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A case study of urban wastewater reclamation in Spain: comparison of water quality produced by using alternative processes and related costs

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Corresponding Author:	Arturo Trapote University Institute of Water and Environmental Sciences, University of Alicante, Campus de San Vicente del Raspeig, Ap. 99, 03080, Alicante, Spain. Tel: (+34) 965 90 3400, ext. 2084; Fax: (+34) 965 90 9418. SPAIN
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	University Institute of Water and Environmental Sciences, University of Alicante, Campus de San Vicente del Raspeig, Ap. 99, 03080, Alicante, Spain. Tel: (+34) 965 90 3400, ext. 2084; Fax: (+34) 965 90 9418.
Corresponding Author's Secondary Institution:	
First Author:	Joaquín Melgarejo
First Author Secondary Information:	
Order of Authors:	Joaquín Melgarejo
	Daniel Prats
	Andrés Molina
	Arturo Trapote
Order of Authors Secondary Information:	
Abstract:	In Spain, and particularly in the Valencia Region, the scarcity of water resources means that water resource exploitation must be optimized. In this light, reusing the large amounts of treated wastewater is top priority, especially in agriculture, urban use and the irrigation of golf courses. "Rincón de León" Wastewater Treatment Plant-Water Reclamation Plant (Alicante, Spain) supplies reclaimed flow to a number of users according to the guidelines stated in Royal Decree 1620/2007. Reclamation treatment includes: coagulation+flocculation+filtration (sand bed), ultrafiltration, UV disinfection and desalination (reverse osmosis). By combining these processes, three tertiary treatment alternatives were configured, and for each of them the quality of effluents, treatment costs, energy consumption and the uses of treated water were analysed. The results show that the quality of the water treated using the three alternatives is suitable for different uses. Moreover, the costs resulting from the tertiary treatment processes, their energy consumption and the final price of the treated water paid by farmers have been obtained.

A case study of urban wastewater reclamation in Spain: comparison of water quality produced by using alternative processes and related costs

Joaquín Melgarejo, Daniel Prats, Andrés Molina and Arturo Trapote (corresponding author. E-mail: *atj@ua.es*)

University Institute of Water and Environmental Sciences, University of Alicante, Campus de San Vicente del Raspeig, Ap. 99, 03080, Alicante, Spain. Tel: (+34) 965 90 3400, ext. 2084; Fax: (+34) 965 90 9418.

ABSTRACT

In Spain, and particularly in the Valencia Region, the scarcity of water resources means that water resource exploitation must be optimized. In this light, reusing the large amounts of treated wastewater is top priority, especially in agriculture, urban use and the irrigation of golf courses. "Rincón de León" Wastewater Treatment Plant-Water Reclamation Plant (Alicante, Spain) supplies reclaimed flow to a number of users according to the guidelines stated in Royal Decree 1620/2007. Reclamation treatment includes: coagulation+flocculation+filtration (sand bed), ultrafiltration, UV disinfection and desalination (reverse osmosis). By combining these processes, three tertiary treatment alternatives were configured, and for each of them the quality of effluents, treatment costs, energy consumption and the uses of treated water were analysed. The results show that the quality of the water treated using the three alternatives is suitable for different uses. Moreover, the costs resulting from the tertiary treatment processes, their energy consumption and the final price of the treated water paid by farmers have been obtained.

Key words: agricultural irrigation, costs and energy consumption, desalinated wastewater, reclamation and reuse, tertiary treatment.

INTRODUCTION

The reuse of reclaimed wastewater in Mediterranean European countries is of increasing potential. Spain, in particular, shows the highest projected reuse potential with the likelihood of it being three to six times higher than in 2005 (Angelakis & Durham 2008; Bixio et al. 2006; Hochstrat et al. 2005; Hochstrat et al. 2005; Iglesias et al. 2010). In Spain, the reuse of wastewater is carried out mainly at the Mediterranean coast and the Islands. Valencia and

Murcia reuse 57% of all the treated wastewater while the Islands (Canaries and Balearic) reuse 23% (Iglesias et al. 2010; Downward & Taylor 2007; Pedrero et al. 2010).

The growth in water reuse presents challenges as a result of inefficiencies in the legal framework. So far, there are no common supra-national regulations on water reuse in Europe. The Spanish legal framework dates back to 2007. Royal Decree 1620/2007 sets out the legal framework governing this field, including authorized and prohibited uses, as well as the quality conditions required for each use.

Notwithstanding, it is necessary to conduct a thorough analysis comparing the social and financial costs and benefits involved in water reuse (Molinos-Senante et al. 2010; Wade Miller 2006). This should, of course, be a comprehensive study not only of the inherent costs of the activity, but of the intrinsic social and environmental outputs and opportunity costs (Hernández et al. 2006). Moreover, the rise in energy costs is one of the greatest concerns meaning that more energy efficient technologies are paramount (Bixio et al. 2008; Salgot 2008).

Among numerous treatment technologies, membrane processes are considered to be the most advanced for wastewater reclamation, of which there are a number of prominent schemes world-wide (Wintgens et al. 2005). There are many publications on the use of membrane bioreactors and membrane applications as prior tertiary treatment for the reuse of wastewater (Cartagena et al. 2013; Lin et al. 2012; Raffin et al. 2013; Santos et al. 2011; Guo et al. 2014; Young 2014; Roccaro 2013). However, very few give information about full-scale facilities that integrate the use of activated sludge (organic matter removal) with micro- or ultrafiltration membranes (disinfection, turbidity and micropollutants removal) as well as reverse osmosis (salinity removal) (Al-Rifai et al. 2011; García et al. 2013).

Treated wastewater is most widely used for irrigation. In the final report on waste water reuse prepared by EMWIS within the Euro-Mediterranean Information System on know-how in the Water sector (http://www.emwis.org/topics/WaterReuse/Final_report.doc) it is stated that: "*The total volume of reused treated wastewater in Europe is 964 Mm³/yr, which accounts for 2.4% of the treated effluent. Spain accounts for largest proportion of this (347 Mm³/yr); Italy uses another 233 Mm³/yr. In both countries, agriculture absorbs most of the treated wastewater*".

State policies in watershed planning (Júcar River Basin Plan: http://www.boe.es/boe/dias/2014/07/12/pdfs/BOE-A-2014-7371.pdf), as well as other regional policies (Master Plan of Sanitation and Purification: www.docv.gva.es/datos/2003/10/08/pdf/2003_10716.pdf), are currently favouring water reuse as a key solution to water stress issues. "Rincón de León" Wastewater Treatment Plant-Water Reclamation Plant (WWTP-WRP) and the corresponding management model discussed in this article are part of this strategy.

This paper presents a real case of desalinated wastewater reuse, carried out in the "Rincón de León" WWTP-WRP, in Alicante (Valencia Region, Spain). The objectives of the work are, on the one hand, to analyze different alternatives of tertiary treatment for wastewater reuse and, on the other hand, to define treatment costs, energy consumption and the cost recovery results.

Tertiary treatments studied include various combinations of coagulation+flocculation+filtration (CFF), ultrafiltration (UF), ultraviolet radiation disinfection (UV) and desalination by reverse osmosis (RO).

SCENARIO ANALYSIS

“Rincón de León” Wastewater Treatment Plant-Water Reclamation Plant

"Rincón de León" Wastewater Treatment Plant-Water Reclamation Plant (WWTP-WRP) (38° 20' 7'' N, -0° 31' 26'' E) is one of the three treatment facilities operating in the city of Alicante (38° 20′ 43″ N, 0° 28′ 52″ W) and nearby municipalities (Fig. 1). The plant is designed to treat 75,000 m^3/d. The operator is EMARASA (Joint Venture Corporation for Wastewater Treatment in Alicante). During 2012 it treated an average flow of 52,644 m^3/d (EPSAR 2012).

Figure 1. “Rincón de León” WWTP-WRP (EPSAR)

The wastewater treatment includes (Fig. 2): pretreatment (screening, grit and removal, and flow equalization), primary treatment (settling), secondary treatment (activated sludge), tertiary treatment (ultrafiltration and reverse osmosis), sludge treatment (thickened, anaerobic digestion, centrifugation, and sludge storage), and cogeneration (combustion of biogas engines to obtain electricity and heat recovery).

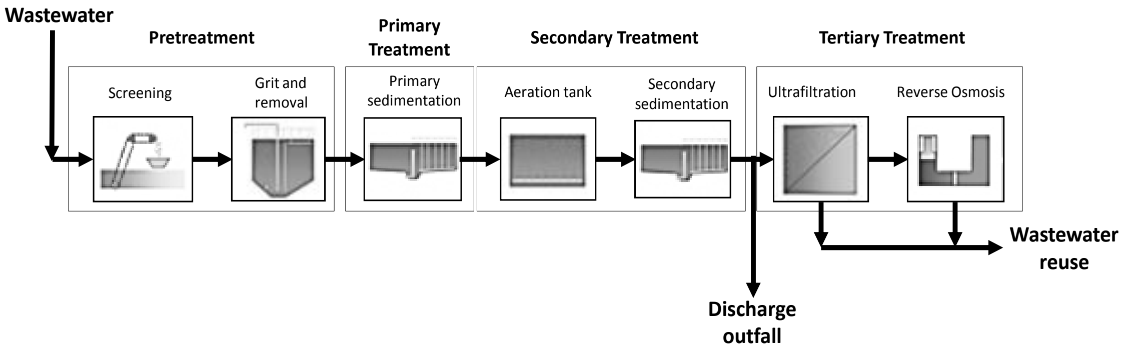

Figure 2. Schematic flow diagram of "Rincón de León" WWTP-WRP (water train)

Treated wastewater uses

So far, no regulation of wastewater reuse has been passed in the E.U. Section 12 of the European Wastewater Directive 91/271/EEC (EU, 1991) only states that: "*Treated wastewater shall be reused whenever appropriate*". In Spain, wastewater reuse was first regulated by an amendment in the Water Act (BOE 2001), and was fully regulated by Royal Decree 1620/2007 (BOE, 2007). According to this legal framework, the quality criteria for reused water distinguishes 14 different patterns of use classified under five headings: 1) Urban, 2) Agricultural Irrigation, 3) Industrial, 4) Recreational and 5) Environmental.

Effluent from "Rincón de León" WWTP-WRP is used for urban, agricultural and recreational uses. Common quality criteria for these uses are shown in Table 1.

Table 1. Quality criteria for water reuse (Royal Decree 1620/2007). Maximum values permitted for urban, agricultural and recreational uses

Use	**Suspended Solids (**mg/L)	**Turbidity (**NTU)	***E. coli* (**cfu/100 mL)	**Intestinal nematode eggs**
URBAN USES				
Quality 1.1 Residential: a) Private garden watering b) Discharge from sanitary appliances	10	2	0	1 egg/10L
Quality 1.2 Urban services: a) Watering of urban green areas (parks, sports grounds, etc.) b) Hosing down streets. c) Fire-fighting systems d) Industrial car wash	20	10	200	1 egg/10L
AGRICULTURAL USES				
Quality 2.1 a) Irrigation of fresh food crops for human consumption, through water application systems allowing for direct contact of regenerated water with edible parts	20	10	100	1 egg/10 L
Quality 2.2 a) Irrigation of crops for human consumption, through water application systems without	35	No limit set	1,000	1 egg/10L

avoiding direct contact of regenerated water with edible parts, but not for consumption as fresh food since there is subsequent industrial treatment b) Irrigation of pastureland for milk or meat-producing animals c) Aquiculture				
Quality 2.3 a) Localized irrigation of ligneous crops impeding contact of regenerated water with food for human consumption b) Irrigation of ornamental flowers, greenhouses and nurseries with no direct contact of regenerated water with crops c) Irrigation of industrial crops, greenhouses, fodders stored in silos, cereals and oleaginous seeds	35	No limit set	10,000	1 egg/10 L
4. RECREATIONAL USES				
Quality 4.1 a) Irrigation of golf courses	20	10	200	1 egg/10 L

The key users of the effluent at "Rincón de León" WWTP-WRP are Alicante Irrigation Association (AGRICOOP) and High Vinalopó Irrigation Association (ARALVI). Part of the reclaimed water also irrigates the median strip of a highway and a public park (1,000 m^3/d, Alicante Palm Tree Grove Park). Other users are members of the *Monforte del Cid* Irrigation Association; they use a mixture of wastewater (35%-40%) and fresh water (part of the treated wastewater comes from WWTP-Elda). Irrigation Associations hold concessions allowing them to reuse wastewater granted by the Watershed Authority.

AGRICOOP was founded as an irrigation association in early 1996. This association uses treated wastewater for agricultural irrigation as well as for watering a golf course. The total area of irrigated land reaches 1,104 ha. The prevailing irrigation system today is drip irrigation. The main crops are: almonds (530 ha), citrus fruits (94 ha), tomatoes (450 ha) and pomegranate and olive trees (30 ha). *El Plantío* golf course is 800,000 m^2. The field requires spray irrigation while the trees are drip irrigated.

ARALVI spans a number of municipalities (San Vicente del Raspeig, Mutxamel, Alcoraya, Rebolledo, Bacarot) and it also waters a golf course. The irrigated agricultural area spreads over 2,040 ha. The main crops are almonds (70%), grapes (8%), nectarines (5%), oranges (2%) and olives (1%). The remaining 15% of the land is not currently being farmed. The soil has low organic matter content, which facilitates controlling the risk of salinization and alkalinization. *Alenda Golf Course* has a total area of 1,331,617 m^2. In summer it requires 1,500 m^3/d of water.

Reused flows by ARALVI and AGRICOOP in 2012 were, respectively, 3,063,033 m^3/yr and 3,467,035 m^3/yr (889,728 m^3/yr from water tank 1 + 2,577,307 m^3/yr from water tank 2), which represents a total of 6,530,068 m^3/yr. Fig. 3 shows the monthly evolution of reused flows during 2012.

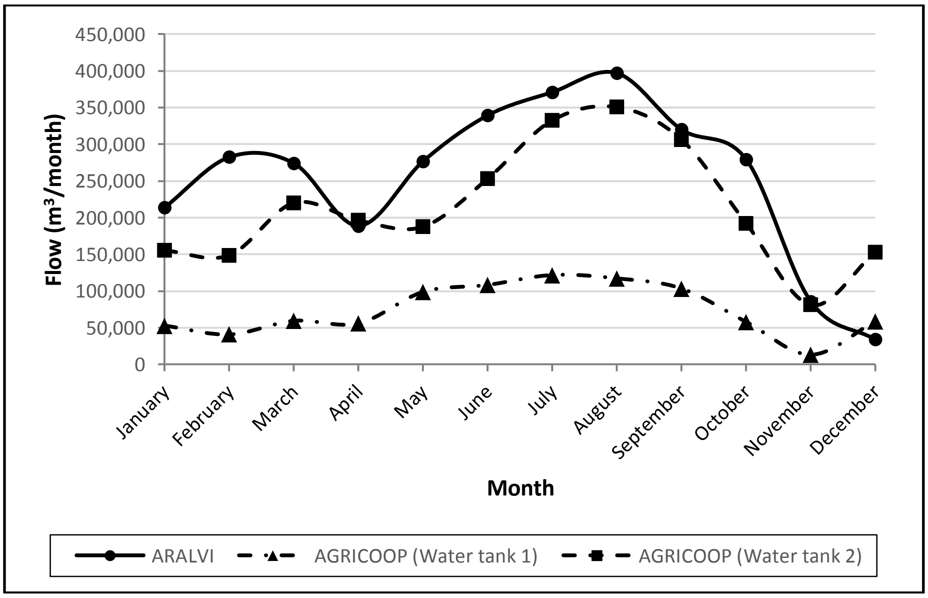

Figure 3. Monthly evolution of reused flows during 2012 (data provided by ARALVI and AGRICOOP)

It can be seen that the summer months are those with the highest demand for water reuse, while in winter demands significantly decrease. As there is not enough storage capacity to keep a fixed pattern in the production of treated water throughout the year, tertiary treatment processes experience frequent stops. This leads to increasing maintenance costs in tertiary treatment facilities.

Tertiary treatment options

Tertiary treatment aims to achieve the quality required for reuse (BOE 2007: Royal Decree 1620/2007). Current treatment got underway in summer 2006, with ultrafiltration (UF) and reverse osmosis (RO). In 2010, operations incorporated an equalization tank, a coagulation+flocculation+filtration stage (CFF) and ultraviolet radiation disinfection (UV).

The various uses of treated water demand different water qualities. The corresponding qualities are obtained by mixing treated water from three treatment options:

- Alternative A. Tertiary treatment is initiated in the homogenization tank (8,500 m^3), which homogenizes the changes in influent quality. Water is pumped to two rapid mixing chambers where ferric chloride is dosed as coagulant (thereby improving the subsequent filtration and removing some of the dissolved phosphorus in water). The flocculated water is led to a filtration process. There are 6 filtration lines, each one with a capacity of 10,000 m^3/d (each line has 10 silica sand filters, a grain size of 1-2 mm, and a filtration rate of 7.88 m/h). Conversion in the filtration process is 93%. Part of the filtered water (up to 8,000 m^3/d) is led to an ultraviolet process, UV disinfection, and then to a mixing receptacle where it mixes with ultrafiltered water.
- Alternative B. The remaining filtered wastewater is led to three self-cleaning 500 µm filters (to protect UF membranes). Then water is ultrafiltered in 6 parallel channels with 6 modules, each with UF submersible hollow fiber membranes (57 Zenon

ultrafiltration modules ZeeWeed model 1000 V3). The specific rate of operation is 20.55 L/m^{2}h, with a yield of 90% filtration. The maximum ultrafiltered water flow is 42,063 m^3/d. Part of the treated effluent is mixed with water resulting from filtration and is supplied to irrigators.

- Alternative C. UF water is led to five 5 µm filter cartridges (to protect the RO membranes). Reverse osmosis is performed in a facility configured as a double desalination stage (with booster pump between stages) reaching 73% conversion. It has 5 racks, quantifying 2016 membranes (most Dow Chemical model DOW FILMTEC(TM) BW30XFR-400/34i) with a total filtration area of 69,955 m^2. A maximum flow of 25,675 m^3/d of desalinated water with a conductivity of 100 µS/cm can be achieved. The osmotic water is also supplied to irrigators.

Osmotic and ultrafiltered water flows are driven to a distribution and regulation chamber. The flow of each type of water is regulated according to the conductivity conditions demanded by irrigators. Pipelines of 630 and 350 mm in diameter are used to respectively carry ultrafiltered water and osmotic water to several deposits owned by the irrigators.

In Fig. 4, tertiary treatment as well as the three treatment alternatives are schematically shown.

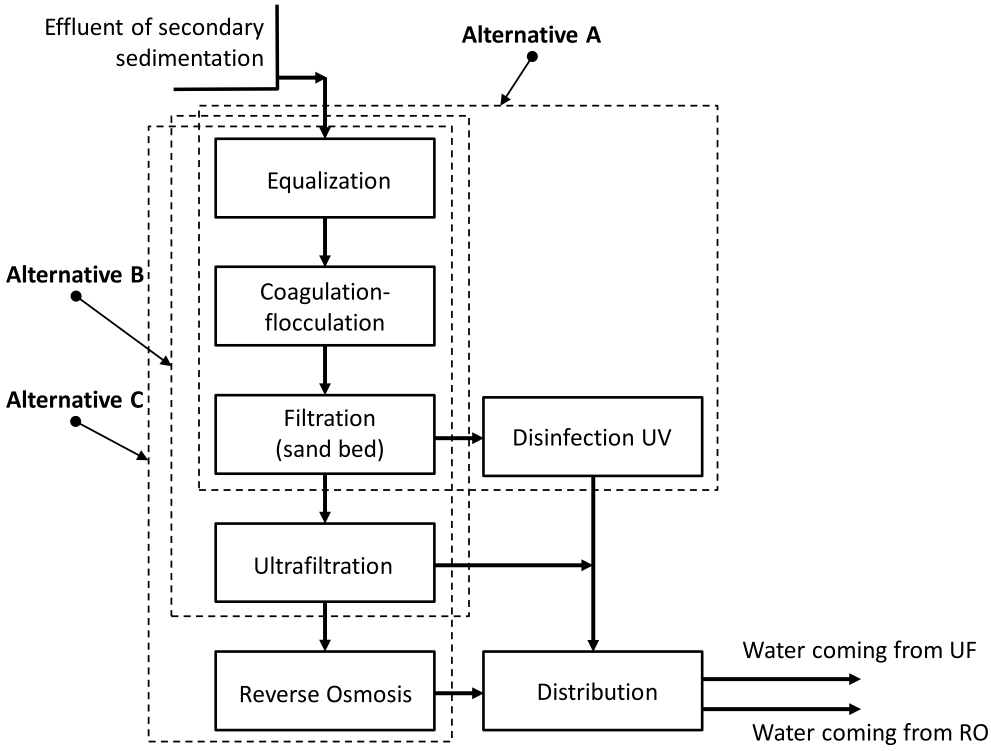

Figure 4. Alternatives of tertiary treatment

RESULTS AND DISCUSSION

Reclaimed water quality and performance of the different treatment alternatives

Tables 2, 3, 4 and 5 respectively show water quality parameters from the secondary sedimentation, and from ultraviolet disinfection (UV) (alternative A), UF (alternative B) and RO (alternative C), corresponding to the monthly average data of 2012. For each parameter the average, minimum, maximum and standard deviation is indicated. These values were obtained by statistical analysis of the monthly average values supplied by EMARASA (Joint Venture Corporation for Wastewater Treatment in Alicante) (Ordóñez 2013).

Table 2. Quality water from the secondary sedimentation of the "Rincón de León" WWTP (compilation using data provided by EMARASA)

Parameter	Mean	Minimum value	Maximum value	Standard deviation
pH	7.43	7.26	7.52	0.07
Suspended Solids, SS (mg/L)	17.0	11.3	23.8	3.8
Conductivity 20ºC (µS/cm)	2,338	2,065	2,542	161
Turbidity (NTU)	4.80	3.18	6.57	1.16
Chemical Oxygen Demand, COD (mg/L)	52.4	42.9	63.8	7.0
Biochemical Oxygen Demand, BOD (mg/L)	12.7	4.0	22.0	5.1
Total Nitrogen, (mg/L)	39.9	29.5	45.5	4.7
Total Phosphorus (mg/L)	4.6	2.3	6.1	1.1
Chlorides (mg/L)	512	480	588	49
E. coli (cfu/100mL)	1.8 exp+5	2.1 exp+4	4.0 exp+5	1.4 exp+5

Table 3. Disinfection effluent quality (alternative treatment A = CFF + UV) (compilation using data provided by EMARASA)

Parameter	Mean	Minimum value	Maximum value	Standard deviation
pH	7.33	7.11	7.49	0.11
SS (mg/L)	11.3	8.3	15.7	2.30
Conductivity 20ºC (µS/cm)	-	-	-	-
Turbidity (NTU)	3.20	1.92	5.11	0.98
COD (mg/L)	41.9	33.6	51.5	5.72
BOD (mg/L)	6.9	3.0	10.0	2.71
Total nitrogen (mg/L)	37.0	26.5	43.5	5.55
Total phosphorus (mg/L)	4.04	2.00	5.35	1.00
E. coli (cfu/100mL)	73.5	6.25	138.5	42.00
Legionella spp. (cfu/100mL)	0	0	0	0

Table 4. Ultrafiltration effluent (alternative treatment B = CFF + UF) (compilation using data provided by EMARASA)

Parameter	Mean	Minimum value	Maximum value	Standard deviation
pH	7.37	7.19	7.48	0.09
SS (mg/L)	0.91	0.31	2.39	0.72
Conductivity 20ºC (µS/cm)	2,311	1,920	2,487	187.79
Turbidity (NTU)	0.43	0.33	0.50	0.06
COD (mg/L)	27.1	23.5	29.8	2.27
BOD (mg/L)	3.08	1.00	7.00	1,93
Total nitrogen (mg/L)	35.0	20.5	45.0	6.89
Total phosphorus (mg/L)	3.54	1.70	4.95	1.03
Chlorides (mg/L)	499	387	571	44.32
E. coli (cfu/100mL)	33.74	6.75	54.25	16.24
Intestinal nematodes (eggs/L)	0	0	0	0

Table 5. Reverse osmosis effluent (alternative treatment C = CFF + UF + RO) (compilation using data provided by EMARASA)

Parameter	Mean	Minimum value	Maximum value	Standard deviation
pH	6.65	6.33	6.86	0.19
SS (mg/L)	0.33	0.00	2.10	0.63
Conductivity 20ºC (µS/cm)	57.09	39.32	76.57	13.22
Turbidity (NTU)	0.20	0.15	0.24	0.03
COD (mg/L)	3.43	0.80	7.30	1.75
BOD (mg/L)	0.92	0.00	2.00	0.51
Total nitrogen (mg/L)	3.60	1.75	8.60	2.25
Total phosphorus (mg/L)	0.20	0.00	0.55	0.16
Chlorides (mg/L)	15.6	11.5	22.7	3.67
E. coli (UFC/100 mL)	0	0	0	0
Intestinal nematodes (eggs/L)	0	0	0	0
Legionella spp. (cfu/100 mL)	0	0	0	0

Comparing the average values of the various flows, Table 6 shows the operational performance of some parameters with the different treatments.

Table 6. Performance of the different treatments (% elimination efficiency)

Parameter	Alternative A	Alternative B	Alternative C
SS	33.5	94.6	98.1
Conductivity 20ºC (µS/cm)	-	1.16	97.6
Turbidity	33.3	91.0	95.8
COD	20.0	48.2	93.5
BOD	45.7	75.7	92.8
Total N	7.2	12.3	91.0
Total P	12.2	23.0	95.6
Chlorides	-	2.5	97.0
E. coli	99.96	99.98	100

As can be observed, with alternative A, *E. coli* bacteria is almost completely eliminated. In addition, SS, BOD and turbidity are significantly reduced. COD and phosphorus concentrations are also partially reduced. Total nitrogen is reduced to a very small proportion. With alternative B, *E. coli* is also almost completely eliminated, whereas turbidity and SS decrease by more than 90%. A very high proportion of BOD is also reduced, with COD reducing to a lesser extent. Phosphorus and nitrogen are reduced in smaller proportions. With alternative C, *E. coli* is removed entirely while removal for the other parameters was over 90%.

Production costs of reclaimed water

The construction cost of reclamation facilities amounted to a total of €20,676,893, of which €15,800,878 corresponded to the initial installation (2006): ultrafiltration and reverse osmosis (€10,970,550 on equipment + €4,830,328 on civil works), and the remaining €4,876,015 on the extension (2010): equalization tank, coagulation+flocculation+filtration and ultraviolet radiation disinfection (€3,657,011 on equipment + €1,219,004 on civil works).

According to information provided by CADAGUA (the company that managed the tertiary treatment from the start of the operations in 2007 until February 2012) the most relevant operating costs are electricity, staff and reactants, in that order. Staff costs cannot be segregated for the different treatments. With regards to the other two concepts, it is possible to estimate the corresponding costs according to the following approximate distribution of the effluent flow in 2011: coagulation+flocculation+filtration (CFF) = 13,000,000 m^3/yr, disinfection (UV) = 2,900,000 m^3/yr, ultrafiltration (UF) = 9,100,000 m^3/yr and reverse osmosis (RO) = 3,500,000 m^3/yr. The cost distribution of energy and reactants is shown in Fig. 5.

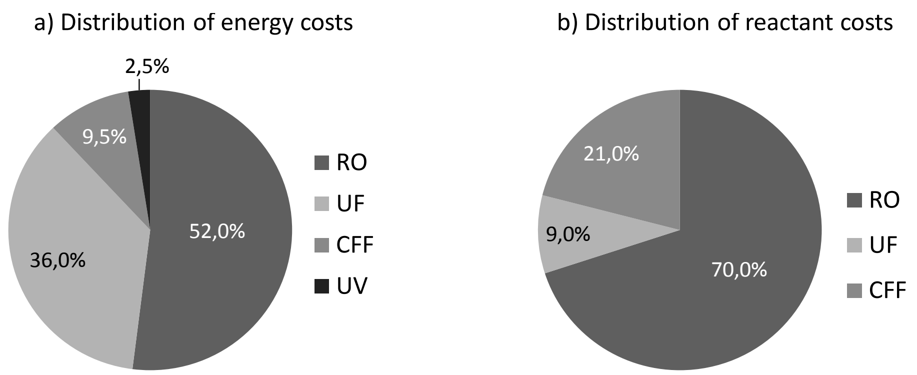

Figure 5. Distribution costs of energy and reactants

The average energy consumption for each unit of treatment is as follows: CFF = 0.047 kWh/m^3, UV = 0.056 kWh/m^3, UF and RO = 0.236 and 0.869 kWh/m^3, respectively. Maintenance costs, overheads and business profit must be added on. As a result, the final average operation cost, taking only variable costs into account, of the effluents from each unit of treatment is: CFF = €0.0142/m^3, UV = €0.0067/m^3, UF = €0.0337/m^3 and RO = €0.2098/m^3.

Economic considerations and cost recovery

The reuse of treated water helps to increase the available amount of water resources at a relatively low marginal cost. In addition, it creates positive environmental outputs since there is no need to use fresh water. From an economic efficiency point of view, a key feature is that the treated effluent quality can be adapted to the users' needs. However, this flexibility can be lost in part when the number of users and destinations increases. In addition, destinations for treated wastewater being closer to each other immediately leads to relevant savings in infrastructure and transport costs (Hermanowicz et al. 2001). For "Rincón de León" WWTP-WRP, effluent quality at an affordable price is achieved by mixing water of three different qualities and therefore three different production costs. This is a good strategy for optimizing production as long as the quality required is variable.

However, operation is strongly related to demands. Demands are communicated at short notice. Therefore, there are frequent stops and starts in operation, which makes it more expensive (it leads to damaged membranes and increased quantities of reactant for cleaning, etc.). Users would be well advised to plan their long-term needs and increase their storage structures to allow the plant to operate on a more regular basis.

The principle of cost recovery was established in the Water Framework Directive EC (WFD) (Directive 2000/60/EC). Its implementation must be applied throughout although socio-economic or physical circumstances (geographical, environmental and climatic) could mean exemptions or limit its enforcement. The water user must bear the full cost of water production, transport and distribution. Cost recovery also concerns tertiary treatment including desalination. It was introduced into the Spanish legal system by means of an amendment to the 1985 Water Act, included Act 62/2003 (BOE 2003).

Operation costs before tertiary treatment are charged to every user of the urban water supply. For this purpose, Wastewater Treatment Regional Act 2/1992 (DOGV 1992) established a particular tax in the Valencia Region. This tax is calculated according to the total operational cost for primary and secondary treatment. Urban users must pay in accordance with the quantity of municipal water they use. It is legally assumed that every water consumer generates pollution, and hence the tax is objectively estimated and imposed on all users regardless of the actual pollution loads. The tax is included as part of the water bill together with the sewage tax and the water supply tariff. This ensures almost 100% of the revenue.

Another relevant factor to consider is the payment that the user of treated waters has to pay to be able to benefit from it. According to the agreements between EPSAR and the Irrigation Associations, the latter are responsible for transporting water to its destination. In 2011, a tariff of €0.124/m^3 for water resulting from the mixture of UV + UF processes (alternative 1 + alternative 2) was agreed with ARALVI, and €0.165/m^3 for water resulting from UF + RO processes (alternative 3). Sale prices are updated in accordance with the consumer price index (CPI). In 2013, the price of desalinated water was €0.19/m^3. However, including energy, staff, transportation and infrastructure costs (€0.17/m^3), ARALVI farmers are charged a total price of €0.36 /m^3.

AGRICOOP users pay €0.28/m^3 on average for drip irrigated land (60% of the total irrigated land) and €0.23/m^3 for flood irrigated land (40%).

The price is affordable for farmers, even though they have to pay a substantially higher amount than the average charged for surface water or groundwater for agricultural use in Spain. Water stress makes cheaper water resources unavailable and therefore makes wastewater reuse financially sustainable and its prices acceptable for users. Given that the cost of tertiary treatment, transportation and distribution is directly charged to the farmers, it can be assumed that the system meets all the requirements of the WFD full recovery cost principle. Costs of wastewater treatment prior to tertiary treatment are obviously charged to urban consumers, who are in fact the pollutant agents.

CONCLUSIONS

Tertiary treatment in “Rincon de León” WWTP-WRP comprises three alternatives: alternative A = CFF + UV, alternative B = CFF + UF, and alternative C = CFF + UF + RO. Treated water is used for urban uses, agricultural irrigation and golf course irrigation. With reference to the parameters considered in Spanish Law (Royal Decree 1620/2007), the results allow us to conclude that the quality of water treated with alternative C is suitable for all uses referred to in this study, i.e., urban uses (residential and urban services), agricultural irrigation (all agricultural uses) and golf course irrigation (recreational use). On the other hand, water treated with alternative B is suitable for all applications except for residential, while water treated with alternative A is suitable for all uses except for residential and irrigation of fresh food for human consumption. Nevertheless, drinking water use is strictly forbidden under Spanish Law.

Regarding to energy consumption, the unitary process that requires more energy is reverse osmosis (0.869 kWh/m^3). It represents more than triple than ultrafiltration (0.236 kWh/m^3), which is the second largest consumer. The coagulation+flocculation+filtration is the unitary process that demands less power (0.047 kWh/m^3).

In terms of variable production costs (2012), reverse osmosis process is the highest (€0.2098/m^3), around 600% higher than the second more expensive process, which is ultrafiltration (€0.0337/m^3). Disinfection UV is the lower cost unitary process (€0.0067/m^3).

The price finally charged to ARALVI farmers in 2013, including the cost of reclaimed desalinated water (€0.19/m^3), as well as energy, staff and infrastructure costs (€0.17/m^3), amounts to €0.36/m^3. The price finally charged to AGRICOOP farmers in 2013 amounts to €0.28/m^3 on average for drip irrigated land and €0.23/m^3 for flood irrigated land.

The total volume of reused water supplied from “Rincon de León” WWTP-WRP in 2012, for agriculture and golf course irrigation, exceeded 6 million cubic metres.

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