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Assessment of surface water vulnerability to pesticide contamination using the modeling tool PegOpera: Application in North Tunisia

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Tunisia is a country in which three quarters of the territory is arid to semi-arid with limited water resources. Decreasing water scarcity and water pollution constitute a big challenge for water stakeholders particularly in rural areas and poor communities. The main factors influencing water availability in this Mediterranean country is, among others, overexploitation of non-renewable resources and diffuse pollution. Due to intensive agriculture in proximity of rivers and continuous use of pesticides, there is a potential risk for contamination of waterbodies by the agrochemicals used. This could have a negative impact on agricultural production as well as human health and threaten in priority the north part of the country where 82% of surface water is available. Despite this situation, no catchment monitoring program is currently put in place since it is expensive and require large investment. In this study, we established a methodology using the PegOpera modeling tool to assess the potential risk of pesticides contamination of surface water at the scale of a rural catchment situated in the northwestern part of Tunisia, the Joumine basin, draining an area of 418 km2 and devoted to agriculture, mainly rainfed cereal crops. In the downstream part of the basin, the Joumine dam was built in 1984 to provide water for irrigation and drinking purposes.

We performed a survey with catchment farmers to report management practices in the area as well as spatial and temporal information about pesticide compounds, timing and application rate from which we identified the most used pesticide molecules. The SIRIS method (System of Integration of Risk with Interactions of Scores) was applied to classify compounds used according to the risk that they present to the aquatic environment and therefore to identify those chemicals that should be monitored (Guerbet et al., 2002; Le Gall et al., 2007). According to the results of this classification, we selected 6 molecules to study in priority. We carried on a monitoring program in 2016 by collecting water samples from the Joumine River and its main tributaries from December to May. Analysis results showed high levels of pesticide molecules in the river, in particular, measured concentrations of the herbicide simazine and the fungicides carbendazim, tebuconazole and chlortoluron at different monitoring stations.
To better understand the fate and transport of these substances at the catchment scale with their routes of entry to Joumine River and the long term potential risk, we will use a modeling approach involving the “planning and management of water treatment” Tool (PEGASE), which is an appropriate simulation tool to evaluate the quality of watercourses developed by the R&D unit of the Aquapôle of the University of Liège. It will make possible to calculate in a deterministic way the water quality of a network of rivers (15 for the Joumine basin) according to pollutant releases, for non-stationary hydrological situations (Deliège et al., 2009, Grard et al. 2014). We prepared a complete database which includes (i) a geographical database (the digital elevation model, the river network, the land use map generated from Landsat 8 LOI imagery, livestock and administrative reference frame), (ii) the hydrometeorological data were provided by the Tunisian National Institute of Meteorology and (iii) data related to human activities and releases was also built in order to implement the model on the Joumine Basin. Non-available parameters, mainly gaps in daily discharge and soil data, were estimated with the Soil and Water Assessment Tool (SWAT) and coupled with the PegOpera Tool.

Keywords: Surface water, Pesticides, PEGASE model, Joumine River.

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