Reviewing the criteria for the sustainable management of the Carboniferous Limestone Aquifer at the Belgium-France border

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ABSTRACT

In Western Belgium qualitative good groundwater is poor. The Carboniferous Limestone Aquifer which is occurring in the southwest of Belgium and northern France is a very important reservoir of groundwater for the whole region. The aquifer has been exploited strongly by industry and drinking water supplies in both France and Belgium. The intensive use combined with poor feeding induced a continuous water level drawdown since the beginning of the 20th century, except for the war periods and a brief period after the `Kain incident'. In 1977, a part of the bank of the Scheldt River collapsed. This had a temporary very negative impact on the water quality in several abstraction wells when the rising water washed oxidized sand. In 1997, a reduction plan for the exploitation of the Carboniferous Limestone between Flanders and Wallonia was accepted: 'the Transhennuyère-agreement'. In consequence of the rigorous compliance of the agreement, in combination with decreasing water abstraction in France, it was possible to stabilize the water level in the beginning of the 21th century. Since 2007 after the last reduction step of 'the Transhennuyère-agreement' water levels increased strongly. As after the Kain-incident, a negative influence on the water quality in different wells now occurs. This case shows that a sound balance between piezometric level, quality and abstraction should be the target of the aquifer management. The quasi-permanent consultations between technicians of both Regions ensure that these matters can be discussed and that experience and knowledge can be exchanged. With the French stakeholders there is consultation in a broader context within the framework of the International Scheldt Commission. The new ongoing Scaldwin modelling project could be an important trigger for deepening the collaboration. One can conclude that continuous monitoring and re-evaluation of the impact of policy decisions is necessary. Protecting the quality and quantity of the strategic groundwater reserve is vital in a period of fast climate change and ambitious ecologic objectives.

Key words: transboundary aquifer, confined aquifer, water table rise, quality deterioration, monitoring

1. INTRODUCTION

The Flemish water supply company (VMW) is the biggest drinking water company in Flanders (northern Belgium). Each of the regions in Belgium has its own water authority and water supply companies.

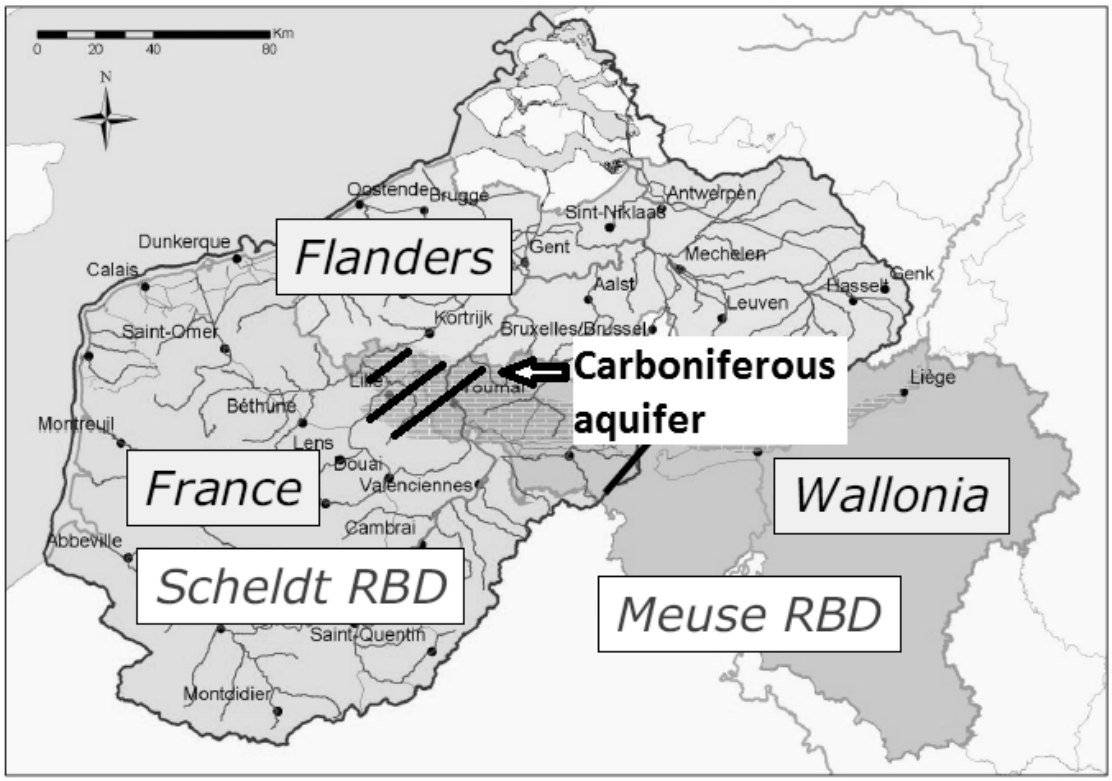
Also in the southern part of the province of West-Flanders VMW is responsible for the water supply. In Western Belgium qualitative good ground- and surface water is poor. Except for the Carboniferous limestone aquifer. This aquifer extends only in the extreme southern part of West-Flanders, but also in Wallonia and France (Fig. 1). In the beginning of the realization of the water supply network in the Flemish region the Carboniferous aquifer was the main source. Therefore water catchments in Pecq and Saint-Léger (Wallonia) and in Flanders (Spiere-Helkijn) were built. For water supply and industry in Wallonia also several catchments are being exploited. In France the water supply of the city of Lille depends partly on this aquifer. Also industry, as textile industry near Roubaix, were very important users. This increasing demand in the 20th century lead to fast decreasing water levels in the confined part of the aquifer. In the second period of last century the decline was dramatic (2 meters/year).

Since the beginning of the 21st century water levels stabilised and now there is an important increase of the levels. This for several reasons. In France the textile industry is no longer an important player. The water supply in France can also count on surface water and on an important aquifer in the Cray layers. In Belgium an interregional agreement (Transhennuyère-agreement) was established for rehabilitation of the aquifer. In this agreement VMW and Walloon water companies are forced to reduce their pumping rates on yearly basis in the confined part of the aquifer. The deficit is delivered by a new duct with water originating from the unconfined part of the aquifer in Wallonia and with surface water from a new modern water factory near

Harelbeke (Flanders). The follow-up of the agreement in Belgium is in practice ensured by a technical working group who reunites on a regular basis.

For the European Water Framework Directive the aquifer is the subject of 3 water basin management plans; one for Wallonia, one for France and one for Flanders. The overall objective is to achieve a good quantitative and chemical status of the water bodies by 2015. According to the declaration of Ghent the partners work together in the International Commission of the Scheldt in view to harmonize the plans.

Figure 1. Location of the confined part of the Carboniferous Limestone aquifer on the Belgium-France border and on the Flanders-Wallonian regional border (adapted from Ph. Meus, 2007)



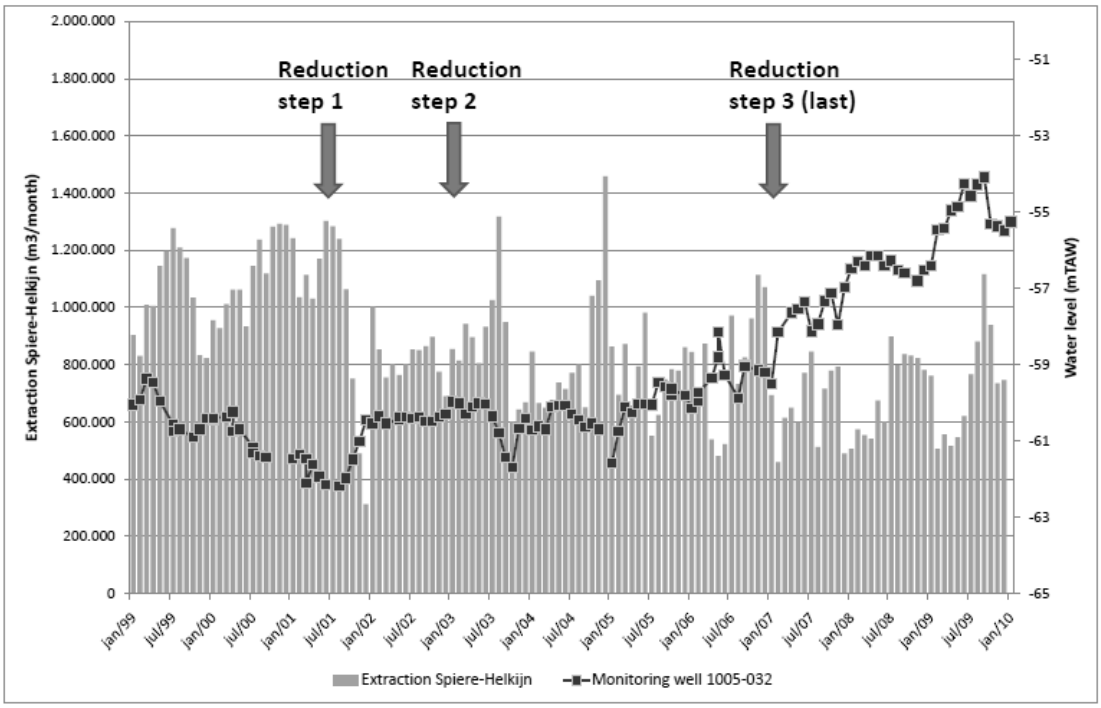
2. OBJECTIVES

Exceptions on the decreasing water level trend in last century were the war years and a sudden rise in 1977. This last rise over the complete surface of the confined part was induced by a collapse of the river Scheldt bottom near Kain (Belgium, Wallonia). The collapse was due to instability in the Carboniferous aquifer induced by the drainage. Immediately after the incident a sudden spectacular quality deterioration took place in several production wells. The phenomenon that is the cornerstone of the quality deterioration is the occurrence of sand with pyrite in and on top of the aquifer. This layer was oxidized when the water level in the Carboniferous decreased. When the level rose suddenly at the time of the Kain incident a portion of the oxidized layer was rinsed. With the experience of the 70s in mind one has built in several safeguards in the Transhennuyère-agreement in case of quality deterioration. The abstraction quota were determined at the time by a compromise between different model results. Because of the degree of uncertainty a flexible process was incorporated to adjust when the increase would go too fast and would lead to quality problems. After the last quotum – decrease step of the agreement in 2007 several quality problems were detected that were very similar to the observations of the 70s. So the time had come to investigate the relations between water level increase, quality and pumping rates.

3. RESULTS

Figure 2 shows the water level changes in relation to the reduction steps and the actual pumping rates for the Spiere-Helkijn well field. One can see that the reduction steps had important influence on the water levels. Since the last reduction step of 2007 the rise in levels developed very fast.

Figure 2. Relation extraction – water level at the Spiere-Helkijn well field (1999 – 2010)



In the spring of 2007 the first problems occurred on production well 1005-004. A sudden rise in heavy metal and magnesium concentrations caused problems for meeting the drinking water standards at the water plant of Kooigem. In the case of this well the pyrite sands form a relatively thick layer on top of the aquifer (Fig. 3). After the last reduction in 2007 the rising water level reached the oxidised layer. After this observation the phenomenon on the well was studied more intensively (Fig. 4). One can see a positive correlation between the water level and the sulphate concentration, in particular in the beginning of the observations when the well worked intermittent. Later when the well was pumped continuously on a smoother rate the concentrations remained more constant.

In 2008 the drinking water treatment for manganese in the water plant of Saint-Léger became problematic. In several wells the concentrations reached high peaks. In the well 1006-014 (Fig. 5) manganese levels were more or less stable until 2007. Since 2007 very high peaks in manganese occur related to the higher rise of the water levels and discontinuous pumping. In the situation of this well the pyrite sands are fallen into the karstic aquifer.

The examples above show the 2 most extreme observations. Several other wells have similar problems on a lower level, for some wells one can expect problems in the future. In some wells there are no problems, nor to be expected (for example no pyrite sands present).

Figure 3. Sulphate concentration in relation to the water level rise and the occurence of pyrite sands (extraction well 1005-004, Spiere-Helkijn well field)

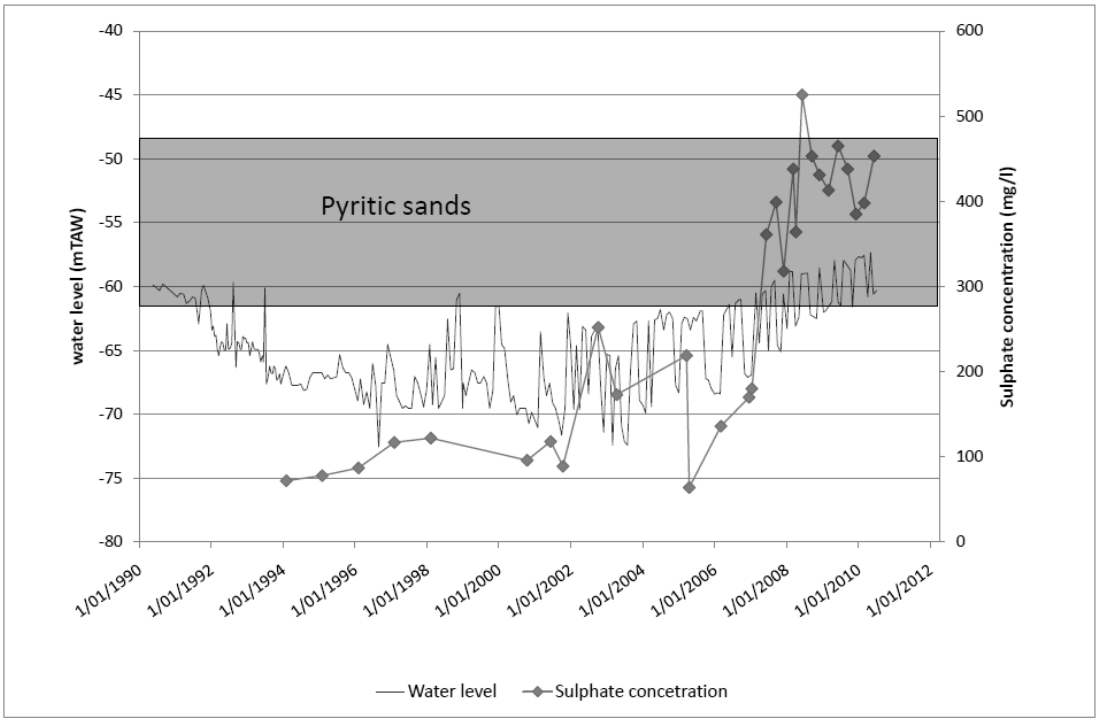


Figure 4. Detailed relation in between water level change and sulphate concentration (extraction well 1005-004, Spiere-Helkijn well field)

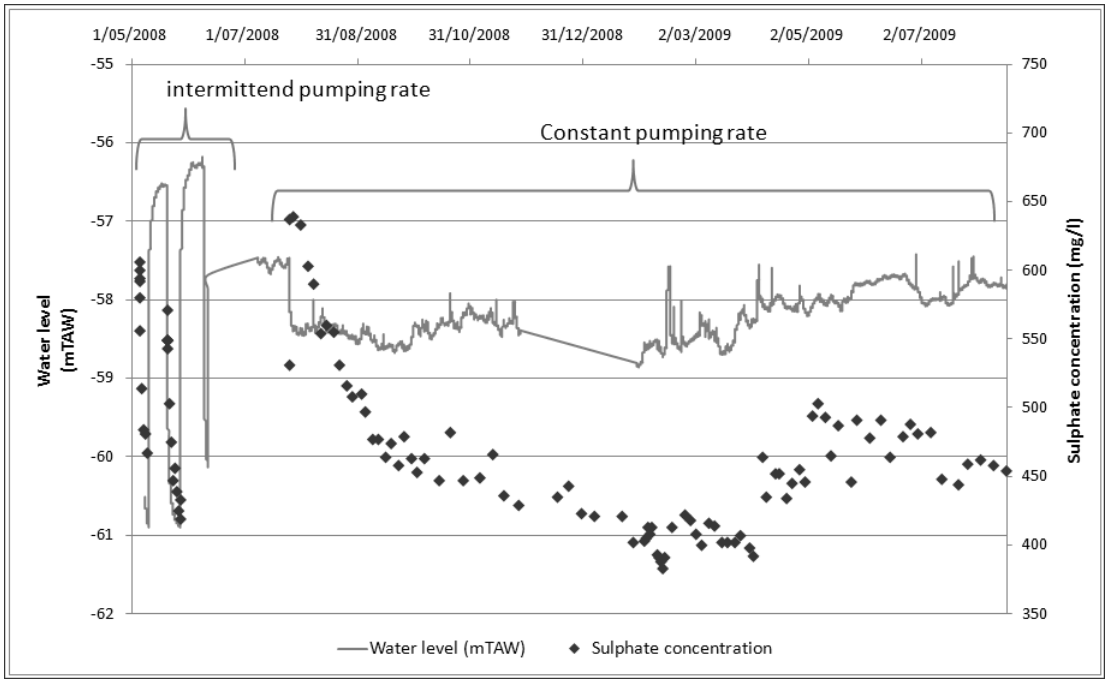
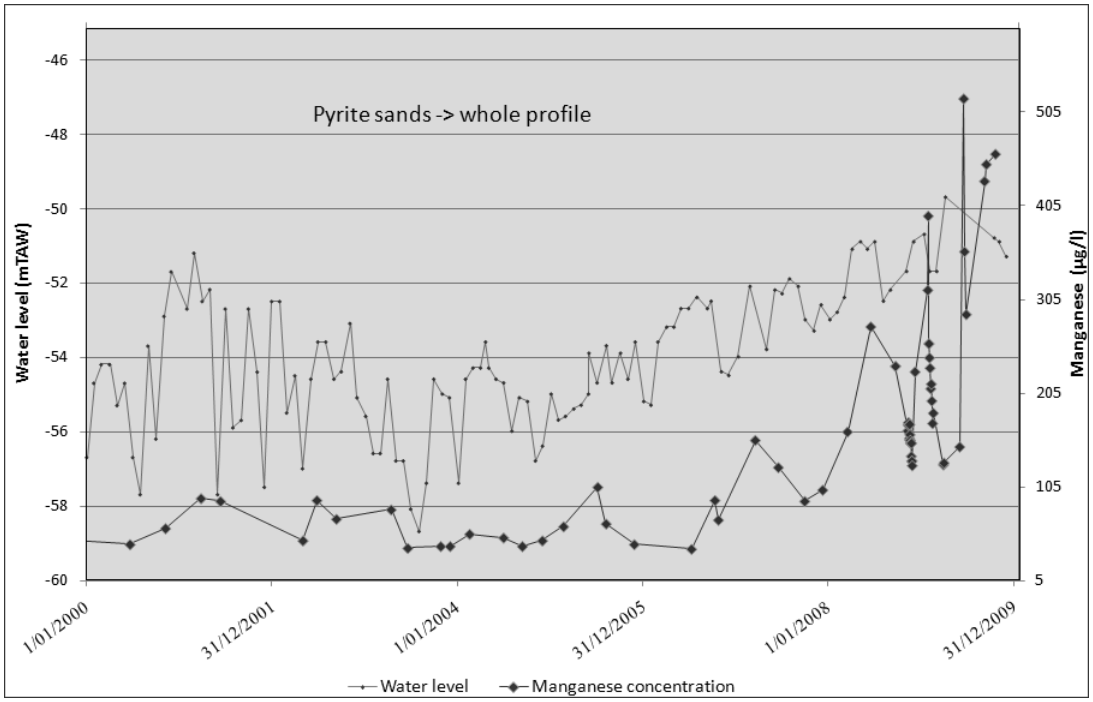


Figure 5. Relation in between water level and manganese concentration (extraction well 1006-014, Pecq – Saint-Léger well field)



4. DISCUSSION

One can conclude that for controlling the quality the actual rise is to steep. Another observation is the correlation between level dynamics and concentrations. To meet the quota at the end of the year it is necessary to built up reserves in the first months of the year in view of the climatologic unpredictable summer period. In the actual situation it is not possible to achieve a more or less stable rate during the year. In the working group of the Transhennuyère-agreement minds converge in the direction of a limited adjustment in order to establish a preferable stable smooth rise in order to meet the goals of the water authorities as to meet the interests of drinking water companies.

5. CONCLUSIONS

In the current situation several wells in the Carboniferous aquifer show phenomena of important quality deterioration . It was shown that with a more or less continuous pumping rate and a steady increase in water levels quality can be held more stable. The evolution of level and quality in the present context means that a level and quality driven management layer is the appropriate way for managing the aquifer. The almost continuous monitoring and evaluation of data is an absolute necessity in such a context. When the Transhennuyère-agreement had not taken into account level and quality evolutions much time would be lost. Moreover, the quasi-permanent consultations between technicians of both Regions ensure that these matters can be discussed and experience and knowledge can be exchanged. Fine-tuning of the agreement can be achieved in a sound manner. The ambition should be consultations with the French stakeholders in a similar way. Now there is already in a broader context consultation within the framework of the International Scheldt Commission. The new ongoing Scaldwin modeling project could be an important trigger for deepening. With regular transnational consultation and exchange of experience and knowledge one can quickly take effective action for achieving a sound and sustainable management of transboundary layers.

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