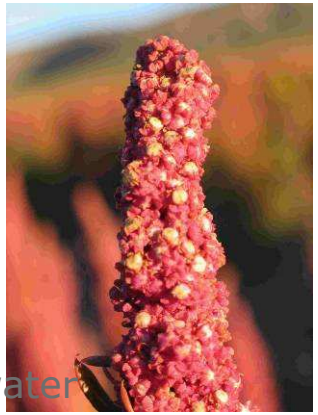


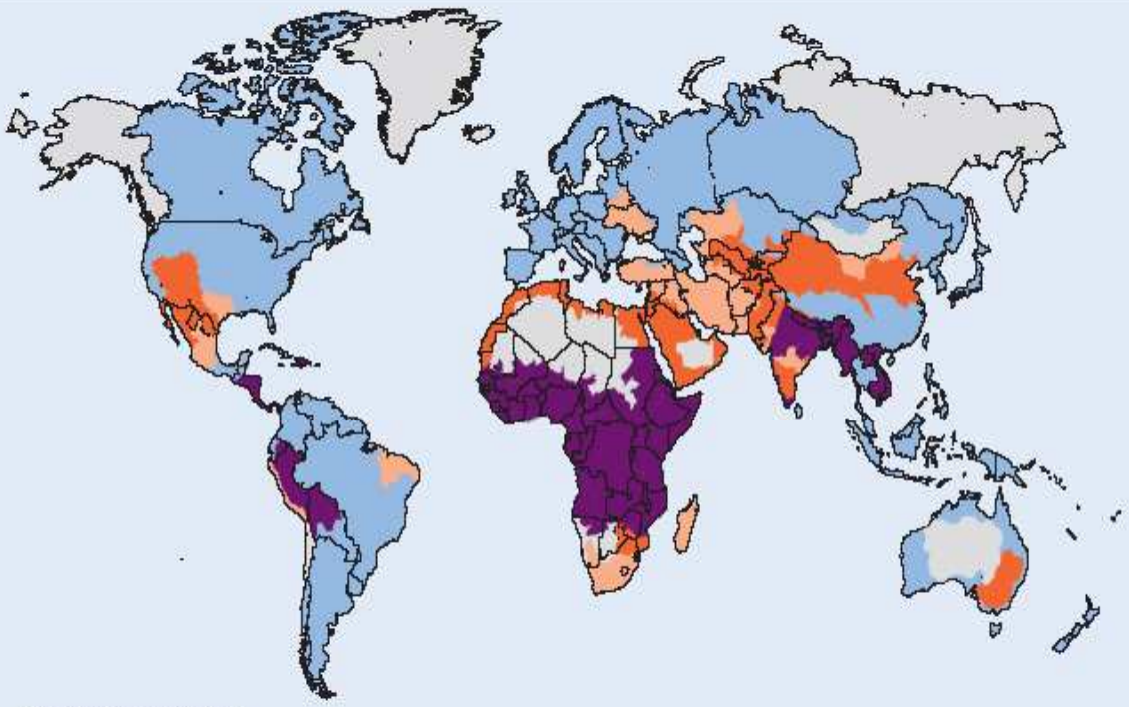
Combining methods for water saving – Cases Western Balkan and Mediterranean region

Sven-Erik Jacobsen

Workshop
Recycling of non-conventional water
Agadir, Morocco

28 April – 1 May 2008

map **2** | **Areas of physical and economic water scarcity**



Definitions and indicators

- *Little or no water scarcity.* Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.
- *Physical water scarcity (water resources development is approaching or has exceeded sustainable limits).* More than 75% of river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition—relating water availability to water demand—implies that dry areas are not necessarily water scarce.
- *Approaching physical water scarcity.* More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.
- *Economic water scarcity (human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands).* Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

Source: International Water Management Institute analysis done for the Comprehensive Assessment of Water Management in Agriculture using the Watersim model; chapter 2.

UN – Priority areas

Water (1.5 bill. lack drinking water)
Energy (2 bill.)
Health (40 mill. AIDS, 1 mill. malaria/y)
Agriculture (shortage of food)
Biodiversity (loss)

Water

Most important adverse factor in agriculture globally

Largest water user: agriculture 67%, industry 19%, municipal 9%

5000 deaths/day due to lack of clean drinking water

Salinity

Childrens education

UNDP: Without policy changes 2025 67% of world pop. suffer from water shortage/safe drinking water. Today 20% (1.5 bill.).

Water saving strategies

Cultural practices. A diversified crop rotation is important, and may include drought tolerant crops and cultivars.

Irrigation. Supplemental and deficit irrigation may reduce water use without reducing crop yield. A special form of deficit irrigation is alternate irrigation, often termed partial root zone drying (PRD), i.e. irrigating half of the root zone in turn.

Water harvesting ís the process of storing precipitation for beneficial use. Microcatchment water harvesting techniques are contour ridges, semicircular bunds, and small runoff basins. Macro-catchment systems are characterized by having runoff water collected from relatively large catchments.

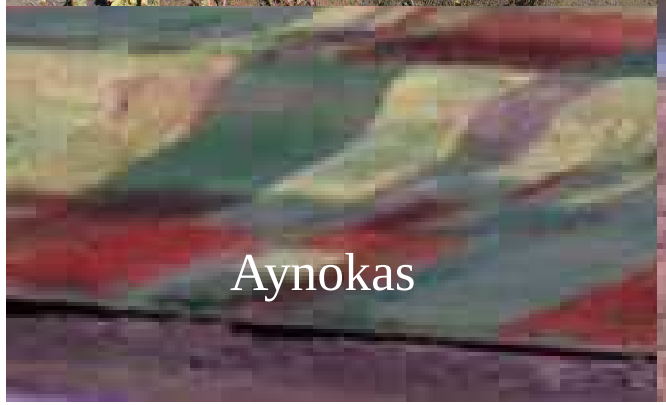
Treated wastewater is a potential resource of water and plant nutrients (N and P) and organic matter, which contribute to soil fertility. Wastewater treatment is, however, characterized by a high cost and technical skills required for operation and maintenance.

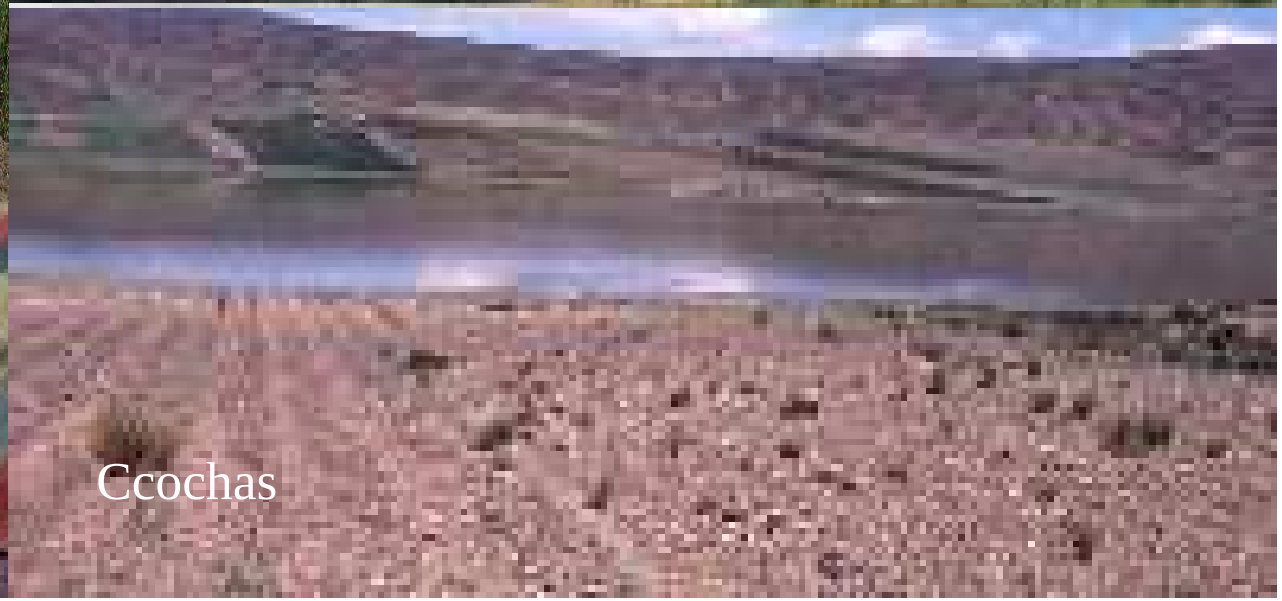
Desalination or use of *saline water*, may be used untreated for some tolerant crops, whereas desalination may provide clean water, after a costly process.

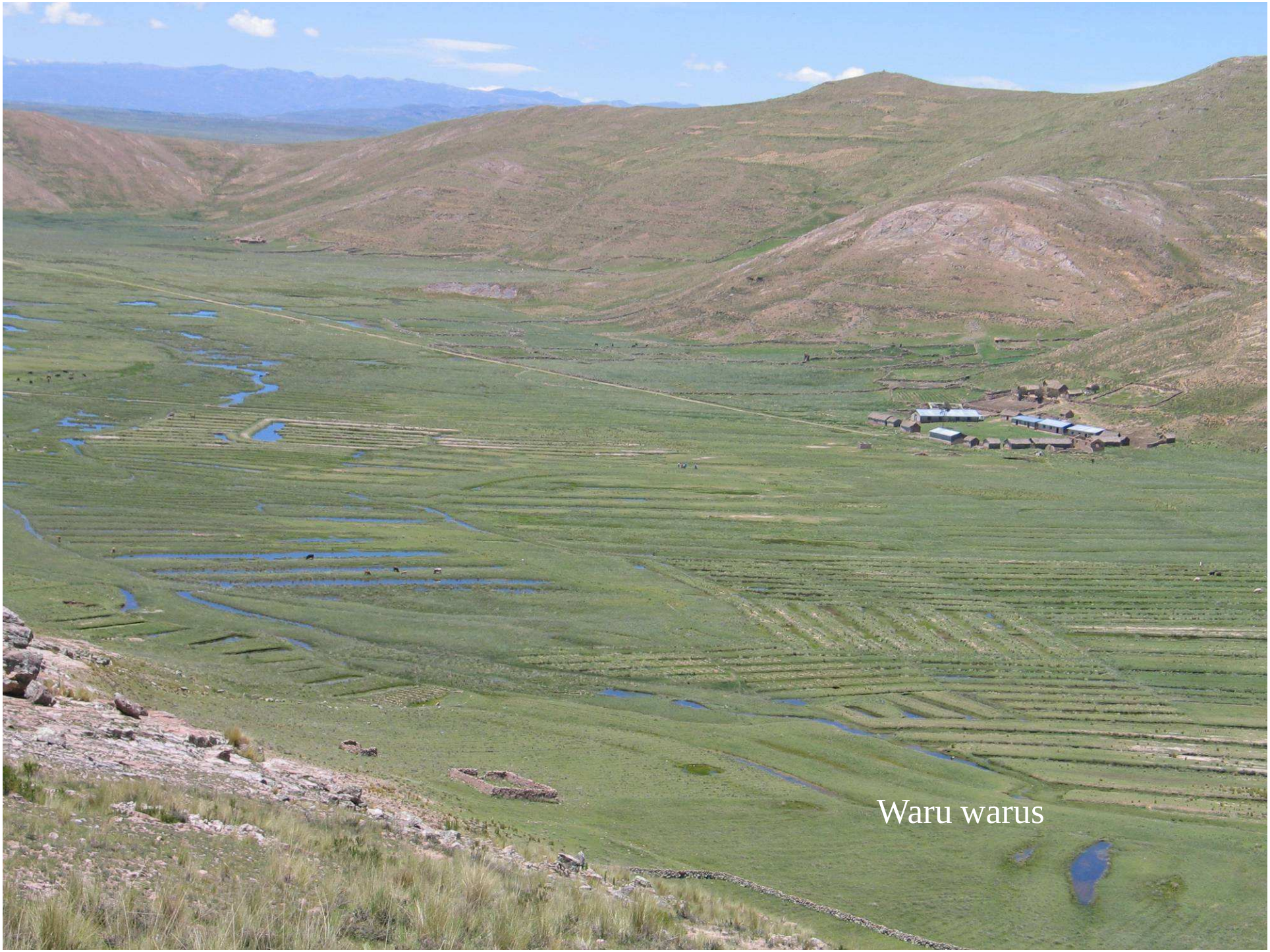
Breeding. Drought tolerant traits should be identified for breeding programmes using advanced physiological and biochemical screening tools.

Others. Water transport and virtual water

Ancient techniques for water saving






Waru warus

Water Resource Strategies and Drought Alleviation in Western Balkan Agriculture

WATERWEB (WATER resource strategies and drought alleviation in WEstern Balkan agriculture)

Proposal/Contract no.: 509163

Problems

Serbia

- Drought
- Increased irrigation, causing chemical and microbiological contamination

Macedonia

- Drought
- Less irrigation, due to climatic conditions, administrative and operational difficulties, farmer reluct pay water charges

WATERWEB

Objectives

Strategic objectives

-to contribute to development in the Western Balkans by introducing strategic water management for drought alleviation and sustainable agricultural practices

-to establish and reinforce research expertise in the WB in a range of technologies for water and crop management.

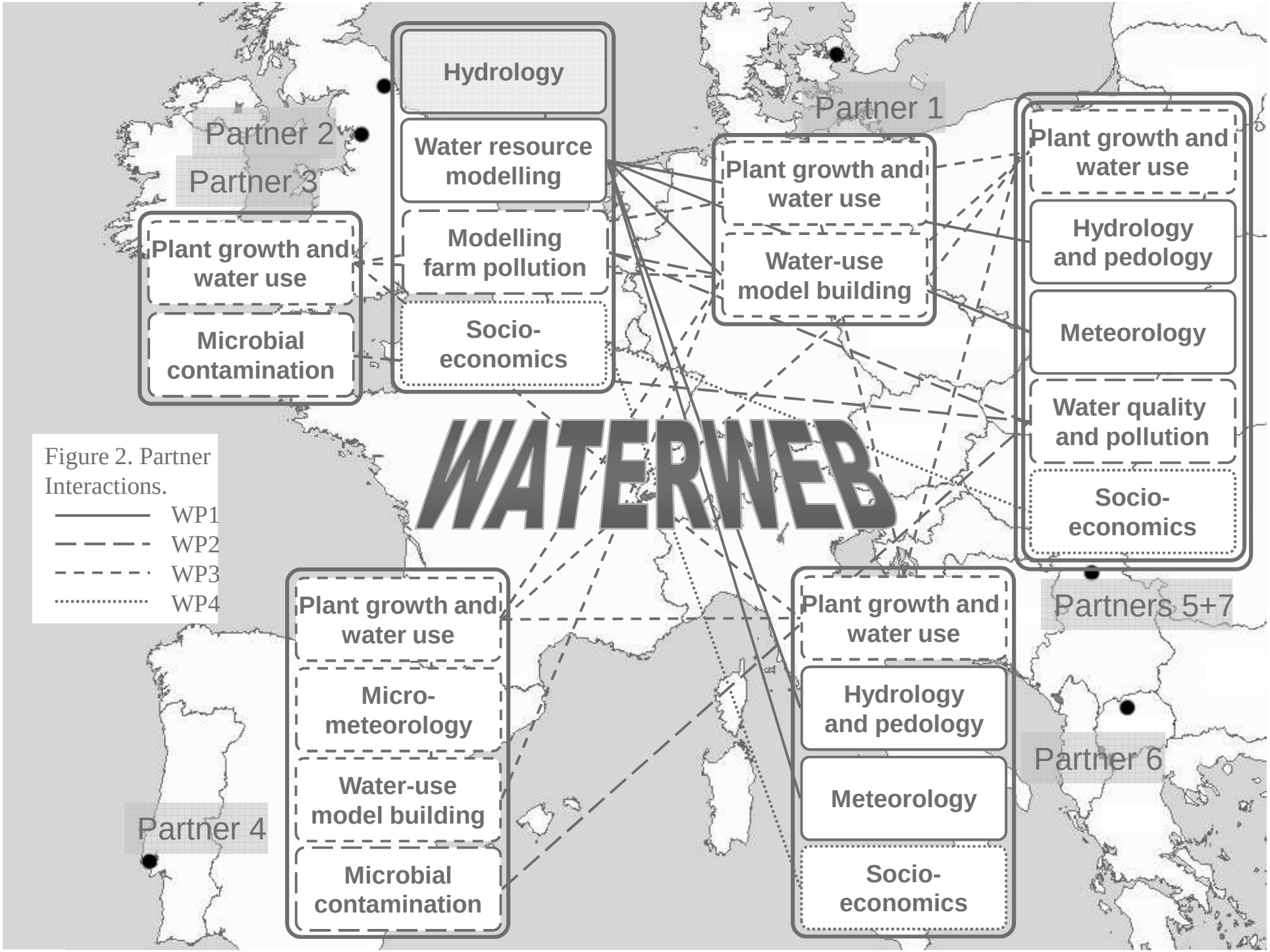
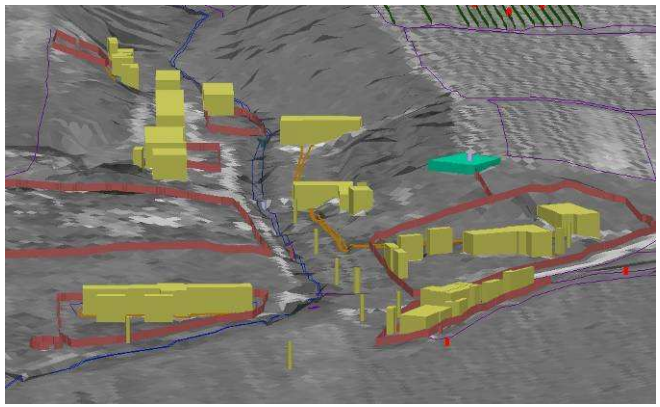


Figure 2. Partner Interactions.

Main results

Water quantity

- Introduction of GIS
- Hydrological monitoring: piezometers, access tubes for profile probes
- Measure water table (profile probes, piezometers, flumes)
- Meteorological information
- Time-series data for hydrological models



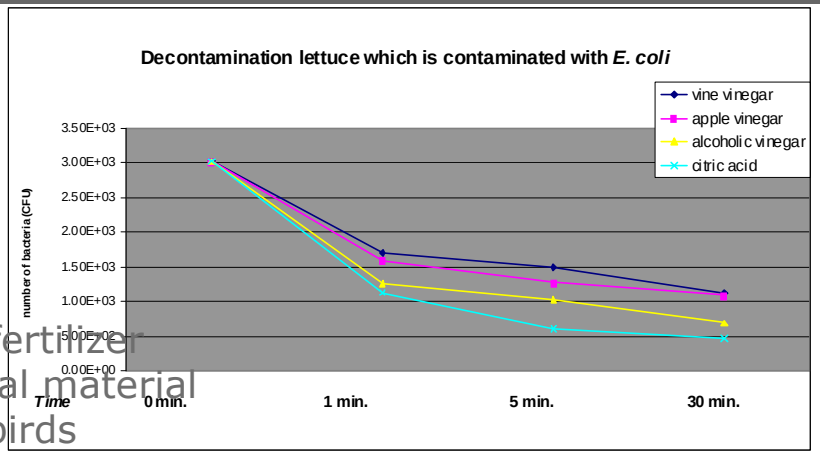
WATERWEB

Incorporation of access tube

Construction of flume

WATERWEB

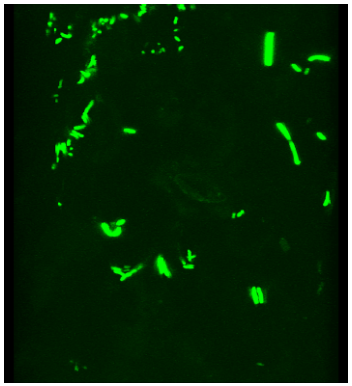
Water quality



Routes of contamination:

Application of organic wastes to agricultural land as fertilizer
Contamination of waters used for irrigation with faecal material
Direct contamination by livestock, wild animals and birds
Postharvest issues such as worker hygiene.

- Water both in S+M polluted, and could not be used for irrigation
- Biochemistry lab equipment for analysis of sugars, peroxidases, anthocyanins
- Chemical analyses of drainage water
  - Heavy groundwater pollution with NO3 (7Juli farm)
  - Periodic increases of organic matter from sewage (Radmilovac)
  - Pollution of river (Macedonia)
- Microbiological analyses
  - E.coli and Salmonella in all water and leaves of plants
  - Some effects on fish
  - Radmilovac: Lettuce E.coli, Salmonella, Listeria, crops more contaminated than products on market
  - Decontamination with UV and organic solutions may have effect
- Ecotoxicological characterization of pesticides (Portugal)
  - Simazine, terbuthylazine, clorpyrifos



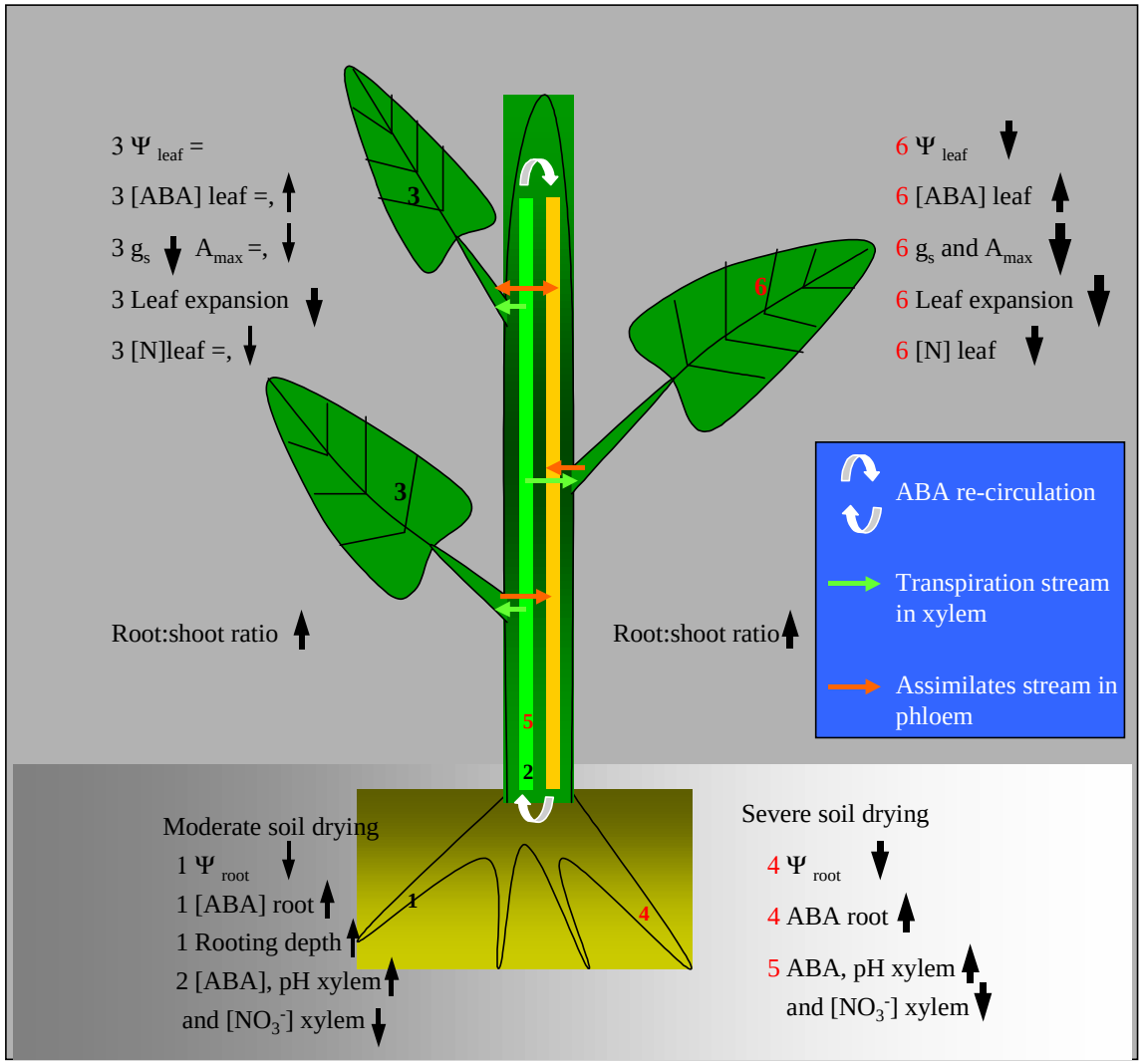
WATERWEB

Water use

- Microscope-Leica software, high resolution
- Tomato (polytunnel, greenhouse). Sugar increased
- Grapevine WUE x2, water 50%, yield same
  - Shoot growth: Natural cover < soil tillage
- Potato WUE up, water 70%, yield same, PRD/DI
  - PRD from tuber initiation
  - Marketable tubers up
  - Improved N availability
- New irrigation of maize
- Quinoa potential

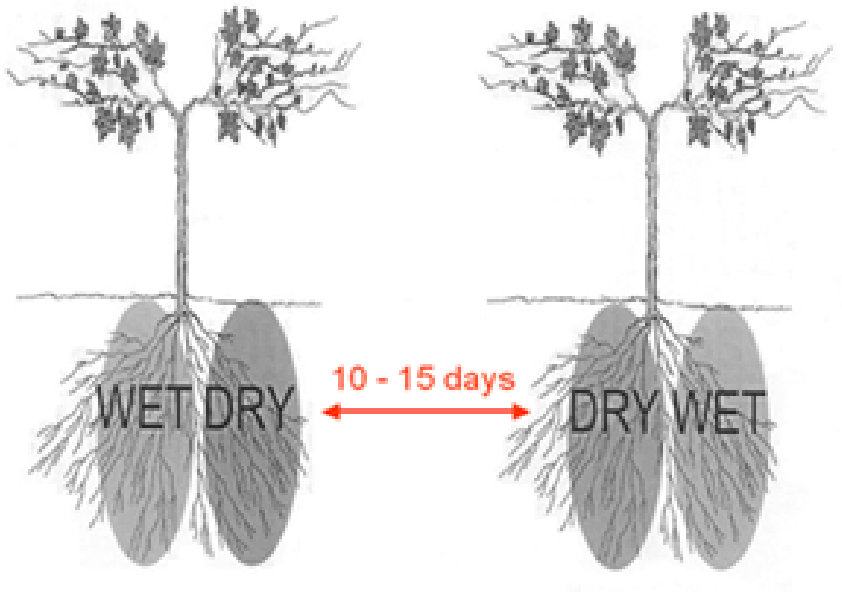
WATERWEB

ABA signalling and plants drought adaptation



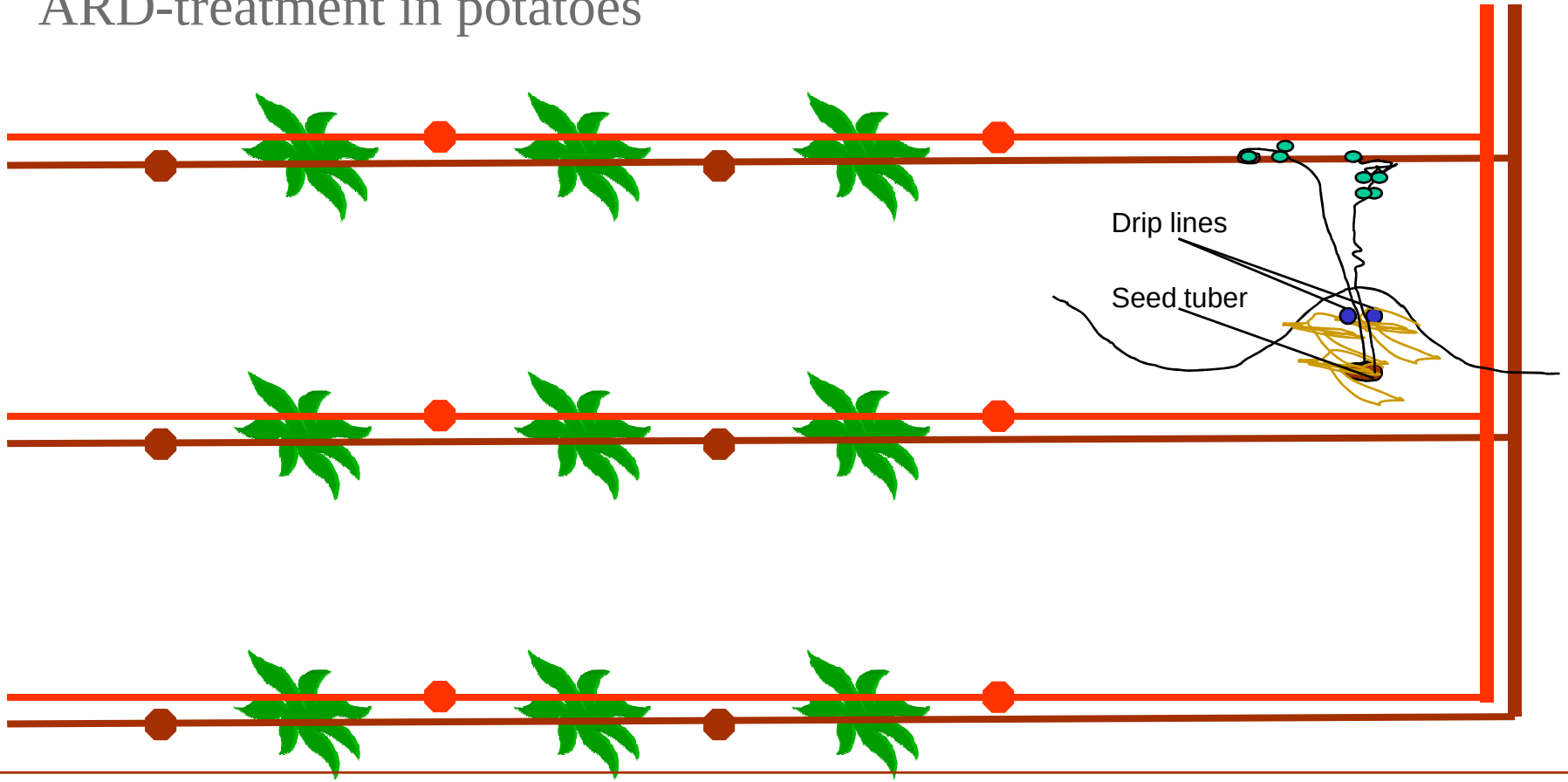
Deficit irrigation

Alternate Root Drying (ARD) or Partial Root Zone Drying is a deficit irrigation strategy, where plants are irrigated alternately in different zones of the root system, so that part of the root system is temporarily exposed to water deficit which may produce chemical signals closing stomata and modifying growth and hereby improving WUE.



Studies in fruit trees and maize show that ARD has a neutral effect on yield, while reducing water use up to 50%, leading to an increased WUE.

ARD-treatment in potatoes



Treatments: No 1 starting at 25 mm def, 2-3-4-5 at 10 mm deficit

1. **Control** sprinkler 100 % of Eta
2 **Normal** line1&2 same time, 66 % of Eta
3. A**RD** line1–line2 alt., 66 % of Eta
4. **Normal** line1&2 same time, 33 % of Eta
5. A**RD** line1–line2 alt., 33 % of Eta

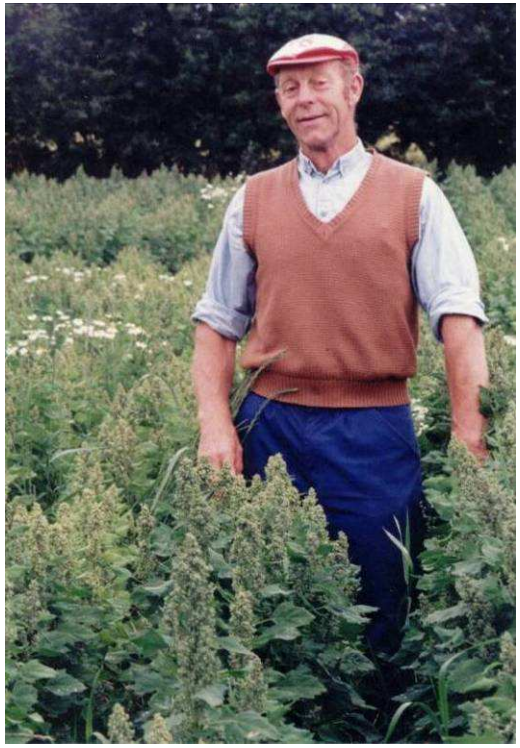
Effect of PRD on water use, WUE and fruit quality

(no or minor reduction in yield)

Plant	Water use, % of FI	Fruit quality	WUE, % of FI	Ref.
Cotton	70 50	I*	134 190	Tang et al., 2005 Kirda et al., 2005
Tomato	50	I	163	Kirda et al., 2004
Pear	55	n.m.	145	Clancy, 1999
Grapevine	50	I	152	Dry et al., 2000
Hot pepper	50	I	166	Dorji et al., 2004
Potato	70	I	143	Shahnazari et al., 2006

I=improvement of quality; n.m.=not measured

Quinoa outside South America



Water economy

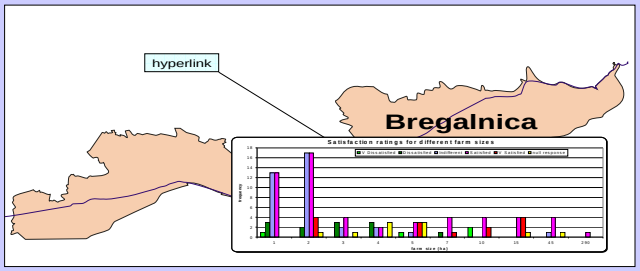
Survey Serbia

- Farmers lack faith
- Many without licence extract water
- Price more important than water quality
- Water contamination is seen in all Serbia
- Foreign market demanding on fresh produce

Survey Macedonia

- Water communities (WC) introduced
- Payment to WCs vary
- Problem non-payers and how to exclude

Land Water Economic Information System:



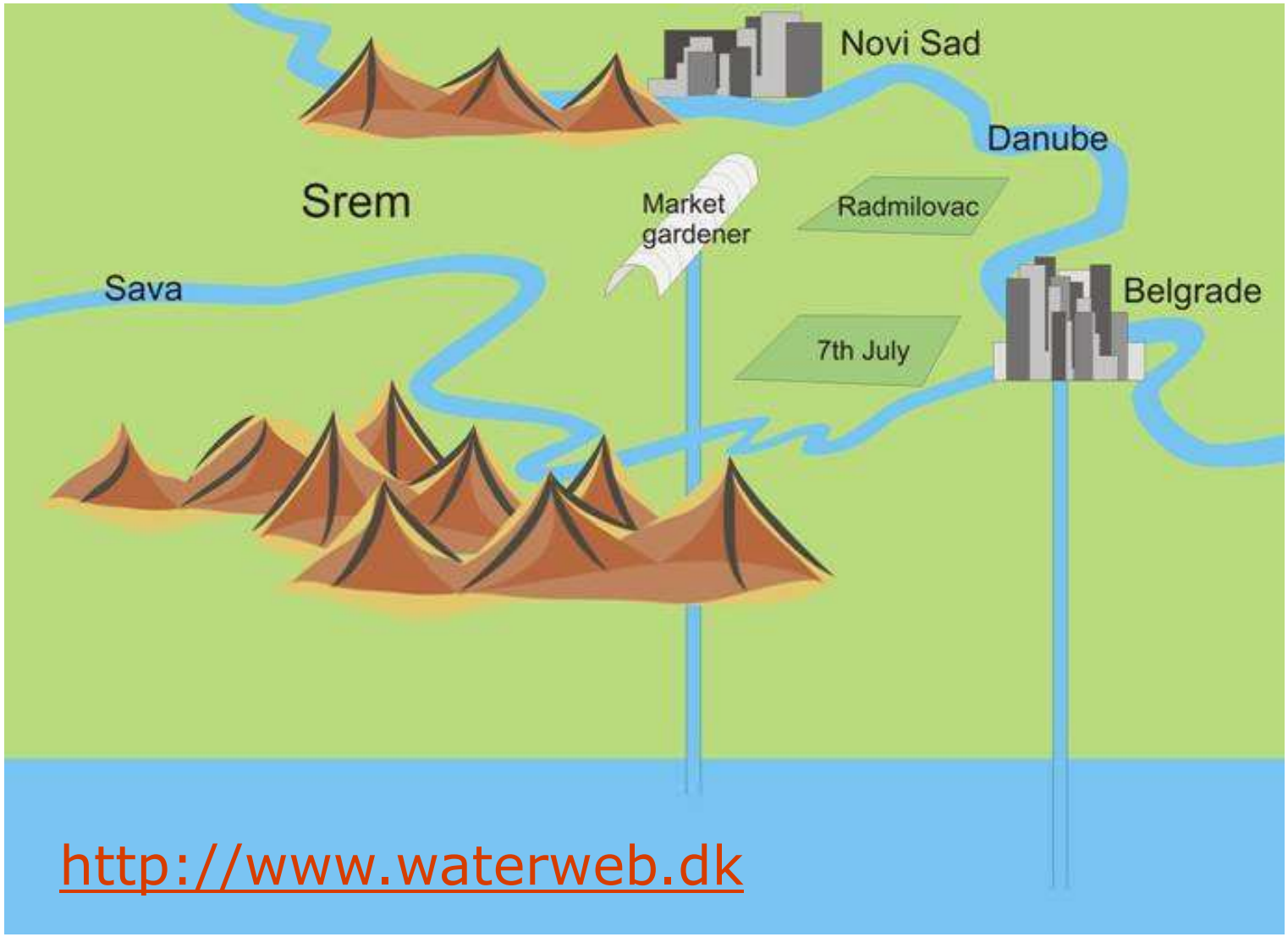
WATERWEB

Water dissemination

The project has produced a large amount of publications, in total 43 scientific papers, 79 conference presentations and 3 popular papers. Presentations at conferences were given 28 times, and 20 posters have been displayed. In addition, various meetings and media briefings were held, and radio and TV interviews given.


НАУКА

„WATERWEB" ПРОТИВ СУША


Novi Sad
Danube
Srem
Market gardener
Radmilovac
Sava
Belgrade
7th July
http://www.waterweb.dk

Interactions

Mutual publications
Exchange of students
Exchange of researchers and professors
New project applications

WATERWEB

Sustainable water use securing food production in dry areas of the Mediterranean region (SWUP-MED)

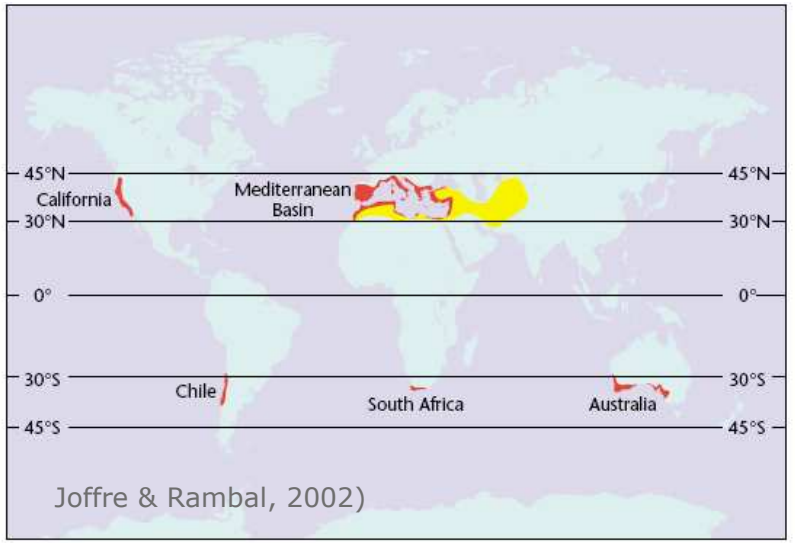
EU FP7 project

Main objective

Improve food production by introducing climate-proof varieties in crop rotations of wheat, grain legumes and new crops (potentially high value food cash crops), in a rainfed system with supplemental deficit irrigation using marginal-quality water and harvested rainwater. This will accelerate adoption of improved agricultural practices supporting small farmers' livelihood and income levels.

Beneficiaries

UCPH	Denmark
ICARDA	Syria
ITQB	Portugal
ISAFOM	Italy
NERC	UK
CEDARE	Egypt
IAV	Morocco
CU	Turkey
UWA	Australia



Joffre & Rambal, 2002)

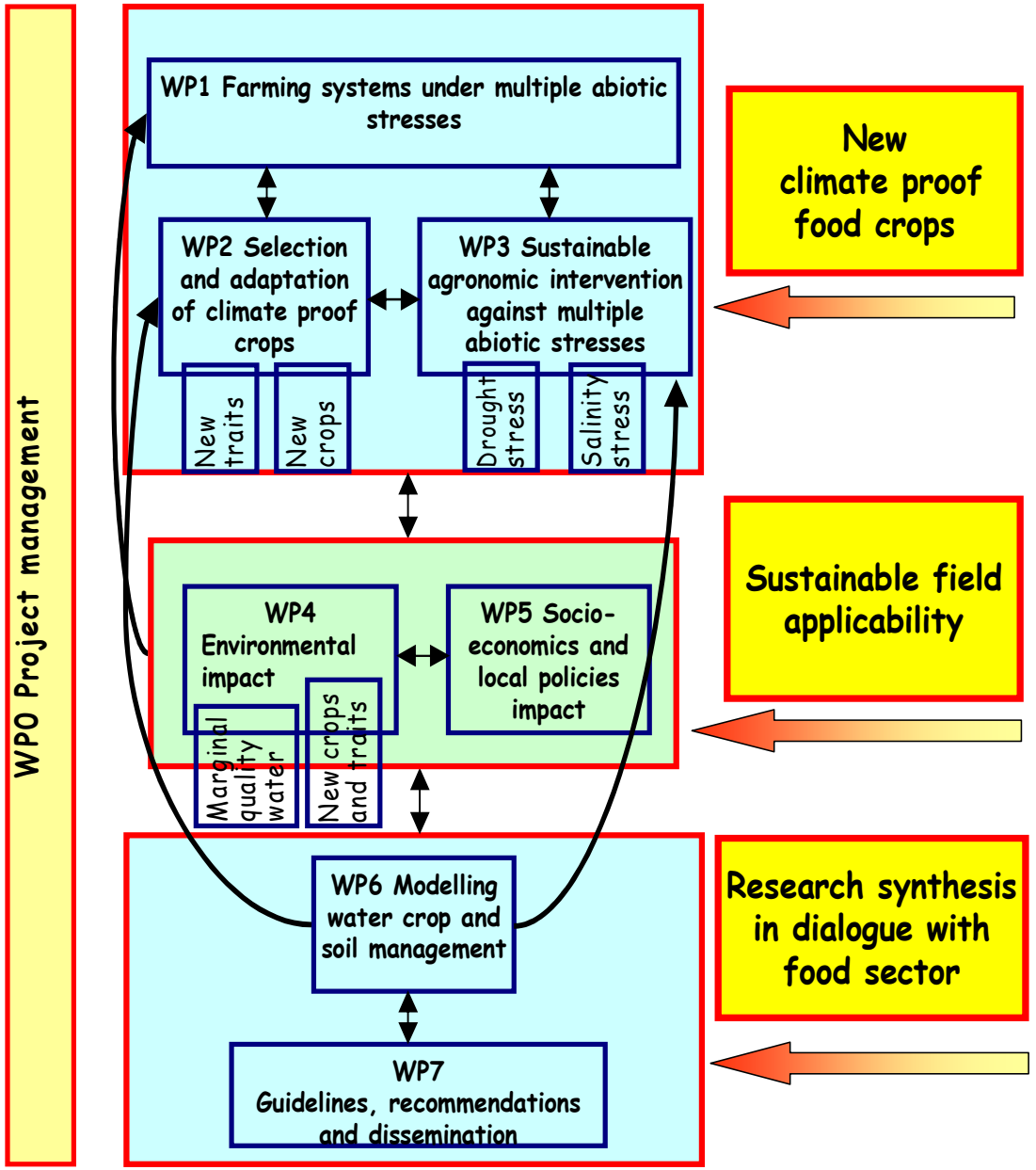
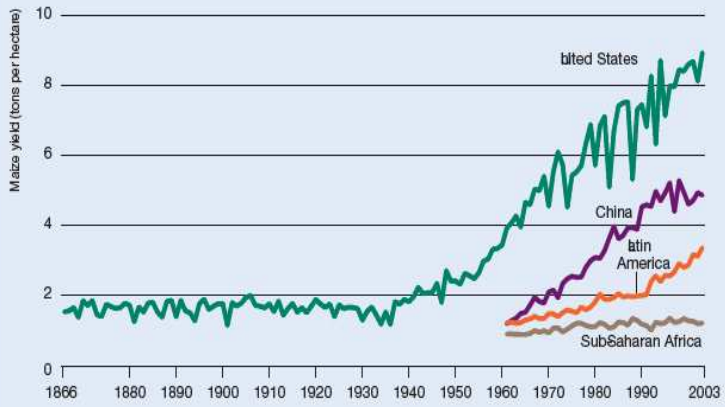

WP0 Project management
WP1 Farming systems under multiple abiotic stresses
WP2 Selection and adaptation of climate proof crops
WP3 Sustainable agronomic intervention against multiple abiotic stresses
New traits
New crops
Drought stress
Salinity stress
WP4 Environmental impact
WP5 Socio-economics and local policies impact
Marginal quality water
New crops and traits
WP6 Modelling water crop and soil management
WP7 Guidelines, recommendations and dissemination
New climate proof food crops
Sustainable field applicability
Research synthesis in dialogue with food sector

table 1 | **Comprehensive Assessment scenario characteristics**

Region	Scope for improved productivity in rainfed areas	Scope for improved productivity in irrigated areas	Scope for irrigated area expansion
Sub-Saharan Africa	High	Some	High
Middle East and North Africa	Some	Some	Very limited
Central Asia and Eastern Europe	Some	Good	Some
South Asia	Good	High	Some
East Asia	Good	High	Some
Latin America	Good	Some	Some
OECD countries	Some	Some	Some

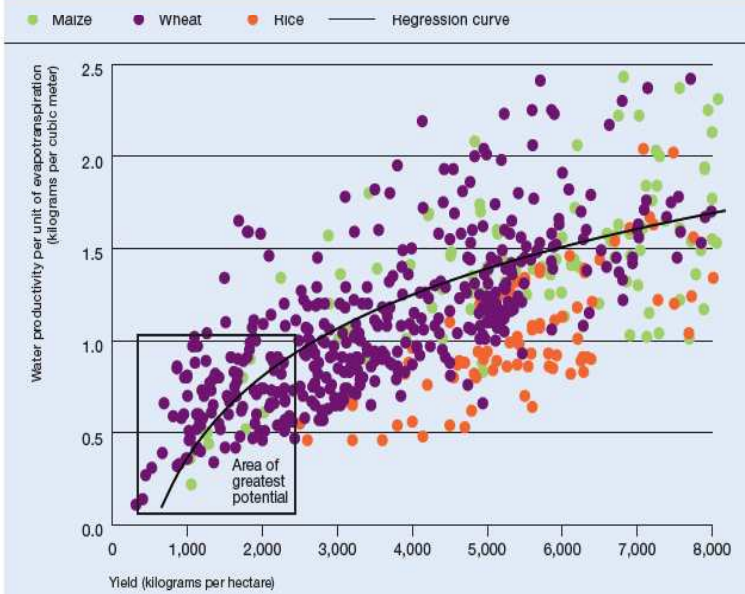
Molden et al., 2007

figure 6 **Sub-Saharan Africa has yet to "take off" as Asia and Latin America did in the green revolution and industrial countries did much earlier**



Source: U.S. data, U.S. Department of Agriculture's National Agricultural Statistics Service; all other countries and regions, FAOStat.

figure 7 **The biggest potential for water productivity gains is in very low-yielding areas, which typically coincide with poverty**



Source: Adapted from Zwart, S.J., and W.G.M. Bastiaanssen, 2004, "Review of Measured Crop Water Productivity Values for Irrigated Wheat, Rice, Cotton and Maize," *Agricultural Water Management* 69 (2): 115–33; chapter 7.

Molden et al., 2007

Conclusion

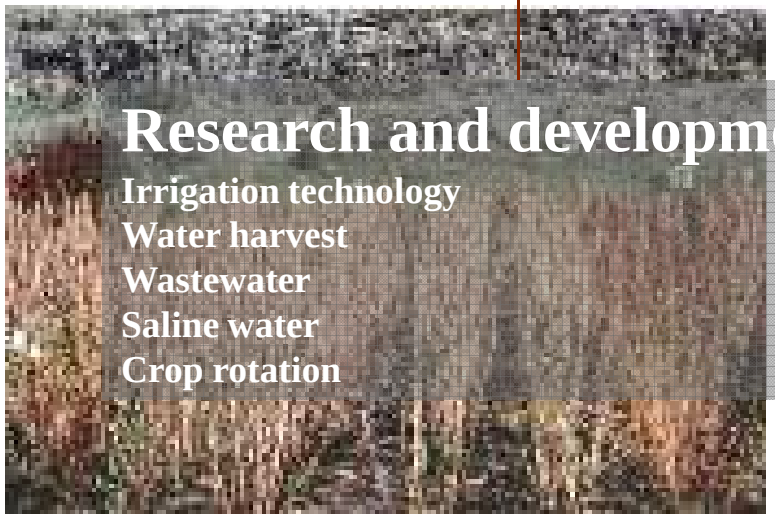
Water saving technique	Water saving	Water source	Technology	Problem	Benefit
Supplemental/deficit irrigation	20-50% of irrigation (20-100 mm)	Marginal-quality (treated wastewater, saline water)	Surface, furrow, sprinkler, drip	Salinisation	Maintain yield, improve quality
Water harvesting	Extra source	Rain	Canals, reservoir	Macro-catchment	Run-off water saved for the crops
Treated wastewater	Extra source	Urban, industrial	Chemical, biological	Contamination of soil and groundwater	Nutrient-rich water source
Saline water	Extra source	Brackish- and seawater	Direct use	Salinisation	Clean water source
Breeding	WUE +10%	Any source	Improved varieties	Longterm effort	Improved yield under drought

Efficient use of resources

Water

Agricultural water management investments alone cannot eliminate poverty. Many poverty reduction gains come from better credit and insurance, better farm practices, stronger links to markets and support services, and improved health care. So water management approaches need to be better integrated into broader poverty reduction strategies.

Adaptation and breeding



Research and development

Irrigation technology
Water harvest
Wastewater
Saline water
Crop rotation


Thank you