AQUARES - WATER REUSE POLICIES ADVANCEMENT FOR RESOURCE EFFICIENT EUROPEAN REGIONS

OCTOBER 2019

A1.2 Final report

on AQUARES regions' needs and opportunities in water reuse

Regional Goverment of Murcia, Ministry of Water, Agriculture, Livestock, Fisheries and Environment.

General Directorate of Water

Región de Murcia
Consejería de Agua, Agricultura y Medio Ambiente
Dirección General del Agua

Región de Murcia
Consejería de Agua, Agricultura y Medio Ambiente
Dirección General del Agua

TABLE OF CONTENTS

1 INTRODUCTION

The AQUARES project supports the integration of water reuse in national, regional and local development plans, in an attempt to promote the efficient use and management of water in EU regions and support sustainable development and eco-innovation adoption across the agricultural, industrial, urban and recreational sectors.

The uptake of water reuse solutions remains quite limited in AQUARES countries in comparison with their potential, which remains largely untapped. This results in a suboptimal contribution to alleviating water scarcity; an increasingly frequent phenomenon that affects at least 11% of the EU population and 17% of the EU territory. At present, only a small share of the approximately 29 billion cubic meters of urban wastewater treated in partnership territories is reused annually while the volume of wastewater reuse varies from country to country. For instance, Malta already reuses more than 60% of its wastewater while Greece, Spain and Italy reuse between 5 and 12% of their effluents[1].

This report presents the findings of the analysis on water reuse needs in AQUARES partners' territories. The analysis focused on territorial attributes and sketches the water consumption profile of AQUARES territories (such as water demand, water supply, wastewater services and facilities, investment and funding), discussing also the specificities of major and water intensive economic activities to identify their water reuse potential and feasibility.

The purpose of this needs analysis is to enable policy makers in partnership areas to i) comprehend the socio-economic and institutional context that could best support the proliferation of water reuse solutions, ii) establish the picture of territorial reality (state of play) on water reuse needs and pinpoint drivers and barriers to the implementation of water reuse, and iii) showcase the sectors and uses that have the largest water reuse potential.

Study results indicate that the sectors with the highest water reuse potential in AQUARES territories are agriculture, manufacturing and power production. These sectors combine significant vulnerability to water scarcity, high water consumption and wastewater generation, intensive economic activity and substantial environmental footprint. Therefore, the use of reclaimed water could provide a viable

[1] http://ec.europa.eu/environment/water/reuse.htm

alternative to mitigate pressures on available freshwater resources while the size of the sector can justify investments in water reuse facilities and advanced treatment methods.

The report is outlined as follows:

- Section 2 provides basic definitions for a number of water related terms used throughout the report, to facilitate readers' understanding.
- Section 3 presents the thematic background of the study focusing on the causes being responsible for the low uptake of water reuse solutions in partnership countries, the benefits and risks associated with water reuse, and possible sources and uses for reclaimed water.
- Section 4 outlines the methodological framework upon the needs analysis was carried out.
- Section 5 discusses the water usage profile of AQUARES territories, showcasing drivers and barriers to water reuse and concluding to water reuse opportunities in key economic and water intensive sectors.
- Section 6 provides a comparative analysis of partners' territorial water conditions and consumption patterns to showcase similarities and differences.

2 BASIC DEFINITIONS

This section provides basic definitions of terms associated with water reuse, to aid readers not familiar with water management field to comprehend the different terms used throughout the present report. A first critical distinction must be made between water reuse and water reclamation. The term "water reuse" refers to the use of treated wastewater for beneficial purposes that may include both potable and non-potable uses such as agricultural & landscape irrigation and industrial cooling. The term "water reclamation" refers to the treatment of wastewater, to control biodegradable organics, nutrients and pathogens in order to make it reusable.

Table 1: Definitions for water reuse terminologies

Term	Definition
Greywater recycling	Reuse of water originally supplied as wholesome (tap) water that has already been used for bathing, washing, or laundry. This does not include foul waste (see Blackwater). There is some dispute as to whether water containing residual food waste should be classified as Greywater or Blackwater.
Domestic sewage	Wastewater draining from household properties.
Industrial trade effluent	Trade effluent is any liquid waste (not surface water or domestic sewage) that is discharged from premises being used for a business, trade or industrial process. Trade effluent can come from both large and small premises, including businesses such as car washes and launderettes. It can be effluent from the industrial process that is discharged into a public sewer, washed down a sink or toilet, or put into a private sewer that connects to the public sewer. Trade effluent may contain: fats, oils and greases; chemicals; detergents; heavy metals; solids; and food wastes (NetRegs, online).
Municipal	Municipal is an international term that refers to resources or infrastructure serving the general public. It is less commonly used in the UK than in other countries where water services are not privatised.
Non-potable water	International terminology referring to water that is not suitable for human consumption.

Term	Definition
Potable water	International terminology referring to water that is suitable for human consumption. Note: the term 'potable' has no meaning in UK law. 'Drinking water' is the official term stipulated by the Drinking Water Inspectorate in the UK.
Public water supply (PWS)	Water supplied by a company or organisation licensed for that purpose and regulated by the Drinking Water Inspectorate in accordance the Drinking Water Quality regulations.
Reclaimed water	Water (other than mains or privately supplied drinking water) that has been collected or otherwise deliberately retrieved from fluvial or coastal waters, or from industrial uses, to be reused. It can also refer to water that is 'reclaimed' from urban surface areas i.e. by drainage systems or localised water harvesting. This ROCK distinguishes between reclaimed water and water that is subsequently treated (see Treated effluent).
Storm water (Surface water runoff)	Rainwater that collects and runs off land, e.g. water that runs down the street and into drains. In this context it is sometimes referred to as surface water (runoff). This is not to be confused with the term surface water that differentiates surface from groundwater.
Treated effluent	Water that has been treated for discharge or reuse. This can include primary, secondary, or tertiary effluent.
Unplanned reuse (*de facto*)	Situation whereby abstractions for public water supply contain a proportion of treated effluent from an upstream wastewater treatment works.
Wastewater	Water that has been used, either in domestic, commercial, or industrial properties. Commonly used in an international context to mean sewage. This is separate to, but can be mixed, with storm water in wastewater drainage and sewer systems.
Wastewater treatment works (WwTW)	Treatment works which treat wastewater and/or industrial wastewater for discharge back into the environment. Also called sewage treatment works (STW) and sometimes water recycling centres (WRC).
Water reuse	The use of reclaimed water for a direct beneficial purpose.

3 THEMATIC BACKGROUND

3.1 PROBLEM DEFINITION

According to the European Commission's (EC) assessment on the requirements of water reuse published in 2018, the adoption of water reuse solutions in Europe is still relatively limited while the potential for water reuse is particularly significant.

Annually, only 2.4% (1,100 million m^3) of treated wastewater is used in the EU; a volume that represents less than 0.5% of EU freshwater abstractions. While the existing water reuse rates are relatively low, their potential is rather high, being estimated to reach approximately 6.000 million m^3.

The water reuse issue has been identified and efforts are being intensified with the adoption of relevant initiatives concerning water reuse for irrigation, industrial uses and aquifer recharge, by both southern and northern member states. Cyprus and Malta lead while water reuse accounts for 90% and 60% respectively, while Greece's, Italy's and Spain's rates are between 5% and 12%.

European freshwater resources also face increasing tension in multiple regions because of the mismatch between the demand and the availability of water resources in both temporal and spatial scale. It is estimated that by 2030, scarcity and water tension will significantly affect half of European water basins. The issue is more prominent during summer months, affecting approximately 70 million citizens, while 30 million approximately are affected during winter months.

The EU authorities have pledged to spread the deployment of water reuse solutions in the EU by raising public awareness on the potential benefits among stakeholders and the general public and crafting a supportive and coherent framework to deal with increasing water pressures. Water reuse has been progressively encompassed within international, regional and national strategies. It is now among top priorities for the EU within the Strategic Implementation Plan of the European Innovation Partnership on Water, and has a significant role in the Communication "Blueprint to safeguard Europe's water resources".

3.2 CAUSES FOR THE LOW UPTAKE OF WATER REUSE SOLUTIONS IN THE EU

There is a number of barriers to the proliferation of water reuse solutions in the EU Member States. These include the insufficient clarity in the regulatory framework, administrative burden for water operators, users and public authorities, stringent national quality requirements, and the absence of national standards for water reuse. The low price of freshwater compared to the price of reclaimed water and the high cost of treatment has been also identified among the highest barriers. Overall, there are 4 principal factors, recognised as the main causes behind the low uptake of water reuse solutions in the EU-28.

1. Limited attractiveness compared to freshwater supply. Fresh supply is usually offered in lower prices compared to reclaimed water, making the latter less attractive and affordable. This means that consumers ought not only to overcome their concerns on the quality of the supplied water but also to accept to pay higher prices. The reason behind the low prices for freshwater supply is that water pricing schemes and associated tariffs ignore the pressures exerted on natural resources and the negative environmental impact caused by intensive consumption. Environmental taxation, instead, allows for the internalisation of the negative externalities into market prices, leading to higher prices and reducing water demand. In addition, environmental pricing through taxation gives customers and businesses the necessary flexibility to determine how best to diminish their ecological footprint by minimising the level of their consumption and provides a strong incentive to look for alternative sources such as reclaimed wastewater.

2. Perceived environmental and health risks due to varying existing quality requirements or the lack thereof. The low uptake of water reuse solutions can be partially attributed to the widely shared environmental and public health concerns associated with the use of reclaimed water in different instances and applications. The debate is on the pollutants and contaminants that cannot be sufficiently removed from wastewater through the existing available treatment technologies and methods. Pollutants can be categorised as organic, microbiological, and chemical; they vary by source and type of wastewater (e.g. industrial or agricultural) and differ in terms of how likely is their occurrence, survival, persistence and detectability. As mentioned, water pollutants may have adverse impact on both the natural environment and human health. Reclaimed water may contain substances from inorganic salt, nutrients, heavy metals and detergents that can have a highly negative impact on the environment as they affect both water and soil. In cases of irrigation, the salinity of water is also considered to be a risk for both crops and the environment. In fact, contaminants of emerging concern (CECs) used in practices such as sewage, e.g. pharmaceutical products, raise even more concerns, while evidence is still limited. Finally, reclaimed water can pose health risks to workers on far and water reclamation industry, as they can potentially be exposed to contaminants. However, as in irrigation, there is not clarity regarding actual risks in public health nor bibliography reports cases with diseases proclaimed by exposure to reused water.

3. Trade barriers. Another major cause for the low uptake of water reuse solutions in Europe is the enforcement of trade barriers for food products irrigated with reclaimed water. This has created serious concerns within the agricultural sector and the food industry regarding the inclusion of such products in the market. Farmers depend significantly on the intra-trade and therefore, they will not risk launching products that have been irrigated with reclaimed water, unless there is insurance for the water quality. Furthermore, farmers may face market restrictions deriving from strict requirements imposed by certification organisations (ISO).

4. Public opinion of risks outweighing benefits. The last category responsible for the low acceptance of water reuse solutions, is public opinion. Reuse and reclaimed water is still considered as risky and perhaps dangerous; nonetheless there is no evidence of significant large-scale pollution or contamination from wastewater reuse in Europe. Reclaimed water, as a source of potable water, is hardly opposed by local communities. Nevertheless, this opposition is also based on misconceptions and is not supported by scientific argumentation. Another issue that affects public opinion, is the general repugnance even for the idea of using treated water, accompanied of course by the risks mentioned earlier, and other factors such as trust to authorities' know-how, commitment to enforce strict quality standards and multi-layer treatment processes. According to Marks (2005), public opinion can be also influenced by each country's political context, local history, perceptions of the public on recycling terminology and the potential threats from water reuse solutions such as dams, river development or ocean outfall, the degree to which potable recycling is promoted as the primary alternative, the "not in my backyard" phenomenon, the degree and nature of education. In this framework a very sensitive aspect, is that public concerns primarily emphasise on the safety of children. It is also noteworthy that higher educated people are more accepting water reuse solutions.

3.3 BENEFITS & RISKS ASSOCIATED WITH WATER RECLAMATION AND REUSE

3.3.1 BENEFITS OF WATER RECLAMATION AND REUSE

Water reuse can help communities provide a safe and reliable sources of water, offering several environmental, social and economic benefits. Still, these benefits are still not widely acknowledged or accepted by public opinion, and that explains the low acceptance of these practices across the EU-28. The benefits associated with water reclamation and reuse can be summarised as follows.

- Conservation of freshwater resources
- Reduction in greenhouse gas emissions
- Aquifers recharge
- Water supply security
- Cost savings
- Long-term economic sustainability
- Business competitiveness
- Increased quality of life, wellbeing and health
- Food quality and security
- Employment opportunities

It is estimated that water reuse can improve the condition of the environment both quantitatively, by substituting abstraction and therefore easing water stress; and qualitatively, by dismissing pressure of discharge from UWWTP to subtle areas. According to the water exploitation index plus (WEI+) for river basin districts , the share of agriculture on total water abstractions varies across Europe, averaging about 60% in Southern countries, 11% in Eastern countries and 7% in Western countries. Considering the capacities of irrigation demand and potentially reusable water displayed in Table 2, the reduction of total abstractions from water reuse is estimated to range from 3.5% in the East, to more than 15% in the North, averaging around 10%[15]. The latter can resemble to a first approximation indicator of the water stress reduction potential of reuse.

Furthermore, water reuse practices tend to have lower investment costs and energy consumption, especially compared with procedures such as desalination, and contribute to the reduction of greenhouse gas emissions.

Table 2 – Reduction of water abstraction potentially allowed by reuse in different European zones. Based on EEA data, 2017

Zone	(A) Total reuse potential, regardless of cost (km3/year)	(B) Irrigation demand (km3/year)	(C) Agricultural share of total abstraction	(A*C/B) Indicative potential % reduction of water abstraction
East	0.44	1.37	11%	3.5%
South	9.34	36.2	60%	15.4%
West	3.31	5.21	7%	4.2%

As far as water supply's reliability is concerned, it is important to mention that reused or treated wastewater supply does not depend on seasonal droughts and weather unpredictability. Farming activities are therefore highly benefited, as they rely on the stability of water supply in order to avoid risks.

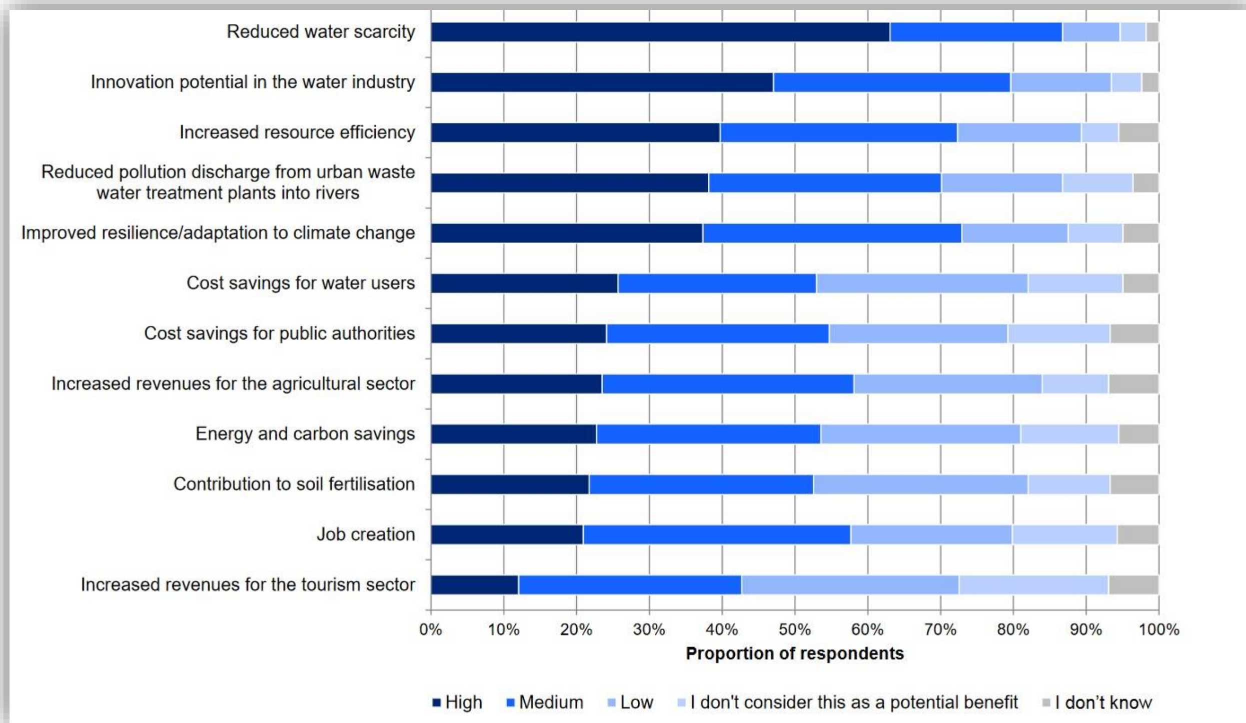
In addition, reuse procedures can have positive impacts for nutrients. This can lead to a reduction of the use of supplementary fertilisers that progressively will be beneficial for both the environment and farmers. Regarding recharge aquifers, water reuse can be found assisting in order to avoid a deterioration of the groundwater's status, if of course it is ensured that chemical status is not unfavourably affected.

Water reuse is also beneficial to the European eco-industrial sector, in which water plays a significant role. In this framework, water industry has a great potential in creating a considerable amount of "green" jobs. Considering that 1% growth increase in the water industry is equal to the creation of approximately 20.000 new jobs.

Moreover, water recycling can be used in order to establish or further boost wetlands and riparian habitats. The latter provide numerous benefits including the improvement of water quality for the habitats, the diminishment of floods and the creation of fisheries breeding grounds.

Finally, reused and reclaimed water can be exploited in public spaces, parks, golf courts, schools etc., ensuring their environmental sustainability and simultaneously buttressing the quality of life level. Benefits of water reuse and reclamation based on public perceptions is demonstrated in the following graph.

Figure 1 - Views of respondents on the level of potential benefits of water reuse



Source: BIO by Deloitte (2015) Optimising water reuse in the EU – Public consultation analysis report prepared for the European Commission (DG ENV)

3.3.2 RISKS ASSOCIATED WITH WATER RECLAMATION AND REUSE

The first category of risks associated with water reclamation and reuse is human health. In this context, water reuse for agricultural especially purposes can be hazardous for the health of both farmers and consumers, especially in case of contact with recycled water that has not been treated to minimum health safety requirements and standards. Moreover, the elimination of polluting substances (e.g. residuals, nutrients, chemicals) requires multiple stages of treatment (from mechanical to advance tertiary), that entail high investment costs for the modernisation and upgrading of existing wastewater treatment plants in most EU countries.

An issue that could constitute a barrier to industrial water reuse derives from the fact that many industrial processes require water that satisfies a set of very specific water quality requirements. Whist this does not impose necessarily a health risk, the risk of industrial process problems or reduced product quality is a significant concern for manufacturers (e.g. food manufacturing) considering replacing a freshwater source with reclaimed water.

Reused water, as already mentioned, can potentially lead to an increase in the water supply, boosting also reliability. However, the transition is problematic in terms of the investment costs. The latter cover the capital and operating costs for the implementation of new water treatment systems in order to create distribution networks and progressively achieve the transition. Considering that industrial and agricultural water users are not yet fully conscious about reused water, such an investment incurs many risks. Another concern occurs over the need for cost recovery and financial sustainability in the water sector.

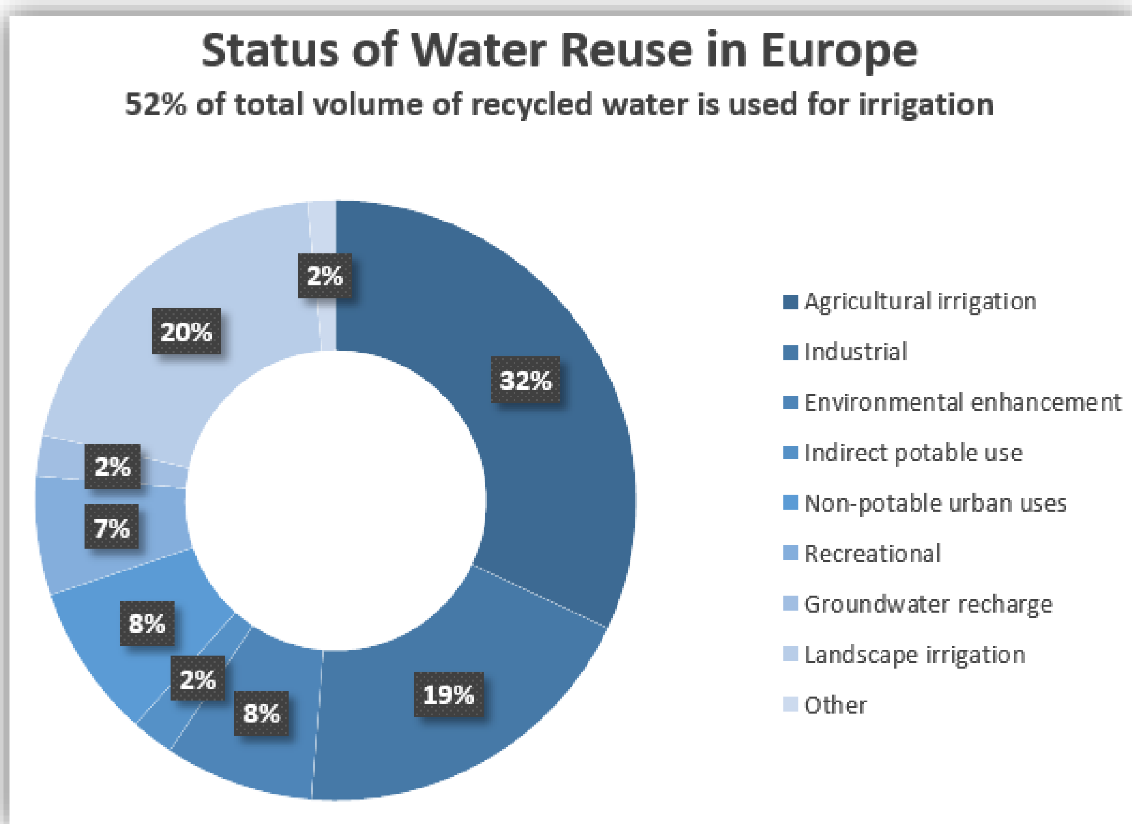
In addition, where reclaimed water is disinfected with chlorine, an impending undesirable consequence of water reuse is the discharge of residues from the chlorine management into the environment, which may detriment aquatic systems. Risks occur as well because of several gaps in regulations. Regulations are eventually, not sufficiently developed to provide within the minimum requirements for water reuse the assurance for both human health, and the protection of the environment. Furthermore, water reuse may stand beneficial in terms of preventing secondary effluent discharges to the environment. However, it is also vital to reflect whether the discharges were contributing to sustaining flows of water bodies to circumvent unexpected harmful impacts on the environment[2].

[2] http://ec.europa.eu/environment/water/blueprint/pdf/EU_level_instruments_on_water-2nd-IA_support-study_AMEC.pdf, p.10

3.4 POSSIBLE SOURCES AND USES FOR RECLAIMED WATER

Water can be reused in many diverse ways and for different purposes. As it is visible in Figure 2, most common water reuse uses concern agricultural, industrial and landscape irrigation, recreational activities, environmental enhancement, groundwater recharge, indirect potable use and non-potable urban uses.

Figure 2 - Status of Water Reuse in Europe (source: GWI/PUB Water Reuse Inventory, 2009)



<u>**Agricultural irrigation:**</u> In this framework, two principle sources can be reused.

- Reclaimed water retrieved from industrial sites
- Municipal treated effluent. This can either be reclaimed directly or indirectly. In the first case reclamation is implemented through a piped non-potable supply from a local wastewater treatment facility. In the second case, reclamation is undertaken by abstracting water from a river rich in effluent from a wastewater treatment works.

Industrial use: Industrial systems can have access to water for reuse via three main ways:

- Cascade water through increasingly low grade requirements but then disposition of the water (trade effluent into a sewer or with a discharge permit to discharge back into the environment) at the end of the concluding stage;
- Reclamation of industrial water, treatment to an appropriate standard, and then recirculation through the industrial process. This procedure is called Water Symbiosis. In most cases, this is managed within the limitations of an individual building but it is possible for multiple businesses to collaborate in order to share Water Symbiosis.
- Reclamation of municipal treated effluent from large scale wastewater treatment works, and its diversion to industrial sites to substitute either main supply or a private water abstraction.

Urban irrigation: In dry and semi-dry places urban landscaped zones (gardens and parks etc.) can be regularly irrigated, streets are also cleaned, and dust is being managed with treated wastewater.

Domestic non-potable use: Reused water could eventually solve the issue of overexploiting freshwater for non-potable purposes, such as toilet flushing, car washing, gardening, and supply of fire hydrants. These applications, especially in water stressed areas (e.g. touristic destinations in South Europe) can have a significant positive impact and definitely reduce pressure on the environment. There are numerous diverse kinds of other than freshwater sources that are accessible to individual properties including in-site domestic rainwater harvesting or greywater recycling, or allocating treated waste from a centralized treatment works through a secondary supply network (dual-reticulation system).

Drinking (potable water supply): Reclaimed water can be also used for potable purposes. This is done via different ways such as:

- Indirect Potable Reuse (IPR) via surface water flows: Indirect systems re-introduce treated waste into environmental water body, typically a river before it is re-abstracted.
- Indirect Potable Reuse (IPR) via surface water: This approach retrieves treated effluent from a wastewater treatment works and then either discharges into a river for subsequent re-abstraction, or stores it, typically in a raw water reservoir.
- Indirect Potable Reuse (IPR) through groundwater: In this case treated waste is stored underground. The latter is known as ‘Aquifer Storage and Recovery – ASR, or Artificial Groundwater Recharge. The water is continuously re-abstracted either directly from the

groundwater, or from the surface. In this way there will always be an element of mixing with freshwater.

- Direct Potable Reuse (DPR): In 'Pipe to Pipe', as it is known wastewater is treated to higher levels than at conventional treatment works and then put directly back into supply.
- Unplanned IPR "*de facto" reuse:* This is the default state for various prevailing public water and industrial supply abstraction that are downstream of treated waste discharges.

Environmental conservation: Water bodies are vital for habitats and biodiversity. Water bodies are being considerably affected by water abstractions. Therefore instead of diminishing the water abstractions, alternative water supplies need to be developed and concerning wetlands, more adequate treated waste should be used to enhance water availability, restore natural habitats and recharge aquifers.

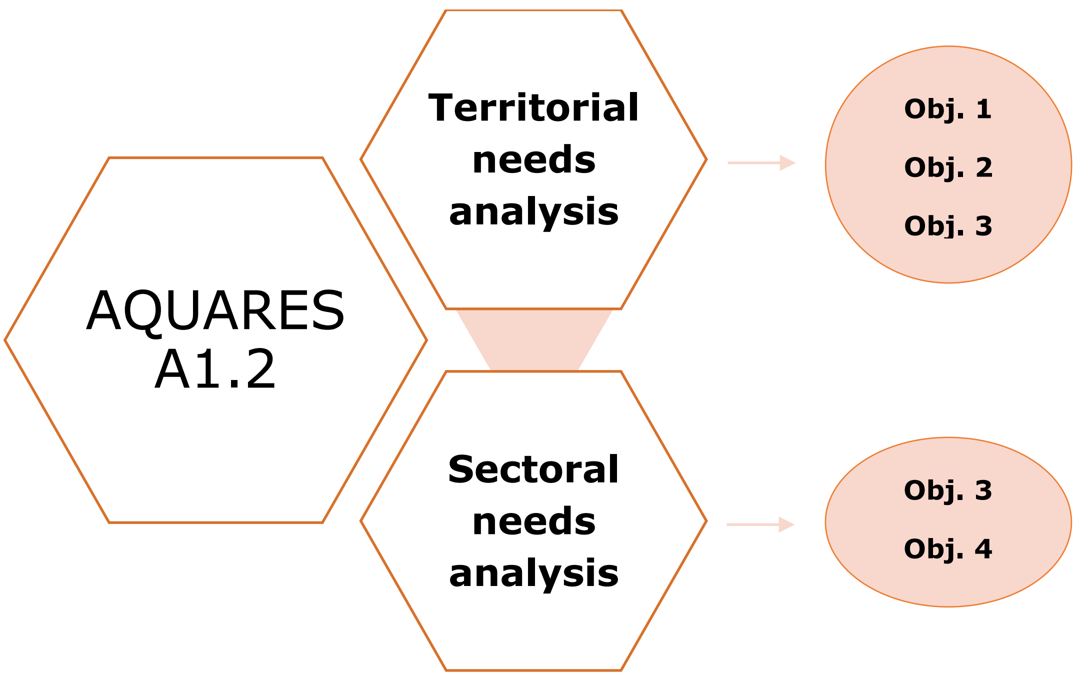
4 METHODOLOGY OVERVIEW

4.1 STUDY OBJECTIVES

This research activity pursued the following objectives:

1. Comprehend the socio-economic context that could best facilitate sustainable water management.
2. Establish the picture of territorial reality (state of play) on water reuse needs for each territory represented in the AQUARES project.
3. Pinpoint drivers and barriers to the implementation of water reuse.
4. Identify priority areas and sectors that have the largest water reuse potential.

To accomplish these study objectives, research was revolved around 2 pillars of analysis, as depicted below.



4.2 RESEARCH DETAILS AND STUDY AREAS

The scope and details of the needs analysis are briefly described as follows:

- **Thematic focus**: Territorial and sectoral needs on water reuse
- **Contributors**: Participating organisations in the AQUARES consortium
- **Data collection method**: Secondary (desk) Research
- **Data collection instrument**: Input documentation forms

Data collection lasted 5 months, from 1 May to 31 September 2019, to secure a critical mass of evidence required for territorial needs analysis and facilitate the appropriate completion of input documentation form from project partners. The General Direction of Water of the Regional Government of Murcia (MURCIA-GDW) was the organisation in charge of coordinating data collection, informing about delays or shortcomings, and guiding partners on how to retrieve relevant territorial evidence. The needs analysis presented in this report was conducted for the geographical areas under the administration (or operation) of partners' organisations, as presented in the following table. The analysis covers 8 out of 9 territories represented in the AQUARES project, as the Greek partner (Ministry of Environment and Energy – Special Secretariat for Water) did not provide any data.

Partner	Study area
Regional Government of Murcia & Euro-Mediterranean Water Institute Foundation	Region of Murcia (Spain)
Łódzkie Region	Łódzkie Region (Poland)
Regional Development Agency of the Pardubice Region	Czech Republic (the entire country)
Energy and Water Agency	Malta (the entire country)
Lombardy Foundation for the Environment	Lombardy Region (Italy)
Water Board of Oldenburg and East Frisia	Lower Saxony (Germany)
Baltic Coasts	Latvia (the entire country)
Municipality of Trebnje	Municipality of Trebnje (Slovenia)

4.3 NEEDS ANALYSIS AREAS

4.3.1 TERRITORIAL NEEDS ANALYSIS AREAS ON WATER REUSE

The first pillar of the needs analysis on water reuse was focused on water demand, water supply, wastewater services, and investment and funding to establish the water consumption profile of AQUARES territories.

1. Water demand. The first needs analysis area aimed to estimate the demand for water resources in partnership territories. Water demand can be defined as the total amount of water required to meet water consumption needs at a given spatial and temporal scale. Several factors may affect water demand including but not limited to population growth and density, intensity of industrial and commercial activities, economic status of consumers, climate and geospatial conditions, quality of water, and water prices. A way to estimate water demand is to measure the water consumed in previous years (as a proxy), and the volume of water abstraction per use/activity. The following variables were considered:

- Population served
- Water consumption rate
- Breakdown of water consumption
- Variations

2. Water supply. The water needed to satisfy water demand can be retrieved from different sources such as rivers, lakes, reservoirs and groundwater. Natural water resources are the most common sources used to meet community and industry water supply needs. Still, freshwater is a finite resource and as the demand for water mounts, the pressures on natural water resources intensify, creating in most cases water scarcity issues with very serious environmental, economic and social implications. This needs analysis area aimed to identify water availability in AQUARES regions. Water availability refers to the quantity of water that can be used for human purposes (both industrial and domestic) without significant harm to the natural environment and human health, as derived from the hydrologic capacity of available water sources at a given spatial and temporal scale. This implies that water supply varies from year to year as availability is subject to various factors such as water sources' volume and flow, climatologic conditions, pollution of water bodies and aquifers contamination, and treatment facilities' capacity to withdraw, process and distribute the water. This needs area also investigated the extent and forms of water reuse that take place in partnership regions. The following variables were considered:

- Regional water availability
- Water sources
- Water reuse

3. Wastewater services: This needs analysis area seeks to identify AQUARES regions' capacity in treating municipal and urban water effluents, mostly by identifying the share of population connected to at least secondary (biological) wastewater treatment and assessing the possibilities of currently operating network of Water Treatment Plants (WTPs) and WasteWater Treatment Plants (WWTPs). Water treatment refers to the process of improving the quality of water collected from surface or underground water resources, by removing organic and inorganic particulate matters to make it suitable for drinking and other domestic uses. Wastewater treatment is the process of converting domestic sewage and (pre-treated) industrial wastewater into effluents (free from polluting load) that can be returned to the water cycle (for instance by ending in aquatic or marine ecosystems) with no or minimum adverse impact on the natural environment or directly reused for other purposes (water reclamation). This needs analysis area also aimed to gather evidence on the (investment, operational/maintenance) costs of wastewater treatment for water reuse, and common application uses of reclaimed water (e.g. cleaning, cooling, agricultural irrigation). Moving from water supply, this needs analysis area explored the volume of wastewater reclaimed in partnership territories and how this amount is distributed to different uses and activities. The following variables were considered:

- Population connected to secondary wastewater treatment
- Wastewater treatment facilities and cost appraisal
- Volume of water reclamation
- Reclaimed water by sector/activity
- Uses of reclaimed water

4. Investment and funding: This investigation area attempted to identify the total amount of money invested in water reuse programs and wastewater infrastructures in AQUARES territories, including the identification of the different types of finance and resourcing options that can be pursued to support water reuse projects and interventions at regional level. It is reasonable that the more a water reuse programme will benefit key economic sectors, the more opportunities and more easily to attract private funds, and more an intervention provides environmental and social benefits, the better the chances to attract more public support and portion from the regional or national budget. Possible funding sources for water reuse investments may be Regional Operation Programmes (ROPs), Special Development

Programmes, European Regional Development Fund, EU Bodies and Programmes (e.g. European Bank for Reconstruction and Development, European Investment Bank, Horizon 2020, InnovFin, LIFE+), PPPs and direct private investments. For instance, Horizon 2020 includes a funding priority for climate action, environment, resource efficiency and raw material, which can be relevant for research and infrastructure development in the water reuse field. The following variables were considered:

- Annual budget for water reuse interventions and wastewater infrastructures
- Additional funding sources for water reuse

4.3.2 SECTORAL NEEDS ANALYSIS AREAS ON WATER REUSE

The second pillar of the analysis focused on AQUARES territories' sectoral needs concerning the implementation of water reuse. The purpose was twofold, first to identify the main drivers of water demand in partnership territories, and second to reveal the potential for water reuse in key industries and use areas. The focus was on industries considered to be particularly intensive in terms of water consumption and wastewater generation, and are characterised by intensive economic activity and substantial environmental footprint. These include but not limited to agriculture, industry (incl. manufacturing), tourism and public uses.

The **primary (agriculture) sector** is the largest consumer of water resources worldwide. According to the European Environment Agency (EEA)[3], agriculture irrigation accounts for 44% of the total water used in Europe, with the Southern countries to demonstrate the largest percentages. In addition, agriculture is considered a major water polluter. Agricultural fertiliser run-off, pesticide use and livestock effluents all contribute to the pollution of waterways and groundwater aquifers. Agriculture is also a mass wastewater producer. The wastewater generated from agricultural activities is primarily the excess water that runs off the field at the low end of furrows, border strips, basins, and flooded areas during surface irrigation. Another source of agricultural wastewater is the effluent from plants processing crops harvested from the field and those preparing processed food. Agriculture wastewater, however, contains high concentration of organic matters and nutrients, which after

[3] https://www.eea.europa.eu/archived/archived-content-water-topic/water-resources/water-use-by-sectors

appropriate treatment can be utilised for cultivation of crops, having beneficial effects for both the environment and farmers.

The **secondary sector** also accounts for a significant share in the total water consumption in the EU. Approximately 40% of the total water abstraction is used in industry (e.g. manufacturing, food processing, construction, and mining) and for cooling in power plants. Central European and the Nordic countries use the largest percentages of abstracted water for industrial processes. The secondary sector is also considered one of the most important sources of water pollution, as the wastewater generated in industrial activities is mostly discharged into lakes, rivers, and coastal and maritime areas, and is largely responsible for serious environmental damages such as natural habitat destruction, biodiversity loss, soil contamination and deteriorating water quality. As the secondary sector encompasses different industry segments, there are different types of industrial wastewater and pollutants with diverse chemical and physical characteristics.

Tourism (incl. recreation) is a water intensive industry. The EEA (2009) estimates that a tourist consumes 3 or 4 times more water (direct water use) than a domestic resident; domestic consumption ranges between 100-200 litres per day. This amount is even larger should we take into account the indirect usage of water resources in tourism facilities, such as landscaping irrigation, daily cleaning and laundry, intensive food preparation and recreational activities (e.g. spa, water sports, golf, green areas). In addition, tourism is expected to put increased pressure on freshwater supplies the near feature, especially in coastal areas and islands, as many of which see a massive influx of visitors during summer months, and already face water shortages. In tourism destinations with outdated or limited sewage network, and lack of biological wastewater treatment processes, it is common for tourism enterprises to discharge their wastes into coastal areas and marine ecosystems.

Public water consumption (also referred as municipal and urban uses) account for approximately 15% of the total water consumption in the EU; while this percentage is even higher in Central and Northern countries. The average per capita water demand for public applications ranges from 180-280 litres per day. Public water consumption usually refers to the following municipal uses: landscaping irrigation (incl. aesthetic impoundments), street cleaning, fire hydrants supply, groundwater and aquifer recharge, and augmentation of surface water resources. These will be the ones to be examined in the present study and for which project partners need to search for relevant data and figures. The amount of wastewater effluents generated from public and domestic uses is non-negligible while municipal wastewater effluents are major contributors to a variety of water pollution problems, frequently witnessed in urban centres and rural communities, especially in cases that only a small percentage of waste water receiving tertiary and biological treatment. Fortunately, the proportion of the population in Europe connected to waste water treatment plants has increased significantly the last decade, exceeding 80%-85%. According to Eurostat[4], the highest connection rates in the EU-28 have been recorded in the United Kingdom (100%), the Netherlands (99.4%), Malta (98.6%), Luxembourg (98.2%), Spain (96.9%) and Germany (96.2%).

The criteria used for assessing water reuse potential in the aforementioned industries and fields were:

- **Water volume**: This criterion refers to the quantity of water consumed by the sector to cover its water consumption needs. It was estimated on an annual basis and serves as a proxy for water demand.
- **Wastewater generation**: This criterion refers to the amount of wastewater effluents generated in sectoral activities. It allows to identify the extent to which the need for water can be covered by reclaimed wastewater, generated within and across own production cycle.
- **Water deficit**: This criterion refers to the portion of sectoral water demand that cannot be satisfied by available water supplies at a given temporal and spatial scale. It was used as a proxy for sectoral vulnerability to water scarcity.
- **Economic output/value**: This criterion refers to the gross value produced by the sectors under examination, and their forecasted growth rate. It helps to identify sectors' contribution/importance to regional economy and employment, and receive insights into potential increasing sectoral needs for water resources as a result of expanded economic activity.
- **Operation of wastewater treatment plants, water prices & minimum treatment requirements.** This refers to the existence and operational status of wastewater treatment plants that supply key industries with reclaimed water at regional level. It focused on the average prices of freshwater and reclaimed water offered in partnership territories, discussing also the minimum treatment requirements (as set out in national water-related regulations) that urban and industrial wastewater generated should go through to be suitable for reuse in other applications.

[4] https://ec.europa.eu/eurostat/statistics-explained/index.php/Water_statistics#Water_uses

- **Water pollution**: This criterion refers to the different types of water pollution caused by operations in water intensive industries. It allows to evaluate the magnitude (severity) of environmental damage as well as the capability of the environment to return to a capacity or condition equivalent to the baseline after impact ceases.

4.4 DATA COLLECTION

Territorial and sectoral evidence was collected with the contribution of all AQUARES partners (with the exception of the Greek partner) through desk research. Desk research involves the collection, sorting and synthesis of relevant information and data from previously conducted and documented research work. This approach was preferred so that partners can build on existing experience and available practices, and not duplicate research efforts every time they implement initiatives and measures targeted at sustainable water management. Desk research also bears the advantage of providing perspectives based on extensive and already validated evidence and data, which partners can filter and use only the parts the current research is targeting. The methodology delivered a structured input documentation form to facilitate the documentation of relevant evidence and information by partners and ensure a comparable presentation of needs analysis results. The form was common for all project partners and was intended to and guarantee that all identified practices would be reported in a consistent and clearly structured manner.

The methodology also foresaw the implementation of a survey with economic operators from partnership territories in an attempt to capture private sector's perceptions and views on water reuse related issues. This research activity would assist to evaluate the surrounding macro-environment affecting the adoption and proliferation of water reuse solutions in AQUARES territories and determine whether partners' regions are adequately prepared to implement water reuse programs. The target was to collect a critical mass of questionnaires from each partnership territory (20-30 questionnaires) that would allow to obtain a reliable picture of territorial reality and hence complement the profile of each study area. The number of questionnaires collected by the partnership, however, was particularly low (13 questionnaires) and non-representative (data from 4 countries); a development that did not allow to proceed with an aggregate analysis for the entire partnership (at the minimum level), let alone a case by case analysis on water reuse needs for each AQUARES partnership territory as it was the initial plan.

5 NEEDS ANALYSIS RESULTS

5.1 MURCIA REGION (ES)

STATE OF PLAY

Murcia Region, with a total area of 11,313 km^2 and resident population of 1,478,509 inhabitants (2018), is an autonomous community located in south-eastern Spain between Andalusia and Valencia, at the Mediterranean coast. The region confronts severe water supply conditions, which can be mostly attributed to its particular geomorphology, the variant and low precipitation levels, and the increased demand for water for agricultural and tourism uses. Large seasonal variations (in the volume and fluctuation of water demand) are also evident in Murcia. They are caused by the significant influx of tourists during the summer months when the tourist period reaches its peak and the need to preserve crops during spring and summer due to high evapotranspiration rates; the loss of water from the soil both by evaporation from the soil surface and by transpiration from the leaves of the plants growing on it. Murcia is characterised also by one of the lowest rainfall intensity rates in Europe; the average annual precipitation is 293 mm while the variation between the driest (June to August) and wettest months (October, April, December) is 46mm.

In Murcia, the average daily consumption of water per capita is 375 litres while the total annual consumption exceeds 2 billion m^3. Agriculture is the largest water consumer; water demand for irrigation reaches 1.66 billion m^3 per year; a number representing approximately 81% of the total regional water demand. Residential and municipal uses (e.g. landscaping irrigation, aesthetic impoundments, street cleaning and fire hydrants) account for 15.3% (277 million m^3), followed by industrial uses with an average annual demand of 35 million m^3. Water losses in the supply and distribution systems account for almost 2% of the total water usage, posing a significant threat to region’s water sufficiency and sustainability.

Water resources availability in Murcia is primarily dependent on surface freshwater and groundwater. Surface freshwater resources provide 640 million m^3 annually, accounting for 39.6% of the total water supply, followed by underground freshwater resources with 220 million m^3 (13.6%). The water used for irrigation mainly comes from the Segura River. Seawater desalination, despite a high cost and energy intensive option, is widely used to increase water supply and eliminate water scarcity problems, particularly during the summer season. The coverage of domestic demand with desalination reaches 6.3%. To accommodate its needs (the deficit created by the gap between water availability in the region and aggregate demand), Murcia imports over 540 million of cubic water from neighbouring regions every year. Murcia is widely acknowledged as a world leader in sustainable water management, with treated wastewater accounting for 7% of the total water supply.

In addition, Murcia exhibits one of the largest percentages of population connected to at least secondary (biological) wastewater treatment. Its connection rate is 99.3%, higher than the national average (96.9%) and significantly above the European average (70%-80%). The region has 97 wastewater treatment plans (WWTPs); most of which equipped with advanced tertiary treatment systems that remove totally inorganic compounds, bacteria, viruses and parasites in treated wastewater flows (following secondary, biological treatment), producing high quality water that can be reused in agriculture and industrial uses. Their combined capacity (average supply of incoming wastewater) approaches 550,000 m^3 per day, the total volume of treated water exceeds 140 hm^3 and the average operation cost is estimated at 0.54 euros per m^3.

In the area of Campo de Cartagena, most of the treated wastewater is used for the irrigation of agricultural crops and the pasture for milking animals. The volume of reclaimed water consumed in the primary sector exceeds 100 hm^3 per year. Lower volumes are used a) within the tourism industry (irrigation of sporting facilities, aesthetic impoundments, vehicle washing) to address the high demand during the summer months, b) for public uses such as the irrigation of green areas and street cleaning, and c) for environmental purposes such as the regeneration of waterways and aquifers.

The regional government, committed to sustainable water management, allocates a significant share of its budget annually (approx. 50 million euros) to maintain/upgrade water infrastructures, and guarantee sufficient water availability in the region. For 2019, the regional government has vowed to increase its investments in the water field with additional 50 million euros, primarily directed at expanding the capacity (daily flow rates) of smaller WWTPs and supporting the adoption of advanced tertiary treatment methods. Particular emphasis is placed on enhancing region's water reuse capacity as a means to address the prevailing deficit and comply with the new EU water reuse regulation. In this context, in 2015, the regional government awarded a 20 million euro contract to 4 companies to deploy a 27.5 kilometre pipeline with a diameter of 1,200 millimetres though which water from the desalination plant in Aguilas will be pumped to the Guadalentin valley to support agricultural activities, acting mostly as a backup water supply during stressed conditions. The main sources of funding that can be used to support water reuse projects in the territory are the regional budget or/and government funds, public utilities funds, and EU funding programmes (European Energy Efficiency Fund, Horizon

2020). For the time being, the tariffs imposed in unitary rates for water supply and for using desalinated water in farming and tourism activities, represent the main source of income for funding water projects in Murcia.

WATER REUSE POTENTIAL

The most suitable potential use of reclaimed water in Murcia Region is agricultural irrigation, as the primary sector is the largest water consumer in Murcia region, and mostly affected by severe water supply conditions. The percentage contribution of agriculture in the total water consumption exceeds 80%. Water demand for irrigation purposes and pastry reaches 1.66 billion m^3 annually. This volume, however, cannot be completely covered by region's available freshwater resources. Instead, agriculture has a mean annual water deficit of 20% whereas a considerable share of water demand is satisfied through water imported by neighbouring regions, and reclaimed or/and desalinated water. In fact, 98 percent of water consumed in agriculture is reused, compared to 5% internationally and 15% in Spain as a whole.

Further to this, agriculture is a sector particularly vulnerable to water scarcity given the low precipitation rates prevailing in the region. Most of the waste water treatment plants (WTTP) operating in the region provides advanced tertiary wastewater treatment (rotating drum screens), biological nutrient removal, and disinfection (chlorination) that make the water reclaimed suitable for irrigation use. In addition, the location of most WWTPs is relatively close to agricultural areas facilitating the distribution of reclaimed water for irrigation purposes.

The region's climatological and geomorphological conditions (proximity to Segura River) favour crop development. Murcia is a major producer of fruits, vegetables and flowers for the rest of Spain and Europe. Agriculture has a significant contribution to the regional economy, providing over 1.6 billion euros annually and representing 5.26% of the total GDP. What is more, the sector is anticipated to grow by 1% next year. An expanding reuse of the effluents for irrigation purposes may result in enhanced economic performance/results, whilst enhancing region's profile as a key exporter of agricultural products worldwide. The price of freshwater supply for agricultural irrigation is 0.20 €/m^3, compared to only 0.07 €/m^3 for reclaimed water. The low price for reclaimed water provides a strong stimuli for farmers to use in their processes; however, it questions the financial viability of investments in water reuse infrastructures. Notably, the price for desalinated water is higher than the freshwater supply, and many farmers appear unwilling to pay; still it acts as a safeguard in cases of prolonged drought and water deficits.

The fragmented application of efficient water management techniques in agriculture irrigation has led to significant wastewater discharges in wetlands, such as the Mar Menor, thereby reducing the quality of water, accumulating organic waste, and causing eutrophication. Agricultural nitrates, derived from inefficient use of water in agriculture, have caused algal blooms that have killed 85% of marine grass deposits in the Mar Menor. In addition, due to the fragmentation of the application of advanced irrigation systems in the Cartagena plain, where a large part of irrigated land does not use advanced irrigation systems, Murcia consumes significantly more water than needed. To sum up, the adverse impacts of primary sector on the natural environment of the Murcia Region comprise surface water pollution, groundwater contamination and nutrients pollution while the magnitude of pollution in water resources is considered to be moderate, with effects that extend beyond the provincial surroundings.

In addition to the traditional water demand for crops, there is currently also an increasing demand for water for the booming tourist developments. Tourism represents a key driver of regional economy, accounting for 12.5% of the annual output. While tourism accounts for only a small share of total water consumption (less than 2%), its strong seasonality puts additional pressure on Murcia’s depleted resource base. Notably, it is estimated that a Spanish city dweller uses some 250 litres a day, while the average tourist uses 440 litres. With an allowance for watering gardens and golf courses and filling swimming pools, this can rise to some 880 litres per day for visitors in luxury accommodation. The above indicates that the industry faces a significant water deficit (especially during summer peak seasons) and is therefore subject to water scarcity issues. Moreover, though most of WTTPs in the region apply advanced tertiary treatment methods, which is the minimum treatment level foreseen by the national law (Reuse of Reclaimed Water: Quality Criteria) for using reclaimed water in tourism, only one plant (Molina de Segura) has been commissioned to supply tourism facilities with reclaimed water. Finally, the price of water supply for the tourism industry 1.80 €/m^3, and the damages caused by unsustainable activity to the natural environment are characterised as low and non-significant.

5.2 LOMBARDY REGION (IT)

STATE OF PLAY

Lombardy, with a surface of 23,861 km^2, is the fourth-largest region of Italy. It lies in the north of the country, sharing a border with Switzerland and its population exceeds 10,000,000 inhabitants. Lombardy is one of the richest regions in Italy and the EU, contributing more than one fifth of the country’s income. The region features several water streams, rivers (with a total length of about

6000km) and lakes of different sizes, alongside with an extensive network of artificial canals (about 40,000 km long). Underground resources adds up to the surfacing ones and they both contribute to covering the regional water demand. Lombardy, as one of the 4 Motors of Europe, makes extensive use of its natural water resources to support different economic processes/activities across the urban, industrial and agricultural sectors, and despite not facing severe water supply conditions, this puts pressure on its attractive wetlands.

Lombardy has a considerable amount of rainfall during the year; precipitation is abundant with an average of 877 mm to 1044 mm annually. Lombardy, however, is not characterised by large variations in water consumption.

In Lombardy, the average daily consumption of water per capita is 272 litres and the total water consumption amounts to 152 billion m^3. The energy sector accounts for the largest share (i.e. 75.6%, 115.6 billion m^3), followed by the primary sector. In 2018, water demand for irrigation purposes exceeded 31 billion m^3 (20.4%). Industrial and domestic/residential uses account for around 4% of the total water abstraction. Remarkably, water losses in the supply and distribution systems together with untreated wastewater are particularly high, posing a serious concern and area for improvement in Lombardy's water management processes.

Lombardy's water needs are completely covered by groundwater and freshwater resources. Underground freshwater resources provide 92% of the total water supply, followed by surface freshwater resources with 8%. Unfortunately, no data are available on the current volume of treated wastewater being reused in Lombardy.

Furthermore, Lombardy has one of the largest connection rates with at least secondary (biological) wastewater treatment. The share of population connected to wastewater treatment systems with at least secondary treatment is 95%, significantly higher than the European average (70%-80%).

In Lombardy, there are 1,569 wastewater treatment plants. Approximately 73.5% of WWTPs have a capacity of less than 2000 Population Equivalent (PE) or unit per capita loading, and serve the needs of small communities in rural Lombardy. Most small wastewater treatment facilities (up to 2000 PE) apply no more than primary level of treatment. This usually involves low technology or basic treatment processes, mostly focused on the removal of settle able organic and inorganic solids by sedimentation, and the removal of materials that will float (scum) by skimming. The WWTPs with capacity over 2000 population equivalent are usually fitted with biological and advanced tertiary treatment systems so as to achieve complete removal of inorganic compounds and nutrients, as well as advanced sludge treatment. For instance, the Nosedo wastewater treatment plant is the oldest and largest sewage processing site in Milan (Lombardy's capital city), with a maximum capacity of 1,250,000 population served and flow rates up to 432,000 m^3 per day. In Italy, the average cost of reclaimed water (as calculated by ISPRA) ranges from 0.0083 to 0.48 €/m^3 while the cost of abstracting water from rivers and groundwater bodies is estimated at 0.015-0.2 €/m^3. It is worth mentioning that the high cost of reclaimed water (as compared to the price of freshwater supply) is cited as one of the main barriers to water reuse in Lombardy.

WATER REUSE POTENTIAL

The most suitable potential use of reclaimed water in Lombardy is for the production of hydropower. The energy sector accounts for 75.6% of all water consumption, compared to 20.4% for agricultural irrigation, 2.9% for industry and 1.1% for domestic and public use. The annual volume of potentially reusable treated wastewater from the energy sector can reach up to 115 billion m^3. Italy is among the top five EU countries in terms of hydropower share in the total electricity mix, and Lombardy generates almost one third of the country's hydroelectric energy. What is more, about 40 % of Italian companies operating in renewable fields are located in Lombardy. In addition, the energy sector accounts for a significant share of the regional GDP and is expected to develop even further given country's commitment (incl. corresponding investments) to increase the share of renewables and clean energy forms in the energy mix, in accordance with EU targets and rules. To conclude, the share of the power generation sector in the total water consumption, combined with its substantial growth potential and the high price of freshwater resources 0.004 euros/m^3 showcase the untapped wastewater reuse potential in this field.

The economy of Lombardy is characterised by a wide variety of industries ranging from traditional sectors, such as agriculture and livestock to heavy and light industries (e.g. mechanical, electronics, metallurgy, textiles) whereas there is a growing demand for water resources. To begin with, agriculture, a sector, which contributes over 40 billion euros every year to the regional economy, consumes over 31 billion m^3 of water annually to cover the irrigation needs of 700,000 ha of surface area with crops. The largest share of this volume comes from surface water resources (89%) while the rest from underground sources (e.g. springs), rainwater and treated wastewater. The agriculture is therefore strongly reliant on natural resources while only a small share of precipitations (18% of the total rainwater is collected and used in productive uses) and reclaimed water is utilised for irrigation purposes. On the contrary, the low price of freshwater supply for irrigation 0.00002 euros/m^3 alongside with the limited number of WWTPs connected with agricultural facilities are the most prominent inhibitors to water reuse. Further to this, water inefficient agricultural processes and the subsequent discharge of wastewater with nitrates have caused significant degradation of water resources in south and central Lombardy, according to the Lombardy Regional Agency for Agricultural and Forest Services. Further to the aforementioned potential uses, treated effluents can be also used for groundwater aquifers discharge (filtration – no abstraction for potable reuse) and the supply of industrial water uses (once-through, non-contact cooling water), as long as their quality characteristics meet the effluent quality standards of the applicable legislation on water reuse.

5.3 MALTA

STATE OF PLAY

Malta is an island country located in the central Mediterranean Sea between Sicily and the North African coast. Its surface area is 316 km^2 and has a population of 475,000 permanent inhabitants. Malta is one of the most water scarce country in Europe with less than 60 m^3 per capita of naturally available freshwater annually. On the island, there are no surface water resources that can be exploited for economic or/and residential purposes, and groundwater resources are subject to increasing competition. The quality of naturally occurring freshwater is deteriorating and is considered inadequate to meet the country’s potable water demand due to nitrate pollution and over extraction. According to the European Environment Agency (EEA), the average consumption of tap water in Malta is 50 water per person while the average consumption in the EU stands at 120 litres every day. Historically, the Maltese people have faced sever water supply conditions albeit in recent years the country has not experienced prolonged periods of water shortages. Rainfall in Malta is not abundant. The country has an average of 90 precipitation days per year while the annual precipitation slightly exceeds 500 mm, ranging from 0.3 mm in July to 110 mm in December. The volume and fluctuations in water demand are slightly higher during spring and summer (versus the autumn and winter) as tourism adds substantially to domestic water demand.

In Malta, the average water consumption is 110-115 litres per person per day and the total annual water consumption amounts to 30 million m^3. Domestic and residential uses account for the largest share (55%, 18.3 million m^3) of water consumption, followed by industrial and commercial uses with a percentage of 27% (9 million m^3). Remarkably, water losses in the supply and distribution systems alongside with untreated wastewater amount to 6 million m^3 annually, representing 18% of the total water usage.

In Malta, the largest proportion of water resources (over 64%, 21.4 million m^3) is sourced from desalination plants, which turn seawater into drinking water; also suitable for other domestic and industrial uses. Underground freshwater resources provides additional 12 million m^3 of potable water, and represent the remaining share (i.e. 36%) in Malta's water supply mix. The main source of groundwater is pumped from private boreholes and conveyed to fields via pipe networks and water tankers. About 80 percent of Malta's groundwater resources are abstracted from sea-level fractured-limestone aquifers. In recent years, however, the excessive groundwater abstraction has affected the sustainability and viability of aquifer systems, resulting in substantial water quality deterioration.

The share of population connected to wastewater treatment systems with at least secondary treatment reaches 100%. Malta has 3 Waste Water Treatment Plants (WWTPs), fitted with advanced secondary treatment systems and a combined capacity of incoming wastewater (flow rates) up to 76,000 m^3/day. The WWTP at Ta' Barkat, Xghajra is the largest treatment plant in the country with flow rates up to 60,000 m^3 per day and operation costs 0.59 euros per m^3. Its construction was completed in 2018 and the total investment cost exceeded 67 million euros.

Most of the treated wastewater is used for the irrigation of agricultural crops. The volume of reclaimed water consumed in the primary sector exceeds 600,000 m^3 per year (2018) while this volume is expected to reach 7 million m^3 once the commissioning of new 3 polishing plants will be completed under the "New Water" initiative. Lower volumes of reclaimed wastewater are used for public uses such as the irrigation of green areas and street cleaning, as processing water in industrial activities, and for aquifer recharge. Notably, the national law on water reuse forbids the use of reclaimed water for tourism and recreational activities.

Malta reserves a significant share of its budget to promote sustainable water management, and safeguard water availability in the country. In particular, the state allocates on average 27 million euros per year to support day-to-day functioning and operation of wastewater treatment facilities; further to this, 7.6 million euros are directed to capital investments such as the construction of new facilities/plants, the upgrading of treatment processes and the maintenance of the pumping network. Other sources of funding that can be used to support water reuse projects in the country are public utilities funds, public private partnerships and EU funding programmes. Most WWTPs have been developed with the support of the EU Cohesion and the Rural Development Funds. For instance, the new urban new wastewater treatment plant at Ta' Barkat on Malta's east coast (Xghajra) was 85% funded by the European Regional Development Fund. The station, connected with the existing sewerage system, can treat volumes of wastewater equivalent to those normally produced by a population of 500,000 inhabitants, supplying farmers with high quality water for irrigation. Finally, Malta operates a rising-block water-tariff system, where successive blocks of water are sold at a higher price. The revenues generated by tariffs in unitary rates are used to cover the operational costs for the reclamation of wastewater.

WATER REUSE POTENTIAL

In Malta, industrial activity is limited compared to agriculture and tourism. Agriculture is the largest water consumer with over 18 million m^3 of water each year to be used for the irrigation of crops. Agriculture is also a sector particularly vulnerable to water scarcity considering the low precipitation rates prevailing on the island. Agriculture is still a key driver for regional growth, contributing over 110 million euros to regional economy every year. The WWTPs, which serve the island, are connected with 3 special reclamation units (polishing plants) that employ a 4 stage process that includes biological nutrient removal and disinfection, ultrafiltration, reverse osmosis and advanced oxidation, to produce high quality water in compliance with the standards and requirements defined by the national law for agricultural use of reclaimed water. Treated sewage from the wastewater treatment plants was previously discharged to the sea. This is now being passed through tertiary treatment polishing plants that ensure high security of the finished product. In addition, the proximity of polishing plants to cultivated areas facilitates the distribution of potentially reusable wastewater for irrigation. In Malta, the annual volume of potentially reusable treated wastewater can reach up to 26 million m^3 per year; 18 million m^3 of wastewater effluents from domestic uses and 8 million m^3 from industrial activities. As a result, irrigation water needs can be completely covered through the reclamation of wastewater effluents while the surplus could be used for aquifer recharge to control overexploitation and saltwater intrusion that adversely affect the quality of groundwater used for domestic and industrial purposes. Further to the water demand for crops, there is also a constantly growing need for water within the tourism industry especially during the summer peak period. Tourism is traditionally a water intensive industry. The average volume of water consumed per tourist during summer amounts up to 312 litres per day when the average water consumption in the country (all year round) is 110-115 litres per capita. Notwithstanding this, at the time being, the national law on water reuse does not permit the use of reclaimed water for tourism and recreational activities. Malta, therefore, will need to introduce new water quality standards, harmonised with EU practices, to support the wider utilisation of reclaimed water in industries facing severe water supply conditions, in an attempt to alleviate pressures on groundwater resources and secure reliability and security of water supply in the country.

5.4 TREBNJE (SI)

STATE OF PLAY

The Municipality of Trebnje lies on the Temenica River in the traditional region of Lower Carniola, Southeast Slovenia. The municipality covers an area of 195 square kilometres and sits at 288.5 metres above the sea level. Trebnje has a population of 14,641 people living in 221 settlements and its population density is 75 inhabitants per square kilometre. There are sufficient quantities of water (and surrounding areas) in the area and most water resources are in a good ecological state/potential. In Slovenia, surface and underground water resources are characterised by a good chemical quality and a high level of reliability. The concentration of nitrates is slightly above the natural background, estimated at 1 mg N/L (4.4 mg NO3/L).

The municipality has a significant amount of rainfall during the year even for the driest months. About 1000 mm - 1100 mm of precipitation falls annually. No major seasonal variations in water usage have been observed in the municipality although the demand for water is slightly higher during the summer mostly because of the low precipitation levels and higher temperatures, as well as the increased number of visitors.

In Trebnje, the average daily consumption of water is 170 litres per capita; slightly lower than the national average (200 litres per capita). The total annual consumption is over 1,270,000 m^3. Domestic and residential uses account for the largest portion of the local water consumption (60.7%, 768,647 m^3). Remarkably, in Trebnje, there are high levels of water losses due to poor management and leakages in the public supply and distribution system (water losses is a nation-wide issue). Over 400,000 m^3 of water are gone astray every year; a volume that represents 33.3% of the local water production. Industrial and commercial activities consume over 60,000 m^3 annually (4.9%), while public uses account only for 1.1% of the total water consumption. Drinking water is supplied to local population through a central supply system and distribution network of underground pipelines of 8,438.84 m length.

Water resources availability in the municipality is largely dependent on groundwater. Underground water streams constitute the predominant drinking water source for the entire country. For Trebnje, freshwater is primarily sourced from the sand and gravel aquifers of the Temenica River Valley. Overall, groundwater represents 100% of the total water supply. Very rarely, and in cases of low rainfall, the region imports water from neighbouring regions with surpluses in water availability.

The Municipality of Trebnje is in dire need to improve the treatment of wastewater from urban agglomerations, including from industrial and agricultural activities. The share of population connected to at least secondary (biological) wastewater treatment stands at 44.2%; significantly below the national average (72%) and in a long distance from the EU target (97%). The reason is that in several (rural) areas across the country there is not an established public sewerage system.

There is only a central waste water treatment plant that serves the city of Trebnje. It is a single-stage mechanical and (tertiary) treatment plant intended for the removal of undissolved substances and carbon compounds from wastewater, and nitrification. The Trebnje WWTP has a designed capacity of 1432m^3 per day and is able to handle all waste water flowing into public sewers in the municipality. In 2013, the municipality constructed a new wastewater treatment plant alongside with a sewage pipeline connection to the sewage network of the Roma settlement “Hudeje”. The plant has the capacity to treat volumes of wastewater equivalent to those normally produced by a population of 600 people.

While the legislation promoting efficient management of wastewater including water reuse is already in force, Trebnje has not yet managed to integrate water recycling and reuse (as a possible alternative water source for different uses) into local water planning and management, as dictated by the EU Water Framework Directive. According to national statistics, the wastewater collected and treated by sewerage networks in the country is discharged into surface water bodies and the sea. A low volume of reclaimed water is occasionally used as processing water in industrial processes or for irrigation but no records are currently available.

Finally, the municipality, devoted to promoting sustainable management of wastewater, allocates 300,000 – 400,000 euros every year to maintain and upgrade the public water supply and distribution system, and increase municipality’s wastewater collection and treatment capacity. Further to this, the municipality pursues funding from available EU structural funds. In this context, the works for the replacement of dysfunctional water pipelines in the water distribution network in the Valley of Temenica River (2015) was 80% funded by the European Fund for Regional Development. The total investment reached 700,000 euros.

WATER REUSE POTENTIAL

Treated wastewater can be a reliable alternative water resource for Trebnje. It can have a key role in integrated water resources management, addressing both water demand and supply. At the same time, reclaimed water can aid to foster environmental protection and maintain a good ecological status of rivers/lakes and coastal waterbodies whilst alleviating pressures on underground water resources; the only source of potable water in the region. According to the latest Slovenian Environmental Implementation Review (2019), chemical pollution was found to be the most severe impact of human induced activities on surface water bodies (99%), followed by organic pollution (73%) and nutrient pollution (72%). Nutrient pollution (14%) also represents the most imminent threat for groundwater quality. The increased pollution of water bodies and/or inadequate funds for the exploitation of available resources, render integrated water resources management and water reuse a necessity. Practically, the central WWTP applies tertiary level of treatment and hence operates in compliance with the standards set by the national legislation on urban wastewater treatment. The national regulation allows the use of properly treated wastewater to agricultural, urban, and industrial reuse as well as aquifer recharge; direct and indirect reuse to supplement potable water supply is not considered at the moment. Overall, the most appropriate potential reclaimed water use (apart from environmental enhancement) in Trebnje is crop irrigation. Agriculture, despite declining, is a key economic activity in Slovenia. The value of agricultural production amounted to EUR 1.22 billion in 2016 (2.3% of GDP), and the sector employed approximately 80,000 people, accounting for 7.8% of the total workforce. Further to this, agriculture is a major water consumer. In Trebnje over 153,498 m^3 of water were used for the irrigation of crops in 2018. As the mean annual volume of potentially reusable treated wastewater is about 1,270,000 m^3, the demand for irrigation can be potentially covered completely. Further to this, the surplus could be used to recharge groundwater aquifers in an attempt to control overexploitation and pollution, or alternatively to get discharged into mainland and coastal water bodies in order to enhance the quality of water.

5.5 LATVIA

STATE OF PLAY

Latvia, with a total area of 64,490 square kilometres and resident population of 1,906,000 inhabitants (2019), is one of the 3 Baltic States. Latvia is bordered in the northeast with Estonia, in the east with the Russian Federation, in the southeast with Belarus, and in the south with Lithuania. Latvia became an independent state in 1990. Administratively, the country consists of 5 planning regions and 110 municipalities.

In Latvia, water is relatively abundant. There are more than 12,400 rivers and 2,250 lakes, which provide a volume of renewable surface water resources of over 34,000 million m^3 annually. The major rivers are Daugava, Lielupe, Gauja, Venta, and Salaca. On average, the annual temperature in Latvia is 6°C, varying from -5ºC in January and February to 17°C in July. Latvia is also characterised by a moderate precipitation rate. The average annual precipitation is 667 mm, ranging from 33 mm in February and March to 78 mm in July. Strong seasonal variations in water usage are not particularly visible in the country despite the higher demand for water during summer for the irrigation of warm season crops.

The average water consumption per capita in Latvia is 295 litres per day. In 2018, the total water withdrawal was estimated at 239.2 million m^3, of which 114.6 m^3 (47.9%) for industry and commercial activities and 112.3 million m^3 (46.9%) for residential and public uses. Losses accounted for about 5.2% of the total water usage, i.e. 12.2 million m^3 of water. The water demand was met through available groundwater (45.47%), surface freshwater (40.46%) while 14.07% came from the use of rainwater and treated municipal wastewater. It is worth mentioning that in 1995, the total water consumption in Latvia was 418 million m^3. This enormous decrease in water usage as compared to the previous decades can be mostly attributed firstly to the application of the Act of Water Management Services which has resulted in the reduction of urban wastewater to the half, and secondly to the sluggish industrial activity.

In Latvia, the percentage of population connected to wastewater treatment systems with at least secondary treatment reaches 84% for large urban agglomerations and 70% for small rural communities/settlements. Latvia has an extended sewerage system with over 1,000 wastewater treatment plans, which have a combined designed capacity of 300,561 m^3 per day. Most WWTPs are fitted with advanced tertiary and secondary (biological) systems that allow for the complete removal of nutrients, thus making the treated water suitable for use in different industrial and economic activities. On average, the volume of wastewater treated in Latvia is over 200 million m^3 annually.

In Latvia, the usage of reclaimed water exceeds 21 million m^3 every year. The vast majority (98.7%) is used as processing water in industry or as input in other economic activities. From this share, around 15 million m^3 are utilised for the manufacturing of metals and 3 million m^3 in aquaculture. Less than

1% is used for the irrigation of agricultural crops and pasture for milking animals while public and other domestic uses reserve over 230,000 m^3 of reclaimed water every year.

The country employs a two tier water management and planning system with responsibilities shared by the central government and municipalities. On the one side, the state government is charged with the protection and sustainable development of water resources, the implementation of national water policy and national macro-management of water resources. On the other side, municipalities are responsible for the supervision and management of water use and sewage treatment.

Owing to the abundance of renewable freshwater resources, Latvia is not likely to face extreme water supply conditions at least in the near future. That said, Latvia needs to resolve or mitigate a series of issues/shortcomings towards the efficient and integrated management of water resources. These include:

- The low purchasing power of some local municipalities that undermines the use of centralized water management services, and creates the risk of not ensuring compliance with quality standards of drinking water and wastewater collection and treatment requirements.
- The limited integration of water efficiency objectives into sectoral planning and regulatory documents.
- The lack of a designated regulatory framework for requirements and standards for water services and use (water supply and sewage).
- The insufficient application of environmental standards for uses of water in various economic sectors.
- The extent of hydro morphological modifications due to drainage of agricultural lands.
- The underestimation of cross-border pollution that jeopardises water supply and the aquatic environment in littoral areas and river basins, including the eutrophication risk of inland and marine waters due to national and cross-border pollution.
- Diffuse pollution from agricultural activities that affect the quality of water.

The single multi-fund Operational Programme "Growth and Employment" (OP, 2014-2020), aimed at achieving key national development priorities along with the "Europe 2020" objectives, constitutes the main financial instrument for the development of the water and wastewater sector as well as the protection of water resources in Latvia. The programme foresees the allocation of almost 126 million euros for actions and investments (e.g. upgrading of water distribution networks, extension of sewerage systems, water reuse technologies, mitigating pollution in water bodies) towards the sustainable and efficient management of water resources. Support from the EU and Direct Foreign Investments have also contributed to the development of the sector. For instance, in 2008, the Nordic Environment Finance Corporation (NEFCO) invested 5 million euros to upgrade wastewater treatment plants in the country.

WATER REUSE POTENTIAL

In Latvia, the sectors with high water reuse potential are the food industry, manufacturing and agriculture. These sectors are intensive in terms of water consumption and characterised by high water discharge rates, intensive economic activity and substantial environmental footprint. The use of reclaimed water in these sectors therefore could provide a viable alternative to mitigate pressures on available freshwater resources while the size of the sector can justify investments in water reuse facilities and advanced treatment methods.

To begin with, the food and beverage production facilities consume over 62 million m^3 of water every year, as water is a critical input in plants' processing and production related operations. Indicatively, in order to produce 1kg of meat requires between 5,000 and 20,000 litres of water whereas to produce 1kg of wheat requires between 500 and 4,000 litres of water. In addition, the annual volume of wastewater effluents generated by the industry amounts to 47.8 million m^3; a quantity that could potentially cover 77% of the initial water demand. Further to this, food and beverage is one of the main sectors of Latvian economy, contributing over 1.7 billion euros every year, and representing 3.4% of the national GDP (2018). The sector is also anticipated to grow by 1%-2% the next year. Finally, food processing, besides one of the most water intensive industries in the country, has the highest contribution to the emissions of organic water pollutants; also responsible for nutrients pollution in surface water bodies and underground aquifers.

Manufacturing (excl. food and beverage) is also a major water consumer in Latvia, accounting for 6.5% of total water abstractions; i.e. 15.7 million m^3 per year. The segments consuming the largest volumes of water to support their operations within the manufacturing industry are mining (9.8 million m^3), the manufacture of pharmaceutical products (1.6 million m^3), the manufacture of chemicals (1.26 million m^3), and the manufacture of timber and wood products (1.26 million m^3). The manufacturing industry, primarily focused on wood processing, textiles and machinery, contributes almost 5.5 billion euros to the national economy, accounting for 5.9% of the national GDP. What is more, approximately 20% of the Foreign Direct Investments in the country are directed at manufacturing and the industry has a forecasted annual growth rate of 1%-2%. Finally, manufacturing is a huge source of water contamination. Industrial pollutant releases to water include compounds that contain nutrient and chemicals that can cause eutrophication and oxygen depletion.

The primary sector is also a large consumer of water resources in Latvia with over 21.5 million m^3 to be used each year for irrigation purposes or animal husbandry. Notably and in juxtaposition with other water intensive sectors, agriculture is characterised by low water discharge rate, which renders the application water reverse systems in agriculture quite questionable. Overall, agriculture is the second largest sector (after services) in the Latvian economy and has been one of its main sources of income, employment, and foreign exchange earnings. It accounts for 3.9% of the national GDP, and 7.7% of the total employment. The agricultural area in Latvia, which is the sum of arable land, permanent crops and permanent meadows and pasture, is estimated at 1.9 million ha; almost 30% of the country's total size area. In 2013, the total physical cultivated area was estimated at 1.2 million ha, of which 99.5 percent (1 208 000 ha) consisted of temporary crops and 0.5 percent (6 000 ha) of permanent crops. When it comes to its environmental footprint, agriculture can be regarded as both a cause and victim of water contamination. On the one side, it is a cause because of the discharge of nutrient and chemical pollutants and sediment to surface and/or groundwater, through net loss of soil by poor agricultural practices, and through salinization. On the other side, it is a victim through the consumption of untreated wastewater and low quality water sourced from polluted surface and groundwater that contaminate crops and transmit disease to consumers and farm workers.

5.6 CZECH REPUBLIC

STATE OF PLAY

The Czech Republic (also called and known by its short name, Czechia), is a landlocked country in Central Europe, bordering with Germany to the west, Austria to the south, Slovakia to the east, and Poland to the northeast. The Czech Republic covers an area of 78,866 square kilometres and its population stands at around 10.6 million permanent inhabitants. The country is distinguished by its hilly landscape. The highest altitude (1602 metres above the sea) is on the mountain Snûĺka and the lowest in the valley of the Elbe River (115 metres above the sea level), while the average elevation in the country is 430 metres.

In the Czech Republic, water resources are relatively abundant, as the country is situated in the watershed of 3 seas: the North Sea, the Baltic Sea and the Black Sea. These in turn divide the country into 3 main hydrological catchment areas: the basins of the River Elbe, the River Odra and the River

Morava. Overall, the country's hydrological system comprises approximately 76,000 km of watercourses and the volume of renewable surface water resources exceeds 16.5 billion m^3 per year. From this amount, the half can be considered as exploitable. No major seasonal variations in water consumption have been observed in the country.

Water resources in the Czech Republic are exclusively replenished through precipitation. Generally, the country has a moderate rainfall rate. The average annual precipitation is 668 mm while this volume varies from area to area, depending on its altitude and relief. For instance, the driest area (North West Bohemia) has an average annual total of 450 mm whereas the biggest average is on the ridges of the Jizerské Mountains with 1700 mm.

In the Czech Republic, the average water consumption per person is 90 litres per day; significantly below the EU average (144 litres). Overall, the annual total water abstraction exceeds 1.8 billion m^3. The greatest share of water resources abstracted (45.7%, 840.7 million m^3) are directed to the energy sector for power generation. Around 43% of freshwater resources are used to cover domestic and residential needs through public supply networks. Industrial activities account for 15.78% (290.4 million m^3), followed by agriculture (irrigation) with an average annual water consumption of 43.2 million m^3. Losses are estimated at 97 million m^3 every year, as a result of the inefficient management of water resources and severe leakages in the public distribution network.

Water resources availability in the Czech Republic is primarily dependent on surface freshwater and groundwater. Surface freshwater resources provide 1.46 billion m^3 every year, accounting for almost 80% of total water supply. Notably, in 2012, 764 abstractions of surface water from water courses and reservoirs were recorded. Underground water resources make available additional 379 million m^3. In 2012, the number of groundwater abstractions was 825; still this number is constantly declining. A total of around 9 million (85% of the total population) inhabitants in the Czech Republic are connected to sewerage systems that apply at least secondary level of wastewater treatment methods. The lowest proportion of inhabitants connected to sewerage is in the Central Bohemia Region (71.6%) followed by the Liberec Region (69%). The annual quantity of wastewater discharged into public sewerage systems is estimated at 1.7 billion m^3, of which around 450 million m^3 are municipal wastewater. The region with the lowest proportion of treated wastewater is Northern Bohemia. As of the end of 2016, the number of waste water treatment plants in the Czech Republic was 2,554; of which the newest and most intensive ones (higher capacity) are fitted with biological and tertiary treatment systems, allowing for the complete removal of nitrogen and phosphorus.

In the Czech Republic, the annual consumption of reclaimed wastewater amounts to 1.65 million m³. The vast majority (57.8%, 947.000 m³) is used as processing water in industry or as input in other economic activities. Public and other domestic uses reserve 37.6% (616.000 m³) of the total reclaimed water while less than 3% is used for irrigation.

Inefficient water management in the Czech Republic has reduced landscape retention capacity, which, combined with urbanization along the watercourses, has boosted significantly the possibility for floods. In Czechia, several water bodies have poor quality water. This is mostly due to inefficient water management and wastewater discharges from:

- Old environmental burdens (old landfills, contaminated areas).
- The urban sector: The country as a whole is a sensitive area, requiring tertiary wastewater treatment in agglomerations above 10,000 PE. Also not all water treatment facilities meet the quality requirements for discharged wastewater, including the Prague central wastewater treatment plant. 11 agglomerations of between 2,000 and 10,000 PE (Byšice– Liblice, Bánov, Dolní Újezd, Hať, Týnec nad Labem, Horní Jiřetín, Zlechov, Dětmarovice, Hrádek u Sušice, Hroznová Lhota – Tasov, Píšť) lack water treatment facilities.
- Rainwater: many municipalities channel off rainwater from paved surfaces by sewers directly into watercourses, thus accelerating runoff.
- Agriculture: nitrates used in agriculture combined with improper irrigation techniques. This inefficient use of water resources has had an impact in Pardubice Region, where a significant 36.4% of water samples does not fulfil the hygienic standard of nitrate content for adults.

To reverse this situation, the government has vowed to invest significant financial resources to promote efficient and integrated water management in the country. To start with, the Ministry of Agriculture funds projects and actions for the maintenance and renovation of water supply and sewerage systems, flood control, and the administration of minor watercourses. In 2016, over 2.66 billion CZK were spent for these purposes in the form of subsidies under various programmes. The Ministry of Environment, under the Operational Programme “Environment 2014-2020 – Priority Axis I) will allocate over 50 billion CZK to a) decrease the volume of pollution discharged into surface and ground water from municipal sources and the input of pollutants into surface and groundwater, b) ensure the supply of drinking water of an adequate quality and quantity, c) ensure flood protection of urban areas, and d) promote flood prevention measures. Further to this, the State Environmental Fund will allocate a share of the revenues from the charges imposed to waste water discharges into surface waters and for abstracting groundwater to promote efficient water management at local level – municipalities.

WATER REUSE POTENTIAL

Treated wastewater can be a viable and reliable alternative water resource for the Czech Republic. It can help to maintain downstream environmental quality and reduce the demand for fresh water sources. It can also provide communities with an opportunity for pollution abatement by reducing effluent discharge to surface waters. In the Czech Republic, the industries exhibiting the higher water reuse potential are energy, manufacturing and agriculture. These sectors combine high water consumption, water discharge rates, intensive economic activity and substantial environmental footprint.

The energy sector accounts for the largest share (45.2%) of water abstractions in Czechia. Water is essential for all phases of energy production, from fossil fuels to biofuels and power generation. The annual water withdrawal for power production is estimated at 800 million m^3 while only 10-15% is actually consumed (80-100 million m^3). The rest is discharged and returns to the natural environment. The volume of wastewater effluents can therefore cover up to 70-80% of industry's initial demand for water. In addition, energy is an important sector of the national economy. It generates around 4 billion euros annually, accounting for almost 2% of the national GDP and its share in total employment stands at almost 1%. What is more, the need for water will become ever greater in the energy sector during the upcoming decades, as the share of nuclear power and renewables (especially hydropower) in the country's energy mix will be increased, following the shutdown of coal fired power generation activities, as projected by the government. Possible constraints on water would challenge the reliability and efficiency of operations as well as the physical, economic and environmental viability of future projects. Finally, energy, besides one of the most water intensive industries in the country, is also a considerable water polluter. Indicatively, a typical 500-megawatt coal power plant creates more than 125,000 tons of ash and 193,000 tons of sludge from the smokestack scrubber each year. The energy sector in Czechia is largely responsible for nutrients pollution and oil spillage in surface water bodies and underground aquifers.

Manufacturing is also a major water consumer in the Czech Republic, accounting for 7.2% of total freshwater abstraction. Manufacturers consume over 250 million m^3 per year to support their operations. The manufacturing industry is the main pillar of the Czech's economy with an annual turnover of over 69 billion euros. Manufacturing tops in terms of GDP contribution to the economy of the country at 32.3%, with high-tech engineering, machine engineering, and automotive engineering to emerge as front runners. Notably, the Czech Republic is the 12th largest car exporter worldwide. Finally, manufacturing is a huge source of water contamination. Manufacturing processes are largely responsible for oil spillage and nutrient & chemicals (e.g. chlorine, benzene) releases into streams, rivers and lakes, which can potentially cause eutrophication and oxygen depletion, deteriorating the quality of freshwater and setting at risk biodiversity and human health.

Agriculture is also a considerable consumer with over 47.5 million m^3 of water to be abstracted annually for the irrigation of food and non-food crops. Though agriculture contributes dismally to the national economy at a rate of about 3.9%, the country has prioritized agriculture as a smart specialisation area, to drive sustainable growth and ensure food security. There are currently 4.2 million hectares of agricultural land in the Czech Republic; a size area that covers around half (54 %) of the country's territory. The share of employees in the primary sector in the overall employment structure stands at 2.9%. Finally, agriculture is associated with water pollution from intensive and unsustainable crop and livestock activities. Since 2010, it has been observed an exponential increase in the total volume of fertilizers used per hectare of farmland (amounting to 6,700 kg/ha), which has adversely affected the quality and functionality of surface and underground water bodies. Another factor negatively affecting the quality of surface waters and ground waters are chemicals used to prevent loss of crops. Thousands of tonnes of chemical compounds, often toxic or with other undesirable effects get in circulation every year. Further to this, the Czech landscape is particularly vulnerable to hydrological extremes (flood episodes caused by extreme rainfall and hydrological drought), and farming is the one of the main causes owing to the erosion of the agricultural land.

5.7 ŁÓDZKIE REGION (PL)

STATE OF PLAY

The Łódzkie Region is a Polish province located at the heart of the country next to Mazowieckie and covers an area of 18,219 km^2. Łódzkie has a total population of 2.47 million residents and the population density stands at 135 persons per km^2 (Eurostat 2018). The two-thirds of the population lives in urban centres. The capital and main centre of economic activity is Łódź; the 3rd largest city in Poland with around 700,000 inhabitants. Administratively, the Łódzkie region is divided into 24 districts and 177 municipalities. The largest cities are Bełchatów, Kutno, Pabianice, Piotrków Trybu-nalski, Radomsko, Tomaszów Mazowiecki, Zgierz.

Łódzkie confronts severe water supply conditions (such as periodic water droughts and deficits) as the availability of freshwater resources in the region is rather limited. In 1960s, the province faced a serious drought when the existing freshwater supplies proved insufficient to fulfil the excessive demand of growing urban populations and industries. To address this deficit, an artificial reservoir known as Sulejowskie Lake was built on the Pilica River. The reservoir supplies the entire region with potable water, and at full capacity the reservoir contains up to 95,000,000 cubic metres of water and has an average depth of 3.3 metres. Due to extensive industrial activity, most of the region's urban streams were canalised and transformed in culvert pipes. As a result, during high intensity rainfalls the capacity of operating wastewater treatment plants is exceeded, leading to the discharge of mixed storm water and untreated wastewater to receiving water bodies. This, in combination with the fact that large rural areas are not connected with municipal sewerage systems and the decreased rainwater absorption capacity of the land, has severely contaminated surface and underground water bodies with high concentrations of pathogens and other pollutants, leading to poor water and ecological quality.

The Region of Łódzkie is overall characterised by poorly managed water resources, since a) the network system of sewage disposal (especially in rural communes - 15.1% of sewerage system provision) is insufficiently developed, b) the overall condition of UPSW (uniform parts of surface waters) has been to a major extent assessed as of low quality or bad (2011), and c) high levels of eutrophication was found in almost half of water bodies in the region. Poorly managed water resources have the negative impact of increasing waste water and water pollution in a region with relatively small amount of water bodies and dams that faces periodic droughts. This water deficit renders difficult the supply of adequate water to satisfy the demand in farmlands and woodlands. This is the reason why, compared to Poland, the region has a small area of irrigated lands. The main source of surface waters pollution is municipal sewage, run-offs from urbanised, agricultural and forest areas as well as line facilities. Even though cities/towns in the region have systems channelling the sewage to mechanical-biological sewage treatment plants (e.g. the GOŚ – ŁAM system in north-west LODZKIE), this does not include water reuse eco-innovations and, hence, underperforms as a method to improve water resource efficiency. Łódzkie has a moderate precipitation level. The average annual rainfall is 564 mm, which ranges from 26 mm in February to 81 mm in July. The demand for water is slightly higher during spring and summer (versus the autumn and winter) as tourism adds substantially to domestic water demand. Water withdrawals are typically higher during the warmer (summer) months when the demand for waters reaches the maximum for the year; however this excessive volume is adequately accommodated by the greater rainfall typically occurring during the summer period in Łódzkie.

The average water consumption per capita in Łódzkie Region is 294 litres per day. In 2018, the total water withdrawal was estimated at 290.4 million m³. Municipal and public uses hold the lion's share with 92 million m³ (31.3%), followed by industrial activities with 84.5 million m³ (29.1%) and domestic/residential usages with 72 million m³ (24.8%). Around 15% of the total water abstracted is used to cover agriculture and forestry related needs. Losses account only for a non-significant portion (0.3%) in total water abstraction. In Łódzkie, the largest proportion of water is sourced from underground resources (over 50%, 148.1 million m³). Surface freshwater resources provides additional 90 million m³ annually, representing 31.1% of the total water supply. The rest (17.8%, 51.6 million m³) comes from farmers' individual groundwater use practices and treated wastewater.

Łódzkie Region has one of the lowest rates (69.3%) in the EU regarding the share of population connected with at least secondary level of treatment. While the connection rate in urban centres reaches 95%, in rural areas only 1 in 4 people is connected to the public sewer system. That said, the region operates an adequate number of wastewater treatment plants. In Łódzkie, there are 205 municipal units with highly efficient treatment technologies (mostly biological and also chemical) allowing for an increased reduction of nitrogen and phosphorus content. Their combined capacity reaches 528,573 m³ of water effluents per day. There are also 66 industrial wastewater treatment plants; 5 of which apply mechanical treatment, 3 chemical treatment, 55 secondary (biological) treatment and 3 increased biological removal. The designed capacity of industrial plants with at least secondary level of treatment is around 45,000 m³ of water per day while the actual daily volume of treated wastewater is less than the half (approx. 20,000 m³). In Łódzkie, the annual consumption of reclaimed wastewater amounts to 660,000 million m³. The vast majority (649.000 m³) is used as processing and cooling/heating water in industry. A small volume (around 12,000 m³) is used for irrigation purposes in agriculture.

The regional government appears committed to promoting efficient water management in the region. Nearly 16 million euros under the Regional Operational Programme are scheduled to be invested in different actions for improving waste disposal, surface water quality, preventing drainage and water and land pollution. Particular emphasis, however, needs to be placed on a) sediment and sludge management innovations in wastewater treatment plants, b) the extension and modernisation of the public water supply network, to include water intake and increase the number of water treatment units in rural areas, c) realising complex investments in the field of water and sewage management in agglomerations from 2000 to less than 10000, and d) the promotion and purchase of water management equipment or apparatus (e.g. mobile laboratories, control and measurement installations).

WATER REUSE POTENTIAL

In Łódzkie, though water shortage conditions have been exacerbated over recent years, reclamation of treated wastewater is not a widespread practice. The foreseen integration of the EU regulation on minimum requirements for water reuse into the national water governance context promotes the implementation of wastewater reuse in Łódzkie Region and provides an opportunity to explore the potential for using reclaimed water in different uses/activities. Water resources availability is mainly reliant upon surface and underground freshwater, which is not only becoming depleted but also is subject to contamination due to uncontrolled discharges and poor wastewater management. Therefore, non-conventional solutions such as the reuse of treated wastewater can be a viable alternative for the region. Overall, the sectors associated with the higher water reuse potential in Łódzkie Region are industry and agriculture.

Industry is the second larger water consumer in the region, accounting for 6.5% of total water abstractions; i.e. 15.7 million m^3 per year. Industry is second most important (after services) pillar of the regional economy. Industrial activities, with an annual turnover of almost 9.9 billion euros, account for 38.4% of the region's GDP, representing a vital source of income and growth for urban populations. The majority of the province's industrial and manufacturing plants are concentrated within the Łódź Industrial District; thus creating a source of high volumes of wastewater effluents that can be treated and reused in industrial and commercial activities. Major industries in Łódzkie include textiles and clothing, pharmaceuticals, rubber, food and beverage processing, machine making, ceramics, and logging. In terms of pollution, wastewater discharges from industrial and commercial sources contain nutrients and chemical pollutants that without tertiary level of treatment will inevitably affect the quality of receiving water bodies, posing serious dangers for human health and biodiversity. Finally, the price of reclaimed water is 60% higher than of freshwater, which acts as a counter incentive for manufacturers to use treated water or invest in water reuse technologies.

Agriculture is also a major consumer of freshwater resources. In Łódzkie, over 42 million m^3 of water are used every year to fulfil agriculture irrigation needs. Almost seven-tenths of the province is agricultural, and, despite predominantly poor soil quality, farming plays an important role in the local economy. Agriculture accounts for 2.9% of the regional GDP, generating around 750 million euros every year. The price of reclaimed water is slightly higher than of freshwater; a fact that can promote the use of treated water for crop irrigation, and justify water reuse investments.

5.8 LOWER SAXONY (DE)

STATE OF PLAY

Lower Saxony (Niedersachsen), located in the North-East of Germany, is the second largest federal state with a surface of 47,624 km^2, of which 53.7% is farmland and 20.6% is forest. It is bordered by the North Sea and the German states of Schleswig-Holstein and Hamburg to the north and by the states of Mecklenburg West Pomerania to the northeast, Saxony Anhalt to the east, Thuringia and Hessen to the south, and North Rhine–Westphalia to the southwest. Its population stands at 7.9 million inhabitants, representing 9.6% of the country's population. The state is sparsely populated with 166 inhabitants per km^2, when the national average is 229 inhabitants. The regional distribution of economic growth and employment is heterogeneous, mostly concentrated around the main urban areas. The capital and main centre of economic activity is Hanover.

Water resources in Lower Saxony is abundant. More than half of Lower Saxony is drained by the Weser River and its tributaries, the Fulda and the Werra. The state is also dominated by other large rivers (and adjacent wetlands and marshes) running northwards through its territory: the Ems, Aller, and Elbe. Notwithstanding the above, the state is now facing an increased risk of water shortages. The rising temperatures and low precipitation levels, which are more frequently observed in the state (as a result of climate change), have driven record heatwaves and prolonged droughts that have substantially increased the demand for water. According to Nature and Biodiversity Conservation Union, the groundwater is sinking by between 1.5 and 2 centimetres annually in Lower Saxony, which (coupled with the lower volumes of rainfall) implies that the availability of freshwater is progressively declining.

In June 2019, an emergency warning app developed by Germany's Office of Civil Protection and Disaster Assistance warned state and regional authorities about the low level of available drinking water reserves in the country. The same period the residents of the Lihne town in Lower Saxony was found in a dire situation whereas the only time they had access to fresh water was in the evenings. These two indicative examples make it clear that the state might experience pressures on water supply conditions in the near future – even though the state is far from being considered as water scarce - unless alternative sources (such as water reuse) and efficient water management are adopted.

Lower Saxony has a moderate rainfall rate, which is on the fall. The average amount of annual precipitation is 670 mm, with August being the wettest month and April the driest one. Variations in water consumption are evident in Lower Saxony. The high temperatures during spring and summer drive the growing demand for freshwater. When temperatures rise, lawns require extra watering and many people yearn for a refreshing shower or swim in a swimming pool. This, in conjunction, with the increased irrigation needs of warm season crops, results in a peak consumption during summer.

The average water consumption per capita in Lower Saxony is 166 litres per day. In 2018, the total water abstraction was estimated at 2.18 billion m^3 – the equivalent of approximately 1.1% of the available freshwater reserves in the country. The largest portion of freshwater resources was directed to industrial and commercial activities (82%, 1.71 billion m^3) - further 367 million m^3 were used to address domestic and residential needs (17%). Water losses within the supply and distribution systems amounted to 32.3 million m^3, accounting for 1.4% of the total water usage. In Lower Saxony, the total water abstraction for public water supply was 479 million m^3 while over 1.7 billion m^3 were supplied to private water structures to cover individual industrial and commercial needs. Public water supply in Lower Saxony relies largely on groundwater (87%).

The Province has an extended sewerage system, made up of 119 secondary (biological) wastewater treatment plants and 480 wastewater treatment plants with advanced tertiary treatment systems that allow for the complete removal of nutrients. The former have a maximum capacity of 11411 m^3 per day while the latter over 155000 m^3 per day. The province has a high treatment coverage with almost 95% of the population to be connected with at least secondary level of treatment. In Lower Saxony, the use of reclaimed water is rather limited. Experience with water reuse is available in the areas of Braunschweig and Wolfsburg in the Lower Saxony, where treated municipal wastewater is being used for hydroponic vegetable and cut flower cultivation. In 2018, over 16 million m^3 of reclaimed municipal wastewater were used for irrigation purposes in the Province. Typically, the treated sewage from municipal wastewater treatment plants is discharged into territory’s water streams and bodies.

Lower Saxony is in need of securing a water supply and treatment system that makes sure that wastewater does not affect surface water and groundwater resources in the territory. The Province is actually suffering from pressures on freshwater resources; mostly caused by human induced activities and which have a negative influence on the quality and quantity of water. These anthropogenic pressures can be summarised as follows:

- Discharges from municipal sewage plants, that caused eutrophication phenomena were found to exist at 13 flowing water bodies in Lower Saxony. Significant pressures from wastewater in general were found to exist at 34 flowing water bodies.
- Wastewater resulting from agricultural activities (seepage, erosion, run-off, drainage, afforestation) affected 1214 flowing water bodies.
- 1539 water bodies in Lower Saxony had problematic water body development
- Wastewater discharges have caused significant hydro-morphological pressures in 9 lakes in Lower Saxony.
- 43 groundwater bodies were affected from wastewater derived from agricultural activities

The State Government has recognised the aforementioned shortcomings and weaknesses and has pledged to improve water management in the region, in an attempt to preserve water resources and address prevailing water scarcity and quality challenges. To this end, the Regional Operational Programme of Lower Saxony (2014-2020) foresees the allocation of over 60 million euros for effective and integrated water resources management. More attention, however, should be devoted towards proliferating the use of treated water from municipal treatment facilities in different industrial and public uses/activities and backing the introduction of water reuse technologies and standards to decrease wastewater and improve water treatment facilities.

WATER REUSE POTENTIAL

In Lower Saxony, the sector that exhibits high water reuse potential are agriculture, manufacturing and energy. They combine significant vulnerability to water scarcity, high water consumption and wastewater generation, intensive economic activity and extended environmental impact. What is more, the size of potentially supplied activities can justify water reuse investment.

Agriculture is one of the most water intensive economic sectors in Lower Saxony. Farming activities consume over 127 million m^3 of water every year. Until recently, farmers relied on rain alone to water their crops. But as summers have been made hotter and drier, farmers are forced to tap into underground freshwater resources to address their growing needs for water. Notably, in some regions, especially in the North-East of Lower Saxony, water scarcity has emerged as a crucial issue for agriculture. In 2018, farmers experienced a 22 percent loss in agriculture production as a result of the prolonged drought during summer. Due to low rainfall in winter and spring, the Elbe and Oder rivers running through eastern Germany carried so little water, even before the start of summer that sandbanks and rocks were left exposed and the soil in watersheds dried up to two metres deep. The region has already experience in water reuse and an increasing interest has been recorded for further projects. Currently, there are 2 wastewater treatment plants (Braunschweig and Braunschweig WWTPs) that apply tertiary treatment, and supply crops with reclaimed water for irrigation. Overall, the potential reuse of effluents from irrigation, which amount to around 10 million m^3 every year, could significantly reduce (if not entirely cover) the annual water deficit caused by low precipitation, alleviating at the same time pressures on freshwater resources. In addition, agriculture is one of the mainstays of Lower Saxony's economy. The primary sector, strongly weighted towards livestock and crop cultivation (wheat, rye, oats, potatoes, dairy, beef cattle), generates over 5 billion euros annually, representing 1.8% of the regional GDP; a share which is higher than the national average. Agriculture is also a major regional employer, with more than 80,000 people working in relevant fields. The north and northwest of Lower Saxony are distinguished by coarse sandy soil that favours grassland and cattle farming while in the south and southeast territories of the province the extensive loess layers in the soil left behind by the last ice age allow for high-yield crop farming. Agriculture, however, is responsible for excessive water pollution, resulting from intensive and unsustainable crop and livestock activities. Notably, the wastewater resulting from agricultural activities (seepage, erosion, run-off, drainage, afforestation) has been found to contain dangerous chemicals and nutrients that have contaminated 1214 flowing water bodies in the territory. Finally, in Lower Saxony, farmers pay a relatively low price (0,007 euros/m^3) for freshwater; a factor which may jeopardise the financial viability of water reuse investments in the region.

Manufacturing is responsible for the largest amount of water abstractions in Lower Saxony; with the average annual water withdrawal to be estimated at 378 million m^3. Substantial water deficits in the sector have not yet been observed but it is inevitable for the sector to remain unaffected as the precipitation levels in the Province are declining and the demand for water is constantly increasing. In Lower Saxony, the mean annual volume of potentially reusable treated wastewater is about 1.6 billion m^3; a volume that can adequately satisfy a considerable share of sector's total water demand. Furthermore, the export dependent manufacturing sector is the main pillar of Lower Saxony's economy, with an annual turnover of over 134 billion euros (52.3% of the regional GDP). More than half a million people are employed in one of Lower Saxony's manufacturing industrial companies, the vast majority of which are based in Hannover and Braunschweig. Lower Saxony's largest manufacturing segments include automotive, food and beverages, heavy machinery, chemicals, raw materials and mining. The price of freshwater for manufacturing processes is (0,030 euros/m^3) 420% higher the price for irrigation water.

High water reuse potential can be found in the energy sector. The power sector is the largest water consumer in the Province with over 1.1 billion m^3 to be extracted annually for the production of electricity. In addition, the energy sector accounts for a significant share of the regional GDP and is expected to develop even further given country's commitment (incl. corresponding investments) to increase the share of renewables in the energy mix, in accordance with EU targets and rules. To conclude, the share of the power generation sector in the total water consumption, combined with its substantial growth potential and the high price of freshwater resources 0.013 – 0.037 euros/m^3 showcase the untapped wastewater reuse potential in this field.

6 COMPARATIVE ANALYSIS AND CONCLUSIONS

WATER SHORTAGES AND SCARCITY

Water scarcity is a situation where the available water resources within a territory cannot adequately address the demand of water usage at a given time period. Water scarcity is driven primarily by a) geophysical and hydrological features alongside with climate conditions that control the availability of freshwater in the natural system and seasonality in water supply, b) water demand which is largely reliant on population, geographic location (urban or rural settlements), extent of economic and industrial activities and price of water, and c) pollution that determines the ecological status of surface and underground water bodies, affecting the physical, biological and chemical properties of water reaching residents.

Given the relative abundance of natural sources, major water shortages have not been observed in AQUARES territories. AQUARES territories share different water stress levels, with southern and western areas to experience more pressing water supply conditions compared to those in Northern countries. Still, northern territories have already started dealing with water scarcity issues as a result of climate change and extended pollution. For example, Lower Saxony is now facing an increased risk of water shortages as the groundwater is sinking by between 1.5 and 2 centimetres annually. Water imbalances, besides low precipitation levels, can be attributed to human related factors; high population density, tourist inflow, intensive agricultural activity (warm season crops), water demanding industries (e.g. hydropower plants), and unsustainable consumption patterns to name but a few. Water scarcity issues are more pronounced during spring and summer (seasonal pattern) mostly because of the drier weather (and prolonged drought), the increasing number of tourist arrivals and the very intensive irrigation. For instance, in the summer of 2015, renewable freshwater resources (such as groundwater, lakes, rivers or reservoirs) in Europe were 20% less in comparison with the previous year because of a 10% net drop in precipitation. The analysis revealed that popular tourist destinations (coastal areas and islands - Malta and Murcia), agricultural areas with intensive irrigation and livestock (e.g. Latvia, Trebnje), large urban agglomerations and industrial zones (e.g. Lombardy) are more vulnerable to water scarcity issues.

Renewable freshwater resources rely on seasonal infiltration of precipitation to recharge and get replenished. When rainfall is low, the flow of surface streams and rivers slows down, water levels in lakes and reservoirs drop, and as a result the volume of available water declines. In AQUARES territories, the precipitation level can be characterised as moderate. The average annual rainfall amounts to 649 mm; ranging from 1050 mm in Trebnje and 950 mm in Lombardy to 450 in the Czech Republic and 293 mm in Murcia. Relevant evidence also reveal seasonal patterns; typically heaviest rainfall occurs in October, April and December while from June to August is considered a relatively dry season.

WATER DEMAND

Water demand can be expressed numerically by average daily consumption per capita or total annual water abstraction. Water consumption in AQUARES territories varies widely. The average person in Murcia Region uses 294 litres per day while in the Czech Republic 90 litres per day. The AQUARES territories that consume the biggest amount of water is Murcia Region, Łódzkie and Latvia with 375 litres, 295 and 294 litres per capita respectively. On the other side, the territories with the lowest water usage are the Czech Republic and Malta with 90 litres and 110 litres per capita per day. Six out of eight AQUARES territories share a water consumption rate above the EU average (120 litres). The annual total water abstraction in partnership countries amounts to 158.52 billion m^3. The above indicates that partnership territories, following the example of Malta, need to build a "water conservation" culture within their societies, prompting residents and industries (incl. visitors and tourists) to pay particular attention in water conservation issues, decrease their environmental footprint and make efficient use of water resources.

Energy production, agriculture and public water supply are the main pressures on renewable water resources in AQUARES territories. The power sector constitutes the largest water consumer in Lombardy and Lower Saxony, and this is why it holds the lion's share in total water abstraction. In Lombardy alone, the annual volume of water used for the production of hydropower stands at 115 billion m^3. The mean water abstraction for irrigation and animal husbandry in AQUARES territories is estimated at around 5 billion m^3 annually. For example, In Murcia, 81% of total water abstraction is used for agriculture irrigation. For a number of territories (Latvia, Trebnje, Czech Republic), public water supply serving mostly residential needs accounts for the largest share of water consumption.

WATER SUPPLY

In AQUARES territories, water resources availability is largely (if not exclusively) reliant on primary freshwater resources (aquifers, rivers, lakes). Freshwater resources continue to provide the greatest share in total water supply, accounting for almost 93.8%. Underground water streams constitute the predominant water source with a share of 67.3%, followed by surface freshwater resources with 26.5%. The rest (7.2%) comes from non-conventional sources of water. These include seawater desalination, the use of brackish water (directly or via desalination), and the reuse of municipal and industrial wastewater with varying levels of treatment. Seawater desalination, despite a high cost and energy intensive option, is widely used in two AQUARES territories, as a viable alternative source to increase water availability and alleviate pressing water supply conditions during the summer season. Notably, the coverage of domestic demand with desalination in Malta reaches an impressive 64%, while in Murcia 6.3%.

Overall, water reuse rates in AQUARES territories (with the exception of Malta) are particularly low even though the potential is rather high. In AQUARES territories, the great majority of treated wastewater is used as processing and cooling water in industrial and power production processes respectively, and to address agriculture irrigation needs. Lower volumes are used within the tourism industry (mostly for the irrigation of sporting facilities, toilet flushing, aesthetic impoundments and vehicle washing) as a response to the increased influx of tourists during summer, for public uses including but not limited to the irrigation of green areas and street cleaning, and for the regeneration of waterways and aquifers. With the water demand to be steadily increasing and an increasing number of regions to be threatened by water shortages, reclaimed water must claim a higher share in AQUARES territories' water supply mix.

WASTEWATER TREATMENT

The treatment of both municipal and industrial wastewater, besides fundamental to ensuring public health and environmental protection, is a prerequisite for water reuse. Wastewater treatment in all countries of the EU has substantially improved over recent decades. In AQUARES territories, the average proportion of population connected to at least secondary wastewater treatment plants reaches 83.7%. The percentage ranges from 42% in Trebnje and 69.3% in Łódzkie to 99.3% in Murcia and 100% in Malta. Evidently, the proportion of the population connected to public sewerage system is significantly lower in rural areas, in juxtaposition with urban agglomerations. For instance, in Łódzkie, while the connection rate in urban centres reaches 95%, in rural areas only 1 in 4 people is connected to the public sewer system.

Most AQUARES territories have a modern and well developed public sewerage system fitted with secondary and tertiary wastewater treatment methods that allow for complete removal of inorganic compounds and nutrients, as well as advanced sludge treatment. In total, over 5,500 WWTPs are currently operating in partnership territories. The territories in a dire need to improve wastewater treatment processes are the Czech Republic, Łódzkie Region and the Municipality of Trebnje; yet all partnership territories must target at increasing the share of population receiving tertiary level of treatment. Czechia and Trebnje need to upgrade their wastewater treatment capacity to serve urban agglomerations above 10,000 PE. In Łódzkie Region, the network system of sewage disposal in rural (15.1% of sewerage system provision) is insufficiently developed.

WATER POLLUTION

According to 2nd River Basin Management Plans, 18% of reported surface waterbodies and 14% of reported groundwater bodies in Europe are under significant environmental pressure caused by extended pollution. In AQUARES territories as a whole, the quality of water bodies can be characterised as relatively good. In some of them, however, the quality of water is declining due to inappropriate and inadequate level of wastewater treatment. The main sources of pollution are untreated municipal wastewater, agricultural pollutants and industrial discharges. In Murcia, the fragmented application of efficient water management techniques in agriculture irrigation has led to significant wastewater discharges in wetlands, reducing the quality of water, accumulating organic waste, and causing eutrophication. Similarly, nutrient pollution caused by unsustainable farming procedures represents the most imminent threat for groundwater quality in Trebnje. In the Czech Republic, manufacturing companies are largely responsible for oil spillage and nutrient & chemicals (e.g. chlorine, benzene) releases into streams, rivers and lakes. Finally, in Lower Saxony, discharges from municipal sewage plants have created eutrophication phenomena were in at least 13 flowing water bodies.

SECTORS WITH WATER REUSE POTENTIAL

When it comes to water reuse opportunities, the sectors that demonstrate the highest water reuse potential in AQUARES territories are agriculture, manufacturing and power production. These sectors combine significant vulnerability to water scarcity, high water consumption and wastewater generation, intensive economic activity and substantial environmental footprint. The use of reclaimed water in these sectors therefore could provide a viable alternative to mitigate pressures on available freshwater resources while the size of the sector can justify investments in water reuse facilities and advanced treatment methods. Lower but still significant water reuse potential has been also found in tourism, food industry and groundwater recharge. For each study area, the sectors/areas with higher water reuse potential are as follows:

- **Murcia Region**: Agriculture and Tourism
- **Lombardy Region**: Energy Production, Agriculture, Freshwater Recharge
- **Malta**: Agriculture and Tourism
- **Municipality of Trebnje**: Agriculture and Freshwater Recharge
- **Latvia**: Food Industry, Manufacturing and Agriculture
- **Czech Republic**: Energy Production, Manufacturing and Agriculture
- **Łódzkie Region**: Manufacturing and Agriculture
- **Lower Saxony**: Agriculture, Manufacturing and Energy Production

BARRIERS TO WATER REUSE

The main barriers to the implementation of water reuse, as drawn from the present study, are firstly the lack of legal framework governing water reuse together with the lack of standards and requirements for the utilisation of reclaimed water in different uses, and secondly water pricing structures that shift demand towards freshwater. Though a series of EC initiatives (e.g. Proposal for Regulation on Minimum Requirements for Water Reuse) promote the adoption of water reuse solutions, only a few number of EU states have established water reuse standards at national level. Currently, all the Mediterranean states in the EU (as facing more severe water supply conditions), except Malta, have introduced new criteria or have revised the existing ones. The water reuse criteria have been issued as regulations and are mostly focused on agricultural and landscape applications, but additional uses, such as recharge for aquifers (not used for potable supply) and environmental uses are also covered in the cases of Greece, Italy and Spain.

7 BIBLIOGRAPHY

Alcande-Sanz L., Gawlik B. M. (2017). Minimum quality requirements for water reuse in agricultural irrigation and aquifer recharge. JRC Science for Policy Report.

Amec Foster Wheeler Environment & Infrastructure UK Ltd, IEEP, ACTeon, IMDEA and NTUA (2016). EU-level instruments on water reuse: Final report to support the Commission's Impact Assessment. Prepared for European Commission.

BIO by Deloitte (2015). Optimising water reuse in the EU. Prepared for European Commission DG Environment.

DEMOWARE (2016). Cost, pricing and financing of water reuse against natural water resources. 7th Framework Programme for research, technological development and demonstration, theme ENV.2013.

Drewes E. J., Hübner U., Zhiteneva V., karakurt S. (2017). Characterization of unplanned water reuse in the EU. Prepared by the Technical University of Munich for the European Commission DG Environment.

Equilibrium (2017). Water Reuse and Recycling: Market Opportunities and Challenges. An Equilibrium Point of View.

European Commission (2016). Common implementation strategy for the water framework directive and the floods directive. Guidelines on Integrating Water Reuse into Water Planning and Management in the context of the WFD.

European Committee of the Regions (2018). Water Reuse – Legislative Framework in EU regions. Commission for the Environment, Climate Change and Energy.

European Environment Agency (2009). Water resources across Europe — Confronting water scarcity and drought. EEA Report No 2/2009. ISSN 1725-9177.

Exall K., Marsalek J. (2004). Water Reuse and Recycling in Canada: A Status and Needs Assessment. Article in Canadian Water Resources Journal.

Pistocchi A., Aloe A., Dorati C. Alcalde Sanz L., Bouraoui f., Gawlik B., Grizzetti B., Pastori M., Vigial O. (2017). The potential of water reuse for agricultural irrigation in the EU. JRC Science for Policy Report.

Sanz L. A., Gawlik B. M. (2014). Water Reuse in Europe: Relevant guidelines, needs for and barriers to innovation. JRC Science and Policy Reports.

Stathatou P. M., Gad F. K., Kampragou E., Grigoropoulos H., Assimacopoulos D. (2015), Treated wastewater reuse potential: mitigating water scarcity problems in the Aegean islands. Journal of Desalination and Water Treatment. Vol. 53. Issue 12.

Styles D., Schönberger H., Galvez Martos J.L. (2013). Best Environmental Management Practice in the Tourism Sector. JRC Scientific for Policy Report.