AGRICULTURAL IRRIGATION WITH RECLAIMED WATER

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Scope and Purpose

The Mas Pijoan ranch is located in Solius, a small community belonging to the municipality of Santa Cristina d'Aro. The ranch was founded in 1913 as a family agricultural project. By gradual farmland acquisition and the establishment of land use agreements with neighboring owners, it has developed into a small irrigation farm capable of producing the food crops necessary to feed a small cattle ranch. Business has grown according to the farmland available. The 12 ha available by 1979 have been gradually expanded up to the 150 ha of farmland managed by 2006, with 40 ha dedicated to irrigated agriculture. Farm production is mainly centered on seed crops (barley) on dry land, and fodder crops in irrigated land, with oat and triticale production during the winter season, and corn during the summer season. The cattle ranch includes 300 cows, of which 140 are milking cows.

Until 2003, agricultural irrigation at Mas Pijoan was conducted on 30 ha of farmland using local groundwater resources. However, while flows available at the beginning of the summer season could reach 150 m^3/hour, they gradually decrease down to 20 m^3/hour after 2 months of operation, forcing the corn field final growth stages to take place under very low water application rates. The excessive groundwater pumping rates were also affecting nearby residential and agricultural users, which were having difficulties in extracting the water necessary for theirs crops and gardens.

By 2000, the Mas Pijoan ranch owner realized that reclaimed water from the Castell Platja d'Aro water reclamation plant was used for horticultural irrigation in small plots around the plant. Managers of the neighboring Costa Brava Golf Course, also in Santa Cristina d'Aro, had shifted in 1998 to reclaimed water, due to recurrent shortages in their groundwater supplies at the end of the summer seasons, which had been further aggravated by an episodic drought in the area. Reclaimed water was being supplied to the golf course through a new pipeline. All that was necessary to connect the Mas Pijoan ranch to the reclaimed water pipeline was a 3-km stretch between the ranch and the golf course.

After securing an overall agreement with neighboring water users, the Mas Pijoan ranch submitted a funding request to the Agricultural Service of the Catalonian Government to cover 70 % of the investment costs of the new pipeline and the associated pumping station. The land agreements and the favorable response of the grant agency offered to Mas Pijoan the possibility of expanding its initial 30 ha of irrigated land to the current 40 ha of irrigated land, with the potential of adding another 10 ha using a limited irrigation strategy.

Reclaimed water for agricultural and landscape irrigation at Castell Platja d'Aro is provided by the Consorci de la Costa Brava (Water and Sanitation Agency for Costa Brava Consortium) through its service company Empresa Mixta d'Aigües de la Costa Brava, S.A.

Driving Forces

The main and basic driving force for switching to reclaimed water irrigation

was the water supply reliability of reclaimed water during the summer season, rendering crop production independent from variable rainfall patterns and groundwater availability. However, other important benefits have become clear after 3 years of operation of the system: 1) the beneficial nutrient contributions of reclaimed water, which have diminished chemical fertilizer applications, and 2) higher productivity and quality of corn fields, which reaches up to 80 tons/ha, with a seasonal water application of 5,600 m^3/ha.

The reclaimed water supply project included: 1) a 3-km pipeline of 200 mm diameter, 2) a 1,800 m^3 storage pond, and 3) a 50-hp pumping station. The total budget of the project was 170,000 euros; the project received a government grant of 100,000 euros. The construction process was completed by September 2003, and the process was ready for operation by the summer of 2004. The project includes water meters at the point when reclaimed water leaves the golf course pipeline and enters the last portion of the conveyance system, ending at the storage pond. Different fertilization programs are applied in the areas irrigated with reclaimed water and those irrigated with well water. The 20 ha irrigated with reclaimed water receive only a cow manure application before plantation, while the other 20 ha irrigated with well water receive similar doses of manure, plus enough mineral fertilizers to reach a 250 kg N/ha application dose.

Benefits and Requirements

The schedules for agricultural irrigation at Mas Pijoan and for landscape irrigation at Costa Brava Golf Course are closely coordinated as to ensure a smooth operation. Reclaimed water pumping operates 20 hours a day, with a 4-hour stop to skip the period with highest power supply rate. However, the pumping station remained in continuous operation for 6 days during the summer of 2005. Golf course irrigation operates from 9 pm to 7 am, and agricultural irrigation is supplied during the rest of the day, to complete the 20 hours of operation. Golf course irrigation with reclaimed water has been conducted for 8 years with only a 8-day water supply interruption. The basic agreement between Mas Pijoan and the Costa Brava Golf Course includes also a reversible pumping station, to ensure that golf course irrigation can be supplied from the storage pond of Mas Pijoan, using well water if necessary. That arrangement has provided added reliability and flexibility to both users.

The reclaimed water use of Mas Pijoan during 2005 was 125,000 m^3 annually. That represents 55% of its water needs, the balance been covered with conventional groundwater supplies. The flow capacity of the pipeline bringing reclaimed water from the reclamation plant to the golf course and the golf course water supply timing are the limiting factors of the Mas Pijoan reclaimed water use during the summer season. The cost of reclaimed water is becoming increasingly more favorable than that of conventional supplies, due to the steady increase of the energy needed for groundwater pumping.

Table CS1-1 summarizes the microbiological and chemical quality of the reclaimed water used for agricultural irrigation at both Mas Pijoan ranch and Costa Brava Golf Course, as it leaves the Castell Platja d'Aro reclamation facility. The cost of reclaimed water for Mas Pijoan ranch is 0.084 euros/m^3, including water production, analytical control and water pumping from the reclamation plant to the storage pond. Figure CS1-1 shows the reclaimed water use patterns for agricultural irrigation at Mas Pijoan ranch during the summer seasons of 2004 and 2005.

The benefits derived from using reclaimed water for agricultural irrigation at Mas Pijoan are: 1) water availability during all the summer season, 2) water supply reliability during the irrigation season, 3) a net nutrients contribution, which provides valuable fertilizer savings, 4) a sense of active contribution to an integrated management of water resources, and 5) an environmental quality improvement by preventing

discharges of treated effluent into coastal areas and river beds.

Table CS1-1. Microbiological and chemical quality of reclaimed water used for agricultural irrigation at Mas Pijoan ranch, Spain, CCB (2004, 2005).

Parameter	2004	2005
Faecal coliforms, cfu/100 ml		
Number of samples	27	27
Geometric Mean	2	2
90th percentile	5	10
Maximum level	30	29
Turbidity, ntu		
Number of samples	29	36
Arithmetic Mean	2.0	2.6
90th percentile	3.4	4.8
Maximum level	11.5	7.3
Total nitrogen, mg N/l		
Number of samples	31	43
Arithmetic Mean	28	32
90th percentile	45	48
Maximum level	56	55
Total phosphorous, mg P/l		
Number of samples	33	55
Arithmetic Mean	3.9	5.1
90th percentile	8.2	8.8
Maximum level	14.0	11.0

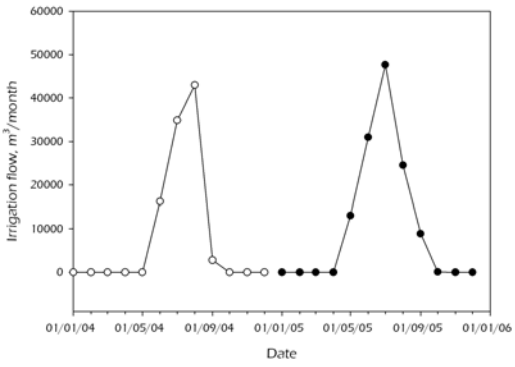

Figure CS1-1. Reclaimed water used for agricultural irrigation at the Mas Pijoan ranch, Costa Brava, Spain, 2004 and 2005.

Future Prospects

Agricultural users familiar with reclaimed water irrigation are concerned with the increasing interest of environmental agencies for adding biological nutrient removal to wastewater treatment plants. In general, nutrients in reclaimed water are considered to be beneficial for agricultural crops, and consequently nutrient removal may have a detrimental effect, as it forces application of additional amounts of mineral fertilizers. On the other hand, golf course greenkeepers tend to favor lower amounts of nitrogen and phosphorous in their irrigation water. Overall, agricultural and landscape irrigation with reclaimed water can be an alternative way for the beneficial use of both water and its mineral contents.

Official approval of the Mas Pijoan irrigation project required a series of conditions and actions that were considered by the user as unjustified and discriminatory. The official water use application required a detailed study of the irrigation zone, where no urban supply wells exits. The water use permit also requires a complete annual analysis of reclaimed water, similar to that applied to drinking water and valued at 800-1000 euros, plus a systematic series of microbiological parameters similar to those conducted at the reclamation plant. The question raised at that point is the justification of the need to duplicate the analyses that are conducted at the reclamation facility, particularly considering that there is no evidence that those contaminants may develop during water transport to the storage pond. Furthermore, the agricultural user is required to determine the residual chlorine concentration and the faecal coliforms concentration in the agricultural storage pond. Those analyses are performed by the water reclamation agency, at an estimated cost of 300 euros/year.

The Mas Pijoan ranch has officially requested a waiver to that large series of analyses, based on its unjustified nature (an extreme application of the precautionary principle to the water quality achieved at the reclamation plant) and its discriminatory character. A much larger flows of reclaimed water are discharged into the Ridaura River, downstream of the reclamation plant, where they infiltrate into surrounding groundwater basins regularly used as a source for urban water supply, and no such series of analyses are required by regulatory agencies. All those regulatory requirements are perceived as clear impediments for an optimal advancement of planned water reuse.

In spite of all those concerns, agricultural irrigation at the Mas Pijoan farm is considered a successful case study both by the user and the Consorci de la Costa Brava, and has provided extensive

practical experience on how to apply water reuse as an element of integrated water resources management.

Economic Indicators

The investment required for the conveyance and storage of the 125,000 m^3 of reclaimed water (variable volume, depending on climatic conditions) used for irrigation of the 40 ha corn field (only 25 ha are irrigated with reclaimed water) amounts to 170.000 euros, of which 100,000 were covered by a governmental grant. Reclaimed water price set by Consorcio de la Costa Brava was 0.084 euros/m^3. Reclaimed water analyses represent an additional expense close to 1000 euros annually.

Based on that information, the following economic indicators can be estimated for the Mas Pijoan water reclamation and reuse project for agricultural irrigation:

1. Reclamation
   Reclaimed water index: 0.084 euros/m^3 used (2005).

   Analytical expenses: 1,000 euros/year

2. Reuse
   Reuse investment index: 0.76 euros/m^3 annually used (2005).

Summary

The Mas Pijoan ranch is quite satisfied with the possibility of using reclaimed water for agricultural irrigation, is proud of the way reclaimed water and nutrients are used for this beneficial use, is convinced that regulatory requirements should be justified and balanced, and believes that planned water reuse is an opportunity for the future, and a basic element of integrated water resources management.

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Edited by

Rafael Mujeriego, PhD
Prof. of Environmental Engineering
Universidad Politécnica de Cataluña

ETS de Ingenieros de Caminos
Jordi Girona, 1-3, Building D1
08034 Barcelona, Spain

rafael.mujeriego@upc.edu