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

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

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

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 (SPRAQUE and ULiège)

3) Definition of a decision-making reference system establishing the importance of pollution
   Scenario analysis and associated risks
   Digital modelling of flows and transport (MODFLOW/MT3DMS)
   Identification of a range of tracer substances and approaches: specific molecules, isotopes, drugs, microbial biomarkers, etc.

METODOLOGY 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.

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 Vandenbergh et al. 2015)

2nd) Collection on context: 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, SPRAQUE).

3rd) Surface and groundwater monitoring network for sampling campaigns: focus on a combination of physico-chemical 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 modeling of pollutant mass fluxes and discharge (MODFLOW, MT3DMS)

- Stable isotopes of NO3 and B on urban effluents as agricultural fertilisers (Nikolajko et al., 2018; Wilde et al., 2005)
- Stable isotopes of SO4 anthropogenic activity, dissolution of evaporates, 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-cars 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 in the surface)
- Correlation/trends analysis
- Redefinition of the PNAC/ZAC based on the numerical model and the results of the following field campaign (fluxes)