



Bedforms morphology in the area of the confluence of Negro and Solimões/Amazon Rivers, Brazil

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Confluences are common components of all riverine systems, and are characterized by converging flow streamlines and mixing of separate flows. The fluid dynamics of confluences possess a highly complex structure with several common types of flow features observed. A field study was conducted in 2014 and 2015 in the area of the confluence of the Negro and Solimões/Amazon Rivers, Brazil, collecting a detailed series of acoustic Doppler velocity profiling (ADCP) transects, multibeam profiling, water quality samples and high-resolution seismic data in different flow conditions. These data were used to investigate the morphology of the bedforms observed in that area. Three sites were considered: the area of the Marchantaria Island on the Solimões River, approximately 8 km upstream of the Negro/Solimões confluence, the area of the confluence and the area of Jatuarana in the Amazon River, approximately 33 km downstream the confluence.

The analysis of the field data showed that the observed bedforms were mostly in the range of large and very large dunes according to Ashley et al. (1990) classification with a maximum wavelength and wave height of 350 and 12 metres, respectively. Second, a comparison between low flow and relatively high flow conditions in the area of the confluence showed an increase in the maximum bedforms sizes as well as in the frequency distribution of bedforms size as it could be expected from the literature studies. Third, all the medium dunes ($5.0 > L_{bf} > 10$ m) were generally in equilibrium with flow conditions as well as most of large dunes ($10.0 > L_{bf} > 100$ m) and very large dunes ($L_{bf} > 100$ m). On the other side, some bedforms observed in relatively high/high flow conditions were developing with the increasing discharge, while some in low flow conditions were in the process of crest flattening and elongation, having been formed during the previous high flow conditions. Fourth, the data from this field study were not exceeding the upper limits of scaling with water depth reported in the literature, but while the data for the length were quite well aligned with scaling curves, the data for the height showed a scatter from these curves. Fifth, in both 2014 and 2015 surveys, the leeside angle was below 10° with an average value of about 3.0° , and wave steepness grew gently with lee side angle and became constant above 6° at $H_{bf}/L_{bf} = 0.05$, while the analysis of vertical velocity measured in the ADCP profiling showed no flow separation confirming past findings on low-angle dunes. Finally, a comparison between the bedforms observed in this study and past literature studies on large rivers suggested that while the smaller dunes were in equilibrium with the flow, several of the larger bedforms were developing or diminishing following the discharge variation in the river.