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Evaluating the impact of Flood-MAR on Groundwater Quality

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Sustainable groundwater management is crucial in arid and semi-arid regions, such as the Mediterranean, due to high water demand, irregular rainfall patterns, and limited surface water availability. Flood-Managed Aquifer Recharge (Flood-MAR) has emerged as an effective strategy for mitigating groundwater depletion in overdrawn aquifers. This approach utilizes surplus water from high-magnitude streamflow events, reservoir releases, or excess surface water deliveries, providing a unique method of managed aquifer recharge by harnessing sporadic water sources. While Flood-MAR has demonstrated positive effects on groundwater quantity, its impacts on water quality remain underexplored. During flood events, rivers collect runoff from impermeable surfaces, such as roads and industrial areas, potentially carrying contaminants like heavy metals. These

pollutants, primarily originating from vehicles, pose risks to aquifer recharge quality during flood-driven recharge operations.

In this work, we evaluated the pollution risk to an aquifer during a high-magnitude streamflow event of the Llobregat River (Barcelona, Spain). Sampling was conducted in both the Llobregat River and a nearby piezometer to ensure that temporal changes in contaminant levels could be attributed to hydrological events rather than spatial variability. Rainwater samples were also collected at the site. Water quality was intensively monitored over the rainfall period (12 hours) and the following five days, characterizing hydrochemistry (anions and cations), heavy metals, and water isotopes. Preliminary results indicate higher contamination levels in the river, particularly regarding heavy metals, especially at the onset of the rainfall event. This increase was attributed to urban runoff from roads and industrial zones in the studied area. Hydrochemistry monitoring,

along with water isotopes analysis, revealed that the high-magnitude streamflow event impacted the aquifer in two distinct phases. First, during the initial hours of the rainfall, the aquifer's water quality was affected, with a general increase in the concentrations of most monitored parameters. Second, two to three days after the event, the aquifer's hydrochemistry was influenced by the upstream rainfall's impact on the catchment area. These findings suggest that, although the aquifer quality is affected, the impact of Flood-MAR on groundwater quality is not expected to be significantly critical.