Geophysical Research Abstracts
Vol. 19, EGU2017-6687, 2017
EGU General Assembly 2017

Tracing wastewater effluents in surface and groundwaters: a couple approach with organic/inorganic tracers and isotopes

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In the context of land use change, the origins of contamination of water resources are often multiple, including for a single chemical element or molecule. For instance, excess of nitrates in both surface and groundwater can originate from agricultural practices and wastewater effluents. The discrimination of the origins and vectors of contamination in the environment is both an environmental and societal issue in order to define an integrated water resources management at the catchment or water body scale by implementing appropriate measures to effectively struggle against pollution.
The objective of this study is to define a methodology for the identification of a "domestic wastewater" contamination within surface waters and groundwater. An ideal tracer should be conservative, persistent in the different water compartments, present in quantity above the detection limit and originate from a single type of pollution source. There is, however, no ideal tracer in the strict sense. Indeed, even chloride which is present in quantity in wastewater, and which behaves conservatively in the environment, is not an univocal tracer of wastewater, as it may come from atmospheric inputs, from the dissolution of evaporitic rocks, from the salting of roads or from fertilizers. To overcome this limitation, in this study, we propose a multi-tracer approach (chemical and isotopic) to identify and validate the relevance of foreseen tracers. Among the relevant tracers of wastewater, the following may be used for their intrinsic or combined discriminant power: 1) organic effluent tracers: nitrogen contents and isotopic ratios of nitrogen and oxygen of nitrates; 2) tracer of detergents: boron contents and boron isotopes; 3) pharmaceuticals tracers: e.g. carbamazepine, ibuprofen, paracetamol, gadolinium anomaly; 4) life-style tracers: e.g. caffeine. The originality of the study relies on small capacities wastewater treatment plants without tertiary treatment process.
Results on a catchment impacted both by diffuse agricultural pollution and punctual wastewater inputs are presented. Investigations concern wastewater effluents resulting from different type of treatment plants, surface and groundwater. Potential combination of suitable tracers is discussed.