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Criteria for assessing the impact of nature-based solutions on groundwater systems

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Nature-based solutions (NBS) involve using natural systems such as wetlands, forests, and rivers restoration, to address challenges related to water, such as flooding, water scarcity, and water quality. Groundwater circulations and processes play a critical role in these natural systems. The solutions applied at the surface will have qualitative and quantitative impacts on groundwater, in this case, we propose the term NBS-GW (nature based solutions on groundwater). Therefore, the impact of the NBS on the groundwater systems should be assessed.

The evaluation of NBS implemented with the objective of sustainable management of groundwater poses particular challenges related to the specificities of aquifers, invisible due to their underground location, whose functioning is complex and highly dependent on the geological context. Many factors influence the hydrogeological effects of a NBS-GW, including the climate, the topography of the watershed, the geology, but also the characteristics of the ecosystems concerned.

The recharge of the aquifers allows to store water during times of plenty, and then it can be released gradually during times of drought providing sustainable base flow in the rivers, helping to mitigate the effects of water scarcity. Moreover, groundwater systems can act as a buffer against flooding by absorbing excess water during heavy rainfall events. NBS can have negative impact if not designed and implemented based on hydrogeological considerations. The benefits of NBS-GW can be maximized by combining different solutions and tailoring them to the specific conditions of a given area.

This work aims to define the criteria to assess the effectiveness of different NBS in terms of their ability to recharge aquifers and improve water quality. NBS-GW can be distinguished according to the type of environment/ecosystem on which the solution acts, by preserving it, by improving its functioning, or by creating a new ecosystem. At the scale of a hydrogeological watershed, we will then distinguish between the solutions implemented (1) in agro-forestry environments, (2) in urban and peri-urban environments, or (3) aimed at aquatic environments.

A review of the scientific literature was carried out in order to characterize the hydrogeological effects of NBS-GW by major type of environment (agro-forestry, urban, aquatic), and to identify the main factors of variation of these effects.

These indicators of hydrogeological effects and efficiency could contribute to the list of NBS impact indicators recommended by the European Commission, which currently do not take groundwater into account.