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Exploring pre-channelization bar and planform dynamics of a large regulated Alpine River

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As a consequence of heavy channelization mostly carried out in the 1800s, the planform and bars morphodynamics of many large European rivers is hardly detectable even from aerial images dating back several decades, because of the marked reduction of the channel width and of the related morphological complexity. However, when available, historical maps can provide quantitative information on the morphology that characterized these rivers before massive human intervention occurred. In this work we focus on a 100 km reach of the Adige – Etsch River, NE, Italy, with the aim of exploring the short-term (some decades) morphological dynamics that might have characterized the pre-channelized river bed and planform in its single-thread reaches before heavy human intervention. To this aim we integrate the application of a morphodynamic analytical model for meandering rivers with irregularly varying curvature and channel width with the multi-temporal analysis of pre-channelization historical maps. The work focuses on the sinuous and meandering reaches once characterized by spatially varying channel width, and presence of alternate, point and mid-channel bars. Challenges in such kind of integrated analysis are posed by the reconstruction of channel – forming streamflow values and of sediment size that may have characterized the river reaches up to nearly three centuries ago prior to heavy regulation. Formative discharge ranges have been obtained as those generating the best geometrical fit between the modeled river bed morphology and the one observed from the maps. Once calibrated by this procedure, the model was fed through the estimated discharge value to compute the longitudinal variability of the outer-bank shear stress, as a proxy for the locations potentially affected by fluvial bank erosion. The historical maps reveal that during the 17th and 18th century, before the massive channelization, the river morphodynamics was already far from being “natural”, especially because of distributed, albeit simple engineering structures, like bank protection works, wooden barriers and groynes. Results showed good correspondence between both position of the centroid of the polygons that identified the deposited sediment of the alternate and point bars. Interestingly, the location of near-bank maximum shear stress was often close to the position of the bank structures detected in the historical maps. The satisfactory results obtained from model applications supports the use of analytical morphodynamic models as suitable tools to explore past, otherwise hidden river morphodynamics, especially if integrated with historical sources. The same model could be used, together with more sophisticated numerical tools, to develop possible response scenarios of the present river bed morphology to future restoration actions based on locally giving more room to the river.