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Citation for published version:

Patidar, S, Allen, DA, Pender, G & Haynes, H 2016, 'Stochastic modelling approach for synthesizing streamflow', Paper presented at Geological Society Conference, Edinburgh, United Kingdom, 27/09/16 - 29/09/16.

Link:

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Document Version:

Publisher's PDF, also known as Version of record

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Stochastic modelling approach for synthesizing streamflow

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ABSTRACT:

Practitioners are keen to maximize long-term sustainability of flood risk management (FRM) projects, such as simulation of the morphological response of rivers for scheduling dredging intervention or designing flood defence levels; assessing long-term loading patterns acting on defence structures; and accounting for the antecedent conditions of flood storage reservoirs. A range of mathematical tools and software's, mainly based on the use of single N year extreme flow or rainfall event, are available to conduct a thorough assessment of fluvial flood risk and various related aspects of FRM projects. Utilizing multiple realizations of flow sequences can assure a robust approach for attaining long-term sustainability of FRM projects. Previous studies by author have been shown to generate reliable results (multiple realizations of daily streamflow sequences) through successful application of stochastic modelling approach such as Hidden Markov Model (HMM) coupled with the generalized extreme value distribution (HMM-GEV) and Generalized Pareto (HMM-GP) distribution (Pender et al., 2015). HMM-GP model has been rigorously assessed for its ability in capturing various statistical characteristics and stochasticity of the simulated flow sequences. Model has been robustly validated across four hydrologically distinct catchments (Rivers Dee, Falloch, Caldew and Lud) and demonstrates excellent performance.

This paper presents an extension to the HMM based modelling approach and thoroughly assess the suitability of approach in simulating streamflow at much finer temporal resolution of 15 minutes. It should be noted that, daily flow sequences could easily miss an entire significant flooding event. Thus, multiple flow sequences at finer resolution of 15 minutes are highly desired for robust modelling as to attain more confidence in their general applicability. Many fine refinements in the HMM-GP modelling procedure have been proposed to effectively capture the dynamics of the flow sequences and to generate replicate series at specified resolutions. Model has been applied to a range of hydrologically distinct catchments in the UK. Results show that the model produces excellent performance, effectively captures extreme events, and is generically applicable across a range of hydrological regimes.

REFERENCE

Pender, D., Patidar, S., Pender, G. & Haynes, H. 2015, 'Stochastic simulation of daily streamflow sequences using a hidden Markov model' *Hydrology Research.*, 47(1).