Environmental Criteria for Alternative Nutrient Removal in Treated Wastewater

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Background

- Despite pollution reduction by WWTP, discharges can still be sources of eutrophication, specially in dry areas such the Mediterranean.
- WWTP are usually upgraded to remove N and P.
- Where reclaimed water is used for irrigation, N and P are recycled, not discharged.
- Can water reuse be an alternative way for nutrient removal? If the WWTP is upgraded and nutrients are removed, will this affect the economic and environmental viability of the reclaimed water supply?
- Data from the Castell-Platja d'Aro area (Costa Brava, Spain) have been used to evaluate the different factors and alternatives.

The Castell-Platja d'Aro WWTP and the irrigation area

- Conventional activated sludge plant with no nutrient removal (avg. 2006: total nitrogen, 42 mg N/L; total phosphorus, 3.0 mg P/L; potassium 20 mg K/L), followed by a reclamation treatment consisting of filtration and disinfection (UV + chlorine). Since 1.989, reclaimed water is supplied for agricultural and golf course irrigation.
- Nutrient contributions accounted by users for fertilizer savings and for adequate agricultural management (Figure 1).
- Successful supply of reclaimed water for the irrigation of 25 hectares of maize fields in the Solius area have produced a big interest in the expansion of the supply to other farming plots in the nearby Llagostera area.
- Need of economic and environmental evaluations of this project, including the consequences of turning 217 ha of dry farming into reclaimed water-irrigated maize fields.

Economic evaluation (capital costs not included) (Figure 2)

The Solius irrigation area

- Agricultural area devoted to growing maize and irrigated both with groundwater and with high nutrient-content reclaimed water from the Castell-Platja d'Aro WWTP since 2004.
- Water extracted from wells running on electrical energy has lower irrigation costs than that coming from wells operating with gasoil pumps. The latter has the highest cost, 2.6 times more expensive than that in which the high nutrient-content reclaimed water is used (present situation) and double the cost of using water with a low nutrient content (if the WWTP was upgraded to achieve nutrient removal).
- The use of reclaimed is the option with the lowest overall runing costs, even if low-nutrient water is used.

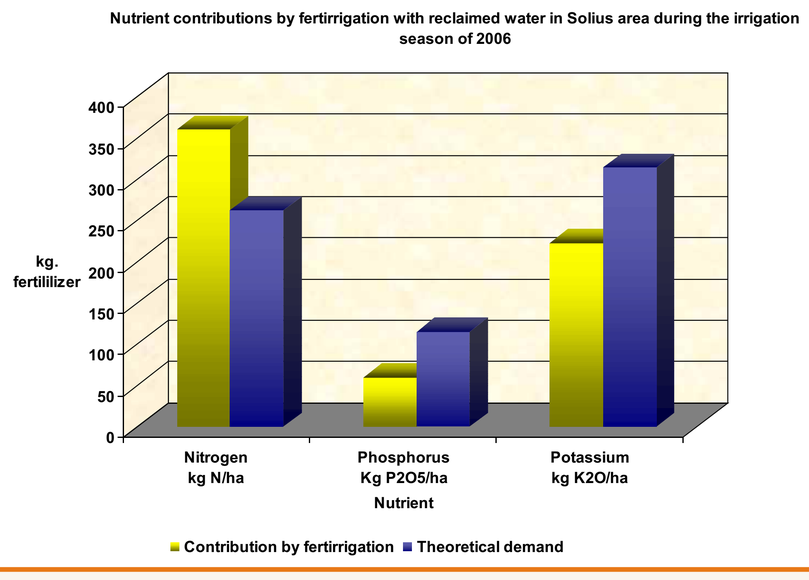


Figure 1

The Llagostera irrigation area

- Agricultural area located 10 km away and 175 m higher in altitude in relation with the Castell-Platja d'Aro WWTP, whose farmers have a keen interest in having reclaimed water available for the irrigation of their fields. Success in Solius, lower overall running costs and greater predictability of the supply in comparison with the local groundwater are the main factors that are propelling the demand.
- Groundwater in the Llagostera area is extracted from depths that range from 80-120 meters, with even a greater energy consumption than in case of Solius.
- The options of the lowest running costs, even for the most distant maize fields, are those in which reclaimed water is used, since fertilizer savings are able to compensate the higher energy costs.

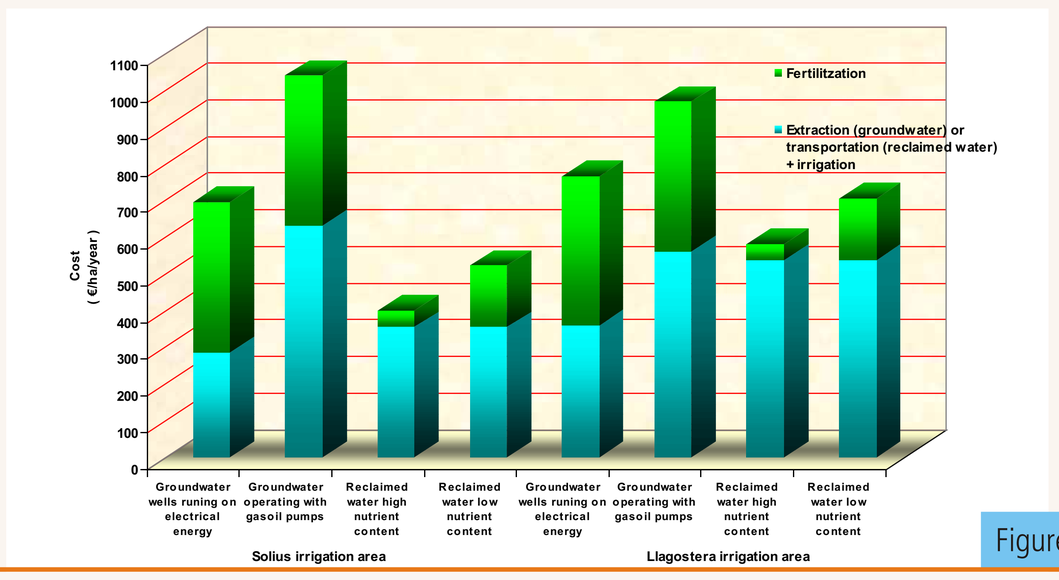


Figure 2

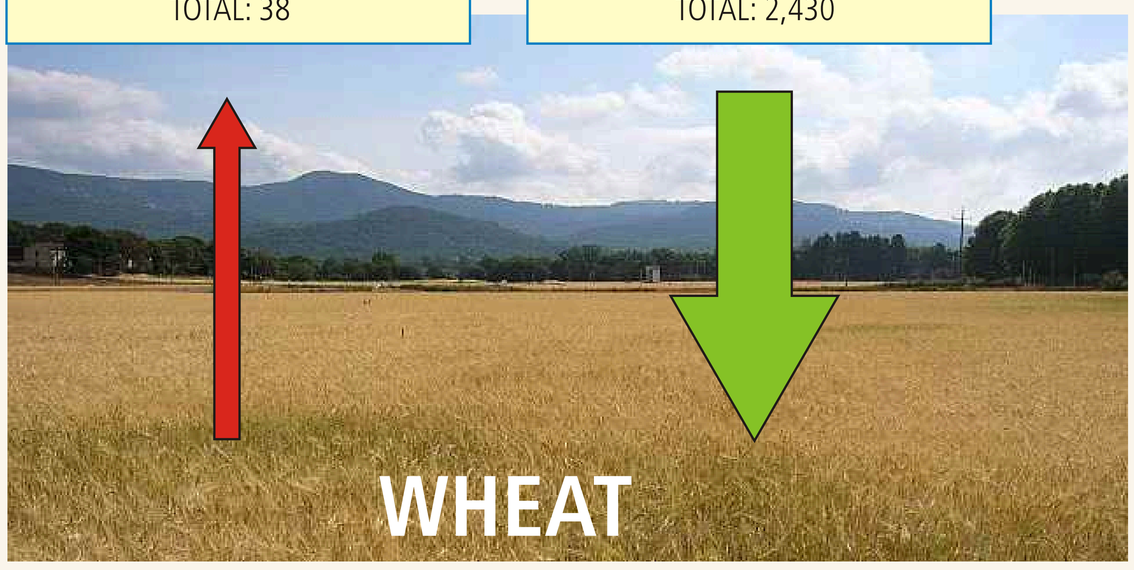
Enviromental evaluation

COMPARISON OF CO_2 BALANCES OF THE PRODUCTION OF WHEAT (DRY FARMING) AND MAIZE IRRIGATED WITH HIGH NUTRIENT RECLAIMED WATER ON 217 ha IN THE LLAGOSTERA AREA

Overall CO_2 balance for wheat in 217 ha: -2,392 tons/year -11 tons/ha/year

EMISSIONS CO_2 (tons/year)
PRODUCTION OF FERTILITZERS: 38
TOTAL: 38

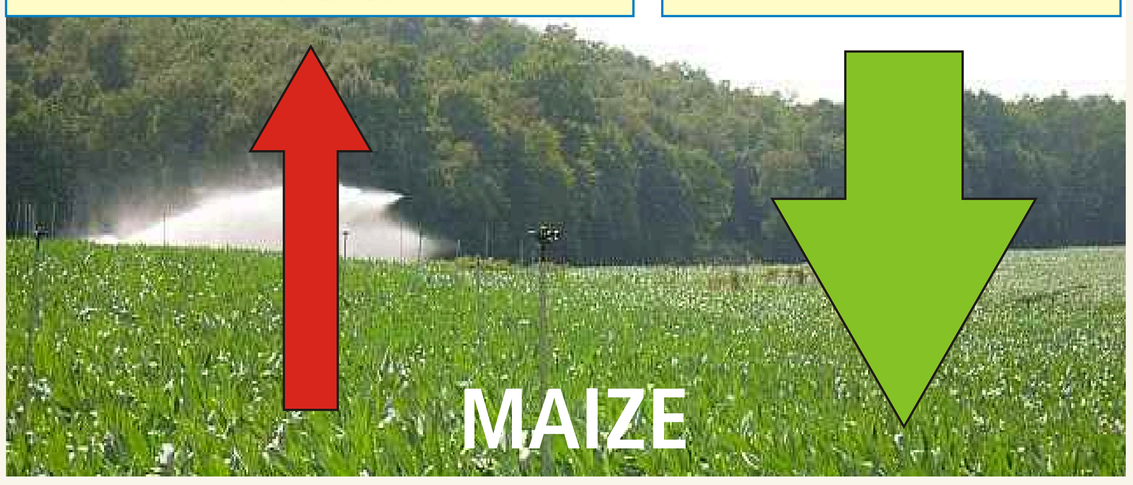
ABSORPTION CO_2 (tons/year)
CROP PRODUCTION: 2,430
TOTAL: 2,430



Overall CO_2 balance for maize in 217 ha: -5,248 tons/year -24 tons/ha/year

EMISSIONS CO_2 (tons/year)
PRODUCTION OF FERTILITZERS: 14
RECLAMATION TREATMENT: 119
TRANSPORTATION OF WATER + IRRIGATION: 317
TOTAL: 450

ABSORPTION CO_2 (tons/year)
CROP PRODUCTION: 5,664
ENERGY SAVINGS IN WWTP: 34
TOTAL: 5,698



- CO_2 emissions associated with dry farming are 11.2 times lower than those released by the production of maize with reclaimed water.
- The uptake of atmospheric CO_2 by maize is 2.2 times greater than that of wheat, which clearly offsets those emissions and renders a much more favourable CO_2 balance, in wich the net uptake by maize fields is more that double of that by wheat fields.
- The increase in CO_2 emissions that would cause the upgrade of the biological reactor from a conventional activated sludge type to an extended aeration one are even smaller than those associated with the reclamation treatment itself, and thus negligible in overall terms

CONCLUSIONS

- **The reclaimed water supplied from the Castell-Platja d'Aro WWTP is the most favourable option for irrigation available in Solius and Llagostera areas.**
- **The fertilizer savings offset the higher energy costs involved in the reclamation treatment and in the transportation from the WWTP to the fields, even if lower-nutrient reclaimed water was used. In order to be competitive with reclaimed water in terms of overall running costs, groundwater has to come from very shallow wells.**
- **From an enviromental point of view (CO_2 balance), the conversion of dry farming areas into maize fields in the Llagostera area by using reclaimed water and its nutrients also doubles the atmospheric CO_2 uptake of the area.**
- **Coupling water and nutrient recycling to increase the surface devoted to maize production could help in the regional strategy for atmospheric CO_2 contention, without harming or risking freshwater or groundwater resources.**