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Regional flux-based risk assessment of contaminants in a groundwater body using remote sensing imagery integrated in a modeling procedure

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In Belgium, as well as in many other European countries, many contaminated sites have been reported as resulting from relatively anarchic economical and industrial development during the 19th and 20th centuries. The last decades stakeholders and population have become more aware of the risk posed by these sites. The Frac-Weco project elaborates an integrated framework for the assessment, at regional scale, of the risk posed by these contaminated sites on water resources and ecosystems. Using analytical models for contaminant leaching in the unsaturated zone and dispersion in the groundwater, contaminant fluxes to the receptors are calculated providing a way of estimating the level of exposure/degradation of these receptors.
Groundwater recharge is identified as the main vector of contaminant leaching and dispersion. An important factor determining the spatial variation of the infiltration in these complex urbanized/industrialized areas is the land cover. To obtain detailed information about the land cover a stratified classification methodology of satellite imagery was adopted. With this approach it is possible to estimate the fraction of imperviousness in every urban pixel of the satellite image. The obtained land cover data is used as an input in the WetSpass model to simulate the groundwater recharge with a high resolution in the complex urban areas. In the next step the simulated groundwater recharge is used as an input in the regional scale groundwater flow model developed using MODFLOW and transport of contaminant using MT3D, both under GMS interface. The regional risk for groundwater and surface water bodies is calculated by classifying the different contaminant plumes, generated using the contaminant dispersion models, in zones of equivalent degradation. For the classification the SEQ-ESO system of the Walloon Region, Belgium is used and adapted for a grid-based application. An aggregated indicator of groundwater degradation is obtained as the mean of the SEQ-ESO indicators weighted by the corresponding volumes of degraded groundwater to the total volume of water in the groundwater body.
The developed methodology is applied on a case site, the RWM073 groundwater body corresponding to the alluvial deposits of the Meuse River, Liège (Belgium).
The high-resolution groundwater recharge estimations provided by remotes sensing imagery integrated in the modeling procedure shows a better identification of the sources of contaminants. It helps also to quantify total fluxes of contaminants from brownfields into the groundwater. The developed regional risk assessment methodology gives a global quality indicator for the groundwater body and is easily transposable for further socio-economic analysis.