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Evidence of influence of regional and local heterogeneities within a chalk karst aquifer based on nitrates and chlorides analysis

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In Upper Normandy, a region located in the western Paris Basin, the main source of drinking water comes from the karst aquifer. Developing under the chalk plateaus, it is a covered aquifer overlaid by superficial formations of clay-with-flints and loess. Clay-with-flints result from chalk weathering whereas loess are wind periglacial deposits. The local geologic and hydrogelogic contexts are characterized by a mature development of sinkholes. The chalk karst is causing turbidity, often linked to the fast infiltration of surface water, carrying the products of river and slope erosion and associated contaminants into the aquifer through the sinkholes. Several authors have shown the potential of turbidity as a marker of suspended elements transport and karst conduits fast transport.
In this study, we conducted monthly monitoring of 11 boreholes located in the upstream watershed near boreholes (surveyed by the French Geological Survey BRGM): Graveron-Semerville in the Southern department of Upper Normandy (Eure) and Rocquemont in the Norhtern department of Upper Normandy (Seine-Maritime). The monitoring carried out included water level and electrical conductivity (reflecting total water mineralization) measurements, and major elements analysis. In any case, the water levels are similar over time (in accordance with the reference borehole). High mineralizations are observed in the Eure boreholes with significant anomalies of nitrate (70 to 130 mg/l) and chloride (35 to 90 mg/l). For the Seine Maritime boreholes, no anomalies in nitrates and chlorides were found. To explain such differences, the agricultural activities are not sufficiently different from the study site. The explanation would then come from different reservoirs involved in water storage: loessic formations, thicker and more spreaded in the Seine Maritime department and clay with flints, of significantly higher thickness on average in the Eure department. We also discuss the influence of the drainage network (input karst more or less connected to output karst) on the water ressource heterogeneity, including storage of contaminants (nitrates and chlorides) within the saturated zone of the chalk aquifer.
This demonstrates two scales of heterogeneities in the chalk aquifer water masses at work in the ground water flow and transport: (i) the regional scale linked to the geological context and (ii) the watershed scale linked to the influence of the karst network. Accounting for these heterogeneities in the framework of a regional conceptual model will give a better understanding of the hydrological functioning of the chalk aquifer. This model will also serve as a basis for the parametrization of a physically-based numerical groundwater flow model presently under development.

Keywords: Clay-with-Flints, loess, chalk aquifer, sinkholes, nitrates, chlorides, Upper Normandy.