project

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D3.2: Policy and planning settings for the transition to Water Circular Economy - barriers and drivers in place

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Deliverable Review and Approval

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Executive summary

The transition towards water circular economy, namely by using alternative water sources such as water reuse, presents many drivers and barriers, as enumerated by the literature. A successful transition towards water circular economy requires an integrated water resources management approach where the new water uses and users, and the water-land use nexus are considered. Dedicated policy instruments, adequate legal and regulatory frameworks and favourable water resources and spatial plans are key factors to consider for a successful transition.

Using an evidence research-based approach, this Deliverable of the Work Package 3 of Project Ô on 'integrated water management, planning and circular economy', assesses how the current policy and planning set-up in place on each demo site of Project Ô, is prepared to accommodate water circular economy initiatives in the perspective of water reuse. It identifies drivers, barriers and challenges raised by the new water loops foreseen with the new technologies developed under Project Ô. The assessment is performed using an analytical framework developed for this purpose. Its core is based on the design of a typical decision-making arena associated with a water reuse loop that includes different types of actors, policy, regulatory and planning documents, and a set of related enabling factors, likely to affect the transition to the water circular economy. These enabling factors are used to undertake a content analysis of particular documents, namely the existing circular economy action plans, the water resources and the spatial planning legal frameworks, the river basin plans and the local master plans in place, considered representative of the policy and planning set-up associated with each demo site.

The findings bring to the fore different policy and planning conditions to accommodate the challenges brought by water reuse. Although the water-land nexus is recognised in all the analysed water resources and spatial planning systems and plans, the integration of circularity codes still needs to be fostered. The case of Almendralejo (Spain) involves many new challenges, including the number of new water uses and users, spatial extension covered, various land-use types, new permits, and new authorities' involvement as new infrastructures. However, the stricter water quality and health regulations and the robust policy and planning set-ups of these demo-sites should overcome most of those challenges. The case of Eilat (Israel) also involves complex challenges. Here, although the circular economy policy is not evident, the water resources and the spatial planning system, as well as the long tradition of water reuse, are also well prepared to accommodate the water reuse loop. In the case of Lecce (Italy), the reduced number of new water uses in the water loop makes its implementation less challenging. Though less robust than the formers, the policy and planning set-up should be enough to overcome these minor challenges, including the need for stricter water quality and health regulations, risk management plans and monitoring schemes due to the indirect use of groundwater by citizens. Despite having a less robust policy and planning set-up, implementing the new water loop in Omis (Croatia) is the least challenging since the new water loop will be implemented within the factory's boundaries.

In conclusion, given the challenges involved in the demosites and the features of the policy and planning contexts, it is recommended to invest in the development of co-creation processes for the demo sites of Almendralejo (Spain) and Eilat (Israel), mostly due to the higher number of new water users, to ensure an adequate implementation process. For Lecce (Italy)'s demosite, the water reuse to recharge the aquifer may also benefit from implementing a co-creation process to define clear responsibilities and public acceptance. The demo site of Omis (Croatia) does not require a co-creation process. The co-creation processes within the scope of Project Ô should identify and lift challenges and barriers and use the drivers in place for water circularity, emphasising policy, planning, and governance benchmarks.

Contents

1. Introduction

Growing pressures on water, a limited and increasingly scarce natural resource, are challenging world-wide decision-making processes. Water circular economy through water reuse and alternative sources of water is increasingly been considered in national and local policies. The transition to water circular economy, though, can be influenced by land and land-use planning concerns. Water resources are spread across the territory, namely through the river basin hydrographic networks and ecosystems, including rivers, lakes, water reservoirs, and aquifers. Water resources are interlinked with the spatial distribution of economic activities, and influenced by land-use planning policy, regulations, and decision-making processes. Consequently, new water loops, created by the circularity of water, are likely to be influenced by land-use planning concerns. By integrating land-based resources, accessibility, knowledge and governance domains, land-use planning can play an important role to reduce the barriers and unblocking the CE' opportunities. The water-land-use nexus approach for water circular economy (WCE) requires integrative resource approaches, enabled by policy and decision-making instruments and processes. Alternative water systems, when altering outer water loops, water producers and users, may challenge policy and planning decision-making and related tools. Are these concepts on the way to becoming institutionalised in the national policies for circular economy (CE) and in the water resources and spatial planning documents? This Deliverable explores this research question.

This Deliverable is inserted in the Work Package 3 of Project Ô dedicated to 'Integrated water management, planning and circular economy'. It studies the main features of the policy and planning set-up in place of the four demo sites of Project Ô. For this purpose, it develops an analysis primarily focused on the circular economy policies, water resources planning and spatial planning contexts. It seeks to understand how the current set-up, as established by policy and planning documents, are prepared to accommodate innovative water loops to foster WCE. In the end, it aims to contribute to the identification of major drivers and barriers for the transition to WCE in the perspective of water reuse. The related governance factors, i.e., the organisational features, responsibilities and arrangements that determine the interaction between stakeholders, equally relevant to characterise the institutional set-up, are to be explored and assessed on deliverable 3.3.

The document is structured into seven sections. After this one, Section 2 outlines the theoretical assumptions and the current scientific knowledge on WCE, use of alternative sources of water and water reuse, and how these matters are being considered and established within an integrated perspective of planning and managing the water resources and land use. It also outlines the major drivers and barriers, referred to in the literature, to be faced when pursuing WCE and water reuse. Section 3 introduces the policy context for WCE by referring to the most relevant EU directives, regulations and, communications related to WCE and water reuse. Section 4 presents the analytical framework's main features to assess the policy and planning contexts beneath the four demo sites of Project Ô. It also describes the methodological steps and the documents used to analyse the policy and planning set-up in place. According to the analytical framework, section 5 presents the results of the analysis for each demo site and undertakes an overall assessment. The Deliverable is concluded with section 6 where results are discussed and conclusions outlined, and with section 7, where forthcoming steps are summarised.

2. Water circular economy, challenges, barriers and drivers

2.1 Integrated water resources management and water circular economy

Over-abstraction from surface and groundwater bodies is a significant pressure over water resources, mainly due to the growing consumption by households, agriculture and tourism. European waters remain under pressure from multiple sources that affect water-related ecosystems' functioning and the long-term delivery of ecosystem services and benefits to society and the economy (EEA, 2018). The water demand is likely to surpass its availability in many

river basins of Southern Europe, systematically more affected by droughts, where lower levels of water on streams, rivers and reservoirs are expected to be reduced by forty per cent due to climate change (JRC, 2014). The balance between water demand and water availability is a challenge to be faced by policy makers, companies, and citizens worldwide. Over two billion people live in countries experiencing high water stress, and about four billion experience severe water scarcity during at least one month of the year, and these figures will continue to increase as water demand grows and the effects of climate change intensify (UNESCO, 2019). Water scarcity means that water demand exceeds the water resources exploitable under sustainable conditions (Schulte, 2014). The water stress is a broader term that includes, besides the abundance for human supply (i.e. water scarcity), the environmental requirements (e.g. ecological flows), also the water quality and the accessibility of water (Schulte, 2014). The depletion of water resources will also result in depleting land and soil, which will impact ecosystems and entail the loss of their services for maintaining human well-being (MEA, 2005; Amenta and van Timmeren, 2018). Land and soil are frequently seen as a platform for human activities, where social, economic and cultural activities occur (Breure et al., 2018). However, land and soil are vital non-renewable resources, essential to biodiversity conservation, as they are the support of terrestrial natural capital (habitat and gene pool), providers of raw materials, food and biomass and fundamental for the closing of natural cycles (e.g. water and nutrients) (Breure et al., 2018). Besides these functions, classified and valuated as supporting and provisioning ecosystem services, the land and soil provide regulating services such as biological control of pest and diseases, climate regulation, hydrological control, filtering of nutrients and contaminants, and recycling of wastes and detoxification (Jónsson and Davíðsdóttir, 2016).

Water use practices and climate change challenge the balance between water demand and availability (Steffen et al., 2015). Coping with this challenge requires improving water use efficiency by eliminating distribution losses, changing users' behaviour or limiting water use and the potential associated economic or social benefits. Alternatively, it may be fostered a diversification of water supply by considering alternative sources of water. With the amelioration and introduction of new technologies, water resources management may enter a new phase where the current pressures become alleviated by using alternative sources of water, thus accruing the importance of the transition to a WCE model and a generalised water reuse approach. Lessons learned from the concept of Integrated Water Resources Management (IWRM) indicate that the institutional frameworks for shared governance of spatial planning and water resources can be one of the foundations to operate that transition. The IWRM concept is defined by the Global Water Partnership (GWP, 2000) as "a process which promotes the coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare equitably without compromising vital ecosystems". IWRM seeks the management of water resources in a "comprehensive and holistic way, taking account of the entire water cycle and the interests of all water users, while acknowledging the temporal and spatial availability and the interactions with water quality and ecology" (van der Zaag and Savenije, 2014; p. 11). The principles of the IWRM approach, represented in Figure 1, imply the coordinated development and management of water, land and related resources, with a basin-level perspective, involving the creation of the "institutional and intellectual infrastructure that allows the numerous competing goals and objectives to be coordinated and administered in a coherent and uniform manner" (UNESCO, 2009; p. 5). In Europe, the Water Framework Directive (WFD) established a new water legislation phase that initiated the move towards IWRM, linking spatial planning with water resources planning (Kaika, 2003).

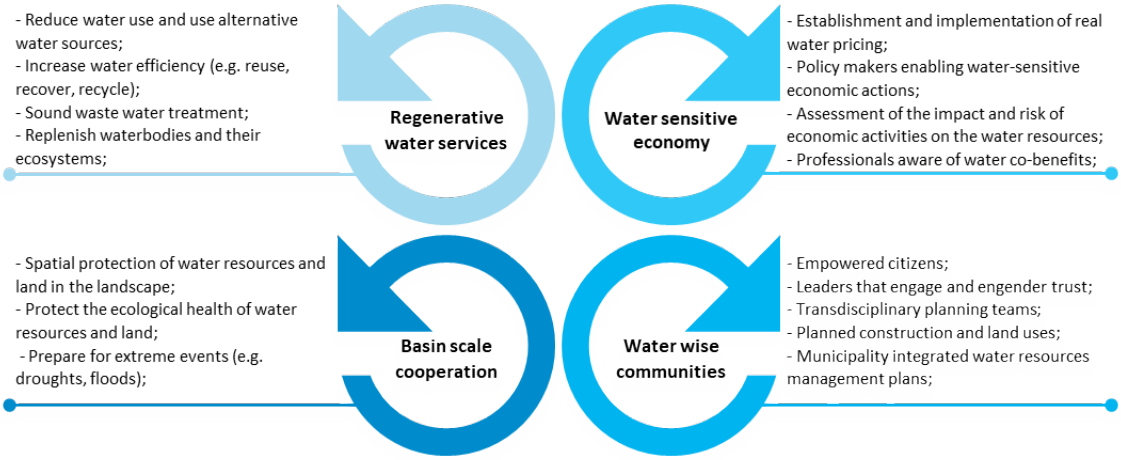


Figure 1. Principles of Integrated Water Resources Management.

The transition to a WCE model and the generalised consideration of alternative water and water reuse sources can bring in a whole new holistic approach to the IWRM. Within this approach, many international water authorities focus on maintaining the balance between demand and availability by including water efficiency, conservation and protection measures to control the growth in demands, and diversifying supplies to augment availability (Lazarova et al., 2013). Supply diversification includes mainly using non-traditional or alternative sources of water, including supplies from rainwater and stormwater, water reuse or even desalination of seawater or brackish groundwater (Lazarova et al., 2013). In fact, with the currently available technologies, any water quality required by users and for compliance with existing regulations can be achieved (Lazarova et al., 2013). However, solutions to water management problems are simultaneously technology issues as they are planning and governance (Cosens and Chaffin, 2016). The global water crisis has been depicted as less technical, but increasingly as a planning and governance problem. In other words, sustainable management typically does not fail due to a lack of knowledge on specific management measures but because of the inadequate political, social, economic and administrative conditions (Ibisch et al., 2011; p. 14). A proactive approach must be developed to ensure the sustainable management of all resources, recognising that water is a precious, finite and irreplaceable resource. Our understanding of public perceptions and attitudes towards water reuse has to be improved and consistent, and if not, harmonised, international regulations should be set up (Lazarova et al., 2013). Thus, adequate institutional contexts and practices of water governance should be assured. They are critical for economic growth, social inclusiveness and environmental sustainability (OECD, 2018).

Water governance is understood as the "range of political, institutional and administrative rules, practices and processes (formal and informal) through which decisions are taken and implemented, stakeholders can articulate their interests and have their concerns considered, and decision-makers are held accountable for water management" (OECD, 2018; p. 22). Water governance includes all social processes − governmental, informal, and customary − that guide people's collective actions towards a common goal among diverse stakeholders (Wiek and Larson, 2012). This robust understanding of water governance includes the collaboration between government agencies and a wide range of stakeholders. The main governance gaps hindering water governance are shown in Figure 2 (OECD, 2018; p. 21). Three major principles to bridge the gaps of water governance are recommended as presented in Figure 3.

Policy
- Institutional and territorial fragmentation;
- Lack of effective policy coherence across sectors;

Administrative
- Mismatch across administrative and hydrological boundaries;

Funding
- Questionable resource allocation and inconsistent financial management;

Capacity
- Gaps in knowledge, human capital, technology and other capabilities to design and implement sustainable, efficient and effective water policies;

Accountability
- Ineffective stakeholder engagement for inclusive and transparent decision making;
- Lack of or not regular use of monitoring, evaluation and enforcement mechanisms;

Objectives
- Divergent objectives that inhibit synergies and complementarities at the right scale;

Information
- Insufficient or incomplete water information systems in support of decision makers;

Figure 2. Gaps of water governance (adapted from OECD, 2018; p.21)

Effectiveness
- Clearly allocate and distinguish roles and responsibilities;
- Manage water at the appropriate scale(s) and foster co-ordination between the different scales;
- Encourage policy coherence through effective cross-sectoral co-ordination;
- Adapt the level of capacity of responsible authorities;

Efficiency
- Produce, update, and share timely, consistent, comparable data and information;
- Ensure that governance arrangements help mobilise water finance and allocate financial resources in an efficient, transparent and timely manner;
- Ensure that sound water management regulatory frameworks;
- Innovation in water governance;

Trust and Engagement
- Mainstream integrity and transparency practices across water policies, water institutions and water governance frameworks for greater accountability and trust in decision-making;
- Promote stakeholder engagement;
- Encourage water governance frameworks that help manage trade-offs across water users, rural and urban areas, and generations;
- Promote regular monitoring and evaluation;

Figure 3. Principles of water governance (adapted from Akhmouch and Correia (2016).

Within the IWRM concept, water governance has the challenge of assuring a horizontal integration by combining different sectoral policies, such as urban, agriculture, industry, energy, or ecosystem protection. These policies interfere with water use, and the location of their sectorial socio-economic purposes must be considered under the spatial planning and related decision-making process (Fidelis and Roebeling, 2014). Spatial planning decisions with implications for water resources are frequently made with limited connection to water resource planning and management (Plummer et al., 2011). This gap occurs even when the required articulation is acknowledged as a key for reducing the environmental and hydrological impacts of land-use change on water resources at any geographical scope.

2.2 Principles of water in circular economy

The concept of circular economy (CE), although not new, has been boosted during the last decade (Geissdoerfer et al., 2017; Sileryte et al., 2018). CE can be defined as “an economic model wherein planning, resourcing, procurement, production and reprocessing of resources are designed and managed, as both process and output, to maximise ecosystem functioning and human well-being” (Murray et al., 2017; p.377). One of the CE model's

primary objectives is to eliminate waste systematically throughout the life cycles and uses of products and their components (Flores et al., 2018). The transition to CE is supposed to reconcile the environment and the economy by using its various dynamics of progress and innovation. Using a circular approach to production and consumption reduces greenhouse gas emissions and our environmental footprint (RF 2018). In short, the principal benefits to moving to the CE are the substantial net material savings and reduced exposure to price volatility, the increased innovation and job creation potential and increased resilience in living systems and in the economy (EMF, 2015b). CE can contribute to the global sustainable development agenda by delivering various opportunities, including reduced pressures on the environment, an enhanced supply of raw materials and resources, and increased competitiveness, innovation, economic growth and employment (EMF, 2015a). Furthermore, CE brings sustainable value by fostering new economic activities and minimising their environmental impacts (van Buren et al. 2016), throughout the renewability of resources, such as energy, materials, water, topsoil, land and air, while retaining or creating value, promoting positive systemic impacts on ecology, economy and society, and preventing adverse impacts (Sileryte et al., 2018).

Water is a precious asset that cannot be substituted and has strong ties to cultural, social, economic and political subjects (Eneng et al., 2018). Water is one of the most critical resources for production (Flores et al., 2018) and the most important shared resource across the entire supply chain (Bianco, 2018). Nevertheless, wastewater is the largest untapped waste category (Bianco, 2018). The deficiencies of past water resources development allied to local scarcity and the increasing pressures to achieve sustainable goals raise the need to transition to CE (Bianco, 2018; Dominguez et al., 2018). Indeed, water is designated as a critical resource and rising problems with securing water supply, and handling of wastewater is turning the water agenda into an area of great corporate and policy attention (OECD 2018). As such, attempts to water consumption cycle towards CE may reduce human pressures on water resources (Abu-Ghunmi et al., 2016).

Models of water use have been dominated by the linearity logic applied to the materials, starting with the extraction, then the utilisation, ending with the discard as residue. These linear models assume an infinite capacity to meet growing demands and that the environment would be capable of absorbing waste and pollution (Bell, 2019). This unsustainable process makes the water too polluted and expensive to treat (Martin Stuchtey, 2015). The evident need for changes converges with the CE concept, which focuses on preventing water contamination when possible, and in the cases that it is not, to use on a closed-loop, maximising its life cycle. CE may create value for local communities and municipalities, which must seize their opportunity to organise inter-city and local closed loops for water, material and energy (Flores et al., 2018). Implementation of CE in cities may also enhance social innovation and improve governance (Koop and van Leeuwen 2017). Application of CE principles to water (Figure 4), will bring greater opportunities for businesses, governments and cities to minimise structural waste and to generate more value from industry and agriculture while regenerating the environment. The water circular economy (WCE) aims to align better the human water cycle and the natural water cycle with measures such as (EMF, 2018):

- avoid use, rethink products and services, and eliminate ineffective actions;
- educe use, improve water use efficiency, and perform better resource allocation and management;
- reuse water within an operation (closed-loop) and for external uses;
- recycle within internal operations or external uses;
- replenish by returning water to the river basin.

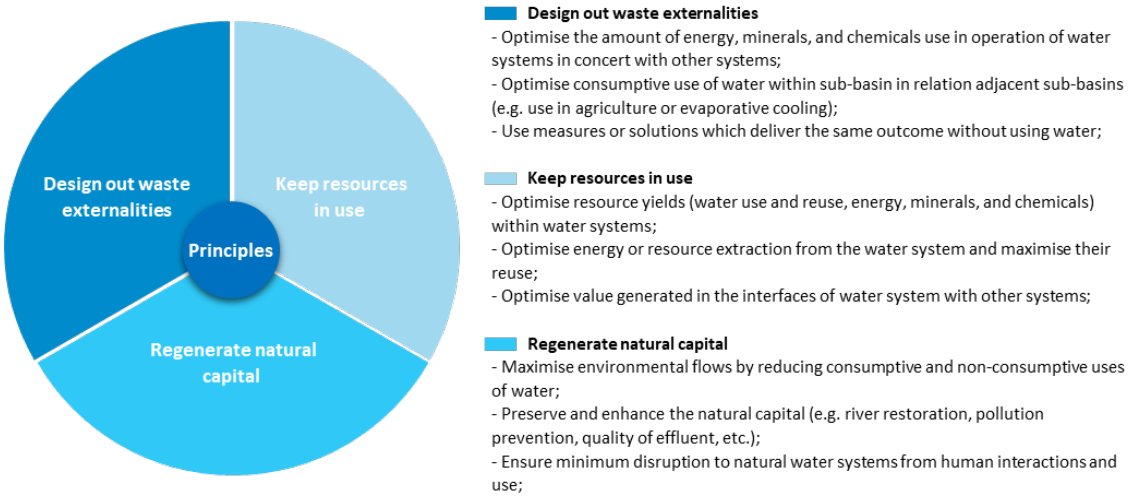


Figure 4 Circular Economy principles for water (adapted from EMF, 2018; p.4)

The inclusion of water in a CE model can be approached in different ways, namely, by a product–design partnership, wastewater treatment plants becoming energy positive, management for production, basin management to reduce risk of flooding or freshwater pollution, and local organic nutrient cycles for agriculture (Martin Stuchtey, 2015). Currently, the CE models entail an increased focus on demand management, i.e., to enable systems to meet a growing population's needs without increasing resources use and coping with conditions of resources scarcity (Butler and Memon, 2006). For water resources, diversifying water supply, by including alternative water sources, could be a way to complement the total amount of fresh water supply and to balance water availability and water demand, while meeting the CE requirement of being "accessible, reliable, and an environmentally sustainable supply" (WRG, 2009; p.126). However, alternative water sources are frequently used to supplement, rather than replace, existing conventional water supplies, reducing the potential of these alternative solutions for sustainability (Bell, 2019). Alternative water sources should be sustainable water supplies, that are not from a new source, in sufficient amounts to serve as a reliable alternative or supplemental water supply (McNabb, 2019; p.253). These may include rainwater, stormwater, brackish water, desalinated water, and reclaimed wastewater (McNabb, 2019). By supporting and improving water regeneration techniques, CE can push traditional systems and give new valuable usages to wastewater and other alternative water sources through innovative adaptations and changes in water supply systems. These systems' circularity depends on the treatment and purification techniques, that deliver less contamination, and create closed smaller loops allowing repeated usages (Flores et al., 2018).

Many states and corporations are moving away from linear towards circular models of production and consumption. Experience is showing the need for policy and regulations to better frame this transition, not only to help to economies break away from a polluting economic trajectory and move to a 'clean' one (Molinos-Senante et al., 2013; Voulvoulis, 2018) but also to prevent potential risks of creating new water loops of new water producers and consumers. Water recycling and reuse can be promoted through policy instruments such as dedicated policy plans, framework laws, and additional regulations challenging how water resources and their circularity are perceived by the national and local communities' contexts.

2.3 The relevance of the water-land-use nexus in the water circular economy

The pressures on water resources from population growth, economic development, urbanisation, inefficient water use and climate change have brought many states and corporations to foster WCE models, by considering alternative sources of water supply, water reuse, and new water loops. However, water services are related to the man-made infrastructure, the different natural water bodies distributed over river basins, including rivers, lakes, water reservoirs and aquifers, and the territory nearby. The water-land interactions are of foremost importance for water supply to the communities and water delivery to the aquatic ecosystems (Grizzetti et al. 2016). The successful implementation of WCE solutions requires, therefore, due attention to the articulation between land use planning

with water resources conservation and efficiency planning, within a water-land use nexus. Integration of these planning processes requires breaking down the traditional planning and operational procedures of different departments and agencies. Traditionally, land-use planners have focused on how much and what type of growth may occur in particular communities or territorial units while water resource managers have focused on ensuring adequate water supply (Curgus, 2018). An integrated water-land use management can ensure a "community's vision for the future considering water and growth together" and a "development occurring in a way that protects the watershed including ecological functions and the quality and quantity of water supplies" (Curgus, 2018; p. 10).

The next paragraphs explore how the scientific community related the water-land use nexus approach with the WCE debate. For this purpose, a brief bibliometric analysis was undertaken using the number of articles published in scientific journals (Figure 5), referenced in the Scopus database in the fields of environmental and social sciences, related to three sets of themes and types of keywords as follows:

- The first, on alternative sources of water concerning water and land use planning, by crossing alternatives sources of water with land or territory, spatial or land-use and planning or plan, river basin plan or integrated water resources management;
- The second, on water reuse, water and spatial planning, by crossing water reuse with land or territory, spatial or land-use and planning or plan, river basin plan or integrated water resources management;
- The third, on circular economy, water and land use planning, by crossing circular economy with water, alternative sources of water, water reuse, land or territory, water resources and planning or plan, spatial or land-use and planning or plan.

The subsequent literature review uses only the highly cited papers to highlight the concerns most raised by the scientific community.

For the first topic, the review showed that although there are examples of studies crossing alternative sources of water, CE and spatial concerns, they are seldom relevant for this investigation' objectives. Among the contributions found two are worth to mention. One relates alternative sources of water with integrated water resources management by proposing a model to optimise approaches for the use of desalinated seawater and reclaimed water while taking into account localised needs for different qualities of water and geographical aspects (Liu et al., 2011). According to these authors, this is relevant to spatial planning. It allows determining the optimal locations, e.g., desalination, wastewater treatment and reclamation plants, and the optimal water distribution infrastructure, storage reservoirs, with scenario analysis that also includes an economic evaluation. Another contribution, given by Kluge et al. (2008), is related to developing a model able to pair the potential use of endogenous alternative sources of water with demand-oriented water and land management. However, Kluge et al. (2008) claims that the implementation of new technologies depends on the institutional and administrative processes of resource management and the integration into the social, economic and ecological conditions of water use.

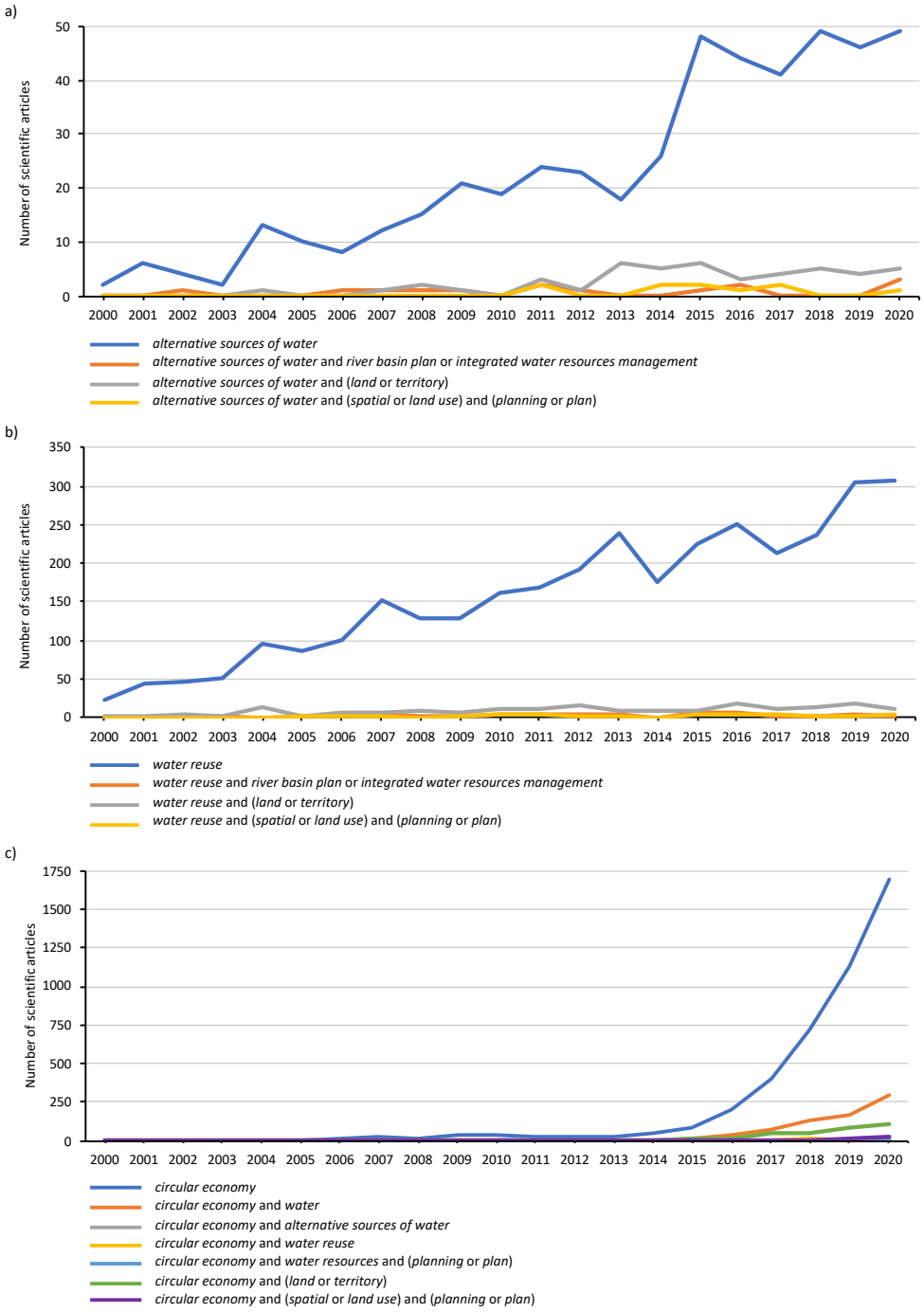


Figure 5. Articles regarding a) alternative sources of water, IWRM and land use planning, b) water reuse, IWRM and land use planning and c) circular economy, water resources and land use planning.

For the second topic, crossing water reuse and spatial planning, the review shows that limited relations are being explored between water reuse in the sense of WCE, river basin planning and IWRM. Generally, articles that combine water reuse (or reclaimed wastewater) and CE themes, focus on new methods to enable the concrete application of CE principles to water, while enhancing energy and materials recovery from wastewater. Among these are advanced anaerobic technologies that combine water reuse and sustainable wastewater treatment with the potential to produce energy and high-quality effluents that respect current regulations (Massara et al., 2017). Sewer-mining water reuse technologies for closing the loop between waste and resource with fewer transmission costs for treated effluent conveyance systems with an ease development, transferable to various cases and scales, operationally efficiency, viable for small-medium enterprises (Makropoulos et al., 2018). Moreover, the scientific literature also addresses treatment wetlands as a technology for the treatment of various types of wastewater and as water protection systems (Kołecka et al., 2018). This type of nature-based solutions for phytoremediation,

combined with other available technologies, may enhance water reuse from a CE perspective with more efficiency and cost-effectiveness, and enable the recovery of nutrients and energy production, while producing ecosystem services in urban areas (Kołecka et al., 2018). As for water reuse and river basin plans, Zoltay et al. (2010) explore integrated watershed management models used to design river basin management plans. These may support decision making and stakeholder negotiations, by modelling the natural and the human components of the river basin, and a wide range of management options, related to land-use and water reuse network schemes (Zoltay et al., 2010).

Water reuse and spatial concerns are addressed simultaneously in the scientific literature on tools of assessing urban water systems, with a focus on sustainability and cost-effectiveness. These included strategic interventions with possible centralised and decentralised water reuse schemes applied for several spatial scales (system, sub-catchment, local and indoor areas) (Behzadian and Kapelan, 2015). Decentralised and centralised non-potable water reuse options were compared using a life-cycle approach, which verified that decentralised systems achieve environmental advantages (e.g. energy use, GHG emissions) (Kavvada et al., 2016). The effects on overall water quality of implementing decentralised water supply systems in existing centralised systems were also evaluated (Sitzenfrei et al., 2017). Spatially explicit water reuse scenarios, combining and processing spatial and non-spatial data (e.g. land use, population, rainfall and climate) under policy changes (e.g. minimum water efficiency compliance or water restrictions), provided relevant results to support strategic planning and spatial design of water reuse network schemes. These may support decision-makers when planning for WCE (Sitzenfrei et al., 2017). The scientific literature also evinces the production of knowledge useful to inform the design of new water loops in order to identify the interplant optimal wastewater reuse schemes that enable industrial symbiosis (Alnouri et al., 2016), to quantify the volume of water reuse and its related cost-benefits in agricultural irrigation systems at different spatial levels (Hafeez et al., 2008), and to delimit agricultural perimeters irrigated with treated wastewater (Neji and Turki, 2015).

The review suggests that the link between WCE and spatial concerns is still poorly discussed in the literature for the third topic. The relevance of a stronger articulation between land use and water resources systems is discussed by some researchers (Biswas, 2008; Brack et al., 2015; Fidelis and Roebeling, 2014; Rodrigues and Fidélis, 2019) but seldom simultaneously with a CE perspective. Land-use planning has, however, been recognised as one of the main drivers of water use. Water related ecosystem services are provided not exclusively by aquatic ecosystems but also from the interaction of water and land in different ecosystems connected to the hydrological cycle in the river basin, for example, water purification, water retention and climate regulation (Grizzetti et al. 2016).

The use of CE's concept and principles to the management of water and territory creates an opportunity to rethink the nexus between vital resources such as water and land. This water-land use nexus has been gaining space in the scientific literature as a transition path to sustainability, however slowly. The water-land use nexus approach still requires integrative resource planning methods before establishing itself in practice, driven by decision-making and implementation. Man-made water infrastructures and natural water bodies are distributed over the territory, interlinked with the spatial distribution of economic activities, and their management can be enabled by a set of policy and decision-making processes associated to water resources planning and spatial planning, as well with sectoral plans, e.g. policy plans for CE and water efficiency, plans for water infrastructures, plans for the restoration of ecological services. However, by changing the scale, source, and use of water, alternative water systems greatly challenge deep-rooted political, regulatory, planning, social, economic, environmental and spatial relationships that support conventional modes of provision of water infrastructure and services.

An illustration of the relevance of land concerns in the WCE is made through Figure 6 (a, b, c and d). There, it is presented a comparison between a traditional linear model of water abstract-use-discard and alternative circular models of alternative sources of water and water reuse.

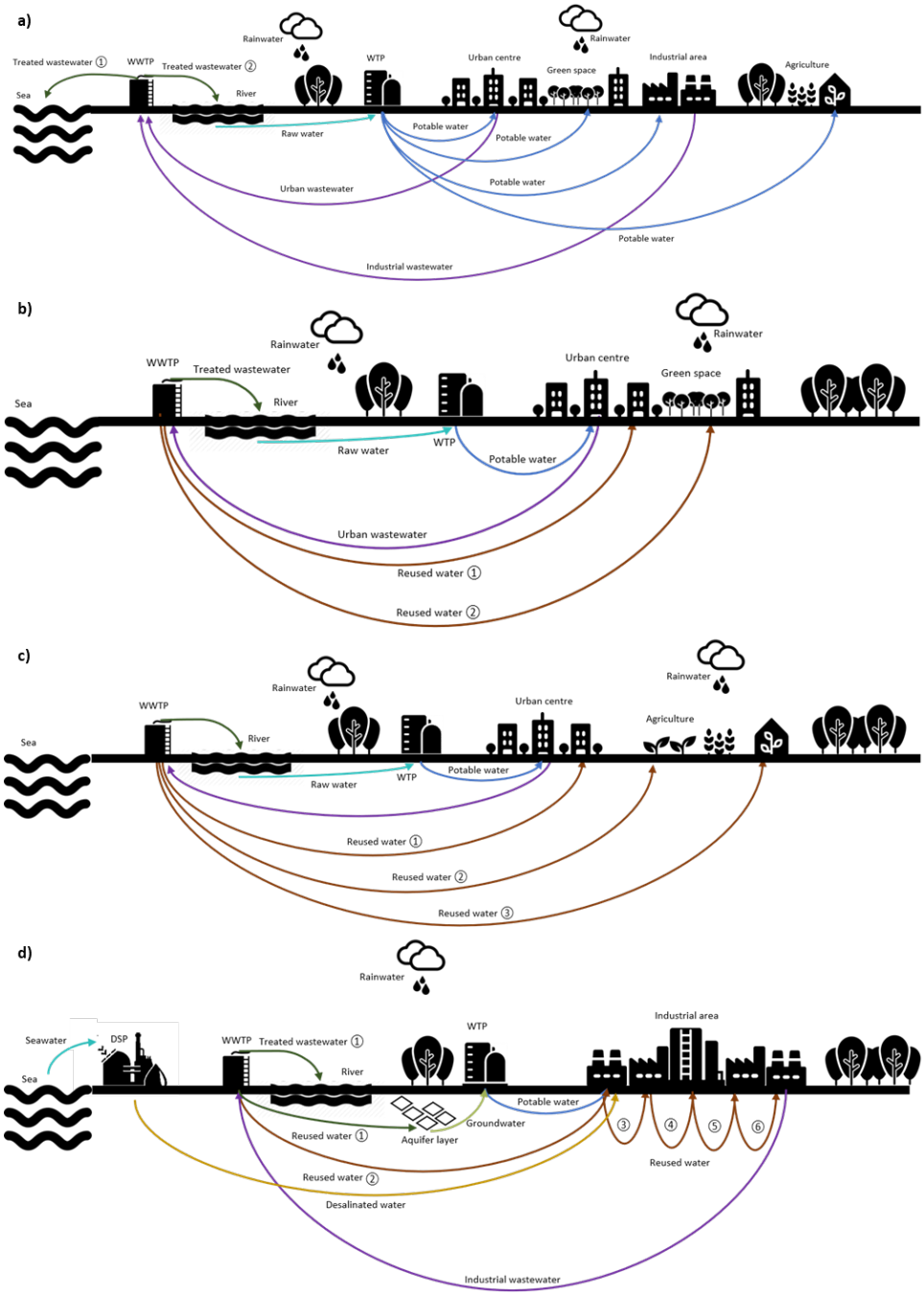


Figure 6. Diagrams of the linear model of water (a) and diagrams of hypothetical water loops in the WCE model, with a fit-for-purpose approach: water reuse for washing of public streets in urban centres and watering of green areas (b), water reuse for urban centres and agriculture irrigation (c) and water reuse for aquifer recharge and industrial uses (d). Icons adapted from https://thenounproject.com.

This first scheme (a) represents the linear model where all the water users (population, industrial, agriculture) use the same water source (blue arrows) whether they need water with such high quality or not. All the water is abstracted (turquoise arrows) from the river, and after use, the resulting wastewater (purple arrows) is treated and then discarded in a river or sea (green arrows). The alternative circular models (represented in schemes b to d) introduce new types of water, such as reclaimed wastewater that is reused (brown arrows) and desalinated water (orange arrows).

In fit-for-purpose water loops, different types of water from different sources and with different qualities have different uses, such as higher quality potable water from freshwater sources for human consumption, and lower quality reclaimed wastewater for reuse in the washing of public streets, watering of parks, irrigation, industry and aquifer recharge. The adjustment of city-regions and river basins to WCE must be considered on a case-by-case

basis, as illustrated by the figure. These solutions depend not only on the types and location of the water sources, water needs and uses, water infrastructures and utilities but also on the topographical and geographical characteristics of the river basins, city size and urban morphology, predominant types of land use, climatic conditions, among other factors.

2.4 Drivers and barriers towards water circular economy in policy and planning contexts

The transition towards WCE, namely using alternative water sources for potable or non-potable uses such as reclaimed wastewater, represents a challenge with many drivers and barriers, enumerated among the literature. Identifying these drivers and barriers is fundamental to evaluate how the different policy, planning and regulatory frameworks, especially the water resources and spatial planning, facilitate or hinder the transition to WCE and the implementation of new water loops. In this context, drivers are understood as factors that are likely to force or strengthen the adoption of WCE, whereas barriers are understood as obstacles or constraining factors. The following paragraphs refer to the main types of drivers and barriers to be faced when pursuing WCE. The identification is based on a brief literature review. This used a dataset of highly cited papers, selected first, by crossing the keywords water reuse and a combination of water and circular economy with drivers, barriers, enablers or challenges, and second, crossing the former keywords with policy, water resources planning, spatial planning or land use planning, and governance (see Figure 7). The articles were retrieved from Scopus in the fields of environmental and social sciences. The subsequent review used only the highly cited papers, considered the most representative, to highlight the concerns most raised by the scientific community.

The literature on WCE is relatively recent. While water reuse has been addressed by the scientific community for a long time, only after 2014, the WCE perspective started to emerge. However, in the present days, the number of publications on the two topics is very similar. A considerable portion of the scientific literature analyses drivers and barriers to water reuse and WCE transition. Nevertheless, the scientific literature that relates these drivers and barriers with policy, water resources and spatial planning and governance is scarce. It is mainly dominated by articles on urban water management that refer to the planning or the design of water reuse schemes as a sub-topic. Scientific literature analysing how the policy and planning contexts and the behaviour of the various actors involved in the water system may favour, or hinder, the drivers and barriers identified for the transition to WCE and water reuse is almost absent.

The main drivers and barriers likely to be found in the transition towards WCE and the implementation of water reuse techniques, as identified in the scientific literature, can be categorised in environmental, spatial, financial, technological, social, policy, and planning, regulatory and governance. They are summarised in Tables 1 and 2. The main driver towards the adoption of CE practices, in general, include long-term strategy with adequate financial investment and monetary incentives to the industrial sector, enhanced marketing strategies with innovative product designs and the creation of markets for the recovered resources, technological progress, favourable governance conditions and social recognition with the establishment of awards and certification (van Leeuwen, et al., 2018; Gue et al., 2020). However, economic attractiveness is usually the core driver in adopting CE strategies (Gue et al., 2020). Amongst the practical approaches to promote CE, industrial symbiosis is officially recognised as a significant catalyser. The dissemination and implementation of these practices increase circularity in production processes, through the use of by-products, including water, and creating opportunities to increase reuse (Domenech et al., 2019).

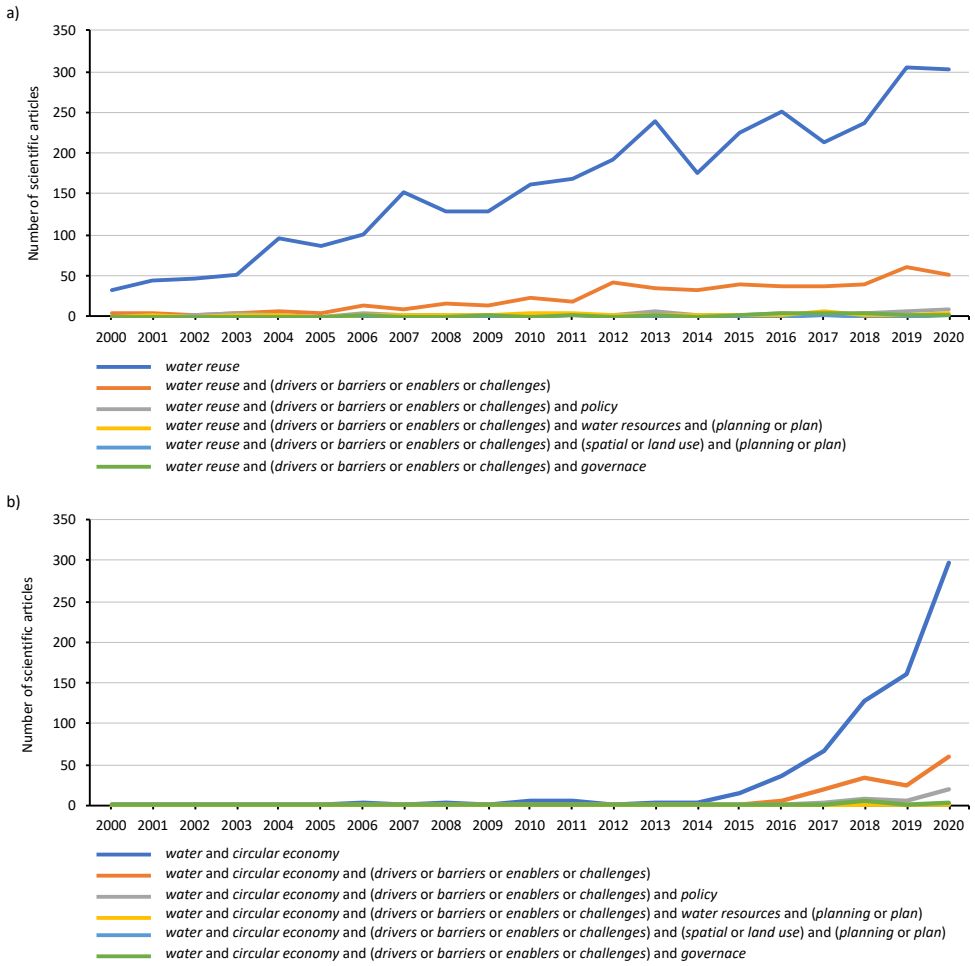


Figure 7. Articles regarding drivers and barriers on a) water reuse and b) water circular economy.

The transition towards WCE, in particular, with the implementation of water reuse schemes and the search for alternative sources of water, are highly motivated by environmental drivers related to general water shortage, depletion and contamination of surface waters and groundwaters (e.g. through polluted discharges, seawater intrusion into freshwater aquifers) (Mills et al., 2004; Scott et al., 2003; Fatta et al., 2006; Keremane and McKay, 2007, 2009). The depletion and contamination of water resources are mostly related to water demand increases due to irrigation and growing population, industrialisation and urbanisation, and extreme climatic events. Together with the environmental drivers, the current technological advances have improved the capacity to produce recycled water and have driven the generalised adoption of water reuse practices in different regions of the globe (e.g. Europe and the Mediterranean region). Furthermore, the potential of moving from conventional wastewater treatment practices to resource recovery practices by treating nutrient-rich wastewaters has also driven the adoption of WCE practices (Lin et al., 2016; van Leeuwen, et al., 2018).

The lack of government support, companies' commitment, consumer demand, social acceptance, economic attractiveness, technological knowledge and information to practitioners are considered main barriers towards WCE (Gue et al., 2020). Hindering the mainstream of water reuse techniques are some relevant factors related to environmental issues, public health, cost and economic, water quality regulation and policy, institutional and governance, negative public perception and acceptance (Dare et al., 2017; Fatta et al., 2006; Frijns et al., 2016; Goodwin et al., 2019; Keremane and McKay, 2007, 2009; Voulvoulis, 2018). Together with these, the lack of participation and week commitment amongst stakeholders hinder the transition to WCE and adoption of water reuse practices (Ezeudu and Ezeudu, 2019).

Table 1. Drivers towards WCE and water reuse in the scientific literature

Environmental	
- Water scarcity or drought - Aquifer depletion and pollution (e.g. avoid pollution discharges, saline intrusion in aquifers) - Reduce the demand for fresh water sources and replenish natural resources - Climate-related challenges to water supply - Seasonal (e.g. emergency) and long-term water storage - Phosphorous capture and prevention of mineral fertilizer extraction - Reduces water, energy and carbon footprint of food and agricultural production (e.g. fertilizer saving, increasing crop yield) - Improving marginal land for environmental or recreational uses	Scott et al., 2003; Mills et al., 2004; Fatta et al., 2006; Miller, 2006; Chen and Lee, 2008; Hochstrat et al., 2008; Keremane and Mckay, 2009; Browning-Aiken et al., 2011; Torrice, 2011; Hanjra et al., 2012; Fawell et al., 2016; Lin et al., 2016; Moss et al., 2017; van Leeuwen et al., 2018; Nölting and Mann, 2018
Spatial	
- Proximity of the treatment facilities to agricultural areas - Proximity between companies and industries fosters industrial symbiosis - Land developments as opportunities for new synergies and territorial symbiosis	Giurco et al., 2011; Dare et al., 2017; Domenech et al., 2019
Financial	
- Increasing costs of fresh water supply and wastewater discharge - Access to financing and cost allocation (e.g. synergies with international funding programs) - Lower input and operational costs and increased revenues (e.g. from nutrient recovery and biomass-production) - Avoided cost of freshwater pumping and energy savings (e.g. uses less energy than importing water or desalination) - Higher agricultural intensity with additional employment - Value of ecosystem services and carbon credits (e.g. carbon tax implications for water pricing)	Casani et al., 2005; Wilderer, 2005; Bixio et al., 2006; Janosova et al., 2006; Miller, 2006; Hochstrat et al., 2008; Keremane and McKay, 2009; Browning-Aiken et al., 2011; Campbell and Scott, 2011; Giurco et al., 2011; Hanjra et al., 2012; Molinos-Senante et al.,2013; Fawell et al., 2016; Nölting and Mann, 2018; van Leeuwen et al., 2018; Gue et al., 2020
Technological	
- Availability of technically feasible treatments (e.g. good performance in the removal of critical parameters in municipal secondary effluents) - Commercial use of by-products after treatment - Obsolete water infrastructures, failing to provide water security and in need of investment	Casani et al., 2005; Wilderer, 2005; Lahnsteiner and Mittal, 2010; van Leeuwen et al., 2018; Domenech et al., 2019
Social	
- High social value attributed to freshwater Public awareness of water resource management - Information dissemination to promote public trust - Corporate sustainability focus - Experience with alternative water sources - Increase in water demand due to urbanisation, industrialisation and agriculture	Casani et al., 2005; Russel and Hampton, 2006; Campbell and Scott, 2011; Torrice, 2011; Hanjra et al., 2012; Meehan et al., 2013; Frijns et al., 2016; Moss et al., 2017; Goodwin et al., 2019; Gue et al., 2020
Policy, planning, regulatory and governance	
- Support by regulators and politicians and endorsement from public representatives - Strict wastewater quality discharge regulations - Strong and well-established non-potable quality criteria - Possibility of lowering requirements for water quality - Regulations allows to use water reuse to secure urban development - Flexible mixes of policy instruments for international convergence on best practice - Incorporation of public values with local and regional policies and into the planning process - Incorporation of reuse schemes in long-term strategic plans - Performance-based policies and regulation to encourage and reward environmental performance improvements - Achieving aims of water and environmental policies (e.g. ecological protection and enhancement goals) - Coordinated support from local, regional, national government levels - Governance structures and procedures that encourage cross-sectoral integration and intersectional policy coordination - Clear and functional administrative arrangements that regulate water use and reuse - Strong private sector involvement - Maintenance of trust between stakeholder groups - Well-conceived and implemented communication campaigns - Improved awareness, knowledge and capabilities (e.g. public awareness of benefits of reuse and openness to the use of alternative water qualities) - Mutual understanding of expectations over water quality and of the perceptions of risks	Mills et al., 2004; Casani et al., 2005; Miller, 2006; Hochstrat et al., 2008; Keremane and McKay, 2009; Campbell and Scott, 2011; Bischel et al., 2012; Hanjra et al., 2012; Gómez-Baggethun et al., 2013; Meehan et al., 2013; Ormerod and Scott, 2013; Ribeiro and Kruglianskas, 2013; Fawell et al., 2016; Frijns et al., 2016; Moss et al., 2017; van Leeuwen et al., 2018; Goodwin et al., 2019

Table 2. Barriers towards WCE and water reuse in the scientific literature.

Environmental	
- Impacts to surface water quality (e.g. eutrophication of receiving water bodies) - Impact to groundwater quality by leaching - Detection of pollutants of emerging concern - Soil salinity and contamination with heavy metals - Excess of nutrients (e.g. phosphorous) may translocate to various parts of the ecosystem - Constrains due to hydrological circumstances (e.g. ecological flows) - Sustainability of using reclaimed water as an alternative source to sustain development - Safety of agricultural products irrigated with treated wastewater - High pH of wastewater reduces the effectiveness of pesticides	Scott et al., 2003; Keremane and McKay, 2009; Bischel et al., 2012; Hanjra et al., 2012; Dare et al., 2017; Moss et al., 2017
Spatial	
- Distance between companies inhibits synergies - Spatial and infrastructural organisation of water–land nexus practices - Infrastructural requirements for conveying and delivering treated water to irrigable land	Giurco et al., 2011; Hanjra et al., 2012; Moss et al., 2017
Financial	
- High investment costs for infrastructures (e.g. recycling plant facilities) - Economic constraints prevent treatment plants from operating effectively - Recovery of investment costs (e.g. companies look for short payback times) - Lack of an intelligent price system (e.g. accounting unable to measure water costs, failure to quantify benefits of reuse and unfair distribution of costs and benefits) - Lack of market demand for reclaimed water (e.g. cost of the produced water is too high) - Lack of financial incentives or subsidies for water reuse (e.g. subsidies do not cover costs) - Potential reductions in value for produce grown with reclaimed water - Damage to on-farm irrigation infrastructure - Wastewater related pollution may affect property values	Casani et al., 2005; Miller, 2006; Chen and Lee, 2008; Browning-Aiken et al., 2011; Bischel et al., 2012; Hanjra et al., 2012; Carr and Potter, 2013; Liu and Persson, 2013; Molinos-Senante et al., 2013; Frijns et al., 2016; Moss et al., 2017; Lombardi, 2017; Govindan and Hasanagic, 2018; Nölting and Mann, 2018; Akyol et al., 2020; Gue et al., 2020; Mallory et al., 2020; Saidan et al., 2020
Technological	
- Lack of technical guidelines and reliable recovery technologies for process water treatment (e.g. inability to fully treat wastewater sludge) - Need for additional research for innovative technologies - Lack of consistency in the validation of technologies - Demanding procedures for quality control of processes and complex implementation of water reuse practices (e.g. testing and documentation) - Unclear relationship between indicators and health (e.g. indicators not being a direct index of safety and uncertainties with risk identification and assessment) - Lack of knowledge on emerging chemicals and available information on catchment hazards - Costs of storage facilities for situations of unmatched operating periods - Lack of interrupted flow of reclaimed water	Casani et al., 2005; Chen and Lee, 2008; Campbell and Scott, 2011; Giurco et al., 2011; Bischel et al., 2012; Carr and Potter, 2013; Liu and Persson, 2013; Goodwin et al., 2015; Govindan and Hasanagic, 2018; Ezeudu and Ezeudu, 2019; Akyol et al., 2020; Jiménez-Benítez et al., 2020; Saidan et al., 2020
Social	
- Negative quality, health and safety perception and acceptance of water reuse - Low level of transparency regarding the technical issues (e.g. accessible information and data) - Perception that recycled water will lead to more urban development and will reduce property value - De-industrialisation, farmland abandonment and declining population - Lack of trust in the authorities with influence in the design of water supply and reuse systems	Scott et al., 2003; Daughton, 2004; Giurco et al., 2011; Bischel et al., 2012; Liu and Persson, 2013; Ormerod and Scott, 2013; Frijns et al., 2016; Dare et al., 2017; Guo et al., 2017; Lombardi, 2017; Moss et al., 2017; Govindan and Hasanagic, 2018; Nölting and Mann, 2018; Šteflová et al., 2018; Ezeudu and Ezeudu, 2019; Goodwin et al., 2019; Akyol et al., 2020; Gue et al., 2020
Policy, planning, regulatory and governance	
- Lack of a circular economy framework - Water reuse is yet to be mainstreamed in the core water policies and programs - Lack of proper regulatory guidance - Existing regulations too strict, not flexible and too unenforced - Fragmented or overlapping rules (e.g. conflicting recommendations and terminology) - Lack of relevant training among regulators - Complex and demanding licencing process (e.g. bureaucratic complexity for acquiring permits) - Lack of regulatory clarity on the approval of reuse schemes (e.g. inconsistency in the way different wastewater products are regulated) - Burdensome and complex monitoring requirements (e.g. distribution of information between monitoring agencies is complex) - Poor definition and understanding of responsibilities (e.g. overlapping responsibilities) - Hierarchical top-down policy formation and implementation - Lack of organisational experience with water reuse schemes and continuous learning - Poor understanding of both stakeholder and public attitudes - Lack of capacity to enact comprehensive water and wastewater management policies - Uncertainty over future recycled water uses of projected users - Lack of institutional arrangements on water management and lack of actor's collaboration - Lack of participation of industries and companies and lack of commitment and long-term plans - Information needs and communication obstacles - Wide range of interest groups involved in policy making pose challenges for the policy design - Informal activities	Casani et al., 2005; Bixio et al., 2006; Russel and Hampton, 2006; Chen and Lee, 2008; Bischel et al., 2012; Hanjra et al., 2012; Carr and Potter, 2013; Liu and Persson, 2013; Lenhart et al., 2015; Fawell et al., 2016; Frijns et al., 2016; Dare et al., 2017; Lombardi, 2017; Moss et al., 2017; Chandrasekaran and Jiang, 2018; Govindan and Hasanagic, 2018; Nölting and Mann, 2018; Šteflová et al., 2018; Ezeudu and Ezeudu, 2019; Goodwin et al., 2019; Rupiper and Loge, 2019; Wakhungu, 2019; Akyol et al., 2020; Gue et al., 2020; Jiménez-Benítez et al., 2020; Saidan et al., 2020

Despite an acceptable level of satisfaction among large-volume and low-contact users (e.g. industry, irrigation), concerns related to public health and the lack of knowledge about the water supply system and the role of reclaimed wastewater in the environment, plus the lack of effective communication skills of water utilities, often jeopardise changes in high-contact consumers attitudes (e.g. domestic) towards water reuse (Campbell and Scott, 2011; Fatta et al., 2006; Keremane and McKay, 2007; Mills et al., 2004; Scott et al., 2003; Wilderer, 2005; Dare et al., 2017). The education of key stakeholders, water users and consumers with modern participatory approaches since early stages of decision-making are of paramount importance to assure good acceptance levels, often depending on communication campaigns and on the endorsement by relevant authorities to build confidence regarding product quality. Access to information, robust and transparent databases are essential to inform decision-makers, especially policymakers. Adequate information is relevant to inform the public better and reduce resistance regarding water reuse systems (Keremane and McKay, 2007; Wilderer, 2005). Furthermore, agreements between the supplier of reclaimed water and customers should cover a set of obligations regarding price, quantity, quality, security, safety, liability and legal issues (Saidan et al., 2020).

Economic and financial barriers can also hinder water reuse projects (Molinos-Senante et al. , 2013). Usually, reclaimed water costs mainly benefit large-volume users, and the other low-volume users' willingness to pay must rely on environmental sustainability, sometimes at higher costs, and thus the reclaimed water flat-rate pricing ends up not encouraging conservation (Campbell and Scott, 2011). Therefore, water reuse projects must focus on the cost recovery principle, and the price of the reclaimed water must reflect the producing, delivering, operational and maintenance costs and the capital costs of providing and administering water services. Moreover, water reuse practices may create different economic and financial opportunities. The use of reclaimed water for agricultural and urban irrigation activities in water scarcity contexts seems to help in the correction of allocations to the local environment adding market value to the land and thus reducing stressed water supplies, and nutrient-rich-treated effluent discharges in natural freshwater bodies (Keremane and McKay, 2007; Wilderer, 2005). All the more, a well-established domestic market and increase production build scope for exportation markets in the area and the growth of water-dependent activities creating local job opportunities (Keremane and McKay, 2007). WCE strategies and water reuse practices require water utilities to ensure the adequate and complete treatment to close the loop complying with regulations in place, which challenges the conventional wastewater treatment technologies. Furthermore, water reuse practices' affluence is context-specific, as the technology developed and implemented in industrialised countries is not universally applicable. Also, the time frame within which water technology is to be implemented and the lack of specific technical means and trained personnel exceeds most local entities' capacity to implement these new water reuse infrastructures (Wilderer, 2005).

Amongst the several barriers towards WCE and water reuse, the policy, planning, regulation and governance issues have been known as crucial non-technical barriers (Akyol et al., 2020; Ezeudu and Ezeudu, 2019; Govindan and Hasanagic, 2018; Jiménez-Benítez et al., 2020; Lombardi, 2017). The implementation and adoption of new water loops based on CE solutions (e.g. water reuse) are mostly hindered by regulatory and institutional factors, and established practices of "poor water-conscious design" and planning, including (Capodaglio et al., 2016):

- lack of a coordinated institutional framework;
- regulatory limitations;
- deficit of public communication, engagement and participation;
- knowledge difficulties in understanding and implementing integrated water management planning;
- absence of monitoring indicators for the ex-post evaluation of proposals and long-term vision.

The most common regulatory barriers mentioned in the transition towards WCE and water reuse are the unsuited regulatory framework that may obstruct water reuse projects or complicate their implementation process (Capodaglio et al., 2016; Miller, 2006; Ormerod and Lansey, 2012; Scruggs et al., 2017; Voulvoulis, 2018). While existing laws and regulations are insufficient, new laws and regulation do not consider CE enough (Govindan and

Hasanagic, 2018). Furthermore, existing regulations are mostly limited to irrigation purposes, not for all water reuse purposes (Akyol et al., 2020). A suitable regulatory framework must include, besides the appropriate treatment levels, risk assessment procedures that inform decision making on a case-by-case basis (Voulvoulis 2018). At the European level, the constraints related to the current regulatory framework might be minimised soon after adopting new water reuse regulations. The transposition of these regulations to an effective regulatory regime in each country should ensure a clear link between regulations and risk management, prevent likely conflicting incentives (Fawell et al., 2016).

Policy change and leadership to a spread head dedicated agency to coordinate and regulate all the (regulator training and technology certification) are also recommended as impactful solutions dealing with onsite water reuse systems' challenges (Rupiper and Loge, 2019; Wakhungu, 2019). The development of a governance framework to the planning and implementation of WCE and water reuse systems whilst ensuring public and environmental health is likely to be a complex task (Frijns et al., 2016; Nölting and Mann, 2018). Governance for WCE involves robust inter-linkage of several issues such as sector policies and regulations, financing and pricing, stakeholder collaboration and public participation. It also presents many challenges like overcoming fragmented knowledge and expertise, heterogeneous actors, institutional diversity, and inefficient coordination, adaptation and learning (Frijns et al., 2016; Nölting and Mann, 2018). These challenges may be addressed with the following strategies (Frijns et al., 2016; Nölting and Mann, 2018; Šteflová et al., 2018):

- realistic and clear policy arrangements with integrated approaches for water-land management;
- inter-cooperated institutional framework and a multi-actor guiding framework to improve the cooperation between all actors;
- a platform to share information and enhance stakeholders and public participation;
- a continuous monitoring and evaluation of water reuse practices and associated quality parameters; and
- easy access to financial capital for new reuse schemes and application of more competitive recycled water).

The implementation of WCE and water reuse systems can be facilitated by the central and local governmental entities, at twofold levels. One, at the central level, where governmental entities must provide regulatory and financial support. Another, and at the local level, where governmental entities promote strategies to steer trust and coordination among stakeholders into the creation of long lasting and thriving symbiosis agreements (Lenhart et al., 2015).

As mentioned before, the literature that relates drivers and barriers towards WCE and water reuse with water and spatial planning aspects is scarce. This lack of research on the inter-linkage between circular economy, water and land concerns also occurs in countries where water reuse is foreseen into the water resources planning and management framework (Fatta et al., 2006). From the point of view of the water security, water resources planning can constrain water reuse by imposing conditions on the use of treated wastewater. These may include reducing wastewater discharge that may be prohibited by legal obligations to return flows to downstream administrations and users (Scruggs et al., 2017). The evaluation of the impacts water reuse may have on the water balance is a fundamental aspect. This is so because, with water reuse, the amount discharged on natural streams may be reduced.

Furthermore, at the European level, the transposition of the WFD to member states national into water resources policy and planning systems forces the discharge of an appropriate flow regime defined in River Basin Management Plans, i.e. ecological flows. In this sense, water reuse schemes may interfere with environmental objectives for surface waters, regarding quality and quantity. Therefore, the impacts of new water reuse loops on the environment, particularly in the hydrological regime, must be further assessed, extending the analysis to consider ecosystem services (Voulvoulis 2018). Barriers to water reuse and closed loops of water must be addressed before, or at least, in early phases of planning reuse projects, since this knowledge base can retrofit the proposals facilitating the permitting process and their implementation. Their acknowledgement in early stages of decision-making may facilitate the design, the location of required water transport infrastructures, and the permitting process and their implementation. Wastewater reuse schemes may be planned with the purpose of discharging

water to riverine ecosystems, ensuring ecological flows, and supply additional water to wetlands as a means to prevent seawater intrusion (Cazurra, 2008). A well-planned reuse scheme backed with effective policy, legal and regulatory framework, is likely to contribute positively to develop an extensive and full distribution system (Fatta et al., 2006; Keremane and McKay, 2007).

Generally, minimal attention is given to spatial planning to develop WCE strategy and implementation of alternative sources of water supply and water reuse. However, it is widely acknowledged that building codes, land use, zoning and planning regulations or strategic plans are relevant factors affecting water reuse management and planning (Capodaglio et al., 2016; Lenhart et al., 2015; Ormerod and Lansey, 2012). Symbiotic agreements between industries or water producers and water users are embedded in political, legal, and technical systems that challenge the design and implementation of symbiosis at territorial level, which requires changes to the existing institutional arrangements (Lenhart et al., 2015). The transition to integrated urban resources management is better supported if coordinated in straight connection with spatial planning, in both design and implementation phases of the policy and planning cycles. The location of new industrial districts should consider the proximity to treatment plants as they are potential alternative sources of water. Furthermore, new treatment facilities should consider the proximity to agricultural areas as potential water reuse users.

Dedicated policy instruments and favourable integrated water resources management and land use planning are, therefore, preconditions for a successful transition towards WCE and implementation of new water reuse loops, since they can favour, or hinder, the main drivers and barriers identified in the literature. Furthermore, the transition towards WCE with innovative adaptations and changes in the water supply systems and the implementation of new water reuse loops, raise new challenges caused by new types of water, new water producers, new water users, and new risks new responsibilities, and new infrastructures. Proper handling of these new challenges requires, therefore, adequate policies, plans, and regulations to define objectives, norms and guidelines, namely, to accommodate in the existing water management system, new water producers, new water types, new water users and the challenges they may bring to the water governance in place. Among these challenges is the need to define authorities and stakeholders' responsibilities. It also includes the need for re-evaluating permits and contractual relations between water producers and water users, considering fit-for-purpose water quality standards, establishing monitoring and communication strategies, and defining risk assessment and management tools, amongst others. Since the implementation of the new water loops foreseen with the technologies developed under the Project Ô, challenge current water use and reuse practices, these concerns motivate the assessment of the institutional set-up in place, while focusing on the policy, planning, regulatory and governance dimensions. Before proceeding to that assessment, the next section briefly presents the broad features of the EU context for WCE as three of the four case studies are inserted in the European Union.

3. Broad features of the EU context for water circular economy

At the institutional level, there are relevant initiatives from the European Union (EU) and European Commission (EC) that were launched to incentivise countries, communities and the business sector to implement WCE and water reuse in particular, as shown in the timeline of Figure 8. Water reuse was first mentioned in EU legislation in 1991, in the Urban Wastewater Treatment Directive (UWWTD; Directive 1991/271/EEC), when mentioning treated wastewater shall be reused whenever appropriate (UWWTD, 1991; Art. 12). This directive concerns the collection, treatment and discharge of wastewater from urban and certain industrial sectors. Its main objective is to protect the environment from the adverse effects of these discharges. The term appropriate means that the reuse of treated wastewater is possible, as far as it is not forbidden or restricted by any other EU legislation, does not compromise the implementation of international commitments, nor does affect the achievement of the EU objectives set up in other legislation (BIO, 2015). It is considered that the potential for treated water reuse in the EU is directly linked with the level of implementation of the UWWTD. This directive requires efficient and reliable

secondary (or even tertiary) treatment of urban effluents as a minimum condition for the subsequent water reuse. The construction or adaptation of wastewater treatment plants (WWTP) may offer a significant opportunity to consider possible reuse applications, and integrated, and well-designed solutions may be developed at competitive costs (BIO, 2015).

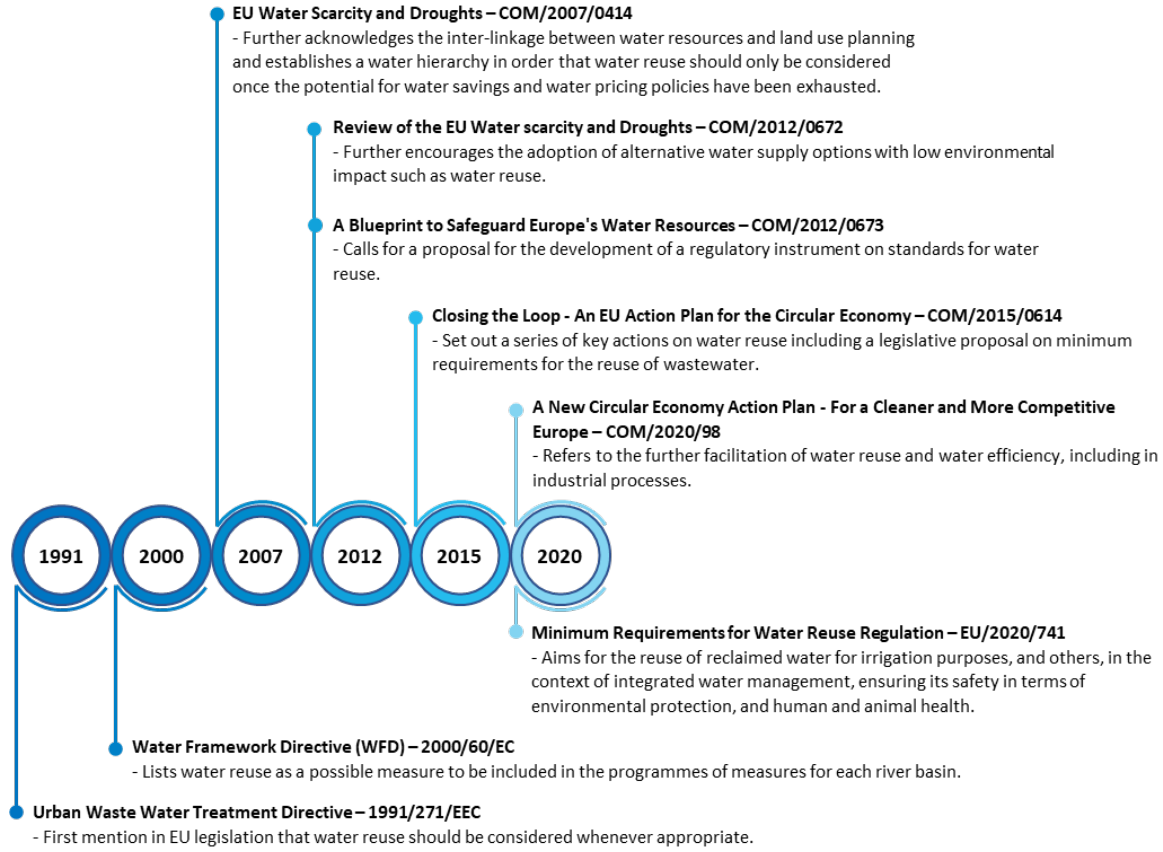


Figure 8. Timeline of EU policy, regulatory and planning initiatives relating to water reuse in the transition to WCE.

The Water Directive Framework (WFD; Directive 2000/60/EC) established the legal framework for water management and environmental protection of water, including surface water and groundwater, based on the concept of river basin planning, aiming to guarantee enough good quality water across Europe as needed for the different water uses, and the environmental quality of this water (WFD, 2000). This directive considers efficiency and reuse measures, inter alia, for the promotion of water-efficient technologies in industry and water-saving techniques for irrigation, recreation and restoration of wetland areas, desalination plants, artificial recharge of aquifers, amongst others. It is sought as a means of increasing water availability and contributes to the good status of water resources (WFD, 2000; Annex VI) and, therefore should be considered as an option as part of the Programmes of Measures (PoMs) within each river basin district to be established when implementing the WFD (WFD, 2000; Art. 11). Apart from this, some other mandatory steps of the WFD are also very favourable for the strategic planning of water reuse, such as (WFD, 2000; Art. 5 and 9):

- review of the impact of human activity on the status of surface waters and groundwater and economic analysis of water use;
- recovery of the costs of water services,
- ensuring that water-pricing policies provide adequate incentives for users to use water resources efficiently and having regard to the social, environmental and economic effects of the recovery as well as the geographic and climatic conditions of the region or regions affected, and
- ensuring public information and consultation, encouraging the active involvement of all interested parties, including users.

These mandatory steps constitute a well-grounded basis for identifying where reclaimed water reuse practices can be successful and long-term options, without compromising further economic development (JRC, 2014).
While water reuse can help to contribute to the objectives of the WFD by increasing water availability and contribute to a good quality status of water resources, it might also conflict with other objectives of the WFD, namely the ecological status of surface waters. Water reuse may result in less water being discharged to a surface water body (e.g. river), which may negatively affect the flow regime downstream of the discharge stream. This may directly affect the ecological flow (i.e. the amount of water required for the aquatic ecosystem to continue to thrive and provide the services we rely upon) and indirectly change the water body's ability to dilute pollutants discharged into it (EC, 2016; p. 43). Planning for the reuse of treated wastewater within the context of the WFD should not be separated from other planning instruments, such as River Basin Management Plans (RBMP) and Municipal Master Plans (MMP). The planning inter-linkages include the following examples:

- water reuse can be used as a measure to mitigate water scarcity and, therefore, planning should be undertaken alongside the RBMP or specific water scarcity and drought management plans;
- water reuse is an auxiliary water source and, therefore, planning needs to be undertaken alongside consideration of water demand changes and use of other sources for particular water demands, as well as opportunities and constraints on expanding water infrastructure, as identified in the MMP or other urban or rural land use plans (EC, 2016; p. 56).

In these integrated planning processes and throughout their implementation, it is essential to identify the different key stakeholders (e.g. different planning managers) that need to be engaged with and when this needs to happen (EC, 2016; p. 56). It is also important to note that different planning processes may be subject to different forms of impact assessment and analysis tools, such as strategic environmental assessment, environmental impact assessment, cost-benefit assessment, life cycle analysis, water balance analysis, water footprint analysis, and health and environmental risk assessment (EC, 2016; p. 59).

The inter-linkage between water resources and land use planning was further acknowledged in the EC Communication Water Scarcity and Droughts in EU (COM/2007/0414). There it is stated that land-use planning is also one of the main drivers of water use, and that inadequate water allocation between economic sectors results in imbalances between water needs and existing water resources (CEC, 2007). A pragmatic shift is required to change policy-making patterns and move forward effective land-use planning at the appropriate levels. All production, including irrigated and biomass production and all economic activities should be adapted to the amount of water available locally (CEC, 2007). The mismanagement of water resources is often seen as a result of ineffective water pricing policies. These are blamed for not reflecting the level of sensitivity of water resources at the local level and that the national priorities can also be counterproductive in promoting additional water supply infrastructure as the primary option, going against the logic of the water hierarchy and the need to support water-saving and efficiency measures in the first place (CEC, 2007). Recommendations point out to water tariffs based on consistent economic assessments of water uses and water value, appropriate incentives to use water resources efficiently, and contributions to recover water services costs from the different water uses (CEC, 2007). In compliance with WFD requirements, it should be considered a water hierarchy in river basins and regions to guide the adoption of preventive measures (from water-saving to water pricing policy and alternative solutions). It should also be taken into due account of the cost-benefit dimension, and where demand still exceeds water availability, additional water supply infrastructure can in some circumstances be identified as alternative ways of mitigating the impacts of severe drought (CEC, 2007). The Review of the EC Communication Water Scarcity and Droughts in EU (COM/2012/0672) further encourages the adoption of alternative water supply options with a low environmental impact such as water reuse and further re-emphasises the need for proper integration between RBMP and other economic and physical planning processes (EC, 2012b).

Since then, water reuse has gained a prominent place in the European water policy as an alternative water supply option. The EC Communication A Blueprint to Safeguard Europe's Water Resources (COM/2012/0673) states that following stakeholders' consultation, the alternative water supply of water reuse for irrigation or industrial purposes has emerged as an issue requiring attention (EC, 2012a). Water reuse from wastewater treatment or

industrial installations was considered to have a lower environmental impact than other alternative water supplies (e.g. water transfers or desalinisation). However, it is only used to a limited extent in the EU, mainly due to the 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. Therefore, it was established that regulatory instruments on standards for water reuse would be proposed by 2015 (EC, 2012a). Adding to this perspective, the EC Communication Closing the Loop - An EU Action Plan for the Circular Economy (COM/2015/0614), within the scope of water scarcity and its damaging effects on the environment and economy. It states that in addition to water-efficiency measures, the reuse of treated wastewater in safe and cost-effective conditions is a valuable but under-used means of increasing water supply and alleviating pressure on over-exploited water resources in the EU (EC, 2015). It further states the need to pursue with a series of actions to promote the reuse of treated wastewater, including legislation on minimum requirements for reused water, such as for irrigation and groundwater recharge, and to promote safe and cost-effective water reuse, including guidance on the integration of water reuse in water planning and management, the inclusion of best practices in relevant reference documents, and support to innovation and investment (EC, 2015). The transition to a more CE, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised, is said to boost the EU's competitiveness by protecting businesses against scarcity of resources and volatile prices, helping to create new business opportunities and innovative, more efficient ways of producing and consuming and save energy and help avoid the irreversible damages caused by using up resources at a rate that exceeds the Earth's capacity to renew them in terms of climate and biodiversity, air, soil and water pollution (EC, 2015). Innovative industrial processes such as symbiosis agreements between industries are among the different measures proposed to achieve more CE since they allow waste or by-products of one industry to become inputs for another (EC, 2015).

The most recent version of the EU action plan for CE, the EC Communication A new Circular Economy Action Plan - For a cleaner and more competitive Europe (COM/2020/98) refers the new water reuse regulations, as an instrument to encourage circular approaches to water reuse in agriculture and the further facilitation of water reuse and efficiency, including in industrial processes (EC, 2020). Recently, the EU has adopted the Regulation on Minimum Requirements for Water Reuse (RMRWR; Regulation EU/2020/741), laying down the minimum requirements for water quality and monitoring and provisions on risk management, for the safe use of reclaimed water in the context of integrated water management (RMRWR, 2020; Art. 1). This regulation intends to guarantee that reclaimed water is safe for agricultural irrigation, thereby ensuring a high level of protection of the environment and of human and animal health, promoting the CE, supporting adaptation to climate change, and contributing to the objectives of WFD by addressing water scarcity and the resulting pressure on water resources, in a coordinated way throughout the EU (RMRWR, 2020; Art. 1). It should be applied whenever treated urban wastewater is reused, following the UWWTD, for agricultural irrigation and further uses, such as industrial water reuse and amenity-related and environmental purposes (RMRWR, 2020; Annex I, Section 1). Possible exemption from this regulation is given to research or pilot projects about reclamation facilities, providing that the research or pilot project will not be carried out within a water body used for the abstraction of water intended for human consumption or a relevant safeguard zone designated according to WFD and that the research or pilot project will be subject to appropriate monitoring (RMRWR, 2020).

The implementation of water reuse systems involves a series of infrastructure necessary for producing, supplying and using reclaimed water, and a series of different elements and actors from the entry point of the urban wastewater treatment plant to the point where reclaimed water is used, including distribution and storage. Therefore, it is necessary to clearly define the point where a reclamation facility operator delivers reclaimed water to the next actor in the chain (point of compliance), and to clarify the responsibilities of the different actors (e.g. reclamation facility operator, reclaimed water distribution operator, reclaimed water storage operator, end-users) (RMRWR, 2020; Preamble 15). On the obligations regarding the reclamation facility operator and reclaimed water quality, it is stated that 'the reclamation facility operator shall ensure that, at the point of compliance, reclaimed water' complies with the following issues:

- the minimum requirements for water quality laid down in Section 2 of Annex I,

- any additional conditions set by the competent authority in the relevant permit according to any conditions about additional requirements for the reclamation facility operator, set out in the plan of water reuse risk management and,
- any other conditions necessary to eliminate any unacceptable risks to the environment and human and animal health so that any risks are of an acceptable level.

Moreover, beyond the point of compliance, the water quality shall no longer be the responsibility of the reclamation facility operator (RMRWR, 2020; Art. 4).

The reuse of adequately treated wastewater (e.g. from urban wastewater treatment plants), is considered to have a lower environmental impact than other alternative water supply methods (e.g. water transfers or desalination). However, it still presents potential risks for health and environmental and obstacles to the free circulation of agricultural products irrigated with reclaimed water (RMRWR, 2020; Preambles 9). Therefore, it is necessary to ensure that the use of reclaimed water is safe, thereby encouraging water reuse at EU level and enhancing public confidence in it (RMRWR, 2020; Preambles 23). In this sense, the production, supply, and use reclaimed water is subjected to establishing a water reuse risk management plan and a reclaimed water permit under the competent authority's supervision. The water reuse risk management plan is to be prepared by the reclamation facility operator, other responsible parties and end-users, as appropriate' in consultation with 'all other relevant responsible parties and end-users. The water reuse risk management plan must be based on all the critical elements of risk management set out in Annex II, outlined in Table 3, and it must assure the following issues (RMRWR, 2020; Art. 5):

- identify the risk management responsibilities of the reclamation facility operator and other responsible parties,
- set out any requirements for the reclamation facility operator to further mitigate any risks before the point of compliance,
- identify hazards, risks and appropriate preventive and possible corrective measures, and
- identify additional barriers in the water reuse system and set out any additional requirements, which are necessary after the point of compliance to ensure that the water reuse system is safe, including conditions related to distribution, storage and use where relevant, and identify the parties responsible for meeting those requirements.

An application for a permit (or for modification of existing permit) must be submitted by the responsible parties in the water reuse system, including the end-user where relevant. The permit must be based on the water reuse risk management plan. When analysing the application permit, the competent authority shall consult and exchange relevant information with other relevant authorities, in particular, the water and health authorities if different from the competent authority (RMRWR, 2020; Art. 6).

Information should be provided to assure the confidence of the public on the security of reused water. Making available clear, comprehensive and updated information on water reuse may allow increased transparency and traceability. Stakeholders should be made aware of the benefits of water reuse (RMRWR, 2020; Preambles 9). Therefore, Member States should set up general awareness-raising and information campaigns on the savings of water resources as a result of water reuse, including the promotion of the benefits of safe water reuse (RMRWR, 2020; Art. 9). To promote and encourage water reuse, the indication of specific uses within this regulation should not preclude the Member States from allowing the use of reclaimed water for other purposes, including industrial, amenity-related and environmental purposes, as considered necessary in the light of national circumstances and needs, provided a high level of protection of the environment and of human and animal health is ensured (RMRWR, 2020; Preambles 29). Moreover, the Commission shall carry out an evaluation of this regulation and shall assess the feasibility of extending the scope of this Regulation to reclaimed water intended for further specific uses, including reuse for industrial purposes and to cover the indirect use of treated wastewater (RMRWR, 2020; Art. 12).

Table 3. Key elements of the water reuse risk management plan of the Minimum Requirements for Water Reuse Regulation (RMRWR, 2020; Annex II)

Key elements
Description of the entire water reuse system, from the entry of wastewater into the urban wastewater treatment plant to the point of use, including the sources of wastewater, the treatment steps and technologies, the supply, distribution and storage infrastructure, the intended use, the place and period of use, the irrigation method, the crop type, other water sources if a mix is intended to be used and the volume of reclaimed water to be supplied.
Identification of all parties involved in the water reuse system and a clear description of their roles and responsibilities.
Identification of potential hazards, in particular the presence of pollutants and pathogens, and the potential for hazardous events such as treatment failures or accidental leakages or contamination of the water reuse system.
Identification of the environments and populations at risk, and the exposure routes to the identified potential hazards, taking into account specific environmental factors, such as local hydrogeology, topology, soil type and ecology, and factors related to the type of crops and farming and irrigation practices.
Assessment of risks to the environment and to human and animal health, taking into account the nature of the identified potential hazards, the duration of the intended uses, the identified environments and populations at risk of exposure to those hazards and the severity of possible effects of the hazards considering the precautionary principle and minimum requirements in relation to food and feed and worker safety.
Consideration of additional requirements for water quality and monitoring, when necessary and appropriate to ensure adequate protection of the environment and of human and animal health, in particular when there is clear scientific evidence that the risk originates from reclaimed water and not from other sources.
Identification of preventive measures that are already in place or that should be taken to limit risks so that all identified risks can be adequately managed.
Adequate systems and procedure for quality control, environmental monitoring and emergencies management.
Ensure that coordination mechanisms are established amongst different actors to guarantee the safe production and use of reclaimed water.

This regulation stands out because new adaptive water governance will have to emerge to establish water reuse as a consolidated alternative source of water supply. This entails the constitution of a proper well-defined policy and regulatory environment at the EU and national level and the creation of new institutional arrangements or the transformation of current ones. Only by these means it seems feasible to properly articulate the set of new actors in water supply chains and tackle the management of the redistribution of responsibilities and risks that comes with creating new water loops. Therefore, the cooperation and interaction between the various parties involved in the water reclamation process should be a precondition for setting up reclamation treatment procedures following the requirements for specific uses, and in order to be able to plan the supply of reclaimed water (i.e. the establishment of new water reuse systems and new water loops) in line with demand from end-users (RMRWR, 2020; Preamble 18).

4. Analytical framework to assess policy and planning contexts

The previous sections presented the theoretical context supported by a literature review on WCE in water reuse, focusing attention on its relationship with integrated water management and the water-land nexus. That context was concluded with the identification of the main types of drivers and barriers, especially those associated with water resources and land use policy and planning contexts. This section presents the features of the analytical framework designed to assess the policy and planning contexts on the four demo sites of Project Ô. The main steps used to design and implement the analytical framework are summarized in Figure 9.

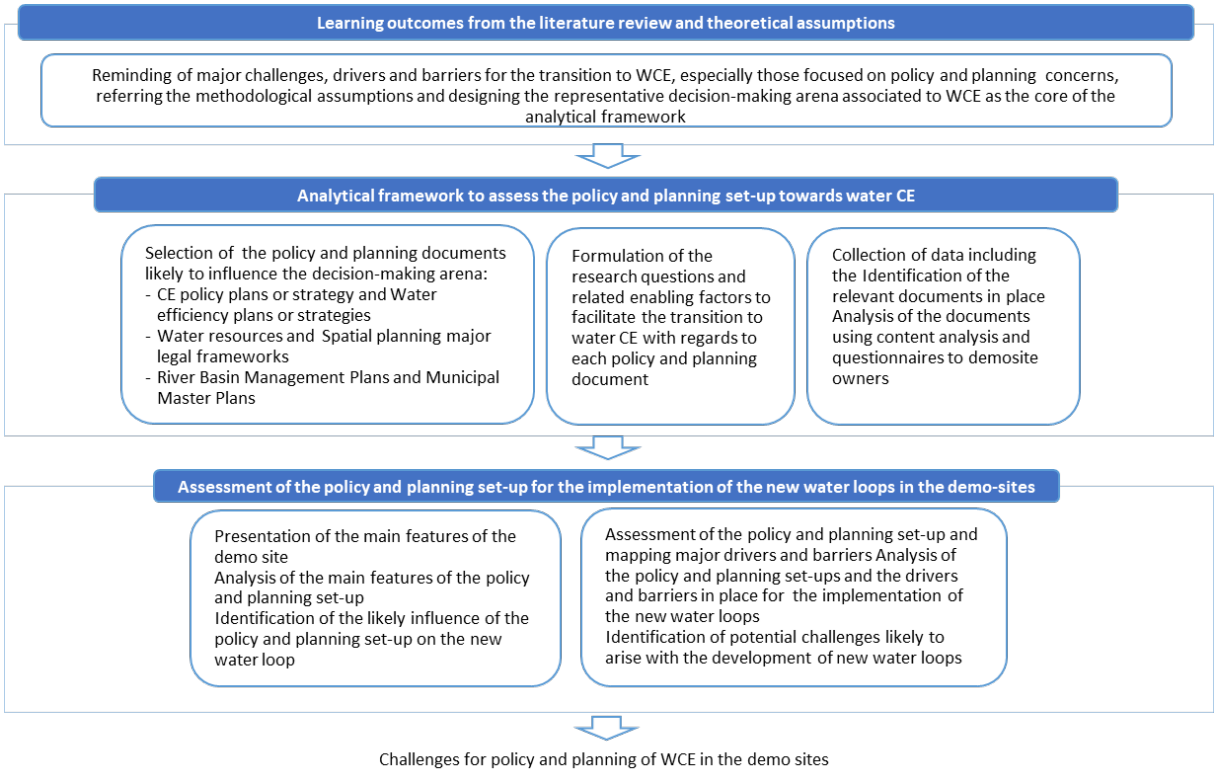


Figure 9. Steps used to design and implement the analytical framework.

As observed, the transition to WCE, by entailing the implementation of new water loops, generates different types and qualities of water, new responsibilities for users or producers and new types of risks to the water cycle (Frijns et al., 2016; Goodwin et al., 2019; IWA, 2016). This transition can challenge institutional arrangements, to adopt well-defined policies, plans, regulations, and governance practices (e.g. integrated policies, water reuse regulations, water-wise planning, integrated basin governance systems). Without an adequate contextual set-up, establishing a robust institutional set-up capable of handling the new challenges, is prone to be difficult and risky.

Water recycling and reuse can be incentivised through policy instruments such as dedicated policy plans, framework laws, and additional regulations that challenge how water resources and their circularity are perceived by the national and local communities' contexts. For these reasons, the EC has been working on policies, legislation or other instruments to boost water reuse when it is cost-efficient and safe for health and the environment (EC, 2018). Besides, applying the CE concept and principles to the territory and cities creates the opportunity to think about the nexus between vital resources such as water and land, which gains space in policy and science as a transition path towards sustainability. Policy, planning and regulatory contexts, with related guidelines, licensing and risk-management tools (Grant et al., 2012) are considered as key drivers of CE. Moreover, the discourse of policy and planning documents is likely to influence the institutionalisation of emerging concepts and actors' related behaviour (Phillips, Lawrence, & Hardy, 2004). In this case, the WCE and the related decision-making arena.

The analytical framework's core is based on the design of a typical decision-making arena associated with the WCE (see Figure 10). It departs from a water reuse loop, characteristic of water CE (the inner circle). It assumes that it is likely to be influenced by different types of actors involved in the design, implementation and monitoring of the new water loop (the middle circle) and by different policy, legal, regulatory and planning instruments likely to influence the behaviour of those actors (the outer circle). The contents of the policy and planning documents and the behaviour of the various actors can favour, or hinder, the main drivers and barriers identified for the transition to water CE (left side). Enabling factors (right side) for the transition to WCE are also part of the design, which, if applied to a real set-up, can provide relevant information for a feasibility analysis (bottom row), i.e., for the

assessment of the institutional set-up to accommodate the new water loops foreseen with the development of the technologies under Project Ô. This report focuses mainly on the policy and planning approaches.

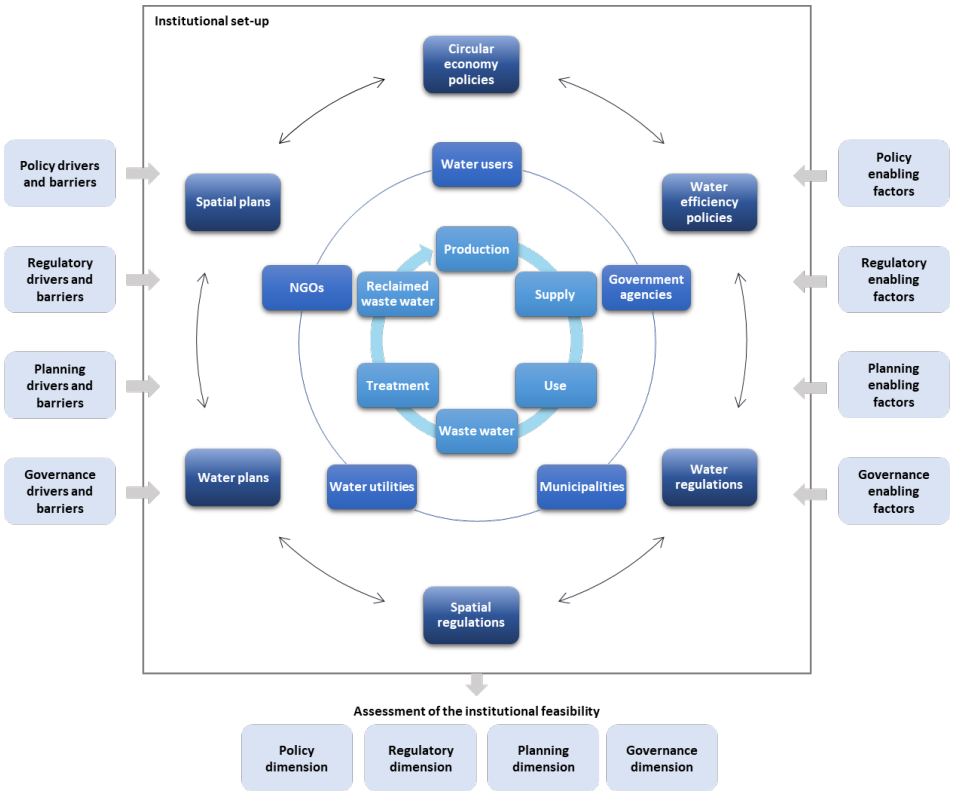


Figure 10. Problem framing used for the assessment of the institutional feasibility towards water circular economy.

An additional component of the analytical framework is the selection of types of policy and planning documents relevant to assess the institutional set-up taking into account the challenges of the WCE with regards to the IWRM water concept and the nexus water-land, as mentioned in section 2. For this study, the following three typologies of policy and planning documents were considered:

- a first type includes action plans or strategies for CE and the action plans or strategies for the efficient water use (or document including the country's vision for the efficient management of the water sector). These are relevant to assess how water reuse is considered a major objective under the circularity policy principles and aims.
- a second type includes national framework laws on water and land management. These are relevant to explore how water reuse, the circularity principles, and the interlinkages between water and land issues, are foreseen and open to new circularity principles.
- a third type includes the most important types of plans influencing water resources protection, river basin management plans and spatial master plans. The first is relevant to assess how water management measures incentivize the water reuse and circularity principles and the second to assess how land-use zoning codes or rules are likely to hinder or foster circularity approaches and the location of new water infrastructures.

Policy and planning processes, and related documents, on water resources and land management are based on complex institutional and legal frameworks and often vary across countries. Nevertheless, the sets of documents chosen, are usually adopted in most countries, especially in the EU context, and are likely to establish, respectively, guidelines for WCE and water reuse, major policy objectives related to water reuse and land interlinkage, and for measures for water protection and prescribing particular land uses for specific locations. Figure 11 lists the enabling factors associated with each type of document, likely to favour or hinder the transition to the water reuse and CE, considered for analysis.

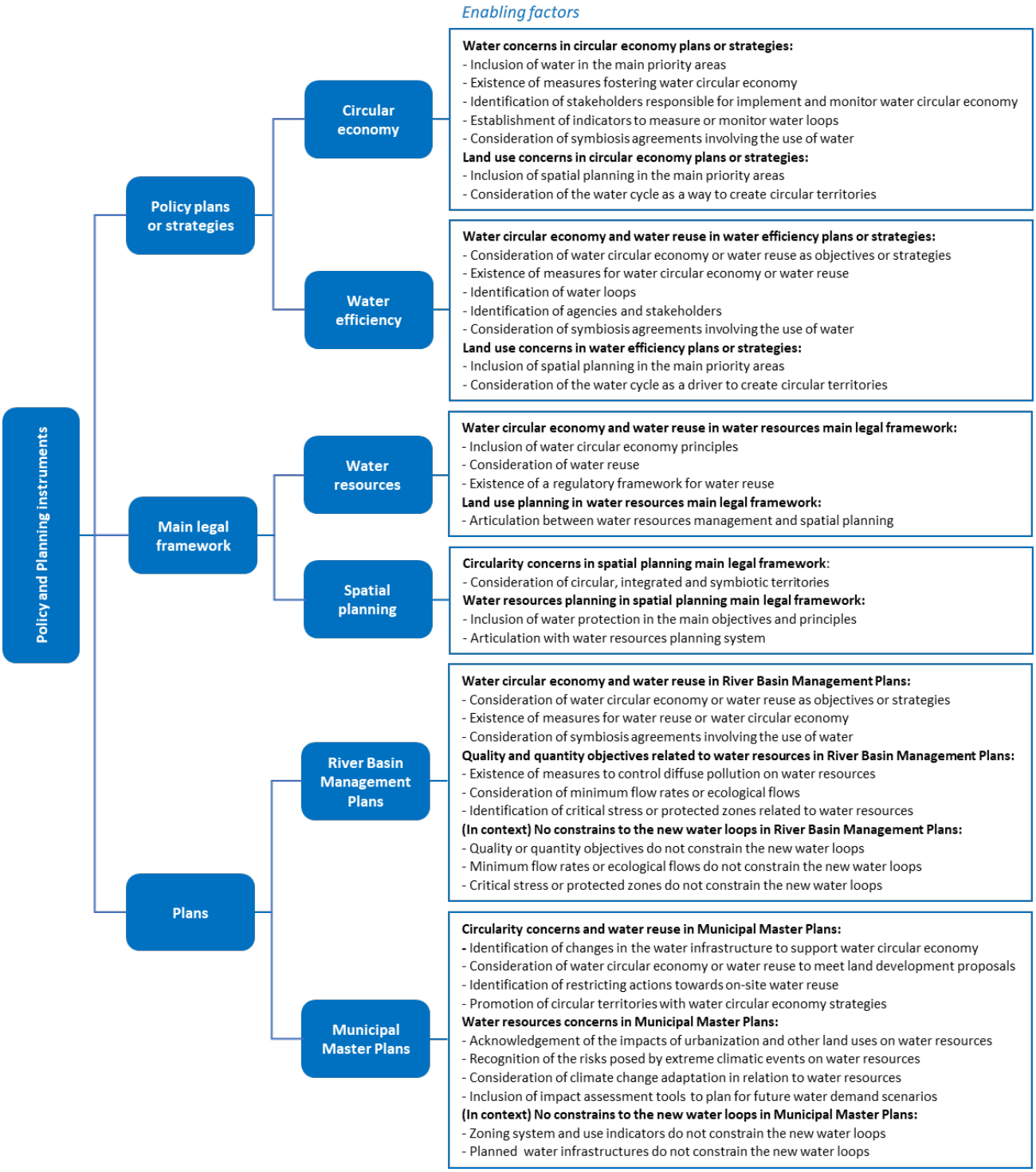


Figure 11. Enabling factors associated with the policy and planning instruments in place, for the transition to WCE and the implementation of new water loops.

These enabling factors were then, used to guide the content analysis of the documents, considered representative of the policy and planning set-up associated with each demo site. The policy, legal and planning documents identified for analysing the institutional set-up of the demo sites, namely Almendralejo (Spain), Lecce (Italy), Omis (Croatia) and Eilat (Israel), are listed in Table 4. The identification and reading of the documents were supported by Project Ô partners close to the demo sites.

Table 4. Identified documents for analysing the institutional set-up for the demo sites.

Type of document	Almendralejo (Spain)	Lecce (Italy)	Omis (Croatia)	Eilat (Israel)
Strategy or plan for circular economy	- Circular Spain 2030 - Spanish Strategy of Circular Economy (GE, 2018) - Extremadura 2030 - Green and Circular Economy Strategy (JE, 2018)	- Towards a Model of Circular Economy for Italy Overview and Strategic Framework (MATTM and MiSE, 2017)	- Sustainable Development Strategy of the Republic of Croatia (NN 30/2009)	- Israel Sustainability Outlook 2030 (MoEP, 2012)
Strategy or plan for efficient water use	- Preliminary Document of the National Plan for Purification, Sanitation, Efficiency, Savings and Reuse (MITECO, 2018)	- Water Protection Plan of Puglia Region 2015-2021 (RP, 2019)	- Water Management Strategy (NN 91/2008)	- Long-Term Master Plan for the National Water Sector (WA, 2012);
Water resources main legal framework	- Water Law (RD 1/2001) - National Hydrological Plan (Law 10/2001) and - Amendment to National Hydrological Plan (Law 11/2005) - Legal Regime for the Reuse of Treated Water (RD 1620/2007)	- Environmental Code (DL 152/2006) - Technical Rules for the Reuse of Waste Water (D 2 May 2006) - Technical Rules for the Agronomic Use of Manure and Waste Water (D 25 February 2016) - Regional Regulatory Regime for the Reuse of Purified Wastewater (RR 8/2012)	- Water Law (NN 66/2019)	- Water Law (Law 5719/1959) - Wastewater Quality Standards and Rules for Sewage Treatment (R 5769/2010) - Quality Standards for Output Water from Fish Ponds and Rules for their Use (R 5772/2012)
Spatial planning main legal framework	- Land and Urban Rehabilitation Law (RD 7/2015) - Land and Territorial Planning of Extremadura (Law 15/2001)	- Urban Planning Law (Law 1150/1942) - Law on the Organization of Local Authorities (DL 267/2000) - Cultural Heritage and Landscape Code (DL 42/2004)	- Law on Spatial Planning (NN 153/2013)	- Planning and Building Law (Law 5725/1965); - National Parks, Nature Reserves, National Sites and Memorial Sites Law (Law 5758/1998)
River Basin Management Plan (RBMP)	- Hydrological Plan of the Spanish Part of the Hydrographic Demarcation of Guadiana for the cycle of 2016-2021 (CHG, 2016)	- Water Management Plan of the Southern Apennines Hydrographic District for the cycle 2016-2021 (DIAM, 2016)	- River Basin Management Plan for the cycle 2016-2021 (HV, 2016)	- Master Plan for Drainage and Canalization of Eilat, the Eilot Area and the Southern Arava (ADA, 2010)
Municipal Master Plan (MMP)	- Municipal Master Plan of Almendralejo (AA, 2016)	- Preliminary Programming Document of the Urban Master Plan of Lecce Municipality (CL, 2011)	- Spatial Development Plan of the City of Omis (CO, 2016)	- Eilat Outline Plan (CE, 2020)

The document analysis seeks to understand whether and how WCE is considered in policy plans and existing water and spatial planning framework. It also seeks to identify what types of barriers and drivers are likely to be faced with the implementation of the Project Ô new water loops on the demo site areas. The analysis of policy documents, essentially based on the discourse and content analysis, supported by the contributions of Fairclough (2001b, 2001a) Flyvbjerg (2001), Gee (2005) or Hajer & Versteeg (2005), among others. The analysis of the documents was complemented by a questionnaire addressed to Project Ô partners closely associated with the demo sites. The results of the analysis are presented as follows:

- First, they are used to characterize the policy and planning set-up covering the demo sites and their preparedness to accommodate the WCE;
- Second, they are used to assess whether the current policy and planning set-up constrain the implementation of the new water loops proposed by Project Ô;
- Third, an overall assessment of the policy and planning set-up and a mapping of the major types of drivers and barriers are presented.

5. Policy and planning set-up on the demo sites

This section presents the assessment of the policy and planning set-up on the demo sites. It is organised into two sections. The first section presents the data analysis results according to the analytical framework presented in the previous section. The data reflects the content analysis undertaken for each demo site's selected type of documents, and the project partners' replies to the previously sent questionnaires (see Appendix 1). The results' presentation is organised into three components:

- The brief features of the location
- The features of the policy and planning set-up
- Their likely influence on the new water loops proposed by the Project Ô technology

The second section undertakes a comparative assessment of the policy and planning set-up and a mapping of the major drivers and barriers towards implementing the new water loops foreseen under Project Ô.

5.1 Assessment of policy and planning set-up in the demo sites

5.1.1 Almendralejo (Spain)

Main features of the demo site

In this demo site, Project Ô will install the new technology in the WWTP of the city of Almendralejo, located in the region of Extremadura in Spain. Almendralejo is located in the Guadiana River's transboundary basin in the Iberian Peninsula (Figure 12). The WWTP, as well as the entire water services in the city, is managed by Socamex S.A. and serves the city citizens and local industries by treating over 2.5million m3/year of surface runoff from the urbanized area, wastewater from about 35,000 inhabitants, together with industrial wastewater mainly from agro-food industries, such as producers of olives, olive oil, wine, other vegetable canneries and associated processing and packaging. The WWTP discharges most of the treated wastewater in the Harnina River, an affluent of the Guadajira River, which is an affluent of the Guadiana River. A small part of the treated wastewater is already reused inside the WWTP, including for cleaning, watering and drip irrigation. The supply of fresh water to the city of Almendralejo is carried out by direct abstraction from the Guadiana River, at the confluence with the Matachel River.

Processes related to the production of olives and olive oil generates wastewater that is particularly problematic for the WWTP. Adding to this, accidental industrial spills put in circulation contaminants that are too toxic for biological treatment and, therefore, can damage the WWTP and end-up as untreated discharges with detrimental effects on the environment. This demo site's primary goal is to develop a treatment module capable of timely detection and proper treatment of accidental industrial spills that may occur. It will assure continuous monitoring of the wastewater already gone through the whole WWTP process, to perform the final elimination of particular micro-pollutants. It aims to produce high-quality water to be reused for street washing, watering of gardens and irrigation of crops, in compliance with European and national legislation for urban wastewater treatment and water reuse. It is also foreseen that the water reuse system developed at this demo site will allow to control and reduce water abstraction in the Guadiana River Basin, especially for irrigation purposes, and therefore reduce problems of water scarcity compliance with the environmental objectives of the WFD.

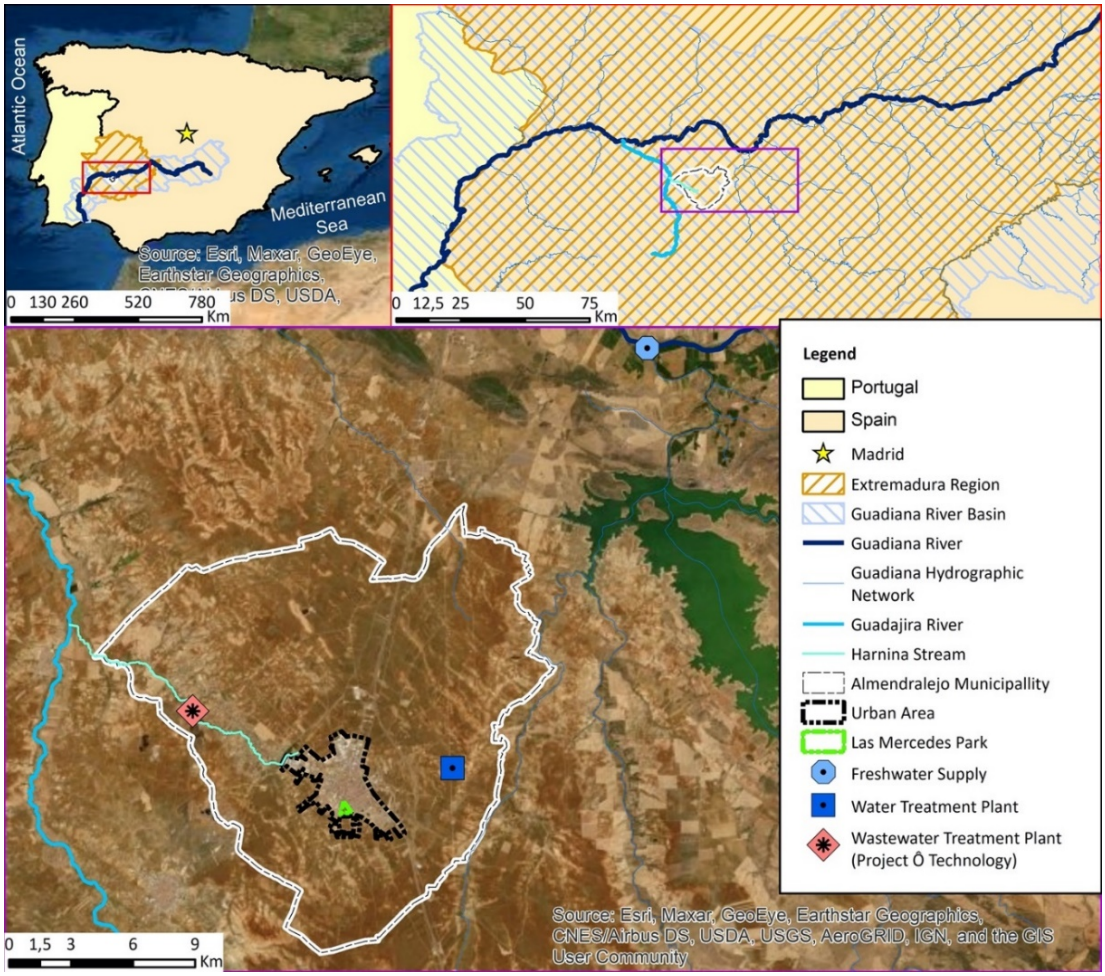


Figure 12. Demo site of Almendralejo (Spain): a) Location within the Region of Extremadura in Spain, and the transboundary Guadiana River Basin in the Iberian Peninsula; and b) Main features of the demo site.

Overall, the reuse of treated wastewater is an accepted and developed practice in Spain (Angelakis and Durham, 2008) and has become an integral and effective component of long-term water resources management. Spain is considered the country with more wastewater reuse experience in Europe (Angelakis and Durham, 2008), and water reuse schemes have significantly advanced since 2000 (BIO, 2015). Still, by 2017, only 12% of treated wastewater was further reused, which is a number clearly behind the rates verified in other European countries, such as Cyprus and Malta (EC, 2018; p. 8). Water reuse practices are expected to be further developed in the future since their potential is estimated to be far more significant in Spain than other European countries (Angelakis and Durham, 2008; BIO, 2015).

Main features of the policy and planning set-up

Spain has adopted a cross-sectorial national strategy for CE in the document Circular Spain 2030 - Spanish Strategy of Circular Economy (GE, 2018). This document incorporates the water reuse as an individual axis separated from other raw materials, given its recognised importance in the Iberian Peninsula, notable impact on the Spanish economy, and Spain's prominent position concerning water reuse practices (GE, 2018; p. 29). The strategy includes specific measures for the development of water reuse practices, aiming to reduce pressures on water resources and, consequently, to foster the implementation of the water CE in the country (GE, 2018; p. 128), namely:

- Adjustment of the current national water reuse regulation to the European level regulation on minimum requirements for water reuse and preparation of its implementation with guidance documents;
- Support for irrigation projects with water reuse;
- Integration of water reuse actions in RBMPs;

- Promotion of research to establish the minimum quality criteria required for water reuse, from health and environmental points of view.

The implementation of these measures should include the involvement of different agents, namely the Directorate General for Rural Development and Forestry Policy, the Directorate General for Water of the Ministry of Agriculture and Fisheries, Food and Environment (MAPAMA), and the Directorate-General for Public Health, Quality and Innovation of the Ministry of Health, Social Services and Equality (MSSSI) (GE, 2018; Annex II). However, water utilities are not specifically mentioned. Specific indicators to monitor these water reuse measures are mentioned, such as the number of investments on water reuse (GE, 2018; p. 169-170). More specific indicators to measure or monitor water loops are not mentioned. Nevertheless, it refers to a particular working group created within the network of environmental authorities to establish other indicators to monitor the CE, including those already considered by the autonomous communities, as well as the proposals that are being worked at national, European and international level (GE, 2018; p. 154). The issues of spatial planning and circular territories are not considered in the strategy. The existence of support for industrial symbiosis is mentioned in the strategy (GE, 2018; p. 176), but not specifically related to water use.

The Region of Extremadura, where Almendralejo is inserted, adopted a regional CE strategy with the document Extremadura 2030 - Green and Circular Economy Strategy (JE, 2018). This document includes sustainable water management in its functional objectives and considers water a public asset necessary to achieve fundamental human rights, and a key element of the CE and the environment (JE, 2018; p. 185). The strategy includes specific measures fostering the development of water in CE through a set of sustainable water management measures that specifically include closed loops of water (JE, 2018; p. 185). The need to increase efficiency in the use of water resources and the implementation of harvesting and reuse techniques to reduce the future vulnerability of the region to climate change is addressed in the strategy (JE, 2018; p. 194). Furthermore, specific measures to ensure the implementation of the WFD and other environmental European directives are also included (JE, 2018, p. 194), namely:

- Development of drought action plans in articulation with the climate change adaptation plans;
- Improvement of the natural hydrological cycle, with the maintenance of ecological flows;
- Measures to manage water infrastructures (catchment, drinking water treatment, distribution, storage and purification), with plans that address risks posed by extreme events.

According to the regional CE strategy, the efficient, supportive, and integrated management of the water resources requires the maximum participation, dialogue and consensus among the different agents involved, namely non-governmental organisations (NGOs), Hydrographic Confederations (Guadiana, Tejo, Guadalquivir and Douro) and Users Communities (Irrigation Communities, Supply and Sanitation Associations) (JE, 2018; p. 194-195). However, water utilities are not mentioned. Specific indicators to measure or monitor water loops are not mentioned. Particular indicators are those established in the future National Water Pact (JE, 2018; p. 324). Spatial planning concerns are considered in the objectives of the strategy. According to the strategy, the integration of sectoral policies such as water resources, environmental, agricultural, rural development and spatial planning is vital. The coordination of their actions may optimise the water resources of the region and citizens, mitigate the adverse effects that cause scarcity and guaranty the conservation of natural ecosystems. It should also allow active participation to companies to move to CE models and optimise productive sectors such as agro-industries or tourism and its consequent impact on job creation (JE, 2018; p. 185). The intention of developing industrial symbiosis projects is mentioned in the strategy (JE, 2018; p. 176) but not explicitly related to water use. Territorial symbiosis is mentioned in the strategy, as an opportunity for new activities and business models, along with other areas, such as industrial ecology, collaborative economy, and bioeconomy (JE, 2018; p. 86).

A National Plan for Purification, Sanitation, Efficiency, Savings and Reuse is currently being prepared in Spain. There is a preliminary document of this plan (MITECO,2018), however, it is still in development and to be completed considering the results from the strategic environmental assessment. Only then the plan will be submitted to public consultation before being adopted, presumably, soon. Several water reuse measures, listed by River Basin, are

considered in the plan, namely specific water reuse projects, the budgets to allocate to each project, the responsible administrative authorities, and the involved water utilities (MITECO,2018; Annex 4). These measures were framed within the purpose of the ecological transition process required by the Spanish economy (MITECO,2018; p. 23) and not with the purpose of the development of WCE. However, both goals are somewhat similar and, therefore, these measures also promote the development of WCE. Administrative authorities responsible for these measures and the water loops and water utilities involved are mentioned (MITECO,2018; Annex 4). The articulation between water resources and spatial planning is considered since the plan, and respective measures must respect the normative principles of the Water Law (R.D. 1/2001) and seek the compatibility of water management with spatial planning, the conservation and protection of the environment and the restoration of nature (MITECO,2018; p. 12). Symbiosis agreements involving the use of water and circular territories are not mentioned in the plan. The implementation of the plan' measures is followed by different actors, namely the Council of Environment and Spatial Planning, Local Entities, Water utilities, Council of Agriculture, Fisheries and Rural Development, State Society of Agrarian Infrastructures S.A., River Basin Authorities, Autonomous Communities, amongst others (MITECO,2018; Annexes 2-4).

The Spanish water resources main legal framework considers water reuse, however, never in the purpose of WCE. The water reuse' regulatory regime was first established by the Water Law (RD 1/2001; Art. 109). Later, it was detailed by the Legal Regime for the Reuse of Treated Water (RD 1620/2007). This legal regime includes the requirements to carry out the activity, the procedures to obtain the concession, and the water reuse standards or the mandatory fit-for-purpose minimum quality criteria required for the use of reclaimed water (RD 1620/2007). Water reuse is also considered in the National Hydrological Plan (Law 10/2001 amended by Law 11/2005). There is a list of investments that includes water reuse projects, and there is a specific reference to water loops for industrial uses (Law 10/2001; Annex II). In the amendment, there is a strengthened consideration of using alternative sources of water, such as water reuse as other solutions and unconventional sources, such as inter-basin transfers or seawater desalination, are considered less viable (Law 11/2005). There is also a list of actions of general interest that include water reuse projects (Law 11/2005; Annex III). The articulation with spatial planning is foreseen. River Basin Authorities must issue a prior report, in the cases determined by regulation, on the acts and plans that the Autonomous Communities and local authorities approve, in the areas of the environment, land use planning and urban development, irrigation and other public works of regional interest (RD 1/2001; Art. 25). River Basin Authorities must declare if there are sufficient water resources to meet the new demands due to urban development (RD 1/2001; Art. 25). The National Water Council must issue a report for plans and projects of general interest for land use planning, among other economic sectors, as they may substantially affect hydrological planning or water use (RD 1/2001; Art. 20). Spatial planning plans need a prior approval report from the River Basin Authority provided that they:

- affect the regime and use of the continental waters,
- the permitted uses in lands of public water domain, or entail new demands on water resources (Law 11/2005; Art. 25).

The urban planning instruments must guarantee the non-affectation of specific zones' water resources and protection perimeters (Law 11/2005; Art. 99). Municipalities may develop and implement plans and programmes for the reuse of water, which define the infrastructural needs, adequate location and implementation program (RD 1620/2007; Art. 7). The Spanish spatial planning main legal framework includes protecting water resources in its main aims and principles, namely in the Land and Urban Rehabilitation Law (RD 7/2015). Public policies related to the regulation, planning, transformation and use of land should follow the principle of the protection of water resources, in particular the prevention and minimisation, of water pollution along other fundamental natural resources, such as the soil and subsoil. They should also foster efficiency in water resources use by reducing water demand (saving) and promoting water reuse (RD 7/2015; Art. 3). The articulation with the water resources planning system is considered under the environmental assessment of spatial and urban planning instruments. It is also considered in the evaluation and monitoring of the sustainability of urban development, which, in turns, requires the consultation of the Hydrological Administration on the existence of water resources to meet new demands,

related to urban development, and on the protection of the public water domain (RD 7/2015; Art. 22). Besides, the Land and Territorial Planning of Extremadura (Law 15/2001), also includes protecting water resources in the main aims and principles. Spatial planning should contribute to the rational use and distribution of hydrological resources by promoting savings in their use, effluent control, and protecting their quality (Law 15/2001; Art. 4). Categories of non-developable land include, amongst others, hydrological uses (Law 15/2001; Art. 11). The concepts of circular, integrated and symbiotic territories are not considered in the Spanish spatial planning main legal framework.

The Guadiana River Basin Management Plan (RBMP), also known as Hydrological Plan of the Spanish Part of the Hydrographic Demarcation of Guadiana, for the cycle of 2016-2021 (CHG, 2016) establishes quality and quantity environmental objectives for surface and groundwater bodies, as well as for protected areas following provisions of the WFD (CHG, 2016; Annex 12). The plan also establishes ecological flow regimes according to the criteria of the WFD, for a total of 27 sections of river-type water masses, of which 19 were classified as strategic (CHG, 2016; Annex 6). The plan identifies in the Program of Measures (PoM) actions to monitor and control diffuse pollution of waters (CHG, 2016; Annex 11, p. 29) due to the excess fertilisation of agricultural origin and the pressures caused by the cattle herd. The plan does not include WCE as part of its main objectives. However, the reuse of reclaimed wastewater is considered under the category of non-conventional source of water. It may be authorised exclusively for irrigation or industrial uses in water deficit areas, especially in the Alto Guadiana Subsystem, to replace conventional sources and to ensure that the deficit is not increased (CHG, 2016; p. 109). The water reuse in deficit areas is permitted under the regulatory provisions if it complies with the quality criteria defined in RD 1620/2007 (CHG, 2016; Annex 6, p. 31). Following these rules, water reuse actions are identified in the Program of Measures (PoM) (CHG, 2016; Annex 11, p. 30). However, none of these measures are articulated within the purposes of WCE. There is no reference to symbiosis agreements involving the use of water.

The Municipal Master Plan of Almendralejo (Almendralejo MMP) (AA, 2016) identifies the need for changes in the existing water infrastructures due to the contamination of surface water by untreated or poorly treated wastewater discharges, and to the lack of tertiary treatment at the WWTP that allows the reuse of the treated wastewater (AA, 2016; Book I, p. 56). Specifically, for the Harnina River, it is mentioned that there are problems with spills of untreated or inadequately treated industrial and urban wastewaters (AA, 2016; Book I, p. 69). Regarding water-use efficiency, losses of around 20% of the water in the urban distribution infrastructure are registered, despite the recent investments (AA, 2016; Book I, p. 211). A set of measures to reduce water demand, promote water's efficient use, and adapt the existing water supply infrastructure are defined (AA, 2016; Book II, p. 208). Moreover, particular investments are foreseen to foster the reuse of treated wastewater from the WTTP, irrigation of green areas of the new urban sectors, and agricultural irrigation. These investments include a new infrastructure for the distribution of treated wastewater, with storage facilities located at different points of Almendralejo (AA, 2016; Book II, p. 215). The promotion of circular territories with CE or WCE strategies are not considered in the plan. The impacts of future urbanisation on water resources are acknowledged in the plan, together with an evaluation of the future water supply needs due to new urban developments, based on a report about resources sufficiency from the River Basin Authority (AA, 2016; Book II, p. 205). According to the plan foreseen new urban developments in the second four-year period, can be undertaken insofar as the availability of sufficient water resources by the River Basin Authority is secured (AA, 2016; Doc. 3, Art. 9.2.4).To cope with the foreseen future water demands, a new water abstraction source from the Villalba de Barros dam on the Guadajira river, is considered to complement the water abstraction from the River Guadiana. This allows to almost double the current supply capacity concerning the current concession, in addition to the improvement in water quality (AA, 2016; Book II, p. 206). Moreover, there are also recommendations for new urbanised areas to prevent significant effects on natural drainage and not increase runoff coefficients and avoid substantial effects on hydrogeological resources and not reduce the rate of infiltration of water into the soil and subsoil (AA, 2016; Book II, p. 249). Furthermore, different criteria for protecting the aquifer and the hydrological system are established in the plan, together with a specific regulation to oblige future urban developments to minimise their territorial and environmental effects using soil and water conservation measures (AA, 2016; Book II, 238). The occurrence of urban floods is foreseen in the plan together with proposals for the

ecological restoration of the streams of Almendralejo to cope with it (AA, 2016; Book 2, p. 239). Climate change, however, is not considered. Impact assessment and analysis tools are considered in the plan, not to plan for water reuse, but to use as a prerequisite for land use decisions and development permits. These regulation aspects consider long-term forecasts of supply and demand for water in the Municipality, made by the River Basin Authority, that already includes the existent and future water concessions and necessary infrastructure projects (AA, 2016; Book II, p. 206). The plan does not restrict siting of reclamation plants nor disallow innovations in wastewater treatment and reuse. However, it refers the need to look for other municipal ordinances and the basic rules and recommendations that the municipal company in charge of the WWTP applies regarding the specific conditions for the sanitation of wastewater and rainwater discharges, and for treated wastewater reuse (AA, 2016; Doc. 3, Art. 8.2.14).

Likely influence of the policy and planning set-up on the new water loop

The new water loop foreseen for the demo site in Almendralejo (Spain) with the Project Ô technology in the WWTP, is represented in Figure 13. The sewerage system collects simultaneously urban and industrial wastewater and surface runoff (e.g. rainfall, street washing, gardens watering), treats that water which is then discharged into the river (treated wastewater) or reused for different purposes:

- water reuse for watering Las Mercedes Park (water reuse #1);
- water reuse for irrigation of agriculture by farmers (water reuse #2);
- water reuse for washing municipal roads and streets (water reuse #3).

At Las Mercedes Park, water that infiltrates into the green areas will be collected in a deposit (infiltrated water collector) before it reaches the sewage system and will be used for watering the park onsite (collected water) as a complement to water reuse #1.

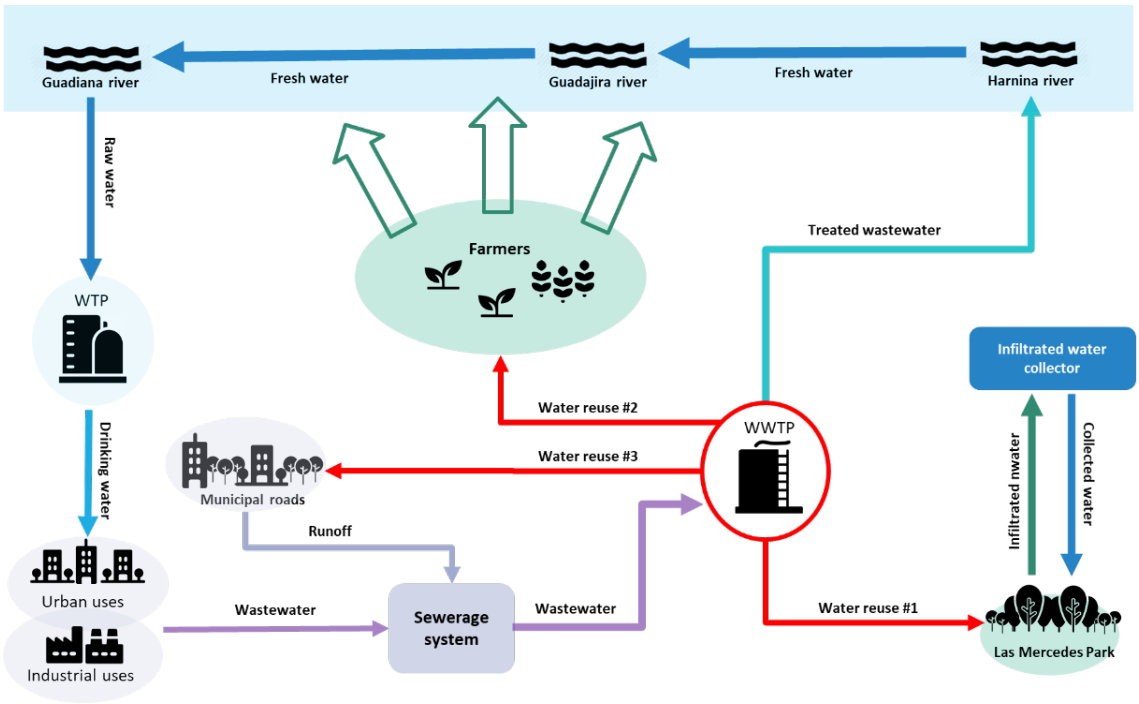


Figure 13. Outer water loop scheme for the demo site of Almendralejo (Spain). The light blue rectangular node represents the natural freshwater system. Circle nodes represent water (light blue) and wastewater (red) treatment facilities: the red circle represents the installation of the Project Ô technology. Ellipse nodes represent urban, industrial, municipal (grey), the park and agricultural (green) agents that use and transform water. Rounded rectangles represent the combined wastewater and runoff sewerage system (grey) and the artificial infrastructure to collect infiltrated water at the park (blue). Large green arrows represent natural water infiltration in agricultural areas. Solid lines represent fluxes of different types of water: dark blue represents freshwater and raw water in or extracted from the natural system; cyan blue represents purified drinking water; purple represents wastewater from urban and industrial activities; grey represents surface runoff from the urban area; turquoise represent treated wastewater that is discharged in the natural system; green represents water infiltrated at the park; and red represents treated wastewater to be reused in watering the park, irrigation of agriculture and washing of municipal roads.

The analysed policy set-up towards WCE in the demo site of Almendralejo (Spain), constituted by the national and regional CE strategies (GE, 2018; JE, 2018) and the water efficiency plan (MITECO,2018), identify specific water reuse measures that foster the implementation of the new water loop foreseen under Project Ô, including the support to irrigation projects with water reuse (GE, 2018; p. 128) and the implementation of harvesting and reuse techniques to reduce the future vulnerability of the region to climate change (JE, 2018; p. 194).

The Spanish water resources main legal framework does not constrain the implementation of the new water loop foreseen under Project Ô in the demo site of Almendralejo (Spain). The adopted Legal Regime for the Reuse of Treated Water (RD 1620/2007) includes the requirements to carry out the activity, the procedures to obtain the concession, and the water reuse standards or the mandatory fit-for-purpose minimum quality criteria required for the use of reclaimed water, including for irrigation (RD 1620/2007).

The Guadiana RBMP (CHG, 2016) does not constrain the implementation of the new water loop foreseen under Project Ô for the demo site of Almendralejo (Spain). It may foster its implementation. Some environmental objectives for the Guadiana and Guadajira Rivers, of which Harnina River is tributary, and that receive the treated wastewater from the WWTP, are established in the plan (CHG, 2016; p. 401). The timely detection and proper treatment of accidental industrial spills and final elimination of particular micro-pollutants, foreseen with the implementation of the new technology, may facilitate the achievement of these environmental objectives. Furthermore, it is not expected for the volume of reused wastewater to be large enough to interfere with the ecological flow regimes established in the plan. In any case, the permits for the new water loop and water reuses, issued by the River Basin Authority, must account for the expected effects of this new water loop on the environmental objectives and ecological flows established in the RBMP, according to specific studies for each river section (RD 1/2001; Art. 59).

The Almendralejo MMP (AA, 2016) does not constrain the implementation of the new water loop foreseen under Project Ô for the demo site of Almendralejo (Spain). The new water loop is in total agreement with the proposed investments to foster the reuse of treated wastewater from the WTTP, namely for irrigation of green areas of the new urban sectors and agricultural irrigation. Furthermore, the new infrastructure proposed for distributing treated wastewater, including storage facilities located at different points of Almendralejo, represents a major opportunity for a future scaling-up of the new water loop foreseen under Project Ô. Complementary, Project Ô will offer the testing arena needed to develop the future water reuse infrastructures and water reuse management schemes needed for Almendralejo.

The new water loop brings new stakeholders into the river basin' community - a company in charge of transporting the reclaimed wastewater from the WWTP to other reuses, and the local health authority whose advice and prior report, required for the permitting by the River Basin Authority (RD 1620/2007; Cap. II, Art. 4).

5.1.2 Lecce (Italy)

Main features of the demo site

In this demo site, Project Ô will install the new technologies in the WWTP in the city of Lecce, located in the region of Puglia, in Italy. Lecce is located in the hydrographic basin of the Southern Apennines (Figure 14). The WWTP and all water services in the city are managed by Acquedotto Pugliese S.p.A. and serves the city citizens and local industries, treating approximately 7 million m3/year of domestic and industrial wastewater. The WWTP discharges the treated wastewater in the Adriatic Sea, at the shore of San Cataldo's village, through a submarine outfall. The water supply to the city of Lecce comes mainly from freshwater sources (reservoirs) located in the neighbour administrative regions, namely Campania and Basilicata, being complemented by groundwater sources (wells) spread across the municipality.

The Puglia region is composed of several coastal karst aquifers, such as the Salentino Aquifer, that are particularly vulnerable to seawater intrusion and microbiological contamination. These coastal karst aquifers have always been able to offset the absence of perennial surface watercourses, by ensuring a minimum water coverage both to drinking and irrigation purposes, via more than 200 wells spread across all the region, such as the Guardati Well in the Salentino Aquifer. However, the overexploitation of these aquifers combined with seawater intrusion and microbiological contamination led to their environmental degradation. It forced the region to rely on external sources of freshwater for water supply. The Guardati Well was used for many years as a source of groundwater supply to the city of Lecce, and, in consequence, due to quality issues, it is currently not used. As such, this demo site's main goal is to develop a treatment module capable of producing high-quality water that can be reused to recharge the Salentino Aquifer and rehabilitate the Guardati Well. The recovery of this degraded and lost water source in a territory with scarce water resources provides a relevant opportunity to obtain water with enough quality to be delivered to the drinking water supply system or, at least, to be used in industrial processes. Another goal of the demo site is to end the discharge of treated wastewater in the Adriatic Sea. When successfully implemented, these interventions are examples of technology solutions available for finding local alternative sources of water, thus contributing to mitigate the pressures on the current freshwater supply system, in compliance with the environmental objectives of the WFD.

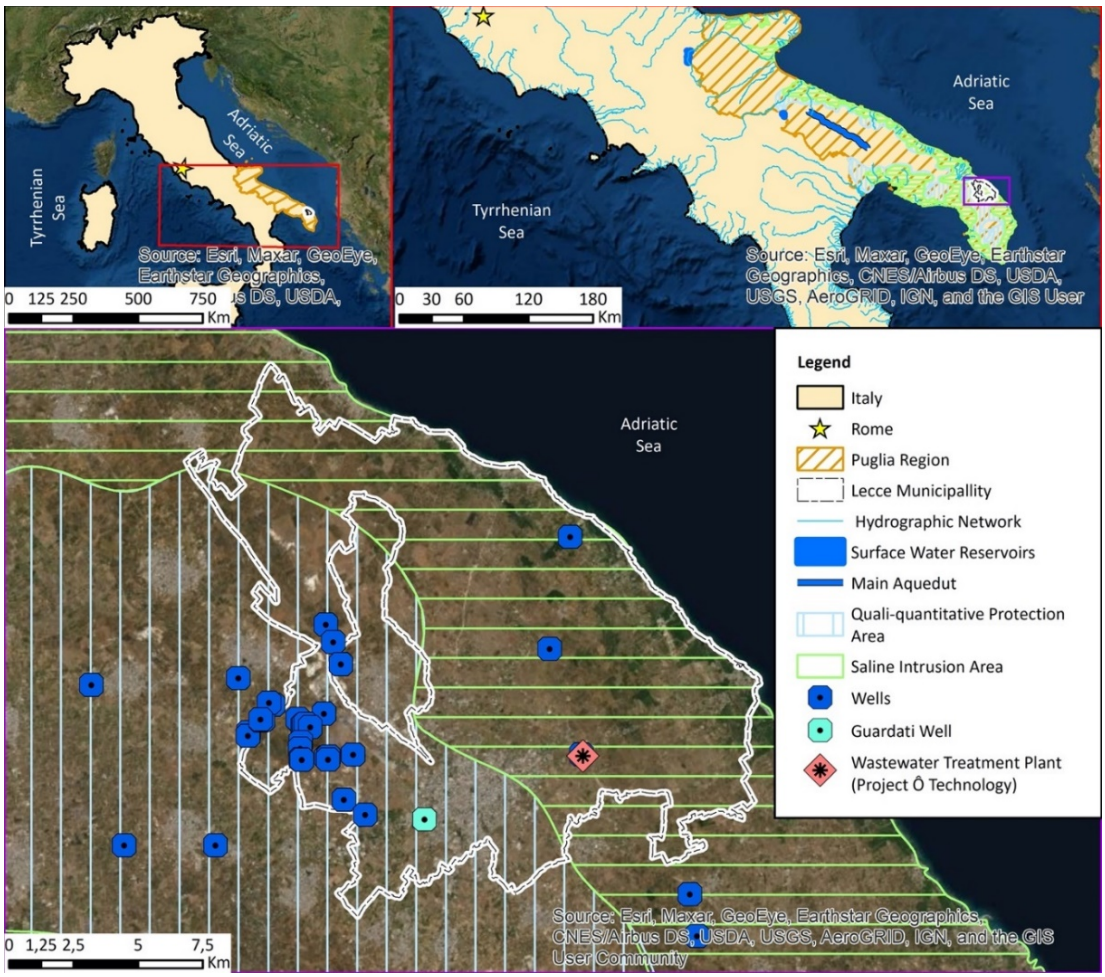


Figure 14. Demo site of Lecce (Italy): a) Location within the Region of Puglia in Italy, and the Southern Apennines Basin; and b) Main features of the demo site.

Puglia region has one of the smallest amounts of available water resources of approximately 136 m3/capita/year (Lopez et al., 2010). It has no permanent water bodies and the lowest rainfall average value in Italy (Lopez et al., 2010) and overexploited groundwater resources has caused a progressive groundwater salinization due to seawater

intrusion (Polemio et al., 2009). Because of this, most agricultural activities are managed with a water deficit strategy (Saliba et al., 2018). Under these circumstances, water reuse becomes a promising alternative for conserving and extending available water sources. However, despite this combination of propitious factors in the region, of the potential 100 million m3/year of reclaimed wastewater available to be reused, only 5 million m3/year were being reused in 2011 (Arborea et al., 2017), while the remaining were being discharged into the sea. Therefore, new water policies to enhance the reuse in Puglia are expected. These should face some technical challenges related to innovative methodologies for the control of wastewater quality, that are fast, safe and available and feasible solutions to address the unbalance between the supply of treated wastewater and the water demand (Saliba, 2018).

Main features of the policy and planning set-up

Italy's strategic positioning on CE is defined in the document Towards a Model of Circular Economy for Italy - Overview and Strategic Framework (MATTM and MiSE, 2017). WCE is not mentioned in its priority areas. However, the significant importance of the efficient use of water resources in a CE context is recognized (MATTM and MiSE, 2017; p. 50), together with the necessity to pursue actions, especially in the context of production processes (MATTM and MiSE, 2017; p. 50), aiming at:

- optimizing water consumption and reducing discharges in water bodies, in particular through the reuse of treated wastewater;
- increasing available water supplies through unconventional resources;
- the recovery of energy and substances through an efficient increase in wastewater treatment.

Further specific measures fostering water reuse practices are also mentioned (MATTM and MiSE, 2017; p. 50-51), such as:

- the preparation of a regulatory framework facilitating and supporting companies to apply different recovery and reuse strategies;
- the introduction of economic incentives encouraging the implementation of appropriate treatments for the use and reuse of water, while guaranteeing adequate and consistent levels according to the current regulations on the protection of human health and the environment

No water utilities and other stakeholders for implementing and monitoring these measures, nor specific indicators to measure and monitor water loops, are identified in the strategy. However, the strategy identifies, in very general terms, three main economic actors for a successful transition towards a CE: the companies, the consumers and the fiscal and economic instruments (MATTM and MiSE, 2017; p. 50). Also, a follow-up document aimed at identifying suitable indicators to measure and monitor the economy's circularity and the efficient use of resources at macro, and micro level, is foreseen (MATTM and MiSE, 2017; p. 56). Spatial planning and circular territories are not considered in the strategy. However, it mentions the existence of a national network of industrial symbiosis (Symbiosis User Network). This aims to promote, through industrial symbiosis, a cultural change towards CE, encouraging the meeting of the various stakeholders involved, the creation and sharing of knowledge, and the identification of new opportunities for economic, social, and territorial development (MATTM and MiSE, 2017; p. 33).

In Italy, each region is expected to adopt a plan for water protection. In Puglia Region, where Lecce is located, the instrument aimed at ensuring the qualitative and quantitative protection of the surface water, groundwater and marine water, and ensuring a high level of environmental protection, is the Water Protection Plan of Puglia Region in its updated version for 2015-2021 (RP, 2019). The actual state of purified wastewater reuse practices, together with the potential reuses and priority intervention measures, involving specific water loops in the sectors of irrigation, industry and environment are described in the plan (RP, 2019; Part E). Furthermore, several key measures for the efficient use of water are identified in the Program of Measures (PoM) of the plan (RP, 2019; Part G). None of the identified measures are associated with the specific purpose of the development of WCE. However, they indirectly promote it. The articulation between water resources and spatial planning is considered in the plan since some of the identified measures should be implemented by specific tools transversal to the different spatial

planning instruments (water and territorial) at different spatial scales (RP, 2019; p. 177). Furthermore, it is mentioned that the importance of a water resource is not only due to its consistency and usability, but also to its location in the context of territorial water needs, namely in the use of the land and in its socio-economic development for productive activities (RP, 2019; p. 82). Specific symbiosis agreements involving the use of water and circular territories are not mentioned in the plan. The plan foresees the involvement of different actors in the implementation and monitoring of its measures, including, amongst others: the Puglia Region and the Local Entities (Provinces and Municipalities) for its implementation and the Puglia Water Authority, Puglia Basin Authority, Local Health Authorities, Regional Environmental Protection Agency and Regulatory Authority for Energy, Networks and Environment for its monitoring.

The Italian water resources main legal framework considers water reuse, however never in the purpose of WCE. The reuse of water for domestic, urban, industrial and agronomic activities (i.e. vegetation water) in irrigation was first mentioned in the Environmental Code (DL 152/2006; Art. 99 and 112). It was later detailed in the Technical Rules for the Reuse of Waste Water (D 2 May 2006), the Technical Rules for the Agronomic Use of Manure and Waste Water (D 25 February 2016). The Puglia Region adopted a Regulatory Regime for the Reuse of Purified Wastewater in 2012 (RR 8/2012). The articulation with spatial planning is foreseen. RBMP have the value of territorial plans and are the cognitive, normative and technical-operational tools through which the actions and rules of use aimed at the conservation, defence and valorisation of the soil and the correct use of water are planned and programmed, based on the physical and environmental characteristics of the territory concerned and, amongst other elements, should contain the organised and updated cognitive framework of the physical system and the uses of the territory provided for by the municipal and inter-municipal urban planning instruments (DL 152/2006; Art. 65). Land use plans and programs must be coordinated, or in any case not in conflict, with the approved RBMP. The Regions must issue the provisions concerning the implementation of the RBMP in the urban planning sector (DL 152/2006; Art. 65). Urban planning instruments, compatible with municipal and national plans and available financial resources, must provide for dual networks to use less valuable water and make possible for more adequate water uses, including non-drinking water (DL 152/2006; Art. 146). Besides, spatial planning instruments (urban, territorial, landscape) should be subjected to strategic environmental assessment and the competent authorities (e.g. water authorities) must be consulted in the process due to the specific responsibilities in the environmental field attributed to them (e.g. water) (DL 152/2006; Art. 6). To ensure the protection of water protection zones must be demarcated under the rules of the regions. These may adopt measures relating to the land zoning, restrictions and prescriptions for civil, productive, tourist, agro-forestry and zootechnical settlements in municipal, provincial, regional, general and sectoral urban planning instruments (DL 152/2006; Art. 94). Hydrogeological Risk Protection Plans shall identify the infrastructures which determine the hydrogeological risk, and the Regions shall draw up a plan for the adaptation of these infrastructures outside the area at risk and for the granting of financial incentives for the relocation of productive activities and private homes built under the urban building regulations and the resulting land is acquired to the unavailable assets of the municipalities (DL 152/2006; Art. 67).

The Italian spatial planning main legal framework considers the protection of water resources, as well as the articulation with the water resources planning system, namely in the Law on the Organization of Local Authorities (DL 267/2000) and in the Cultural Heritage and Landscape Code (DL 42/2004). The Province is responsible for the protection and valorisation of water resources (DL 267/2000; Art. 19). It should prepare and adopt the territorial coordination plan that determines the general guidelines for spatial planning and, amongst others, the lines of intervention for the development of the water, hydrogeological and hydro-forestry systems and, in general, for soil consolidation and water regulation (DL 267/2000; Art. 20). The Region, in agreement with the local authorities of the metropolitan areas, may define supra-municipal areas for the joint exercise of the functions of local authorities in, amongst others, interventions for the protection of the soil and hydrogeological resources, and water collection, distribution and treatment (DL 267/2000; Art. 24). Wetlands and water bodies (rivers, streams, watercourses, lakes, glaciers) represent landscape values (DL 42/2004; Art. 142) and are subjected to protection and valorisation in the spatial planning and management (DL 42/2004; Art. 1). It should be noted that the protection of water resources is not considered in the Urban Planning Law (Law 1150/1942) and further updates, that regulates the planning and

development of residential areas and urban development in general in the territory. The concepts of circular, integrated and symbiotic territories are not considered in the Italian spatial planning main legal framework.

The Southern Apennines River Basin Management Blan (RBMP), also known as Water Management Plan of the Southern Apennines Hydrographic District, for 2016-2021 (DIAM, 2016) establishes quality and quantity environmental objectives for surface and groundwater following provisions of the WFD (DIAM, 2016; p. 389). The plan also sets protected areas (DIAM, 2016; p. 126) and minimum vital flows (i.e. ecological flow regimes) according to the criteria of the WFD (DIAM, 2016; p. 379). The plan identifies in the Program of Measures (PoM) actions to monitor agricultural sources of diffuse pollution of waters (DIAM, 2016; p. 433). The plan does not include water reuse or WCE as part of its main objectives. However, water reuse is considered within the economic analysis of water uses. It is mentioned that the competent authorities must identify and apply the appropriate regulatory and technical actions:

- to achieve the best possible allocation of the resource and, in the case of management inefficiencies, t
- to provide for measures to recover water losses, water reuse and aquifer recharge, and the costs of which will be borne by the responsible sector. (DIAM, 2016; p. 406).

As such, measures fostering water reuse are indicated in the Program of Measures (PoM):

- the modernisation, adaptation and upgrading of purification systems, including for water reuse (DIAM, 2016; p. 429);
- the integration of ecological networks and the physical-environment recovery of wetlands, to be reclaimed and enhanced through non-potable water or reused water (DIAM, 2016; p. 431).

Additional measures that may foster the development of water reuse in the future, such as the adaptation and upgrading of the wastewater treatment plants' purification technologies, are referred in the Program of Priority Measures (DIAM, 2016; Annex 7). However, none of these measures is articulated within the purposes of WCE. Furthermore, two projects involving experimentation with new techniques for reusing treated domestic wastewater in agriculture and in aquifer recharge, are also proposed (DIAM, 2016; Annex E). There is no reference to symbiosis agreements involving the use of water.

The last approved version of the Municipal Master Plan of Lecce (Lecce MMP) dates from 1983. A preliminary document of a newer version of the Lecce MMP, also known as Urban Master Plan of Lecce Municipality (CL, 2011), has already been subjected to strategic environmental assessment and is to be approved, presumably, soon, following verification of compliance with the regional documentation. The plan identifies the need for changes in existing water infrastructures to promote water reuse (CL, 2011; p. 41), namely:

- the verification and improvement of the efficiency of the sewerage network;
- the designation of the areas destined to wastewater treatment plants;
- the use of diversified techniques for wastewater treatment;
- the use of phyto-purification in areas not served by the sewerage system;
- the impediment of the discharge of treated wastewater to the sea.

However, these improvements, or any other changes to existing water infrastructures, are not considered in the strategic objectives (CL, 2011; pp. 263-264). The plan also foresees the construction, in rural areas with more restrict access to water and to the sewerage system, of compensatory infrastructures of ecological nature for more efficient use of water, namely by the construction of systems for the collection, recycling and purification of rainwater and wastewater (CL, 2011, pp. 268-269). The promotion of circular territories with CE or WCE strategies are not considered in the plan. The negative impacts of urbanisation on water resources are acknowledged in the plan. It mentions that the anthropic landscape uses related to the surface hydrography, such as hillslopes and karst areas, contribute to fragment the natural morphological continuity, and to increase the conditions of hydraulic risk, since these play a primary role in the regulation of surface hydrography, such as watercourses and sinkholes (CL, 2011; p. 101). Moreover, the negative impacts of the crescent civil, industrial and irrigation demands of water on the quality and quantity of the groundwater in the aquifers is also acknowledged (CL, 2011; pp. 221-222). The risks posed by floods are also recognised in the plan, namely by presenting a flood probability map and flood hazard (CL, 2011; p. 79). Although referred to in the plan, climate change is not related to water security and water adaptation

measures. The plan was subjected to strategic environmental assessment and information on water resources was used and the competent water authorities, namely the Puglia Water Authority and the Southern Apennines Basin Authority, were consulted in legal compliance requirements (DL 152/2006; Art. 6). The analysis tool included territorial sensitivity, environmental pressure factors and the degree of potential fragility (CL, 2011; pp. 233-240), which are not specifically appropriate to plan for water reuse. However, they may be used to plan for water availability scenarios. The plan does not restrict the siting of reclamation plants nor disallow innovations in wastewater treatment and reuse.

Likely influence of the policy and planning set-up on the new water loop

The new water loops foreseen for the demo site in Lecce (Italy), with Project Ô technology in the WWTP, are represented in Figure 15. In this loop, the supply of drinking water to the city of Lecce is made mainly from freshwater sources located outside the Puglia region (drinking water #1) and complemented with groundwater sources belonging to the Salentino Aquifer (drinking water #2). As mentioned, this demo site foresees the reuse treated wastewater from the WWTP for recharging the Salentino Aquifer system (water reuse) to rehabilitate degraded wells belonging to it, particularly the Guardati Well. The recharge of the Salentino Aquifer will be performed through the use of drainage trenches. The demo site also foresees the cessation of the discharge of treated wastewater into the sea.

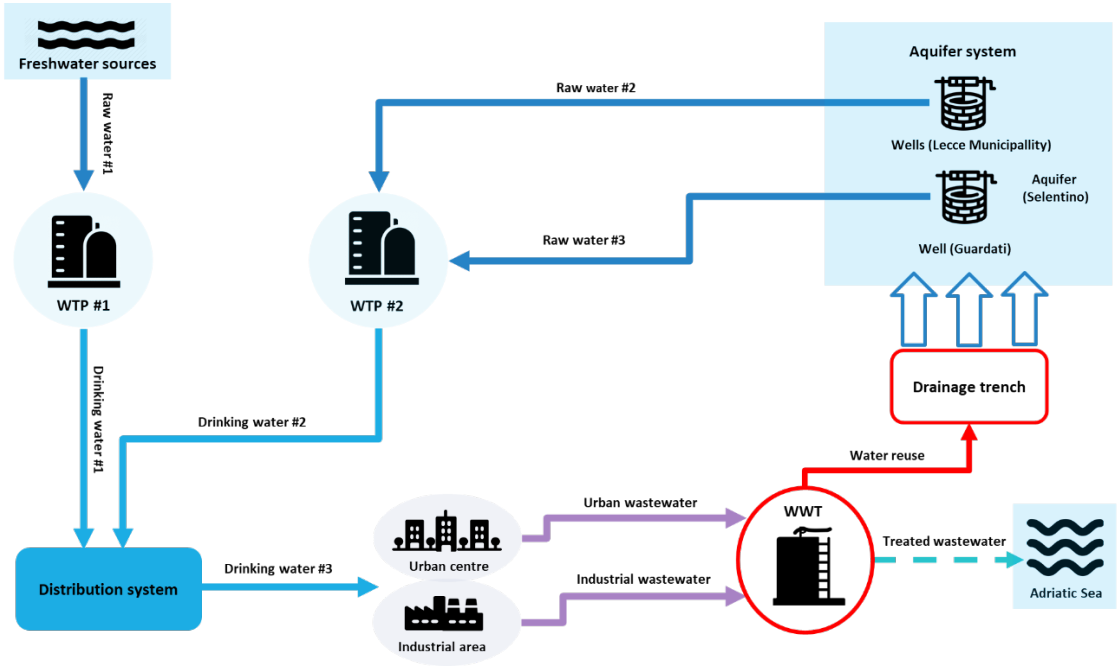


Figure 15. Outer water loop scheme for the demo site of Lecce (Italy). Light blue rectangular nodes represent the natural freshwater, groundwater and seawater systems. Circle nodes represent water (light blue) and wastewater (red) treatment facilities: the red circle represents the installation of the Project Ô technology. Grey ellipse nodes represent urban and industrial agents that use and transform water. Rounded rectangles represent the water distribution system (blue) and the drainage trenches constructed for the recharge of the aquifer (red). Large blue arrows represent natural water infiltration in the drainage trenches. Solid lines represent fluxes of different types of water: dark blue represents raw water extracted from the natural system; cyan blue represents purified drinking water; purple represents wastewater from urban and industrial activities; and red represents treated wastewater to be reused in aquifer recharge. The dashed turquoise line represents the cessation of the discharge of treated wastewater into the sea.

The analysed policy dimension of the institutional set-up towards WCE in the demo site of Lecce (Italy), constituted by the national CE strategy (MATTM and MiSE, 2017) and the water protection plan (RP, 2019), identify specific water reuse measures that foster the implementation of the new water loop foreseen under Project Ô, including the reduction of discharges in water bodies, in particular through the reuse of treated wastewater, the increase in available water supplies through unconventional resources (MATTM and MiSE, 2017; p. 50) and priority

intervention measures (RP, 2019, Part E) involving specific water reuse loops in the sectors of irrigation, industry and environment, such as aquifer recharge.

The Italian water resources main legal framework does not constrain the implementation of the new water loop foreseen under Project Ô in the demo site of Lecce (Italy). The requirements to carry out the activity, the procedures to obtain the concession, and the water reuse standards or the fit-for-purpose minimum quality criteria required for the use of reclaimed water, including for aquifer recharge, are set out by the Technical Rules for the Reuse of Waste Water (D 2 May 2006) and the Regional Regulatory Regime for the Reuse of Purified Wastewater (RR 8/2012).

The Southern Apennines RBMP (DIAM, 2016) does not constrain the implementation of the new water loop foreseen under Project Ô for the demo site of Lecce (Italy). On the contrary, the plan establishes general chemical, ecological and quantitative objectives (DIAM, 2016; p. 393-394) which can be achieved more quickly and satisfactorily with the water loop foreseen for Lecce under Project Ô, by reusing the purified water to recharge and rehabilitate the aquifer associated to the Guardati Well. Nonetheless, it should be noted that for underground water bodies of Puglia Region, characterised by irreversible problems of saline intrusion, extensions for the achievement of these objectives based on the status and risk conditions currently assessable are foreseen in the plan (DIAM, 2016; pp. 393-394). This may weaken the achievements of the new water loop foreseen for Lecce under Project Ô.

The Lecce MMP (CL, 2011) does not constrain the implementation of the new water loop foreseen under Project Ô for the demo site of Lecce (Italy). On the contrary, the plan favours the new water loop, namely by promoting the reuse of purified wastewater for aquifer recharge (CL, 2011; p. 41). Furthermore, the plan identifies clear distinct aquifer safeguard zones: the protected zone, the groundwater recharge zone and the water supply zone (CL, 2011; pp. 85-86). In agreement with the plan, the Lecce WWTP location lies within the groundwater recharge zone, and the site of the Guardati Well lies within the water supply zone. The location, dimension, and structure of the drainage trenches are yet not fully known. As such, attention should be paid to these structures as they should agree with the groundwater recharge zone set in the plan.

The new water loop is not expected to bring new stakeholders into the river basin community.

5.1.3 Omis (Croatia)

Main features of the demo site

In this demo site, the technology developed under Project Ô will be installed at the Galeb textile production factory's wastewater treatment unit based in the city of Omis, located in the region of Dalmatia in Croatia. Omis is located at the mouth of the Cetina River, on the Adriatic Sea (Figure 16). The factory treats the wastewater generated in the production process, before discharging it into the Adriatic Sea.

The processes of bleaching, dyeing and washing require large amounts of water. Furthermore, the dyeing process uses high saline water, so that the resulting wastewater contains a high concentration of surfactants, residual dyes and salts. This wastewater requires high energy consumption treatments before being discharged into the sea in full compliance with legal requirements. Therefore, the company intends to develop a more cost-efficient and environmentally sustainable production process, with the implementation of circular water technologies for the textile industry, aiming at 20% and 15% reductions in water and energy consumptions, respectively. As such, the main goal in this business-driven demo site is to develop a treatment module capable of producing wastewater of sufficient quality to be reused in the production process (bleaching and dyeing processes) and to reduce the discharge of wastewater into the sea and the consumption of potable water at the factory.

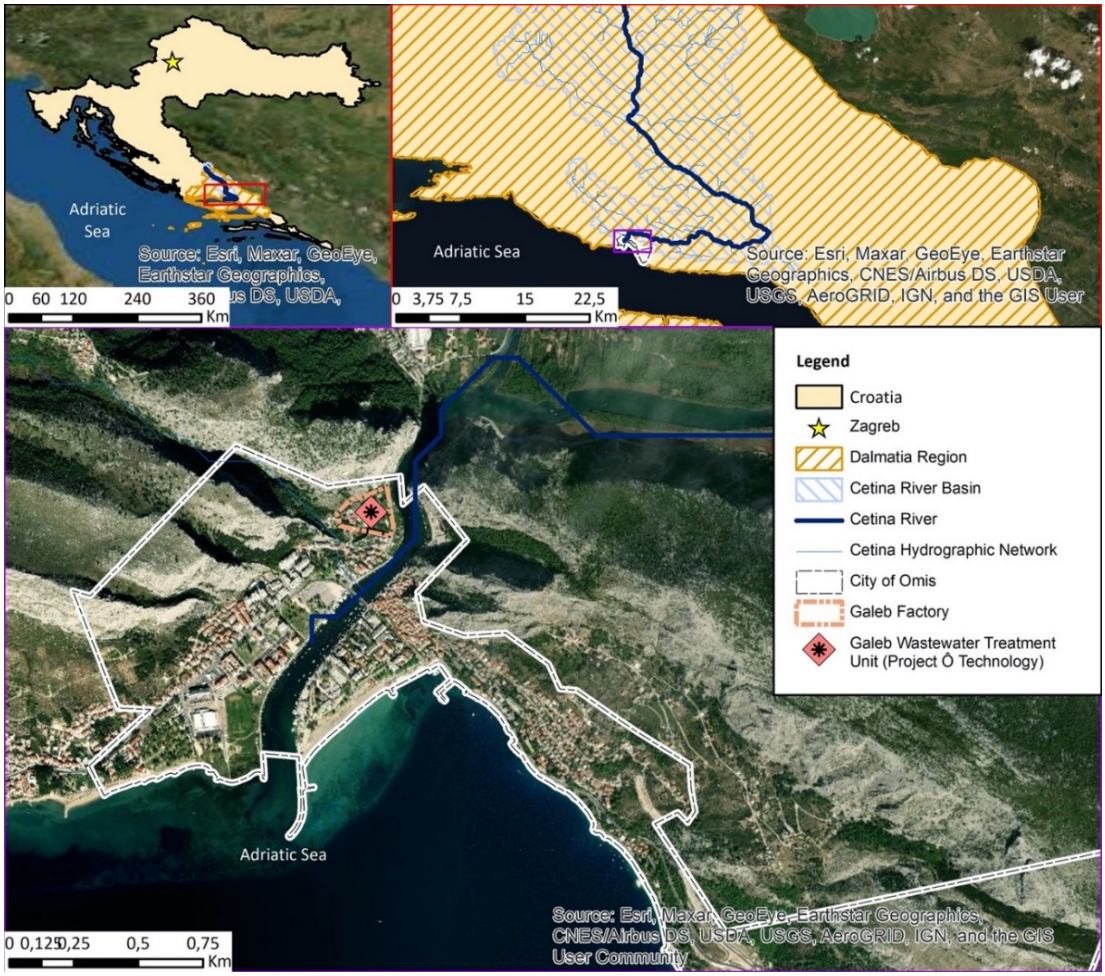


Figure 16. Demo site of Omis (Croatia): a) Location within the Region of Dalmatia in Croatia, and the Cetina River; and b) Main features of the demo site.

Croatia recorded the highest volume of freshwater resources within Europe, of approximately 27,339 m3/inhabitant, in 2017, more even than Finland and Sweden (Eurostat, 2017). So far, it is not facing water scarcity problems. Croatia is a country rich in water, especially considering the low population density and modest demand for industrial and agricultural water. The relatively high quality of both surface and ground waters can undoubtedly be regarded as a positive element. Most problems occurring during warm summer periods when the natural discharge is small, the groundwater level low and water demand increased due to tourism and irrigation demands (Matković, 2018). When compared to other European countries, Croatia is a relatively newly formed country. There has been little progress regarding wastewater treatment due to inadequate sewage network and basic infrastructure the possibility for wastewater treatment (Kellis et al., 2013). Central sewer systems are constructed only in large urban and industrial centres. Less than 35% of wastewater in Croatia is discharged into sewer systems, and less than 10% is treated (Matković, 2018). Together with non-existent focal regulations, these aspects result in the absence of water reuse practices in Croatia.

Main features of the policy and planning set-up

Croatia has not yet adopted a plan or strategy for CE. Croatia's point of view on CE is, at this stage, expressed in the Sustainable Development Strategy of the Republic of Croatia (NN 30/2009). The strategy includes key challenges in its main areas of action to achieve sustainable development for the environment and natural resources, including water, describing the main goals, documents, and institutions involved (NN 30/2009; p.13). However, WCE or water reuse and specific measures fostering the development of these practices, are not mentioned in the strategy. Furthermore, the strategy does not consider spatial planning in the transition towards a WCE.

Croatia's policy for regulating, exploiting, and protecting water resources is expressed in the long-term (2008-2038) Water Management Strategy (NN 91/2008). Water reuse is barely considered in the document, and WCE is never mentioned. Reuse of treated wastewater is considered to achieve a more sustainable water use for irrigation (NN 91/2008; Section 4.3.4) and the planned industrial development (NN 91/2008; Section 4.1.4). However, no specific measures are fostering the development of water reuse practices, nor associated water loops or water utilities. The articulation between water resources and spatial planning is considered in the document. It does so by referring that, in addition to water management planning documents, spatial development acts are also adopted in areas outside water management in which water is at stake. Examples include the areas covered by the Strategy for National Spatial Planning, Strategy for National Environmental Protection, Strategy and Action Plan for Biological and Landscape Conservation, amongst others (NN 91/2008; Section 3.1.5). Symbiosis agreements involving the use of water and circular territories are not mentioned in the plan. The document foresees the involvement of different actors in implementing its activities and measures (NN 91/2008; Section 5.1), of which the more mentioned are the Ministry of Regional Development, Forestry and Water Management and the Croatian Waters.

The Croatian water resources main legal framework, expressed in the Water Law (NN 66/2019), does not consider water reuse nor WCE. The articulation with spatial planning is foreseen. The regulations on spatial planning that conflict with the water law provisions shall not apply to the division of cadastral parcels of real estate of a public water good (NN 66/2019; Art. 9). The development of spatial plans by local agencies have to comply with the water management planning documents. The compliance is to be assessed by the Croatian Waters (NN 66/2019; Art. 39). Moreover, Croatian Waters may adopt more detailed management plans related to other sectors of interest for water management (NN 66/2019; Art. 39).

The Croatian spatial planning main legal framework, expressed in the Law on Spatial Planning (NN 153/2013), considers water protection as one of its main goals. It does so by stating that the spatial sustainability relates with the rational use and preservation of land use capacity, groundwater and sea (NN 153/2013; Art. 6). Moreover, spatial planning must determine environmental protection measures on land and sea, to protect drinking water resources (NN 153/2013; Art. 46). The articulation with the water resources planning system is considered in the sense that the adoption and implementation of development strategies, plans, programs, regulations and other general acts that may affect space, should respect the principle of integrated spatial planning. For this purpose, uniform measures between different economic and administrative areas, should be assured to achieve balanced spatial sustainability in processes affecting the transformation of settlements, use of natural resources, nature and environment protection and the development of activities and infrastructure and their distribution in space (NN 153/2013; Art. 12). The concept of circular, integrated and symbiotic territories is not considered in the Croatian spatial planning main legal framework.

The Croatia River Basin Management Plan (RBMP) for the cycle of 2016-2021 (HV, 2016) determines environmental objectives of water protection as a combination of ecological and chemical status for surface waters, quantitative and chemical status for groundwaters and additional standards for waters in protected areas (HV, 2016; p. 13). The plan establishes protected areas, specifically areas of special protection of surface waters, groundwaters and unique and valuable water-dependent ecosystems (HV, 2016; p. 67) and analyses current minimal flow rates and establishes measures to improve the ecological flows of water bodies (HV, 2016, p.330). The plan does not include water reuse or WCE, nor specific measures for developing water reuse projects. However, the plan identifies specific measures to control and reduce water pollution from point and diffuse sources of pollution (HV, 2016; Chapter 5). It also refers to investments in public sewerage network and investments in the wastewater treatment system may foster opportunities for the development of future water reuse projects (HV, 2016; pp. 250-252). There is no reference to symbiosis agreements involving the use of water.

The Municipal Master Plan of Omis (Omis MMP), also known as Spatial Development Plan of the City of Omis (CO, 2016), foresees several changes to the existing water infrastructures and the planning of new water infrastructures as well, including four new water supply systems with new pipelines (CO, 2016; p.69) and new treatment plants and submarine outlets (CO, 2016; p. 70). However, these changes to the water infrastructure seem to be centred

in improving urban water distribution and ensuring an adequate wastewater drainage system for the city rather than promoting efficient water use or fostering water reuse and WCE. The promotion of circular territories with CE or WCE strategies are not considered in the plan. The impacts of urbanisation on water resources are not explicitly acknowledged in the plan. However, the importance of water resources protection in land-use planning is recognised. As such, several improvements in the water supply distribution and network and in the wastewater treatment systems, envision the reduction of pollution effects in the environment, are foreseen. Risks posed by floods are also acknowledged in the plan, together with protective and preventive measures against them, namely the construction of protection structures to regulate watercourses (CO, 2016; p. 73) and appropriate sizing of drainage systems to prevent uncontrolled floods (CO, 2016; p. 99). Climate change and impact assessment tools are not considered in the plan. The plan does not restrict the siting of reclamation plants nor disallow innovations in wastewater treatment and reuse. However, it is mentioned that the planning of the drainage system and wastewater treatment, requires the submission of a conceptual design following special regulations. The exact location of collectors, pumping stations, treatment plants and submarine discharges is determined by the conceptual design based on hydrogeological exploration works at potential locations of devices and entry points into the terrain, watercourse or sea (CO, 2016; p. 70).

Likely influence of the policy and planning set-up on the new water loop

The new water loops foreseen for the demo site of Omis (Croatia), with the installation of Project Ô technology in the Galeb factory WWTP, are represented in Figure 17. As mentioned, this demo site foresees the reuse of treated industrial wastewater in the production process. In the loop, the existing WWTP provides physicochemical and biological treatments for industrial wastewater before being discharged into the river (treated wastewater #3). A portion (approximately 20%) of the treated wastewater (treated wastewater #2) will be subjected to an additional photo-catalytic treatment using the new technology developed under Project Ô to be reused in the production process (water reuse).

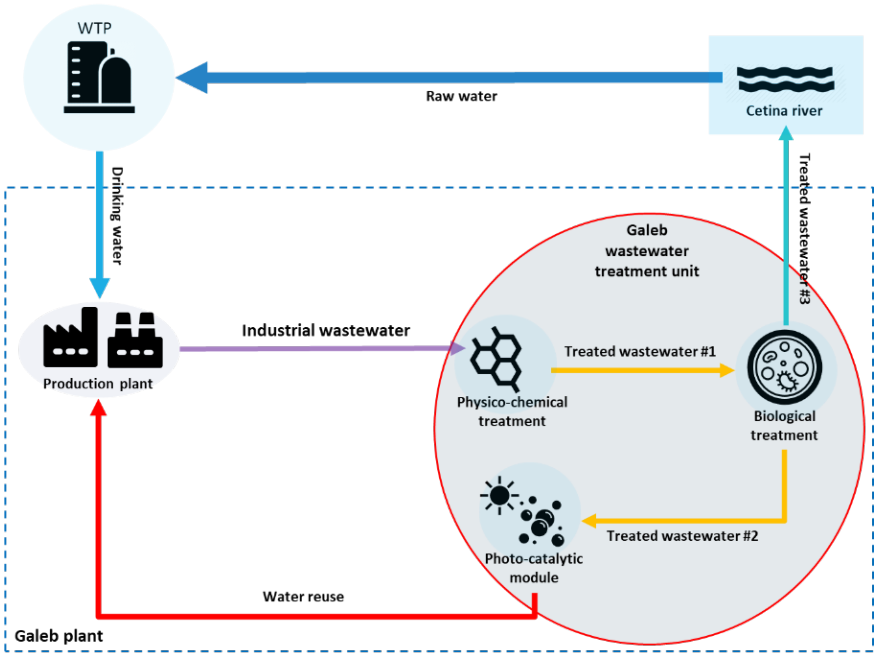


Figure 17. Outer water loop scheme for the demo site of Omis (Croatia). The light blue rectangular node represents the natural freshwater system. Circle nodes represents the water (light blue) and wastewater (red) treatment facilities: the red circle represents the installation of the Project Ô technology. The dashed blue rounded rectangle represents the industrial facility. The grey ellipse node represents the industrial agent that uses and transform water. Solid lines represent fluxes of different types of water: dark blue represents raw water extracted from the natural system; cyan blue represent purified drinking water; purple represent wastewater from the industrial activity; yellow represents treated wastewater that will be subjected to additional treatments; turquoise represent treated wastewater that is discharged in the natural system and red represents treated wastewater to be reused in the industrial activity.

The analysed policy and legal dimensions of the institutional set-up towards WCE in the demo site of Omis (Croatia), constituted by the sustainable development strategy (NN 30/2009), the water management plan (NN 91/2008) and the Water Law (NN 66/2019), do not constrain the implementation of the new water loop. However, they also do not favour its implementation, since water reuse is barely considered in these documents.

The Croatia RBMP (HV, 2016) does not constrain the implementation of the new water loop foreseen under Project Ô for the demo site of Omis (Croatia). In fact, it may be the other way around. One of Croatian water bodies' more critical water challenges is water pollution, namely the strong impact from human activities resulting in nutrient and chemical pollution in rivers both in the basin districts of the Danube River and Adriatic Sea (HV, 2016; p. 88). The reuse of wastewater in the production process of Galeb will reduce the discharge of wastewater and possible pollutants into the Adriatic Sea, and, therefore, facilitate the achievement of good ecological status. Furthermore, the reused wastewater volume will not be large enough to interfere with ecological flow regimes established in the plan.

The Omis MMP (CO, 2016), does not constrain the implementation of the new water loop foreseen under Project Ô for the demo site of Omis (Croatia). This water loop will be implemented inside the Galeb industrial facility. Therefore, the zoning systems (e.g. water protection zones) and land-use indicators do not conditionate its implementation.

The new water loop is not expected to bring new stakeholders into the river basin community.

5.1.4 Eilat (Israel)

Main features of the demo site

In this demo site, the new technology developed under Project Ô will be installed at the wastewater treatment unit of the National Centre for Mariculture (NCM) for aquaculture, based in the city of Eilat, located in the Southern region of Arava in Israel. Eilat is the southernmost city in Israel, located at the northern tip of the Gulf of Aqaba on the Red Sea, also known as the Gulf of Eilat (Figure 18). The aquaculture centre operates in a recirculating aquaculture system. The wastewater from the fish tanks is treated, and then, a part recirculates back to the tanks, and another part is discharged into the Red Sea. The water supply for Eilat and the aquaculture centre uses seawater from the Red Sea, desalinated at the Eilat Desalination Plant run by Mekorot, Israel's National Water Company.

NCM is focused on developing a cost-efficient and environmentally friendly land-based system for rearing fish in land-based seawater tanks using a recirculating aquaculture system. This system currently faces challenges related to stricter environmental regulations under quality standards for wastewater discharged into the Red Sea. The current treatment process does not allow an increase in the required nutrients removal rate. Moreover, the present scenario uses seawater with daily water exchanges of 40-50% of the system's total volume, far from the desired 0% exchange that would correspond to a 100% closed-loop reuse of water. The main goal in this business-driven demo site, is to develop a treatment module more efficient in removing nitrogen, phosphate and total suspended solids, enabling for a higher recirculation rate and the production of wastewater that meets environmental regulations for discharge into the Red Sea and also for irrigation purposes.

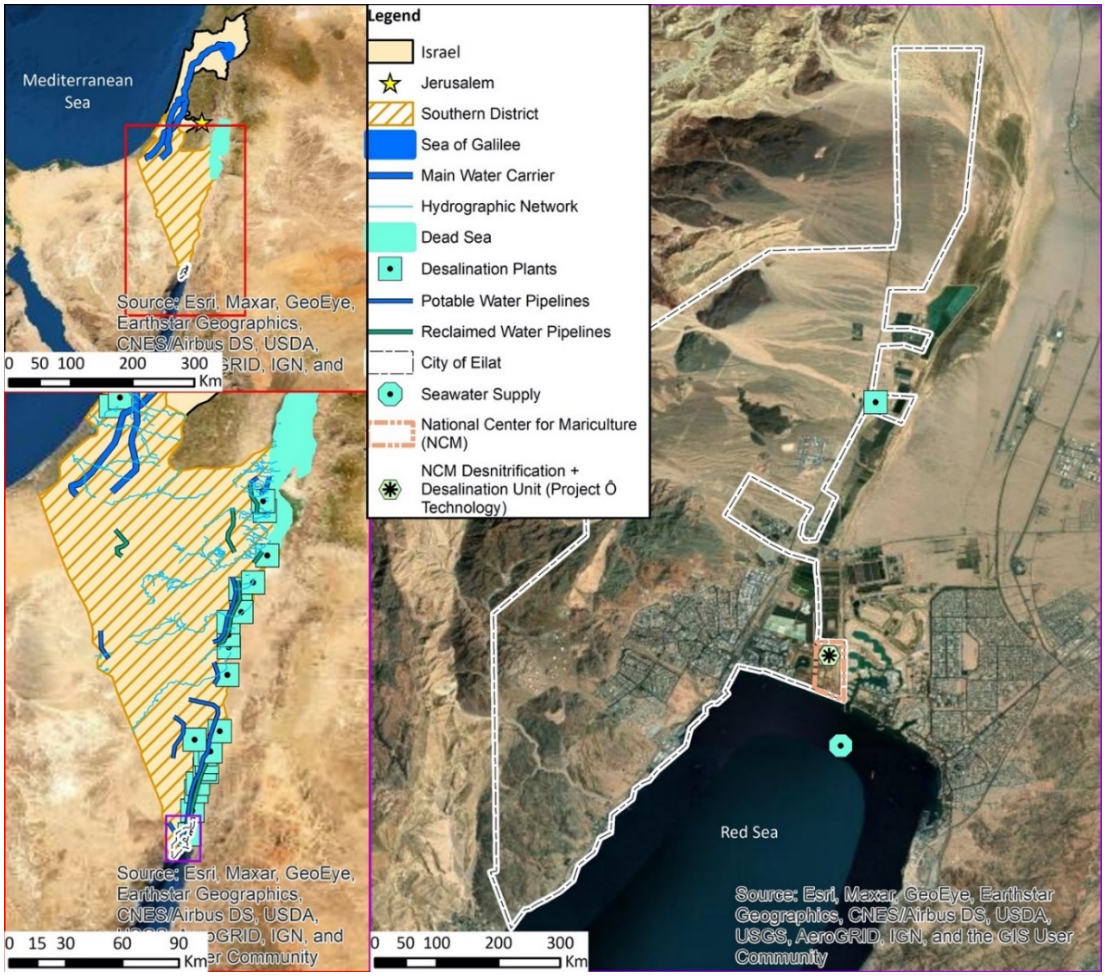


Figure 18. Demo site of Eilat (Israel): a) Location within the Southern Arava District in Israel, and the Red Sea; and b) Main features of the demo site.

Israel is one of the most water-scarce countries in the world. The total renewable volume of water per capita stands at 276 m3/year, which is about half of the red line of 500 m3/year that outlines a situation of water scarcity (Troop and Jägerskog, 2006). This shaped Israel's water sector's development with a series of technological innovations in operational practices and major legal and institutional reforms. The implementation of these reforms has gradually reduced the overexploitation of aquifers through a massive increase in the volume of wastewater reuse (since 1998), and seawater desalination (since 2006 with the installation of the first desalination plant in the city of Eilat) (Marin et al., 2017). In 2015, Israel was treating and reusing 86% of its wastewater for irrigation (approximately half of the total water that farmers use across the country) and for aquifer recharge (during periods of low irrigation demand). This number ranks Israel as the global leader for water reuse (MFA., 2018). By 2017, 85% of all potable water municipal and regional utilities distributed in the country is desalinated seawater and brackish water (Marin et al., 2017). However, this strategic choice of relying on desalination plants has increased the water supply sector's dependence on the energy sector, thus creating a dependency on natural gas supply companies (Marin et al., 2017).

Main features of the policy and planning set-up

Israel has not yet adopted a plan or strategy for CE. Israel's point of view on CE is expressed in the Israel Sustainability Outlook 2030 (MoEP, 2012). WCE is not mentioned in the document. However, the significant importance of the efficient use of water resources in the country, namely by practices of desalination and reuse of wastewater in agriculture, is recognised (MoEP, 2012; p. 58). It was foreseen that the extensive use of these practices would allow that by 2020, Israel's water potential would be doubled in relation to 2012 (MoEP, 2012; p. 60). No specific measures fostering the development of WCE and associated water loops, water utilities and stakeholders are mentioned. However, the document refers to the master plan for the water sector (WA, 2012) for

specific water reuse measures. Specific indicators to measure and monitor the efficient use of resources, including water, are identified, namely:

- the Environmental Vulnerability Index, which includes the reuse of water (MoEP, 2012; p. 139-140);
- the Environmental Performance Index, which includes water quality and availability (human consumption and environment), water pressure and the percentage of use of water resources for agriculture (MoEP, 2012; pp. 141-142);
- Sustainable Society Index, which includes the reuse of water (MoEP, 2012; pp. 143-144).

Spatial planning is considered in the document since the significant importance of the efficient use of land and space is recognised. An analysis of the current situation and future trends in the efficiency of land use for construction and development is presented, namely by analysing the rate of expansion of built-up areas concerning the rate of population growth, the price of land in relation to costs arising from its use, and land allocation between competing uses (MoEP, 2012; pp. 57-58). The creation of a city-state in a future scenario of continuation of the current spatial-environmental trends is recognised. This city-state is characterised by the development of the city towards peripherical open spaces, which is inconsistent with the principles of sustainability, namely by causing unrestrained distribution over space, while increasing congestion, pollution and overcrowding, an increase of physical infrastructures, damage to ecosystems and social-environmental inequality, namely in the management and distribution of water resources. This situation will only change if land pricing includes external costs, and urban renewal is valued as an economic activity, instead of expansion of built-up area (MoEP, 2012; p. 76). Specific recommendations for increasing urbanity, reducing the rate of expansion and preserve and protect the open space are presented in the document (MoEP, 2012; pp. 134-135). Symbiosis agreements involving the use of water and circular territories are not mentioned in the strategy.

In Israel, the current programming document that defines the vision, goals and objectives for the national water sector, including water protection, water supply, wastewater management and water reuse, is the Long-Term Master Plan for the National Water Sector (WA, 2012). Some of the main objectives of the plan (WA, 2012; p. 20) for the national water sector, are:

- Ensuring efficient use of water, and savings in utilising natural and artificial resources, including reclamation of treated wastewater.
- Providing sewage services, including collection and treatment of all the sewage and sources of contamination, to the level of quality that ensures the public's health, the flexibility of uses and preventing risks for the environment and for the natural water sources.

Specific measures for the management of sewage (WA, 2012; p. 23) as well as a specific project for implementation in the field of wastewater reuse (WA, 2012; p. 59) and reuse of greywater (WA, 2012; p. 29), regarding specific water loops, water utilities, stakeholders and responsible agencies, are presented in the plan, namely:

- Treatment of sewage and regional reclamation systems will be primarily based on criteria of reliability, efficiency and spatial fairness;
- Continued gradual enhancement of the quality of treated wastewater, according to cost-benefit analyses, the accumulated know-how regarding reclamation impacts, and according to future regulations;
- Continued investing in expansion and upgrade of WWTPs, regarding the quality of the treated wastewater as per legal standards;
- Upgrading WWTPs for quaternary treatment, with the objective of treatment of 50% of the wastewater to potable water quality;
- Connecting sewage producers to the treatment systems;
- Greywater reused projects for domestic purposes, such as for flushing toilets, thereby replacing the use of freshwater, and for public urban purposes, such as for irrigation in parks, can be carried out.

None of the identified measures is associated with the specific purpose of the development of WCE. However, they indirectly promote it. The articulation between water resources and spatial planning is considered in the plan, since the water sector will serve as a supportive factor in realising Israel's national goals, such as residential expansion and development, industry, agriculture, nature and landscape and regional agreements (WA, 2012; p. 7). Ensuring

the supply of water and sewage infrastructures for the development of settlements and industry, following the government decisions and supporting communities in the periphery, is one of the main objectives of the plan (WA, 2012; p. 20).·Land resources, population and infrastructures should be considered in the planning of the water sector. Water planning is to be conducted under the premise that there is a shortage of available land. Consequently, land use should be minimised for future water infrastructures. This is to be carried out by coordinating planning with other infrastructures (WA, 2012; p. 27). Water infrastructures should be developed under the assumption that the national outline plan for regional development (which shapes the population size and expansion) will be implemented as planned (WA, 2012; p. 28). A method should be found for the national infrastructure companies to secure spaces for water and sewage infrastructures in all their respective plans (WA, 2012; p. 45). The urban water sector is a major concern of the plan. Management of runoff in the urban domain will be used to enhance its contribution to the quality of life, improve the urban landscape, contribute to the residents' health, and involve civil society (WA, 2012; p. 55). Planning and operating the runoff and drainage management systems in urban areas will remain the local authorities' responsibility. However, at critical points, they will adhere to the master plans which will be prepared by the basin authorities, which will integrate relevant professionals on all levels of planning, including hydrology, drainage, statutory planning, urban planning, landscape architecture, land engineering, amongst others (WA, 2012; p. 55). The document foresees the involvement of different actors in different aspects related to the implementation of the plan, namely the Water Authority, Ministry of Health, Ministry for Environmental Protection, Ministry of Agriculture, Mekorot, private water and sewage corporations, amongst others (WA, 2012; p. 45-57). Symbiosis agreements involving the use of water and circular territories are not mentioned in the strategy.

The Israeli water resources main legal framework considers water reuse, however never in the purpose of WCE. Water reuse is considered in the main principles of the Water Law (Law 5719/1959) in the sense that, for the law, treated wastewater is considered a source of water (Law 5719/1959; Art. 2) and every person is entitled to receive and use water from a water source (Law 5719/1959; Art. 3), as long as that acceptance and use does not cause the salination or depletion of the water source (Law 5719/1959; Art. 5). The production and supply of treated wastewater were firstly regulated in the Water Law, in the sense that a person shall not produce water from a water source (e.g. treated waste water), shall not desalinate seawater, and will not supply it to others or self-consume it, except under a production license and related conditions (Law 5719/1959; Art. 23). Regulations regarding the quality of wastewater for various purposes, excluding drinking purposes, will be prescribed by the competent environmental and health authorities (Law 5719/1959; Art. 20). Such regulations were later detailed in the Wastewater Quality Standards and Rules for Sewage Treatment (R 5769/2010) and in the Quality Standards for Output Water from Fish Ponds and Rules for their Use (R 5772/2012) for the particular case of wastewater from aquaculture activities. The articulation with spatial planning is foreseen. It should be noted that, in Israel, all sources of water are public property, are under the control of the state, are intended for the needs of its residents and the development of the country (Law 5719/1959; Art. 1) and a person's right to land does not confer on him a right to a source of water located in or passing through that land or within its boundary (Law 5719/1959; Art. 4). A water plant (e.g. WWTP, desalination plant) plan shall not be approved before bringing it before the competent construction and urban planning authority, and the committee may approve the plan, notwithstanding the Planning and Building Law (Law 5725/1965). If the competent authority does not approve the water plant plan, the government may further approve it, with or without changes, or reject it (Law 5719/1959; Art. 68). The power of a water plant plan approved under this law is superior to any city building plan (Law 5719/1959; Art. 69).

The Israeli spatial planning main legal framework considers the protection of water resource, in the Planning and Building Law (Law 5725/1965), but especially in the National Parks, Nature Reserves, National Sites and Memorial Sites Law (Law 5758/1998), that legislates on all matters of nature reserves, including water resources, and national parks and to promote their affairs, as well as to protect the values of nature and heritage, to supervise their conservation and to cultivate them. The articulation with the water resources planning system is foreseen, since the instruments that determine the planning of the entire territory of Israel, should label the main national water supply lines, dams and storage lakes, and set provisions regarding afforestation, land conservation and the

preservation of landscape values and areas that remain in their nature (Law 5725/1965; Art. 49). The spatial planning instruments should also set provisions to ensure adequate conditions in terms of health, sanitation, cleanliness, safety, security and prevention of hazards by land planning and use and to preserve and develop important places in terms of nature or beauty while avoiding, as far as possible, damage to vegetation, natural values (including water), landscape and heritage (Law 5725/1965; Art. 61). Moreover, The Water Authority may, at any time, appoint an inspector to supervise the implementation of the Water Law (1959) in national parks and nature reserves (Law 5758/1998; Art. 60). The concepts of circular, integrated and symbiotic territories are not considered in the Israeli spatial planning main legal framework.

The city of Eilat and the entire Southern Arava district in Israel, are not covered by a typical RBMP. Instead, there is a Master Plan for Drainage and Canalisation of Eilat, the Eilot Area and the Southern Arava (ADA, 2010). The main purpose is to adopt a new drainage canalisation system in the built-up part of the city, which is absent of an underground drainage system, or whenever the existing system is in an inadequate state, to prevent floods and damage to the city and its residents (ADA, 2010; p. 10). The plan establishes quantity objectives and protected areas and minimum flow rates, related to drainage waters. However, these objectives are not associated with surface water and groundwater bodies' environmental or ecological status. The plan does not foresee measures to prevent diffusive pollution. The management of water abstraction, water supply, and sewerage collection and treatment is not part of this plan. As such, water reuse is not considered. Moreover, there is no reference to symbiosis agreements involving the use of water.

The Municipal Master Plan of Eilat (Eilat MMP), also known as Eilat Outline Plan (CE, 2020), foresees changes to the existing water infrastructures that may support efficient water use and promote WCE, including the planning for water-efficient landscaping and utilisation of surface runoff and water recirculation systems for a new industrial complex (CE, 2020; p. 75). However, the concept of circular territories with CE or WCE strategies are not considered in the plan. The plan acknowledges risks posed by floods on water resources and presents specific measures to prevent them (CE, 2020; p. 76). However, climate change, the impacts of urbanisation on water resources and impact assessment are not considered. The plan does not restrict the siting of reclamation plants nor disallow innovations in wastewater treatment and reuse.

Likely influence of the policy and planning set-up on the new water loop

The new water loops foreseen for the demo site of Eilat (Israel), with the installation of Project Ô technology in the treatment unit of the NCM aquaculture centre, are represented in Figure 19. In this loop, the wastewater from the fish tanks (fish farming wastewater) is first subjected to a denitrification treatment before being discharged into the sea (treated wastewater #1) or subjected to further treatments to be reused:

- the wastewater to be reused in the fish tanks of the aquaculture centre (water reuse #1) is further subjected to a mixed biological treatment in a macro-algae unit (treated wastewater #3);
- the wastewater to be reused in agriculture irrigation by farmers (water reuse #2) is further subjected to a desalination treatment (treated wastewater #2).

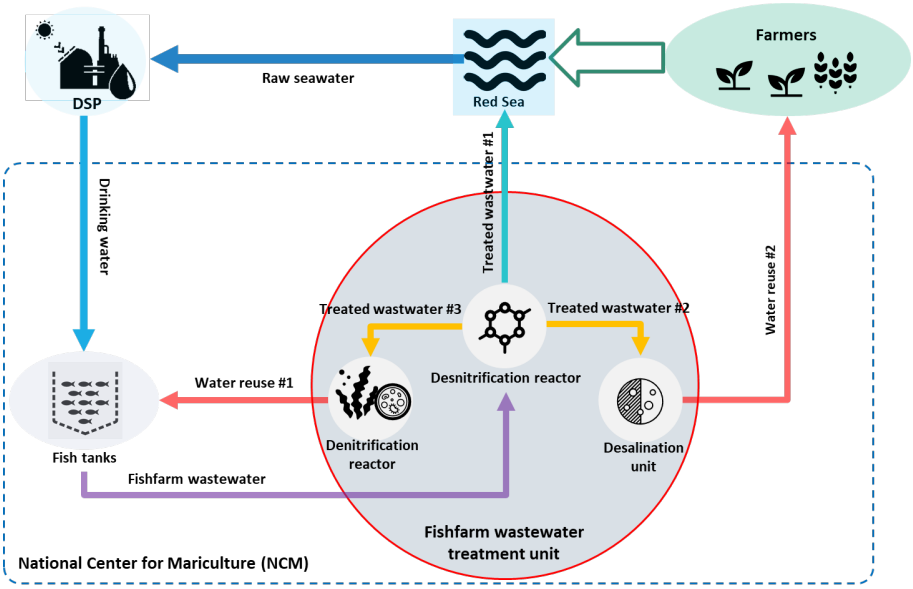


Figure 19. Outer water loop scheme for the demo site of Eilat (Israel). The light blue rectangular node represents the natural seawater system. Circle nodes represent desalination (light blue) and wastewater (red) treatment facilities: the red circle represents the installation of the Project Ô technology. The dashed blue rounded rectangle represents the aquaculture centre. The ellipse nodes represent the aquaculture (grey) and agricultural (green) agents that use and transform water. The large green arrow represents natural water infiltration in agricultural areas. Solid lines represent fluxes of different types of water: dark blue represents raw water extracted from the natural system; cyan blue represents purified drinking water; purple represents wastewater from the aquaculture activity; yellow represents treated wastewater that will be subjected to additional treatment; turquoise represent treated wastewater that is discharged in the natural system and red represents treated wastewater to be reused in the aquaculture activity.

The analysed policy dimension of the institutional set-up towards WCE in the demo site of Eilat (Israel), constituted by the sustainability strategy (MoEP, 2012) and water master plan (WA, 2012) identify specific water reuse measures that favour the implementation of the new water loop foreseen under Project Ô, including the utilisation of artificial resources, such as reclamation of treated wastewater (WA, 2012; p. 20).

Israel's water resources main legal framework does not constrain the implementation of the new water loop foreseen under Project Ô in the demo site of Eilat (Israel). The adopted Quality Standards for Output Water from Fish Ponds and Rules for their Use (R 5772/2012) define the fit-for-purpose regulations regarding the reuse of wastewater from aquaculture activities, excluding reuse for drinking purposes.

The Eilat MMP (CE, 2020) does not constrain nor favour the implementation of the new water loop foreseen under Project Ô for the demo site of Eilat (Israel).

The new water loop brings new stakeholders into the water resources management river basin community, namely the Minister of Health and the Minister of Agriculture whose consultation and permit are required to reuse wastewater for irrigation purposes (R 5772/2012). All the other stakeholders foreseen for the new water loop are already present in the river basin community.

5.2 Assessing the policy and planning set-up and mapping major drivers and barriers

Dedicated policies and planning instruments are preconditions for a successful transition towards water CE and the implementation of new water reuse loops at demo sites. This sub-section presents a comparative assessment of how the current policy and planning set-up favours the water circular economy's adoption in the perspective of water reuse and the implementation of the new water loops foreseen under Project Ô. The assessment is represented through the circular graphs in Figure 20. The extent of each circumference represents the degree of inclusion of the enabling factors considered in the analytical framework by the policy and planning documents (Figure 11 in section 4) in place at each demo site. The data supporting the graphs are presented in Appendix 2. The

assessment concludes with a mapping of the major drivers and barriers associated with the new water loops and the possible upscale of similar initiatives to implement water CE.

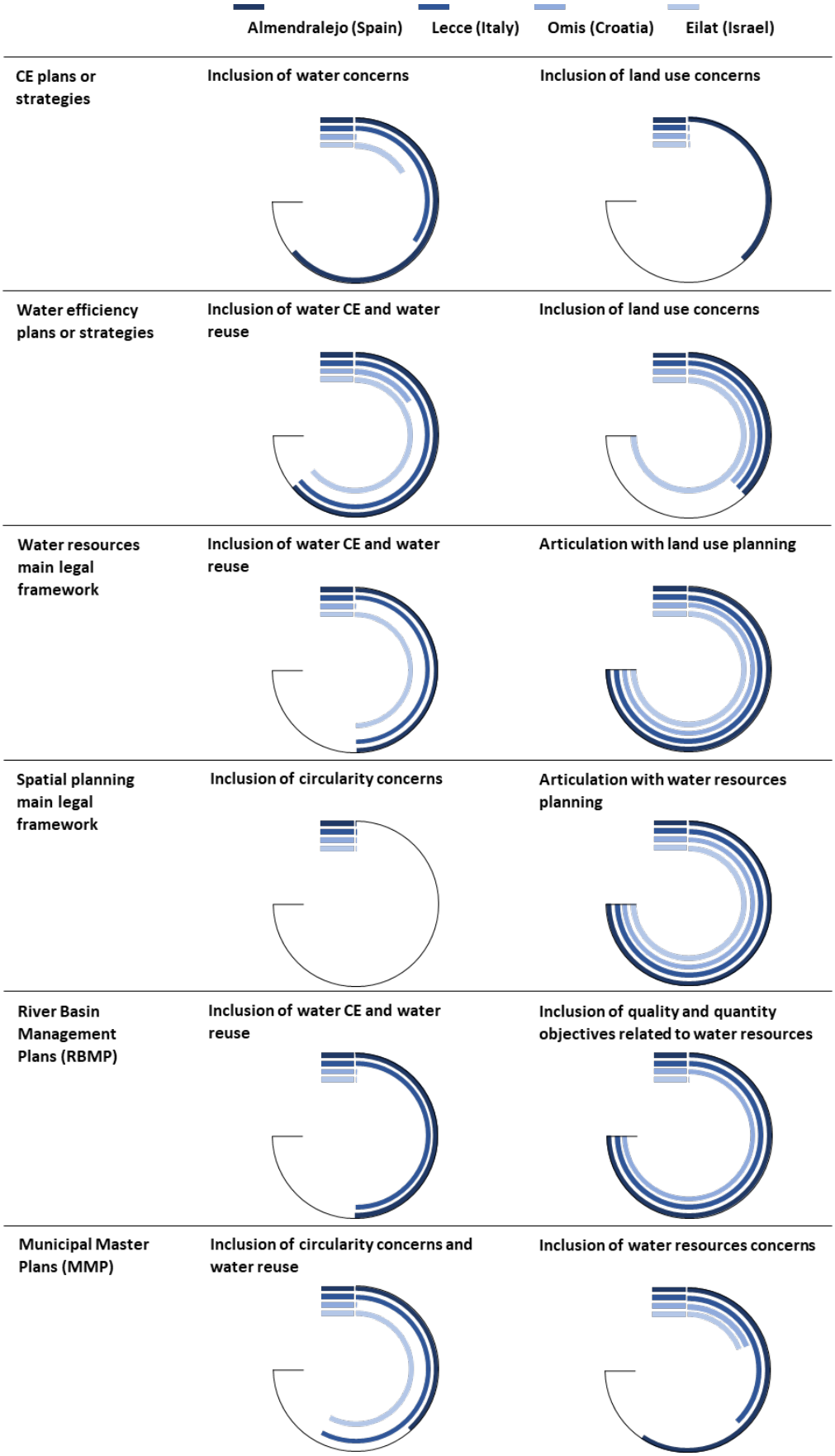


Figure 20. Assessment of the policy and planning set-up of the four demo sites. The outer thin black line represents the maximum degree of inclusion of the enabling factors by the selected policy and planning documents.

Overall, the inclusion of water and land concerns in the CE plans or strategies is most evident in Almendralejo (Spain), followed by Lecce (Italy). Spain and Italy have adopted CE strategies that recognise the significant importance of efficient water resource use in a CE context and include specific measures fostering water reuse practices. Furthermore, in Spain, the region of Extremadura, where Almendralejo is located, has also adopted a CE strategy that includes specific measures fostering water development in the CE through a set of sustainable water management measures that specifically include closed water loops. Spain's national CE strategy also mentions specific indicators to monitor water reuse measures and recognises the importance of spatial planning in the transition to a CE. However, the national CE strategies in Spain and Italy hardly consider spatial planning in their objectives. Israel and Croatia have not yet adopted a CE strategy or plan. Instead, their views on the CE are expressed in national sustainable development strategies, which recognise the significant importance of the efficient use of water resources, but not for the development of CE. The Israeli sustainable development strategy mentions specific indicators to measure and monitor the efficient use of resources, including water. It also recognises the significant importance of land and territory's efficient use, but not in the CE context. None of the analysed documents considers the management of the urban water cycle as a way of creating circular territories.

Concerning policy plans for efficient water use, both Spain, Israel and Italy, consider water reuse as a primary objective and strategy. Spain, Italy and Israel have water efficiency programming documents that define the vision, goals and objectives for the national water sector, including water protection and supply, wastewater management and water reuse. These documents identify measures for efficient water use, including specific water reuse with specific water loops and utilities. None of the measures identified is associated with the specific purpose of developing the WCE. However, indirectly, they promote it. Croatia's water efficiency plan does not identify measures fostering the development of water reuse practices, nor associated water loops or water utilities. All selected documents identify the leading agencies responsible for implementing the plans and other agencies and stakeholders involved. The water efficiency programming documents of the four demo sites consider the articulation with spatial planning. However, Israel's water efficiency plan pays special attention to the urban water sector's management to increase the efficiency in water use. None of the selected documents identifies symbiosis agreements involving the use of water.

In general, the water resources major legal frameworks in Spain, Italy, and Israel are integrated and compatible with the water reuse principles and solutions, but never to develop WCE. There are specific legal regimes in these countries that regulate fit-for-purpose procedures, standards, and minimum quality criteria for water reuse practices, such as reuse of domestic, urban and industrial wastewater, reuse of water from agronomic activities in irrigation. In Croatia, the water resources main legal framework does not consider water reuse or WCE. The link between water resources management and spatial planning is clearly foreseen in the water resources major legal framework in the four countries.

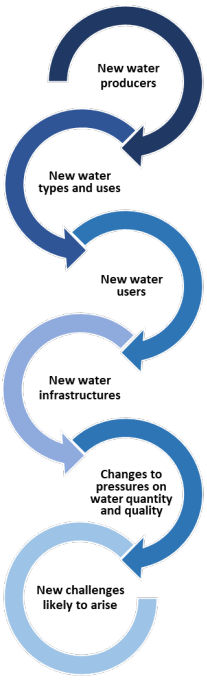
The four countries' spatial planning major legal frameworks consider the protection of water resources in their main aims and principles and foresee the need for a clear articulation with the water resources planning system. However, the concepts of circular, integrated or symbiotic territories are never considered.

Almendralejo (Spain), Lecce (Italy) and Omis (Croatia) are covered by typical River Basin Management Plans (RBMP) that establish environmental quality and quantity objectives for surface and groundwater bodies, as well as ecological flow regimes. These plans also establish areas of special protection for surface and groundwater and unique water-dependent ecosystems. In their Programs of Measures (PoM), these plans also include actions to monitor and control diffuse water pollution. The PoM of the RBMP of Almendralejo (Spain) and Lecce (Italy), includes specific actions fostering water reuse for different purposes, such as irrigation and aquifer recharge. None of these actions are articulated within the purposes of the development of the WCE but indirectly endorse it. The PoM of the RBMP of Omis (Croatia) does not consider actions towards the development of water reuse or WCE. However, it includes investments in the sewerage system that can foster opportunities to develop future water

reuse projects. Eilat (Israel) is not covered by a typical RBMP. Instead, there is a drainage plan that does not cover aspects related to the environmental or ecological status of water bodies and does not cover aspects related to the management of water abstraction, water supply, and sewerage collection treatment. As such, water reuse is not considered. Furthermore, none of the documents analysed considers symbiosis agreements involving the use of water.

The four demo sites are covered by Municipal Master Plans (MMP) that foresee changes to existing water infrastructures. However, whereas for Almendralejo (Spain), Lecce (Italy) and Eilat (Israel) these changes are centred on the efficient use of water and can promote water reuse and the development of water CE, for Omis (Croatia) these changes are centred on improving urban water distribution and ensuring an adequate wastewater drainage system. For Lecce (Italy) and Eilat (Israel), the plans also consider new developments as opportunities to treat and reuse water on-site, such as projects involving rainwater collection tanks and on-site treatment. However, none of the plans foresees the promotion of circular territories with CE or WCE. The plans of the four demo sites recognise the risks posed by floods. Nevertheless, climate change is never mentioned in the context of water adaptation measures. Almendralejo (Spain) 's plan explicitly considers impact assessment and analysis tools, not to plan for water reuse, but to use as a prerequisite for land use decisions and development permits.

The new water loops' implementation implies innovative adaptations and changes, with new challenges in the water supply systems. Figure 21 summarises a set of changes and consequent challenges that the implementation of the new water loops arise or are likely to arise, due to the emergence of new water producers, new types of water, new water uses and users, new water infrastructures and changes to pressures on water quality and quantity. These challenges are related to regulations, water quality standards, water balances, permits, risks management plans, monitoring schemes, contracts, stakeholders, responsibilities, prices, land uses, etc.



	Almendralejo (Spain)	Lecce (Italy)	Omis (Croatia)	Eilat (Israel)
New water producers	- Almendralejo WWTP (runned by Socamex)	- Lecce WWTP (runned by Acquedotto Pugliese)	- Galeb wastewater treatment unit	- National Center for Mariculture (NCM) wastewater treatment unit
New water types and uses	- Treated wastewater (agricultural and non-potable reuses) - Water reuse #1 (watering of Las Mercedes Park) - Water reuse #2 (irrigation of agriculture) - Water reuse #3 (washing of municipal roads and streets)	- Treated wastewater (environmental reuse) - Water reuse #1 for aquifer recharge	- Treated wastewater (industrial reuse) - Water reuse #1 in the production processes	- Treated wastewater (aquaculture and agricultural reuse) - Water reuse #1 (recirculating aquaculture system) - Water reuse #2 (irrigation in agriculture)
New water users	- Municipality of Almendralejo (watering of Las Mercedes Park and washing of roads and streets) - Farmers (irrigation of agriculture) - Citizens (indirect contact in Las Merceds Park, roads and streets) - Retailers and consumers of agricultural products (indirect)	- Lecce Municipality water users (indirect due to use of groundwater for potable and non-potable uses)	- Galeb factory	- Fish farmers (aquaculture tanks) - Farmers (irrigation of agriculture) - Retailers and consumers of fishery and agricultural products (indirect)
New water infrastructures	- Storage (small tanks, reservoirs) - Transport (pipelines, trucks)	- Drainage trenches (for aquifer recharge)	- Pipes (inside the Galeb factory)	- Storage (small tanks, reservoirs) - Transport (pipelines, trucks)
Changes to pressures on water quantity and quality	- Decrease of freshwater abstraction (from the Guadiana River) - Decrease of effluent discharge (into the Harnina River) - Increase in effluent quality	- Increase in groundwater availability (in the Salentino Aquifer) - Decrease in freshwater supply (from external sources) - Cessation of effluent discharge (into the Adriatic Sea)	- Decrease of water abstraction (from the Cetina River) - Decrease of effluent discharge (into the Cetina River) - Increase in effluent quality	- Decrease in seawater abstraction (from the Red Sea) - Decrease of effluent discharge (into the Red Sea) - Increase in effluent quality
New challenges likely to arise	- New water quality standards (Waste Water Reuse Law) - New water balance and pollutant loads (quality and quantity environmental objectives for surface water and groundwater bodies defined in the Guadiana RBMP) - New permits (reuse of wastewater in agriculture) - New authorities (local health authority) - New risks management plans (health, security and environmental risks) - New monitoring schemes (indicators to monitor, schedule, communication of results) - New contracts (responsibilities, water quantity and quality, user's priority, supply method, prices, compensations) - New actors (water storage and transport company) - New land uses (water storage and transport infrastructures in agreement with Almendralejo MMP)	- New water quality standards (Rules for Reuse of Waster Water) - New water balance and pollutant loads (quality and quantity environmental objectives for groundwater bodies defined in the Southern Apennines RBMP) - New areas for aquifer recharge and groundwater abstraction (aquifer safeguard zones defined in the Lecce MMP)	- New water quality standards (specific water reuse regulations) - New water balance and pollutant loads (quality and quantity environmental objectives for groundwater bodies defined in the Croatia RBMP)	- New water quality standards (Quality Standards for Output Water from Fish Ponds and Rules for their Treatment) - New water balance and pollutant loads (quality and quantity environmental objectives for water resources) - New permits (reuse of wastewater in agriculture) - New authorities (Health and Agricultural Authority) - New risks management plans (health, security and environmental risks) - New monitoring schemes (indicators to monitor, schedule, communication of results) - New contracts (responsibilities, water quantity and quality, user's priority, supply method, prices, compensations) - New land uses (water storage and transport infrastructures in agreement with Eilat MMP)

Figure 21. Potential changes raised to the IWRM with the implementation of the new water loops at the demo sites.

The implementation of the new water loop in Almendralejo (Spain) presents the most significant number of new challenges, namely due to the higher amount of new water uses and users, including irrigation purposes by farmers, as well as the indirect contact of citizens with the reused water in Las Mercedes Park, roads and streets. This implies the adoption of stricter water quality and health regulations, risk management plans and monitoring schemes to ensure safety and protection for retailers and consumers of agricultural products and citizens. The use of reused water for irrigation requires new permits and the involvement of new authorities, such as the local health authority. Furthermore, the implementation of the new water loop in Almendralejo (Spain) requires the storage and transport of water from the WWTP to reuse locations, which implies new infrastructures and land uses and new contracts with water storage and transportation companies.

Like Almendralejo (Spain), the implementation of the new water loop in Eilat (Israel) also presents many new challenges, namely due to the water reuse for aquaculture by fish farmers and for irrigation purposes by farmers. This implies adopting stricter water quality and health regulations, risk management plans and monitoring schemes, which must attend the different fishing and agricultural products produced with reused water to ensure safety and protection of retailers and consumers. The use of reused water for irrigation also requires new permits and new authorities' involvement, such as the Minister of Health and the Minister of Agriculture. Implementing the new water loop in Eilat (Israel) also requires the storage and transport of the water from the aquaculture centre to the agricultural areas to be reused, which implies new infrastructures and land uses.

The smaller amount of new water uses in the new water loop in Lecce (Italy) makes its implementation less challenging. However, the indirect use of groundwater for potable and non-potable uses by citizens also implies strict water quality and health regulations, risk management plans and monitoring schemes to assure water safety. Implementing the new water loop in Lecce (Italy) does not bring new stakeholders into the water supply system. However, the aquifer recharge requires new infrastructures (drainage trenches) that must be planned in agreement with the aquifer safeguard zones defined in the Lecce MMP.

The implementation of the new water loop in Omis (Croatia) is the least challenging. The new water loop will be implemented within the factory's boundaries, and most of the new challenges occur within its limits, namely the new water to be reused in the production process and the new infrastructures to transport the water. Risk management plans and monitoring schemes must still be adopted, although they should not be so strict, since there is no direct or indirect contact with water.

All four demo sites must deal with changes to pressures on the quantity and quality of water resources. The new water loops will generate a new water balance, due to changes in freshwater availability, abstraction and effluent discharge. In Almendralejo (Spain) there is a decrease of freshwater abstraction from the Guadiana River and decreased effluent discharge into the Harnina River. In Lecce (Italy) there is an increase in groundwater availability in the Salentino Aquifer, a decrease in freshwater supply from external sources and a cessation of effluent discharge into the Adriatic Sea. In Omis (Croatia) there is a decrease of water abstraction and effluent discharge from and into the Cetina River. In Eilat (Israel) there is a decrease in seawater abstraction and effluent discharge from and into the Red Sea. Furthermore, the new water loops will generate a new distribution of pollutant loads. Water reuse may decrease the discharge of pollutants into water bodies that receive effluents. It may also increase the concentration and accumulation of pollutants in soils and water bodies in water reuse areas, such as the agricultural areas in the case of Almendralejo (Spain) and Eilat (Israel), the urban area in the case of Almendralejo (Spain) and the aquifer recharge area in the case of Lecce (Italy). The changes in the water balances and distribution of pollutant loads must be planned in agreement with the water's environmental quality and quantity objectives (e.g. ecological flows) and the protected areas defined in the RBMP of each demo site.

The assessment of the demo sites policy and planning contexts towards WCE and water reuse and the analysis of the new challenges that the demo sites will have, or will likely have, to deal with in the implementation of the new water loops foreseen under Project Ô, allowed to identify the set of major environmental, spatial, policy, planning, regulatory and governance drivers and barriers presented in Figure 22. It should be noted that further analysis with

key stakeholders and water and land use policy and planning specialists at each demo site is needed to identify other potentials drivers and barriers, namely regarding regulatory and governance aspects.

Water scarcity and shortage of freshwater resources, together with the future impacts of climate change, are the major environmental drivers in Almendralejo (Spain), Lecce (Italy) and Eilat (Israel). Other major drivers are the depletion of water resources due to untreated discharges or saline intrusion and the need for Almendralejo (Spain), Lecce (Italy) and Omis (Croatia) to comply with EU environmental objectives related to wastewater treatment and discharge. In Omis (Croatia), the high availability of freshwater resources is a major environmental barrier.

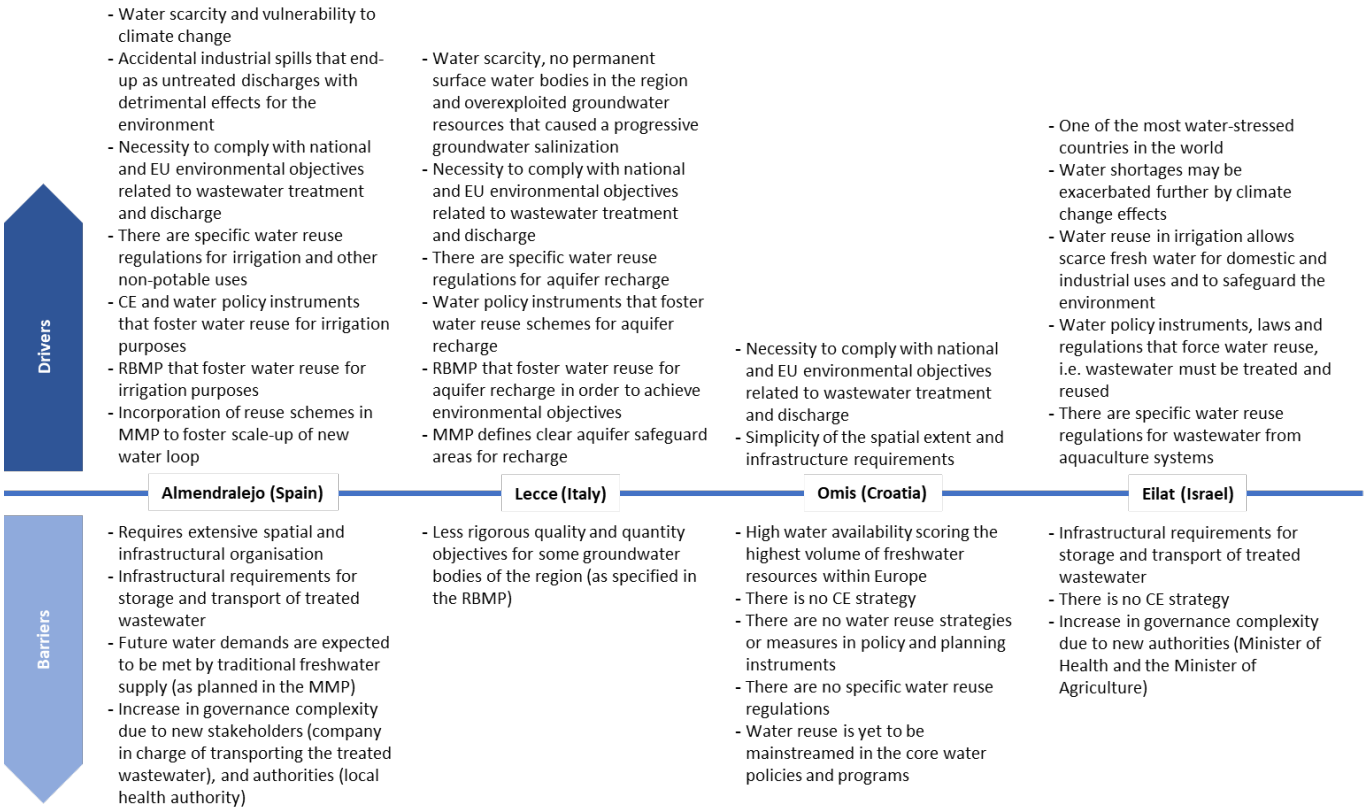


Figure 22. Major drivers and barriers associated with the new water loops at the demo sites.

The simplicity of the spatial extension and the new water loop's infrastructure requirements in Omis (Croatia) is a major spatial driver. For Almendralejo (Spain) and Eilat (Israel), the new water loops' infrastructure requirements may work as spatial barriers. Besides, for Almendralejo (Spain), the great spatial extent and different land-uses represent another significant barrier.

The existence of CE and water policy instruments and water resources and land use plans (RBMP and MMP) that foster the implementation of water reuse schemes are the primary policy and planning drivers for Almendralejo (Spain) and Lecce (Italy). By forcing water reuse, water policy and law are the primary drivers of Eilat (Israel). The existence of fit-for-purpose water reuse regulations is another major driver for Almendralejo (Spain), Lecce (Italy) and Eilat (Israel). On the contrary, by not considering water reuse, policy, planning and regulatory instruments are the significant barriers for Omis (Croatia). A major driver of Omis (Croatia) is the simplicity of the governance arrangement due to the reduced number of stakeholders. On the contrary, the increase in governance complexity due to new stakeholders and authorities are the main barriers for Almendralejo (Spain) and Eilat (Israel).

The analysis of each demo site's policy and planning contexts also allowed to identify a few social drivers and barriers towards the implementation of new water loops in the demo sites. For Eilat (Israel) there is a comprehensive experience with alternative water sources (desalinated brackish water and seawater, reclaimed

wastewater). Therefore, there is a consolidated social acceptance towards water reuse for irrigation and non-potable uses and a high valorisation of freshwater that can be stored and used for potable uses. For Almendralejo (Spain) and Lecce (Italy) there may be a negative perception and acceptance for the water reuse due to indirect contact with treated wastewater due to road and street washing, park irrigation and use of groundwater for potable uses. Furthermore, the use of treated wastewater for irrigation purposes in Almendralejo (Spain) can raise problems with the negative marketing of agricultural products and decrease agricultural properties' value.

6. Discussion and conclusions

This report analysed how current policy and planning settings related to CE policy, water resources and spatial planning, are prepared to accommodate innovative and integrated water resource planning to foster water CE in the perspective of water reuse in each demo site of Project Ô. The document also sought to identify the major drivers and barriers for implementing the new water loops foreseen with the implementation of the new technologies developed under Project Ô and to identify major new challenges that the demo sites must deal with in this implementation.

The set of documents chosen is usually adopted in most countries, especially in the EU context. The methodology used, based on the qualitative document analysis, provided valuable and reliable information. The qualitative analysis heavily relies on the researchers' knowledge and on the researchers' ability to extract information based on existing facts and evidence (Ostrom, 2010). Nevertheless, the collection of information from the documents was guided by a set of pre-defined questions with direct quotation minimising the researchers' bias and subjectivity. Furthermore, the translation of some documents can lead to misinterpretation or assigning of inappropriate meaning to words. This was particularly relevant for documents from Israel in Hebraic. The project partners checked the information collected on each demo site, to avoid errors. Two main reasons have stemmed the comparative analysis of the documents on the demo sites. First, because not all countries have equivalent policies and plans, and second, the structure of documents varies significantly, revealing different structures and content approaches. Croatia and Israel have not yet adopted plans or strategies for CE and in the demo site of Eilat (Israel) are not covered by a River Basin Management Plans, typical of EU countries.

While there is ample evidence of the importance of policy and planning documents in the call to action and the call for adopting WCE and water reuse, it is also recognised that these written documents have limitations. Written documents comprise only one side of policy and planning and do not correspond directly to action (Brunsson, 2003). The inclusion of a particular objective or measure in a policy or planning document does not necessarily mean that it will be implemented. Conversely, its absence in a policy or plans is not always a guarantee that it will not be practised. The analysis of policy and planning must be understood as institutional contexts reflecting expectations, priorities and rules in-use in a particular community, territory and time. Further relevant insights on institutional set-ups can be provided by the study of more practice-related documents, such as calls for proposals and project reports, and other sources of information, including consultations with experts, agencies and other water actors, able to provide further understandings on the practices being taken on each demo site.

Despite the limitations, this report provided relevant results to understand better the extent to which the policy and planning contexts of demo sites reflect the major drivers and barriers to the transition towards the WCE and the implementation of water reuse solutions, namely:

- Almendralejo (Spain) presents a more robust policy and planning set-up towards the WCE and the water reuse. The water scarcity and the shortage of freshwater resources, together with the future impacts of climate change, are the major drivers of the policy and planning set-up's robustness. The implementation of water reuse is driven by integrating these practices in the water policy and legal and planning frameworks. The transition to the water CE in Almendralejo (Spain) is also driven by a more substantial inclusion of water and land concerns in national and regional CE policy.

- Lecce (Italy) also presents a robust policy and planning set-up towards water reuse; however, there is a weaker inclusion of water and land concerns in the national CE policy. The implementation of water reuse is driven by a full integration of these practices in water policy, legal and planning frameworks. Water scarcity, the absence of permanent surface water bodies in the region and the overexploited groundwater resources that have caused progressive groundwater salinisation are also significant drivers towards water reuse;
- Omis (Croatia) policy and planning set-up towards the WCE and the water reuse are still under development, which can be a barrier to the transition to new WCE initiatives. A CE policy plan or strategy considering water and land concerns is yet to be adopted, and water reuse is yet to be mainstreamed in the core water policy, legal and planning frameworks. Another barrier towards water reuse is the lack of effective sewerage systems and the absence of appropriate wastewater treatment.
- Eilat (Israel), although without a CE policy plan or strategy fostering water CE and water resources planning instruments typical of EU countries, presents a full integration of water reuse in water policy planning and legal frameworks. The constraints of water scarcity, combined with a fast-growing population, have driven Israel to engage in a massive water reuse policy.

Implementing the new water loops foreseen with the implementation of new technologies developed under Project Ô implies new challenges for the demo sites. The existence of a more robust policy and planning set-up on the demo sites can help to overcome these challenges:

- The implementation of the new water loop in Almendralejo (Spain) presents the highest number of new challenges, including the higher amount of new water uses and users, stricter water quality and health regulations, risk management plans and monitoring schemes, new permits and the involvement of new authorities, as well as new infrastructures. The new water loop in Almendralejo (Spain) implicates the highest spatial extension, and different land uses. However, the more robust policy and planning set-up should help to overcome most of these challenges. Specifically, the Almendralejo MMP already foresees a new water infrastructure for the distribution of treated wastewater, which includes storage facilities and transport pipelines, that represent a major opportunity for a future scaling-up of the new water loop;
- The smaller amount of new water uses in the new water loop in Lecce (Italy) makes its implementation less challenging. Furthermore, the robust policy and planning set-up should be enough to overcome these minor challenges, including the need for stricter water quality and health regulations, risk management plans and monitoring schemes due to the indirect use of groundwater for potable and non-potable uses by citizens;
- Despite having a less robust policy and planning set-up, implementing the new water loop in Omis (Croatia) is the least challenging. The new water loop will be implemented within the boundaries of the factory, and most new challenges occur within its limits and overcoming them should not require a robust policy and planning set-up;
- The implementation of the new water loop in Eilat (Israel) also presents several new challenges, namely due to the different amount of new water uses and users, stricter water quality and health regulations, risk management plans and monitoring schemes, new permits and the involvement of new authorities. However, the robust policy and planning set-up and the country's vast experience with water reuse should help overcome most of these challenges.

The higher number of new challenges foreseen for the demo sites of Almendralejo (Spain) and Eilat (Israel), namely the higher number of new water users, clearly calls for the implementation of a co-creation process. A co-creation process occurring in open dialogue and interaction between the different stakeholders (i.e. water producers, water users, water authorities, amongst others) benefits from a wide range of knowledge, experiences and skills. It should help define and solve the new challenges in collaboration with each other (Frantzeskaki and Kabisch, 2016). For the demo site of Lecce (Italy), the water reuse to recharge the aquifer used by the citizens should benefit from implementing a co-creation process to define clear responsibilities and reduce negative public perception and acceptance. For the demo site of Omis (Croatia) there should not be necessary to implement a co-creation process, since it only involves water reuse in the internal industrial process, not involving any other external new water users. The development of co-creation processes within the scope of Project Ô should use an engagement strategy

suited for water governance, specifically for the implementation of the new water loops. This entails identifying and lifting challenges and barriers and using the drivers in place for water circularity, emphasising policy, planning and governance practices. It should be noted that models of co-creation are highly contextual and can differ for each demo-site.

It is expected that, at this stage, the findings provided by this document enlightens the contextual policy and planning features surrounding the demo sites. Also, it is hoped that they contribute to enriching further research on decision-making tools and practices and the roles of stakeholders associated with the demo sites. The results are useful as a platform for further discussion and engagement of stakeholders, helping them screen the major challenges and propose innovative and integrated strategies to manage new water loops. Furthermore, the analytical framework developed can be extended to other case studies to support the development of water CE and water reuse policy and planning contexts.

7. Further steps

The next steps in this study are twofold. One step seeks to analyse the current institutional arrangements for water supply, distribution and use and the likely changes caused by the implementation of new water loops in the demo sites of Project Ô. For this purpose, using document analysis and interviews with local stakeholders, the key features of the institutional arrangements associated with the water system will be studied to identify potential drivers and barriers for innovative water governance. The study aims to contribute to improving the institutional interplay surrounding the WCE in the perspective of water reuse. The related governance factors, equally relevant to characterise the policy and planning set-up, should also be explored here. The second step that follows is building a co-creation process to identify potential solutions for complex problems caused by the adoption of WCE, with interdisciplinary approaches, building dialogue bridges between stakeholders from water management, experts and local communities. The task's objective is to use the demo sites as laboratories to design a process of co-creation (on a pilot demo site) with relevant stakeholders to enhance the implementation of adopting WCE approaches.

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Appendix 1

Research questions and answers used in the assessment of the policy and planning contexts of the demo sites to accommodate WCE. This research questions correspond to the several general and specific enabling factors presented in Figure 11 in section 4.

Almendralejo (Spain)

Almendralejo (Spain) Strategy or plan for circular economy (National level)	
Questions	**Answers**
1. Is water circular economy included in the priority areas of the strategy/plan?	- *In the Circular Spain 2030 - Spanish Strategy of Circular Economy (GE, 2018), water circular economy, although not included on its broader sense, is considered as water reuse and as an individual axis separated from raw materials, allegedly for its special impact on the Spanish economy (GE, 2018; p. 22).* - *The strategy main areas of action, on which policies and instruments are focused, are production, consumption, waste management, secondary raw materials, and water reuse (GE, 2018; p. 20).*

2. Are there specific measures fostering the development of a Water Circular Economy?	- *There are specific measures for the development of water reuse that can be considered as fostering the implementation of water circular economy. The strategy has a set of policies for the transition to the circular economy: competitiveness, social and environmental policies. Water emerges in the group of environmental policies where the objective of sustainable water management and efficient use of this scarce resource includes, specifically, water reuse (GE, 2018; p. 56).*
	- *Water reuse is a priority axis of the strategy and of its first action plan (2018-2020) with the main objective of reducing pressures on water resources. For this a set of actions is proposed related to the removal of existing regulatory barriers and the promotion of water reuse by means of research and funding (GE, 2018; p. 128).*
	- *The strategy includes the following measures for water circular economy (GE, 2018; p. 128):*
	  - *Adjustment of the current national water reuse regulation to the European level regulation on minimum requirements for water reuse and prepare its implementation with guidance documents;*
	  - *Support to irrigation projects with water reuse;*
	  - *Integration of reuse actions in the River Basin Management Plans;*
	  - *Promotion of research to establish the minimum quality criteria required for water reuse, from the sanitary and environmental points of view.*

3. Are water utilities and other stakeholders identified for the implementation and monitoring of measures for a Water Circular Economy or water reuse?	- *The strategy identifies several stakeholders for the implementation of measures in the water reuse priority axis, but water utilities are not considered.*
	- *The following stakeholders are considered (GE, 2018; Annex II), by measure:*
	  - *MAPAMA and MSSSI for the regulatory adjustment for the promotion of the reuse of reclaimed waste water;*
	  - *MAPAMA and MSSSI for the preparation of a guide for the implementation of the regulation instrument issued at European level;*
	  - *MAPAMA for the support to irrigation projects that have as resources the reuse of wastewater;*
	  - *MAPAMA for the reuse actions included in the River Basin Management Plans;*
	  - *MAPAMA and MSSSI for the promotion of research work to establish the minimum quality criteria required for water reused from the sanitary and environmental point of view.*

4. Does the strategy or plan establishes specific indicators to measure and monitor water loops? Which ones?	- *The strategy has very general indicators and considers for water reuse actions, included in the RBMPs, to monitor the number of investments (GE, 2018; Annex II).* - *More specific indicators for the new water loops are not mentioned. It is referred that a specific working group has been created within the network of environmental authorities to establish other indicators to monitor the circular economy that will start from the identification of existing indicators in circular economy or similar, already considered by the autonomous communities, as well as the proposals that are being worked at state, European and international level (GE, 2018; p.154).*
5. Is spatial planning considered in the strategy/plan? How and in which parts (problem, objectives, measures, stakeholders, monitoring)?	- *The strategy does not consider spatial planning as general framework relevant for the circular economy and, in particular, as a means to the implementation of water circular economy (GE, 2018).*
6. Does the strategy refer spatial planning in relation with symbiosis agreements involving the use of water?	- *Symbiosis agreements are not mentioned in the strategy in relation to water or spatial planning (GE, 2018).* - *European research opportunities are mentioned for several areas of circular economy, including industrial symbiosis, that is considered in the scope of the action axis for production and design. Under this axis, it is mentioned the existence of support to industrial symbiosis projects (GE, 2018; p. 176).*
7. Does the strategy/plan considers the concept of circular territories regarding the management of the urban water cycle (or others) and any consequences at the spatial planning level?	- *The strategy does not consider circular territories and no reference to it is made in the document (GE, 2018).*

Almendralejo (Spain) Strategy or plan for circular economy (Regional level)	
Questions	**Answers**
1. Is water circular economy included in the priority areas of the strategy/plan?	- *The strategic plan for circular economy in the region of Extremadura, called Extremadura 2030 – Green and Circular Economy Strategy (JE, 2018), includes the sustainable water management in its functional objectives and water in the thematic axis (JE, 2018; p. 185). In this document water is considered a public good necessary to achieve fundamental human rights, and a key element of the circular economy and the environment.*

2. Are there specific measures fostering the development of a Water Circular Economy?	- *The strategy includes specific measures fostering the development of a water in the circular economy included in the energy, water and waste thematic axis, under water policy. It is stressed that the National Water Pact will be a guidance for the regional Water Pact and for the Green and Circular Economy Strategy for Extremadura. This is considered through a set of measures of sustainable water management that include specifically closed loops of water (JE, 2018; p. 185). It is addressed the need for increased efficiency in the use of water resources and the implementation of harvesting and reuse techniques to reduce the future vulnerability of the region to climate change (JE, 2018; p. 194).*
	- *It is worth mentioning that it is foreseen to seek a greater integration of sectoral policies such as water resources planning, environmental policy, agriculture, rural development and spatial planning (JE, 2018; p. 185). This is advocated as a means to ensure the implementation of the WFD and other environmental European directives (JE, 2018; p. 194), and may constitute an important institutional feature for the implementation of water circular economy.*
	- *Other set of measures include (JE, 2018; p. 194):*
	  - *The development of drought action plans in articulation with the climate change adaptation plan;*
	  - *The improvement of the natural hydrological cycle, with the maintenance of the ecological flows;*
	  - *Measures to manage water infrastructures (catchment, drinking water treatment, distribution, storage and purification), with plans that address risks posed by extreme events.*

3. Does the strategy/plan identify the main water utilities and other specific stakeholders involved in the implementation and monitoring of measures for Water Circular Economy?	- *The strategy identifies specific stakeholders involved in the implementation and monitoring of measures for water circular economy (JE, 2018).* - *The document refers meetings with users, associations and non-governmental organisations (NGOs), involving all sectors and agents involved in the management or use of water i.e. the key administrative structures that support water administration, constituted by the River Basin Authorities and the communities of users. In what regards the communities of users, the public law corporations such as the Irrigation Communities and the Commonwealths of Supply, Sanitation and Hydroelectric Users are fundamental to address the management of most of the region's water resources (JE, 2018; p.194-195).*
4. Does the strategy/plan establish specific indicators to measure and monitor water loops? Which ones?	- *There are no measures in the strategy directly related to the implementation of new water loops and, as such, there are no specific indicators to measure and monitor water loops (JE, 2018);* - *In what concerns the follow-up and evaluation of the Water Policy' line of action, the achievement of measures depends on the National Water Pact's approval initiative and the consequent formulation of the Water Law of Extremadura. The indicators to be followed will be those agreed in the future National Water Pact with the various stakeholders who will participate in the concertation meetings (JE, 2018; p. 324).*
5. Is spatial planning considered in the strategy/plan? How and in which parts (problem, objectives, measures, stakeholders, monitoring)?	- *The strategy considers spatial planning threefold in its functional objectives. The most significant mention is done in the scope of the thematic line on water policy where the coherent integration of sectoral policies such as water resources planning and spatial planning is advocated (JE, 2018; p. 194).*
6. Does the strategy/plan consider the existence or creation of symbiosis agreements involving the use of water? Are these considered in relation to spatial planning?	- *The strategy intends to develop an industrial symbiosis project, to foster a resource-efficient and sustainable growth (JE, 2018; p. 176). However, there is no specific mention to water and spatial planning requirements to develop this symbiosis project.*
7. Does the strategy/plan consider the urban water cycle as a way to create circular territories?	- *The strategy does not consider any connection between the urban water cycle and circular territories (JE, 2018).* - *There is a mention to territorial symbiosis, where it is considered as an opportunity for new activities and business models, along with other areas, such as industrial ecology, collaborative economy, and bioeconomy (JE, 2018; p. 86).*

Almendralejo (Spain) Strategy or plan for efficient water use	
Questions	**Answers**
1. Is there a national or regional strategy/plan for efficient use of water?	- *Spain has prepared a plan for water management and efficient water use called National Plan for Purification, Sanitation, Efficiency, Savings and Reuse (MITECO,2018). There is a preliminary version of this plan that is available, although it is still in development and to be completed considering the results from the strategic environmental assessment. Only then the plan will be submitted to public consultation before being adopted presumably in the near future, in 2020-2021.*
2. Are there specific measures for water reuse? Are any specific water loops mentioned?	- *The preliminary version of the plan foresees specific water reuse actions that are listed by River Basin Authority, with information about the number of water loops and the budget to allocate to these projects (MITECO,2018; Annex 4).*
3. Are they associated to the development of water circular economy?	- *In the preliminary version of the plan there are no references to water circular economy (MITECO,2018). However, the plan assumes water circular economy objectives contained in the National Water Quality Plan (MITECO,2018; p. 23). These objectives are considered in the framework of the ecological transition process required by the Spanish economy (MITECO,2018; p. 23).*
4. Does the strategy/plan identify water loops	- *The preliminary version of the plan identifies water loops with water reuse actions, listed by River Basin Authority, and include the administrative authorities responsible for the water reuse actions, as well as the water utilities involved (MITECO,2018, Annex 4).*
5. Does the strategy consider water circular economy as a water resources management strategic objective?	- *Water circular economy is not considered in the preliminary version of the plan. However, water reuse is mentioned and related to the ecological transition of the Spanish economy (MITECO,2018).* - *It is stated that the plan must fit with the general framework of water management existent in Spain, respecting its normative principles and establishing synergies with this framework (MITECO,2018; p. 12).*

6. Is spatial planning mentioned in the strategy/plan?	- *Spatial Planning is mentioned in the preliminary version of the plan, in the sense that this policy document is meant to be in accordance with the water planning and management regulatory framework, or more concretely the Water Law (MITECO,2018, p. 12). As such, the plan must respect the Water Law normative principles, namely integrated water management and seek the compatibility of public water management with spatial planning, the conservation and protection of the environment and the restoration of nature (MITECO,2018; p. 12).*
7. Does the strategy/plan consider the existence or creation of any symbiosis agreement involving the use of water?	- *The preliminary version of the plan does not mention symbiosis agreements (MITECO,2018).*
8. Does the strategy/plan consider the urban water cycle as a way to create circular territories? Is the management of the urban water cycle considered and related to spatial planning?	- *In the preliminary version of the plan there are no references to the concept of circular territories (MITECO,2018).* - *The urban water cycle is mentioned in a section of the preliminary version of the plan, on public participation and it is mentioned that this phase of policy formulation should include the water users and managers of the urban water cycle (MITECO,2018; p. 23). However, no references are made to spatial planning in this version of the policy document (MITECO,2018).*
9. Which are the agencies responsible for implementing the strategy and other agencies and stakeholders to be involved?	- In the preliminary version of the plan there are several stakeholders related to the measures to *implement, namely the purification and sanitation measures, water efficiency and savings measures and water reuse measures (MITECO,2018; Annexes 2-4), including: Council of Environment and Spatial Planning, Local Entities, Water utilities, Council of Agriculture, Fisheries and Rural Development, State Society of Agrarian Infrastructures S.A., River Basin Authorities, Autonomous Communities.*

Almendralejo (Spain) Water resources main legal framework	
Questions	**Answers**

1. Is water reuse inserted in the objectives and principles of the water policy?	- *The water resources main legal framework in Spain is based on the Water Law (RD 1/2001) that transposes the Water Framework Directive (2000). The regulatory regime for water reuse was firstly established in the Water Law (RD 1/2001, Art. 109) and posteriorly detailed in the Wastewater Reuse Law (RD 1620/2007). This legal regime includes the requirements to carry out the activity, the procedures to obtain the concession, and the water reuse standards or the mandatory fit-for-purpose minimum quality criteria required for the use of reclaimed water (RD 1620/2007).*
	- *Water reuse is also considered in the National Hydrological Plan (Law 10/2001 amended by Law 11/2005):*
	  - *There is a list of investments that includes the use of alternative resources to obtain water from desalination of sea and brackish water, water reuse from wastewater reclamation, from rainwater and stormwater and there are specific references to water loops for industrial uses (Law 10/2001, Annex II);*
	  - *In the amendment, there is a strengthened consideration of using alternative sources of water, such as water reuse as other solutions and unconventional sources, such as inter-basin transfers or seawater desalination, are considered less viable. There is a list of actions of general interest that include water reuse projects (Law 11/2005; Annex III).*

2. Is water circular economy mentioned? How?	- *Water circular economy is never mentioned in the water resources main legal framework, although efficient water use and water reuse is considered in all the water resources legal and regulatory documents analysed.*

3. Is the articulation between water resources management and spatial planning foreseen in the main legal framework? How?	- *The water resources main legal framework foresees the articulation with spatial planning.*
	- *In the Water Law (RD 1/2001) there are several examples of the articulation between water resources management and spatial planning:*
	  - *In the scope of the River Basin Authorities and their functions and configuration, it is mentioned that these institutions must issue a prior report, in the cases determined by regulation, on the acts and plans that the Autonomous Communities and local authorities (municipalities) approve, among others, in the areas of the environment, land use planning and urban development, irrigation and other public works of regional interest (RD 1/2001; Art. 25). This is only the case of acts and plans that affect the regime and development of inland waters or the uses allowed in public water domain lands and in their areas of servitude and regulation, taking into account for this purpose the provisions of water planning and sectoral planning approved by the Government (RD 1/2001; Art. 25).*
	  - *Other important aspect of the articulation between water resources management and spatial planning, involves plans where urban development requires new demands for water resources, when a report of the River Basin Authorities must declare if there are sufficient water resources to meet the new demands (RD 1/2001; Art. 25). There is also a case for a mandatory report of the National Water Council for plans and projects of general interest for land use planning, among other economic sectors, insofar as they substantially affect hydrological planning or water use (RD 1/2001; Art. 20).*
	- *In the National Hydrological Plan, spatial planning is mentioned in the scope of specific procedures that should be undertaken in the river basins subjected to water transfers (Law 10/2001) and in the scope of general measures that promote the integration of water protection and sustainable water management in other policies (Law 11/2005):*
	  - *Spatial planning plans are said to need a prior approval report from the River Basin Authority provided they affect the regime and use of the continental waters, the permitted uses in lands of public hydraulic domain, or entail new demands on water resources (Law 11/2005; Art. 25).*
	  - *The urban planning instruments must also guarantee the non-affectation of the water resources of specific zones and protection perimeters by the Hydraulic Administration (Law 11/2005; Art. 99).*

Almendralejo (Spain) Spatial Planning legal framework	
Questions	**Answers**
1. Is the protection of water resources included in the main aims and principles of the spatial planning legal framework?	- *The spatial planning main legal framework in Spain is based on the Land Use and Urban Renewal Act (RD 7/2015), which includes the protection of water resources in its main aims and principles. There is a list of principles of sustainable territorial and urban development that public policies related to the regulation, planning, occupation, transformation and use of land should follow (RD 7/2015; Art. 3), including:*

	- *The protection of water resources in particular the prevention and minimisation, of water pollution along other fundamental natural resources, such as the soil and subsoil;* - *The efficiency in the use of water resources, by reducing water demand (saving) and water reuse.* - *In addition, in the region of Extremadura, there is the Soil and Spatial Planning of Extremadura (Law 15/2001) that also includes the protection of water resources in the main aims and principles, namely:* - *Spatial planning should contribute to the rational use and distribution of hydrological resources by promoting savings in their use, effluent control and the protection of their quality (Law 15/2001, Art. 4).* - *On the rules of the categories of non-developable land, it is mentioned that this category includes non-developable land for structural protection, whether hydrological, agricultural, livestock, forestry, because of its potential for the said uses (Law 15/2001, Art. 11).*
2. Is the articulation with the water resources planning system foreseen? How?	- *The articulation with the water resources planning system is foreseen in the spatial planning main legal framework, since spatial and urban planning instruments are subject to environmental assessment. On the evaluation and monitoring of the sustainability of urban development, it is mentioned that the Hydrological Administration must be consulted on the existence of water resources to meet new demands and on the protection of the public water domain (RD 7/2015, Art. 22).*
3. Is the concept of circular territories mentioned? How?	- *There is no reference to circular territories, or any contents related to it, in the spatial planning main legal framework.*
4. Does the spatial planning legal framework foresee the existence of integrated and symbiotic territories and related environmental objectives, principles and measures?	- *The spatial planning main legal framework has no reference to symbiotic territories or circular economy. However, there is a reference to Special Industrial Plans that could be the right framework to include it for the industrial sector (Law 15/2001; Additional provision 6).*

Almendralejo (Spain) River Basin Management Plan (RBMP)	
Questions	**Answers**
1. Does the plan establish quality and quantity objectives able to interfere with new water loops?	- *The River Basin Management Plan (RBMP) of the Spanish part of the Guadiana River Basin District (RBD), for the planning period 2009-2015 (CHG, 2016) has established quality and quantity objectives. However, at the moment, we do not have enough information to directly answer the question if the RBMP's environmental objectives are able to interfere with the new water loops foreseen for Almendralejo under Project Ô. It may be the other way around, that the new water loops will allow the quality and quantity objectives to be achieved. The River Basin Authorities are the entities that give permits in the scope of new water loops and water reuse (RD 1/2001; Art. 109) and they are, simultaneously, entrusted with the definition of quality and quantity objectives for each RBMP, according to the Water Law (RD 1/2001; Article 24) and the hydrological planning.* - *In the specific case of the new water loops in Almendralejo the main producers of the wastewater and nutrients contained in it are citizens (n=35.000), together with food industries (olives, olive oil, wine, vegetable canneries, processors and packaging), located in the surroundings of the city. High Total Organic Carbon (TOC) values have been reported for wastewater from olive processing (between 43-53 mg/l), together with high concentrations of macronutrients and polyphenols (ranging from 1,3 to 5 g/l). In the RBMP some environmental objectives are established for rivers Guadiana and Guadajira of which Harnina river is tributary and were treated wastewaters are spilled.* - *According to Socamex, expected values of the output water will necessarily adapt to the current law in Spain on spills to water streams (RD 509/1996) and the permit for the new water loops, issued by the River Basin Authority, must account for the expected effects of these new water loops on the environmental objectives for rivers Guadiana and Guadajira, of which Harnina is tributary.*
2. Do the water loops bring new stakeholders into the water resources management river basin community? Who? Do they increase the complexity of the water management network?	- *The new water loops should bring new stakeholders into the water resources management river basin community, namely the enterprise in charge of street watering and agricultural associations and farmers. All the other stakeholders are already present in the current water loops.* - *In addition, for the new water reuse loops there is the need to include other stakeholders as the necessary permits are authorised by the river basin authorities (RD 1/2001; Art. 109). Also, the river basin authorities require the advice of other stakeholders to give these permits, since in all cases of water reuse, the river basin authority will request from the health authorities a prior report that will be binding (RD 1620/2007; Art. 4).*
3. Are there minimum flow rates or ecological flows established by the RBMP, and are the water loops able to interfere with them?	- *The Guadiana RBMP determined for the first time the ecological flow regimes according to the criteria of the WFD and the hydrological planning instruction, for a total of 27 sections of river-type water masses, of which 19 were classified as strategic (CHG, 2016; Annex 6).* - *According to the Water Law, the new water loops should not interfere with minimum flow rates or ecological flows:* - *Any permit for water use must take in consideration that the private use of water is restricted by the ecological flows or environmental demands that the river basin authorities establish in RBMP, according to specific studies for each river section (RD 1/2001, Art. 59);* - *The public supply of water to populations has in any case supremacy if there are restrictions due to ecological flows (RD 1/2001; Art. 60);* - *River basin authorities in the concessions and authorisations they grant, will adopt the necessary measures to make the use compatible with respect for the environment and to guarantee the ecological flows or environmental demands foreseen in the hydrological planning (RD 1/2001; Art. 98).*
4. Does the RBMP consider the existence or creation of any symbiosis agreement involving the use of water?	- *There is no reference to symbiosis agreements involving the use of water in the Guadiana RBMP (CHG, 2016).*
5. Does the RBMP consider water re-use as an objective? Are there measures to foster it? Do they articulate with water circular economy purposes?	- *The reuse of water is not part of the main objectives of the Guadiana RBMP (CHG, 2016). However, it is considered under other non-conventional resources, which is restricted to irrigation and industrial uses. In deficit areas, and in particular in the Alto Guadiana Subsystem, reuse will be granted exclusively to replace water rights for irrigation or industrial uses (CHG, 2016; p. 109).*

	- *In systems where deficit is accounted for, the reuse of reclaimed wastewater is authorised or granted, where appropriate, exclusively to replace resources from conventional sources, to ensure that the deficit is not increased. In the regulatory provisions (CHG, 2016; Annex 6), the reuse of water in deficit systems and subsystems is permitted if it complies with the quality criteria defined in the juridical regime for the reuse of treated waters (RD 1620/2007). Furthermore, the following considerations should be taken:*
	  - *Consider the preferential uses and the priorities, that are oriented to a policy of saving the water, improving the state of the water bodies and reaching the environmental objectives;*
	  - *In systems where deficit is accounted for, the reuse of reclaimed wastewater is authorised or granted exclusively, if appropriate, to replace resources from conventional sources.*
	- *The program of measures (POM) includes several water reuse actions (CHG, 2016; Annex 11, p. 30). Furthermore, the POM also includes the relationship between the state of water masses, pressures and measures and water reuse actions listed along with the list of water masses identified with pressures lacking corrective action (CHG, 2016; Annex 11, Appendix 1).*

6. Are there objectives and measures (financing, technical and governance) at basin level including the development of re-use projects?	- *There are many reuse actions in the program of measures (POM) of the Guadiana RBMP (CHG, 2016; Annex 11).*

Almendralejo (Spain) Municipal master plan (MMP)	
Questions	**Answers**
1. Does the zoning system and the land use indicators constraint the implementation of the new water loops, e.g. through the location of new pipes?	- *It is proposed in the Municipal Master Plan (AA, 2016) the reuse of treated wastewater for irrigation purposes and a new specific reuse network from the wastewater treatment plant through the new urbanised sectors, which will serve to irrigate parks and new green areas, and also for existing parks, whose design follows the general plan of the network of sanitation and wastewater treatment (AA, 2016; Book 2, p. 215). The new network will include storage facilities for the reused water located at several different points of Almendralejo.* - *The water loops proposed for Almendralejo under Project Ô, are limited to irrigation purposes and street washing and the distribution of treated wastewater for the purpose of reuse in the new water loops is meant to be done with trucks and independently of any pipeline reuse network. However, in the future and for scaling-up purposes it is possible that other water loops may be conditioned by the design of the distribution network of treated wastewater foreseen in the MMP and presumably to be constructed. This question has to be raised to local stakeholders namely from the water utilities and the municipality in order to understand if new water loops could easily be accommodated within the designed distribution network of treated wastewater foreseen in the version of the MMP analysed and currently in force.*
2. Does the plan foresee the promotion of circular territories or circular city-regions/cities with circular economy strategies? Is water included?	- *There is no mention to circular economy or circular territories/city-regions in the Almendralejo MMP (AA, 2016).*
3. Does the plan identify the need for changes in existing water infrastructures to support efficient water use and the circular economy of water?	- *The memory report in the section on major environmental dysfunctions and deficits it is mentioned the need for changes in existing water infrastructures due to the contamination of surface water by untreated or poorly treated wastewater discharges and the lack of tertiary treatment and of recycling of treated wastewater at the wastewater treatment plant (AA, 2016; Book 1, p. 56). Specifically, for the Harnina River it is mentioned that there are problems with spills of untreated or inadequately treated industrial and urban wastewaters (AA, 2016; Book 1, p. 69). In what regards water-use efficiency, in the analysis of the infrastructure system for water distribution are mentioned losses of around 20% of water in the urban distribution network, despite the recent investments in the water supply network (AA, 2016; Book 1, p. 211).* - *The memory of the MMP, in the chapter on actions to reduce the demand for water in Almendralejo, water use efficiency is considered and a set of measures to reduce water demand, promote the efficient use of water and adapt the water supply infrastructure are mentioned (AA, 2016, Book 2, p. 208).* - *Although water recycling is mentioned, there is no connection to the concept of circular economy. Concrete investments are foreseen for water recycling, with the reuse of treated wastewater from the wastewater treatment plant, for irrigation of green areas of the new urban sectors and for agricultural use, taking advantage of the tertiary treatment that these facilities have (AA, 2016; Book 2, p. 215). In this scope, a specific infrastructure for water reuse from the wastewater treatment plant through the new urbanised sectors is proposed in the general plan of the sanitation and purification infrastructures (AA, 2016; Book 2, p. 215).*
4. Does the plan acknowledge the impacts of urbanisation on water resources (e.g., water quality and quantity)? Are other land uses referred in the same manner?	- *The Almendralejo MMP acknowledges the impacts of future urbanisation on water resources, in the chapter on uses and demands of water, by evaluating the water supply needs to the new developments. The quantity and quality of the new water supply obtained by the concession from the Villalba de Barros dam on the Guadajira river, to complement the water abstraction permitted from the River Guadiana, is considered (AA, 2016; Book 2, p. 206).* - *In the Almendralejo MMP, there are also two recommendations to new urbanised areas that acknowledge the impacts of urbanisation on water resources, and reflect an understanding of the urban water cycle. They instruct that new developments should prevent significant effects on natural drainage and not increase runoff coefficients and avoid significant effects on hydrogeological resources and not reduce the rate of infiltration of water into the soil and subsoil (AA, 2016; Book 2, p. 249).*
5. Does the plan recognise the risk posed by extreme events on water resources (e.g., floods and droughts)? Is climate change adaptation considered in relation to water security and water adaptation measures?	- *Extreme events are considered in the Almendralejo MMP. Ecological restoration is envisioned for the streams of Almendralejo in order to cope with urban flooding (AA, 2016; Book 2, p. 239).* - *Climate change although referred in the Almendralejo MMP, is not related to water security directly. The Regional Strategy of Adaptation to Climate change is mentioned in the MMP and it is highlighted the need for the efficient use of water. Also, the Regional Strategy for Sustainable Development is mentioned, and reinforces the need for the adequate management of water supply for current and future demands to ensure the sufficiency and quality of the resource for each use and the long term protection of available water resources (AA, 2016; Book 1, p. 111).*

	- *The Almendralejo MMP establishes different criteria for the protection of the aquifer and the hydrological system, and in addition incorporates a specific regulation in order to oblige future urban developments to minimise their territorial and environmental effects by means of soil and water conservation measures (AA, 2016; Book 2, p. 238).*
6. Does the plan include impact assessment and analysis tools appropriate to planning for water reuse, such as water footprint analysis, to characterise water demand scenarios? Are these analyses a key prerequisite for land use decisions and development permits and how?	- *The Almendralejo MMP does not include impact assessment and analysis tools appropriate to planning for water reuse. However, impact assessment and analysis tools are considered in the MMP to use as a prerequisite for land use decisions and development permits. These regulation aspects take into consideration long term forecasts of supply and demand for water in the Municipality, made by the River Basin Authority, that already includes the existent and future water concessions and necessary infrastructure projects, including the construction of the infrastructure provided for in the project to improve the supply to Almendralejo from the Villalba dam (AA, 2016; Book 2, p. 206). This project defines the new infrastructures, foreseen in the RBMP that allow to almost duplicate the current supply capacity with respect to the current concession (AA, 2016; Book 2, p. 206).* - *In fact, urban developments already foreseen may be prevented even if reserved rights have been granted before as mentioned in the regulatory document of the MMP, since no new urban developments foreseen in the second four-year period, can be undertaken insofar as the availability of sufficient water resources by the River basin authority is secured (AA, 2016, Doc. 3, Art. 9.2.4).*
7. Does the plan restrict siting of water reclamation plants, and disallow innovations in on-site water treatment and reuse (such as blackwater and greywater systems)?	- *Only centralised municipal-scale water reuse is foreseen and pipes for the distribution system for existent wastewater treatment plants are designed in the general plan of sanitation and wastewater treatment (AA, 2016; Book 2, p. 210).* - *The regulatory document of the Almendralejo MMP has no prohibitions in what regards water reuse, or the siting of water reclamation plants. Also, the MMP does not provide regulations either in what regards decentralised or on-site water reuses. However, as it is mentioned in the regulatory document of the MMP, there is the need to look for other municipal ordinances and the basic rules and recommendations that the municipal company in charge of the wastewater treatment plant applies with regard to the specific conditions for the sanitation of wastewater and rainwater discharges, and for treated wastewater reuse (AA, 2016; Doc. 3, Art. 8.2.14).*

Lecce (Italy)

Lecce (Italy) Strategy or plan for circular economy (National level)	
Questions	**Answers**
1. Is water circular economy included in the priority areas of the strategy/plan?	- *Italy's strategic positioning on circular economy is defined in the document Towards a Model of Circular Economy for Italy Overview and Strategic Framework (MATTM and MiSE, 2017). Water circular economy is not included, in its broader sense, in the main priority areas of the strategy.* - *The strategy calls for a paradigm shift in Italy's economy, in particular a new way to consume, produce and do business, where research and innovation would be the key factors in boosting the transition towards circular economy which will also contribute to strengthening competitiveness and modernizing the industry. (MATTM and MiSE, 2017; p. 7).* - *The strategy recognizes the significant importance of the efficient use of water resources in a circular economy context and mentions the necessity to pursue actions, especially in the context of production processes, aiming at optimizing water consumption, reducing discharges in water bodies, in particular through the reuse of treated wastewater, increasing available water supplies through unconventional resources and the recovery of energy and substances through an efficient increase of wastewater treatment (MATTM and MiSE, 2017; p. 50).*
2. Are there specific measures fostering the development of a Water Circular Economy?	- *The circular economy strategy advises the preparation of a regulatory framework facilitating and supporting companies to apply different recovery and reuse strategies, as well as to introduce economic incentives encouraging the implementation of appropriate treatments for the use and reuse of water, while guaranteeing adequate and consistent levels according to the current regulations on the protection of human health and the environment (MATTM and MiSE, 2017; p. 50-51).*
3. Are water utilities and other stakeholders identified for the implementation and monitoring of measures for a Water Circular Economy or water reuse?	- *No water utilities and other stakeholders are identified for the implementation and monitoring of measures for a water circular economy or water reuse (MATTM and MiSE, 2017).* - *The strategy, however, identifies, in very general terms, three main economic actors and their role in a successful transition towards a circular economy: the companies, the consumers and the fiscal and economical instruments (MATTM and MiSE, 2017; p. 50-51).*
4. Does the strategy or plan establishes specific indicators to measure and monitor water loops? Which ones?	- *No specific indicator to measure and monitor water loops are identified in the strategy (MATTM and MiSE, 2017).*
5. Is spatial planning considered in the strategy/plan? How and in which parts (problem, objectives, measures, stakeholders, monitoring)?	- *Spatial planning is not considered in the strategy (MATTM and MiSE, 2017).*
6. Does the strategy refer spatial planning in relation with symbiosis agreements involving the use of water?	- *The strategy does not refer spatial planning in relation with symbiosis agreements involving the use of water (MATTM and MiSE, 2017).* - *The strategy, however, notes the existence of a national network of industrial symbiosis (Symbiosis User Network, SUN) that aims to promote, through industrial symbiosis, a cultural change towards circular economy, encouraging the meeting of the various stakeholders involved, the creation and sharing of knowledge, and the identification of new opportunities for economic, social, and territorial development (MATTM and MiSE, 2017; p. 33);*
7. Does the strategy/plan consider the concept of circular territories regarding the management of the urban water cycle (or others) and any	- *The strategy does not consider the concept of circular territories regarding the management of the urban water cycle (or others) and any consequences at the spatial planning level.*

consequences at the spatial planning level?	

Lecce (Italy) Strategy or plan for efficient water use	
Questions	**Answers**
1. Is there a national or regional strategy/plan for efficient use of water?	- *There is no national strategy or plan for efficient use of water. Instead, regions are expected to adopt plans for water protection. In Puglia region, the programming document aimed at ensuring the qualitative and quantitative protection of the surface water, groundwater and coastal marine water, and promoting the sustainable development and a high level of environmental protection, is the Water Protection Plan of Puglia Region in its updated version for 2015-2021 (RP, 2019).*

2. Are there specific measures for water reuse? Are any specific water loops mentioned?	- *The plan describes the actual state of the reuse of purified wastewater, together with the potential reuses and priority intervention measures, involving specific water loops in the sectors of irrigation, industry and environment (RP, 2019; Part E):*
	  - *In the actual state of the reuse of purified wastewater, the plan lists the wastewater treatment plants that, from the point of view of the treatment processes, are already in operation or in condition to start operating, to purify wastewater to be reused in the sector of irrigation and environment (RP, 2019; p. 158-159);*
	  - *In the potential reuses and priority intervention measures in the sector of environment, the plan mentions the priority given to the reuse of part of the purified wastewater from the wastewater treatment plant of Carovigno for the rebalancing of the water circulation inside the oasis of Torre Guaceto, which tend to be affected by the increase in the salinity content, and mentions the proposed reuse of the purified wastewater from the wastewater treatment plant of Noci for the requalification of the Milecchia Lake, an artificial reservoir fed by artesian wells that serves for irrigation (RP, 2019; p. 161, 165);*
	  - *In the potential reuses and priority intervention measures in the sector of industry, the plan mentions the priority given to the reuse of the purified wastewater from Taranto, Gennarini and Bellavista wastewater treatment plants in the ILVA steel plant of Taranto (RP, 2019; p. 164);*
	- *The Plan of Measures (PoM) outlines the framework of the key measures of the plan, aligned with the 25 Key Measures (KTMs) set out in the Water Framework Directive Reporting Guidance 2016, which includes key measures for the efficient use of water (RP, 2019; Part G);*

3. Are they associated to the development of water circular economy?	- *The potential reuses of purified wastewater (RP, 2019; Part E) and priority intervention measures (RP, 2019; Part G) mentioned in the plan are not specifically associated to the development of water circular economy.*
4. Does the strategy/plan identify water loops	- *The plan (RP, 2019) identifies different water loops, including water utilities, stakeholders and responsible agencies, within all its different areas of application.*
5. Does the strategy consider water circular economy as a water resources management strategic objective?	- *The plan (RP, 2019) does not consider water circular economy.*
6. Is spatial planning mentioned in the strategy/plan?	- *The plan mentions that the importance of a water resource is not only due to its consistency and usability, but also to its location in the context of territorial water needs, namely in the use of the land and in its socio-economic development for productive activities (RP, 2019; p. 82).* - *The plan notes that some of the key measures outlined in the Plan of Measures (PoM) can be implemented by specific tools transversal to the different spatial planning instruments (water and territorial) at different spatial scales (RP, 2019; p. 177).*

7. Does the strategy/plan consider the existence or creation of any symbiosis agreement involving the use of water?	- *The plan (RP, 2019) does not considers the possible creation of different symbiosis agreements involving the use of water.*
	- *The plan, however, it mentions possible and foreseen agreements involving the use of water and, in particular, for water reuse:*
	  - *The reuse of part of the purified wastewater from the wastewater treatment plant of Carovigno for the rebalancing of the water circulation inside the oasis of Torre Guaceto, which tend to be affected by the increase in the salinity content (RP, 2019; p. 161);*
	  - *The reuse of the purified wastewater from the wastewater treatment plant of Noci for the requalification of the Milecchia Lake, an artificial reservoir fed by artesian wells that serves for irrigation (RP, 2019; p. 161);*
	  - *The reuse of the purified wastewater from Taranto, Gennarini and Bellavista wastewater treatment plants in the ILVA steel plant of Taranto (RP, 2019; p. 164);*

8. Does the strategy/plan consider the urban water cycle as a way to create circular territories? Is the management of the urban water cycle considered and related to spatial planning?	- *The plan (RP, 2019) does not consider the urban water cycle as a way to create circular territories.* - *The plan, however, defines and delimitates the urban agglomerates to evaluate the generated urban wastewater and the sewage-treatment system (RP, 2019; p. 107). The delimitation of the urban agglomerates is based on the existing spatial planning instruments (RP, 2019; p. 108);*

9. Which are the agencies responsible for implementing the strategy and other agencies and stakeholders to be involved?	- *The plan (RP, 2019) foresees the involvement of different actors in the implementation and monitoring of its measures:*
	  - *Puglia Region and Local Entities (Provinces and Municipalities) for implementation;*
	  - *Puglia Water Authority, Puglia Basin Authority, Local Health Authorities, Regional Environmental Protection Agency (ARPA Puglia) and Regulatory Authority for Energy, Networks and Environment (ARERA) for management and monitoring;*
	  - *Other stakeholders involved in the elaboration and implementation include the Regional Union of the Land and Water Irrigation Management and Protection Consortium (ANBI Puglia), Managing entities of water utilities and of the integrated water service, namely the Acquedotto Pugliese (AQP), Association of Puglia Municipalities (ANCI Puglia), Regional delegation of the National Union of Mountain Municipalities and Communities (UNCEM Puglia), Non-Governmental Organisations (NGOs) and civil society.*

Lecce (Italy) Water resources main legal framework	
Questions	**Answers**

1. Is water reuse inserted in the objectives and principles of the water policy?	- *In Italy, the water resources main legal framework is based on the Part III (Rules on the matter of soil protection and fight against desertification, protection of water against pollution and management of water resources) of the Environmental Code (DL 152/2006), that transposed the Water Framework Directive (2000).*
	- *Water reuse is not inserted in the main objectives and principles of the Environmental Code. However, it is considered, namely by establishing the first regulatory regimes for water reuse, including:*
	  - *The rules governing the reuse of domestic, urban and industrial wastewater, with a view to reducing the exploitation of surface water and groundwater and ensuring the protection of water resources (DL 152/2006; Art. 99), posteriorly detailed in the Rules for Reuse of Waster Water (D 2 May 2006);*
	  - *The rules for the irrigation reuse of water from agronomic activities, so called vegetation water, which do not contain dangerous substances (DL 152/2006; Art. 112), posteriorly detailed in the Rules for Reuse Vegetation Water (D 6 July 2005 and D 25 February 2016).*

2. Is water circular economy mentioned? How?	- *Water circular economy is never mentioned in the water resources main legal framework. However, efficient use of water and water reuse are considered.*

3. Is the articulation between water resources management and spatial planning foreseen in the main legal framework? How?	- *The articulation between water resources management and spatial planning is foreseen in the Environmental Code (DL 152/2006):*
	  - *On the principles, objectives, and contents of the Basin Plans, it is mentioned that these plans have the value of territorial plans and are the cognitive, normative and technical-operational tools through which the actions aimed at the conservation, defence and valorisation of the soil and the correct use of water are planned and programmed, on the basis of the physical and environmental characteristics of the territory concerned. Amongst other elements, the Basin Plans should contain the organized and updated cognitive framework of the physical system and the uses of the territory provided for by the municipal and inter-municipal urban planning instruments. Land use plans and programs must be coordinated, or in any case not in conflict, with the approved Basin Plans. The Regions must issue the provisions concerning the implementation of the Basin Plans in the urban planning sector (DL 152/2006; Art. 65);*
	  - *On the Hydrogeological Risk Protection Plans and prevention measures for risk areas, it is mentioned that these plans shall identify the infrastructures which determine the hydrogeological risk and the Regions shall draw up a plan for the adaptation of these infrastructure outside the area at risk and for the granting of financial incentives for the relocation of productive activities and private homes built in accordance with urban building regulations. The resulting land is acquired to the unavailable assets of the municipalities (DL 152/2006; Art. 67);*
	  - *On regulation of areas for the protection of surface water and groundwater intended for human consumption, it is mentioned that in order to ensure the protection of water resources, these protection zones must be demarcated in accordance with the indications of the regions or autonomous provinces, which may adopt measures relating to the destination of the territory, restrictions and prescriptions for civil, productive, tourist, agro-forestry and zootechnical settlements to be included in municipal, provincial, regional, general and sectoral urban planning instruments (DL 152/2006; Art. 94);*
	  - *On water saving it is mentioned that the urban planning instruments, compatible with municipal and national plans and available financial resources, must provide for dual networks in order to use less valuable water and make possible for more adequate uses of water, including non-drinking water (DL 152/2006; Art. 146).*

Lecce (Italy) Spatial Planning legal framework	
Questions	**Answers**

1. Is the protection of water resources included in the main aims and principles of the spatial planning legal framework?	- *In Italy, the spatial planning main legal framework is based on the State Urban Law (Law 1150/1942), Local Authorities Code (DL 267/2000) and Cultural Heritage and Landscape Code (DL 42/2004).*
	- *The State Urban Law (Law 1150/1942), that regulates the planning and development of residential areas and urban development in general in the territory, does not include the protection of water resources.*
	- *The Local Authorities Code (DL 267/2000) that regulates the administrative activity of Italian local entities which, together the State Urban Law, institutes the instruments that establish the general spatial planning directives in the municipal territory (Municipal Master Plans) and in the provincial or supra-municipal territory (Territorial Plans of Provincial Coordination) does not include the protection of water resources in the main aims and principles. However, it is considered in the document, namely:*
	  - *The Province is responsible for the administrative functions of, amongst others, the protection and valorisation of water resources (DL 267/2000; Art. 19);*
	  - *The Province prepares and adopts the territorial coordination plan that determines the general guidelines for spatial planning and, amongst others, the lines of intervention for the development of the water, hydrogeological and hydro-forestry systems and, in general, for soil consolidation and water regulation (DL 267/2000; Art. 20);*
	  - *The Region, in agreement with the local authorities of the metropolitan areas, may define supra-municipal areas for the coordinated exercise of the functions of local authorities in, amongst others, interventions for the protection of the soil and hydrogeological resources, and for water collection, distribution and treatment (DL 267/2000; Art. 24).*
	- *The Cultural Heritage and Landscape Code (DL 42/2004) that regulates the planning and management of the territory accordance the protection and valorisation of the cultural heritage and landscape and institutes the instrument that establishes the general spatial planning directives in the regional territory (Regional Landscape Plans), includes the protection of water resources in its main aims and principles. It considers that several wetlands and water bodies (rivers, streams, watercourses, lakes, glaciers) present landscape interest (DL 42/2004; Art. 142) and, therefore, are subjected of protection and valorisation in the planning and management of the territory (DL 42/2004; Art. 1).*

2. Is the articulation with the water resources planning system foreseen? How?	- *The articulation with the water resources planning system is foreseen in the spatial planning main legal framework since the spatial planning instruments (urban, territorial, landscape) are subject to strategic*

	environmental assessment and the competent environmental authorities must be consulted in the process due to the specific competences or responsibilities in the environmental field attributed to them.
3. Is the concept of circular territories mentioned? How?	- *The concept of circular territories is not mentioned in the spatial planning main legal framework.*
4. Does the spatial planning legal framework foresee the existence of integrated and symbiotic territories and related environmental objectives, principles and measures?	- *The spatial planning main legal framework does not foresee the existence of integrated and symbiotic territories.*

Lecce (Italy) River Basin Management Plan (RBMP)	
Questions	**Answers**
1. Does the plan establish quality and quantity objectives able to interfere with new water loops?	- *The Water Management Plan of the Southern Apennines Hydrographic District for the cycle 2015-2021 (DIAM, 2016) establishes general quality and quantity objectives that can be achieved more quickly and more satisfactorily with the new water loop foreseen for Lecce under Project Ô, namely by reusing the purified water to recharge and rehabilitate the aquifer associated to the Guardati Well;* - *On the other hand, the plan establishes specific quality and quantity objectives that, to some extent, may be able to interfere with the new water loop foreseen for Lecce under Project Ô. Less rigorous quality and quantity objectives have been specified for the underground water bodies of Puglia Region characterized by a now non-reversible problem of saline intrusion, such as the aquifer associated to the Guardati Well. For these situations, extensions to the achievement of the environmental quality and quantity objectives have been identified on the basis of the status and risk conditions currently assessable, with a differentiated extension for chemical, ecological and quantitative status (DIAM, 2016; p. 393-394). This can lead to a relaxation on the implementation of the new water loop foreseen for Lecce under Project Ô.*
2. Do the water loops bring new stakeholders into the water resources management river basin community? Who? Do they increase the complexity of the water management network?	- *It is not expected that the new water loop foreseen for Lecce under Project Ô brings new stakeholders into the water resources management river basin community.*
3. Are there minimum flow rates or ecological flows established by the RBMP, and are the water loops able to interfere with them?	- *The plan defines and evaluates minimum vital flows (DIAM, 2016; p. 379). However, the new water loop foreseen for Lecce under Project Ô will not interfere with minimum flow rates or ecological flows.*
4. Does the RBMP consider the existence or creation of any symbiosis agreement involving the use of water?	- *The plan (DIAM, 2016) does not consider the existence or creation of any symbiosis agreement involving the use of water.*

5. Does the RBMP consider water re-use as an objective? Are there measures to foster it? Do they articulate with water circular economy purposes?	- *The reuse of water is not part of the main objectives of the plan. However, it is considered in the plan, namely it is mentioned the necessity for the competent bodies to identify and apply the appropriate regulatory and technical actions to achieve the best possible allocation of the resource and, in the case of management inefficiencies, to provide for measures to, amongst others, recover water losses, water re-use and aquifer recharge, the costs of which will be borne by the responsible sector (DIAM, 2016; p. 406);*
	- *Within the plan of Measures (PoM), the following measures to foster water re-use are specified:*
	  - *Modernization, adaptation and upgrading of purification systems, including for water re-use (DIAM, 2016; p. 429);*
	  - *Actions aimed at the integration of ecological networks and at the physical-environment recovery of wetlands, to be reclaimed and enhanced through non-potable water or reused water (DIAM, 2016; p. 431).*
	- *However, none of the measure is articulated within the purposes of water circular economy.*

6. Are there objectives and measures (financing, technical and governance) at basin level including the development of re-use projects?	- *The Program of Priority Measures of the plan defines specific interventions at the basin level with indication of their reference programming and financing (DIAM, 2016; Annex 7). However, none includes the specific development of water re-use projects. Some of these measures, however, may be able to foster the development of water re-use in the future, since they specify adaptation and upgrading of the purification technologies of the wastewater treatment plants.* - *Two projects involving experimentation with new techniques for the re-use of treated domestic wastewater in agriculture and in aquifer recharge are proposed in the plan (DIAM, 2016; Annex E).*

Lecce (Italy) Municipal master plan	
Questions	**Answers**

1. Does the zoning system and the land use indicators constraint the implementation of the new water loops, e.g. through the location of new pipes?	- *The last approved version of the Municipal Master Plan of City of Lecce (Lecce MMP) dates from 1983 and is outdated.*
	- *A preliminary document of a newer version of the Lecce MMP, also known as Urban Master Plan of Lecce Municipality (CL, 2011), has already been subjected to strategic environmental assessment and is to be approved, presumably, in the near future, following verification of compliance with the regional documentation.*
	- *The preliminary version of the newer Lecce MMP should not constrain the new water loop foreseen for Lecce under Project Ô:*
	  - *On one hand, the document may favour the new water loop foreseen for Lecce under Project Ô, namely by mentioning the re-use of purified wastewater for aquifer recharge, thought the verification and improvement of the efficiency of the sewerage network, the designation of the areas destined to wastewater treatment plants, the use of diversified techniques for wastewater treatment, the use of phyto-purification in areas not served by sewerage system and the impediment of the discharge of treated wastewater to the sea (CL, 2011; p. 41).*
	  - *On the other hand, the document may constrain the new water loop foreseen for Lecce under Project Ô, since it identifies three distinct aquifer safeguard zones: the protected zone, the groundwater recharge zone and the water supply zone. Whereas the location of the Guardati Well is known and it lies within the water supply zone, the location, dimension and structure of the drainage trenches is not known and may not agree with the groundwater recharge zone (CL, 2011; p. 85-86).*

2. Does the plan foresee the promotion of circular territories or circular city-regions/cities with circular economy strategies? Is water included?	- *There is no mention to circular territories or circular city-regions/cities or circular economy in the document (CL, 2011).*
3. Does the plan identify the need for changes in existing water infrastructures to support efficient water use and the circular economy of water?	- *The Lecce MMP identifies the need for changes in existing water infrastructures as a way to promote water reuse (CL, 2011; p. 41). However, this improvement, or any other changes to existing water infrastructures, are not considered in the strategic objectives (CL, 2011; p. 263-264).* - *Within the theme Rural City, the Lecce MMP foresees the construction, in rural areas with more restrict access to water and to sewerage system, of compensatory infrastructures of ecological nature for a more efficient use of water, namely by the construction of systems for the collection, recycling and purification of rainwater and wastewater (CL, 2011; p. 268-269).* - *There is no mention to circular economy in the document (CL, 2011).*
4. Does the plan acknowledge the impacts of urbanisation on water resources (e.g., water quality and quantity)? Are other land uses referred in the same manner?	- *In relation to the impacts of urbanization on water resources, the Lecce MMP mentions that the anthropic occupations of the landscape forms related to the surface hydrography, such as hillslopes and karst areas, contribute to fragment the natural morphological continuity and to increase the conditions of hydraulic risk, since these landscape forms play a primary role in the regulation of surface hydrography, such as watercourses and sinkholes (CL, 2011; p. 101).* - *The document also acknowledges the negative impacts of urbanization and other land uses on water resources, as a consequence of the negative impacts of the crescent civil, industrial and irrigation water demands on the quality and quantity of the groundwater in the aquifers (CL, 2011; p. 221-222).*
5. Does the plan recognise the risk posed by extreme events on water resources (e.g., floods and droughts)? Is climate change adaptation considered in relation to water security and water adaptation measures?	- *The Lecce MMP recognizes the risks posed by floods, namely by presenting a map of flood probability and flood hazard (CL, 2011; p. 79). However, no other extreme events related to water resources are recognized;* - *Climate change, although referred in the document (CL, 2011), is not related to water security and water adaptation measures.*
6. Does the plan include impact assessment and analysis tools appropriate to planning for water reuse, such as water footprint analysis, to characterise water demand scenarios? Are these analyses a key prerequisite for land use decisions and development permits and how?	- *The Lecce MMP was subject to strategic environmental assessment and information on water resources was used and the competent water authorities were consulted. The analysis tool included territorial sensitivity, environmental pressure factors and the degree of potential fragility (CL, 2011; p. 233-240), which are not specifically appropriate to plan for water reuse. However, they may be used to plan for water availability scenarios.*
7. Does the plan restrict siting of water reclamation plants, and disallow innovations in on-site water treatment and reuse (such as blackwater and greywater systems)?	- *The Lecce MMP does not restrict siting of reclamation plants nor disallow innovations in on-site water treatment and reuse. On the contrary, the document favours these actions, namely regarding the construction of systems for the collection, recycling and purification of rainwater and wastewater in rural areas with more restrict access to water and to sewerage system (CL, 2011; p. 268-269).*

Omis (Croatia)

Omis (Croatia) Strategy or plan for circular economy (National level)	
Questions	**Answers**
1. Is water circular economy included in the priority areas of the strategy/plan?	- *Croatia has not yet adopted a Circular Economy strategy or action plan.* - *Croatia's point of view on CE is expressed in the Strategy of Sustainable Development of The Republic of Croatia (NN 30/2009). The strategy includes in its main areas of action, on which policies and instruments are focused, Key Challenges to Achieve Sustainable Development for Environment and Natural Resources with a subsection dedicated to Water, describing the main goals, documents and institutions involved (NN 30/2009, p.13). However, water circular economy or water reuse are not included.*

2. Are there specific measures fostering the development of a Water Circular Economy?	- *The strategy (NN 30/2009) does not mention specific measures fostering the development of water circular economy.* - *The strategy, however, includes as one of the main goals the rational use of non-renewable natural resources and the sustainable use of renewable natural resources during the planning of economic activities. However, it does not consider water reuse practices (NN 30/2009, p.13).*
3. Are water utilities and other stakeholders identified for the implementation and monitoring of measures for a Water Circular Economy or water reuse?	- *The strategy (NN 30/2009) does not identify water utilities and other stakeholders for the implementation and monitoring of measures for a water circular economy or water reuse.* - *The strategy, however, identifies the main institutions to be involved in the implementation of the strategy (NN 30/2009, p.13). However, these are unrelated to water circular economy or water reuse practices or measures.*
4. Does the strategy or plan establishes specific indicators to measure and monitor water loops? Which ones?	- *The strategy (NN 30/2009) does not refer the use of specific indicators to measure or monitor water loops.*
5. Is spatial planning considered in the strategy/plan? How and in which parts (problem, objectives, measures, stakeholders, monitoring)?	- *The strategy (NN 30/2009) does not consider spatial planning in the transition towards a water circular economy.*
6. Does the strategy refer spatial planning in relation with symbiosis agreements involving the use of water?	- *The strategy (NN 30/2009) does not consider symbiosis agreements involving the use of water nor spatial planning.*
7. Does the strategy/plan consider the concept of circular territories regarding the management of the urban water cycle (or others) and any consequences at the spatial planning level?	- *The strategy (NN 30/2009) does not consider the concept of circular territories regarding the management of the urban water cycle (or others) and any consequences at the spatial planning level.*

Omis (Croatia) Strategy or plan for efficient water use	
Questions	**Answers**
1. Is there a national or regional strategy/plan for efficient use of water?	- *Croatia does not have a strategy or plan for efficient water use.* - *In relation to water management, there is a Strategy for Water Management of the Republic of Croatia (NN 91/2008) that is a long-term planning document that defines the vision, mission, objectives and tasks of the state policy in water management.* - *The strategy (NN 91/2008) main objectives and measures for water management and protection are centred in maintaining the high standards of quality of water for all purposes and ensuring an adequate treatment for the protection of the environment.*
2. Are there specific measures for water reuse? Are any specific water loops mentioned?	- *The strategy (NN 91/2008) does not consider any specific measures for water reuse.* - *In relation to public water supply, the strategy refers as a goal to ensure enough quantities of high-quality water from existing or new sources. In this sense, reuse of treated wastewater is considered as a way to achieve a more sustainable water use for irrigation (NN 91/2008; Section 4.3.4) and a way to achieve the planned industrial development (NN 91/2008; Section 4.1.4).* - *The strategy (NN 91/2008) considers, as a water protection measure to mitigate water pollution problems, to plan and invest in public sewerage systems through the development of joint programs and to encourage the separate collection of rainwater from urban areas and consequent treatment.*
3. Are they associated to the development of water circular economy?	- *There is no association to the development of water circular economy in the strategy (NN 91/2008).*
4. Does the strategy/plan identify water loops	- *The strategy (NN 91/2008) does not identify water loops between water utilities or other specific stakeholders.*
5. Does the strategy consider water circular economy as a water resources management strategic objective?	- *The strategy (NN 91/2008) do not consider water circular economy as a water resource management strategic objective.*
6. Is spatial planning mentioned in the strategy/plan?	- *The strategy refers that, in addition to water management planning documents, development acts are also adopted in areas outside water management in which, to a greater or lesser extent, the issue of water is covered, such as the areas covered by the Strategy for National Spatial Planning, Strategy for National Environmental Protection, Strategy and Action Plan for Biological and Landscape Conservation, amongst others (NN 91/2008, Section 3.1.5).*
7. Does the strategy/plan consider the existence or creation of any symbiosis agreement involving the use of water?	- *The strategy (NN 91/2008) does not consider the existence or creation of any symbiosis agreement involving the use of water*
8. Does the strategy/plan consider the urban water cycle as a way to create circular territories? Is the management of the urban water cycle considered and related to spatial planning?	- *The strategy (NN 91/2008) does not consider the urban water cycle as a way to create circular territories.*
9. Which are the agencies responsible for implementing the strategy and other agencies and stakeholders to be involved?	- *The document foresees the involvement of different actors in the implementation of its activities and measures (NN 91/2008, Section 5.1), of which the more mentioned are the Ministry of Regional Development, Forestry and Water Management and the Croatian Waters.*

Omis (Croatia) Water resources main legal framework	
Questions	**Answers**
1. Is water reuse inserted in the objectives and principles of the water policy?	- *In Croatia, the water resources main legal framework is based on the Water Law (NN 66/2019).* - *Water reuse is not considered in the Water Law (NN 66/2019).*
2. Is water circular economy mentioned? How?	- *Water circular economy is never mentioned in the Water Law (NN 66/2019).*

3. Is the articulation between water resources management and spatial planning foreseen in the main legal framework? How?	- *The articulation with spatial planning is foreseen in the Water Law (NN 66/2019):*
	  - *The regulations on spatial planning that are in conflict with the provisions of the water law shall not apply to the division of cadastral parcels of real estate of a public water good (NN 66/2019; Art. 9);*
	  - *Local entities are obliged to obtain from Croatian Waters, requests for the development of spatial plans and an opinion on compliance of these spatial plans with the water management planning documents (NN 66/2019; Art. 39);*
	  - *Croatian Waters may adopt more detailed management plans related to other sectors of interest for water management (NN 66/2019; Art. 39).*

Omis (Croatia) Spatial Planning legal framework	
Questions	**Answers**
1. Is the protection of water resources included in the main aims and principles of the spatial planning legal framework?	- *The Croatian spatial planning main legal framework is expressed in the Spatial Planning Law (NN 153/2013).* - *The Spatial Planning Law (NN 153/2013) considers the protection of water resource, since one of its main goals is the spatial sustainability in relation to the rational use and preservation of space capacity on land, sea and underwater in order to effectively protect space (NN 153/2013; Art. 6). Moreover, spatial planning must determine environmental protection measures on land and sea, in particular to protect drinking water resources (NN 153/2013; Art. 46).*
2. Is the articulation with the water resources planning system foreseen? How?	- *The articulation with the water resources planning system is considered in the spatial planning main legal framework, in the sense that the adoption and implementation of development strategies, plans, programs, regulations and other general acts that may affect space, should respect the principle of integrated spatial planning and uniform measures between different economic and administrative areas, in order to achieve balanced spatial sustainability in processes affecting the transformation of settlements, use of natural resources, nature and environment protection and the development of activities and infrastructure and their distribution in space (NN 153/2013; Art. 12).*
3. Is the concept of circular territories mentioned? How?	- *The concept of circular territories is not mentioned in the Spatial Planning Law (NN 153/2013).*
4. Does the spatial planning legal framework foresee the existence of integrated and symbiotic territories and related environmental objectives, principles and measures?	- *The Spatial Planning Law (NN 153/2013) does not foresee the existence of integrated and symbiotic territories.*

Omis (Croatia) River Basin Management Plan (RBMP)	
Questions	**Answers**
1. Does the plan establish quality and quantity objectives able to interfere with new water loops?	- *The River Basin Management Plan for the cycle 2016-2021 (HV, 2016) should not be able to interfere with the implementation of the new water loops foreseen under Project Ô for the demo site of Omis, Croatia. In fact, it may be the other way around.* - *According to the RBMP, one of the more critical water challenges of Croatian water bodies is nutrient pollution, and data collection and analysis showed that a satisfactory ecological status of surface waters was not yet achieved. Also, the plan highlights as key management issues a strong impact from human activities resulting in nutrient and chemical pollution in rivers both in the Danube river basin district and in the Adriatic water area (HV, 2016; p. 88). Therefore, and in order to achieve compliance with European directives and improve the ecological status of Croatian water bodies, the RBMP includes protective measures to control the nutrient load of discharges.* - *In this sense, the reuse of wastewater in the production process of Galeb will reduce the discharge of wastewater into the Cetina Reiver and possible pollutants into the Adriatic Sea, and, therefore, facilitate the achievement of a satisfactory ecological status*
2. Do the water loops bring new stakeholders into the water resources management river basin community? Who? Do they increase the complexity of the water management network?	- *It is not expected that the new water loop foreseen for Omis under Project Ô brings new stakeholders into the water resources management river basin community. The water loop will be implemented inside an industrial facility, for internal processes.*
3. Are there minimum flow rates or ecological flows established by the RBMP, and are the water loops able to interfere with them?	- *The RBMP analyses current minimal flow rates and establishes measures to improve the ecological flows of water bodies (HV, 2016; p. 330). However, the new water loop foreseen for Omis will probably not interfere with minimum flow rates or ecological flows.*
4. Does the RBMP consider the existence or creation of any symbiosis agreement involving the use of water?	- *The plan (HV, 2016) does not consider the existence or creation of any symbiosis agreement involving the use of water.*
5. Does the RBMP consider water re-use as an objective? Are there	- *Water reuse, recycling, or alternative sources of water are not mentioned in the plan (HV, 2016).*

measures to foster it? Do they articulate with water circular economy purposes?	- *Water management objectives and measures of the plan (HV, 2016) are focused on the reduction of water losses from the supply system, the control of water abstraction levels, the improvement of water quality and distribution to all water users, the rationalization of the economic price of water (the application of fees and water tariffs) and in the improvement of water use.*
6. Are there objectives and measures (financing, technical and governance) at basin level including the development of re-use projects?	- *The plan (HV, 2016) does not foresee the development of reuse projects among the objectives and measures at basin level.* - *However, the plan includes a multi-year program for the construction of municipal water structures that, although not considering water reuse, may foster future opportunities for the development of such techniques, that includes investments in public sewerage (drainage improvements) and in the wastewater treatment system (increase connection to public systems, quality and safety of water services); (HV, 2016; p. 250-252).*

Omis (Croatia) Municipal master plan	
Questions	**Answers**
1. Does the zoning system and the land use indicators constraint the implementation of the new water loops, e.g. through the location of new pipes?	- *The implementation of the new water loop planned for Omis will probably not generate any conflicts with the zoning system and the land use indicators considered in the Municipal Master Plan of the City of Omis (CO, 2016), since the new water loop will be implemented inside and industrial facility.*
2. Does the plan foresee the promotion of circular territories or circular city-regions/cities with circular economy strategies? Is water included?	- *The Omis MMP (CO, 2016) does not foresee or refers the promotion of circular territories or circular city-regions/cities with circular economy strategies.*

3. Does the plan identify the need for changes in existing water infrastructures to support efficient water use and the circular economy of water?	- *The Omis MMP foresees several changes to the existing water infrastructures and the planning of new water infrastructures as well, including:*
	  - *Four new water supply systems are planned to supply the city area of Omis (CO, 2016; p.69);*
	  - *The construction of several water systems with treatment plants and submarine outlets (CO, 2016; p. 70).*
	- *These water infrastructure changes seem to be centred in improving urban water distribution and ensuring an adequate wastewater drainage system for the city, rather than in promoting an efficient use of water or introducing the principles of circular economy of water.*

4. Does the plan acknowledge the impacts of urbanisation on water resources (e.g., water quality and quantity)? Are other land uses referred in the same manner?	- *The Omis MMP (CO, 2016) does not refer the impacts of urbanization on water resources. However, it acknowledges the importance of water resources protection in land-use planning and foresees several improvements in the water supply distribution and network and in the wastewater treatment systems, envision the reduction of pollution effects in the environment.*
5. Does the plan recognise the risk posed by extreme events on water resources (e.g., floods and droughts)? Is climate change adaptation considered in relation to water security and water adaptation measures?	- *The document recognizes the risks posed by floods, and include protective and preventive measures against them, namely the construction of protection structures to regulate water courses (CO, 2016; p. 73) and appropriate sizing of drainage systems to prevent uncontrolled floods (CO, 2016; p. 99).* - *Climate change, is not referred in the document (CO, 2016).*
6. Does the plan include impact assessment and analysis tools appropriate to planning for water reuse, such as water footprint analysis, to characterise water demand scenarios? Are these analyses a key prerequisite for land use decisions and development permits and how?	- *The plan (CO, 2016) does not refer the existence of impact assessment, analysis tools or scenarios to the planning of water reuse.*
7. Does the plan restrict siting of water reclamation plants, and disallow innovations in on-site water treatment and reuse (such as blackwater and greywater systems)?	- *The plan (CO, 2016) does not restrict siting of reclamation plants nor disallow innovations in wastewater treatment and reuse. However, water reuse measures are not foreseen or planned.* - *Regarding the siting of water reclamation plants, the document establishes that for the planning of the drainage system and wastewater treatment, it is necessary to develop a conceptual design in accordance with special regulations. The exact location of collectors, pumping stations, treatment plants and submarine discharges will be determined by the conceptual design based on the conducted hydrogeological exploration works at potential locations of devices and points of entry into the terrain, watercourse or sea (CO, 2016; p. 70).*

Eilat (Israel)

Eilat (Israel) Strategy or plan for circular economy (National level)	
Questions	**Answers**
1. Is water circular economy included in the priority areas of the strategy/plan?	- *Israel has not yet adopted a plan or strategy for CE.* - *Israel's point of view on CE is expressed in the Israel Sustainability Outlook 2030 (MoEP, 2012). Water CE is not mentioned in the document, however the significant importance of the efficient use of water resources in the country, namely by practices of desalination and reuse of wastewater in agriculture, is recognized (MoEP, 2012; p. 58).*
2. Are there specific measures fostering the development of a Water Circular Economy?	- *The document (MoEP, 2012) does not include specific measures fostering the development of a water circular economy. However, it refers to the Long-Term Master Plan for the National Water Sector (WA, 2012) for specific water reuse measures.*

3. Are water utilities and other stakeholders identified for the implementation and monitoring of measures for a Water Circular Economy or water reuse?	- *The document (MoEP, 2012) does not identify specific water utilities and other stakeholders for the implementation and monitoring of measures for a water circular economy or water reuse. However, it refers that stakeholders whose cooperation is essential for the implementation of any measure (ISO, 2012; p. 45) and who would benefit from and be interested in promoting each policy package and who would be capable of adapting the required measures during the process of their implementation (ISO, 2012; p. 47) were identified for the elaboration of the document.*

4. Does the strategy or plan establishes specific indicators to measure and monitor water loops? Which ones?	- *Specific indicators to measure and monitor the efficient use of resource, including water, are identified in the document, including:*
	  - *The Environmental Vulnerability Index, which includes the re-use of water (MoEP, 2012; p. 139-140);*
	  - *The Environmental Performance Index, which includes water quality and availability (human consumption and environment), water pressure and the percentage of use of water resources for agriculture (MoEP, 2012; p. 141-142);*
	  - *The Sustainable Society Index, which includes the re-use of water (MoEP, 2012; p. 143-144).*

5. Is spatial planning considered in the strategy/plan? How and in which parts (problem, objectives, measures, stakeholders, monitoring)?	- *Spatial planning is considered in the document since the significant importance of the efficient use of land and space is recognized. An analysis of the current situation and future trends in the efficiency of land use for construction and development is presented, namely by analysing the rate of expansion of built-up areas in relation to the rate of population growth, the price of land in relation to costs arising from its use, and land allocation between competing uses (MoEP, 2012; p. 57-58).* - *The creation of a city-state in a future scenario of continuation of the current spatial-environmental trends, is recognized. This city-state is characterized by the development of the city towards peripherical open spaces, which is inconsistent with the principles of sustainability, namely by causing unrestrained distribution over space, while increasing congestion, pollution and overcrowding, increase of physical infrastructures, damage to ecosystems and social-environmental inequality, namely in the management and distribution of water resources. This situation will only change if land pricing includes external costs and urban renewal is valued as an economic action, instead of expansion of built-up area (MoEP, 2012; p. 76).* - *Specific recommendations for increasing urbanity, reducing the rate of expansion and preserve and protect the open space are presented in the document (MoEP, 2012; p. 134-135).*
6. Does the strategy refer spatial planning in relation with symbiosis agreements involving the use of water?	- *The document (MoEP, 2012) does not refer spatial planning in relation with symbiosis agreements involving the use of water.*
7. Does the strategy/plan consider the concept of circular territories regarding the management of the urban water cycle (or others) and any consequences at the spatial planning level?	- *The document (MoEP, 2012) does not consider the concept of circular territories regarding the management of the urban water cycle (or others) and any consequences at the spatial planning level.*

Eilat (Israel) Strategy or plan for efficient water use	
Questions	**Answers**

1. Is there a national or regional strategy/plan for efficient use of water?	- *In Israel, there is no specific national plan for efficient use of water.*
	- *The current programming document that defines the vision, goals and objectives for the Israeli water sector, including water protection, water supply, wastewater management and water reuse, is the Long-Term Master Plan for the National Water Sector (WA, 2012).*
	- *Some of the main objectives of the plan for the national water sector, are (WA, 2012; p. 20):*
	  - *Ensuring an efficient use of water, and savings in the utilization of the natural and artificial resources, including reclamation of treated wastewater;*
	  - *Providing sewage services, including collection and treatment of all the sewage and sources of contamination, to the level of quality that ensures the public's health, flexibility of uses and preventing risks for the environment and for the natural water sources.*

2. Are there specific measures for water reuse? Are any specific water loops mentioned?	- *Water reuse is fundamental in Israel. It is a main area of the plan (MoEP, 2012), which identifies several specific measures and strategies for water reuse and specific water loops;*
	- *Providing sewage services, including collection and treatment of all the sewage and sources of contamination, to the level of quality that ensures the public's health, flexibility of uses and preventing risks for the environment and for the natural water sources are main objectives of the plan (MoEP, 2012; p. 20).*
	- *Management of sewage and treated wastewater are within the main points of the policy, and it is recommended that (MoEP, 2012; p. 23):*
	  - *The sewage and treated wastewater management system should be structurally organized;*
	  - *Efforts should be made to ensure that the reclamation systems are cost-based and meet national targets (as decided by the government), and efficient in removal of treated wastewater;*
	  - *Aggressive action will be taken to connect as many producers of sewage as possible to sewage treatment plants, with clear prioritization of central plants;*
	  - *Construction and regulation of sewage treatment plants will be based on proven ability of their management, technical and financial reliability;*
	  - *Treatment of sewage and regional reclamation systems will be primarily based on criteria of reliability, efficiency and spatial fairness;*
	  - *In some cases (when there is agricultural designation for treated wastewater, and there is Ministry of Health approval), approval will be issued for advancing greywater projects;*
	  - *Gradual enhancement, in the present decade, of the quality of treated wastewater will be advanced to Inbar Committee standards, and to enhanced levels, according to cost – benefit analyses, the accumulated knowhow regarding reclamation impacts, and according to future regulations.*
	- *A master plan for sewage and treated wastewater was recently initiated which includes an evaluation of the sewage and treated wastewater sector. This entails an analysis of treated wastewater uses, optimum*

	mobilization, and a number of issues relating to regulation of the treated wastewater sector (MoEP, 2012; p. 25).
	- *The following main project for implementation in the field of sewage treatment and wastewater reclamation and reuse are presented (MoEP, 2012; p. 59):*
	  - *Investing in expanding and upgrading sewage treatment plants (with reference to the quality of the treated wastewater as per the Inbar Committee standard). At this stage, focusing on expanding and upgrading existing sewage treatment plants (50-60) in the Sewage Infrastructure Development Administration master plan*
	  - *Connecting sewage producers to the treatment systems, including IDF bases;*
	  - *Upgrading the sewage treatment plants for quaternary treatment (treatment of 50% of the treated wastewater to potable water quality) to be examined as part of the sewage and reclamation master plan;*
	  - *Mekorot Ltd treatment plants: Continued upgrading and expansion of the system in the Dan Region sewage treatment plant, construction of the Kishon combined plant, Treated Wastewater North (utilization of treated wastewater of Carmiel), 'Geulat Hayarkon' project, Plants for processing sewage from the West Bank;*
	  - *Principle private sector projects: Mei LG in Lower Galilee (plant-based and inter-plant), Menasheh Treated Wastewater (plant based and inter-plant), Jordan Valley Treated Wastewater, Gush Zevulun Treated Wastewater (Asher reservoirs).*
	- *The potential re-use of greywater is also considered in the document. Greywater could be reused for domestic purposes, such as for flushing toilets, thereby replacing the use of freshwater, and for public urban purposes, such as for irrigation in parks. The obstacles to using greywater today are mostly of a regulatory nature, from the Ministry of Health, which is concerned about public health issues due to cross-connections (between freshwater systems and greywater systems) and the difficulty of supervision and control of this type of system which, in effect, acts as a small sewage treatment facility within buildings and/or public districts. Nevertheless, interested parties will not be prevented from carrying out their specific greywater re-use projects, provided that they have received all the requisite approvals from the relevant ministries (particularly the Ministry of Health) (MoEP, 2012; p. 29-30).*

3. Are they associated to the development of water circular economy?	- *The specific measures, strategies for water reuse and specific water loops mentioned in the plan (MoEP, 2012) are not specifically associated to the development of water circular economy.*
4. Does the strategy/plan identify water loops	- *The plan (MoEP, 2012) identifies different water loops, including water utilities, stakeholders and responsible agencies, within its different areas of application.*
5. Does the strategy consider water circular economy as a water resources management strategic objective?	- *The plan (MoEP, 2012) does not consider water circular economy as a water resources management strategic objective.*

6. Is spatial planning mentioned in the strategy/plan?	- *The plan (MoEP, 2012) mentions spatial planning within its different areas of application. For example:*
	  - *Within the main points of the policy it is mentioned that the water sector will serve as a supportive factor in realizing Israel's national goals (residential expansion and development, industry, agriculture, nature and landscape, regional agreements, etc.) (MoEP, 2012; p. 7);*
	  - *Ensuring the supply of water and sewage infrastructures for the development of settlements and industry, in accordance with the government decisions and in support of communities in the periphery (MoEP, 2012; p. 20);*
	  - *Land resources should be considered in the planning of the water sector. Water planning should be conducted under the premise that there is a shortage of available land. Consequently, land use should be minimized for future water infrastructures. This will be carried out by coordinating planning with other infrastructures. Progress will also be made with infrastructure tunnels and feasibility studies for executing part of the production capacity of desalinated water on artificial islands or facilities in the sea, or underground (MoEP, 2012; p. 27);*
	  - *Population size and expansion should be considered in the planning of the water sector. Water infrastructures are developed on the assumption that the national outline plan for regional development (the population distribution) will be implemented as planned (MoEP, 2012; p. 28);*
	  - *Steps should be taken to coordinate major plans of other infrastructures with the plans of the Water Authority. It is suggested that a method may be found for the national infrastructure companies to secure spaces for water and sewage infrastructures in all of their respective plans (MoEP, 2012; p. 45);*
	  - *A national authority for managing runoff and drainage water which will comprise members of all the relevant professions for managing runoff, and will have the professional ability to recommend policy and implementation tools to the council. The national authority will prepare guidelines for basin master plans, which will be adjusted to the regional plans for land use (including transportation), and will engage in planning and ongoing management of runoff and drainage water. The relevant professionals will be integrated on all levels of planning, including hydrology, drainage, statutory planning, urban planning, landscape architecture, land engineering, etc (MoEP, 2012; p. 55).*

7. Does the strategy/plan consider the existence or creation of any symbiosis agreement involving the use of water?	- Symbiosis agreements involving the use of water are not considered in the plan (MoEP, 2012).

8. Does the strategy/plan consider the urban water cycle as a way to create circular territories? Is the management of the urban water cycle considered and related to spatial planning?	- The plan (MoEP, 2012) does not consider the term circular territories. However, the urban water sector is considered a main area of the plan. Policies and recommendations made regarding the management of the water within the urban domain, namely urban runoff and drainage, are (MoEP, 2012; p. 55):
	  - Management of runoff in the urban domain will be used to enhance its contribution to the quality of life – to improve the urban landscape, to contribute to the health of the residents and for involving the civil society;
	  - Efforts should be made to integrate basin runoff management and urban runoff management;
	  - Planning and operating the runoff and drainage management systems in urban areas (the channelling systems) will remain the responsibility of the local authorities although, at critical points, they will adhere to the master plans which will be prepared by the basin authorities. Basin master plans will

	integrate relevant professionals on all levels of planning, including hydrology, drainage, statutory planning, urban planning, landscape architecture, land engineering, etc.

9. Which are the agencies responsible for implementing the strategy and other agencies and stakeholders to be involved?	- Several governmental authorities were involved in the preparation and steering of the plan (MoEP, 2012) including the Ministry of Water and Energy, the Ministry of Agriculture, the Ministry of Finance, the Ministry of Interior's Planning Administration, the Ministry of Environmental Protection and the Israel Nature and Parks Authority (NPA). Professional academic experts were also involved, as well as interested parties including Mekorot Ltd and representatives of private companies and non-governmental bodies (MoEP, 2012; p. 5).
	- Several governmental authorities and other component bodies are responsible for implementing the recommendations in the plan (MoEP, 2012), namely:
	  - A National Planning Council (or inter-ministerial unit) should be created under the aegis of the Prime Minister's Office / Ministry of Water and Energy, which will oversee the needs of national planning and the strategic objectives with the various government ministries (MoEP, 2012; p. 45);
	  - The Water Authority will begin to regulate the organizational structure relating to the management of the sewage and treated wastewater system. (MoEP, 2012; p. 46);
	  - In certain situations, primarily where there is no designation of treated wastewater for agriculture in the region, greywater and domestic reclamation projects will be approved, subject to a cost benefit analysis and approval by the Ministry of Health (MoEP, 2012; p. 46);
	  - Responsibility and authority for the quality of the water and prevention of contamination of the natural water sources will continue to be divided between the Water Authority and the Ministry for Environmental Protection (MoEP, 2012; p. 47);
	  - The standards for the quality of supplied water to the various consumers are set by the Ministry of Health (MoEP, 2012; p. 48);
	  - Consumption management will be performed by the water suppliers (Mekorot Ltd., the water and sewage corporations and other local suppliers) (MoEP, 2012; p. 50);
	  - The government and Ministry of Agriculture determine the objectives, requirements and distribution of agriculture (MoEP, 2012; p. 50-51).

Eilat (Israel) Water resources main legal framework	
Questions	**Answers**

1. Is water reuse inserted in the objectives and principles of the water policy?	- *The Water Law (Law 5719/1959), and further amendments, are the cornerstone of Israel's main legal water framework, setting the overall principles for managing the sector.*
	- *The production and supply of water from wastewater is considered in the Water Law (Law 5719/1959):*
	  - *A person shall not produce water from a water source, shall not desalinate seawater, and will not supply it to others or self-consume it, except under a production license from the director of the Government Authority and in accordance with the license conditions (Law 5719/1959; Art. 23);*
	  - *The establishment of a system for collecting rainwater, the production of water through such a system, and reasonable use of it, except for drinking purposes, established by a person on land which is lawfully owned or held by him, shall not be subject to a construction license or a production license (Law 5719/1959; Art. 23);*
	  - *Regulations regarding the quality of water, including flood water and wastewater, but excluding the sanitary quality of drinking water, for various purposes will be prescribed by the Minister of the Environment, after consultation with the Government Authority Council and the Minister of Health (Law 5719/1959, 1959; Art. 20).*
	- *Water regulations were posteriorly detailed in the Effluent Quality Standards and Rules for Sewage Treatment (R 5769/2010) and in the Quality Standards for Output Water from Fish Ponds and Rules for their Treatment (R 5772/2012) for the particular case of waste water from aquaculture activities.*

2. Is water circular economy mentioned? How?	- *Water circular economy is never mentioned in the water resources main legal framework. However, efficient use of water and water reuse are main objectives of the Water Law (Law 5719/1959).*

3. Is the articulation between water resources management and spatial planning foreseen in the main legal framework? How?	- *The articulation between water resources management and spatial planning is foreseen in the Water Law (Law 5719/1959):*
	  - *In Israel, all sources of water are public property, are under the control of the state, are intended for the needs of its residents and the development of the country (Law 5719/1959; Art. 1) and a person's right to a land does not confer on him a right to a source of water located in or passing through that land or within its boundary (Law 5719/1959; Art. 4);*
	  - *A water plant (e.g. WWTP, desalination plant) plan shall not be approved before bringing it before the competent construction and urban planning authority, and the committee may approve the plan, notwithstanding the Planning and Building Law (Law 5725/1965). If the competent authority does not approve the water plant plan, the government may further approve it, with or without changes, or reject it (Law 5719/1959; Art. 68);*
	  - *The power of a water plant plan approved under this law is superior to the power of any city building plan (Law 5719/1959; Art. 69).*

Eilat (Israel) Spatial planning main legal framework	
Questions	**Answers**
1. Is the protection of water resources included in the main aims and principles of the spatial planning legal framework?	- *In Israel, the spatial planning main legal framework is based on the Planning and Building Law (Law 5725/1965) and in the National Parks, Nature Reserves, National Sites and Memorial Sites Law (Law 5758/1998).* - *The protection of water resources is not included in its main aims and principles of the Planning and Building Law (Law 5725/1965).* - *The procedures regarding the declaration, management, and operation of heritage sites (national parks) and sites intended to preserve unique natural values (nature reserves, including water resources) are consolidated in the National Parks, Nature Reserves, National Sites and Memorial Sites Law (Law 5758/1998). It establishes the Nature and Parks Authority, with the functions of taking care of all matters*

	of nature reserves (including water resources) and national parks and to promote their affairs, as well as to protect the values of nature and heritage, to supervise their conservation and to cultivate them (Law 5758/1998; Chapter 3).

2. Is the articulation with the water resources planning system foreseen? How?	- *The articulation with the water resources planning system is foreseen in the Planning and Building Law (Law 5725/1965), namely:*
	  - *The authorized planning institution may issue a permit for a water plant in accordance with the plan for a water plant under the Water Law (Law 5719/1959), even if the said plan did not establish determined provisions required for other plans for the land (Law 5725/1965; Art. 145);*
	  - *Approval for a new building constructed in the area of a corporation within the meaning of the Water and Sewage Corporations Law, will only be granted after the said corporation has confirmed that the building is connected to the water system and the sewage system, or that there is another solution for sewage, depending on the use of the building and its purposes, and in accordance with all laws (Law 5725/1965; Art. 157);*
	  - *The National Outline Plan that will determine the planning of the entire territory of the country, and among other things, label the main national water supply lines, dams and storage lakes, and set provisions regarding afforestation, land conservation and the preservation of landscape values and areas that remain in their nature (Law 5725/1965; Art. 49).*
	- *The articulation with the water resources planning system is foreseen in the National Parks, Nature Reserves, National Sites and Memorial Sites Law (Law 5758/1998). The Water Authority with the approval of the Minister in charge of the implementation of the Water Law (Law 5719/1959), may appoint an inspector to supervise according to the f functions of the Water Authority under the Water Law (Law 5719/1959) (Law 5758/1998; Art. 60).*

3. Is the concept of circular territories mentioned? How?	- The concept of circular territories is not mentioned in the spatial planning main legal framework.
4. Does the spatial planning legal framework foresee the existence of integrated and symbiotic territories and related environmental objectives, principles and measures?	- *The spatial planning main legal framework does not foresee the existence of integrated and symbiotic territories.*

Eilat (Israel) River Basin Management Plan (RBMP)	
Questions	**Answers**
1. Does the plan establish quality and quantity objectives able to interfere with new water loops?	- *The city of Eilat, as well as the entire Southern Arava region in Israel, are not covered by a typical River Basin Management Plan. Instead, there is a Master Plan for Drainage and Canalization of Eilat, the Eilot Area and the Southern Arava (ADA, 2010), whose main purposes is to plan for a new drainage canalization system in the built-up part of the city, which is absent of an underground drainage system, or whenever the existing system is in an inadequate state, as a way to prevent floods and damage to the city and its residents (ADA, 2010; p. 10).* - *The plan establishes quantity and quality objectives to drainage waters. However, it is not expected that these objectives could interfere with the new water loops.*
2. Do the water loops bring new stakeholders into the water resources management river basin community? Who? Do they increase the complexity of the water management network?	- *It is expected that the new water loop foreseen for Eilat under Project Ô bring new stakeholders into the water resources management drainage community. According to the Quality Standards for Water Output from Fish Ponds and Rules for their Treatment (R 5772/2012), it is expected that, apart from the authorities already involved in the current water loop, such as the Water Authority and the Ministry of Environmental Protection, the new water loop with reuse of wastewater for irrigation purposes, may also involve the consultation and permits from the Minister of Health and the Minister of Agriculture. Inevitably, this will increase the complexity of the water management network.*
3. Are there minimum flow rates or ecological flows established by the RBMP, and are the water loops able to interfere with them?	- *The plan (ADA, 2012) does not establishes minimum flow rates or ecological flows.*
4. Does the RBMP consider the existence or creation of any symbiosis agreement involving the use of water?	- *The plan (ADA, 2012) does not consider the existence or creation of any symbiosis agreement involving the use of water.*
5. Does the RBMP consider water re-use as an objective? Are there measures to foster it? Do they articulate with water circular economy purposes?	- *The management of water abstraction, and water supply, as well as sewerage collection and treatment are not part of this plan (ADA, 2012). As such, water reuse is not considered.*
6. Are there objectives and measures (financing, technical and governance) at basin level including the development of re-use projects?	- *The plan (ADA, 2012) only refers objectives and measures at the basin level for the development of drainage and water transfer channels for the prevention of floods.*

Eilat (Israel) Municipal Master Plan	
Questions	**Answers**
1. Does the zoning system and the land use indicators constraint the implementation of the new water loops, e.g. through the location of new pipes?	- *The zoning system and the land use indicators considered in the Eilat Outline Plan (CE, 2020) should not constrain the new water loop foreseen for Lecce under Project Ô.*

2. Does the plan foresee the promotion of circular territories or circular city-regions/cities with circular economy strategies? Is water included?	- *The Eilat MMP (CE, 2020) does not mention circular territories or circular city-regions/cities.*

3. Does the plan identify the need for changes in existing water infrastructures to support efficient water use and the circular economy of water?	- *The Eilat MMP (CE, 2020) identify instructions that may support efficient water use. The plan refers that:*
	  - *Detailed plans in Complex C3 should include instructions and arrangements that ensure the continued operation and proper functioning of the Birding Park, including the supply of brackish water to them, all in coordination with the Eilat Birding Park (CE, 2020; p. 62);*
	  - *Provisions for Roca infrastructure should include planning for water-efficient landscaping and utilization of surface runoff and water circulation systems for the building complex (CE, 2020; p. 75).*

4. Does the plan acknowledge the impacts of urbanisation on water resources (e.g., water quality and quantity)? Are other land uses referred in the same manner?	- *The Eilat MMP (CE, 2020) does not refer to the impacts of urbanization on water resources.*
5. Does the plan recognise the risk posed by extreme events on water resources (e.g., floods and droughts)? Is climate change adaptation considered in relation to water security and water adaptation measures?	- *The Eilat MMP (CE, 2020) does not refer to the risk posed by extreme events on water resources (e.g., floods and droughts). However, specific measures are referred to prevent floods, such as a detailed plan for Nasha Tishtan will be accompanied by a construction plan that will include the solutions for flood prevention, drainage and water conservation in accordance with the guidelines in the drainage appendix attached to this plan (CE, 2020; p. 76).* - *Climate change is not referred in the document (CE, 2020).*
6. Does the plan include impact assessment and analysis tools appropriate to planning for water reuse, such as water footprint analysis, to characterise water demand scenarios? Are these analyses a key prerequisite for land use decisions and development permits and how?	- *The Eilat MMP (CE, 2020) does not include impact assessment nor analysis tools appropriate to planning for water reuse or to characterize water demand scenarios.*
7. Does the plan restrict siting of water reclamation plants, and disallow innovations in on-site water treatment and reuse (such as blackwater and greywater systems)?	- *The Eilat MMP (CE, 2020) does not restrict siting of reclamation plants nor disallow innovations in on-site water treatment and reuse.*

Appendix 2

This appendix presents the result of the assessment of the policy and planning context of the demo sites to accommodate WCE. This are the results of the application of the assessment framework, by answering the set of research questions presented in Appendix 1, that correspond to the several general and specific enabling factors presented in Figure 11 in section 4. The following code was used: Yes for enabling factor in place; and No for enabling factor not in place.

Policy context: CE and water efficiency plans and strategies

Enabling factors	Almendralejo (Spain)	Lecce (Italy)	Omis (Croatia)	Eilat (Israel)
Water concerns in CE plans or strategies				
Water is considered in the policy and included in the priority areas (e.g. water circular economy is treated as a driver to the transition into a circular economy)	Yes	Yes	No	No
There are measures to foster water circular economy (e.g. specific incentives for the implementation of new water loops)	Yes	Yes	No	No
There is the identification of the main water utilities and other specific stakeholders involved in the implementation and monitoring of measures for a water circular economy	Yes	No	N	No
There are specific indicators to measure and monitor new water loops	Yes	No	No	Yes
There is the proposition of symbiosis agreements involving the use of water	No	No	No	No
Land concerns in CE plans or strategies				
Spatial planning is considered in the main priority areas of the strategy (e.g. spatial planning is treated as a driver or barrier to the transition into a circular economy)	Yes	No	No	No
The management of the urban water cycle is considered as a way to create circular territories and is related to the spatial planning level	No	No	No	No
WCE and water reuse in water efficiency plans or strategies				
Water circular economy or water reuse are treated as water resources management strategic objectives	Yes	Yes	No	Yes
There are specific measures for water circular economy or water reuse (e.g. use of alternative sources of water)	Yes	Yes	No	Yes
There is the identification of water loops, water utilities or other specific stakeholders	Yes	Yes	No	Yes
There is the identification of the main agencies responsible for implementing the strategy and other agencies and stakeholders to be involved	Yes	Yes	Yes	Yes
There is the proposition of symbiosis agreements involving the use of water	No	No	No	No
Land concerns in water efficiency plans or strategies				
Spatial planning is considered in the main priority areas of the strategy	Yes	Yes	Yes	Yes
The management of the urban water cycle is considered as a way to create circular territories and is related to the spatial planning level	No	No	No	Yes

Main legal context: water resources and spatial planning main legal frameworks

Enabling factors	Almendralejo (Spain)	Lecce (Italy)	Omis (Croatia)	Eilat (Israel)
WCE and water reuse in water resources main legal framework				
Water circular economy principles are included and compatible	No	No	No	No
Water reuse is included in the main aims and principles	Yes	Yes	No	Yes
There is a regulatory framework for water reuse	Yes	Yes	No	Yes
Land concerns in water resources main legal framework				
The articulation between water resources planning and spatial planning is foreseen	Yes	Yes	Yes	Yes
Water concerns in spatial planning main legal framework				
The protection of water resources is included in the main aims and principles	Yes	Yes	Yes	Yes
The articulation with water resources planning system is foreseen	Yes	Yes	Yes	Yes
Circularity in spatial planning main legal framework				
The concepts of circular, integrated and symbiotic territories are mentioned and are related to the environmental objectives, principles and measures	No	No	No	No

Planning context: River Basin Management Plans (RBMP) and Municipal Master Plans (MMP)

Enabling factors	Almendralejo (Spain)	Lecce (Italy)	Omis (Croatia)	Eilat (Israel)
WCE and water reuse in RBMP				
Water circular economy or water reuse are included as objectives	Yes	Yes	No	No
There are measures at basin level for the development of water reuse projects or fostering water circular economy	Yes	Yes	No	No
There is the proposition of symbiosis agreements involving the use of water	No	No	No	No
Water protection in RBMP				
There are measures to control diffuse pollution on surface waters and groundwaters (e.g. environmental quality and quantity objectives)	Yes	Yes	Yes	No
Minimum flow rates or ecological flows for surface waters are established	Yes	Yes	Yes	No
Critical stress or protected zones related to water resources are identified	Yes	Yes	Yes	No
WCE and water reuse in MMP				
The need for changes in existing water infrastructures to support the efficient water use and the water circular economy is identified	Yes	Yes	No	Yes
There is the proposition of water circular economy or water reuse measures and new water loops in order to meet land development proposals	Yes	Yes	No	Yes
New developments are considered as opportunities to treat and reuse water on-site (e.g. decentralised projects involving rainwater collection tanks and on-site treatment and reuse)	No	Yes	No	Yes
The promotion of circular territories or circular city-regions/cities with circular economy strategies is foreseen	No	No	No	No
Water protection in MMP				
The impacts of urbanisation or other land uses on water resources are acknowledged	Yes	Yes	No	No
The risks posed by extreme events on water resources are considered (e.g. floods and droughts)	Yes	Yes	Yes	Yes
Climate change adaptation is considered in relation to water security and water adaptation measures	No	No	No	No
Impact assessment and analysis tools appropriate to planning for future water demand scenarios (e.g. water footprint analysis) are included and are related with land use decisions and development permits	Yes	No	No	No

Appendix 3

Glossary

Concepts	Definitions
Circular economy	A perspective in which the economic value of materials is optimized over time. This calls for minimal raw material extraction, reintroduction of materials already in the economy and no waste (WBCSD, n.d.).
Governance	The conceptual and theoretical representation of the role of the state in the coordination of socioeconomic systems. State capacity to "steer" the socioeconomic system and therefore the relationships between the state and other policies. Coordination and self-government, especially with respect to network relationships and public—private partnerships actors. Contemporary state adaptation to its economic and political environment --"new governance"(Hall, 2011).
Integrated water resources management	Process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP, 2000)
Institutions	Refers to many different types of entities, including both organisations and the rules used to structure patterns of interaction within and across organizations (Ostrom 2010, p. 2)
Land use	Territory characterized according to its current and future planned functional dimension or socio-economic purpose (e.g. residential, industrial, commercial, agricultural, forestry, recreational) (JRC, n.d.).
Policy	A statement of a public body that forms the basis for enacting legislation or making decisions (ILG, 2010).
Regulation	A rule or order issued by a public agency having the force of law (ILG, 2010).
Spatial plan	A set of documents that indicates a strategic direction for the development of a given geographic area, states the policies, priorities, programmes and land allocations that will implement the strategic direction and influences the distribution of people and activities in spaces of various scales. Spatial plans may be developed for urban planning, regional planning, environmental planning, landscape planning, national spatial plans, or spatial planning at the Union level (JRC, n.d.).
Spatial planning	Refers to the methods and information used by the public sector to influence the distribution of people and activities in spaces at various scales as well as the location of the various infrastructures, recreation and nature areas (CEMAT, 2007).
Closed-loop/water loop	Recycling a product and manufacturing it into the same product again and again (WBCSD, n.d.). When applied to water a loop is a set of operations in water management that allows its continued recycling.
Water resources	Include a physical dimension (hydrological and hydrogeological), the 'flows and stocks', and other more qualitative, environmental and socio-economic dimensions. Distinction is made between renewable and non-renewable water resources. Renewable water resources are computed on the basis of the water cycle. They represent the long-term average annual flow of rivers (surface water) and groundwater. Non-renewable water resources are groundwater bodies (deep aquifers) that have a negligible rate of recharge on the human time-scale and thus can be considered non-renewable (FAO, 2003).
Water resources planning	Involves the development, conservation and allocation of a scarce resource, and seeks to match water availability and demand, taking into account the full set of national objectives and constraints and the interests of stakeholders (ESCWA and BGR, 2009)
Water reuse	Treated wastewater can be indirectly reused when it is discharged into a watercourse, diluted and used again downstream. Direct reuse means the direct supply of treated effluent from the treatment plant to the user. It also can apply to the recharge of an aquifer (EEA, n.d.).