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Using graph approach for managing connectivity in integrative landscape modelling

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In cultivated landscapes, a lot of landscape elements such as field boundaries, ditches or banks strongly impact water flows, mass and energy fluxes. At the watershed scale, these impacts are strongly conditionned by the connectivity of these landscape elements. An accurate representation of these elements and of their complex spatial arrangements is therefore of great importance for modelling and predicting these impacts.We developped in the framework of the OpenFLUID platform (Software Environment for Modelling Fluxes in Landscapes) a digital landscape representation that takes into account the spatial variabilities and connectivities of diverse landscape elements through the application of the graph theory concepts.

The proposed landscape representation consider spatial units connected together to represent the flux exchanges or any other information exchanges. Each spatial unit of the landscape is represented as a node of a graph and relations between units as graph connections. The connections are of two types - parent-child connection and up/downstream connection – which allows OpenFLUID to handle hierarchical graphs. Connections can also carry informations and graph evolution during simulation is possible (connections or elements modifications). This graph approach allows a better genericity on landscape representation, a management of complex connections and facilitate development of new landscape representation algorithms.

Graph management is fully operational in OpenFLUID for developers or modelers ; and several graph tools are available such as graph traversal algorithms or graph displays. Graph representation can be managed i) manually by the user (for example in simple catchments) through XML-based files in easily editable and readable format or ii) by using methods of the OpenFLUID-landr library which is an OpenFLUID library relying on common open-source spatial libraries (ogr vector, geos topologic vector and gdal raster libraries). OpenFLUID-landr library has been developed in order i) to be used with no GIS expert skills needed (common gis formats can be read and simplified spatial management is provided), ii) to easily develop adapted rules of landscape discretization and graph creation to follow spatialized model requirements and iii) to allow model developers to manage dynamic and complex spatial topology.

Graph management in OpenFLUID are shown with i) examples of hydrological modelizations on complex farmed landscapes and ii) the new implementation of Geo-MHYDAS tool based on the OpenFLUID-landr library, which allows to discretize a landscape and create graph structure for the MHYDAS model requirements.