



**EU-CHINA  
PIANO**



LABORATÓRIO NACIONAL  
DE ENGENHARIA CIVIL

\*\*\*João Paulo Lobo Ferreira (lferreira@lnec.pt)

**Task 1d: River basin management**  
**Task leader: LNEC; Involved partners**  
**EU: ISPRA, DTU, EWA**

**Task 1e: Water for energy**  
**Task leader: LNEC; Involved partners**  
**EU: DTU, EWA, EDP/Labelec**



## **Task 1a: Agricultural Water Management**

**Task leader: ISPRA; Involved partners EU:**

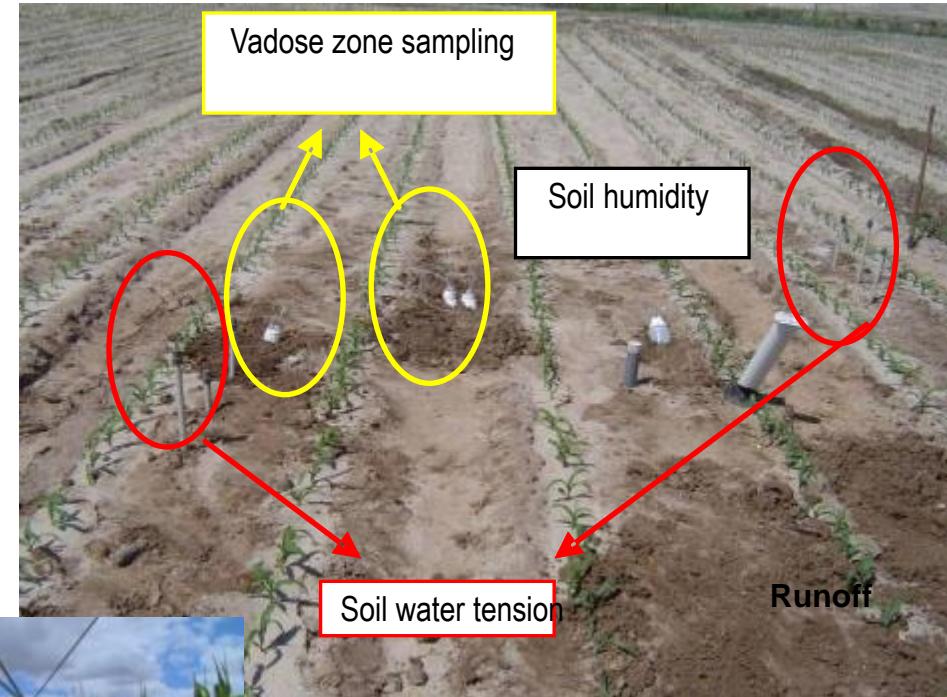
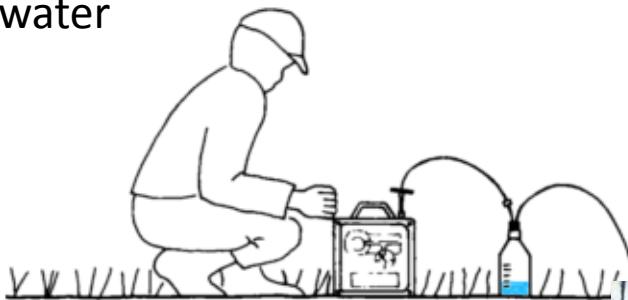
**LNEC, DTU, EWA**

**In the scope of LNEC investigations on diffuse pollution prevention and monitoring, the main goals have been to:**

- Implement the measures necessary to prevent or limit the input of pollutants into groundwater and to prevent the deterioration of the status of all bodies of groundwater ....
- Contribute to support future decisions in terms of more adequate policies regarding rural land use planning (type of crops and associated fertilizers and treatment techniques), taking into consideration the protection of the environment based on vulnerability and risk concepts and a sustainable and integrated water management.



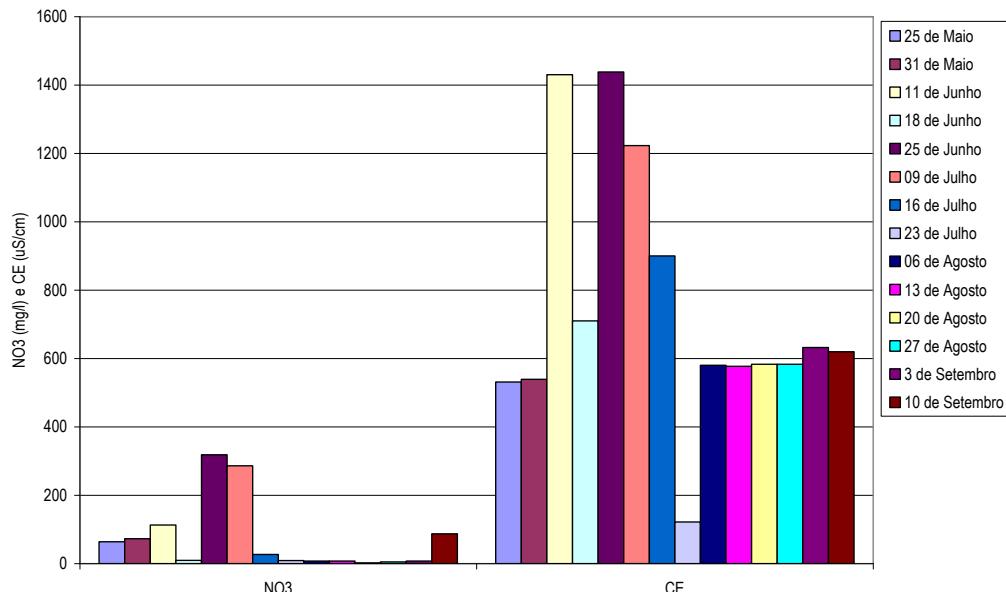
**Monitoring devices:** Runoff, soil, vadose zone, groundwater, surface water



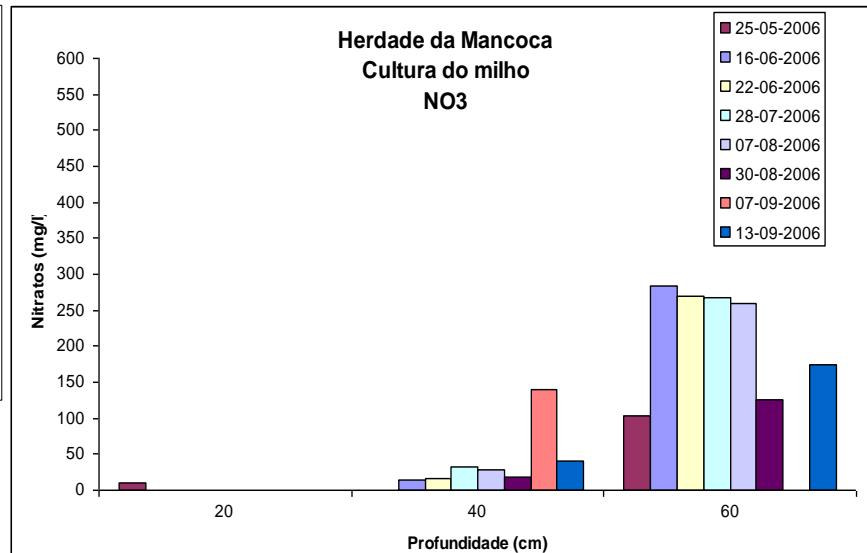
Groundwater

## Monitoring results: runoff and vadose zone

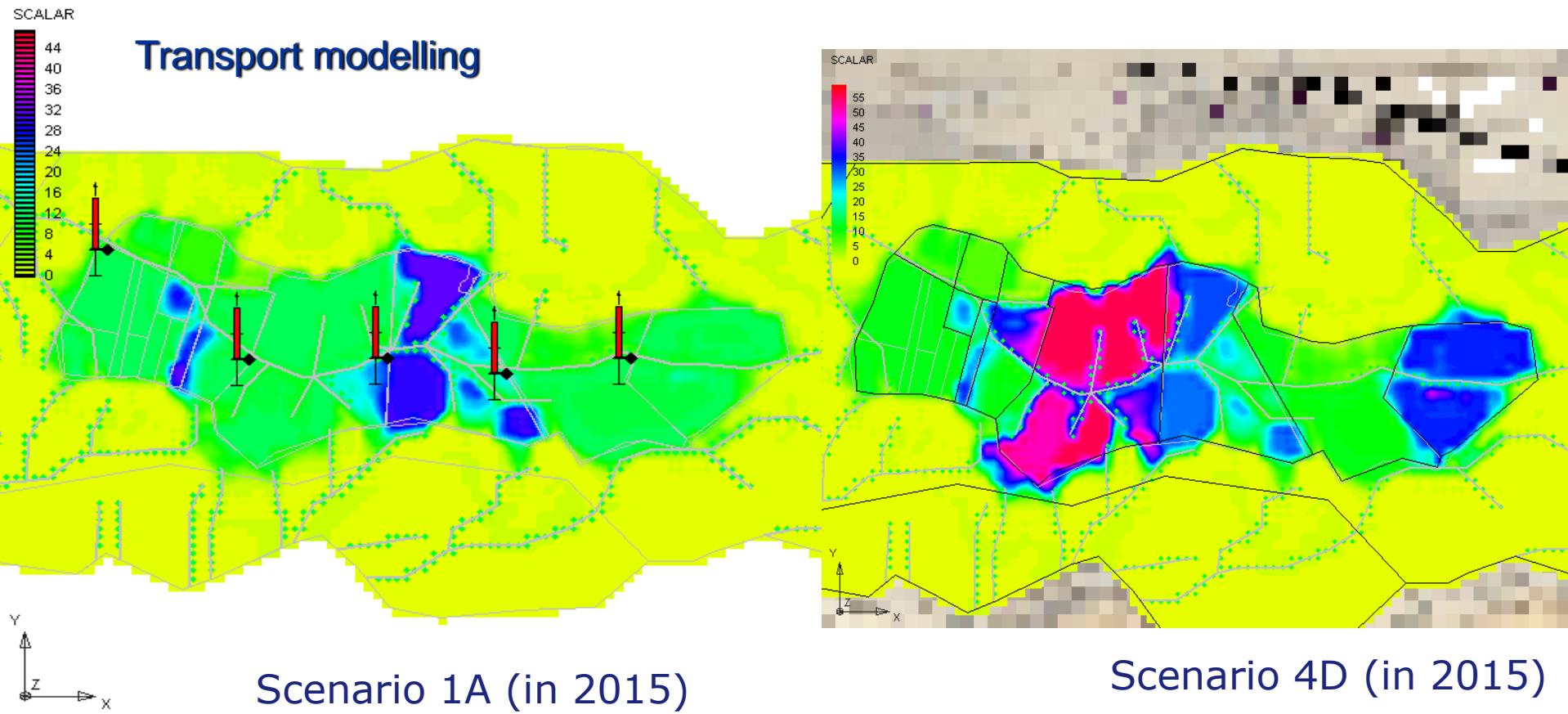
### Runoff: $\text{NO}_3^-$ and Electrical cond.



### Vadose zone: $\text{NO}_3^-$



## Numerical modelling of land use scenarios: groundwater content in nitrates in 2015



Task 1d: River basin management

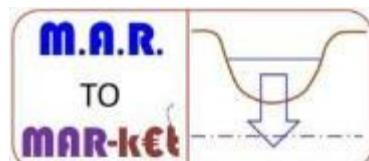
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ISPRA, DTU, EWA



## Innovative groundwater artificial recharge techniques and experiments. Schemes to solve WR problems in EU and China semi arid regions\*\*\*\*



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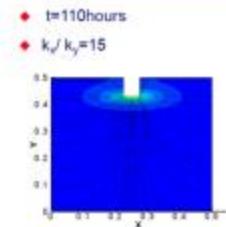


\*<http://www.marsol.eu>

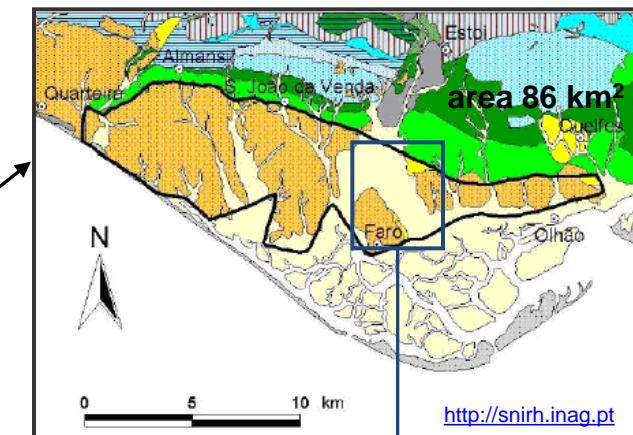
# ARTIFICIAL AQUIFER RECHARGE EXPERIMENTS IN THE PORTUGUESE CAMPINA DE FARO CASE-STUDY AREA, DEVELOPED IN THE FRAMEWORK OF GABARDINE PROJECT

- Flow and transport groundwater modeling for different artificial recharge scenarios in Campina de Faro

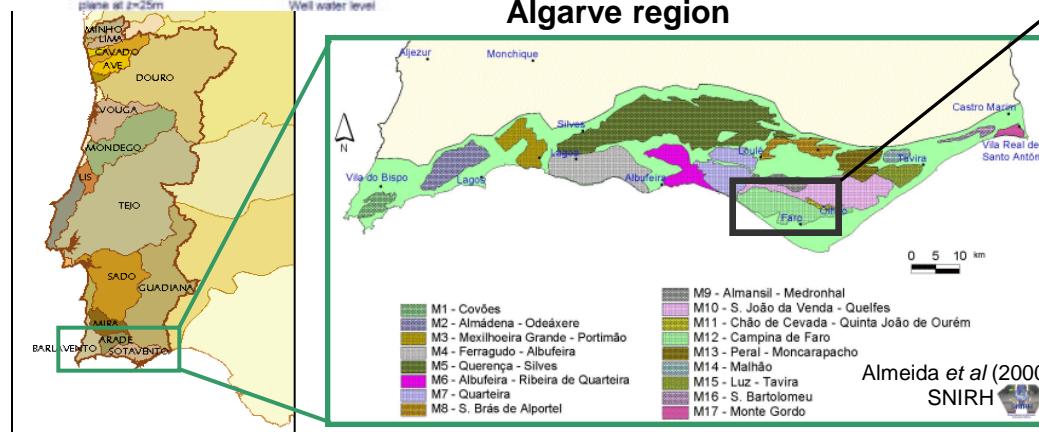
## Portuguese Infiltration well



Aquifer system of  
Campina de Faro

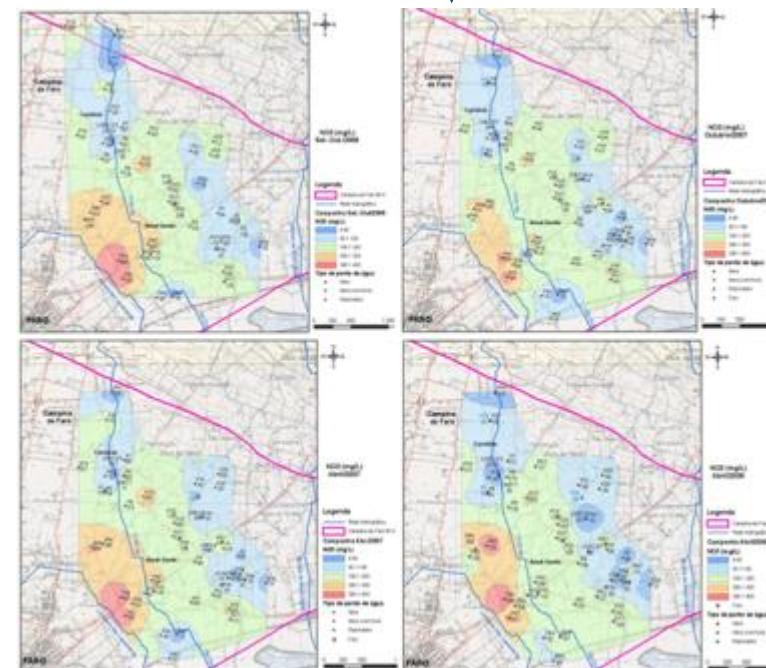
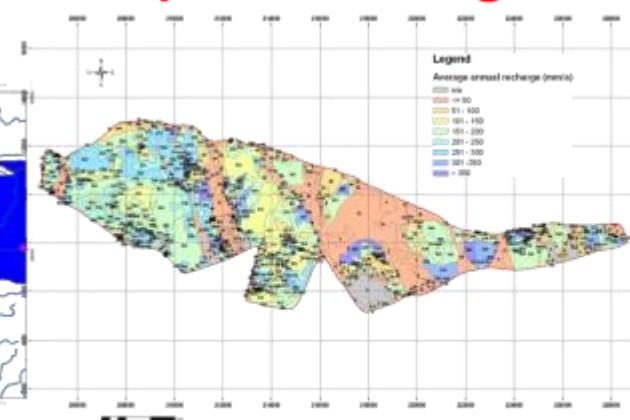


Algarve region



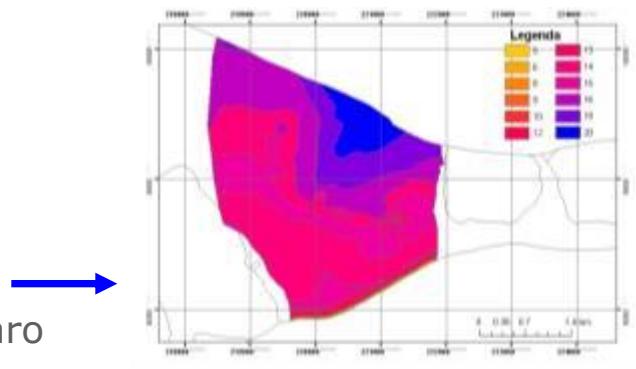
## GABA-IFI<sub>N</sub>

## Aquifer recharge

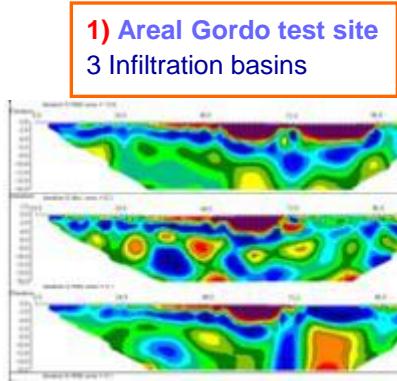


# Main Results/Conclusions

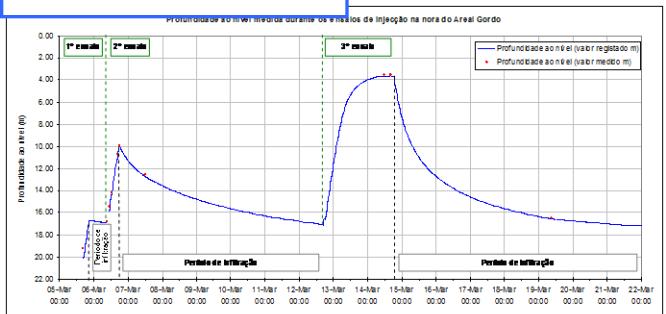
- Methodology to identify preliminary candidate areas to implement artificial recharge (GABA-IFI Index)



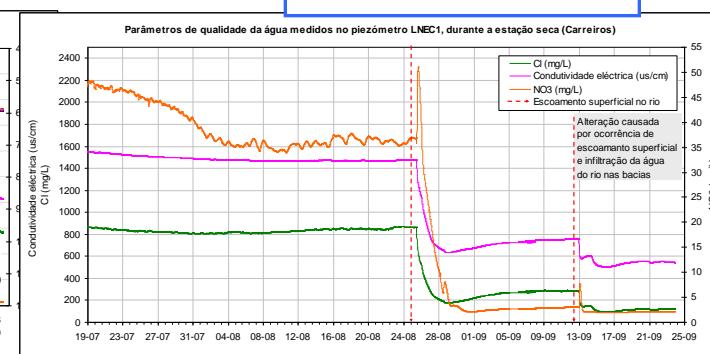
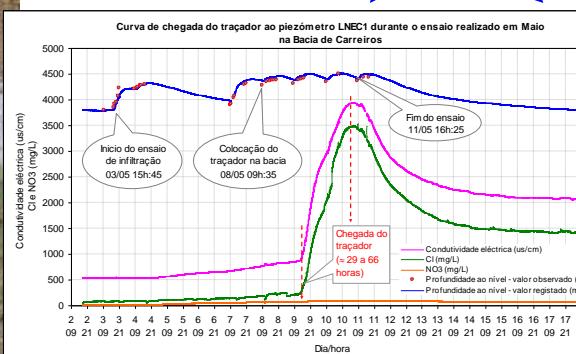
- Artificial recharge infiltration and tracer tests in Campina de Faro



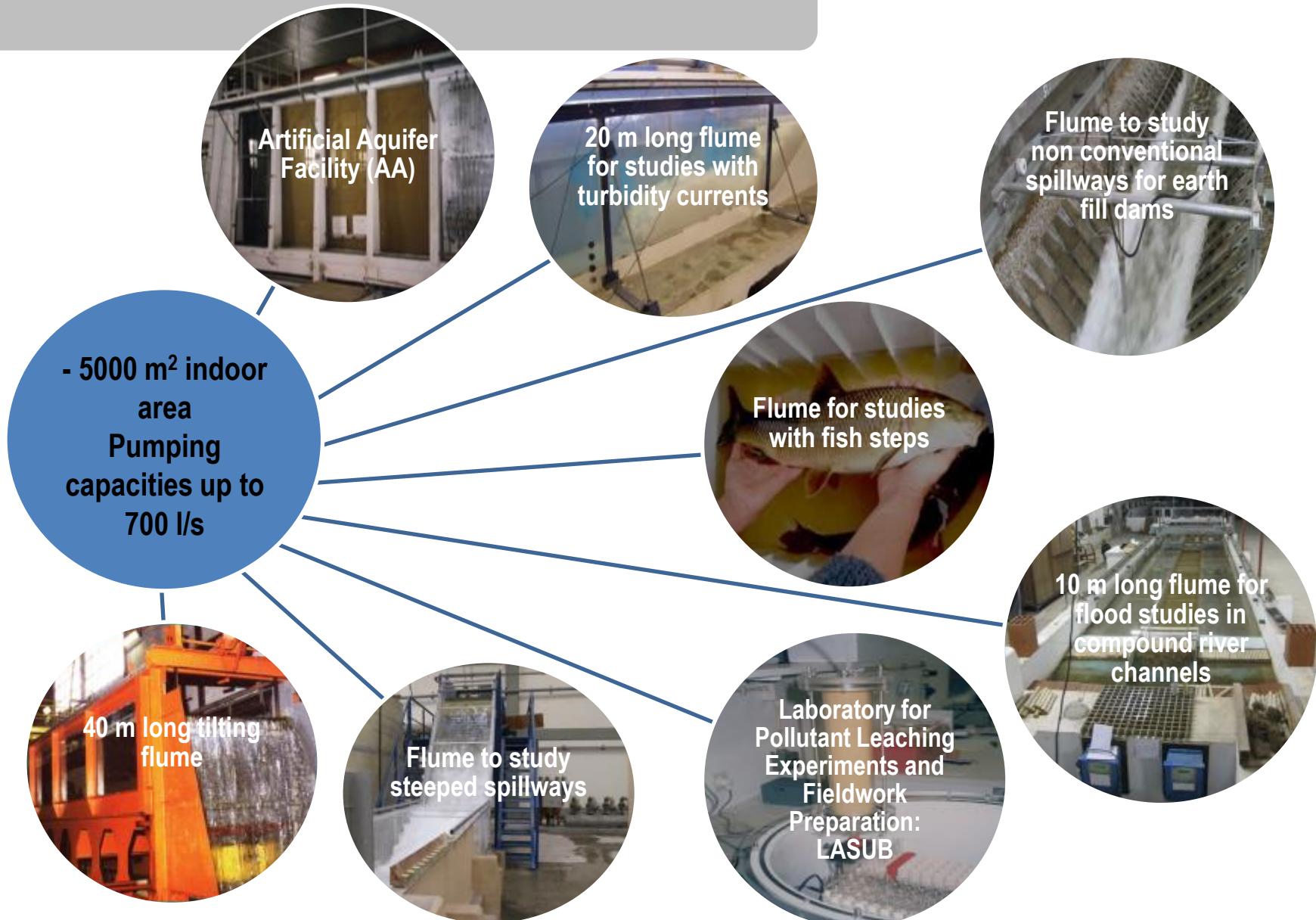
**2A) Areal Gordo test site**  
Injection tests in large diameter well "nora"



**2B) Areal Gordo test site**  
Injection test in medium diameter well



## Experimental facilities



## Research Projects

### ControlSed – CONTROL OF SEDIMENTATION IN RESERVOIRS INDUCED BY TURBITY CURRENTS

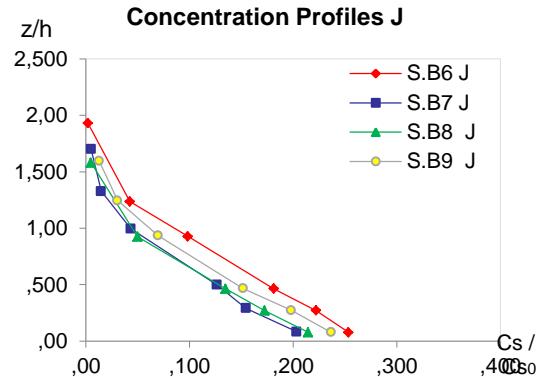
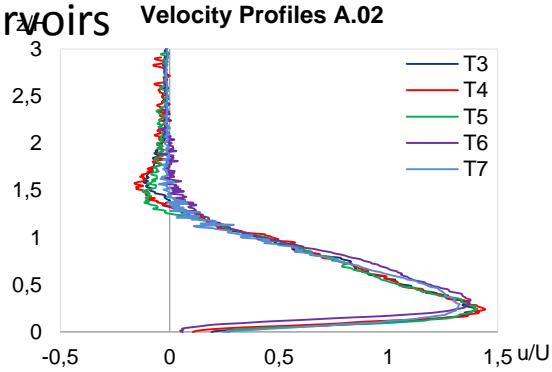
Main objectives:

Blocking the sedimentation of fine sediments in reservoirs

Study the efficiency of placing an obstacle on the bottom of a reservoir to control the deposition of fine sediments

Flow structure of turbidity currents interacting

Numerical model to predict the effects of obstacles on real reservoirs

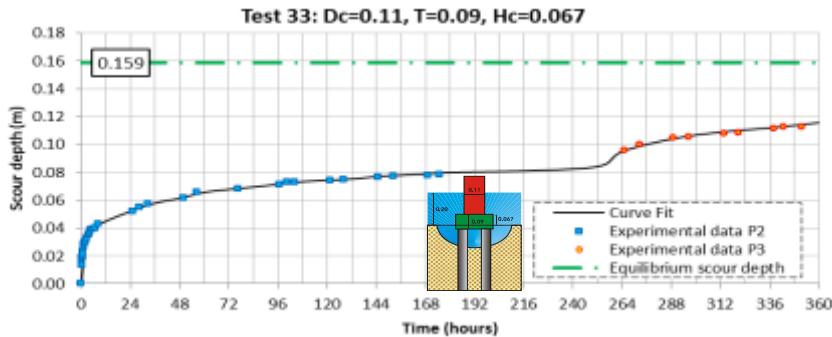


## Research Projects

### COMPLEX - EXPERIMENTAL STUDY ON LOCAL SCOUR AROUND COMPLEX BRIDGE PIERS

Main objectives:

- Methodology to estimate the scour depth around complex piers
- Laboratory tests at 3 Universities and LNEC
- Design Manual and Short Course



# Research Projects

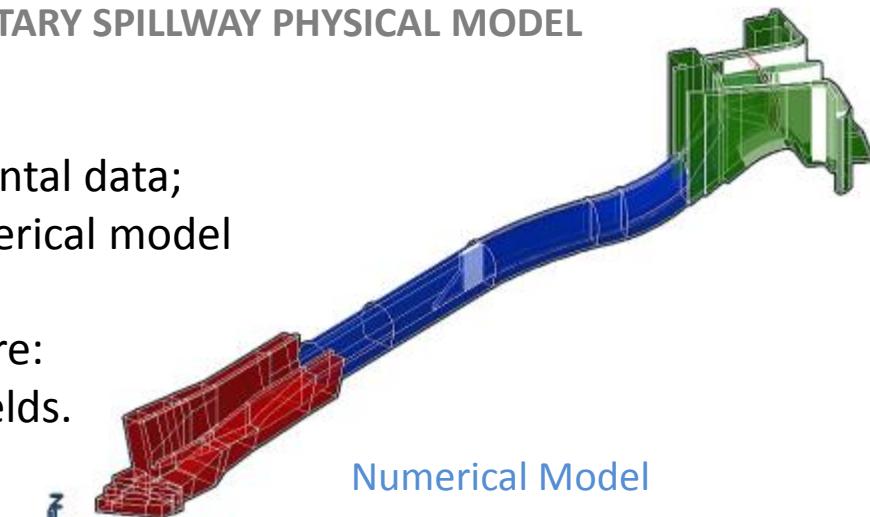
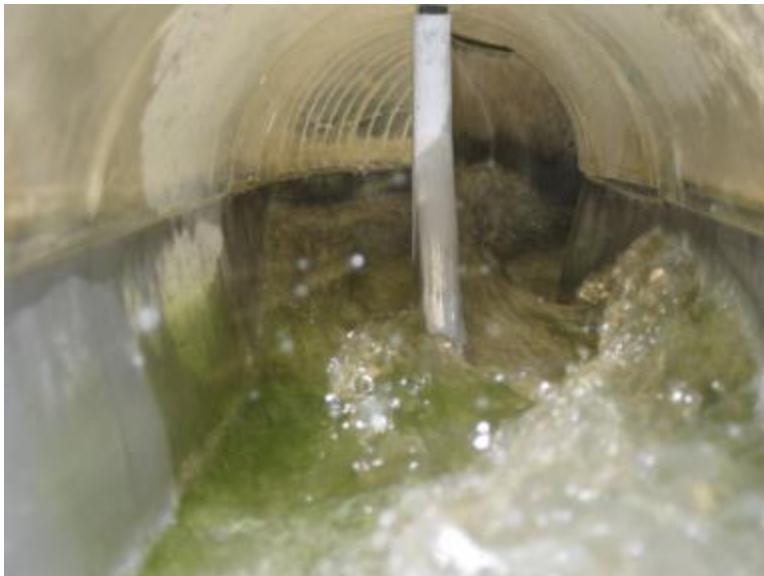
## CALIBRATION OF NUMERICAL MODELING BASED ON PHYSICAL MODELS

CASE STUDY: SALAMONDE DAM COMPLEMENTARY SPILLWAY PHYSICAL MODEL

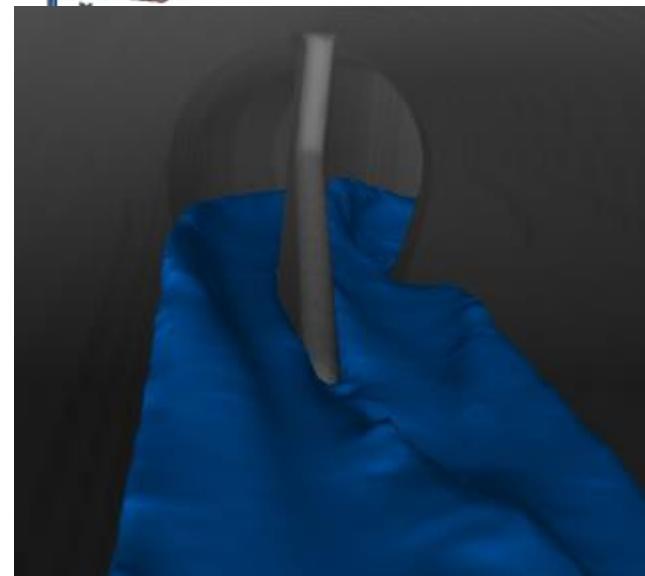
Main objectives:

- Calibration of numerical models using experimental data;
- Comparison of flow height obtained in the numerical model with the observations in the physical model;
- Use of “Flow 3D” to calculate, along the structure:
  - pressures, water levels, jet impact, velocity fields.

Physical Model



Numerical Model



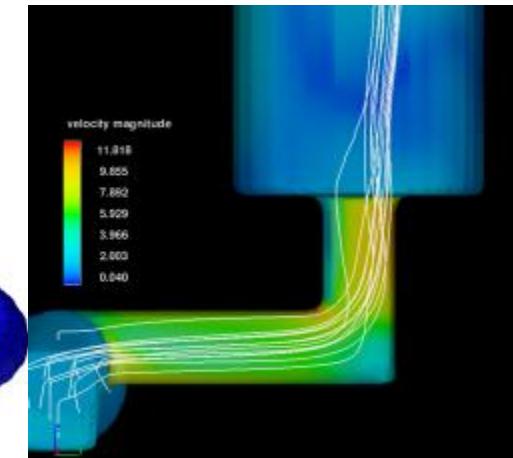
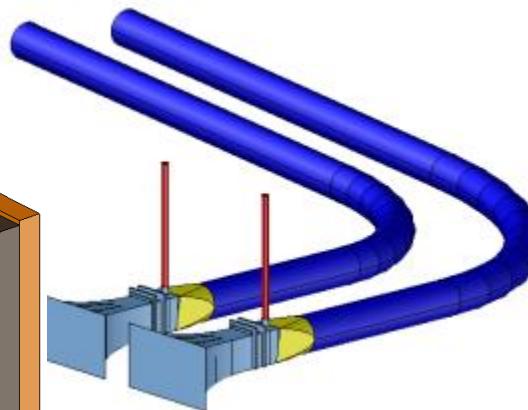
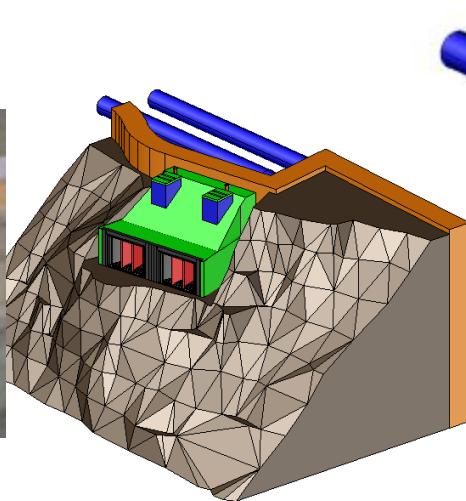
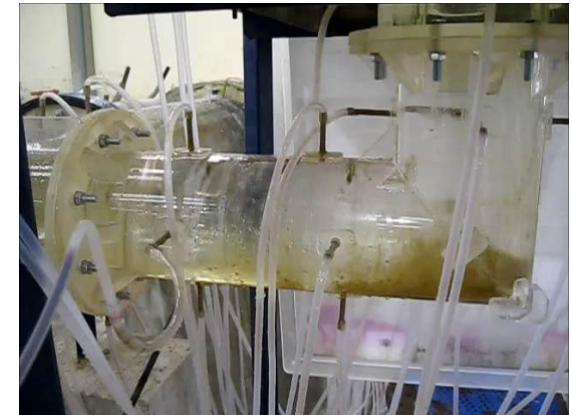
## 5. Research Projects

### NUMERICAL MODELING OF COMPLEX FLOWS IN HYDRAULIC STRUCTURES

**STUDY CASES:** FOZ TUA DAM WATER INTAKE, SALAMONDE II WATER INTAKE AND SURGE TANK

#### Main objectives:

- Calibration of CFD numerical models using experimental and physical models
- New measurement and flow visualization techniques (UVPs, ADVs, PIV)
- Study of alternative design forms

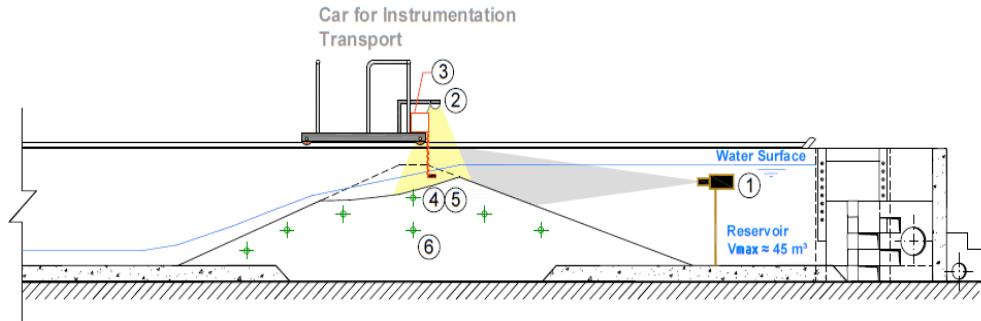


# Research Projects

## PIRE – Modeling Flood Hazards and Morphological Impacts of Levee Breach and Dam Failure

### Main objectives:

- Development of a conceptual model for dam breaching
- Mathematical modelling of breaching processes on earth dam failures caused by overtopping
- Development of advanced experimental techniques to measure dam breaching and flow



#### LEGEND

- 1 - Video Camera HD (inside a waterproof case)
- 2 - Laser System Illumination or Fluorescent Light Illumination (for proper breach evolution recording)
- 3 - System of Linear Guidance (for UVPs and MPMs displacement)
- 4 e 5 - Bat of UVPs and MPMs
- 6 - Interstitial Pore Pressure Transducers

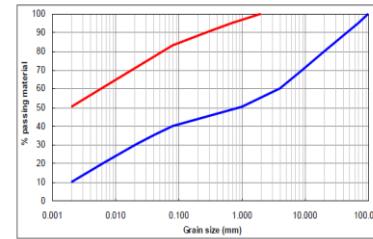
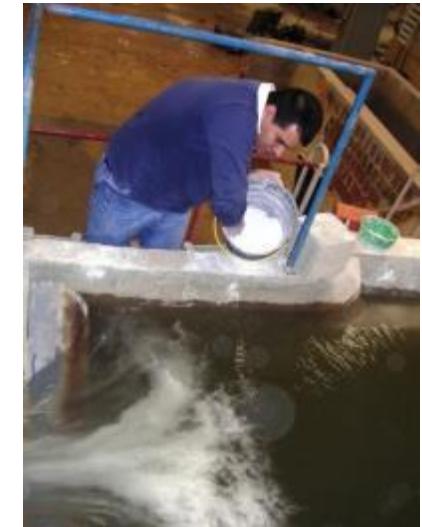


Fig. 4 - Reference Sieving curves for the failure tests of homogeneous earth dams  
— Characteristic sieving curve of Portuguese earth dams;  
— Characteristic sieving curve of Portuguese earth dams with maximum geotechnical reduction.



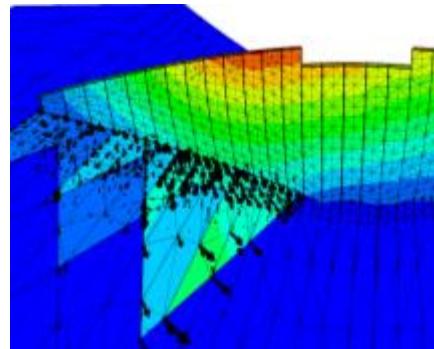
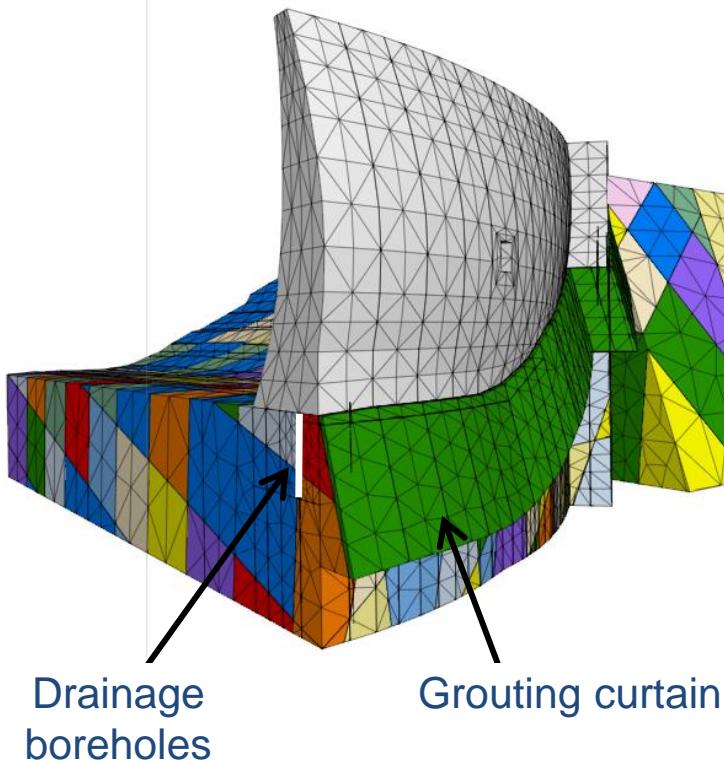
## Task 1e: Water for energy

Task leader: LNEC; Involved partners EU: DTU, EWA, EDP/Labelec

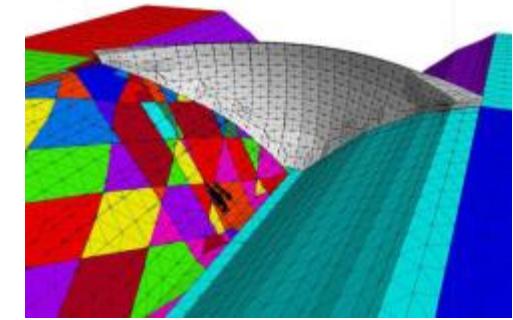
## Dam Foundation in Rock Masses

- Foundation treatment
- Hydromechanical behaviour
- Safety evaluation up to rupture of the rock masses

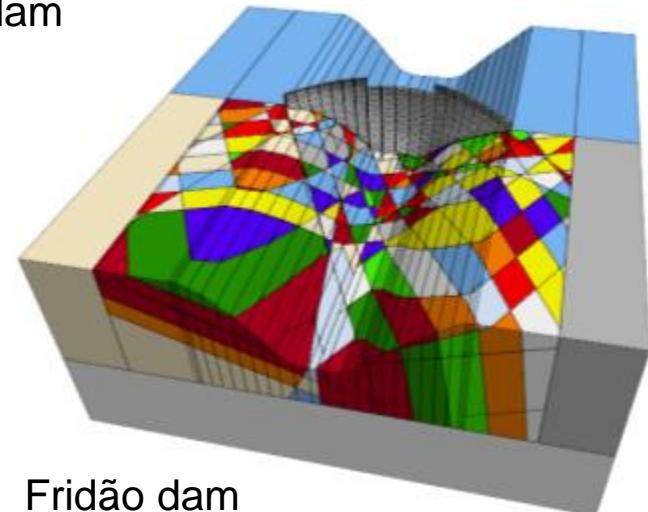
Alqueva dam



Baixo Sabor dam



Alto Tâmega dam



Fridão dam

# Monitoring and modeling the dynamic behavior of concrete dams

In the scope of LNEC investigations on safety control of large dams it was recently installed in Cabril dam a long-term dynamic monitoring system.

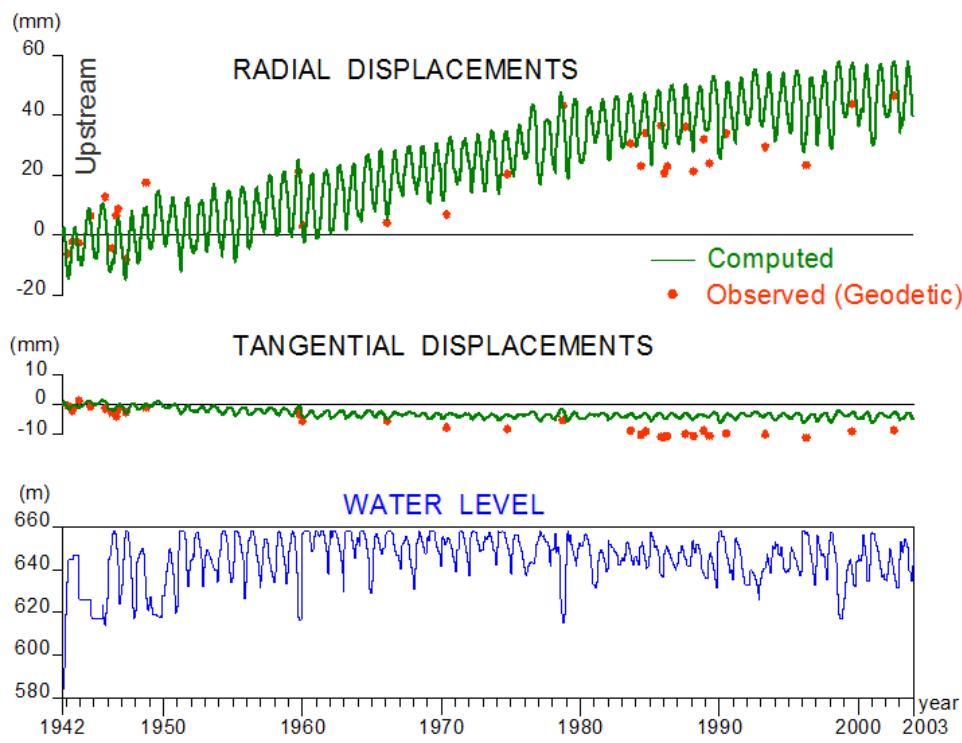
The measured acceleration records can be used:



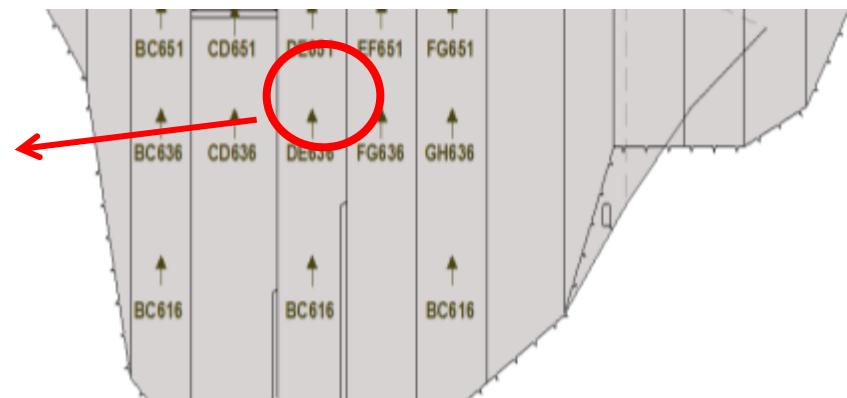
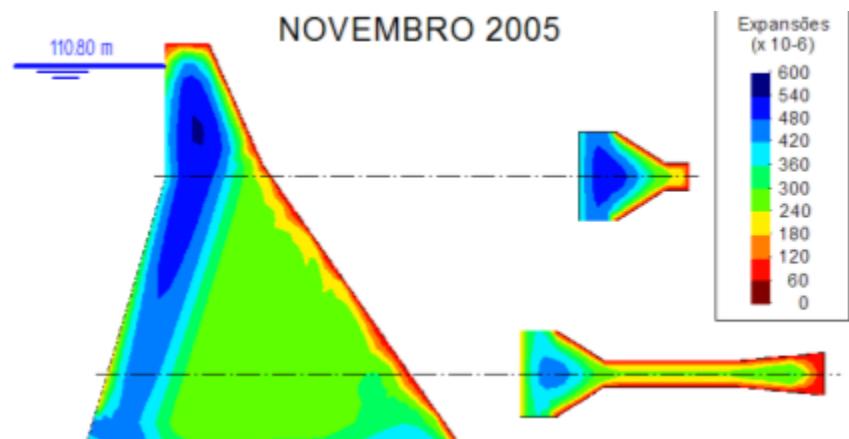
- to study the time evolution of the main modal parameters (natural frequencies, modal damping and mode shapes)
- to study the correlation between changes in the modal parameters and structural changes due to deterioration processes
- to study the dynamic dam response under ambient/operational excitation and under seismic loads
- to study the influence of the reservoir on the structural dynamic behavior of the system dam-foundation-reservoir
- to calibrate/validate finite element models in order to obtain reliable numerical tools for the assessment of the dam safety

# Analysis of swelling processes in concrete dams

Cracking patterns (Alto Ceira dam)



Swelling computations in function of the temperature and moisture fields (Pracana dam)



Analysis over time  
(Santa Luzia dam)

# LNEC Participants and Acknowledgements

- LNEC

- Dr.-Ing.Habil. J.P. Lobo-Ferreira (LNEC contact person for PIANO proposal & Task 1d: Managed Aquifer Recharge Strategies and Actions)  
Dr. Teresa E. Leitão (LNEC Hydraulics and Environment Department contact person for Task 1.a: Agricultural Water Management)  
Dr. Luís Lamas (LNEC Concrete Dams Department contact person for Task 1.e: Water for energy)  
Dr. José Melo (LNEC Hydraulics and Environment Department contact person for Task 1d: River basin management / dam safety and dam flood risk management)

- EDP/Labelec

- Dr. João Pádua (LNEC subcontractor for Task 1.e: Water for energy)

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