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Flood forecasting using non-stationarity in a river with tidal influence – a feasibility study

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Flooding is the most common natural hazard causing damage, disruption and loss of life worldwide. Despite improvements in modelling and forecasting of water levels and flood inundation (Kretzschmar et al., 2014; Hoitink and Jay, 2016), there are still large discrepancies between predictions and observations particularly during storm events when accurate predictions are most important. Many models exist for forecasting river levels (Smith et al., 2013; Leedal et al., 2013) however they commonly assume that the errors in the data are independent, stationary and normally distributed. This is generally not the case especially during storm events suggesting that existing models are not describing the drivers of river level in an appropriate fashion.

Further challenges exist in the lower sections of a river influenced by both river and tidal flows and their interaction and there is scope for improvement in prediction. This paper investigates the use of a powerful statistical technique to adaptively forecast river levels by modelling the process as locally stationary. The proposed methodology takes information on both upstream and downstream river levels and incorporates meteorological information (rainfall forecasts) and tidal levels when required to forecast river levels at a specified location. Using this approach, a single model will be capable of predicting water levels in both tidal and non-tidal river reaches.

In this pilot project, the methodology of Smith et al. (2013) using harmonic tidal analysis and data based mechanistic modelling is compared with the methodology developed by Killick et al. (2016) utilising data-driven wavelet decomposition to account for the information contained in the upstream and downstream river data to forecast a non-stationary time-series. Preliminary modelling has been carried out using the tidal stretch of the River Lune in North-west England and initial results are presented here.

Future work includes expanding the methodology to forecast river levels at a network of locations simultaneously.

References

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