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Analysis of Meander Migration Rates in Tidal Landscapes

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Meandering patterns are universal features of tidal landscapes, which exert a great influence on the dynamics of tidal channel networks and on the stratigraphy of intertidal platforms. Despite their importance in landscape evolution and their ubiquity, tidal meanders have received less attention when compared to their fluvial counterparts. Quite a few studies, in fact, have focused on the morphodynamic evolution of tidal meanders, together with their planimetric shape and morphometric characteristics. To improve current understanding of tidal meander migration, a key step to address tidal meander evolution, we have analyzed a sequence of aerial photographs (from 1938 to present day) for about 400 meander bends, over 40 salt-marsh channels in the Northern part of the Venice Lagoon (Italy). Tidal meanders display similarities with fluvial meanders, although important differences emerge. Meanders cutting through the San Felice marsh follow the relationship between cartesian length and channel width, typical of meanders developed within different landscapes. However, meander migration rates, which were determined on the basis of three different methods, proved to be smaller than those characterizing fluvial meanders. Our analysis suggests mean migration rates of about 0.10 m/year, which is consistent with migration rates determined by previous studies on tidal meanders. The relationship between erosion (migration) rate and bend radius (R), both made dimensionless with channel width (W), displays a bell-shaped envelope pattern, in analogy with fluvial meanders although with smaller migration rates. In the tidal case, in fact, the largest migration rate is about 0.10 channel widths per year, which is smaller than the largest migration rate (0.20 channel widths per year) characterizing fluvial meanders that we found in the literature. Interestingly, in the case of tidal meanders the peak of the bell-shaped curve corresponds to a R/W ratio between 4 and 5, whereas the same ratio displays values between 2 and 3 in fluvial environments. Possible explanations for the observed similarities and differences between tidal and fluvial meanders are finally discussed.