ICG2022-125
https://doi.org/10.5194/icg2022-125
10th International Conference on Geomorphology

Large-Scale Flood Model Simulations Reveal the Significant Role of Changing Channel Conveyance Capacity in Driving Altered Flood Hazard

Steve Darby[1] and the EVOFLOOD Team[*]
[1]School of Geography and Environmental Science, University of Southampton, Southampton, UK
[*]A full list of authors appears at the end of the abstract

Flooding is the deadliest and most costly natural hazard on the planet, affecting societies across the globe. Nearly one billion people are exposed to the risk of flooding in their lifetimes and around 300 million are impacted by floods in any given year. The impacts on individuals and societies are extreme: each year there are over 6,000 fatalities and economic losses exceed US$60 billion. Moreover, these problems will become much worse in the future: There is now clear consensus that climate change will, in many parts of the globe, cause substantial increases in the frequency of occurrence of extreme rainfall events, which in turn will generate increases in peak flood flows and flood increased areas of land.

Faced with this pressing global challenge, reliable tools are required to predict how flood hazard and exposure will change in the future. Existing state-of-the-art Global Flood Models (GFMs) are now widely used to simulate the probability of flooding across the Earth, but in some instances the predictive ability of current models is constrained by a fundamental limitation. Specifically, current GFMs treat rivers and their floodplains essentially as 'static pipes' that remain unchanged over time. In reality, river channels evolve through processes of erosion and sedimentation, driven by the impacts of diverse environmental changes (e.g., climate and land use change, dam construction), which lead to changes in channel flow conveyance capacity and floodplain connectivity.

In this paper we demonstrate the extent to which flood model predictions of flood inundation are sensitive to altered representations of channel morphology, across large spatial scales. In our GFM the channel bathymetry is inverted from bank elevation given an assumption of bankfull discharge (typically 1 in 2 year). By changing the bankfull discharge and recomputing the bathymetry it is therefore possible to simulate the impact of conveyance changes, driven by channel erosion and sedimentation, on flood hazard. Here we conducted a suite of simulations for test sites within the Mississippi River basin, at which long term change or variability in bankfull conveyance have been constrained by direct observations at gauging stations.

Our results clearly indicate that in-channel changes are significant in driving altered flood hazard. It follows that until GFMs are able to fully account for morphological changes predicting the evolution of future flood hazard, understanding its underlying causes, or quantifying associated uncertainties, will remain very challenging.

EVOFLOOD Team: Dan Parsons, Stuart McLelland, Pauline Delorme (Hull); Jeff Neal, Laurence

Hawker (Bristol); Louise Slater, Michel Wortmann (Oxford); Julian Leyland, Solomon Gebrochorkos, Andy Tatem (Southampton); Hannah Cloke, Helen Griffiths (Reading); Andrew Nicholas, Georgie Bennett, Ellie Vahidi (Exeter); Phil Ashworth (Brighton); Greg Sambrook Smith, Rich Boothroyd (Birmingham); Richard Hardy (Durham)