EGU General Assembly 2022

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Quantifying long-term sediment dynamics of a proglacial river in an alpine catchment

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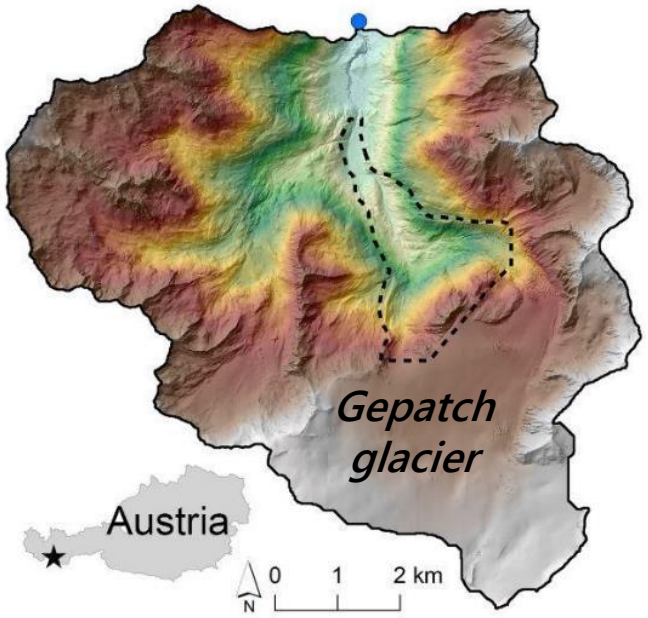
SEHAG – SEnsitivity of High Alpine Geosystems to climate change since c. 1850
https://sehag.ku.de/en/our-project/

OBJECTIVE

What are the effects of ongoing climate change since the end of the LIA on proglacial river morphodynamic and sediment transfer

1) How **glacier forefield** and the **active floodplain** (e.g. length, area) change due to climate change

2) What are the **main factors** that influence **river sediment change** among:
   - Glacier retreat
   - Lateral hillslope
   - Strong runoff events
   - Human factors

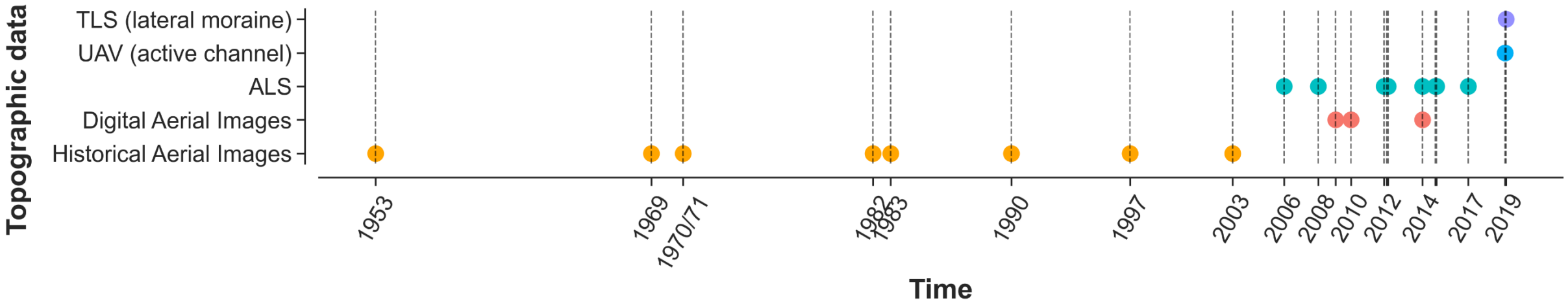


Kaunertal catchment, Austria

DATASET

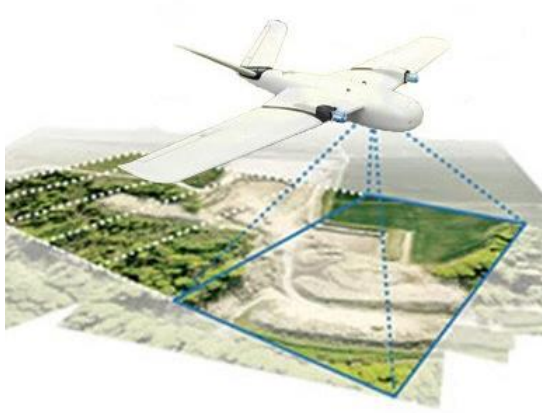
66 years, 19 digital elevation model (DEMs)

spanning inter-survey periods between one month and 16 years



Historical aerial images

Digital aerial images



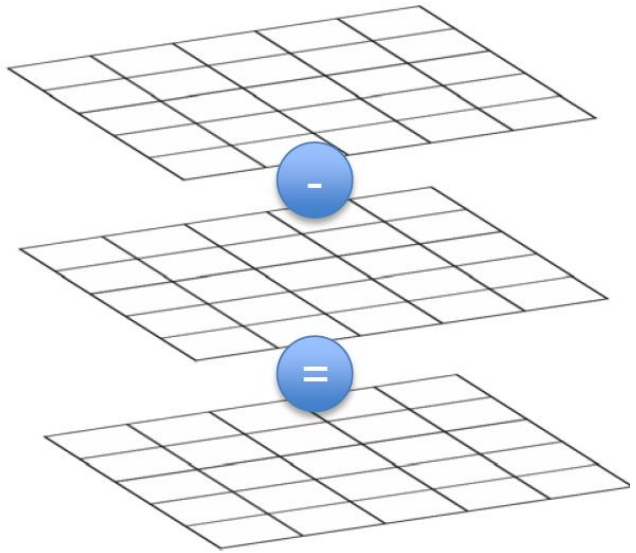
Airborne Lidar (ALS)

Terrestrial Lidar (TLS), drone (UAV)

METHOD

66 years, 19 digital elevation model (DEMs)
spanning inter-survey periods between one month and 16 years

DEM of difference (DEM_{diff}):

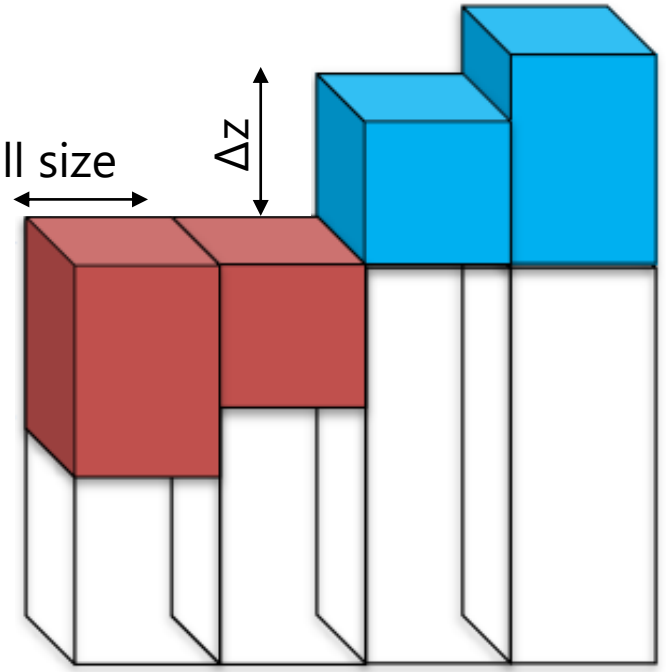


DEM_2 (time 2, after)

DEM_1 (time 1, before)

DEM_{diff}

EROSION (negative elevation changes)

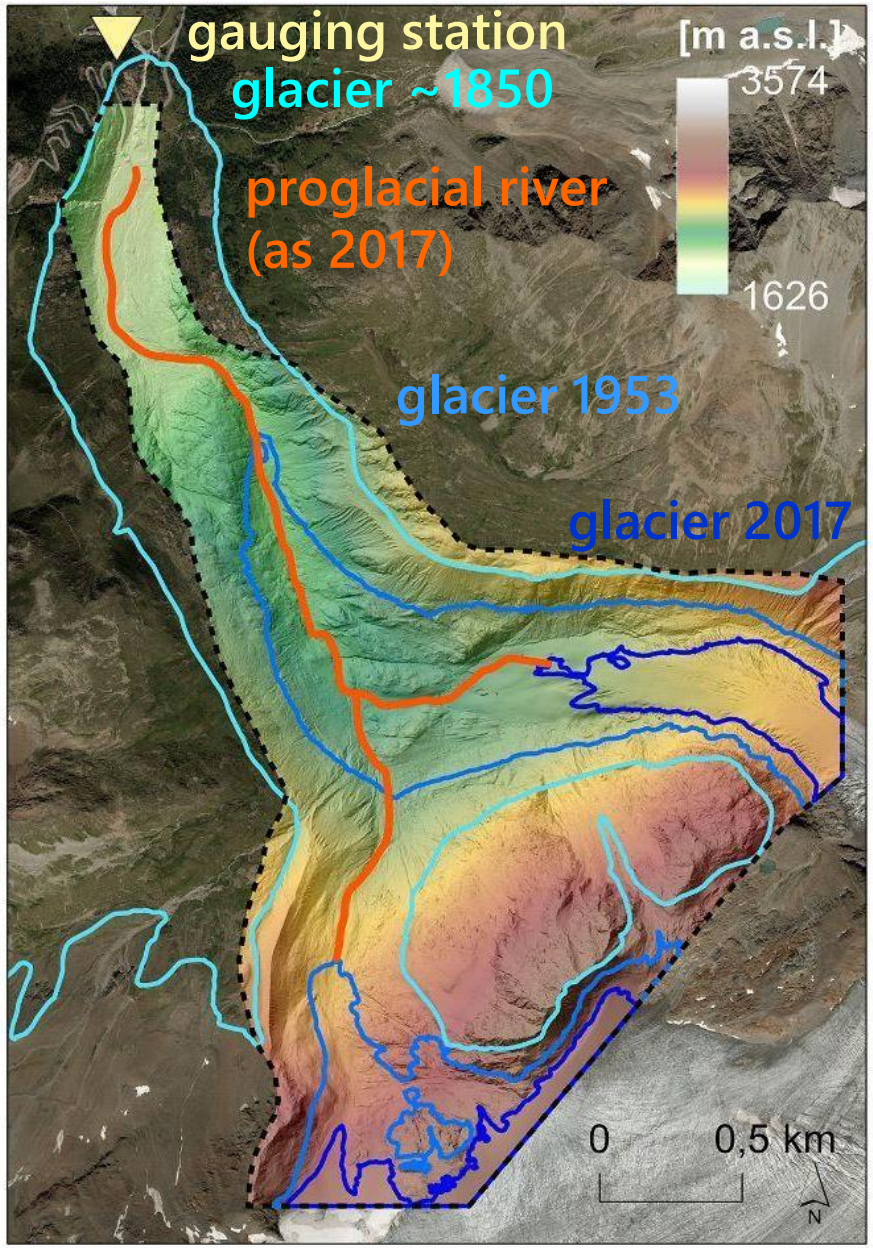


DEPOSITION (positive elevation change)

DEM_{diff} = Elevation change

DEM_{diff} * Cell size^2 = Volume change

Glacier forefield changes

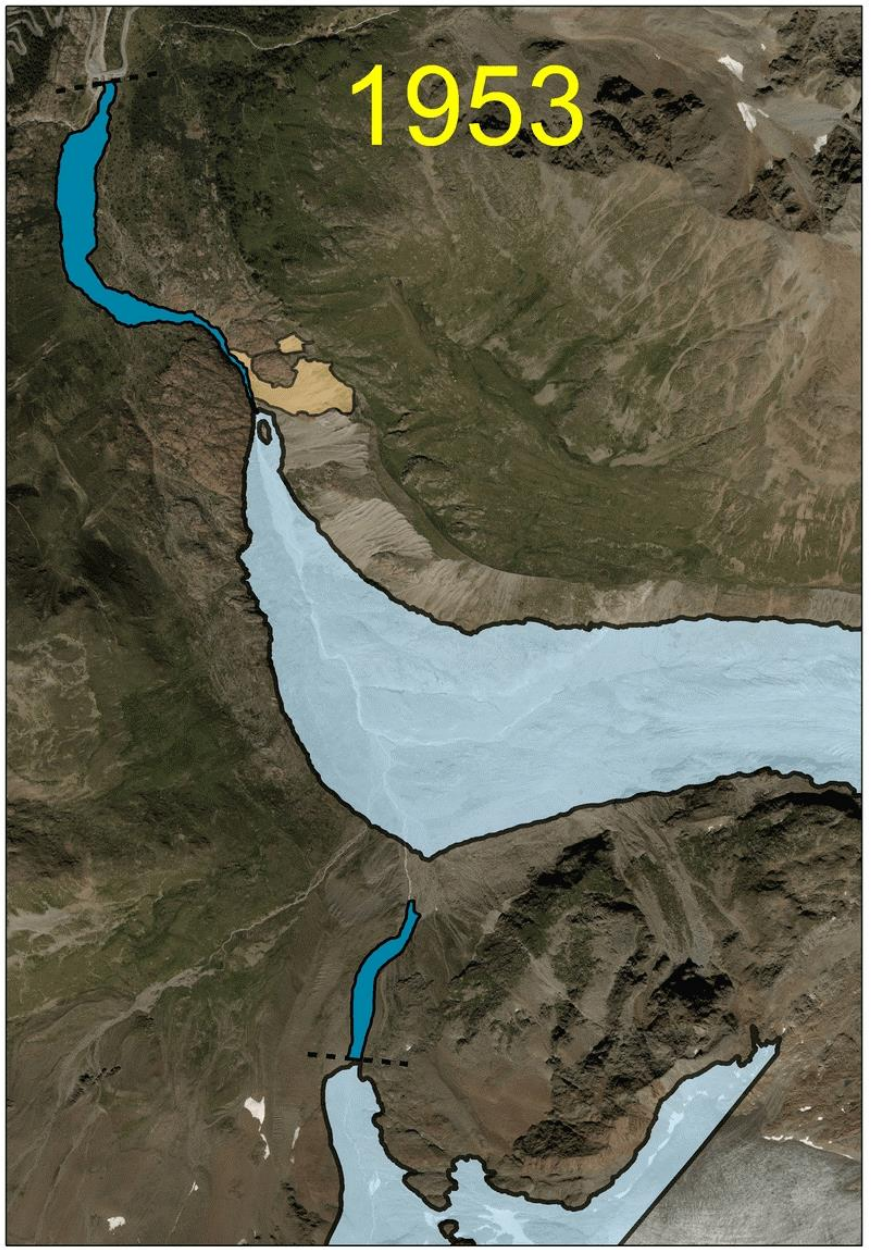


Mapping morphologies

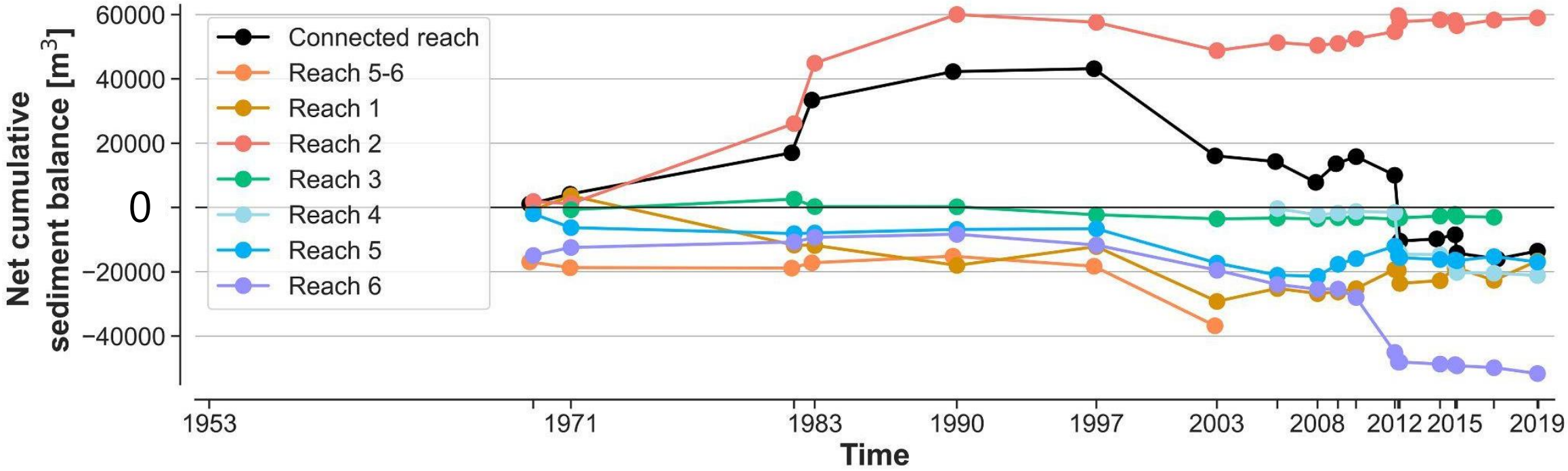
- Glacier
- Active floodplain
- Lateral moraine (ice free)

in ~70 years:

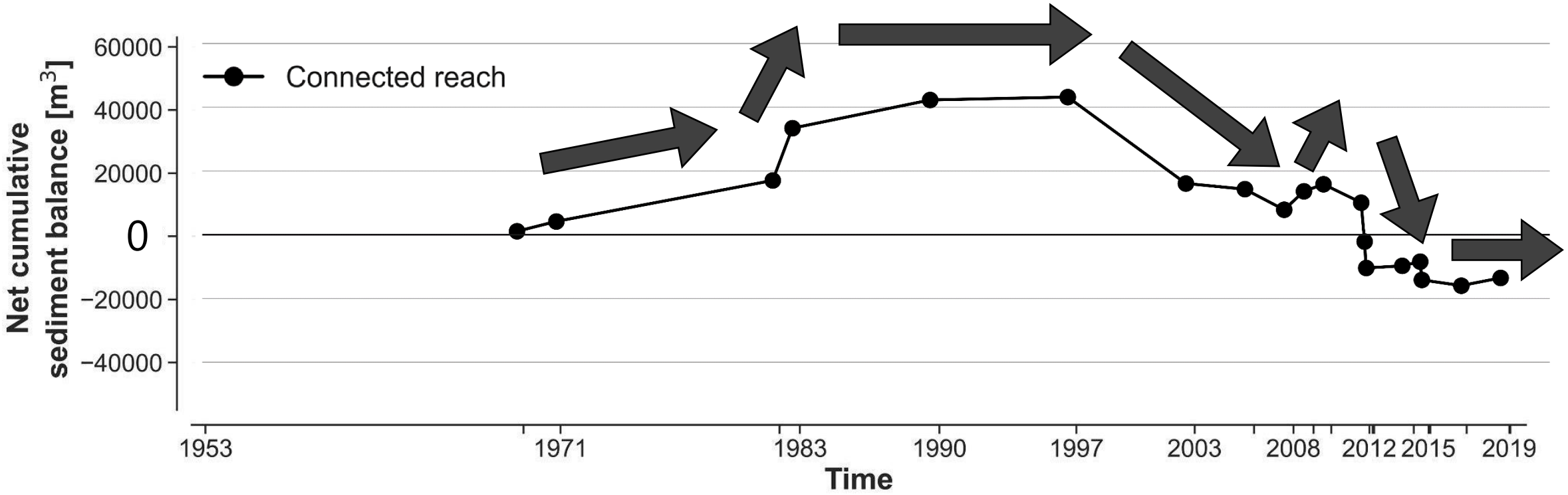
- Area of the active floodplain increased by 60%
- River length from 1.4 km to 4.3 km



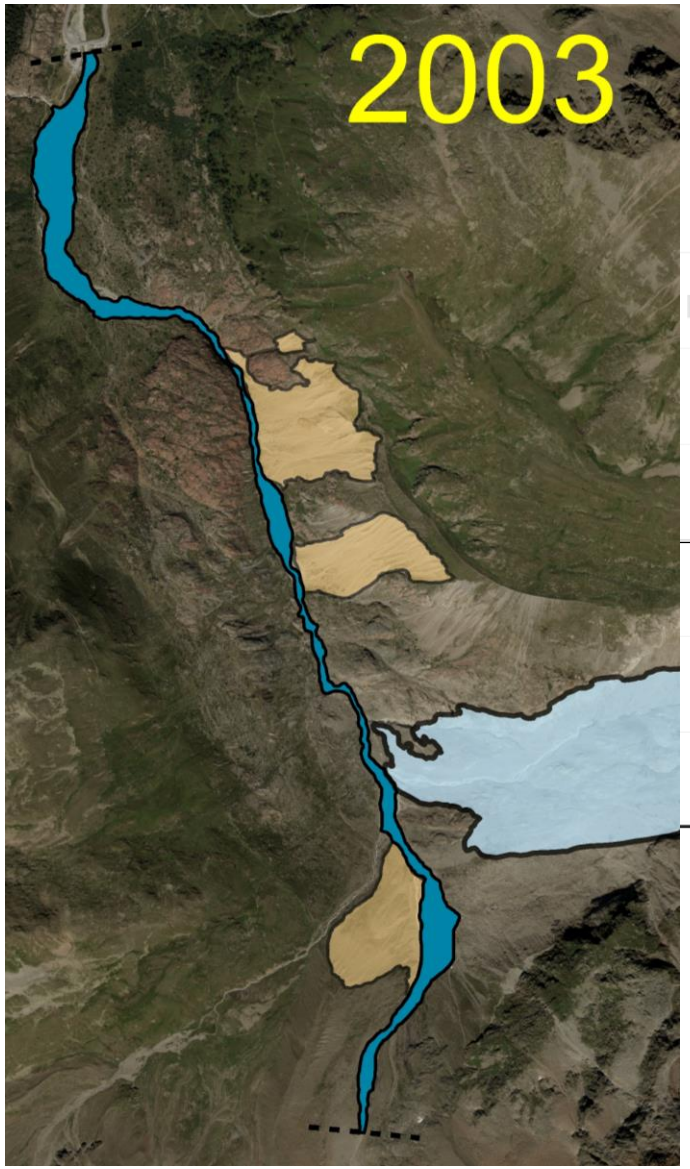
Net cumulative sediment balance

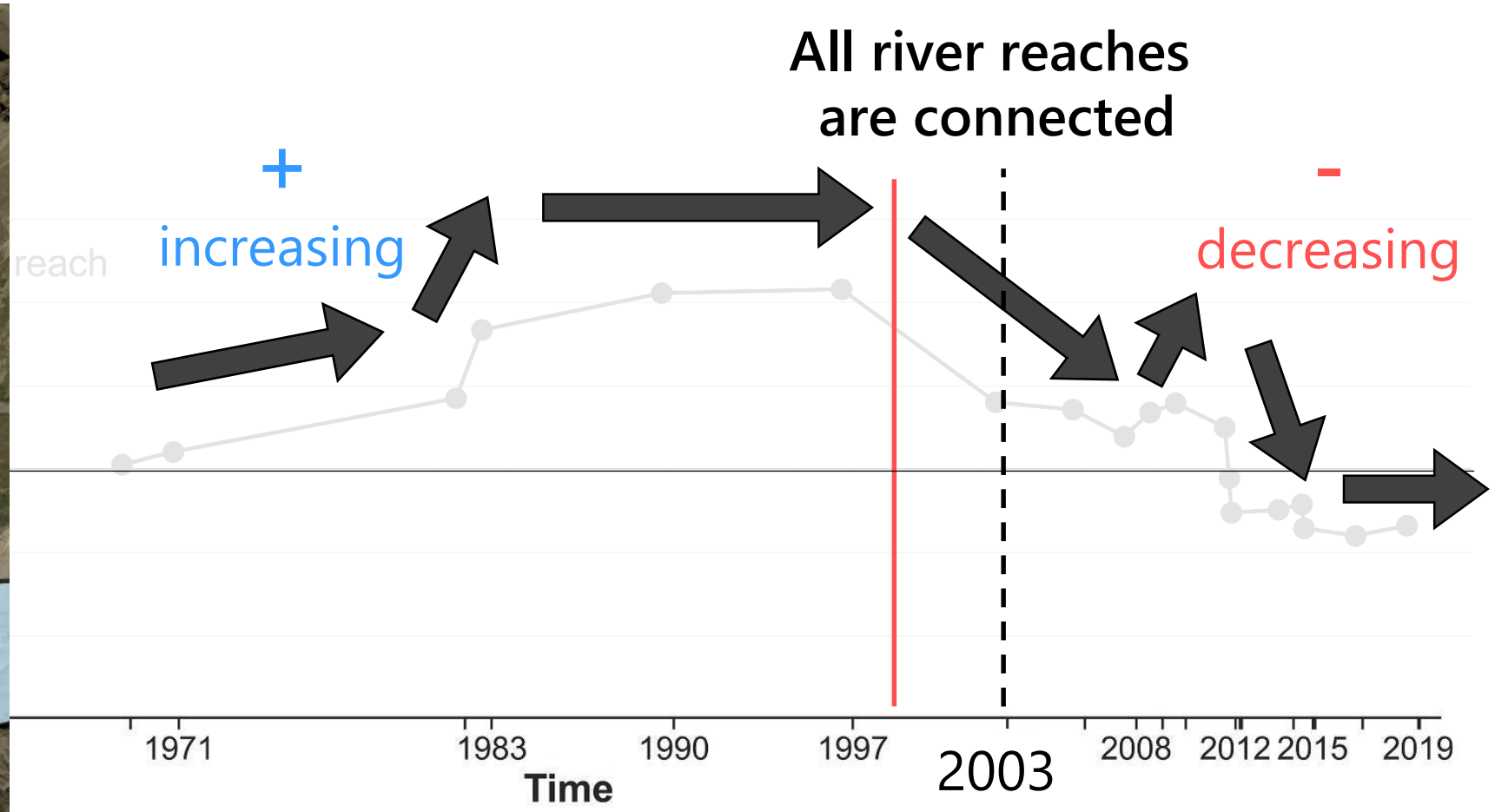


Net cumulative sediment balance

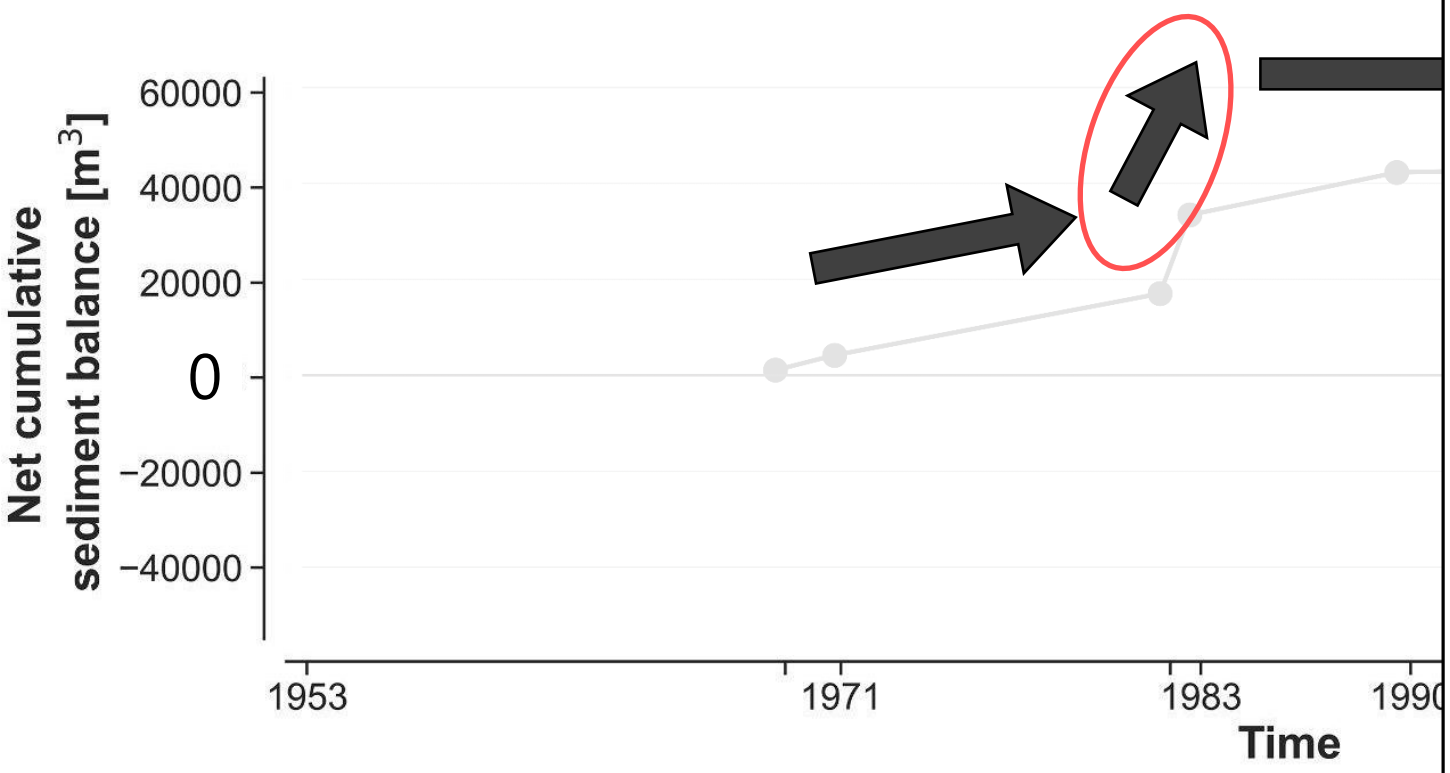


Net cumulative sediment balance

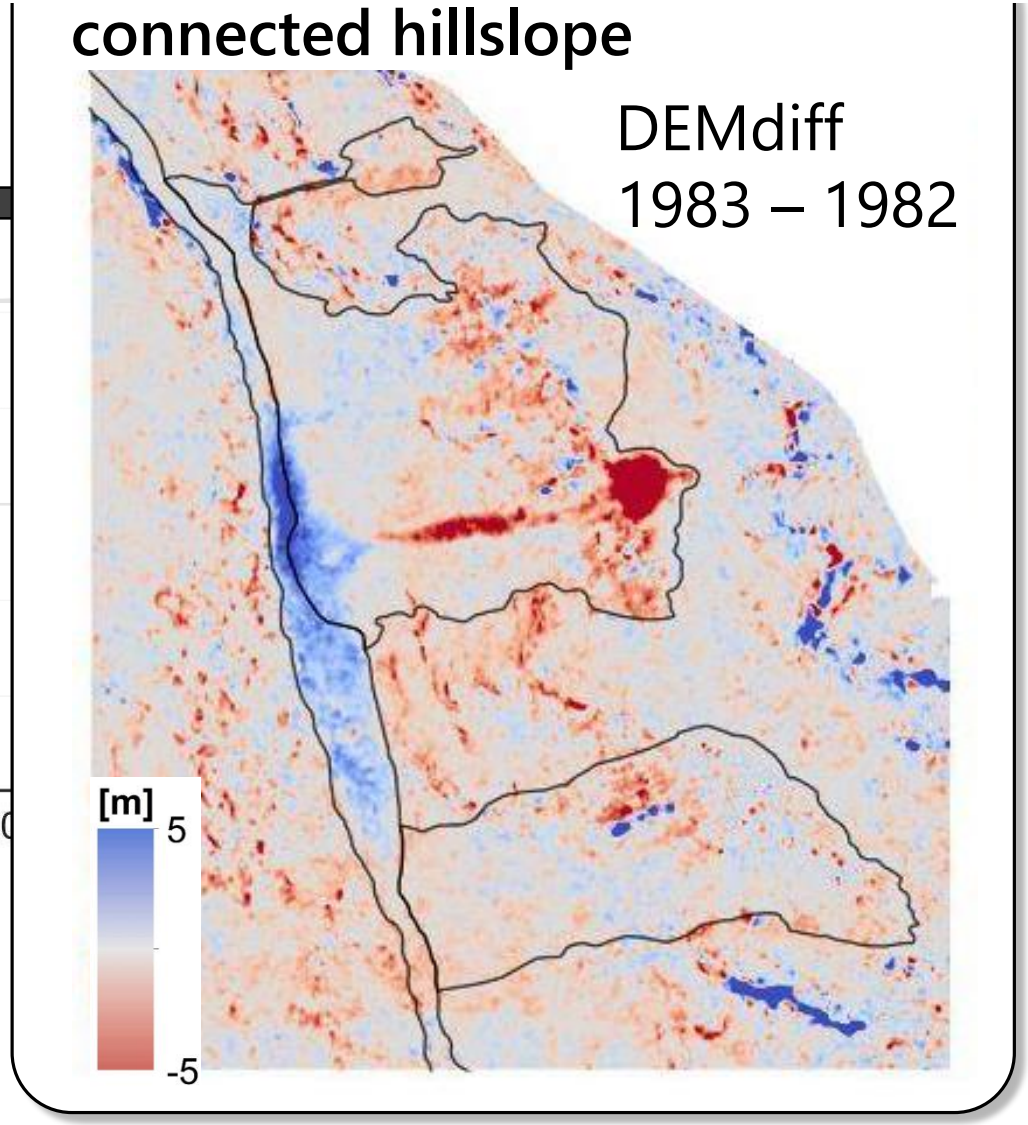




Net cumulative sediment balance

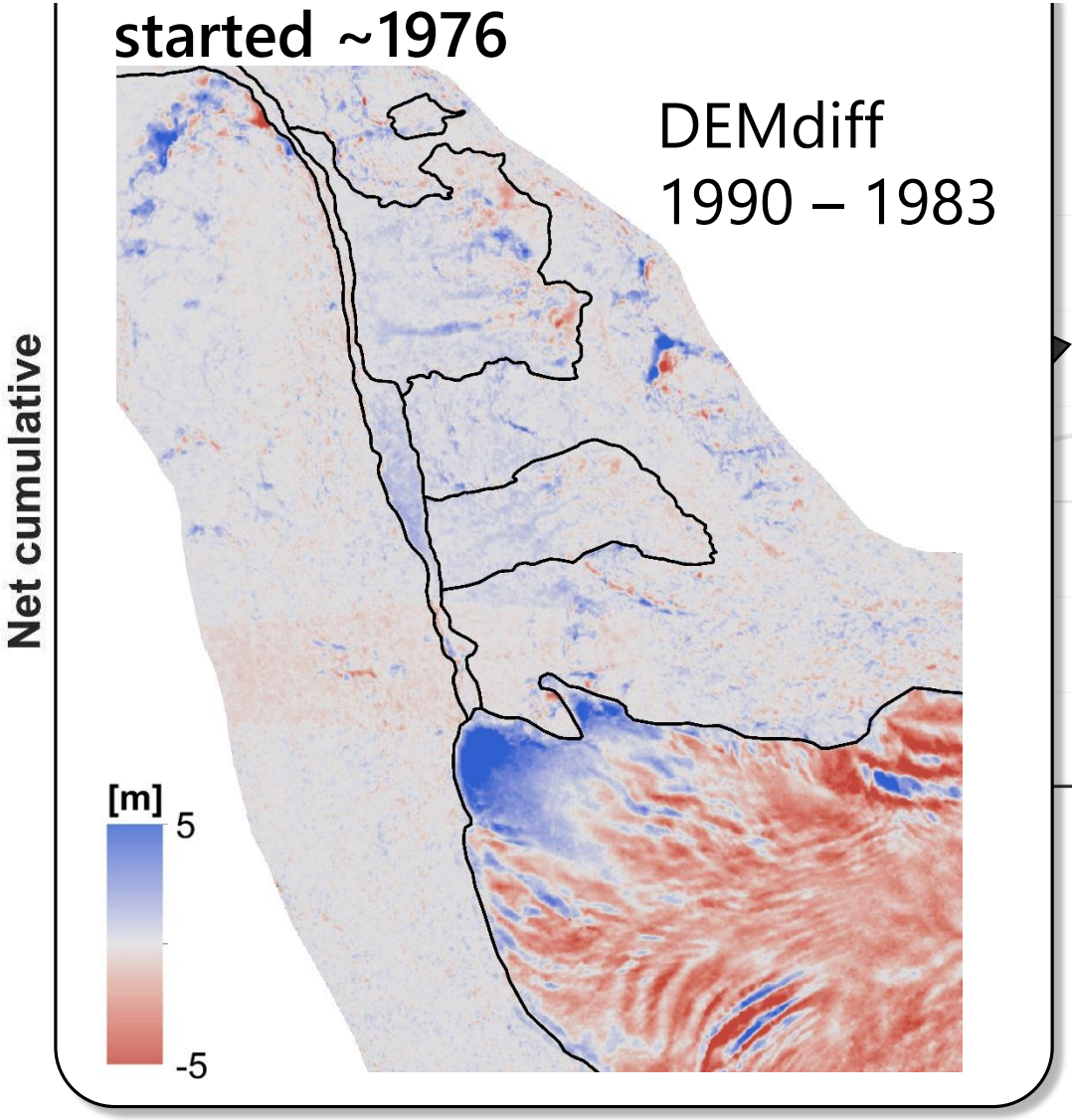


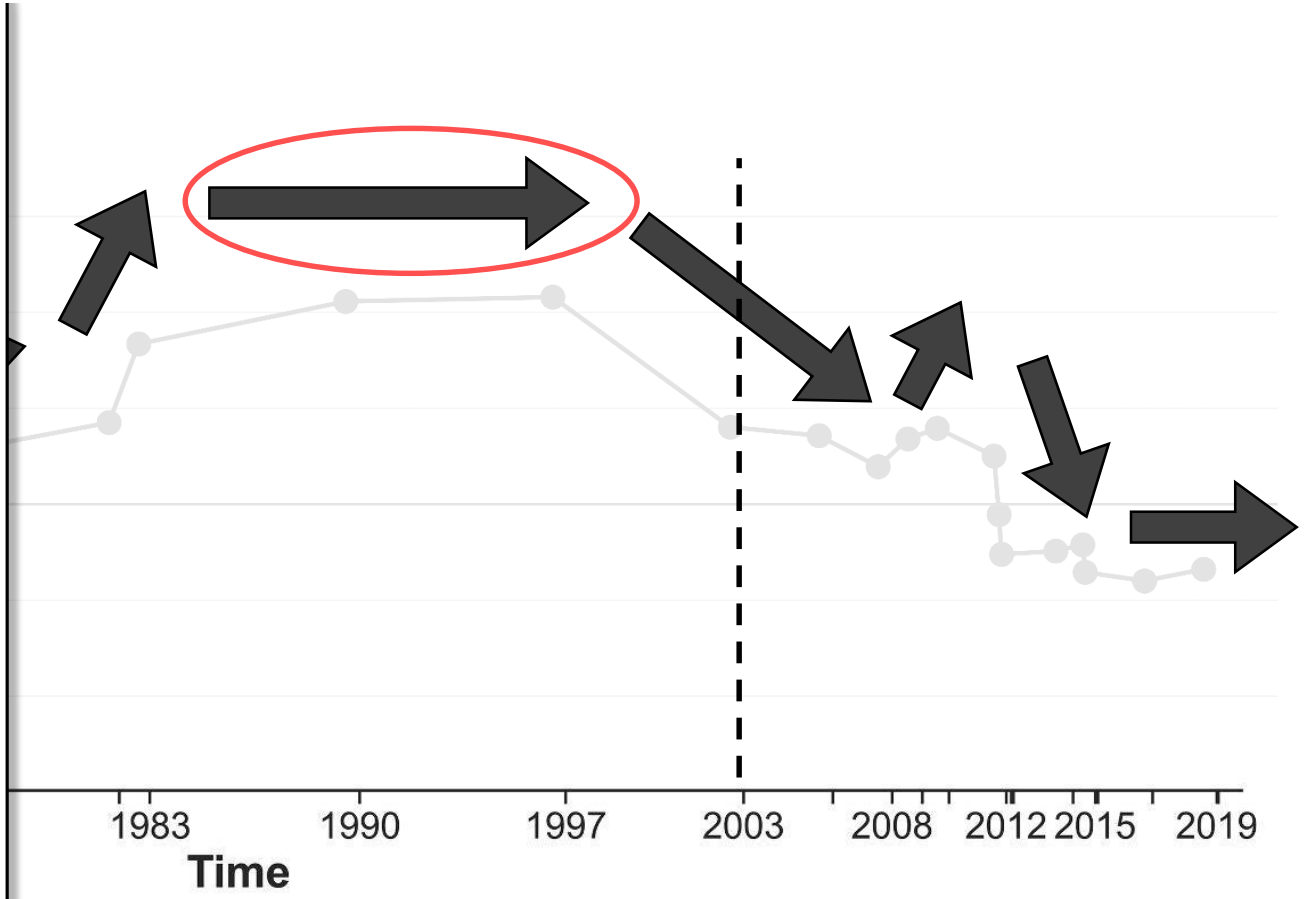
Sediment deposition from connected hillslope



Net cumulative sediment balance

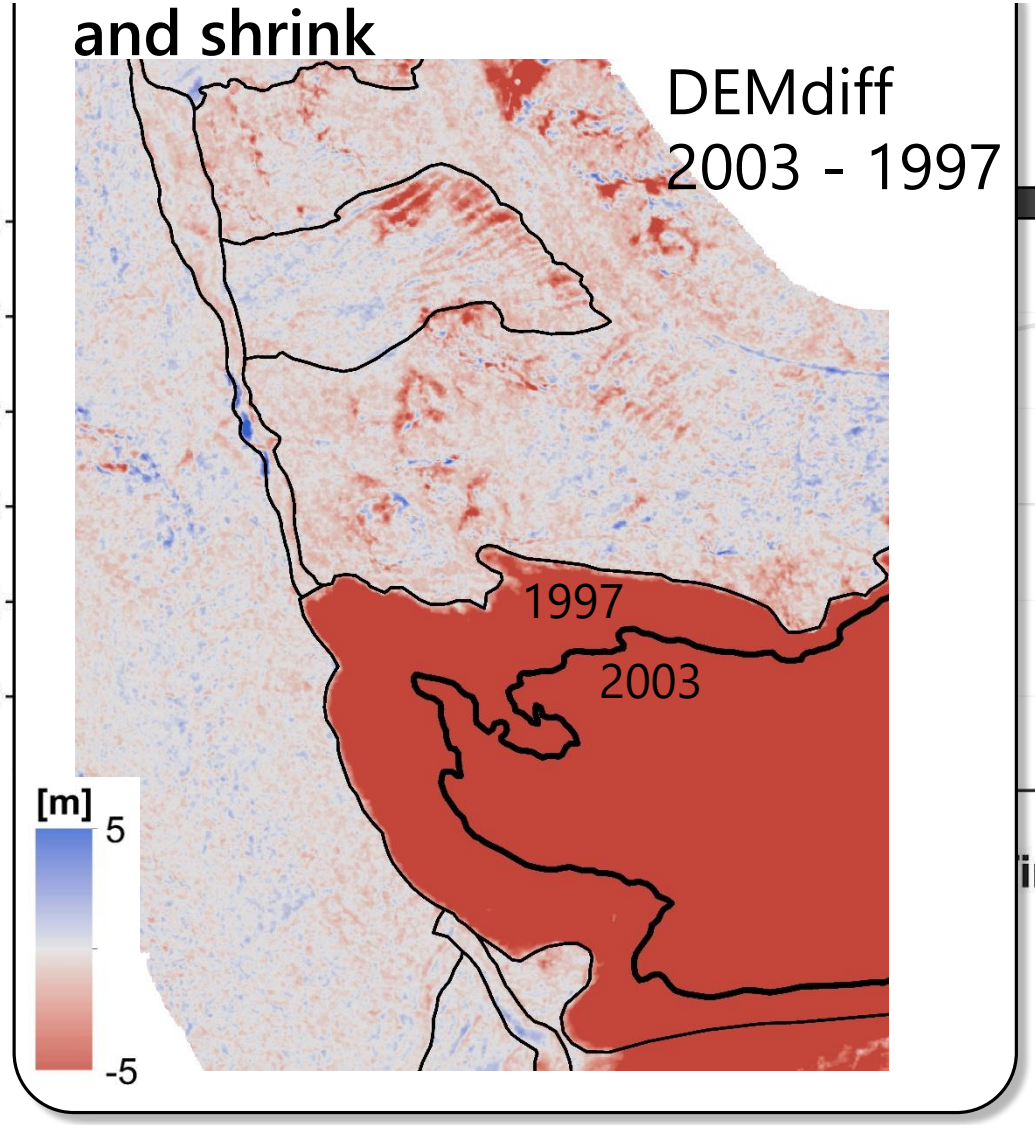
Advance phase of the glacier started ~1976





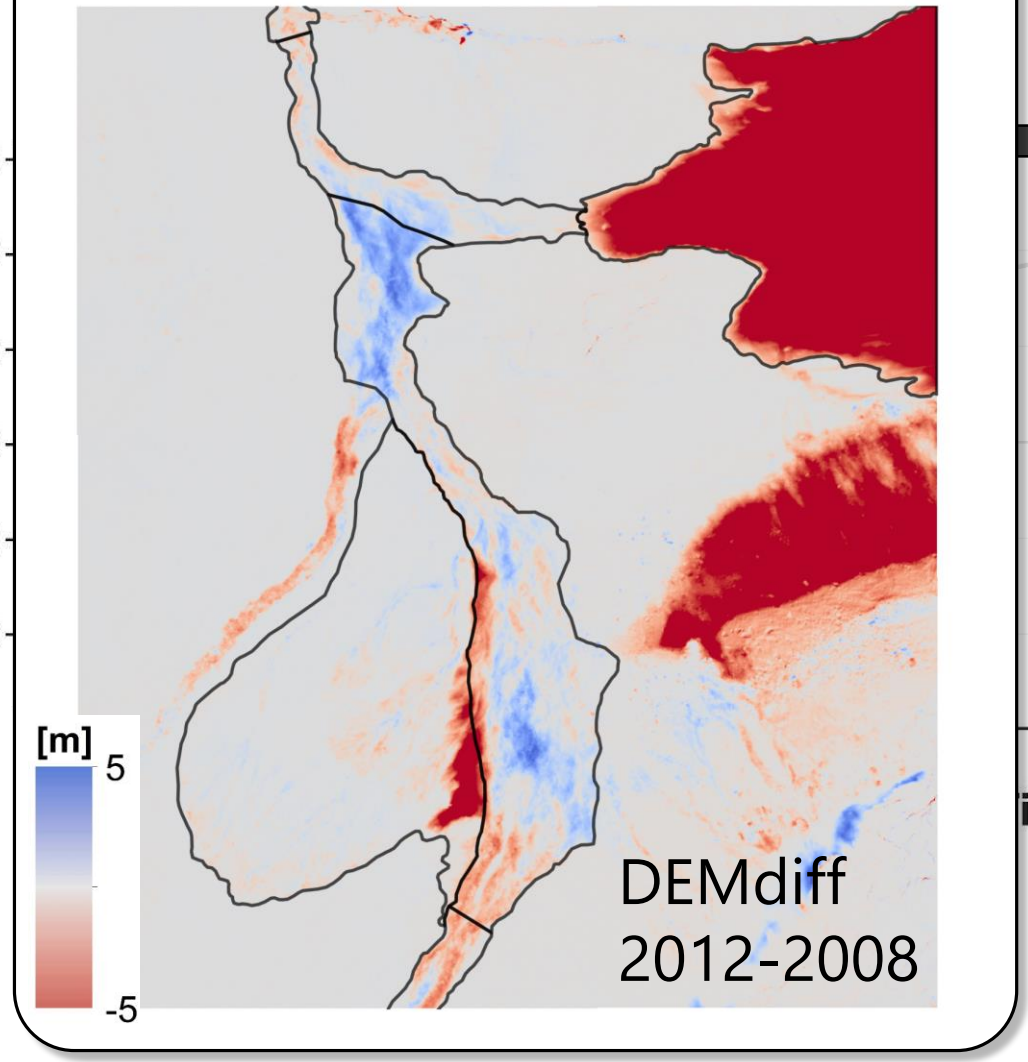
Net cumulative sediment balance

Massive glacier retreat (~300m) and shrink



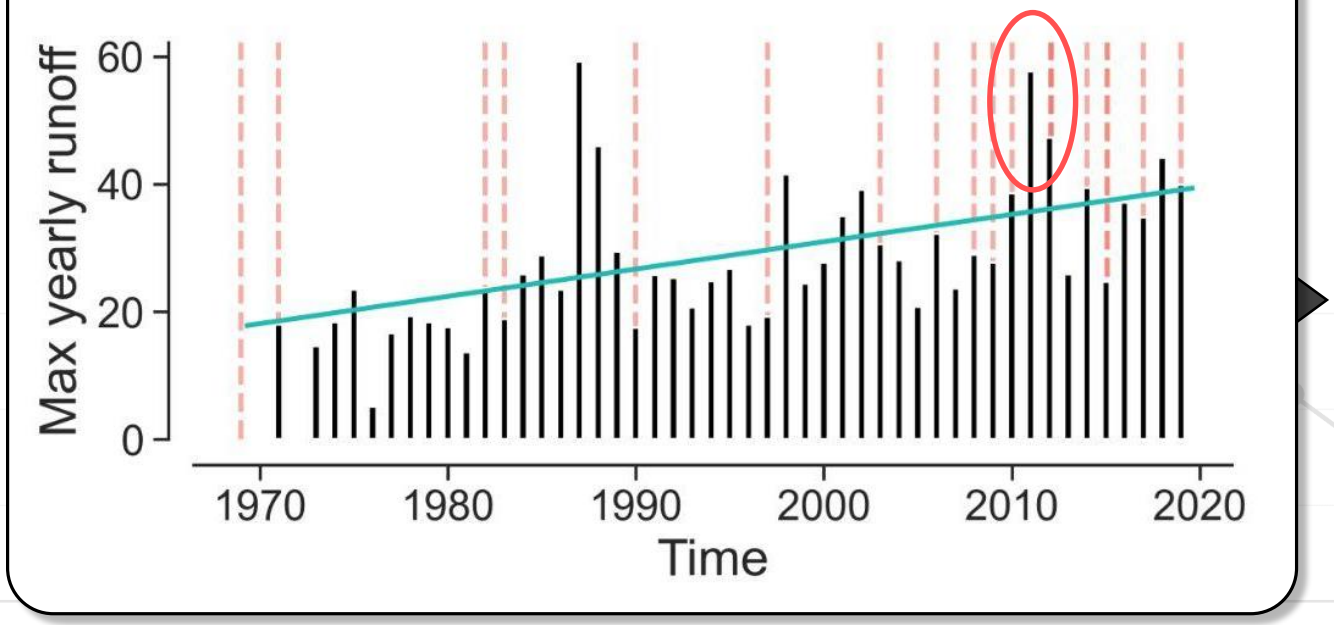
Net cumulative sediment balance

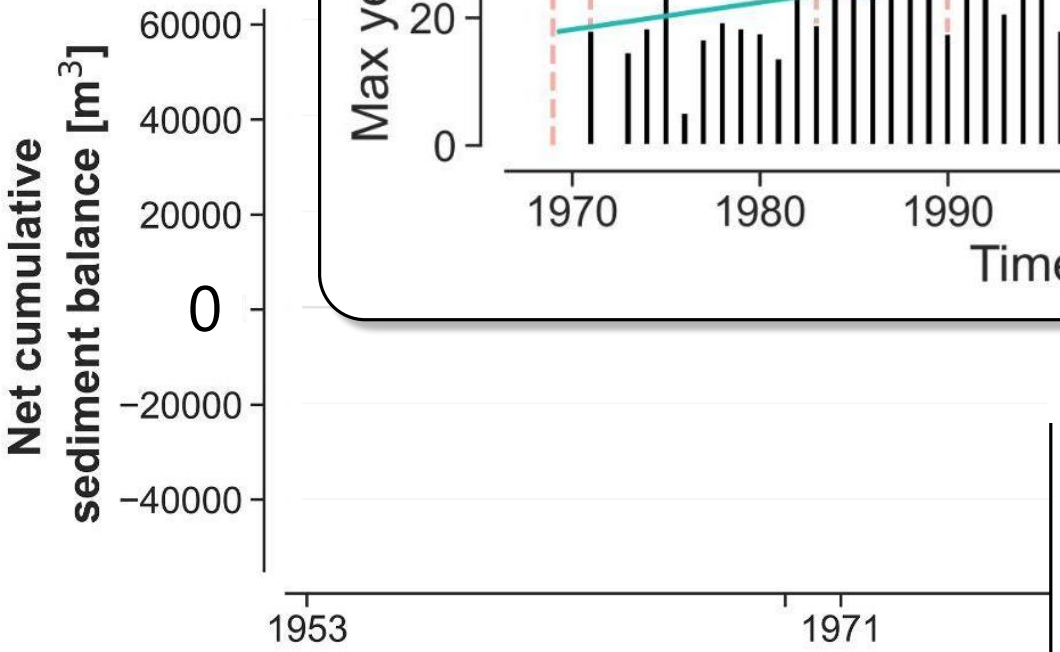
Sediment deposition from connected hillslope



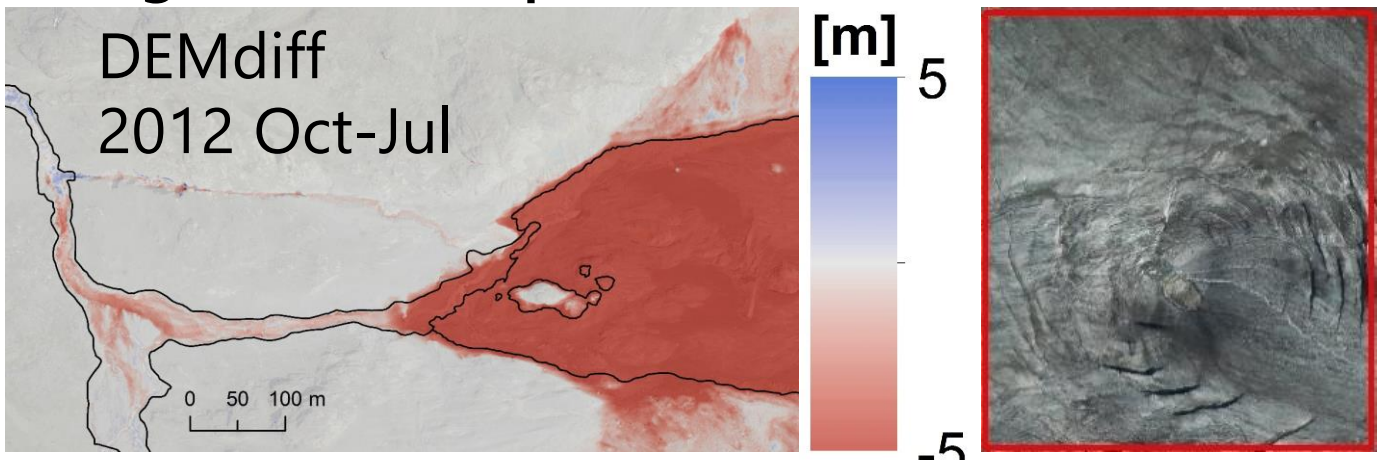
alance

Strong runoff events & increase runoff trend

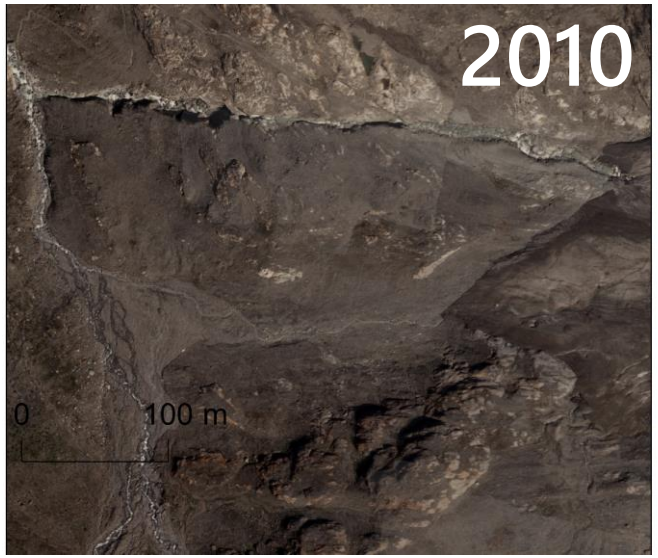




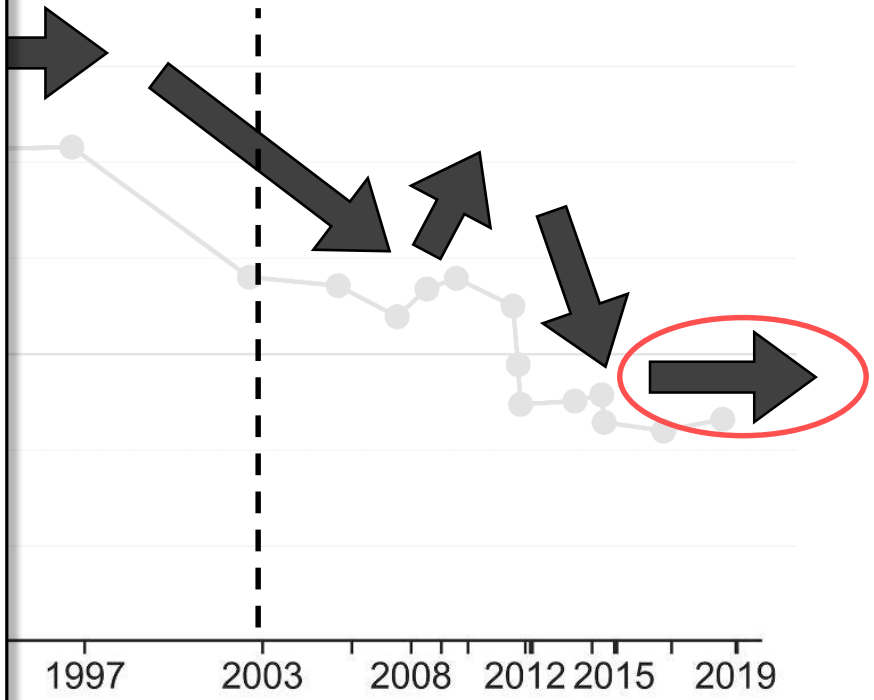
Subglacial water pocket outbursts



Net cumulative sediment balance



after 2014, the glacier bed is mainly rocky and no strong runoff events have occurred



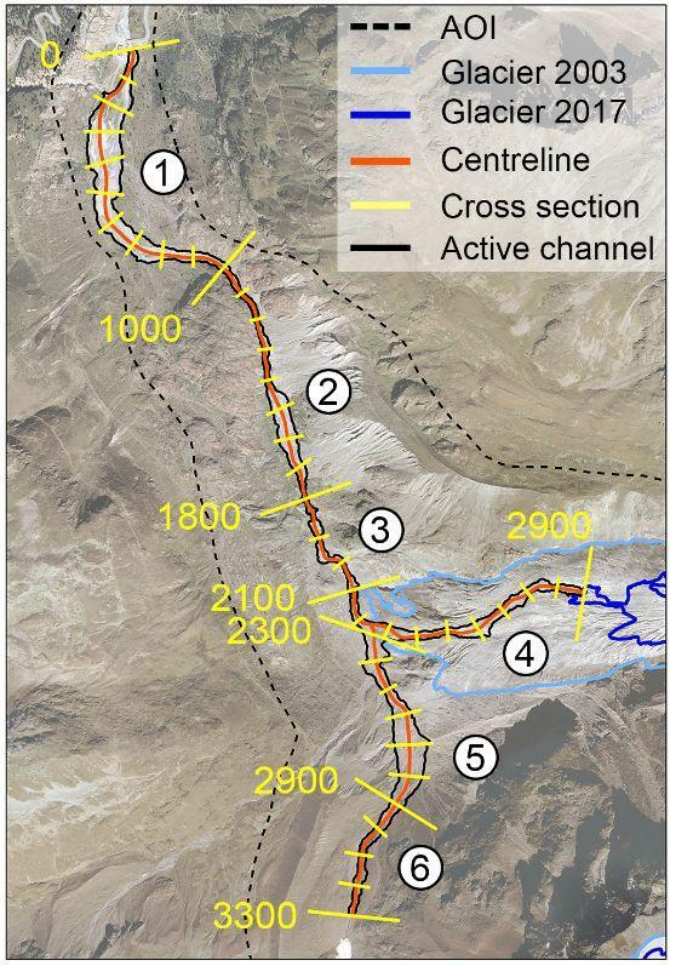
Conclusions and Outlook

- **DEMs from historical images** can capture accurate erosional and depositional patterns at the resolution of **1 m**
- **Glacier changes**, glacier bed (e.g. sediment bed, bedrock), and **lateral hillslope** have the largest impact on sediment balance
- **Strong single event** (e.g. lateral moraine sediment deliver, glacial outburst and runoff) can have a large impact on sediment balance
- **High temporal resolution data** are **needed** to detect the variability of proglacial river sediment budget

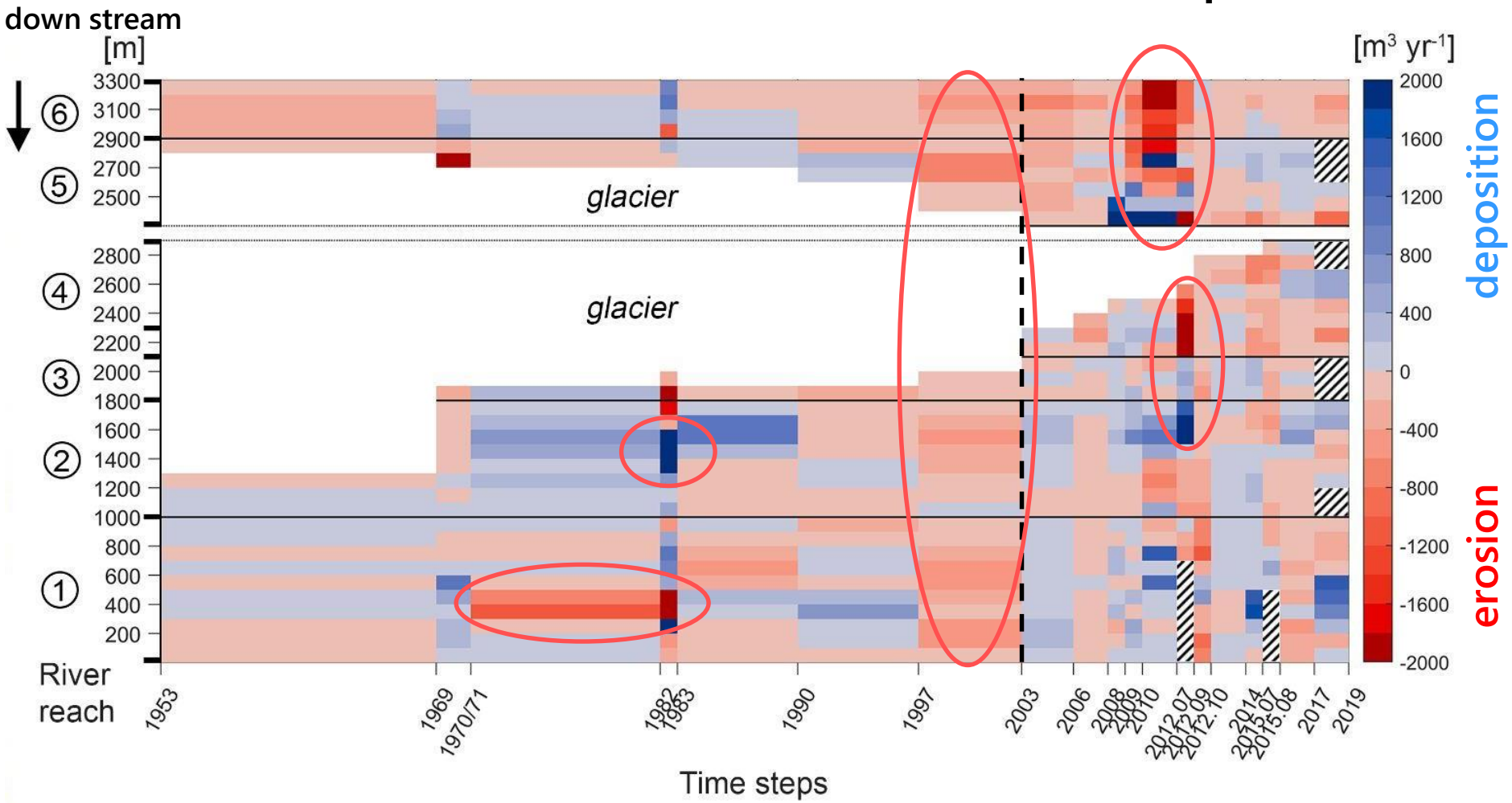
Appendix

Spatio-temporal variability of net sediment volume

6 River reaches and 100 m subsection



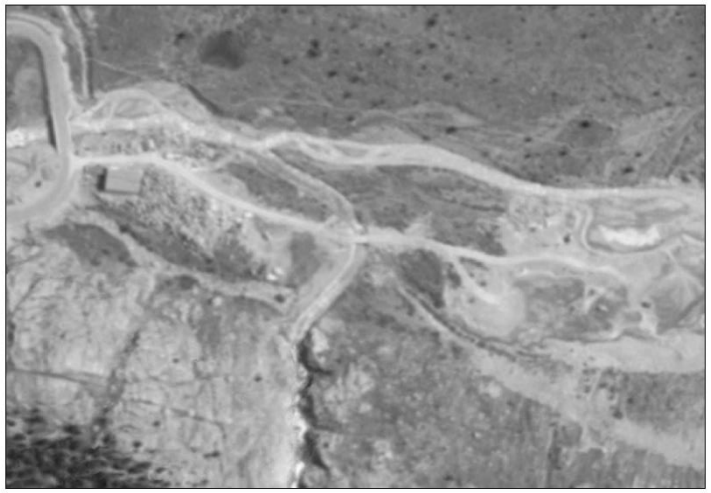
Net sediment volume of the active floodplain



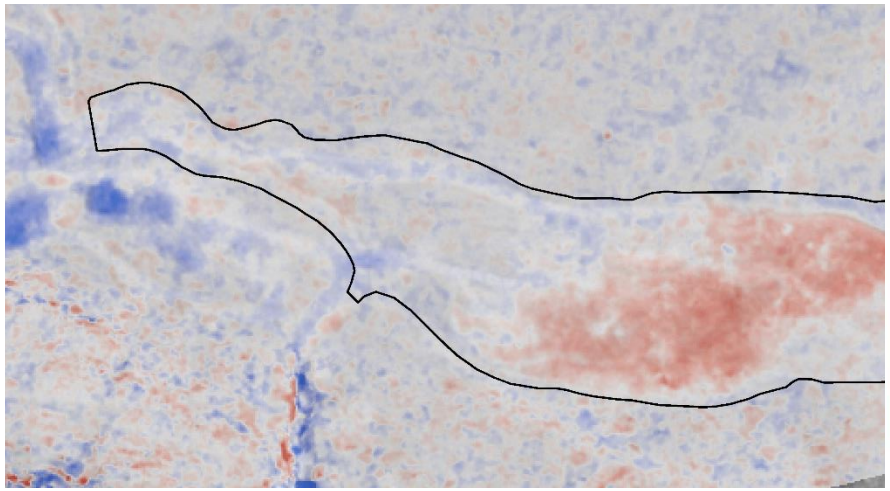
Spatio-temporal variability of net sediment volume

1970

1982



DEMdiff 1982 -1970



Human factors: instream gravel mining, road and bridge construction