

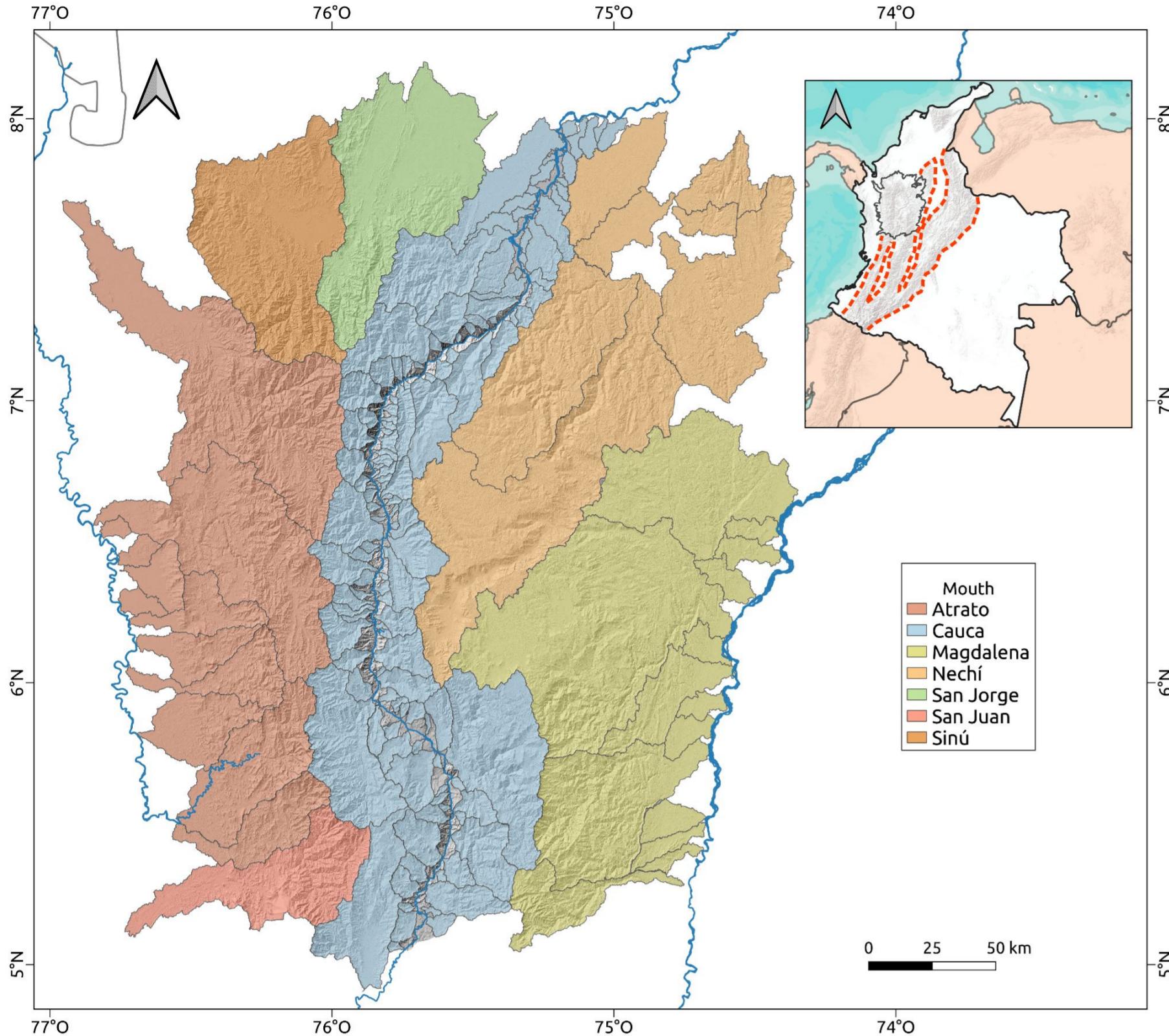
# LANDSLIDE AND TORRENTIAL FLOW SUSCEPTIBILITY CONDITIONS REGARDING LANDSCAPE EVOLUTION IN THE NORTHERN COLOMBIAN ANDES



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## Study Area



## Abstract

Colombia is an equatorial country characterized by a complex mountainous topography and strong hydroclimatic variability, located in a tectonically active region, as a result of an interaction of three tectonic plates and crustal blocks in subduction and collision settings. As a consequence, it is configured as a multi-hazard setting, where earthquakes, volcanoes, landslides, flooding, torrential flows and concatenated processes are very common, and the origin of huge destructive disasters such as Armero (1985) where a lahar claimed the lives of more than 22,000 people; and recently, Salgar (2015) with 104 fatalities and Mocoa (2017) where 333 people died.

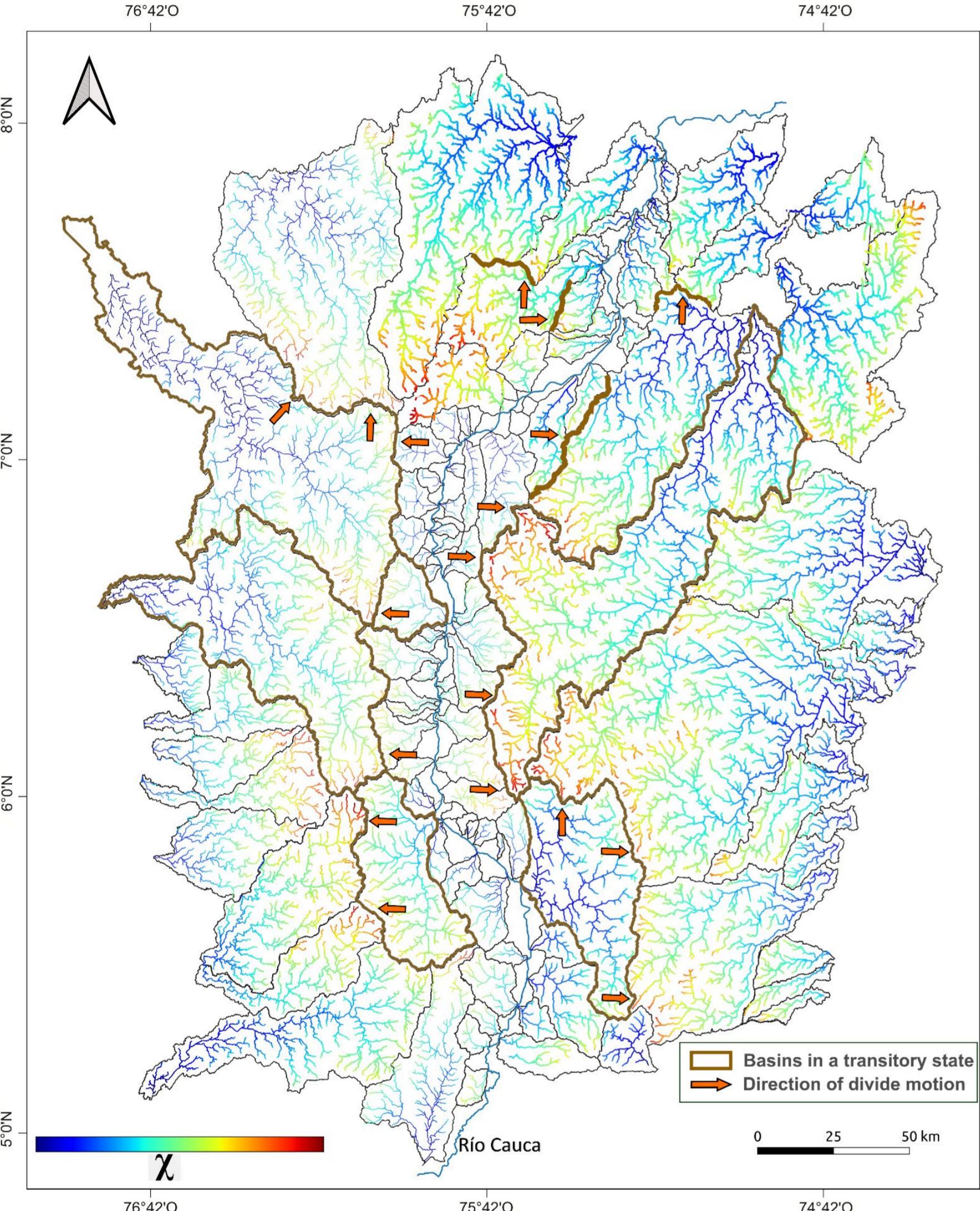
In order to evaluate current hazard conditions it is needed to understand that landscape configuration is not a static process, it corresponds to a continuous evolution and transformation process control by tectonic and climatic settings. In this study, we aim to gain a better understanding of landscape evolution in the northern Colombian Andes by using quantitative geomorphology analysis derived from 30m and 12.5m Digital Elevation Models (DEM) to unravel landslide and torrential flow susceptibility current conditions. Several morphometric indexes (Stream Length-Gradient Index, the x-z coordinate plot, indexes related to drainage network, basin geometry, drainage texture, relief characteristics) were implemented for 168 basins, ranging in areas from 10 km<sup>2</sup> to 5000 km<sup>2</sup>. Furthermore, morphometric index patterns were compared with regional fault systems, landslide inventories, and torrential fans location to correlate landscape evolution with hazard conditions.

## Methodology

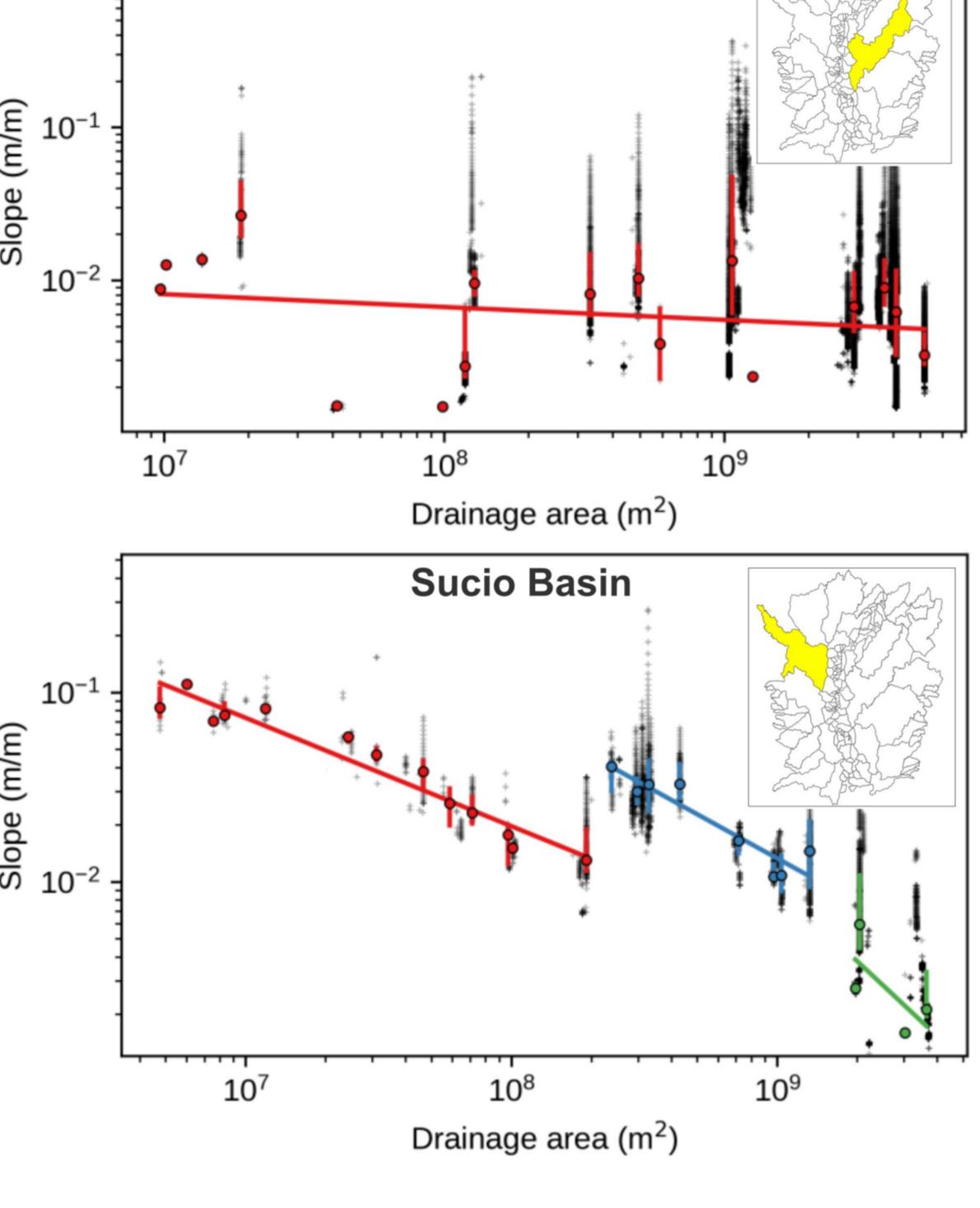


## Results

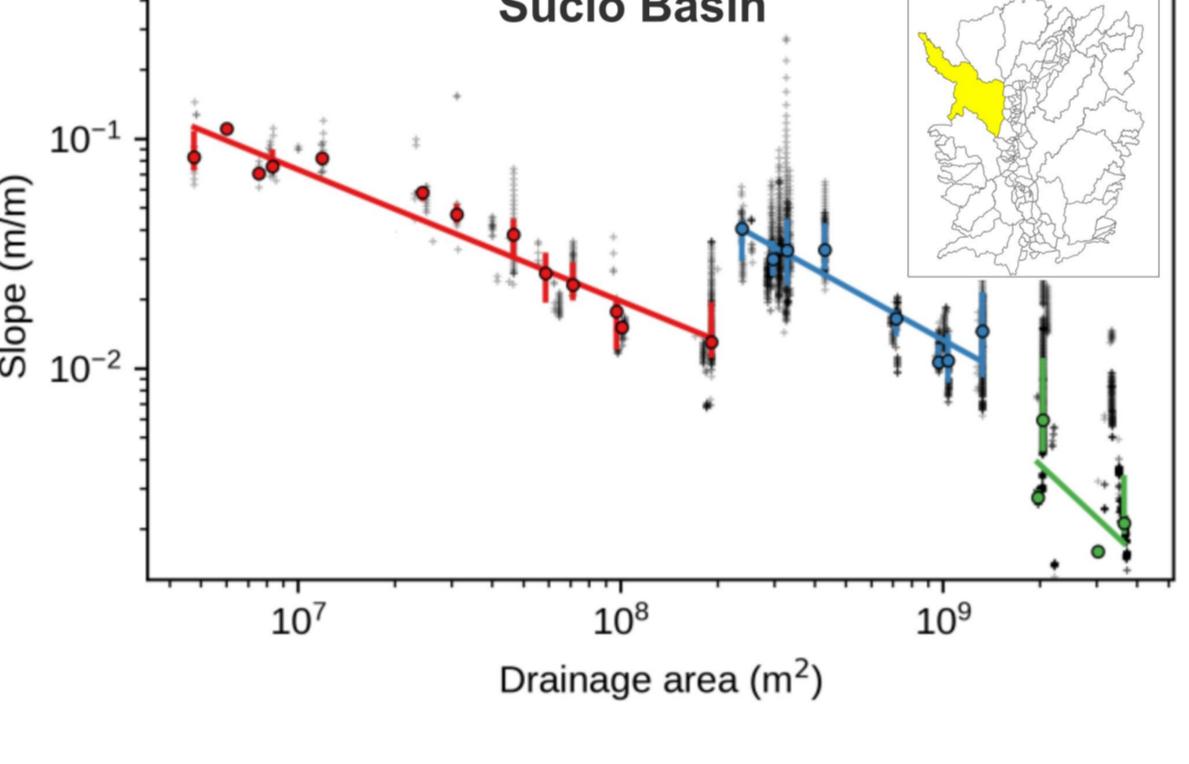
Fig 1. x-map and basin in a transitory state



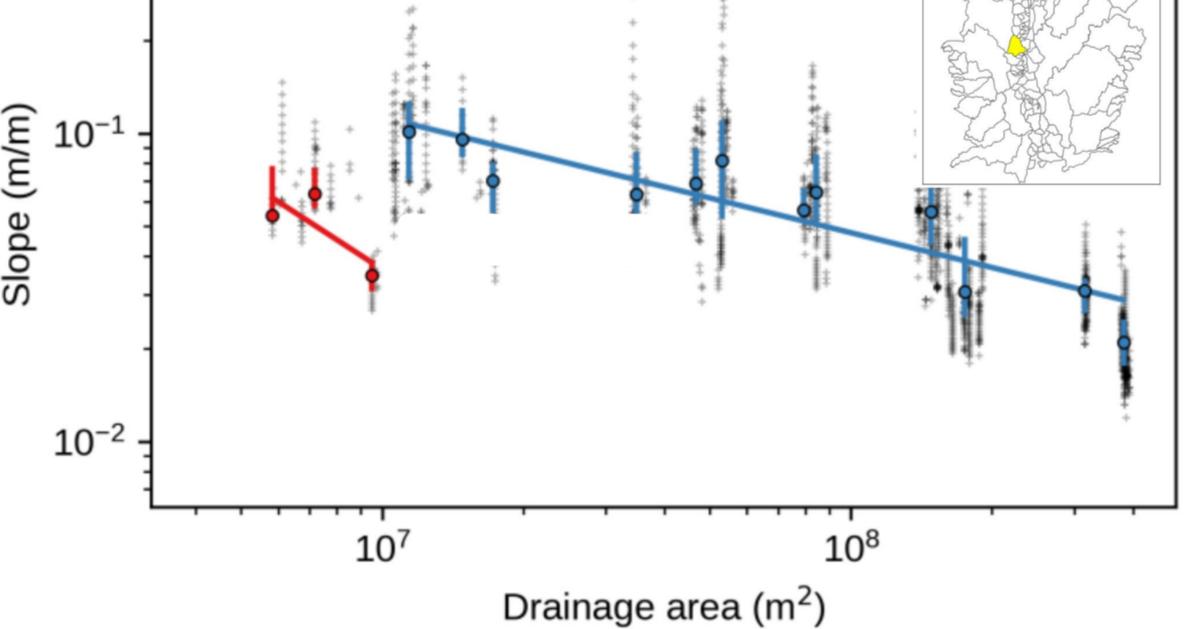
Porce Basin



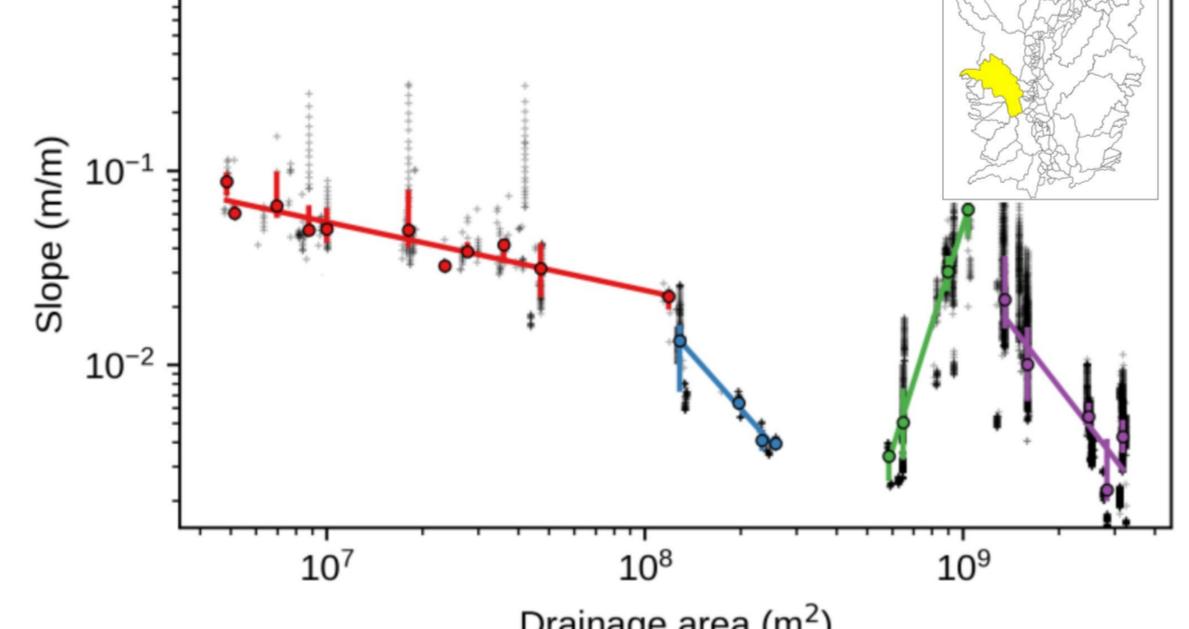
Sucio Basin



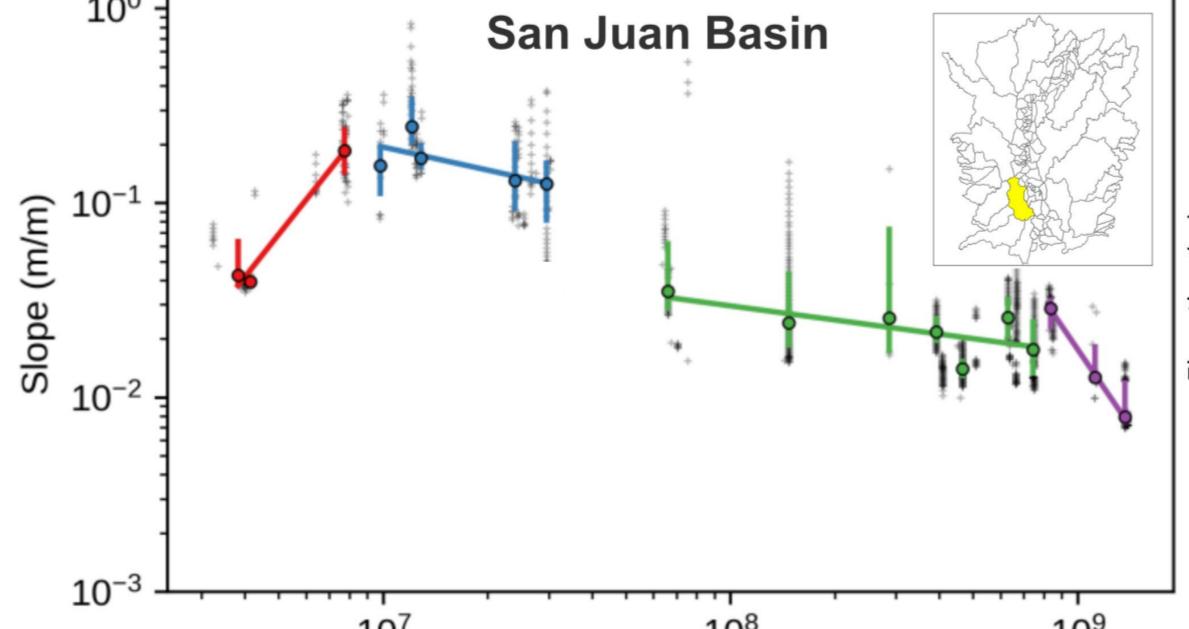
Tonuzco Basin



Sucio Basin



San Juan Basin



Arma Basin

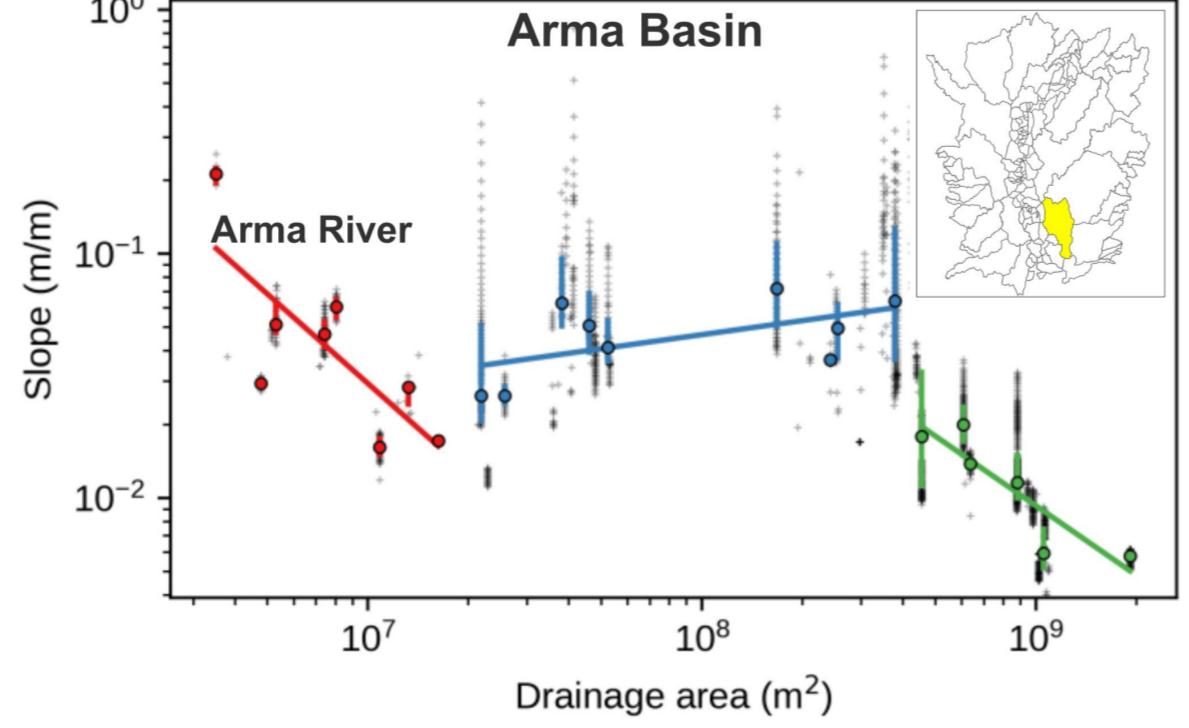
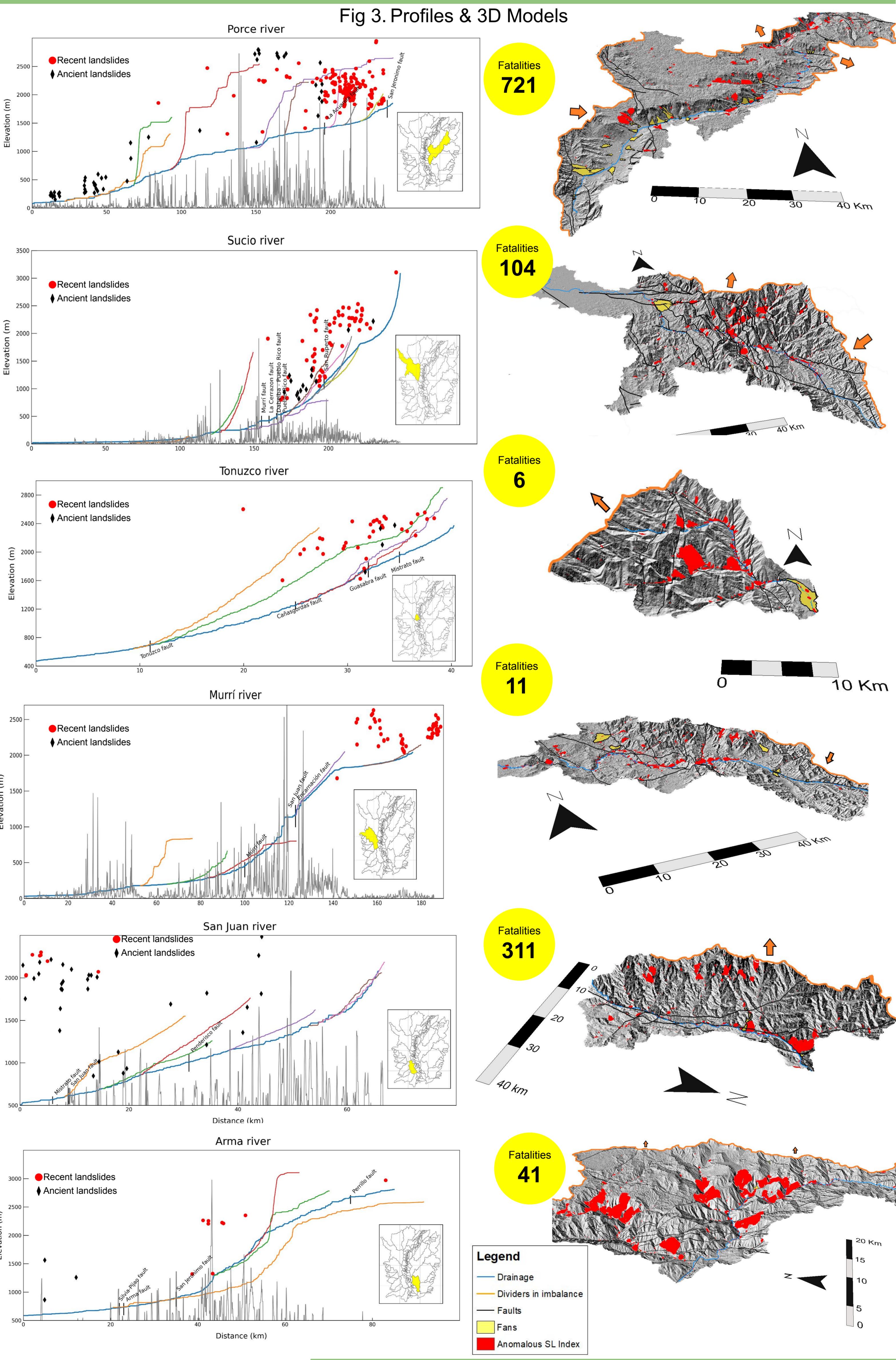


Fig 3. Profiles & 3D Models



## Conclusions

- The x map shows contrasting values between the watersheds draining large portions of the low-relief surfaces (high x values) located to the E and W of the study area and the watersheds draining the steep margins towards the Cauca River (low x values). This suggests that a migration of the drainage divide is occurring and that the steep basins draining the western flank of the Cordillera Central and eastern flank of the Cordillera Occidental are capturing area from the low-relief basins in the E-W direction.
- Concavity of basins ( $\theta$ ) in the study area show values out of range of literature values which may correspond to zone-specific values to indicate basins in a transient state.
- The imbalance in the drainage networks evidences an increase in the basin morphodynamics and is correlated with the most critical areas showing historical records of torrential events.

## References

- Aristizabal, Edier & Sanchez, Oscar. (2020). Spatial and temporal patterns and socioeconomic impact of landslides in the tropical and mountainous Colombian Andes. *Disasters*, 10.1111/disa.12391.
- Mudd, S.(2014). Introduction to using LSDTopoTools .LSDTopoTools .[https://lsdtopoools.github.io/LSDTT\\_documentation/LSDTT\\_basic\\_usage.html](https://lsdtopoools.github.io/LSDTT_documentation/LSDTT_basic_usage.html)
- Piacentini, Daniela & Troiani, Francesco & Servizi, Tommaso & Nesci, Olivia & Veneri, Francesco. (2020). SLIX: A GIS Toolbox to Support Along-Stream Knickzones Detection through the Computation and Mapping of the Stream Length-Gradient (SL) Index. *ISPRS International Journal of Geo-Information*, 9, 69. 10.3390/ijgi9020069.