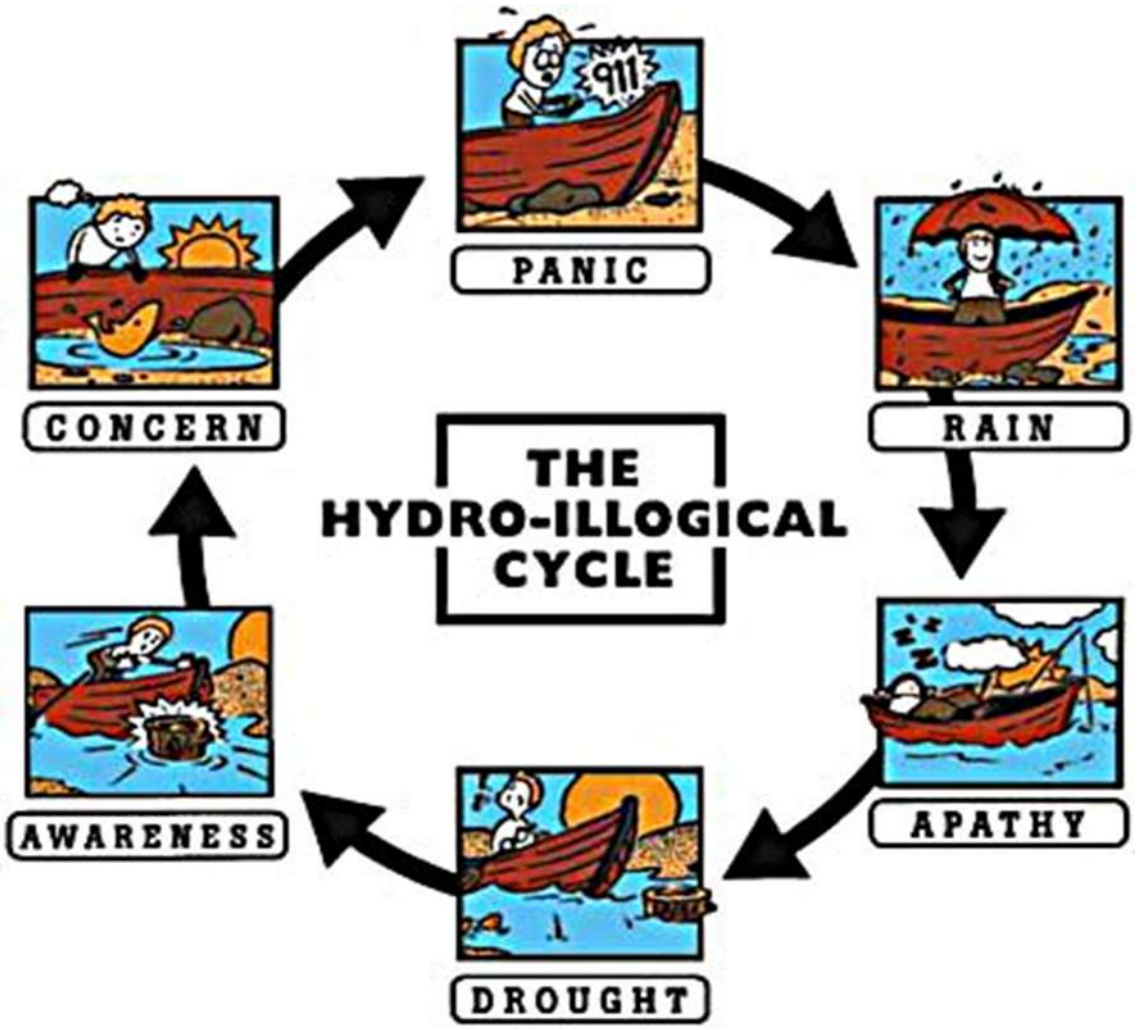
Innovative groundwater artificial recharge techniques and experiments. Schemes to solve WR problems in the Mediterranean Region

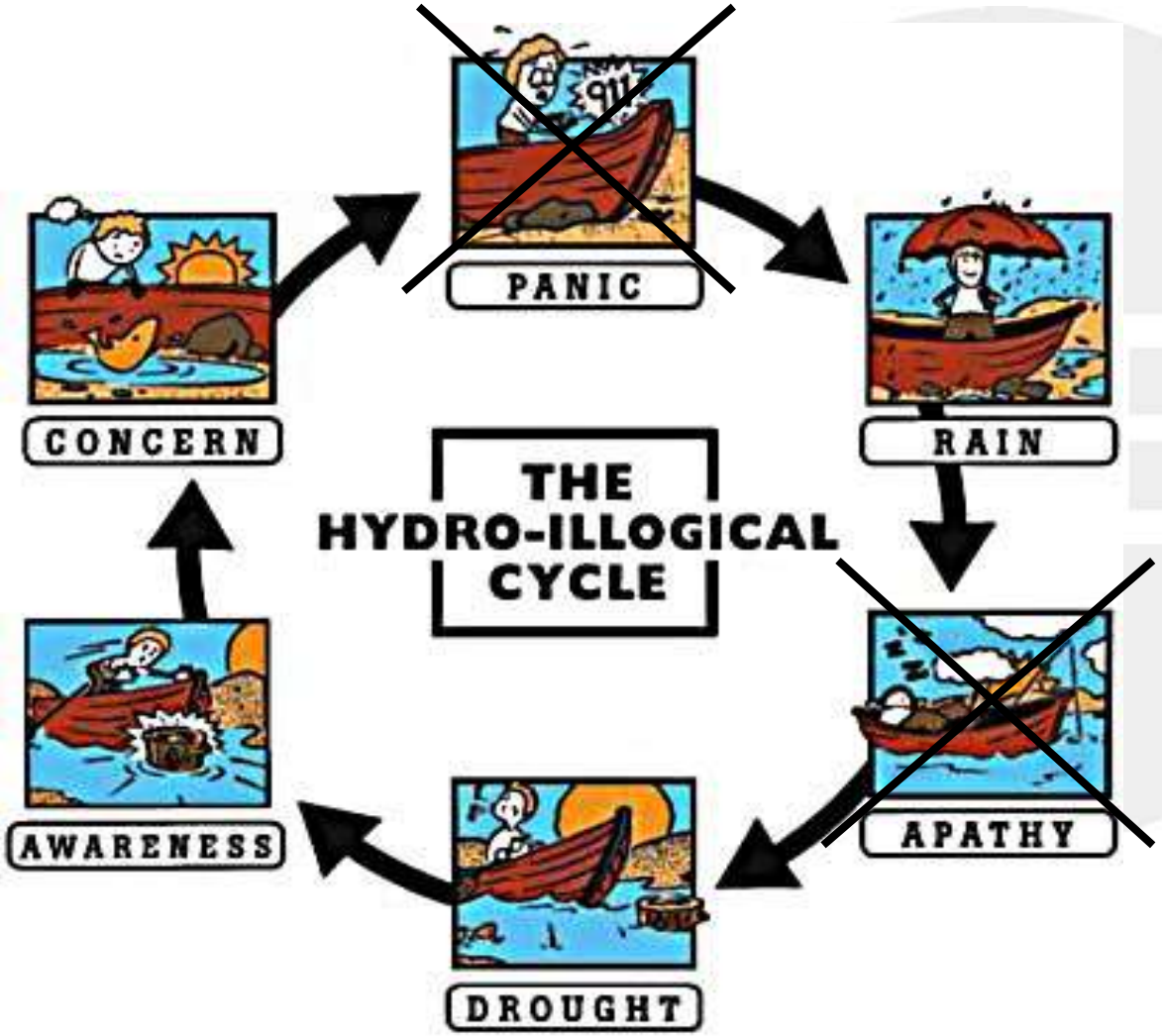
João Paulo Lobo Ferreira (lferreira@lnec.pt)

*http://www.marsol.eu

INTRODUCCIÓN



Drought : A behaviour problem



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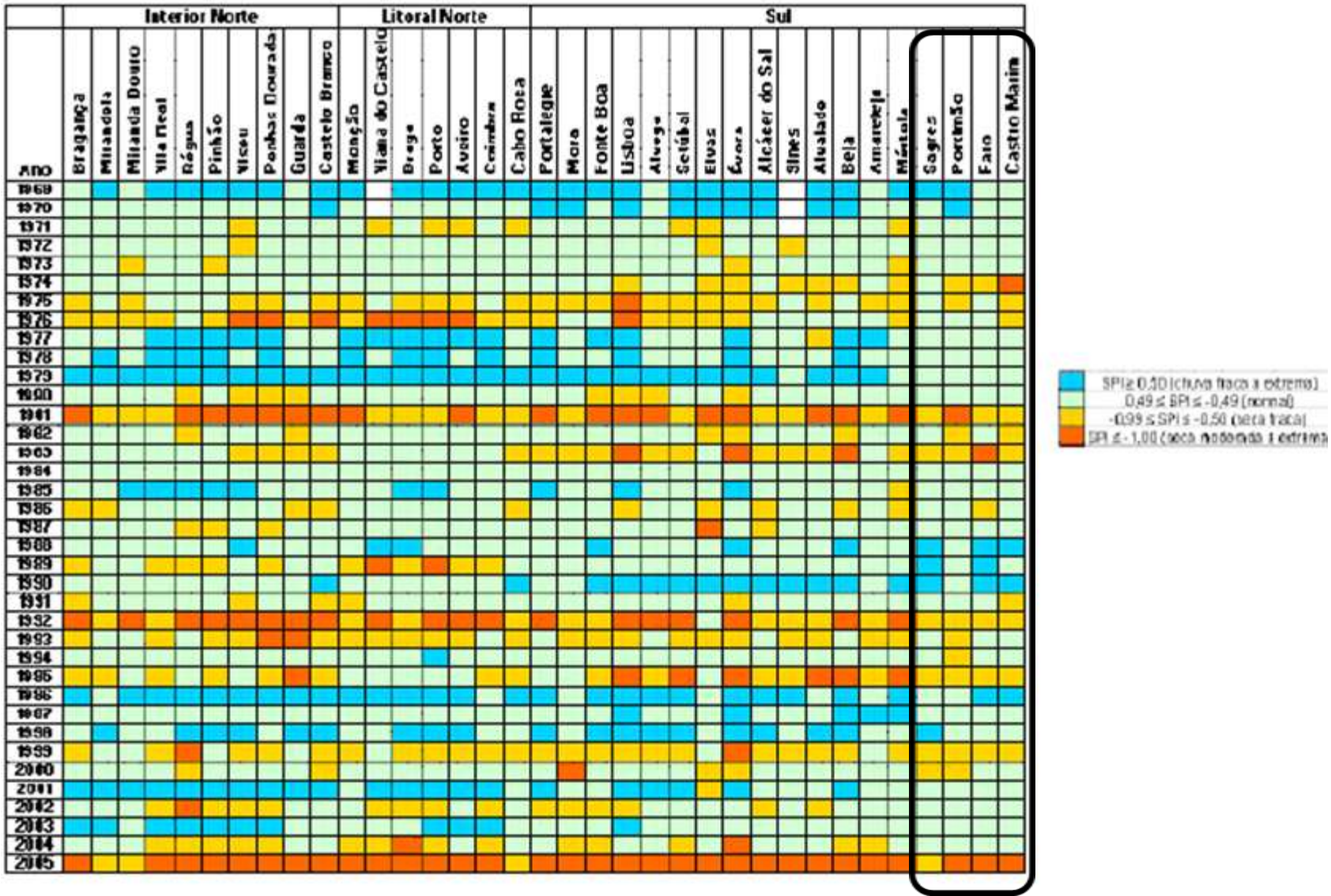
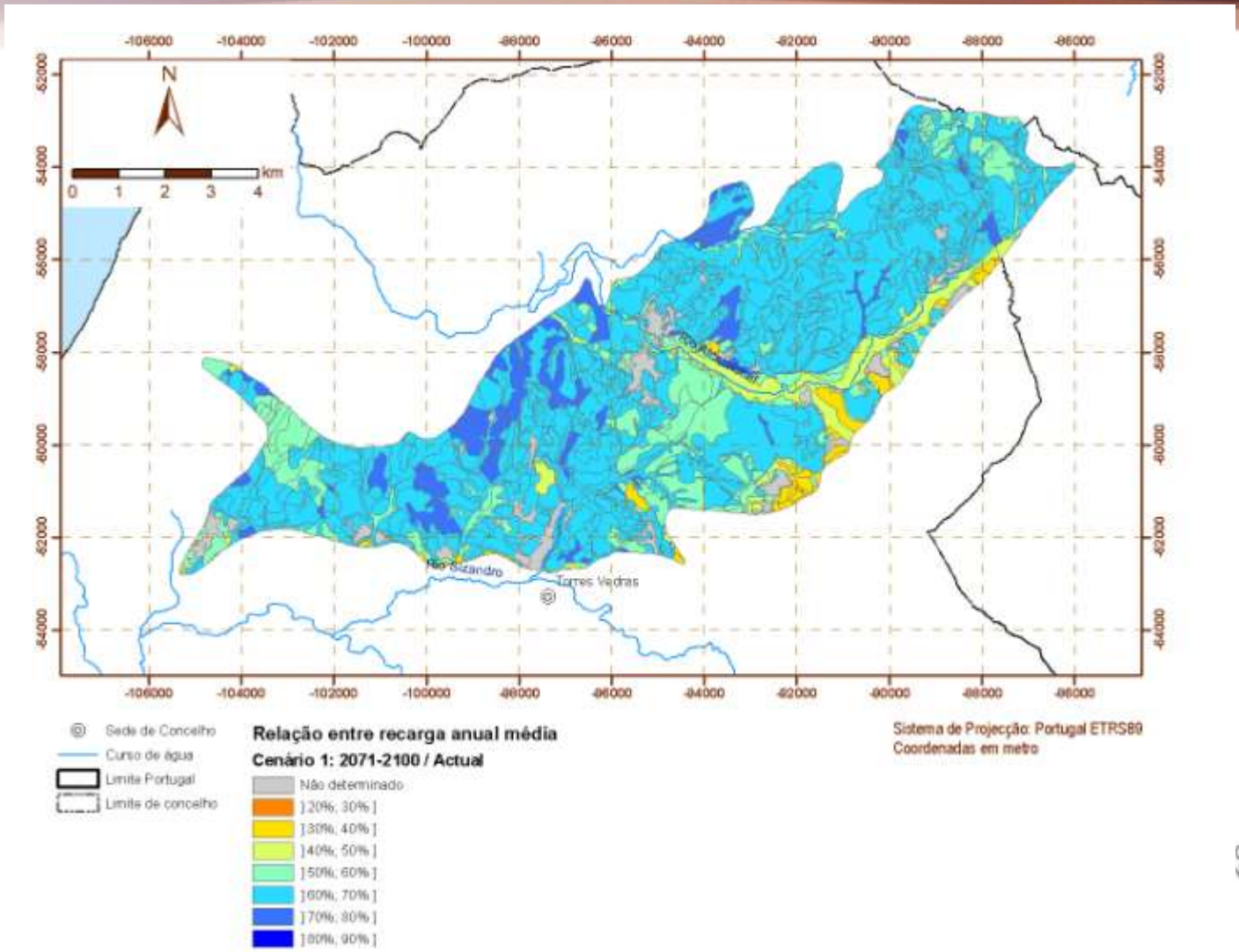
Precipitation natural variation in Mediterranean countries: the example of Portugal



5. DIAGNOSIS: IMPLICATIONS OF CLIMATE CHANGE FOR GROUNDWATER RECHARGE



Torres Vedras groundwater body

Climate change impacts on the behaviour of aquifers and consequently on Groundwater Dependent Ecosystems

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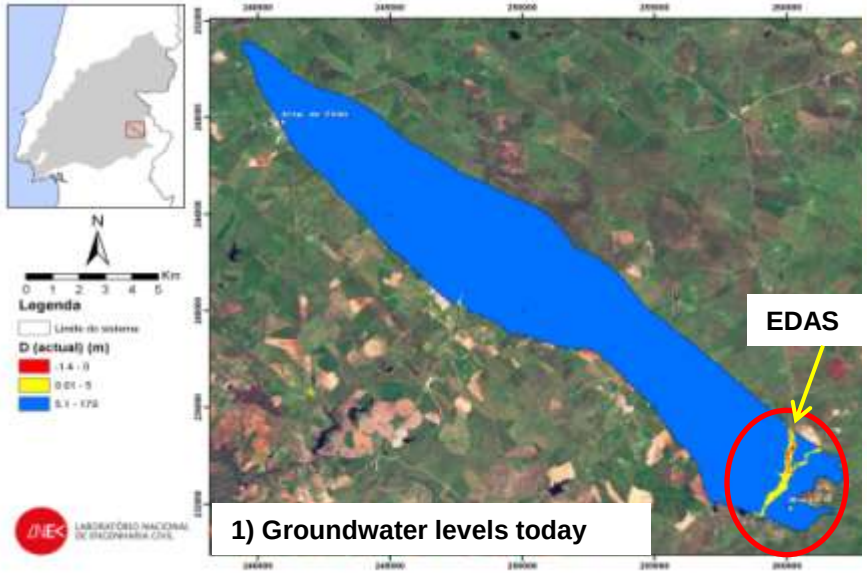
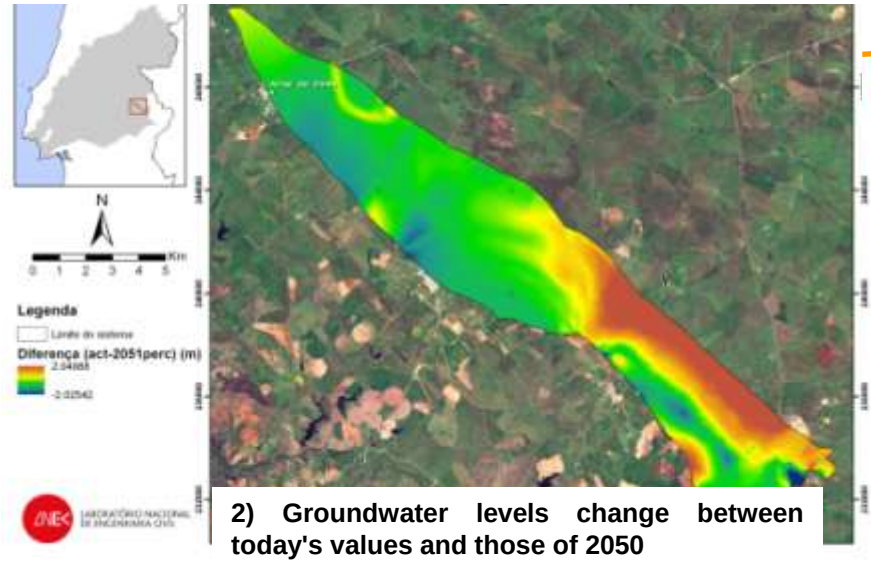
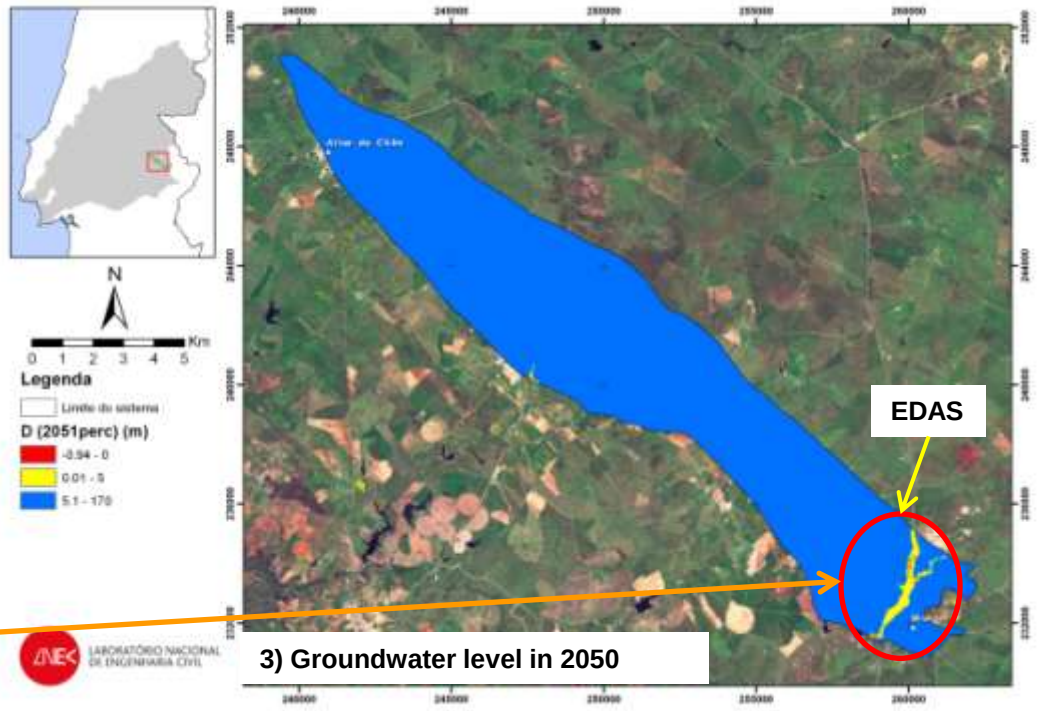
> Groundwater levels change due to groundwater recharge decrease



1) Groundwater levels today



2) Groundwater levels change between today's values and those of 2050



3) Groundwater level in 2050

> Consequences of aquifer behaviour change:

- **Modifications in groundwater recharges amounts and periods**
- **Modification in groundwater flow directions**
- **Modification in the amount of groundwater reaching GW dependent ecosystems**
- **Modification on the behaviour of GW dependant ecosystems (eventually at risk)**

Sources for the artificial recharge : Quantity

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Dam	Hydrological year	Depth discharge (*10^3 m^3)	Surface discharge (*10^3 m^3)	Total discharge (*10^3 m^3)
ARADE	2000/2001	37 499.20	19 256.70	56 755.90

Dam	Hydrological year	Depth discharge (*10^3 m^3)	Surface discharge (*10^3 m^3)	Total discharge (*10^3 m^3)
ARADE	1995/96	0	81 255.39	81 255.39
	1996/97	0	42 599.62	42 599.62
	1997/98	8 556.65	113 762.30	122 318.97
			TOTAL (*10^3 m^3)	**246 173.98**

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During the extreme drought of 2004/2005

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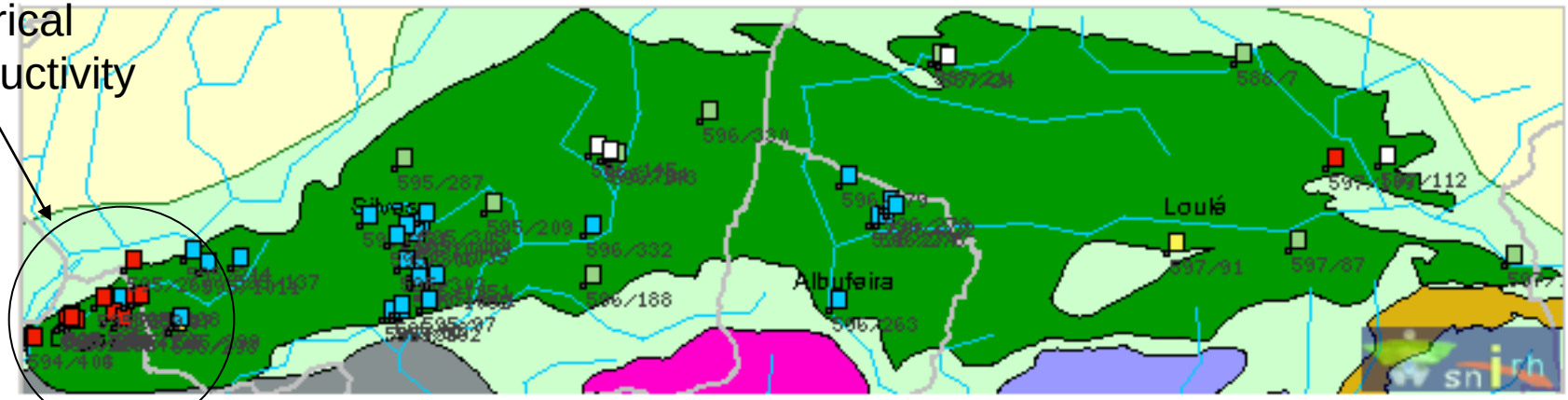
	Volume of withdrawal water (*10 ^{6} m ^{3})	Percentage
Agriculture	23.79	47.31%
Urban supply of the *Águas do Algarve* regional system of Algarve	14.25	28.34%
Urban supply of the local municipalities	12.25	24.36%
Private users	Not Available	-
Total	50.29	100%

Electrical Conductivity



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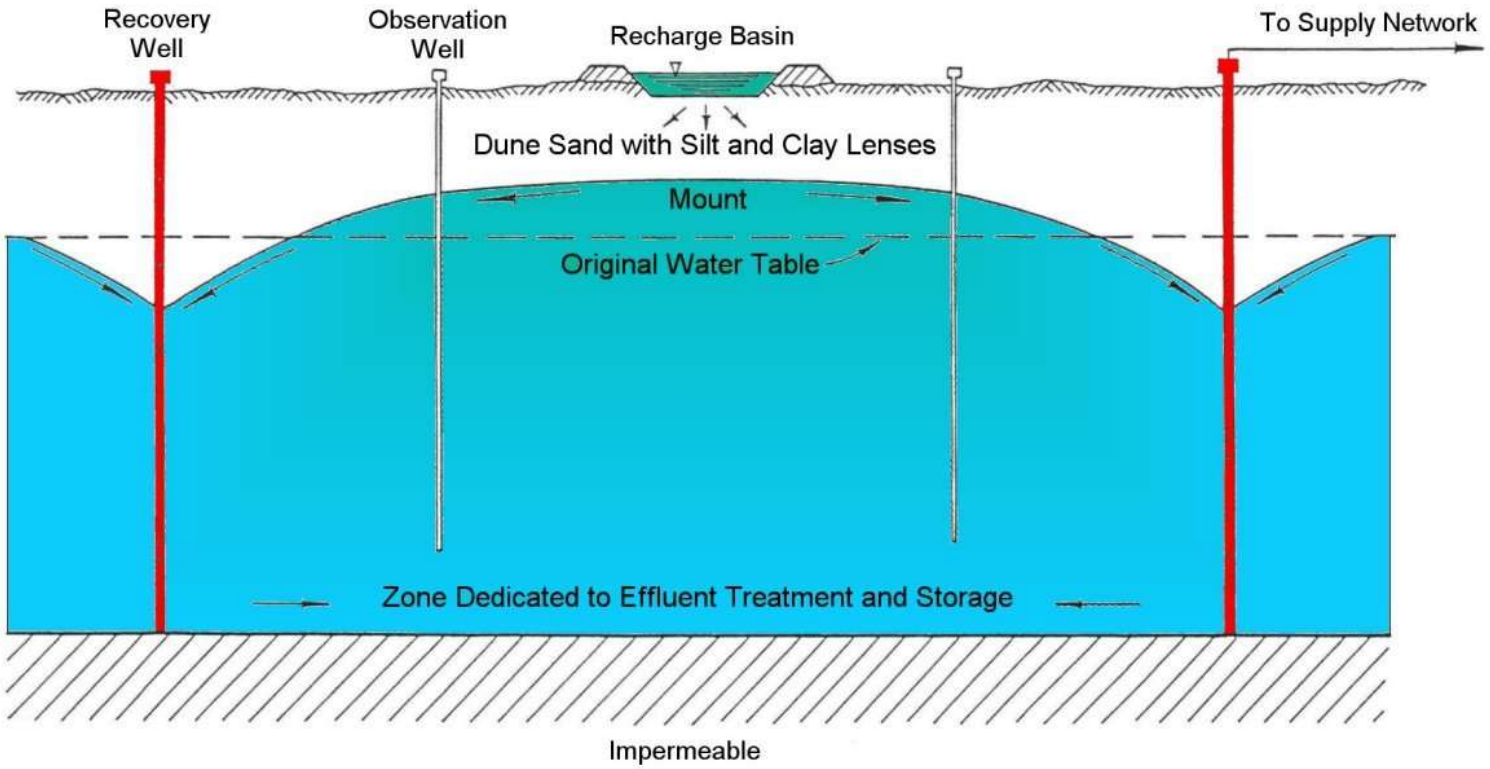
Simplified Recharge-pumping scheme



Recharge - Recovery Scheme

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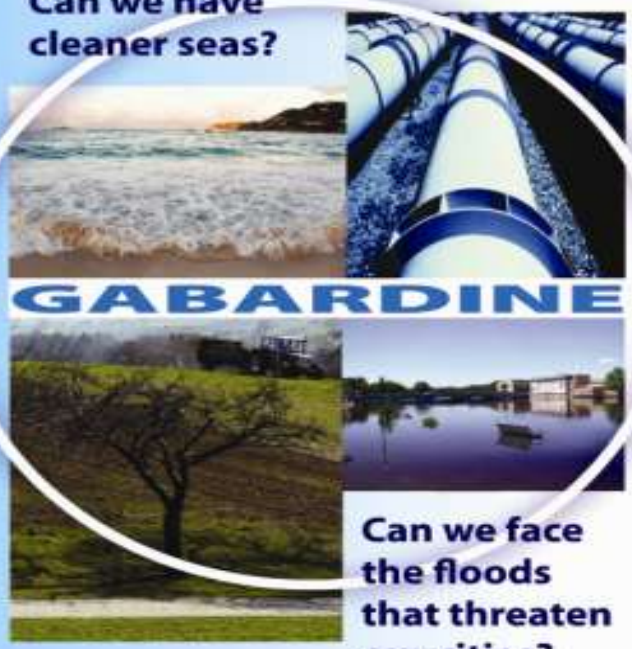

Project financed from the 6th Framework Program of the European Union

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GABARDINE

Groundwater artificial recharge based on alternative sources of water: advanced integrated technologies and management

Contract no.: 518118-1

SIXTH FRAMEWORK PROGRAMME
PRIORITY 1.1.6.3
Global change and Ecosystems

DELIVERABLE 51

Test sites and their characteristics

Due date of deliverable: November, 2006
Submission date to EC: December, 2006

Start date of Project: November, 1st , 2005
Duration: 3 years

Coordinating Authors: João Paulo Lobo Ferreira, Catarina Diamantino, Maria João Moinante, Manuel Oliveira, Teresa Leitão, Maria José Henriques, Albino Medeiros (LNEC).

Participating Authors from each Test Site: Klisthenis Dimitriadis and Mike Styllas (GEOSERVICE), Thanassis Soupilas (EYATH), Panagiotis Maheras, Christina Anagnostopoulou, Konstantia Tolika, Margaritis Vafiadis, Christos Machairas (AUTH), Xavier Sanchez-Vila and Manuela Barbieri (Universitat Politecnica de Catalunya), Jacob Bensabat (EWRE), Avichai Hadad (HSI), Ayman Rabi and Abdel Rahman Tamimi (Palestinian Hydrology Group).

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Organisation name of lead contractor for this deliverable: Laboratório Nacional de Engenharia Civil - LNEC

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

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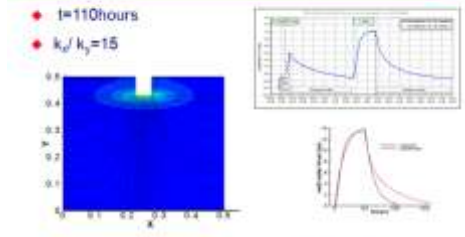
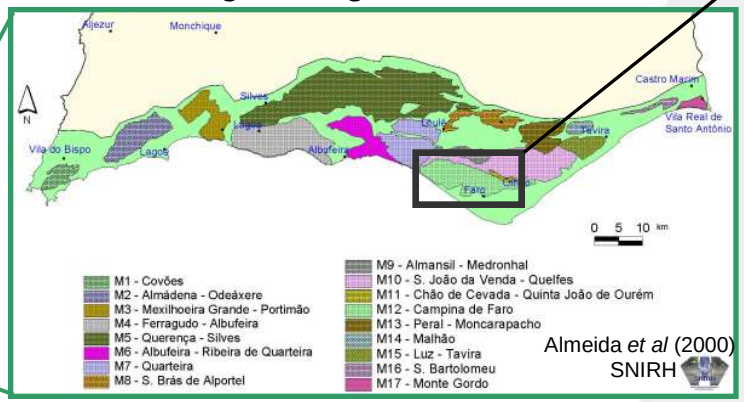
•Flow and transport groundwater modeling for different artificial recharge scenarios in Campina de Faro

Portuguese Infiltration well

- t=110hours
- k_v / k_h=15

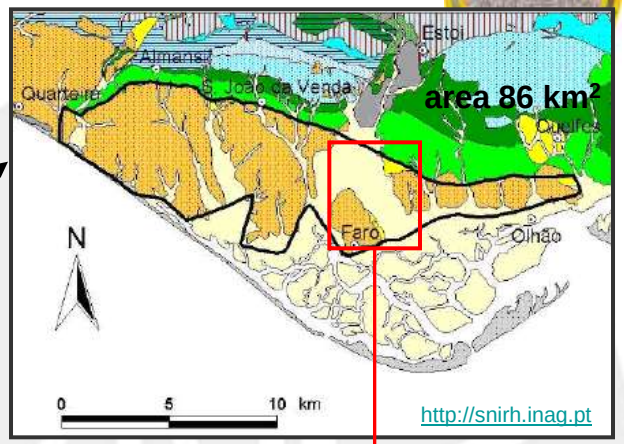


Algarve region

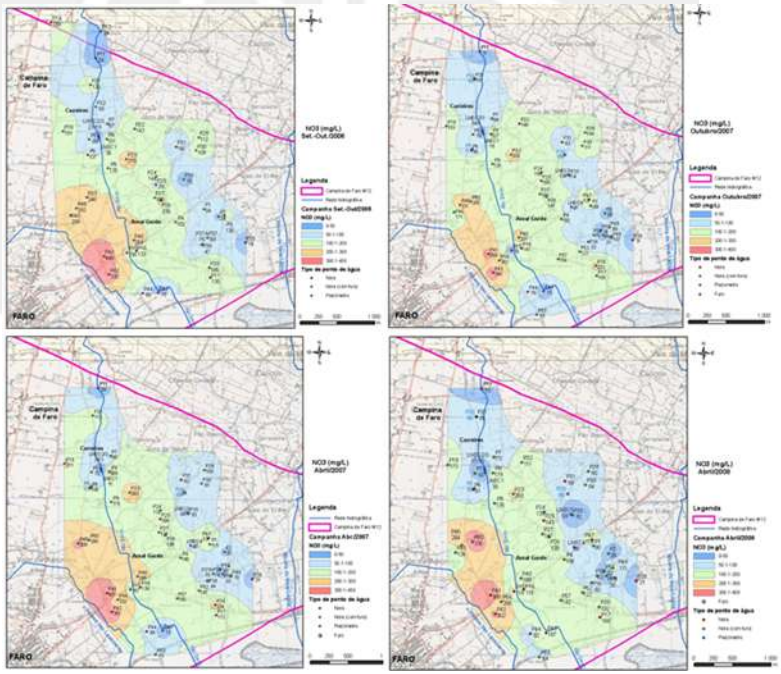


Almeida *et al* (2000)
SNIRH

Aquifer system of Campina de Faro

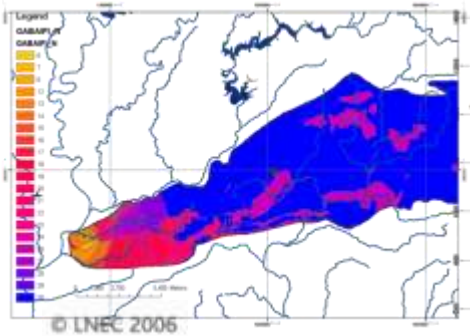


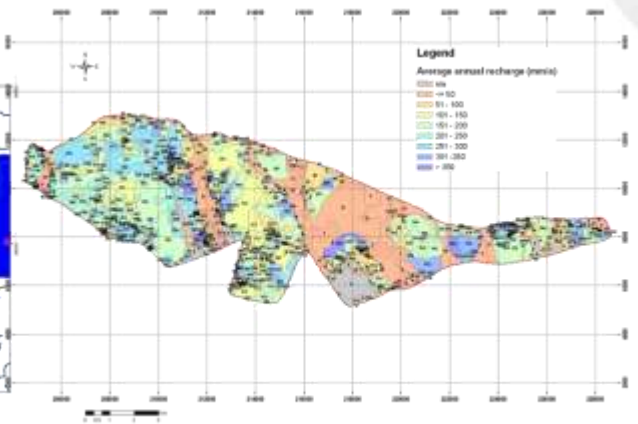
http://snirh.inag.pt



Aquifer recharge

GABA-IFIN





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AREAL GORDO INFILTRATION BASINS

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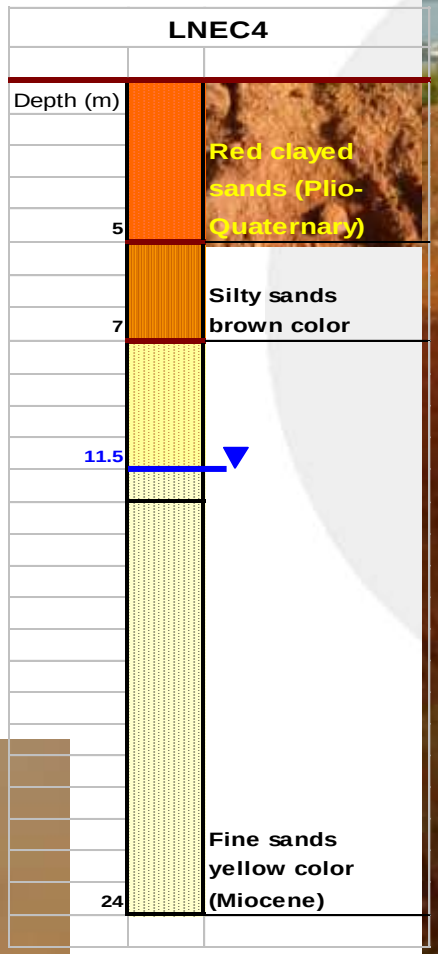
Infiltration test in several layers



Results from continuous monitoring (groundwater and surface water) in Rio Seco artificial recharge basins during winter time (Out.2007/Mar.2008) Carreiros test site

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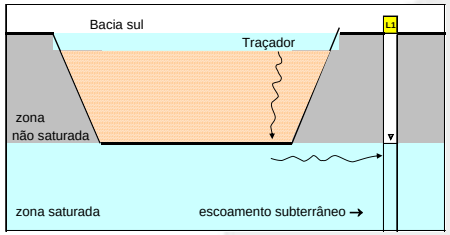
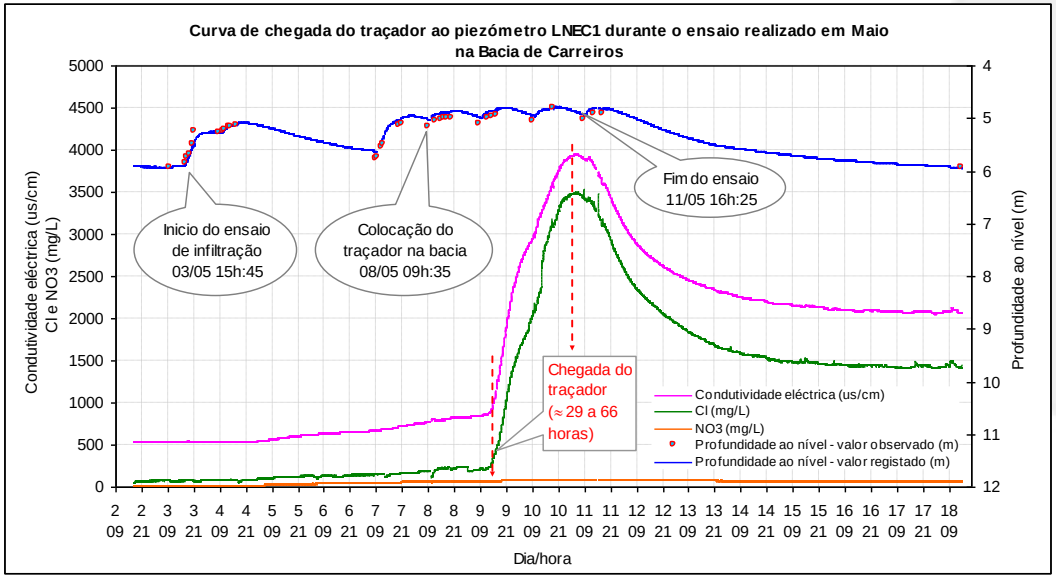
Natural recharge monitoring

- ✓ Continuous monitoring in three piezometers





Artificial recharge experiments

- ✓ Electrical resistivity assessment

May 2007

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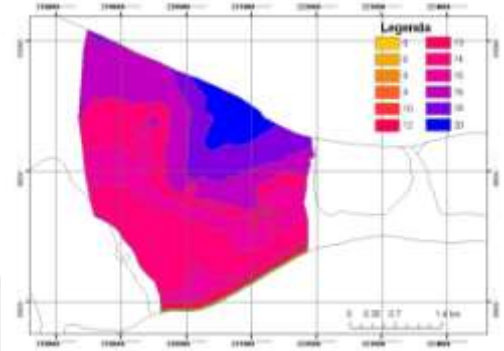
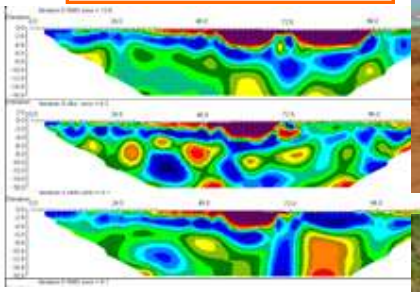
Main Results/Conclusions

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

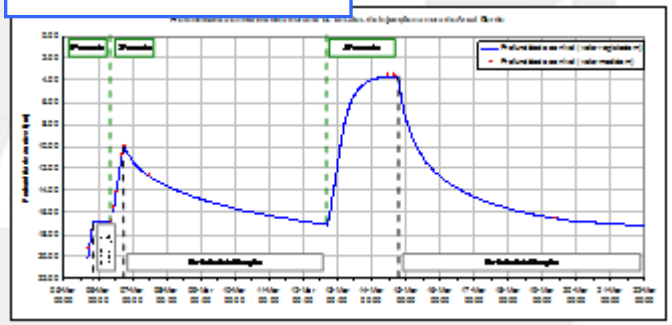


- Artificial recharge infiltration and tracer tests in Campina de Faro

1) Areal Gordo test site
3 Infiltration basins

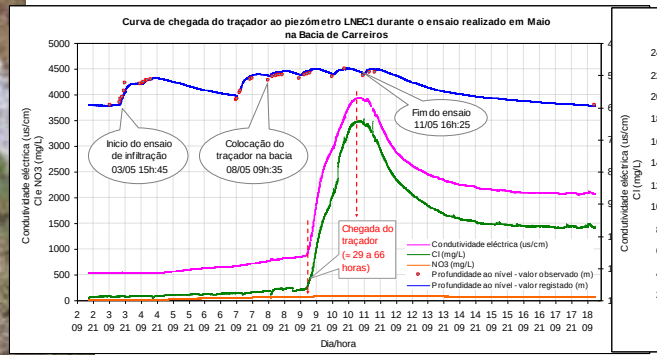


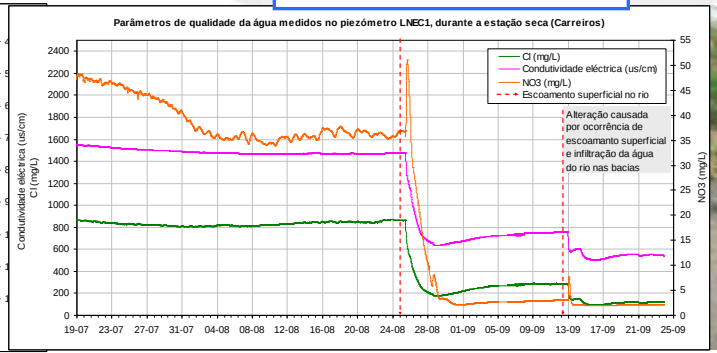
2A) Areal Gordo test site
Injection tests in large diameter well “nora”



3) Carreiros test site
2 Infiltration basins in the river bed

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





Correlation infiltration rates vs hydraulic head and soil types

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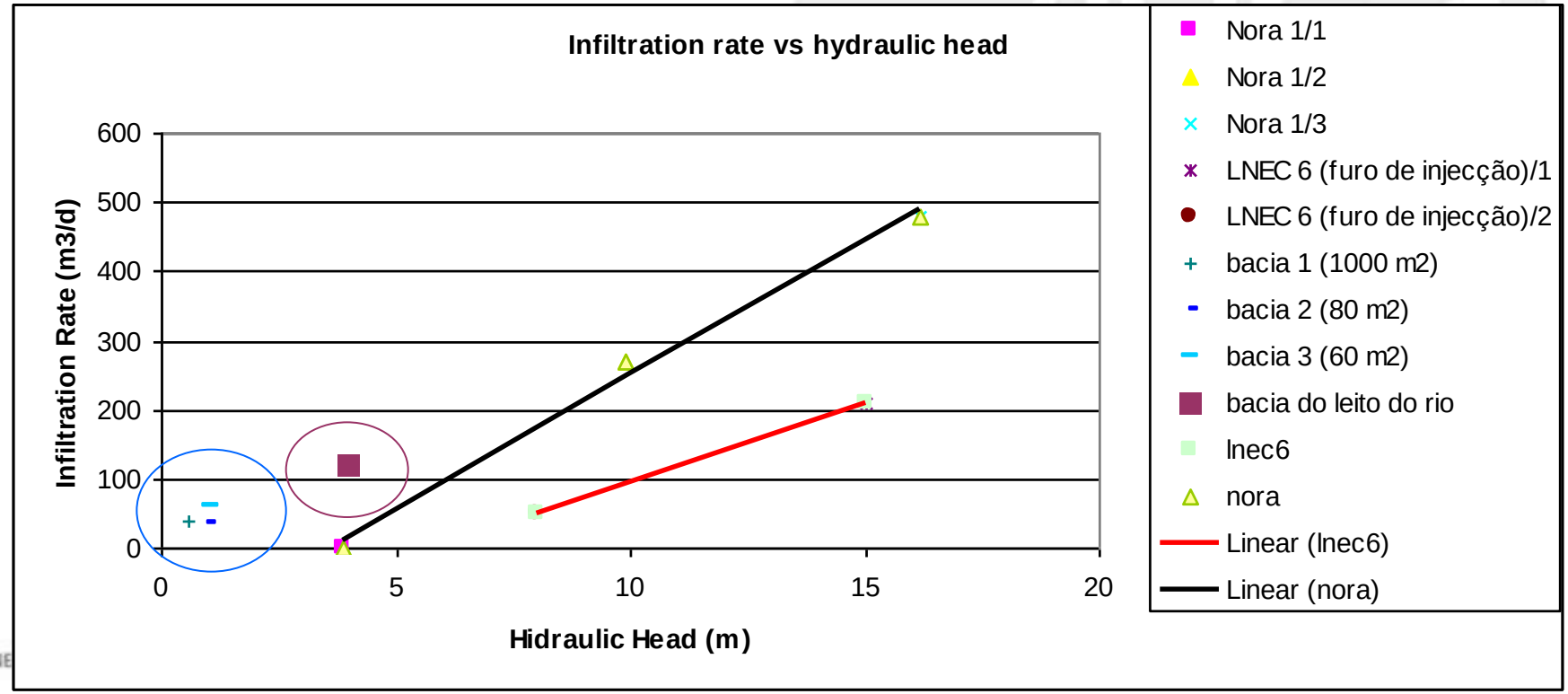
Test site Algarve	Infiltration rate (m3/d)	Hydraulic Head (m)	Soil type
Nora 1/1 (5 m diameter)	0.27	3.85	yellow sand
Nora 1/2 (5 m diameter)	270	9.88	yellow sand
Nora 1/3 (5 m diameter)	480	16.19	yellow sand
LNEC 6/1 (0.5 diameter)	208	15	yellow sand
LNEC 6/2 (0.5 diameter)	50	8	yellow sand
bacia 1 (1000 m2)	40	0.6	red sand
bacia 2 (80 m2)	37	1	brown sand
bacia 3 (60 m2)	60	1.025	yellow sand
bacia do leito do rio (80 m2)	120	4	yellow sand



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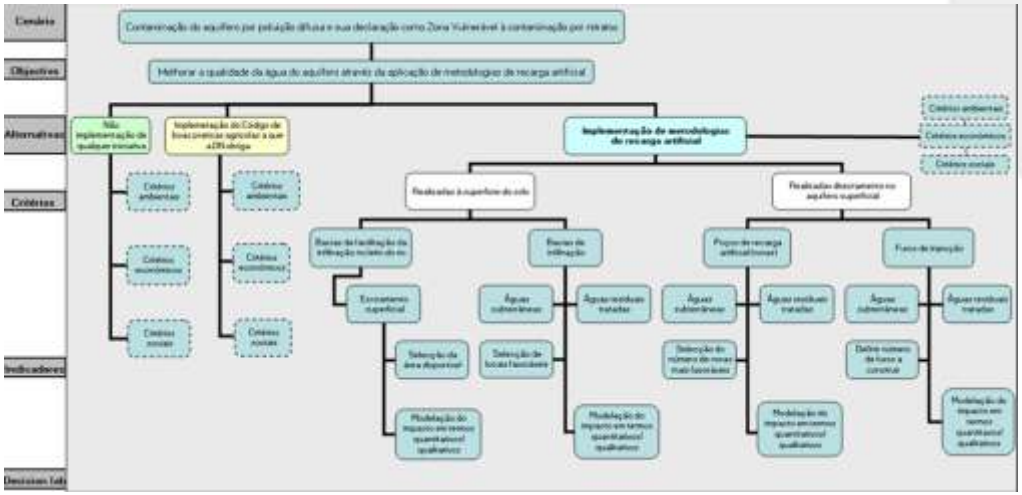
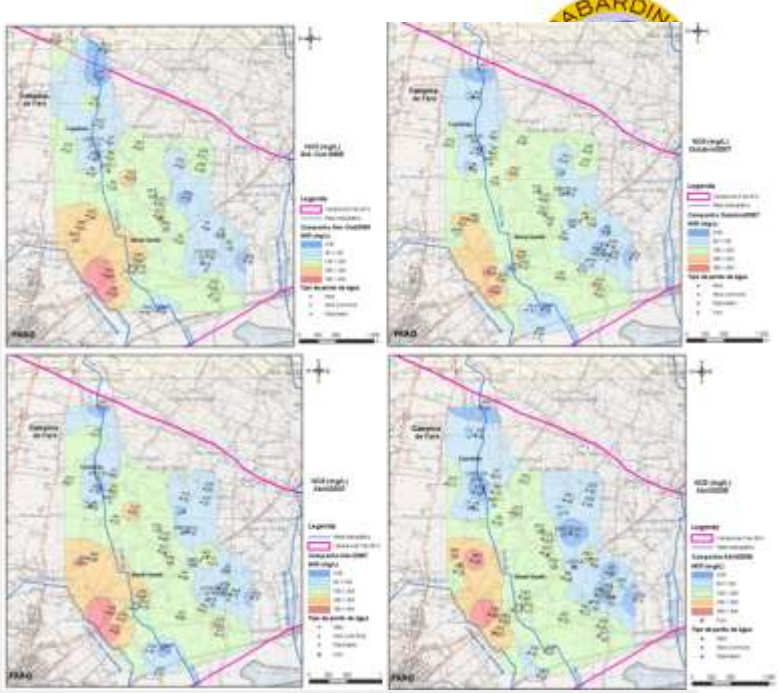
Main Results/Conclusions (cont.)

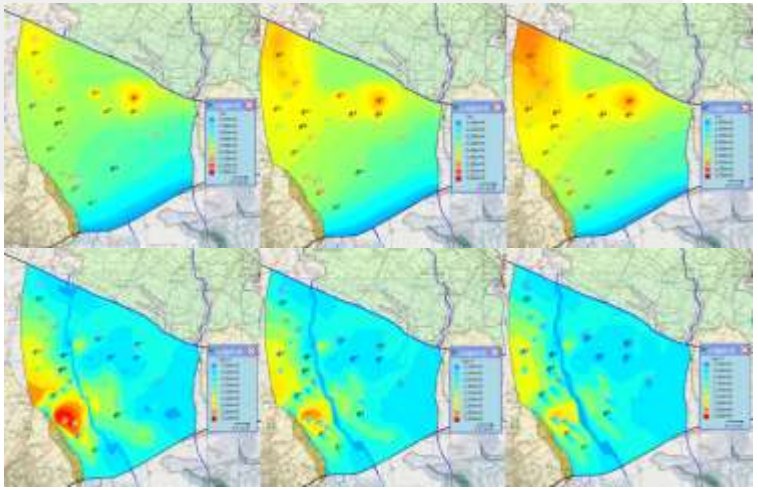
- Seasonal monitoring of piezometry and groundwater quality.

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

- DSS application based on a multicriteria analysis considering environmental and economical aspects







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ARTIFICIAL RECHARGE ENHANCEMENT TO PREVENT SEAWATER INTRUSION, KORBA (TUNISIA)

- Introduction and justification

Coastal aquifers in Tunisia suffer from over-exploitation causing:

- Problems in the quantity
  (piezometric level varies between 0 and 5 m)

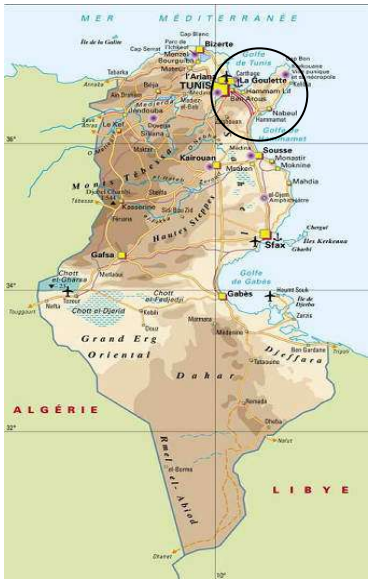
- Problems in the quality
  (salinity varies between 5 and 8 g/l)

- Serious salt water intrusion problems

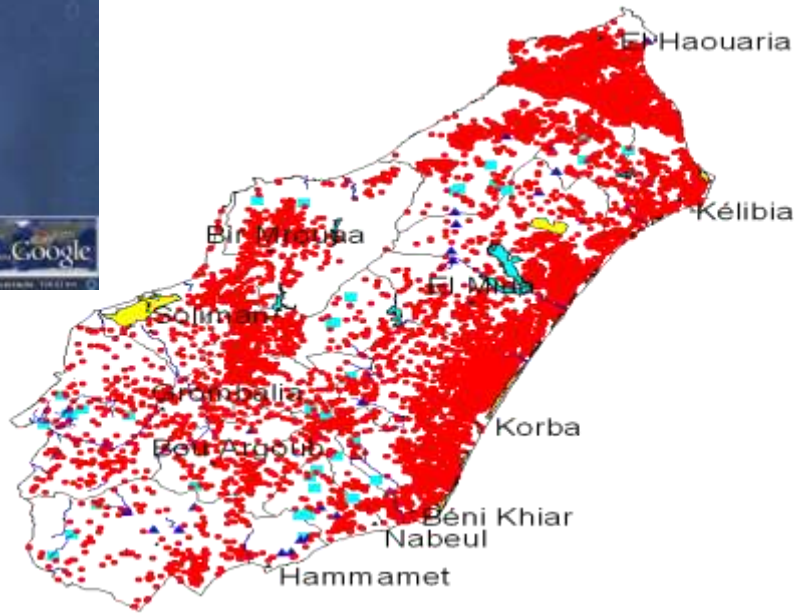
Coastal aquifers boundary

ARTIFICIAL RECHARGE ENHANCEMENT TO PREVENT SEAWATER INTRUSION, KORBA (TUNISIA)

- Introduction and justification



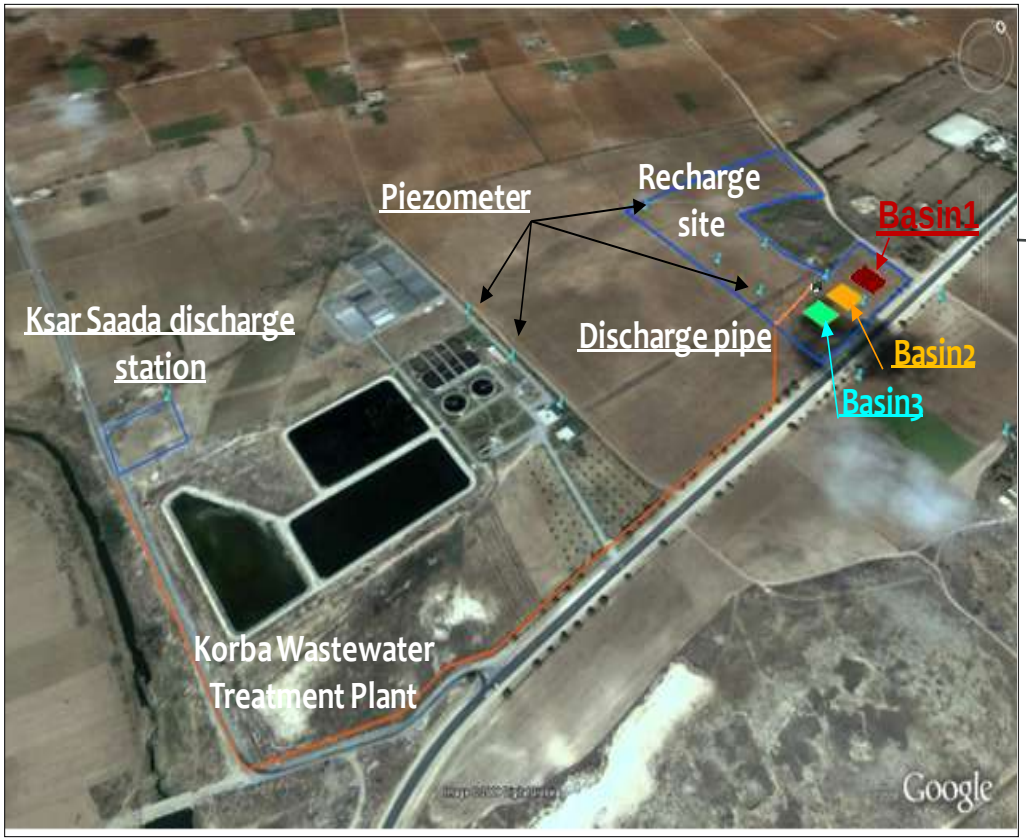
Cap Bon Peninsula



- More than 21000 wells for water supply (3000 abandoned)

ARTIFICIAL RECHARGE ENHANCEMENT TO PREVENT SEAWATER INTRUSION, KORBA (TUNISIA)

- MAR experiments
  - MAR site: WWTP water, since 2008, 3 basins with 400 m^2, aprox. 1500 m^3/d of recharge



- CTD divers were installed in 8 piezometers, at two depths

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ARTIFICIAL RECHARGE ENHANCEMENT TO PREVENT SEAWATER INTRUSION, KORBA (TUNISIA)

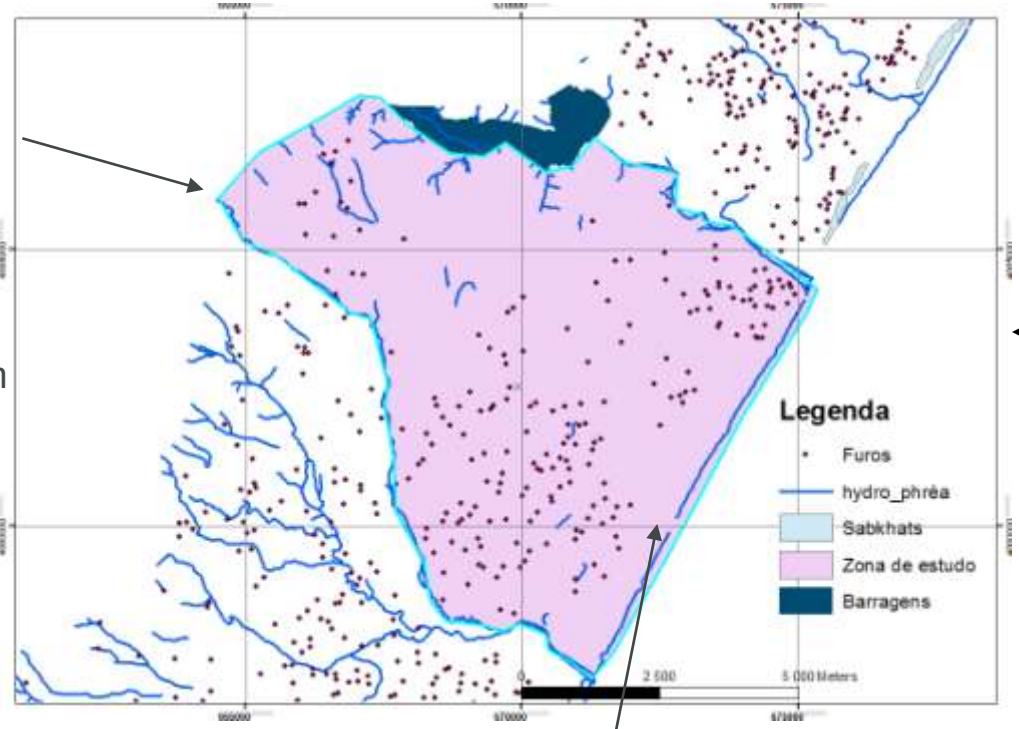
Results and conclusions

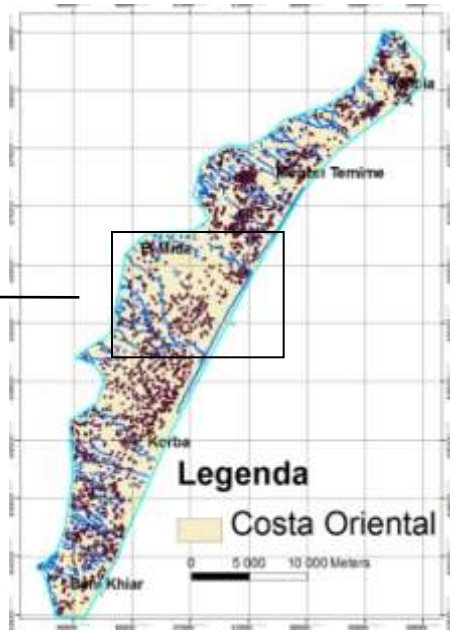
Conceptual model; Modflow

Wells – constant level

Area = 57,3 km^2

Average depth for abstraction = 20 m





(Data from I.N.R.G.R.E.F.)

Mediterranean sea – constant level

- Existing material: limestone and marl
- Constant hydraulic conductivity = 3 m/d
- Average annual recharge = 56 mm
- Abstractions = 6200 m^3/d

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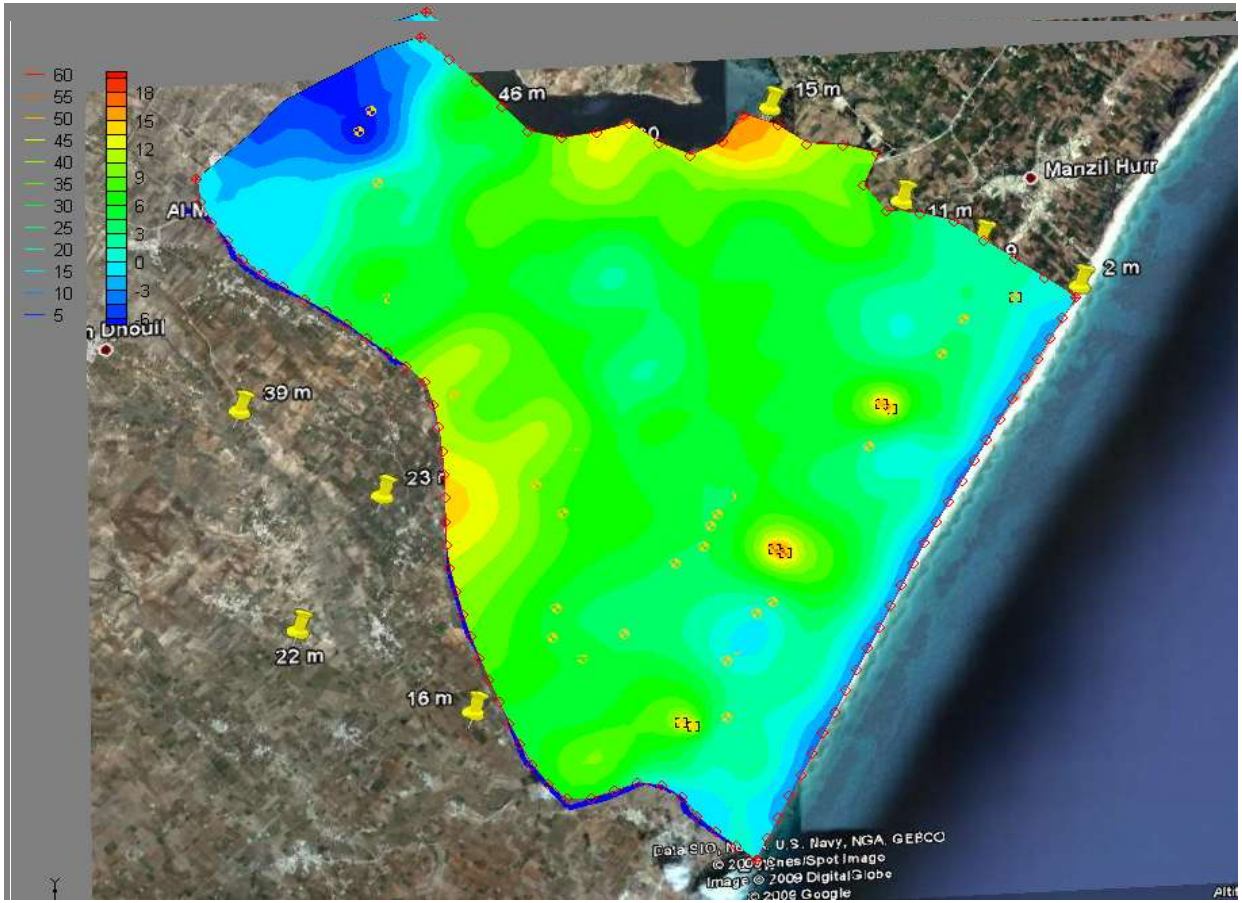
ARTIFICIAL RECHARGE ENHANCEMENT TO PREVENT SEAWATER INTRUSION, KORBA (TUNISIA)

- Results and conclusions
  - Transient state modelling – 3000 m^3/d of MAR in 3 different locations (9000 m^3/d)



•**Terceiro, A., Oliveira, L.G.S., Lobo Ferreira, J.P., Miguel, G., Gaaloul, N., Rocha, E. (2010) – "Modelação matemática em aquíferos costeiros. Aplicação a dois casos de estudo em países africanos: Angola e Tunísia". 10.º Congresso da Água, Hotel Pestana Alvor Praia, Algarve.**

Thank you
Muito Obrigado

ARTIFICIAL RECHARGE ENHANCEMENT TO PREVENT SEAWATER INTRUSION, KORBA (TUNISIA)

- Results and conclusions
  - To solve locally the salt water intrusion question, the existing MAR site facility should duplicate its volume of recharge (i.e. 3000 m^3/d)
  - At a regional scale, two other MAR facilities should be constructed along the coast, each one with a recharge rate of 3000 m^3/d to avoid salt water intrusion
  - A clear increase of the piezometric level can be observed in the regional aquifer piezometers surrounding the MAR basins
  - An improvement in the groundwater EC was observed in the well near to the MAR (1-3 g/L). Still, their values continue to be very high due to the insufficient treatment of the WWTP
  - Wastewater treatments need to be greatly improved before recharge to prevent degradation of groundwater quality
  - The site played the role of a hydraulic barrier to mitigate the problem of marine intrusion and to limit its geographical extension

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Groundwater Artificial recharge based on Altranative sources of water : aDvanced INtegrated technologies and managEment (GABARDINE)

Dr ABDEL RAHMAN TAMIMI
Palestinian Hydrology Group for water and environmental resources Development

Göttingen. December 2005

© LNEC 2006

Gaza strip

The GAZA Strip covers an area of 360 KM2

(30 KM long and 12 KM width)

With a population of about 1.2 million and

a population growth of about 4% per annual.

The population is expected to reach 2.5 million in the next decade.

Having a weak infrastructure and a shortage in natural resources such as water, the Gaza Strip faces a crisis in meeting an increasing demand for water.

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Water Balance in the northern part of Gaza (Aquifer System)

Natural Recharge 42.8 Mcm/yr

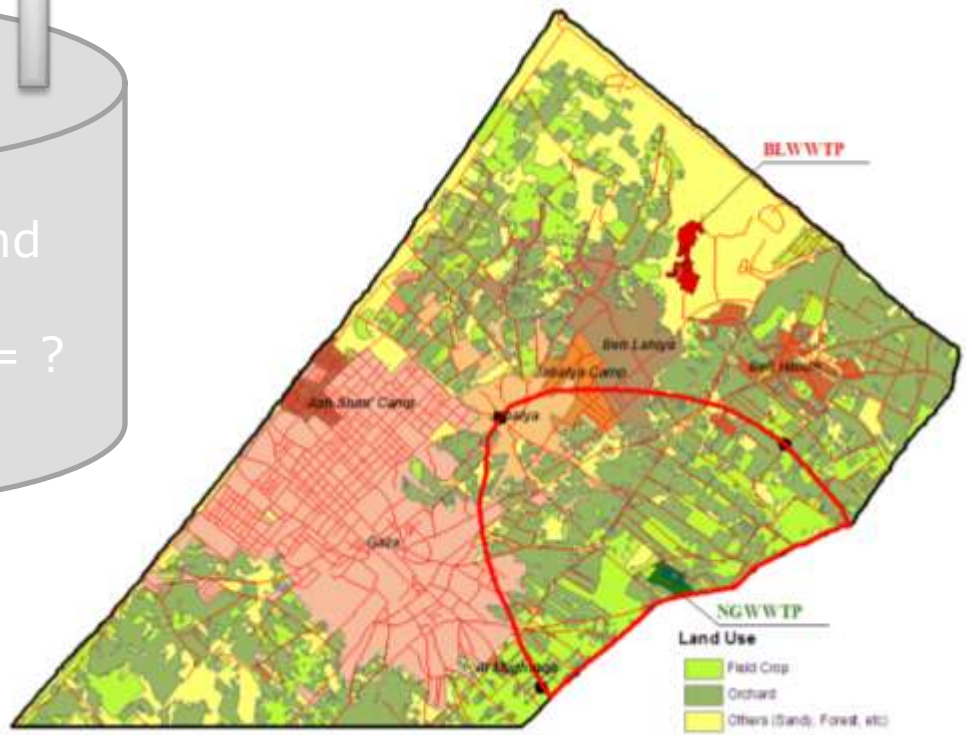
Domestic Abstraction 48.7 Mcm/yr
Year 2006

Agricultural Abstraction 40.8 Mcm/yr

Domestic Abstraction 58.7 Mcm/yr
Year 2025

Agricultural Demand =48.2 Mcm/yr
Domestic Demand = ?

Deficit: 46.7 Mcm/yr



Reference Year: 2006

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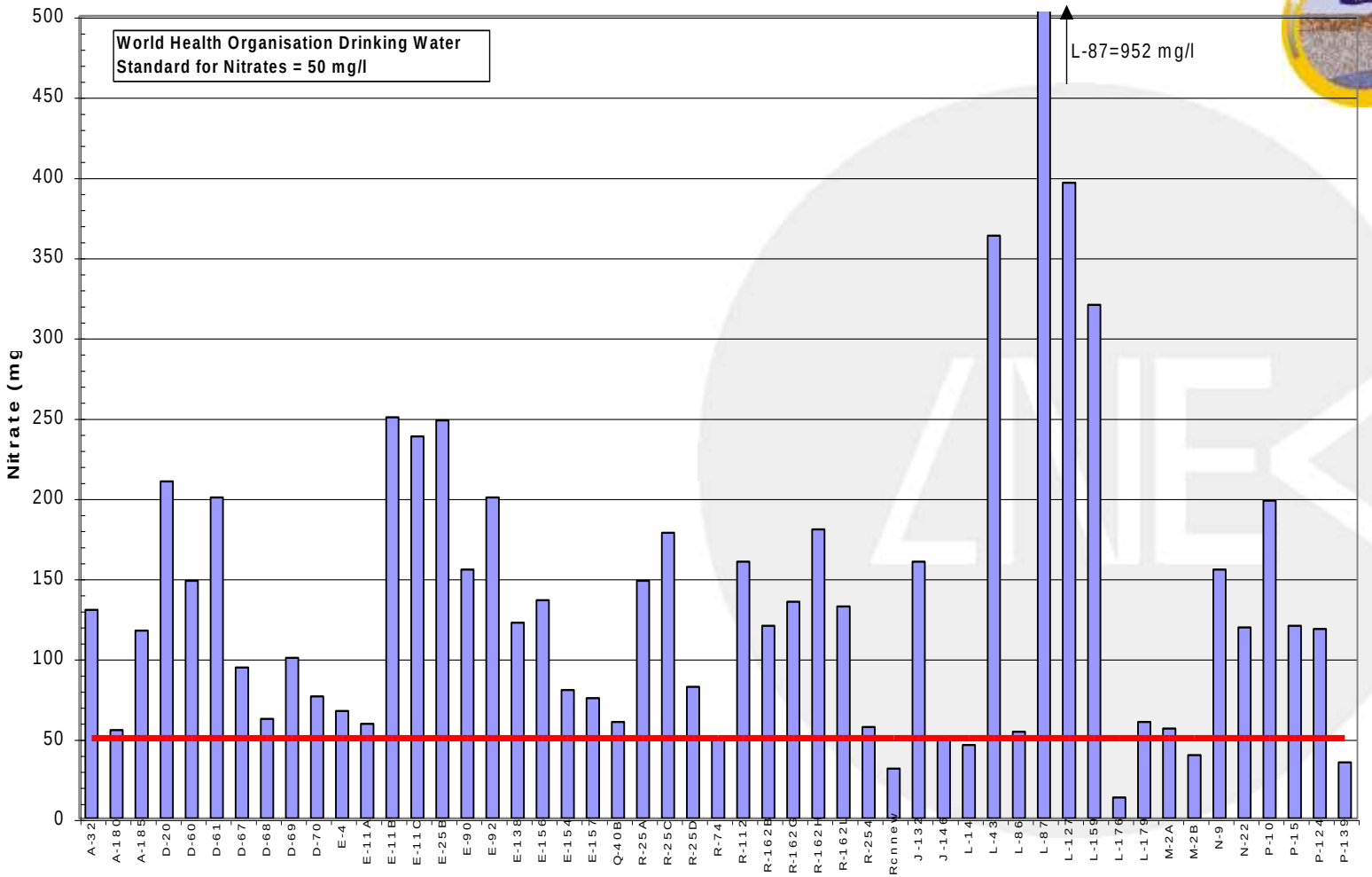

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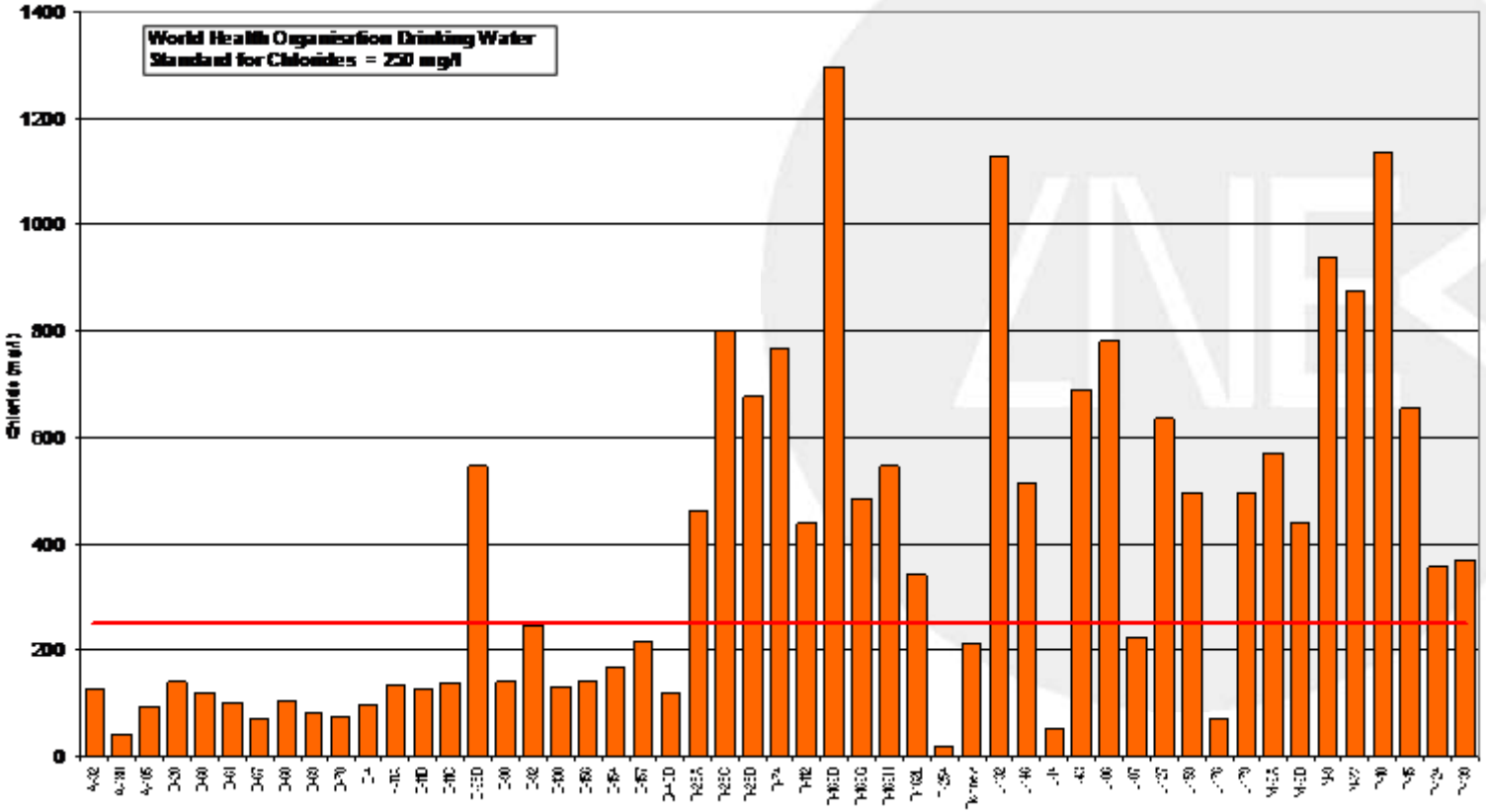
World Health Organisation Drinking Water
Standard for Chlorides = 250 mg/l
1400
1200
1000
800
600
400
200
0

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S.A.T- Soil Aquifer Treatment and Simultaneous freshwater production and wastewater reclamation in Israel Coastal Aquifer

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Dr. Joseph Guttman, Mekorot

Thanks to Dr. Joseph Guttman of the Mekorot water company, Israel

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Recharge Basin and the wells fields

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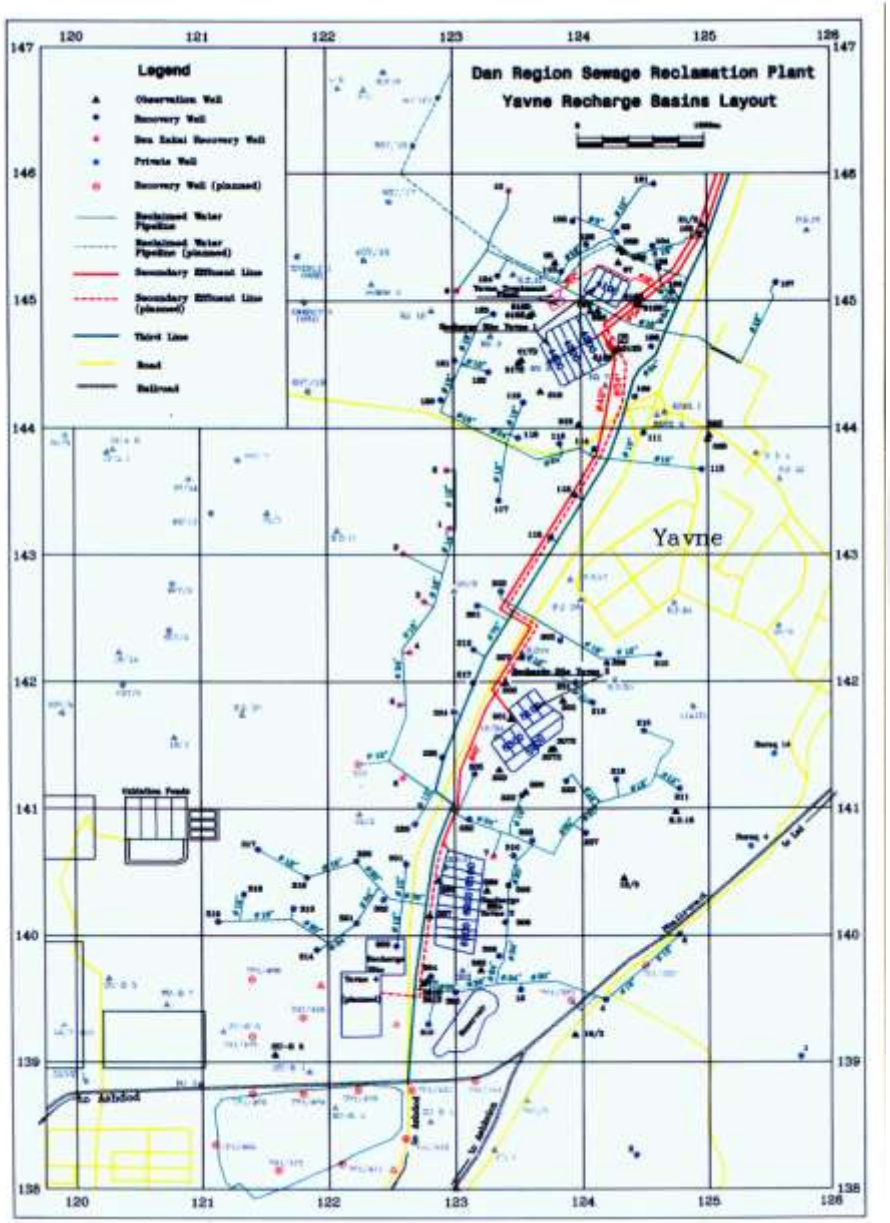

Flow chart of the Dan sewage plan

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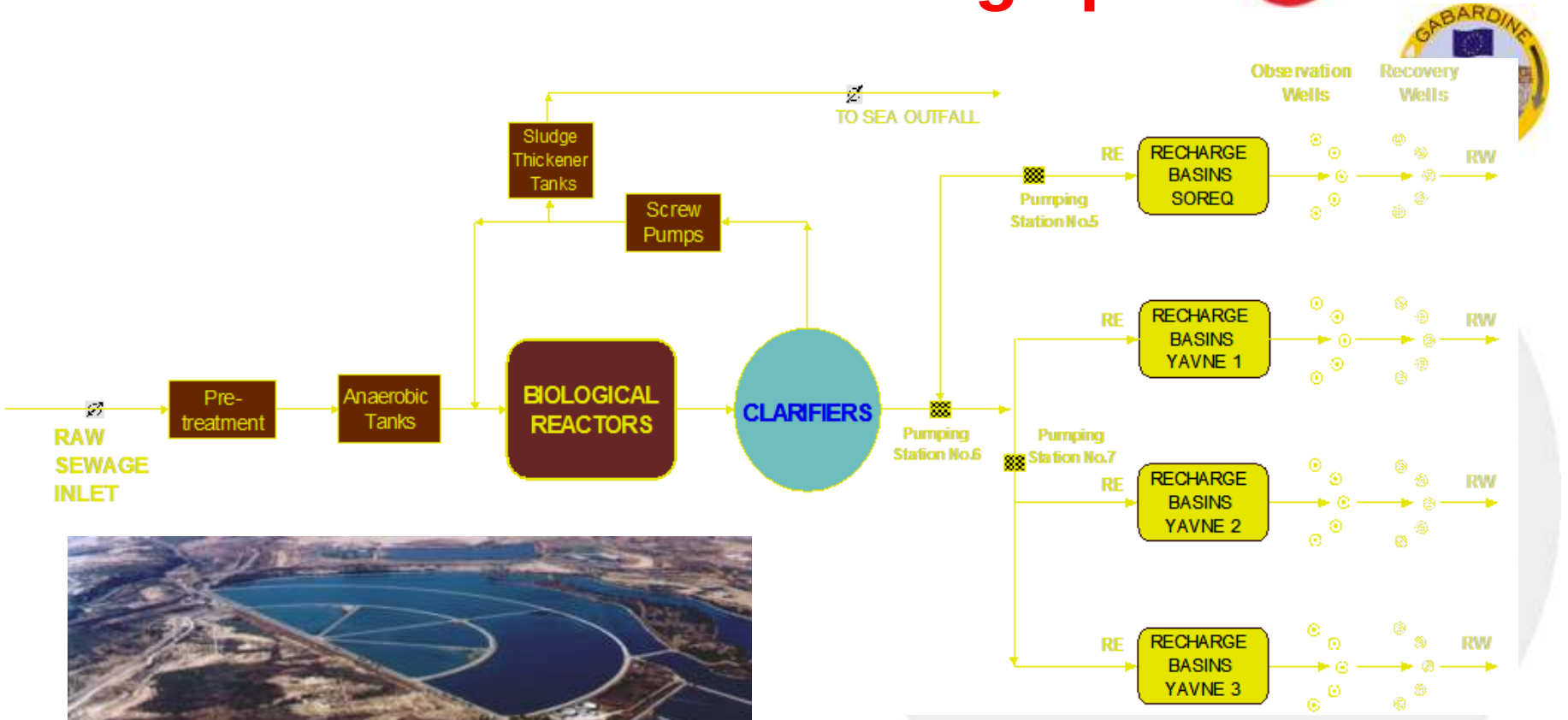

MAR Solutions - Managed Aquifer Recharge Strategies and Actions (AG128)

Led by: João-Paulo Lobo-Ferreira

Priority Area: Flood and drought risk management

Develop and demonstrate solutions, based on **Managed Aquifer Recharge** (MAR) in nine case studies, with inclusion of ecological modelling, economic incentives and risk aspects.

M.A.R. TO MAR-k€t

FP-7 ENV

EIP Water Online Market Place
Matchmaking for water innovation

MAR SOL MANAGED AQUIFER RECHARGE SOLUTIONS

MARSOL: Demonstrating Managed Aquifer Recharge as a Solution to Water Scarcity and Drought

The **Mediterranean region** is suffering from increasing **water scarcity**, which is further exacerbated by climate change, high population density, and high water consumption by agricultural, industrial, and urban uses. Not only quantity but also **quality** is of increasing importance, e.g. due to intensive use of fertilizers and seawater intrusion. Meanwhile, **large water quantities are lost** to the Mediterranean Sea as surface runoff, river discharge, discharge of treated and untreated wastewater, and as discharge of excess water from various sources during periods of low demand. This water can be used in principle for the **controlled (re-)filling of exploited aquifers by artificial infiltration, referred to as *Managed Aquifer Recharge* (MAR).**

1. Lavrion Technological & Cultural Park, Greece

— Development and implementation of advanced sensors

- Treated wastewater effluents
- Infiltration basins
- Replenishment of exploited aquifer
- Combating seawater intrusion
- Soil Aquifer Treatment

2. Algarve and Alentejo, Portugal

— River water infiltration at three sites

- Surface water
- Infiltration basins
- Wells
- Improving the ecological and chemical status of the aquifer

3. Arenales, Castile and Leon, Spain

— River water infiltration in two catchments

- Surface water
- Treated wastewater effluents
- Infiltration ponds, artificial wetlands, drainage ditches
- Replenishment of exploited aquifer
- Soil Aquifer Treatment

Demonstration Sites

For the project eight demonstration sites have been selected to represent different MAR purposes and hydrological settings.

MARSOL follows an holistic approach, which considers different:

- **Recharge water sources**
- **Recharge techniques**
- **MAR objectives**

4. Llobregat River, Catalonia, Spain

— River water infiltration basin

- Surface water
- Infiltration basin
- Replenishment of exploited aquifer
- Improving the ecological and chemical status of the aquifer

5. River Brenta Catchment, Vicenza, Italy

— Agricultural area with a network of ditches

- Surface water
- Forested infiltration area
- Replenishment of exploited aquifer
- Improving the ecological and chemical status of the aquifer

6. Serchio River Well Field, Tuscany, Italy

— River bank infiltration with an advanced monitoring network

- Surface water
- Induced river bank filtration
- Improving groundwater quantity and quality
- Continuous monitoring and automated operations

7. Menashe Infiltration Basin, Hadera, Israel

— Aquifer storage of surplus water from the Hadera desalination plant

- Desalinated water
- Infiltration basin
- Seasonal storage and aquifer storage recovery of surplus desalinated water

8. South Malta Coastal Aquifer, Malta

— Create a seawater intrusion barrier at a coastal wastewater treatment plant

- Treated municipal sewage effluent
- Injection boreholes
- Combating seawater intrusion

The Project

- 21 Partners
- 36 months, starting 12/2013
- Total budget – 8.0 million EUR
- EU contribution – 5.2 million EUR

MARSOL Project—Main Objectives

- **Demonstrate at 8 field sites that MAR is a sound, safe, and sustainable strategy** to increase the availability of freshwater under conditions of water scarcity.
- Improve the state of MAR applications to enable **low-cost, high-efficiency MAR solutions** that will create market opportunities for European industry and SMEs (**MAR to Market**).
- Promote the advantages of MAR **by tailored training and dissemination programs** to enable and **accelerate market penetration**.
- Deliver a **key technology to face the challenge of increasing water scarcity** in the Mediterranean region of southern Europe and other regions of the world.

Tools to Reach the Objectives

- **Data collection**
- **Monitoring** (improvement of sensors, new sensors)
- **Improvement of MAR devices** (planning, design, and maintenance)
- **Modelling** (to simulate the impact of MAR on aquifer hydrology and hydrogeochemistry)
- **Scenario analysis**
- Development of a **Decision Support System**
- Definition of **guidelines and policies**
- Increase of public participation within **Public Private Partnership** (PPP) schemes
- **Market analysis** on the potential market exploitation solutions

www.marsol.eu

Con el apoyo de:

LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

Comunidad de regantes
Cubeta de Santiuste...

Comunidad de Regantes El Carracillo

GOBIERNO DE ESPAÑA
MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE
CONFEDERACIÓN HIDROGRÁFICA DEL DUERO

Junta de Castilla y León

plan 2020 AIMCRA

M.A.R. TO MAR-kEt

WIRE
Water & Irrigated agriculture Resilient Europe
EIP Water Action Group
Pooling resources - Innovating water

PLATAFORMA TECNOLOGICA ESPAÑOLA DEL AGUA

iah aih

dm dina-MAR

Exmo Ayto. de Santiuste de San Juan Bautista

Ayuntamiento de Gomezserracín

Comisión Europea

Grupo Tragsa

LA RECARGA GESTIONADA DEL ACUÍFERO DE LA CUBETA DE SANTIUSTE

JORNADA TÉCNICA INFORMATIVA "MAR4FARM"

Exmo. Ayto. de Santiuste de San Juan Bautista (Segovia)
Miércoles, 29 de octubre de 2014. 17 h.
Jornada dirigida a los usuarios del acuífero.
Entrada libre

Colaboran:

Exmo Ayto. de Santiuste de San Juan Bautista

This initiative takes place in the framework of "FP7-ENV-2013 **MARSOL** (GA 619.120). Demonstrating Managed Aquifer Recharge as a Solution to I Scarcity and Drought (WPS)" with the support of the European Commission, however it reflects the views only of the authors, and the Commission can held responsible of any use which may be made of the information contained therein.
http://www.marsol.eu/

Comisión Europea

MARSOL. TALLERES INFORMATIVOS EN LA CUBETA DE SANTIUSTE Y EL CARRACILLO

MAR4FARM

Desde que en 2002 empezaran las actividades de recarga inducida en este sector del acuífero de los Arenales, como "obra de interés general para la nación", se han llevado a cabo acciones de recarga gestionada a cargo de la comunidad de regantes con el soporte, cuando lo han requerido, de los técnicos involucrados en la elaboración de los estudios y ejecución de las obras.

Pasada una década, se han publicado varios artículos y libros, dirigidos especialmente a técnicos y científicos, pero todavía gran parte de los regantes y usuarios ignoran detalles de esta actuación. En este contexto se ha planteado este taller, que hemos llamado MAR4FARM, dirigido a agricultores de la zona, como principales usuarios de sus aguas subterráneas. En este se pretende dar información y solucionar las dudas que pudieran tener (evitando el lenguaje muy técnico) sobre aspectos tales como: **¿para qué se hizo esta obra? ¿qué beneficios reporta a un agricultor?, ¿cómo funciona el acuífero?, ¿qué deben saber sobre gestión del agua a escala de usuario?. Estas preguntas y todas las que pudieran surgir serán contempladas por los técnicos que han participados en los proyectos, obras, cargos de la Comunidad de Regantes y de los Exmos. Aytos. implicados, técnicos de la Confederación Hidrográfica del Duero y de la Junta de Castilla y León, como agentes más involucrados junto con los regantes, verdaderos protagonistas de esta historia.**

PROGRAMA PRELIMINAR

17:00 – 17:15	**Bienvenida.** D. Octavio Esteban Fernández. Presidente de la CCRR de la Cubeta de Santiuste.
17:15 – 17:35	**Aspectos generales sobre la recarga gestionada (antes llamada recarga artificial)** • Dr. Ing. João Paulo Lobo Ferreira. Ingeniero civil (LNEC, Portugal)
17:35 – 17:55	**La actividad vista desde la Confederación Hidrográfica del Duero. Estudios y trabajos previos** • D. Víctor del Barrio Beato. Hidrogeólogo (Confederación Hidrográfica del Duero)
17:55 – 18:15	**Regadío con agua regenerada. La experiencia de Alcazarén** • D. José Luis Sevilla Portillo. Ingeniero Agrónomo (Junta de Castilla y León)
18:15 – 18:40	**Pausa, café**
18:40 – 19:00	**Funcionamiento del acuífero** • Dr. Enrique Fernández Escalante. Hidrogeólogo (TRAGSA)
19:00 – 19:20	**Descripción de las obras** • D. Roberto Fernández García. Ingeniero Agrónomo (TRAGSA)
19:20 – 19:40	**Medio ambiente y recarga gestionada. Impacto ambiental de la actuación** • Dr. Jon San Sebastián Sauto. Biólogo (TRAGSATEC)
19:40 – 20:00	**Técnicas de gestión hídrica a escala de usuario. Recomendaciones** **Presentación del Ebook:** 2002-2012, una década de recarga gestionada. Acuífero de la Cubeta de Santiuste, Castilla y León http://goo.gl/NGXSAS • Dr. Enrique Fernández Escalante. Hidrogeólogo (TRAGSA)
20:00 – 20:20	**Técnicas para la eficiencia energética y uso de energías alternativas para el regadío en los Arenales (Castilla y León).** Bombeo mediante energía solar fotovoltaica y ahorro energético en el riego por aspersión • José Manuel Omaña Álvarez. Ingeniero Agrónomo (AIMCRA-Plan 2020)
20:20 – 20:40	**Debate abierto** • Relator: D. Luis Sayalero. Ingeniero técnico agrícola. Técnico de la CCRR de Santiuste.
20:40	**Clausura.** Sr. D. Juan Martín Gómez. Alcalde de Santiuste de San Juan Bautista.

Este programa, aprobado en un principio, puede sufrir algunas modificaciones

Organiza:

Comisión Europea

MAR SOL MANAGED AQUIFER RECHARGE SOLUTIONS

GrupoTragsa

SEPI

LA RECARGA GESTIONADA DEL ACUÍFERO DEL CARRACILLO

JORNADA TÉCNICA INFORMATIVA "MAR4FARM"

MAR4FARM. Jueves, 30 de octubre de 2014. 10 h.
Centro cultural "Las Fuentecillas", C/ Alta, nº 21 -23. Gomezserracín (Segovia)
Jornada dirigida a los usuarios del acuífero
Entrada libre

Colaboran:

Junta de Castilla y León

Enrio Ayto. de Santiuste de San Juan Bautista

Gomezserracín

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http://www.marsol.eu/

Comisión Europea

MAR4FARM

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Pasada una década, se han publicado varios artículos, dirigidos, especialmente, a técnicos y científicos, pero todavía gran parte de los agricultores y usuarios ignoran gran parte de esta actuación. En este contexto se ha planteado este taller, que hemos llamado MAR4FARM, dirigido a agricultores de la zona, como principales usuarios de sus aguas subterráneas. En este se pretende dar información y solucionar las dudas que pudieran tener (evitando el lenguaje técnico) sobre aspectos, tales como: **¿para qué se hizo esta obra? ¿qué beneficios reporta a un agricultor?, ¿cómo funciona el acuífero?, ¿qué deben saber sobre gestión del agua a escala de usuario?. Estas preguntas y todas las que pudieran surgir, serán contempladas por los técnicos que han participados en los proyectos, obras, cargos de la Comunidad de Regantes y de los Exmos. Aytos. implicados, técnicos de la Confederación Hidrográfica del Duero y de la Junta de Castilla y León, como agentes más involucrados junto con los regantes, verdaderos protagonistas de esta historia.**

PROGRAMA PRELIMINAR

10:00 – 10:15	**Bienvenida.** D. Enrique Herranz García. ITA. Presidente de la CCRR del Carracillo.
10:15 – 10:35	**Aspectos generales sobre la recarga gestionada (antes llamada recarga artificial)** • Dr. Ing. João Paulo Lobo Ferreira. Ingeniero civil (LNEC, Portugal)
10:35 – 10:55	**La actividad vista desde la Confederación Hidrográfica del Duero** • D. Víctor del Barrio Beato. Hidrogeólogo (Confederación Hidrográfica del Duero)
10:55 – 11:15	**Descripción de los estudios y trabajos previos y futuros y funcionamiento del acuífero** • Dª. Carmen Macías Antequera. Geóloga del Dpto. de hidrogeología (TRAGSATEC)
11:15 – 11:40	**Pausa, café**
11:40 – 12:00	**Descripción de la obra** • D. Roberto Fernández García. Ingeniero Agrónomo (TRAGSA)
12:00 – 12:20	**Impacto ambiental de la actuación, en especial sobre las masas forestales** • Dr. Jon San Sebastián Sauto. Biólogo (TRAGSATEC)
12:20 – 12:40	**Recomendaciones de gestión hídrica a escala del usuario de Los Arenales** • Dr. Enrique Fernández Escalante. Hidrogeólogo (TRAGSA)
12:40 – 13:00	**Modelos para prever la evolución del agua del acuífero en cantidad y calidad** • Dr. Xavier Sánchez Vila. Ingeniero de caminos... (UPC)
13:00 – 13:20	**Regadío con agua regenerada. La experiencia de Alcazarén** • D. José Luis Sevilla Portillo. Ingeniero Agrónomo (Junta de Castilla y León)
13:20 – 13:40	**Técnicas para la eficiencia energética y uso de energías alternativas para el regadío en los Arenales (Castilla y León).** Bombeo mediante energía solar fotovoltaica y ahorro energético en el riego por aspersión • José Manuel Omaña Álvarez. Ingeniero Agrónomo (AIMCRA-Plan 2020)
13:40 – 14:00	**Debate abierto** • Relator: *. Secretaría de la CCRR del Carracillo.
14:00	**Clausura.** Sra. Dª. Laura del Río Arranz. Alcaldesa de Gomezserracín.

Este programa, aprobado en un principio, puede sufrir algunas modificaciones
*Pendiente de confirmación

Organiza:

MAR SOL MANAGED AQUIFER RECHARGE SOLUTIONS

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