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Construction of a river network map and a floodplain topography dataset for use in river-floodplain modeling

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River-floodplain models are useful for the validation of the land surface processes in GCMs, estimation of the carbon and nutrient cycle in floodplains, as well as flood forecasts and water resources assessments. River routing calculation requires a ”river network map” which describes the upstream-downstream relationship within the interested basin, while ”floodplain topography” data is essential for flooding scheme in order to describe the relationship between water storage, water level, and inundated area. Here we introduce a new method to construct the ”river network map” and the ”floodplain topography” datasets, which can be applied to any interested basins at flexible spacial resolutions.

The proposed method requires a ”global high-resolution DEM” (e.g. SRTM3 at 90-m resolution) and the ”flow direction map” derived from the high-resolution DEM (e.g. HydroSHEDS at 90-m resolution). Those high-resolution datasets can be directly used for river-floodplain modeling, but the size of the calculation domain is limited under the current computer resources. Thus, the high-resolution datasets should be converted to a low-resolution ”river network map”, but common algorithms such as taking the averaged elevation within the low-resolution grid-box may reduce the information of detailed topography which regulates the hydrodynamics in river channels and floodplains. Instead of taking the averaged elevation, the new algorithm resamples the representative points from high-resolution datasets which is considered to be essential for organizing the ”river network map” at low-resolution. Because the detailed topography is not flattened by the new resampling algorithm, the ”floodplain topography” can be extracted from the high-resolution DEM as the sub-grid-scale parameters of the low-resolution ”river network map”.

We also performed hydrological simulations by a global river-floodplain model using the ”river network map” and ”floodplain topography” datasets derived by the proposed method. Explicit representation of the sub-grid-scale ”floodplain topography” significantly improves the predictability of ”river discharge” compared to the previous models which only consider river channels. The validation against in-situ and satellite observations suggests that the river-floodplain modes can also represent ”water surface elevation” and ”inundated area” realistically. The output datasets from the global river-floodplain model (i.e. ”river discharge”, ”water surface elevation”, and ”inundated area”) are also helpful for various kinds of hydrological researches.

Keywords: River, Floodplain, Modeling, DEM