Energy estimation of resonant waves in channels with lateral cavities

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Macro-roughness elements, such as lateral cavities and embayments, are usually built in the banks of rivers for different purposes. They can be used to create harbors, or to promote morphological diversity that enhance habitat suitability in an attempt to restore the sediment cycle in channelized rivers. In presence of lateral cavities, shallow water flows may exhibit a rhythmic water surface oscillation, called seiche. The formation of the seiche is triggered by the partially bounded in-cavity water body which leads to the generation of a standing wave. Amplitude and periodicity of the seiche is jointly controlled by the dominant eigenmodes of the standing wave and by the turbulent shear layer structures created at the opening of the cavity. Seiches have been studied in the past decades putting the focus on their impact on river hydrodynamics and morphodynamics. However, the study of the seiches from an energy harvesting perspective is still unexplored. Seiche waves could represent a distributed hydropower source with a low environmental impact, being energy extraction possibly integrated with river restoration works. In this work, we use an in-house numerical simulation model to reproduce the water surface oscillation in a channel with multiple lateral cavities and study their wave energy potential. The interaction of multiple cavities has an additional effect in the propagation and formation of multiple standing waves, ultimately leading to two-dimensional and multi-modal seiche waves. Therefore, a detailed analysis of the seiche amplitude and energy spatial distribution is presented.