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The Rance tidal power station: a preliminary study of its impact on tidal patterns and sediments dynamics in the Rance estuary (France) from 1957 to 2018

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The Rance tidal power station (located on the Brittany coast of Northern France), was opened in 1966 as the world's first and largest tidal power station, with peak output capacity of 240 Megawatts. It is currently the second world's largest tidal power installation after the Sihwa Lake Tidal power station (South Korea). The power plant is located at the mouth of a small steep-sided ria, with a maximum perigean spring tidal range of 13.5 m and an average fluvial discharge of 7 m³/s. The dam is 750 m long and the tidal basin measures 22.5 km². Despite a well-known effect of the plant on the damping of estuarine water levels, little attention has been given to the consequences of the dam in the estuarine environment in terms of hydrodynamics, for instance, the propagation of the tidal wave and tidal currents along the estuary are still little understood. Moreover, net siltation has been reported by several observations, but there is no specific knowledge on the role of the plant on sedimentation. In this study, we analyze the impact of the tidal power station on tidal wave patterns and sediment dynamics in this particular man-engineered system. To this goal, a numerical model based on a two-dimensional depth-averaged approach is implemented to predict the tide propagation and tidal currents along the estuary accounting for the presence of the tidal power station. Three modelling scenarios were performed: the first considering the bathymetry of 1957 (before the plant's construction), a second scenario considering the bathymetry of 2018 without the presence of the power station and a third scenario considering the bathymetry of 2018 with the power station. Preliminary results showed that, with and without the tidal power station, the upper estuary exhibits a flood dominant behavior, with longer duration of falling water than rising water, and conversely the lower estuary is ebb dominant with shorter duration of falling water than rising water. This analysis also revealed that the tidal power station might switch the flood dominance in the central estuary to ebb dominance. These findings imply a net seaward transport of both coarse and fine sediments in the lower estuary. Therefore, the tidal power station might have a considerable role in modulating the estuarine turbidity maximum and channels' morphology. Finally, these results are compared with preliminary numerical simulations of suspended sediment transport to further quantify the impact of the tidal power plant on the dynamics of the estuarine turbidity maximum.