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Foreword

Rivers of the Andes and the Amazon Basin: Deciphering global change from the hydroclimatic variability in the critical zone☆

The Critical Zone has been defined as the thin layer of the continental surfaces extending from fresh bedrock and the bottom of groundwater up to vegetation canopy, where soil, rock, water, air, and living organisms interact (Banwart et al., 2012; Lin et al., 2011). Despite the Critical Zone's importance to terrestrial life, it remains poorly understood. In this context, understanding the complex interactions between physical, chemical, and biological processes of the Critical Zone requires long-term observations (Anderson et al., 2012; Brantley et al., 2017), not only because different mechanisms have varying time frames, but also because it is necessary to monitor its natural and anthropogenic evolution in response to global climate and environmental changes.

Today, several French regional environmental observatories carry out research and long-term monitoring of different compartments of the Critical Zone within the OZCAR network. The HYBAM Observation Service (www.so-hybam.org) is a critical zone observatory that results from a cooperation between France, Brazil, Peru, Bolivia, Equator, Venezuela, and the Republic of the Congo, which collects and disseminates data on the hydrological, sedimentary, and geochemical fluxes in the Amazon Basin, since 2003, at nearly 40 hydrometric stations distributed from the Andean Mountains to the Atlantic Ocean. The network also includes two stations in French Guiana and two stations on the Congo and Orinoco Rivers, which all together contribute to an improved understanding of the variability of continental flows to the tropical Atlantic Ocean. Due to these characteristics, HYBAM observatory is the only observation system able to monitor the hydrological extreme events in the whole Amazon Basin, to measure its impacts on sedimentary and geochemical fluxes.

Since 2005, the HYBAM observatory organizes scientific and technical meetings in different Amazonian countries. The 6th HYBAM scientific meeting, held in Cuzco, Peru, in 2015, gathered scientists interested in the studies of large river basins.

The eight papers from the meeting selected for this thematic issue address different questions related to the great rivers and floodplain lakes. Several disciplines are concerned: hydrology, remote sensing, sedimentology, geomorphology, and geochemistry, showing the multidisciplinary of large river basin studies.

In this issue, three papers are presented, using remote sensing images to monitor suspended sediment transport in rivers. The first one, by Espinoza-Villar et al. (2018, this issue), is an important contribution about the transport of the suspended sediments in the western Amazon basin. The results point out the importance of sediment resuspension in floodplain lakes in the annual sediment discharge balance of the Amazonas–Solimões River mainstream system. The paper also puts in evidence the efficiency of satellite data to assess river solid discharge in large basins where conventional monitoring network data are scarce. The second article, by Martinelli et al. (2018, this issue), also investigates suspended sediment transport using MODIS satellite images in a tributary of the Amazon River basin showing complex hydraulic processes such as backwater effects of the Solimões River main stream. The authors used MODIS image time-series to estimate a 16-year time series of suspended sediment concentrations at the Purus River surface, making it possible to estimate a mean annual sediment discharge about $16{\cdot}10^6$ $ton{\cdot}yr^{-1}$. The third article, by Santiago Yepez et al. (2018, this issue) reports the relationships between Lansat-8 satellite data and suspended sediment concentration in the Orinoco River. The result shows the good quality of the OLI sensor images as an efficient tool to analyze the suspended sediment transport patterns along the Orinoco River.

Two papers have focused their efforts on a better understanding of the confluence zone of the Negro and Solimões Rivers, both using different acoustic sensors. The first one, by Gualtieri et al. (2018, this issue) studied the hydrodynamic and sediment transport at the confluence.

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The results confirm that common hydrodynamic features noted in previous confluence studies, such as stagnation zone, velocity deflection and realignment zone, separation region with recirculation, maximum velocity, and flow recovery region, were observed herein. The authors point out some differences between low-flow and high-flow conditions about the transfer of momentum from the Solimões to the Negro side of the Amazon Channel. The second one, by Ianniruberto et al. (2018, this issue), puts in evidence the bed morphology and stratigraphy within a deep section of the largest river on Earth. The authors identified in the Amazon several classic morphologic features expected to be observed under natural confluence zones, such as a stagnation, deposition, erosion, and sedimentary bedforms on the Solimões side of the Amazon River. They also put in evidence the geologic and hydrologic settings of the confluence that are responsible for such a special behavior of the site. The local dynamic are strongly controlled by structural aspects as well as controlled by the backwater effects resulted by the power of the Solimões current against the one from the Negro. Finally, Ianniruberto et al. (2018, this issue) also showed how an array of different acoustic sensors can be useful for a morphology and stratigraphy study in that kind of conditions. They also recommend more data collection for a better behavior understanding in different periods of the hydrological cycle.

The paper by Quintana-Cobo et al. (2018, this issue) covers an interesting and relevant topic in hydrogeology, describing the dynamics of floodplain lakes of the Ucayali and Marañon Rivers in western Amazonia. Four sediment cores were used to better understand the impact of channel migration processes and climate change on the depositional dynamics of the floodplain lakes of the Upper Amazon Basin during the Late Holocene. The results show that sedimentation in Ucayali floodplain lakes was marked by variations during the late Holocene, with periods of intense hydrodynamic energy and abrupt accumulations, and periods of more lacustrine conditions. On the other hand, in the Marañón River, floodplain lakes exhibit a different sedimentary environment of low hydrodynamics, and no intense migration process was experienced during the last 600 cal yr BP.

The following paper, from Albéric et al. (2018, this issue), explores the links between the mainstream, the tributaries, and the floodplain, using a detailed spatial and temporal sampling strategy in order to describe how Dissolved Organic Carbon (DOC) from various potential sources might be transported into the river in relation with the flood pulse. The results point out three specific zones between the Negro River confluence and the Tapajós River mouth based on the δ^{13}C-DOC variations:

- upstream of the Rio Negro and the Rio Solimões confluence, where no seasonal variation was observed;
- upstream of Itacoatiara (Rio Madeira mouth), higher δ^{13}C-DOC values were observed during the falling water period, but the origin of this ^{13}C-enrichment remains to be determined unambiguously;
- downstream the Rio Madeira mouth, where an increase in the plankton contribution to DOC leads to a seasonal pattern with lower δ^{13}C-DOC values during high and falling water periods, and higher values during low waters.

These results demonstrate the very complex biogeochemical processes that take place between river and floodplain systems.

The study by Moquet et al. (2018, this issue) present an unprecedented dataset of river chemistry from 28 Andean rivers distributed along the Ecuadorian and Peruvian Pacific coast (1°N and 18°S), a region characterized by a strong climatic gradient and usually impacted by El Niño events. The authors estimated an annual flux of total dissolved solids from the Andes to the Pacific Ocean of about 30 Mton·yr^{-1}.

All these original research articles based on multidisciplinary approaches – mainstream, tributaries, flow plain and confluence during high-flow and low-flow periods – across the HYBAM Observation Service, promotes a better understanding of large river environment in tropical South America, in response to global climate.

Disclosure of interest

The author has not supplied his declaration of competing interest.

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