

# APSUGIS : A GIS-BASED INTERFACE FOR GROUNDWATER VULNERABILITY ASSESSMENT AND RISK MAPPING

Caroline Thomas<sup>1</sup>, Fabien Dollé<sup>1</sup>, Philippe Orban<sup>1</sup>, Ileana Cristina Popescu<sup>2</sup>, Patrick Engels<sup>3</sup>, Alain Dassargues<sup>1</sup>, Serge Brouyère<sup>1</sup>

<sup>1</sup>Urban & Environmental Engineering Department, Hydrogeology & Environmental Geology, B-52/3, Liège University, B-4000 Liège, Belgium

<sup>2</sup>Groundwater Direction, Water Division, DGO3, Walloon Region, Belgium

<sup>3</sup>GIS cell, Environmental State Direction, DMNA, DGO3, Walloon Region, Belgium

The Apsû method was developed to produce groundwater intrinsic and specific vulnerability maps based on a quantitative description of contaminant transport processes in the subsurface. It is based on the source-pathway-receptor approach, driven by two concepts: land surface danger that accounts for lateral flow on land surface and infiltration and subsurface attenuation capacity. Vulnerability classes are based on physically-based criteria reflecting the sensitivity of groundwater to pollution events, namely contaminant travel time across the unsaturated zone, pollution duration, or contaminant concentration or mass recovery factors at the groundwater table.

To facilitate the application of the Apsû method to case studies, GIS-based applications and interfaces have been developed to integrate geodatabases and user interfaces in the same environment software. The main geodatabase contains all the data required for the calculation of the vulnerability coefficient, such as spatial data (topography, land cover, hydrological network, meteorology, soil types...) and specific databases on contaminant properties (i.e. Koc values, degradation constants...), on hydrogeological properties of geological layers constituting the unsaturated zone flow path. Specific user interfaces have been developed to prepare and export spatial data required by the Apsû calculations. Once the groundwater vulnerability factors are calculated, another user interface is available to automatically create and customize different thematic layers related to groundwater vulnerability mapping. This integrated system makes it possible to automate numerous data formatting geoprocessing operations, and to ensure data integrity by minimizing user interactions with the data (spatial frame, data projection, link between spatial data and databases, etc.) and to focus work on the specificities of the areas studied and the interpretation of the vulnerability maps created.

The GIS-based interface has been used to produce groundwater vulnerability maps for the main aquifers of the Walloon Region of Belgium, as a support to the implementation of the EU Water Framework and Groundwater Directives. They will also serve as a basis for aquifer and groundwater contracts that aim at implementing land management measures to improve the quality of groundwater in groundwater protected areas and safeguard zones. Results will also be presented on the combination of the groundwater vulnerability maps and hazard maps to produce groundwater pollution risk assessment maps for a chalk aquifer in Belgium.

## References:

- Beaujean J, Lemieux J.M., Gardin N., Dassargues A., Therrien R. and Brouyère S., 2013, Physically-based groundwater vulnerability assessment using sensitivity analysis methods, *Groundwater*, 52(6), pp. 864-874.
- Brouyère S., Jeannin P.Y., Dassargues A., Golscheider N., Popescu I.C., Sauter M., Vadillo I., Zwahlen F., 2001, Evaluation and validation of vulnerability concepts using a physically based approach, Proc. of the 7th Conf. on Limestone Hydrology and Fissured Media, J. Mudry & F. Zwahlen (Eds.), Sciences et Techniques de l'Environnement, Université de Franche-Comté, Mémoire n°13, pp. 67-72.
- Dassargues, A., Popescu, I.C., Beaujean, J., Lemieux, J.M. and Brouyère, S., 2009, Reframing groundwater vulnerability assessment for a better understanding between decision makers and hydrogeologists, In: *The Role of Hydrology in Water Resources Management* (Proc. of IAHS - IHP2008) Eds. H.J. Liebscher, R. Clarke, J. Rodda, G. Schultz, A. Schumann, L. Ubertini & G. Young, Capri, 13-16 October 2008, IAHS Press, Publ. n°327, pp. 278-284.
- Popescu, C., Brouyère, S. and A. Dassargues, 2019. The APSÛ method for process-based groundwater vulnerability assessment. *Hydrogeology Journal* (published online) <http://dx.doi.org/10.1007/s10040-019-02013-z>
- Popescu, I.C., Gardin, N., Brouyère, S. and Dassargues, A., 2008, Groundwater vulnerability assessment using physically based modelling: from challenges to pragmatic solutions, in *Calibration and Reliability in Groundwater Modelling: Credibility in Modelling* (Refsgaard J.C., Kovar, K., Haarder, E. & Nygaard E. Eds) IAHS Publ. 320, pp. 83-88.

**Contact Information:** Last Author, Urban & Environmental Engineering Department, Hydrogeology & Environmental Geology, B-52/3, Liège University, B-4000 Liège, Belgium, Email: [serge.brouyere@uliege.be](mailto:serge.brouyere@uliege.be)