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Morphodynamic modelling in the middle-section of River Paraná, Argentina

Gastón Latessa (1) and Martín Sabarots Gerbec (2)

(1) University of Buenos Aires, Faculty of Engineering, Argentina (gastonlatessa@gmail.com), (2) University of Buenos Aires, Faculty of Engineering, Argentina (msabger@gmail.com)

As part of the preliminary design studies of a new bridge over the River Paraná, Argentina, to connect the cities of Resistencia and Corrientes, a hydrodynamic and sedimentologic model was developed to assess the erosion risks at the structure and define foundation levels. At this section, the River Paraná drains a catchment of over 2M km^2 and presents an alluvial floodplain width of 25 km, with an average yearly discharge of 15,000 m^3/s (Drago, 1998). Although these figures are already quite unique, the morphological characteristics of this site are exceptional due to the very high sediment load provided by the River Paraguay. It is estimated a mean discharge of 250 mg/l (Drago, et al, 1998) of solid material is transported, characterizing the alluvial system from the confluence with this tributary down to the Delta of the River Paraná, about 800 km downstream.

The solid material transported through this section is mainly constituted of fine sand and lime (Amsler, et al, 2009) whilst the mobile bed in predominantly formed by sands that can form dunes of up to 12 m high (Drago, 1977). Driven by the sediment load characteristics and the average hydraulic slope, the Middle Paraná presents a braided pattern with a fringing floodplain, with high rates of movement and formation of bars and islands, thalweg shifting, erosion and deposition, and bedforms.

Geotechnical investigations were run on the future location of the bridge, through several pit holes, and in addition to a vast literature review, permitted the selection of the appropriate parameters for the modelling application. Steady and unsteady simulations were run on a pseudo-3D morphodynamic model, which permitted to represent the detailed hydrodynamic interaction between the main channel and the floodplain, whilst calculating the morphodynamic evolution in the domain.

The main difficulties proved to be validating the obtained results and deciding the scour depths at the bridge site. This depth will define the foundation positions and therefore, the technical and economic viability of the project. Sensitivity runs considering different characteristics of the sediments proved to have small effects on the total scour and deposition rates.

The amount of available sediment was decided it will be limited by the presence of a highly-compacted sand bed layer, located between 10 and 15 m under the existing bed level. Furthermore, given the strong evidence proving that the bed load was constituted by medium size sands, the sediment range was represented with only one non-cohesive phase (sand) with a representative d50 of 0.48 mm.

The morphodynamic model was run under different scenarios, considering extraordinary events (1% and 0.1% of Annual Exceedance Probability) for design purposes, but also under dominant flows (Rayano, 2003) to provide validation scenarios against observed movement of the islands through satellite imagery.