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Remote sensing applied to the reconstruction of Amazonian fluvial dynamics in the Quaternary and its relation to tectonics

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Large tropical river systems have been increasingly investigated, because of the main interest for both the discussion of their origin and evolution, and the establishment of models that might help to recognize ancient analogs. Amongst all modern megariver systems, the Amazonas is the largest one, with a drainage area of 6,000 (103 km2), mean annual discharge of 209,000 m3/s, and a sediment load of 167 tons/km2 year. Reconstructing the evolution of this drainage basin through time is an issue of great international interest that remains to be approached. A significant step toward this issue derives from the study of paleomorphologies related to ancient drainage networks, which have been increasingly documented in Amazonian areas. Recent developments have shown that these features have greatly influenced the establishment of modern plant communities, particularly controlling the occurrence of savanna patches, which are in sharp contrast with the dense rainforest. Therefore, mapping paleomorphologies and understanding their relationship with plant distribution are of particular interest for reconstructing the latest stages of evolution of the Amazonian drainage system. Because direct investigation in this region is not favored by the difficult access, remote sensing imagery can be of particular importance to detect paleodrainage morphologies and allow morphostructural studies aiming fluvial paleoreconstructions. In this study, we applied different remote sensing techniques (Landsat, ASTER, Japanese Earth Resource Satellite/JERS-1, Digital Elevation Model (DEM) derived from the Shuttle Radar Topography Mission-SRTM, and high resolution Image GOOGLE) in order to characterize several areas with occurrence of savanna within the Brazilian Amazonian forest. The results revealed an abundance of paleomorphologies chiefly related to fluvial paleochannels, some in association with fluvial fan depositional systems. These areas are most often recorded by numerous narrow, but elongated belts, ranging from straight to highly sinuous similar to morphologies related to many modern fluvial channels. The paleomorphologies are either continuous or discontinuous, the latter consisting of sets of segments that can be promptly reconstructed as paleochannel segments. In optical images, these features are only detected where highlighted by savanna and pioneer formations and/or bare soil that are in sharp contact with adjacent areas, otherwise covered by dense forest. In addition, high resolution QuickBird images reveal that parts of the paleochannels might be covered by sand dunes. In contrast to optical images, DEM-SRTM provided the most complete view of the studied paleomorphologies, particularly those hidden under dense forest. The detailed characterization provided in the present study brings new data concerning to Amazonian paleodrainage that are invaluable to reconstruct channel dynamics through time and analyze the main factors that have controlled successive channel migration and abandonment in Amazonian areas during the Quaternary. Rather than climate fluctuations associated with glacial/interglacial episodes, as frequently proposed, several characteristics (i.e. favorable geological setting with evidence of neotectonics, terrains with sharp topographic gradients bounded by straight lineaments, overall northeastward tilting of terrains with Quaternary strata, frequent orthogonal drainage inflections and several other drainage anomalies) led to the interpretation that tectonics was an important mechanism to trigger subtle shifts in many Amazonian tributary systems. As a consequence, the evolution of the physical environment imposed by frequent channel dislocations as a response of tectonics might constitute the most important factor to have determined sharp plant contrasts within the Amazonian forest.