Scaldwin Project
Sustainable aquifer management

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ABSTRACT

Since the beginning of the 20th century, the Carboniferous aquifer was known as a high potential aquifer. Groundwater has been exploited for decades to provide drinkable water and supply heavy factories in north of France and Belgium. Over-pumped during the last century, the Carboniferous aquifer has seen its water level dramatically decreased. Since the end of industrial period, groundwater consumption has decreased and water table is now stabilized and slowly coming back to a more "natural" level in some areas. However, this recent water level rise has triggered some chemical problems, such as the increase of sulphurs.

The "Carboniferous limestones aquifer" is composed by two rock layers: the Visean and the Tournaisian, representing the lower parts of the Carboniferous era. The higher part of the aquifer is very productive and generally considered as a karstified zone. Recharge areas are located on the eastern part of the aquifer, in Belgium, where limestones laid under a few meters thick soil. Slightly dipping toward south - west, the geometry of the aquifer is not accurately known due to a lot of east - west faults and the presence of a faulted synclinal near Tournai (Be).

In the past, a lot of hypotheses have been made regarding geometry and piezometry of this aquifer. Thanks to the "Scaldwin" project (launched in 2009), the assumptions are going to be set against more recent hydrogeological data and information provided by new borehole logs.

In one hand, this project should encourage and stimulate international cooperation at large scale: studies and methods standardisation, data transfer and sharing, common reporting process. On the other hand, this cooperation will reduce scientific uncertainties about the Carboniferous aquifer: more accurate geometry, building of hydrogeological referentials, extension of piezometrical maps, hydrochemical and isotopic characterization of different groundwaters…

New data from next field campaigns should help to generate a conceptual model of the aquifer behaviour, build a numerical model, and eventually modelize transfer functions between surface water and groundwater, in order to organize a sustainable management of the Carboniferous aquifer between France and Belgium.

Key words: limestones, karst, management, France, Belgium.

HISTORY

Since the beginning of the 20th century, the Carboniferous aquifer, mainly composed by partly-eroded sedimentary rocks, was known as a high potential aquifer. Groundwater has been pumped for decades to provide drinkable water and supply heavy factories in France (Lille and its suburbs representing 1 million of inhabitants) and Belgium.

Over-pumped during the second part of the last century, the Carboniferous aquifer has seen its water level dramatically decreased, until 90 m deep in France. From the 90's until now, corresponding to the end of industrial period, groundwater consumption has decreased and water table is now stabilized and slowly coming back to a more "natural" level in some areas (Fig. 1). However, the recent water level rise has triggered some chemical problems, such as the increase of heavy chemical compounds and sulphurs (Fig. 2).

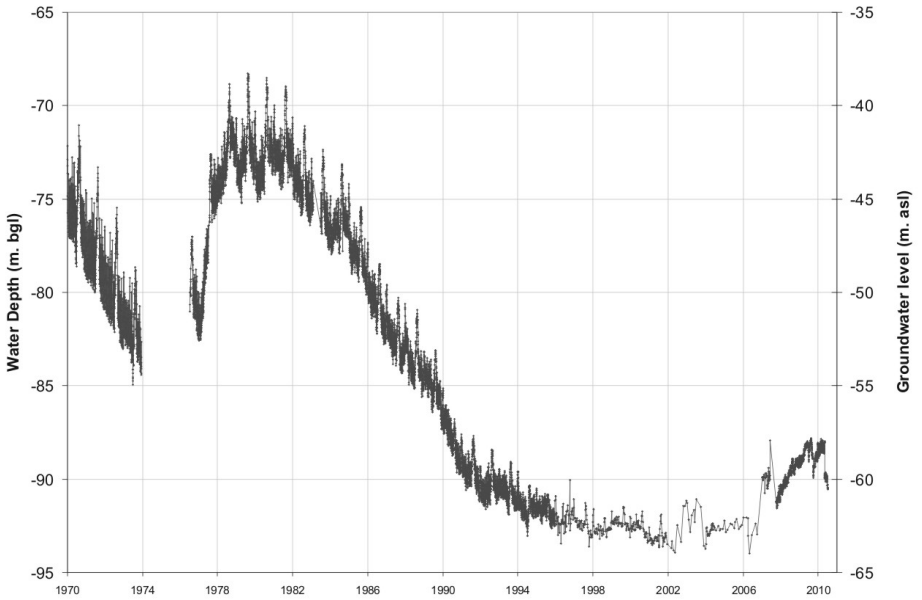

Figure 1: Piezometrical level (m) in a monitored borehole in Bondues (Fr), from 1970 to 2010.

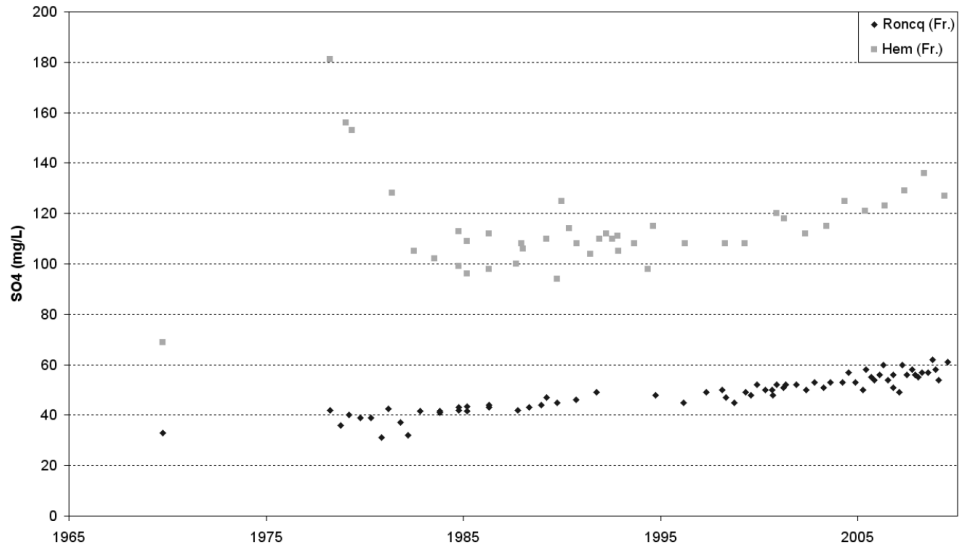

Figure 2: Sulphur concentration (mg/L) from two boreholes in France, from 1965 to 2010.

TRANSBOUNDARY COOPERATION

In 2000, European Union decided to globally protect water and published the directive 200/60/EC, establishing a framework for community action in the field of water policy. In this document, some articles directly refer to an "international cooperation for the management of transboundary aquifers". In 2002, Belgium, France and Netherlands signed the Gand agreement, confirming their will to coordinate the application of the EC law for the Escaut hydrological district. It reinforced the role played by the Escaut International Commission, created in 1994. One of its work topics was the groundwater vulnerability, with a focus on the Carboniferous limestones aquifer.

AQUIFER CHARACTERISTICS

The Carboniferous limestones aquifer is composed by two rock layers: the Visean (limestones and dolomites) and the Tournaisian (limestones, dolomites and shales), representing the lower parts of the Carboniferous era. The higher part of the aquifer, with an approximate thickness of 30 - 130 m, is very productive and generally considered as a karstified zone. The study area is 120 km long, from the west

of Lille (Fr) to the east of Ath (Be), and 30 km wide on both sides of the administrative boundary (Youssof, 1973).

Recharge areas are located on the eastern part of the aquifer, in Belgium, where limestones laid under a few meters thick soil (unsaturated zone). Slightly dipping toward south - west, the geometry of the aquifer is not accurately known due to the number of east - west faults and the presence of an faulted anticline near Tournai (Be). Therefore, groundwater is mainly considered as confined in the west part of the study area, due to the impermeable cover by clayey layers (Secondary and Tertiary, depending on location). Nevertheless, some previous studies tended to prove that direct flow connections may exist between surface water and the Carboniferous aquifer (Mania, 1974).

A lot of studies have been carried in the past regarding aquifer geometry and groundwater flows (Talbot *et al*., 1979). And tries of mathematical modelling (Mania, 1974 and 1976) suggested that spatial data density (transmissivity, piezometrical level, pumping volume…) was too weak to have confidence in modelling results. One scope of these works was to create management rules for water supply in Lille (Besbes and Talbot, 1983), even if some areas of the Carboniferous aquifer are not well known (Fig. 3).

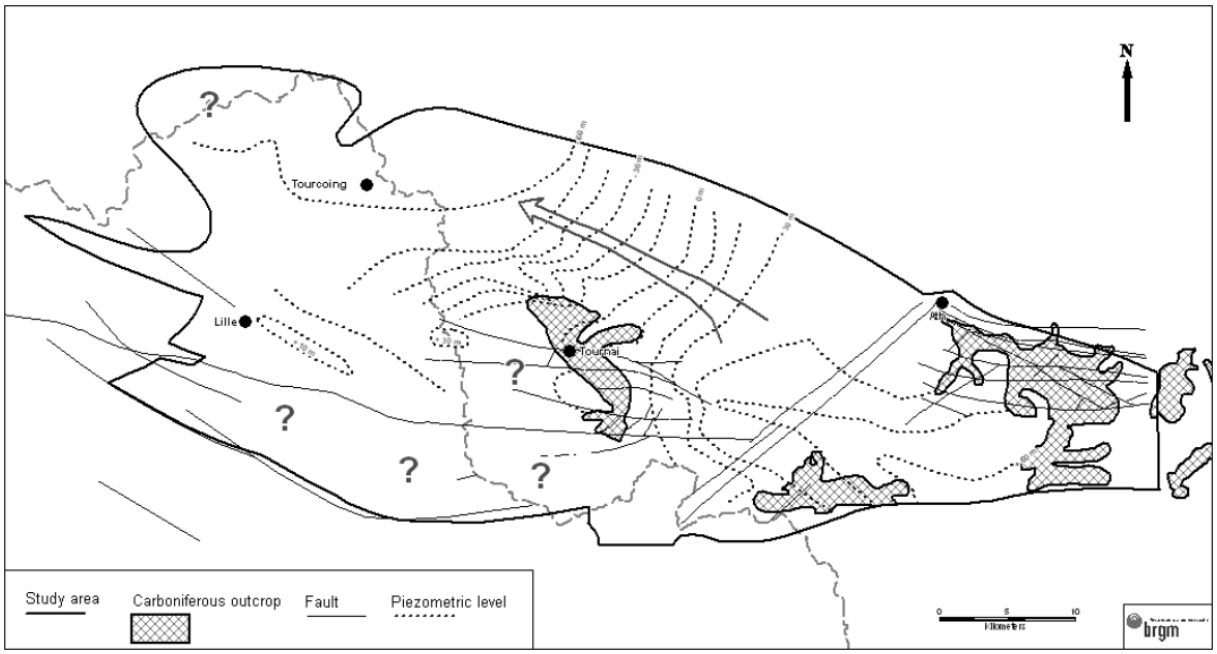

Figure 3: Map showing global groundwater flow and uncertainty areas (data from a piezometrical campaign in 2006).

SCALDWIN PROJECT

This international project, established in 2009, has two main goals. First, it should encourage and stimulate international cooperation at large scale: studies and methods standardisation, data transfer and sharing, building of geological and hydrogeological referentials. Then, further studies could help to reduce scientific uncertainties about the Carboniferous aquifer: more accurate geometry, extension of piezometrical maps, hydrochemical and isotopic characterization of groundwater…

Thanks to the next field campaigns, all the past results and assumptions will be compared with geological and hydrogeological data from new boreholes drilled in different parts of the study area. All the contributors are expecting to be able to generate a conceptual model of the aquifer behaviour, to build a numerical model, and eventually to modelize transfer functions between surface water and groundwater, in order to organize a sustainable management of the Carboniferous aquifer between France and Belgium.

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