

Measuring changes to floodplains after serial damming of the Tocantins River in the eastern Amazon

Christine Swanson¹, Stephanie Bohlman¹, and David Kaplan²

¹School of Forest Resources and Conservation, University of Florida

²University of Florida

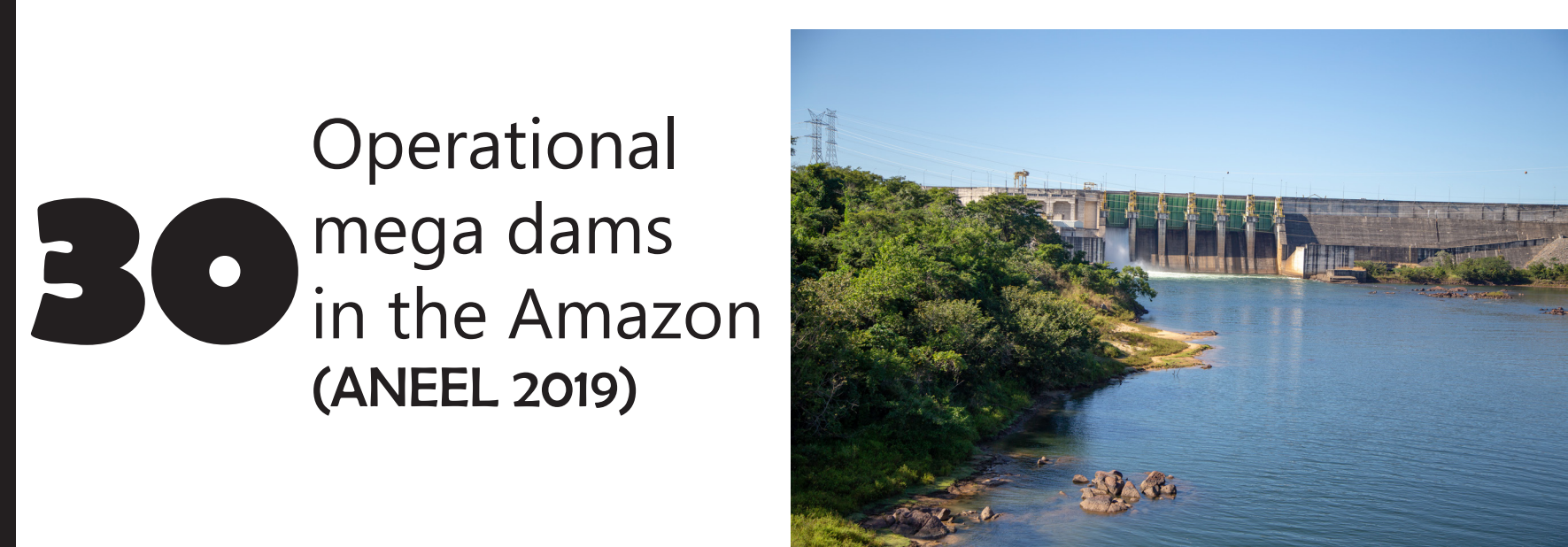
November 22, 2022

Abstract

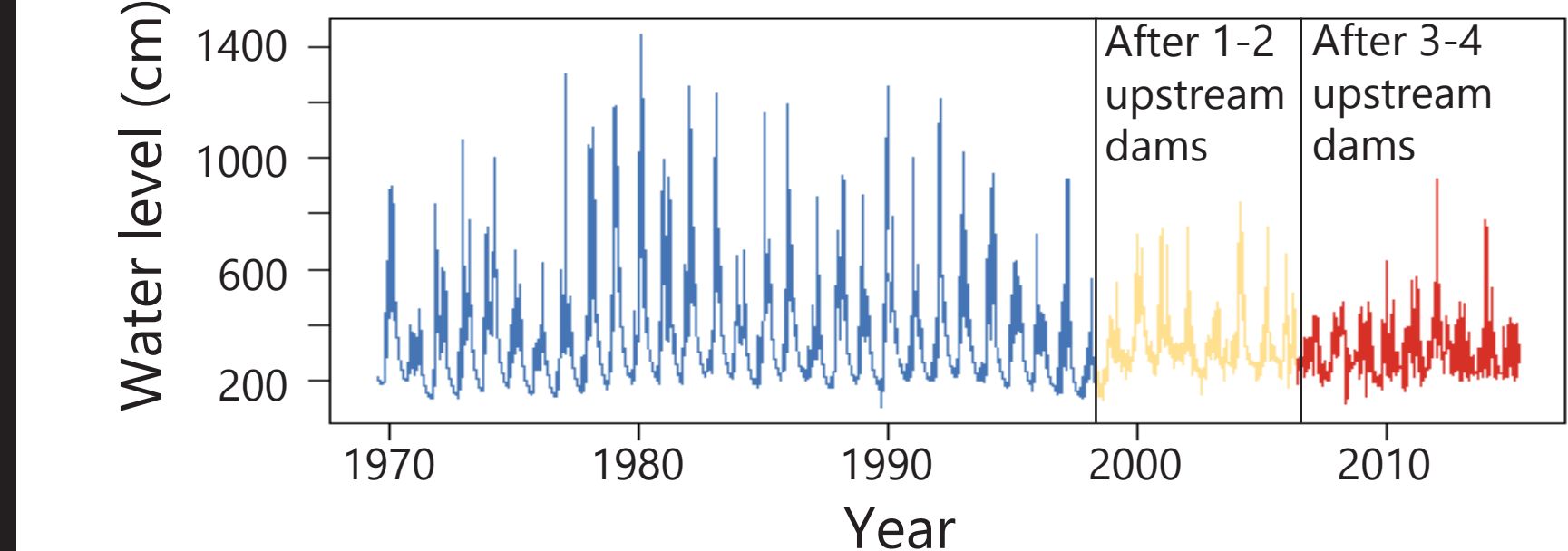
Riparian forests are critical ecotones linking aquatic and terrestrial habitats, providing important ecosystem services such as sediment control and nutrient regulation. The function of riparian forest is intimately linked to river hydrology and floodplain dynamics. The Tocantins River in the eastern Amazon currently has 7 mega-dams along its course with 2 more proposed. As these dams alter the hydrology of the river, it is expected that the riparian vegetation will respond to these hydrological alterations. To understand large-scale and cumulative impacts of multiple dams on floodplains of the Tocantins, we quantify the landscape scale changes in floodplain extent, flood timing, and hydroperiod along an approximately 1400 km stretch of the extensively dammed Tocantins River. Because riparian forests are also impacted by other anthropogenic changes, namely climate change and land use change, we developed linear models to examine the impacts of these drivers in addition to dams. We use water level data collected by the Agencia Nacional das Aguas from the 1930s to the present to map floodplains throughout the Tocantins basin. Several years of floodplain data were validated against SAR data. We then compared floodplain maps before and after damming to determine whether significant changes occurred. Preliminary analysis shows that after installation of the Estreito dam, the hydroperiod downstream of the dam increased 7.5 days on average with a standard deviation of 36.5 days. The floodplain also expanded by 177 sq m. throughout the study area between the two time periods analyzed. Expansions of floodplain area and hydroperiod have implications for riparian forest ecology. Riparian trees are adapted to seasonal flooding and exhibit traits which allow them to be waterlogged for long periods of time, while upland vegetation may lack these characteristics. As dams change hydrology in the rivers and surrounding floodplains, less-adapted trees may be impacted by hydrologic alterations.

Measuring changes to floodplains after serial damming of the Tocantins River in the eastern Amazon

Background



These dams drastically change river dynamics, including daily water level



Floodplain forests are essential for:

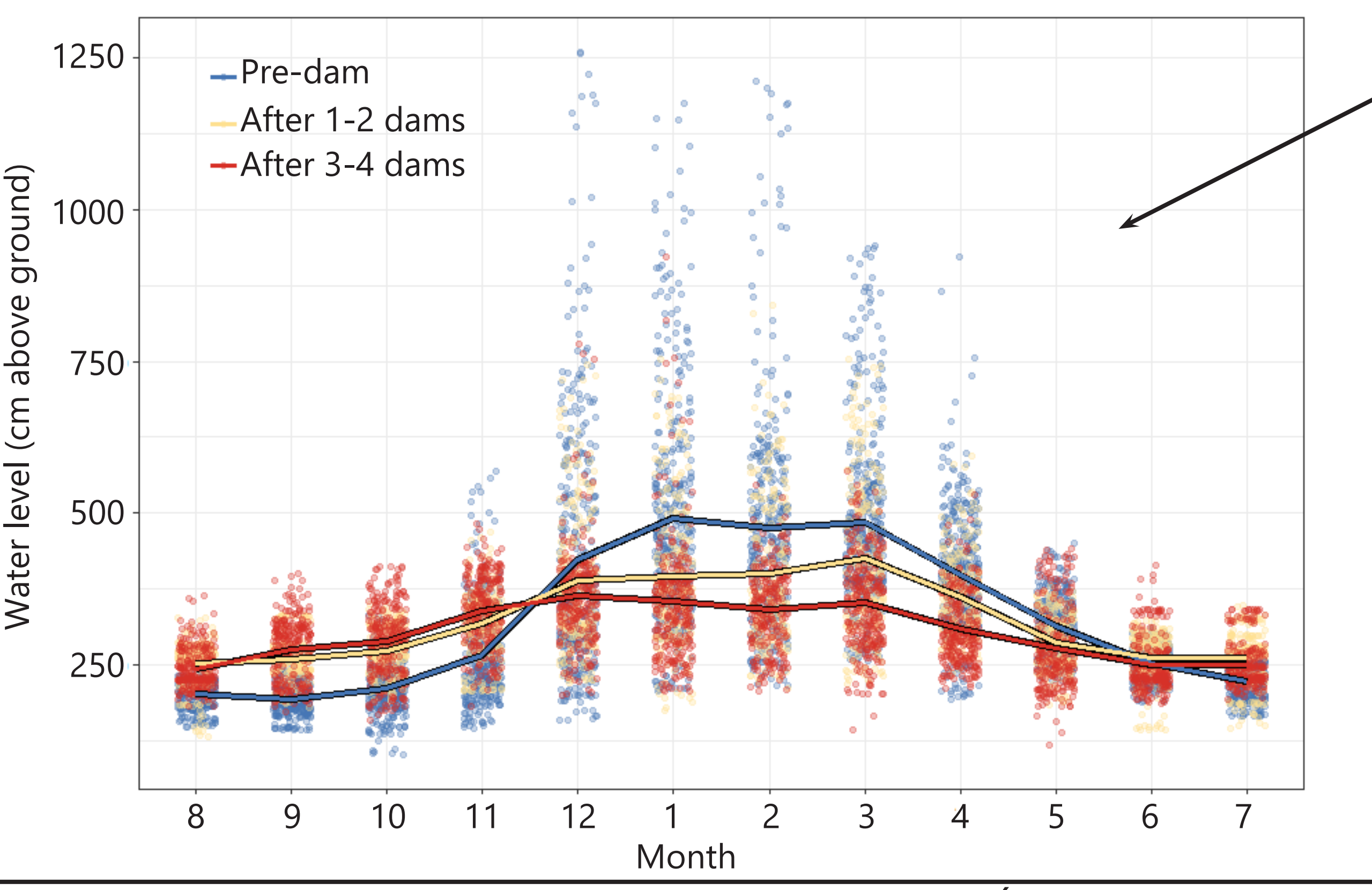
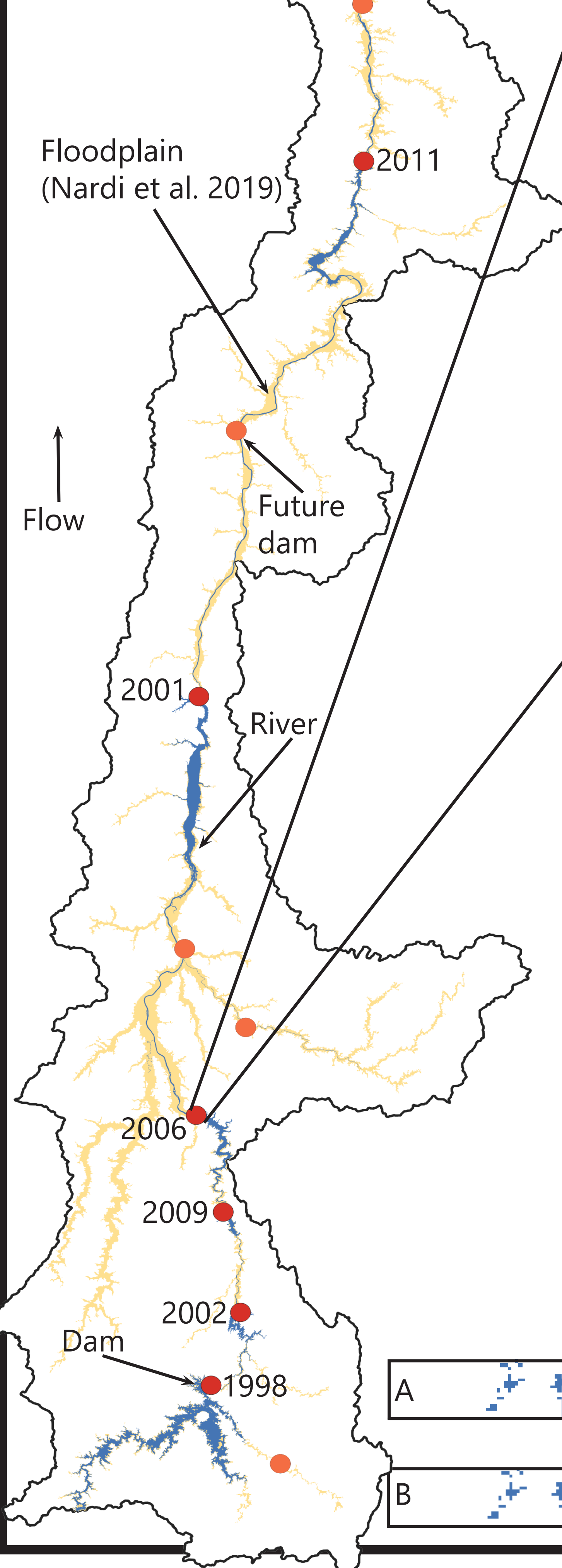
- nutrient uptake
- climate regulations
- flood mitigation
- erosion/sediment control
- upkeep of biodiversity

Main Findings

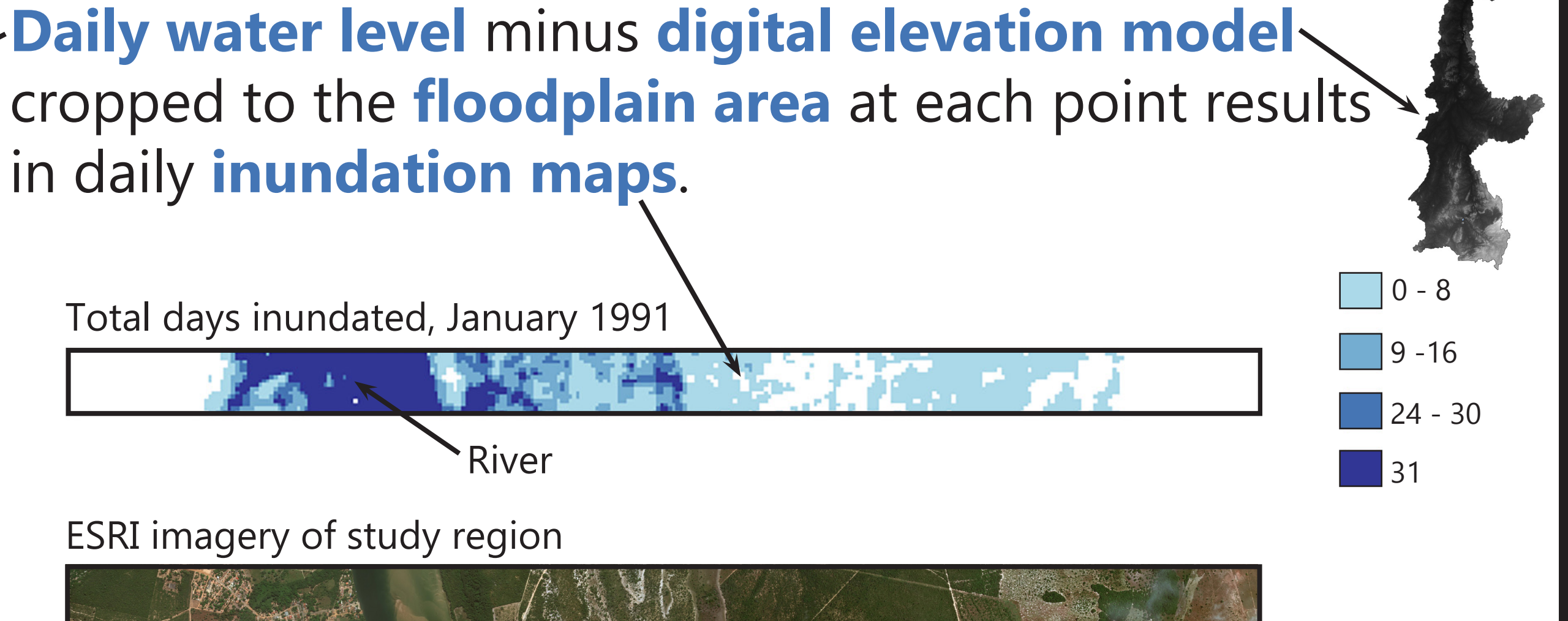
- After the installation of 1 dam, 1.41 million m² of the floodplain shown below no longer flooded. An additional 1.38 million m² of floodplain was inundated for less time.
- Changes to the floodplain are spatially and temporally explicit
- During the dry season, 190,800 m² near the river had an increased inundation time of 8 days after one dam was installed.
- In the wet season, the floodplain became drier, and the installation of additional dams worsened the drying



How does the installation of multiple dams across a river change flood duration and floodplain extent?

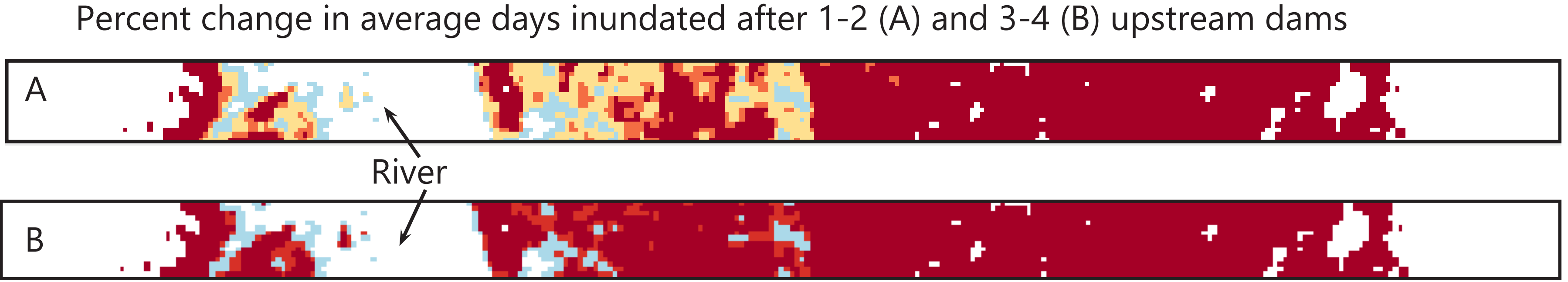


Daily level data from Agência Nacional das Águas.

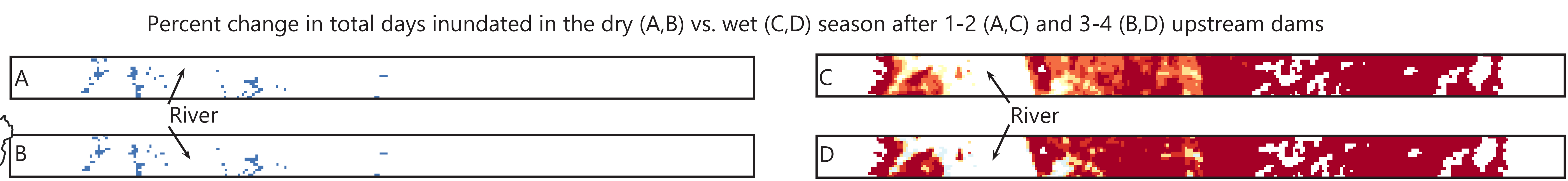


Maps were aggregated at monthly and yearly intervals, before and after damming. Pre-dam maps were subtracted from post-dam maps to better understand changes in floodplain extent and flood duration after damming.

Difference in Yearly Inundation



Dry Season (August) vs. Wet Season (January)



Future Directions

- Measure changes to floodplain extent through use of synthetic aperture radar
- Model how climate and land cover change may be affecting flooding patterns in the Tocantins
- Use the results of this study to better understand how changes in flooding affect riparian forest throughout this floodplain, including changes to NDVI and total floodplain forest extent

