Phd topic - Hydrological modelling of the impact of stormwater infiltration on soil water status in an urban context - Adaptation of the modelling to descriptive data at the neighbourhood scale.

In order to adapt cities to global change, urban planning strategies are encouraging the development of vegetation in cities, and urban water management is based on an integrated management strategy combining the control of sealing, the implementation of stormwater management systems at source, and the reuse of other types of water such as grey water.
The management of rainwater in cities is therefore characterised by major changes, which give greater importance to the role of the soil in relation to the stormwater discharges produced by the city (Furumai, 2008), and to the preservation of groundwater resources by recharging the aquifers, but require particular attention to be paid to the quality of the infiltration water and the properties of the soil (capacity to infiltrate, level of contamination, etc.). Furthermore, the role of soil in the hydrological functioning of urban catchment areas has been demonstrated in past research, but taking this into account is still hampered by a lack of appropriate description of the complexity of the characteristics of urban soils, which are heavily reworked and the site of many buried structures (Pophillat 2022). However, operational staff have high expectations of integrated soil management.

Hydrological modelling is a relevant approach for helping operational staff to make the right choices in terms of development and management at source, as long as the models provide an appropriate representation of the physical processes involved in the functioning of the above-ground and underground compartments. Spatially distributed modelling tools are also very useful for 'moving towards' more operational applications that can be used to test development scenarios. However, the implementation of models is still hampered by the level of parameterisation required to properly represent certain processes and water flows, such as exchanges between the groundwater table and buried structures, and exchanges between vegetation and soil. This level of parameterisation is often guided by the availability of data to describe the compartments concerned and the envelope constructed: geology, soil characteristics, presence of underground networks and car parks, land use, characteristics of infiltration structures (substrates, geotextiles....).

The aim of this thesis is to adapt the representation of urban catchment components in hydrological models to the level of description available in geographic databases. In particular, the proposed work should make it possible to identify strategies for using models in the case of limited descriptive information and to qualify the limits of this use. The case of the representation of soil characteristics and hydrogeological contexts will be studied, in connection with the description of the characteristics of rainwater management systems, whether above or below ground.

From a methodological point of view, the hydrological model under consideration is the URBS model (Rodriguez et al., 2008; Pophillat, 2022 ; Pophillat el al., 2021 & 2022), which provides a detailed description of the underground compartment. This model makes it possible to test different options for describing the characteristics of the urban environment and also different options for simulating the processes, which can be adjusted according to the level of description.

Case studies

As part of the ONEVU research observatory, the IRSTV in Nantes has set up permanent monitoring of water balances in a neighbourhood of individual and collective housing, the Pin sec catchment area (30 ha), as well as an eco-neighbourhood where management works at source are monitored. In addition, the ZAC du Moulon site, currently being developed on the Sacaly plateau, has been monitored hydrogeologically and hydrologically for the past 10 years by CEREMA (Li, 2015; Pophillat 2022).

Potential scientific and operational spin-offs

For the use of hydrological models:

- Recommendations for adapting modelling practices to the context, objectives and level of knowledge available, etc.
- Better understanding of the impact of the simplifications required to apply distributed hydrological models on larger scales
- Possibility of moving towards simplified tools that are easier to implement in operational contexts.

More broadly:

-A better understanding of the ability of hydrological models such as URBS to describe the urban water cycle (and to some extent the role of heterogeneities in hydrological functioning).
- To better assess the other benefits of integrated stormwater management, such as the control of pollutant flows or urban cooling, which are partly conditioned by soil water stocks and flows.

Context of the thesis supervision

The thesis will be hosted on the Univ Eiffel campus in Nantes and co-supervised by F Rodriguez (LEE, Univ Eiffel) and J Sage (TEAM, Cerema). It will contribute to the scientific coordination between GERS and TEAM.

References

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