The Water Reuse project

Sustainable waste water re-use technologies for irrigated land in NIS and southern European states

Project overview and first results

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Water Re-Use
Sustainable waste water reuse technologies for irrigated land in NIS and southern European states

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  knowledge base program 4 (kb4) – sustainable agriculture

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- Project partners & Study sites
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The problem – what is this project about?

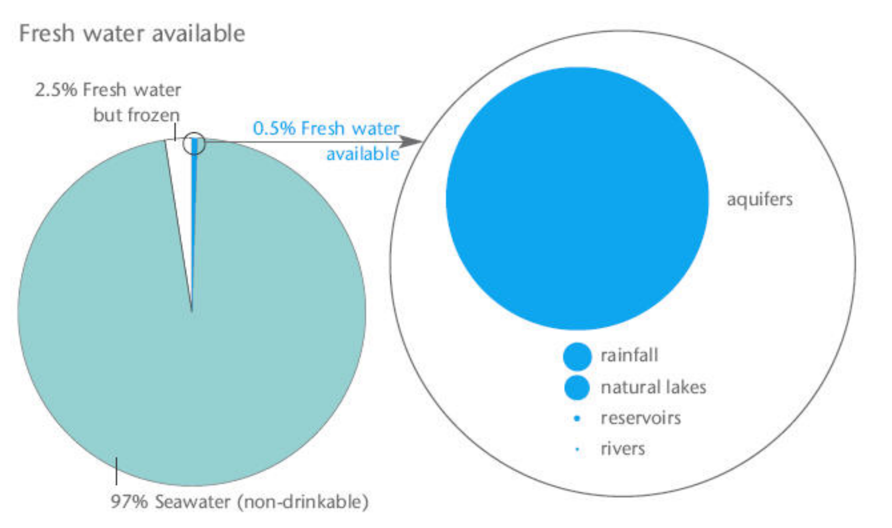
General project objective

- To develop new, and advance existing, sustainable water saving strategies in the NIS and Mediterranean States

Important focus points

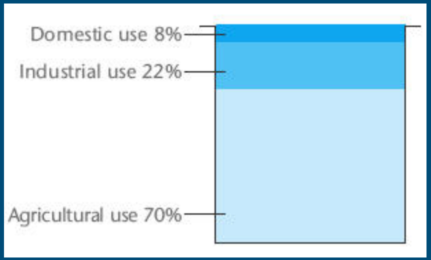
- Addressing soil wetting characteristics will counter particularly those water losses, which occur through surface runoff, evaporation, and uneven wetting and preferential flow in the subsoil
- The use of organic-rich waste water will provide an alternative water source for irrigation and can provide additional nutrient input, improve soil hydraulic properties

The problem – what is this project about?



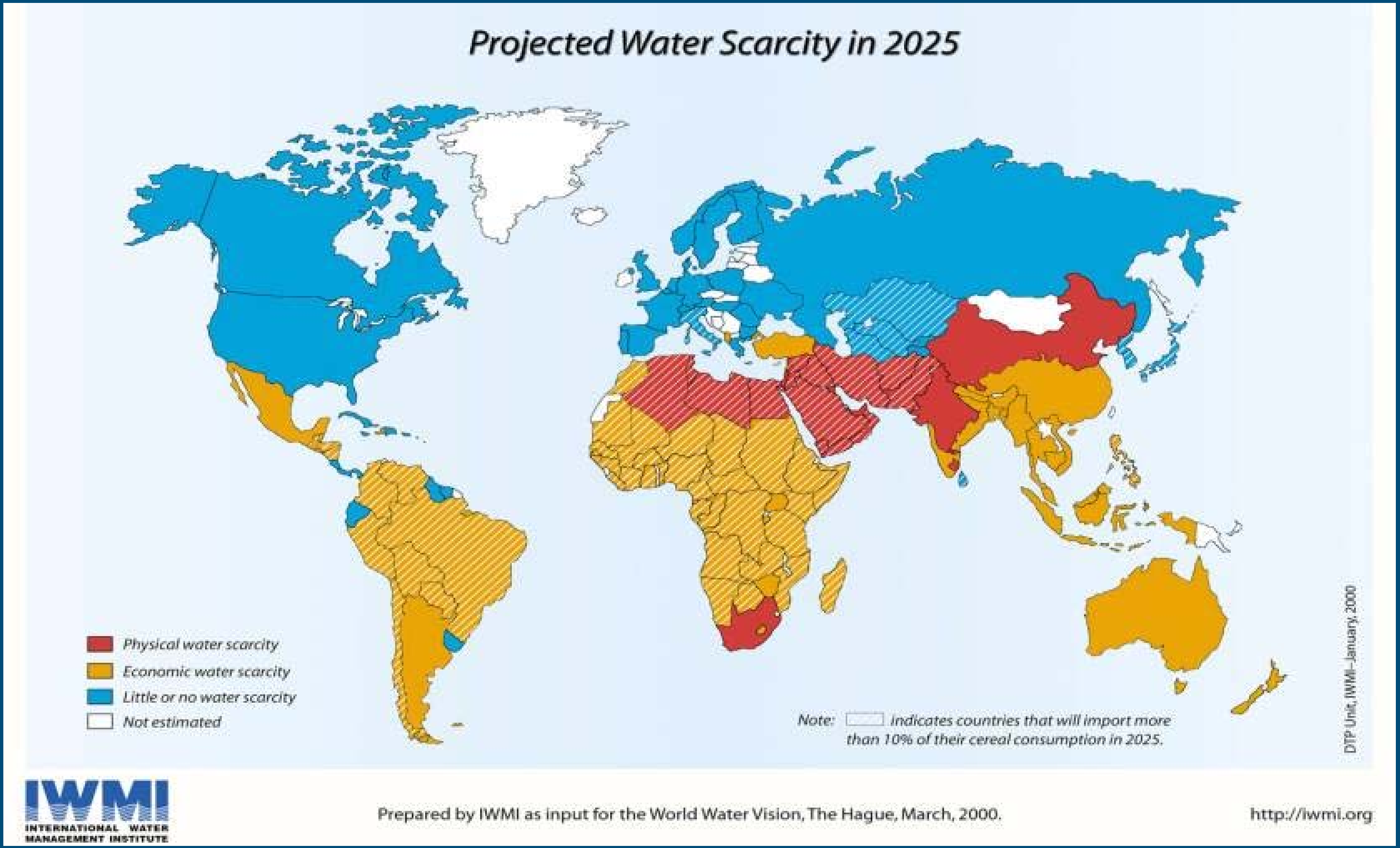
Facts*

- **0.5%** of all the water on earth is available fresh water (2.5% is frozen)
- About **70%** of available fresh water is used in agriculture
- About **22%** of available fresh water is used in industry
- The rest (about **8%**) is used for domestic use (a.o. drinking water)



* Source: World Business Council for Sustainable Development (WBCSD)

The problem – what is this project about?



The problem – what is this project about?

Irrigation efficiency is estimated* to be about 13-18%

(*Based on data given in Wallace and Batchelor (1997) and reproduced from Falkenmark et al. (1998))

Water division in irrigation fed agriculture for semi-arid areas

Storage and conveyance	**30**%
Runoff and drainage	**44**%
Evaporation	**8-13**%
Transpiration	**13-18**%

Soil related losses add up to more than **50%** !

The problem – what is this project about?

Although improved above ground irrigation systems have been developed to increase Irrigation Efficiency (e.g. drip and trickle irrigation) Irrigation Efficiency is still low due to the following factors:

- Drainage of water to the sub-soil (excessive irrigation, water repellency)
- Runoff (excessive irrigation, water repellency)
- Ponding (excessive irrigation, water repellency)
- Evaporation (bad irrigation timing, irrigation method)

The problem – what is this project about?

Water Repellency is the hydrophobicity of soils to water causing bad and/or irregular wetting

- Water repellency is caused by organic hydrophobic compounds, which are present as coatings on soil particles or as interstitial matter between soil particles.
- Water repellency is found in all soil types, but is more prominent in course soils.
- Effects:
  - Ponding
  - Runoff
  - Preferential flow
  - Dry spots

The problem – what is this project about?

Reduction of fresh water use in agriculture can be found in:

- Improving Irrigation Efficiency
  - Reducing ‘loss’ factors (drainage, runoff, evaporation)
  - Reducing or removing Water Repellency
- Using treated waste water (!)

- Boundary conditions:
  - Not changing soil hydraulic properties in a negative way (e.g. k)
  - Not inducing Water Repellency through organic compounds in the applied waste water
  - Positive effects of organic compounds in treated water?
  - Concentration of waste water compounds must be permitted by local legislation

Project partners & Study sites

Project partners:

- Alterra (Netherlands, c
- University of Wales Sw
- Mediterranean (MED) c
  - University of Migu
  - Democritus Univer
- New Independent Stat
  - Department of En (Moscow, Russia)
  - Saratov State Agr
  - Institute for Soil S Ukrain)

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Project partners & Study sites

Study sites:

Water Repellency issues

- University of Miguel Hernandez (Alicante, Spain)
- Democritus University of Thrace (Xanthi, Greece)

Irrigation Efficiency issues

- Department of Environmental Engineering, University of Moscow (Moscow, Russia)
- Saratov State Agrarian University, (Saratov, Russia)
- Institute for Soil Science and Agrochemistry Research (Kharkiv, Ukrain)

Project setup

Year 1

Socio-economic inventory, Field site selection, Selection of waste water treatment plant, Basic characterization of soils and water.

Year 2

Definition of (water and soil) monitoring strategies, Field site setup, Start of monitoring program.

Year 3

SWAP modeling, Definition of alternative irrigation strategies, Implementation of alternative irrigation strategies, Continuation of field measurements.

Year 4

Evaluation of alternative strategies, Reporting.

Project setup

Year 1

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Year 4

Evaluation of alternative strategies, Reporting.

Preliminary results – example from Spain

Experimental field location

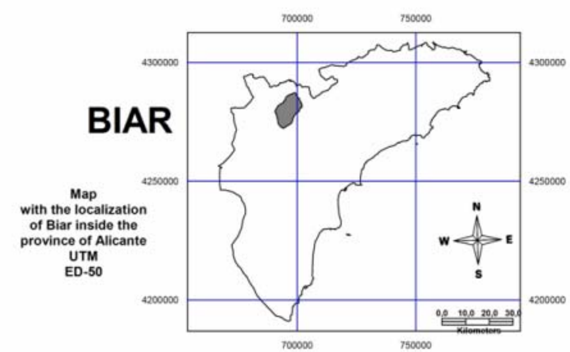
Study area

Field plots

Meteorological station

Location:

UTM : X: 693.809 ,Y: 4.279.922 , Z: 626



Preliminary results – example from Spain

General data of the waste water plant and the field study site:

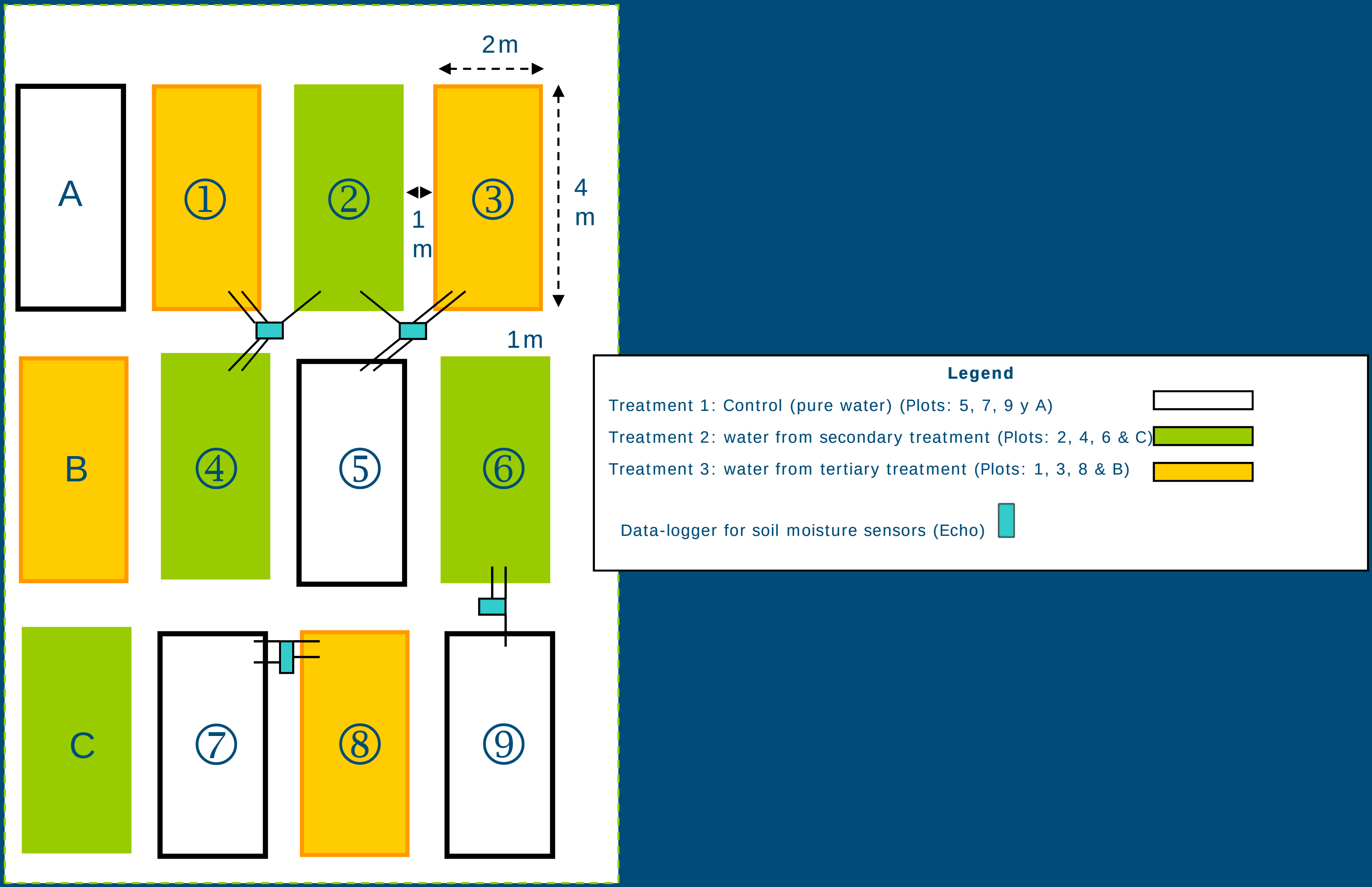
Biar waste water plant and field data

Water input flow: 740 m3/day
Population: 4683

Water treatment in the plant

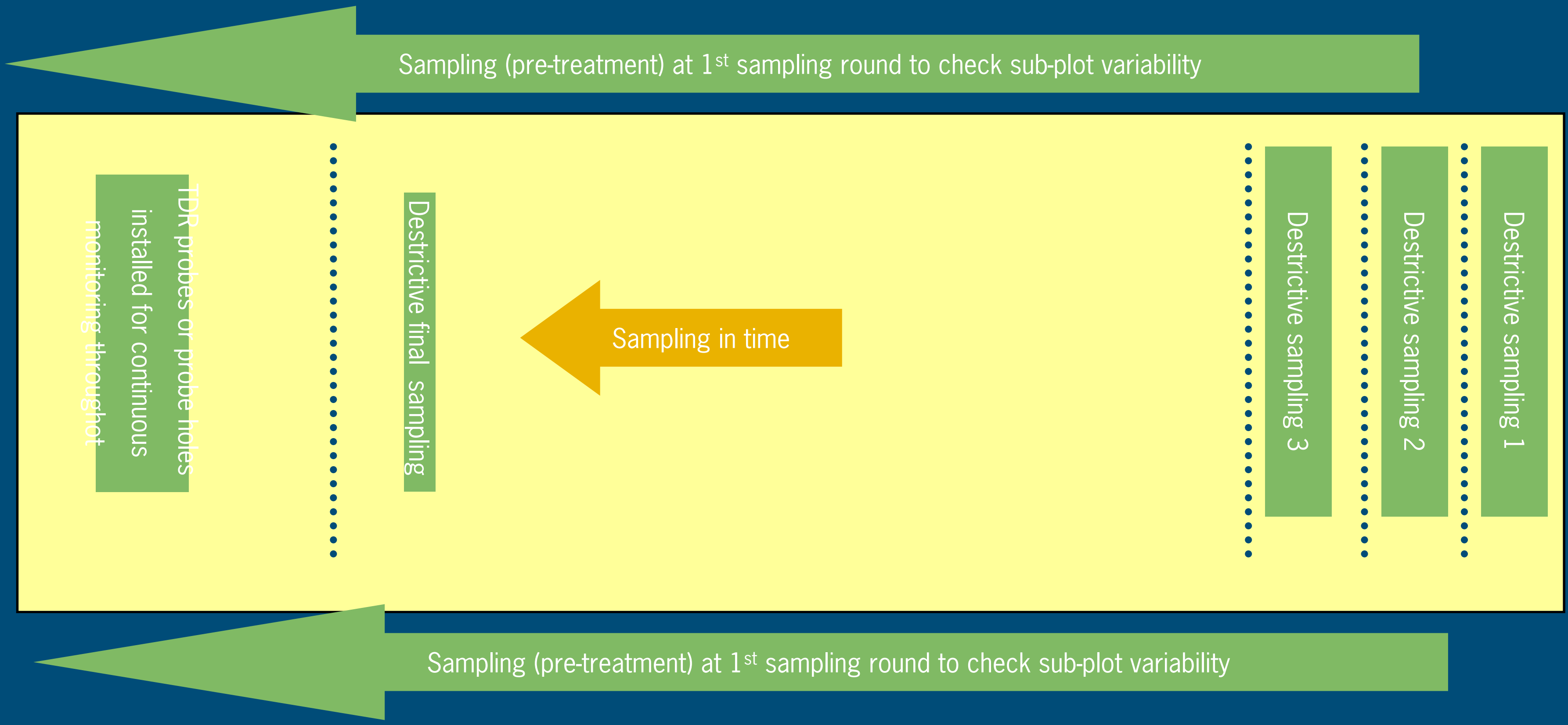
- **Primary treatment:** waste water after inorganic particles elimination by sedimentation processes.
- **Secondary treatment:** water coming from primary treatment is maintained in continuous flux of oxygen to favour organic matter oxidation by the microorganisms, and the organic matter remnant is eliminated by sedimentation process.
- **Tertiary treatment:** tertiary treatment is an additional treatment after secondary le. The specifically treatment depends on the waste water plant equipment. In the case of Biar compromises sandy filters.

Preliminary results – example from Spain



Preliminary results – example from Spain

Scheme of one destructive sub-plot layout (A, B & C)

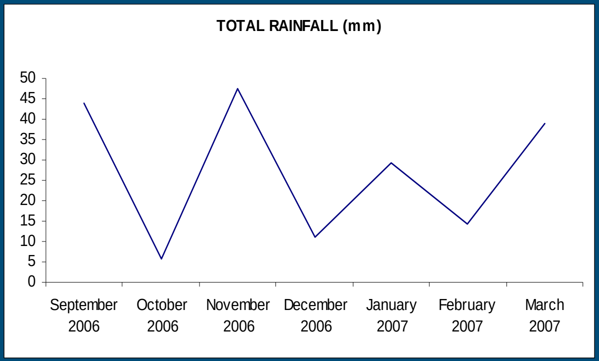


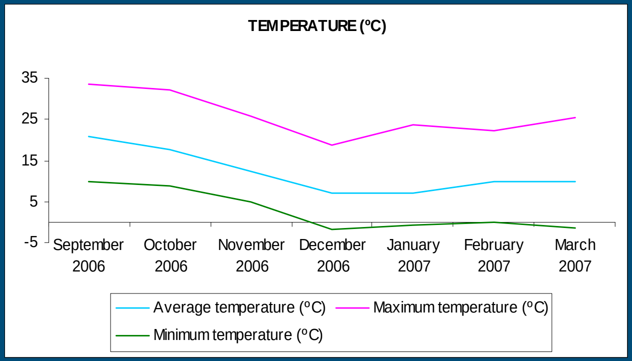
Preliminary results – example from Spain

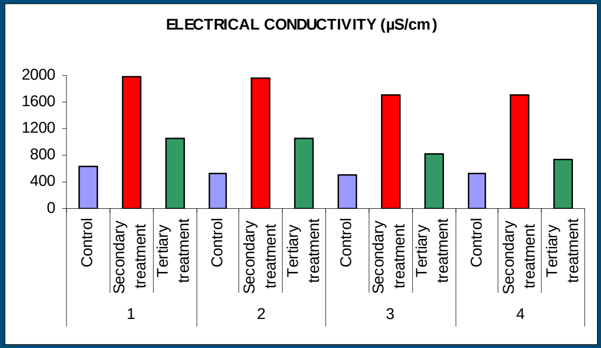
Preparing the experimental plots before start of the experiment

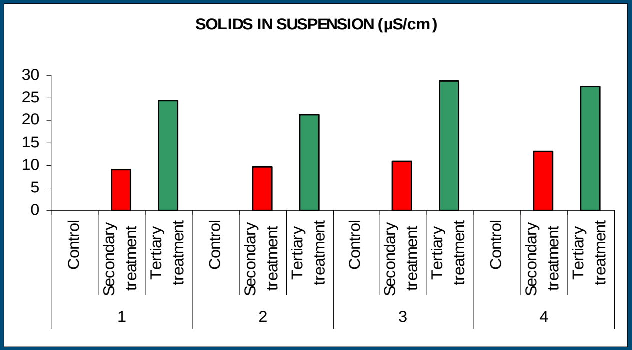
Preliminary results – example from Spain

Preliminary results – example from Spain



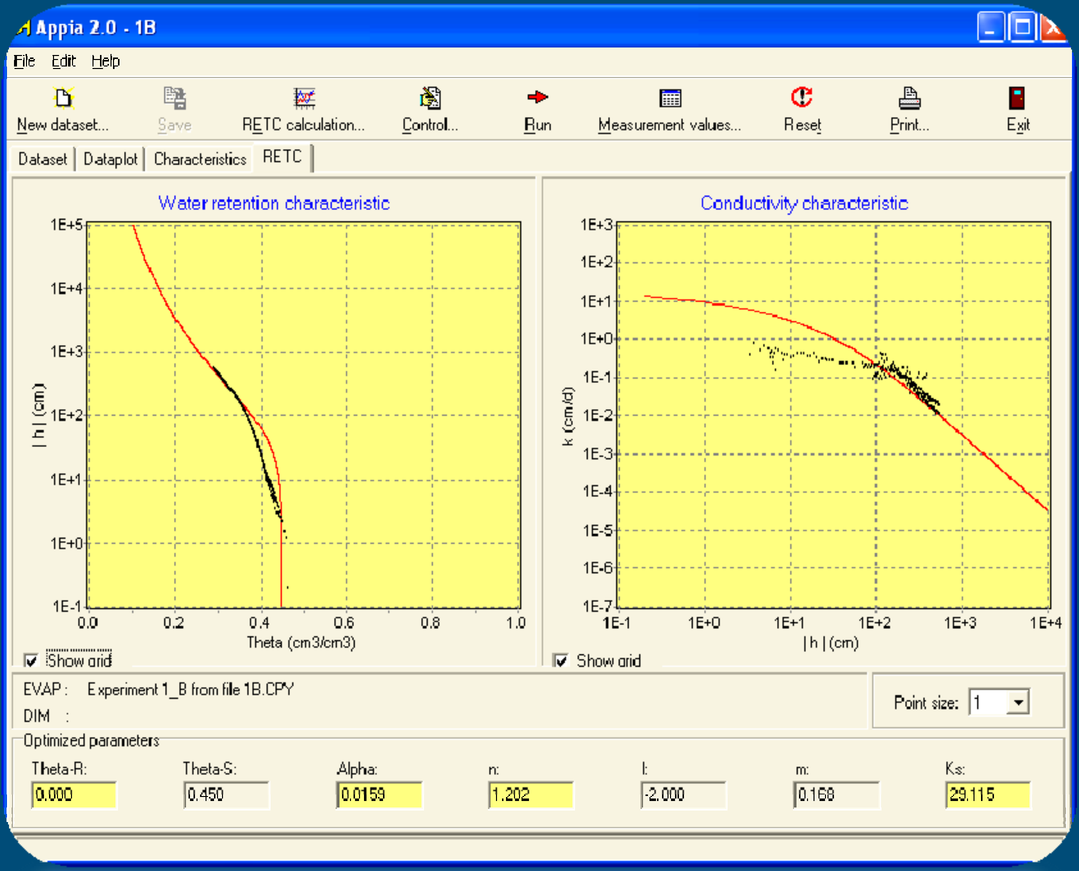






	Gravel (%)	*Soil Moisture (m³/m³)*	*Bulk Density (g/cm³)*	*Water Repelency (s)*	*pH*	*Soil organic matter content (%)*	*Electrical Conductivity (µs/cm)*	**Clay (%)**	**Silt (%)**	**Sand (%)**	**Particle size distribution Texture USDA**
Control	5,81	0,0061	1,15	< 5s	8,78	2,24	192,9	24,2	41,0	34,8	Loam
Secondary treatment	5,89	0,0057	1,14	< 5s	8,69	2,21	186,5	24,7	45,0	30,3	Loam
Tertiary treatment	5,98	0,0054	1,13	< 5s	8,71	2,16	180,8	24,9	40,8	34,3	Loam

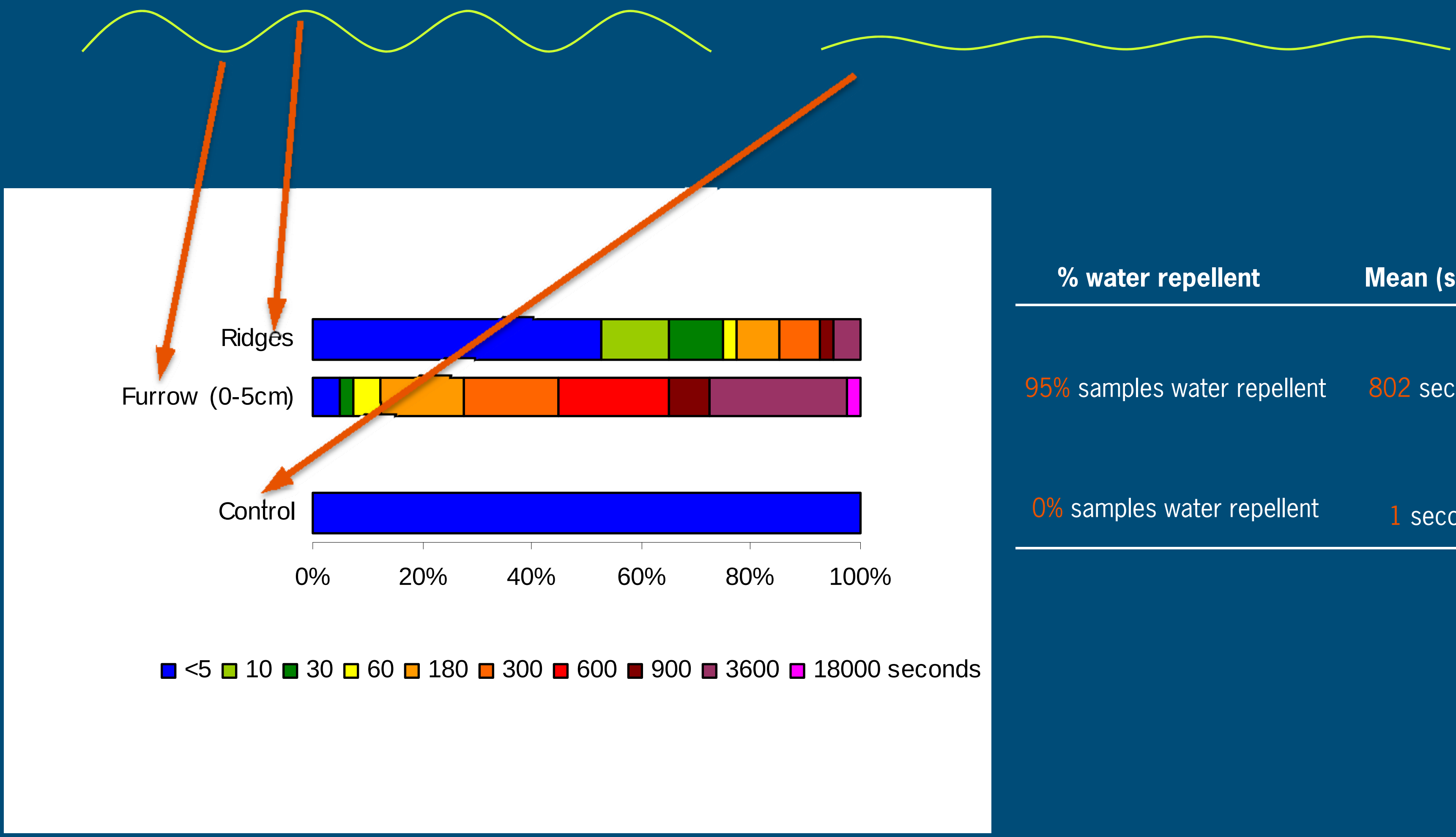
Preliminary results – example from Spain



Preliminary results – example from Spain

Water Repellency measurements in the 'historical site'

(has been irrigated with untreated waste water for >10 years)



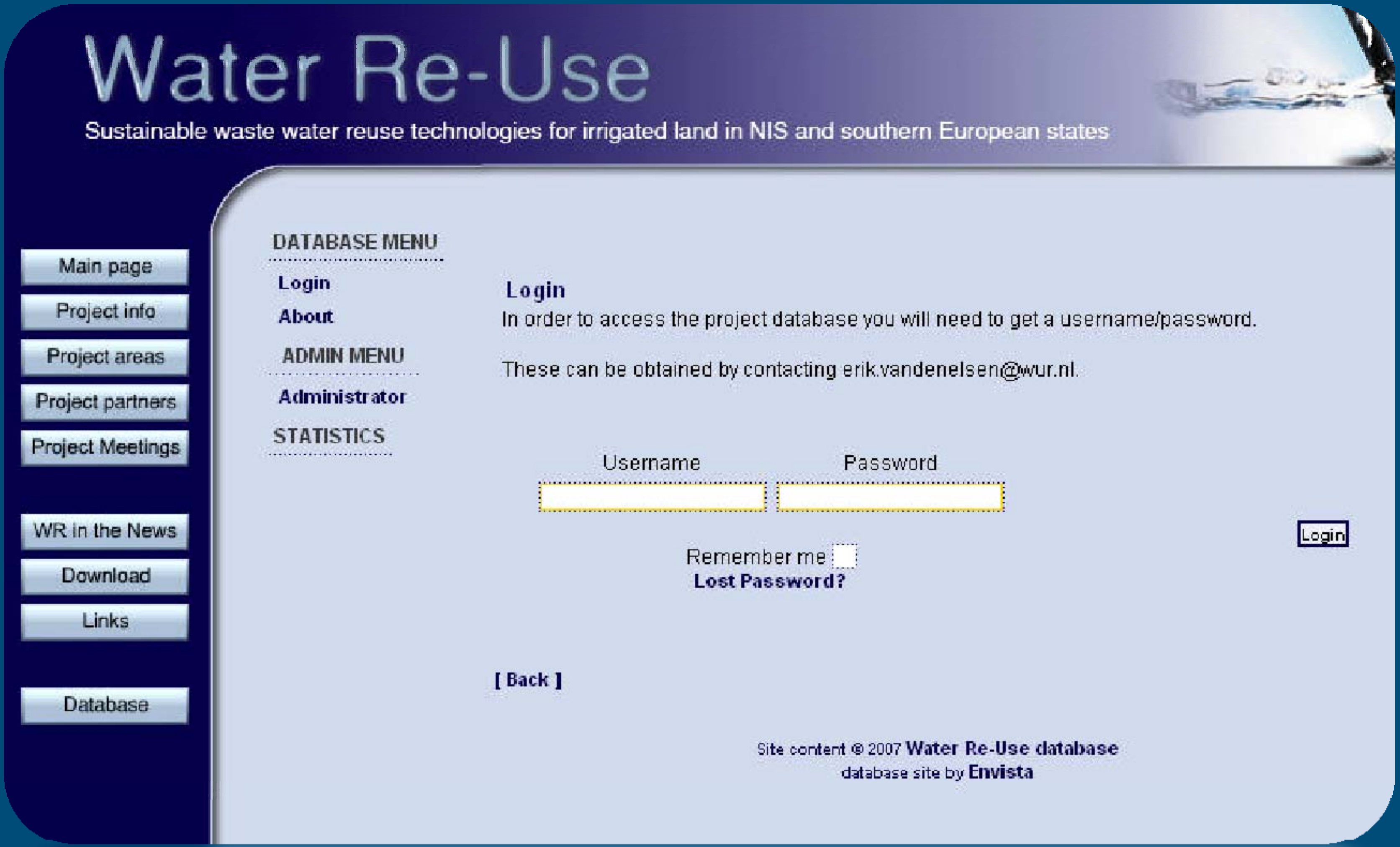
% water repellent	Mean (s)
95% samples water repellent	802 seconds
0% samples water repellent	1 second

Preliminary results

Proposed new irrigation strategies (Spain example)

Spain (water repellency prevention, irrigation efficiency)	**1**	Keeping the soil above the critical soil moisture content (prevents water repellency from developing).
	2	Applying Clay amendments (prevents generation of water repellency).
	3	Using surfactants (prevents generation of water repellency).
	4	Avoid build-up of organic compounds that induce water repellency above a critical threshold.
	5	Avoid application of types of organic components in the waste water application that induce water repellency.
	6	Avoid growing of 'wrong' crop types (certain crop types induce water repellency).
	7	Use treated waste water (saves fresh water, amends organic matter into the soil)
	8	Irrigation dose: use exactly the right amount of water (calculate the appropriate dose of irrigation water given the circumstances of crop, evaporation, losses, etc.; this will prevent over-use of water).
	9	Irrigation dose (smaller multiple doses vs one large dose – prevent throughflow of large quantities of water to the subsoil).
	10	Irrigation dose (keep soil at a constant moisture level, prevents cracking of the soil and macropore flow).
	11	Irrigation dose (smaller multiple doses vs one large dose – prevent water runoff).
	12	Irrigation dose (smaller multiple doses vs one large dose – prevent water ponding and evaporation).
	13	Increase in surface roughness / decrease surface crusting – improves infiltration.
	14	Decrease surface runoff (and improve infiltration, e.g. on sloped sites: build small dams, use grass strips, contour line ploughing, etc.)
	15	Irrigation timing (preventing evaporation during the night).

Preliminary results



Afsluiting

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