

A REGIONAL FLUX-BASED RISK ASSESSMENT APPROACH OF CONTAMINATED SITES ON GROUNDWATER BODIES

S. Brouyère^{1,3}, P. Jamin^{1,3}, F. Dollé^{1,3}, Ph. Orban^{1,3}, C. Hérivaux², I.C. Popescu⁴ & A. Dassargues^{1,3}

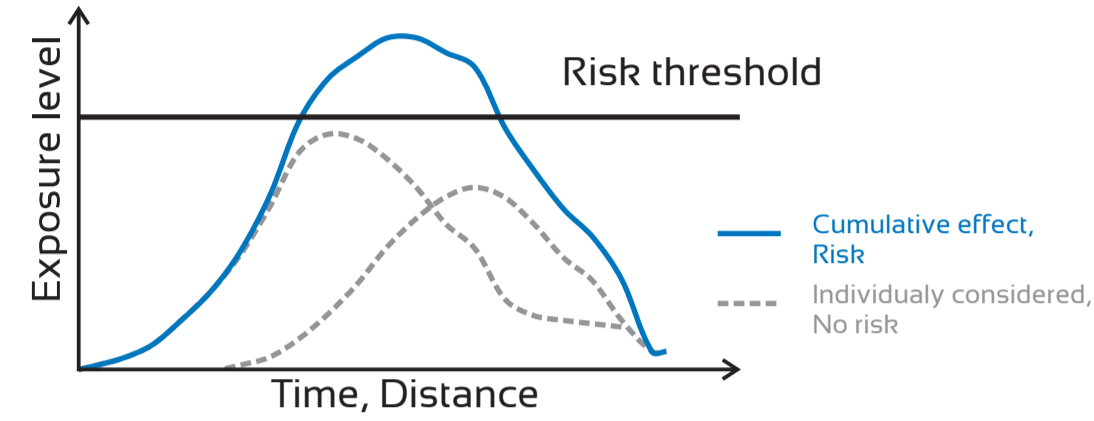
FRAC-WECO project :

¹ University of Liège, Fac. Applied Sciences, Dpt ArGEaCo, GEO³, Hydrogeology and Environmental Geology, Liège, Belgium. Serge.Brouyere@ulg.ac.be
² BRGM (French Geological Survey), Water department, Montpellier, France
³ University of Liège, Aquapôle Research Centre, Liège, Belgium
⁴ Service Public de Wallonie, DGARNE-DGO3, Division de l'Eau, Direction des Eaux Souterraines, Namur, Belgium

Flux-based Risk Assessment of Contaminants on Water resources and ECOSystems

Regional-scale, flux-based risk assessment

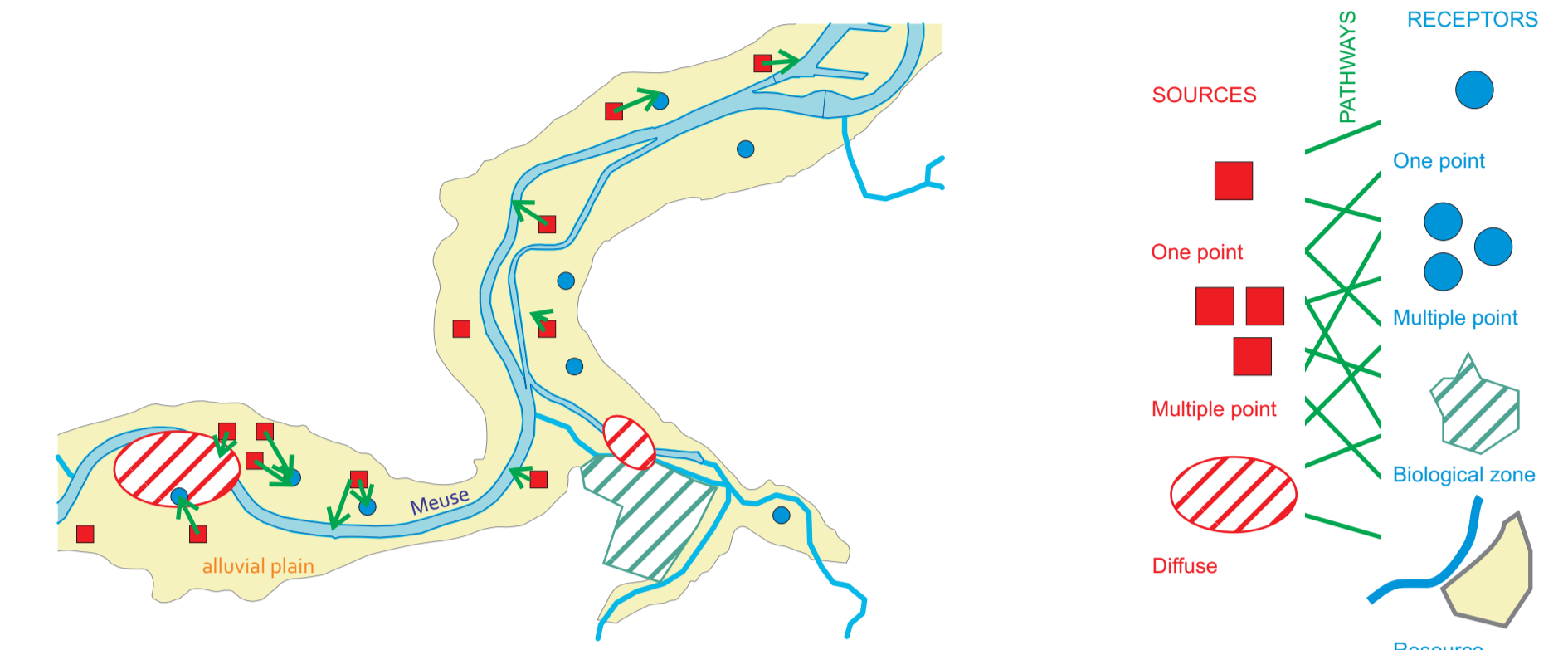
✘ Cumulative effect of several pollutant sources



From the perspective of water resource management, each contaminated industrial site taken individually does not necessarily constitute a threat for the whole aquifer or the groundwater body. However, in heavily industrialised and urbanised areas, the cumulative effect of multiple contaminant sources is likely to present a risk. The risk assessment has to be flux based to consider cumulative effects of the contaminants

➔ NEED FOR FLUX-BASED RISK ASSESSMENT

✘ Spatial distribution of pollutant sources and receptors



Considering a large scale area for risk assessment involves many contaminant sources of many types (point-type: leaking storage tank, diffuse-type: smokestacks), many receptors (point-type: groundwater abstraction well, diffuse type: zone of biological interest, aquifer, river) and lots of pathways linking them to each other. Efficient management all the spatially distributed data requires GIS databases

➔ NEED FOR GIS DATABASE FOR S-P-R DATA MANAGEMENT

Regional Risk Assessment methodology

STEP 1 : CREATION, FEEDING AND HANDLING OF A GEODATABASE

- GIS geodatabase for storing, managing and using all the spatially distributed information required for regional risk assessment.
- Specific activity-pollutant matrix module integrated into the geodatabase to list potentially generated contaminant for each type of industrial activity.

○ Developed under Microsoft Access with the ability to be used with GIS-based applications. Organised according to the SPR schema.
 ○ Geodatabase includes a list of relevant contaminants (75) and associated physical and chemical properties (solubility, Koc,...) governing their behaviour in the environment.
 ○ Activity-pollutant matrix : Most of the time the only available information about contaminant source is a list of industrial activities. This tool gives a list of pollutants potentially released by a given industrial activity and inversely.

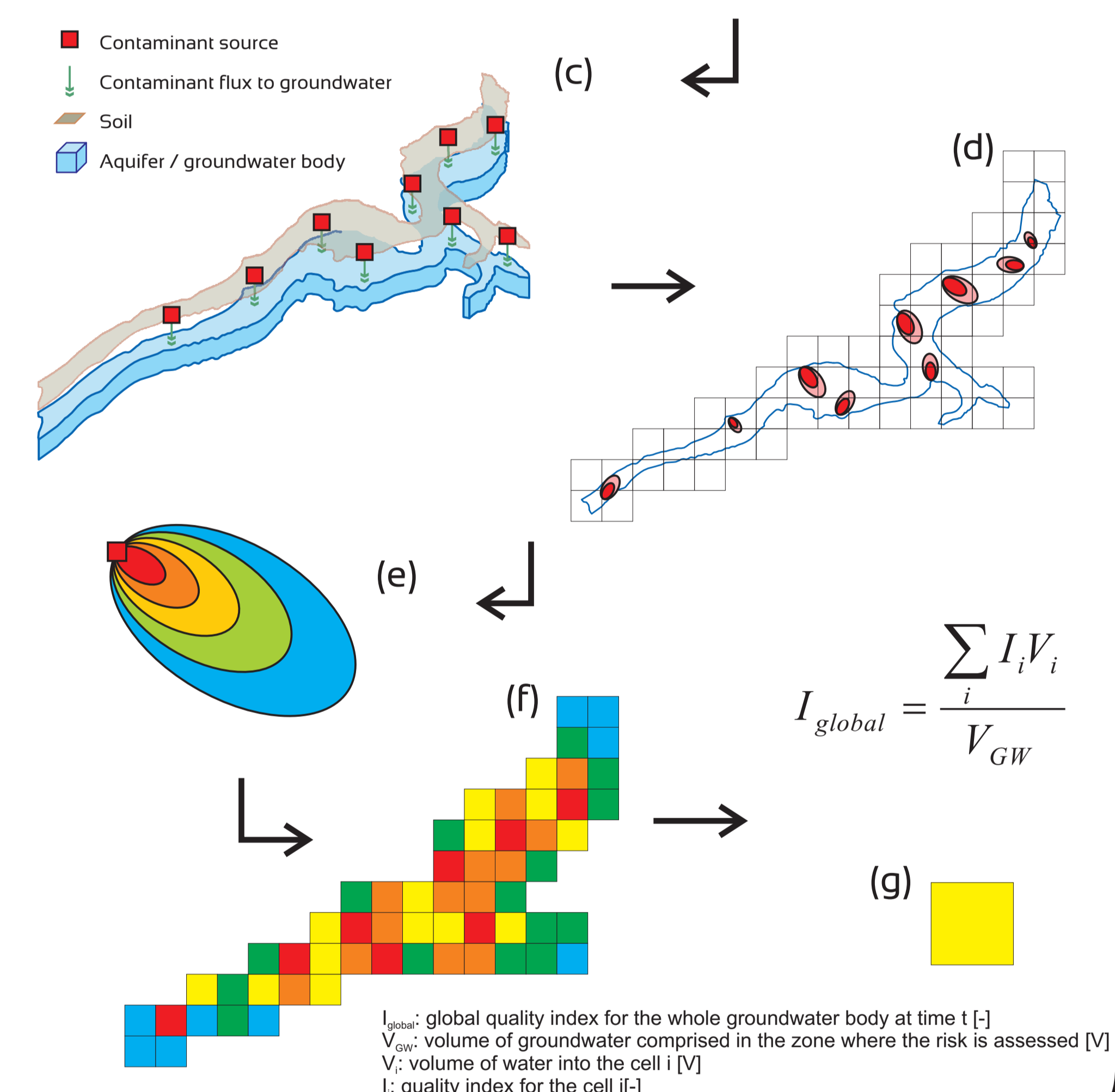
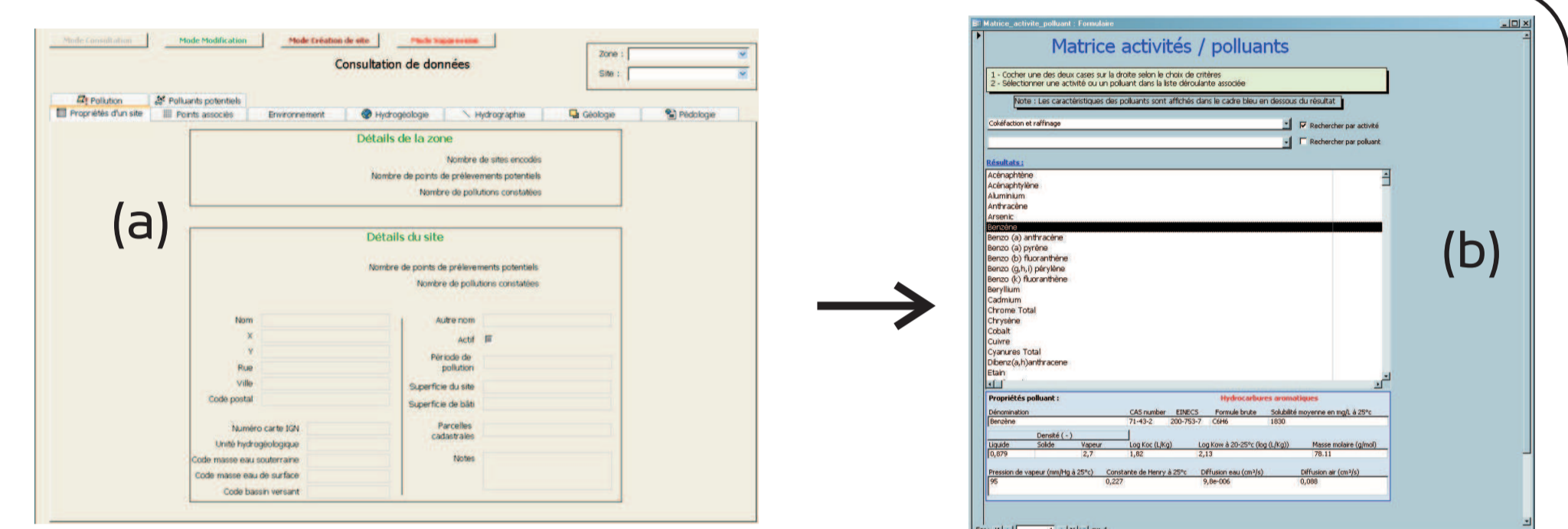
STEP 2 : MODELLING OF GROUNDWATER FLOW AND TRANSPORT OF CONTAMINANT

- Calculation of vertical pollutant fluxes through soil and vadose zone using leaching-dispersion model.
- Calculation of contaminants dispersion through the aquifer using a numerical groundwater flow and transport model developed for the groundwater body to provide a map of contaminants plumes.

○ GMS with MODFLOW/MT3D in finite differences used for groundwater flow and contaminant transport in saturated zone.

STEP 3 : CALCULATION OF THE GROUNDWATER QUALITY INDEX FOR THE GROUNDWATER BODY USING SEQ-ESO

- At each time step, classification of the generated plumes using the threshold values defined in the Walloon Region SEQ-ESO system for groundwater quality evaluation.
- Compute a global picture of the water quality on the basis of the finite difference grid for each time step.
- Calculation of the global quality index [0-100] for the groundwater body at each time step using an especially developed routine based on weighting-average procedure.



Application on RWM073 groundwater body: first tests of the approach

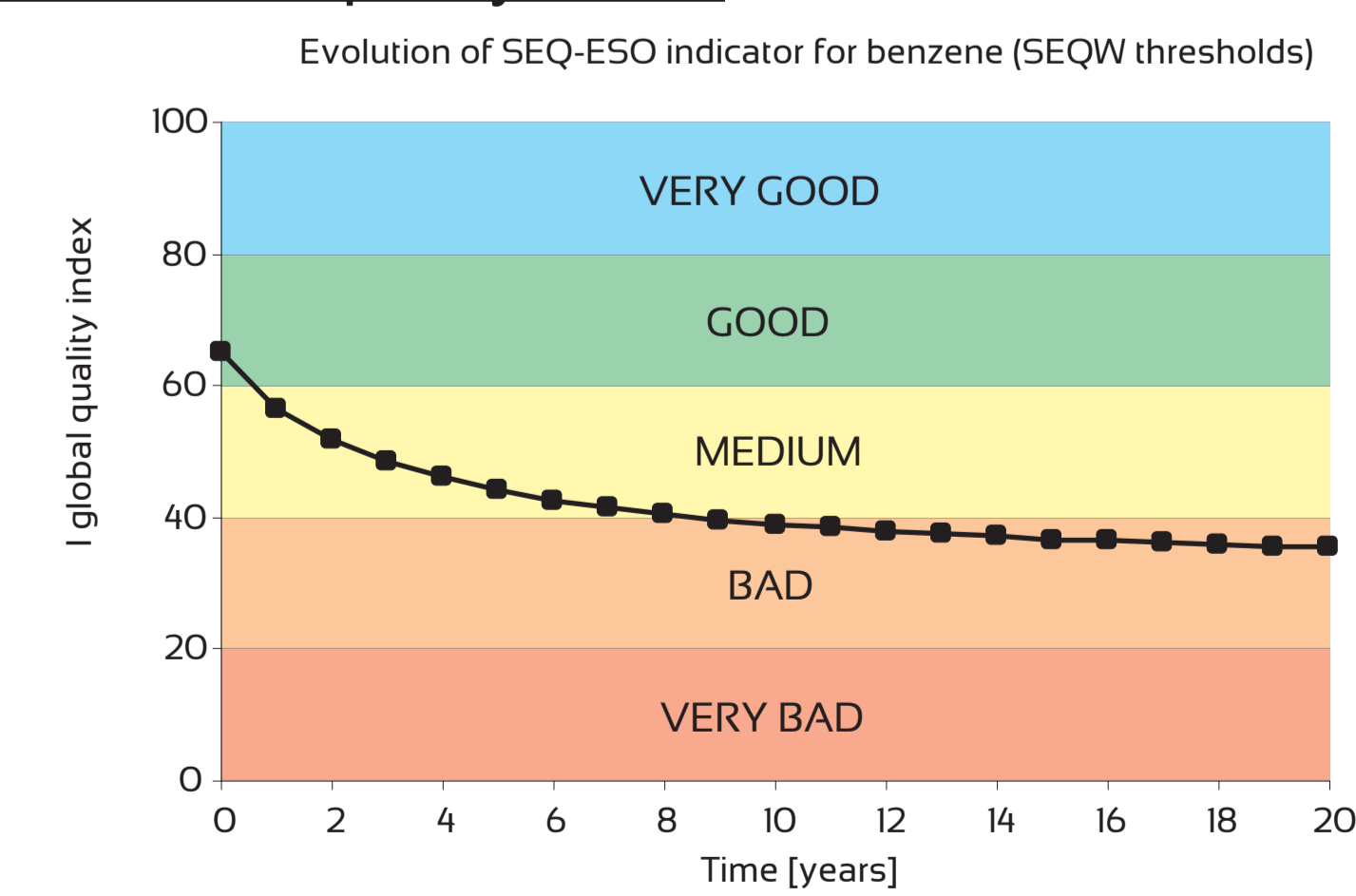
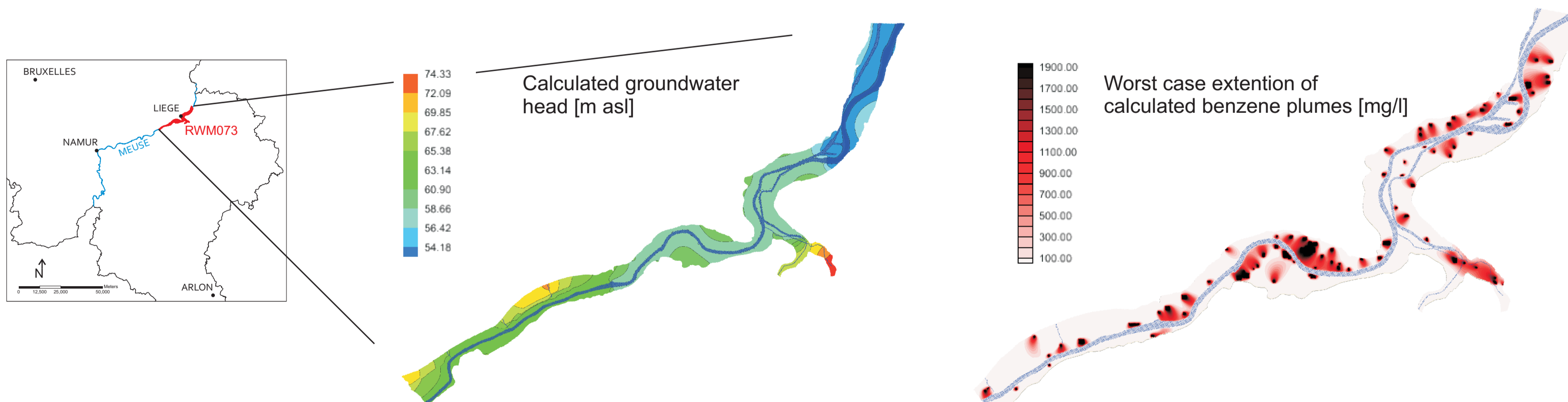
The groundwater body RWM073 "Gravels and alluvial deposits of the Meuse river between Engis and Herstal" has been chosen for its heavy industrial past and current situation and its presumed bad chemical status.

The first application of the Regional Risk Assessment method consider worst case scenario:

- Data about all the part of the SPR schema were collected and organised into a geodatabase. Sources of contaminant come from an inventory of industrial activities from Year 2000 on a cadastral frame and sorted using the 3rd Annex of the Walloon Soil Decree.
- Only industrial plants lying within the category "mining", "gas station" and "metallurgy", and with a area of >100 m² were considered. Benzene was chosen among that given by the activity pollutant matrix as the most commonly found pollutant.
- Pollutant leaching not considered. Contaminant supposed to be present at concentrations equal to solubility at the top of water table.
- GMS Modflow and MT3D used to perform groundwater flow and transport simulations using finite differences for a 20 years period.

- ✘ 3 types of industrial activities generating benzene
- ✘ Worst case scenario with all industrial plants polluting
- ✘ Simulation time: 20 years
- ✘ Groundwater use thresholds corresponds to general quality of groundwater (SEQW)

Final SEQ-ESO global index: 35 → bad quality status



Conclusions and perspectives

- ✘ Compliant with EU Water Framework Directive and Walloon legislation.
- ✘ Investigation of groundwater quality including degradation/improvement trends.
- ✘ Integration of multiple contaminations to a single quality index easily transposable for further analysis.
- ✘ Next step: Coupled socio-economical approach as a support to WFD management plans.

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