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## ► To cite this version:

Iman Soukrate, Corinne Le Gal La Salle, Mahmoud Khaska, Loic Ducros. Potential of nature-based solutions to enhance groundwater recharge in conditions of high water stress : application to the Vistrenque aquifer. Spring day de l'Ecole Doctorale 583, Apr 2025, Nîmes, France. <hal-05069721>

**HAL Id: hal-05069721**

**<https://hal.science/hal-05069721v1>**

Submitted on 15 May 2025

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# Potential of Nature-Based Solutions to Enhance Groundwater Recharge in Conditions of High Water Stress: Application to the Vistrenque Aquifer.

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## I-Introduction

Groundwater recharge is essential for maintaining water availability, particularly in areas experiencing growing water stress due to climate change and human activities. Using the Vistrenque aquifer as a case study, this project explores the potential of nature-based solutions to enhance groundwater recharge and strengthen territorial resilience. **This poster focus on hydrogeological modeling to assess the recharge potential using the SWAT software.**

## II- Objectives

- ✓ Evaluate the potential of nature-based solutions to increase groundwater recharge .
- ✓ Identify the most suitable areas for implementing these solutions.
- ✓ Evaluate the effects of these solutions on water quality.

## III- Nature-Based Solutions (NBS) for Groundwater Recharge: Methods and Impacts

- The following figure shows various types of nature-based solutions classified according to their implementation environments.

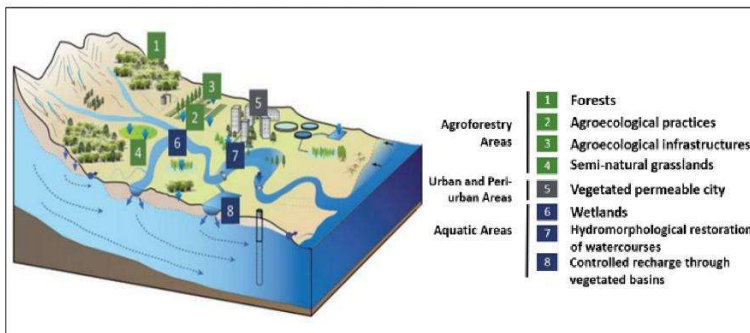


Fig 1 : Types of Nature-Based Solutions for Groundwater Management (NBS-GW) Adapted and translated from [HÉRIVAUX *et al.*, 2023]

- The figure below classifies Nature-Based Solutions (NBS) according to their contribution to groundwater recharge increase or groundwater quality improvement

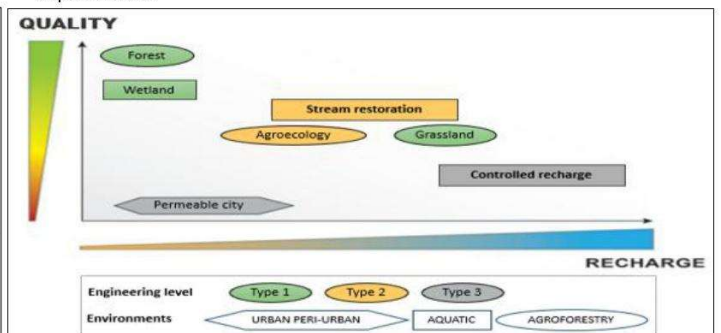


Fig 2 : Comparison of NBS-GW based on their contribution to improving groundwater recharge or maintaining good groundwater quality. Adapted and translated from [SELLES *et al.*, 2023]

## IV- Methodology

### Evaluation of recharge potential through hydrogeological modeling with SWAT+

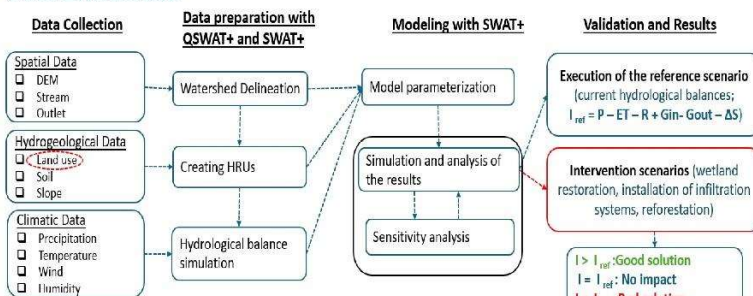
The methodology assesses groundwater recharge potential through SWAT+ hydrogeological modeling. Following data collection, processing in QGIS and QSWAT+ involves:

- Watershed delineation
- Hydrological Response Unit (HRU) identification (grouping areas with similar hydrogeological properties)

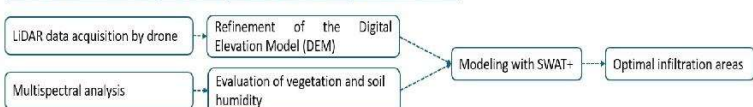
The model is then configured and calibrated over a defined period, with sensitivity analysis to optimize key parameters. An initial simulation establishes a reference water balance. Subsequent simulations integrate land-use modifications and nature-based solutions (e.g., wetlands, infiltration systems, reforestation) to:

- Quantify impacts on water balance
- Determine optimal land management strategies.

### Phase 1 : Watershed scale



### Phase 2 : Multicriteria Spatial Analysis at the scale of predefined areas



## V- Watershed delineation

The case study focuses on a typical alluvial aquifer known as the Vistrenque Aquifer, which covers an area of 325 km<sup>2</sup>. The aquifer is mainly recharged by rainwater, with an estimated annual recharge of 180-220 mm under a Mediterranean climate.

The watershed was delineated using QSWAT+, with the outlet set at the Caissargues hydrometric station. This location was selected to:

- Focus on upstream areas where recharge processes dominate
- Prioritize rural recharge zones
- Exclude the urban influence of Nîmes.

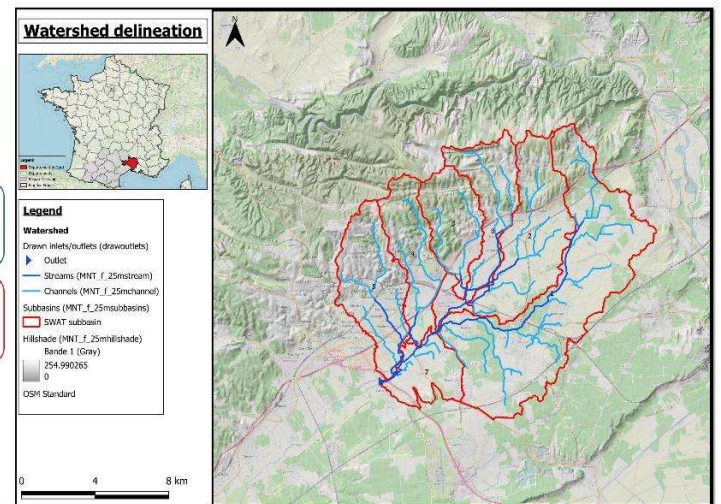


Fig 4 : Map of modeled Watershed (QSWAT+) for Vistrenque Aquifer Recharge Study (Gard, France): Hydrographic Network and Subbasins – Upper Aquifer Sector

## VI- Perspectives

- **Optimization of nature-based solutions:** Assessing the impacts of reforestation, wetlands, and infiltration systems for sustainable water resource management.
- **Refinement of hydrological models:** Improving simulations by integrating more precise data.
- **Application to other watersheds:** Adaptability of the methodology to different regions for both local and global water resource management.

## VII- References

- HÉRIVAUX C., SELLES A., LE COËNT P. (2023) : SFN-ESO : Des solutions fondées sur la nature pour une gestion durable des eaux souterraines ? Note de cadrage. *Rapport final. BRGM/ RP-72417-FR*, 118 p.
- SELLES, A., HÉRIVAUX, C., le COËNT, P., & MARECHAL, J.-C. (2023). Des solutions fondées sur la nature pour une gestion durable des eaux souterraines ? Une revue des effets hydrogéologiques. *Techniques Sciences Méthodes*, 71–101.