'**Interactions between flooding and tidal energy extraction in estuaries**'

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Abstract:

Estuaries are usually highly vulnerable to flooding due to the combination of coastal and fluvial extreme events.

With the recent development of marine renewables, some estuaries have been considered as potential sites for the extraction of energy. Tidal in-stream turbines can be deployed for that purpose without the need of a partial inundation of the estuary, like in the case of tidal barrages or lagoons. However, in order to obtain energy at a competitive scale, tidal farms would have to comprise a large number of turbines. Therefore, an associated effect of the tidal farm on the global hydrodynamics of the estuary must be expected. That effect will include changes to the peak water levels associated to the flood risk, which are the main focus of this study.

In order to evaluate the impact of tidal farms on flood risk in estuaries, a generic methodology has been applied to a real case study, the Solway Firth estuary in the UK. The high speed of the current observed at certain locations, reaching up to 2 m/s, and the important damages caused in the last decade by flooding to the urban areas along the shoreline have been the main criteria taken into account to select the Solway Firth from a group of estuaries with similar features.

A numerical model of the Solway Firth has been carried out in Mike21 by DHI, a FVM solver of the Shallow Water Equations for coastal applications. The bathymetry has been discretised over an unstructured triangular mesh and the model has been calibrated and validated against observed measurements of the current speed and water levels at certain stations inside the estuary. In order to represent an extreme event in the estuary, a combination of coastal and fluvial flooding has been applied to the open boundaries. The results from the initial model without the turbines have been used to identify the location of the tidal farm. The tidal turbines have been introduced in the model as retarding forces to the flow. Two tidal farms with different number of turbines, which could be regarded as large and very large, and with the same turbine size and configuration have been tested. The results for the peak water levels over the period of the simulation have been compared between the situations with and without turbines in both cases.

From the analysis of the results, it can be highlighted that the peak water levels are generally decreased at the inner part of the estuary and increased in a lesser extent at the outer area as a consequence of the tidal farms. In the case of the very large tidal farm the effects are more noticeable, reaching the order of decimetres at the inner estuary. Thus, it can be concluded that the tidal farms do not represent an added hazard to the existing levels of flood risk in the estuary and that on that sense their effect could be considered to be beneficial to a certain degree.
