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Enhanced understanding of coastal karst aquifer system through monitoring of source-specific contamination occurrences at intertidal springs

Content

Lowland coastal karst aquifers in the west of Ireland are considered to be highly vulnerable to pollution and impacted by multiple contamination sources on land (in particular, diffuse rural sources from agriculture and on-site domestic wastewater effluent) as well as by saltwater intrusion near the coast. Most of these aquifers are exceptionally complex which makes their protection and management extremely challenging. Human wastewater effluent from on-site wastewater treatment systems (DWTSs) is identified as a significant threat to groundwater quality in such lowland Irish karst environments, since approximately one-third of the population in Ireland is relying on these systems for the treatment of domestic wastewater. However, it is difficult to distinguish between agricultural pollution and DWTS effluent using only traditional water quality parameters or any single environmental tracing method. Hence, the impact of contaminants from DWTSs on groundwater quality must be assessed using a source-specific multiple-tracer approach. Such an approach allows the development and application of effective management strategies on the catchment scale.

Kinvara Bay catchment in the southern part of County Galway has been selected for this study due to a large number of DWTSs located above a well-developed shallow epikarst and extensively karstified Carboniferous limestone bedrock across the largest part of the catchment. The karst conduit network also receives significant quantity of relatively fast allogenic runoff from Devonian Old Red Sandstone bedrock hills in its eastern part. The catchment has been the subject of many studies over the years with respect to groundwater flooding, ecohydrology of turloughs and submarine groundwater discharge into the bay. Previous studies have estimated discharge and the nutrient loading from the two main springs into the Kinvara Bay using hydrological modelling; one of these springs being the outlet of a major karst conduit network (known to be the output of the allogenic recharge from the hills), while the other spring predominantly discharges water from more diffuse/autogenic sources.

Monthly hydrochemical and water quality parameter monitoring has been carried out over the course of a year, with concurrent application of microbial and chemical wastewater contaminant fingerprinting techniques. Such techniques include fluorescent whitening compounds, fluorescence-based investigations of organic matter with parallel factor (PARAFAC) analysis, specific anion ratio signatures, flow cytometry and faecal sterol and stanol profiles and ratios. The observed variations over time in concentrations of hydrochemical parameters and targeted contaminants specific to on-site wastewater sources at two springs were contrasted. The results, which have been compared to the known locations and densities of DWTSs in the area, have highlighted the previously suggested complexity of groundwater flow and distinctive conduit pathways within the same karst aquifer system. Such information can contribute to improved future catchment management policy to minimise the effect of contaminants on karst groundwater resources.

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