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Common or independent ? The debate over regulations and standards for water reuse in Europe.

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Abstract

Unplanned water reuse has been practiced in numerous parts of Europe for many decades as a consequence of the need to use surface water that often contains a high proportion of treated wastewater. Recent years have seen multiple stresses on the supply demand balance driving a rapid increase in the number of planned reuse schemes for a variety of applications. The legislative and regulatory regime required to underpin this growing sector has arguably failed to emerge. In this paper we explore why this might have been the case and assess the arguments for and against common EU level legislation and standards for water reuse schemes. We use literature and secondary data to illustrate current arrangements, draw on examples and lessons from outside the EU, and compare and contrast the often contentious arguments for different forms of regulatory regime and their geographical remit. Our conclusions flag up a challenge for politicians and policy makers to move swiftly to establish appropriate regulatory systems and associated water quality standards in order to underpin the embryonic European water reuse sector.

Keywords: Water Reuse, Europe, Regulations, Standards, Governance.

Introduction

In the 28 member states of the European Union, approximately 81% of the freshwater used for energy production, agriculture, public water supply and industry originates from surface water bodies, with groundwater being the primary source for public water supply (EEA, 2009). Abstraction pressures on surface water bodies are likely to increase in the medium to long term as a result of population growth and the impact of climate change (Alcalde and Gawlik, 2014). As well as being a source of potable and irrigation water, rivers are also widely used as a receiving-water for treated wastewater effluent. In effect this has meant that unplanned indirect reuse has been practiced for many decades where river water used for water supply is abstracted downstream of cities discharging their treated wastewater in the river (Asano, 1998). The increasing pressures on water sources and the need to dispose of treated wastewater effluent has driven significant improvements in wastewater treatment as well as drinking water treatment although these have not been specifically driven by the potential for planned wastewater reuse. Wider implementation of water reuse would have distinctive benefits for the European environment and economy by providing additional water resources at competitive cost and reducing the demand on limited fresh water resources. For instance, Hochstrat *et al.* (2008) estimated that water savings resulting from the implementation of water and wastewater reclamation in Europe could reach up to 1.5% by 2025, with specific southern European countries such as Malta, Spain and Cyprus having the potential to reduce by up to 17%, 7%, and 3% respectively their water abstraction as a result of wider use of water reclamation and reuse.

Although Europe has a number of areas where water reuse is practiced (either directly or indirectly), the lack of any European wide standards or guidelines for reuse, either for potable or agriculture applications is viewed as one of the major barriers to the development of the water reuse sector (Technopolis group, 2013). As an agglomeration of 28 member states, many of which have significant internal variation in terms of culture and history, Europe (in the form of the European Union) provides a particularly delicate patchwork of norms and behaviours within which to develop a consistent and coherent water reuse framework. Any standards or water quality guidelines developed through such a framework will not only need to cover a wide range of water reuse purposes, from agricultural to urban, but also to be both acceptable and equitable across all 28 member states. Failure to achieve this may for example compromise the free trade of agricultural products irrigated with treated wastewater from countries applying less stringent health and safety standards than those applied in the countries importing the products (European Commission, 2014). In addition, the EU has a number of trans-boundary water bodies and rivers, such has the Danube river flowing through seven EU countries, which further complicate the position. EU level regulatory changes are often slow to be implemented as they (quite rightly) require extensive review, revision, and impact assessments. The fact that the EU is such a large trading block also impacts on other countries in the region that are not EU members. The importance of ensuring that regulation facilitates rather than burdens reuse schemes was starkly illustrated in a recent report commissioned by the EU itself, pointing out that in three large EU countries (France, Italy, and Greece) overly stringent non-potable reuse quality standards was seen as a major barrier to the further development of reuse projects (BIO by Deloitte, 2015a). We briefly discuss variations in these national standards in the following section.

The EU currently relies on several major pieces of legislation to regulate the natural and engineered water cycles. Member states are expected to adopt these directives and incorporate their requirements into national legislation with the Commission itself overseeing their implementation. Two of these are of particular significance with respect to water reuse. Council Directive 2000/60/EC establishes a framework for action in the field of water policy (the Water Framework Directive - WFD) and indirectly recognises reuse as a strategy for increasing water availability which thereby contributes to the good quality status of water bodies. It also refers (in Annex VI:x) to ‘efficiency and reuse measures’. A second significant influence is Council Directive 91/271/EC which relates to wastewater treatment and discharge (the Urban Waste Water Treatment Directive - UWWTD). Article 12 of the UWWTD states that ‘*treated wastewater shall be reused whenever appropriate*’ inferring that wastewater reuse is acceptable in as much as it does not breach other EU legislation or national laws. Other relevant EU ordinances include the Drinking Water Directive (80/778/EC revised with 98/83/EC), which sets out the quality of water intended for human consumption, and the Groundwater Directive (2006/118/EC) which seeks to protect groundwater against pollution and deterioration.

Of particular significance to reuse schemes which rely on the use of an environmental buffer (e.g. a river or aquifer), the anticipated revision of the Priority Substances Directive - PSD - Directive 2013/39/EU, a so called ‘daughter’ directive of the WFD), will impose water quality standards for emerging pollutants that may influence Indirect Potable Reuse (IPR) scheme design and treatment technology selection in particular. The impact of this legislation will depend on the type of water body being used as the environmental buffer and the details of scheme design. Indeed, the PSD could well strongly influence the economics and therefore the attractiveness of large scale reuse schemes across the continent.

Importantly, none of the statutory instruments listed above are overtly directed at regulating or promoting wastewater reuse as such. The EU has historically shied away from intervening in the fledgling European water reuse sector, preferring that national administrations take the lead in setting appropriate laws and regulations. It has not imposed universal non-potable water quality criteria, and nor has it provided the sort of enabling legislation and guidance which might encourage reuse at large or small scale.

This is not to say that the EU’s various functional and policy bodies have ignored water reuse. The European Commission (EC), which is the executive arm of the European Union, has funded research and innovation activities to promote the development of reuse strategies and advanced treatment technologies and has developed appropriate risk management strategies for reuse schemes (e.g. the Aquarec - Framework V / EVK1-CT-2002-00130, Reclaim Water –Framework VI / #18309, and Demoware – Framework VII / #619040 projects). It has also encouraged and responded positively to the inclusion of reuse within wider analyses of water policy and catchment based management strategies. The most recent of these initiatives involves the widely referenced ‘Water Blueprint’ (European Commission, 2013) which made it clear that reuse of wastewater should be a major consideration for improving water efficiency in the European Union and recommends that reuse should be particularly focused on irrigation and industrial uses. It goes on to note that the limited extent of such schemes in the EU appears to be due to a lack of common EU environmental / health standards for reused water and the potential obstacles to the free movement of agricultural products irrigated with reused water. Several initiatives have been catalysed by the Blueprint reports. The EC’s Directorate-General for the Environment conducted a public consultation in late 2014, which concluded that the principle of reusing wastewater attracted widespread acceptance within the EU despite concerns regarding its use for food crop irrigation and drinking water. In addition, there was a substantial majority of opinion that considered regulation as essential to promoting re-use in the European Union (BIO by Deloitte, 2015b)

The EC are also working with the World Health Organization which is considering revisions to its Guidelines for the Safe Use of Wastewater, Greywater and Excreta (WHO, 2006). In addition the Commission has established a close collaboration with the European Innovation Partnership on Water (EIP), which is a platform to facilitate innovation in all parts of the European water industry. In particular, collaboration with two of the EIP Action Groups on

Industrial Water Reuse and Recycling and on Water and Irrigated Agriculture are delivering welcome support to the industrial and agricultural sectors. However, it is also worth noting that, in extremis of the WHO standards, point-of-use water quality criteria across different regions of the world are variable. The WHO is currently reviewing its standards for reuse in agriculture and for other purposes and the outputs of this activity are likely to have a significant impact on European attitudes.

Variable point-of-use non-potable water quality standards across the EU

Untreated wastewater from municipal or industrial origins contains a range of hazards in the form of pathogens such as viruses and bacteria, and chemicals such as pharmaceutical substances, hormones and heavy metals. Wastewater reclamation, if not appropriately managed, could therefore present a threat to public health and the environment (Salgot *et al.*, 2003). The potential for both microbial and chemical contaminants to cause adverse effects on human health will depend on transport and routes to human contact as well as on levels of exposure. Possible routes of exposure to pathogens and/or compounds of concern may include ingestion through the consumption of drinking water or crops, meat, or fish produced using reclaimed wastewater, skin contact / inhalation through recreational activities (e.g irrigation of public parks, sports fields and golf courses), or direct contact through professional activities (e.g. agricultural workers) (Godfree and Godfrey, 2008).

In the EU, a number of countries including Cyprus, France, Greece, Italy, Portugal and Spain have developed point-of-use standards for non-potable water applications in their jurisdiction (Paranychianakis *et al.*, 2015). Among the requirements for the monitoring of treated wastewater to be reused, microbiological parameters are mandatory in all countries. The indicator typically used to evaluate the microbial quality of the reclaimed water is *E.coli,* which is considered to be more accurate than total coliforms and faecal coliforms at describing the microbial contamination of waters (Alcalde and Gawlik, 2014). To illustrate, the limit values for *E.coli* for unrestricted irrigation vary between ≤ 5 cfu.100mL^{-1} (in 80% of samples) in Greece to ≤ 250 cfu.100mL^{-1} per week in France (Table 1). Paranychianakis et al. (2015) indicate that some of these countries such as France, include additional parameters such as the irrigation methods used and type of irrigated crops, soil properties and sampling frequency etc. to better prevent risks. In some cases additional water quality parameters are specified that can add significantly to the costs of monitoring. For example France defines a total of six water quality parameters while Italy, Greece and Spain include over 50 each (Table 1). However, France also requires that the sludge from the wastewater treatment works is monitored. In most cases there are additional stipulations such as water application control measures, ensuring that there are no cross connections, and limits on the type of irrigation method (e.g. banning spray irrigation).

Table 1. Microbiological standards for unrestricted irrigation set in France, Greece Italy, Portugal and Spain. Adapted from Paranychianakis *et al.* (2015).

	Cyprus(1)	France	Greece	Italy	Portugal	Spain(3)

Microbiological indicators						
E. coli (cfu/100mL)	-	≤ 250	≤5 *(For agricultural crops)*	≤10	-	≤100
Total Coliforms (cfu/100mL)	-	-	2 *(For urban irrigation)*	-	-	-
Faecal coliforms (cfu/100mL)	≤5	-	-	-	≤100	-
Helminth eggs (eggs/L)	0	-	-	-	≤1	<0.1 *(0 for urban uses)*
Additional information						
Frequency of analysis(2)	1/15 days	1/week	1 to 4/ week depending on population served	Frequency not considered – to be determined by the facility managers	Frequency not considered – to be determined by the facility managers	Once to 3 times per week
Additional parameters included in the standards	-	-	64 (incl. heavy metals, metalloids, toxic substances incl. priority substances)	53 (incl. heavy metals, metalloids, toxic substances incl. priority substances)	Heavy metals, metalloids, toxic substances incl. priority substances(2)	up to 60 (incl. heavy metals, metalloids, toxic substances incl. priority substances
Additional requirements		Distance between irrigated areas Slope of the irrigated fields irrigated*			Type of soil (irrigation not allowed in karstic geological formations). slopes of fields irrigated (not authosised if slopes > 20%)	Monitoring at the point of use

(1) Irrigation of leaf vegetables and other vegetable eaten raw forbidden

(2) Source: Alcalde and Gawlik, 2014

(3) Term “unrestricted irrigation” not described for Spanish criteria

While the European Union has introduced a number of binding policies in relation to the water environment, including the management of wastewater, individual member states are responsible for implementation at a national level with consequential variation (to a wider or lesser degree) across the 28 member states. Differences in attitude to specific aspects of EU level policies also results in variations in the tone and emphasis of national implementation legislation and regulation. Where there is exists a policy vacuum at European level (as is the case with water reuse standards) these differences can become both evident and significant.

As noted above, a recognised challenge for the European Union is to agree a common set of non-potable water quality criteria between the 28 member states that can transcend these differing attitudes that often reflect differing priorities, legacies, and capacities in member states. The fact that several states have already established their own non-potable water quality criteria makes this process more difficult as there may be limited willingness on behalf of those states to compromise and adapt their existing standards to a unified EU version. There are also differences in the attitudes of consumers between different countries (often between the north of Europe and the South – see Nocella *et. al,* 2012) and in abilities to police and enforce regulations. Consequently, there needs to be compromise between excessive precaution and insufficient safety in developing regulations. Where there is a widely agreed set of international norms this can be much more easily overcome but the WHO guidelines, which are what Europe usually looks to, have proven to be difficult to implement and they do not cover many emerging chemical contaminants of concern. The process of revision for the WHO Guidelines is unlikely to be complete for some time.

Despite the lack of specific EU reuse regulations, wastewater reuse schemes have been successfully implemented under country specific or even regional guidance (Hochstrat *et al.,* 2006). Among these are the Torreele/ Wulpen (Belgium) aquifer recharge scheme for indirect potable reuse, the aquifer recharge site of Tossa de Mar (Spain) for urban reuse and the wastewater recycling for agricultural irrigation schemes in Milan (Italy) and Braunschweig (Germany) (Table 2).

Table 2. Examples of wastewater reclamation schemes in Europe

Location	Year	Owner	Drivers for implementation	Reuse purpose	Source	Treatment	Volumes of treated wastewater and/or reclaimed water	Costs (€)	Benefits	Reference
Amathus-Limassol CYPRUS	1992 – 2013(0)	Sewerage board of Limassol (SBLA)	Sever drought leading to water restrictions Increasing water demand (population growth and tourism) Aquifer depletion and pollution (saline intrusion)	Non Potable (Urban and Agricultural reuse)	Municipal wastewater	Primary treatment Secondary treatment (conventional activated sludge) Tertiary treatment (sand/gravel filtration+ disinfection)	Capacity of the Limassol wastewater treatment plant (WWTP) in 2008: 40000m^3/d (270,000 p.e.) (1). Reclaimed water production: 6.7 Mm^3/y in 2011(1) (4.8Mm^3 used for agricultural purposes, 1.2 Mm^3 discharge to see, 0.7 Mm^3 send to Polemidia dam)	Capex (1995) for tertiary treatment plant in 1995(5): CYP 1.85M (approx. 3.16 M€ in 2008)** Customers are charged for the use of reclaimed water. In 2008, the price varied from 0.05€/m^3 for agricultural irrigation to 0.21€/m^3 for golf course irrigation(1)	Freshwaterresources savings Preservation of the natural environment Conservation of the sustainable development of the region Improvement of living standards of the region inhabitants	Papaiacovou and Papatheodoulou (2013)
Wulpen – Torrele – St André BELGIUM	2002	I.W.V.A	Increasing water demand (population growth and tourism) Risks of saline intrusion in aquifer	Potable (Indirect – Groundwater augmentation)	Municipal wastewater	Tertiary treatment (disinfection; membrane filtration (UF/RO)) Infiltration to aquifer via pond After abstraction: aeration, rapid sand filtration, storage, and UV disinfection prior to distribution	WWTP capacity: 2.3Mm^3/y Reclaimed water production 1.8Mm^3/y in 2011(2)	Capex: 7M€ Cost to produce and infiltrate water: 0.64€/m^3 (2011)(2) The cost for recycled water is recovered from the drinking water price. A 21% increase in the drinking water price after the scheme implementation was reported(3). In 2011, the price was 1.75€/m^3 compared to an average of 1.83€/m^3	35 to 40% of IWVA's annual drinking water production achieved by the scheme Improvement of the ecological value of the aquifer recharge site Improvement of the drinking water quality.	Van Houtte et al., (2012)

								in the Flanders region (2)		
Braunschweig GERMANY	1979-2005(0)	Stadtent-wässerung Braunschweig (operator: Abwasser-verband Braunschweig)	Need for water and fertilisers in an area where soils are poor. Environmental protection and health risks management (odour, heavy metals, groundwater pollution)	Non Potable (Agricultural reuse)	Municipal wastewater	Primary treatment Secondary treatment (conventional activated sludge with nitrification and denitrification stages)	Braunschweig WWTP capacity in 2008: 22Mm^3/y (385,000 p.e.) 2/3 of the treated wastewater is use to irrigate 3,000 ha of agricultural lands; 1/3 further purified by infiltration fields before discharge or further use.	Data not available	Irrigation of lands with reclaimed water having fertilising properties Prevention of contamination of surface water bodies.	Ternes *et al.* (2007) Abwasser verband Braunschweig
Clermont-Ferrand FRANCE	1996	Clermont-Ferrand Municipality	Pollution of the river due to the discharge of wastewater effluent Reduction in river flow and degradation of its quality due to agricultural irrigation Regular drought events	Non Potable (Agricultural reuse)	Municipal wastewater	Primary treatment Secondary treatment (conventional activated sludge) Lagooning (surface 13ha / 312,000m^3)	Clermont WWTP capacity: 64Mm^3/y – (425,00 p.e.); Volume of water use for irrigation: 1.1Mm^3/y on average between	Capex (1996): 30M€ (WWTP) and 5.3M€ for the reclamation scheme Opex (1996): 86k€+0.05€/m3 as energy	Distribution of water for irrigation to 50 local farmers Moderate investments and operational costs Preservation of the environment	Loubier and Declercq (2014)
Milan-San Rocco ITALY	2004	Suez Environnement –Degremont Italia Consortium di bonifica Est Ticino Villoresi (distribution	Pollution (i.e. discharge of raw wastewater in the environment) Contamination of the water used for agriculture Recurrent periods of droughts Increasing pressure on	Non Potable (Agricultural reuse)	Municipal wastewater	Primary treatment Secondary treatment (conventional activated sludge with nitrification and denitrification stages) Tertiary treatment (rapid sand filtration+ UV disinfection)	San Rocco WWTP treatment capacity from 350,000 m^3/d to 1.04 Mm^3/d Average production of tertiary effluent between 2005 and 2010: 96Mm^3/y	Capex: 184M€ (WWTP) (4) Opex (2009): 567k€ for maintenance 900k€ for energy; 157k€ for natural gas and 75k€ for chemicals (4)	Improvement of the chemical and microbiological quality of surface water bodies; Restoration of the biodiversity of the surface water bodies; Supply of high quality water for agricultural	Mazzini et al. (2013)

			groundwater resources						irrigation at no cost for farmers.	
Tossa de Mar SPAIN	2003	Consorci Costa Brava	Over exploitation of the Tordera river's aquifer for drinking water supply as a result of tourism. Severe droughts in the late 90s and early 2000s Reduction of groundwater levels and groundwater quality deterioration	Non Potable (urban reuse)	Municipal wastewater	Tertiary treatment (Coagulation / flocculation followed by rapid sand filtration; disinfection (sodium hypochlorite and UV))	Average volume of reclaimed water produced in 2009: 80,000m^3	Capex (2009): 837,000€ for the water reclamation plant and recycled water distribution network2	Reduction in freshwater consumption through the use of reclaimed water for various activities (municipal services, landscape irrigation… Environmental protection (restoration of the Sa Riera park an local stream)	Sala (2010) Mujeriego et al. (2011)
Old Ford Water – London Olympic Park UNITED-KINGDOM	2011	Thames water utilities	Droughts Rapid population growth	Non Potable (urban reuse)	Raw wastewater	Pre-treatment stage (sceptic tanks) Biological treatment (Membrane bioreactor) Polishing using granulated activated carbon filtration and disinfection (chlorination)	Reclamation plant capacity: 574m^3/d	Capex (2012): £7M (approx. 10M€ at 2015 exchange rate)	In 2014, the scheme recycled: 41 ML of treated wastewater to irrigate the Parklands 4.2 ML for non-potable use at the Copper box sport venue - equivalent to 19% of the site water consumption. 40% water reduction in potable water use.	Knight et al (2012)

* Constuction/implementation in phases.

** Fixed exchange rate of CYP 0.585274 per EUR 1.00 on 1st January 2008 (date of Cyprus entry in the euros zone)

(1) Larcou, (2012)

(2) Van Houtte and Verbauwhede (2012).

(3) Otoo, M et al., (2015)

(4) Casiraghi et al. (2014)

(5) European commission (1999)

As can be seen from Table 2, a lack of EU level regulation has arguably not stopped the development and implementation of reuse schemes, but is it hindering the development of a more confident and effective water reuse sector? Is it slowing down the development of more progressive water policies? And why not leave it up to individual European nation states to set their own standards for recycled water?

What makes for effective regulation of water reuse schemes

Regulation has a major influence on the feasibility, implementation, and operation of water reuse schemes. A clear definition of realistic standards to protect the environment and human health and guidelines for the credible operation and monitoring of schemes provides public and commercial stakeholders with the confidence needed for investment. If licencing is to be the primary tool for regulatory control then details of the expected spread of risk and responsibilities is required. However, regulatory policy needs to be flexible and robust to reflect the variability of scheme context. The establishment of clear standards for the quality of water provided for non-potable uses is an important pre-requisite to a workable water reuse sector. Such standards provide both an operational performance target for scheme developers and confidence for water users. The legal position of companies offering non-potable water services is severely compromised in the absence of clear and binding regulations which aim to protect public health and ensure the safe operation of reuse schemes. In this context it is perhaps unsurprising that those countries with benchmark water reuse operations (e.g. USA, Australia, Cyprus) have strong and well established non-potable quality criteria and mature governance arrangements. Mature water reuse sectors which make substantial contributions to resource management do not operate in a regulatory vacuum. For example, there are long histories of reuse regulations in many US states such as Texas and California. In addition to the underpinning regulations around process and responsibilities, rules and regulations relating to consumption and supply are also often very comprehensive.

An effective regulatory regime for water reuse schemes at EU level which provides common targets on water quality and risk management is desirable for three main reasons. Firstly, the provision of a firm legal basis to protect the health of the public and the environment is vital for any sector involved in the management and anthropogenic use of natural resources. The absence of such a robust legal architecture within which commercial and public bodies can operate erodes the confidence and conviction needed by potential reuse scheme developers; uncertainty reigns and there are no independently set performance objectives upon which to found risk management practices.

This link between regulation and risk management is central to the effective operation of engineered systems which deliver utility for citizens on a large scale through the management of natural resources. Although several EU member states have legislated requirements for risk-based approaches to drinking water supply (e.g. the UK, Netherlands, Norway, and Estonia) there is no EU-wide obligation and there has been extensive debate about what an appropriate risk assessment method for water reuse schemes might look like (Nandha et al., 2013), particularly within a wider context of drinking water safety plans (Goodwin et al., 2015). Although the relative suitability of different risk frameworks such as Hazard &

Operability studies (HAZOP) and Hazard Analysis and Critical Control Point (HACCP) have been explored in relation to water reuse schemes, there is some consensus emerging around the adoption of modified Water Safety Plans (WSPs). WSPs provide an holistic approach to water service risk management by determining whether the water supply chain as a whole can deliver water of a sufficient quality, ensuring the effective monitoring of those control measures in the supply chain that are of particular importance in securing water safety, and setting out management plans describing the actions to be undertaken from normal conditions to extreme events (Bartram et al., 2009). Originally developed as a multiple-barrier risk management approach (i.e. from source to tap) for drinking water treatment plants to protect public health (Almeida et al., 2014), the adaptation of WSP principles to broader applications, and more specifically water reuse that involve additional water management challenges such as public safety and environmental protection, has attracted much attention in recent years (Goodwin et al., 2015). For example, in 2008, the Queensland government (Australia) reinforced its legislation for the protection of public health by introducing new measures in its Water Supply (Safety and Reliability) Act 2008 concerning the use of recycled water which may end up in the drinking water supply chain (Roux et al., 2010). This implied the development of water management plans as a prerequisite to the approval of water recycling schemes. These plans, which include a risk based approach for the management of recycling schemes (Roux et al., 2010), were derived from the Australian Guidelines for water recycling (NRMMC, 2008), which as WSP, are based on Hazard Analysis and critical control point (HACCP).

Secondly, effective regulation moderates the perverse or conflicting incentives which can appear in sectors and markets and which lead to undesirable social or economic outcomes (as explained in Bakker, 2003). The provision of appropriate incentives for companies delivering services is a central tenet of regulation theory, a point succinctly made by the WWF when commenting on the role of the financial regulator in the UK. Stating that '*Companies must be given better incentives to manage water resources sustainably'* and urging the removal of *perverse incentives'* as well as rewards for '*companies that invest in creative and innovative ways to reduce their impact on the environment*, they crystalize the relationships between regulation, innovation, and stewardship of the natural environment (WWF, 2010). However, in order for regulation to play this role, it must both understand the impact of regulatory interventions and anticipate institutional responses. This is a non-trivial challenge for those charged with developing and implementing regulatory regimes, made even more difficult in the case of water reuse by the fact that the activities being regulated are often novel and only have sparse precedent. Under such circumstances governance bodies are perhaps understandably cautious and conservative.

The third principal argument for the development of an effective regulatory regime for water reuse schemes at EU is that geographical heterogeneity in regulation would have unwelcome consequences for European business and communities. For example, variability in non-potable water quality standards for agricultural use across the continent has the potential to damage the free movement of goods across Europe's internal borders as consumers in one part of Europe become anxious about perceived lower standards in other parts of the continent. This issue is potentially damaging to the single market principle held so dear by the EU and is perhaps the reason why there has been more interest in developing water quality standards for agricultural water reuse than for the non-potable and potable municipal sectors.

Of course, on the other hand there are a number of well understood disadvantages to a pan-European regulatory approach to water reuse which are worth articulating. We are entering a period in which there a number of uncertainties regarding some aspects of the science surrounding possible health risks from re-use of wastewater. In Europe concern over chemical contaminants, including emerging contaminants, remains a perceived problem and data confirming or refuting whether or not this is really a problem and under what circumstances. Such a situation creates difficulties in developing regulations and there is a danger that some member states who have less pressure on water resources may seek to propose a very precautionary approach. Such a situation would create significant tensions between member states with differing pressures on water resources.

There would also be difficulties for member states with existing standards because these would normally be superseded by EU regulation. For those users who have invested in treatment and monitoring to achieve standards in their country that are higher than the final EU-wide standards there is an issue of wasted investment. For others the contrary may be true and they may have to add further investment on treatment and irrigation systems that might render existing investment redundant. While such situations are not uncommon in European negotiations they do make the negotiations more difficult. In addition, some users who are able to operate satisfactorily in their own country and are content with the local market may find that they have increased monitoring and verification requirements that will simply add cost to their operations.

In addition there may be issues between different member states due to the variability of the source water quality for re-use that could result in calls for significant changes to treatment and control of inputs. While this may be desirable to provide reassurance and would have additional benefits in improving the quality of receiving waters for the stream that is not going for re-use, it requires a very long-term approach with substantial requirements for investment. Such calls could potentially be a disincentive for the introduction of re-use in the short-term.

Finally, the introduction of EU wide regulation could be potentially costly in terms of administration and monitoring and could also be unhelpful in the development of other water conserving options by diverting attention and resources. This risk is, of course, a recipe for paralysis as fear of compromising parallel or alternative strategies incentivises procrastination, indecisiveness, and inaction. European politicians are well able to develop clear policy objectives within complex contexts and develop instruments to pursue realisation of those objectives. The prioritisation of incentives and regulations to shape desirable responses to Europe’s degenerating water balance is the policy challenge. Trading off the first and second order impacts of preferred incentives against lost opportunities and unavailability of resources in other areas will expose the wider costs of candidate instruments.

Conclusion

The foregoing reflections on potential European approaches to regulating water reuse schemes is informed by a growing need for action. As the impacts of climate change and population growth / relocation transform the geography and temporality of Europe's supply – demand balance, water service providers are looking for new ways to enhance resource availability. Treating water to the quality needed for specific applications (and thereby not treating it all to potable quality) offers significant opportunities in this respect as well as delivering resource and cost savings. The fact that Europe, despite several initiatives, does not yet have a unified regulatory regime which can boost the embryonic reuse sector and protect citizens' interests is, from our perspective, disappointing. Progress compared with other countries (e.g. Australia & the USA) has been unhurried and lacklustre. Guidance and standards for non-potable reuse schemes are perhaps unsurprisingly more commonly available than those for potable applications with several countries (e.g. Greece and Spain) having mature and comprehensive regulations. The argument we develop in this paper is in many respects intended as a challenge to politicians and regulators. A decision on how integration and subsidiarity should be balanced with respect to water reuse regulation for EU member states is overdue. Whether the context is potable or non-potable applications, the challenge is the same – a socially and economically profitable European water reuse sector requires the direction and confidence of a progressive and enabling regulatory regime.

One might argue that there is little urgency to develop such governance tools whilst other interventions remain viable and capable of making significant contributions to the supply demand balance. This is a valid argument to make and has perhaps influenced the observed (lack of) pace and resolve to date. However, we would argue that under conditions where none of the component trends of the supply demand balance are moving in a useful direction, the time has come to inject some urgency into the process. Regulation which is catalysed by a crisis is rarely good regulation but regulation informed by an appreciation of changing circumstances can drive innovation and provide the confidence which emerging actors need to plan and resource their initiatives. The nascent European water reuse sector, recently emboldened by the founding of its own industry association – Water Reuse Europe) can only grow and make a meaningful contribution to a sustainable water future for the region if there is progressive enabling legislation in place to frame its initiatives and operations.

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