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Automatic pre-processing for an object-oriented distributed hydrological model using GRASS-GIS

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Landscapes are very heterogeneous, which impact the hydrological processes occurring in the catchments, especially in the modeling of peri-urban catchments. The Hydrological Response Units (HRUs), resulting from the intersection of different maps, such as land use, soil types and geology, and flow networks, allow the representation of these elements in an explicit way, preserving natural and artificial contours of the different layers. These HRUs are used as model mesh in some distributed object-oriented hydrological models, allowing the application of a topological oriented approach. The connectivity between polygons and polylines provides a detailed representation of the water balance and overland flow in these distributed hydrological models, based on irregular hydro-landscape units. When computing fluxes between these HRUs, the geometrical parameters, such as the distance between the centroid of gravity of the HRUs and the river network, and the length of the perimeter, can impact the realism of the calculated overland, sub-surface and groundwater fluxes. Therefore, it is necessary to process the original model mesh in order to avoid these numerical problems. We present an automatic pre-processing implemented in the open source GRASS-GIS software, for which several Python scripts or some algorithms already available were used, such as the Triangle software. First, some scripts were developed to improve the topology of the various elements, such as snapping of the river network to the closest contours. When data are derived with remote sensing, such as vegetation areas, their perimeter has lots of right angles that were smoothed. Second, the algorithms more particularly address bad-shaped elements of the model mesh such as polygons with narrow shapes, marked irregular contours and/or the centroid outside of the polygons. To identify these elements we used shape descriptors. The convexity index was considered the best descriptor to identify them with a threshold of 0.75. Segmentation procedures were implemented and applied with criteria of homogeneous slope, convexity of the elements and maximum area of the HRUs. These tasks were implemented using a triangulation approach, applying the Triangle software, in order to dissolve the polygons according to the convexity index criteria. The automatic pre-processing was applied to two peri-urban French catchment, the Mercier and Chaudanne catchments, with 7.3 km^2 and 4.1 km^2 respectively. We show that the optimized mesh allows a substantial improvement of the overland flow pathways, because the segmentation procedure gives a more realistic representation of the drainage network.

KEYWORDS: GRASS-GIS, Hydrological Response Units, Automatic processing, Peri-urban catchments, Geometrical Algorithms