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Coupling a basin erosion and river sediment transport model into a large scale hydrological model: an application in the Amazon basin

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This study presents the first application and preliminary results of the large scale hydrodynamic/hydrological model MGB-IPH with a new module to predict the spatial distribution of the basin erosion and river sediment transport in a daily time step. The MGB-IPH is a large-scale, distributed and process based hydrological model that uses a catchment based discretization and the Hydrological Response Units (HRU) approach. It uses physical based equations to simulate the hydrological processes, such as the Penman Monteith model for evapotranspiration, and uses the Muskingum Cunge approach and a full 1D hydrodynamic model for river routing; including backwater effects and seasonal flooding. The sediment module of the MGB-IPH model is divided into two components: 1) prediction of erosion over the basin and sediment yield to river network; 2) sediment transport along the river channels. Both MGB-IPH and the sediment module use GIS tools to display relevant maps and to extract parameters from SRTM DEM (a 15" resolution was adopted). Using the catchment discretization the sediment module applies the Modified Universal Soil Loss Equation to predict soil loss from each HRU considering three sediment classes defined according to the soil texture: sand, silt and clay. The effects of topography on soil erosion are estimated by a two-dimensional slope length (LS) factor which using the contributing area approach and a local slope steepness (S), both estimated for each DEM pixel using GIS algorithms. The amount of sediment releasing to the catchment river reach in each day is calculated using a linear reservoir. Once the sediment reaches the river they are transported into the river channel using an advection equation for silt and clay and a sediment continuity equation for sand. A sediment balance based on the Yang sediment transport capacity, allowing to compute the amount of erosion and deposition along the rivers, is performed for sand particles as bed load, whilst no erosion or deposition is allowed for silt and clay. The model was first applied on the Madeira River basin, one of the major tributaries of the Amazon River ($\sim$1.4*106 km2) accounting for 35% of the suspended sediment amount annually transported for the Amazon river to the ocean. Model results agree with observed data, mainly for monthly and annual time scales. The spatial distribution of soil erosion within the basin showed a large amount of sediment being delivered from the Andean regions of Bolivia and Peru. Spatial distribution of mean annual sediment along the river showed that Madre de Dios, Mamoré and Beni rivers transport the major amount of sediment. Simulated daily suspended solid discharge agree with observed data. The model is able to provide temporaly and spatialy distributed estimates of soil loss source over the basin, locations with tendency for erosion or deposition along the rivers, and to reproduce long term sediment yield at several locations. Despite model results are encouraging, further effort is needed to validate the model considering the scarcity of data at large scale.