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Editorial: Landscape evolution of the tropical regions: Dates, rates and beyond

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Editorial on the Research Topic
Landscape evolution of the tropical regions: Dates, rates and beyond

The Tropics represent a large portion of Earth's continents, including the highest mountains, ancient flat surfaces, arid landscapes, major rivers, floodplains, and deltas. These contrasting landscapes play critical roles in land-sea sediment fluxes, biogeochemical cycles, global climate change, critical zone processes, biodiversity conservation, and supporting densely populated urban centers. Studying these landscapes since the 19th century, geoscientists have gained a greater understanding of how they were formed and evolved through time. However, a recent boom in new methods and techniques has allowed the quantification of the timing and rates of the processes that shape these landscapes and has driven a transformative revolution in understanding tropical surface dynamics.

In this Research Topic, we bring together the contributions of scientists from across disciplines who share a common interest in applying quantitative approaches to investigate the internal and surface processes that drive landscape evolution in the Tropics. It gathers six original articles covering unresolved questions about the timing and rates of tropical weathering and river and wetlands evolution.

Landscape evolution in humid Tropics is often related to high chemical weathering, deep weathering profiles, and duricrust formation (e.g., Vasconcelos et al., 2019). Therefore, investigating the mechanisms and rates at which these processes operated across timescales is crucial to improving landscape evolution models. Hynek et al. (this Research Topic) used geochemical data from streams and groundwater to investigate subsurface flow paths and weathering reactions in watersheds developed on various bedrocks around an igneous intrusion in the Luquillo Mountains (Puerto Rico) belonging to the U.S. Long-Term Ecological Research (LTER) and Critical Zone Observatory (CZO) networks. Their results demonstrate that variation in lithology and fracture arrangement drive changes in porosity/permeability that result in significant differences in water flow paths, stream chemistry, regolith thicknesses, and, ultimately, the topography. Ansart et al. (this Research Topic) and Horbe et al. (this Research Topic) shed light on the past climate history in the Amazon Basin, as some previous studies showed that the minerals contained in weathering profiles could reflect pulses of intense weathering that occurred during past climatic events (e.g., Balan et al., 2005; Allard et al., 2018; Mathian et al., 2022). In particular, Horbe et al. (this Research Topic) investigated the processes responsible for the fate of rare Earth elements (REE) and Sr combined in Amazonian lateritic profiles. They combined REE concentration and Nd and Sr isotope analyses to major and trace element analyses. They show that the Nd and Sr systems have very contrasted behavior linked to the variety of processes occurring in the critical zone, that is the "heterogeneous, near surface environment in which complex interactions involving rock, soil, water, air, and living organisms regulate the natural habitat and determine the availability of life-sustaining resources" (National Research Council, 2001). Ansart et al. (this Research Topic) dated with (U-Th)/He methods Fe-oxides subsamples from Brownsberg plateau duricrusts (Guyana). They demonstrated that the analyzed weathering profile results from a long-lasting weathering history involving the formation of multiple generations of Fe oxides in the bauxite and the duricrusts due to successive cycles of dissolution and reprecipitation that occurred since the early Oligocene.

The tropical regions contain the largest rivers and inland wetlands on Earth (Gupta, 2008). These riverine landscapes are sensitive to changes in tectonic and climate conditions, which control the long-term (10^3–10^7) evolution of the physical landscapes and biodiversity (e.g., Pupim et al., 2019; Sawakuchi et al., 2022). On a historical timescale, anthropogenic stressors are the most effective factor in the river and wetlands changes (Best, 2019). Therefore, advancing those research fields depends on developing and using new approaches and technologies. Here, two articles used optically stimulated luminescence (OSL) dating techniques to disentangle the evolution of two important fluvial systems in South America, the Magdalena and Amazon rivers. First, Souza et al. (this Research Topic) combined OSL dating in fluvial terraces and drainage morphometric analysis in the Cabrera River, a tributary of Magdalena (Colombia), to investigate climate and tectonic controls in drainage reorganization during the Late Pleistocene. Their results suggest that a northward shift of the Cabrera River and a westward migration of the Magdalena Valley have drastically reduced the surficial water availability in the Tatacoa Desert, resulting in aridification and increasing the erodibility. Second, Rodrigues et al. (this Research Topic) investigated the age and formation of substrates that support closed and open vegetation ecosystems in the Amazon (Brazil). They used cutting-edge luminescence technics, OSL and TT-OSL dating, which allowed them to date sedimentary deposits from 1 ka to almost 2 Ma. The significance and reliability of these ages are discussed in depth. Moreover, the validation of TT-OSL technics implies a valuable tool for investigating Amazon's history through the mid and early Quaternary. The recent impact of human activities in shallow lakes in tropical floodplains is a relevant issue addressed by Lo et al. (this Research Topic). The authors present a global meta-analysis of sediment core-derived accumulation rate data for shallow floodplain lakes in tropical lowlands to quantify the timescales of basin infill. They evidence an order of magnitude increase in sediment accumulation rates in lakes over the past 50 years, correlated with increased human populations and land use changes in the catchments.

Broadly, the six articles present modern methods and techniques that help the scientific community understand and quantify surficial processes that shape tropical landscapes. Moreover, these findings can be helpful for researchers from areas beyond geoscience, such as biologists and archeologists, for which the studied objects are highly dependent on the physical history of the landscapes.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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