EVALUATING RECLAIMED WATER REUSE PROJECTS IN RURAL SEMI-ARID AREAS

Antonio Bolinches1,2 Irene Blanco3,4,*, Sergio Zubelzu5, Paloma Esteve3,4, Almudena Gómez-Ramos6

1 General Foundation, Universidad Politécnica de Madrid, Calle Pastor 3, 28003 Madrid, Spain, antonio.bolinches@upm.es
2 Botín Foundation, Water Observatory, Calle de Castelló 18, 28001 Madrid, Spain
3 Department of Agricultural Economics, Statistics and Business Management, ETSIAAB, Universidad Politécnica de Madrid (UPM), Campus Ciudad Universitaria, Av. Puerta de Hierro 2-4, 28040 Madrid, Spain, irene.blanco@upm.es, paloma.esteve@upm.es
4 CEIGRAM, Universidad Politécnica de Madrid (UPM), Senda del Rey 13, 28040 Madrid, Spain
5 Department of Agroforestry Engineering, ETSIAAB, Universidad Politécnica de Madrid (UPM), Campus Ciudad Universitaria, Av. Puerta de Hierro 2-4, 28040 Madrid, Spain, sergio.zubelzu@upm.es
6 Department of Agricultural and Forestry Engineering. Universidad de Valladolid (UVA), Av. de Madrid 57, 34004 Palencia, Spain, mariaalmudena.gomez@uva.es

Corresponding author (irene.blanco@upm.es)

Abstract

Problem: Water reuse is a strategic priority for Water Authorities in Europe to reduce the pressure on water resources. Although major regulatory strides have been made to boost water reuse in the EU, only a small part of treated wastewater is currently reused. Recent research on the subject claims that, while technical barriers related to water reuse could largely be resolved (e.g., through adapted irrigation systems, improved storage, and treatment methods), social and economic issues (e.g., public acceptance and the cost of reclamation) may seriously condition the success of water reuse projects, and yet they are poorly investigated. In this context, there is a special interest to identify in which specific Wastewater Treatment Plants it would be interesting to add a Water Regeneration Plant, taking account of potential existing clients in the vicinity and the implied costs and benefits.

Methodology: In this paper we propose a methodology to estimate the costs of implementing a water reuse project (initial investment in the reuse plant and distribution network, operation and maintenance costs) using secondary data from official sources, then estimating the benefits of the additional productivity of the agricultural fields irrigated with the reused waters. This allows the organization of candidate reuse projects according to their cost and benefit ratio, supporting Water Authorities to prioritize projects with better prospects.

The proposed methodology streamlines the process through the minimization of the inputs (Wastewater treatment plant location and capacity, potential client's location and water use). The definition of the pipe distribution network is automated through the design of an algorithm based on Minimum Span Trees.

The flexibility of the methodology allows for the creation of different scenarios that facilitate the optimization of the process. In particular, the methodology allows for the quantification of the effects of the yearly regeneration period (whether the water regeneration plant works all year long or only in the irrigation months) and the choice of output water quality and process technologies.

The methodology is applied in the Upper Guadiana area in Central Spain, where overexploited aquifers can no longer provide for the water volumes required by agricultural users. Here, the regeneration of a portion of the wastewater generated by the urban agglomerations may alleviate the pressure on water resources.

Results: Taking account of the existing Wastewater Treatment Plants, candidate reuse projects are classified according to their benefit/cost ratio, showing large differences according to the location and potential use of the regenerated water.

Results show that prioritization is driven by the benefits obtained, rather than the cost structure that has minor differences between projects. The generation of net benefits is restricted to candidate projects where high benefit crops are present in the vicinity of the Wastewater Treatment Plant.

The regeneration plant initial investment and operation and maintenance costs represent the biggest portion of the overall costs. Expanding the water regeneration to all year would increase storage costs (larger tanks or ponds to accumulate the water in non-irrigation periods) and distribution network costs (longer and bigger pipes to reach additional water users), thus reducing the net benefit/cost ratio from a 31% to a 25%.

The results also show how critical on the benefit-cost structure is the decision of the quality of reused water. The choice of a less strict class within the options of Annex I of the European Regulation implies lower costs, but also restricts current and future uses of the reclaimed water. With the current cost structure, ultrafiltration technology is only competitive at very low interest rates.

Conclusion: The analysis allows for a quick assessment of the costs and benefits implied in different reuse projects and scenarios, providing science-based evidence to support water policy decisions.

Keywords

Wastewater reuse, Optimization, Irrigation network, Cost Benefit Analysis, Spain.

Funding

This work was supported by the Spanish Ministry of Science and Innovation- State Research Agency. Project R&D&i - Challenges 2019: The contribution of water REuse to a resourCe-efficient and sustainabLe wAter manageMent for irrigatiOn (RECLAMO) [grant number PID2019-104340RA-I00].