

## The use of fluvial resources and river ecosystems degradation

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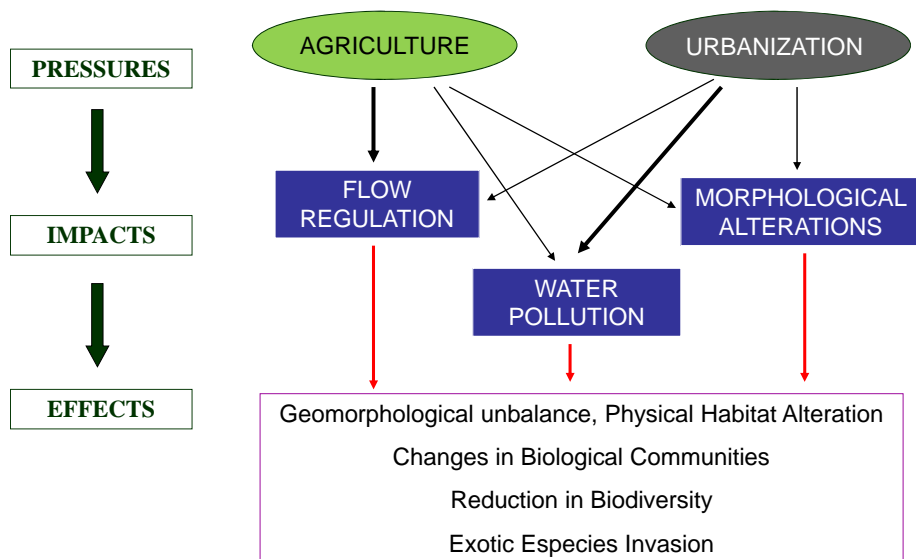
### The Fluvial Resources

- Raw materials
  - Water
  - Sediments (gravel & sand)
  - Fisheries
  - wood
- Space
  - Horticulture lands
  - Parking plots
  - Industries
- Energy

## The use of fluvial resources under mediterranean constrains

- Urban
  - Water supply & sewage
  - The need of space
- Agriculture: the profit of irrigation lands
  - Water scarcity & water demand
  - The rich soils of the floodplains
  - Fertilizers & Pesticides

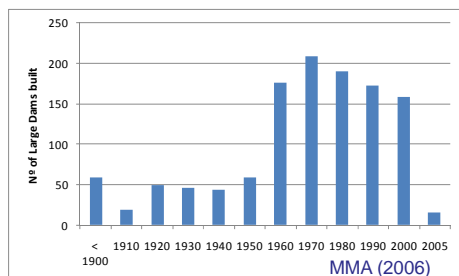
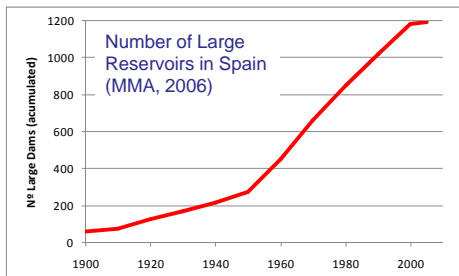
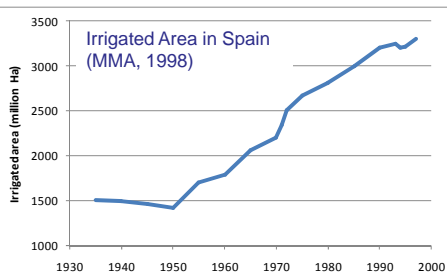
## The use of fluvial resources under Mediterranean constrains



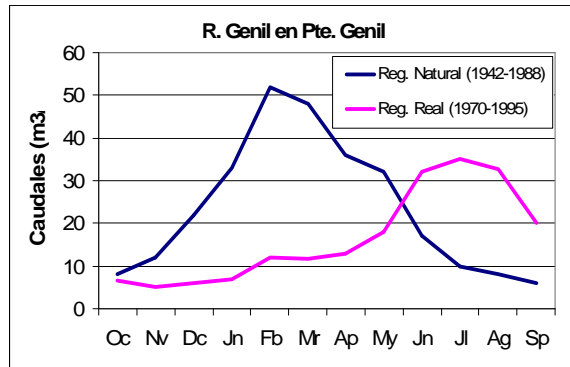
# AGRICULTURE

- **Water demand for irrigation:** Flow Regulation and Groundwater Overuse (80%)
- **The occupation of flood plains:** Elimination of riparian vegetation and Channel morphological alteration
- **Agricultural emissions of Nutrients and Pesticides to rivers and streams:** Eutrophication and water pollution

## Agriculture: Irrigation and Reservoirs



## Irrigation Flow regulation

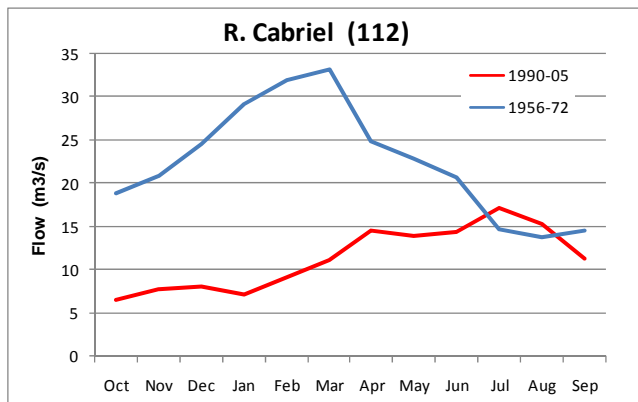


'Mediterranean' regime toward a 'Monzonic' regime

Maximum monthly flows in summer

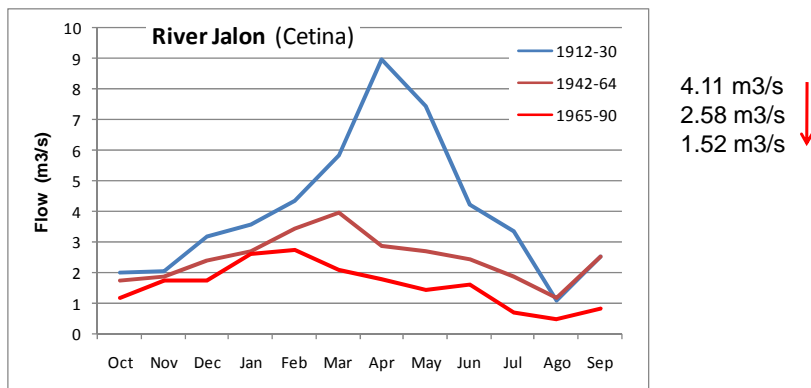
Flow reduction:  
 23,7 m<sup>3</sup>/s → 16,6 m<sup>3</sup>/s

## Irrigation Flow regulation



22.5 m<sup>3</sup>/s ↓  
 11.3 m<sup>3</sup>/s

## Irrigation Flow regulation



## Seasonal Constancy Flows

- Winter floods are eliminated or reduced
- Summer high flows & cold waters
- Channel Stabilization:
  - Riparian Vegetation is greatly promoted
  - Turbidity diminishes

## Temporary streams Endemic sp.

- Plecoptera:
  - *Guadalupeus franzi*, *Hemilelaena flaventris*
  - *Tyrrhenoleuctra minuta*
- Small size Cyprinids :



*Anaecipris*



calandino

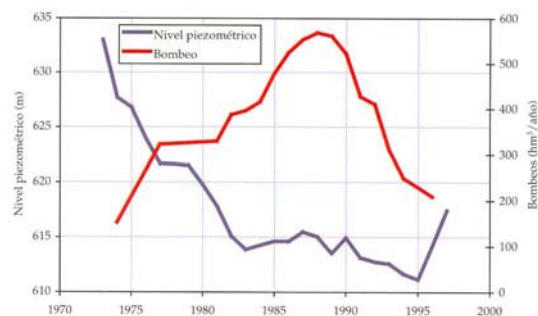


pardilla



## AGRICULTURE: *The Aquifers Overexploitation*

- Main effects when crossing certain thresholds, as is the case of a permanent stream turn into a temporary one.



Piezometric levels and pumping intensity in the aquifer of La Mancha (MMA,1998)

- In coastal streams the overexploitation of their aquifers facilitates the marine introgression into the interstitial environment

## Tablas de Daimiel National Park



- Actually, only 35 Ha are flooded, out of the 1.750 Ha that used to be.
- 12.000 ilegal wells over the aquifer nº 23

## AGRICULTURE: *Occupation of riparian spaces*

- Channelization, straightening and dredging
- Geomorphological destabilization :
  - Incision & aggradation
  - Remontant erosion and downstream sedimentation



*Río Ciguela*

- farmers claimed for damages to their crops and properties, and water authorities have built dykes, levees and rip-rap defenses

## AGRICULTURE: *Fertilizers*

- main nutrient coming from agriculture is the **nitrogen** in the form of nitrate
- **Eutrophication:**
  - nutrients promote phytoplankton and macrophyte growth, which decomposition produces **anoxic conditions** specially during nights.
  - An excessive growth of macrophytes within the channel slows down water flow and may change the habitat for aquatic fauna,
- Rivers transfer Agriculture Nitrogen to the Mediterranean coast, where **Nitrates** may reach higher levels.

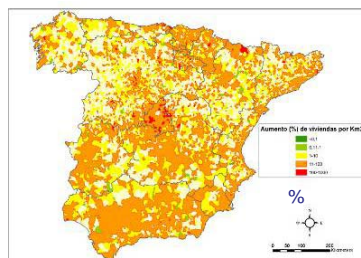
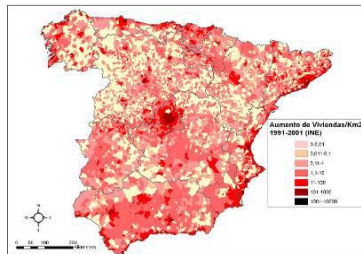


Invasion of water hyacinth (*Eichornia crassipes*) in the bed of the Guadiana River upstream from Merida (Jan. 2005)

## AGRICULTURE: *Herbicides & pesticides*

- Herbicides and pesticides coming from the agricultural drainages cause the pollution of rivers and may be toxic to many species of benthic and fish
- These pollutants can be **very stable** and stay long periods of time accumulated in the benthonic sediments, affecting very negatively to the biological communities and to use potential of water for domestic purposes.
- The herbicides (as **atrazine**) are used very often in farming without tilling (widespread in the olive plantations) and have contaminated water supply reservoirs.

## URBAN DEVELOPMENT



Increase in housing units built in Spain between 1991 and 2001 (INE, 2004)



## URBAN DEVELOPMENT

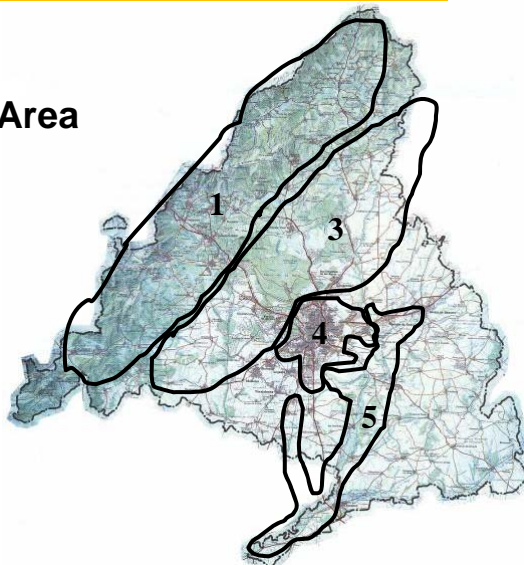
- **Increased demand for water and flow regulation**
- **Alteration of the balance between water and sediments and channel morphology destabilization.**
- **Promotion of the Pipes and Dredgings and Increased Hydrological Risk**
- **Water pollution by discharges of urban and industrial sources**
- **Gravel mining**

## Flow Regulation for urban water supply

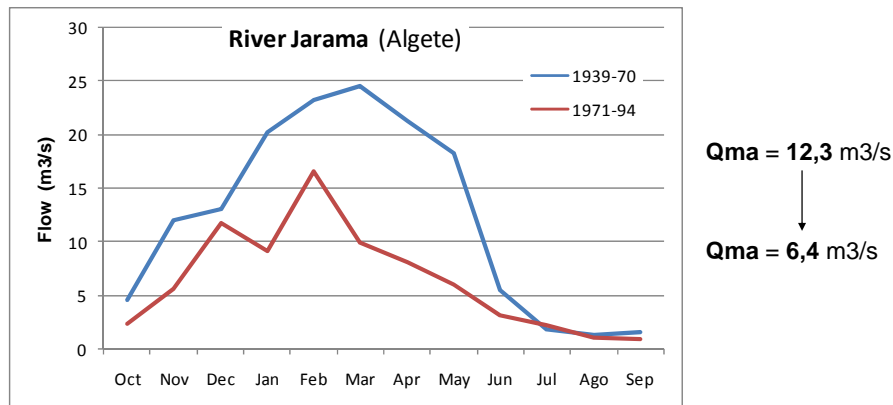
- Water demand (14%):
  - Sanitary uses,
  - park & golf irrigation,
  - Streets cleaning
  - swimming pools,
  - Network losses,..
- Warranty in water supply
- Reduction in stream flows below reservoirs

## Madrid Water Supply & River Zones:

1. Water Catchment Area
2. Storage reservoirs
3. By-pass Area
4. Urban Zones
5. Polluted Zones



Changes in flow regime in a bypass area, before and after building Madrid water-supply Reservoirs



### Alteration of the balance between water and sediments produces channel destabilization

- urban hydrology is designed for **evacuating the rain runoff as quickly as possible**, by means of pluvial and sewage pipelines hydraulically very efficient.
- The result, is flow is concentrated in a short time in the main network, reaching the river channels in a short time, producing hydrographs with **high peak flows**
- urban pavement has **low infiltration capacity**, and produces **large volume** of runoff after each rainfall
- urban runoff generated on paved surfaces carries a very **low sediment flow**
- These flows have **high potential for erosion** when they are incorporated into the natural channels, producing in them incision and subsequent widening processes.

## Promotion of the Pipes and Dredgings

### As result of the Increased Hydrological Risk:

- channelization and flood defense works
- In Mediterranean cities is frequent to cover streams and transformed into pipes above the urban areas. (gaining space, & avoiding bad smells in summer).
- The habitat created after channelization is homogenous and with small refuge capacity and thus, few species and low diversity communities may sustain.
- But its most important effect and prolonged in time is the induced geomorphological instability of the river along its continuum, which affects a far greater reach than the dredged section itself.



## Urban and Industrial Water pollution

- Discharges of urban waste water contain a high percentage of organic matter, suspended solids, nutrients.
- Still today there are some important towns without any sewage treatment plants,
- However, even in cities with 'legal' sewage treatments we find in their rivers downstream, anoxic conditions and a great concentration of nutrients. This is because in Mediterranean urban rivers instream flows come mainly from spills of sewage treatment plants, and the **dilution factor maybe almost none** (especially in dry seasons).
- In these circumstances the **standards for releases from treatment plants** applied in humid countries are not sufficient



## Gravel mining

- gravel mining activities are very frequent in rivers near cities, as the demand for construction materials for urban development has found a cheap source of gravel and sand
- the removal of gravel and the process of screening and cleaning causes an increase of suspended sediments in the flowing water that produces **siltation** in the downstream benthic microhabitats
- the spaces are taken from the gravel and sand have become **lagoons** associated with the mainstream that often are refilled with non permeable materials



## CUMULATIVE EFFECTS IN TIME AND SPACE

- Rivers have lost sediments
- Rivers have lost their dynamism
- Rivers reaches below cities are always polluted
- Rivers have been fragmented and lost their natural connectivity
- Rivers have reduced their native biodiversity
- Rivers have been invaded by introduced species

## CUMULATIVE EFFECT IN TIME AND SPACE

### Rivers have lost their sediments

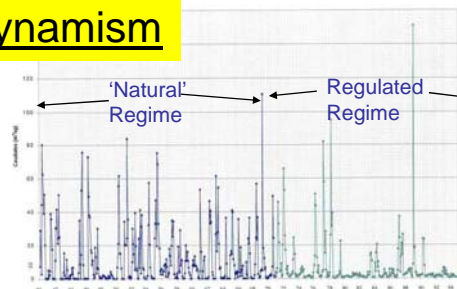
- abandoned high lands have reduced the sediments sources,
- the reservoirs built act as huge sediment traps,
- gravel mining takes away the sediment left.

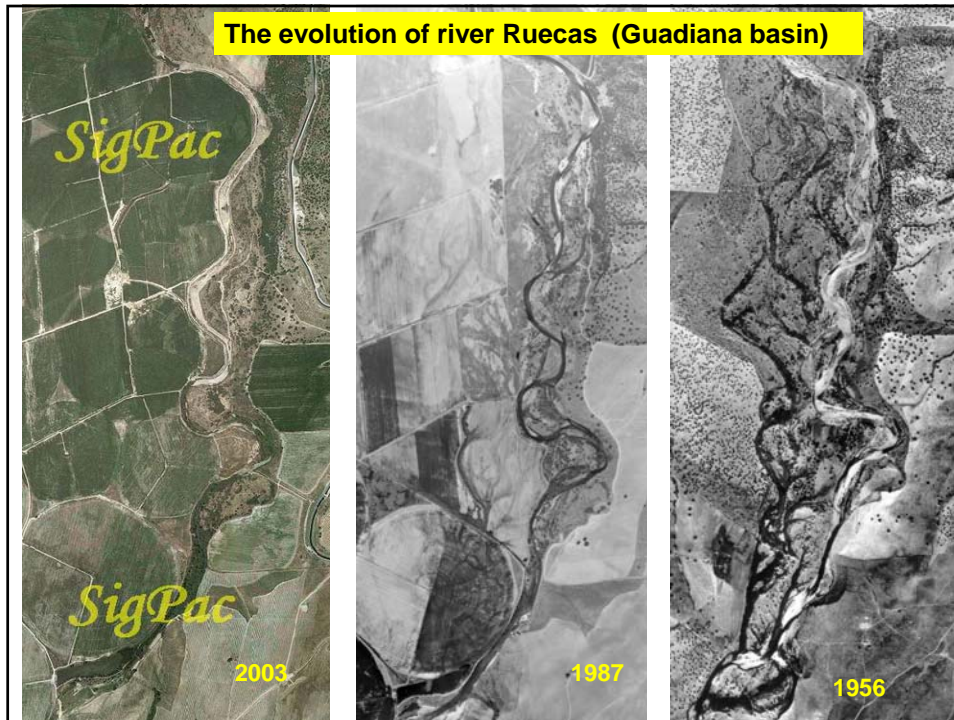


## CUMULATIVE EFFECT IN TIME AND SPACE

### Rivers have lost their dynamism

- Reservoirs laminate larger floods
- bankfull discharges become very rare,
- riparian vegetation overgrowths invading channel river margins,
- humans fix rivers by constructing levees and longitudinal dykes.





## CUMULATIVE EFFECT IN TIME AND SPACE

### Rivers reaches below cities are polluted

- in Mediterranean urban rivers **dilution factor** is so low that self-depuration processes are insufficient to avoid intense eutrophication and anoxic conditions.
- Polluted reaches are barriers for biotic connectivity



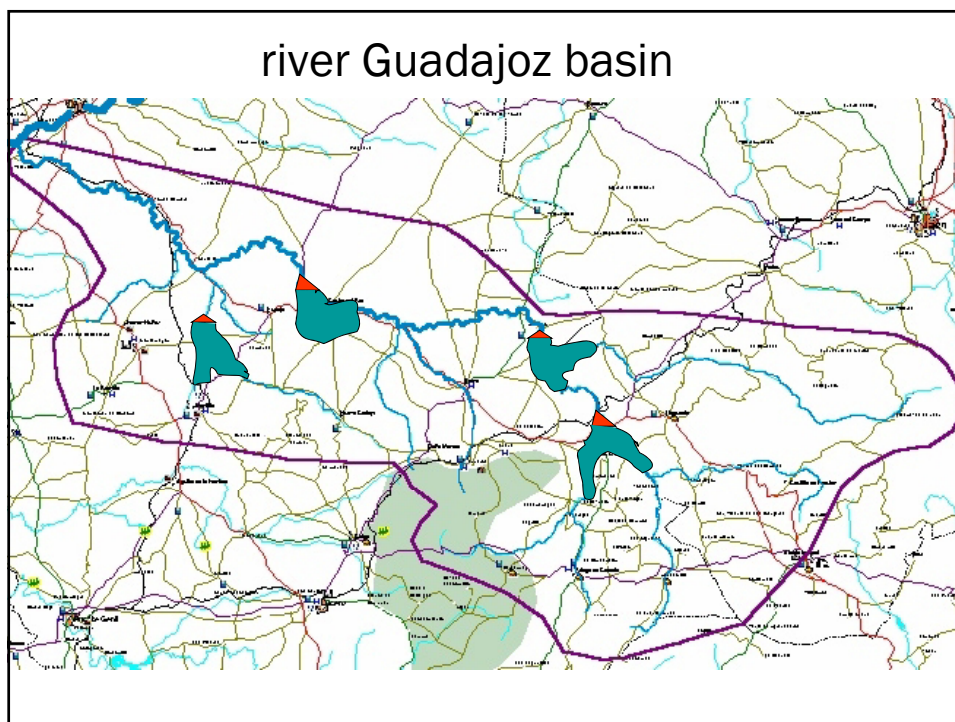
## CUMULATIVE EFFECT IN TIME AND SPACE

### Rivers have been fragmented and lost their natural connectivity

- dams are physical **barriers** and polluted reaches are chemical ones.
- Also, river reaches dried by water overexploitation are temporal barriers.
- All barrier types together prevent the migration of fishes, and the arrival of seeds, plant sprouts upstream, as well as the drift of benthic invertebrates.



River Jarama



## CUMULATIVE EFFECT IN TIME AND SPACE

### Rivers have reduced their native biodiversity

- water management have reduced **resilience capacity** in Mediterranean fluvial systems.
- **Isolated populations** in heavily impacted reaches are threatened to be extinct, as they have lose their recovery capacity.
- Autochthonous reophilous species are **not adapted** to the new aquatic habitat created (uniform temporally and homogeneous spatially) by intense flow regulation.
- Under these conditions, the effect is a reduction on fluvial biodiversity at **long term**.

## CUMULATIVE EFFECT IN TIME AND SPACE

### Rivers have been invaded by introduced species

- Native species are not anymore adapted to the altered habitats and thus, are not competitive to introduced species.
- On the contrary, certain introduced species are well adapted to the domesticated new fluvial habitats,
- and as a consequence they become dominant in the aquatic community.



