



## **Biogeochemistry of greenhouse gases in groundwater under agricultural area (the Geer catchment, Belgium)**

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The rising concern regarding global climate change caused by the surge of the atmospheric concentrations of GHGs observed during the last century (IPCC AR4 FAQ, 2007) have promoted the scientific interest towards the study of global GHGs cycles. Contributing to these research efforts, several recent studies have suggested that groundwater systems might be significant sources of GHGs emissions occurring at the surface water-atmosphere interface (Organisation of Economic Co-operation and Development, 2009; Jahangir et al., 2012; Jurado et al., 2017). However, the transfer of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in the subsurface are still poorly characterized due to the insufficient insight into kinetics and controls of processes regulating their production, transport and consumption. Our study attempts to enrich the evidence about the subsurface processes that control GHGs dynamics, focusing on the exploration of groundwater systems in agricultural areas which are often considered as the “hotspots” of GHGs evasion (Smith, 2010). Research activities are conducted in the chalk aquifer of the Geer catchment in Belgium (the area of the basin 480 km<sup>2</sup>), where previous studies have suggested pronounced impact on groundwater chemistry of intensive agricultural activities prevailing in this basin (Brouyère et al., 2004). Here, results of stable isotope analyses of NO<sub>3</sub><sup>-</sup>, N<sub>2</sub>O, SO<sub>4</sub><sup>2-</sup>, B, DOC and <sup>3</sup>H along with the hydrogeochemical data are employed in order to identify the sources of GHGs and their production/consumption processes along lateral and vertical scales of the studied aquifer. In particular, correlation analysis of groundwater chemical parameters, examination of their distribution maps, study of isotopic signals of compounds of interest and analysis of isotopomer maps of N<sub>2</sub>O help to elucidate the causes of occurrence of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in the subsurface. Such analyses help to obtain valuable information regarding dynamics of GHGs in groundwater systems and their controls.

IPCC AR4 FAQ, (2007). Frequently Asked Questions. 8.

Jahangir, M. M., Johnston, P., Khalil, M. I., Hennessy, D., Humphreys, J., Fenton, O., & Richards, K. G. (2012). Groundwater: A pathway for terrestrial C and N losses and indirect greenhouse gas emissions. *Agriculture, ecosystems & environment*, 159, 40-48.

Jurado, A., Borges, A. V., Pujades, E., Hakoun, V., Otten, J., Knöller, K., & Brouyère, S. (2018). Occurrence of greenhouse gases in the aquifers of the Walloon Region (Belgium). *Science of The Total Environment*.

Organisation of Economic Co-operation and Development. (2009). *OECD environmental performance reviews of Ireland, conclusions and recommendations* (pp. 2–18). Paris: Organisation of Economic Co-operation and Development.

Brouyère, S., Dassargues, A., & Hallet, V. (2004). Migration of contaminants through the unsaturated zone overlying the Hesbaye chalky aquifer in Belgium: a field investigation. *Journal of Contaminant Hydrology*, 72(1), 135-164.

Smith, K. A. (Ed.). (2010). *Nitrous oxide and climate change*. Earthscan.