LEGISLATION AS AN ECONOMIC TOOL IN WASTEWATER REUSE

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ABSTRACT

1. Introduction

Wastewater reuse aims to increase the amount of water available for use in a region; in developed countries it is based on political will, acceptance of practice by end users and in general by society, and especially by regulations and recommendations in this regard. However, as in a number of activities, the success of the practice depends mainly on its economic viability, marked by the benefits that can be obtained by the availability of more water for the activities of the various sectors of the economic society. Assuming that the priority water use is tap water supply**,** the remaining uses are secondary; although the use for agriculture is legally prioritized over industrial and leisure uses.

From a legal point of view, it is mandatory that waters have adequate quality for its uses, marked by standards or recommendations and in recent years by good reuse practices. The latter may include HACCPs (Hazard Analysis and Critical Control Points) and SSPs (Sanitation Safety Plans) that do not actually have legal coverage, except for the political and sanitary willingness to minimize reuse risks. The fact that these initiatives departed from the World Health Organization (WHO) gives them an important strength (WHO, 2006; 2015).

In wastewater reuse, confluence between legislation and economy is essential for the success of the practice, although numerous additional conditions are compulsory and diverse uses can also be described. Table 1 applies to irrigation uses; other aspects must be added/removed for other various applications. For example, in cooling towers it is very important to perform a specific study of Legionella.

Reuse rules began with the 1918 California recommendations' (State of California, USA, 2009) and has been evolving with successive adaptations. Subsequently, developments from other international agencies and from different countries can be verified (Paranychiannakis et al, 2015). In the European Union, the common regulation on wastewater reuse is being developed, with several documents. These include the rules to be applied (EU 2020) which entered into force on 2023; and a draft on recommendations for the practical applications (2023), still under development. In the European Union, some legal pieces must be implemented without any delay all over the Union, which is the case for the 2023 rules, and the different countries can only define stricter or complementary legal pieces.

2. Legislative aspects

As the UN specifies in its 2017 World Water Development Report: "Global policy frameworks for wastewater include the 2030 Agenda, which builds on other global policy instruments for water, environment and development aspects as well as prevention, precautionary and polluter pays' principles. "Global recognition of the human right to water and sanitation also has implications for wastewater policy, urging Member States to adopt policies to increase access to sanitation and ensure that water resources are protected from pollution" (WWAP, 2017).

The table 1 reflects the actors and functions to manage wastewater reuse. There, you can see the variety of agents participating in the process, as well as the diversity of functions and areas related to it. The shading that appears refers to the typical level of responsibility: darker = more important, lighter = less involved.

The legal needs differ among countries and the economic aspects are inseparable from the health reality of each country. The availability of economic funds to operate the treatment plants (mainly energy and personnel) also differ depending on the technologies used: hard or soft.

When dealing with rules and regulations, reference is mainly made to the recommendations of the WHO (2006, 2015), those of the state of California, USA (State of California 2009) or Australia, in the event that there are no national standards. As indicated, in the European Union, there is a strong movement to develop own rules, but, nevertheless the issued ones are not really appreciated by the experts and scientists in the Union.

Table 1. Actors, roles and functions to govern wastewater reuse

Functions \ Actors	Legislator/politician/ policy-maker	Regulators (environment, health, economic)	System owner (city, ministry, basin agency)
Law-making	Define and adopt laws through inclusive consultative process	Share expectations as to governance role	Share expectations as to governance role
Policy-making	Define and adopt policies to implement the law through inclusive consultative processes	Share information on current situation and policy preferences	Share information on current situation and policy preferences
Planning, coordination and budgeting	Define modalities for planning, coordination and budgeting	Share preferences through constructive participation	Lead consultations, define standards for service delivery; allocate and disburse budget
Financing wastewater management	Decide on subsidies and modalities for financing	Regulate tariffs and service quality	Strategic financial planning, decision on tariffs
Wastewater infrastructure development and operation of wastewater services and facilities	Guide standards/regulations for construction and operation of infrastructure	Regulate tariffs and service quality	Coordinate spatial planning, siting/zoning decisions; prepare call for tenders, depending on the type of services/goods
Regulation – monitoring and enforcement	Define regulatory framework	Implementation of regulatory framework (including collection of information from service providers and permit holders, ensuring compliance, inspections, etc.)	Report suspect actions
Redress mechanisms (including judiciary)	Define competent authorities for redress	Accountable or party to complaint	Accountable or party to complaint
Compliance and pollution prevention	Develop incentives for prevention and disincentives for pollution	Implement incentives (including monitoring and advocacy for pollution prevention and water-use efficiency)	Support implementation
Advocacy and communications	Define policy goals and defend space for communication	Advocacy for pollution prevention and water-use efficiency	Awareness-raising and information to the public; solicit compliant behaviours from industry and households
Capacity development	Defining policy goals for sector; and develop capacities	Monitor capacities and incentivize development	Support development
Research and innovation	Highlight research needs, ensure support to research and development (R&D)	Highlight research needs; incentivize R&D	Highlight research needs; guide and engage in R&D

*Shading relates to typical level of responsibility: darkest = leading, lightest = least involved

Source: WWAP, 2017

The need to increase available water resources and improve their quality is increasingly evident in many places around the world; with a strong relationship to the millennium development goals regarding water. This has led to diverse applications of reclaimed water being proposed in many countries, up to the point of using reclaimed water for drinking purposes, directly as is the case of Windhoek (Namibia) or Singapore (Voulvoulis, 2018), and also indirectly in many places around the most developed countries. Nevertheless, it has been typical to use untreated wastewater for irrigation and the typical example has been for many years the Mezquital site in Mexico (Caucci, S. & Hettiarachchi, H., 2017).

3. Economic aspects: their relationship with legislation

Economy has been and is an integral part of wastewater reclamation and reuse and is really difficult to separate from all the other circumstances of the practice. When wastewater discharge causes environmental damage, external costs (externalities) are generated and the potential benefits of direct reclaimed water use are lost. To guarantee the efficient management of any reclaimed water project, it is essential to quantify its possible consequences or externalities. For example, in a reuse project the following positive externalities should be considered: increase in the availability of water, decrease in the use of fertilizers, and more revenues to the farmers; among other. Negative externalities are essentially related to chemical and biological risks (Alfranca, 2016), as well as in some cases the ones derived from physical characteristics of the reclaimed water (e.g. salinity)

Along these lines, it should be noted that the United Nations in its Environment Program (UN, 2023) points out that if wastewater is recognized as an economic good, properly treated can have a positive value for both producers and consumers.

The relationship between legal and economic aspects in any water matter is clearly evidenced in the Water Framework Directive, since among its fundamental concepts is cost recovery. This principle implies that when calculating the costs and benefits related to water reuse, not only financial costs should be considered, but also environmental costs and benefits. The incorporation of environmental costs and benefits introduces complexity in

the analysis, considering that frequently there is no market for these goods, and therefore they cannot be assigned a price, making it necessary to apply environmental valuation techniques.

In the context of water resources management, a series of methodologies are applied to support the decision-making process. One of the most widely accepted methods is Cost-Benefit Analysis (CBA). It is evident that the realization of a CBA requires benefits and costs to be expressed in the same units. However, when a project is analyzed in terms of environmental aspects, the benefits are generally measured in different physical units, while the costs are measured in monetary units. Hence, CBA requires monetary valuation as a method of homogenizing the units of measurement for further valuation.

In this sense, various methodologies have been developed, with the basis of the economic theory for the quantification and internalization of environmental externalities derived from investment projects. In the field of water resources, the specialized literature states that, in the majority of applications, the quantification of these externalities has been carried out using the contingent valuation method. However, although many authors consider this method as a consolidated technique because it is supported by numerous practical applications, in the scientific community there is no unanimous consensus on the validity of this methodology as a tool for valuing environmental assets. This debate, together with the high monetary cost of this studies, has sparked a certain interest in the search for alternatives to contingent valuation in the environmental context, especially for water resources studies (Hernández et al. 2010).

Another example of the relationship between legal and economic aspects regarding water is the economic and agricultural policies of the EU, transferred to the regulations of the different member countries, from the Common Agricultural Policy (CAP) to the requirement to pay for all the costs associated with reclamation and reuse (Paranychiannakis et al, 2015). The financing of infrastructures and its maintenance are theoretically included in these considerations. The factors prior to reclamation and after the application of reclaimed water are included, but not additional advanced treatments to fulfil the regulations. Reference is made to other uses of reclaimed water.

Currently, reuse in Spain depends in part on what is established in the Royal Decree (RD) 1620/2007 and related documents (MMAMRM, 2010a, 2010b), in what depends on reclaimed water uses other than agriculture.

This RD distinguishes up to twelve types of quality grouped into the five regulated uses, namely: urban, agricultural, recreational, industrial and environmental; setting for each type of quality the maximum required values (UMA) for a series of parameters. By the end of November 2023, a project for a new Spanish Regulations appeared. This new rule is still waiting to be officially published before being applied.

In terms of agriculture, as per August 2024, the 2020/741 EU regulation which entered into force on June 23th, 2023, is governing agricultural reuse all over Europe and, of course, in Spain. Later on, appeared a communication draft of the European Commission (2022/C 298/01) in order to support the Regulation, also trying to correct some misunderstandings that appear there. In terms of economy, the application of legal aspects has a significant impact on costs, as per Table 2.

Table 2. Costs associated to reuse, after secondary treatment

Part of the project	**Costs' items**	**Controls**	**Comments**
Classical wastewater treatment	Operation and Maintenance	Performance; Quality	Paid by the water administration
Implementation of reclamation technologies	Project; Building; Equipment	Construction quality	Paid by the administration or the end-user
Operation & Maintenance	Energy & maintenance	Performance End quality	Paid by the contractor, the end-user, or users' association
Distribution systems			
Storage	Maintenance, including control of fauna and flora	Changes of quality over time and place	
End-user management	Quality maintenance		
Communication & Research	To be established case by case	Acceptance of the project	Formation and information

In all cases it is necessary to include impact of subventions on the economy of the project, and the practical implementation of rules and regulations has a significant impact on costs. In fact, the conveyance and treatment of wastewater to the secondary outlet are paid for by the initial user of the water or the administration in charge of the project. From here a range of possibilities opens up in this economic aspect, and consequently the cost calculations are not as simple as they might initially seem.

Firstly, reuse implies that the water does not return directly to the environment, but rather passes to other matrices, usually with additional treatment in most cases. The most common consideration at this point is that the end-user of the reclaimed water has to pay for this treatment and for any subsequent investment, management or treatment, including analytics and data interpretation. Alternatively, there is the possibility to obtain subventions for all or part of the processes and procedures, including the final use.

On the other hand, by limiting/reducing discharges into bodies of water, negative impacts may arise due to reduced flows, even if the quality improves. The problem, as in other circumstances, is how to quantify this apparent contradiction.

Secondly, if water is considered a substitute resource, a part of the first-hand, high-quality water is reserved for other uses either stored in reservoirs or in the basin. Replaced water means that resources increase and can be redistributed to other users. This increase in reserves has a value that should be considered in the economic evaluation.

On the other hand, it must be taken into account whether the quality of the replaced and reclaimed water allows the

same uses. It often happens that the reclaimed water does not allow to grow the same crops as usual. It can be interpreted that this change causes a loss or increase of profits that must be evaluated case by case and area by area.
If the body of water is a river, the generalization of purification has allowed an improvement in quality, the economic consequences of which are several, from the improvement of biodiversity and fishing to aesthetic values. It also contributes to the management of floods. The ecological improvement caused by replacing treated wastewater without tertiary treatment with reclaimed water, allowing a qualitative and quantitative improvement in terms of flora and fauna. Quantification in this case is more difficult and can be considered in the field of intangibles.

4. Conclusions

Legislation has been considered a barrier to the economically viable development of reuse for several reasons, among which it is worth noting:

• The obligation established by the EU that all costs are included in the price of water. There are serious doubts that this is adequate for reuse and must be differently developed.

• Inadequate legislative developments, appreciable in European and Spanish legislation, by an excessive number of analyses, that mainly does not provide additional useful knowledge.

• The low quality of existing legislation on reuse in Europe is evident. In part this is due to the fact that has never been developed independently and considering European approaches on water items, and has been related to advances in legislation for other kinds of water supply and foreign approaches.

• Difficultly finding legally valid arguments to redistribute costs among the various beneficiaries of reuse. In many cases, it has been chosen, even contradicting the legislation, to implement "political" prices for reclaimed water.

• On the other hand, within the economic-legislation nexus in the field of wastewater, it is necessary to fully develop the tools that allow the cost-benefit ratios to be evaluated considering the safe use of reclaimed water.

• The fact that reuse allows the economic development of irrigable areas should be a reason for special attention to environmental policies, especially water ones, due to the benefits of all kinds that it can bring to users of reclaimed water and those benefiting from the replacement of water resources, such as cities or industry.

• It is obvious that legislation regarding reclamation and reuse should be complied with, even in spite of the errors or difficulties thereof. It is expected that the new European regulations will be able to improve the legislative context, and as a result the economic one.

•Also, from an economic point of view, and in this case secondary to the legislative, but not to the sanitary, it is important to be able to evaluate the benefits associated with increasing water safety, both in quantity and quality. Legislation should favour this increased safety, which should not translate only into the assessment and reduction of risk in reuse.

REFERENCES

Alfranca, O., 2017. Métodos de valoración ambiental aplicados a la regeneración y reutilización de aguas residuales en agricultura (Environmental valuation methods applied to wastewater reclamation and reuse in agriculture). Agua y Territorio, nº 8, pp. 61-69.

Caucci, S., Hettiarachchi, H., 2017. Wastewater irrigation in the Mezquital Valley, Mexico: solving a century-old problem with the Nexus Approach. Proceedings of the International Capacity Development Workshop on Sustainable Management Options for Wastewater and Sludge, Mexico, 15−17 March 2017.

Hernández, F., Molinos, M., Sala-Garrido, R., 2010. Estudio de viabilidad económica para el tratamiento de aguas residuales a través de un análisis coste beneficio. Revista Electrónica de Comunicaciones y Trabajos de ASEPUMA. Vol. 11, pp. 1-25.

MMAMRM, 2010a. Guía para la Aplicación del R.D. 1620/2007 por el que se establece el Régimen Jurídico de la Reutilización de las Aguas Depuradas. Ministerio de Medio Ambiente y Medio Rural y Marino. España.

MMAMRM, 2010b. Versión preliminar del plan: Plan nacional de reutilización de aguas. Ministerio de Medio Ambiente y Medio Rural y Marino. España.

Paranychianakis, N., Salgot, M., Snyder, S.A., Angelakis, A.N., 2015. Water reuse in EU states: necessity for uniform criteria to mitigate human and environmental risks. Critical Reviews in Environmental Science and Technology, 45: 1409 – 1468.

United Nations Environment Programme, 2023. Wastewater – Turning Problem to Solution. A UNEP Rapid Response Assessment. Nairobi. DOI: https://doi.org/10.59117/20.500.11822/43142

Voulvoulis, N., 2018. Water reuse from a circular economy perspective and potential risks from an unregulated approach. Current Opinion in Environmental Science & Health. Volume 2, April 2018, pp. 32-45.

WHO, 2006. Guidelines for the safe use of wastewater, excreta and greywater. Volume 1: Policy and regulatory aspects. Volume 2: Wastewater use in agriculture. OMS, Ginebra

WHO, 2015. Sanitation safety planning. Manual for safe use and disposal of wastewater, greywater and excreta. OMS, Geneva.

WWAP (United Nations World Water Assessment Programme), 2017. The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource. Paris, UNESCO.