



ismar₁₀
INTERNATIONAL SYMPOSIUM ON MANAGED AQUIFER RECHARGE
Madrid, 2019 May



ASCE AMERICAN SOCIETY
OF CIVIL ENGINEERS

AMPHOS²¹
SCIENTIFIC AND STRATEGIC ENVIRONMENTAL CONSULTING

Roundtable 4
Water
management and
digitalization

Ester Vilanova, Jorge Molinero, Diego Sampietro,
Martí Bayer, Jordi Guimerà

Amphos 21

Amphos 21 Market Sectors

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SCIENTIFIC AND STRATEGIC ENVIRONMENTAL CONSULTING



NUCLEAR
NUCLEAR



MINERÍA
MINING



AGUA
WATER



SOSTENIBILIDAD
SUSTAINABILITY



OIL&GAS
OIL&GAS



Consulting
R&D
Numerical Modelling

A²¹

28/05/2019

Customized apps for MAR with reclaimed water

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28/05/2019

Customized apps for MAR with reclaimed water

5 YEARS
1994
2019
BREAKING THROUGH

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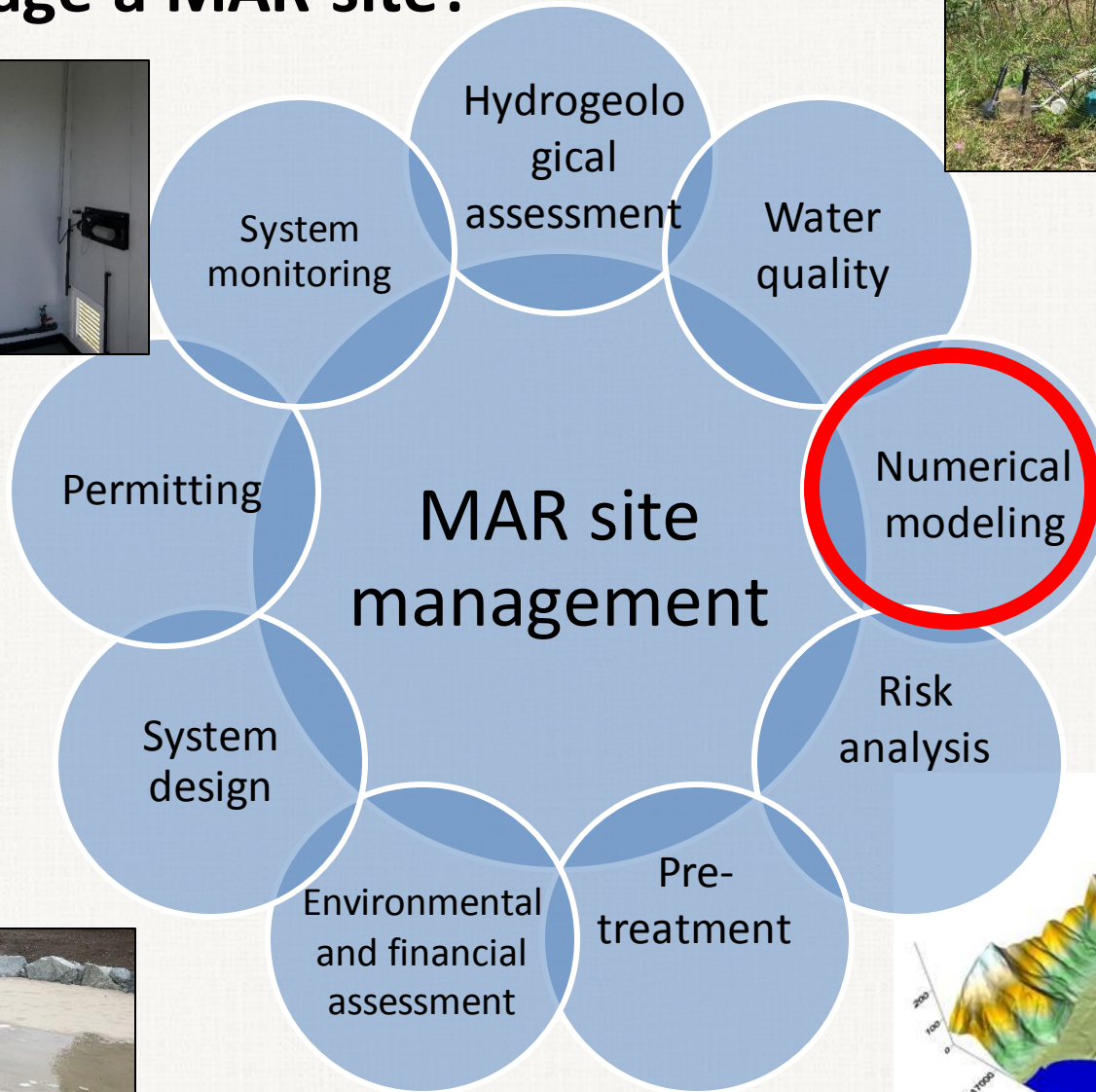
Apps for MAR

- What does an operator needs to manage a MAR site?
- What are the critical parameters for MAR (specially with reclaimed water)?

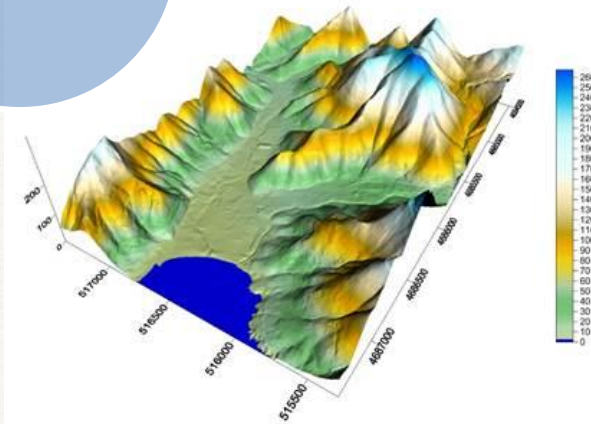




What does an operator needs to manage a MAR site?



for MAR with reclaimed water





Apps for MAR

■ Case study

- EARSAC project lead by TRAGSA
- MAR related to the irrigation with wastewater
- Numerical model to simulate aquifer flow and transport

■ Needs

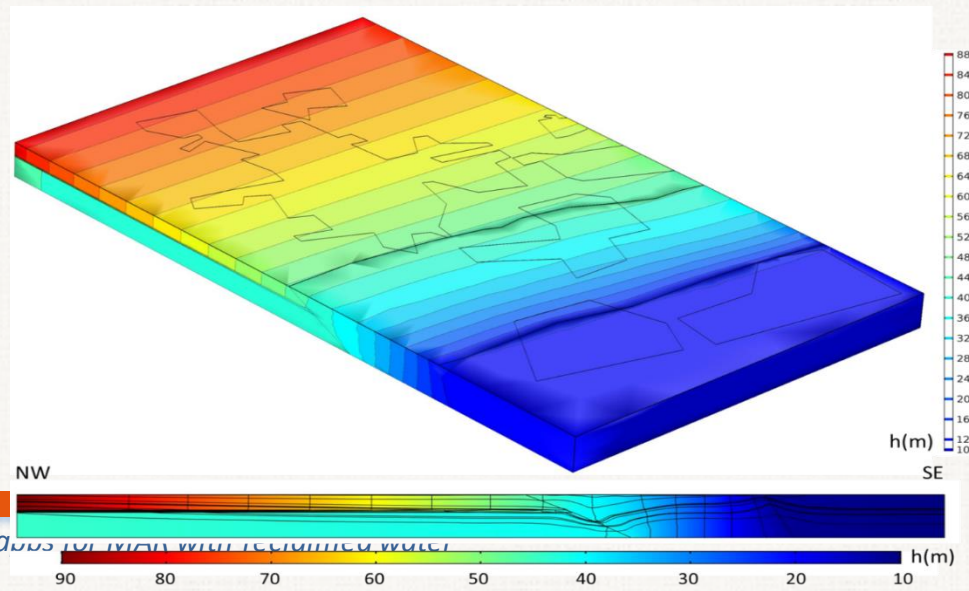
- Irrigation is variable in time and space
- Irrigation water quality is variable along time



Apps for MAR

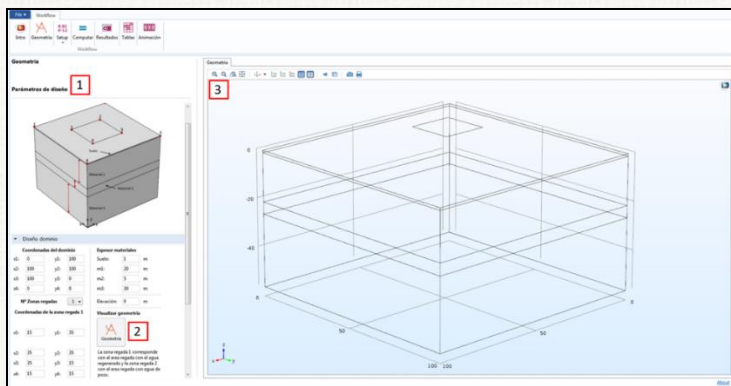
■ Development

- Numerical model using COMSOL MULTIPHYSICS
- Coupled with Phreeqc (Nardi et al., 2014) to simulate geochemical reactions
- Allows the generation of an APP, once the model is developed, where the user can change different parameters or variables (COMSOL SERVER)



Apps for MAR: MARtool

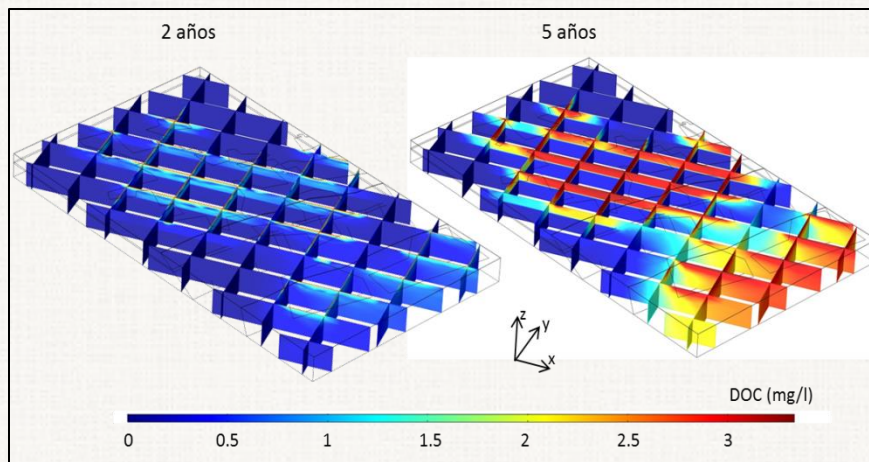
APP to assess the MAR with reclaimed water



Pre-processing

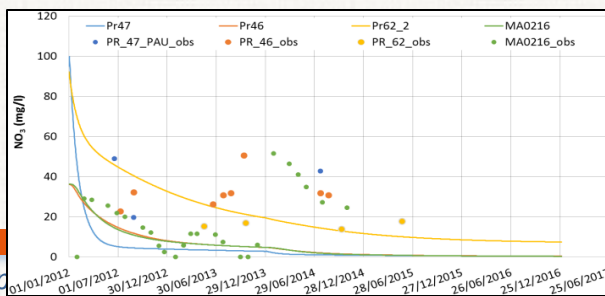
Selection:

Geometry, domain (dimensions, materials).
Dominant processes (Redox, adsorption).
Parameters, initial and boundary conditions
Time stepping.



Post-processing

Time evolution of water quality in 1D, 2D, 3D plots
Export data to other graphical software



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Customized app



Apps for MAR

- What are the critical parameters for MAR with reclaimed water?
 - Residence time
 - Presence of hazardous substances

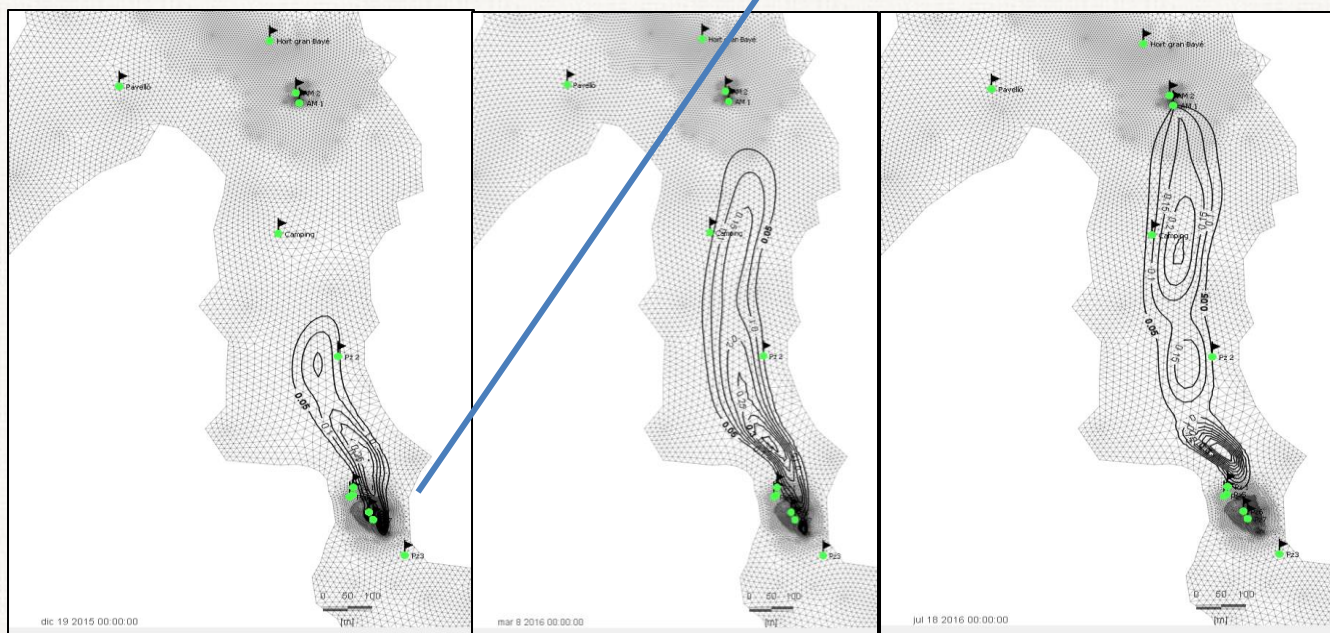
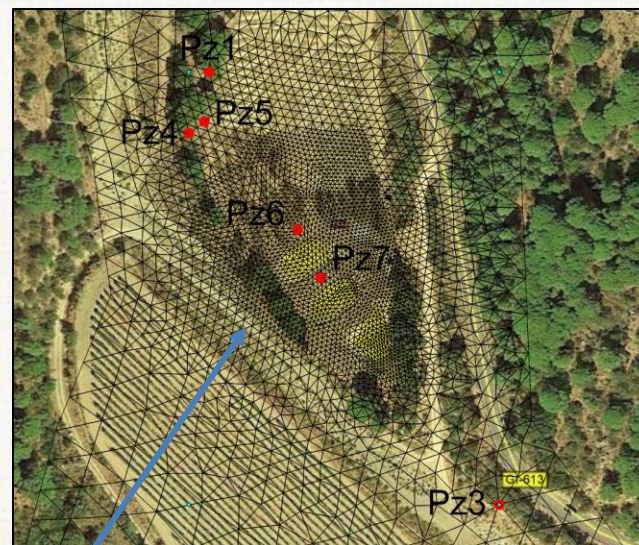


Apps for MAR

Numerical models provide residence time to extraction wells, dilution and biogeochemical reactions



Risk analysis



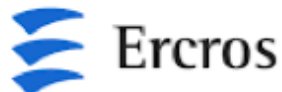
Demoware project

Future challenges

- Fully extend quality issues in predictive tools dedicated to MAR sites.
 - To link models to real time data (DSS)
 - In case of reclaimed water, big data analysis and machine learning can be applied in risk prediction
- Connection with legislation

Thank you!
























Apps for MAR

- What does an operator needs to manage a MAR site?
 - Hydrogeological assesment
 - Numerical modeling
 - Risk analysis
 - Water pre-treatment
 - Environmental and financial assesment
 - Site design and engineering
 - Permitting
 - Monitoring
 - Management



Apps for MAR

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 - **Environmental and financial assessment**
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