

Workshop River Basin Network on Water Framework Directive & Agriculture

Water Quality and Irrigation Return Flows: concepts and facts

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Zaragoza, 26 January 2012



Research Group “Irrigation, Agronomy and the Environment”



<http://www.cita-aragon.es>



<http://www.eead.csic.es>

Unidad de Suelos y Riegos
Centro de Investigación y Tecnología
Agroalimentaria, Diputación General de Aragón

Grupo de Riego, Agronomía y Medio Ambiente
Departamento de Suelo y Agua, Estación
Experimental de Aula Dei, CSIC

Zaragoza (Spain)

General 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 a **research-applied focus**.

Personnel – Total

Year 2011

Permanent researchers	12
Temporary researchers	4
Technicians	19
Students	18
TOTAL	53

Largest group in Spain working
on irrigation and the environment

Priority lines

- 1- Sustainable use of water and soil resources
- 2- Environmental impact of agricultural activities
- 3- Crop agronomy

Priority works

- 1- Diagnosis and improvement of irrigation management.
- 2- Impact of irrigated agriculture on soil and water quality (“off-site” diffuse pollution).
- 3- Response of crops to abiotic stresses (water, salinity).
- 4- Nitrogen fertilization and nitrate leaching control. Optimization of pig-slurry applications.
- 5- Agronomic applications of remote sensing.

RIVER BASINS NETWORK
WFD AND AGRICULTURE



GOBIERNO
DE ESPAÑA

MINISTERIO
DE MEDIO AMBIENTE
Y MEDIO RURAL Y MARINO

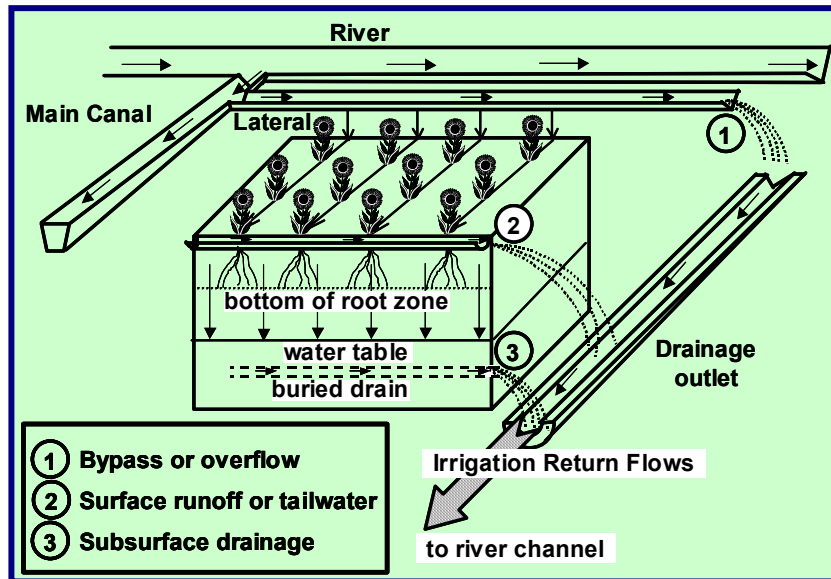
CONFEDERACIÓN
HIDROGRÁFICA
DEL EBRO

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**Water Quality and Irrigation Return Flows:
concepts and facts**

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Main components of Irrigation Return Flows (IRF)



Main quality parameters of the IRF components and expected quality changes in relation to the quality of irrigation water

Quality parameters	Components of IRF		
	Bypass	Tailwaters	Drainage
General quality degradation	0	+	++
Salinity	0	0, +	++
Nitrogen	0	0, +, ++	+, ++
Phosphorous	0, +	++	0, -, +
Biological oxigen demand	0	+, 0	0, -, --
Sediments	0, +, -	++	--
Pesticides	0	++	0, -, +
Trace elements	0	0, +	0, -, +
Phatogens	0	0, +	-, --

0: Negligible degradation

+, ++: Moderate, High degradation (evapoconcentration, agrochemicals, erosion, mineral dissolution...)

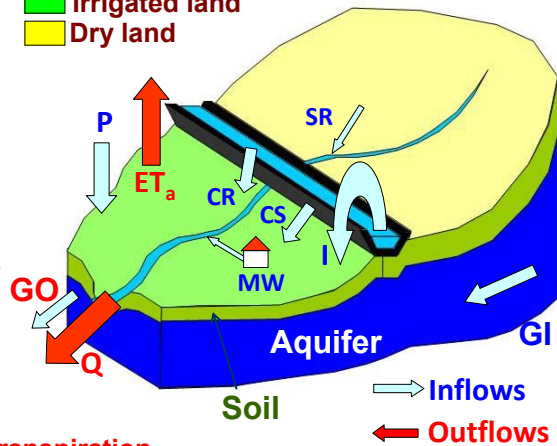
-, --: Moderate, High amelioration (filtration, fixation, microbial degradation, mineral precipitation...)

Water inflows and outflows at irrigation district level

Inflows

- I = Irrigation
- P = Precipitation
- CR = Canal Releases
- CS = Canal Seepages
- SR = Surface Runoff
- MW = Municipal Wastes
- GI = Groundwater Inflows

■ Irrigated land
■ Dry land



Outflows

- Q = Surface outflow
- ETa = Actual crop evapotranspiration
- GO = Groundwater Outflow

$$Q - CR - SR - MW - \% GI + \% GO$$

Monitoring of quantity and quality of irrigation return flows



Gauging and water quality station

Continuous water level recorder



Automatic water sampler



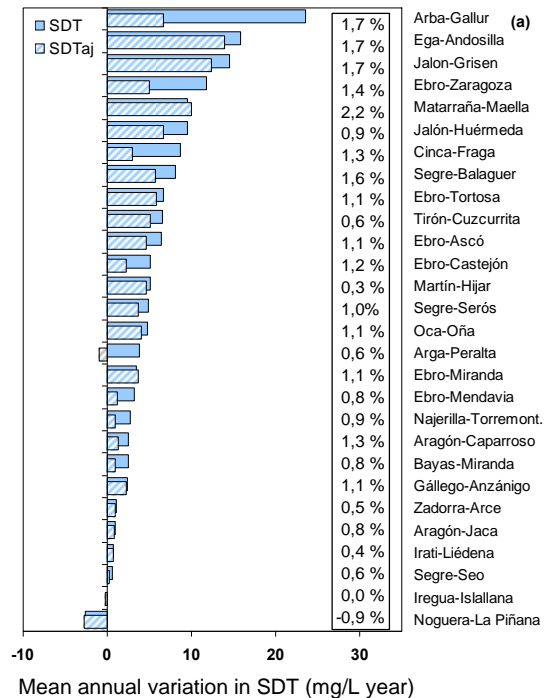
Why IRF are important within the European WFD?

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)

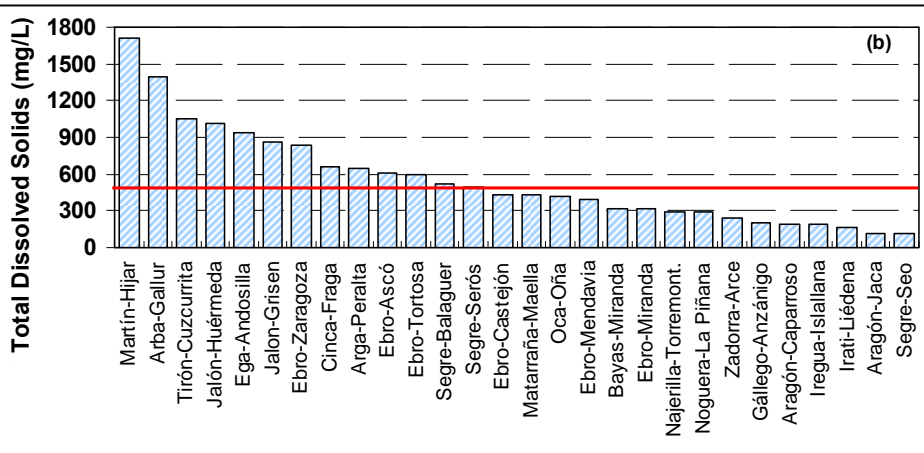
Hence, salt and nitrate concentrations is a relevant and increasing problem in many rivers of the Ebro Basin...

Salinity tendencies (SDT = total dissolved solids in mg/L) in 28 rivers of the Ebro Basin based on 1975-2008 data. The percent SDT increase over the mean SDT is also shown.

Several of the most problematic rivers collect the IRF of important irrigation districts...



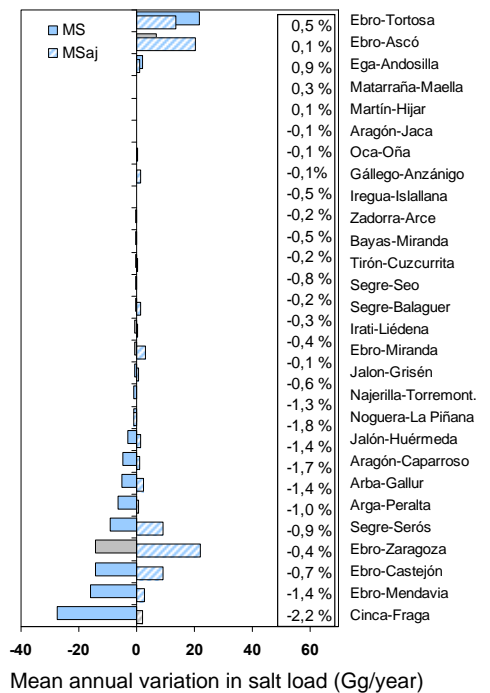
Mean 1975-2008 salt concentrations (Total Dissolved Solids) in 28 rivers of the Ebro Basin. The red line at 450 mg/L indicates the FAO threshold value above which waters are moderately restricted for irrigation purposes of salt-sensitive crops

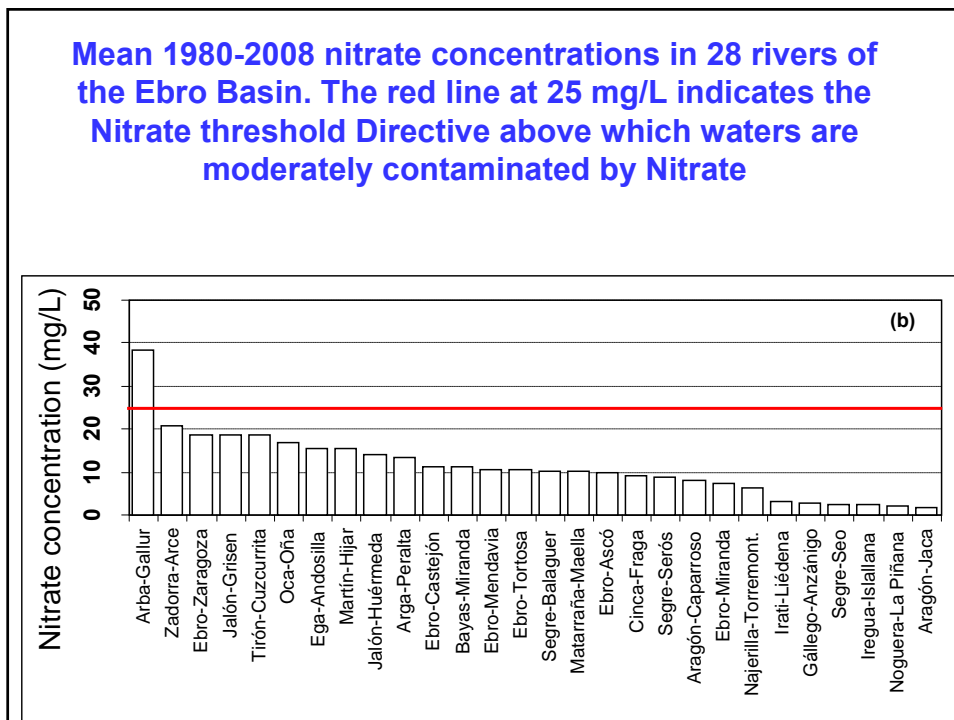
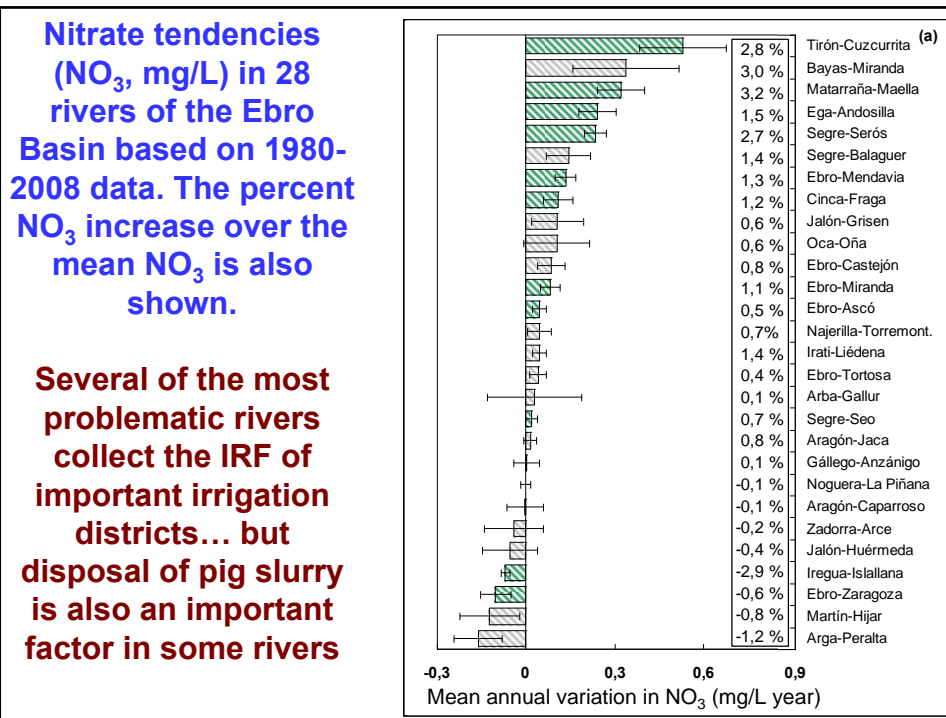


Salt load tendencies (MS, Gg) in 28 rivers of the Ebro Basin based on 1975-2008 data.

The percent MS variation over the mean MS is also shown.

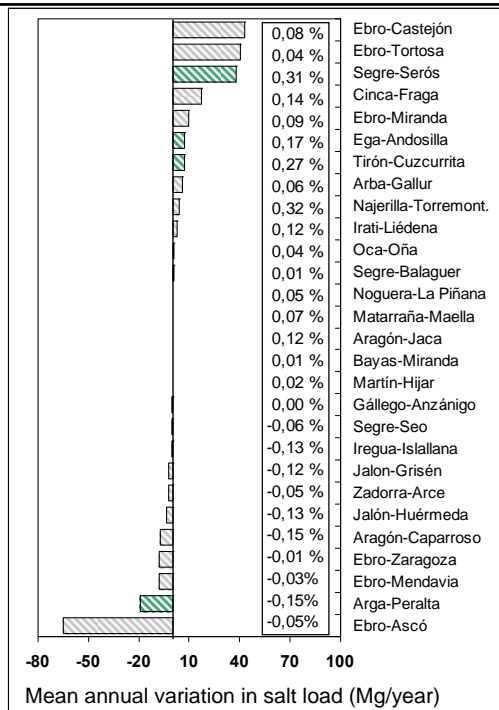
Negative salt load tendencies due to negative tendencies in flow volumes





Nitrate load tendencies (NO_3 , Mg) in 28 rivers of the Ebro Basin based on 1980-2008 data. The percent NO_3 load increase over the mean NO_3 load is also shown.

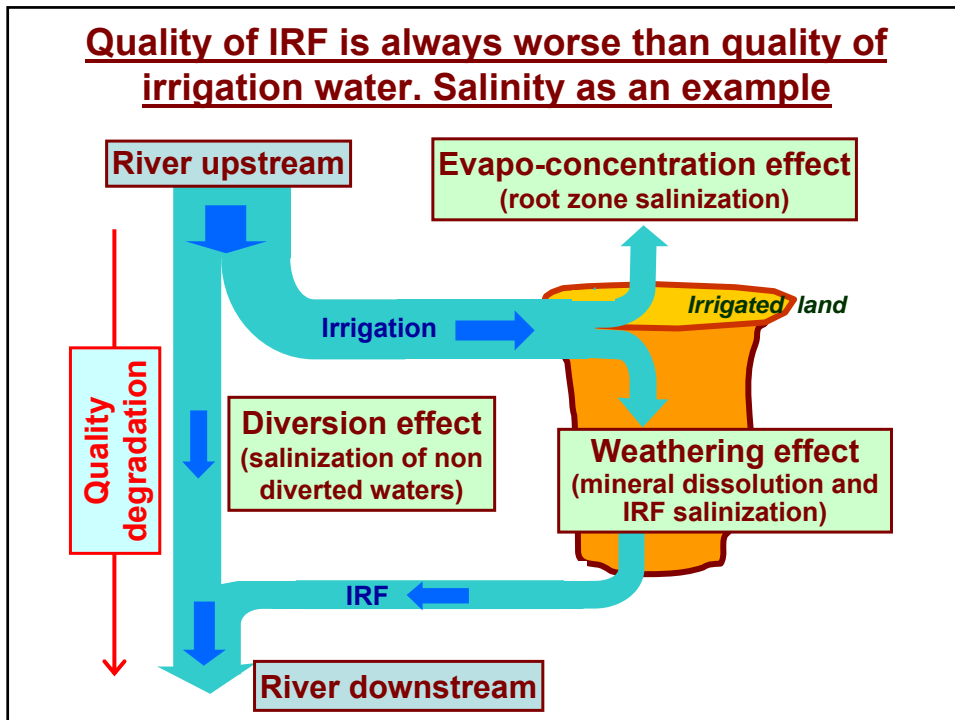
Negative salt load tendencies due to negative tendencies in flow volumes



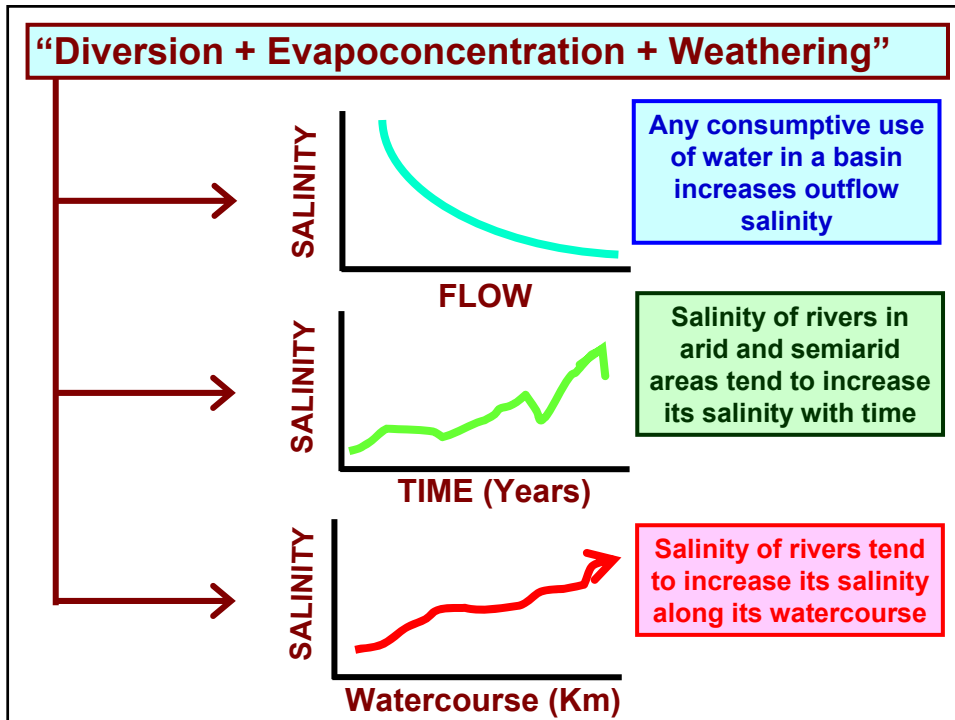
Summary of conclusions

- 1- Positive tendencies in salt concentrations in 93% of rivers based on 1975-2008 data.
- 2- Positive tendencies in Nitrate concentrations in 29% of rivers based on 1980-2008 data... but in 68% of rivers based on 1975-2008 data.
- 3- Negative tendencies in flow volumes in 82% of rivers based on 1975-2008 data.
- 4- Non significant salt and nitrate load tendencies in most rivers due to positive concentrations and negative flow tendencies.

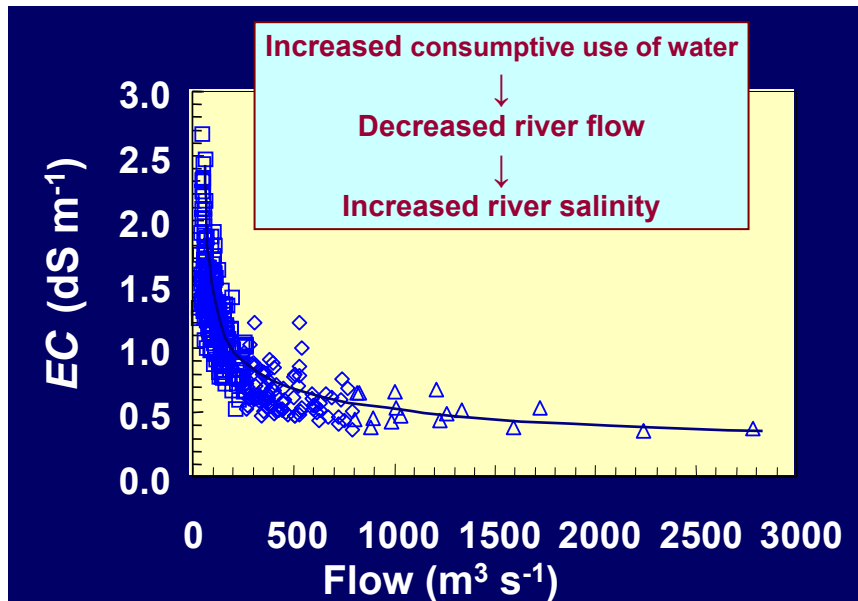
Quality of IRF is always worse than quality of irrigation water. Salinity as an example



“Diversion + Evapoconcentration + Weathering”



The Ebro river at Zaragoza as an example



Threshold water quality values for human consumption

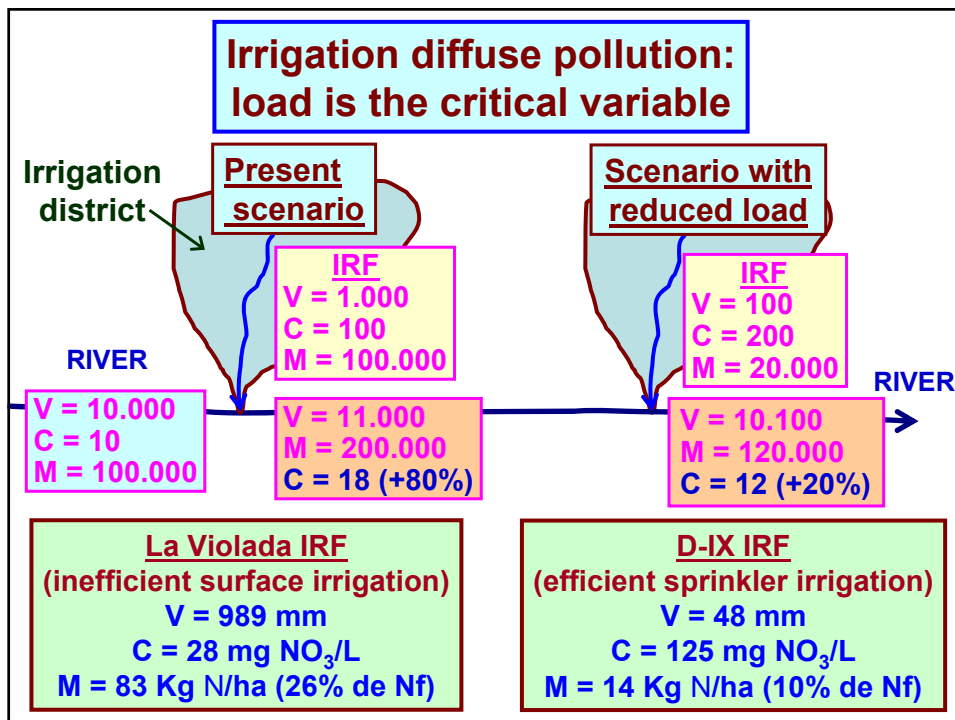
Substance	Threshold (mg/L)	Substance	Threshold (mg/L)
Arsenic	0.01	Mercury	0.001
Boron	0.5	Molybdenum	0.07
Cadmium	0.005	Nickel	0.02
Copper	1.3	Nitrate	50
Chromium	0.10	Nitrite	3.0
Lead	0.015	Selenium	0.01
Manganese	0.05	Uranium	0.002

Conclusion

**Substance concentrations determine
the water suitability for its different uses**

But...

- The load of contaminants in the irrigation return flows (IRF) determines the concentration of contaminants in the receiving water bodies
- Hence, diffuse pollution induced by irrigated agriculture should be quantified in terms of IRF contaminant loads, not in terms of contaminant concentrations
- **Load is the critical variable for the assessment of irrigation pollution**
- Approach taken by USA EPA (TMDL), but not by the European Water Framework Directive...



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

Reducing contaminant concentrations

- Decreasing agrochemical inputs
- Improving application dates
- Improving the management of livestock wastes
- Set up green filters/wetlands in drainage courses

Reducing the volume of IRF

Source control

- Optimize irrigation
- Regulated deficit irrig.

Sink control

Decreasing drainage

Reuse

- Internal
- External

Emergency Plan for Irrigation Modernization in Spain (MARM, 2006)

River water quality will increase because:

- 1- The volume of good quality waters non diverted for irrigation will increase in the rivers
- 2- The load of contaminants will decrease in IRF

... even though the concentration of contaminants in IRF will/could increase

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

