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Improving surface-subsurface water budgeting for Brownfield study sites using high resolution satellite imagery

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Countries around the world have problems with contaminated brownfield sites as resulting from a relatively anarchic economical and industrial development during the 19th and 20th centuries. Since a few decades policy makers and stakeholders have become more aware of the risk posed by these sites because some of these sites present direct public hazards. Water is often the main vector of the mobility of contaminants. In order to propose remediation measures for the contaminated sites, it is required to describe and to quantify as accurately as possible the surface and subsurface water fluxes in the polluted site. In this research a modelling approach with integrated remote sensing analysis has been developed for accurately calculating water and contaminant fluxes on the polluted sites. Groundwater pollution in urban environments is linked to patterns of land use, so to identify the sources of contamination with great accuracy in urban environments it is essential to characterize the land cover in a detailed way. The use of high resolution spatial information is required because of the complexity of the urban land use. An object-oriented classification approach applied on high resolution satellite data has been adopted. Cluster separability analysis and visual interpretation of the image objects belonging to each cluster resulted in the selection of 8 land-cover categories (water, bare soil, meadow, mixed forest, grey urban surfaces, red roofs, bright roofs and shadow).To assign the image objects to one of the 8 selected classes a multiple layer perceptron (MLP) approach was adopted, using the NeuralWorks Predict software. After a post-classification shadow removal and a rule-based classification enhancement a kappa-value of 0.86 was obtained. Once the land cover was characterized, the groundwater recharge has been simulated using the spatially distributed WetSpass model and the subsurface water flow was simulated with GMS 6.0 in order to identify and budget the water fluxes on the brownfield. The obtained land use map shows to have a strong impact on the groundwater recharge, resulting in a high spatial variability. Simulated groundwater fluxes from brownfield to a receiving river where independently verified by measurements and simulation of groundwater-surface water interaction based on thermal gradients in the river bed. It is concluded that in order to better quantify total fluxes of contaminants from brownfields in the groundwater, remote sensing imagery can be operationally integrated in a modelling procedure.
The developed methodology is applied to a case site in Vilvoorde, Brussels (Belgium).