



Spatial distribution and (of) controlling factors of the debris flow hazard across High Mountain Asia

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GeoHyd Lunch Seminar

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131gravelly Sphagnum 2 Kastoria 2 2023-06-15 15:30:04



- Most types of natural hazards are projected **to change in frequency, magnitude and areas** affected as the cryosphere continues to decline (*high confidence*).
- Glacier retreat and permafrost thaw are projected to **decrease the stability of mountain slopes** <...> (*high confidence*). Resulting landslides and floods, and cascading events, will also **emerge where there is no record of previous events** (*high confidence*).
- As documented for sites in the European Alps and Scandinavia < ... >, rock glaciers replenished debris flow starting zones at their fronts, so that the intensified material supply associated with **accelerated movement contributed to increased debris flow activity** (*higher frequency, larger magnitudes*) or slope destabilisation.
- At lower elevations < ... > climate driven changes such as a **reduction in number of freezing days** are projected to lead to a reduction in debris flows.



Christoff Andermann
@ChrisAndermann

Lete Kali Gandaki hydrology station hit by Mustang landslide dam lake outburst flood **#LLOF** this morning. Maybe it is still recording 🤔 ? I am operating this station since 2012 @GFZ_Potsdam



7:33 AM · Aug 14, 2023 · 62.4K Views



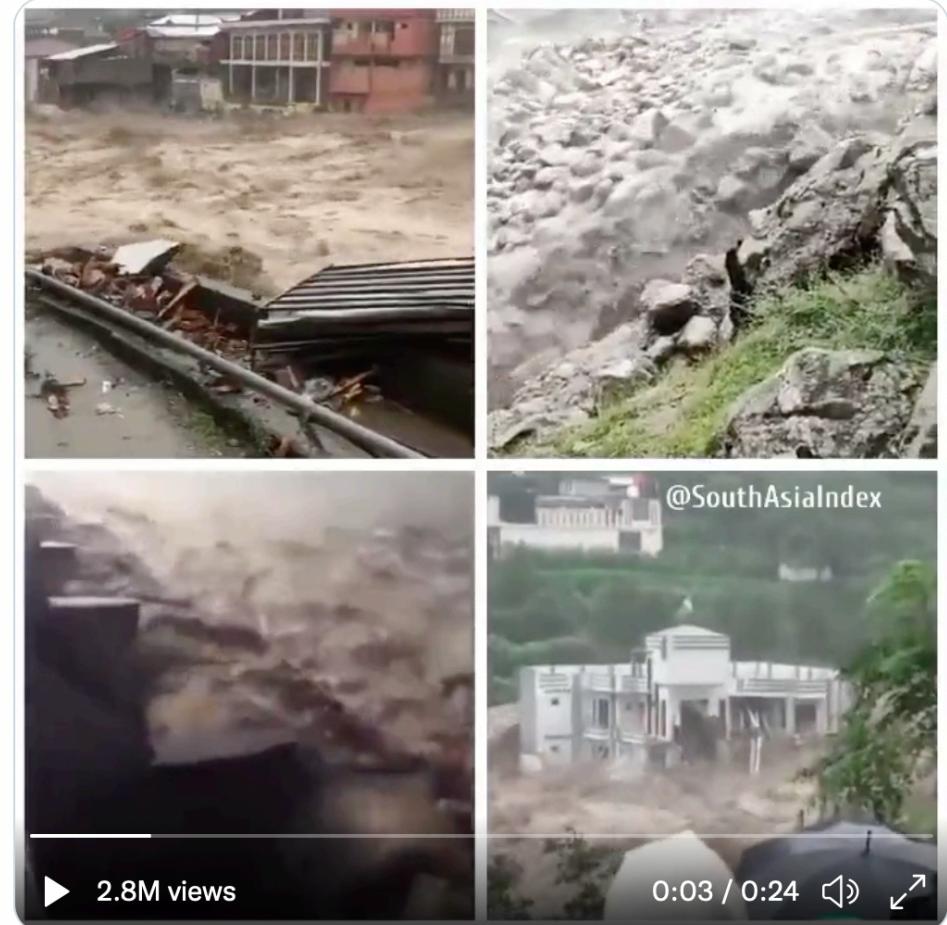
Colin McCarthy @US_Stormwatch · Aug 30

...

Hard to comprehend the scale of the **flood** disaster in Pakistan, the 5th most populated nation in the world.

Nearly 1400 dead, 1 million houses damaged or destroyed, and 50,000,000 people displaced.

1/3 of the country is underwater.



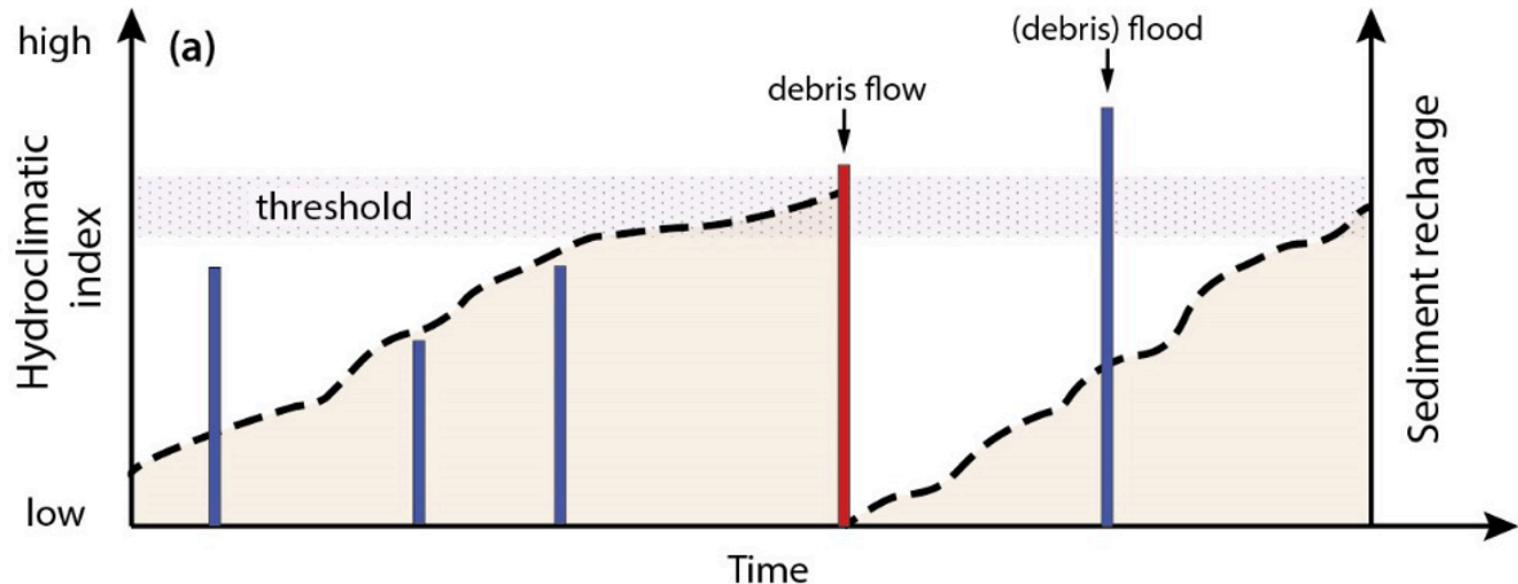
▶ 2.8M views

0:03 / 0:24 ⏴ ↗



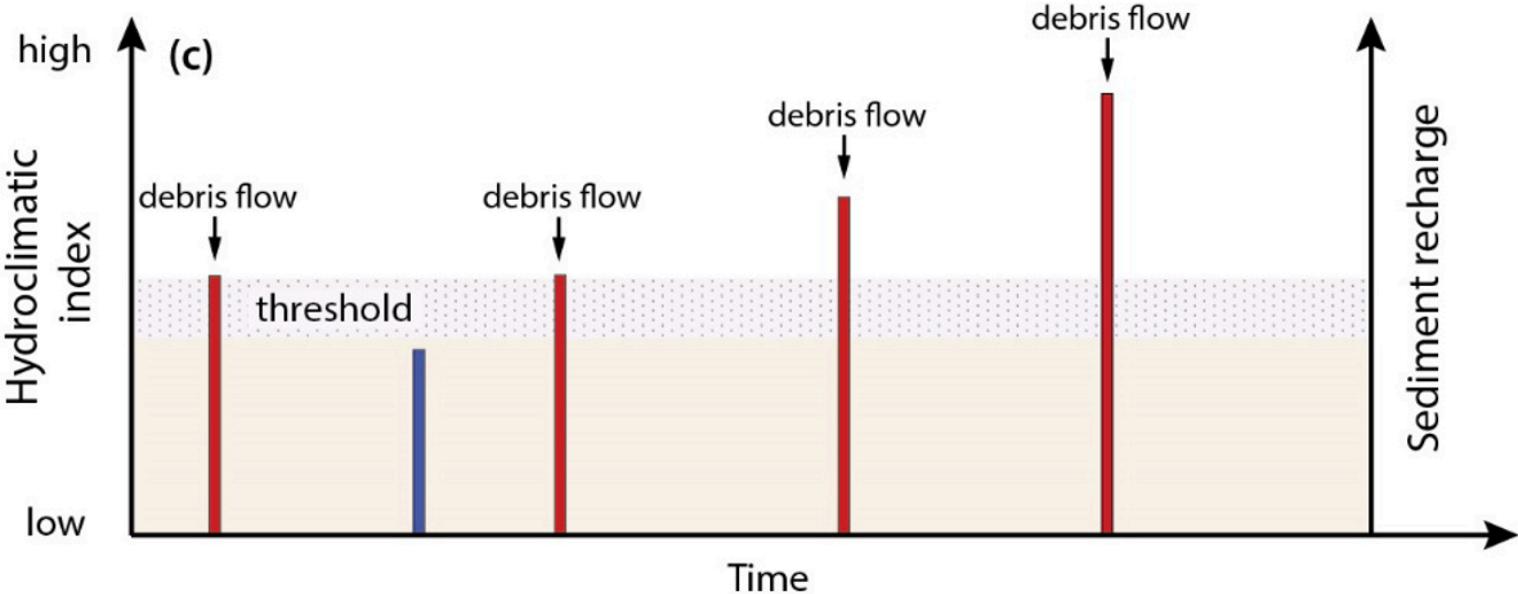
Enough water
✗ Enough sediments

Supply-limited system (weathering-limited)



Enough water
✓ Enough sediments

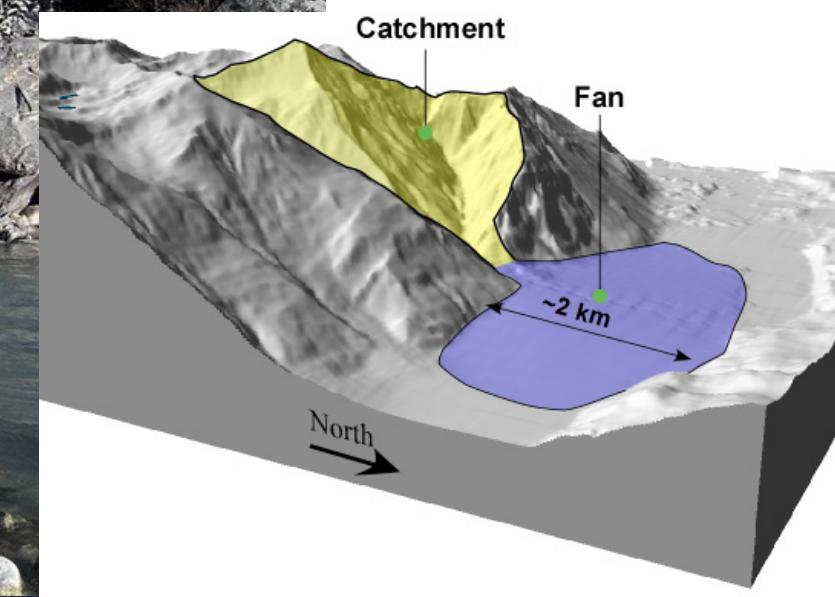
Transport-limited system (supply-unlimited)



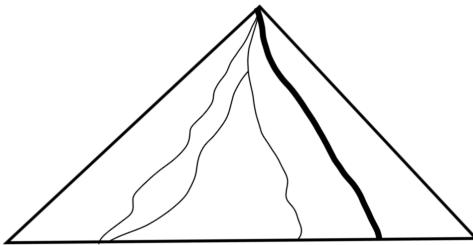


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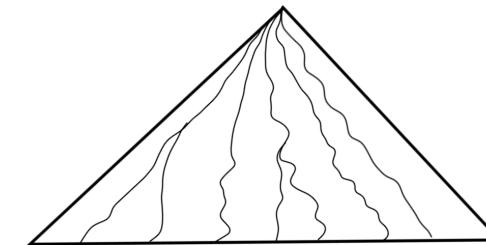
Langtang, Nepal Himalaya



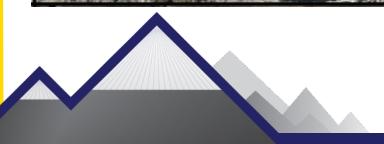


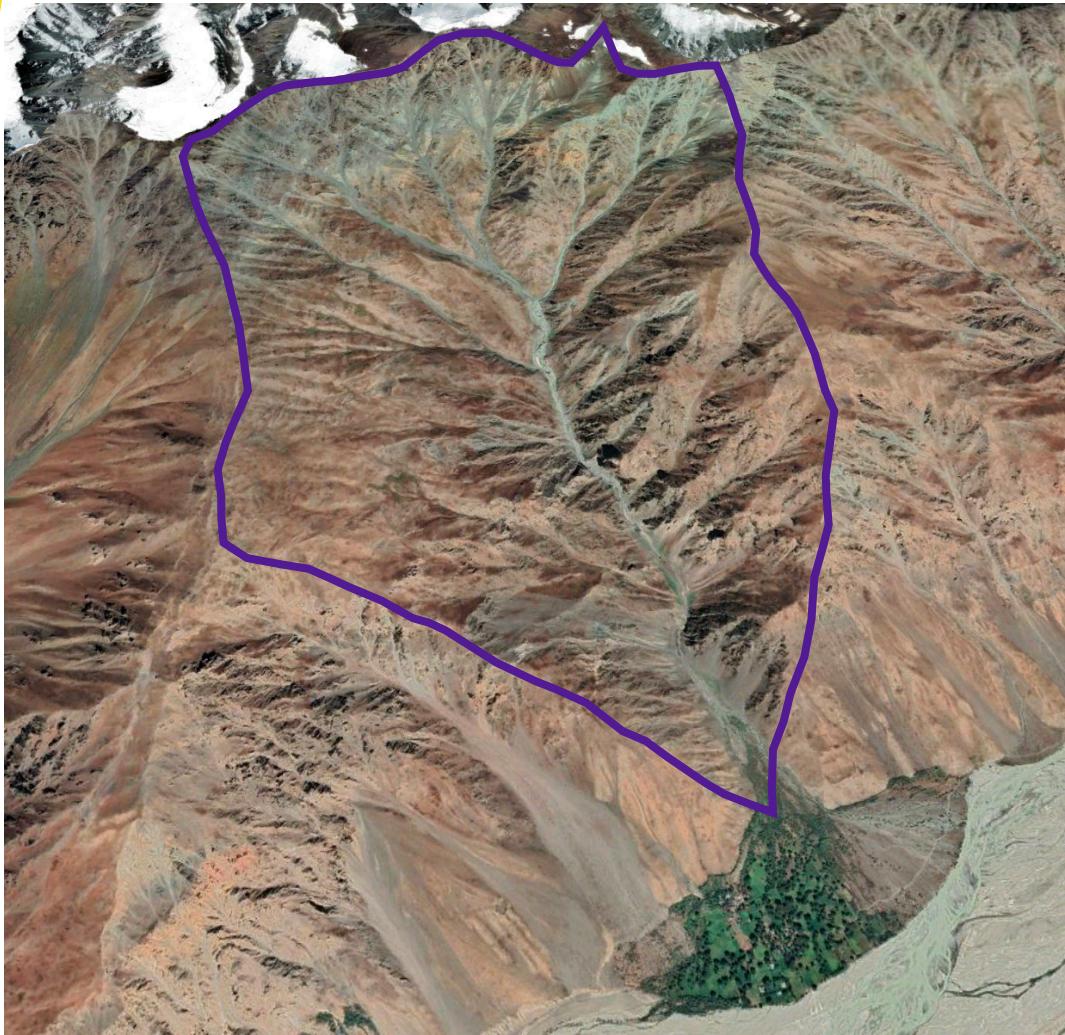


Debris flow dominated



Flood dominated



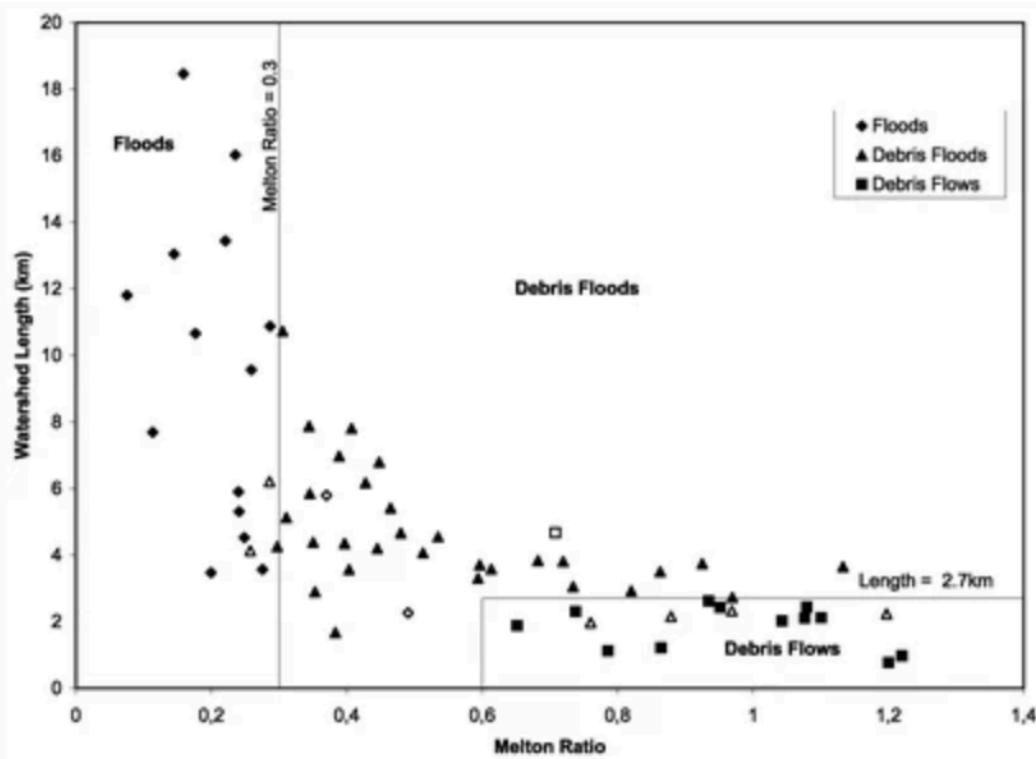


somewhere in Pamir

Image source: Google Earth

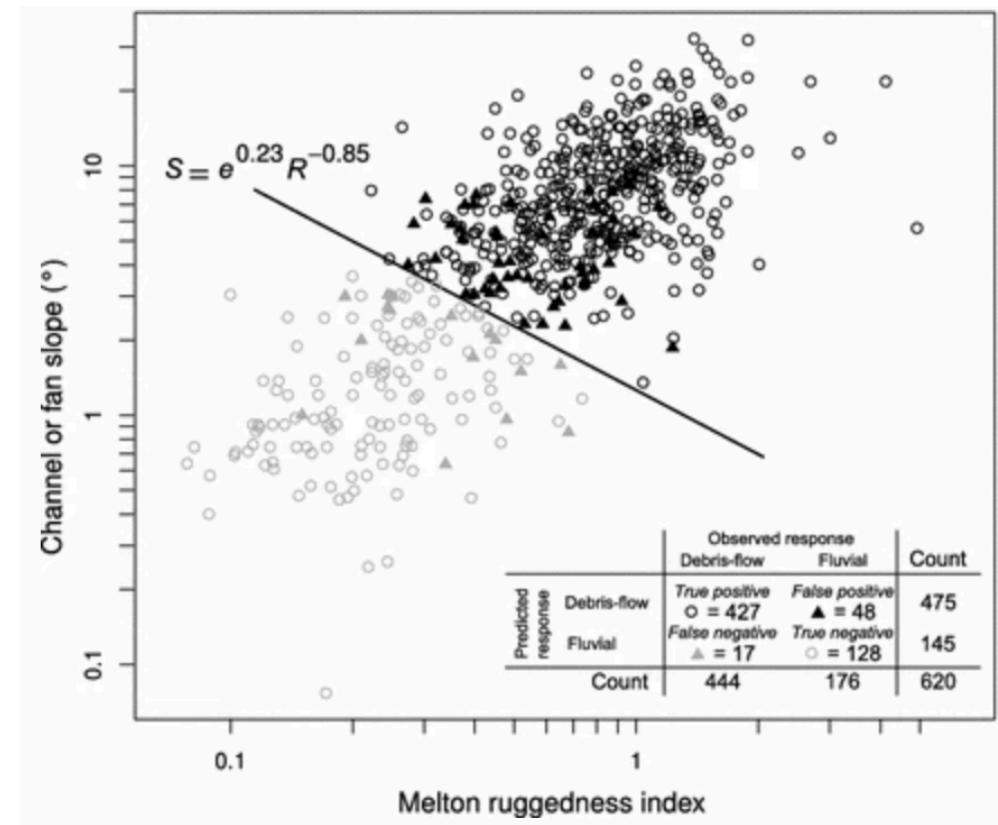


Morphometry threshold for classification



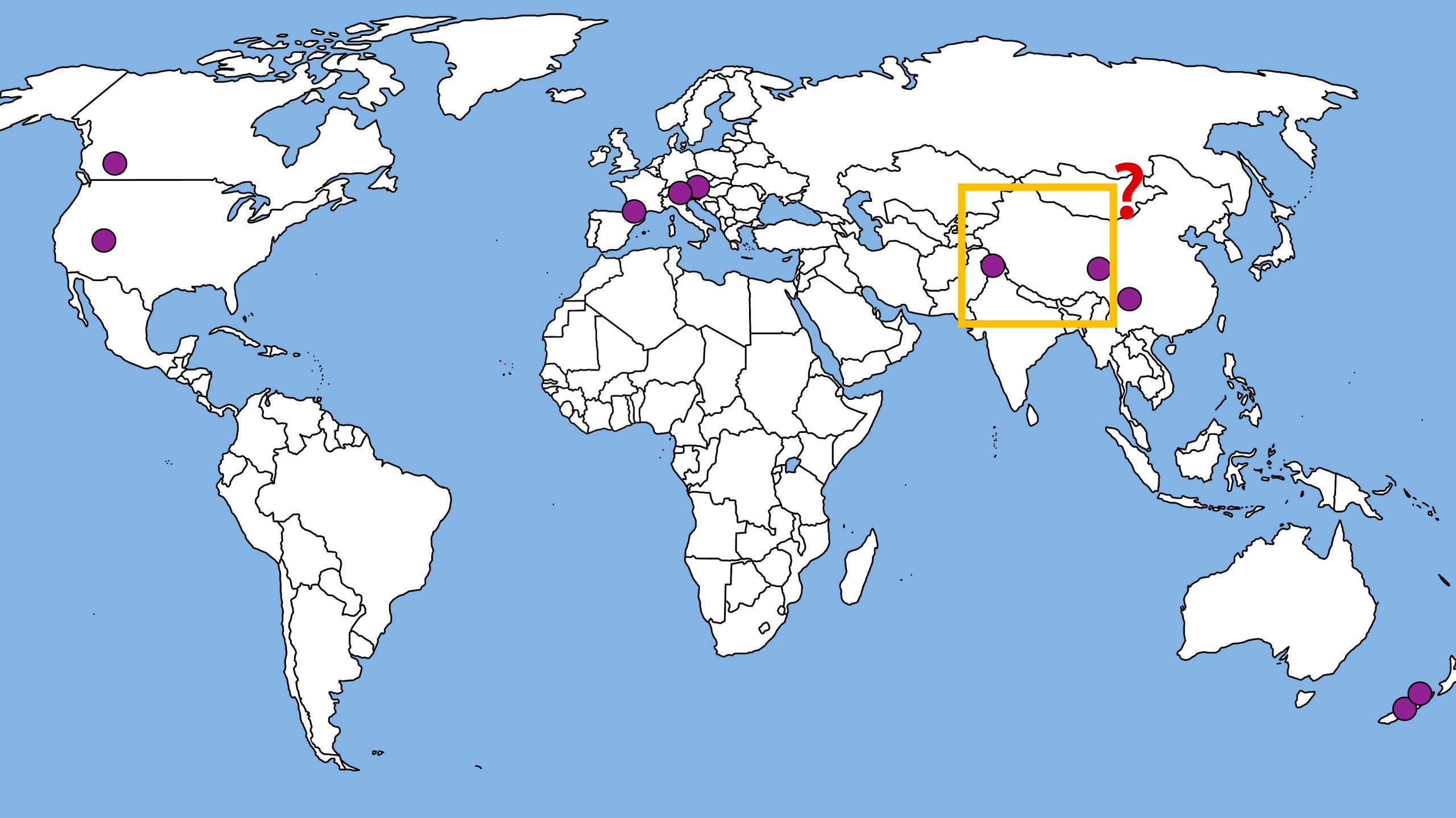
- Field based -> small scale
- Melton index and watershed length are good enough

(Wilford et al., 2004)

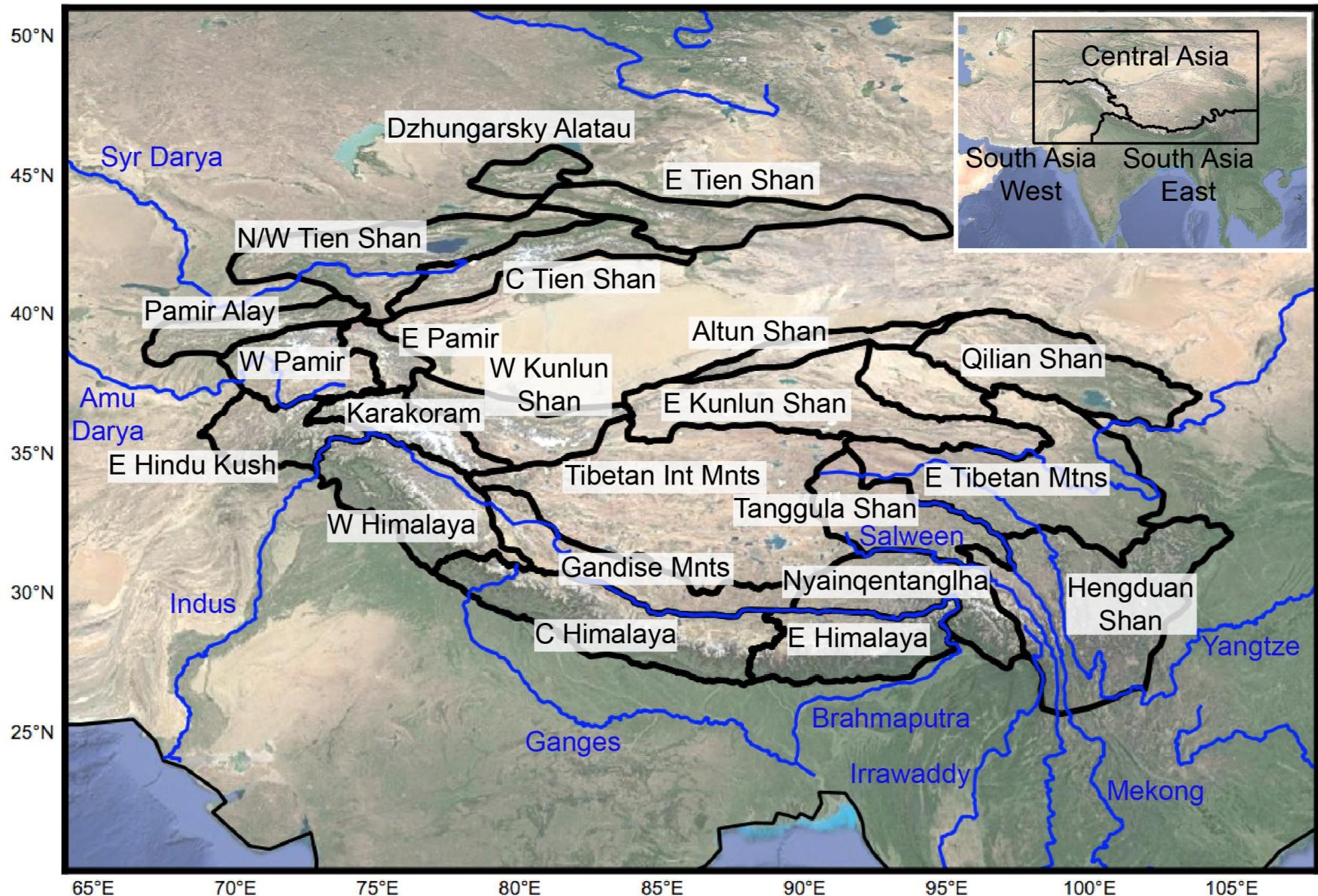


- Dataset from all over the world (review)
- Only Melton index and the fan slope as predictors

(Bertrand et al., 2013)



What is happening in HMA?



(D. Rounce et al., 2020)



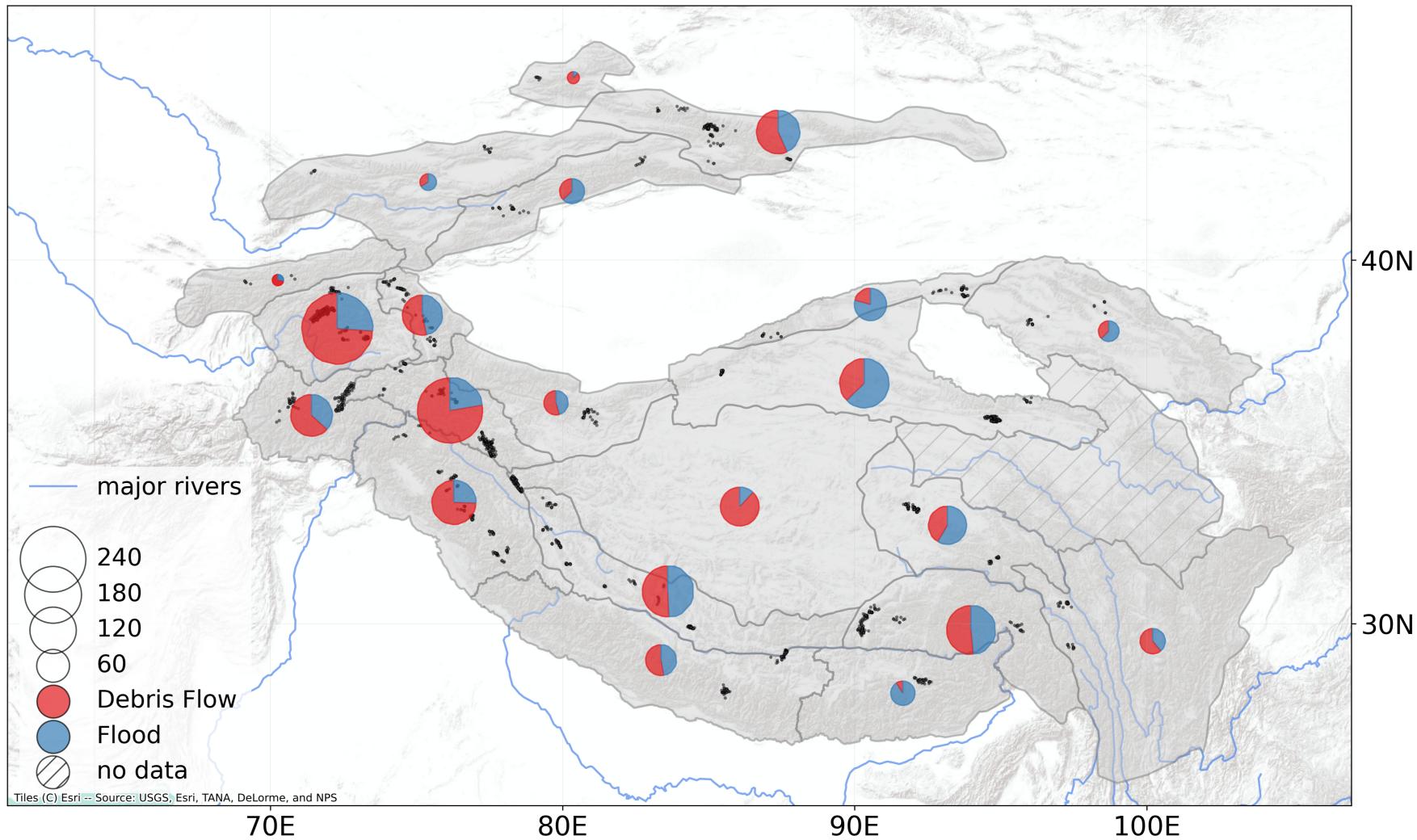
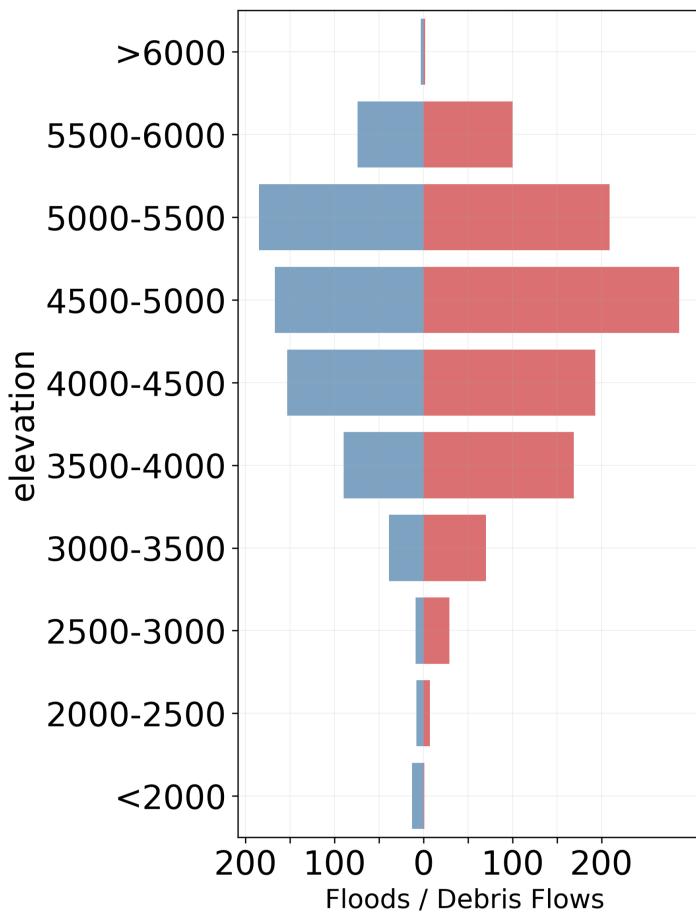
Research questions and the goals:

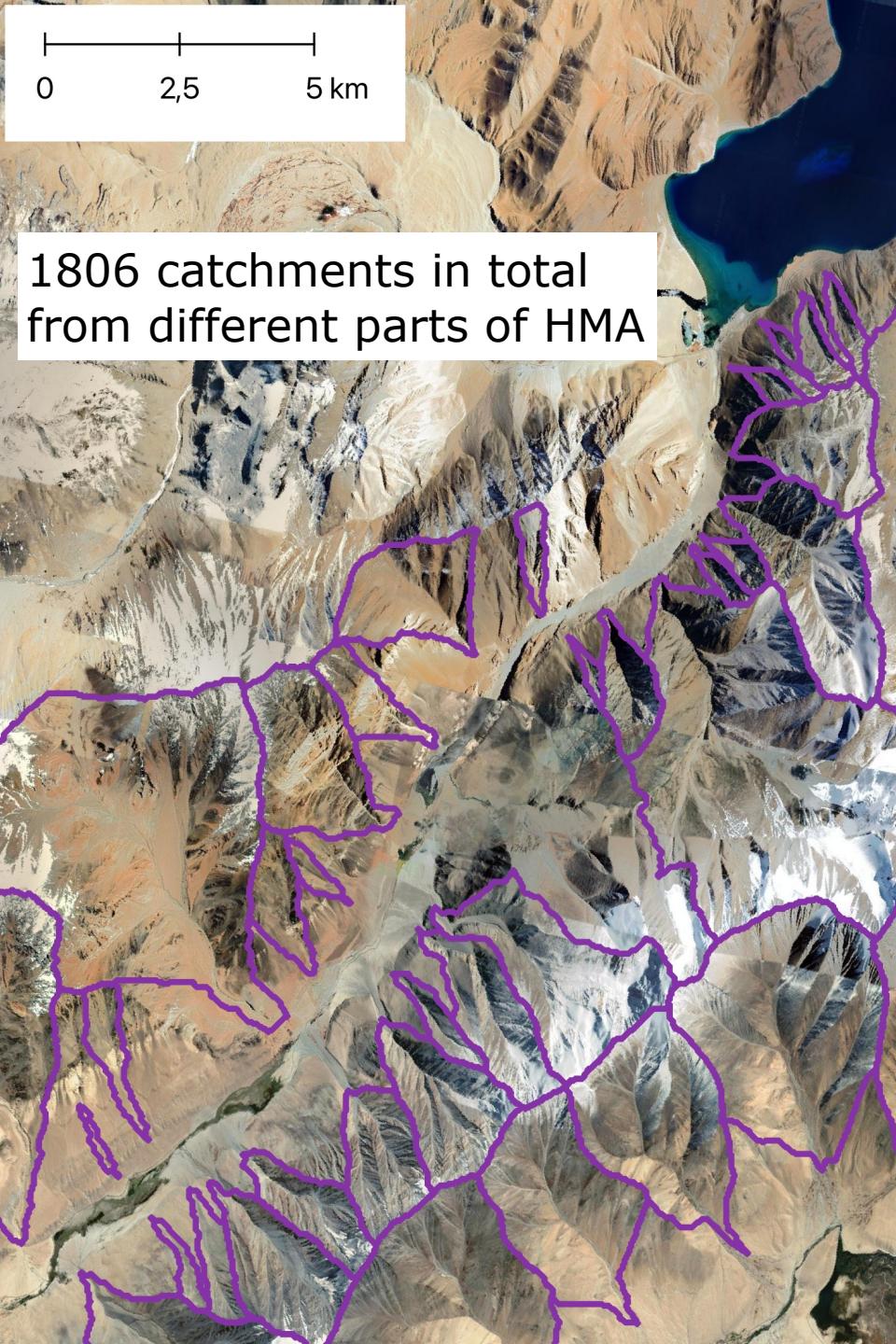


- to **use ML classifier to estimate probabilities** of debris-flow vs flood dominated system
- to **identify the parameters, that matter** for the classification
- to see if adding **climatic features** affects the classification
- to find out if there are any regional differences



Data





Morphometry

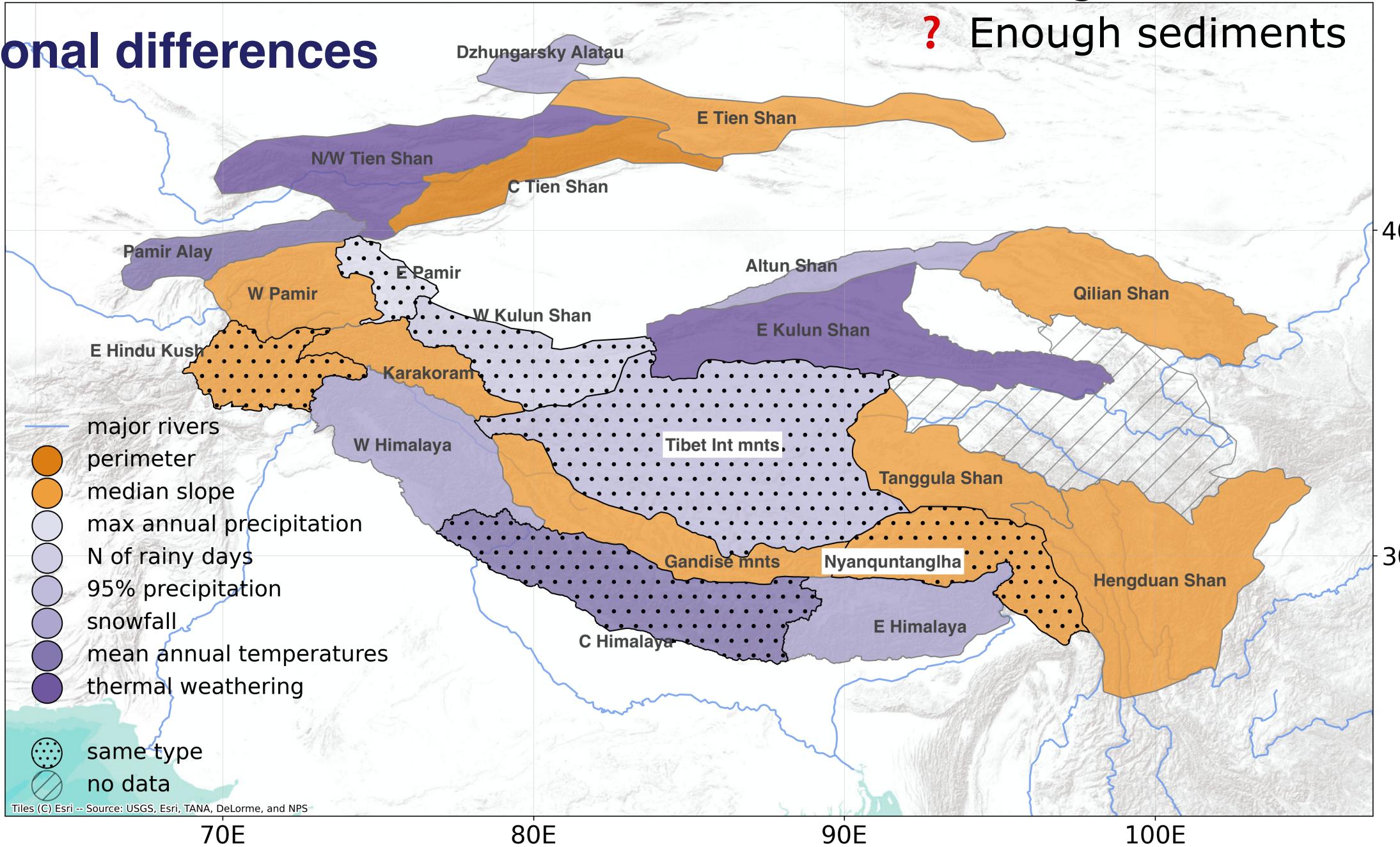
- median elevation
- relief
- area
- perimeter
- median slope
- Melton ratio
- circularity ratio
- compactness

Climate

- total annual precipitation
- max annual precipitation
- N of wet days
- 95% precipitation
- snowfall
- rainfall
- mean annual temperature
- thermal weathering
- frost weathering
- vegetation cover (%)
- continuous permafrost
- glacier

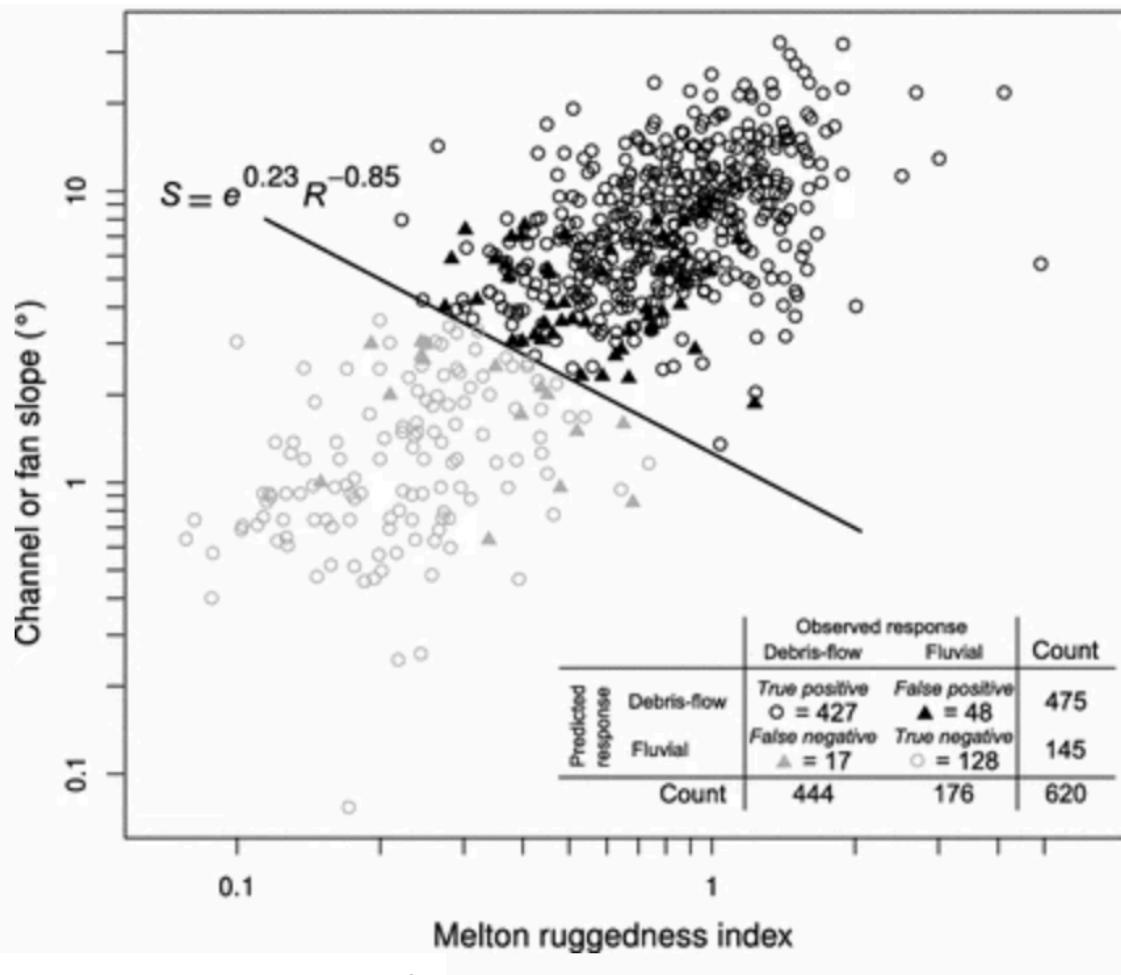
? Enough water
? Enough sediments

Regional differences

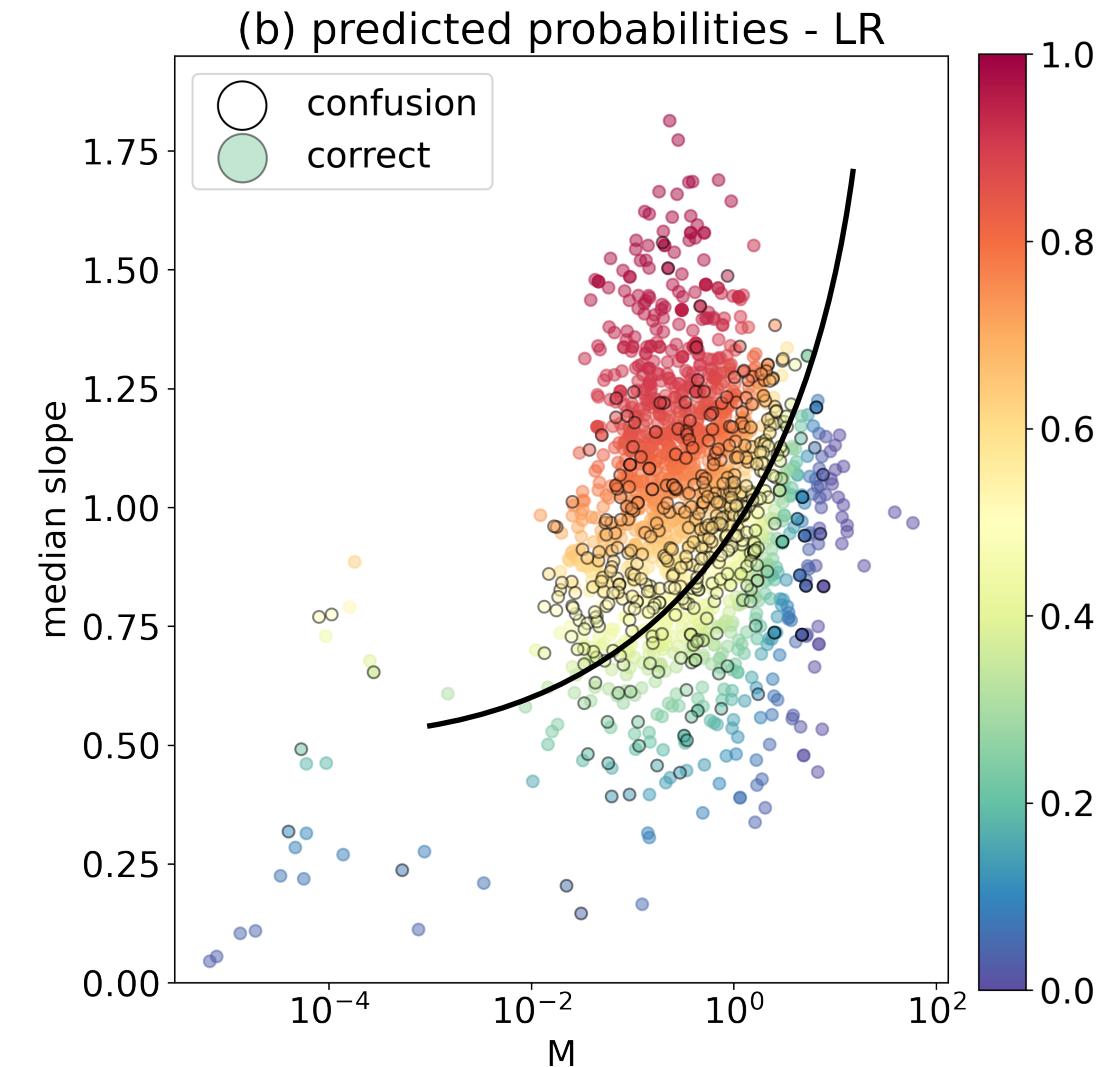




More sophisticated classification structure?

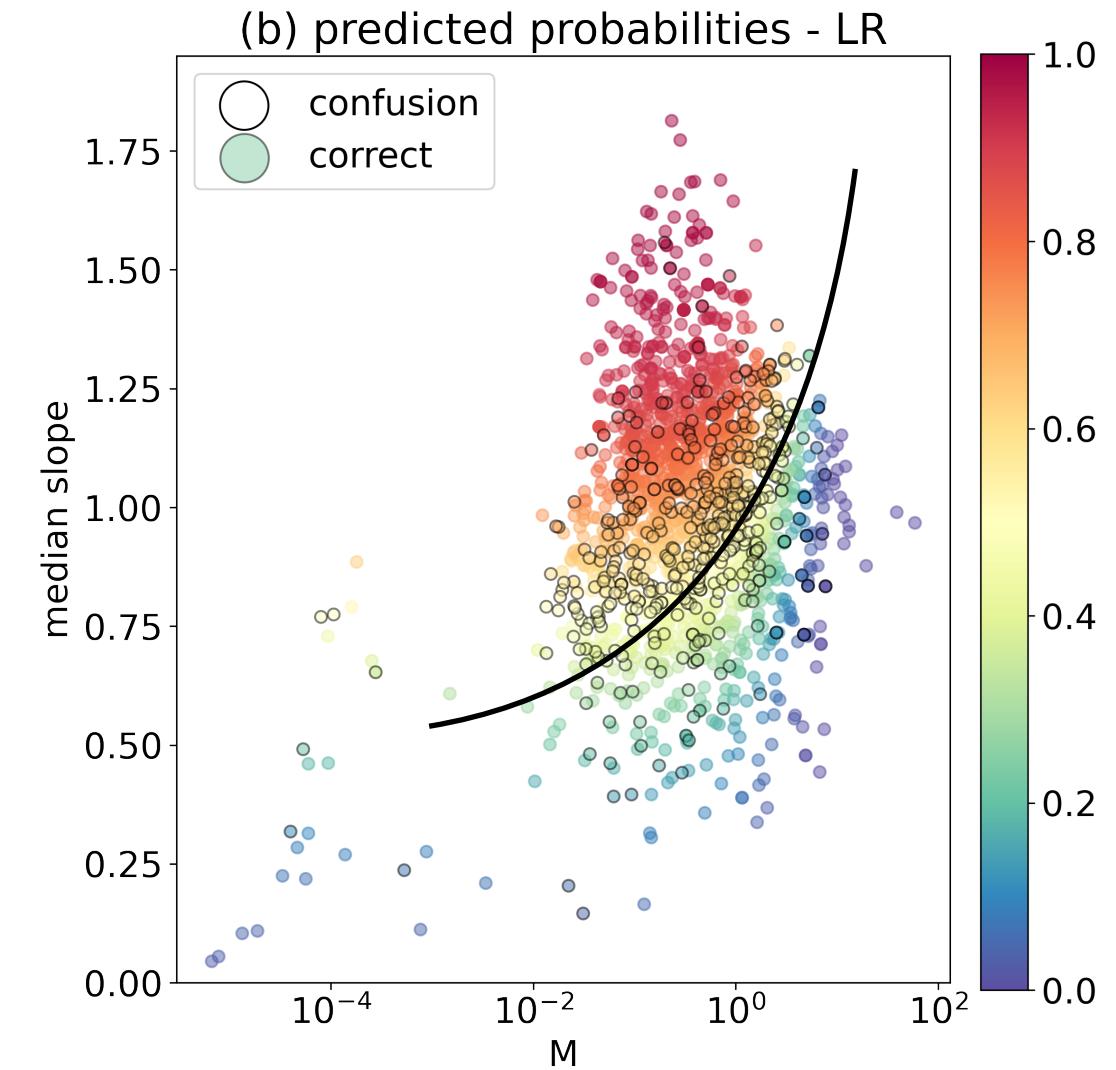
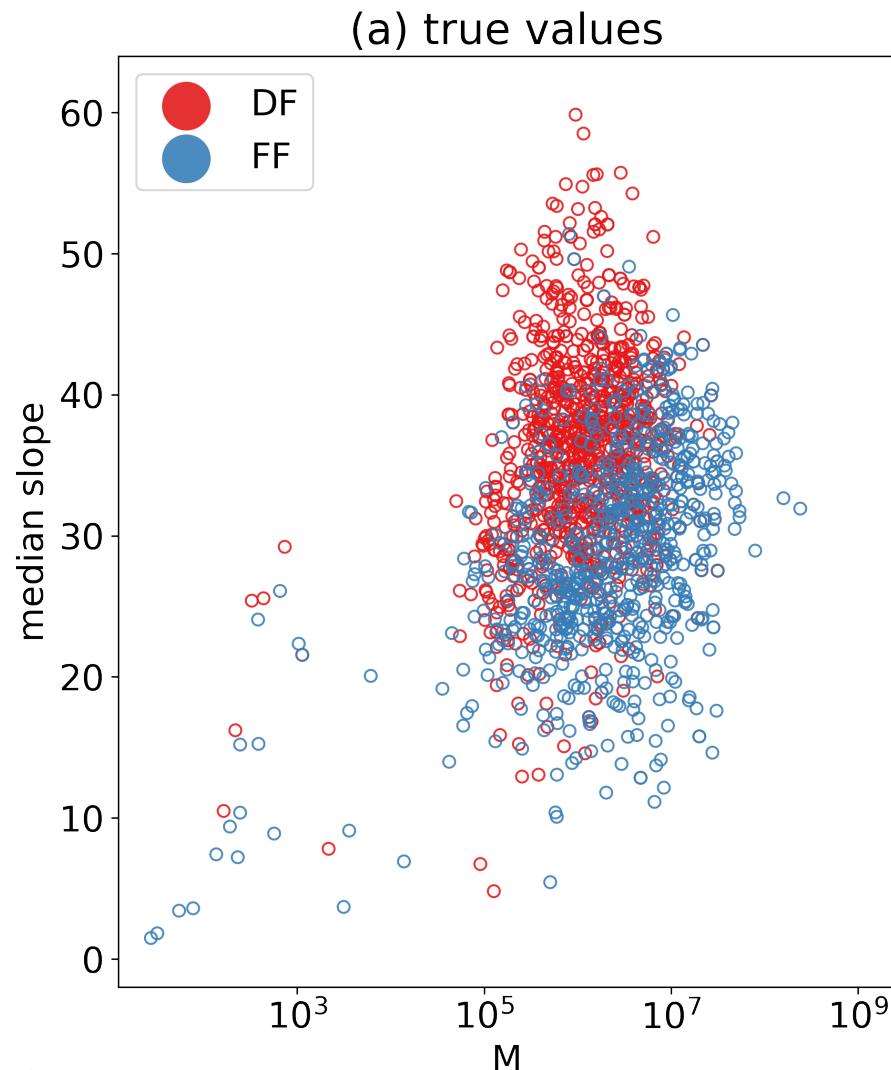


(Bertrand et al., 2013)



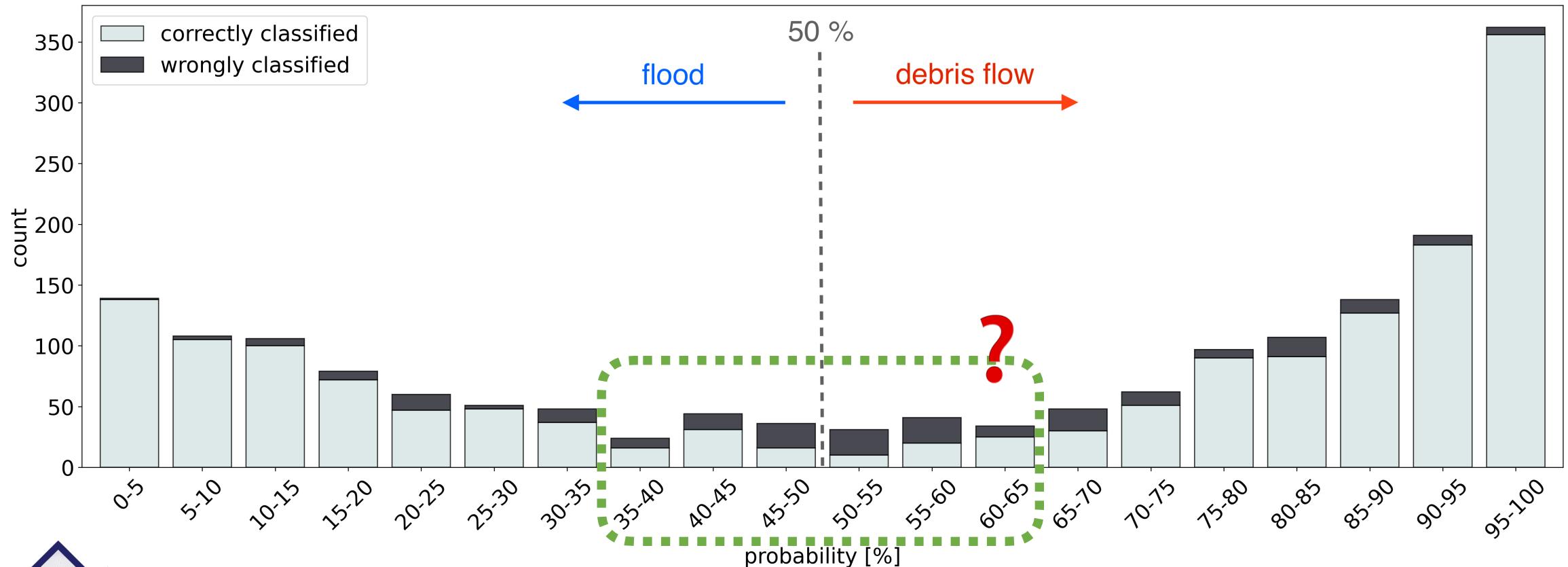


More sophisticated classification structure? High Mountain Asia data





What can we learn from the classification performance?

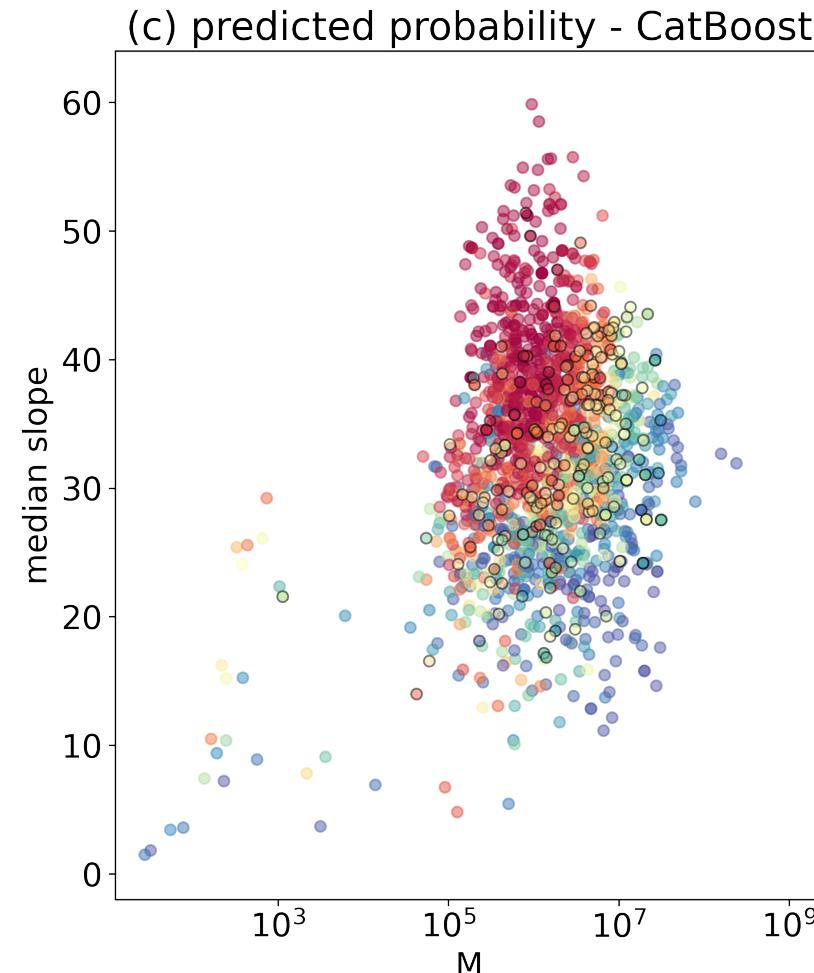
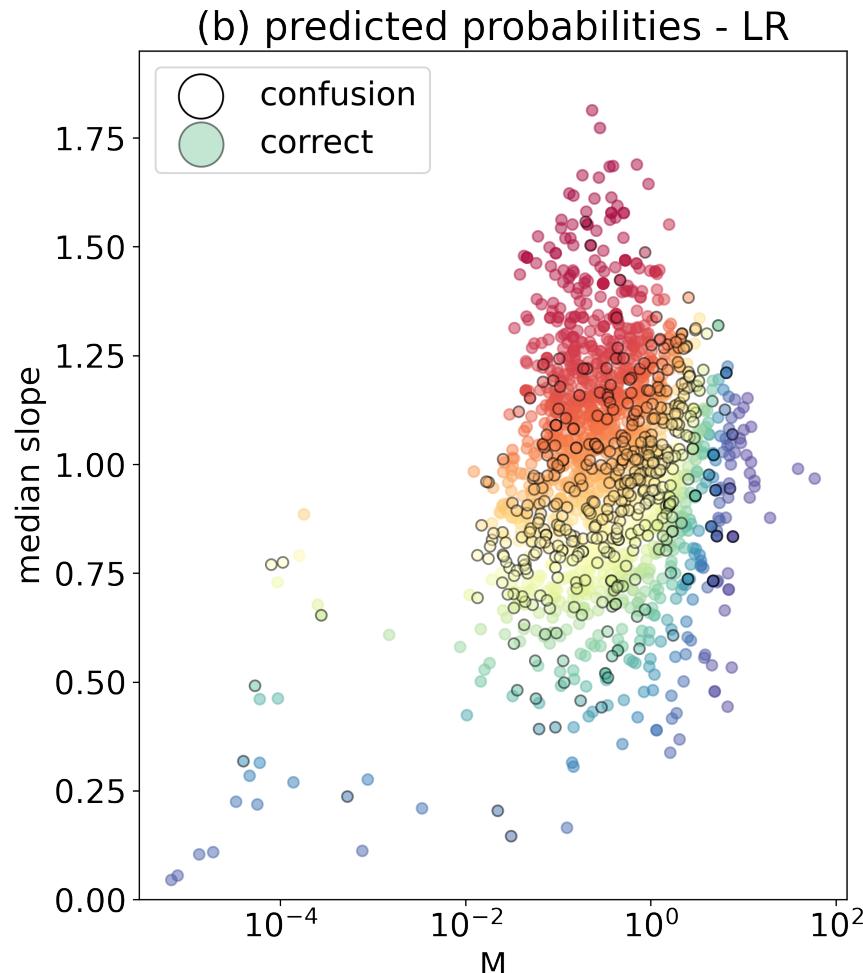




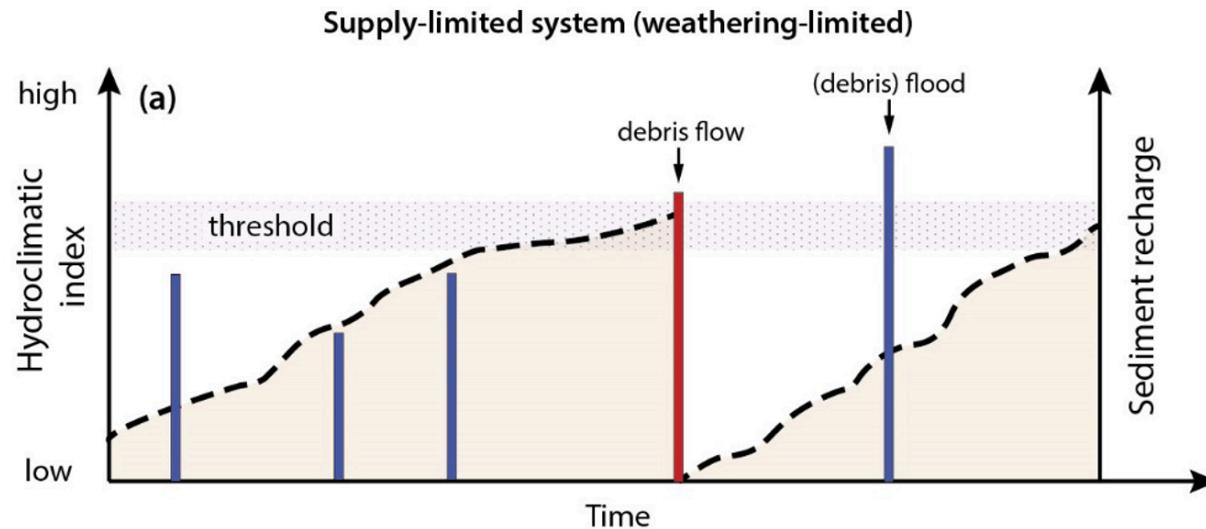
Does this work for HMA data?

- 2 Morphometric features
- Logistic regression

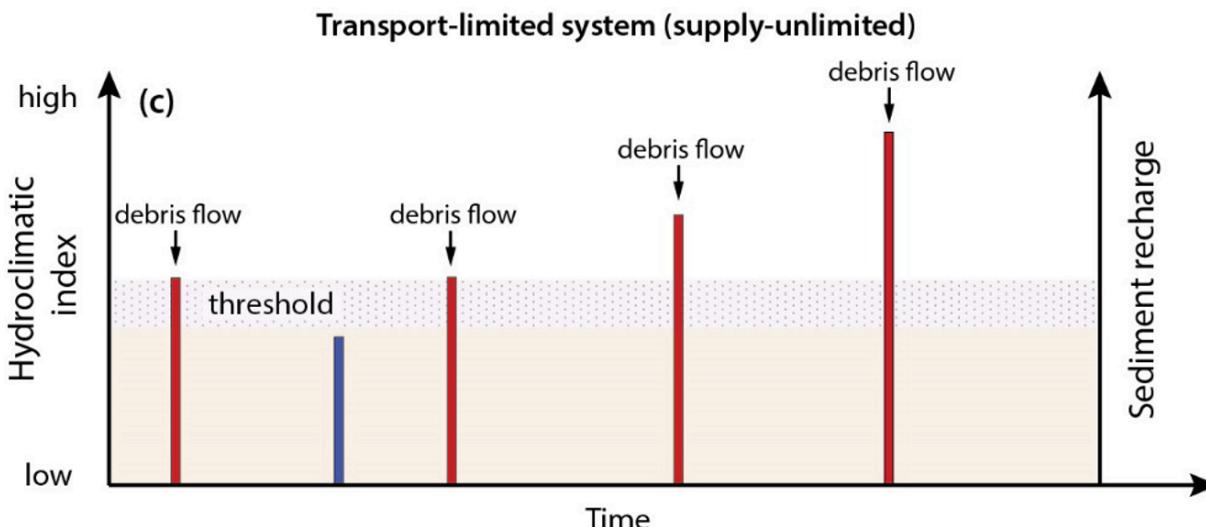
- Morphometric features
- Climatic features
- More sophisticated model



Concluding thoughts..



- ✓ water availability
- ✓ sediment availability

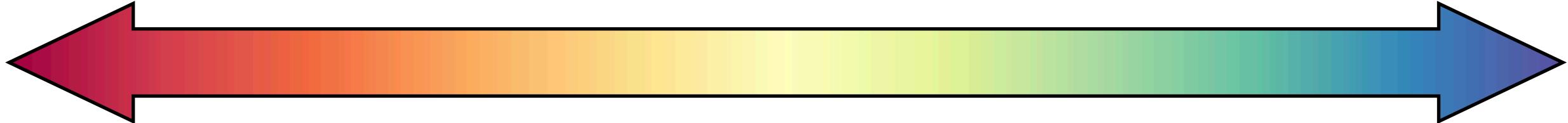


- X size and slope



Concluding thoughts..

water
 sediments



**Debris flow
dominated**

? water
? sediments

water
 sediments

**Flood
dominated**

