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Coupled hydrology - routing model to improve hydrogeological and hydraulic data across a tropical basin in Colombia

Maria Arenas, Pedro Felipe Arboleda Obando, and Leonardo David Donado Garzón
Universidad Nacional de Colombia, Bogota, Colombia (mcarenasb@unal.edu.co)

Hydrologic models allow to simulate the water fluxes and storages inside a watershed, and so, to compute the water budget at different time and spatial scales. Even if they are important tools for water management, uncertainty can affect their results. The output data of the hydrologic model can be used to run other models, i.e, a hydrogeologic model (which needs recharge data) and hydrodynamic models (which need discharge data for some tributaries with no gauge stations). Therefore, with the scope to reduce uncertainty and to achieve a better representation in tropical basin systems, we focus on building a coupled hydrology model able to simulate data to be used inside of groundwater flow and surface water hydrodynamic models. In order to do so, we decided to use Dynamic Topmodel, a recent development from the well – known Topmodel, as the hydrologic module, through the HRU (hydrological response units) approach to split the area in smaller units. Then, to include the routing processes, we decided to couple Dynamic Topmodel to the Variable Infiltration Capacity model 2D routing module (VIC-2D), to represent the drainage network using cells, and simulate discharge values at some non-gauged locations. The coupling was built under one single main hypothesis: all the cells inside a single HRU will produce the same recharge and runoff value. Based on this hypothesis we built the input data maps to run the routing module.

As our case study, we chose a 31 140 km^2 basin in the Middle Magdalena Valley (MMV), a central area with important economic activities, as oil and gas (O&G) exploration and production, agriculture and livestock. Our model used cells of size 3 km with 76 HRU, but only seven parameter sets, so many of those 76 HRU shared parameter values, according to the digital elevation model (DEM), soil texture, and land used data. Our analysis is grounded on a record of 30 years of hydro-meteorological variables. The results of the coupling model described in a satisfactory way the following outcomes: (i) the fluxes among hydrosystems, (ii) channel flows, (iii) optimizing the computational performance (budget) of models in basins of tropical regions and (iv) allowing identification of trends on the discharge across the area to support the calibration of hydrodynamic models. In addition, the developed technique reduces the uncertainty of the model outcomes in areas with no data.