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Groundwater interactions with surface waters: consequences on diffuse pollution pathways

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The interactions between groundwater and surface water are complex. Surface-waters and groundwaters are, in fact, linked components of a hydrologic continuum. In general, diffuse pollution in surface waters is difficult to quantify since it follows a multitude of pathways and acts on different time scales. During rainfall events most of the diffuse pollutant load follows the surface runoff pathways and, reaches the surface acquifers however, a fraction of this load will follows the sub-surface runoff pathways and it will possibly reach the surface acquifers after a certain time lag. The time scale of the sub-surface runoff pathways is very different from the surface runoff time scale and rarely a subsurface diffuse pollution event can be directly correlated to a specific rainfall event. This is the reason why even though there are models that enable to simulate the groundwater-surface water system (GW-SW), yet the effect of these interactions in terms of diffuse pollution pathways and their correspondent effect on the quality of surface waters to date are largely unknown. To upgrade the conceptual modeling of the "groundwater–surface water" system, a broader perspective of such interactions across and between surfacewater bodies is needed. Multidimensional analyses may help in understanding the effect of such interactions, as the characterization of the hydraulic interface and its spatial variability.

To fully understand these interactions, modeling studies need to be coupled to sound and robust monitoring of surface- and ground- water quality data. Modeling can be combined with multivariate statistical techniques (e.g. factor analysis) to improve our capability to "detect" the effect of the sub-surface runoff on the water quality of specific water courses.

Aim of this study was to analyse the groundwater contribution to the total nutrient river load of different watersheds that share a very intensive agriculture and landfarming system. The studied watersheds all belong to lowland rivers, located in the Northern Italy and caharacterized by a groundwater recharge which significantly contributes to the total nitrate load. We found that up to 60% of the measured load could be apportioned as sub-surface-runoff-derived, allowing to conclude that the sub-surface runoff can be a significant source of diffuse pollutant even in dry weather conditions. Moreover, special effort was dedicated in this study to apportion the groundwater nitrate load into the agricolture diffuse sources and the component due to the presence of On-site Wastewater Treatments of scattered dwellings. It was found that OWTs accounted for about 10% of the total groundwater nitrate load.

This study outlines the significant role of the groundwater interactions with surface waters for the understanding of the pathways and fate of nutrients and pollutants and it shows how site-to-region regionalization studies and cross-disciplinary collaborations may help in improving the understanding of the complexity of the watershed system to face the management requirements linked to the evolving of such knowledge.