A new methodological approach for the protection of peri-urban groundwater catchments

In the context of CASPER, an SPGE project agreement for the "development of an integrated methodology for the protection of catchments in sub-urban areas"

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CONTEXT

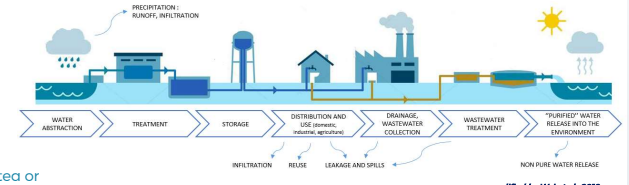
Management and protection of water catchments (water quality)
Drinking water distribution in **Wallonia** ≃ 76 % linked to groundwater catchments

Peri-urban area
(≃ 25% SWDE catchments)

Relevant diversity of pollution sources linked to land use occupation:
- pollutants of **agricultural origin**
- **economic & industrial activities**
- **accidental sources** (spills)
- **continuous, hidden sources** linked to sewage systems, dumps (known/unknown), treated or untreated domestic wastewaters, sinkholes, private or industrial product storage systems (oil tanks)
- **interactions with watercourses** characterized by poor chemical quality

Urban water cycle
- **Increase of the impermeable surfaces** due to the construction of houses and traffic lanes, car parks, ...
- **Increase in domestic water consumption** because of the increase in individual households per house) and comfort use such as swimming pools, gardens **(despite the water-efficient machines)**

Problems
- **nitrate** (agricultural vs urban)
- **specific substances** (pesticides, sulfates, chlorides, chlorinated solvents, etc.)
- **mixed and varied pollutions**



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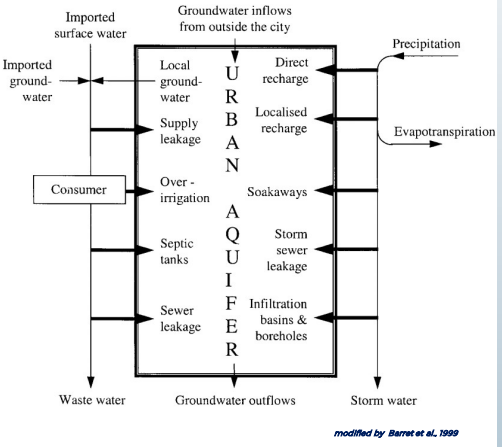

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MAIN OBJECTIVES

Development of an integrated methodology for the protection and prioritisation of catchments in peri-urban contexts

1) **Discriminate between different types of waters and pollution sources (mixtures)**
Identification of a range of tracer substances and approaches: specific molecules, isotopes, drugs, microbial biomarkers, etc.

2) **Variety of supporting tools**
Field measurements/acquisition
Integration of different types of lab analyses (isotopes, pharmaceutical compounds, bacteria, etc.)
Integration of PEGASE data → tool for the estimation of the quality of watercourses in contact with the aquifers (Aquapôle, ULiège)
Adaptation of POLLUSOL2 → tool to estimate and assess the pollution risk of areas (SPAQuE and ULiège)

3) **Definition of a decision-making reference system establishing the importance of pollution** (prioritizing remediation measures)
Digital modelling of flows and transport (MODFLOW/MT3DMS)
Quantification and modelling of pollutants mass fluxes and discharge,
Scenario analysis and associated risks

METHODOLOGY BASIC CONCEPTS AND APPLICATION TO 1st PILOT SITE

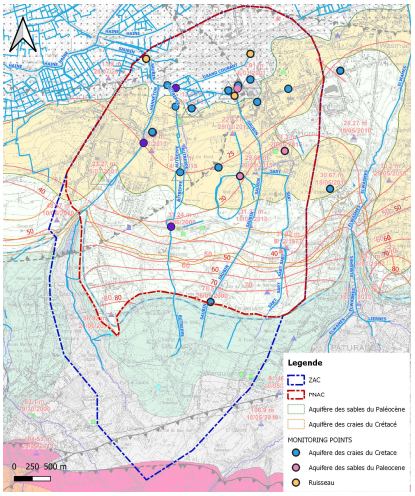
PILOT SITE: Boussu (province of Hainaut, western Belgium, Mons basin), peri-urban area impacted by various sources of pollutants: old dumps and slag heaps surrounding the site, railway wastes, discharges from small and medium-sized enterprises (Le Marais – SPAQuE) , hospitals, housing and possibly agriculture.

1st) Determination of the groundwater catchment area (ZAC *zone d'alimentation du captage ZAC, and PNAC portion de nappe alimentant le captage PNAC*), corresponding to the land surface perimeter in which abstracted groundwater is recharged, either by direct or indirect infiltration of surface water (procedure explained by Vandenberghe et al. 2015).

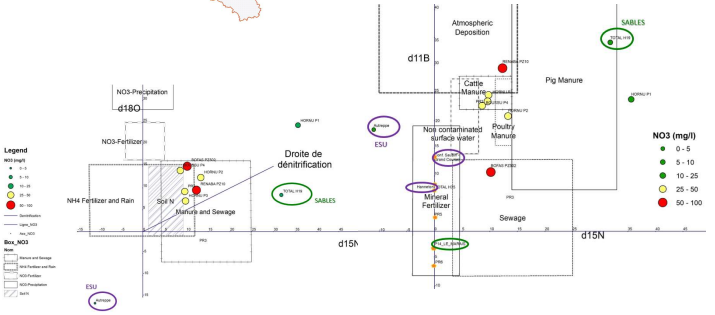
2nd) Collection on contexte, expertise, historical data available for the site and known sources of pressures on it
(historical flow rates, catchment operation and chemical data, works and contaminated sites in the vicinity, based on consultancy of a series of dataset and SIG information :
WALONMAP, CALYPSO, BD-Hydro, 10-Sous, archives SWDE, SPAQuE).

3rd) Surface and groundwater monitoring network for sampling campaigns : focus on a combination of physicochemical parameters, traditional hydro-chemicals and set of more advanced indicators

4th) Evaluation of the contribution of the different pollution sources identified in the catchment area based on in situ measurement and numerical modelling of pollutant mass fluxes and discharge (MODFLOW, MT3DS).



- **Stable isotopes of NO_3^- and Boron** → urban effluents vs agricultural fertilisers (Nikolenko et al., 2018; Widori et al., 2005).
- **Stable isotopes of SO_4^{2-}** → anthropic activity, dissolution of evaporates, or alteration of carbon mines waste (Knöeller et al., 2011).
- **Occurrence of pharmaceutical and lifestyle products** → anthropogenic contamination (Neufcourt, 2017).
- **Microbial/bacterial populations** → specific sources and biochemical reactions



PRIMARY CONCLUSIONS

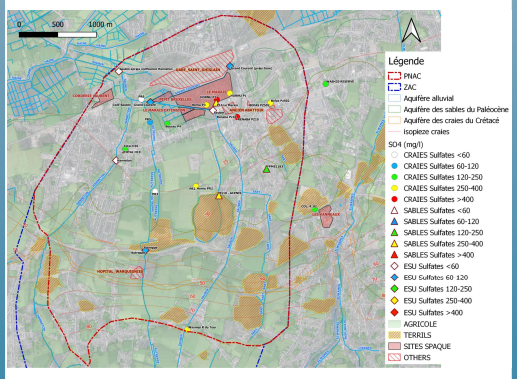
Hypothesis on the origins of pollutants:

Sulphates → "terrils" , carbon mine waste / heaps located on south-east + domestic wastewater

Nitrate→ south east (thinner layer of sands); wastewater + agriculture

Pharmaceutical substances → mainly related to human health and consumption, and probably some hospital waste in Le Marais landfill

Chlorinated solvents → no links with landfill Le Marais, but possible links with mainly garage-carwash and laundry activities all around in the area, in particular going in the east side; + hospital cleaning section (?)



FOLLOWING INVESTIGATIONS

- Drilling of additional monitoring wells to go further in the investigation of pollutant sources (determine the source of chlorinated solvents and the sulfates)
- Correlation/trends analysis
- Redefinition of the PNAC/ZAC based on the numerical model and the results of the following field campaign (fluxes)