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

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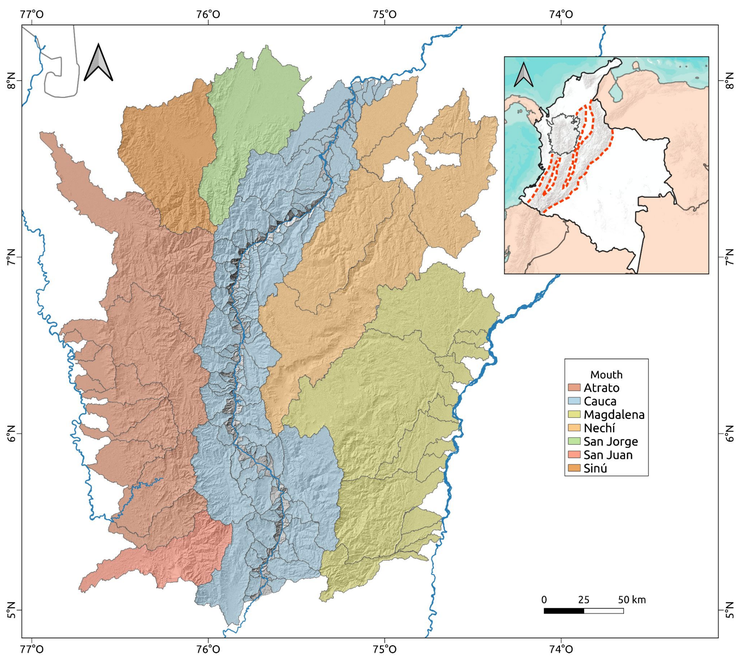
Study Area



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 Lenght-Gradient Index, the χ-z coordinate plot, indexes related to drainage network, basin geometry, drainage texture, relief characteristics) were implemented for 168 basins, ranging in areas from 10 km2 to 5000 km2. 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. χ-map and basin in a transitory state

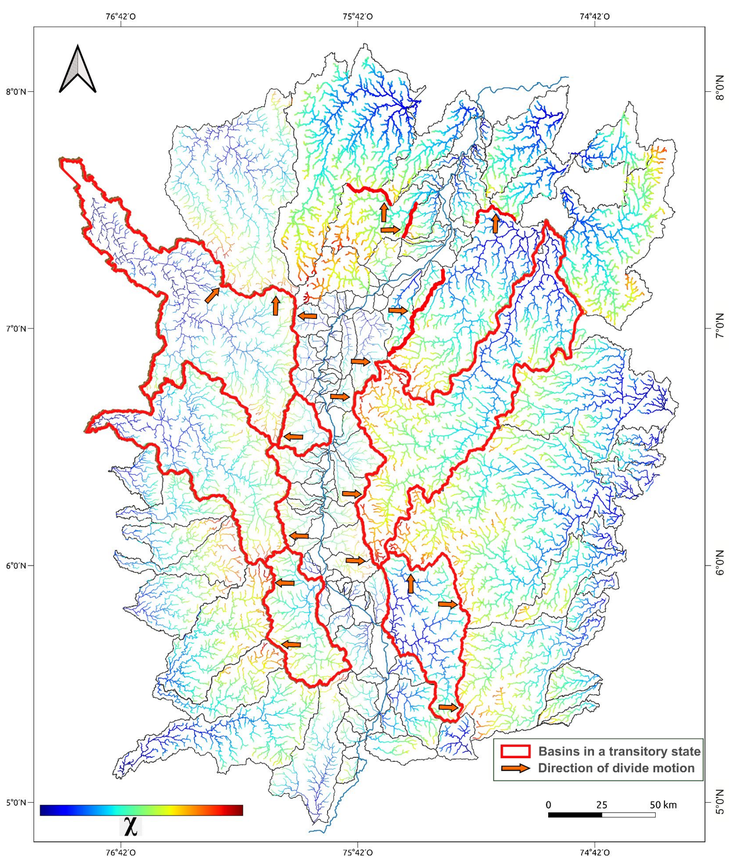
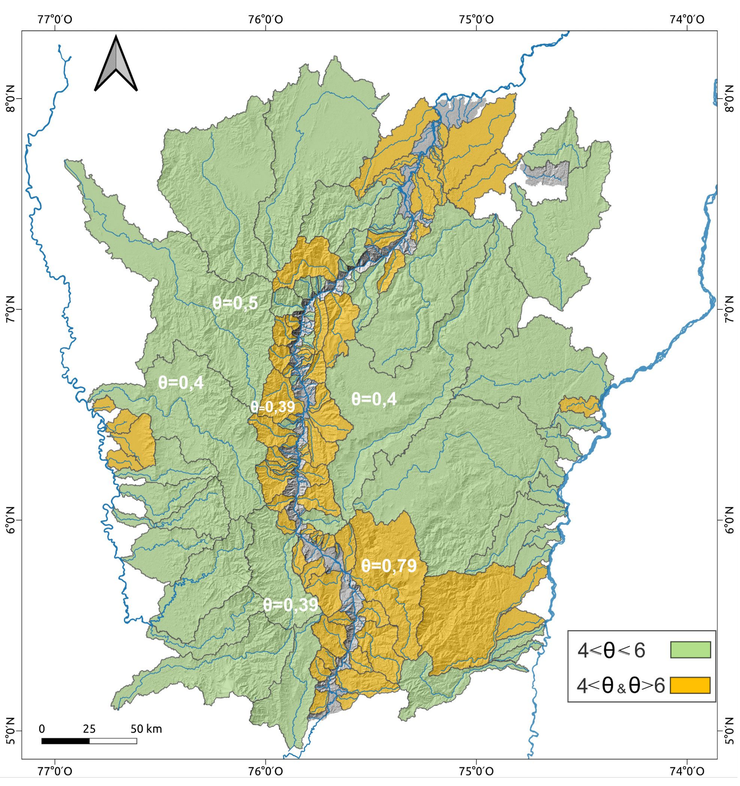


Fig 2. θ*ref* values for each of the watersheds in the study area.



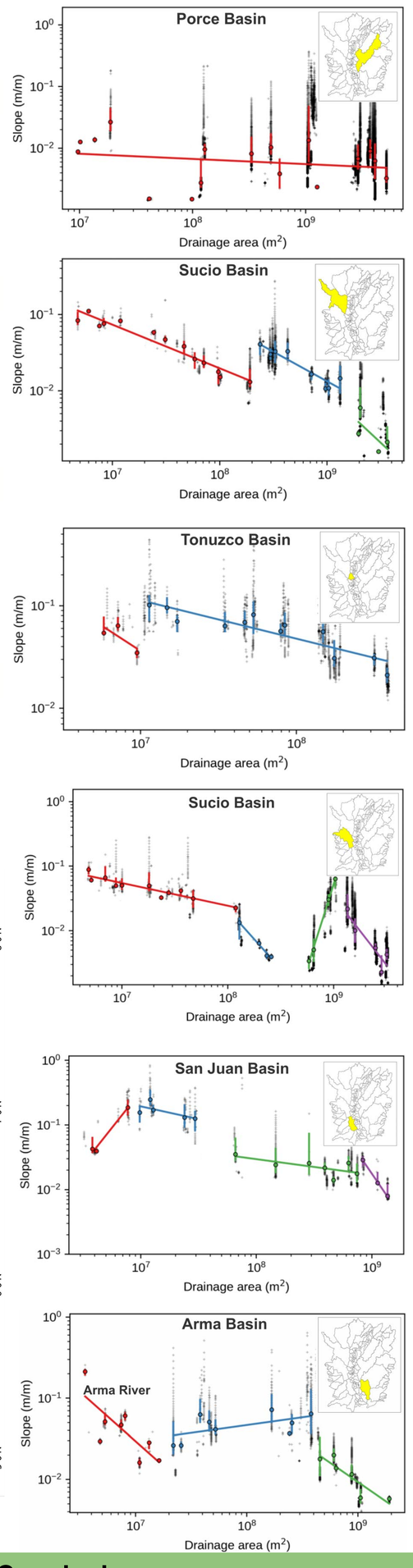
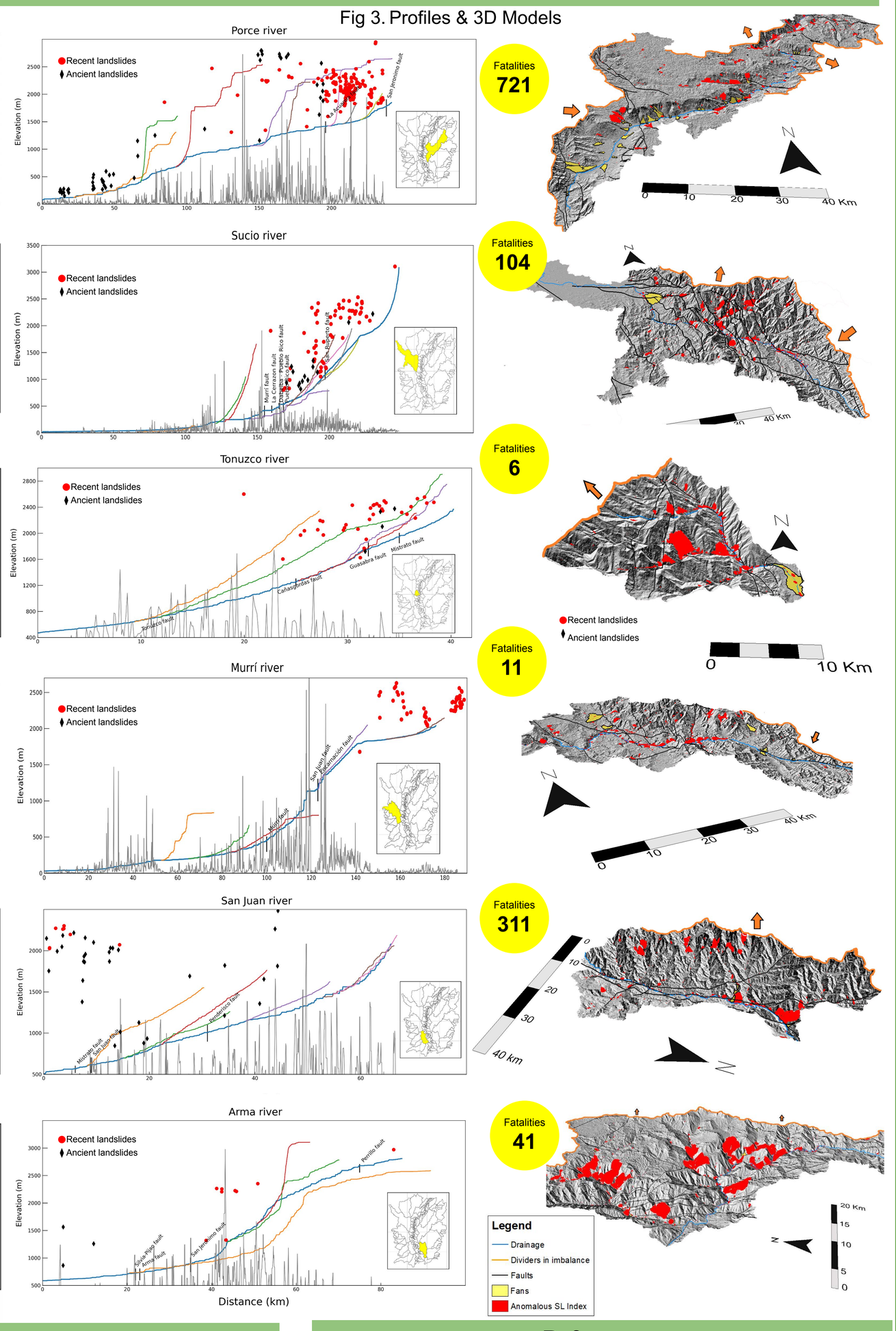


Fig 3. Profiles & 3D Models



Conclusions

- The χ map shows contrasting values between the watersheds draining large portions of the low-relief surfaces (high χ values) located to the E and W of the study area and the watersheds draining the steep margins towards the Cauca River (low χ 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 (θ) 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

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