



# Soil Aquifer Treatment in coastal areas

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## INTRODUCTION

Soil Aquifer Treatment (SAT) is one of the broad collection of practices for groundwater recharge and storage for its recovery. Climate change, population growth and economic development may be behind the acute tension over water resources. In these areas, recourse to new sources of water has to be considered in order to secure water supply for drinking, irrigation, tourism and domestic using. Artificial groundwater recharge using water resources (desalted waters, river waters, treated wastewater, etc.) appears as one of major solution to the recurrent issue of water scarcity. It is also a pragmatic way to store and restore water allowing to: i) maintain water supply levels, ii) alleviate salt water intrusion into coastal aquifers, iii) store water avoiding evaporation as it happens for dams.

## METHODOLOGY & CONCEPT DEVELOPMENT

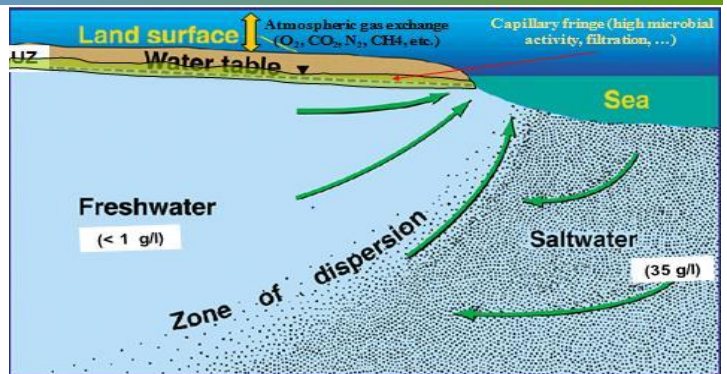
The global methodology of MAR development consists in:

- A geological model built using relevant software's (i.e., Dynamic Graphics Inc.). This geological model 3D integrates all available geological data of drillings, geophysical data (seismic and resistivity and profiles) for the studied area,
- A deterministic model of flow and transport of salinity in the aquifer based will be developed. Quantitative and qualitative monitoring will be undertaken especially piezometric levels and salinities at various periods (low water, average water and high waters).
- Hydrodynamic model for active management exploitation scenarios of the aquifer is developed and calibrated.
- Reactive column simulating reactive transfers throughout a continuum water unsaturated - saturated conditions for reactive transport model "calibration".

## OBJECTIVES

This project aimed to develop a general concept and transferable methodology of MAR for better management of water resources to solve the recurrent issue of water scarcity in coastal regions:

- Conceptualize a general methodology of underground water recharge and storage for its recovery to guarantee permanent availability of water with good quality.
- Develop hydrodynamic model based on an adapted geological model integrating reactive transport processes (i.e., geochemical and biogeochemical processes, etc.) to preserve - improve water quality.
- Develop a numerical model of water management scenario of complex coastal aquifers under sea water intrusion pressure.



### Reactive column simulating reactive transfers throughout a continuum water unsaturated - saturated conditions

**NOMENCLATURE DES PROCHES DE PILOTE**

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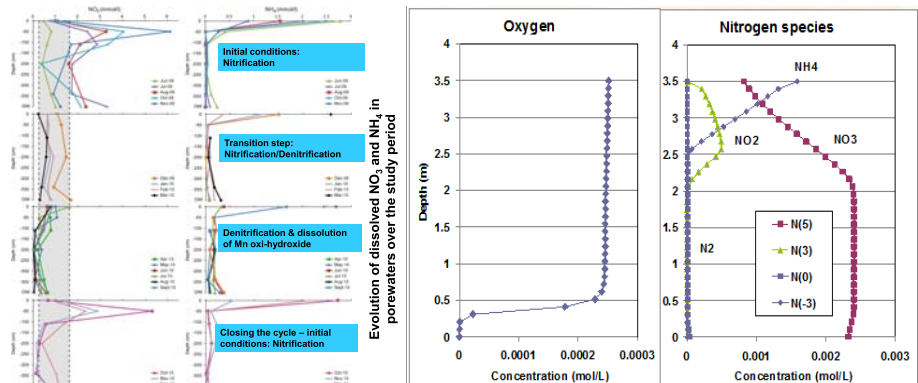
With 42 sampling/measurement points

**Field measurements:**

- pH, T, Eh (Ag/AgCl), Conductivity,
- Dissolved O<sub>2</sub>, NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup>, Fe<sup>2+</sup>

**Analysis in laboratory:**

- Cations & traces (Ca, Na, K, ..., Se, As, Cr, Cu, Mn, Ni, Pb, Zn B)
- Anions (Cl<sup>-</sup>, NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, S<sub>2</sub>O<sub>3</sub><sup>2-</sup>, F<sup>-</sup>, PO<sub>4</sub><sup>3-</sup>, Br<sup>-</sup>) and DIC, NH<sub>4</sub><sup>+</sup>, DOC, <sup>13</sup>C/<sup>12</sup>C ratio, some gases.
- Polluants organiques pesticides, hormones, some emergent pollutants.



## CONCLUSIONS

The joint project BRGM-VEOLIA generated very important results allowing analyzing the effectiveness of various actions being able to be planned to limit the projection of the salt water intrusion and best practices of MAR in various water stressed regions for complex geological structures and different climatic conditions.

The methodology is based on 3 main steps:

- General geological model development integrating geological, sedimentological, geophysical, ... data for each specific site.
- Hydrodynamic model development based/calibrated on piezometric data integrating heterogeneities of the concerned aquifer.
- Model of aquifer management and exploitation scenarios for stressed and overexploited coastal aquifers integrating reactive geochemistry.

## REFERENCES

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## PERSPECTIVES

This multiannual project has developed a general methodology and transferable technology on the MAR site development and / or creation of strategic water reserves in complex geological reservoirs. This concept integrates various scientific and engineering skills from basic geology to the water quality of desalinated and stored water in deep reservoirs. This technology integrates numerical models, techniques for characterization and geophysical and geochemical monitoring as well as the reactivity of the mineral phases with respect to native, stored and/or sea waters taking into account the chemical effects of mixtures. This technology is ready and adapted for industrial deployments in arid and semi-arid climate conditions for various geological settings (sandstone, carbonate, ...) under coastal constraints.