APSÛ-GIS : A Gis-Based Interface For Groundwater Vulnerability Assessment and Risk Mapping

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PARTNER

Convention between Hydrogeology and Environmental Geology (Liege University) and Walloon Region

2004: development of the method and application to a small area (Néblon basin)

2016-2019 : adaptation of the method and application to the entire Walloon Region

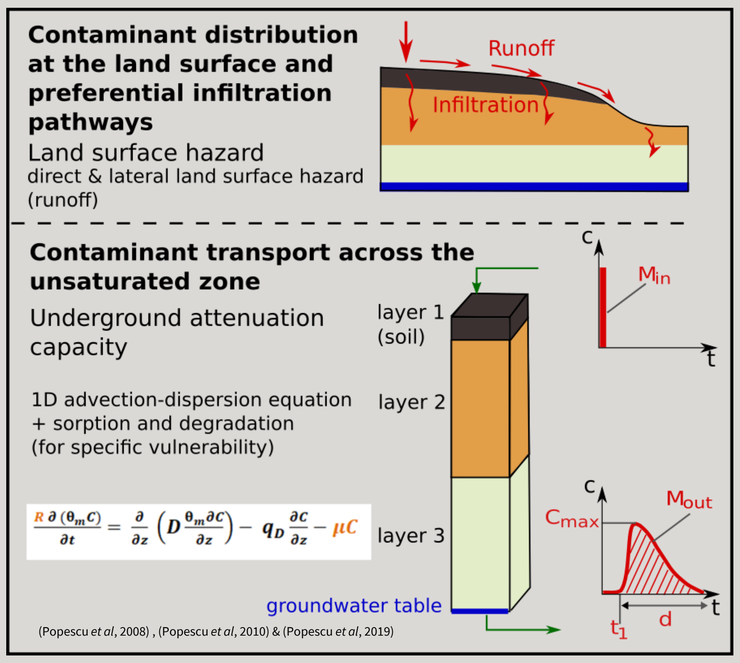
OVERVIEW

A GIS tool based on the APSÛ methodology was developed for mapping groundwater intrinsic and specific vulnerability.

This decision support tool is designed for groundwater resource managers to determine the areas most sensitive to a polluting incident.

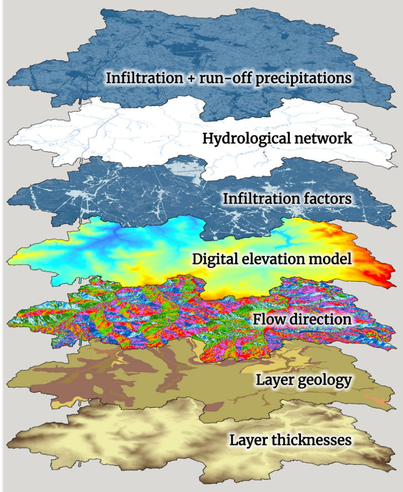
1. THE APSÛ METHOD

The APSÛ method is 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 hazard and subsurface attenuation capacity.



Vulnerability classes are based on process-based criteria reflecting the sensitivity of groundwater to pollution events, namely contaminant travel time across the unsaturated zone (t_1), pollution duration (d), or contaminant concentration (C_{max}) or relative quantity of pollutant (M_{out}/M_{in})at the groundwater table.

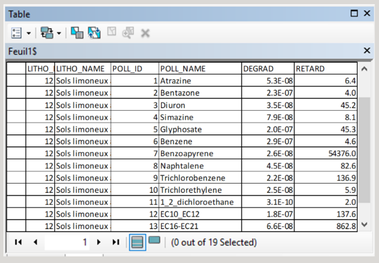
2. GIS SYSTEM



Input spatial data required

The GIS tool provides spatial and tabular data management, as well as user-defined options for creating vulnerability maps. Custom toolboxes have been developed to automate many geoprocessing operations and to guide the user on how to use the functions. Two databases are also integrated to define the hydrogeological properties of materials and the physicochemical properties of pollutants.

To apply the APSÛ method, a GIS-based tool under ArcGIS software has been developed: The GIS-tool embeds all the data within a same software environment, to ensure integrity and compliance of the input data and the vulnerability maps produced with APSÛ method.



Database properties of pollutants

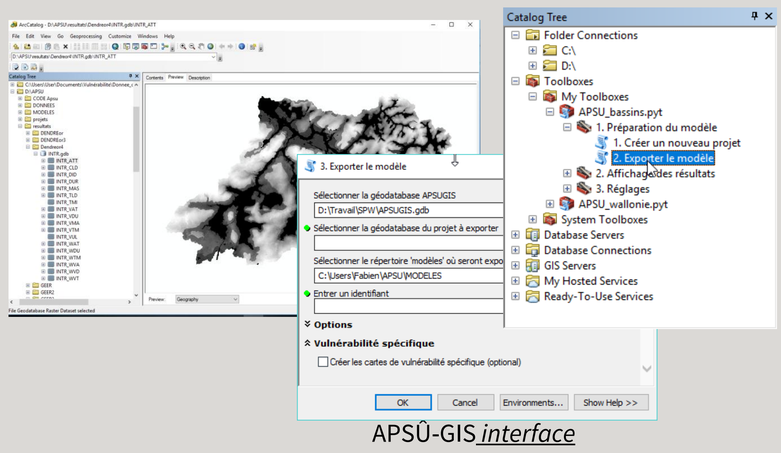
GIS tool :

- ❑ simplify the compilation
- ❑ same format (spatial reference, resolution, mesh size, etc.)

3. APSÛ-GIS STRUCTURE & INTERFACE TOOL

APSÛ-GIS is structured around 4 main steps, each assisted by specific tools to facilitate its treatment.

- ❑ collecting the spatial data required by APSÛ, and formatting them to be used by the tool.
- ❑ prepare specific data for the study area, such as preferential infiltration points, hydrogeological properties of the lithologies encountered, etc.
- ❑ run the code computation outside the GIS software in order to avoid locking a license during the process. This structure also makes it possible to use the APSÛ computation code with any GIS software, including freeware, such as QGIS.
- ❑ importing the vulnerability maps created by the computation code into the GIS system



APSÛ-GIS *interface*

4. RESULTS

With the APSÛ-GIS tool several thematic maps are produced :

- ❑ land surface hazard,
- ❑ maps of attenuation capacity : travel time, pollution duration, contaminant concentration or mass recovery,
- ❑ maps that cross land surface hazard and attenuation,
- ❑ the user can also create a map by weighting different criteria.

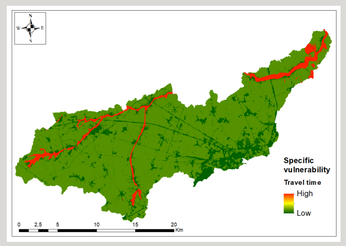
Data can be presented in raw or classified ways. The user can choose the symbology he considers most appropriate and choose these own interval classes according to this case study.

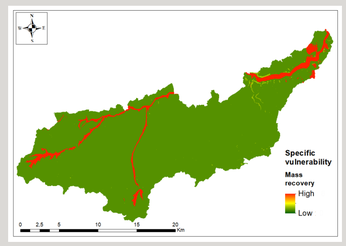
For intrinsic vulnerability, the most important criterion seems to be transfer time. For the specific vulnerability, it is important to represent the travel time and the mass recovery.

These vulnerability maps can be used with land use maps (industrial sites, agricultural parcels, etc.) and hazard maps to produce risk maps.

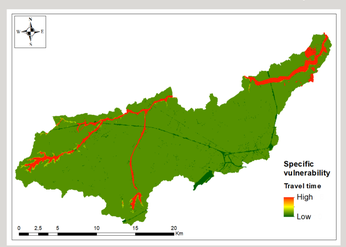
Case study : specific vulnerability of the Geer basin

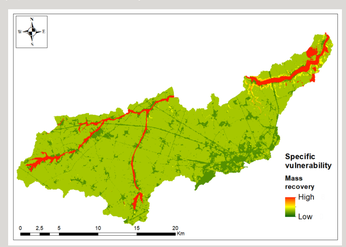
Glyphosate (R=45 ; $\mu = 2.10^{-7}s^{-1}$)



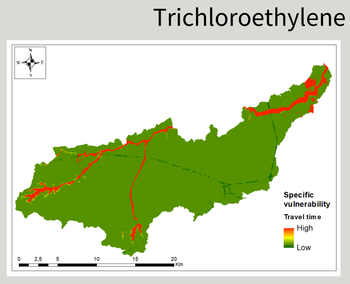


Atrazine (R=6.5 ; $\mu = 5.10^{-8}s^{-1}$)

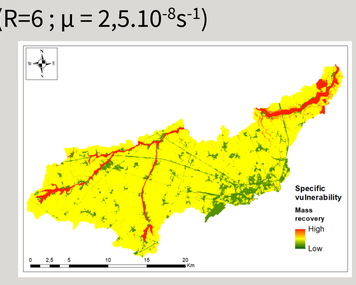




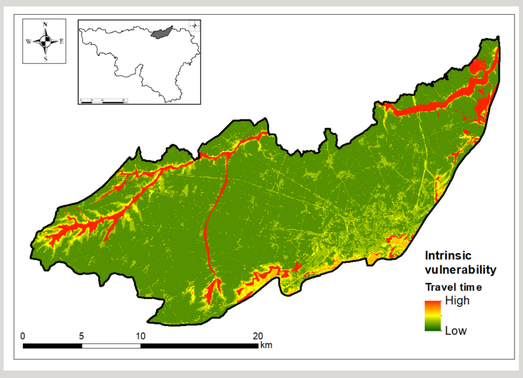
Trichloroethylene (R=6 ; $\mu = 2,5.10^{-8}s^{-1}$)



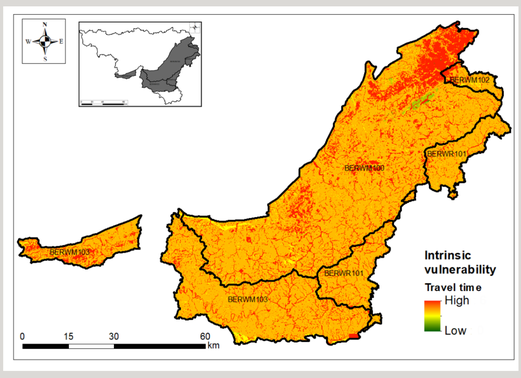
Travel time



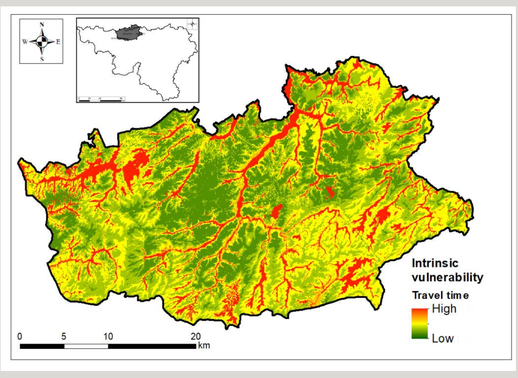
Mass recovery



Chalk aquifer of the Geer basin (RWM040)
Intrinsic vulnerability : travel time
Low vulnerability because aquifer protected by a thick layer of silt



Sandstones and schists of the Ardenne massif (RWM100, RWM102, RWM103)
Intrinsic vulnerability : travel time
High vulnerability because the alteration aquifer is shallow



Bruxellian sands(RWE051)
Intrinsic vulnerability : travel time
Variable vulnerability, highly dependent on topography

CONCLUSIONS

1. The APSÛ method is process-based and allows a better understanding of the vulnerability of groundwater.
2. The tool APSÛ-GIS automate numerous operations, ensure data integrity and focus work on the specificities of the areas studied and the interpretation of the vulnerability maps created.
3. The modular structure of APSÛ-GIS enable it to be used in various study areas with different configurations (country, scale of the area and resolution of available data).

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More information:

- ❑ Popescu I. C., Gardin N., Brouyère S. & Dassargues A. (2008). https://orbi.uliege.be/handle/2268/3595
- ❑ Popescu I. C., Brouyère S.,Derouane J. & Dassargues A. (2010). https://orbi.uliege.be/handle/2268/14373
- ❑Popescu I. C., Brouyère S. & Dassargues A. (2019). https://orbi.uliege.be/handle/2268/238771