Hydrological modelling of the EU Nitrates Directives Actions Programme: new developments in the Walloon Region (Belgium)

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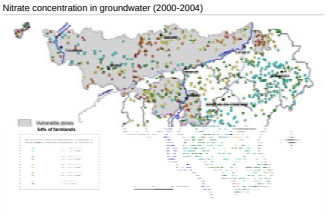
Context



Wallonia (Southern Region of Belgium) implemented the Nitrates Directive through a first actions plan in 2002 followed by a second action plan in 2007. It designated vulnerable zones and introduced various mandatory practices in order to reduce the nitrate contamination risk. At the same time, the government decided to fund non mandatory practices focused on agro-environment. Some of these (like buffer strips) should also be useful in nutrient mitigation.

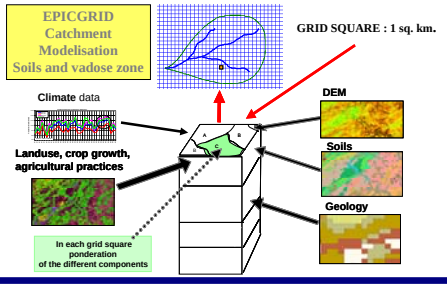
In Wallonia, nitrate-related problems are obvious in several groundwater bodies and their trends over the past 30 years are worrying. The main part of the contamination level is due to agricultural diffuse pollution. Nevertheless, some pollution peaks are observed mainly coming from domestic sewage.

EPICgrid model

In order to assess the global effectiveness of all the mitigation practices, we have been developing a hydrological model spatially distributed using a 1km² grid cell on the whole Region (16 900 km²).

This model is an EPIC derived software (Williams, 1995). Once coupled with a geographical information system, and linked with the data bases (so as soil, geology, land use, agricultural practices, DTM), EPICgrid becomes a regional modeling software (Sohier et al., 2009). Within each cell of 1km², it identifies consistent hydrological units and calculates water and nutrient flows and balances.

The EPICgrid model represents the root zone and the vadose zone. In Wallonia, groundwater tables are more than 30 m deep in 8% of the territory. It is therefore of major importance to fill the gap between the root zone and the groundwater bodies.

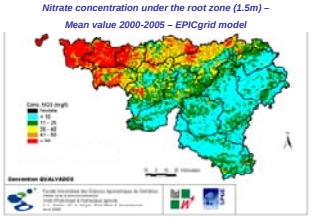


Exemples of EPICgrid model results

▪ Maps of nitrate concentration in water

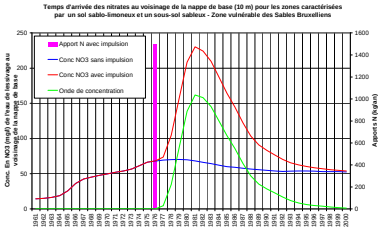
EPICgrid permits to calculate the water and nutrient flows under actual conditions as well as under different scenarios (climate change, modified agricultural practices,...). As an example, the Figure below presents the actual nitrate concentration of leaching water under the root zone (1,5m) at the regional scale (mean value 2001-2005). This nitrogen, lost for crop uptake, is an major pressure indicator for nitrogen management. One can see that the North and particularly the North-West of the Walloon Region presents the higher pressure level concerning nitrate leaching. This region is mainly dedicated to intensive crop productions.

Nitrate concentration under the root zone (1.5m) – Mean value 2000-2005 – EPICgrid model

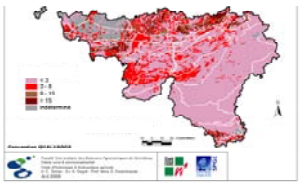


▪ Transfert time of nitrate from surface to groundwater

The EPICgrid model permits also to assess the mean nitrate transfer delay from the root zone to the groundwater table. The methodology used is to virtually apply an nitrogen's impulse in 1976, all else being equal, and to observe the wave transferred at the bottom of each grid cell (example of the left Figure). The time between impulse and maximum concentration of the wave at groundwater level is showed in the right Figure for the whole region. In a few zones, the delay exceeds 15 years. This means that 15 years are needed for a new cropping practice to influence the groundwater recharge quality.

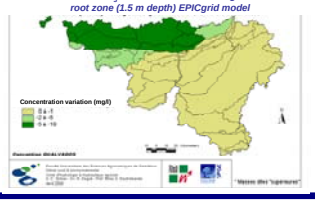


Lag time (years) for NO_3 transfer to groundwater



Modelling of the EU Nitrates Directive Actions Programme

PGDA2 's effect on NO_3 concentration in leaching water under the root zone (1.5 m depth) EPICgrid model



The model can also be used to evaluate the mitigation measures' effect in time, space and amplitude.

The effect of the second Action programme in Walloon Region on nutrients flows' trends at the 2015 horizon was evaluated with the EPICgrid model . The impact on groundwater recharge quality varies between the North of the Region which is covered by crop production largely concerned by the mitigation measures and the southern part where the mitigation measures do not largely impact the agricultural practices. The action plan is useful where the need is the more important. The reduction's amplitude stay quite low.

Perspectives

The EPICgrid model is currently developed to take into account some new mitigation measures aiming at water quality improvement (agro-environnemental measures and buffer strips).

Acknowledgements

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References :
Williams J.R. (1995). The EPIC model. In : Singh V.P., ed., Computer models of watershed hydrology. Pages 909-1000.
Sohier C., Degré A., Dautrebande S. (2009). From root zone modelling to regional forecasting of nitrate concentration in recharge flows – The case of the Walloon Region (Belgium). Journal of Hydrology, Volume 369, Issues 3-4, 15 May 2009, Pages 350-359.