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Simulation of the impacts land use and land cover changes - LUCC on the hydrological response of the Ji-Parana Basin with MGB-INPE model

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Hydrological response results from innumerous processes interacting at different spatial and temporal scales and with various intensities. Since the hydrological impacts of Land use and land cover change (LUCC) and climate variability (CV) are strongly dependent on soil water flow pathways, an adequate representation of the runoff generation mechanisms are crucial to assess the hydrological impacts of LUCC and CV on a basin scale.
Model responses to LUCC depend on structure and parameterizations used in the model. There are two basic methodologies adopted to define the structure of the hydrological model: downward and upward approaches. Upward approach is more appropriate for identifying causal relationships, but their results are highly affected by assumptions used in the development of the model. Besides, model structure and parameters values definition are strongly affected by scale issues and their inter-relationships. Downward approach is more appropriate for studying the effects of LUCC, but casual relationships are more difficult to identify.
MGB-INPE model was developed based on the Large Scale Basins Model of Brazilian Institute of Hydraulic Research (MGB-IPH). It uses the Xinanjiang Model approach for soil water capacity distribution at each cell combined with TopModel philosophy. Both methodologies follow a downward approach: the hydrologic response of the basin is associated with patterns of self-organization observed at the basin-scale.
The model was applied in the Ji-Parana Basin (JPB), a 30.000-km2 basin in the SW Amazonia. The JPB is part of the Deforestation Arc of Amazonia in Brazil and it has lost more than 50 % of his forest cover since the 80's. Simulations were performed between 1982 and 2005 considering annual land use and land cover change.
MGB-INPE model was able to represent the impact of LUCC in the runoff generation process and its dependence with basin topography. Simulation results agree with observational studies: LUCC impacts in fast response processes are marked in sub-basins with steep slopes; while in basins with more gently topography the impacts are more pronounced in slow responses processes.
The model was not able to capture the dependence of LUCC impacts on spatial scales: results from simulations have shown the impact increases almost linearly with basin scale, while analysis based on observed data have indicated that impacts are diluted at larger scales. These discrepancies are probably associated with limitations in the spatial representation of heterogeneities within the model, which become more relevant at larger scales. For instance, land use sub-grid variability is accounted only through the percentage of each land use within the cell, without an explicit representation of the location of each use within the gridcell, nor the interaction between land uses.