Workshop with Water User Associations of Southeast Anatolian Project (Turkey)

Ramón Aragüés and Enrique Playán
Research group Irrigation, Agronomy and the Environment

Mediterranean Agronomic Institute
Zaragoza, 8 and 15 April 2013

Aula Dei Campus (Zaragoza, España)

- CITA (DGA)
- E. E. Aula Dei (CSIC)
- IAMZ (CIHEAM)
- Leading Spanish Campus in agricultural sciences

RESEARCH GROUP "IRRIGATION, AGRONOMY AND THE ENVIRONMENT"

- CITA and EEAD staff
- Largest national group in the area
- One of group leaders in Europe

Personnel in 2013

- 12 staff researchers
- 4 temporary researchers
- 11 students
- 9 staff technicians
- 9 temporary technicians
- Total: 45

Objective

Generate scientific and technological information in the "soil-water-crop-atmosphere" interface leading to more competitive, efficient and sustainable agricultural systems with emphasis on irrigation, agronomy and the environment, and with an applied-research focus.

Priority lines:

1- Sustainable use of water and soil resources

2- Environmental impact of agricultural activities

3- Crop agronomy

Irrigated Agriculture in the Ebro Valley

Enrique Playán

Where are we?

1

A slide show on dryfarming and irrigated agriculture

Where are we today?

- The central Ebro valley depression
- Precipitation: 250 – 400 mm
- Reference evapotranspiration of about 1,100 mm per year
- Shallow, poorly developed soils
- Salinity resulting from lake like evaporation
- Rivers and wind have modeled the landscape

Dryfarming in Monegros

- Rich agricultural tradition
- Barbecho system
- Deforestation boosted by diesel power
- Linked to the 20th century history
- Now a days:
  - Poor yields
  - Harvest only a fraction of the years

A bit of irrigation history, XIX and XX

- Regeneracionisn
- Looking inside
- Water for rural development
- Strong governmental intervention
- A popular policy

Irrigation systems

2

Identifying limiting factors to sustainable Mediterranean agriculture

Sustainable Mediterranean Agriculture

- Mediterranean climate is naturally characterized by variability
- Pending issues on water quality, derived from the WFD: irrigation return flows
- Need to adjust inputs to improve energy, pollutant and economic budgets
- Soil protection: key issue in an extremely vulnerable area
  - Erosion
  - Salinity

Sustainable Mediterranean Agriculture

- Our best farmers are using resources rather well… what can we do for the rest?
  - Part-time farmers
  - Poorly educated farmers
  - **To what extent can technology alleviate deficits in dedication or training?**

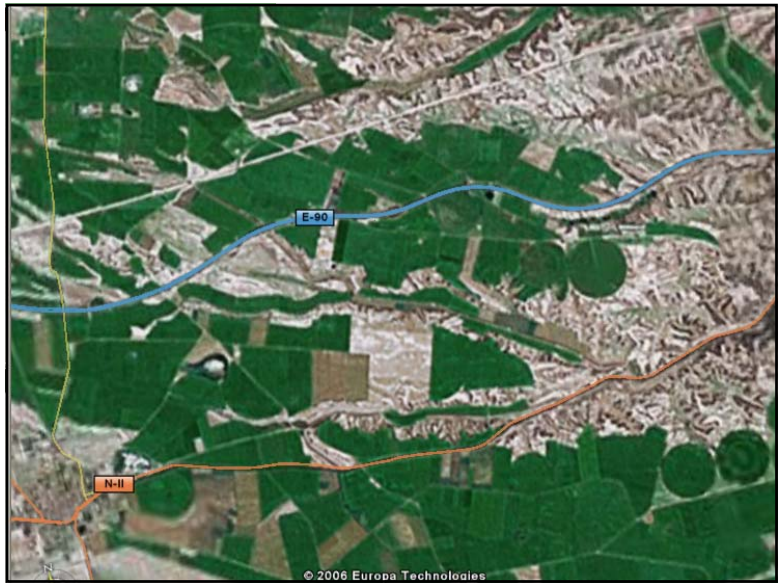
Surface irrigation

- Initial irrigation system
- The only one available
- Applied to all soils and conditions
- Successes and failures
- In clear regression


Image © 2007 DigitalGlobe
265 m
Google

Sprinkler irrigation (1970+)

- Started as individual fields
- Continued with collective networks
- Today we are in the middle of rebuilding about half of the surface irrigated area, switching to collective sprinkler (and drip) irrigation networks


E-90
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Drip irrigation

- Relevant in some areas: fruit production
- Warm climate
- Large properties: industrial
- Aggregated supply
- Associated to labor intensive crops

Collective Water Management

3

Specific challenges derived from collective structures

Collective water management

- Difficult access to water, surface water developments
- Large initial investments required
- Strong initial public intervention
- Mandatory “irrigation districts”
  - Not only irrigation now
  - Long tradition in overland water
  - Accounting efforts
- Districts + Basin authorities
  - Public-private interaction
  - Embryo of some WFD concepts
  - 80 years old here

Challenges for the 21st century

- Inspiring the National Irrigation Plan:
  - Improve irrigation efficiency
  - Improve irrigation structures
    - Sustainable, profitable irrigated farming
  - Protect water quality
  - Improve water management
- The Plan has been in operation for about 10 years now
  - Projects in about 1 Mha
  - Large public-private investments
  - From surface to sprinkler/drip irrigation
  - Collective networks

Two paths to improve irrigation efficiency:

- Structures
  - 99 % of the Spanish National Irrigation Plan
- Management
  - 1 % of the Spanish National Irrigation Plan (26 M€)
  - Advantages:
    - Bottom - up
    - Slow and endogenous
    - Much cheaper (€/m^3 of conserved water)
- Need to combine both approaches for optimum results (Styles, 1999; Vidal et al., 2001)

Irrigation management principles

- Transparency
- Participation
- Traceability
- Effectiveness
- Standarization
- Certification

…These are the ingredients we used to build ***Ador***, an irrigation district water management software

Ador: a tool for collective water management

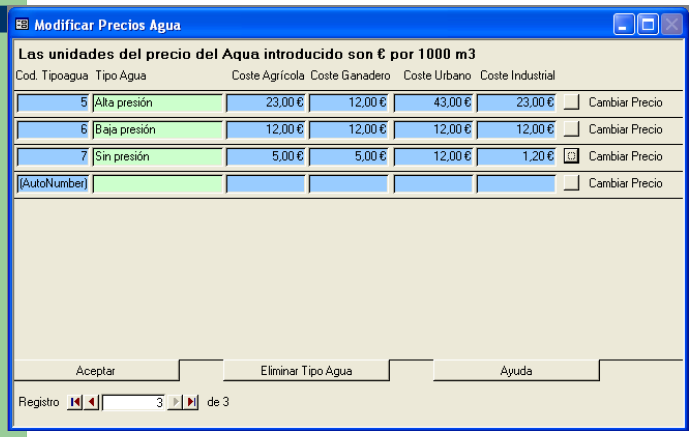
4

And also a Trojan horse…

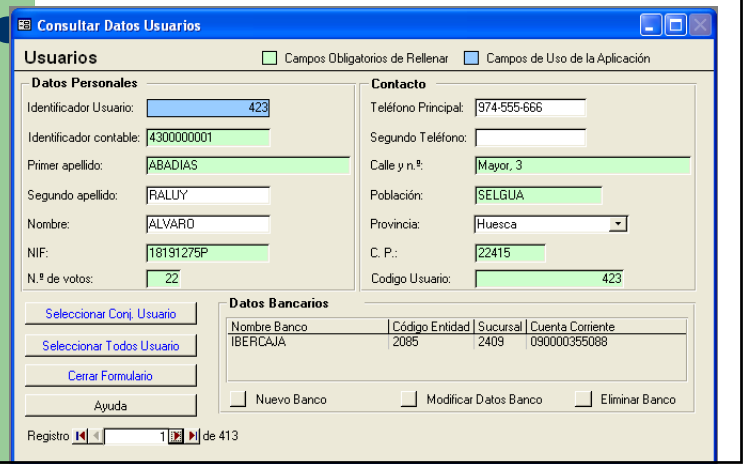
Ador: Strength gained at the districts

- Cooperation between:
  - researchers,
  - farmers,
  - companies,
  - public administration and
  - water managers.
- Half of the Aragonese irrigated land is managed with Ador (about 180,000 ha)
- The project has boosted water management utilities nationwide
- Currently released version: 1.2.9 (free download)

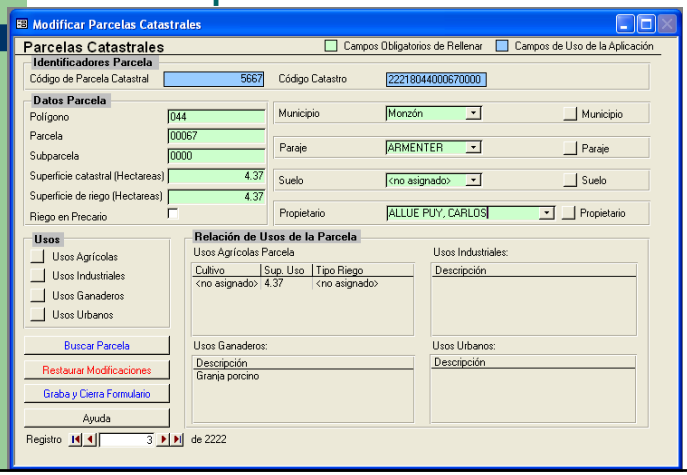
Water pricing: a matrix



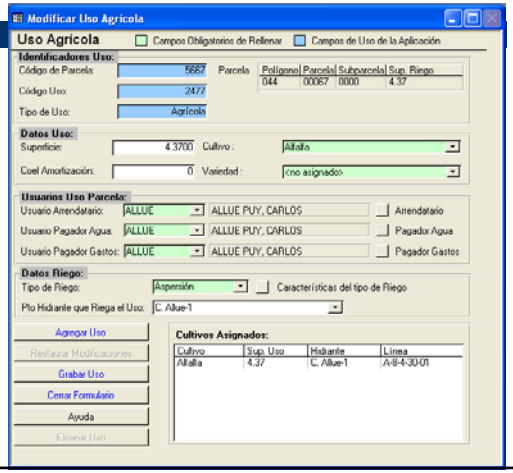
Water users



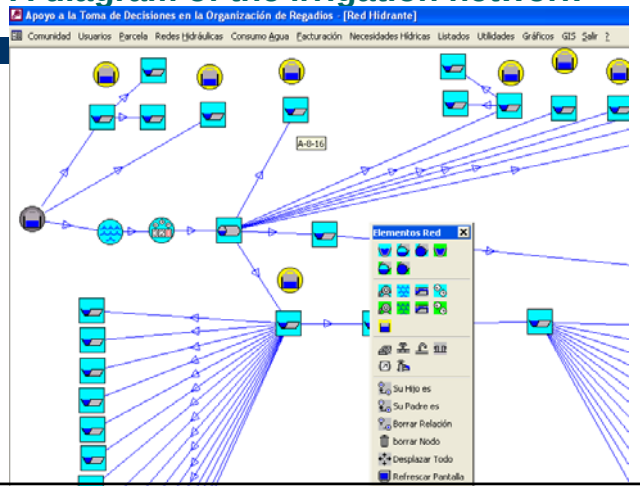
Cadastral plots and water uses



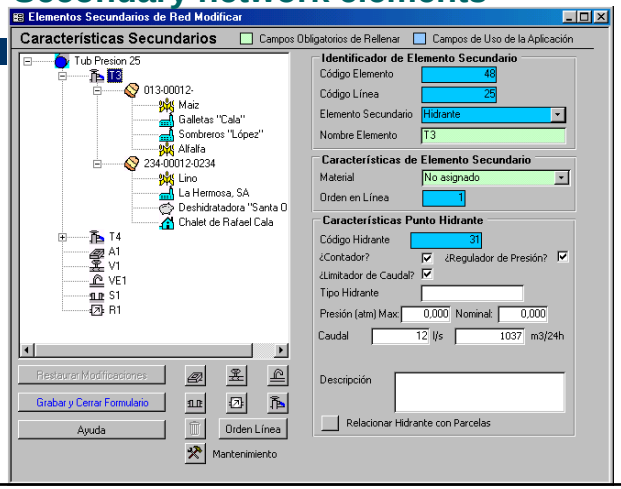
Water uses



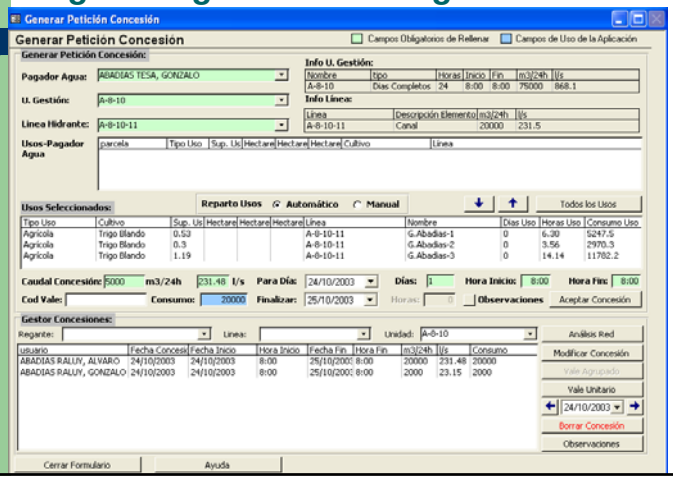
A diagram of the irrigation network



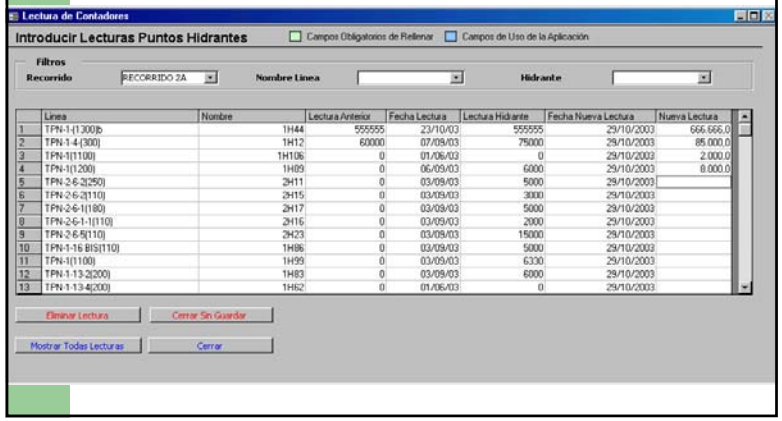
Secondary network elements



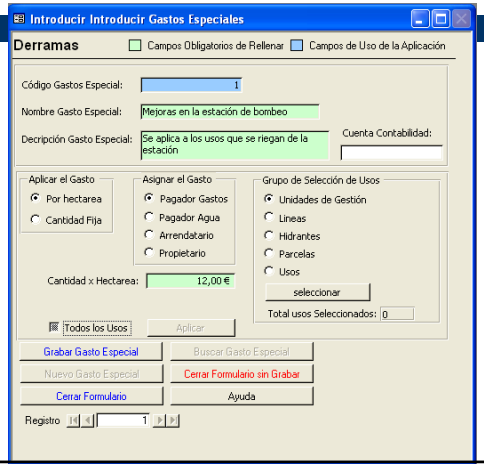
Registering and allocating water orders



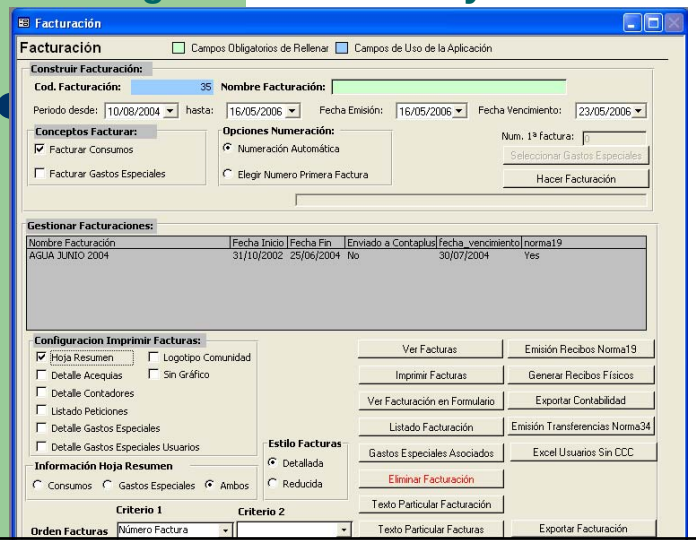
Registering water meter readings



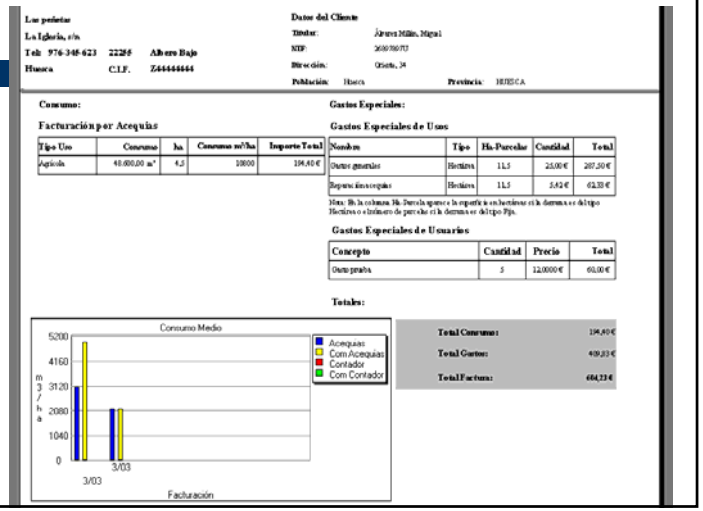
Billing for general costs: by the hectarea



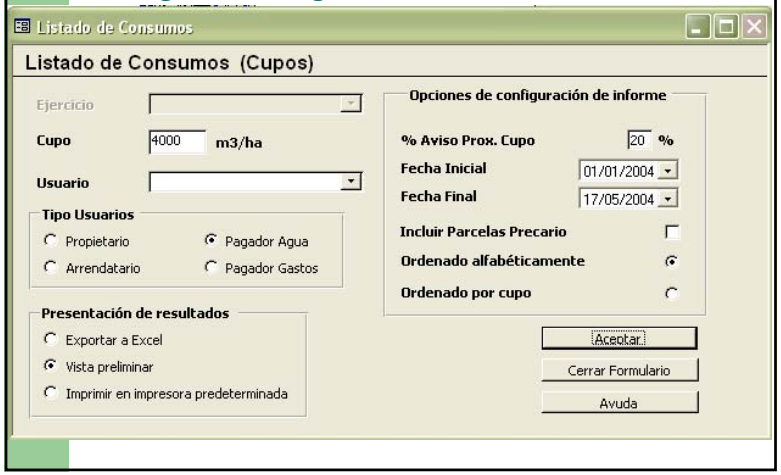
Billing for water use: by the m³



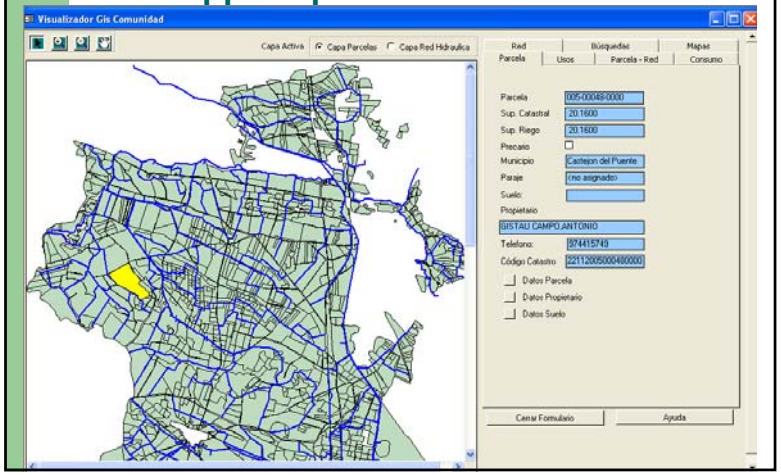
The educational water bill



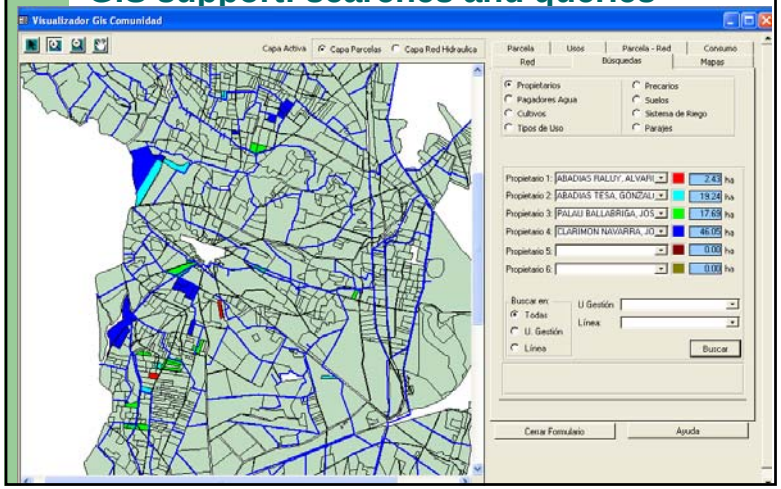
Drought management: water restrictions



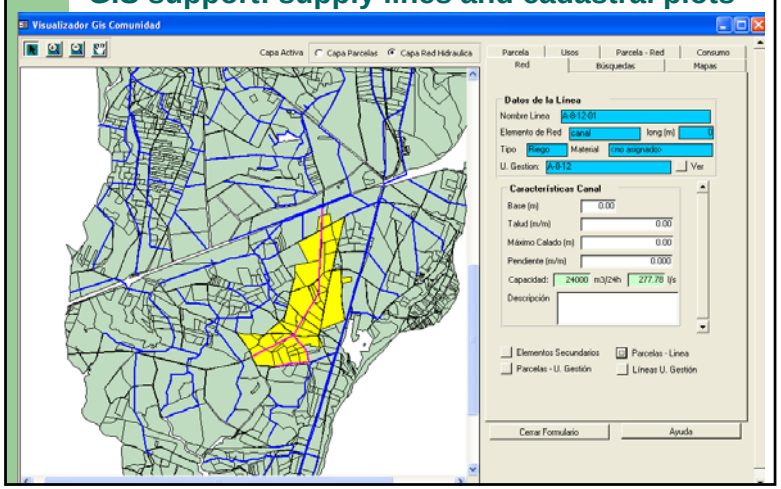
GIS support: plot identification

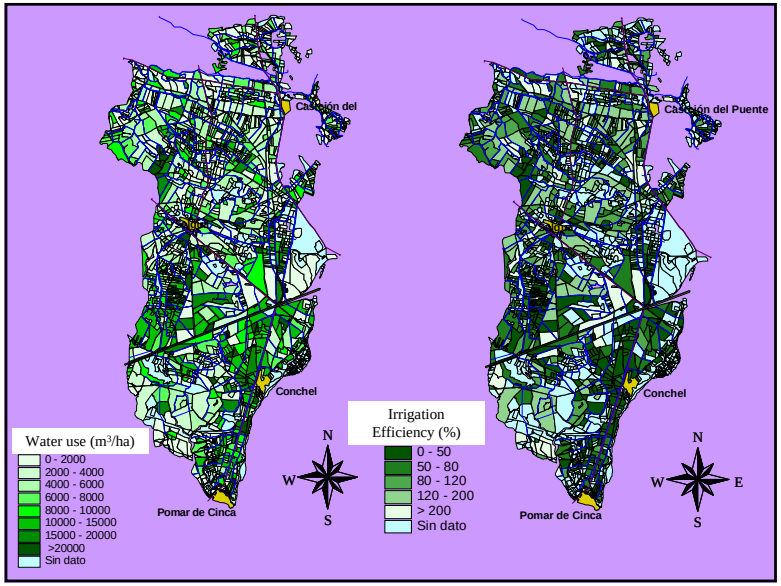


GIS support: searches and queries



GIS support: supply lines and cadastral plots





Irrigation and salinity of waters and soils

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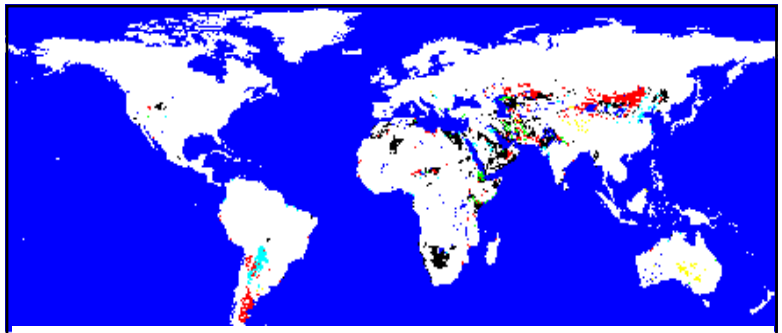
CENTRO DE INVESTIGACIÓN Y TECNOLOGÍA AGROALIMENTARIA DE ARAGÓN

Ramón Aragüés



- Salinity is one of the most important problems in agriculture (around 1000 m ha worlwide).
- Of the 230 ha irrigated land, about 10% is seriously affected and 30% is moderately affected. Each year, about 0.25-0.50 m ha are lost due to salinization.
- Areas affected by salinity: USA (28%), China (23%), Pakistan (21%), India (11%), Ebro river (20%)…

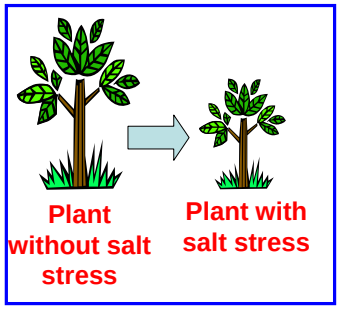
Irrigated agriculture and salinity

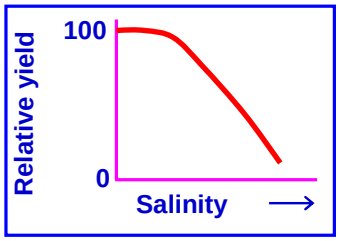
¿Why is there salinity?

Because both the irrigation water and the soil water dissolve salt minerals

- **Why is salinity a problem?**

- Because it affects negatively crop yield





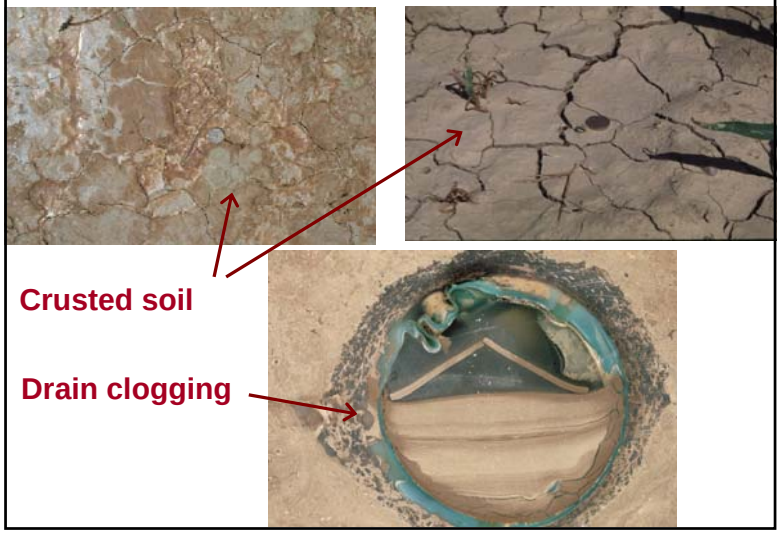
Salinity effects on crops

• **Why is salinity a problem?**

Because if sodium is preponderant ("sodicity") it may affect negatively soil's structural stability.

Pakistan: saline, sodic, alkaline soil, impermeable

Effects of sodicity on soils



• **Why soil salinity increases in irrigated agriculture?**

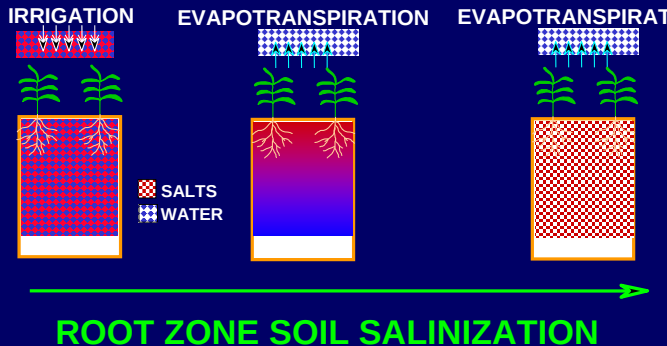
- Because plants extract water from the soil, but not the salts that accumulate in the soil.

- Because water evaporates from the soil as vapor, leaving the salts in the soil.

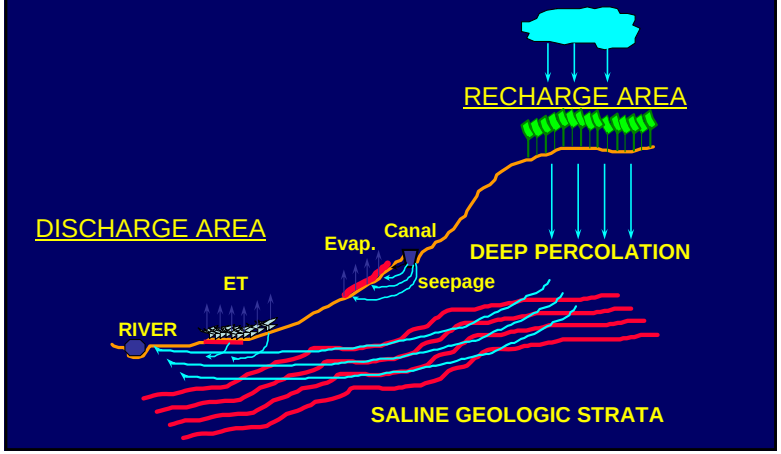
- Thus, soil evaporation (E) and plant transpiration (Tc), in other words ETc, is one main reason for salinity increases in irrigated agriculture.

SOIL SALINIZATION IN IRRIGATION

● **Evapotranspiration effect: soil water evapo-concentration**

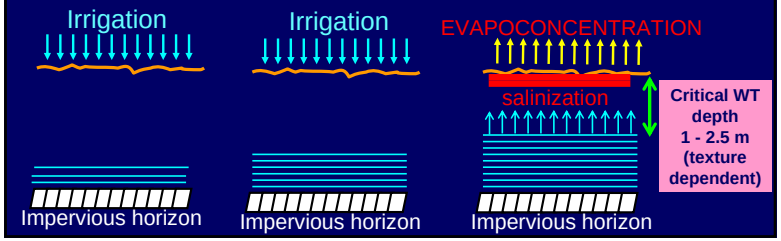


- **Weathering effect**: dissolution of mineral/salt deposits due to deep-percolation waters.

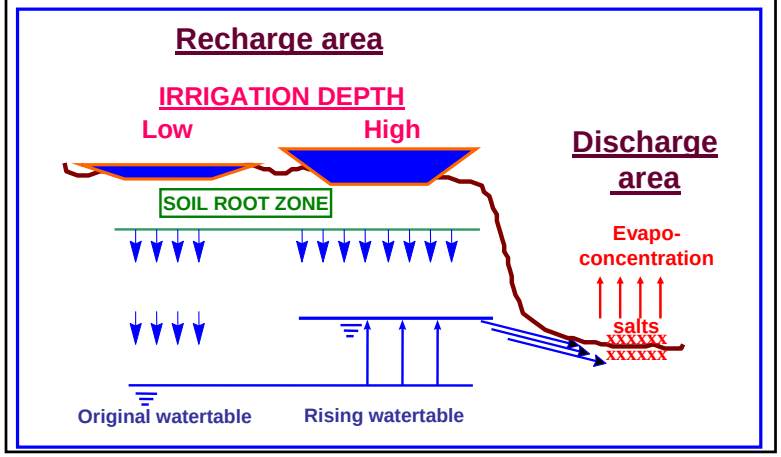


SOIL SALINIZATION IN IRRIGATION

- Excessive application of irrigation water in soils with limited drainage.
- Creation of shallow watertables that:
  - (1) prevent the leaching of salts
  - (2) induce the capillary rise of water and salts and the subsequent evapoconcentration at the soil surface.

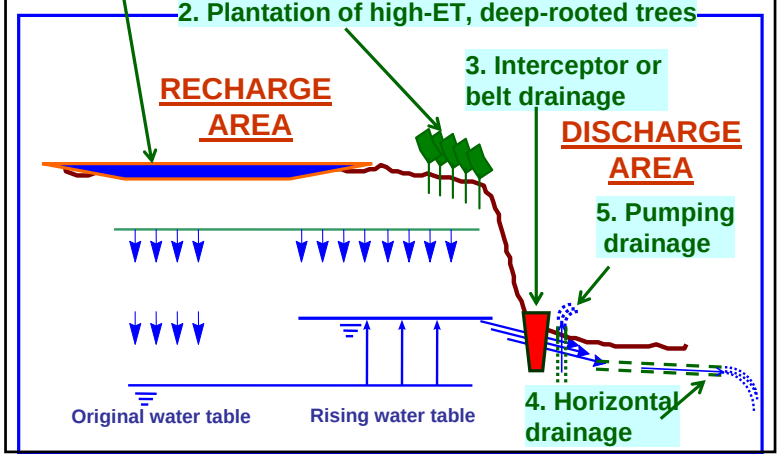


Irrigation and soil salinization: the inefficiency of irrigation in the recharge areas provokes soil salinization in the discharge areas



¿How to avoid soil salinization in the discharge areas?

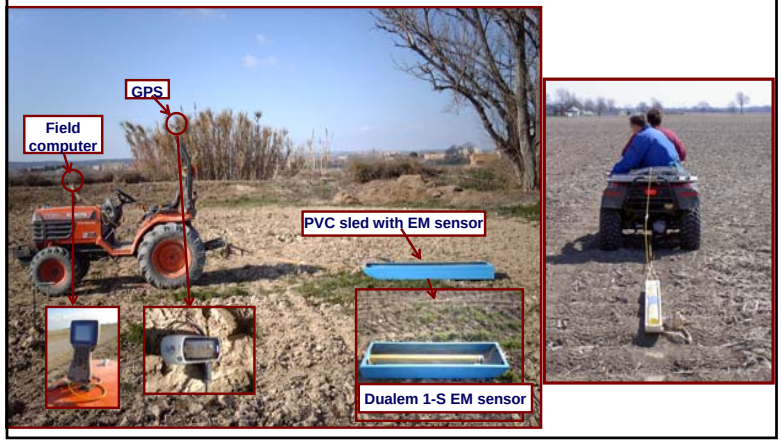
1. Increase efficiency/uniformity of irrigation
2. Plantation of high-ET, deep-rooted trees
3. Interceptor or belt drainage
4. Horizontal drainage
5. Pumping drainage



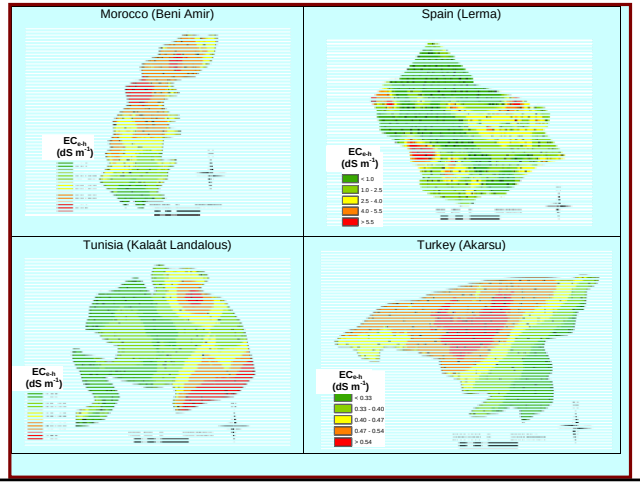
THE APPROPRIATE MANAGEMENT OF IRRIGATION AND DRAINAGE ARE THE TWO KEY STRATEGIES FOR CONTROLLING SALINITY IN IRRIGATED AGRICULTURE

- **Soil salinity must be measured in space and time.**
- **Today, we have remote sensors that are able to estimate salinity of large-scale irrigation districts:**
  - **1- Terrestrial vehicles with electromagnetic sensor**
  - **2- Aerial vehicles with electromagnetic sensor**
  - **3- Image satellites as Landsat**

Terrestrial vehicles: mobile and geo-referenced electromagnetic sensor. Prototype designed at CITA



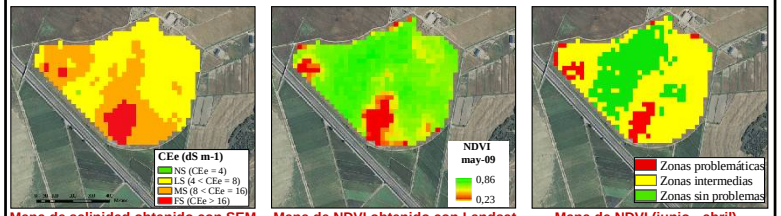
Salinity maps performed with the terrestrial EM sensor in Spain, Morocco, Tunisia and Turkey (INCO project)



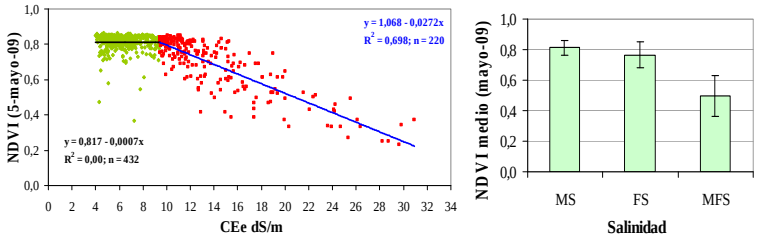
Aerial vehicles: helicopter with RESOLVE EM sensor

Landsat satellite images

Barley, Pompenillo farm (Huesca, España)



Mapa de salinidad obtenido con SEM | Mapa de NDVI obtenido con Landsat | Mapa de NDVI (junio - abril)

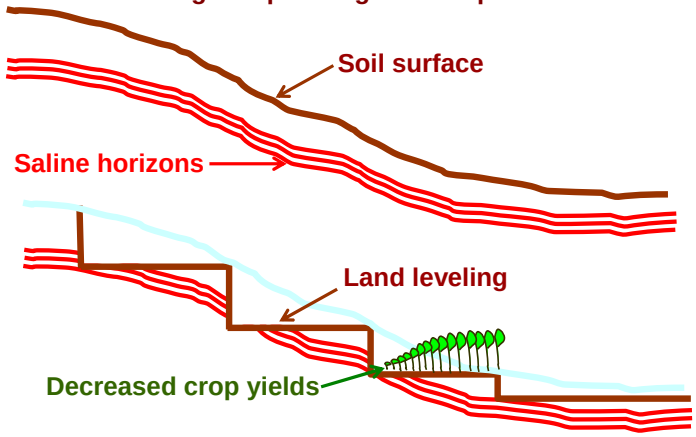


Irrigation systems and salinity: synthesis of potential problems and corrective measures

System	Potential problem	Corrective measures
Flood	Low distribution uniformity ⇒ differential leaching of salts	Reshape of plot/laser leveling
Furrow	Evaporation of water ⇒ salt accumulation in the upper part of ridges	Soil mulching
Sprinkler	Wetting of leaves and foliar absorption of ions ⇒ specific ion toxicity (Na, Cl, B)	Avoid wetting of leaves; irrigate at times of low evaporation
Drip	Salt accumulation at soil surface and edges of wetted areas	Increase drip density

Plot's configuration for basin irrigation

✓ An excessive land leveling may outcrop deep saline horizons. It is recommended to take out the surface soil, perform the leveling and place again on top this soil



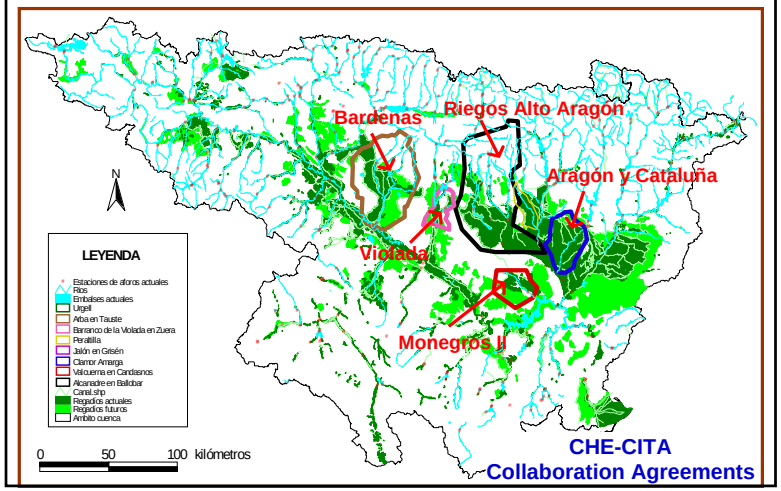
The European Water Framework Directive and the National Hydrologic Plan

- Objective of the WFD: Framework for the protection of water quality in Europe.
- All water bodies must attain a good chemical and ecological status in year 2015.
- "Polluters pay"... A difficult task when pollution is diffuse (as in agriculture). Role of WUA…
- Increasing pressure towards agricultural systems that garanty the quality of waters: increasing need to quantify pollution induced by irrigation.

The Spanish Environmental Monitoring Program

- Monitoring of environmental impacts.
- Research of "cause-effects".
- Elaboration of codes of good agricultural practices.
- Establishment of agro-environmental indicators.
- Network of environmental monitoring stations in each Spanish hydrological basin.

RECOREBRO: Ebro River Basin Network for the assessment of irrigation-induced pollution



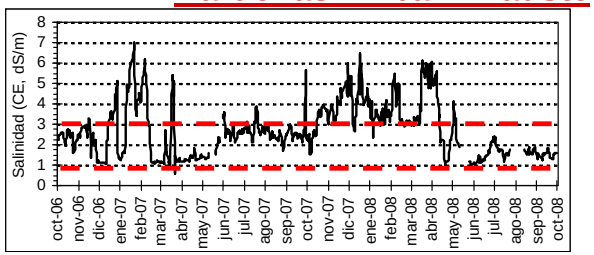
Measurement of flows and water quality at the exit of an irrigation district

Measurement of flows and water quality at the exit of an irrigation district

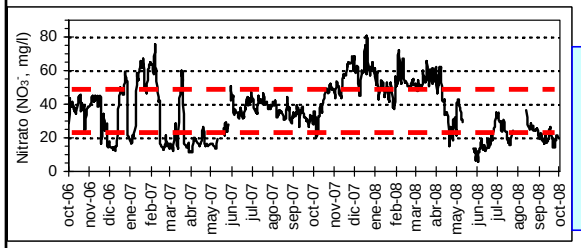
Flow and quality station in Lerma (Bardenas)

Measurement of flow in Akarsu irrigation district (Adana, Turkey)

Bardenas: Arba in Tauste



Mean 07+08
2,7 dS/m
6,0 T/ha·year



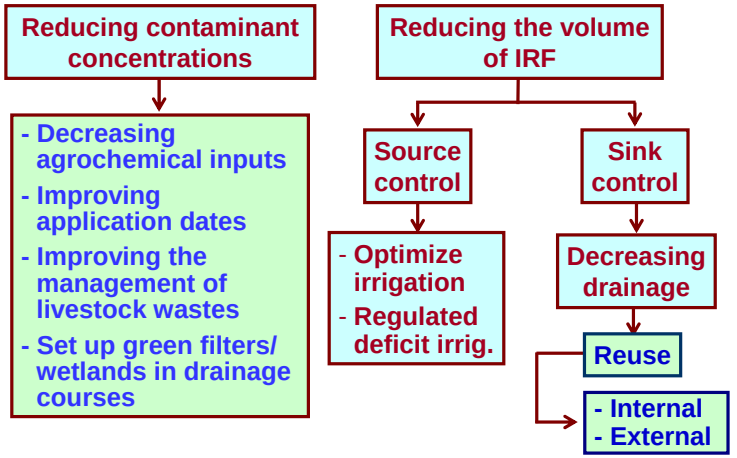
Mean 07+08
37 mg/l
114 Kg NO_3/ha·year
= 26 Kg N/ha·year
24% with NO_3 > 50
68% with NO_3 > 25

Why IRF are important within the European WFD?

Because the load of contaminants (i.e., volume of IRF and contaminant concentrations) largely determine the quality (i.e. the concentration of contaminants) in the receiving water bodies (rivers)

Hence, salt and nitrate concentrations is a relevant and increasing problem in many rivers of the Ebro Basin…

How to minimize contaminant loads in IRF?
(Load = Concentration x Volume)



In all these activities, Water User Associations play a major role for:

1- Environmental monitoring of irrigation

2- Establishment of good agricultural practices for pollution control

3- Training and dissemination activities

4- Interaction with research