

Perchlorates sources in agricultural land use groundwater

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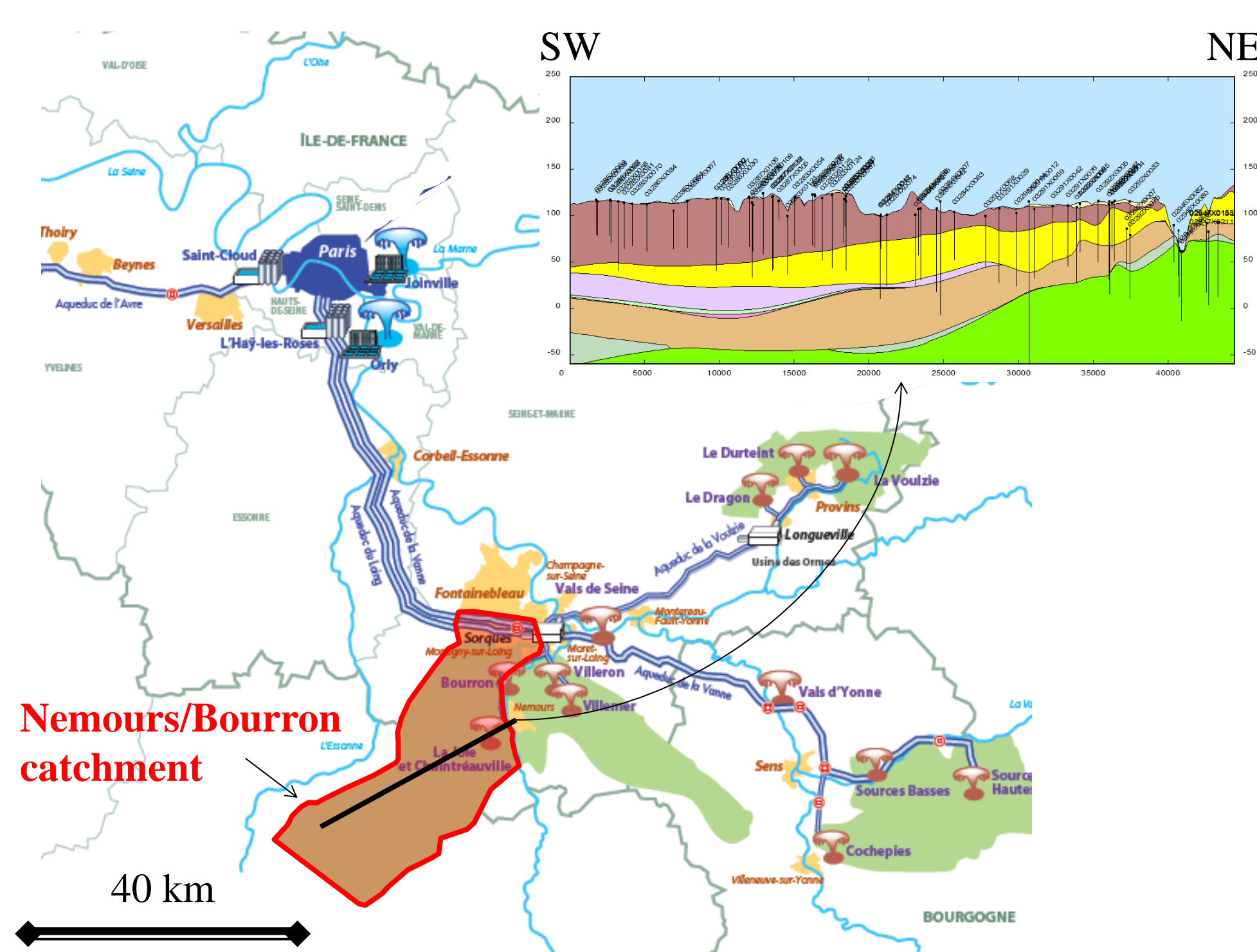
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Topics: In 2012, perchlorate ions were found in a multi-layers sedimentary aquifer, located in the centre of France, both exploited for irrigation and water supply. Concentrations measured in groundwater often exceed 4 and 15 µg/L values defined by the WHO (World Health Organization) as toxicity thresholds for infants (and pregnant women) and adults respectively. Nevertheless, considerable uncertainties remain about the sources, fate and transport of perchlorates in this agricultural land use environment. Fresh water contamination by perchlorates is a major issue because it is not removed by conventional treatment plants.

1. State of the art

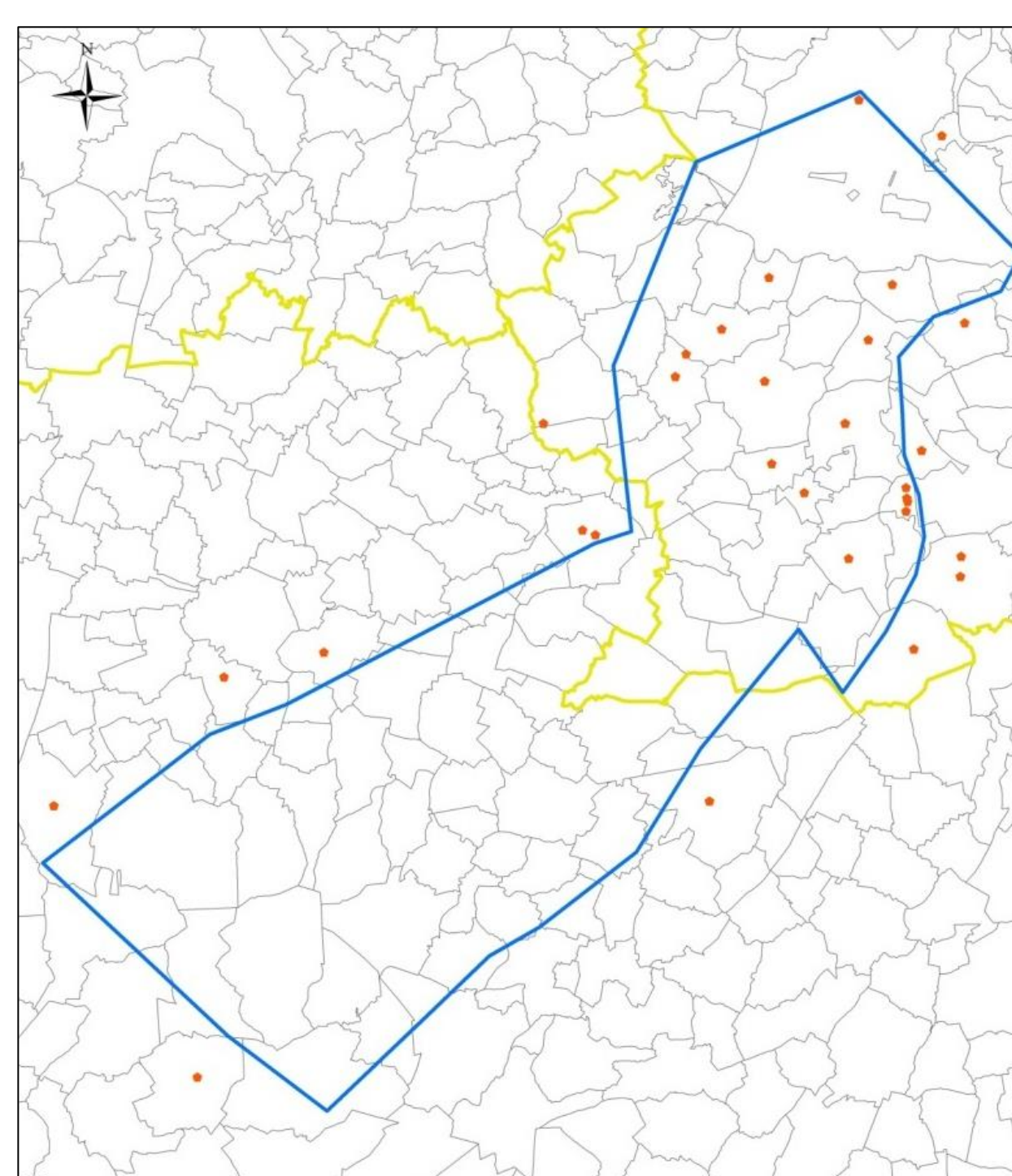
➤ The “Nemours/Bourron” catchment area

- 1000 km²
- Multilayer tertiary sedimentary aquifer
- Part of a major fresh groundwater resource network



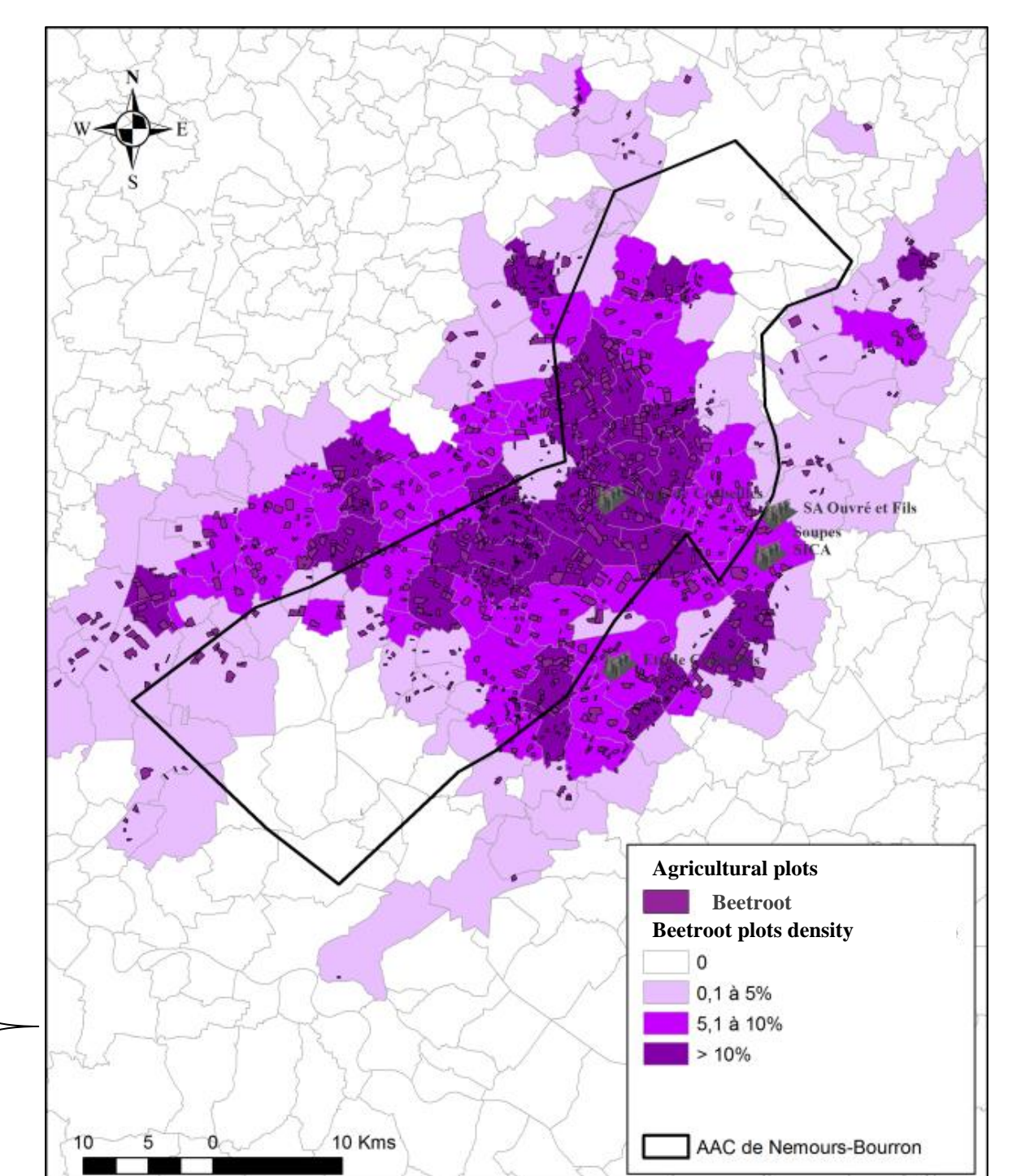
➤ Potential perchlorate sources at the catchment area scale

In its various salt forms, synthetic perchlorate has been used as an oxidizer in solid propellants for military and pyrotechnic uses, and in air bag inflators. It has also been used in many others industrial activities. Its manufacture and use has spread in many regions of the world. It is also present as impurities in significant concentrations in various products as hypochlorite solutions, chlorinated herbicides and Chilean nitrates. Evidences of Chilean Nitrate uses during the early part of the last century have been inventoried in the studied area.



Local Military and industrial sites

	Activities
Military and pyrotechnic sources	Pouders / propellants
	Explosives and experimental explosives
	Pyrotechnic products/ Alarm rockets
Industrial sources	Airbags / batteries
	Metal industry
	Plastic industry (PVC)
	Pharmaceutical products
	Chemical industry (catalyser, drying agents, electrolytes)
Plant control sources	Paper production/ leather
	Former Chilean nitrate soil amendment
	Sodium Chlorate



Beetroot agricultural plots density

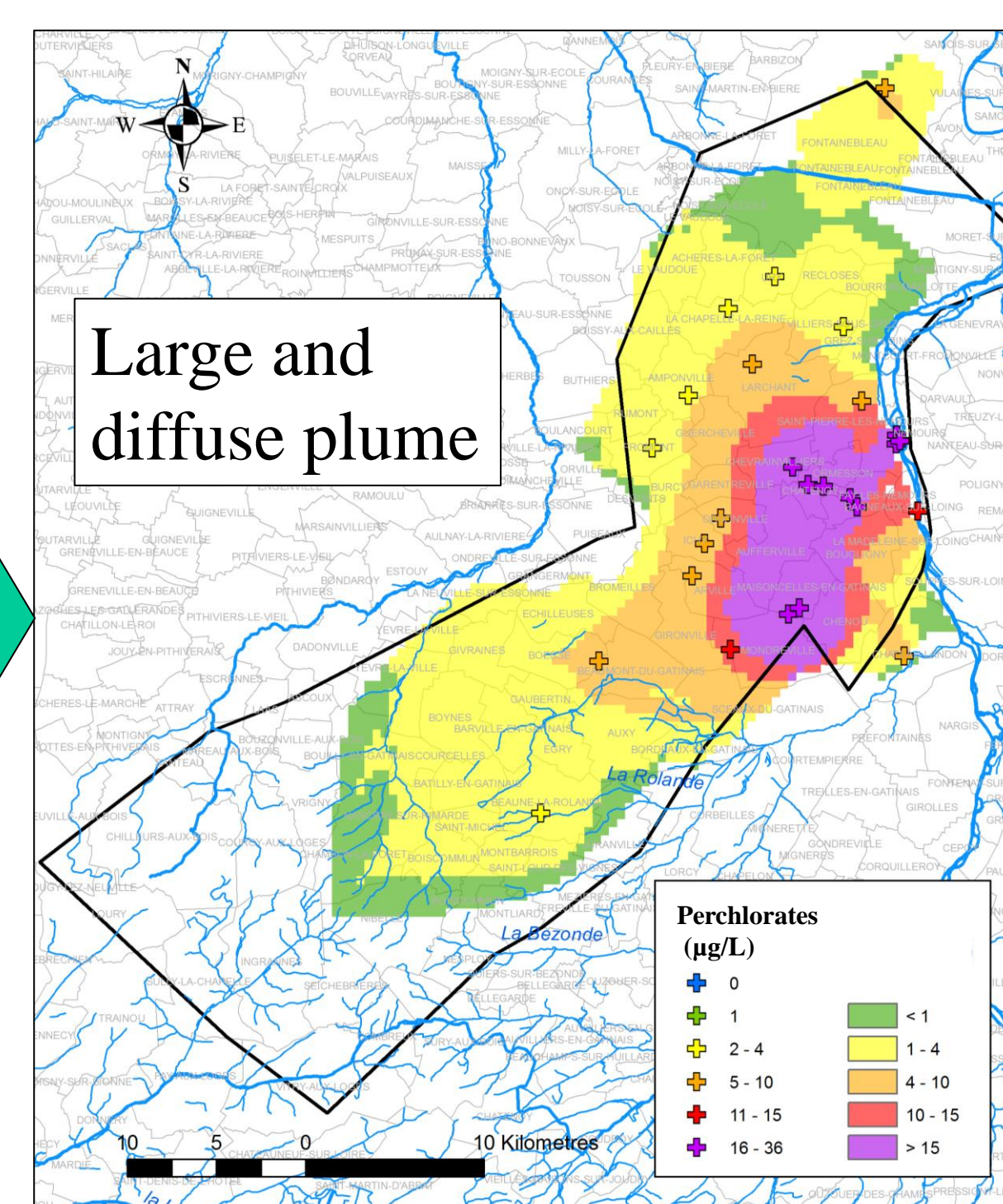
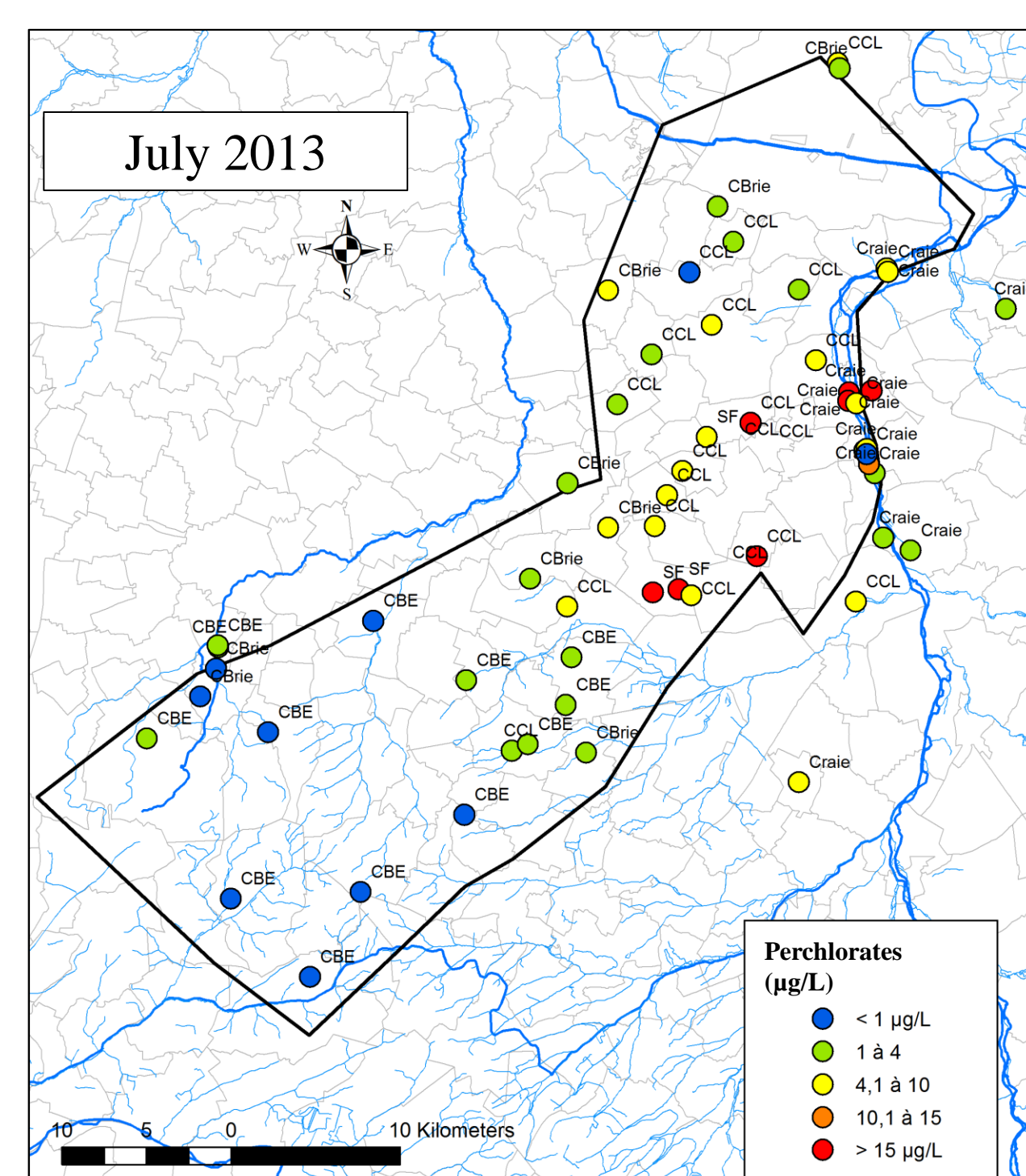
2. Perchlorate groundwater contamination

➤ Sampling campaigns

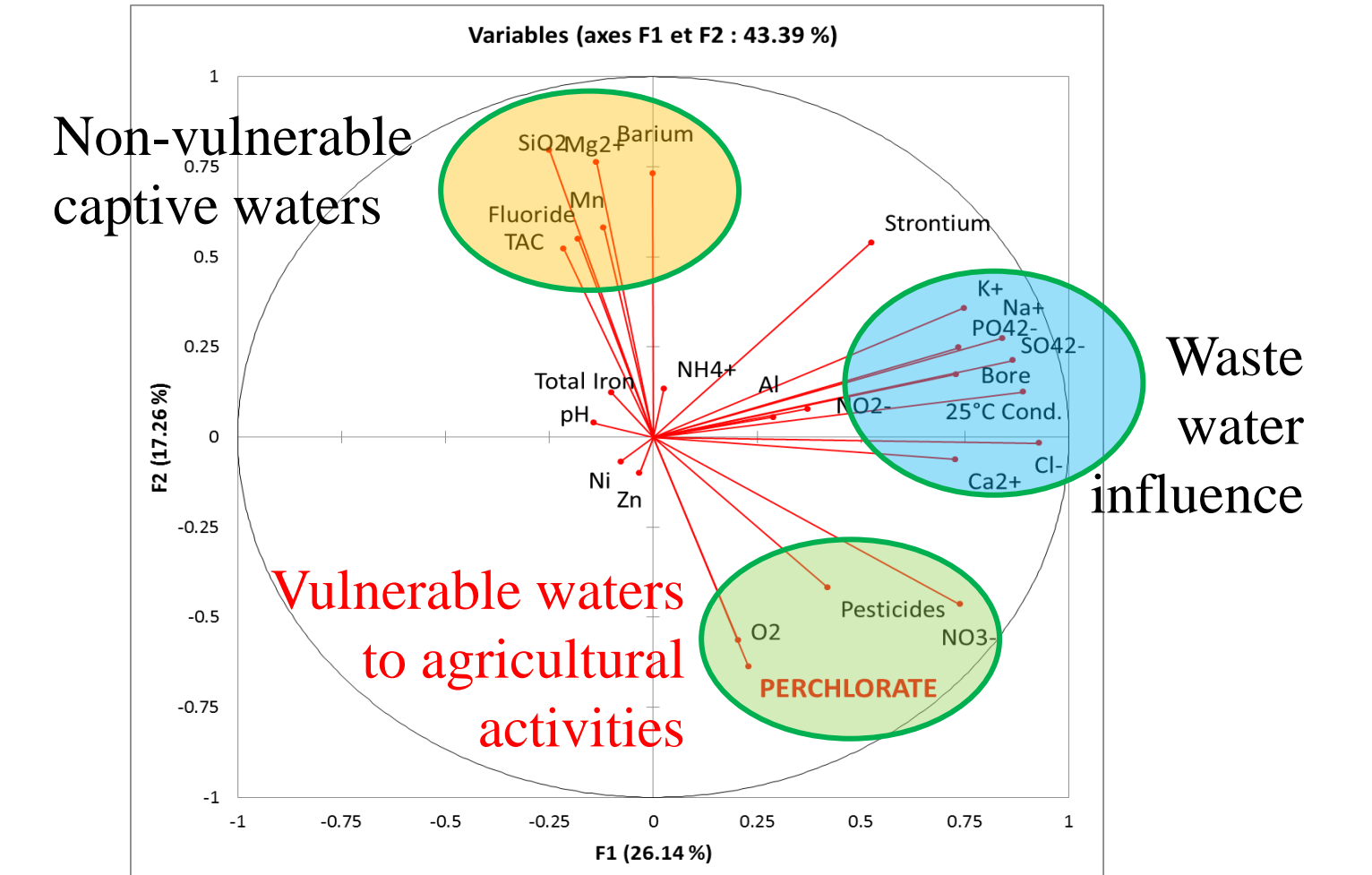
- 2 campaigns (2013 - 2014)
- 72 sampling sites
- 9 sites monthly monitored
- Complete physico-chemical analyses:
 - ✓ Pesticides
 - ✓ Trace metals
 - ✓ Major ions
 - ✓ Perchlorates (LoQ:1 µg/L)
- CFC/SF6 age dating (12 sites)

➤ Plume mapping

- Kriging method



➤ Multicomponent analysis



Perchlorate Nemours/Bourron shallow groundwater contamination shows a non-point-source agricultural pollution pattern

3. Discuss - hypothesis tests

➤ Potential sources

➤ On the catchment area

➤ Emission period

➤ CFC/SF6 age dating

➤ Sought tracers

➤ Chemical analysis

➤ Expected pollution

➤ Plume mapping

	Military & pyrotechnic	Industrial	Plant control
Source	1 st war bomb storage	Carriers	Car scrapping
Emission period	1914-1950	1960-today	1980-today
Age dating	Confirmed	Possible	Not possible
Tracers	?	?	Bore
Chemical analysis		Locally found	Not found
Expected pollution	Point-source pollution	Local pollution	Diffuse pollution
Plume mapping	Not confirmed	?	Confirmed and spatially correlated with beetroot plot density

Conclusion: The large spread of perchlorates uses for different activities and the lack of data on the catchment area made it necessary the implementation of a “step-by-step” approach. Tasks were carried out to better understand the hydrogeological and geochemical context, to inventory potential sources (either military, industrial or agricultural) and to assess the groundwater perchlorate contamination. Results suggest a diffuse pollution by the Chilean nitrates widely used during the early part of the last century. These nitrates are the major source of Perchlorates emission in this catchment area. Based on this hypothesis, it could be possible to assess the time to dispose the remaining stock of perchlorates using a global time-transfert modeling for Perchlorates facilitated by its conservative properties.