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An integrated approach to investigate the reach-averaged bend scale dynamics of large meandering rivers

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Planform development of evolving meander bends is a beautiful and complex dynamic phenomenon, controlled by the interplay among hydrodynamics, sediments and floodplain characteristics.
In the past decades, morphodynamic models of river meandering have provided a thorough understanding of the unit physical processes interacting at the reach scale during meander planform evolution. On the other hand, recent years have seen advances in satellite geosciences able to provide data with increasing resolution and earth coverage, which are becoming an important tool for studying and managing river systems. Analysis of the planform development of meandering rivers through Landsat satellite imagery have been provided in very recent works. Methodologies for the objective and automatic extraction of key river development metrics from multi-temporal satellite images have been proposed though often limited to the extraction of channel centerlines, and not always able to yield quantitative data on channel width, migration rates and bed morphology. Overcoming such gap would make a major step forward to integrate morphodynamic theories, models and real-world data for an increased understanding of meandering river dynamics.
In order to fulfill such gaps, a novel automatic procedure for extracting and analyzing the topography and planform dynamics of meandering rivers through time from satellite images is implemented. A robust algorithm able to compute channel centerline in complex contexts such as the presence of channel bifurcations and anabranching structures is used.
As a case study, the procedure is applied to the Landsat database for a reach of the well-known case of Rio Beni, a large, suspended load dominated, tropical meandering river flowing through the Bolivian Amazon Basin. The reach-averaged evolution of single bends along Rio Beni over a 30 years period is analyzed, in terms of bend amplification rates computed according to the local centerline migration rate. A quantitative assessment of the location and movement of river point bars and mid-channel bars along evolving meander bends is also performed through a coordinate mapping that allows to express morphological features in an intrinsic reference system and therefore to compare their topographical structure in subsequent years.
A novel bend-scale reach-averaging concept of evolutionary parameters is proposed and performed by adopting bend sinuosity as a proxy of evolutionary time. This allows to extract comparable metrics to those predicted by nonlinear morphodynamic theories that are typically developed at the meander bend scale. The proposed approach allows to develop a consistent comparison between observed evolution and predictions from morphodynamic theories.