Geo-PUMMA : une boîte à outils pour la représentation des bassins urbains et périurbains dans la modélisation hydrologique distribuée

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Geo-PUMMA: Urban and Periurban Landscape Representation Toolbox for Hydrological Distributed Modeling

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In addition to land use changes, the process of urbanization can modify the direction of the surface and sub-surface flows, generating complex environments and increasing the types of connectivity between pervious and impervious areas. Thus, hydrological pathways in urban and periurban areas are significantly affected by artificial elements like channels, pipes, streets and other elements of storm water systems. This work presents Geo-PUMMA, a new GIS toolbox to generate vectorial meshes for distributed hydrological modeling and extract the drainage network in urban and periurban terrain. Geo-PUMMA gathers spatial information maps (e.g. cadastral, soil types, geology and digital elevation models) to produce Hydrological Response Units (HRU) and Urban Hydrological Elements (UHE). Geo-PUMMA includes tools to improve the initial mesh derived from GIS layers intersection in order to respect geometrical constraints, which ensures numerical stability while preserving the shape of the initial HRUs and minimizing the small elements to lower computing times. The geometrical constraints taken into account include: elements convexity, limitation of the number of sliver elements (e.g. roads) and of very small or very large elements. This toolbox allows the representation of basins at small scales (0.1-10km2), as it takes into account the hydrological connectivity of the main elements explicitly, and improves the representation of water pathways compared with classical raster approaches. Geo-PUMMA also allows the extraction of basin morphologic properties such as the width function, the area function and the imperviousness function. We applied this new toolbox to two periurban catchments: the Mercier catchment located near Lyon, France, and the Estero El Guindo catchment located in the Andean piedmont in the Maipo River, Chile. We use the capability of Geo-PUMMA to generate three different meshes. The first one is the initial mesh derived from the direct intersection of GIS layers. The second one is based on fine triangulation of HRUs and is considered the best one we can obtain (reference mesh). The third one is the recommended mesh, preserving the shape of the initial HRUs and limiting the number of elements. The representation of the drainage network and its morphological properties is compared between the three meshes. This comparison shows that the drainage network representation is particularly improved at small to medium spatial scales when using the recommended meshes (i.e. 120-150 m for the El Guindo catchment and 80-150 m for the Mercier catchment). The results also show that the recommended mesh correctly represents the main features of the drainage network as compared to the reference mesh.

KEYWORDS: GRASS-GIS, Computer-assisted mesh generation, periurban catchments