Groundwater management of large aquifers in southwestern France by regional hydrodynamic models

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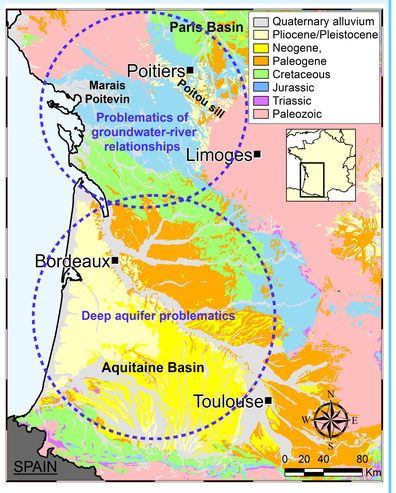
In southwestern France, groundwater resources are withdrawn for various uses like drinkable water, irrigation, industry, geothermal energy, forestry, conservation of wetlands, shellfish breeding and much more can sometimes cause conflicts between users. To help the management of these resources regional hydrodynamic models have been developed. These models have been a support to the public policies for over 20 years.

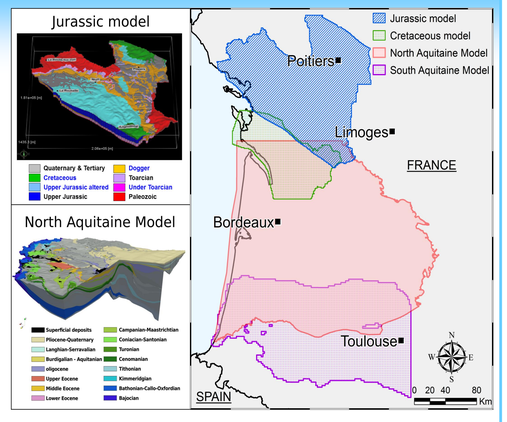
The Context

The study area is located in southwestern France on two basins, the Aquitaine and Paris basins, separated by the Poitou sill. In the northern region, groundwater is in close relation with rivers especially during periods of low-water levels. Indeed, groundwater used for irrigation impacts not only the stream flows but also the water supply for the second largest wetland of France: the Marais Poitevin. Further south, the major problem is the important level reduction of some deep aquifers in the department of Gironde under Bordeaux metropolis. The extreme southern region has a significant particularity where, on two different sites, groundwater is used for the storage of gas.



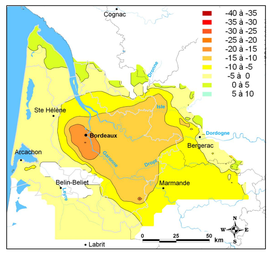
The regional models

To respond to the different problematics, 4 regional models have been developed with the funding of the Aquitaine and Poitou-Charentes regions as well as the Adour-Garonne and Loire-Bretagne water agencies. These models cover a total area of 82,570 km², from north to south: Jurassic model [a,b], Cretaceous model [c], North Aquitaine Model [e] and South Aquitaine Model[d].

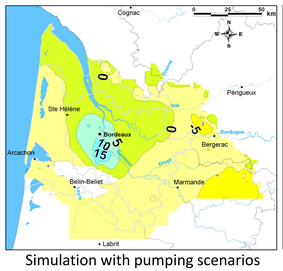


Sustainable management of deep aquifers for drinking water supply

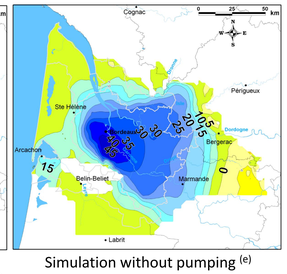
Authorities are facing long-term groundwater declines due to excessive pumping in the Eocene aquifer. Groundwater over exploitation has also induced local dewatering of the Oligocene aquifer. In this area, the regional hydrodynamic model has been developed since 1990 to guide the management of deep groundwater resources and to validate strategies of exploitation based on different simulations. This model also allows to answer problems of overexploitation, to analyze the impacts of water saving policies during exploitation and to estimate the impacts of new well fields in order to have better distribution of withdrawal on the territory.



Simulation with current pumping trend [e]



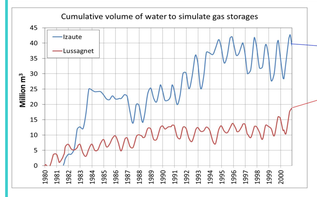
Simulation with pumping scenarios (pumping in others areas / aquifers) [e]



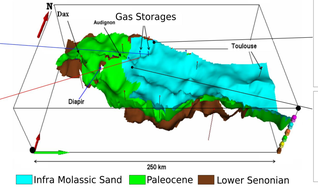
Simulation without pumping [e]

Gas storage and water management

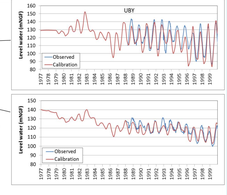
The cyclic injection and withdrawal of gas impacts significantly the aquifer level in the extreme southern region. In this case, the suggested model is adapted for the knowledge of groundwater resource and its management. To simulate the gas storages the adopted solution was to inject in the model an equivalent volume of water.



Equivalent volume of water injected [d]



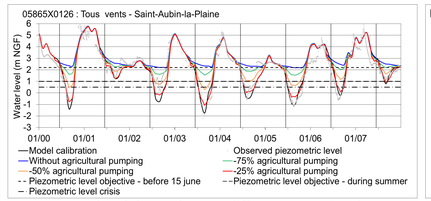
South Aquitaine model [d]



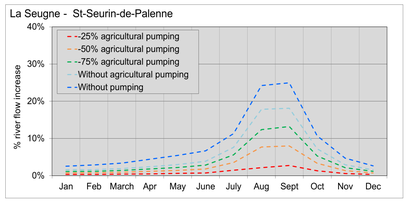
Model Calibration [d]

Groundwater, irrigation and groundwater-river relationships

The developed models allowed to test the impacts of several scenarios concerning water withdrawals. These tests help to determinate the amount of water that can be pumped to respect defined objectives of water levels in piezometers and river flows. These models were also used to test the impacts of the eventual implementation of water tanks (400,000 to 800,000 m³ by tank).



Water level depending on different pumping down scenario and objective level - Jurassic model [b]



Flow increase versus lower pumping - Interannual monthly average of 2000-2008 – Cretaceous model [c]

Synthesis

Developed during many years, these models are usually used to support the authorities in water resource management. Note that these models were also used at a national level in the researches on the consequences of climate change. Eventually, local models have been developed from these regional models to deal with specific issues within the research of alternative resources, local problematic on nitrate transfers or as a basis for prospective studies in geothermal energy.

References

(a) Douez O., 2015. Actualisation 2008-2011 du modèle maillé des aquifères du Jurassique en Poitou-Charentes. Rapport final. BRGM/RP-64816-FR. 161 p., 223 ill., 4 ann.

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(d) Seguin, J-J. (2003) - Outil de gestion des aquifères du Sud du Bassin Adour-Garonne – Année 4. Calage du modèle hydrodynamique en régime transitoire - BRGM/RP-52041-FR, 80 p.

(e) Saltel M. et Pedron N. (2012) - Contribution à la révision du SAGE Nappes Profondes de Gironde : Utilisation du Modèle Nord-Aquitain - phase « Tendances et Scénarios » -Rapport final, BRGM/RP-60416-FR, 58 p., 24 fig., 5 ann.

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