Managed Aquifer Recharge (MAR) to reduce aquifer vulnerability to climate change and to control groundwater declining yields

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Managed Aquifer Recharge (MAR)

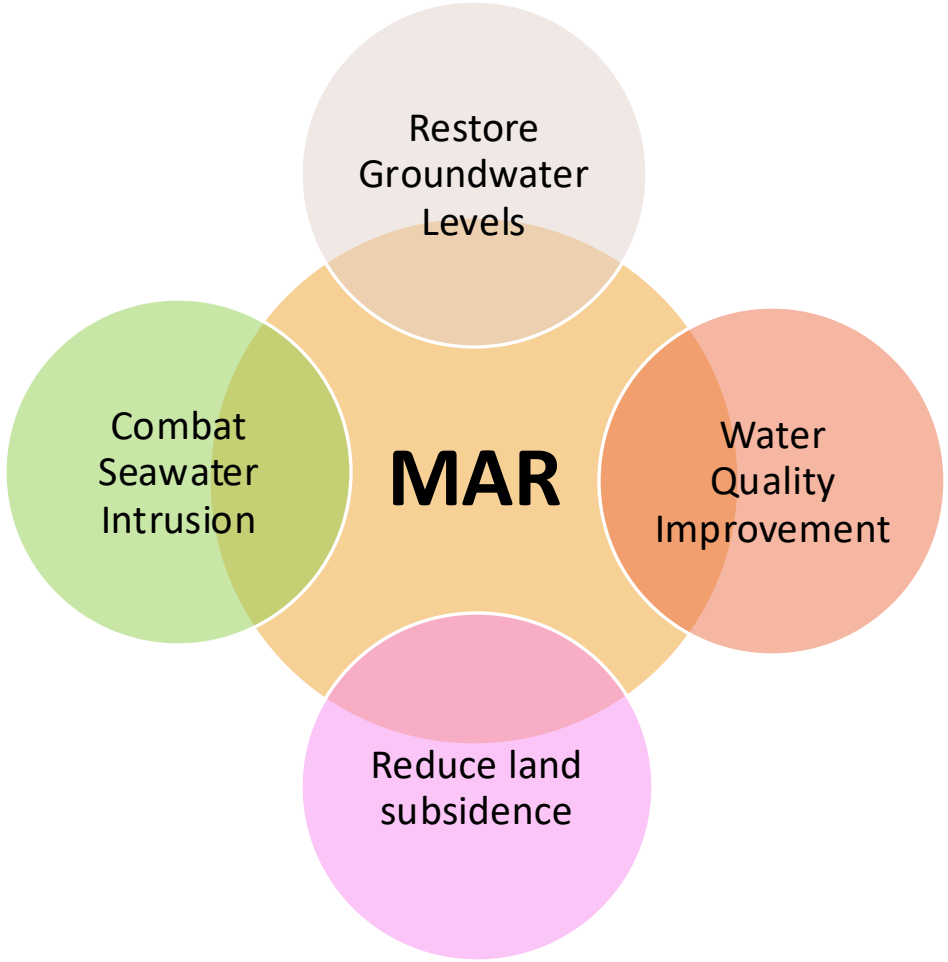
A water management strategy to increase surface water infiltration and storage in underground space.

Source*: KQED*

Recharge is **managed** in order to assure an adequate protection of human health and the environment.

Scope: to protect and prepare water resources against drought, increasing demand and uncertainties of the changing climate.

Objectives of MAR



Water Sources for MAR

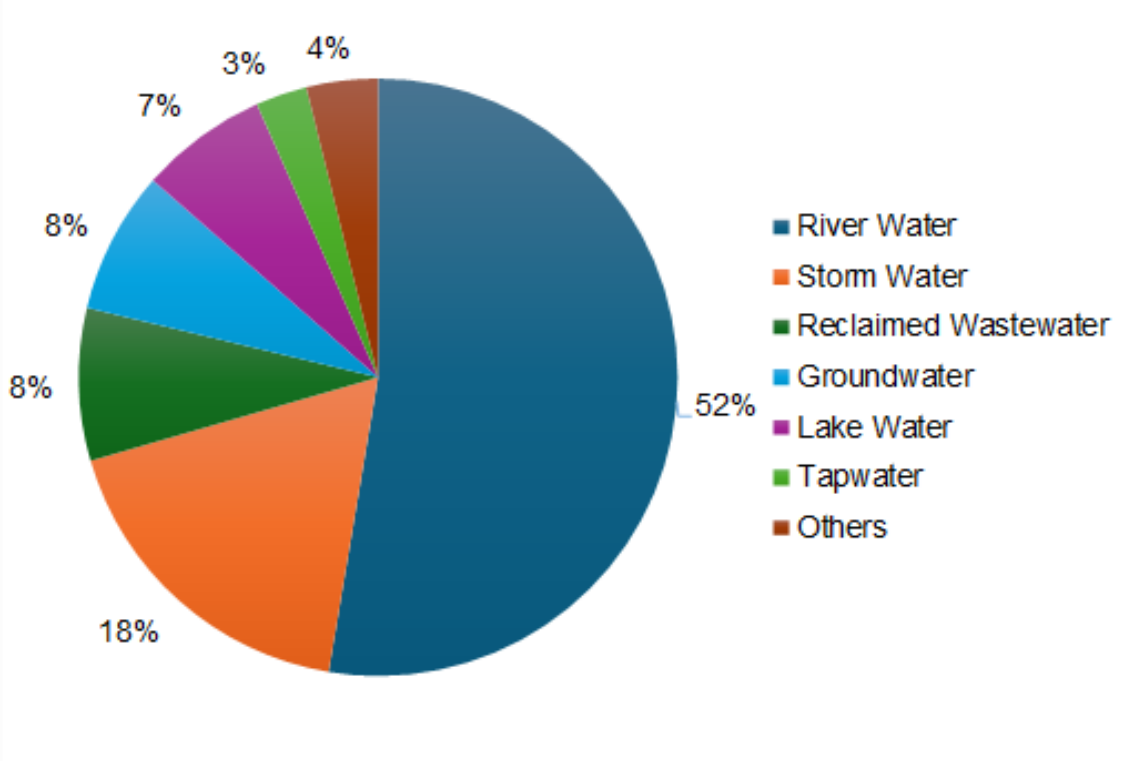
Surface water (river, streams, lakes, dams)

Treated wastewater (reclaimed water)

Desalinated water

Groundwater from aquifers other than that to be recharged

Urban runoff



Source: *IGRAC, 2024*

MAR Types

1. Surface Spreading

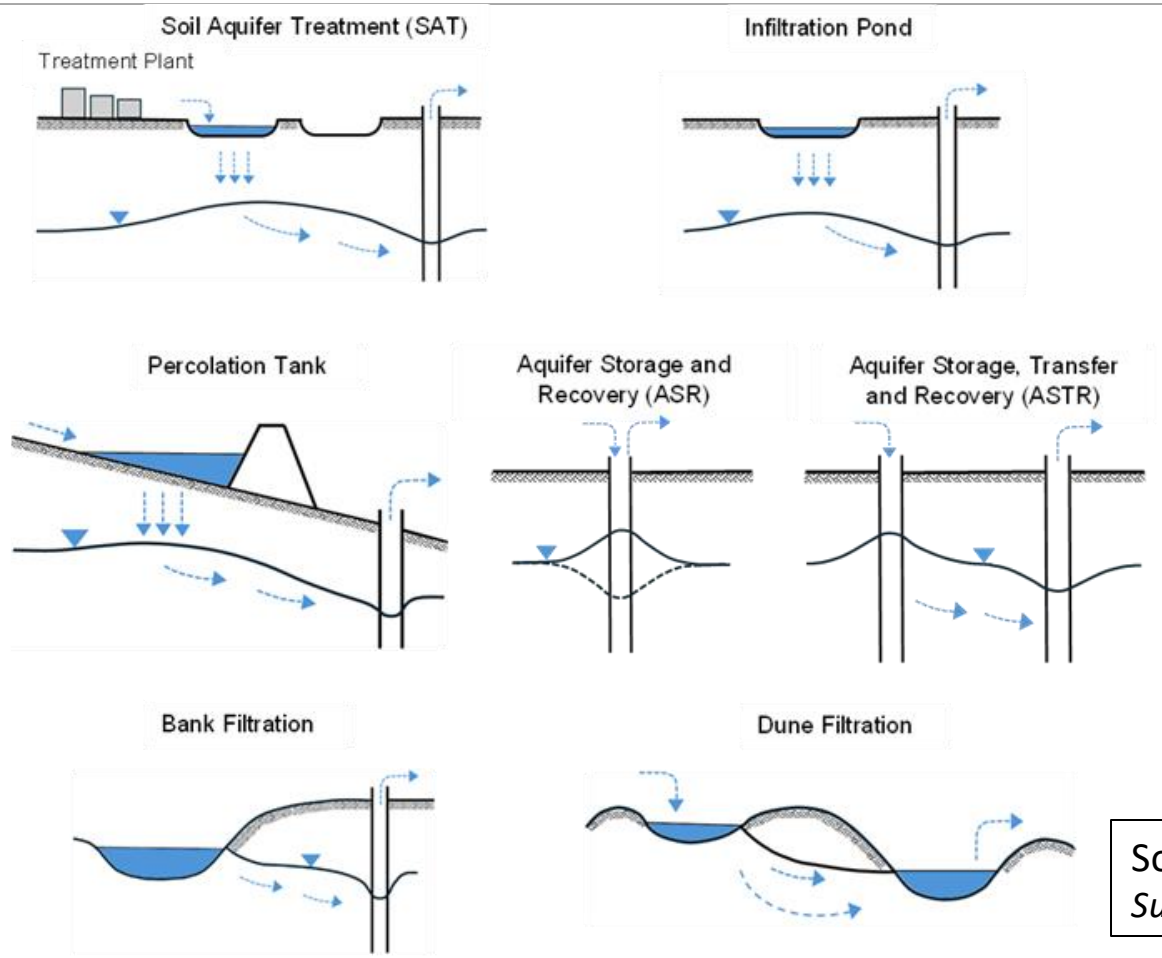
- Infiltration ponds
- SAT
- Excess Irrigation
- Flooding

2. Subsurface

- Recharge wells (ASR/ASTR)
- Recharge pits and shafts

3. Induced Recharge

- Bank Filtration
- Dune Filtration



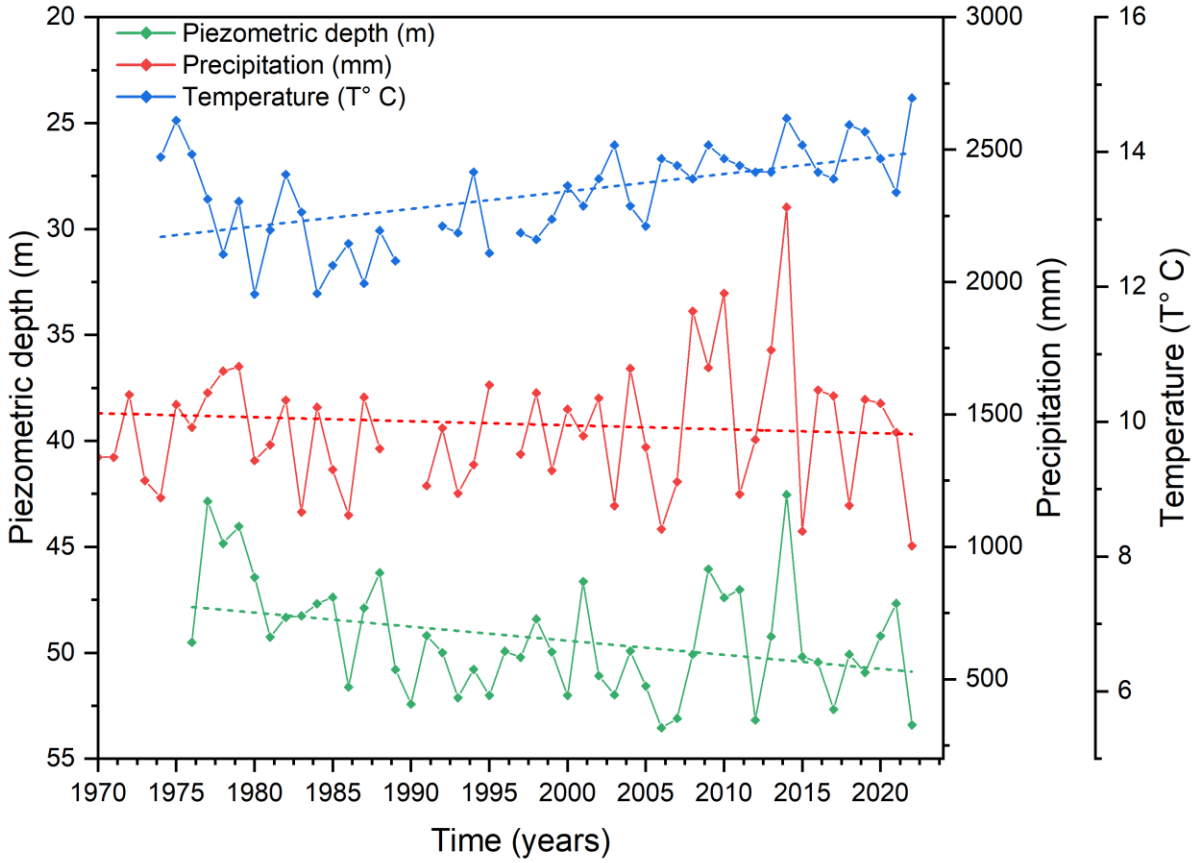
Source:
Sufyan et al. 2024

Why MAR in FVG region?

-an average temperature of about 0.3 ◦C every 10 years

-a decrease in precipitation of up to 15–20% in eastern areas.

-an average decrease in piezometric levels of 3 m.



High MAR potential in the region, due to;

-availability of high quality surface water

-a number of existing structures.

-highly permeable thick aquifer system (mainly gravel).

Study Area

MAR Site

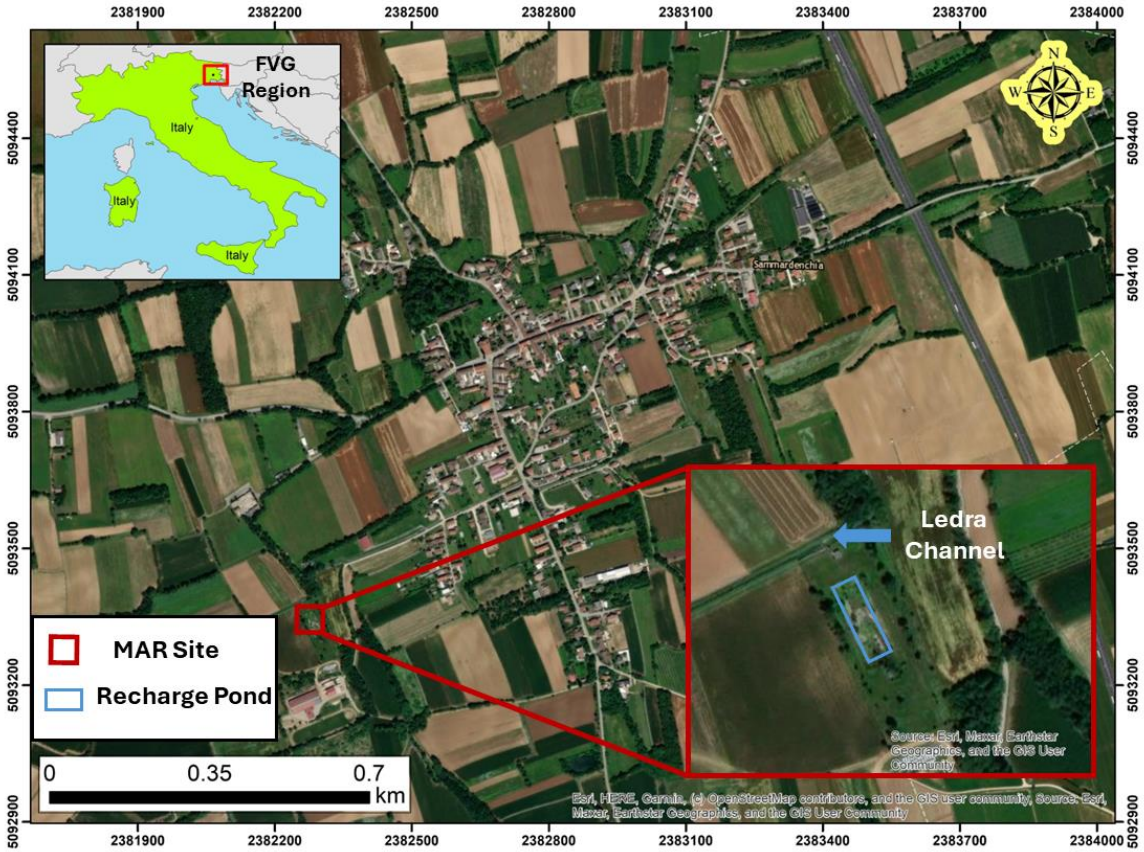
Sammardenchia

MAR structure

Pond (45×10×6.5 m)

Source Water

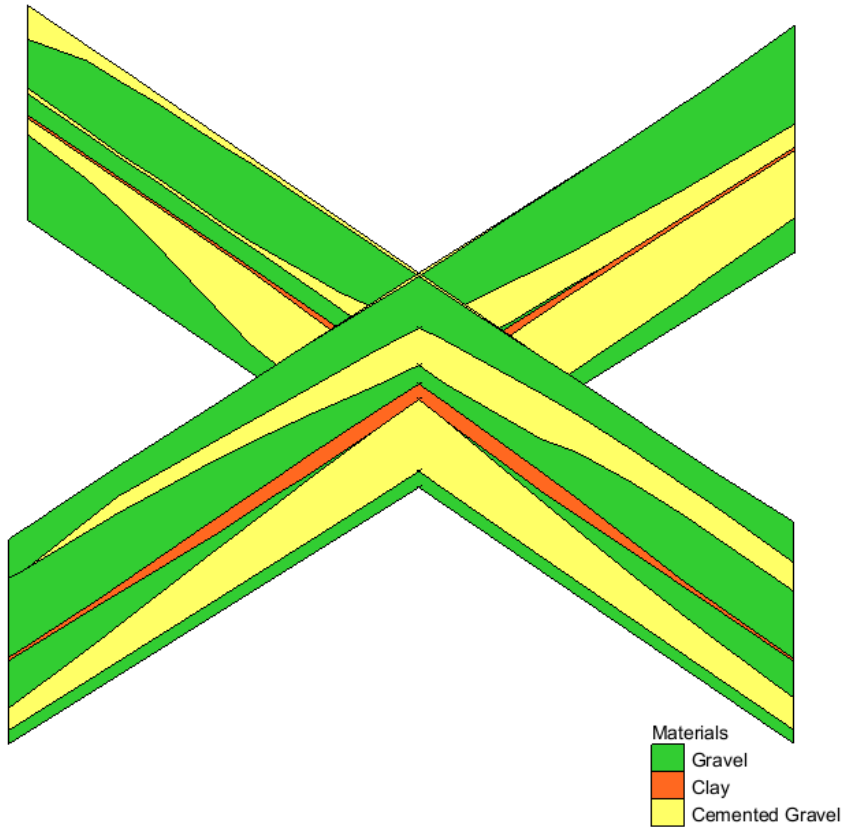
Ledra Channel



Geology of study area

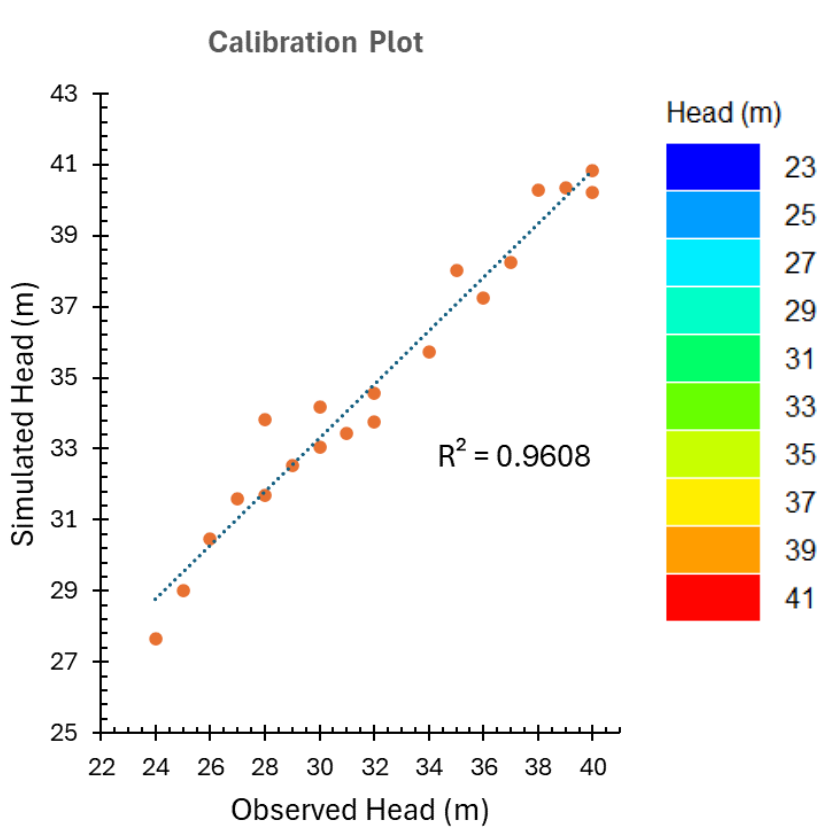
Geological Profile (Top to bottom)

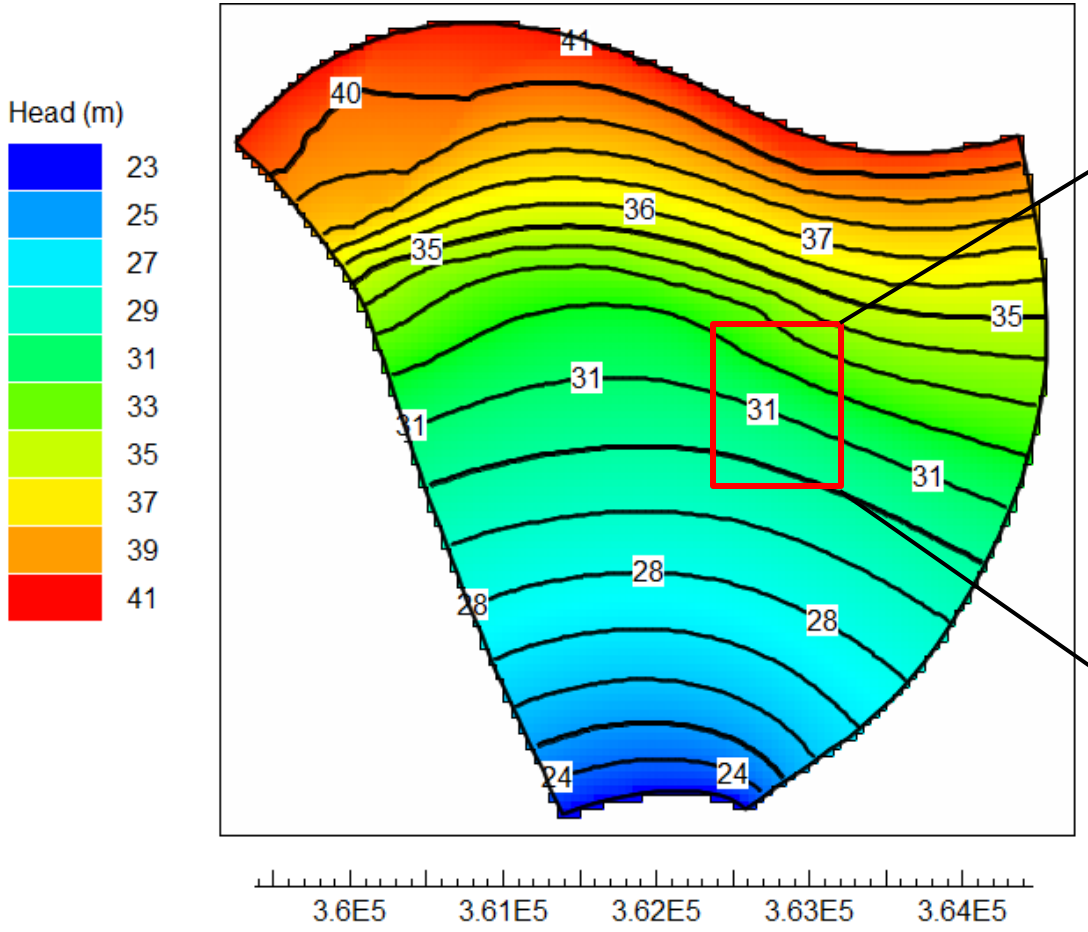
- **Gravel**
- **Cemented Gravel**
- **Gravel**
- **Clay**
- **Gravel**
- **Cemented Gravel**

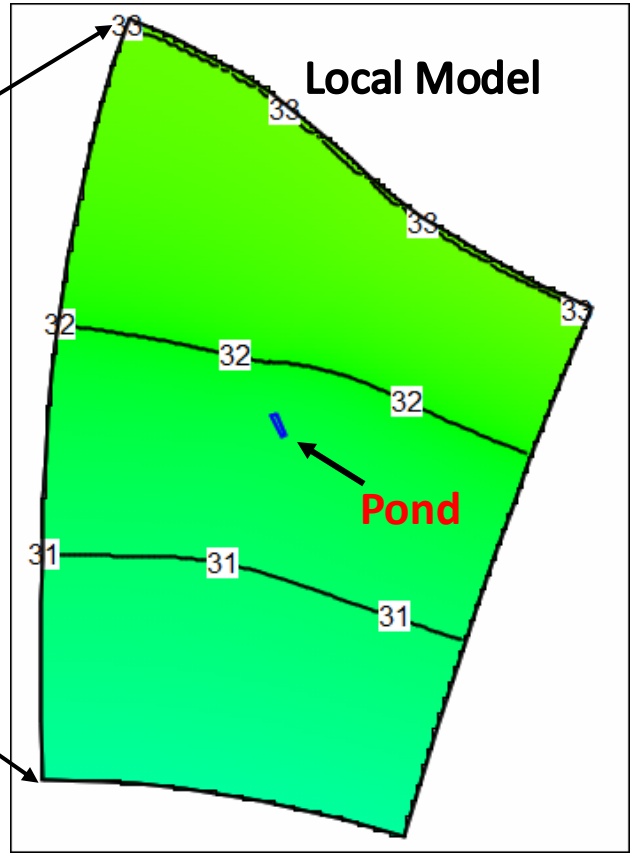


Material	Hydraulic conductivity (m/s)
Gravel	$5.5\text{-}5\times10^{-3}$
Cemented gravel	2.5×10^{-4}
Clay	4×10^{-9}

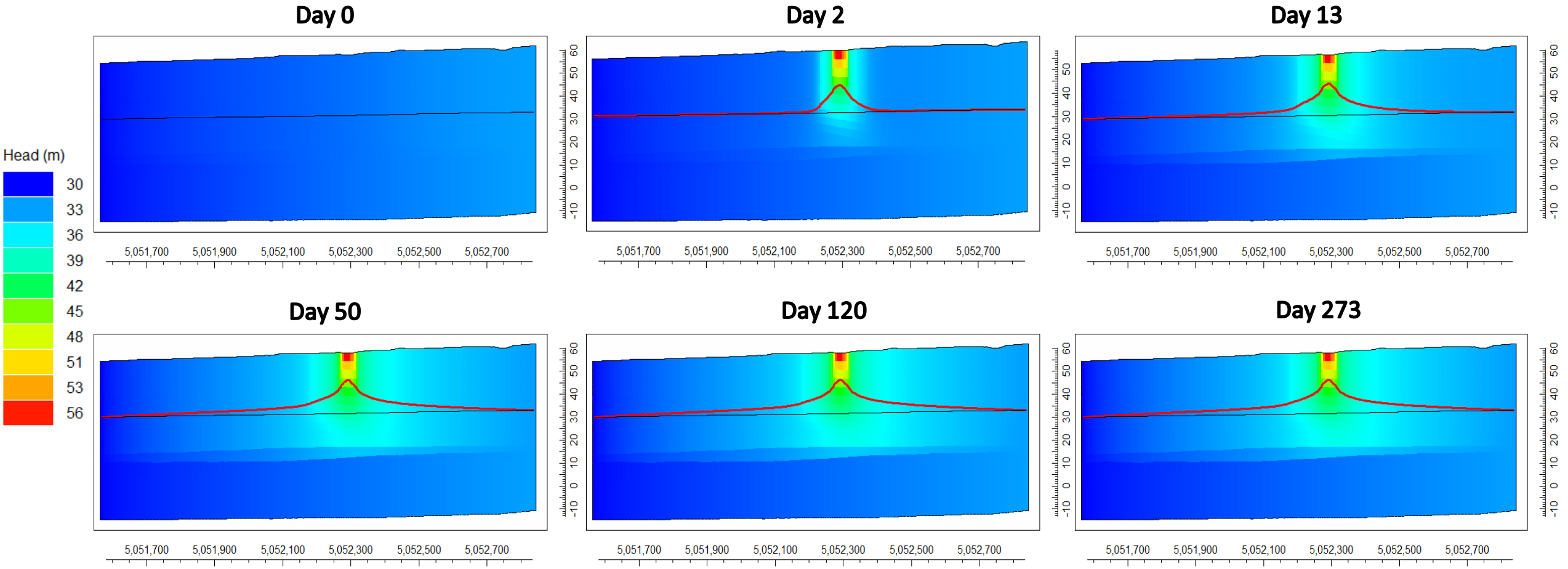
Simulated Hydraulic Heads and MAR Focus Area



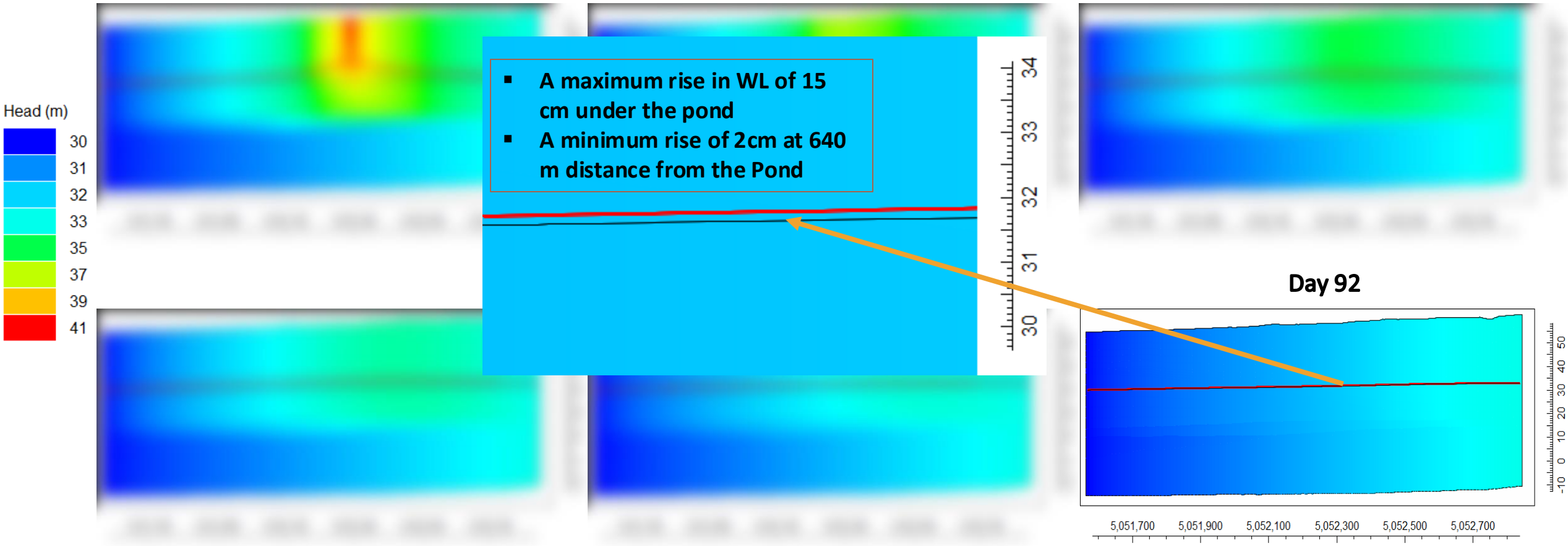




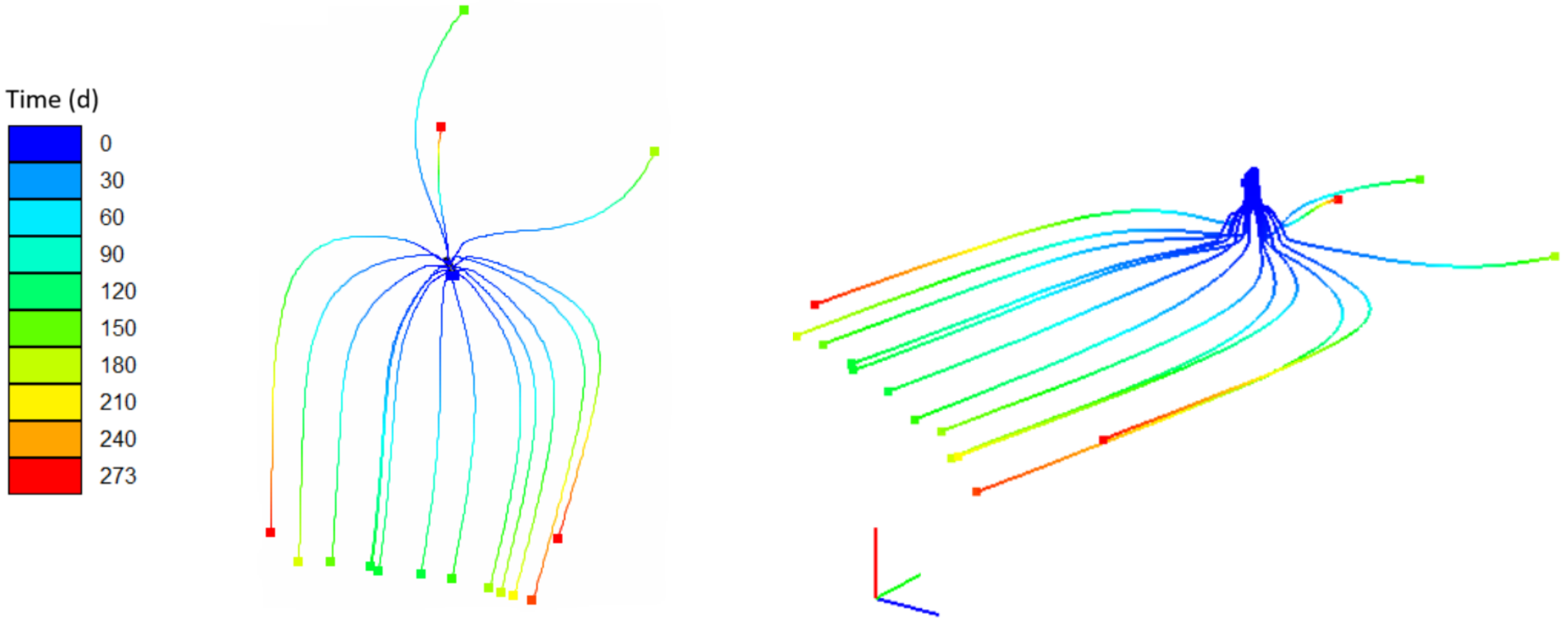
Model outcomes for the wet period (0-273 days)



Model outcomes for the dry period (273-365 days)



Particle Tracking



Published Review Article

Key Highlights:

- A detailed discussion of objectives, techniques, challenges, and developments in the field of MAR.
- MAR potential in the FVG region through analysis of the historical hydrogeological and climate change trends.
- Comparative analysis of previous studies on MAR, which revealed a notable research focus on the quantitative aspect compared to the qualitative one.
- A detailed analysis of qualitative studies to identify the water quality parameters considered over the years, revealing a notable neglect of organic parameters compared to inorganics.

water

MDPI

Review

Managed Aquifer Recharge for Sustainable Groundwater Management: New Developments, Challenges, and Future Prospects

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Abstract: The combined effect of climate change and increased water demand has put significant strain on groundwater resources globally. Managed aquifer recharge (MAR) has become an effective approach for addressing groundwater depletion problems and sustainable management of groundwater resources. This review article provides an extensive insight into the existing knowledge of MAR, including the main objectives and applications, implementation techniques (surface spreading, subsurface, and induced recharge) being practiced over the years, risks and challenges associated with the MAR, and the developments in the field of MAR. This review also explores the potential of MAR in the Friuli Venezia Giulia (FVG) region, north-eastern Italy. An average increase in temperature and a decrease in precipitation and piezometric levels in the region suggest the development of a proper MAR plan to manage water resources in the decades to come. Additionally, a comparative analysis of studies published over the last 20 years, focusing on the quantitative and qualitative aspects of water resource management, is conducted to analyze the research trends in the field of MAR. The reviewed literature reveals a notable research trend towards the quantitative aspect compared to the qualitative one. This review also identifies a notable disparity in qualitative studies during the analysis of water quality parameters considered in different MAR studies. Based on this review, a prospective viewpoint to address the challenges and expand the scope of the field is presented. This calls for an optimized strategy that considers both water quality and quantity issues, along with incorporating environmental and socio-economic aspects within the framework of MAR.

Keywords: managed aquifer recharge (MAR); water quantity; water quality; groundwater management; MAR in the Friuli Venezia Giulia region

check for updates

Citation: Sufyan, M.; Martelli, G.; Teatini, P.; Cherubini, C.; Goi, D. Managed Aquifer Recharge for Sustainable Groundwater Management: New Developments, Challenges, and Future Prospects. *Water* **2024**, *16*, 3216. https://doi.org/10.3390/w16223216

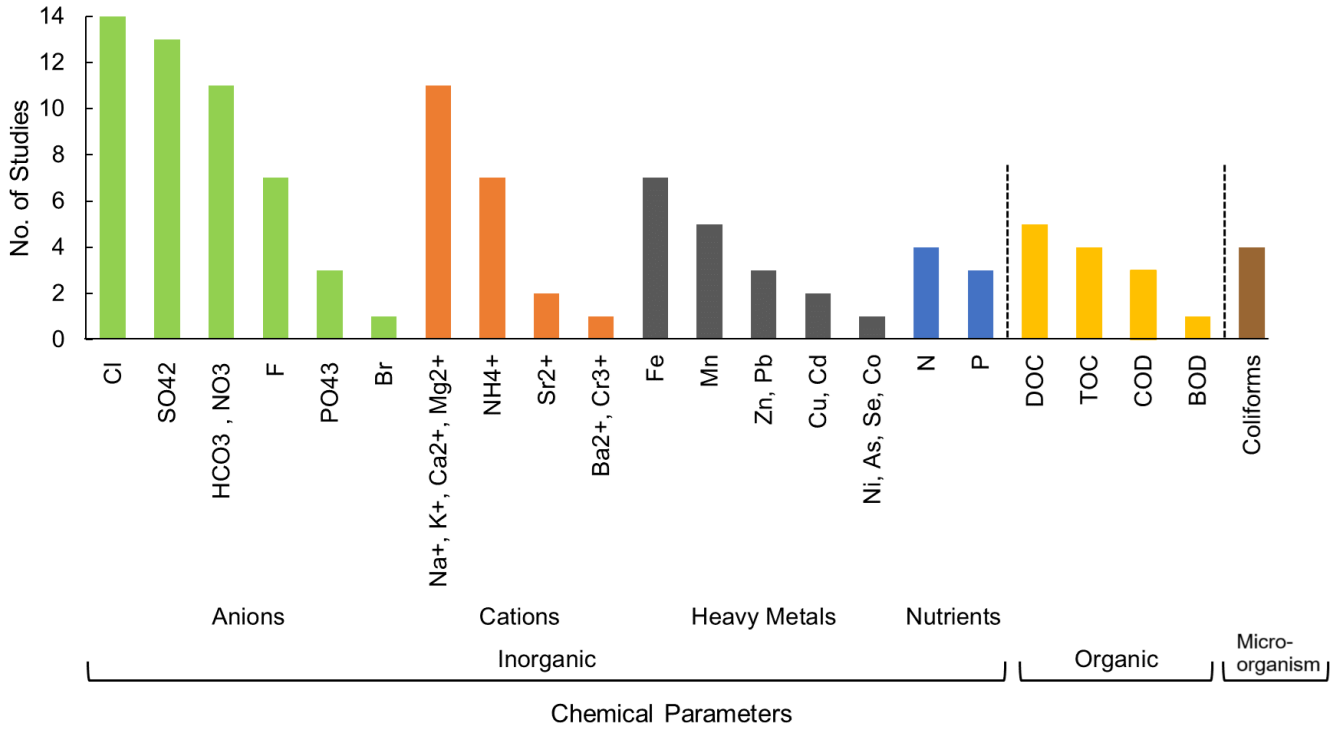
Academic Editors: Lucila Candela and Chin H Wu

Sufyan, M., Martelli, G., Teatini, P., Cherubini, C., & Goi, D. (2024). Managed Aquifer Recharge for Sustainable Groundwater Management: New Developments, Challenges, and Future Prospects. *Water*, *16*(22), 3216.

➢ **Acknowledgments**: The authors acknowledge the UNESCO-UNIUD Chair grant by the ***Livenza Tagliamento Acque (LTA spa).***

Future Perspective

- **Characterize surface water quality** in the plain based on chemical parameters identified in the review, with a focus on **organic contaminants**.
- **Investigate micropollutants** such as microplastics, pesticides, pharmaceuticals, personal care products, and endocrine-disrupting compounds (EDCs) etc.
- Assess the toxicity of micropollutants determined using **in-silico** methods to evaluate potential risks to aquatic ecosystems and human health.



Thank You!