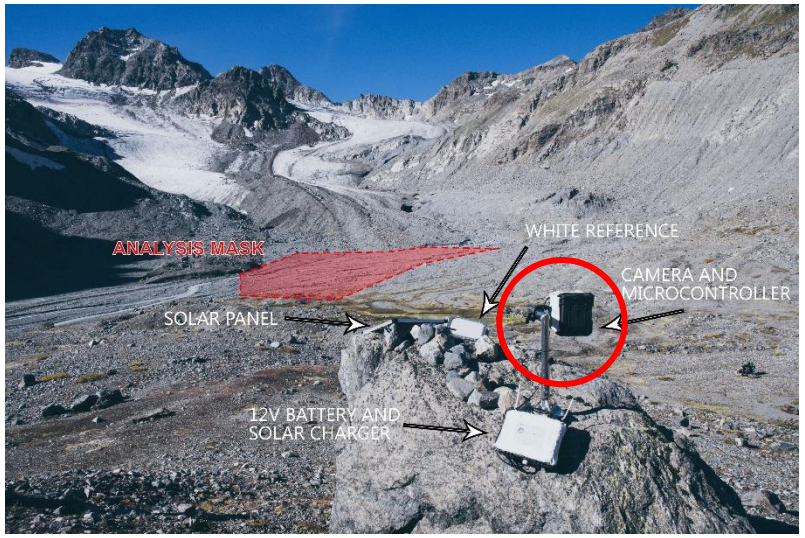
- Synergies? – **YES!**



Inundation from Time-Lapse Camera

- **RGB camera** mounted on top of boulder
- Overlooking the investigated proglacial OWP
- **Hourly recordings** from 6 AM to 8 PM (CET)
- Observation periods **2018, 2019 and 2020**



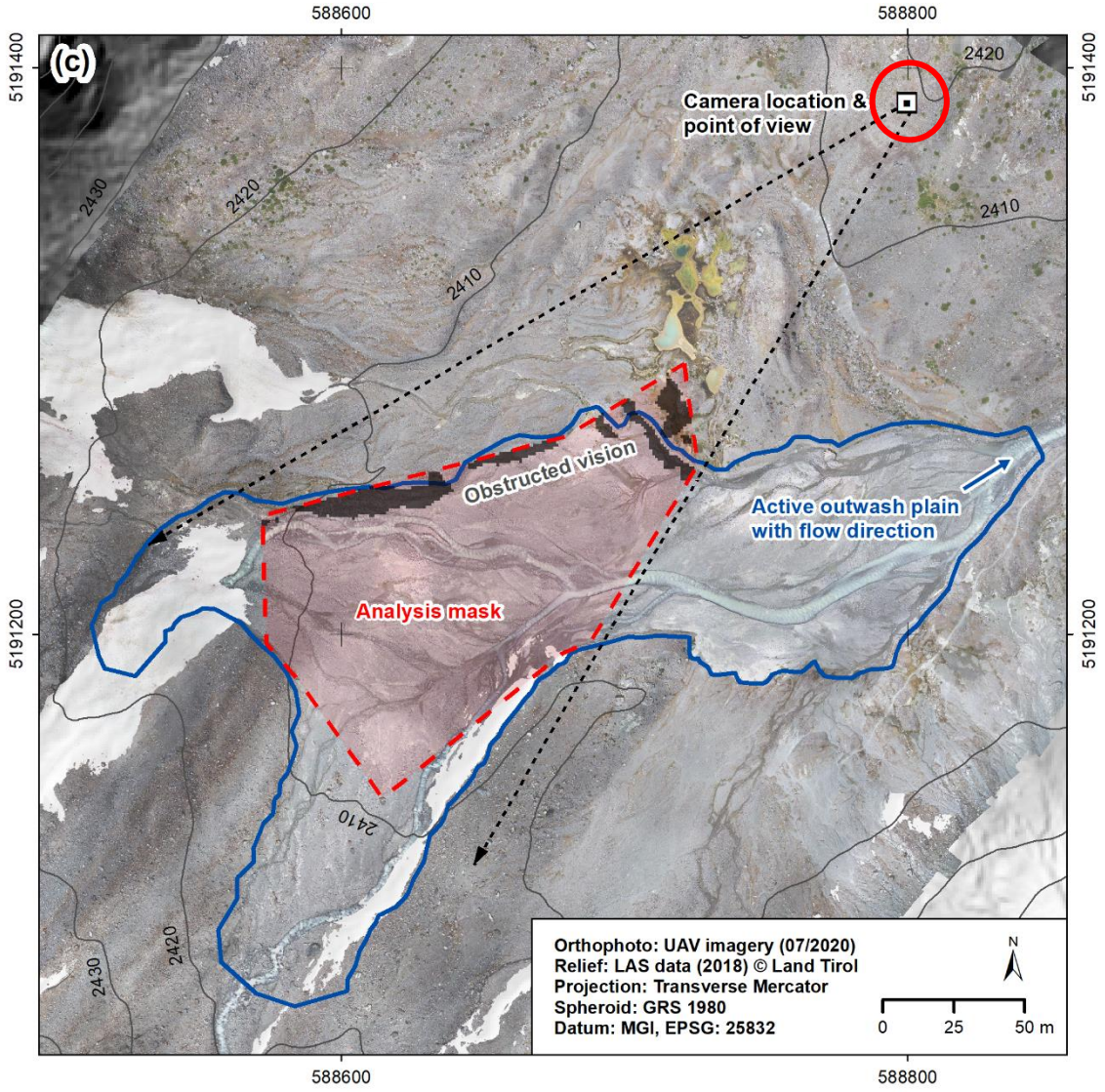


Image Analysis Process

- Semi-automatic image processing using open-source **Fiji –ImageJ** (*Schindelin et al., 2012*)

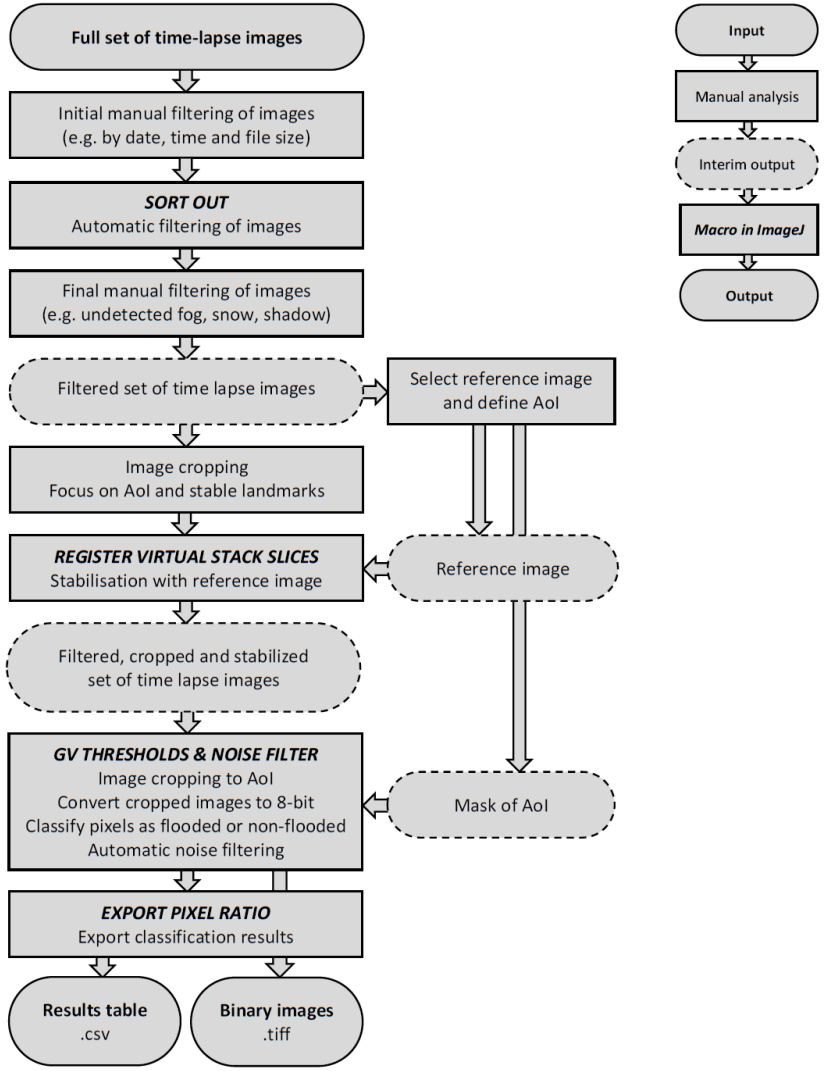


Image Analysis Process

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- **Filtering images by quality criteria** (greyscale value analysis, dismissing images at night, fog, snow conditions…)

- **Stabilisation of image series using a reference image**; **Cropping to area of interest** (analysis mask)
- Converting images to **8-bit**

- **Classify pixels** (flooded/ non-flooded) by applying dynamic thresholds to the greyscale values
- **Noise filtering** of binary images

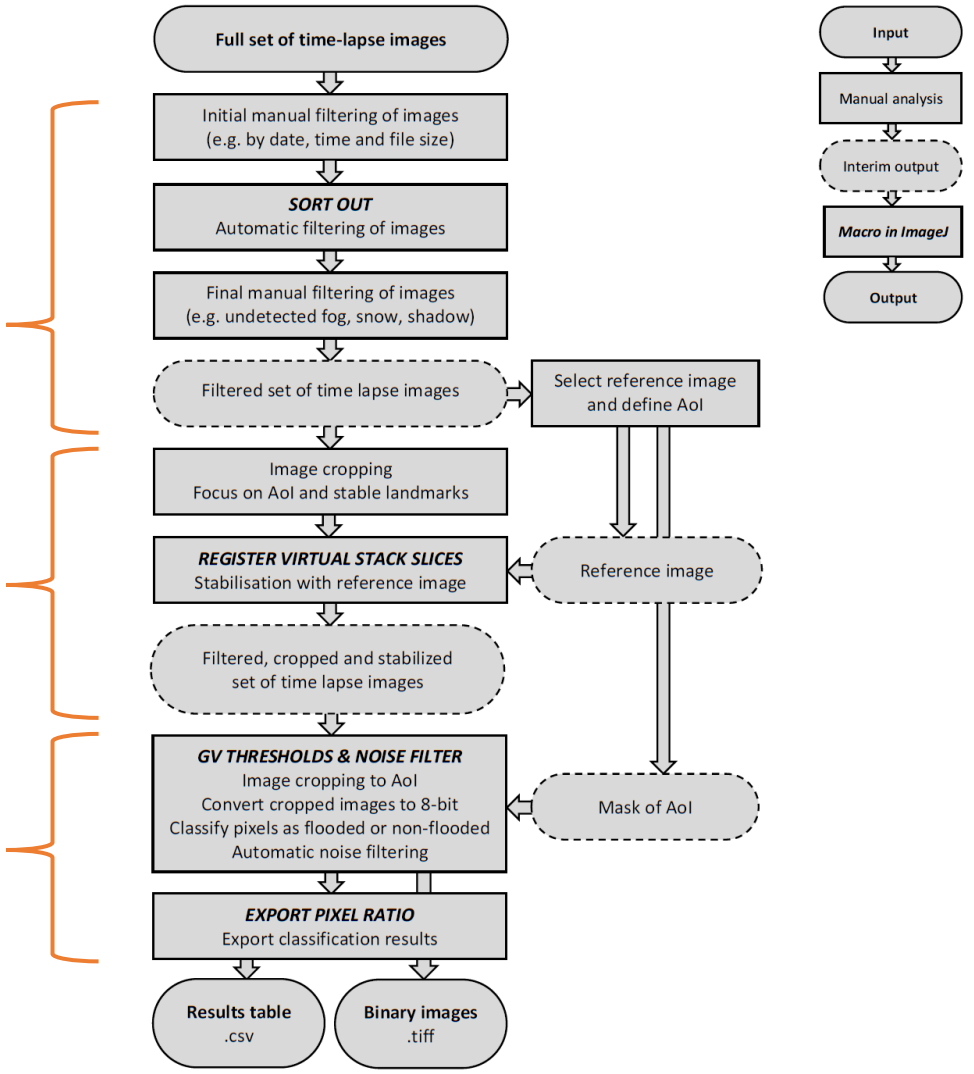
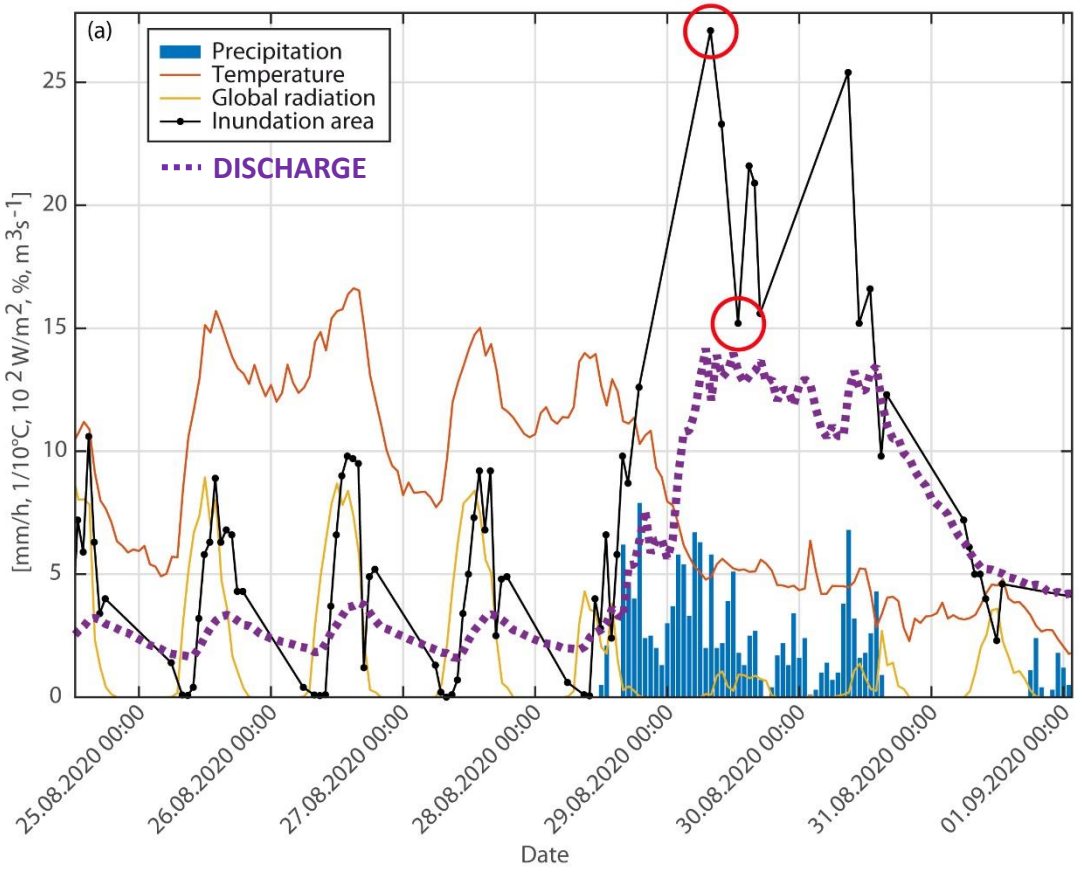
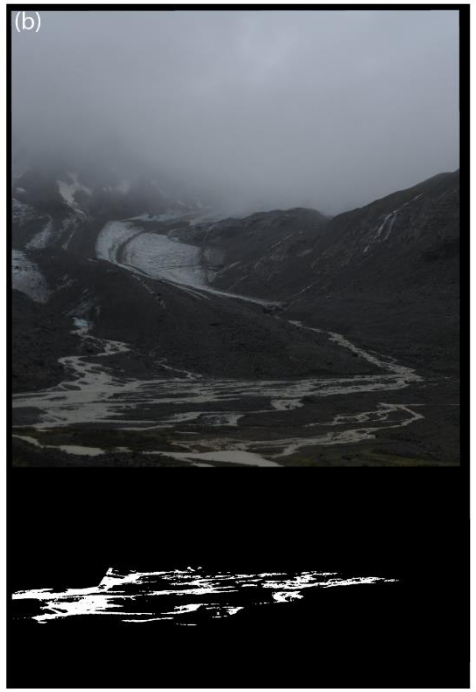


Image Analysis Process + Plausibility check

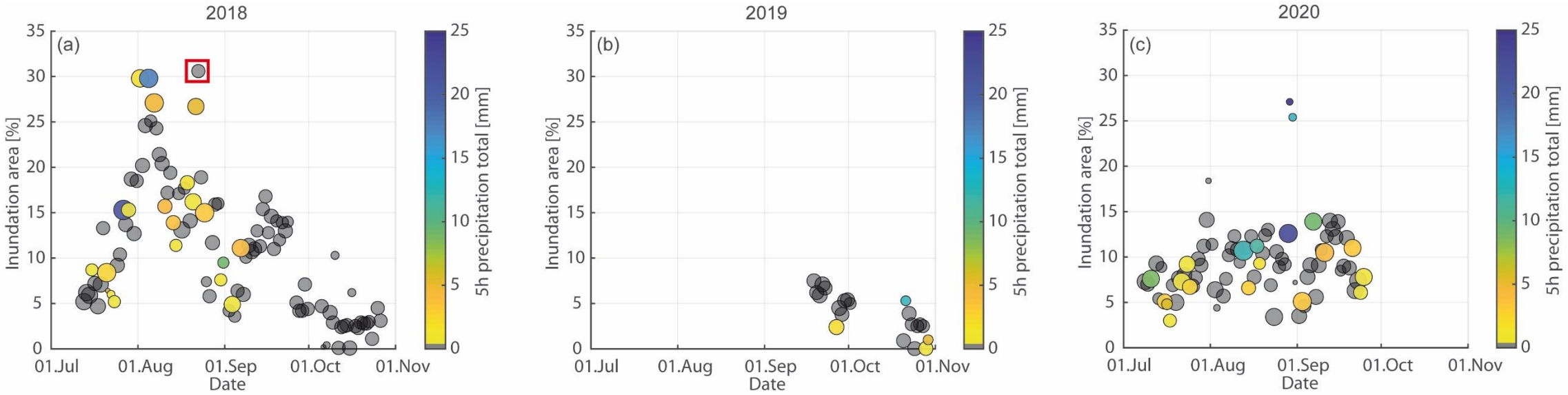
- Comparison **flooded/ non-flooded ratio** with **meteorological and discharge data**:





Meteorological Impulses on Observed Inundated Area

- Considered parameters: **air temperature**, **precipitation** (5h total) and **global radiation**



Note: Circle size according to global radiation

- Max. oberserved inundation (2018) attributed to snow melt, ice ablation followed by convective precipitation
- Isolated inundation maxima in 2020 related to intense precipitation

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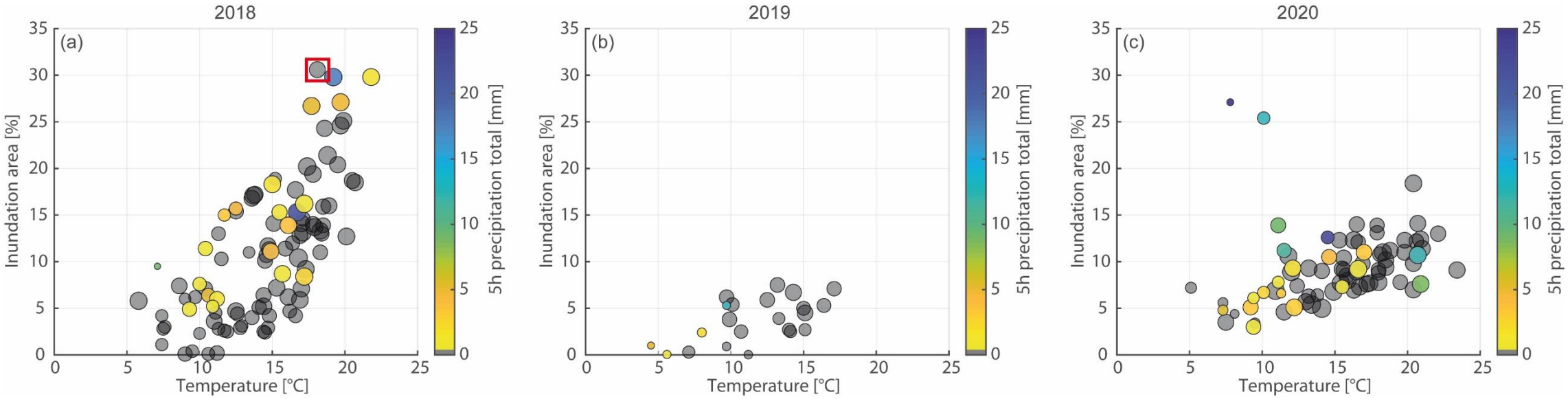
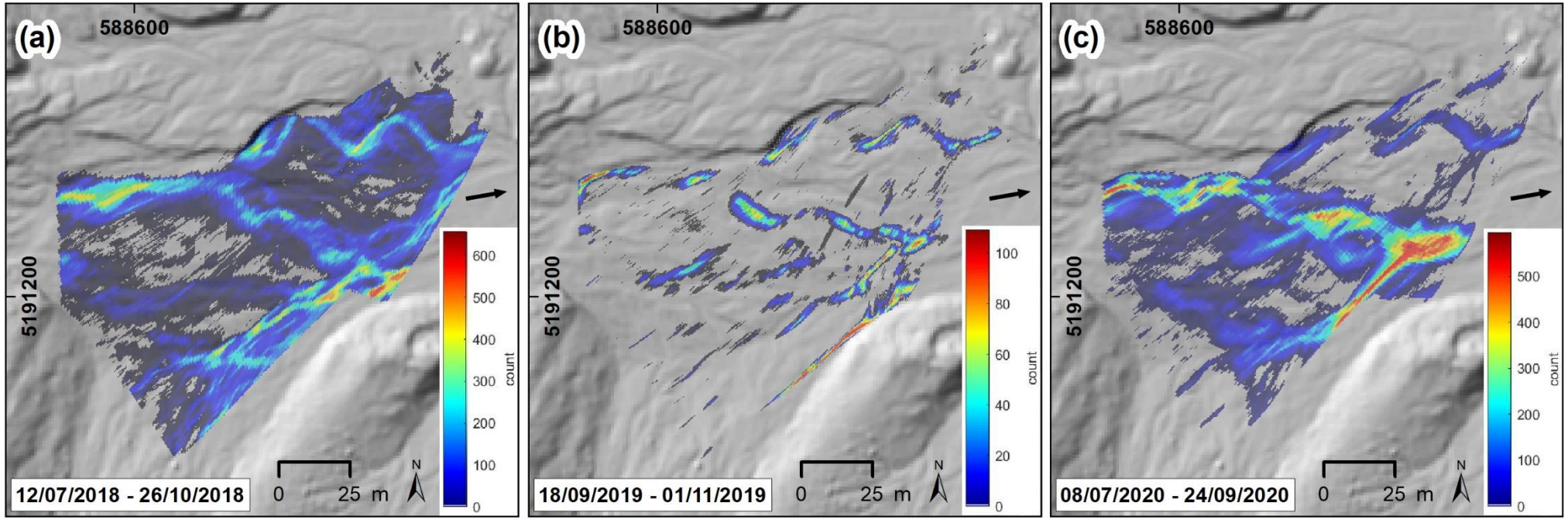


Note: Circle size according to global radiation

- Max. oberserved inundation (2018) attributed to snow melt, ice ablation followed by convective precipitation
- Isolated inundation maxima in 2020 related to intense precipitation
- Intense, but spatially confined precipitation events may not be recorded by weather station

Extent and Frequency of Inundation

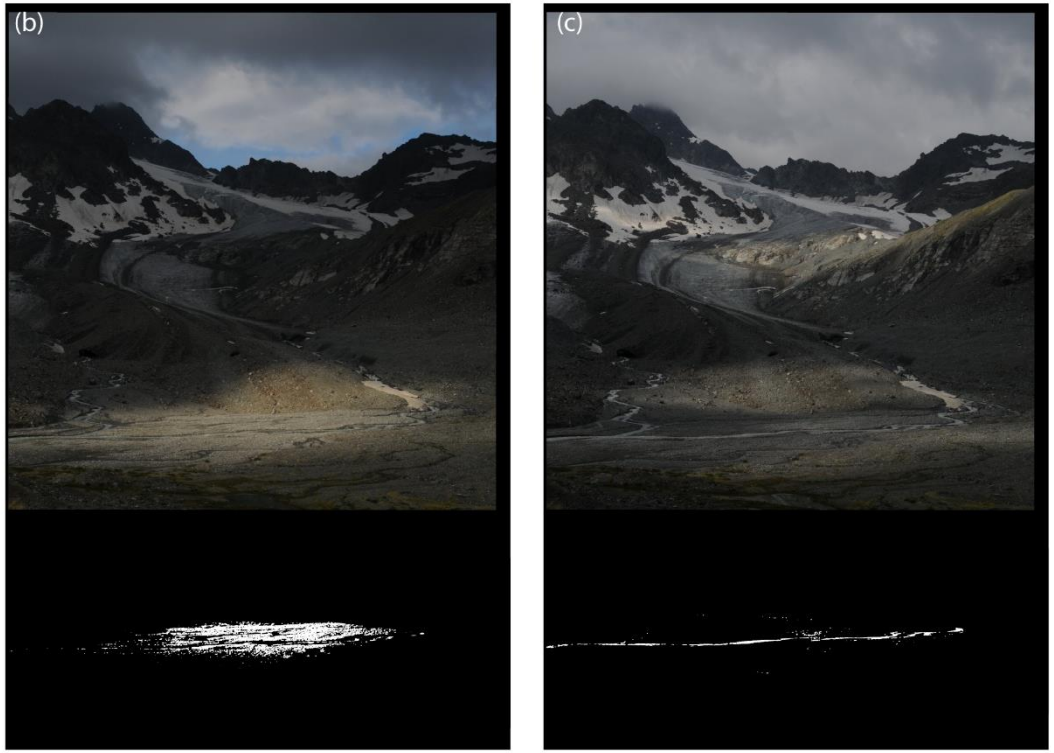
- **Cumulative inundation maps** reveal:



- Primary channel network (highest inundation frequency) and **extended flood plain** (high-runoff events)
- **Shift in channel network** between 2018 and 2020 -> increased degree in channel concentration

Discussion and Conclusion

- **Re-dedication of time-lapse camera in data-scarce environment**
- **Plausible results for a wide range of light and weather conditions** (with some limitations, see Fig. on the right)
- **Insights into proglacial runoff dynamics**
- RGB-time-lapse imagery **can close the monitoring gap between conventional discharge stations and remote sensing** for short-lasting floods in headwater catchments
- Future improvements:
  - Extend network of cameras to cover entire OWP with intersecting directions of view to enable 3-D analysis and minimize „blind spots“



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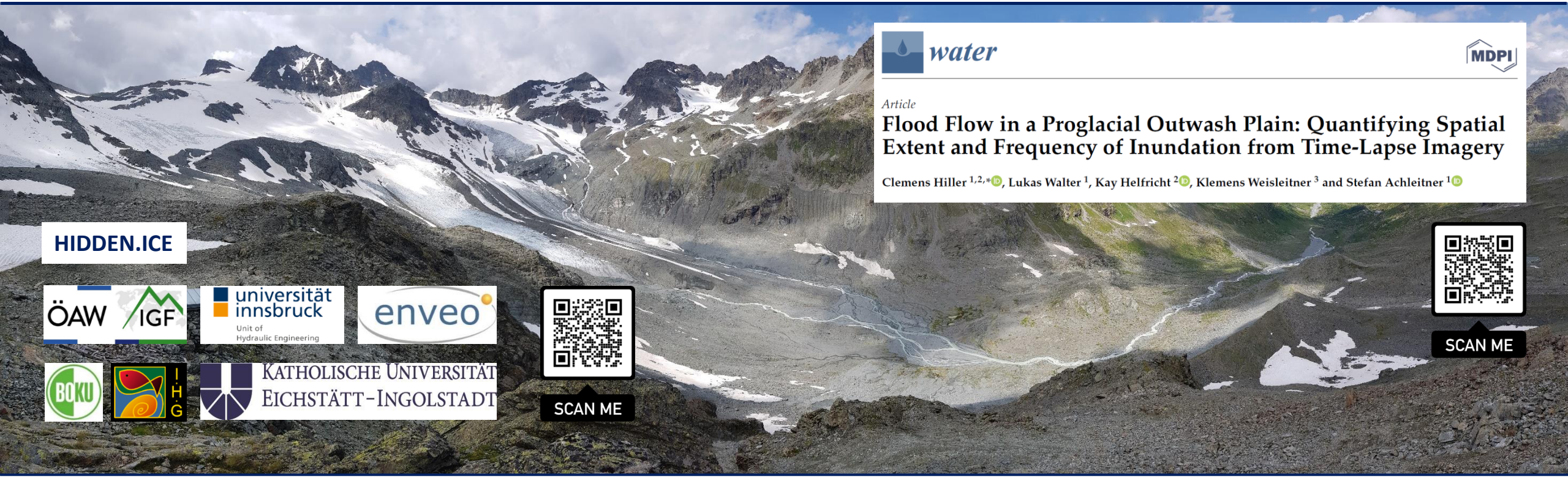
THANK YOU FOR YOUR INTEREST!



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