MULTIPLE BENEFITS OF THE WATER REUSE PROJECT FOR ENVIRONMENTAL PURPOSES AT THE AIGUAMOLLS DE L'EMPORDÀ NATURE RESERVE

Lluís Sala and Manel Serra. Consorci de la Costa Brava

Anna Huguet, Joan Colom and Marc Carré. SEARSA

Sergi Romero de Tejada. Parc Natural dels Aiguamolls de l'Empordà

Eduard Marquès. Servei Control Mosquits Badia de Roses i Baix Ter

THE 7th INTECOL INTERNATIONAL WETLANDS CONFERENCE IN UTRECHT, THE NETHERLANDS

25 - 30 JULY 2004

Session 10: The Waterharmonica

The Aiguamolls de l'Empordà Nature Reserve (AENR)

- Remain of a large coastal strip of wetlands on the coast of NE Spain, south of the Pyrenees
- Beginning of dessication in 18th century in order to reclaim land for agricultural purposes and to prevent waterborne diseases
- Flooding totally prevented in the late 60's after the construction of the Boadella reservoir and the Muga river levees
- Preservation of the last non-developed areas in the mid 80's with the creation of the AENR

The environmental reuse project

- Need for a new freshwater source to prevent the summer dessication of the manmade 18-ha Cortalet lagoon, in the AENR
- New Empuriabrava WWTP (1995) located on the right bank of the Muga river, 3 km north of the AENR

The environmental reuse project

- Availability of water of excellent quality almost all year round (except August)
- Funding from EU Cohesion Funds in 1996. The project consisted of three stages (1,382,000 €):
  - Construction of 7-ha treatment wetlands
  - Construction of pumping station and installation of pipeline connecting the WWTP and the Cortalet lagoon
  - Construction of a pedestrian walkaway on the bridge over the Muga river

Goals

- To provide water of sufficient quality to the Cortalet lagoon to avoid its dessication in summer and/or to flood the wet meadows in the surrounding area
- To reduce effluent discharges to the Muga river
- To avoid the eutrophication that reclaimed water would cause if there was inadequate nutrient removal
- To restore the healthy ecological condition (flora and fauna) of the area in order to achieve a degree of biodiversitaty similar to that of natural ecosystems

The Empuriabrava WWTP

- Started operation in 1995. Services the community of Empuriabrava (Castelló d'Empúries)
- Present flows: 1,000 - 6,500 m^3/day
- Extended aeration plant with N/DN and ponds for effluent polishing
- Two parallel lines to cope with seasonal variations

The Constructed Wetland System (CWS)

- Beginning of operation: 1998
- 3 vegetated (reed, cattail) cells of 160 m x 50 m (8.000 m^2) and avg depth of 0.5 m.
- Shallow pond (0.2 m depth) and 4.5 ha of surface (Estany Europa): additional treatment and excellent habitat for limicolous birds
- Avg data 2000-2003: Reuse of 70-80% of treated wastewater (600,000 m^3/year of reclaimed water out of the 800,000 m^3/year of wastewater treated in the Empuriabrava WWTP)

Scheme of the facilities

Old ponds for storage of sludge (now for enhanced water treatment)

Biological reactor

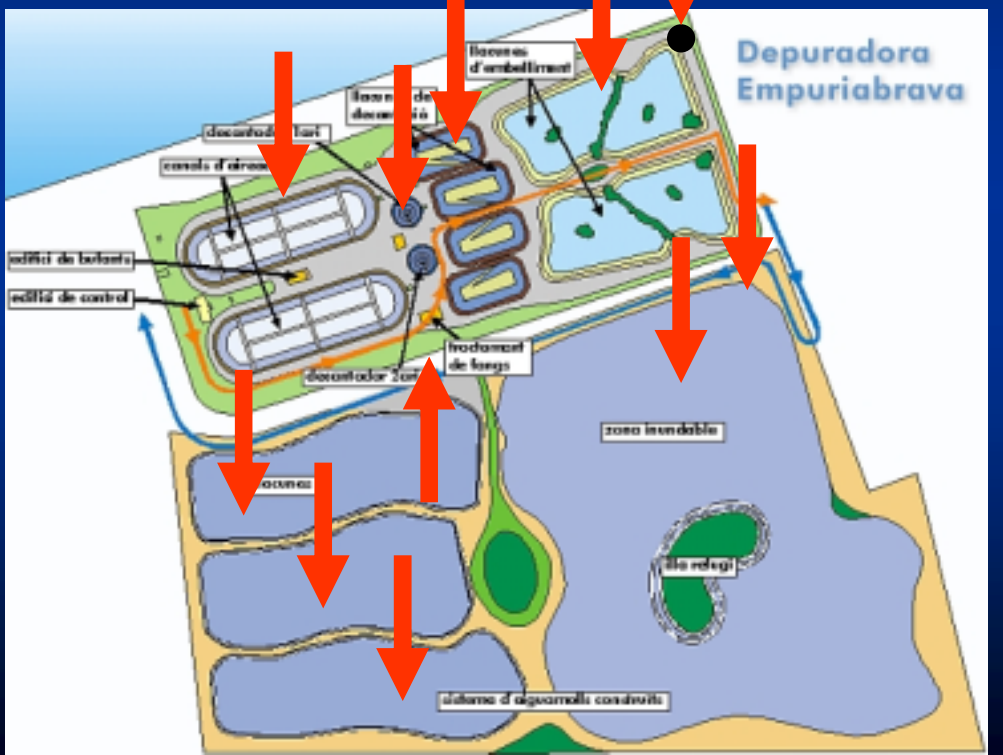
Clarifier

Constructed wetlands

Polishing ponds

Centrifuge for sludge dewatering

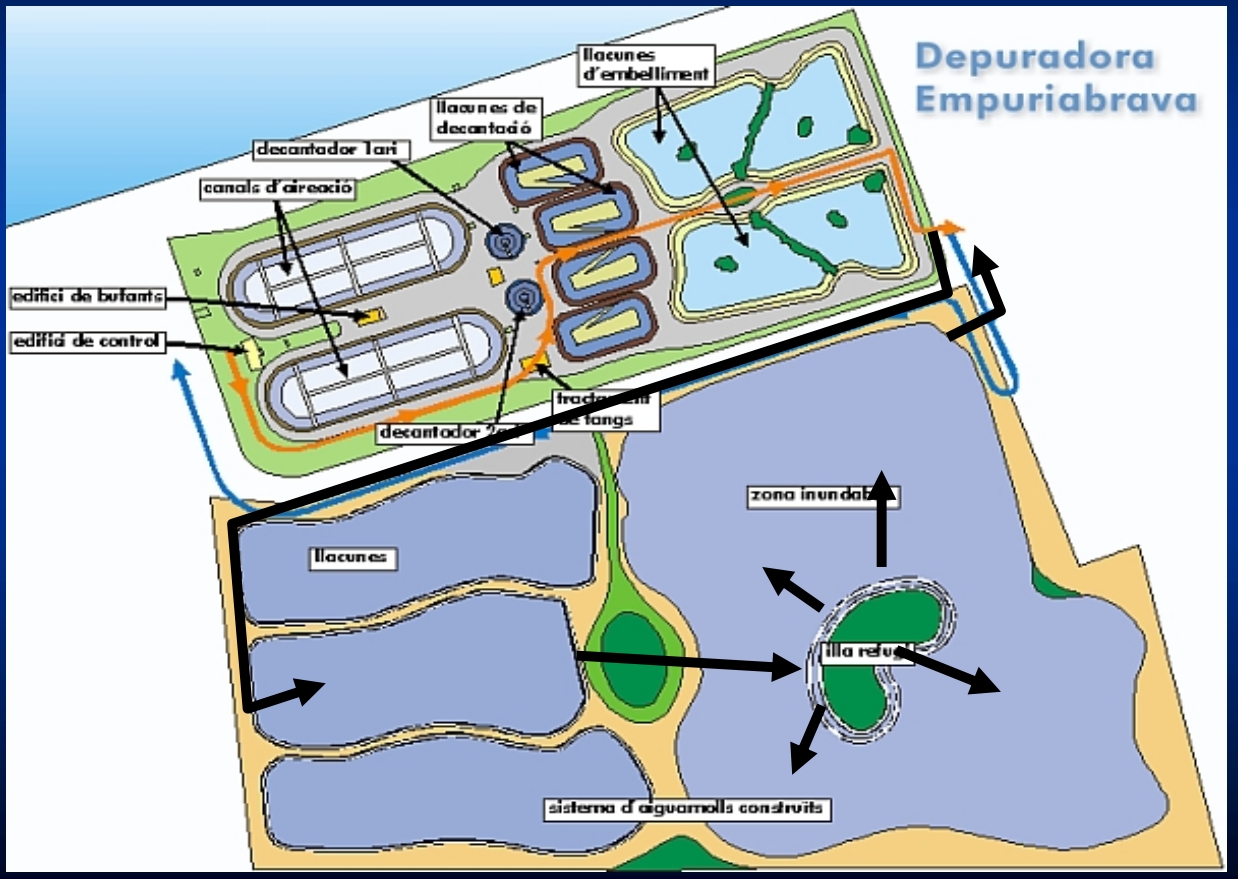
On-line probe for monitoring of ammonia



Outlet weir

Shallow pond - Estany Europa

Flow chart


Depuradora
Empuriabrava
llacunes d'embelliment
llacunes de decantació
decantador Imhoff
canals d'aireació
edifici de bufants
edifici de control
llacunes
zona inundable
illa refugi
sistema d'aiguamolls construïts

Operational criteria of the WWTP

- Classical criteria (DBO, SS) are no longer useful
- Need for complete or near-complete oxidation of nitrogen (removal of ammonia)
- Probe installed for on-line monitoring of ammonia in treated wastewater. Destination is decided according to the following criteria:
  - If NH_4-N < 5 mg N/l, water is allowed to enter the constructed wetland system (CWS)
  - If NH_4-N > 5 mg N/l, water is discharged into the Muga river (original discharge point)
- Complete oxidation almost all year round, but limitation of available oxygen transfer in summer

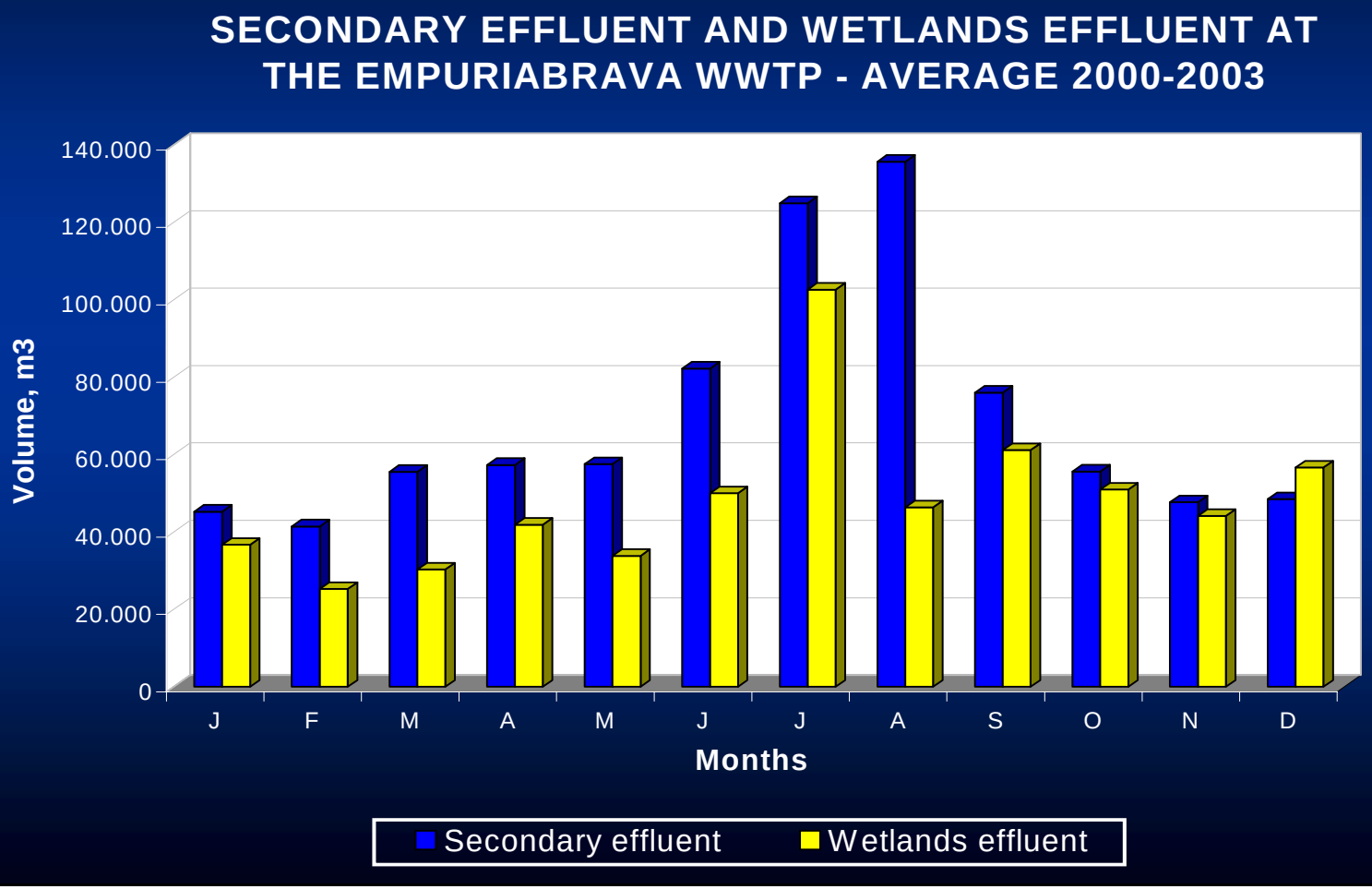
Advantages of oxidized effluent

- Makes no oxygen demand on the receiving environment
- Phytoplankton growth not stimulated - water remains transparent
- Allows the growth of filamentous algae and hydrophyta (*Zannichellia palustris, Najas minor*) - enhanced nutrient removal and oxidized environment. Growth of dense populations of cladocera

⇒ Once effluent oxidation has “turned the corner” of nitrification, anything happening spontaneously produces an improvement in the both the quality of the water and the environment

http://www.biologie.uni-halle.de/zool/dev_biol/lect/pk_lim/limno/Daphnia.jpg

Treated volumes

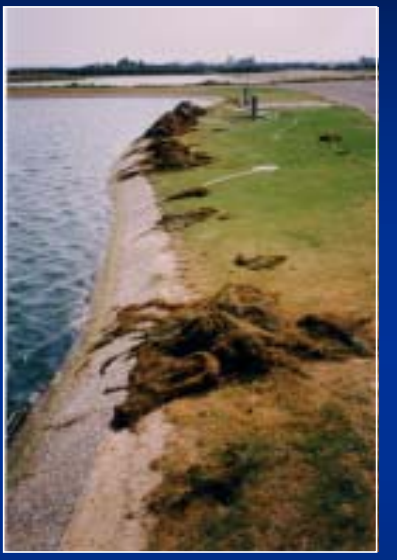


System performance

- Evaluated according to removal of total inorganic nitrogen (TIN). Lower degree of phosphorus removal - chemical removal already included in the project for the upgrade of the WWTP
- Nitrogen loads (concentration x flow) calculated for both the inlet and the outlet of the system
- January - December 2003: Removal of 74% of the TIN (2,500 kg) but only 5 % of the soluble P (60 kg) entering the system
- Decrease of DN performance in winter due to low temperature

Maintenance & conservation of the CWS

- Control of growth of duckweed and filamentous algae - periodical removal
- Control of macrophyte growth in the Estany Europa
- Mowing of vegetation growing on the paths and margins
- Progressive introduction of improvements:
  - Installation of weirs at the cell inlets
  - Installation of an adjustable weir at the outlet of the Estany Europa
  - Installation of floodgates for the isolation of each wetland cell - greater operational flexibility
  - Additional reed plantation

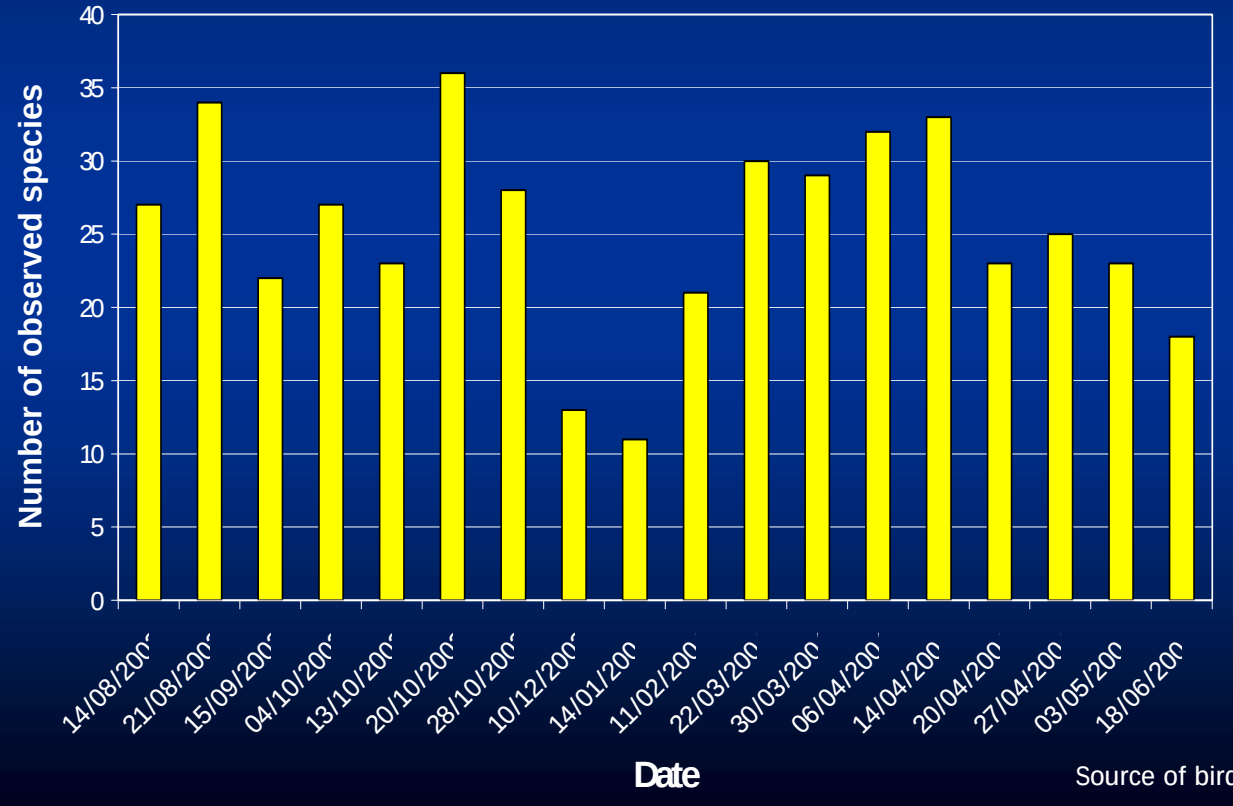


Flora

The system is in evolution and still gaining botanical diversity. Several communities have already been identified.

Fauna

Monitoring of birds in the Empuriabrava CWS



Source of bird data: J.Martí / P Feliu

Collateral benefits

- Improvement of the bacteriological condition of the beach at the mouth of the Muga river (data produced by the Catalan Water Agency, ACA):

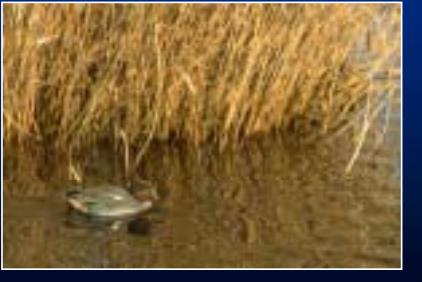
  Until 1994: Swimming not allowed

  1995 - 1997: Swimming allowed

  1998 - 2003: Swimming allowed and maximum quality, except 2001

Conclusions

- Since 1998, the Empuriabrava WWTP has turned into a freshwater source for the AENR
- Efforts made towards treatment (WWTP + CWS) and close monitoring minimize the issue of the origin of the water
- Rational management of the system allows an improvement of the local aquatic flora and fauna
- This project has multiple environmental benefits, far beyond the mere recycling of water



Specific features of sanitation in Mediterranean areas

- Complex sewerage systems
  - Compact urban developments
  - Lower degree of planning than in Central or Northern European countries
  - Rugged orography
- Substantial seasonal variations in flows (summer peaks)
- Increased strength of raw wastewater
- Low or absent dilution flows in natural streams
- European regulations for wastewater discharge (BOD<25 mg/l, SS<35 mg/l) are insufficient for many Mediterranean streams $\Rightarrow$ They should be treated, at least, as sensitive areas (limitation of N and P)

The Waterharmonica concept in Mediterranean countries (I)

- Advantages
  - Increased treatment of wastewater before its release into the environment
  - Nutrient recycling to create food webs - lower discharges
  - Recreation and/or reclamation of Mediterranean wetlands, which are undergoing a disturbing process of transformation (more than 100,000 ha estimated to be lost in the Mediterranean region - http://www.insula.org/wetres.htm)
  - Provide habitat for aquatic flora and fauna, some of which are endangered because of habitat destruction
  - Prevent further land development
  - Provide an excellent opportunity for environmental education and for raising awareness among local residents

The Waterharmonica concept in Mediterranean countries (II)

- Disadvantages
  - Usually little land is available for extensive treatments
  - If available, usually very expensive
  - Budget limitation sometimes already exists for conventional wastewater treatment
  - Perceived as something still rather experimental

The Waterharmonica concept in Mediterranean countries (III)

- Future
  - Further advancement of the implementation of the Waterharmonica concept in Mediterranean areas will require dedicated political commitement
  - The measurement of collateral benefits (improvement at the discharge point) is of key importance
  - Need for monitoring and promotion of the projects in operation around the world, and more specifically in the Mediterranean environment


Caminante, no hay camino,
se hace camino al andar.
(Walker, there is no path,
You make the path as you walk.)
Antonio Machado
Proverbios y cantares - XXIX