



Representing river–floodplain interactions in large lowland basins: development and evaluation of a floodplain module within mHM

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Almost one-quarter of the global population resides on floodplains, although they cover only about 6.6% of the Earth's land surface. Floodplains play a central role in regulating river discharge in large lowland river systems, yet their seasonal hydrological function is still poorly represented in large-scale hydrological models. In such systems, river–floodplain interactions control the attenuation, timing, and seasonal persistence of high flows during the wet season. Neglecting these effects leads to simulated hydrographs with unrealistically sharp flood peaks and a limited representation of sustained elevated flows throughout the wet season.

Here, we present the development and evaluation of a floodplain module integrated into the mesoscale hydrologic model (mHM) [1]. Each river reach is represented as a coupled river–floodplain system in which water exceeding the bankfull channel capacity is temporarily stored in an adjacent floodplain compartment. Floodplain storage capacity is derived from high-resolution topographic information using the Height Above Nearest Drainage (HAND) concept, yielding reach-specific height–area–volume relationships. At each routing time step, the available water volume is partitioned between the channel and the floodplain assuming a uniform water level shared by both compartments within the reach. Only the channel volume is routed downstream using the selected routing scheme (e.g. Muskingum–Cunge) in the multiscale Routing Model (mRM) module of mHM [2]. This module is also scalable, as it is based on the Subgrid Catchment Conservation (SCC) concept [3], enabling the simulation of river–floodplain interactions at different routing resolutions while ensuring hydrological connectivity and preserving subgrid-scale catchment contributions.

Simulations for the Ucayali River Basin (Upper Amazon, Peru) show that accounting for floodplain storage attenuates and delays flood peaks and enhances wet-season persistence of high flows. Overall, the results indicate that the proposed module improves the representation of wet-season discharge dynamics in the Ucayali River Basin and is transferable to other floodplain-dominated catchments.

Keywords

floodplains; river routing; large-scale hydrology; mHM; HAND; Amazon Basin

References

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