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Impact of ocean tide on surface water dynamics in Amazon River: Analysis by a new large-scale floodplain model

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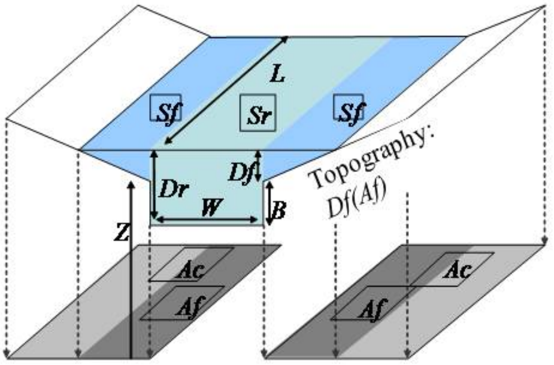

Fig.1: Sub-grid topographic parameters for CaMa-Flood. Parameters for river channel and floodplain morphology are decided for each grid.

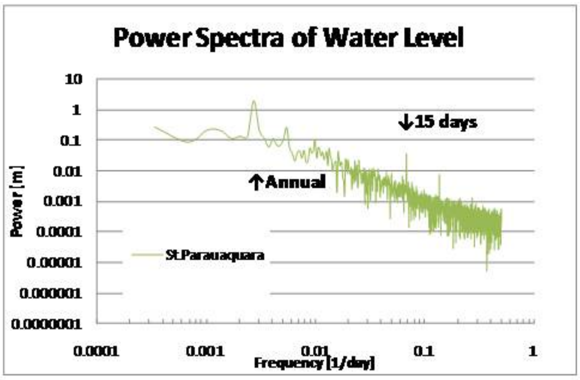

Fig.2: Spectra analysis for water level at St. Parauaquara. Annual and 15-days cycle components are significantly detected.

Surface water dynamics in Amazon River is affected by ocean tide. Because Amazon River is located in an extremely flat basin, water level change in downstream propagates to upstream by " backwater effect". Water level variation due to ocean tide can be detected even at the point 800-km upstream from the ocean. However, impact of ocean tide on surface waters is not adequately quantified. It is due to the lack of river routing model's ability to represent surface water storage and movement, such as floodplain inundation dynamics regulated by much smaller-scale topography than model resolution.

In this research, we introduce the Catchment-based Macro-scale Floodplain model (CaMa-Flood), which overcomes this drawback by representing micro-scale topography as sub-grid parameters (ex. river channel and floodplain morphology; see Fig.1). CaMa-Flood can explicitly simulate water depth and inundated area as well as river discharge, by objectively representing these sub-grid parameters based on 1km-resolution DEM and flow direction map. This enables explicit representation of surface water altitude, which is essential for simulating backwater effect based on diffusive wave equation.

Simulation for entire Amazon River basin is executed using CaMa-Flood. Water level variation due to ocean tide is formulated based on observed sea level, and it is given as the boundary condition for the river mouth. By applying Fourier Decomposition to simulated water depth along the mainstream of Amazon River, a significant 15-days cycle component due to tidal effect is detected at St. Parauaquara, 500-km upstream from the river mouth (Fig.2). Even though the amplitude of 15-days cycle is weaker than observation, it can be said that CaMa-flood succeeded to represent the impact of ocean tide on surface water dynamics.

Additionally, impact of global sea level rise expected under global warming is assessed by modifying the boundary condition at the river mouth. We found that sea level rise will alter the

high water level not only around river mouth but also in upstream river channels. This result may influence the future conditions for flood control in Amazon River. The detailed analysis for the impact of ocean tide and sea level rise on surface water dynamics will be discussed.

Keywords: Amazon River, Surface waters, Ocean tide, River routing model, Floodplain