EIP WATER CONFERENCE 2017

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WATER INNOVATION: BRIDGING GAPS, CREATING OPPORTUNITIES

27 AND 28 SEPTEMBER 2017
ALFÂNDEGA PORTO CONGRESS CENTRE

WATER AND THE CIRCULAR ECONOMY, PART 2 – AGRICULTURE

NOVEL WATER SUPPLY SOLUTIONS FOR AGRICULTURE: MANAGED AQUIFER RECHARGE AND SUBSURFACE STORAGE

JOÃO PAULO LOBO FERREIRA
LNEC / EIP WATER "MARTOMARKET" ACTION GROUP

PORTO INNOVATION WEEK. WATER

Managed Aquifer Recharge

Challange and Opportunity

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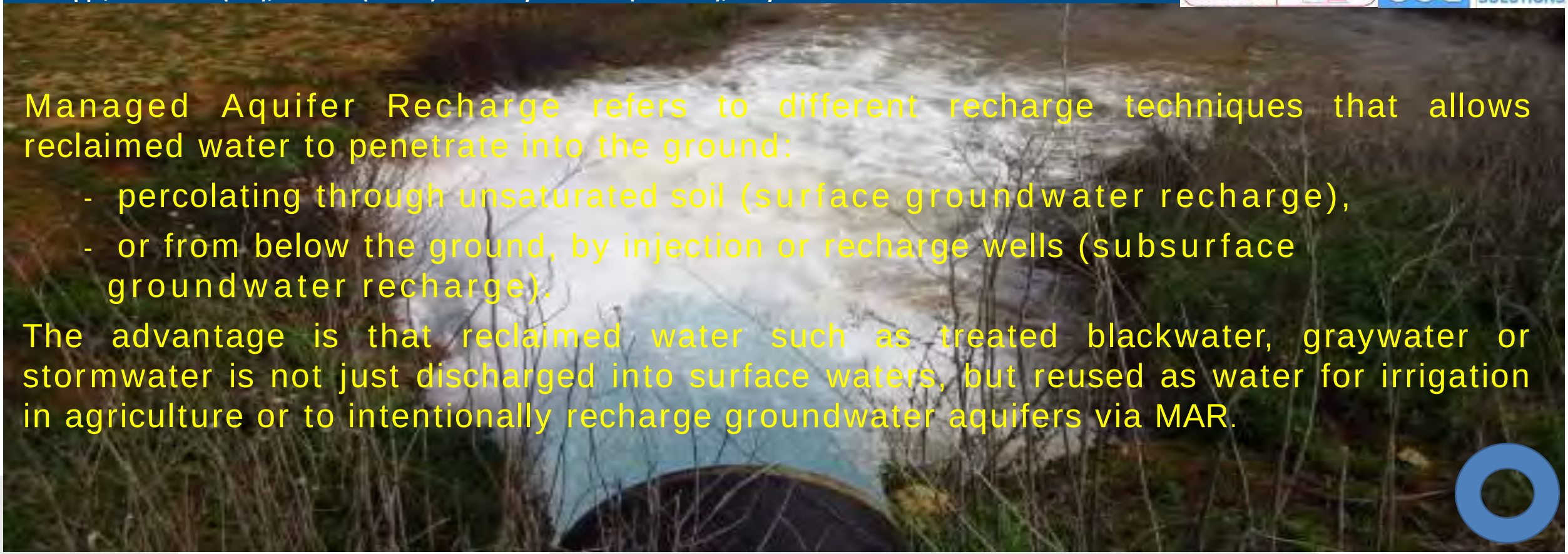
E. Filippi, V. Marsala (SGI), M. Ferri (AAWA) and Rudy Rossetto (SSSA UP), Italy



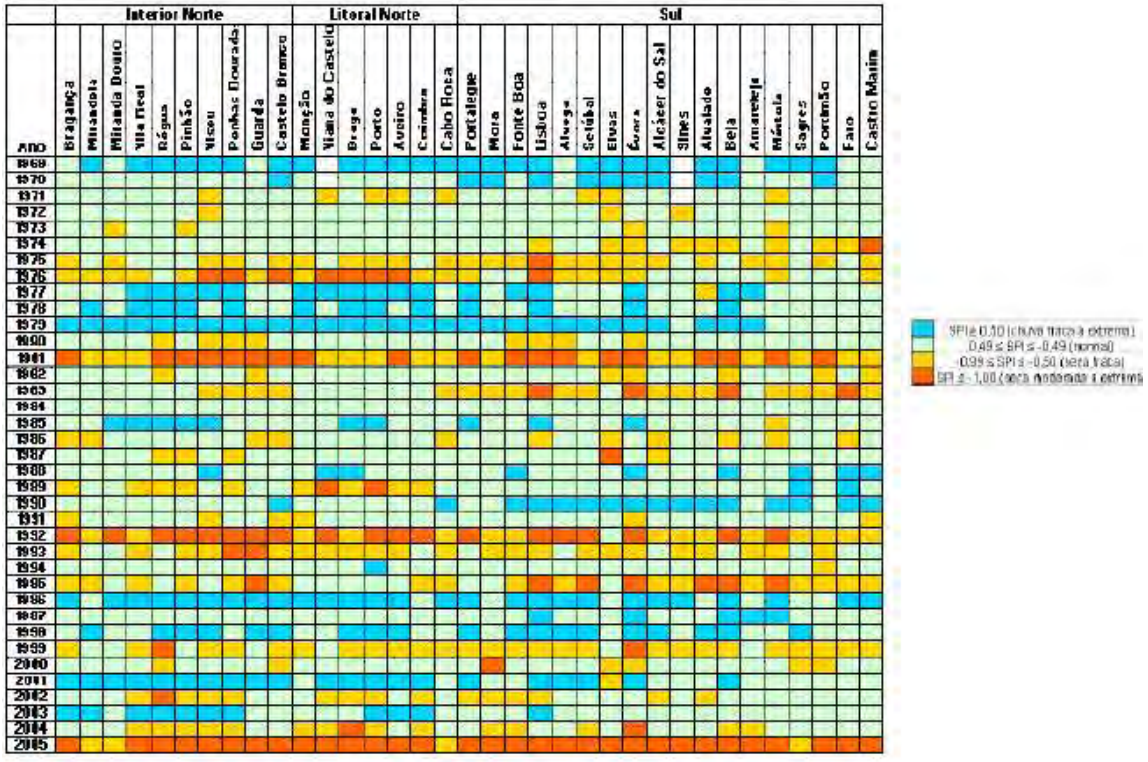
Managed Aquifer Recharge refers to different recharge techniques that allows reclaimed water to penetrate into the ground:

- percolating through unsaturated soil (surface groundwater recharge),
- or from below the ground, by injection or recharge wells (subsurface groundwater recharge).

The advantage is that reclaimed water such as treated blackwater, graywater or stormwater is not just discharged into surface waters, but reused as water for irrigation in agriculture or to intentionally recharge groundwater aquifers via MAR.

Managed Aquifer Recharge - Principles

Precipitation natural variation in Mediterranean countries: the example of Portugal

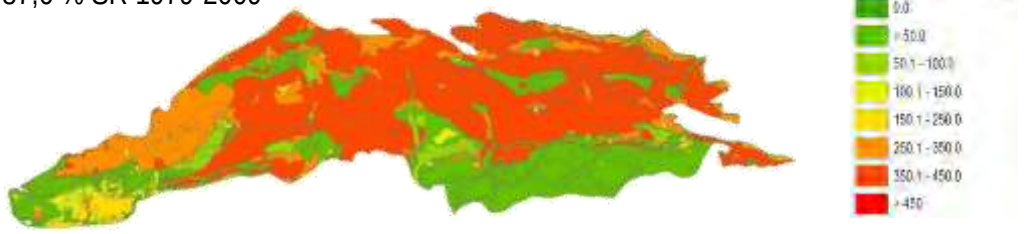


Climate change impact

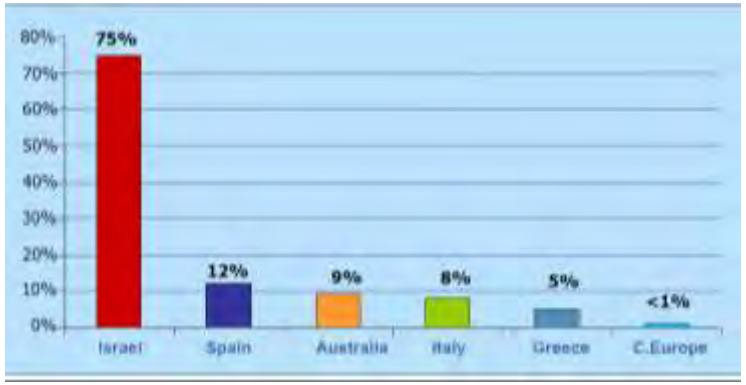
Model HadRM2S92a

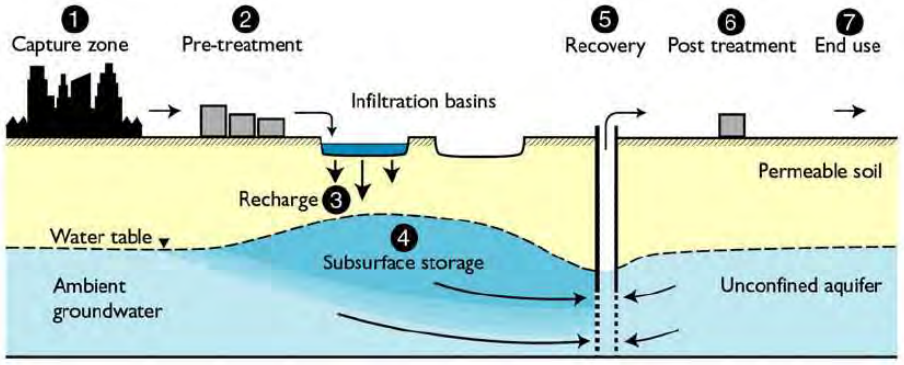
Average surface runoff:
100 mm/yr
87,6 % SR 1979-2009

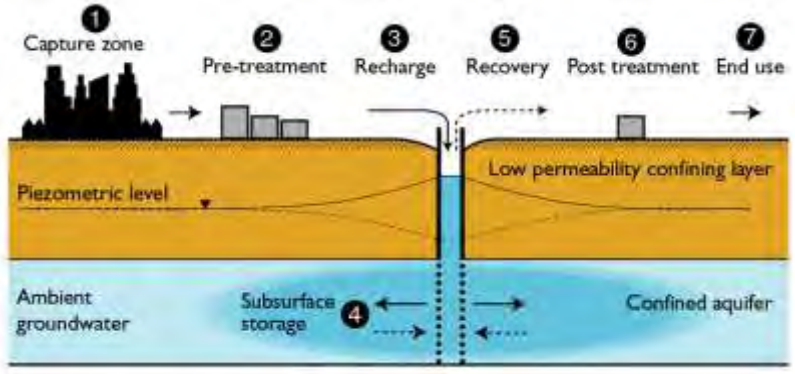
Average yearly recharge:
245 mm/yr
83,4 % Rec 1979-2009



Percentage of water reuse







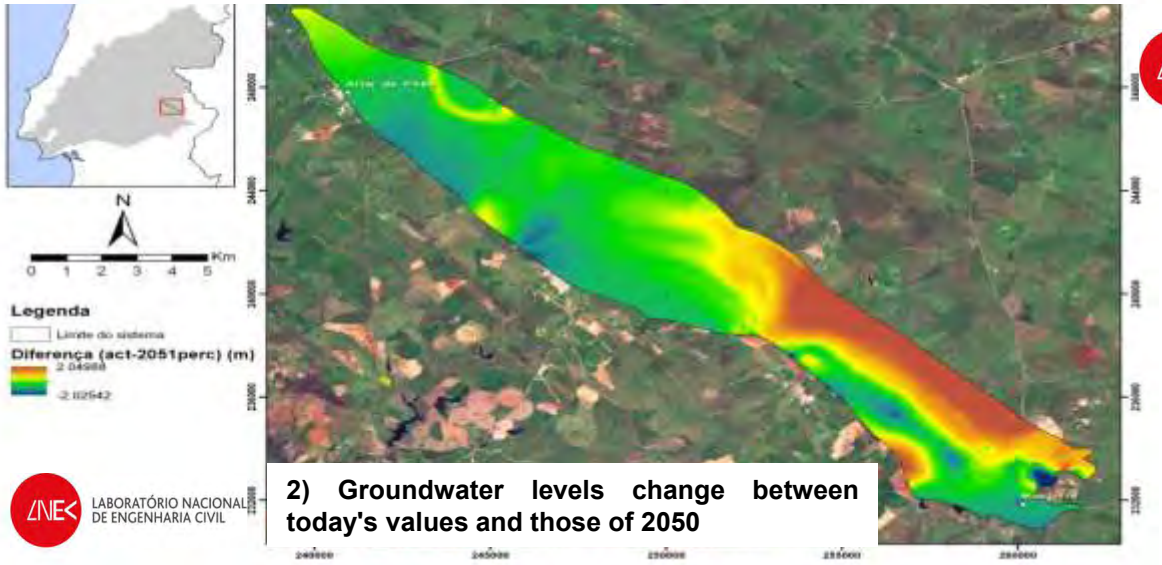
LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

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

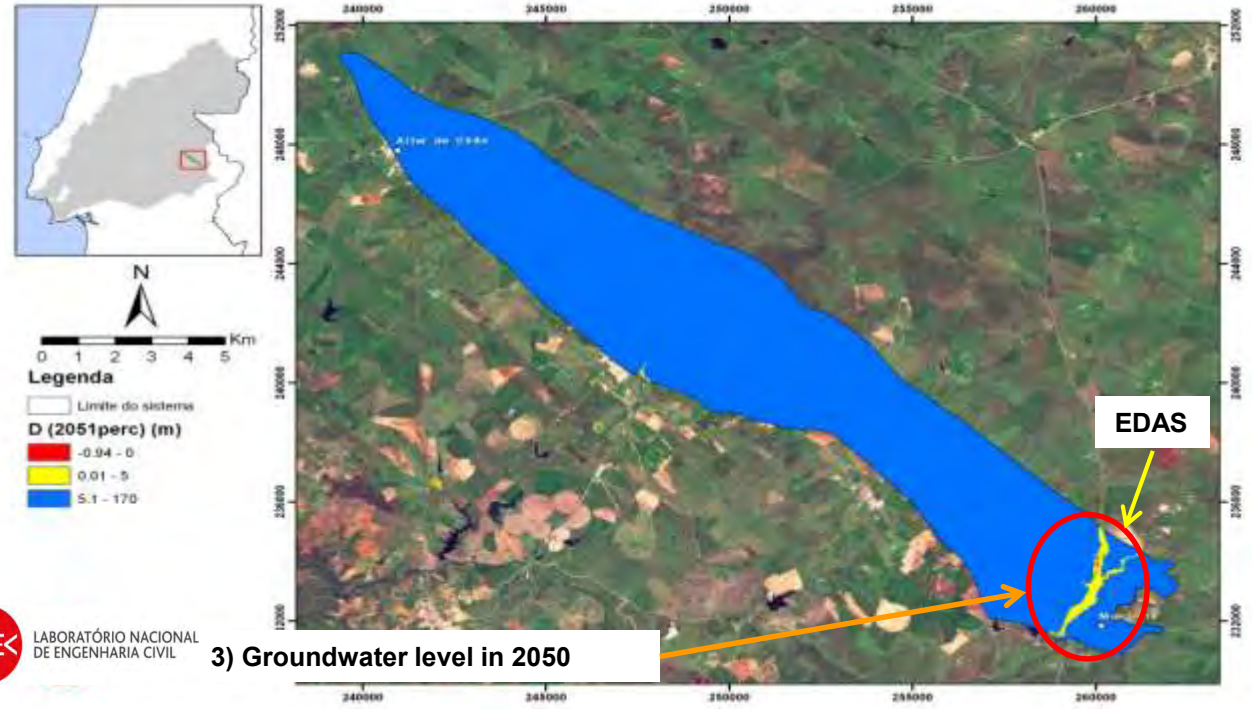
LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

> 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)

MARSOL

Demonstrating Managed Aquifer Recharge as a Solution to Water Scarcity and Drought (FP7-Env-2013-Water-Inno-Demo)

Start: 12.2013 **Duration: 3 years** **EU Contribution: 5.2 Mio €**

The main objectiv ***fe and sustainable strategy that can b*** ***timulate the use of reclaimed water ar*** ***M through storage of excess water to***

...sound, safe and sustainable strategy...

Australian guidelines for Water recycling, 24: Managed Aquifer Recharge (2009)

TECHNISCHE UNIVERSITÄT DARMSTADT

MARSOL

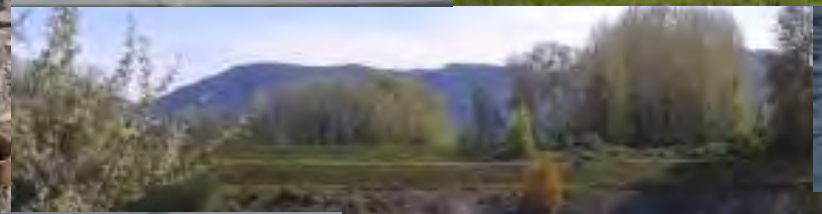
Demonstration sites activities…

…treated waste water, river water, desalinated water, rainwater harvesting …











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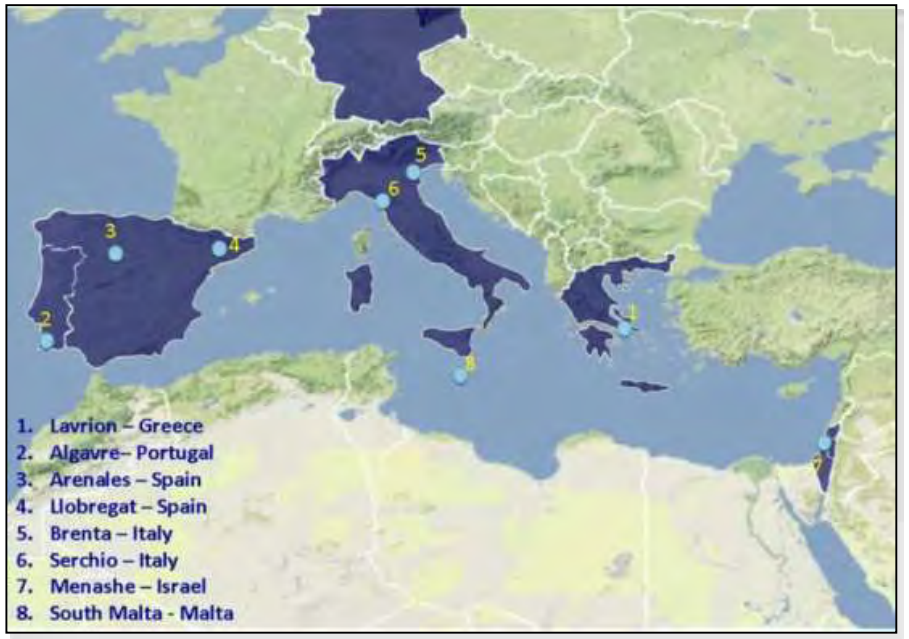
"**Technical Solutions**" (**T.S**) are not related to Managed Aquifer Recharge (MAR) technique as if it was the problem to solve. They are, to a large extent, the **group of activities to increase MAR effectiveness**, being MAR the solution to many related water management dysfunctions.

DEL 13.1 MAR TECHNICAL SOLUTIONS

Q: How to increase the **effectiveness of the devices and the infiltration rate?**

A: Adoption of Soil and Aquifer Treatments **(SATs) and other complementary techniques**, such as design and management improvements applicable to existing devices



MARSOL demo sites: Experiences in **8** Mediterranean demo sites:

1- Lavrion
2- Algarve & Alentejo
3- Arenales
4- Llobregat
5- Brenta
6- Serchio
7- Menashe
8- Malta South

Tragsa

WP12 “Modelling"

https://www.researchgate.net/publication/314957907_White_book_on_MAR_modelling_Selected_results_from_MARSOL_PROJECT

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MAR SOL — MANAGED AQUIFER RECHARGE SOLUTIONS

MARSOL

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

White book on MAR modelling: Selected results from MARSOL PROJECT

Deliverable D12.7

Deliverable No.	D12.7
Version	1.0
Version Date	31.01.2017
Author(s)	J.P. LOBO FERREIRA, TERESA LEITÃO, TIAGO MARTINS and ANA MARIA CARMEN ILIE (LNEC), JOSÉ PAULO MONTEIRO, LUÍS COSTA and RUI HUGMAN (UALG), TIAGO CARVALHO, RUI AGOSTINHO and RAQUEL SOUSA (TARH), LAURA FOGLIA, ANJA TOEGL AND CHRISTOS POULIARIS (TU DARMSTADT), RUDY ROSSETTO (SSSA), IACOPO BORSI (TEA), XAVIER SANCHEZ-VILA AND PAULA RODRIGUEZ-ESCALES (UPC), ENRIQUE F. ESCALANTE (TRAGSA), MANUEL M. OLIVEIRA (LNEC), ANDREAS KALLIORAS (NTUA), YORAM KATZ (MEKOROT)
Dissemination Level	PU
Status	Final

The MARSOL project has received funding from the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration under grant agreement no 619120

Contents

Facilities inventory

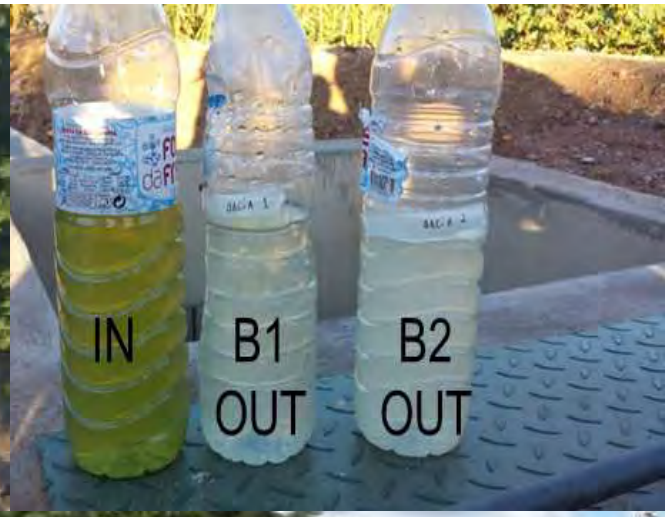
DEL 13.1 MAR T

25 devices

N	SYSTEM	MAR DEVICE	LOGO	FIGURE	PHOTO	LEGEND
1	DISPERSSION	INFILTRATION PONDS/WETLANDS				Artificial wetland to recharge in Sanchón, Coca, Segovia (Spain). Photo: DINA MAR
2		CHANNELS AND INFILTRATION DITCHES				Artificial recharge channel of the Basin of Santiuste, Segovia, Spain, operative since 2002. Photo: DINA MAR.
3		RIDGES/SOIL AND AQUIFER TREATMENT TECHNIQUES	SAT			Ridges in the bottom of a infiltration pond. California. Photo: D. Peyton.
4		INFILTRATION FIELDS (FLOOD AND CONTROLLED SPREADING)				Infiltration field in Omdel (Namibia). Photo: G. Tredoux.
5		ACCIDENTAL RECHARGE BY IRRIGATION RETURN				Artificial recharge by irrigation return. Extremadura, Spain. Photo: Tragsa
6		BOFEDALES WETLANDS				Bofedales (Colombia)
7	CHANNELS	RESERVOIR DAMS AND DAMS				Artificial recharge dam in basin head. Alicante, Spain.
8		PERMEABLE DAMS				Permeable dam in Huesca, Spain. Photo: Tragsatec.
9		LEVEES				Levees in Santa Ana river, Orange County, California, USA. Photo: A. Hutchinson.
10		RIVERBED SCARIFICATION				Scarification at Besós riverbed, Barcelona, Spain. Photo: J. Armenter.
11		SUB-SURFACE/UNDERGROUND DAMS				Sub-surface dam in Kitui, Kenya. Photo: Sander de Haas.
12		DRILLED DAMS				Drilled dam. Lanjarón, Granada, Spain. Photo: Tragsatec.

WP4: DEMO SITE 2 - PORTUGAL

PT2_6 Algarve, São Bartolomeu de Messines



Sources for the artificial recharge : Quantity

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Dam	Hydrological year	Depth discharge (*10³ m³)	Surface discharge (*10³ m³)	Total discharge (*10³ m³)
ARADE	2000/2001	37 499.20	19 256.70	56 755.90

Dam	Hydrological year	Depth discharge (*10³ m³)	Surface discharge (*10³ m³)	Total discharge (*10³ m³)
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 (*10³ m³)	**246 173.98**

During the extreme drought of 2004/2005

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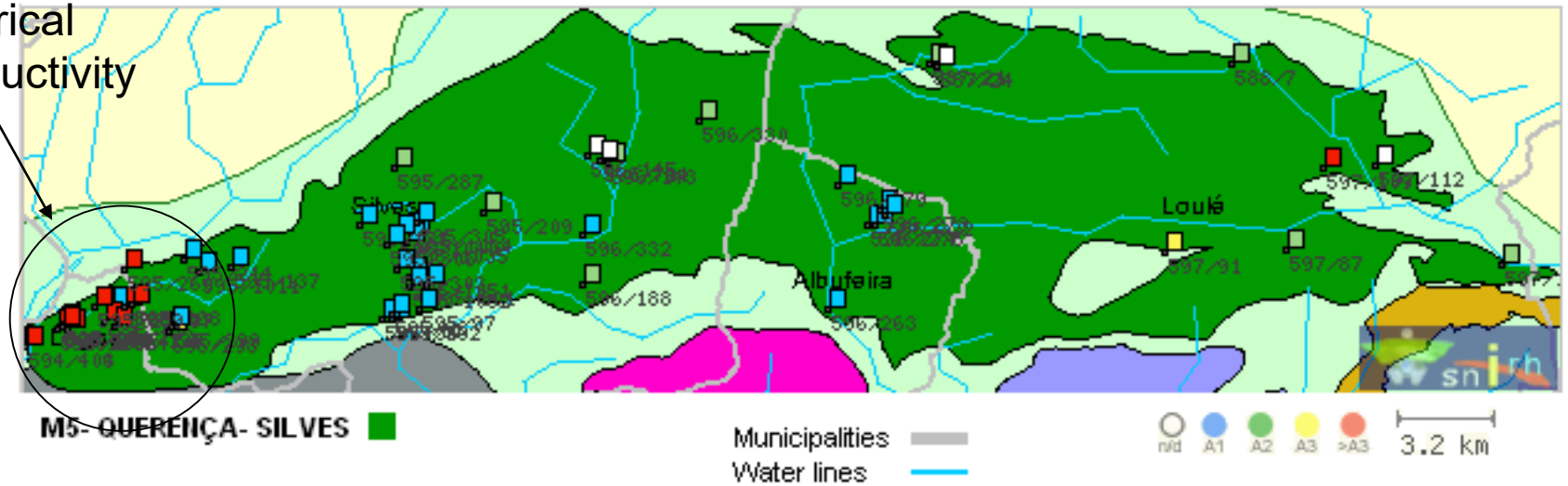
	Volume of withdrawal water (*10 ^{6} m ^{3})	Percentage
Agriculture	23.79	47.31%
Urban supply of the *Águas do Algarve* regional system of Algarve	14.25	28.34%
Urban supply of the local municipalities	12.25	24.36%
Private users	Not Available	-
Total	50.29	100%

Electrical Conductivity

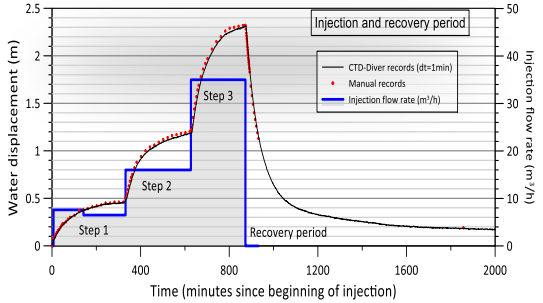


WP4: DEMO SITE 2 - PORTUGAL

PT2_6 Algarve, Cerro do Bardo

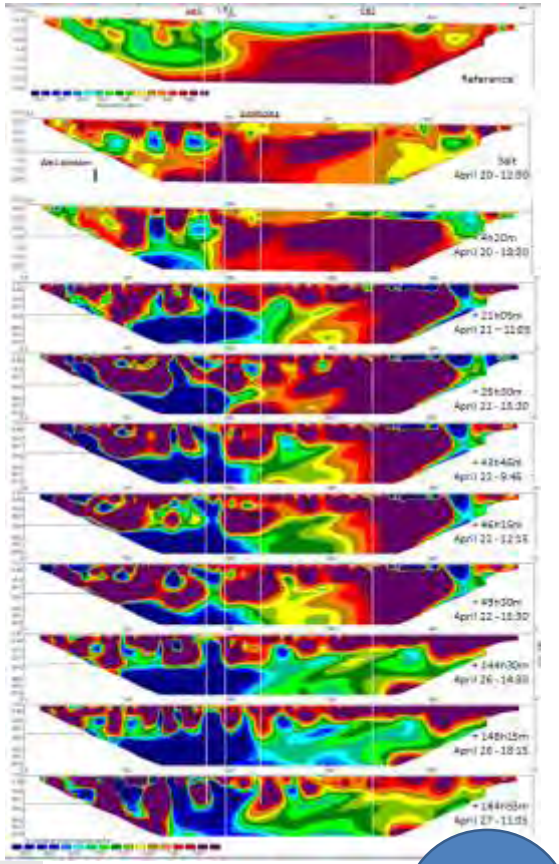
- Experiment goal: assess Cerro do Bardo MAR site infiltration capacity and groundwater flow path
- Recharge experiment: infiltration of 47 L/s (~170 m3/h) of water in Cerro do Bardo dug well and natural sinkholes during 90 hours (coming from a AdA well located ~1,4 km distance)
- Tracer: 1000 kg NaCl

April 2016



This MAR infiltration and tracer test allowed confirming that the DEMO Site:

- Is an adequate area to infiltrate water coming from the three dams, with the surplus from wet years
- The area has a minimum infiltration capacity of 4060 m3/d (170 m3/h, compared with 35 **m3/h in Campina well…, but it** depends on headwater…)



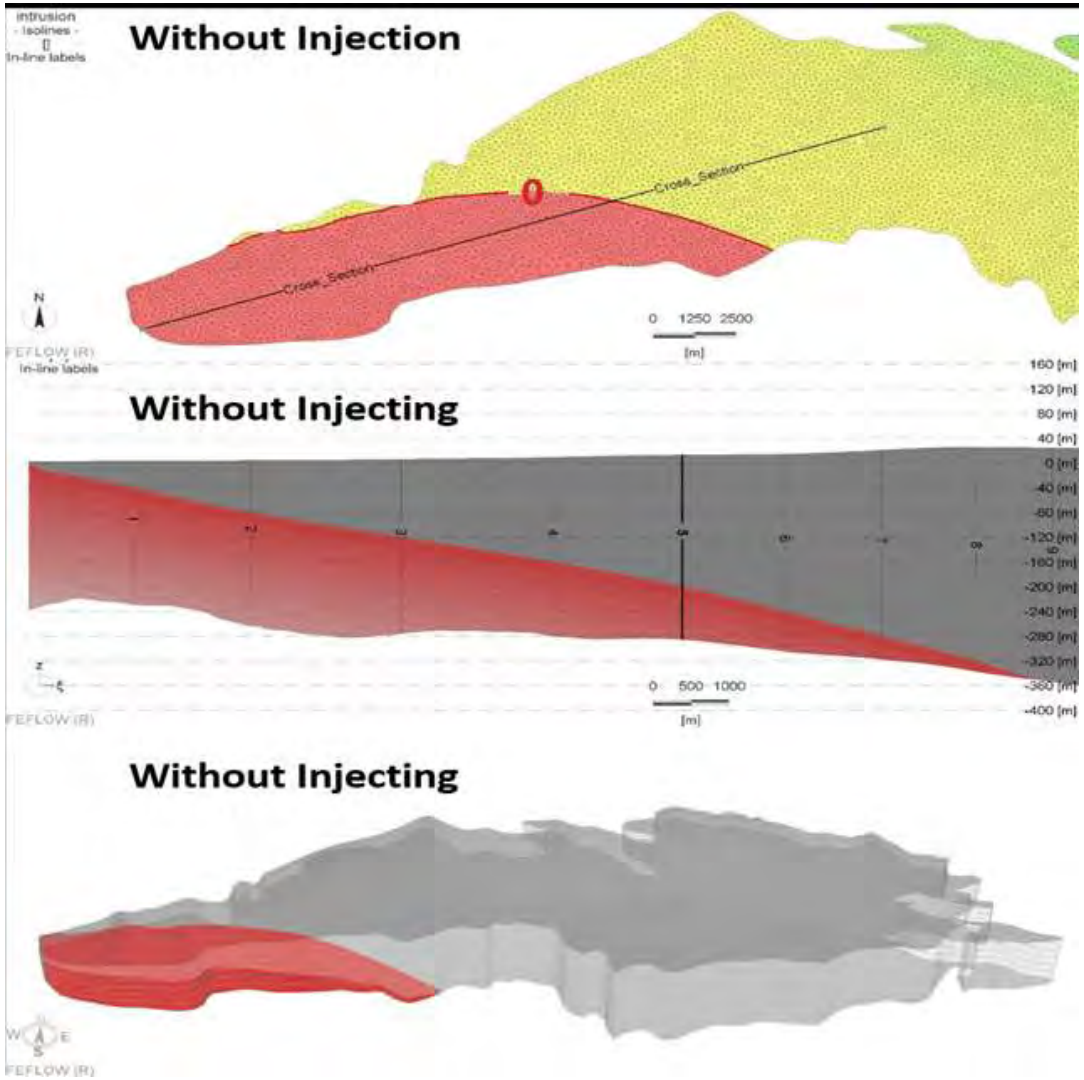
Finite element regional fow model of the Querença Silves **Aquifer System**

- SW-FW interface Scenario drought 2004-2005 simulation with diferente injection scenarios

Evolution of Seawater intrusion estimated at Bottom slice

Evolution of Seawater intrusion at cross-section view

Evolution of Seawater intrusion plume at 3D view



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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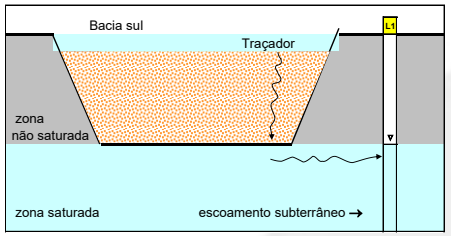
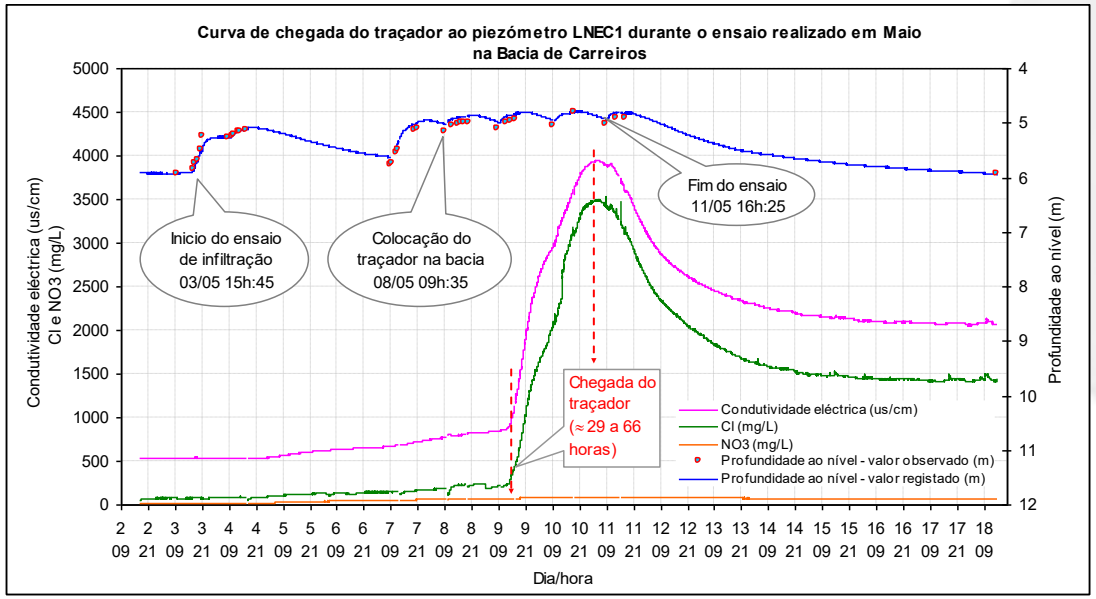
Natural recharge monitoring



✓ Continuous monitoring in three piezometers

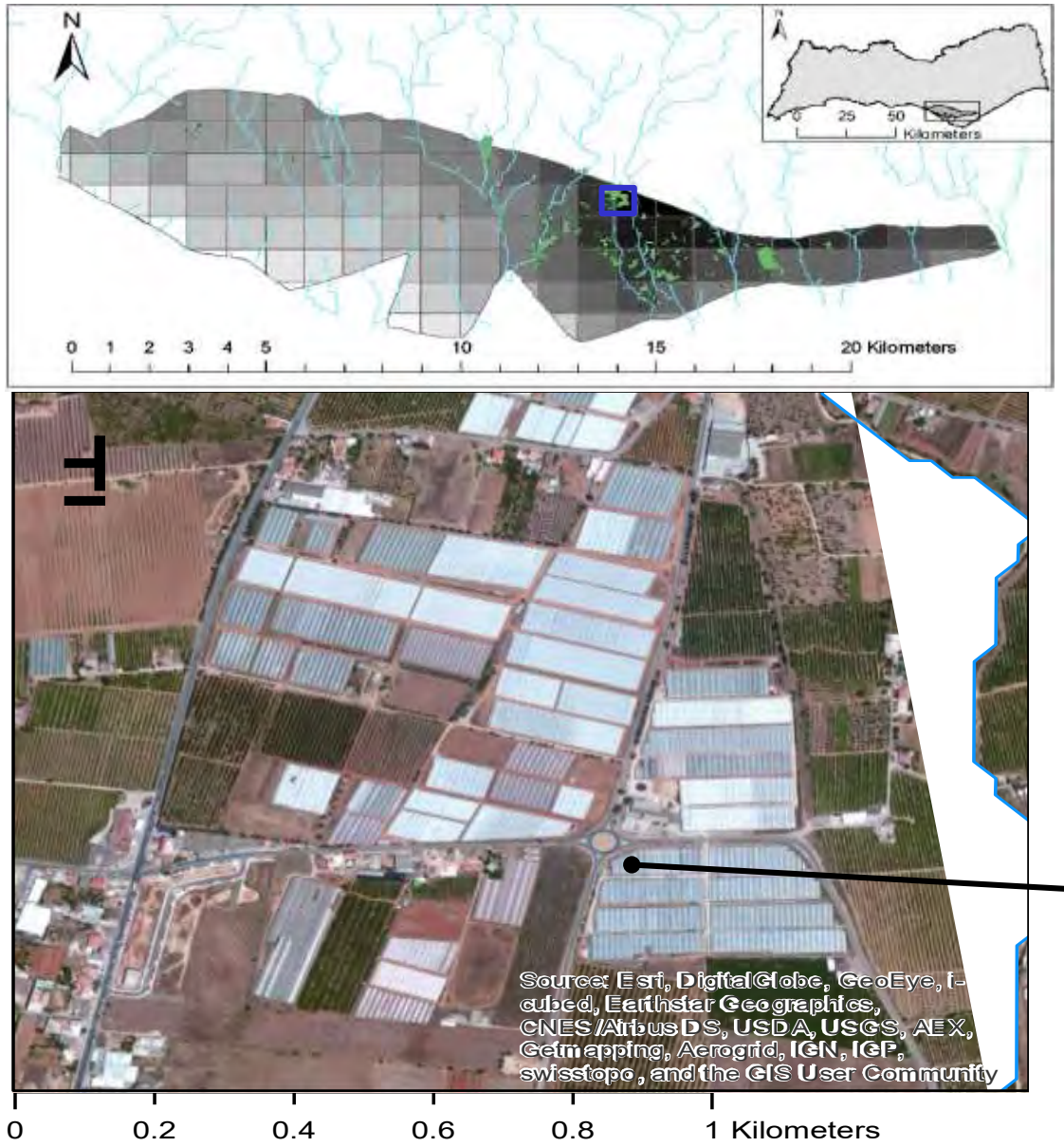


Artificial recharge experiments

✓ Electrical resistivity assessment

May 2007

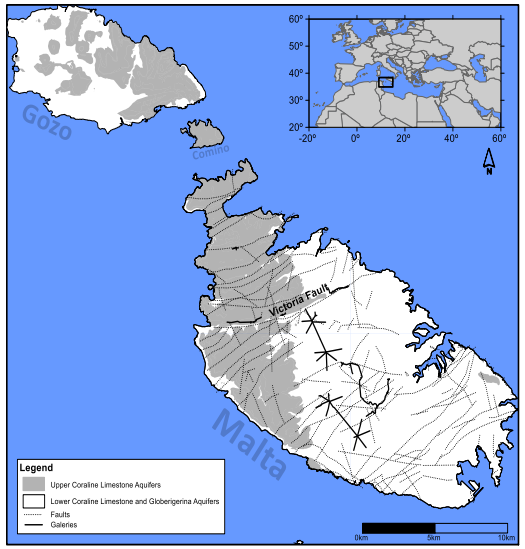
Rainwater harvesting (interception of precipitation in greenhouses) in Campina de Faro, Algarve

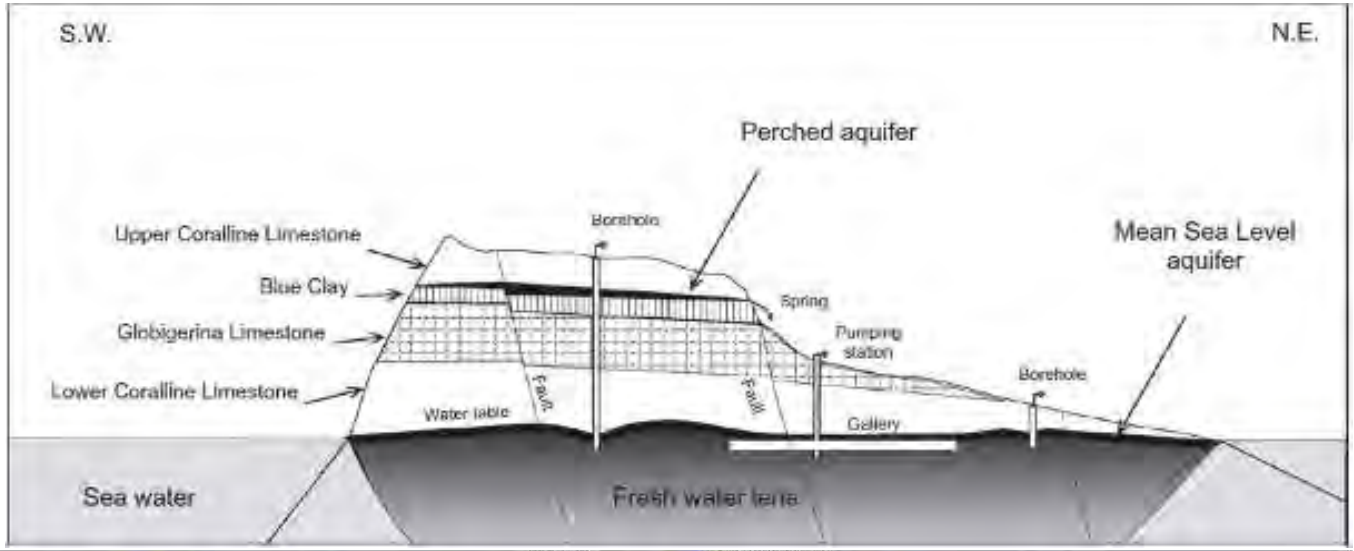


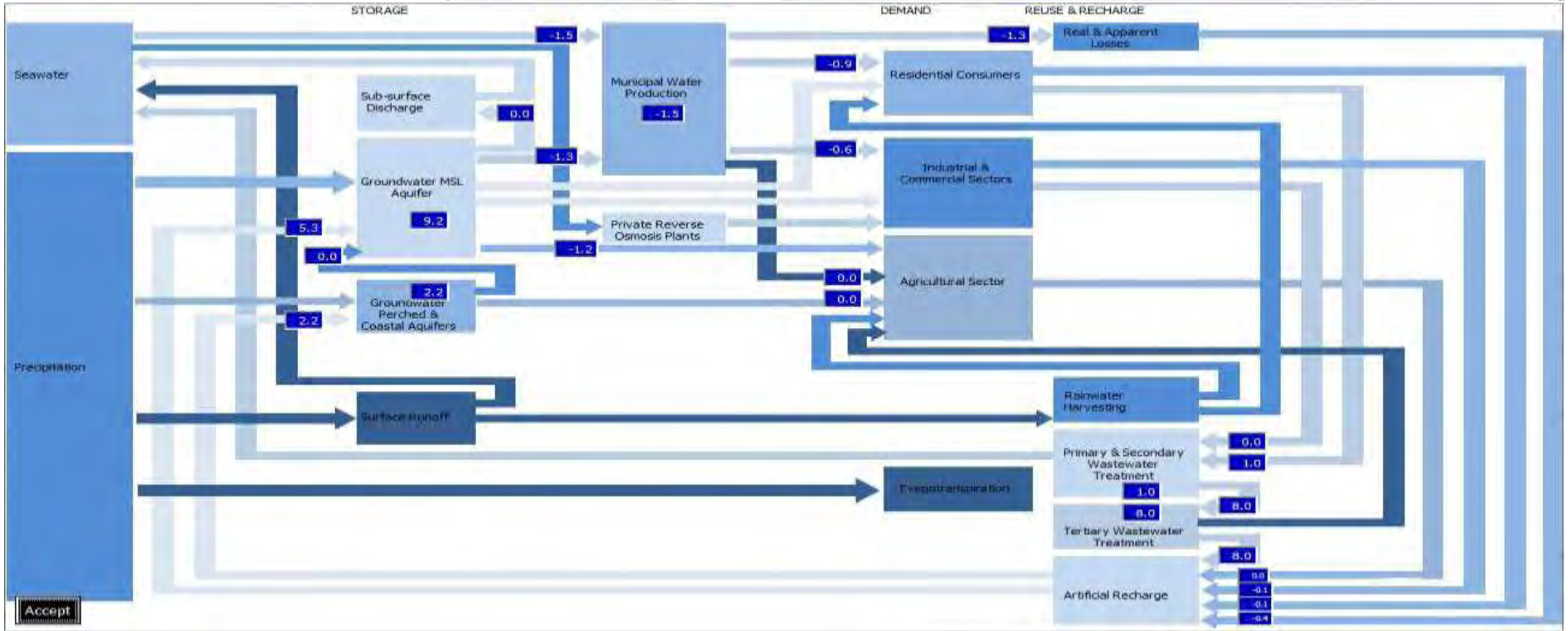
Aerial view of a greenhouse complex and **picture showing it's actual drainage system.**

The area is flat and is characterised by low recharge rates. In this conditions drainage is a serious problems in this area.

Malta MAR: reusing WWTP to prevent saltwater intrusion







DEMO SITE ARENALES, SPAIN (WP 5, TRAGSA)

Arenales (DINA-MAR/TRAGSA)


LA RECARGA GESTIONADA DEL ACUÍFERO DE LA CUBETA DE SANTIUSTE

JORNADA TÉCNICA INFORMATIVA "MARAFARM"

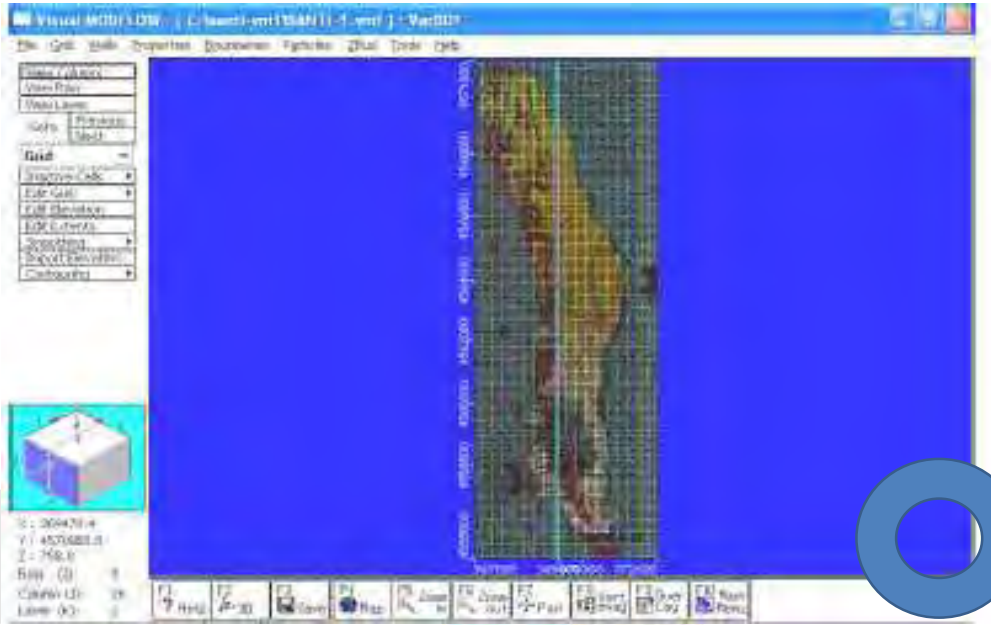
ENTRADAS	Infiltración directa del agua de lluvia	De 2.825 a 3.287 hm³/año
	Infiltración a través de la escorrentía superficial	
	Importaciones	0,19
	Entradas por arroyos	0,056
	Retornos de riegos	0,25 a 0,30 (0,28)
RECARGAS	Recarga artificial del acuífero	0,933 a 1,344 hm³/año
	Flujo subsuperficial y manantiales entrantes	0,081 hm³/año
SALIDAS	Salidas por bombeo:	
	Destino del agua de las captaciones:	
	Regadíos	2.649 a 2.966 hm³/año
	Abastecimiento urbano	(importaciones)
	Abastecimiento industrial	0,165 hm³/año
	Abastecimiento ganadero	0,154 hm³/año
	Salidas por cauces superficiales.	0
	Percolación hacia el acuífero profundo.	0,762 a 1,107 (1,0) hm³/año
DESCARGAS	Descargas Manantiales y retornos	De 0,241 (0,3) a 0,677 hm³/año
	Drenaje subsuperficial y subterráneo hacia el norte de la Cubeta	0,039 hm³/año
TOTAL	E (de 3,382 a 3,817) + (AR) - S (De 4,010 a 5,108) = ΔV	De - 0,628 a - 1,291 hm³/año (promedio = -0,959) hm³/año
	(AR = volumen de entradas por recarga artificial.	3,422- 4,307= 0,885 hm³

LA RECARGA GESTIONADA DEL ACUÍFERO DE LA CUBETA DE SANTIUSTE: Medio soluciones y recarga gestionada. Impacto ambiental de la actuación

GEOLOGÍA

- SISTEMA DUNAR SOBRE UN SUSTRATO MARGOSO
- EXISTENCIA DE UN ACUÍFERO PROFUNDO (CENTRAL DEL DUERO)

Grupo Tragsa



DEMO SITE BRENTA, ITALY (WP 7, SGI) & DEMO SITE SERCHIO, ITALY

TEASISTEMI

Sant'Anna

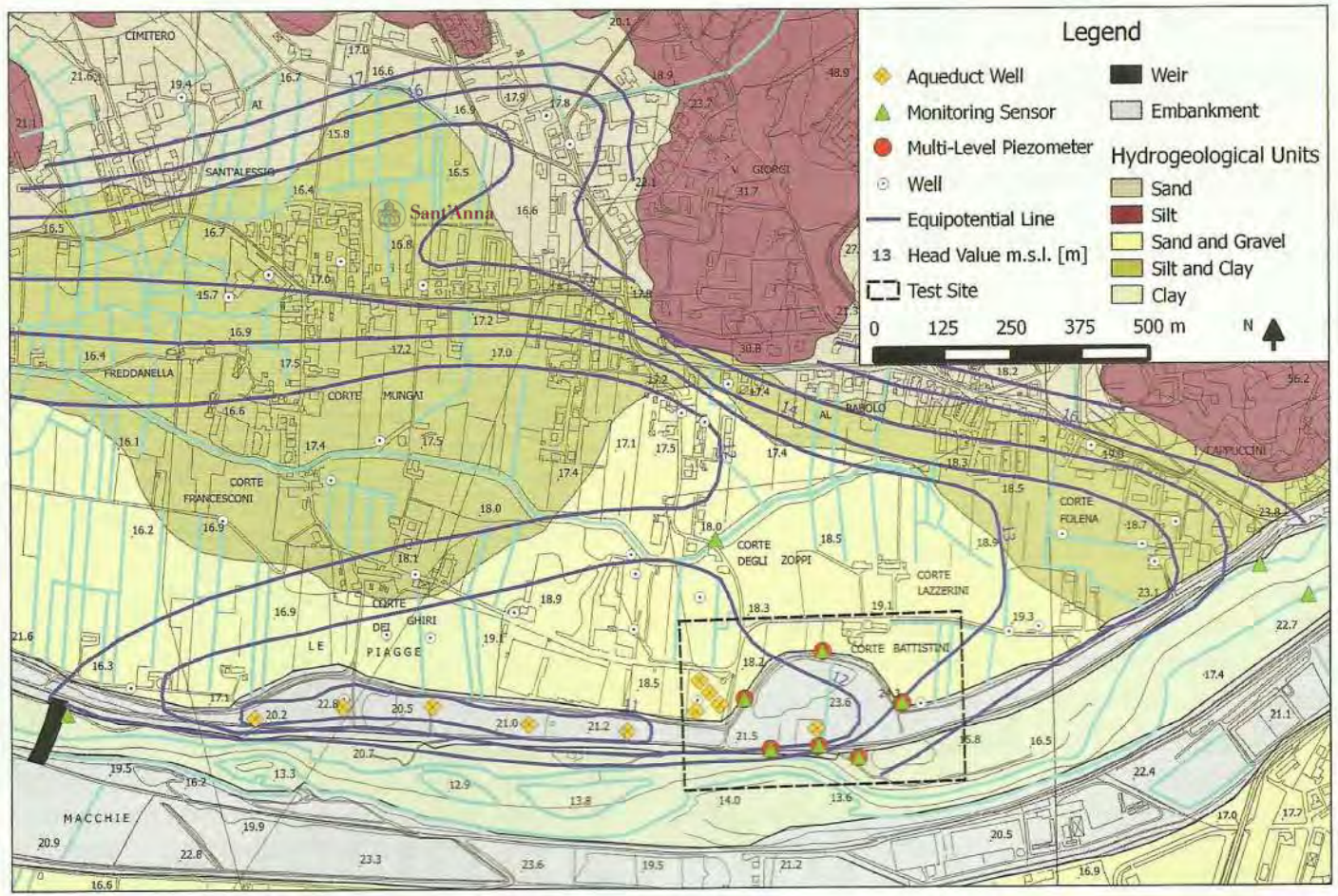
DOI 10.7343/AS-085-14-0112

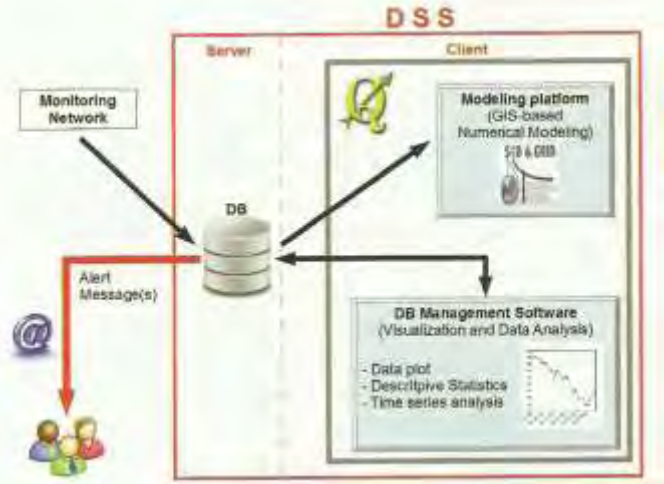
Perspective research Ricerca

L'impianto di ricarica riverbank filtration di S. Alessio (Lucca): attività di monitoraggio e modellistica nel progetto EU FP7 MARSOL

The riverbank filtration plant in S. Alessio (Lucca): monitoring and modeling activity within EU the FP7 MARSOL project

Iacopo Borsi, Giorgio Mazzanti, Alessio Barbagli, Rudy Rossetto





Brenta Sites Introduction

SCHIAVON Forested Infiltration Area

- Approx. 2 hectares
- **Water infiltration rate: 20-50 l/sec/hectare**
- Fast growing tree species
- GW level: around -3 m b.g.l.
- Undifferentiated aquifer with high/medium permeability

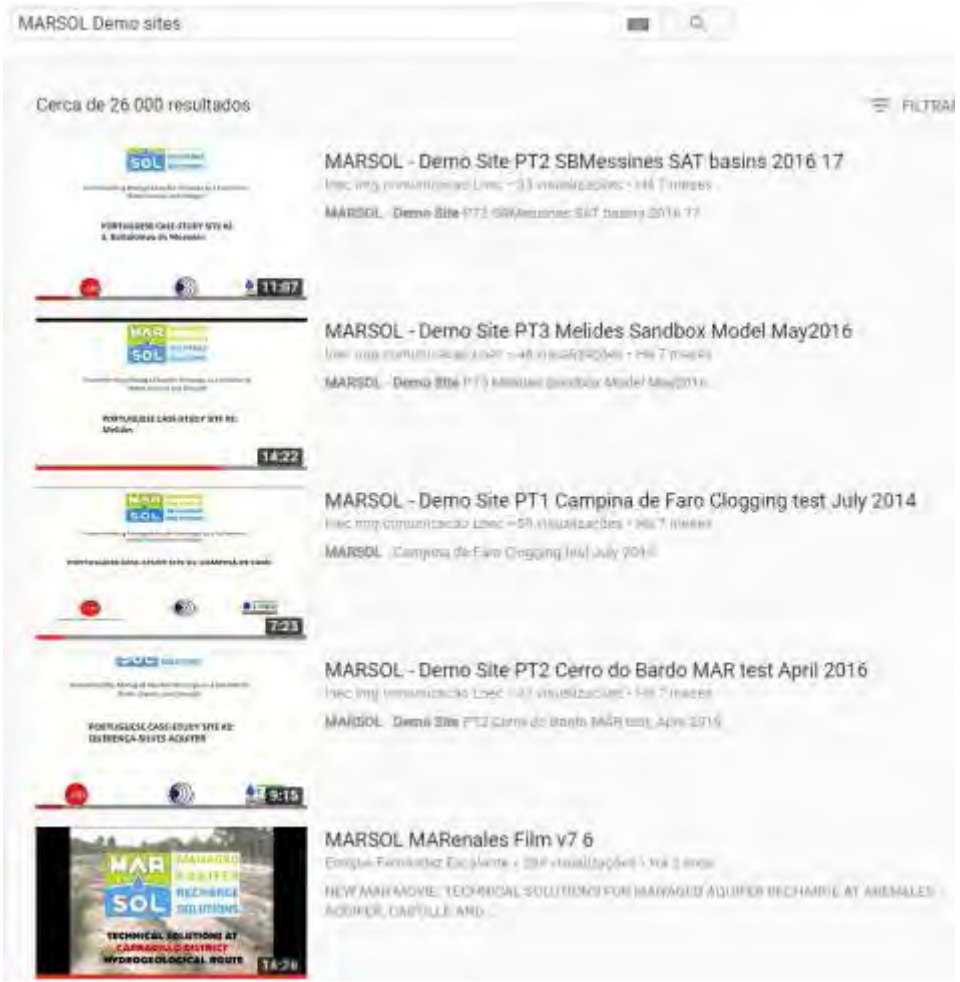
The watering of the pilot F.I.A. area takes place generally during non-irrigation periods, using the existing irrigation water conveyance system (**ditches, underground pipelines**).

WP7: Brenta, Italy
SGI, AAWA, UFZ, ICCS

http://www.marsol.eu/

https://www.youtube.com/results?search_query=MARSOL+Demo+sites

YouTube PT



https://vimeo.com/channels/marsol

Do visit us in EIP Water Exhibition Booth 108 !

M.A.R. TO MAR-kET

EIP CONFERENCE 2017 WATER

Thank you !
Obrigado !