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Exploring Natural Flood Management in Littlestock Brook (United Kingdom) using a Distributed Hydrological Model

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Introduction
Natural Flood Management (NFM) measures can regulate floods in a catchment and provide additional benefits like increasing biodiversity, improving soil and water quality, carbon sequestration, decreasing soil erosion, increasing agricultural productivity and improving public health and well-being.

Previously, NFM measures were mainly modelled using lumped approaches which do not take into account the spatial distribution of the area in question. A distributed hydrological model makes use of areas with the same hydrological behaviour called Hydrological Response Units (HRUs), which can be divided to represent distributed NFM measures in the catchment. It is also able to represent key catchment processes like subsurface flow and overland flow pathways efficiently.

This study will utilise a version of the HBV-96 distributed model built in Python 3.6, and whose implementation follows the HBV-96 model of Lindstrom et al. (1997). The NFM measures will be represented as units in the different sub basins of the catchment and the effect of these measures on the neighbouring cells will be examined. The effect of the measures on the peak stream flow and attenuation of the flow hydrograph will also be examined at key locations within the catchment.

The research is centred on the Littlestock Brook, a rural catchment of about 16km2 located in West Oxfordshire, United Kingdom. Littlestock Brook is a tributary of the River Evenlode, which is in turn a tributary of the River Thames. A programme of NFM measures including storage ponds, hedge rows and bunds is currently being implemented in the Littlestock Brook. (Ramsbottom, 2017). The study sets out to represent, calibrate, validate and implement a fully distributed hydrological model of the catchment with the NFM measures. The model focuses on the effect of the NFM measures on the peak flow hydrograph and the timing of the peak.
The effect of NFM measures can be investigated by modifying model parameters to represent runoff attenuation features like storage areas, soil structure, infiltration, surface roughness and canopy evaporation.

Study Objectives
The study seeks to address:
a) how NFM measures can be incorporated in a fully distributed hydrological model;
b) the effects of NFM measures on flood peak hydrographs ; and
c) how the representation of NFM measures affects the neighbouring cells in the catchment.

Material and Methods
The fully distributed model is currently under development to represent and study the effect of NFM measures on flood peaks.
The main model inputs are: precipitation, air temperature, potential evapotranspiration, flow direction and flow accumulation maps which can be extracted from the topography map using the ArcGIS reference system.

Expected study results
The study is specifically expected to: (i) identify catchment characteristics that could enhance performance of NFM measures ; (ii) demonstrate the effect of NFM measures on flood peak hydrographs; (iii) indicate how changes in the catchment affect other processes in the neighbouring cells. The insight on inundation areas, the effect on the flood peak and the timing to peak the results can be used to develop an optimized strategy to reduce

flood risk downstream in similar catchments.