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Major changes in the dynamics of Amazon surface waters revealed by hydrodynamic modeling, in situ and multisatellite data

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The vast Amazon wetlands support multiple social-ecological systems basin-wide, and influence global water and carbon cycles. Recent environmental changes related to climate and infrastructure expansion have altered their rhythmicity and dynamics in many aspects, and understanding their impacts on hydrological variables such as river and floodplain water levels and discharges, inundation extent and storage, is urgent. The combination of new hydrodynamic modeling approaches with in situ and multisatellite data provides great opportunities to fostering this research agenda.

Here, we present an unprecedented analysis of the Amazon's surface water dynamics, its status and long-term trends, as well as perspectives with in situ and satellite data. We analyze inundation extent, water levels and river-floodplain interactions based on in situ (water levels across rivers and floodplains) and satellite data (radar altimetry, optical imagery, passive microwave and L-band SAR), as well as hydrodynamic modeling (MGB and CaMa-Flood models). Firstly, we present the outcomes of a recent intercomparison project where 29 inundation datasets were compared across the basin (Fleischmann et al., 2022; WebGIS at <http://amazon-inundation.herokuapp.com/>). While a higher agreement was observed along the Amazon river floodplain, major discrepancies occurred for interfluvial wetlands, stressing the need of pursuing

optimal merging techniques to improve local to large-scale inundation estimates. By looking at the dynamic inundation datasets, we were able to analyze long-term inundation trends, revealing a major increase of 26% in the maximum annual inundation across the Amazon River system since 1980, associated with longer flood duration and higher river-floodplain connectivity over multiple areas.

While changes in regional-scale hydroclimatic processes have led to the intensification of the Amazon's hydrological cycle, local geomorphological processes are able to largely alter river-floodplain interactions. To investigate it, we used long-term optical data from the Global Surface Water dataset to assess changes along the Amazon River channels and the associated erosion/sedimentation processes. Our results evidence major changes along the river over the last decades, and a mapping of the impacts on 238 riparian communities shows that 21% have been largely affected by bank erosion, damaging several properties, while 19% have been affected by sedimentation, impairing transportation and reducing access to the river waters.

Finally, we present the first outcomes of a new floodplain hydrology monitoring network in the Mamirauá region of Central Amazon, which includes the widest floodplain reach of the Amazon. The network under development is the first of its kind in the Amazon, and aims at improving our understanding of river-floodplain dynamics through the optimal combination of in situ (more than 25 in situ water level loggers, several weather stations, among others) and satellite data, especially from current SAR altimetry missions such as Sentinel-3A/B and Sentinel6 and the forthcoming wide-swath SWOT mission. The presented results provide an important step towards a broad understanding of the Amazon surface water dynamics, from basin to local scales, and the sustainable use of the region's river and wetland resources.