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HYDROUSA

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Water in the context of circular economy

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HYDROUSA water loops in the context of the EU and international policy (including Innovation Deal)

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Brief Description	In order to assess the best enabling conditions to transfer and replicate the HYDROUSA solutions, the deliverable frames HYDROUSA water loops within the context of EU directives and ongoing policy initiatives. International water and materials quality standards, that are currently set or under definition, were used to address the best strategies for operation, transferability and replicability of HYDROUSA demos and related value chains. Finally, a targeted institutional analysis is provided to outline the boundaries and address the HYDROUSA application or applicability in local contexts. Finally, financing and economic framework are analysed to provide basis and potential barriers for transferability, replication and exploitation strategies.
Keywords	EU Directives; Policy progress; Fitness Check and Application Boundaries; National regulation; Institutional analysis; Financial framework; Water Economics

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EXECUTIVE SUMMARY

Deliverable D7.1 is related to the Task “Transferability and replication of HYDROUSA services” and it is implemented within the activities of T7.1. of the Work Package 7.

Globally or locally, practical feasibility, transferability or replicability of HYDROUSA regenerative water loops could face challenges or be hampered by constraints or barriers related to policy, legal, governance or regulatory framework. Such circumstances are even more probable, if the size of the HYDROUSA services, mainly small systems for small communities, are considered. In fact, HYDROUSA solutions are particularly attractive for rural or decentralized areas that have often received less attention than urban areas from policy makers and regulators of water and water-related services. Therefore, in addition to the possible barriers in the present scenario, a relevant constraint is likely to be the lack of regulation, rules, institutional capacity and support, financing schemes that consider the peculiarities of closed and regenerative water loops of small size and for small communities, at European, national or local level.

In order to best steer and support the implementation and exploitation of the HYDROUSA solutions, considering the HYDROUSA water categories, recovered materials and potentially marketable products, this report critically analyses, reviews and check the fitness within relevant EU directives, on-going policy initiatives, minimum requested quality standard, regulatory and financing frameworks. Then, institutional capacities, roles and responsibilities are critically framed in order to provide initial guidance even to replication and transfer of the HYDROUSA eco-innovative loops to other sites. By this approach the enabling environment conditions in which HYDROUSA loops can be supported are analysed and contextualized in the present scenario, so as to support possible targeted actions within the legislative and regulatory framework, institutional capacity and support, financing, asset management, monitoring and risk-based approach.

After having schematized the six HYDROs and highlighted the relevant input (e.g. water categories) and output (e.g. recovered materials and potentially marketable products), the fragmentation and complexity of the legislative, regulatory and institutional scenario immediately emerged from the relevant, binding or non-binding, legal acts and guidance docs to be considered (ref Table below).

Directive / Regulation / Decision / Recommendation / Guidelines	Relevant INPUT	Relevant OUTPUT	Relevant HYDROs
Proposal EC COM 337/2018 and 2019 revision	Municipal/Domestic Wastewater	Water for Irrigation Reuse	HYDRO 1 HYDRO 6
Council Directive 91/271/EEC1(+98/15/EC) (UWWTD) and ongoing revision (COM (2017) 749)			
WHO Report 2006			
ISO/TC 282			
278/86 EEC	Municipal/Domestic Wastewater (Sewage Sludge/Digestate)	Compost	HYDRO 1 HYDRO 6
86/278/EEC Sewage Sludge Directive and amendment (EC 219/2009)			
STRUBIAS Technical Proposal 2019 EC/JRC Report			
EC report on Digestate and compost as Fertilizers			
EC 178/2002 on procedures in matters of food safety	Water for irrigation, Compost, Seawater and domestic wastewater	Crops (for Food and industrial uses), Salts from Brine	HYDRO 2 HYDRO 5 HYDRO 6
EC 1881/2006 on maximum levels for certain contaminants in foodstuffs			
EC Best Environmental Management Practice in The Tourism Sector	Rainwater	Rainwater for: Irrigation, Drinking water and domestic uses	HYDRO 3 HYDRO 4 HYDRO 6
Environment Agency Harvesting Rainwater for Domestic Uses: An Information Guide			

EU 83/1998 EC Drinking Water Directive and amendment (EU 2015/1787)	Rainwater, water vapour, seawater	Drinking Water	HYDRO 4 HYDRO 6 HYDRO5
Proposal EC COM 753/2017 (2018) on the quality of water intended for human consumption			
WHO Guidelines for Drinking-Water Quality (GDWG)			
Small-scale drinking water supplies in the pan-European region (UNECE/WHO Regional Office for Europe, 2011) *and* Water safety planning for small community water supplies (WHO, 2012)			
EC 118/2006 - The Groundwater Directive (GD)	Rainwater, stormwater run-off	Water for aquifer recharge / storage	HYDRO 4
2000/60/CE - Water Framework Directive (WFD)			
EU 80/2014 on the protection of groundwater against pollution and deterioration			
EC 2003/2003 Fertilizer Regulation and subsequent (EU 463/2013) and (EC 1009/2019)	Municipal/Domestic wastewater	Recovered fertilizers	HYDRO 1
EC 2001/2018 on the promotion of the use of energy from renewable sources	Municipal/Domestic Wastewater	Biogas for Biofuel	HYDRO 1
EN 16726 European standard that on the quality of gas of the H category			
EN 16723-2 Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 2: Automotive fuels specification			

When moving from linear to circular water and water-related services, the ad-hoc and site-oriented harmonization of relevant legal acts is a must to provide enabling environment conditions. At this stage no general major barriers that can completely prevent the application and spreading of HYDROUSA loops have been found in the European legislative context. However, the achievement of required quality standard by not entailing excessive costs might be a challenge for economic sustainability of small and decentralized closed and regenerative loops, as long as holistic costs are not properly accountable.

While irrigation water recovery seems challenging but achievable and to be associated with a proper Water Reuse Risk Management Plan, higher constraints might be found when the goal is to produce drinking water from alternative sources. It is crucial to have a risk-based and risk-assessment approach and deliver Water Safety Plans even to improve community engagement.

Community composting to valorise sewage sludge can be problematic when EC-marked compost of organic farming is targeted. In addition, high attention should be paid to quality standard, probably with concern to pathogen removal and related indicators.

In terms of governance of water and water-related services, although decentralization has been suggested as a valuable shift especially for rural areas that are still very relevant in Europe, support to small and decentralized water and water-related services is less provided: in general, local operator models and self-supply, that are more relevant and appropriate for HYDROUSA, have received little or no attention. In some Countries decentralization reforms have assigned the responsibility for water service provision to rural local governments, which often have poor capacities and financial resources. On the other hand, even as indirect consequence of EU Directives (e.g. UWWTD 91/271/EC) major interest and support is given to larger urban and regional utilities, which are often prioritized in investment strategies. However, the last evaluation of the UWWTD has clearly highlight that: (a) “small agglomerations or non-connected dwellings not completely covered by the Directive still constitute a significant pressure on 11% of the EU’s surface water bodies”; (b) “remaining sources of loads result from the use of potentially mal-functioning individual or other appropriate systems. The Directive allows the use of these systems where a collection systems comes at disproportionate costs, and as long as these individual systems achieve the same level of environmental protection. But it is not clear on the extent to which this provision can be applied and how the functioning of these systems should be monitored". HYDROUSA is addressing those issues by both providing fit-for-purpose treatment solutions, and by providing digital systems to monitor water quality and treatment performances.

Water tariff structures (approved by national or regional authorities) are mainly addressing urban environment and larger utilities' needs, while smaller service authorities (e.g. municipalities, communities) have to find ad-hoc solutions for local service providers that can be community-based, private operators, local administrations, individuals. Therefore, benchmarking of urban water tariff for larger systems is often feasible and available for policy and regulatory support, while actual benchmarking small and decentralized closed water loops is unavailable and policy actions are often based on analyses of very local (and often subjective) evaluations of technical, economic and environmental sustainability. These will be analysed in each of the replication sites in Task 7.3-7.4, to finally have a representative set of data and examples to provide objective basis for water professionals and stakeholders to evaluate the replicability of HYDROUSA solutions.

Possible further actions should be directed to creating regulatory and institutional clarity, a conducive enabling environment for the decentralized service delivery models. An Innovation Deal could support European (and national) governments to recognize water and water-related small and decentralized services to deliver regenerated closed loops. However, at the moment the Innovation Deal initiative seems not active and apparently proposals cannot be submitted. In the current scenario, generally and practically, a framework similar to the community composting could probably work even for community-based water and water-related services management. In such a framework, the role of municipalities and local authorities is crucial. Those local public bodies must be engaged in planning, programming, implementing and assessing the HYDROs.

As major focus is on rural and decentralized areas, transition to a citizen-centred, zero-carbon, resource-efficient and biodiverse economy, HYDROUSA water loops can support to deliver the European Green Deal without leaving individual or region behind and ensure a just and inclusive transition.

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ABBREVIATIONS

AnMBR	Anaerobic Membrane Bioreactor
AA	Appropriate Assessment
AdP	Águas de Portugal
AEAS	Spanish Water and Wastewater Association
APA	Portuguese Environmental Agency
ARERA	Regulatory Authority for Energy, Networks and Environment
ARPA	Regional Environment Authority
ASL	Local Health Authority
BAFG	Federal Institute of Hydrology
BEMP	Best Environmental Management Practice
BFG	Federal Ministry for Health (BFG)
BMBF	Federal Ministry of Education and Research
BMLFUW	Federal Ministry for Agriculture, Forestry, Environment and Water
BMU	Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety
BMWI	Federal Ministry of Economics and Technology
BOD_5	Biological Oxygen Demand
C:N	Carbon:Nitrogen
CAPEX	Capital Expenditure
CIW	Co-ordination Committee on Integrated Water Policy
CW	Constructed Wetland
DRIRE	Regional Directorates for Industry and Environment
DWD	Drinking Water Directive
EIA	Environmental Impact Assessment
EC	European Commission
ECN	European Compost Network
EDC	Endocrine Disrupting Compounds
EEA	Executive Environment Agency
EEC	European Economic Community
EGA	Government Area Authorities
EGTOP	Expert Group for Technical advice on Organic Production
EMEPA	Enterprise for Management of Environmental Protection Activities
EPA	Environmental Protection Agency
ERSAR	Water and Waste Services Regulation Authority
FAO	Food and Agriculture Organization
FS	Faecal Sludge
FSM	Faecal Sludge Management
FZK	Project Agency for Water Technology
GAEC	Good Agricultural and Environmental Conditions
GD	Groundwater Directive
GTZ	Organization for Technical Cooperation
HACCP	Hazard Analysis and Critical Control Points
HZJZ	Croatian Institute of Public Health
IBT	Increasing Block Tariff
ISO	International Organization for Standardization
ISS	Institute of Health
JMP	Joint Monitoring Program
JRC	Joint Research Centre
LNG	Liquefied Natural Gas

MAF	Ministry of Agriculture and Forestry
MAOTE	Ministry for Environment and Energy
MATTM	Ministry of the Environment, Land and Sea
MEE	Ministry of Economy and Energy
MH	Ministry of Health
MIPAAF	Ministry of Agricultural, Food and Forestry Policies
MIT	Ministry of Infrastructure and Transport
MBR	Membrane Bioreactor
MOEW	Ministry of Environment and Water
MRDPW	Ministry of Regional Development and Public Works
MS	Member State
MSE	Ministry of Economic Development
N2000	Natura2000
NAP	National Adaptation Plan
NTU	Nephelometric Turbidity Unit
NWC	National Water Council
NWCt	National Water Committee
OECD	Organisation for Economic Co-operation and Development
ONEMA	French National Agency for Water and Aquatic Environment
OPEX	Operating Expense
OSS	Onsite Sanitation System
ÖVGW	Austrian Association for Gas and Water
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofurans
PCE	Perchlorethylene
p.e.	Population quivalent
PFAs	Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonates
PPP	Public Private Partnership
RBMD	River Basin Management Directorate
RBO	River Basin Organization
REFIT	Regulatory Fitness and Performance programme
RIEW	Regional Inspectorates of Environment and Water
RMOA	Risk Assessment Options Analysis
RQSII	requirements and compliance of each individual service
RWA	Regional Water Authorities
SEA	Strategic Environmental Assessment
SEWRC	State Energy and Water Regulatory Commission
SNV	Netherlands Development Organisation
SSD	Sewage Sludge Directive
SSW	Special Secretariat for Water
STRUBIAS	STRUvite, BIochar, or incineration Ashes
TCE	Trichlorethylene
TSS	Total Suspended Solids
TWW	Treated Waste Water
UASB	Upflow Anaerobic Sludge Blanket

UBA	Federal Environmental Agency
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
UV	UltraViolet
UWWTD	Urban Waste Water Treatment Directive
VMM	Flemish environment agency
WAREG	European Water Regulators
WDD	Water Development Department
WFD	Water Framework Directive
WHO	World Health Organization
WRSP	Water Reuse Safety Plan
WSP	Water Safety Plans
WW	Waste Water

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1 INTRODUCTION

Although the HYDROUSA innovative, regenerative and circular solutions generally fulfil the principles for best sustainable water governance and management (e.g. Organization for Economic Co-operation and Development (OECD) Principles on Water Governance), practically the fitness to current relevant directives, as well as compliance to local legislation and regulations has to be analysed, so as to identify possible barriers that can be addressed within the implementation of HYDROUSA project to pave the way for enabling environment and better exploitation. The goal to enhance the enabling environment and framework conditions for nature-based solutions and closed water loops at EU policy level has been often reported, even within the discussion about the revision of the main European Directives. However, fragmentation of roles and responsibilities for water policymaking, policy implementation, operational management, environmental protection, water governance and regulation can slow down or impede such an enhancement and the market uptake of HYDROUSA innovations, even considering the decentralized (and generally less considered) nature of the HYDROs. Therefore, this deliverable addresses the legislative, governance, regulatory and institutional complexity and barriers to provide framework analyses that support decisions for the best and safe transferability, replicability and widespread exploitation of the HYDROUSA solutions.

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2 CONCEPTUAL FRAMEWORK, STRUCTURE AND ELEMENTS ANALYSED

The framework analysis and assessment were carried out according to the following steps:

1- HYROUSA loops are segmented and schematized to clearly highlight boundaries and main input/output flows, that are to be considered for relevance or compliance to policy, legal or regulatory frameworks.

2- HYDROUSA loops, value chain and products are analysed and assessed within directives, regulations, quality standards and guidelines.

3- Enabling conditions in which HYDROUSA loops can be supported are analysed within governance scenarios and institutional capacity

4- HYDROUSA loops are preliminary analysed with concern to financing frameworks

3 HYDROUSA WATER LOOPS WITHIN EU LEGISLATION

3.1 HYDRO schemes and related boundaries relevant to the policy-legal-regulatory framework

3.1.1 HYDRO 1

HYDRO1 consists of a sewage treatment system to be applied in decentralized areas with high seasonal loads. The Upflow Anaerobic Sludge Blanket – Constructed Wetland (UASB-CW) effluent will be filtered by membranes and treated with Ultraviolet (UV) to meet the local legal standards for final water reuse (unrestricted agricultural irrigation). Furthermore, two innovative wetlands are developed at pilot scale: a bio-electrified wetland to recover small amounts of energy and decrease the required size of the wetland, and an aerated wetland to demonstrate the integration of aeration systems in wetlands, while minimizing land occupation. The excess sludge from the UASB is mixed with biomass and co-composted in an innovative in-vessel composting system, with humidity capture and plants that treat the odours.

Figure 3.1 Simplified scheme of HYDRO 1 (derived from www.hydrousa.org/)

3.1.2 HYDRO 2

In HYDRO2 the nutrient-rich water recovered in HYDRO1 is used to cultivate 1 ha of an agroforestry system. The agroforestry system will be divided in 3 main groups: forestry trees for fruit and timber production; orchards/bushes; herbs and annual crops. Superfoods like goji berries and aromatic plants, which will be processed for essential oils production will be planted. The plant setup is co-creatively elaborated with the public for a definition of business cases and to form resilient ecosystems.

Figure 3.2 Simplified scheme of HYDRO 2 (derived from www.hydrousa.org/)

3.1.3 HYDRO 3 and HYDRO 4

In HYDRO3 an innovative rainwater harvesting system is implemented in a remote area in Mykonos, where house roofs are not available. It consists of a sub-surface rainwater collection system. Harvested water is used to irrigate 0.4 ha of oregano. The cultivation of oregano was selected as it can grow on the island and requires small amounts of water.

Nutrients are provided by composting of green material. In terms of the remote rainwater harvesting unit, its capacity is adequate to serve the agricultural activities which will be implemented in the 0.2 hectare of land.
HYDRO4 upgrades an existing rainwater harvesting system of domestic residences located in a village of Mykonos to recharge water into the aquifer from rainwater and surface water, mitigating the long-encountered problem of saline water intrusion. The recovered rainwater and stormwater will be reserved both for domestic use (i.e. flushing toilet) and for agricultural use, to cultivate 0.2 ha lavender. Lavender was chosen to produce high added value essential oil. Nutrients are provided through composting of greens available on-site.

Furthermore, the harvesting system will also be implemented to reclaim potable water after slow sand filtration. The amount of drinking water that is produced aims to cover the needs of such a decentralized scheme.
The envisaged system of rainwater harvesting and drinking water production is a decentralized solution for recovering rainwater which finds application at a couple of houses. So, its scale is small since it collects water from the roofs of individual houses.

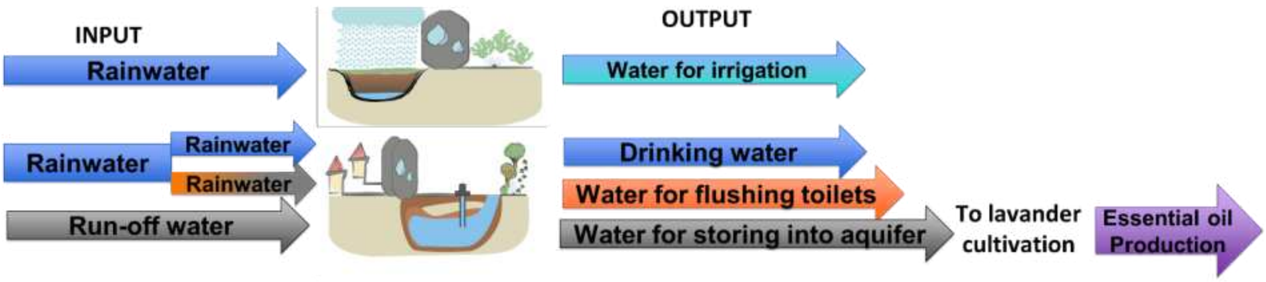

Figure 3.3 Simplified scheme of HYDRO 3 (up) and HYDRO 4 (down) (derived from www.hydrousa.org/)

3.1.4 HYDRO 5

In HYDRO5 seawater and brine from the existing desalination plant are treated in a Mangrove Still to produce clean water via evaporation and condensation and edible salt. The clean water is then used to irrigate a greenhouse where tropical fruits are produced. 180-200 m^3/year seawater will be treated throughout HYDRO5. 70 m^3 freshwater from saltwater/brine, 700 kg salt and 1.5 tons tropical fruits are targeted to recover in a year.

Figure 3.4 Simplified scheme of HYDRO 5 (derived from www.hydrousa.org/)

3.1.5 HYDRO 6

In HYDRO6 water loops are integrated within a remote eco-tourist facility. This includes the production of drinking water from vapour water using passive and active water condensation systems, the treatment of wastewater using reed beds and rainwater harvesting. Reclaimed water will be used to irrigate 0.15 ha of local crops. The facility is remotely located off the grid and thus all activities are powered using renewable energy.

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In touristic facilities, freshwater is often wasted for various purposes (amenities, tourist use, restaurants). Within the eco-tourist facility nonconventional water sources will be recovered from sewage, rainwater, water vapour to be used to cover the needs of the tourists living in the residence.

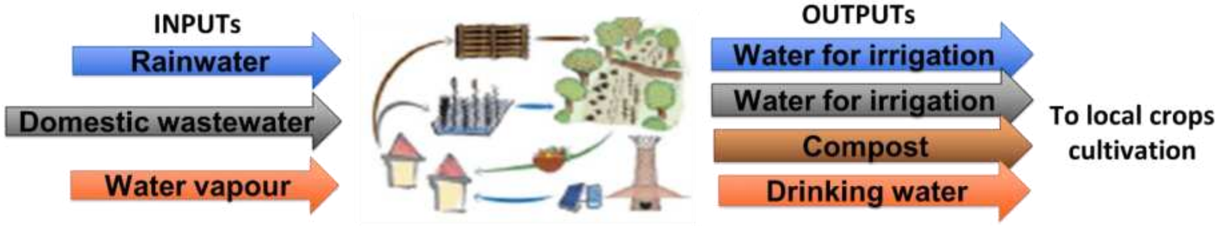

Figure 3.5 Simplified scheme of HYDRO 6 (derived from www.hydrousa.org/)

3.2 General relevance of HYDROUSA water categories & products within EU directives, international regulations and guidelines

HYDROUSA water loops were specifically evaluated at EU level in the context of: The Water Framework Directive and its daughter Directives and particularly the Urban Waste Water Treatment Directive; the Fertilizer Regulation; the Food safety legislation. Furthermore, other EU policy initiatives (EC policy framework on phosphorus; resource-efficient Europe initiative; EU biodiversity strategy; EU climate change adaptation and disaster prevention; Thematic Strategy for Soil Protection) and policy proposals were also analysed as well as the important initiatives such as the EC Innovation Deal on anaerobic MBR for wastewater treatment and reuse of the final effluent.

Measures as price incentives, awareness-raising measures and water reuse standards and targets were also analysed for HYDROUSA loops. All the products were evaluated in this context, but mainly, attention was paid to the use of treated wastewater. Moreover, the reference guidelines published by the World Health Organization (WHO) and its revision (concluded in 2019) that is key reference even for the food industry; (b) the progress of ISO/TC 282 under development standardization of water re-use of any kind and for any purpose; (c) the EU policies and ongoing changes (i.e. Proposal for Regulation of the European Parliament and of the Council on minimum requirements for water reuse); (d) existing national policies of reclaimed water reuse were also evaluated for all HYDROUSA water loops. Table 3.1 shows the relations between the HYDROUSA water loops and related EU Directive/initiative/regulation/legislation.

Table 3.1 HYDROUSA loop fitness check in international policy/regulatory/guidance framework

Directive / Regulation / Decision / Recommendation / Guidelines	Relevant INPUT	Relevant OUTPUT	Relevant HYDROs
Proposal EC COM 337/2018 and 2019 revision	Municipal Wastewater	Water for Irrigation Reuse	HYDRO 1 HYDRO 6
Council Directive 91/271/EEC1(+98/15/EC) (UWWTD) and ongoing revision (COM (2017) 749)			
WHO Report 2006			
ISO/TC 282			
86/278/EEC Sewage Sludge Directive	Municipal Wastewater (Sewage Sludge/Digestate)	Compost	HYDRO 1 HYDRO 6
86/278/EEC Sewage Sludge Directive and amendment (EC 219/2009)			
STRUBIAS Technical Proposal 2019 EC/JRC Report			
EC report on Digestate and compost as Fertilizers			
EC 178/2002 on procedures in matters of food safety	Water for irrigation, Compost, Seawater and domestic wastewater	Crops (for Food and industrial uses), Salts from Brine	HYDRO 2 HYDRO 5 HYDRO 6
EC 1881/2006 on maximum levels for certain contaminants in foodstuffs			

EC Best Environmental Management Practice in The Tourism Sector	Rainwater	Rainwater for: Irrigation, Drinking water and domestic uses	HYDRO 3 HYDRO 4 HYDRO 6
Environment Agency Harvesting Rainwater for Domestic Uses: An Information Guide			
EC 83/1998 Drinking Water Directive and amendment (EU 2015/1787)	Rainwater, water vapour, Seawater	Drinking Water	HYDRO 4 HYDRO 5 HYDRO 6
Proposal EC COM 753/2017 (2018) on the quality of water intended for human consumption			
WHO Guidelines for Drinking-Water Quality (GDWG)			
Small-scale drinking water supplies in the pan-European region (UNECE/WHO Regional Office for Europe, 2011) *and* Water safety planning for small community water supplies (WHO, 2012)			
EC 118/2006 - The Groundwater Directive (GD)	Rainwater, stormwater run-off	Water for aquifer recharge	HYDRO 4
2000/60/CE - Water Framework Directive (WFD)			
EU 80/2014 on the protection of groundwater against pollution and deterioration			
EC 2003/2003 Fertilizer Regulation and subsequent (EU 463/2013) and (EC 1009/2019)	Municipal wastewater	Recovered fertilizers	HYDRO 1
EC 2001/2018 on the promotion of the use of energy from renewable sources	Municipal Wastewater	Biogas for Biofuel	HYDRO 1
EN 16726 European standard that on the quality of gas of the H category			
EN 16723-2 Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 2: Automotive fuels specification			

In the following sections, legislation's relations with the HYDRO solutions are evaluated. The purpose of the analysis was to highlight if the implementation of the HYDRO, at European level, is enabled, supported or hindered by barriers. The latter derive from the application of a specific regulation to one of the INPUT flows or the HYPRO OUTPUT products. For this purpose, for each directive summary tables were prepared, and results were highlighted with different colours. Specifically, each Directive/Regulation/Decision/ Recommendation /Guidelines can influence HYDRO implementation in one of the following ways:

- ***Green***. The implementation of the HYDRO is not hindered by law or guidelines. The use/reuse of the output recovered/produced from the treatment/system of the input is clearly allowed whenever the local given requirements / quality standards are achieved;
- ***Yellow***. No clear barriers were found for the implementation of the HYDRO. However, the possibility of using/reusing the output recovered/produced is not clearly provided or recommended by law or guidelines;
- ***Red.*** The implementation of the HYDRO is hindered by law that does not provide the use/reuse of the output for the specific purposes planned by the project.

3.2.1 Water Framework Directive

The overarching European Water Framework Directive (WFD) 2000/60/EC is one of the key instruments of the EU policy (European Commission, Evaluation Roadmap, Q3 2019). Its main objective is to achieve good qualitative and quantitative status of all water bodies (including marine waters up to one nautical mile from shore). It is a framework in the sense that it prescribes steps to reach the common goal rather than adopting the more traditional limit value approach.

In the WFD, the use of reclaimed water is considered as a means of increasing water availability which may contribute to the good quality status of water resources; it should therefore be considered as an option in the 'programmes of measures' to be established when implementing the WFD. The Directive refers, under Annex VI (v), to 'emission controls' and, under Annex VI(x), to 'efficiency and reuse measures, promotion of water efficient technologies in industry and water saving techniques for irrigation' to help achieve good environmental status of water bodies.

Recently (in December 2019) Fitness check of the Directive was concluded, verifying its relevance, effectiveness, efficiency, coherence and EU added value (European Commission, Fitness Check of the Water Framework Directive and the Floods Directive. SWD (2019) 439 final). The evaluation report will lead to a Legislative proposal (in 2021-2022) (Pertierra et al., 2019) in which main problems in directive implementation will be managed. Specifically, the next program of measures will aim to ensure the necessary instruments for the achievement of the environmental objectives by the 2027 (European Commission, Commission Staff Working Document. Fitness Check. SWD (2019) 439 final).

Concerning the implementation of HYDROUSA solutions (i.e. HYDRO 4) in the in-force legislative context, the directive was analysed to better understand minimum requirements and conditions for aquifer recharge, including sources of water intended for the recharge. In this perspective, the WFD in Art. 11(3(f)) provides information on the possibility to artificially recharge or increase groundwater bodies by using water that *"…may be derived from any surface water or groundwater…"* as long as it *"…does not compromise the achievement of the environmental objectives…"* and after a prior authorization. Control measurements must be periodically done according to prescriptions in Annex II (part 2) and V (part 2). Thus, in the WFD, there is no explicit limitation to use a specific type of water; the only requirement concerns the achievement of quality standards defined in the legislation (either in the WFD itself or in other related Directives).

Furthermore, despite the WFD provides few references for what concerns water sources intended for drinking water production (Art.7(1) and (2)), information is provided only for the use of waters from water bodies. Thus, no explicit permit or prohibition is express for rainwater use for drinking water production. The EU Water Framework Directive's relation with HYDROs is schematized in Table 3.2.

Table 3.2 The EU Water Framework Directive relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF WATER FRAMEWORK DIRECTIVE	
Aim of the Directive	Maintaining and improving the aquatic environment in the Community
Scope of the Directive	• Control of quantity is an ancillary element in securing good water quality and therefore measures on quantity; • Serving the objective of ensuring good quality
Environmental Objectives & Monitoring	• Implementing the necessary measures to prevent deterioration of the status of all bodies of surface water; • Establishment of programmes for the monitoring of water status
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From Run-off water and Rainwater to aquifer recharge; From Receiving Waterbody to Drinking Water
Related HYDROs	HYDRO 4, HYDRO 6
Possible barrier or constraint	No specific barriers/boundaries are identified for implementation and exploitation of the HYDROs

3.2.2 Groundwater Directive

The Directive 2006/118/EC, "Groundwater Directive" (GD), defines prescriptions for groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater (https://ec.europa.eu/environment/water/water-framework/groundwater/framework.htm). The directive considers local characteristics for setting quality criteria concerning the chemical status of groundwater, in response to the requirements of the WFD. MS should determine the most proper level for their standards, taking into consideration their local or regional conditions. The GD supports the WFD in implementing the groundwater quality standards by analysing pollution trend studies, enforcing measures to prevent or limit inputs of pollutants into groundwater and granting compliance with nitrates and pesticides EU standards as well as with threshold values defined by Member States (https://ec.europa.eu/environment/water/water-framework/groundwater/framework.htm). Annexes I and II of the GD were reviewed in 2013 and are reflected under the Commission Directive 2014/80/EU of 20 June 2014.

In the context of HYDRO 4 implementation, as even according to the WFD, no explicit limitation in the use of specific water source for artificial/managed recharge or augmentation are reported in the present directive. However, safety and sustainability of managed aquifer recharge depends on local conditions and presence of contaminants (e.g. pesticides) in the stormwater run-off that may impact on the groundwater quality, so major attention is needed within national and local legislations towards appropriate controls, that can vary greatly from jurisdiction to jurisdiction. In particular, the directive requires to the member States the establishment of threshold values of As, Cd, Pb, Hg, NH4, Cl, SO4, PCE, TCE and electrical conductivity. These threshold values have to take into account the intrinsic or natural concentrations.

Nevertheless, in case of artificial recharge the allowed concentration of contaminants can be adapted to each situation by the correspondent environmental authority avoiding the violation of other regulations. The EU Groundwater Directive's relation with HYDROs is schematized in Table 3.3.

Table 3.3 The EU Groundwater Directive relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF GROUNDWATER DIRECTIVE	
Aim of the Directive	Protection of groundwaters against pollution and deterioration
Scope of the Directive	Defines prescriptions for groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater
Environmental Objectives & Monitoring	• to prevent deterioration of the status of groundwater; • Establishment of programmes for the monitoring of water status
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From Run-off water and Rain water to aquifer recharge
Related HYDROs	HYDRO 4
Possible barrier or constraint	No specific barriers/boundaries are identified for implementation of HYDROs – attention to protection of underground sources of drinking water and appropriate control to stormwater run-off; safeguarding groundwater intrinsic or natural qualities

3.2.3 Urban Waste Water Treatment Directive

The Council Directive 91/271/EEC "Urban Waste Water Treatment Directive" (UWWTD) is one of the key elements of the EU water policy. The adopted directive has the main objective of protecting the environment from the adverse effects of urban wastewater and certain industrial sectors discharges (see Annex III) and concerns the collection, treatment and discharge of: domestic waste water, mixture of waste water, wastewater from certain industrial sectors. Specifically, the UWWTD defines that the main objective can be achieved by:

- ensuring the collection of wastewaters from all European agglomerations with more than 2,000 population equivalents (p.e.) (Art.3);
- ensuring that wastewater is subjected to biological wastewater treatments (i.e. secondary treatment) for reducing the biodegradable pollution in wastewaters (Art.4);
- ensuring that in sensitive areas (i.e. those subjected to eutrophication or used for bathing or drinking water abstraction) and their related catchments, stricter treatments are necessary to remove nutrients (principally nitrogen and/or phosphorus) before the wastewater discharge in cases of p.e. > 10,000 (Art.5).

The in-force UWWTD was recently evaluated and assessed. In fact, a Regulatory Fitness and Performance programme (REFIT) evaluation was started in October 2017 with the aim of aligning the UWWTD nature to the WFD one and thus reduce the substantial legislative and political differences between the instruments (European Commission, Publication of the consultation strategy, Q1 2019). Since the UWWTD is essential for the goals of the WFD, a proper revision of the UWWTD may identify areas where simplifications or implementation are needed in order to increase the synergy with the WFD and to easily achieve its objectives. The evaluation, through assessing five criteria (i.e. effectiveness, coherence, efficiency, relevance and EU-added value), outlines the direction in which Europe is going (European Commission, Evaluation Roadmap, 2017). Specifically, the compliance assessment, resulted from public consultation, highlights a slight decrease in EU compliance (from the previous consultation) concerning the collection, secondary and stricter treatments applied to wastewaters (from 98.4% to 94.7%, from 91.9% to 88.7% and from 87.9% to 84.5% respectively) (European Commission, COM (2017) 749 final). These results make additional efforts necessary to reach the compliance, especially in cases of big agglomerations (> 100.000 p.e.) and medium cities (from 10.001 to 100.000 p.e.) since they represent the 51% and 38% of the total generated wastewater loads, respectively. In this perspective, the Commission implemented several initiatives to support and ensure the full implementation of the UWWTD and to face some of the still ongoing challenges as (European Commission, COM (2017) 749 final):

- Improving the quality and recovery of sludge;
- Minimizing the effects of storm water overflows that pollute water bodies with untreated wastewater, by a) encouraging the use of natural water retention systems; b) enhancing the management of the networks connected with treatment plants; c) additional investments;
- Increasing the reuse of treated wastewater (in cases of water scarcity), guaranteeing the proper water quality;
- Enhancing the energy consumption of sanitation systems, producing (when possible) renewable energy at treatment plant level (e.g. biogas);

With regard to the implementation of specific HYDROUSA solutions which involve the decentralized reuse of wastewater (i.e. HYDRO 1 and 6), Art. 12(1) of the still in-force UWWTD, encourages to the reuse of "treated wastewater…whenever appropriate", as far as it is not forbidden or restricted by any other EU legislation and it does not affect the achievement of the environmental objectives. Flexibility is left to Member States (MS), who can make their decisions on a case-by-case basis. Thus, according to the directive no limitations are specified for the reuse of treated wastewater except for the compliance to the quality standard. However, compliance with the UWWD (91/271/EEC) requires large wastewater collection and treatment investments in urban areas, which in turn may lead to governments giving lower investment priority to tackling sanitation challenges in rural areas or for small and decentralized solutions like the HYDROs (The Danube Water Program, RWSS Report 0418, 2018).

Further, in Art. 14(1) the directive encourages to the reuse of sludge from wastewater treatment *"…whenever appropriate…"*. This generic encouragement, although not defining the specific conditions for re-use, does not deny the possibility of implementing technologies whose objective is the treatment of sewage sludge for its re-use. In the context of HYDROUSA, the UWWTD's relation with HYDROs is schematized in Table 3.4.

In December 2019 the "Evaluation of the UWWTD" has been published. The final report highlights how "other remaining sources of loads result from the use of potentially mal-functioning individual or other appropriate systems. The Directive allows the use of these systems where a collection systems comes at disproportionate costs, and as long as these individual systems achieve the same level of environmental protection. But it is not clear on the extent to which this provision can be applied and how the functioning of these systems should be monitored". In addition, the evaluation highlights as "those small agglomerations or non-connected dwellings not completely covered by the Directive constitute a significant pressure on 11% of the EU's surface water bodies". Finally "As regards circular economy potentials, the UWWTD contains limited provisions on waste water and sludge reuse or recovery of valuable components. These have never been strictly enforced, partly due to the lack of strong harmonised standards at EU level and the potential risks to human health. The adoption of the Commission proposal on iv water reuse will create further incentives to reuse water". Therefore, HYDROUSA is addressing both "individual or other appropriate systems" and the small agglomerations and the sustainable resource recovery and safe reuse.

The HYDROUSA consortium provided a position which was sent to the EC to be considered during the consultation stage of the UWWTD. The HYDROUSA position focused mainly on the need to improve regulations for decentralized schemes.

Article 3 of the UWWTD specifies that "*where the establishment of a collecting system is not justified either because it would produce no environmental benefit or because it would involve excessive cost, individual systems or other appropriate systems which achieve the same level of environmental protection shall be used*."

Discharges of wastewater, originating from areas outside agglomerations and agglomerations with less than 2,000 p.e. without a collecting system, should comply with the relevant quality objectives and the relevant provisions of other Community Directives for receiving waters, such as Directive 2000/60/EC and Directive 2006/118/EC. A range of wastewater disposal arrangements is excluded from the scope of the UWWTD because they occur outside agglomerations covered by Article 3(1) (i.e. agglomerations of less than 2,000 p.e.). Nonetheless, it is important to remember that there are considerable challenges to ensure that existing practices (such as the use of septic tanks, cesspits, etc.) do not cause water pollution.

Considering the application of individual or appropriate systems (IAS) as an alternative to the centralised collection, the Commission is investigating whether the conditions for applying IAS (registration, permits, monitoring and inspection, types and related environmental protection) are in line with UWWTD requirements. It should be noted, however, that the UWWTD does not specify the characteristics of these systems, nor the design specifications.

As a result, and in view of the evaluation process of the UWWTD, the IAS are currently being vividly discussed and further justification for their adoption by the Member States is required by the DG Environment. It is anticipated that IAS should be framed by specific regulations in the future. Specifically, the requirements for designing, constructing and maintaining IAS must be defined and environmental protection must be ensured on the same level as a collecting system followed by centralized wastewater treatment.

The key challenges for their adoption are linked to specific regulations: framing or specifically defining the application of IAS, technical standards for eligible IAS technologies, setting minimum requirements for their design, structure and performance. In this framework, HYDROUSA project endorses an integrated, decentralized approach of wastewater treatment linked to sustainable development, water resources and energy conservation and environmental protection. HYDROUSA state-of-the-art implemented practices promote IAS and can highly improve the previous efforts made in the past by the EC.

The main approach in the HYDROUSA project is to utilize nutrients present in residual streams. In this sense, the nutrient-focused or resource-oriented approach suggests to start thinking in nutrients rather than contaminants. In the HYDROUSA case, wastewater is used after effective treatment to overcome the big trade-off of conventional recovery systems, where energy or chemical input is exchanged with nutrient recovery. The nature-based systems, which are applied within HYDROUSA are characterized by very low energy footprint.

Moreover, with concern to the EC proposal for a regulation that defines minimum quality standards for reclaimed water to be used for agricultural irrigation, HYDROUSA will demonstrate how IAS can deliver safe water for irrigation and fertigation. In addition, we, the HYDROUSA team, will address the risk management that is more critical for smaller systems. Finally, HYDROUSA digital solutions will increase transparency in water reuse by potentially allowing public access to online information about water reuse practice in small and decentralized systems and potentially even in bigger systems.

Table 3.4 The UWWTD relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF URBAN WASTE WATER TREATMENT DIRECTIVE	
Aim of the Directive	To protect the environment from the adverse effects of urban wastewater discharges and discharges from certain industrial sectors
Scope of the Directive	Collection, treatment and discharge of urban wastewater and the treatment and discharge of wastewater from certain industrial sectors
Environmental Objectives & Monitoring	Discharge parameters are specified (i.e. BOD_5, COD, total Suspended Solids, Total phosphorous, Total Nitrogen)
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From Wastewater to Water for Irrigation Reuse Sewage Sludge to be reused
Related HYDROs	HYDRO 1, HYDRO 6
Possible barrier or constraint	No specific barriers/boundaries are identified for implementation of HYDROs (as far as local quality standard are achieved and proper control is in place). Small and decentralized solutions might have lower investment priority

3.2.4 Proposal for regulation on reclaimed water reuse

On 28 May 2018, the Commission put forward the Proposal for Regulation of the European Parliament and of the Council on minimum requirements for water reuse 2018/0169 (COD) aimed to increase the uptake of water reuse, in particular for agricultural irrigation wherever this is relevant and cost-effective while ensuring the maintenance of a high level of public health and environmental protection. The proposed type of legal instrument (a regulation) is intended to stimulate market uptake, as it would be directly applicable to businesses, and to come into force faster than an amendment to the Urban Waste Water Treatment Directive. The proposal would apply solely to water reused for agricultural irrigation. The Commission notes in this regard that agricultural irrigation has the highest potential for an increased uptake of water reuse. On 12 February 2019, Parliament adopted its position at first reading. Council reached agreement on its general approach on 26 June 2019. On 2 December 2019, Parliament and Council reached a provisional agreement on the legislative proposal in inter-institutional negotiations (https://www.europarl.europa.eu/committees/en/envi/subject-files.html?id=20191218CDT03241).

The proposal of the regulation was prepared in line with the regulatory framework at EU level on health and environmental protection, along with their experience in water reuse systems, world-wide reference guidelines and regulations on water reuse, additional scientific references considered relevant for the topic. Within the scope of the proposal, classes of reclaimed water quality and allowed agricultural use are defined as well as permitted irrigation methods. Specifically, reclaimed water quality requirements are established and minimum frequencies concerning the routine monitoring for agricultural irrigation (in accordance with the classes) are prescribed. Additionally, key risk management tasks and specific preventive measures for a certain water quality class water are specified. According to the proposal, adequate quality control and environmental monitoring systems are in place and appropriate precautions are taken in the case of emergencies. In the context of HYDRO1 and HYDRO6, relation with this proposal is found and, for the implementation of the technologies, limits for the reclaimed water reuse must be taken into consideration in the replication sites.

With a view to develop and promote the reuse of properly treated wastewater as much as possible, reclaimed water reuse is encouraged even for other purposes than those established by this Regulation (i.e. reuse for industrial, amenity-related and environmental purposes) as long as MS ensure compliance with the obligations and guarantee a high level of protection of human and animal health and the environment. Further the definition of "permit or authorisation" provides information on the necessity to have a *"written approval issued by the competent authority to produce and/or supply reclaimed water for agricultural irrigation…"*.
The Council Position introduces, in the revision, prescriptions related to the Table 1 of Annex I for classes C and D of reclaimed water. Specifically, for C category drip irrigation but also *"…other irrigation method that avoids direct contact with the edible part of the crop"* are allowed, while for D class further details are given for irrigation methods which imitate rain. In this case *"…special attention should be paid to the protection of the health of workers or bystanders…"* and *"…appropriate preventive measures should be applied"*. Concerning the limits to comply with, minor modifications are made by the Council concerning the Salmonella and Clostridium perfringens (See Table 9.1 in Annex 9.1).

Specific preventive measures (See Section Treated water for irrigation), compared to the previous version of the commission proposal, are implemented for: sprinkler irrigation (i.e. maximum wind speed, distances between sprinkler and sensitive areas), agricultural fields (i.e. slope inclination, field water saturation, karstic areas), minimum safety distances (i.e. from surface water etc…) and signage for reclaimed water reuse. It should also be considered that for small-scale systems such as in the case of HYDROs, it is essential to follow the risk-based approach defined by Water Reuse Risk Management Plans (WRRMPs), which are included in the proposal 2018/0169 (COD) with guidelines currently under definition within institutional European boards. In the context of HYDROUSA, the proposal represents not only a way to encourage the reuse of urban wastewater (in agreement with UWWTD Art.12(1)) but also a fundamental instrument to evaluate necessary requirements and conditions for the reuse of treated wastewater for agricultural purpose. The proposal's relation with HYDROs is schematized in Table 3.5.

Table 3.5 The Reclaimed water reuse proposal relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF RECLAIMED WATER REUSE PROPOSAL	
Aim of the Proposal	To manage water scarcity across Europe and increase the uptake of water reuse
Scope of the Proposal	To set minimum requirements for agricultural irrigation
Environmental Objectives & Monitoring	Minimum frequencies for routine monitoring
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From wastewater to water for agricultural irrigation reuse
Related HYDROs	HYDRO 1, HYDRO 6
Possible barrier or constraint	Not identified. HYDROs implementation enabled and supported, when quality standards and regulation requirements are achieved

3.2.5 Drinking Water Directive (and Water Safety Plans)

The Council Directive 98/83/EC of 3 November 1998, and its latest amendments including Commission Directive (EU 2015/1787, known as "Drinking Water Directive" (DWD) concerns the quality of water for human consumption. The directive applies to distribution systems serving more than 50 people or that supply more than 10 cubic meters per day for use of human consumption. However, the level of de facto compliance varies among countries. Under the DWD, rural people relying on individual (or shared) self-supply, such as wells or local springs, are not regulated. Its objective is to protect human health from negative effects of any contamination of water destined to human consumption by granting its healthiness and cleaning (https://ec.europa.eu/environment/water/water-drink/legislation_en.html). Specifically, the in-force directive recommends that MSs monitor and regularly test 48 microbiological, chemical and indicator parameters (set in Annex I to the directive) whose values are generally based on the guidelines for drinking water of the World Health Organization (WHO). On 11/Sept/2017 the WHO published the "Support to the revision of Annex I Council Directive 98/83/EC on the Quality of Water Intended for Human Consumption (Drinking Water Directive) – Recommendations". Generally, WHO considered the need for a new approach to assuring drinking-water safety that would be proactive in preventing risks to health, where water safety plan (WSP) approach is a core pillar. For each supply, WSPs lead to the development of a supply-specific profile of chemical and microbiological hazards of local concern, including the events and routes by which those hazards can enter the supply. Such profiles form the basis for effective management, operation and monitoring of water supplies. In synopsis, WHO recommended: (a) Stipulating periodic catchment appraisals and investigative monitoring of source water quality; (b) Introducing generic and specific requirements for operational monitoring; (c) Refining requirements for assessing and effectively controlling potential health risks from enteric pathogens in drinking-water; (d) Introducing specific requirements for prevention and control of Legionella proliferation in warm drinking-water installations in priority buildings; (e) amending and restructuring Annex I. **The application of such a risk-based approach to water safety, together with investigative and vigilant monitoring of source water quality, is crucial to evaluate the economic sustainability of small and decentralized solutions based on alternative water sources and low-cost treatments. As for the HYDROUSA sites, where climate is warm, particular attention should be paid even to microbial safety and pathogens proliferation.** In the decentralized system context, the "Water safety planning for small community water supplies" (WHO, 2012) should be anyway considered for the application of a **comprehensive risk assessment and risk management.** The validity of WSPs is based on universal principles of public health protection and therefore applicable to any water supply regardless of size, system layout or organizational configuration. In particular, the added value obtained from the implementation of the WSP, as a proactive and preventive approach for identifying and assessing the risks for the supply of drinking water, stimulates the creation and dissemination of programs aimed at raising policy awareness maker towards the implementation, at various levels, of small-scale water supply improvement policies. The analysis of the hazards and critical control points provided by the WSP (HACCP) can provide a fundamental tool for achieving numerous advantages, including (WHO, 2011): more reliable operation of decentralized small-scale structures; improvement of the quality and compliance of drinking water; support for prevention and management; more considerable attention towards risks to human health; schedule of updates; stimulation of multi-stakeholder cooperation and communication. In this perspective, the solutions proposed by HYDROUSA, respecting the criteria defined by the WSP, also offer an answer to problems related to the sustainability of the water demand through solutions that can be easily adapted and replicated to any possible circumstance (www.hydrousa.org).

The WHO recommendations were taken into account in the Proposal EC COM 753/2017 (01.02.2018), the directive is being implemented since quality standards did not fully reflect the scientific progress, monitoring method does not grant systematic risk assessment and information on water quality provided to consumers was insufficient (Laaninen, 2019). The proposal, adopted by the European Commission on 1 February 2018, seeks to improve water quality and safety by focusing the attention on critical issues such as:

- Emerging contaminants (i.e. perfluorinated compounds), disinfection by-products and distribution impurities (i.e. chlorate, and endocrine disrupting compounds such as bisphenol A);
- Microbiological parameters such as Clostridium Perfringens spores, coliform bacteria and somatic coliphages (upon the WHO's recommendation);
- Materials in contact with drinking water. Specifically, rules on materials (defined in Art.10 of Directive 98/83/EC) will be revised and a standardization mandate will be issued under the Construction Products Regulation, to set requirements applicable to products in contact with drinking water (European Commission, COM (2017) 753).

According to the position taken by the European Council at the Environment council on 5 March 2019, hygienic requirements for materials in contact with drinking water should be established through implementing acts (Dantin and Hansen, 2019).

Regarding the relevant HYDROUSA solutions (HYDRO 4, 5 and 6), the proposal provides necessary requirements for the compliance of the output but does not provide specific information on the possibility to produce drinking water from the used input (i.e. rainwater and/or water vapour). On the other hand, the Joint Monitoring Program (JMP) for Water Supply and Sanitation of WHO includes rainwater as "improved" drinking water source in rural or urban areas, where "improved" is referred to protection from external contamination, especially referred to faecal matter. On the other hand, vapour water is not included in the drinking water source. In fact, the proposal integrates Articles 6, 7 and 8 of the WFD only for what concerns the requirements of the water bodies used for abstraction of drinking water. However, hazard assessment of bodies of water used for the abstraction of water intended for human consumption (new), supply and domestic distribution risk assessment and new monitoring rules may become an economic constraint for small decentralized solutions using alternative water sources such as water vapour and rainwater, where compliance to water directive can be not sustainable from economic viewpoint. Therefore, barriers and constraints for the implementation of HYDRO solutions need to be analysed at national and local level considering a risk-based approach to water safety. In the context of HYDROUSA, the proposal's relation with HYDROs is schematized in Table 3.6.

Table 3.6 The Drinking water proposal relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF DRINKING WATER DIRECTIVE	
Aim of the Directive	To protect human health from negative effects of any contamination of water destined to human consumption
Scope of the Directive	To define prescription and requirements to improve drinking water quality
Environmental Objectives & Monitoring	microbiological, chemical, indicator parameters, materials and water bodies used for abstraction of drinking water. Risk-based approach to water safety and periodic investigative source water monitoring
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From Rainwater or vapour water to Drinking water
Related HYDROs	HYDRO 4, HYDRO5 and HYDRO 6
Possible barrier or constraint	No specific general barriers are identified for implementation of the HYDROs. However, compliance with potable quality to the standards required by the Drinking Water Directive, periodic monitoring of variable alternative water sources (e.g. harvested rainwater) and risk-based approach to water safety can lead to relevant economic and technical barrier for low-cost decentralized solutions. These should be addressed even within WSP properly developed for the specific cases

3.2.6 Sewage Sludge Directive

In the context of HYDROUSA Project, sewage sludge is one of the valuable INPUTs that can be treated for possible reuse, specifically for producing compost. Despite possible problems with concentrations of heavy metals and potential pathogenic organisms (viruses, bacteria etc.) present in the generated sludge, this matrix is rich in nutrients (i.e. nitrogen and phosphorous) and contains valuable organic substrate, useful for improving the soil properties. The organic matter and nutrients are the two main elements that make the spreading of this kind of waste on land as a fertilizer or an organic soil improver suitable (https://ec.europa.eu/environment/waste/sludge/).

The Directive 86/278/EEC "Sewage Sludge Directive" (SSD) regulates the use of sewage sludge for agricultural purposes (Art.3(2)) as long as MS implement necessary measures for protecting human and environmental health and for preventing harmful effects on soils. For this purpose, it prohibits the direct use of untreated sludge, namely the sludge which has not "…undergone biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use" unless it is injected or incorporated into the soil (Art.6(a)). Further the SSD specifies that sludge must not be applied to soil in which fruit and vegetable crops are growing or grown, or less than ten months before fruit and vegetable crops are to be harvested (Art.7).
Since SSD of 1986 is 20 years old and several MS have implemented stricter limits for heavy metals and other contaminants, the directive had to be revised. After few revisions (in 1991, 1995 and 2003) in 2009 the European Commission adopted the in-force Regulation (EC) No 219/2009 in which the provisions of the Annexes (II C on sampling and analysis methods) are adapted to the technical and scientific progress. It must be noticed that, in the consolidated version of 15/07/2019, no changes on limits regarding the concentrations of heavy metals in soils and in sludge were done and other prescriptions/restrictions for sewage sludge uses have remained unchanged.
In the context of HYDROUSA, specifically for HYDRO 1 and 6 implementations, limitations to reuse the treated sewage sludge for agricultural purposes concerns the prohibition of use in cases of:

- pastures or fodder crops where grazing or forage harvesting is carried out on these soils for a period of three weeks;
- on land used for horticulture and fruit-growing during the growing season. Exemption for fruit trees; on land used for horticulture and fruit-growing, whose products are normally in direct contact with the soil and are eaten raw. This prohibition applies for ten months before the harvest and during the harvest itself.

The SSD's relation with HYDROs is schematized in Table 3.7.

Table 3.7 The Sewage Sludge Directive relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF SEWAGE SLUDGE DIRECTIVE	
Aim of the Directive	To define possible reuse of sewage sludge for soil improvements
Scope of the Directive	To define prescription and requirements for use of sewage sludge
Environmental Objectives & Monitoring	Pathogens, heavy metals, organic contaminants as indicator parameters, sampling and analysis methods
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From Sewage Sludge to Soil improvement
Related HYDROs	HYDRO 1, HYDRO 6
Possible barrier or constraint	No general barrier identified if the quality complies with quality standard for land application (for HYDROs major focus should be on pathogens). HYDROs implementation supported, but with limitations for food crops growing period

3.2.7 Focus on Faecal Sludge

Faecal sludge, raw or partially digested, slurry or semisolid, derives from onsite sanitation systems (OSS) and, differently from Sewage Sludge, is not transported through a sewer, but it is collected, stored or treated in combinations of excreta and blackwater, with or without greywater. Some examples of onsite technologies applied are: pit latrines, unsewered public ablution blocks, septic tanks, aqua privies, and dry toilets (Strande et al., 2014). For the correct faecal sludge management (FSM), proper collection, transport, treatment and safe end-use (or in case disposal) are necessary.

In this perspective, the most detailed part of some FSM regulations regards the design of toilet systems and their control. Different countries and international organizations (i.e. the World Bank, World Health Organization (WHO), United Nations Children's Fund (UNICEF), WaterAid, and the Netherlands Development Organisation (SNV)) have defined or collected guidelines regarding the OSS that can be applied in urban, peri-urban and rural contexts (Jayathilake et al., 2019). Further OSS are recommended both in case of high-density and low-density settlements such as: Single pit latrine, ventilated improved latrine, pour flush toilet, double vault composting toilet, self-topping aqua privy, septic tank and container-based sanitation. Some national OSS standards, originated from international guidelines, provide regulations and prescriptions for the design, construction and operation of OSS not only for developing countries but also for high-income countries where OSS coexist with sewer systems.

Concerning the treatment and disposal of FS, prescriptions are provided in order to avoid possible risks to public health and the environment. Guidelines and OSS are summarized in

in Annex 9.1. With a view to the reuse, different opportunities can be evaluated such as: soil conditioner (FS raw or composted or co-composted in land application), building materials (cement mixture), biofuel (gas, char briquettes) and in the production of protein (e.g., animal feed and via the black soldier fly). However, with the exception of land application in agriculture, aquaculture and disposal, the rules and guidelines for other reuse applications are rare.

Through Directive 86/278/EEC, the EC has set limits on the heavy metal concentrations allowed (in soils and sludge) for the application of the sewage sludge in agriculture. Specifically, since in the context of this Directive residual sludges from domestic or urban WWTPs as well as septic tanks are regulated (Art.2 (a -i, -ii, -iii)), thus FS can be included in this regulation (See Section 3.2.6).

3.2.8 Focus on Decentralized (Community or Domestic) Composting

Decentralized composting is the composting at a neighbourhood or community scale (The World Bank, 2000). United Nations Environment Programme (UNEP, 1996) sets requirements for the composting site for environmentally friendly community composting:

- the site has to be accessible to all individuals who want to use it
- the site has to be clearly designated with signs which all users and non-users can understand
- the site should have approval from all surrounding land users
- the site should have adequate controls to prevent it from becoming an area for local dumping
- the site should have appropriate soil and drainage to accommodate the leachate

Feedstocks for community composting are food scraps e.g. (fruits & vegetables, breads & grains, meat & dairy), industrial and commercial food processing by-products, butcher residuals, animal manures (cow, chicken), grass, woody materials (e.g. wood chips, sawdust, bark, leaves, garden wastes, hay, straw), well - bedded manures (varies widely, e.g. horse bedding, calf bedding), paper & card board, fats & greases (Platt, 2014). There are several projects on community compost in the US (e.g. in New York, Philadelphia) (Platt, 2014).

On the other hand, in Canada, the manual for composting toilets was released in 2016. According to the manual, the system receives excreta from residential use only and set specific limits for Residual organic matter quality for on-site surface discharge such as pathogens, moisture content, C:N ratio (BC Ministry of Health, 2016). Although there are some manuals for composting toilets, there is no regulation for community composting or for composting toilets.

Table 3.8 The Community Composting relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT DECENTRALIZED (COMMUNITY OR DOMESTIC) COMPOSTING	
Aim	Defines requirements for community composting
Scope	Safe and environmental-friendly measures for community composting
Environmental Objectives & Monitoring	Sets requirements for environmental-friendly community composting
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From sewage sludge to compost
Related HYDROs	HYDRO 1, HYDRO 6
Possible barrier or constraint	No general relevant barriers are identified for implementation of HYDROs, but need to comply with local legislation and compost quality standard

3.2.9 Fertilizing Product Regulation and Recent Reports on Digestate and Compost

In February 2019, Wood with partners Peter Fisk Associates and Ramboll published a report on “Digestate and compost as fertilizers: Risk assessment and risk management options” for European Commission, DG Environment. This project aimed to prepare an environmental and human health risk assessment and a risk management options analysis (RMOA) for decision makers where regulatory measures are needed to prepare to control the risks associated with contaminants in compost and digestate (hereafter referred to as C/D) used as a fertilizer and soil improver. According to the risk assessment, potential risks (and safe limits) specifically for digestate and/or compost applied to agricultural land have been found for Mercury (safe limit of 0.2 mg/kg dw). Heavy metals (Nickel (Ni), Lead (Pb), Copper (Cu), Zinc (Zn), Mercury (Hg)), 17α-ethinylestradiol, PCBs (PCB28), dioxins and furans (TCDD, PCDF), Nonylphenol, PFAs (PFOA, PFOS), Cadmium and PAH16 substances (as a lower priority) were defined as priority substances for risk management.

The report shows that, there is not any restriction on input materials, on uses or reduction of contaminants through specific processes in the EU regulations neither compost nor digestate used as fertilizer. Thus, when HYDRO1 are intended to apply in the EU countries, there is no limitation on the input materials for compost application. However, national-level regulations should be evaluated as they can include restrictions on allowed concentrations for input materials.

Moreover, the European Compost Network (ECN) Assurance Scheme for Compost and Digestate includes further risk management measures; these include restriction of input materials for CE-marked fertilizers under the Fertilizing Products regulation (e.g. sludges and not separately collected waste are excluded) and limit values for heavy metals. It also lays down harmonized requirements for national certification bodies as well as quality criteria for recycled materials from organic sources in digestate and compost (ECN, 2018).

In the JRC Science for Policy report (Process and quality criteria; assessment of environmental and market impacts for precipitated phosphate salts and derivates; thermal oxidation materials and derivates; pyrolysis and gasification materials), published in 2019, the technical and market conditions were evaluated for a possible legal framework, for the manufacturing and placing on the market of specific safe and effective fertilizing products derived from biogenic wastes and other secondary raw materials. In the report, the information on technical proposals on eligible input materials and process conditions for STRUBIAS (STRUvite, BIochar, or incineration AShes) production pathways, quality requirements for STRUBIAS materials, and quality management systems were collected and assessed. Moreover, the possible impacts of STRUBIAS on food security, food safety, environmental protection, and the European fertilizing and agricultural sector were evaluated. STRUBIAS materials are mainly manufactured from specific secondary raw materials, including waste and by-products within the meaning of Directive 2008/98/EC and biological materials. Several STRUBIAS materials show a substantial potential to provide safe sources of phosphorus (P) that can constitute an alternative for the primary raw material phosphate rock. The compost which would be produced within HYDRO1, can contribute P recovery. In HYDRO1 N and P are also recycled through fertigation.

According to the STRUBIAS recovery rules, phosphate salts can be obtained from wastewaters and sewage sludge from municipal wastewater treatment plants by anaerobic digestion or by composting which is related with HYDRO1. Moreover, in this report phosphate salt quality is specified regardless of the input material applied. According to the report, a minimum P2O5 content should be 16% of the dry matter content and it should not include organic carbon more than 3% of the dry matter. It also specified parameters and limits for macroscopic impurities such as glass, stones, metals and plastics as well as microorganisms and PAHs. Furthermore, Al and Fe levels for precipitated phosphate salts & derivates incorporated into the EU fertilizing product were also determined in the report.

The priority pollutants are specified in the European legislative framework. European countries must directly apply these restrictions or adapted to their national legislation such as the latest Fertilizing Products Regulation. When the HYDRO1 considered, limit values for contaminants should be taken under consideration and the parameters should be meet with the national regulations. European Commission released Fertilizer Regulation in 2003 (No 2003/2003) and an amending regulation in 2009 (No 1069/2009). In 5 June 2019, EC published the newest regulation amending the previous regulations. It aimed to incentivize large scale fertilizer production from domestic sources, transforming waste into nutrients for crops; and introduce harmonized cadmium limits for phosphate fertilizers. Overall principles of 2003 Regulation are kept but expanded the scope. The regulation prepared for a wider range of fertilizing products which includes:

- quality, for instance on minimum nutrient content or organic matter content
- safety, for instance maximum limits for heavy metals (such as cadmium, chromium, mercury, nickel, lead and arsenic), for organic (such as biuret in organic and inorganic fertilizer, or polycyclic aromatic hydrocarbons in compost and digestate), for microbial contaminants (such as salmonella or E. coli) and for impurities (such as glass, metal and plastics in compost or digestate).

Moreover, the limit for cadmium in phosphate fertilizer is reduced from 60 mg cadmium/kg phosphorus, to 40 mg/kg after 3 years, and to 20 mg/kg after 12 years.

In conclusion, in the context of implementation of HYDRO 1 and HYDRO6 in HYDROUSA, it has to be noticed that compost derived from digestate and sewage sludge, according to the 2019 Regulation, cannot be labelled and marked as EU fertilising products. The same is true for fertigation water. In fact, according to Annex II of the present directive “An EU fertilising product may contain compost obtained through aerobic composting of…living or dead organisms…except…. sewage sludge, industrial sludge or dredging sludge…”. The fertilizer regulation’s relation with HYDROs is schematized in Table 3.9.

Table 3.9 Fertilizer Regulation relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF THE FERTILIZER REGULATION	
Aim of the Regulation	To incentivize large scale fertilizer production from domestic sources, transforming waste into nutrients for crops
Scope of the Regulation	Standardization of the fertilizer quality
Environmental Objectives & Monitoring	Parameters and limitations for different kind of fertilizers are specified. Methods for the analysis of fertilizers are defined.
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From Sewage Sludge to Compost
Related HYDROs	HYDRO 1, HYDRO 6
Possible barrier or constraint	Partial constraint found for EC-marked and labelled compost

3.2.10 Food Safety Legislation

This is notably the case of Commission Regulation (EC) No. 1881/2006 setting maximum levels for certain contaminants in foodstuffs, with the purpose of keeping them at toxicologically acceptable levels. The Annex on this Regulation lists the concerning foodstuffs as well as the maximum level allowed. These include agricultural products (whether they are irrigated or not with treated wastewater). Failure to comply with those maximum levels means that the foodstuff cannot be placed on the market (Article 1). Parameters include, depending on the foodstuffs, maximum levels for: nitrates; mycotoxins; metals (incl. lead, cadmium, mercury); 3-MCPD; dioxins and PCBs; and polycyclic aromatic hydrocarbons.

Based on the food safety legislation, marketability of products depends on the compliance of the final product and thus, not on the type of water used for irrigation or on the type of fertilizer used on the soil. The Food Safety Regulation's relation with HYDROs is schematized in Table 3.10.

Table 3.10 Food Safety Regulation relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF THE FOOD SAFETY REGULATION	
Aim of the Regulation	To protect public health, to keep contaminants at levels which are toxicologically acceptable
Scope of the Regulation	To set maximum levels for certain contaminants in foodstuffs
Environmental Objectives & Monitoring	Parameters defined and limitations for maximum levels are set at a strict level which are reasonably achievable by following good agricultural, fishery and manufacturing practices and taking into account the risk related to the consumption of the food.
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From Reclaimed water + Sewage sludge-based Compost to Marketable Food Crops
Related HYDROs	HYDRO 2, HYDRO 5, HYDRO 6
Possible barrier or constraint	No general relevant barriers are identified, once the required quality standard for treated water or compost are achieved

3.2.11 Organic Farming Regulation

The organic farming regulation (EC) No. 889/2008 lays down the detailed rules for the organic production, labelling and control of organic products. Specifically, in Title II, Chapter 1, Art.3(1) defines the types and requirements for the soil management and fertilization allowed for improving soil quality. It should be noted that in the specific sector of organic agriculture, the EC Directive 889/2008, which amends EEC 2092/1991 and EC 834/2007, establishes in the above cited article that: "...**only** fertilizers and soil conditioners referred to in Annex I to this Regulation may be used in organic production ... ".From the soil conditioners, listed in Annex, no information is given with reference to sewage sludge matrix for fertilizer production. Therefore, the mixed soil conditioner produced with the use of sewage sludge cannot be used for organic or biodynamic agriculture, but it can be used for other agronomic applications (Broglio, 2018). However, “composted or fermented household waste” can be authorized unless it contains just vegetable and/or animal waste. For this conditioner category, specific maximum concentrations of metals are described (See Annex 9.1).

To develop the organic farming market and to increase consumer confidence, the 889/08 regulation is been revised and will be repealed by the Regulation (EU) No. 848/2018, in force from 1st January 2021 (https://www.compostnetwork.info/organic-farming-regulation/). The revision is based on the latest recommendations by the Expert Group for Technical Advice on Organic Production (EGTOP) (https://www.compostnetwork.info/organic-farming-regulation/).

With reference to HYDRO 1 and 6 implementation, no changes in the implementation of rules (and its Annex I ‘Fertilizers, soil conditioners and nutrients’) were made for compost derived from digestate and no information is found for using digestate in organic farming. Thus, it can be concluded that for foodstuffs marketable as organic products, digestate cannot be used to improve soil quality. The Organic Farming Regulation’s relation with HYDROs is schematized in Table 3.11.

Table 3.11 Organic Farming Regulation relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF THE ORGANIC FARMING REGULATION	
Aim of the Regulation	To detail rules for the organic production, labelling and control of organic products
Scope of the Regulation	To define the use of plant protection products, fertilizers, soil conditioners, certain non-organic feed materials, feed additives, feed processing aids and certain products used for cleaning and disinfection.
Environmental Objectives & Monitoring	Fertilizers and soil conditioners quality and parameters, types of pesticides authorized, minimum surface areas in different production species, feed additives and substances used as in animal nutrition.
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From Sewage Sludge to Soil Conditioner for organic farming
Related HYDROs	HYDRO 1, HYDRO 6
Possible barrier or constraint	Barrier found for organic food production

3.2.12 Regulation on Biogas as Renewable Energy

The original renewable energy directive (2009/28/EC) defines a general policy for the production and promotion of energy from renewable sources in the EU (https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive/overview). One of the main objectives of this directive is the achievement in EU of at least 20% of the total energy needs with renewables by 2020. For this purpose, individual national targets in all European countries should be achieved such as ensuring that at least 10% of their transport fuels originate from renewable sources by 2020.

To fulfil sustainability objectives, in December 2018, the 2009/28 directive was revised and directive 2018/2001/EU entered in-force with the main goal of reducing emissions in EU, as established under the Paris Agreement. The new directive defines a new mandatory renewable energy target for EU countries that implies the achievement of at least 32%, with a clause for a possible upwards revision by 2023.

In this perspective, biofuels and bioliquids are fundamental instruments for helping EU countries to meet their 10% renewables target in transport. Specifically, the Directive defines biofuels sustainability criteria for all biofuels produced or consumed in the EU, ensuring that they are produced in a sustainable and environmentally friendly manner (https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive/overview).

Annex IX of the present directive can be taken into consideration for the implementation of HYDRO 1 as it provides information on *"Feedstocks for the production of biogas for transport and advanced biofuels…"*. Specifically, at point (f) sewage sludge is allowed. To complete the legislative framework for biogas and biomethane regulation, technical standards for biogas EN 16726 and EN 16723 on Liquefied Natural Gas (LNG), biomethane and blends for automotive fuels are examined. In these technical documents, minimum requirements in terms of gas quality and reliable measurement methods are prescribed.

Specifically, the new EN 16723 reflect EN 16726, implementing new requirements to cover substances, not normally contained in natural gas derived from traditional origin, that are not covered by EN 16726. Technical parameters are highlighted in Annex 9.1 Directive on renewable energy promotion relation with HYDROs is schematized in Table 3.12.

Table 3.12 Directive on renewable energy relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF THE BIOGAS PRODUCTION FOR BIOFUEL	
Aim of the Directive	To reduce emissions, protect environment against the air pollution, production of "clean energy"
Scope of the Directive	To achieve at least 32% of the total energy needs with renewables.
Environmental Objectives & Monitoring	Parameters on greenhouse gas emission savings
Relevant INPUT and OUTPUT in the HYDROUSA Loop	From Biogas to Biofuel
Related HYDROs	HYDRO 1
Possible barrier or constraint	Not generally identified. HYDROs implementation supported, when quality standards are achieved

3.2.13 EC POLICY FRAMEWORK ON PHOSPHORUS

The European Commission organized a Consultative Communication in 2013 (Consultative Communication on the Sustainable Use of Phosphorus COM (2013) 517) for the sustainability of phosphorous use and all the interested institutions participated to build a consortium within this scope. It also aimed to initiate a debate on the state of play and the actions that should be considered. It is not designed having in mind a specific legislation on phosphorus.

Then, 'Circular approaches to phosphorus: from research to deployment' workshop, held in 2015. In this workshop, the action on P removal from wastewater proposed to have a P in the form of struvite. Furthermore, the countries established their own standards and targets. In Sweden, a national interim target was published as "By 2015, at least 60% of phosphorus compounds present in wastewater will be recovered for use on productive land. At least half of this amount should be returned to arable land". The Netherlands has put in place a phosphate value chain agreement, in which a range of stakeholders have committed themselves to targets such as using a set percentage of recycled phosphorus in their manufacturing process. Germany is working on legislation planned to reduce the waste of phosphorus. Following the first European Conference on Sustainable Phosphorus, a European Phosphorus Platform has been set up by stakeholders in order to create a European recycled phosphorus market and to achieve a more sustainable use of phosphorus. The agronomic quality of the product is crucial to ensure that the phosphorus is actually available and being taken up by crops. About 25% of the phosphorus contained in waste water is currently reused, the commonest method being direct application of sewage sludge on to fields. The total potential for recovery is quite high – about 300,000 tonnes of phosphorus per annum in the EU57 – and the significant discrepancies between the different Member States in the EU in terms of how much sewage sludge is used (either directly or in the form of ash) shows potential for harmonization around best practice. Sewage sludge can also be composted and the End of Waste criteria currently under development is examining whether this sludge compost can fulfil the stringent standards to safeguard its use by farmers once composted.

Although many industrial technologies for the recovery of phosphorus (from manure and sewage and biodegradable waste) are already on-stream and used to varying degrees, there is no common strategy to promote the use of such renewable sources by farmers. The price of recovered fertilizer is generally higher than the price of mineral phosphate fertilizer. Much more could be done in terms of identifying markets for recycled phosphorus and barriers to its increased use, and in implementing the technologies that are already available.

With reference to HYDRO 1 and HYDRO 6, the possibility to recover and reuse phosphorus from domestic wastewater for agricultural purposes is encouraged, as long as it meets with the limitations in the Fertilizer Regulation. The EU Policy Framework's relation with HYDROs is schematized in Table 3.13.

Table 3.13 The EU Policy Framework's relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF EU PHOSPHORUS POLICY	
Aim of the Communication	The sustainability of phosphorus usage
Scope of the Communication	Efficient crop production
Environmental Objectives & Monitoring	It provides potential for and obstacles to a more efficient use of phosphorus
Application in the HYDROUSA Loop	Water for fertigation and Compost for soil improvement
Related HYDROs	HYDRO 1, HYDRO 6
Possible barrier or constraint	Not identified. HYDRO's implementation supported, with limitations in the Fertilizer Regulation

3.2.14 Resource-Efficient Europe Initiative

A resource efficient Europe initiative is prepared under the Europe 2020 strategy in the scope of low-carbon economy to achieve sustainable growth (www.eea.europa.eu). The flagship initiative also supports secure growth and market opportunities as well as reduce costs and increase competitiveness. It is a long-term action plan in many policy areas, supporting policy agendas for climate change, energy, transport, industry, raw materials, agriculture, fisheries, biodiversity and regional development. This is to increase certainty for investment and innovation and to ensure that all relevant policies factor in resource efficiency in a balanced manner.

3.2.15 EU Biodiversity Strategy

The EU has substantial legislation requires the achievement of good ecological status for water by 2015 and marine ecosystems by 2020, tackling pollution from various sources, and regulating chemicals and their effects on the environment (www.eea.europa.eu). According to the strategy:

- Habitat protection and management requirements are going to be integrated into the land and water policies. They are going to be applied both for Natura 2000 areas and beyond.
- Good Agricultural and Environmental Conditions will be simplified and improved by EC.
- Operational conditions are going to be defined for farmers to protect and improve the state of aquatic ecosystems in rural areas.

The new Biodiversity Strategy will also support the implementation of the Marine Strategy Framework directive which aims to bring all EU marine waters into a good environmental status by 2020. The EU Biodiversity Strategy's relation with HYDROs are given in Table 3.14.

Table 3.14 The EU Biodiversity Strategy's relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF EU BIODIVERSITY STRATEGY	
Aim of the Strategy	Halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss
Scope of the Strategy	More resource efficient economy, climate-resilient, low-carbon economy, leader in research and innovation, business opportunities.
Environmental Objectives & Monitoring	It is related with The Birds and Habitats Directives
Application in the HYDROUSA Loop	HYDROUSA solutions impact to receiving environments
Related HYDROs	HYDRO 1, HYDRO 2, HYDRO 3, HYDRO 4, HYDRO 5, HYDRO 6

3.2.16 EU Climate Change Adaptation and Disaster Prevention

The European Commission published the EU Adaptation Strategy in the communication (COM (2013) 216). The EU Strategy on adaptation to climate change in 2013. The aim of this communication is to enhance European preparedness and capacity to respond to climate change impacts at local, regional, national and EU levels. Specific aims are:

- to encourage and support EU Member States' action on adaptation
- to foster the knowledge base through EU-funded research in support of better-informed decision-making
- to make key EU economic and policy sectors more resilient to the impacts of climate change.

While 21 EEA member countries have an adopted national adaptation strategy (NAS) and 12 have developed a national adaptation plan (NAP), others are still in the starting phase of the adaptation policy process (EEA, 2017).

3.2.17 Thematic strategy for soil protection

The strategy proposed by the Commission is built around four key pillars (COM (2012) 46 final):

- framework legislation with protection and sustainable use of soil as its principal aim
- integration of soil protection in the formulation and implementation of national and Community policies

- closing the current recognized knowledge gap in certain areas of soil protection through research supported by Community and national research programmes
- increasing public awareness of the need to protect soil.

Actually, there is no information available on reclaimed water reuse and irrigation. However, it is stated in "The implementation of the Soil Thematic Strategy and ongoing activities" that salinization affects soil productivity. On the other hand, there are no systematic data available on trends across Europe. Thematic Strategy for Soil Protection's relation with HYDROs are schematized in Table 3.15.

Table 3.15 Thematic Strategy for Soil Protection's relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF EU STRATEGY FOR SOIL PROTECTION	
Aim of the Strategy	Preventing further soil degradation and preserving its functions and restoring degraded soils to a level of functionality consistent at least with current and intended use, thus also considering the cost implications of the restoration of soil
Scope of the Strategy	Propose a legislation to ensure a comprehensive approach to soil protection whilst fully respecting subsidiarity
Application in the HYDROUSA Loop	Irrigation and compost use in soil
Related HYDROs	HYDRO 2, HYDRO 3, HYDRO 4, HYDRO 5, HYDRO 6

3.2.18 EC Innovation Deal on Anaerobic MBR for Wastewater Treatment and Reuse of the Final Effluent

The main objective of this EC Innovation Deal document was to propose and to analyse solutions to overcome the perceived barriers related to water reuse for agriculture, fertilizing and the implementation of Anaerobic Membrane Bioreactor (AnMBR) technology for WW treatment (ID, 2017). In this document, analysis of legal, technological and economic feasibility of water reuse by combining wastewater treatment with AnMBR technology is conducted.
That innovation deal results reported the multiple benefits that could derive from the implementation of anaerobic membrane bioreactors in terms of: production of biogas as possible renewable energy source; nutrients recovery, reducing mineral fertilizers demand in line with CE principles while ensuring environmental and health security; food production security improvement; increase of water availability while preventing water bodies deterioration; support to the economic activities management in rural areas for avoiding rural exodus; protection of ecosystems related to agricultural activities.
The synergic relation of the EC Innovation Deal on anaerobic MBR for wastewater treatment and reuse with the project's HYDROs is schematized in Table 3.16.

Table 3.16 The relation of the EC Innovation Deal on anaerobic MBR for wastewater treatment and reuse with the project's HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF INNOVATION DEAL	
Aim of the Innovation Deal	To analyse the regulatory barriers that prevent a paradigm shift towards converting waste water treatment plant into water and resource recovery facility
Scope of the Innovation Deal	Recovery of costs for water services, discharge requirements for urban wastewater treatment, and responsibility of end-users for water reuse
Application in the HYDROUSA Loop	Wastewater reuse
Related HYDROs	HYDRO 1, HYDRO 2, HYDRO 6

3.2.19 Guidelines by World Health Organization (WHO)

WHO Guidelines for the safe use of wastewater, excreta and greywater includes the information about the current situation on the impacts of treated wastewater usage in agriculture (WHO, 2006). The guidelines aim to enhance the public health and beneficial usage of wastewater in agriculture. This is key reference even for the food industry. Furthermore, WHO guidelines for drinking-water quality were also analysed. This document aims to provide basic requirements to guarantee the safety of drinking-water, including (WHO, 2017):

- a health-based targets established by a competent health authority
- an adequate and proper management systems (i.e. infrastructures and monitoring plans)
- a system of independent surveillance.

Specifically, in the drinking water guidelines, the rainwater harvesting, practiced not only at a household level, but also at larger community scale, can provide an important source of drinking-water in some circumstances (WHO, 2017). Moreover, it also pointed out that *"…rainwater harvesting systems with clean catchments, covered cisterns and storage tanks, and appropriate treatments…"* can provide drinking-water with low health risk. Guidelines by World Health Organization (WHO)'s relation with HYDROs are schematized in Table 3.17.

Table 3.17 Guidelines by World Health Organization (WHO)'s relation with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF WHO Guidelines	
Aim of the Guidelines by WHO	to protect and promote public health
Scope of the Guidelines by WHO	• To maximize the benefits of the use of wastewater, excreta and greywater in agriculture and aquaculture (WHO, 2006) • To minimize the health risks involved and to promote proper environmental management, ensuring long-term sustainability (WHO, 2006) • To set essential requirements for ensuring the safety of drinking-water (WHO, 2017)
Application in the HYDROUSA Loop	Wastewater reuse (WHO, 2006) and rainwater reuse (WHO, 2017)
Related HYDROs	HYDRO 1, HYDRO 6

3.2.20 Water Reuse International Standard - ISO/TC 282: "Guidelines for Treated Wastewater use for Irrigation Projects"

ISO/TC 282 is the standardization of water reuse of any kind and for any purpose. It covers both centralized and decentralized or on-site water reclamation, and direct and indirect reuse applications, taking into consideration the potential for unintentional exposure or ingestion. It includes technical, economic, environmental and societal aspects of water reuse. Water reuse comprises a sequence of the stages and operations involved in collection, conveyance, processing, storage, distribution, consumption, drainage and other handling of wastewater, and treated effluent, including water that is reused in repeated, cascaded and recycled ways. The scope of ISO/PC 253 (Treated wastewater reuse for irrigation) is merged therein.
In this standard the following issues are excluded:

- the limits of allowable water quality in water reuse, which should be determined by the governments, WHO and other relevant competent organizations.
- all aspects of ISO/TC 224 scope (service activities relating to drinking water supply systems and wastewater systems - Quality criteria of the service and performance indicators)
- methods for the measurement of water quality, which are covered by ISO/TC 147.

The relation of ISO/TC 282 with HYDROs are schematized in Table 3.18.

Table 3.18 The relation of ISO/TC 282 with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF ISO/TC 282	
Aim of the ISO	To standardize water reuse and determine the limits of allowable water quality in water reuse
Scope of the ISO	Provides guidance for good operation, monitoring and maintenance
Application in the HYDROUSA Loop	Water reuse
Related HYDROs	HYDRO 1, HYDRO 2, HYDRO 3, HYDRO 4, HYDRO 5, HYDRO 6

3.2.21 Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora

The main objective of Council Directive 92/43/EEC of 21 May 1992 is to sustain the biodiversity regarding to economic, social, cultural and regional requirements. It also contributes to the general objective of sustainable development (CD 92 /43 /EEC).

Key points of the directive can be listed as:

- Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive.
- Member States shall take the required measures to establish a system of strict protection for the animal species listed in Annex IV in their natural range, prohibiting: (a) all forms of deliberate capture or killing of specimens of these species in the wild; (b) deliberate disturbance of these species, particularly during the period of breeding, rearing, hibernation and migration; (c) deliberate destruction or taking of eggs from the wild; (d) deterioration or destruction of breeding sites or resting places.
- Member States shall take the requisite measures to establish a system of strict protection for the plant species listed in Annex IV (b), prohibiting: the deliberate picking, collecting, cutting, uprooting or destruction of such plants in their natural range in the wild.

The relation of Council Directive on The Conservation of Natural Habitats and of Wild Fauna and Flora with HYDROs are schematized in Table 3.19.

Table 3.19 The relation of Council Directive on The Conservation of Natural Habitats and of Wild Fauna and Flora with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF NATURAL PARKS and PROTECTED AREAS	
Aim of the Council Directive	To sustain the biodiversity regarding to economic, social, cultural and regional requirements
Scope of the Council Directive	Strict protection measures are specified
Application in the HYDROUSA Loop	General application
Related HYDROs	HYDRO 1, HYDRO 2, HYDRO 3, HYDRO 4, HYDRO 5, HYDRO 6

3.2.22 Directive of the European Parliament and of the Council on the Conservation of Wild Birds

This Directive 2009/146/EC relates to the conservation of all species of naturally occurring birds in the wild state in the European territory of the Member States to which the Treaty applies (CD 2009/147/EC). It includes the protection, management and control of these species and lays down rules for their exploitation. Key points of the directive can be listed as:

- The preservation, maintenance or restoration of diversity and area of habitats is essential to the conservation of all species of birds. Certain species of birds should be the subject of special conservation measures concerning their habitats in order to ensure their survival and reproduction in their area of distribution. Such measures must also take account of migratory species and be coordinated with a view to setting up a coherent whole.
- Member States shall take the required measures to preserve, maintain or re-establish a sufficient diversity and area of habitats for all the species of birds.
- Member States shall classify, in particular, the most suitable territories in number and size as special protection areas for the conservation of these species in the geographical sea and land area where this Directive applies.
- Member States shall take similar measures for regularly occurring migratory species not listed in Annex I, bearing in mind their need for protection in the geographical sea and land area where this Directive applies, as regards their breeding, moulting and wintering areas and staging posts along their migration routes. To this end, Member States shall pay attention to the protection of wetland.
- In respect of the protection areas referred to in paragraphs 1 and 2, Member States shall take measures to avoid pollution or deterioration of habitats or any disturbances affecting the birds, complying to the objectives of this Article. Outside these protection areas, Member States shall also strive to avoid pollution or deterioration of habitats.
- Particular attention shall be paid to research and work on the subjects including: determining the role of certain species as indicators of pollution; studying the adverse effect of chemical pollution on population levels of bird species.

The relation of The Directive 2009/147/EC OF the European Parliament and of The Council of 30 November 2009 on the Conservation of Wild Birds with HYDROs are schematized in Table 3.20.

Table 3.20 The relation of Directive on the Conservation of Wild Birds with HYDROs

HYDRO TECHNOLOGIES IN THE CONTEXT OF NATURAL PARKS and PROTECTED AREAS	
Aim of the Council Directive	To conserve all species of naturally occurring birds in the wild state in the European territory of the Member States to which the Treaty applies
Scope of the Council Directive	Strict protection measures are specified
Application in the HYDROUSA Loop	General application
Related HYDROs	HYDRO 1, HYDRO 2, HYDRO 3, HYDRO 4, HYDRO 5, HYDRO 6

3.2.23 HYDROUSA in the context of the European Green Deal

On 11/12/2019 the European Commission launched the European Green Deal as “the most ambitious package of measures that should enable European citizens and businesses to benefit from sustainable green transition” and the greatest challenge and opportunity is “becoming the world’s first climate-neutral continent by 2050”. The policy areas are: clean energy; sustainable industry; building and renovation; sustainable mobility; biodiversity; from fark to fork; eliminating pollution. HYDROUSA water loops will contribute to eliminate pollution, while delivering more sustainable agriculture and reducing the carbon footprint. Therefore, HYDROUSA loops are already supporting the delivery of the European Green Deal. As far as the European Green Deal is currently detailed, HYDROUSA is mainly contributing to: (a) “Farm to Fork” strategy, providing measures to significantly reduce the use and risk of chemical pesticides, as well as the use of fertilizers and antibiotics; (b) “preserving and protecting biodiversity”; (c) Mainstreaming sustainability in community-based policies. A specific policy brief will detail the HYDROUSA relation to the EU Green Deal.

3.3 General legislative fitness check of the HYDROs

The ultimate purpose of our analysis is to check and outline enabling conditions or possible barriers in the implementation of the HYDRO solutions within the European legislative framework. Evaluation Fitness Check for each HYDROs is reported. In particular, in this section the single HYDRO main outputs or objectives are summarized in terms of final products or resources recovered (column header: OUTPUTS)

Moreover, the main parameters for the implementation of the HYDROs have been highlighted in relation to the prescriptions of the legislation/guideline/recommendation analysed (column header: PARAMETERS TO CONSIDER). Parameters are intended as key factors or required conditions to obtain the compliance of the HYDROs to the European Legislative Framework. For each parameter, the reference documents containing the main quality control requirements have been reported (column header: REFERENCE DOCUMENTS). Analysed documents were divided according to directives, technical standards, guidelines, manual (column header: DOCUMENT TYPE).

According to the analysis presented in Section 3.2, "RELEVANT INFORMATION" are summarized to highlight if the analysed legislative framework "supports" or "hampers" the specific resources or products recovery and use/reuse. Specifically, the easiness of implementation is categorized as follows:

- **A: "CONSIDERED, NO BARRIER/CONSTRAINT", in green**: whenever quality and/or safety standards are met, the output is referenced in current legislation and use/application is generally allowed
- **B: "NOT CONSIDERED", in yellow**: whenever quality and/or safety standards are met, but there is no clear reference or information in the current legislation
- **C: "CONSIDERED, POTENTIAL BARRIER/CONSTRAINT" in red**: when legislation shows potential barriers or constraints to be overcome.

3.3.1 HYDRO 1

Regarding HYDRO1, along the water line the different parameters have to be checked as: the crop category which will be irrigated, indicative required treatment and influent water quality. These parameters are considered by the EU proposal for Regulation and by the ISO/TC 282. The latter defines the standardization of technical, economic, environmental and societal aspects of water reuse.

Regarding the compost application, there is no unified EU regulation/legislation or directive except for the outdated Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture. However, this Directive has limit values only for heavy metal concentrations in the applied sludge and in soil where the sludge is applied.

Therefore, regional quality standard should be considered. However, the compost quality parameters and/or presence of sewage sludge were considered in the Report "Digestate and compost as fertilizers: Risk assessment and risk management options", which can be taken as early recommendation possibly to be further analysed. In terms of quality standards, most probably major efforts should address the pathogens content and related indicators. Regarding the biomethane line, characteristics of biomethane for fuel usage in the cars and transportation and distribution specifications are permitted in EU level directives (Table 3.21).

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Table 3.21 Summary of fitness check for HYDRO1

HYDRO 1 OUTPUTs	PARAMETERS TO CONSIDER	REFERENCE DOCUMENTS		RELEVANT INFORMATION
		DOCUMENT TYPE	REFERENCE NUMBER	
Water for HYDRO 2	Categories of crops allowed to be cultivated	Proposal for Regulation	Proposal 337/2018 and 2019 revision ISO/TC 282	A
	Indicative treatments required for reaching water quality effluent		Proposal 337/2018 and 2019 revision ISO/TC 282	A
	Influence of flow quality on the final intended use		Proposal 337/2018 and 91/271/EEC and revisions ISO/TC 282	A
Compost	CE Labelling for the fertilizer	Directive	1009/2019	C
	Influence of sewage sludge for agricultural uses		219/2009	A
	Use of sewage sludge for organic farming		889/2008	C
	Compost parameters to be considered for agricultural uses at National Level	Report	ENV.A.2. /ETU/2001/0024 Digestate and compost report JRC Report	A
	Use of sewage sludge for agricultural purposes		ENV.A.2. /ETU/2001/0024 Digestate and compost report JRC Report	A
		Directive	86/278/EEC	
Biomethane to automotive fuel	Biomethane characteristics for transport, distribution and use	Technical standards	EN 16726	A
	Characteristics of methane for use as automotive fuel		EN 16723-2	A

3.3.2 HYDRO 2

Considering the irrigation of the agroforestry system in HYDRO 2, the applicators should be averred of the necessities in EU regulations, namely EC 337/2018, EC 91/271 and EC 118/2006. As defined in the Proposal for reclaimed water reuse (337/2018), crops are grouped in four categories, which identify the type of crop/plant and how water possibly wets the edible parts of the crops. For further information on category descriptions see Table 9.1 of the Annex.

According to the cultivated crop/plant, potential required technologies, water and food quality standards are monitored to allow the use reclaimed water. In addition, standard amount of water is recommended for each type of crop as specified in a FAO Manual (Table 3.22).

Table 3.22 Summary of fitness check for HYDRO2

HYDRO 2 OUTPUTs		CROP CATEGORY	PARAMETERS TO CONSIDER FOR EACH OF THE CROP CATEGORY	REFERENCE DOCUMENTS		RELEVANT INFORMATION
				DOCUMENT TYPE	REFERENCE NUMBER	
Agroforestry system (1ha):	**Trees for fruits** (sweet chestnut)	Category B	Categories of crops allowed	Proposal for Regulation	Proposal 337/2018 and 2019 revision	A
	Timber	Category D	Indicative treatments required for reaching water quality standard		Proposal 337/2018 and 2019 revision	A
	Orchards/bushes (goji berries, pomegranate, sea buckthorn, olive tree)	Category B	influence of flow quality on the final intended use		Proposal 337/2018 and 91/271/EEC and revisions	A
			Types of food regulated		1881/2006	A
	Herbs and annual crops** (lavender)	Category D	Limits for compliance in foodstuffs		1881/2006	A
	Aromatic plants (laurel, sage, oregano thyme, mint)	Category A Category B	Amount of water required by crops	Manual	FAO Manual	B

**maize and cereal crops can be considered as annual crops

3.3.3 HYDRO 3

In HYDRO 3, an oregano field is irrigated using rainwater. The oregano will be used to produce essential oils Therefore, based on the EC Proposal for Regulation 337/2018, Category D class water is needed for irrigation. The site manager needs to comply with the criteria for indicative treatment technology, treated water quality, limits in the foodstuff which are permitted by EU regulations, namely EC 337/2018, EC 91/271 and EC 118/2006. Since there is no specification in European legislations for rainwater reuse, special attention should be paid on local legislation and regulations (Table 3.23). For further information on Guidelines and report from world-wide experiences see Table 9.6 and Table 9.7 of the Annex.

Table 3.23 Summary of fitness check for HYDRO3

HYDRO 3 OUTPUTs		CROP CATEGORY	PARAMETERS TO CONSIDER	REFERENCE DOCUMENTS		RELEVANT INFORMATION
				DOCUMENT TYPE	REFERENCE NUMBER	
Agroforestry system (0.4ha):	Oregano for essential oil	Category D	Categories of crops allowed to be cultivated	Directive	Proposal 337/2018 and 2019 revision	A
			Indicative treatments required for reaching required water quality		Proposal 337/2018 and 2019 revision	A
			Influence of quality on the final intended use		Proposal 337/2018 and 2019 revision	A
			Types of food regulated		1881/2006	A
			Limits for compliance in foodstuffs		1881/2006	A
			Permitted reuse of rainwater in relation to required treatments	Guideline	Guidelines and report from world-wide experiences	A

It should be noted that proposal 337/2018 focuses on the production of reusable water from wastewater and does not give specific indications related to different water sources such as run-off and rainwater. Therefore, the analysis was carried out for the purposes of providing a full picture of the legislative framework also linked to the relationship between water quality for irrigation and the specific type of crop.

3.3.4 HYDRO 4

In HYDRO4, rainwater and stormwater are collected, stored and used for multiple uses, which include domestic non-potable use, drinking water (after treatment), agricultural irrigation. Regarding the water intended for potable use, parameters for potable uses are defined at an EU level (EC 98/83, EC 1878/2015 and proposal: EC 753/2017); this does not apply for very small-scale water supply systems (less than 50 people or less than 10 cubic meters per day for use of human consumption). For what concerns treatment for that purpose, monitoring and control measures, special emphasis on risk-based approach to water safety , hazard and risk assessment for both source water bodies and distribution network are clearly mentioned, often referring to the WHO Guidelines (Table 3.24). In the guidelines, rainwater is considered an important source of drinking-water in some circumstances (WHO, 2017). It has to be noticed that since no clear barriers are detected for rainwater reuse to drinking water production, national/regional legislations should also be analysed to find out possible restrictions or permissions. In addition, quality standards for potable uses and monitoring requirements do not seem economically and technically sustainable for the HYDRO solutions, which are small, decentralized and are based on a variable alternative water source.

Water quality for irrigation of the lavender field should meet requirements for Category D crops. Specifically, the crop type, treatments for reaching the water quality, monitoring measures and limits in the foodstuff are considered as minimum requirements to respect. Regarding aquifer recharge, attention should be paid on the quality of water used for recharge as the “Good” status of ground water must be maintained (Table 3.24).

Table 3.24 Summary of fitness check for HYDRO4

HYDRO 4 OUTPUTs		CROP CATEGORY	PARAMETERS TO CONSIDER	REFERENCE DOCUMENTS		RELEVANT INFORMATION
				DOCUMENT TYPE	REFERENCE NUMBER	
Rain water harvested and filtered to:	Drinking water	-	Permitted water source for drinking purpose	Directive	2000/60/CE and 98/83/EC and revisions	B
			Parameters to meet for potable uses		98/83/EC and revision; (Proposal 753/2017 EC)	B
			Permitted water source for drinking purpose	Guidelines	WHO Guidelines for drinking water quality	A
			Treatment for the purpose and monitoring / control measure			B
Rain water harvested and filtered run-off from road to store into the aquifer to:	Lavender (0.2 ha) for essential oil	Category D	Type of water to aquifer recharge	Directive	2000/60/CE	A
			Attention to water quality to maintain the "Good" status of groundwater		2000/60/CE and 2006/118/EC (2014/80/EU)	A
			Categories of crops allowed to be cultivated		Proposal 337/2018 and 2019 revision	A
			Indicative treatments required for reaching water quality effluent		Proposal 337/2018 and 2019 revision	A
			influence of water quality for irrigation use		Proposal 337/2018 and 2019 revision	A
			Permitted reuse of rainwater in relation to required treatments	Guidelines	Guidelines and report from world-wide experiences	A

3.3.5 HYDRO 5

Regarding1 the plant irrigation provided to the greenhouse in HYDRO 5, the water quality should meet the standard for Category C crops. Specifically, the crop type, treatment for reaching the water quality, monitoring measures and limits in the foodstuff are considered as minimum requirements to respect, according to EU Legislation. Regarding the amount of water required by crops, the FAO Manual can be taken into consideration (Table 3.25). Concerning the produced salt, the standards elaborated by FAO and WHO determine the quality of food grade salt. Since no information is supplied in terms of source of salt and of the minimum treatment, reuse at this stage of analysis is considered as “not defined”. Quality requirements need to be met and national/regional regulations must be further analysed.

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Table 3.25 Summary of fitness check for HYDRO5

HYDRO 5 OUTPUTs		CROP CATEGORY	PARAMETERS TO CONSIDER	REFERENCE DOCUMENTS		RELEVANT INFORMATION
				DOCUMENT TYPE	REFERENCE NUMBER	
fresh water produced to:	Irrigate the greenhouse	Category C	Categories of crops allowed to be cultivated	Proposal for Regulation and Directive	Proposal 337/2018 and 2019 revision	A
fresh water produced to:	Irrigate the greenhouse	Category C	Indicative technology target	Proposal for Regulation and Directive	Proposal 337/2018 and 2019 revision	A
fresh water produced to:	Irrigate the greenhouse	Category C	influence of flow quality on the ultimate intended use	Proposal for Regulation and Directive	Proposal 337/2018 and 91/271/EEC and revisions	A
fresh water produced to:	Irrigate the greenhouse	Category C	Amount of water required by crops	Manual	FAO Manual	B
Concentrated Brine	Salt	-	Salt quality parameters	Standards	CXSTAN 150-1985	B

3.3.6 HYDRO 6

Within the eco-tourist facility of HYDRO6, a variety of water uses are considered, which include agricultural irrigation and drinking water. Regarding drinking water, the source of water and the parameters for potable use are defined in the relevant EU Directives (EC 98/83, EC 1878/2015 and the proposal: EC 753/2017); this does not apply for very small supply systems. Small and decentralized alternative solutions such as HYDRO 6 may not be economically or technically sustainable for safe drinking water production in line with a risk-based approach and periodic investigative monitoring. In such a case, Water Safety Plans can support improvement and enable community engagement and long-term sustainability.

Regarding crop irrigation, water quality should obtain compliance for Category B crops. The crop type, treatment for reaching the required water quality, monitoring measures and limits in the foodstuff are considered as minimum requirements with respect to the EU Legislation. Regarding the amount of water required by the different types of crops, the FAO Manual can be taken into consideration (Table 3.26). Regarding rainwater use, there is no specification in European Directives; consequently, special attention should be paid in local regulations in a further level of analysis.

Table 3.26 Summary of fitness check for HYDRO6

HYDRO 6 OUTPUTs		CROP CATEGORY	PARAMETERS TO CONSIDER	REFERENCE DOCUMENTS		RELEVANT INFORMATION
				DOCUMENT TYPE	REFERENCE NUMBER	
Water vapour to:	Drinking water	-	Water source for drinking purpose	Directive and Revisions	2000/60/CE and 98/83/EC and revisions	B
			Parameters to respect for potable uses		98/83/EC and revision; Proposal 753/2017 EC	B
			Treatment for the purpose and monitoring/control measure	Guidelines	WHO Guidelines	B
Treated wastewater to:	Agriculture irrigation of local crops and herbs (0.15 ha)	Category B	Crop category permitted for irrigation reuse	Proposal for Regulation	Proposal 337/2018 and 2019 revision	A
			Indicative technology target for irrigation		Proposal 337/2018 and 2019 revision	A
			Influence of flow quality on the ultimate intended use		Proposal 337/2018 and 91/271/EEC	A
			Types of food regulated		EC 1881/2006	A
			Limits for compliance in foodstuffs		EC 1881/2006	A
			Amount of water required by crops	Manual	FAO Manual	B
Rainwater to:	Irrigate the greenhouse (0.15 ha) for crops	Category B	Permitted reuse of rainwater in relation to required treatments	Guidelines	Guidelines and report from world-wide experiences	A

3.4 Specific Provision and Legislative Requirements for HYDROs implementation and exploitation

Further to the wide legislative and regulatory framework which was analysed, this paragraph summarizes the specific technical and safety quality standards that the HYDROs have to fulfil. Hereby we report the specific requirements (when defined by the directives) for INPUT/OUTPUT of the HYDROs:

- Concentration limits and/or minimum quality standards and requirements for compliance;
- Minimum frequencies for monitoring;
- Sampling mode;
- Specifications on the necessary technologies and/or allowed materials;
- Types of specific streams exploitable for the purpose;

Further details and information are available in Annex 9.1.

3.4.1 Quality Standard to be achieved by the HYDROUSA regenerated flows

According to the HYDROUSA loops, different streams/flows such as reclaimed water for irrigation, compost, biogas, water for potable use, water for aquifer recharge, food and salt are exploited. In the following sections, specific focus on main quality standards and prescriptions from EU regulations/legislations/directives is assessed. For each flow/stream main relevant policy framework is summarized and limits and parameters are highlighted in tables.

3.4.2 Treated Water for Irrigation

In HYDRO 1 and 6, water is produced for irrigation. Within this scope, necessary water quality for irrigation was evaluated at the European scale. Irrigation water quality should have the specifications stated in the Proposal for "Regulation of the European Parliament and of the Council on Minimum Requirements for Water Reuse – COM (2018) 337" and "The Urban Waste Water Treatment Directive (91/271/EEC, UWWTD)". Based on the COM (2018) 337, minimum requirements of reclaimed water for agricultural irrigation are grouped in 4 classes. Each class is characterized by biological and physicochemical quality requirements (e.g. *E. coli*, *Legionella*, nematodes, total coliphages, BOD_5, turbidity and TSS), type of crops which can be irrigated, irrigation method and indicative technology target to achieve the quality standards.

In HYDRO1, treated water is produced to supply agricultural irrigation water for HYDRO2 in all classes for different crops. In HYDRO3, it is planned to supply water for the irrigation of an oregano field to produce essential oils; this requires class D quality. In HYDRO4, rainwater will be harvested and runoff from the road will be collected, filtered and stored into the aquifer; this water is going to be used to irrigate lavender field. For this purpose, the water quality required is class D. In HYDRO5 tropical fruits will be irrigated by treated seawater which requires class C quality. In HYDRO6, it is planned to irrigate local crops and herbs. Thus, the water quality should meet the class B standards. Limits and parameters for irrigation water is depicted in Table 3.27.

Table 3.27 Limits and parameters for irrigation water according to COM (2018) 337 and 91/271/EEC (UWWTD)

Minimum reclaimed water quality class	Crop category	Irrigation method	Indicative technology target	Parameters	Limits
Class A	The **edible part** is in direct contact with reclaimed water	All irrigation methods	Secondary treatment, **filtration**, and disinfection	E. coli	≤10/100 mL or below detection limit
				BOD_5	≤10 mgO_2/L
				TSS	≤10 mg/L
				Turbidity	≤5 NTU
				Legionella	<1,000 cfu/L
				Intestinal nematodes (helminth eggs)	≤1 egg/L
				E. coli	**≥ 5.0 log_{10} removal**
				Total coliphages/ F-specific coliphages/somatic coliphages/coliphages*	**≥ 6.0 log_{10} removal**

				Clostridium perfringens spores/spore-forming sulphate-reducing bacteria*	**≥ 4.0 log_{10} removal** in case of spores; **≥ 5.0** in case of spore-forming sulphate-reducing bacteria
Class B	The **edible part** is produced **above ground** and is not in direct contact with reclaimed water	All irrigation methods	Secondary treatment, and disinfection	E. coli	≤100/100 mL
				BOD_5	25 mgO_2/L
				TSS	35 mg/L 60 mg/L
				Turbidity	-
				Legionella	<1,000 cfu/L
				Intestinal nematodes (helminth eggs)	≤1 egg/L
Class C	The **edible part** is produced **above ground** and is not in direct contact with reclaimed water	Drip irrigation [a] only **or other method that avoids direct contact with the edible part of the crop**	Secondary treatment, and disinfection	E. coli	≤1000/100 mL
				BOD_5	25 mgO_2/L
				TSS	35 mg/L 70 mg/L
				Turbidity	-
				Legionella	<1,000 cfu/L
				Intestinal nematodes (helminth eggs)	≤1 egg/L
Class D	Industrial, energy, and seeded crops	All irrigation methods [b]	Secondary treatment, and disinfection	E. coli	≤10000/100 mL
				BOD_5	25 mgO_2/L
				TSS	35 mg/L 70 mg/L
				Turbidity	-
				Legionella	<1,000 cfu/L
				Intestinal nematodes (helminth eggs)	≤1 egg/L

[a]Validation monitoring of reclaimed water for agricultural irrigation shall be met at the outlet of the reclamation plant (point of compliance), considering the concentrations of the raw waste water effluent entering the urban waste water treatment plant;
[b]In cases of irrigation methods which imitate rain, special attention should be paid to the protection of the health of workers or bystanders. For this purpose, appropriate preventive measures should be applied.

Furthermore, monitoring and maintenance of water reuse projects for unrestricted and restricted irrigation of agricultural crops, gardens, and landscape areas using treated wastewater are specified in ISO 16075-2. In this document, parameters in wastewater reuse projects are evaluated independently of size, location, and complexity of the project. Table 3.28 summarizes the regulated parameters average with the average and maximum limits for water reuse in the agricultural sector according to ISO 16075 - Guidelines for treated wastewater use for irrigation projects - Part 2: Development of the project. The reused water is categorized in four groups and indicative technologies are also specified.

Table 3.28 Limits and parameters for irrigation water according to ISO 16075

Minimum reclaimed water quality class	Potential uses without barriers	Indicative technology target	Parameters	Units	Average Limit	Maximum Limit
Class A (very high quality treated wastewater*)	Unrestricted urban irrigation and agricultural irrigation of food crops consumed raw	Secondary treatment [a], contact filtration or membrane filtration [b], and disinfection [c]	Thermo-tolerant coliforms	no./100 mL	(95%ile) ± ≤10	100
			BOD_5	mgO_2/L	≤5	10
			TSS	mg/L	≤5	10
			Turbidity	NTU	≤2	5
			Intestinal nematodes (helminth eggs)	egg/L	-	-
Class B (high quality treated water*)	Restricted urban irrigation and agricultural irrigation of processed food crops	Secondary treatment [a], filtration [b], and disinfection [c]	Thermo-tolerant coliforms	no./100 mL	(95%ile) ≤200	1000
			BOD_5 (determined with 5 days test)	mgO_2/L	≤10	20
			TSS	mg/L	≤10	25
			Turbidity	NTU	-	-
			Intestinal nematodes (helminth eggs)	egg/L	-	-
Class C (good quality treated wastewater)	Agricultural irrigation of non-food crops	Secondary treatment [a] and disinfection [c]	Thermo-tolerant coliforms	no./100 mL	(95%ile) ≤1000	10000
			BOD_5	mgO_2/L	≤20	35
			TSS	mg/L	≤30	50
			Turbidity	NTU	-	-
			Intestinal nematodes (helminth eggs)	egg/L	≤1	-
Class D (medium quality treated wastewater)	Restricted irrigation of industrial and seeded crops	Secondary treatment [a] or high rate clarification with coagulation, flocculation [d]	Thermo-tolerant coliforms	no./100 mL	-	-
			BOD_5	mgO_2/L	≤60	100
			TSS	mg/L	≤90	140
			Turbidity	NTU	-	-
			Intestinal nematodes (helminth eggs)	egg/L	≤1	5
Class E (extensively treated wastewater)	Restricted irrigation of industrial and seeded crops	Stabilization ponds and wetlands [e]	Thermo-tolerant coliforms	no./100 mL	-	-
			BOD_5	mgO_2/L	≤20	35
			TSS	mg/L	-	-
			Turbidity	NTU	-	-
			Intestinal nematodes (helminth eggs)	egg/L	≤1	5

According to the new revision of the European Council, specific preventive measures relevant to the reuse of reclaimed water should be taken into consideration for different water quality class. Table 3.29 summarizes the relevant information for HYDROs implementation.

Table 3.29 Specific preventive measures according to ISO 16075

Specific preventive measures	Specific preventive measures
A	• Pigs must not be exposed to fodder irrigated with reclaimed water unless there is sufficient data to indicate that the risks for a specific case can be managed.
B	• Prohibition of harvesting of wet irrigated or dropped produce • Exclude lactating dairy cattle from pasture until pasture is dry. • Fodder has to be dried or ensiled before packaging. • Pigs must not be exposed to fodder irrigated with reclaimed water unless there is sufficient data to indicate that the risks for a specific case can be managed.
C	• Prohibition of harvesting of wet irrigated or dropped produce. • Exclude grazing animals from pasture for five days after last irrigation. • Fodder has to be dried or ensiled before packaging. • Pigs must not be exposed to fodder irrigated with reclaimed water unless there is sufficient data to indicate that the risks for a specific case can be managed.
D	• Prohibition of harvesting of wet irrigated or dropped produce.

Table 3.30 summarizes the suggested types and accredited number of barriers according to ISO 16075 (adapted from WHO 2006 and USEPA 2012). According to the irrigation method, the allowed pathogen reduction rate is differed. The number of barriers is calculated according to the treated wastewater quality (such as very high quality, high quality, good quality etc.) and type of the barriers (such as distance from drip irrigation system using treated wastewater, additional disinfection in the field, etc). An additional disinfection system can be required for the irrigation of vegetables due to the local conditions of storage and conveying. In this case, residual chlorine must be controlled. Low-level disinfection is considered as one barrier: high-level disinfection is considered as two barriers. Whereas, a distance > 25 cm of clean air between drip irrigation and the vegetables and fruit is considered as one barrier, a distance of 50 cm of clean air between drip-irrigation and the vegetables and fruit is considered as two barriers. On the other hand, the distance should be calculated from the height to which the sprayed effluents arise by spraying irrigation and is considered as only one barrier because of the aerosols in the air. According to the ISO, effluents of medium quality and effluents of extensive treated wastewater should not be used for the irrigation of vegetables.

Table 3.30 Suggested types and accredited number of barriers according to ISO 16075

Type of barrier	Application	Pathogen reduction (log units)	Number of barriers
Irrigation of food crops			
Drip irrigation	Drip irrigation of low-growing crops such as 25 cm or more above from the ground	2	1
	Drip irrigation of low-growing crops such as 50 cm or more above from the ground	4	2
	Subsurface drip irrigation where water does not ascend by capillary action to the ground surface	6	3
Spray and sprinkler irrigation	Sprinkler and micro-sprinkler irrigation of low-growing crops such as 25 cm or more from the water jet	2	1
	Sprinkler and micro-sprinkler irrigation of low-growing crops such as 50 cm or more from the water jet	4	2

Additional disinfection in field	Low level disinfection	2	1
	High level disinfection	4	2
Sun resistant cover sheet	In drip irrigation, where the sheet separates the irrigation from the vegetables	2 to 4	1
Pathogens die-off	Die-off support through irrigation cessation or interruption before harvest	0.5 to 2 per day	1 to 2
Produce washing before selling to the customers	Washing salad crops, vegetables, and fruits with drinking water	1	1
Produce disinfection before selling to the customers	Washing salad crops, vegetables, and fruits with a weak disinfectant solution and rinsing with drinking water	2	1
Produce peeling	Peeling of fruits and root crops	2	1
Produce cooking	Immersion in boiling water or under high temperature until the product is cooked	6 to 7	3
Irrigation of fodder and seeded crops			
Access control	Restricting entry into the irrigated field for 24 h and more after irrigation, for example, animal entering in pastures or entering of field workers	0.5 to 2	1
	Restricting entry into the irrigated field five days and more after irrigation	2 to 4	2
Irrigation of public gardens			
Access control	Irrigation by night when the public does not enter the irrigated parks, sport fields, and gardens	0.5 to 1	1
Spray irrigation control	Spray irrigation at distances greater than 70 m from residential areas or places of public access	1	1

3.4.3 Compost

In HYDRO1, the compost is going to be produced from the excess sludge from the UASB mixed with green biomass in an innovative in-vessel composting system. At the EU level, there is no unitary regulation or legislation about the compost quality. However, there is a report entitled as “Heavy Metals and Organic Compounds from Wastes Used as Organic Fertilizers (ENV.A.2. /ETU/2001/0024)”, resulting from a study carried out on behalf of the Directorate-General for the Environment of the European Commission in the context of the European waste management policy and work on the biological treatment of biodegradable waste. Compost categories are defined according to the source and application purposes. Compost parameters and limits are shown in Table 3.31.

Table 3.31 Limits and parameters for compost

CATEGORY	SOURCE	PURPOSE	APPLICATION	PARAMETERS	UNITS	LIMITS
Category 1	Separately collected organic waste	**Class A+**	Organic farming	Cd	mg kg^{-1} d.m	0.7
				Cr_{TOT}	mg kg^{-1} d.m	70
				Cu	mg kg^{-1} d.m	70
				Hg	mg kg^{-1} d.m	0,4
				Ni	mg kg^{-1} d.m	25
				Pb	mg kg^{-1} d.m	45
				Zn	mg kg^{-1} d.m	200
Category 1 and 2	Separately collected organic waste or quality sewage sludge	**Class A**	Agriculture	Cd	mg kg^{-1} d.m	1
				Cr_{TOT}	mg kg^{-1} d.m	70
				Cu	mg kg^{-1} d.m	150
				Hg	mg kg^{-1} d.m	0.7
				Ni	mg kg^{-1} d.m	60
				Pb	mg kg^{-1} d.m	120
				Zn	mg kg^{-1} d.m	500
Category 3	Municipal sewage sludge	**Class B**	Reclamation of landfill sites; biofilter	Cd	mg kg^{-1} d.m	3
				Cr_{TOT}	mg kg^{-1} d.m	250
				Cu	mg kg^{-1} d.m	400/500
				Hg	mg kg^{-1} d.m	3
				Ni	mg kg^{-1} d.m	100
				Pb	mg kg^{-1} d.m	200
				Zn	mg kg^{-1} d.m	1200/1800

In the EU Fertilizing Regulation released in 2019, The European Commission sets specific limits for the different product function categories of EU fertilizing products. Since compost is referred as organic soil improver, specific limits for chemical content are summarized in Table 3.32. According to the regulation, contaminants in the soil improver must not exceed these values. When we compare the contaminates defined in the regulation with ENV.A.2./ETU/2001/0024 report, there are some additional limits were set for As and dry matter as well as organic carbon content.

Table 3.32 Chemical content in soil improver

Parameter	Unit	Limits
Cadmium (Cd)	mg/kg dry matter	2
Hexavalent chromium (Cr VI)	mg/kg dry matter	2
Mercury (Hg)	mg/kg dry matter	1
Nickel (Ni)	mg/kg dry matter	50
Lead (Pb)	mg/kg dry matter	120
Inorganic arsenic (As)	mg/kg dry matter	40
Copper (Cu)	mg/kg dry matter	300
Zinc (Zn)	mg/kg dry matter	800
Dry matter	%	≥20
Organic carbon (C_{org})	% mass	≥7.5

Furthermore, in the regulation, there are limits for pathogens which are shown in Table 3.33.

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Table 3.33 Limits for pathogens

Micro-organisms to be tested	Sampling plans			Limit
	n	c	m	M
Salmonella spp.	5	0	0	Absence in 25 g or 25 ml
Escherichia coli or *Enterococcaceae*	5	5	0	1 000 in 1 g or 1 ml
Where: n = number of samples to be tested, c = number of samples where the number of bacteria expressed in CFU is between m and M, m = threshold value for the number of bacteria expressed in CFU that is considered satisfactory, M = maximum value of the number of bacteria expressed in CFU.				

According to the Fertilizing Regulation, an EU fertilizing product shall consist solely of component materials complying with the requirements including compost. However, the sewage sludge is excluded as an input material (Annex II).

3.4.4 Biogas and Biomethane

Biogas is going to be produced in HYDRO1 by the UASB system. Biogas quality is evaluated within the European standards “EN 16726 -Gas infrastructure - Quality of gas - Group H” standard and “EN 16723-2 Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 2: Automotive fuels specification”. In these standards, the parameters are defined to use biogas in energy production. To evaluate the biogas, the parameters and limitations are shown in Table 3.34.

Table 3.34 Limits and parameters for biogas

Field	Parameter	Unit	Limits: Based on standard reference conditions 15°C/15°C		Limits: Based on normal reference conditions 25°C/0°C		Reference standards for methods (informative)
			Min.	Max.	Min.	Max.	
Gas of H Group family, according to EN 437	**Relative density**	-	0.555	0.7	0.555	0.7	EN ISO 6976, EN ISO 15970
	Total sulphur without odorant	mg/m^3	not applicable	20	not applicable	21	EN ISO 6326-5, EN ISO 19739
		High pressure networks and on interconnection points, the max content is 20 mg/m^3. For existing practices with respect to transmission of odorized gas max value of 30 mg/m^3 can be accepted.					
	Hydrogen sulphide + Carbonyl sulphide (as sulphur)	mg/m^3	not applicable	5	not applicable	5	EN ISO 6326-1, EN ISO 6326-3, EN ISO 19739
	Mercaptan sulphur without odorant (as sulphur)	mg/m^3	not applicable	6	not applicable	6	EN ISO 6326-3, EN ISO 19739
	Oxygen	mol/mol	not applicable	0.001 % or 1%	not applicable	0.001% or 1%	EN ISO 6974-3, EN ISO 6974-6, EN ISO 6975
		At network entry points and interconnections the mol fraction shall be < 0.001% (as a moving 24-hour average). If gas can be demonstrated not to flow					

		to installations sensitive to higher levels of oxygen, limit of 1% may be applied.					
	Carbon dioxide	mol/mol	not applicable	2.5% or 4%	not applicable	2.5% or 4%	EN ISO 6974-1-6, EN ISO 6975
		At network entry points and interconnections the mol fraction shall be < 2.5% (as a moving 24-hour average). If gas can be demonstrated not to flow to installations sensitive to higher levels of CO_2, limit of 4% may be applied.					
	Hydro carbon dew point (at any pressure from 0.1 to 7 Mpa)	°C	not applicable	-2	not applicable	-2	ISO 23874, ISO/TR 12148
	Water dew point (at any pressure from 0.1 to 7 Mpa)	°C	not applicable	-8	not applicable	-8	EN ISO 6327, EN ISO 18453; EN ISO 10101-1-3
	Methane Number	-	65	not applicable	65	not applicable	See EN 16726 - Annex A
	Contaminants	The gas shall not contain constituents other than listed in this table all levels that prevent its transportation, storage and/or utilization without quality adjustment or treatment.					
GNL, **biomethane** and their blends of H and L Group families, according to EN 437, used for automotive fuels			Min.		Max.		
	Total volatile Silicon (as Si)	Mg Si/m^3	-		0.3		EN ISO 16017-1:2000 TDS-GC-MS
	Hydrogen	% mol/mol	-		2		EN ISO 6974-3, EN ISO 6974-6, EN ISO 6975
	Hydrocarbon dew point temperature (from 0.1 to 7 Mpa)	°C	-		-2		ISO 23874, ISO/TR 11150, ISO/TR 12148
	Oxygen	% mol/mol	-		1		EN ISO 6974 series, EN ISO 6975
	Hydrogen sulphide + Carbonyl sulphide (as sulphur)	mg/m3	-		5		EN ISO 6326-1, EN ISO 6326-3, EN ISO 19739
	S total (including odorization)	mg S/m^3			10[a] 30[b]		EN ISO 6326-5, EN ISO 19739
	Methane Number	Index	65				See EN 16726 - Annex A
	Compressor oil*				Free from impurities other than level of compressor oil and dust impurities.		ISO 8573-2
	Dust impurities*				Free from impurities other		ISO 8573-4

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				than level of compressor oil and dust impurities.	
	Amine*	mg/m^3		10	VDI 2467 Blatt 2:1991-08
	Water dew point °C at 20000 kPa	Class A	-10		ISO 6327 (applicability at 20000 kPa)
		Class B	-20		
		Class C	-30		
	*To avoid problems with lubricating oil filter should be used (cartridge type). The cartridge should retain 99% of the solid particulates ≥ 5µm and 99% of liquid particulates ≥ 10 µm				
	[a]Automotive industry needs for sulphur content including odorization				
	[b]Values the gas industry can provide including odorization				

3.4.5 Food Safety

Food safety is related with HYDRO2 where it is planned to cultivate herbs and annual crops and superfoods like goji berries and aromatic plants as well as forestry trees for fruit production. In HYDRO5 tropical fruits will be watered and in HYDRO 6 herbs and annual crops will be watered for human consumption. There are different categories according to the food type. Whereas for fresh herbs like oregano, cadmium is the only parameter to evaluate the quality, for berries like goji berries, lead is the only parameter. According to the crop to be harvested in HYDRO2, there are different parameters like Aflatoxins, Cadmium etc.; the parameters and limits are shown in Table 3.35.

Table 3.35 Limits and parameters for foodstuffs

Type of "food" regulated*	Parameters in foodstuffs	Units	Limits for compliance in foodstuffs
Maize for food	Aflatoxins B1	µg/kg	5
	Aflatoxins Sum of B1, B2, G1 and G2	µg/kg	10
Unprocessed cereals	Ochratoxin A	µg/kg	5
	Deoxynivalenol	µg/kg	1250
	Deoxynivalenol	µg/kg	1750
	Deoxynivalenol	µg/kg	1750
	Zearalenone	µg/kg	200
	Fumonisins	µg/kg	2000
	Zearalenone	µg/kg	100
Cereals, legumes and pulses	Lead	mg/kg wet weight	0.2
Fruit, excluding berries and small fruit	Lead	mg/kg wet weight	0.1
Berries and small fruit	Lead	mg/kg wet weight	0.2
Cereals excluding bran, germ, wheat and rice	Cadmium	mg/kg wet weight	0.1
Bran, germ, wheat and rice	Cadmium	mg/kg wet weight	0.2
Vegetables and fruit, excluding leaf vegetables, fresh herbs, fungi, stem vegetables, pine nuts, root vegetables and Potatoes	Cadmium	mg/kg wet weight	0.05
Leaf vegetables, fresh herbs, cultivated fungi and celeriac	Cadmium	mg/kg wet weight	0.20

3.4.6 Drinking Water

Drinking water will be produced in HYDRO4, HYDRO5 and HYDRO6. Drinking water is regulated by the EU Council Directive 98/83/EC on the quality of water intended for human consumption, the Water Framework

Directive 2000/60/CE, WHO Guidelines for Drinking-Water Quality, EU Commission Directive 2015/1787 amending Annexes II and III to Council Directive 98/83/EC on the quality of water intended for human consumption and EC COM 753/2018: Proposal for a Directive of The European Parliament and Of The Council on the quality of water intended for human consumption (recast). These were evaluated and all the parameters were depicted in Table 3.36. It must be noticed that parameters highlighted in grey are removed in the 2018 Proposal for Directive.

Table 3.36 Limits and parameters for drinking water

	Parameters	Units	Parametric value
A Group	E.Coli	n°/100 mL	0
	Enterococci	n°/100 mL	0
	Coliform bacteria	n°/100 mL	0
	Somatic coliphagens	n°/100 mL	0
	Pseudomonas aeruginosa	n°/250 mL	0
	Colony at 22°C	100/mL	No abnormal change
	Colony at 36°C	20/mL	No abnormal change
	Colour	-	Acceptable & No abnormal change
	Turbidity	NTU	Acceptable & No abnormal change **(<1)**
	Taste	-	Acceptable & No abnormal change
	Odour	-	Acceptable & No abnormal change
	pH	-	6.5≤ x ≤ 9.5
	Conductivity	µS/cm	2500
	Nitrite*	mg/L	-
	Ammonium*	mg/L	-
	Iron**	µg/L	-
	Aluminium**	µg/L	-
B Group	Other parameters	-	micro-organisms, parasites (potential danger to human health)
Chemical parameters	Acrylamide	µg/L	0.1
	Antimony	µg/L	5 (20)
	Arsenic	µg/L	10
	Benzo(a)pyrene	µg/L	0.01
	Benzene	µg/L	1
	Beta-estradiol	µg/L	0.001
	Bisphenol A	µg/L	0.01
	Boron	mg/L	1 (2.4)
	Bromate	µg/L	10
	Cadmium	µg/L	5
	Chlorate	mg/L	0.25 (0.7)
	Chlorite	mg/L	0.25 (0.7)
	Chromium	µg/L	50 (25)
	Copper	mg/L	2
	Cyanide	µg/L	50
	1,2-dichloroethane	µg/L	3
	Epiclorohydrin	µg/L	0.1
	Fluoride	mg/L	1.5
	pH	-	6.5≤ x ≤ 9.5
	Haloacetic acids (HAAs)	µg/L	80
	Lead	µg/L	10 (5)
	Legionella	n°/L	<1000
	Mercury	µg/L	1

	Microcystin-LR	µg/L	1
	Nickel	µg/L	20
	Nitrate	mg/L	50
	Nitrite	mg/L	0.5
	Nonylphenol	µg/L	0.3
	Pesticides	µg/L	0.1
	PFAS	µg/L	0.1
	PFASs-TOT	µg/L	0.5
	Polycyclic aromatic hydrocarbons (PAHs)	µg/L	0.1
	Selenium	µg/L	10 (40)
	Tetrachloroethene	µg/L	10
	Trichloroethene	µg/L	
	Trihalomethanes—TOT	µg/L	100
	Uranium	µg/L	30
	Vinyl chloride	µg/L	0.5
Indicator parameters	Aluminium	µg/L	200
	Ammonium	Mg/L	0.5
	Chloride	mg/L	250
	Clostridium perfringens	n°/100 mL	0
	Conductivity	µS/cm	2500
	Colour	-	Acceptable & No abnormal change
	Hydrogen ino concentration	pH units	6.5≤ x ≤ 9.5
	Iron	µg/L	200
	Manganese	µg/L	50
	Odour	-	Acceptable & No abnormal change
	Oxidisability	mgO_2/L	5
	Sodium	mg/L	200
	Sulphate	mg/L	250
	Taste	-	Acceptable & No abnormal change
	Colony at 22°C	100/mL	No abnormal change
	Coliform bacteria	n°/100 mL	0
	TOC	mg/L	No abnormal change
	Tritium	Bq/L	100
	Total indicative dose	mSv/year	0.1
	Turbidity	-	-
* If chloramination is used			
** If used as water treatment chemicals			

The Proposal 2017/0332 on "the quality of water intended for human consumption", is proposed to replace the existing Directive 98/83/EC and its update 2015/1787 (Amendment of Annexes II and III). In the proposal, the European Commission suggested some significant modifications mainly regarding limits and parameters for water quality, monitoring and sampling methods. According to the Proposal for Directive, Part A is revised by including in the Microbiological parameter prescriptions such as Clostridium perfringens spores, Coliform bacteria, and somatic coliphages. All these values are set at 0 n°/100 mL. Furthermore, for turbidity the maximum value of 1 NTU is defined.

Other significant changes to the in-force directive (98/83/EC and subsequent amendments of 2015) regard the Part B of the Chemical parameters. In fact, the proposal recommends values for endocrine disrupting compounds (EDCs), in accordance with WHO guidelines. Specifically, EDCs values are: beta-oestradiol at 0.001 µg/L, nonylphenol at 0.3 µg/L and bisphenol A at 0.01 µg/L.

Furthermore, as in the WHO Guidelines, chlorate (ClO_3) and chlorite (ClO_2) are recommended, since they are mainly disinfection by-products when hypochlorite is used. For both the limit value of 0.25 mg/L is defined. The values are around 3 times lower than those proposed by the WHO. This safety factor is considered after a specific European Food Safety Authority (EFSA) study (opinion of 201553) in which the authority established that chlorate concentrations of 0.7 mg/L in drinking water (proposed by the WHO), could lead to infants and toddlers being overexposed to chlorate and to iodine uptake inhibition. Further, in a Joint FAO/WHO Expert Committee on Food Additives (JECFA) analysis, chlorate and derived values of 0.01 mg/kg of body weight (corresponding to drinking water value of 0.24 mg/L) are considered as a toxicological value for chronic risk assessment.

Regarding heavy metals, the European Commission in the new proposal recommends lowering parametric values of 5 µg/L for lead and of 25 µg/L for total chromium in a transition period of 10 years, differently from what is defined by the WHO and by the in-force directive. Uranium is added to the list of metals with limit values of 30 µg/L. Perfluorinated compounds are also been considered in the proposal. Specifically, for per- and polyfluoroalkyl substance (PFASs) values of 0.1 µg/L for individual PFAS and 0.5 µg/L for PFASs in total are suggested, as for pesticides.

Part C of the in-force directive, regarding the Indicator parameters is also revised. Specifically, "Parameters relevant for the domestic distribution risk assessment" are regulated, highlighting maximum limit values for Lead and Legionella at 5 µg/L and 1000 n°/L respectively. Regarding the monitoring activities, programmes will include the monitoring of the turbidity (0.3 NTU (95%) and not >0.5 NTU for 15 consecutive minutes) in accordance with the volume (m^3) of water distributed or produced each day within a supply zone and minimum frequencies indicated.

3.4.7 Groundwater

In HYDRO4, an existing rainwater harvesting system of domestic residences located in a village of Mykonos will be upgraded to reclaim potable water after slow sand filtration and recharge water into the aquifer. Since there will be a recharge to groundwater, The Groundwater Directive 2006/118/EC, Commission Directive 2014/80/EU amending Annex II to Directive 2006/118/EC and 2000/60/CE - Water Framework Directive were evaluated and parameters and limits are listed in Table 3.37.

Table 3.37 Limits and parameters for groundwater

Parameters		Units	Limits for compliance
			Parametric value
Quantitative Status	Groundwater level	Green/red	Good/Poor
	Concentrations of pollutants		
	Oxygen content		
	pH	-	
	Nitrate	mg/L	50
	Ammonium	mg/L	
	Active substances in pesticides, including their relevant metabolites, degradation and reaction products. [5]	µg/L	0.1
	Active substances in pesticides, including their relevant metabolites, degradation and reaction products_TOT [6]	µg/L	0.5
	Arsenic	µg/L	

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	Cadmium	µg/L	Member States will establish threshold values for all pollutants and indicators which characterise bodies or groups of bodies of groundwater as being at risk of failing to achieve good groundwater chemical status.
	Lead	µg/L	
	Mercury	µg/L	
	Chloride	mg/L	
	Sulphate	µg/L	
	Man-made synthetic substances	µg/L	
	Thricloroethylene	µg/L	
	Tetrachloroethylene	µg/L	
	Parameters indicative of saline or other intrusions [7]		
	Nitrite	mg/L	
	Phosphorus_{TOT}/ Phosphate [8]	mg/L	

[5]'Pesticides' means plant protection products and biocidal products as defined in Article 2 of Directive 91/414/EEC and in Article 2 of Directive 98/8/EC, respectively.
[6]'Total' means the sum of all individual pesticides detected and quantified in the monitoring procedure, including their relevant metabolites, degradation and reaction products.
[7]With regard to saline concentrations resulting from human activities, Member States may decide to establish threshold values either for sulphate and chloride or for conductivity.
[8]Member States may decide to establish threshold values either for phosphorus (total) or for phosphates.'

3.4.8 Rainwater

When the rainwater is considered under European Directives/Regulations, there is no direct specification or limit for rainwater or runoff. However, there are guidelines where rainwater is mentioned: "JRC Scientific and Policy Report: Best Environmental Management Practice in the Tourism Sector (BEMP)", "EA Harvesting rainwater for domestic uses: an information guide" and "Water Harvesting Guidelines to Good Practice". Within these guidelines, best practice is considered to be the installation of a rainwater collection and distribution system for use inside the building. The harvested water can be used for non-potable demand such as irrigation. Specifications about the microbiological parameters for domestic systems are used. These reports guide to alternative systems, cost of installation, suitability of a rainwater harvesting system, maintenance requirements, and water quality issues.

Since there is no EU level direction, national and macro regional analysis is needed for rainwater harvesting. In fact, specifically for Italy, runoff and rainwater management are based on national Legislative Decree 152/2006 (Art.113 - Rainwater run-off and first rainwater). According to this article, in paragraph 1, for the prevention against hydraulic and environmental risks it is defined that "...the regions, ..., govern and implement":

a) the forms of control of rainwater, runoff, wastewater from separate sewerage networks
b) the cases in which it may be required that the inlet of rainwater runoff, carried out through separate pipelines, be subjected to specific prescriptions, including authorization.

Furthermore, the regions regulate the cases in which it may be required that the first rain and washing waters of the external areas be conveyed and appropriately treated in wastewater treatment plants for particular conditions in which there is the risk of washout of impermeable surfaces exposed to dangerous substances or substances that cause damage to the achievement of the quality objectives of water bodies. It must be noticed that according to this Decree, the discharge or direct introduction of rainwater into groundwater is prohibited. As shown for the Italian context, the management of rainwater takes place on a national scale. Therefore, since no specific reference to the reuse of rainwater and runoff has been detected at European level, it becomes necessary to analyse the regulatory framework at national and local level.

A first analysis of the study in fact shows that not only in Europe, but also in the rest of the world, "good practices" for the reuse of rainwater are already in place for various purposes including:

- domestic purposes (i.e. toilet flushing, garden watering, cleaning and laundry washing)
- irrigation
- potable uses.

Data are summarized in Annex 9.1.

3.4.9 Salt Quality

Edible salt will be produced from brine in HYDRO5. Salt quality standard in EU regulations is not clearly available. However, there is a CODEX standard for food grade salt (CX STAN 150-1985, Rev. 1-1997 Amend. 1-1999, Amend. 2-2001, Amend. 3-2006). There parameters for the edible salt is depicted in Table 3.38.

Table 3.38 Limits and parameters for edible salt

Parameters	Units	Values
Minimum NaCl content	%	97
Arsenic	mg/kg	0.5
Copper	mg/kg	2
Lead	mg/kg	2
Cadmium	mg/kg	0.5
Mercury	mg/kg	0.1

3.4.10 Restrictions from Natural Parks and Protected Areas Regulations

When the natural parks and protected areas are intended to be evaluated, there are actually no European-wide exact specifications/limits etc. like with other EU directives. Under Article 6 of the Habitats Directive, however, there is the obligation to conduct an Appropriate Assessment (AA) if a plan or project will be implemented in a Natura 2000 (N2000) site if it is not directly connected with or necessary to the management of the site but likely to have a significant effect thereon. There are some European guidelines for the AA but countries implement this within their national regulations and are responsible for approving such a plan/project, except for certain occasions where the EC should also provide its opinion (for example if within the protected area there are priority species or habitats).

The AA is very closely linked usually with the Environmental Impact Assessment (EIA) and the Strategic Environmental Assessment (SEA). It is possible that for the implementation of the HYDRO technologies, or at least maybe for some of them, an AA will need to be conducted if inside a N2000 site, as a minimum maybe the screening stage. When we evaluated the replication sites, the countries Italy, Spain, Bulgaria, France, and Portugal are in the Natura2000 site, Cyprus, Croatia and Turkey (non-EU) are not listed. For example, in Greece, if a plan / project is implemented within a N2000 site, usually it needs to undergo a Special Ecological Assessment (as part of the EIA and AA process).

To ensure compatibility and consistency with the requirements of Directive 85/337/EEC as amended by Directive 97/11/EC (the EIA directive), and in order to reflect the fact that many projects which are likely to affect Natura 2000 sites will be projects covered by the EIA directive, procedures have been included that are similar to those in common use in EIA. Where projects or plans are subject to the EIA or SEA directives, the Article 6 assessments may form part of these assessments. However, the assessments required by Article 6 should be clearly distinguishable and found within an environmental statement or reported separately. Similarly, MN2000 makes clear that where a project is likely to have significant effects on a Natura 2000 site it is also likely that both an Article 6 assessment and an EIA, in accordance with Directives 85/337/EEC and 97/11/EC, will be necessary.

One of the key distinctions between SEAs/ EIAs and Habitats Directive's Appropriate Assessments, apart from the fact that they measure different aspects of the natural environment and have different criteria for determining 'significance', is how the outcome of the Assessment is followed. In this regard, the assessments under the SEA and EIA lay down essentially procedural requirements and do not establish obligatory environmental standards; on the contrary, the assessment under the Habitats Directive lays down obligations of substance, mainly because it introduces an environmental standard, i.e. the conservation objective of a Natura 2000 site and the need to preserve its integrity.

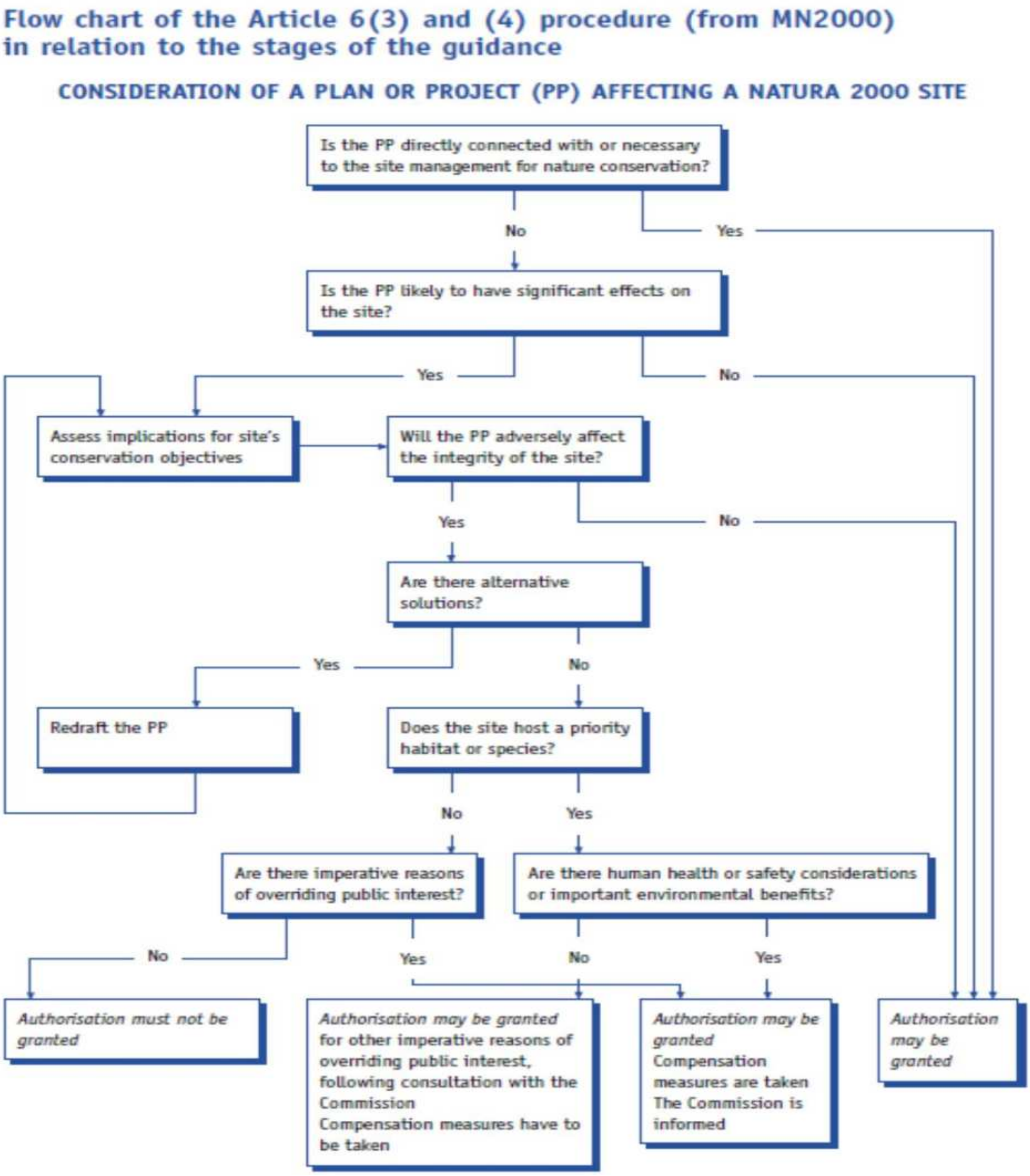

Figure 3.6 Consideration of a plan or project affecting a Natura2000 site

The appropriate assessment stages are described in Table 3.39.

Table 3.39 Appropriate assessment stages proposed by Article 6

Appropriate Assessment Stages	Description
Stage One: Screening	— the process which identifies the likely impacts upon a Natura 2000 site of a project or plan, either alone or in combination with other projects or plans, and considers whether these impacts are likely to be significant;
Stage Two: Appropriate assessment	— the consideration of the impact on the integrity of the Natura 2000 site of the project or plan, either alone or in combination with other projects or plans, with respect to the site's structure and function and its conservation objectives. Additionally, where there are adverse impacts, an assessment of the potential mitigation of those impacts;
Stage Three: Assessment of alternative solutions	— the process which examines alternative ways of achieving the objectives of the project or plan that avoid adverse impacts on the integrity of the Natura 2000 site;
Stage Four: Assessment where no alternative solutions exist and where adverse impacts remain	— an assessment of compensatory measures where, in the light of an assessment of imperative reasons of overriding public interest (IROPI), it is deemed that the project or plan should proceed (it is important to note that this guidance does not deal with the assessment of imperative reasons of overriding public interest).

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4 ENABLING ENVIRONMENT CONDITIONS FOR HYDROUSA WATER LOOPS: FOCUS ON GOVERNANCE, INSTITUTIONAL CAPACITY AND SUPPORT

4.1 General conceptual framework of rural water services (adapted from World Bank Group and IAWD, RWSS Report 0418, 2018)

Water governance is the set of rules, practices, and processes through which decisions for the management of water resources and services are taken and implemented, and decision-makers are held accountable.

HYDROUSA is mainly focusing on water services as defined in Article 2 (38) of the WFD as: "all services which provide for households, public institutions or any economic activity: (a) abstraction, impoundment, storage, treatment and distribution of surface water or groundwater, (b) waste-water collection and treatment facilities which subsequently discharge into surface water." However, as the management of water services is a national competence, the definition of 'water services' varies from country to country and may include activities that go beyond the definition enshrined in the WFD (The governance of water services in Europe, Eureau, 2019).

The supply of drinking water and the collection and treatment of waste water go under the definition of 'water services' in all European countries. In the majority of states, water services are also responsible for rain water management, but in some countries, storm water activities do not fall within the definition of water services. In a few countries flood protection and reclaimed water provision is also carried out by water service providers.

HYDROUSA water loops can probably find more appropriate, sustainable and convenient applications in small and decentralized systems, in water-scarce rural regions more than in urban and densely populated areas. It is therefore important to focus on the urban-rural divide and to frame the enabling environment conditions in which HYDROUSA solutions can have a direct improvement of technical, economic and environmental sustainability. In addition, HYDROUSA is also focusing on water-related services, again to be delivered mainly in rural areas, that make the enabling conditions even more complex to be assessed.

The enabling environment conditions for efficient and effective water services in rural areas have been assessed in large catchments such as Danube (The Danube Water Program, 2018) by a methodology that can be adequate to other rural areas where HYDROUSA solutions can be applied and replicated. Therefore, in this paragraph we report that methodological context that will be examined in the replication sites (in Tasks 7.3-7.5), with the collaboration of the local HYDROUSA support.

While utilities—in different sizes, functional forms, ownership, and governance—operate predominantly within urban contexts, in rural areas, a much more diverse range of management models exists. Rural water (and water-related) service delivery, that is more appropriate for association to HYDROUSA solutions, has been examined at different institutional levels, aligned with a conceptual framework for rural water service recently developed as part of a global study by the World Bank.

The conceptual framework recognizes that any given management model operates within a country-specific context and a sector enabling environment, which shape political, institutional, and other conditions for sustainable rural service provision. The following five key elements guide the analysis of the enabling environment and institutional context that, in turn, will have a bearing on the service level outcomes and performance of service providers:

- **Institutional arrangements and capacity**—sector reform leadership, clarity of roles and mandates, institutional and contractual arrangements, capacity for planning and implementation, support to service providers and service authorities
- **Financing and affordability**—funding arrangements for the rural sector (tariffs, taxes, transfers, including national and subnational resource allocation) and service affordability
- **Asset management arrangements**—clarity on asset ownership and mechanisms (including funding) for asset replacement and maintenance
- **Water resource management**—adequacy of resource availability, water permit regulation, management of conflicts concerning local water use
- **Monitoring and regulatory oversight**—presence and use of performance monitoring systems, oversight and tariff regulations, and water quality monitoring and safety

In this context:

- National—entities concerned with enabling policies, institutional and legal arrangements, funding, and regulatory and monitoring functions
- Service authority—the role of “duty bearer” to whom functions for water service provisions are assigned; often the lowest level of self-government (e.g., municipalities, communes)
- Service provider—operator of the water (HYDROUSA) system and facilities; management models take many shapes and hybrid forms:
    - community-based providers
    - private operators
    - direct local government provision, typically a unit in the local administration
    - municipal or regional utility companies, or parastatals
    - individual self-supply

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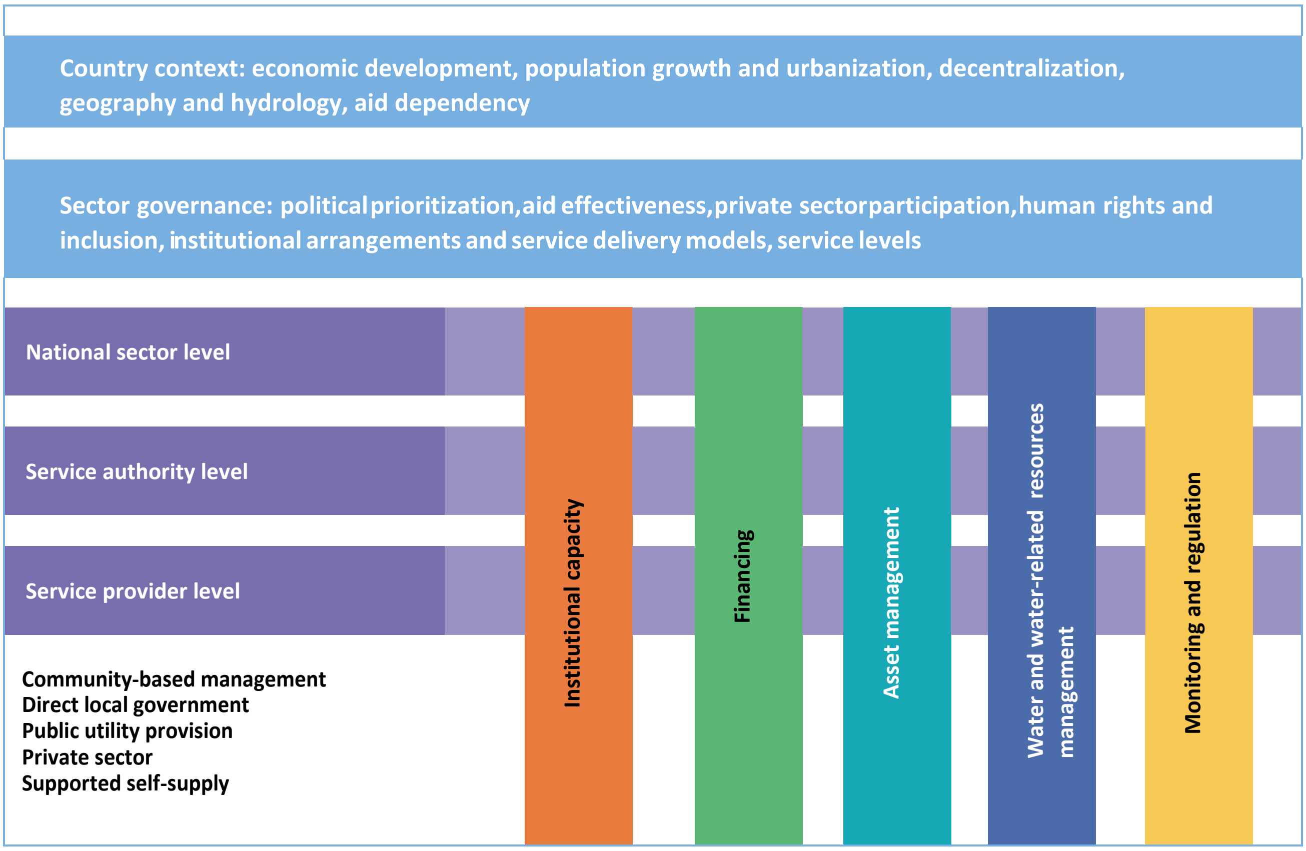
Table 4.1 Guiding framework for rural water supply analysis– to be adapted to water and water-related HYDROUSA services in replication sites



4.2 Specific analysis in terms of Water Categories/Products: Methodology and Definitions

In order to provide guidance to the delivery and replication of the HYDROUSA solutions, to contextualize the institutional analysis in the context of different HYDRO solutions, governance schemes of 12 countries were analysed, within different water categories involved in the HYDROUSA water loop. Specifically, the institutional structure has been analysed for: Austria, Belgium, Bulgaria, Croatia, Cyprus, France, Germany, Greece, Italy, Poland, Portugal and Spain.

The conceptual framework consisted in identifying the institutional organization and the decisional levels for the water categories analysed in the legislation Paragraph (i.e. drinking water, wastewater and water resources). For each institutional body, the level of competence was reported.
Specifically, all the *Competences* of the legislative chain have been analysed to better understand the structure and the competences of the water institutional system:

1. ***Regulation.*** In this section Institutions responsible for enforcing the implementation of European directives on water policies are analysed in terms of limits and prescriptions for water and resources re-use;

2. ***Management.*** In this section Institutions responsible for the collection, treatment, distribution, supply of different water types (i.e. wastewater, surface and groundwater resources, water destined for human consumption, etc...) as well as the planning of measures to preserve the water resources are analysed;
3. ***Monitoring and control.*** In this section Institutions responsible for the surveillance of the quality in the water types are analysed according to the local/national legislation;
4. ***Authorizations (and permits).*** In this section Institutions responsible for issuing licenses for discharges, use and / or treatment of water resources are analysed;
5. ***Tariff (and Fees).*** In this section Institutions responsible for setting and approving water tariffs.

The study was conducted in different countries, where it is possible, by detailing the previous *Competences* both at national (Country/State) and at local level (Basin/Region/Province/Municipality). For each country and for different water categories, a specific summary with the analysis of different *Competences* was produced, to identify the correlations between different institutions. The analysis will also highlight the co-operation and coordination between regulatory bodies, Ministerial figures and other stakeholders that are involved in the implementation of environmental policies, definition of criteria for management and protection of the environment and water resources (WAREG, 2015). The methodological approach is schematized in Figure 4.1.

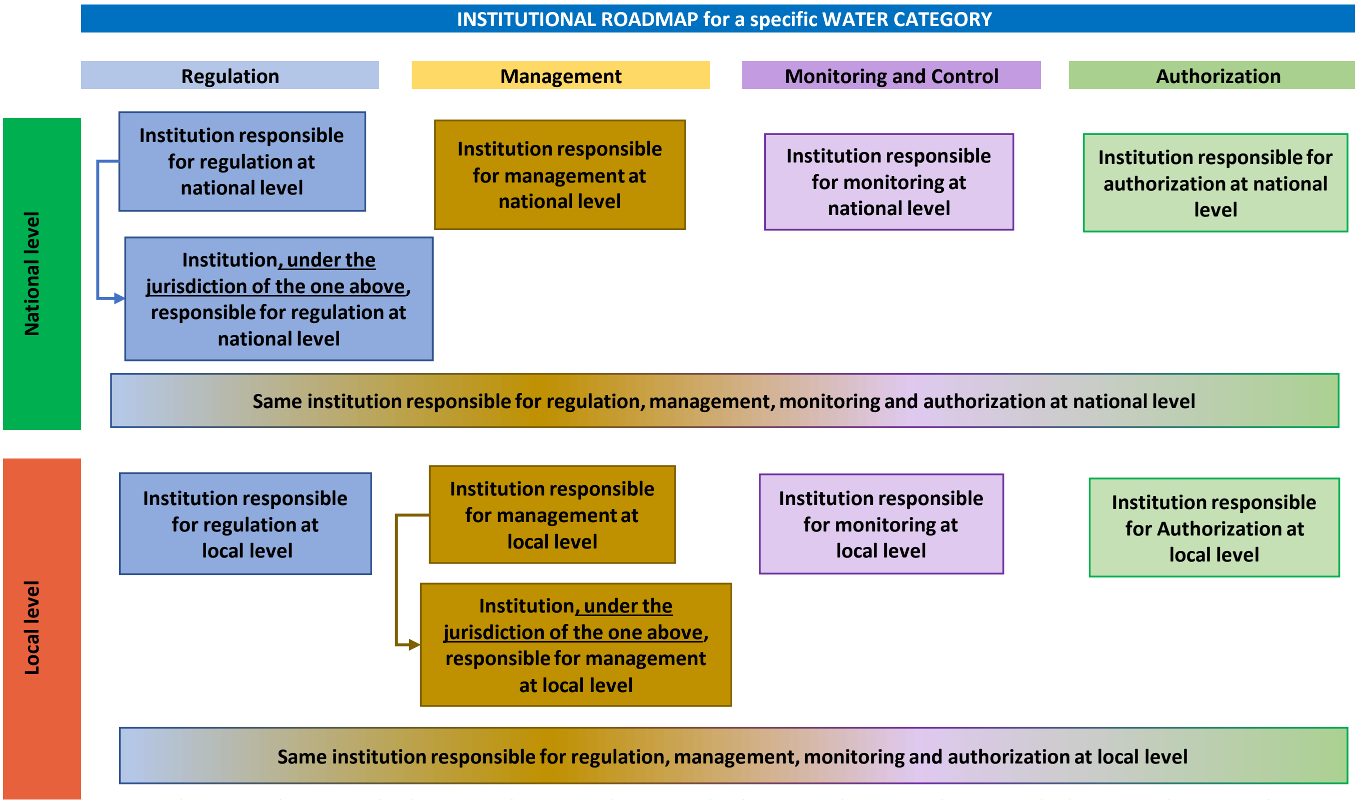


Figure 4.1 Methodological structure for Institutional Analysis

In the scheme above, institutions are allocated under one or more pertinent column of *Competence,* depending on whether they have one or more governmental responsibilities. Further, if the interrelationships between different Institutions are detected, arrows are drawn to highlight this cooperation in the water governance. Connections can also highlight delegation of responsibility from an authority to another.

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4.3 Analysis in terms of Water Categories/Products: Results

The preliminary information found for the regulation of different water types is summarized in the following matrix (Figure 4.2) divided by countries. Regarding the water categories different from groundwater and wastewater no relevant documentation was found, so they will have to be analysed within the single replication studies.

	REGULATION					MANAGEMENT					MONITORING & CONTROL					AUTHORIZATIONS					TARIFF				
	Rainwater	Groundwater	Wastewater	Water vapour	Seawater	Rainwater	Groundwater	Wastewater	Water vapour	Seawater	Rainwater	Groundwater	Wastewater	Water vapour	Seawater	Rainwater	Groundwater	Wastewater	Water vapour	Seawater	Rainwater	Groundwater	Wastewater	Water vapour	Seawater
Austria		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Belgium		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Bulgaria		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Croatia		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Cyprus		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
France		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Germany		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Greece		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Italy		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Poland		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Portugal		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		
Spain		✓	✓				✓	✓				✓	✓				✓	✓				✓	✓		

Figure 4.2 Preliminary results on regulated water categories

The importance of highlighting the institutional structure in each legislative chain phase can be translated into the possibility to define if complexity of the governmental landscape will support or block the development of HYDROUSA innovative technologies in different countries.

Institutional schemes reported in the following section shows the whole Institutional structure with respect to wastewater, water bodies (i.e. surface water and groundwater) and drinking water. Specifically, for the whole water sector all institutions and their interrelationships are shown, while specific water category-based schemes are reported in the in Annex 9.2

4.3.1 AUSTRIA

In Austria water services are not legally defined according to the Austrian Water Law. However, a common definition of water services involves: wastewater disposal, sewage disposal and drinking water supply (EurEau, 2018).

Regulation

In Austria governmental responsibilities are distributed around four levels of territorial authorities: the federal state, *Bund* (National level); 9 provinces, *Länder* (Local level); around 100 district authorities (Local level); and around 2100 municipalities as local authorities (Local level). At National level, the majority of the aspects related to the water services are condensed in the Ministry of Agriculture, Forestry, Environment and Water Management (the BMLFUW), the Ministries of Environment and Health which have relevant responsibilities, especially concerning the monitoring and environmental protection matters (Michaud et al., 2015). Further, technical supporting activities to the BMLFUW are performed by the Austrian Environment Agency (Umweltbundesamt) with the aim of developing and enforcing the environmental policy (OECD, 2013). General responsibilities for environmental issues (planning and zoning codes, nature protection, hunting, fishing, farming, youth protection, and certain issues of public health and welfare) are shared between the federal state and the provinces (and district authorities), whereas specific environmental ones (i.e. construction and maintenance of waterways) are under the responsibility of the federal state. Other matters (i.e. nature conservation, sewage sludge) are totally handled by the provinces (Frischenschlager and Lenz, 2018). Although there is no water regulator in Austria, the Austrian Association for Gas and Water **–** ÖVGW set rules and guidelines for the gas and water sectors.

Management

Water services are arranged in both direct and delegated public management models. In the delegated public management, companies and corporations are the most frequent form of organizational management, where the public authority holds the majority (in most cases 100%) of shares. Concerning the drinking water supply, Austria has about 6,000 utilities (49% urban structures, 20% smaller municipalities, 11% water boards and 10% water co-operations) (ÖVGW statistics, 2013), of which 150 handled integrated services and that provide about 90% of Austria’s population with drinking water. The remaining 10% is self-supplied by private wells or springs.

Regarding the wastewater sector, the main management form is direct public, although in some big cities the public authority nominates the public companies responsible to manage water tasks (delegated public management) (EurEau, 2018). Therefore, responsibilities about water supply, sewerage and municipal waste management are handled by the municipalities.

About water resources management, the BMLFUW is the major responsible for the Danube, Rhine and Elbe river basin districts, while local authorities are responsible for the application of management models (OECD, 2003). Moreover, the management of water, wastewater and waste is assigned even to the Austrian Water and Waste Management Association - ÖWAV with the specific purpose of achieving sustainability of the water management.

Monitoring and Control

Austria has no central monitoring authority, in fact the provinces at local level are responsible for inspections, through specific plans in accordance with the EU Recommendation on Minimum Criteria for Environmental Inspections (2001/331/EC). The BMLFUW supervises monitoring activities for waste delivery and some waste streams as well as co-ordination for the application of the activities. In some cases, experts from the ministry and the environment agency take part in inspections led by state authorities, issuing a report every three years (OECD, 2013).

Regarding the effluent monitoring and inspection, the competent authority depends on the type of discharge. The system of surveillance is under the direction of the state or the regional authority, depending on the size of the installation. For smaller treatment plants, authorized or accredited (commercial) laboratories are often involved in sampling. Large and relevant discharges are usually monitored once a year (grab samples) by environment authorities. For drinking water quality, the Ministry of Health is in charge of monitoring at national level, whereas the nine provinces are responsible for the technical inspection of water utilities at local level (International Commission for the Protection of the Danube River, 2000).

Licensing and authorizations

The nine provinces are the main licensing authorities in Austria and grant drinking water permit. Responsibilities about building permits are handled by the municipalities (OECD, 2003) as well as permits for small discharges (generally sewage), whereas regional administrations issue license for the larger effluents, (i.e. large sewage treatment plants or industry) (Hansen et al., 2001). Permits are usually provided for a reference period of 15 years. Further, the pertinent water authority (for UWWTPs >20,000 p.e. is the provincial government; for UWWTPs ≤ 20,000 p.e. is the district authority) can impose a permit to the owner for wastewater emission control. According to the federal water act: General public water use (i.e. water for bathing, washing, watering animals, soaking, dipping, watering plants, earth, sand, gravel, stones and ice) doesn't need a permit, while all other water uses require it (International Commission for the Protection of the Danube River, 2000).

Fees and Tariff

Regarding the tariff regulation in Austria fees for direct discharges of effluents into natural waters are not collected. The effluent costs for direct discharges in Europe vary between 0.35 and 1.18 € per m^3 and Austria has one of the lowest tariffs (Hansen et al., 2001). An overview of the Institutional analysis for the Austrian governance and relationships of the competent authorities are highlighted in Figure 4.3.

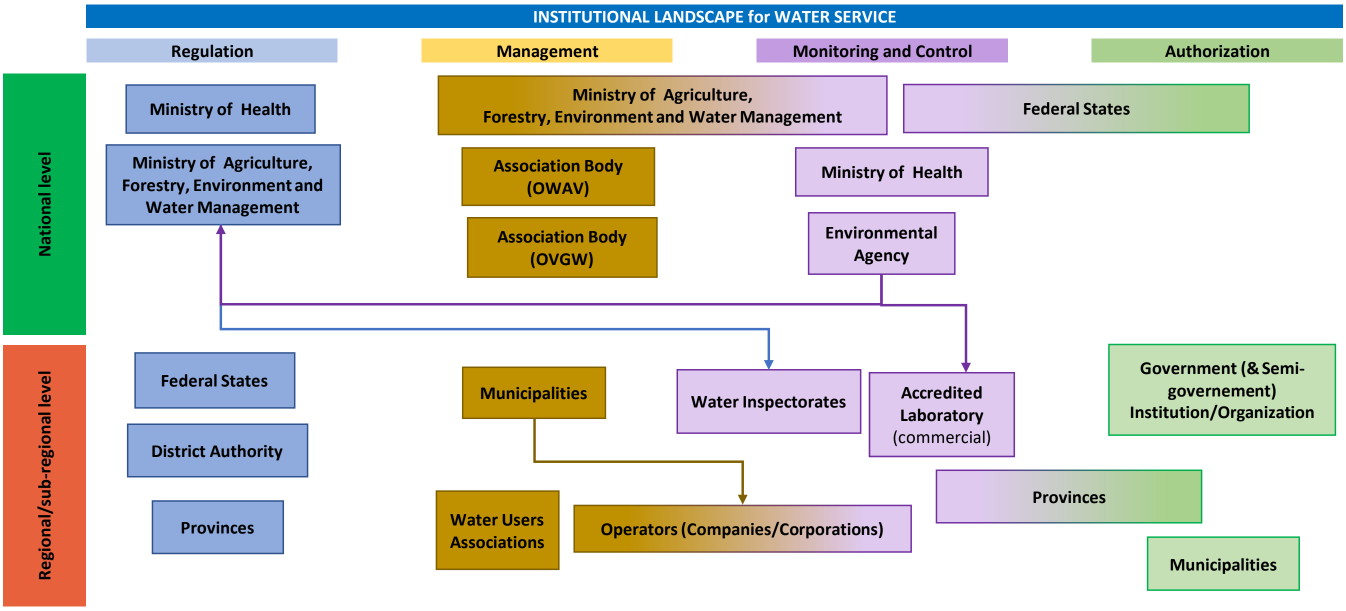

Figure 4.3 Austrian Institutional landscape for water service

Austrian Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2.

4.3.2 BELGIUM

Belgium is a federal state constituted by three communities and three regions (Flanders, Wallonia and Brussels) which are the responsible institutions for water services, namely drinking water supply and sanitation (including wastewater treatment).

Regulation

In Belgium governance is articulated both at national and at regional level. At national level Ministry of Health is responsible of setting quality parameters for drinking water supply, while Ministry of Public Works is entrusted to supervise inter-municipal operating companies (OECD). In addition, the Ministry of Environment plays a crucial role in water governance, by regulating environmental policies. The regions are responsible for environment and water policy in their territory (including technical regulations regarding drinking water quality), land development, nature conservation and public works and transport. Because of these different responsibilities, several river basin management plans are developed for each main river basin district at regional level and the co-ordination is carried out at national and regional level. Particularly, in the Flemish Region the competent authority for the preparation, control and the follow up of the integrated water policy is the Co-ordination Committee on Integrated Water Policy (CIW), whereas in the Brussels Capital Region the main authority is the Government of Brussels which is entrusted with the task of providing the monitoring programs and the organization of the program of measures for the Brussels Region. Finally, in the Walloon region, implementation of the Water Framework Directive is issued by the Walloon Government and its following two directorates-general: Directorate General for Agriculture, Natural Resources and Environment and Directorate General of Mobility and Waterways. At regional level, regulation is strengthened by the ministerial department, or a part of a governmental agency.

Management

In Belgium water services are under the responsibility of the regions for what concerns drinking water supply and sanitation (including waste water treatment). In particular, the water management is issued both at federal and the regional level, where local governments can be involved in matters regarding the water and wastewater service regulation.

In Flanders water services are totally under the delegated public management model, while in Wallonia the principal model is delegated public management with a small private shareholding for the company in charge of waste water treatment co-ordination. In Brussels the model is mainly delegated public management, but delegated private management is used for waste water treatment. The management issues are shared with the Flemish environment agency (VMM) which is responsible for ensuring that the delivered complies with legislation requirements (EurEau, 2018). Concerning the drinking water, the responsible regulatory body at regional level for the Flanders region is the VMM, which handles issues related to the regulation of the production and distribution.

Monitoring and Control

In Wallonia Brussels regions, drinking water quality is monitored by the regional administration for the environment (European Commission, 2015), while in Flanders by the VMM which defines the standards for water quality, regulating catchment areas and volumes and supervises the quality of services (EurEau, 2018). Responsibilities for effluent monitoring are mainly self-monitoring, with inspections carried out by the States' authority to validate and to control the quality of the data collected by the operators, apart from the Walloon Region, in which the inspections are conducted by the Division of Environment Police.

Concerning the responsibility for the water quality monitoring, surface waters are monitored by the environment authorities, typically a specific Ministerial Departments according to the type of water resource (i.e. navigable/non navigable surface water, groundwater) as according to Table 4.2 below (Hansen et al., 2001).

Licensing and authorizations

In the Walloon and the Flemish Region all discharge permits are issued by one central authority. The respective Ministry of Environment or Environment Agency is responsible just for the permits regarding discharges by industrial and municipal sewage treatment plants (Hansen et al., 2001).

Fees and Tariff

The Federal Government has the responsibility for economic aspects of drinking water provision (i.e. the establishment of maximum prices and the approval of price increases) across the entire Belgian territory.

The water price structure is established by law and is the same for drinking water, sanitation and wastewater treatment. The water price (fixed fee + variable fee) is defined according to the volume (drinking water) consumed.

Table 4.2 Responsibilities for monitoring

Member State	Responsibility for effluent monitoring	Responsibility for water quality monitoring	Responsibility for inspection
B			
B (WAL)	No data.	Surface Water Department (part of DGRNE).	Division of Environment Police (part of DGRNE).
B (BCR)	Self-monitoring (via accredited labs), fixed in the permit; plus counter-analyses by IBGE/BIM (accredited lab). Legislation on effluent charges, specifies the companies authorised to conduct analyses.	Inland surface water monitoring depends on the following classifications: Navigable waters (including canals): monitored by Brussels Port. Non-navigable waters: usually monitored by the Administration de l'Equipment et de Deplacement (AED – Administration for Equipment and Transport), in some cases by IBGE/BIM or local authorities. Other non-specified watercourses: monitored by AED, IBGE/BIM (department 'Espace Vert'), local authorities, or owners, depending on the location. Groundwater: monitored by AED.	IBGE/BIM controls the effluents of the installations (with accredited laboratories), at least 5 samples/year : - when complaints are lodged; - as an action of a work program (during the year 2000, large and medium-sized polluters). Groundwater is controlled by AED, IBGE/BIM and the 19 municipalities.
B (FLA)	Self-monitoring (industry).	Surface waters: VMM. Groundwater: AMINAL, Department of Water. Coastal waters: BMM - Belgian Scientific and Administrative Agency on Environmental Matters.	Environmental Inspectorate Division of AMINAL (according to Flemish Decree on Environmental Permits and VLAREM I).

Source: Effluent Charging Systems in the EU Member States. 2001

Specifically, in Flanders the drinking water tariff is agreed by the Water Regulator, held by the VMM. Once this price is determined, all the calculations are sent to the *Comité de contrôle de l'eau* for pre-evaluation and then to the competent authority (Walloonian Minister of the Economy) for the final decision on the proposed price. The price for wastewater treatment follows the same path, except that it is based on a financial plan without the research based on analytical expenditures. In Brussels water utilities assess the financial needs to recover the operational service costs and investments. A tariff proposal is sent to the minister in charge of water for decision. From 2018 the water tariff is under the jurisdiction of the Brugel, the regional energy sector regulator.

An overview of the Institutional analysis for the Belgian governance and relationships of the competent authorities are highlighted in Figure 4.4.

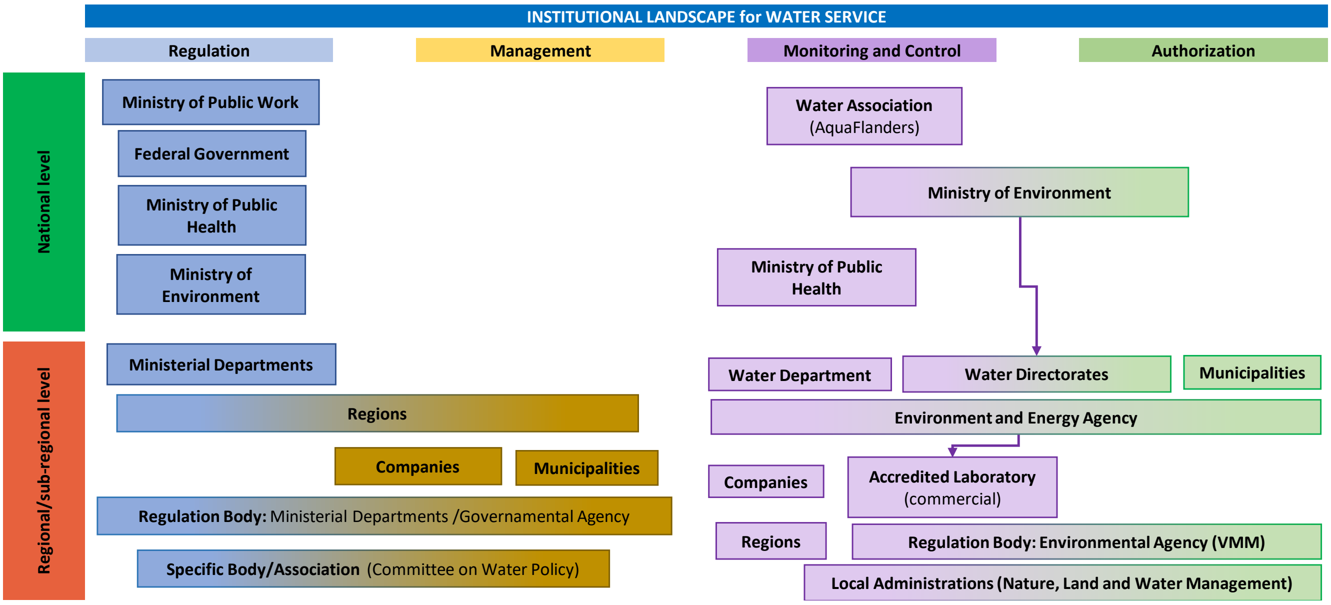

Figure 4.4 Belgian Institutional landscape for water service

Belgian Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.3 BULGARIA

In Bulgaria water service includes different activities, from the treatment and delivery of drinking water, water for household, industrial use and other uses to the treatment of wastewater and run-off rain water from domestic, commercial and state/municipal clients. Furthermore, according to the Water Supply and Sewerage (WSS) Services Regulation Act, construction, maintenance and operation activities for the supply of water and sewer systems, including treatment plants and other facilities, are included in the definition of water service.

Regulation

Bulgaria is a unitary state with 28 regions, administered by governors appointed by the Council of Ministers and 264 municipalities, administered by mayors and municipal councils (World Bank Group, 2015). At national level, different Ministerial Authority are in charge to set policies in the water sector. In particular, water policies concerning the management, protection, pollution of water resources and waste management are implemented by the Ministry of Environment and Water (MOEW), which is also responsible for approving river basin management plans and for the preparation of annual report on the environmental situation. The Ministry of Regional Development and Public Works (MRDPW) is accountable for policy about design, construction and operation of the water supply and sewerage systems as well as for coordinating the management of the water and sanitation system; the Ministry of Agriculture and Forestry (MAF) is responsible for irrigation, land reclamation systems and for defence against water damage and loss outside the limits of communities; the Ministry of Economy and Energy (MEE) handles issues related to hydro-energy systems and facilities and the Ministry of Health (MH) is accountable for the exercise of control on the drinking water quality (Organization for Security and Co-operation in Europe Secretariat, 2007).

At local level, control of the waste management activities is carried by 16 Regional Inspectorates of Environment and Water (RIEW) which guarantee that waste management comply with environmental standards. Further, 264 Municipalities, organized in Regional Municipal Associations, are accounted to implement the national waste management policy on the regional level (Country Factsheet Bulgaria, 2011). All legislative documents have to be approved by the Council of Ministers to whom the State Energy and Water Regulatory Commission (SEWRC) provides support in terms of setting regulation for the water supply and sewerage services both in terms of prices and quality of services provided by companies, in any of different cases of management models.

Management

In Bulgaria, management models are divided into: direct public, delegated public and delegated private management. Specifically, out of 64 water and sanitation service providers only 24 are 100% owned by municipalities, 16 are state owned and municipal ownership, 8 are 100% private, 1 is Public Private Partnership and 15 are 100% owned by the state. The latter cover most of the country service area and they are managed by the Ministry of Regional Development (EurEau, 2018).

Management of water service is handled both at national and at local level. At the upper level, the management is issued by the MOEW and by the Executive Environment Agency (EEA). Under the jurisdiction of the MOEW, the EEA handles issues regarding the management and coordination of environmental protection by administering the National System for Environmental Monitoring, performing laboratory analyses (in its own central and 14 regional laboratories) and integrated permitting procedures.

At local level, 4 River Basin Management Directorates RBMDs (and basin councils) are responsible for the implementation of the water management policy in all the 4 river basins and issuing control, improvement, protection and maintenance of water status under the control of MOEW. As local MOEW representatives, 16 RIEWs not only supports regulatory functions, but also tasks concerning the environmental control of the service quality of all sites and municipalities (United Nations, 2017).

Monitoring and Control

RBMDs supervise the National System for Water Monitoring and control of the results obtained from the internal monitoring of the enterprises at basin level. If monitoring activities done by the sanitation companies are insufficient to grant “good” water quality, as a temporary measure, the MOEW may support the activity (World Bank Group, 2015).

Generally, the frequency of monitoring is 1 to 6 times per year by the authority, depending on the size of the plant. The samples are collected by the staff of the regional authority and analysed by authorized laboratories. In self-monitoring, the personnel of the municipal WWTP analyses the samples. Furthermore, in case of industrial discharge, the owner of the sewer system (for water supply, sewerage company and WWTP) monitors the industrial dischargers. Monitoring is issued by authorities only in few cases (International Commission for the Protection of the Danube River, 2000).

Licensing and authorizations

RBMDs update registers, control the respect of requirements of the permits as well as issue the authorization of water use, withdrawal and abstraction (from rivers; lakes, groundwater etc.). Specifically, when municipal is the owner of the waters, permits for the use of these waters can be issued by the municipal council. In 2012 the control of treated wastewater discharge into the respective water body was moved from the MOEW to the RIEWs. It also issues permit to carry out waste management activities (i.e. waste collecting, transporting, utilization, disposal etc.). Although different permits are needed to be issued for building and operation of new and existing facilities (listed in the Environment Protection Act), an “integrated” permit can be issued instead of separate permits for waste treatment, wastewater discharge and/or activities with impact on the natural status of water resources (United Nations, 2017).

Fees and Tariff

The SEWRC is an independent regulatory state authority responsible for the approval of water and wastewater tariffs and monitoring performance indicators. It is composed of 9 members with experience in water supply and sewerage who are appointed by the parliament for 5 years (SEWRC, 2015). Water tariffs is averagely set at €0.94/m^3 for water and wastewater. An overview of the Institutional analysis for the Bulgarian governance and relationships of the competent authorities are highlighted in Figure 4.5.

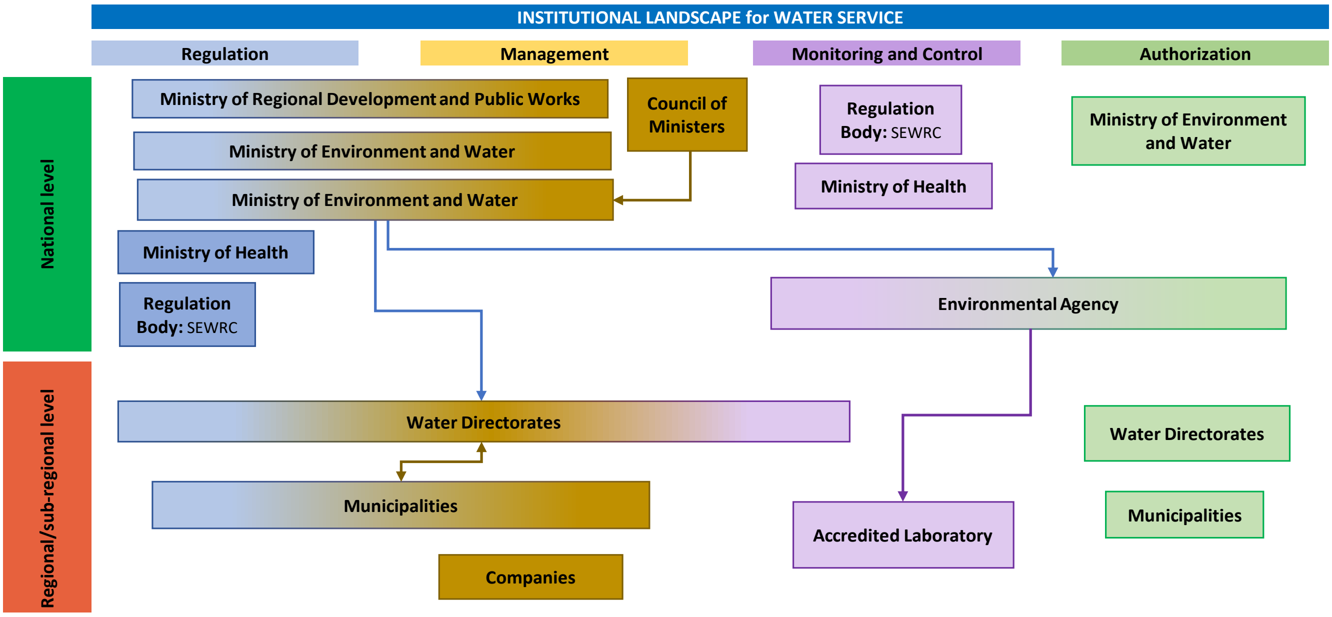

Figure 4.5 Bulgarian Institutional landscape for water service

Bulgarian Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.4 CROATIA

In Croatia, water services include not only public water supply (considering the abstraction of groundwater and surface water and delivery to the end user) but also wastewater collection, treatment and sludge management. Public wastewater services involve in the pumping and transport of wastewater from septic tanks.

Regulation

Water governance in Croatia is entrusted both at national and at local level. At national level, the Ministry of Environmental Protection and Energy, and its Directorate for Water Management at local level, is entrusted not only to the enforcement of water policies concerning water supply, but also to the sanitation services and wastewater treatment standards. Furthermore, the Ministry of Environment is responsible for the supervision of implementation of the Water Act by towns, municipalities, counties and Croatian Waters at local level (World Bank Group, 2018). Governance is also at the responsibility of the Ministry of Health for issues related to drinking water standards.

Management

On one side, at national level all aspects of water service management (i.e. public water supply and public sewage and waste water treatment) together with water companies matters and infrastructure development are at the responsibility of Ministry of Agriculture. On the other side, at local level, municipalities and towns are responsible for granting water and sanitation service according to the different management models: direct public and delegated private management (concession). Actually, about 156 public water and wastewater service operators perform services; specifically, 140 supply only water (or water and wastewater services) and 16 deliver only wastewater services.

A medium level of management is entrusted by the Croatian Waters Board (organized into 6 Water Management Departments and further into 32 Water Management Branch Offices) which is the competent entity for ensuring the adequate supply of water for various purposes, water pollution protection, regulation of water courses and other water bodies, together with flood protection. Specifically, Croatia follows an Integrated Water Resources Management approach for water resources management thanks to the national state Water Agencies that have significant water management responsibilities (Michaud et al., 2015).

Monitoring and Control
At national level aspects related to monitoring and environmental protection are at the responsibility of the Ministries of Environment for water resources and Health for drinking water sector. Concerning water intended for human consumption, the quality is enforced both at national level by the Ministry of Health, that supervising controls conducted by county authorities through the Water Inspectorate, and at local level by the public water supplier which is responsible for granting the accordance of water with quality standards for Water Intended for Human Consumption (OG 56/13). Furthermore, the supplier determines the sampling frequency, and the analyses are conducted by the Croatian Institute of Public Health (HZJZ).

The Council for Water Services regulates and monitors the performance of the public water provider in Croatia as well as lays down an obligation of reporting and analysing indicators of efficient performance of service providers (World Bank Group, 2018). Generally, when monitoring is done by the authority, the frequency is 1 to 6 times per year, depending on the size of the plant, and samples are collected by the staff of the regional authority and then analysed by authorized laboratories. Differently, in case of self-monitoring, the collected data must be transferred to the authority not later than one month after the analysis. No different monitoring method is applied for industrial plants to waters (International Commission for the Protection of the Danube River, 2000).

Fees and Tariff
Aspects related to economic and quality of service for water and sanitation services are issued by the Water Services Council, that approves any tariff revision before it can be consented to by local governments. It also regulates the highest allowed connection fee. The economic regulation is based on the cost recovery principle and on a price-cap approach. At national level, the government determines the lowest price base for water services and the types of costs covered by water tariffs, whereas at local level tariffs are proposed by the water service providers and then are evaluated by the local government (i.e. mayor of the municipality).

The water tariff is made up of a fixed and a variable part. The fixed part covers the costs associated with the connection to the municipal water network. The variable part is dependent on water consumption (EurEau, 2018). An overview of the Institutional analysis for the Croatian governance and relationships of the competent authorities are highlighted in Figure 4.6.

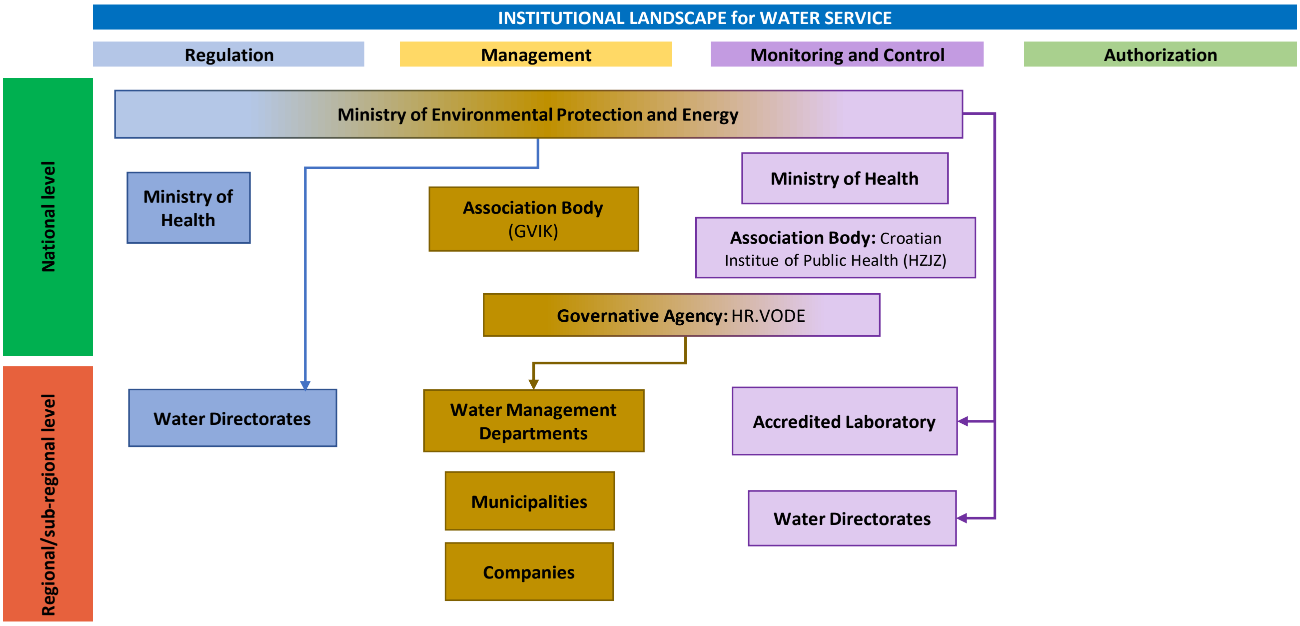

Figure 4.6 Croatian Institutional landscape for water service

Croatian Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.5 CYPRUS

In Cyprus water services include both activities related to the supply to households or public organizations (i.e. abstraction, storage, treatment and distribution of surface water or groundwater) and wastewater collection and treatment facilities, which partly discharge into surface water (EurEau, 2018).

Regulation

In Cyprus, the water governance is strengthened both at national level by different Ministries and at local level by Departments and District Officers that are incorporated in the Ministries. Specifically, the Ministry of Agriculture, Natural Resources and Environment is the competent authority for setting water policies related to supply, protection of water resources and irrigation water. This issue is supported by the Departments (Water Development Department - WDD, Geological Survey Department, Agriculture Department and Environment Service Department) at local level. In particular, the WDD is responsible for implementing policy concerning the rational development and use of water resources. Moreover, the Ministry of the Interior has the responsibility for the local government through its Districts Officers about the control of groundwater resources. Finally, Ministry of Finance is accounted for budgets and financial issues.

Management

In Cyprus, responsibilities of water service management are distributed among different authorities, according to the specific competence sector in the form of direct public management. At local level, specifically for urban context and rural communities (over 2000 p.e.), the accountability for the construction and operation of sewerage network and WWTP (included desalination plants) is given to the Urban Sewerage Boards (Public Utility Organizations) and to the WDD, respectively. Among all other responsibilities, WDD is also responsible for the setting up Storm water drainage systems, collection of water in reservoirs and administration (i.e. supply) and reuse of treated effluent. Furthermore, for rural communities, a Rural Communities Sewerage Boards supports the WDD in managing the operation and maintenance of the systems (Neocleous, 2017).

At user level, Water Boards, Municipal Boards and Village Boards (semi-governmental agencies) manage the water supply, sanitation and sewage services under the jurisdiction of local governments (municipalities) (SEMIDE, 2005). When boards are not established, municipal or local directions integrate services in their administrative responsibilities.

Monitoring and Control

At local level, the effluent quality is monitored by the Department of Environment, accounted by the Ministry of Agriculture, Natural Resources and Environment in cooperation with the S.G. Laboratory and WDD. Quality of water intended for human consumption is under the responsibility of the Director of Medical Services and Services of Public Health of the Republic of Cyprus, who is accountable by the Minister of Health, whereas sewage and treated effluent service is regulated by law (sewage laws and environmental legislation) and by the Department of the Environment, through the Disposal Decree and other decrees (EurEau, 2018).

Licensing and authorizations

Discharge Permits for the operation of UWWTPs and the effluent discharges is issued at local level by the Department of Environment, which is accounted by the Minister of Agriculture, according to the Laws of the Water Pollution Control (Neocleous, 2016). Specifically, in the discharge Permit quality characteristics of the effluent, number and the type of analysis, disposal of the treated effluent are defined for granting accordance with legislation.

Fees and Tariff

At user level, Water Boards determines water tariff in order to finance the operating expenses and development project of the Board. Tariff rates are progressives and are composed by two parts: fixed charge and volumetric charge, which increases as consumption increases (SEMIDE, 2005). Drinking water tariffs are proposed by the Water Boards and approved by the Cypriot Council of Ministers for consumers living within the limits of a Water Board area. For users that reside outside of the jurisdiction of the Water Boards, the tariffs are set by the pertinent municipal council and accepted by the Minister of the Interior or by the relative community council and further approved by the local district officer that is appointed by the government itself. Independently by the case, water tariffs have to be firstly approved by the director of the water development department (the Water Director of Cyprus). For what concerns sewage tariffs, fees and limits are set and proposed by the relative Sewerage while the Council of Ministers and then the House of Representatives are responsible for accepting the tariff (EurEau, 2018).

An overview of the Institutional analysis for the Cypriot governance and relationships of the competent authorities are highlighted in Figure 4.7.

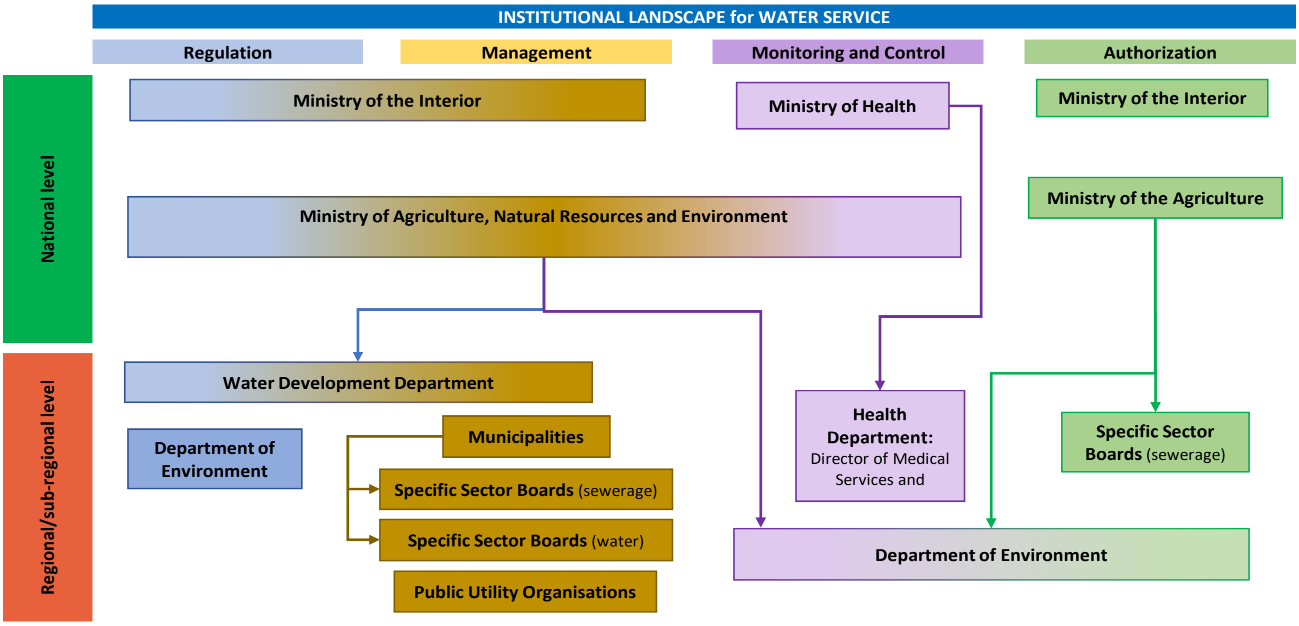

Figure 4.7 Cypriot Institutional landscape for water service

Cypriot Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.6 FRANCE

In France water services involve different activities in the water sector as follows: the preservation of abstraction zones, treatment, transport and storage, and the distribution of drinking water together with the collection, transport, treatment and discharge of wastewater, according to the General Local Authorities Code (*Code général des collectivités territoriales,* Art. L2224-7 (EurEau, 2018).

Regulation

The institutional framework in France is divided between national and local responsibilities. At national level, the Ministry for the Ecological and Inclusive Transition, known as Ministry of Environment is the principal authority, entrusted of setting environmental policy and legislation (https://www.ecologique-solidaire.gouv.fr/). At a regional level, different bodies cooperate in setting up and implementation of environmental legislation. Specifically, at this level, the fragmentation of responsibilities includes:

- 21 Regional Departments of the Environment, Planning and Housing (DREALs) that are the administrative divisions involved in implementing sustainable development policies (under Decree No. 2011-828) (*www.paca.developpement-durable.gouv.fr)* (Clifford Chance, 2012);
- the *Préfet*s (state representatives) of 101 departments (and sometimes of 18 regions), the Environmental Inspectorate and the municipalities assist in the administration of water policies (Barraque and Le Bris, 2007).
- about 35885 municipal authorities are responsible for developing local land-use plans and ensuring the application of rules and the quality of service (EurEau, 2018);
- in wider urban areas, inter-municipal associations oversee establishing strategic plans that aim to supply a strategy for the whole urban area (OECD). The Governance of Land Use).

Concerning the land-use governance, planning is mainly under the responsibility of the national government as well as environmental policies.

Management

In France, the management model for water services (i.e. drinking water and sewerage services) is determined by the cooperation between public authorities and private companies (Barraque and Le Bris, 2007) and it is distributed between national and local level. In fact, though municipalities are overseen by the state for what concerns the water supply and wastewater services, they are allowed to decide on different management models:

- direct public management (régie) in which municipalities choose to handle water services;
- delegated public management in which a public structure or local public company manages water services;
- delegated private management (gestion déléguée) in which municipalities are the owner of facilities but share the responsibility of operating the service with private operators by means of Public Private Partnership (PPP) contracts (EurEau, 2018).

Furthermore, a crucial role in water management is played by six water agencies (*Agences de l'eau*), public institutions under the Ministry for Ecological and Inclusive Transition with the main responsibility of protecting the water resources, aquatic environment and the drinking water supply by providing Water Development and Management Master Plans (SDAGE, French management plans of the Water Framework Directive) (*http://www.lesagencesdeleau.fr*).

It must be noted that, independently from the management models, municipalities have to supervise on the quality of water service (EurEau, 2018). The mayors of each town are responsible for waste management (Barraque and Le Bris, 2007).

Monitoring and Control

In France, monitoring activities involve different administrative institutions both at national and at local level. On one hand, a national entity called the French National Agency for Water and Aquatic Environment (ONEMA) was established in 2007 with responsibilities of safeguarding water quality and good ecological status of aquatic systems by monitoring activities (Organisation de Coopération et de Développement Économiques Organisation for Economic Co-operation and Development, 2014). On the other hand, monitoring tasks are locally distributed among different institutional bodies:

- the *Préfet*s that supervise the environmental compliance and establish administrative sanctions to operators in case of non-compliance;
- the Environmental Inspectorate (including the Classified Facilities Inspectorate) is in charge as the environmental police for industrial, agricultural and water facilities. Inspectors are required both to protect the environment and human health, by monitoring that facilities guarantee compliance with the environmental requirements, and to performing inspections. Further, they are responsible for supplying information to operators for what concerns the environmental hazards *(www.installationsclassees.developpement-durable.gouv.fr)*.
- Municipalities, under the figure of their majors are responsible for public hygiene and the quality of the environment (Barraque and Le Bris, 2007);
- Concerning the drinking water, the Regional Health Agencies (*Agences régionales de santé*) publish detailed information on water quality under the jurisdiction of the Ministry of Health;
- For the wastewater discharge, the Regional Directorates for Industry and Environment (DRIRE) is the competent authority for inspections of industrial discharges, while for municipal discharges the *Mission Interservices de l'Eau is in charge* (Hansen et al., 2001).

Licensing and authorizations

In France discharge permits are managed by different regional and local water authorities, depending on the types of the discharger (industry or municipality). In particular, the *Préfets* are responsible for issuing abstraction (Barraque and Le Bris, 2007) and discharge permits for sewage treatment plant (Hansen et al., 2001), while the Regional Directorates for Industry and Environment (DRIRE) issue permits for industrial discharges. Further, municipalities are entrusted of releasing building permits (OECD). The Governance of Land Use, 2017).

Fees and Tariff

In France the average price of water is about 15% higher when the management of the service is delegated to a private operator rather than carried out directly by a municipal service (Blagoeva and Rossing, 2015).

An overview of the Institutional analysis for the French governance and relationships of the competent authorities are highlighted in Figure 4.8.

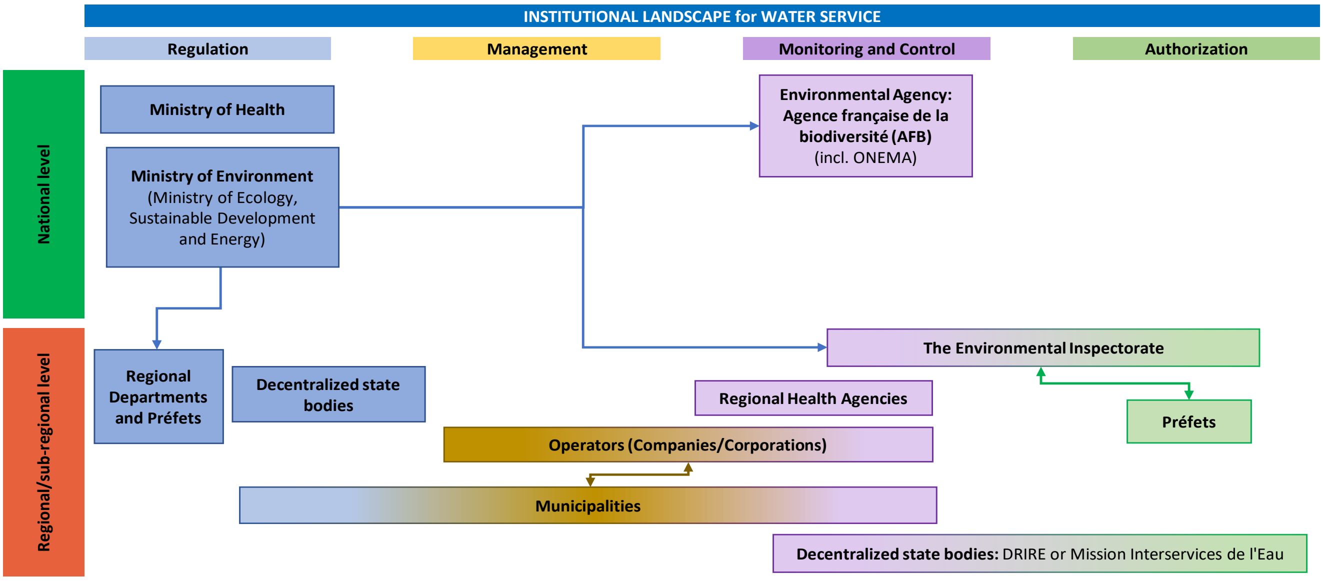

Figure 4.8 French Institutional landscape for water service

French Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.7 GERMANY

In Germany, water services include: supply of drinking water and, in some parts of the country, also the wastewater treatment (EurEau, 2018).

Regulation

Germany is a federal country with 3 levels of institutional responsibilities: 1 at national level and 2 at local level (16 federal states and municipal). In particular, the federal government is responsible for setting national legislations concerning the water sector and is the reference authority for all of the Ministries established for different environmental sectors. The latter are: the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (*BMU* - http://www.bmu.de) which is responsible for the safety of water bodies and for setting standards for wastewater disposal and levies; the Federal Ministry of Economics and Technology (*BMWI* – http://www.bmwi.de) which supervises water supply systems and the water industry; the Federal Ministry of Education and Research (*BMBF* – http://www.bmbf.de) which entrusted of developing new technologies and the Federal Ministry for Health (*BFG* – http://www.bmgesundheit.de) which guarantee the quality of drinking water (qualitative requirements in the Drinking Water Ordinance, 2001).

At local level, BMU and BFG are supported by subordinate agencies which cooperate to implement water policies such as: the Federal Environmental Agency (UBA - http://www.umweltbundesamt.de) and the Federal Institute of Hydrology (BAFG - http://www.bafg.de), as well as private, commissioned agencies, such as the Project Agency for Water Technology (FZK - http://www.fzk.de) or the Organization for Technical Cooperation (GTZ - http://www.gtz.de) (OECD, 2012). For wastewater, the federal government defines the minimum requirements for the wastewater discharge into water bodies with the approval of the States, as well as details on maximum quantity, actions against pollution and necessary treatment technologies. These provisions are applied both to industrial and municipal wastewater treatment.

At local level, the federal states are entrusted of regulating the water supply and wastewater disposal in their competent area, while the municipalities are responsible for the implementation of the water legislations (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2001) and for wastewater collection and treatment (Lanz, 2004).

Management

In Germany 3 water management models are applied:

- direct public management, in which drinking water utilities (< 50) are organized as supporting municipal utilities;
- delegated public management, in which the management is carried out mainly through special associations (almost 64% of drinking water utilities);
- delegated private management, in which drinking water is managed by companies (i.e. AG or GmbH) with private participation (EurEau, 2018).

According to these models, the wastewater collection sector is mainly handled by municipal utilities (for 43%), by municipal departments (for 20%), by inter-municipal and water management associations (for 10%) and by public-law institutions (for 17 %) (EurEau, 2017). It should be noticed that both the supply of water (i.e. drinking water) and the disposal of wastewater, as well as the collection and treatment of wastewater through local sewer systems, are directly at the responsibility of municipalities (Lanz, 2004), as according to Art. 28(2) of Germany's Basic Law.

Monitoring and Control

In Germany, control of the water sector is carried out at local level, principally at regional and municipal level where monitoring activities are performed by local authorities (Blagoeva and Rossing, 2015).

Specifically, at regional level, the States and the municipal public Health Departments monitor the status of waters and supervise the indirect discharges (i.e. discharges via wastewater treatment plants). In particular, Health Departments internally oversee the quality assurance measures implemented by the water utilities (EurEau, 2018), not only for the discharges but also for the drinking water (Lanz, 2004). Specifically, monitoring strategies applied in Germany are: monitoring by the authority and self-monitoring, in which municipal plant laboratories can analyse the samples under the control of the competent authority.

Licensing and authorizations

In Germany the Federal States regulate licensing procedures for uses of waters (i.e. abstraction, wastewater or rainwater disposal) and indirect discharges into waters. Specifically, all water uses are subject to approval by the water authorities, which can be, depending on the size of the water body, the types of substances discharged, the plant size and on the discharger, at state (Länder) level, sub-regional level or the municipal water authority.

The Environmental Ministry, together with the regional water administrations issues licenses for abstraction of water from surface water and groundwater as well as for wastewater disposal both to industries and to water supply and sanitation operators (Lanz, 2004).
As a general principle, all uses of water (e.g. discharge of substances or abstraction of water) aresubjected to official authorization, apart from a few significant exceptions. In terms of small discharges (generally sewage) the municipal governments issue permits, whereas for the larger effluents (i.e. large sewage treatment plants or industry) the regional administrations release the permit (Hansen et al., 2001).

Fees and Tariff
Operations are checked by the municipal administrations and the municipal parliament who is also responsible for fixing water and wastewater tariffs (Lanz, 2014).
Most households (97%) pay a two-component tariff for drinking water supply where the level varies within municipalities. Furthermore, a resource fee is applied for groundwater abstraction for various purposes, such as drinking water, irrigation, mine draining, cooling and industrial use (OECD, 2012).

An overview of the Institutional analysis for the German governance and relationships of the competent authorities are highlighted in Figure 4.9.

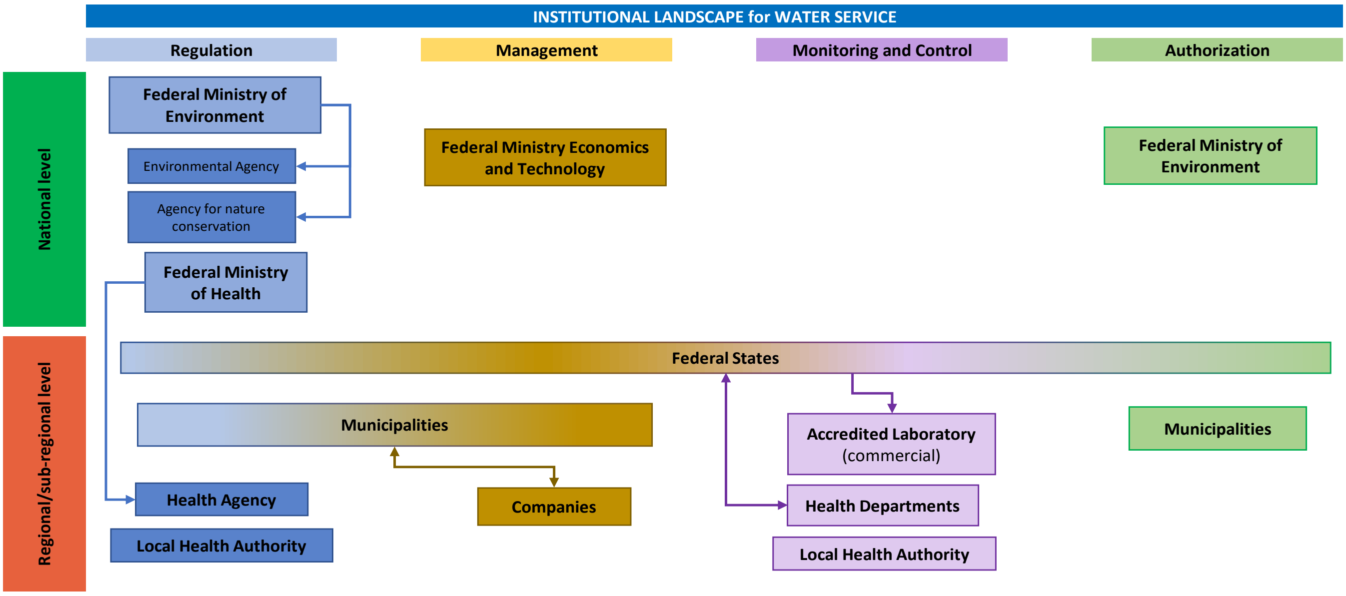

Figure 4.9 German Institutional landscape for water service

German Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.8 GREECE

According to Greek national legislation, water services include drinking water supply and wastewater collection and treatment.

Regulation
In Greece the distribution of powers and responsibilities involves different administrative structures both at national and at local level (i.e. ministry, decentralized administration, regional administration, municipal

administration etc.). Specifically, at national level, different government ministries are involved in the environmental governance such as:

- Ministry of the Environmentand Energy implements environmental policy and programme (i.e. on air, water, hazardous waste) and environmental inspections;
- Ministry of Development implements energy and water policy and programmes (i.e. on renewable energy, energy conservation, industrial pollution prevention and monitoring activities) cooperating with Ministry of environment;
- Ministry of Rural Development and Food (agri-environmental measures; forest protection; aquaculture; biodiversity and biosafety; irrigation);
- Ministry of Shipping and Island Policy (marine safety against pollution and transport matters);
- Ministry of the Interior (aspects regarding relationships with international organizations; administration of EU Cohesion Fund);
- Ministry of Health (food safety in the fisheries sector; quality of water for human consumption; environment-related health issues) (OECD, 2009).

At the administration level, also the National Centre for the Environment and Sustainable Development (EPA in Greece and the Centre of Renewable Energy Sources (CRES) play important roles in terms of providing technical and scientific support to the Ministries (i.e. Environment) on implementation of policies (http://epanet.pbe.eea.europa.eu/european_epas/countries/gr/) and on enforcing innovative programmes on environmental protection and rational use of energy (http://www.cres.gr/kape/index_eng.htm), respectively. Also, according to the Law 3199/2003, the National Water Committee (NWCt) cooperates with ministries in terms of defining river basins and competent regional authorities, implementing national policy on water protection and management and approving national water programs together with the prime competent agency, the Special Secretariat for Water – SSW (former Central Water Agency under the Ministry of Environment). Moreover, annual report on water resources quality status and compliance with European Directive is written by the National Water Council (NWC, board with consulting role). The Secretariat, headed by a Secretary appointed by the Ministry of Environment, formulates and implements the River Basin Management Plans and the national monitoring program (www.ypeka.gr) in collaboration with the Regional Water Authorities (RWA), upon the approval by the National Council for Water (Podimata and Yannopoulos, 2014). At regional level, the Regional Water Councils (as representatives of the regions) are responsible for consulting about the formulation river basin management plans (Podimata and Yannopoulos, 2014).

Management

In Greece, the water/wastewater management in the two large cities of Athens and Thessaloniki are managed by E.YD.A.P. and E.Y.A.TH. respectively. The representatives of these public companies, appointed by the government, are responsible for water/wastewater treatment plants, distribution and sewerage networks (Assimacopoulos, 2012). In the other cities the water/wastewater management is implemented by the local Municipal Enterprises for Water Supply and Sewerage. The model is usually the direct public management in which municipalities are the responsible public entities entrusted of water services supply sanitation services (EurEau, 2018). The institutional structure in terms of management responsibilities is articulated both at national and at local level. Specifically, the Ministry of Environment is responsible for water resources management and the Ministry of Interior is entrusted of supervising municipalities. Cooperation of the SSW is fundamental to regulate water services (EurEau, 2007). Though national level has a great impact on the water service management, the main responsibility for water supply and sanitation are assigned to municipalities at local level.

Monitoring and Control

Concerning the drinking water quality, monitoring activities are implemented at national level by the Ministry of Health, which is responsible for consumer protection with respect to water quality (EurEau, 2007) and its

Regional Laboratories for Public Health. Drinking water is analysed in rivers and lakes, using the laboratory infrastructure of the General Chemical State Laboratory of Greece (GCSL - http://www.gcsl.gr/index.asp?a_id=150). Therefore, monitoring programmes for drinking water quality are implemented by the Directorate for Health of the corresponding Prefecture for acceptance and reported to the competent Regional Authorities (Papaioannou et al., 2004). For what concerns the quality of the discharge, responsibilities for monitoring lie to the Prefectural Health Directorate at local level for industrial discharges and to regional/prefectural authorities for sewage treatment plant discharges (Hansen et al., 2001).

Licensing and authorizations

In Greece the prefectural health authorities are responsible for issuing permits in co-operation with the Ministry of Environment. Specifically, permits for industrial plants and sewage treatment plants of all sizes are issued at local level by the prefectural health authorities, while the rules and standards for the permits are defined by regional or central authorities (Hansen et al., 2001).

Every water uses need to obtain official permission and license following specific procedure (according to the Presidential Decree 256/1989), in relation to the quantity, quality and the final use of water abstracted. Further, abstractions of water from wells require a license specifically to allow the pumping and collecting of a certain amount of water (OECD, 2009). Generally, environmental permit is mandatory in cases such as creation, enlargement, modification or upgrading of public or private activities that impact on the environment, according to the classification defined by the Minister of Environment, which, together with the competent Minister for the relevant work or activity, is responsible for issuing the permit (Law 1650/1986). Furthermore, the Ministers may transfer the Prefecture the responsibility of releasing the permit for specific categories of works (or activities) to the local General Secretary of the Periphery or (Christofilou and Koliatsi, 2010).

Fees and Tariff

Tariffs and sewerage charges are defined by the Ministries of Finance and the Environment every 5 years according to the inflation, the costs of water service provision and the Water Framework Directive requirements. Pricing policy and tariffs are based on: the operative and maintenance costs of the company, the implementation of new infrastructure (reference of Law 2937/2001), the increasing Block Tariffs and the revenue from domestic users (70% of total revenue) (Assimacopoulos, 2012).

An overview of the Institutional analysis for the Greek governance and relationships of the competent authorities are highlighted in Figure 4.10.

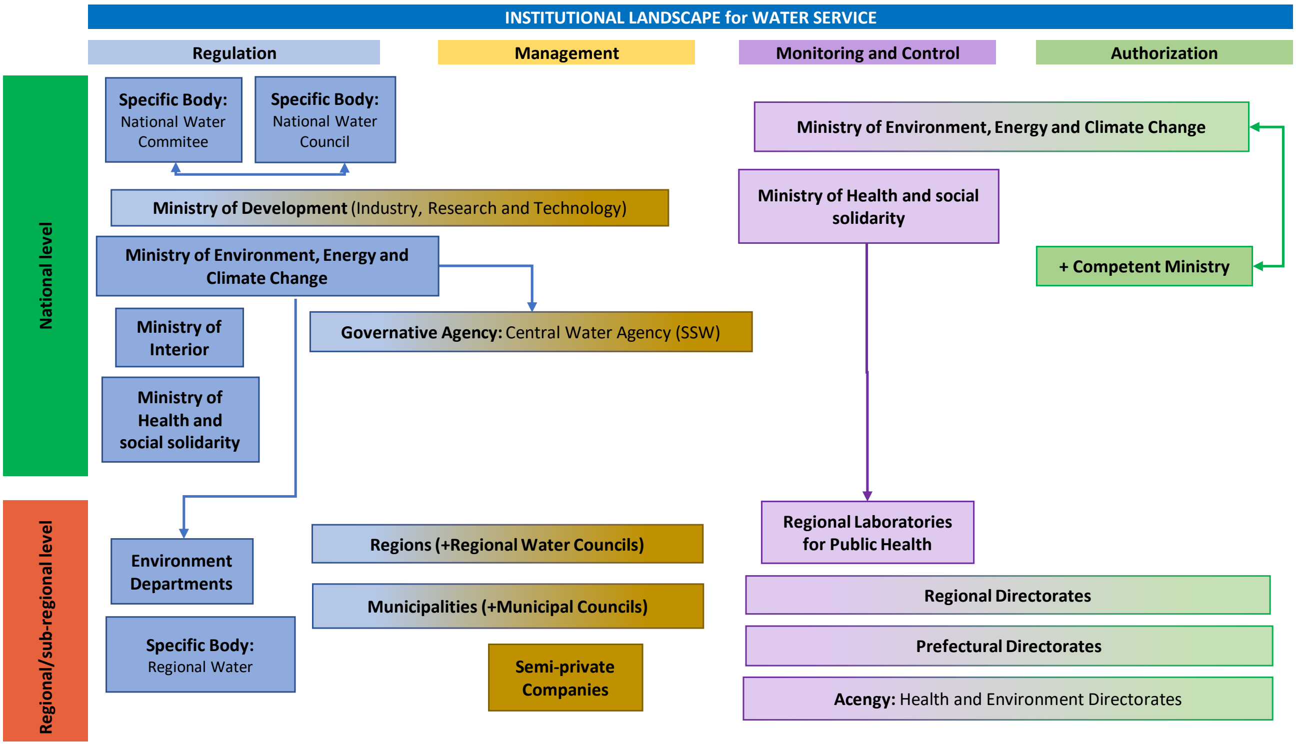

Figure 4.10 Greek Institutional landscape for water service

Greek Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.9 ITALY

In Italy, water services include drinking water supply, sewage (including urban drainage and rain separated sewage management) and wastewater treatment (sludge included). The definition of water services also referrers to all the operations needed to operate them such as new connections and water meter management.

Regulation

Italy has four levels of administrations: 1 national and 3 locals, the latter specifically divided into: 20 regions with their own statutes, Regional Councils and regional governments directed by presidents; 110 provinces and relative presidents, Provincial Councils and prefects directed by the central government; 8100 municipalities with relative mayors and managed by Municipal Councils. Each of these actors decides on the form, organization and operation of its administrative structure through the regional statutes (OECD, 2013).
At a national level, six ministries and public agencies are involved in water policy design, regulation and implementation. In particular, the Ministry of the Environment, Land and Sea (MATTM) oversees setting water policy and coordinating river basin authorities. Other ministries responsible of water matters are:

- the Ministry of Infrastructure and Transport (MIT), which handles national scale infrastructure (i.e. long-distance water transport);
- the Ministry of Economic Development (MSE), which regulates water use by industries;
- the Ministry of Health, which supervises drinking water standards and water monitoring, including bathing waters (OECD, 2013).

Critical role in the regulation of the water system is assigned to the Regulatory Authority for Energy, Networks and Environment (ARERA, ex AEEGSI), which is an independent regulatory institution at national level for energy and integrated water service sectors. The Regulatory Authority in fact is responsible for establishing minimum quality standards for every water provider as well as standard framework contracts for the assignment and the management of the service (including sanctions). Further, the Institute for Environmental Protection and Research (ISPRA), under the MATTM, is entrusted of technically supporting the rules to set for water discharges and coordinating Italy’s regional environmental protection agencies (ARPAs) in each region. At a regional level, the regions coordinate planning activities, implement water protection plans and must appoint Government Area Authorities (EGA, ex AATO) where the integrated water service is organized (Fracchia, 2018). Specifically:

- regions and provinces regulate water service investment plans;
- river basin authorities are responsible for guaranteeing cohesion between the river basin plans and European, national, regional and local rules;
- Government Area Authorities (EGAs), as inter-municipal structures, are entrusted of developing technical and financial plans, selecting operators and setting service levels and tariffs;
- local communities (municipalities) take part in the implementation of water management plans adopted by each region (OECD, 2013).

Management

In Italy there are different managing models for water services. Specifically, delegated public management model (50% of population served), Public Private Partnerships (PPPs for 36%) and concessions (for 5%) coexist, while for the rest of the population water services are directly supplied by municipalities through direct public management model. Models are chosen by the regions as well as the assignment of the service (EurEau, 2007). At national level, the MATTM oversees defining general frameworks for water resources management and water services provision (quality, continuity, access and tariffs) while the Ministry of Agricultural, Food and Forestry Policies (MIPAAF), is involved in strategic planning, monitoring and assessment of water intended for reuse in irrigation and agricultural activities (OECD, 2013). Furthermore, the Ministry of Health, with the Institute of Health (ISS - Istituto Superiore della Sanità), defines the responsibilities of the Local Health Authority (ASL - Azienda Sanitaria Locale) and sets standards for quality parameters (chemical and biological), analytical methodology and implements EU legislation, liaising with the European Commission. Concerning the quality of service, both the ARERA and the EGA define requirements and compliance of each individual service (RQSII). Requirements are referred to the minimum contract levels and quality objectives of the Integrated Water Service. ARERA also defines methods for recording data on services provided by operators. In case of failure to meet specific quality standards the authority applies a penalty mechanism.

At local level, regions and provinces supervise quality and quantity of surface and groundwater, design plans for water use, regulating water service investment plans and compliance monitoring. Further, river basin authorities are entrusted to elaborate river basin management plans and guaranteeing cohesion between the plans and European, national, regional and local rules while local administrations are responsible for the implementation of the plans adopted by each region. EGAs have the responsibility of contracting and supervising the drinking water supply and wastewater activities in those areas that fall under their competence (Optimal Territorial Area, Ambito Territoriale Ottimale - ATO). They draw up technical and financial plans, choose operators and define the level of service. All local authorities take part of the EGAs and thus participate to its decision-making and management activities. Furthermore, specific boards for controlling the land reclamation and water supply for irrigation are established (Reclamation and Irrigation Boards) (OECD, 2013). The operators handle the service and make investments as according to the service contract, that is established by the EGA (Fracchia, 2018). The Regional Environment Authority (ARPA – Agenzia Regionale per la Protezione Ambientale) oversees the environmental audit and is responsible for WWTPs compliance with EU and national legislation. The ASL is responsible for ensuring drinking water complies with EU and national legislation at the local level (EurEau, 2018).

Monitoring and Control

Inspections can be done both through the self-monitoring (by operators) and through the states' authorities, the latter to control the quality of the data collected by the operators. Specifically, at local level regions and provinces supervise monitoring activities (OECD, 2013) while the local authorities (ARPA officers) control the effluents on-site, supported by the regions (Hansen et al., 2001). At national level the National Agency for the Protection of Environment (ANPA - Agenzia Nazionale per la Protezione dell'Ambiente) is responsible for coordinating collection of data and transmit them to the Ministries. Concerning the quality of surface water, monitoring activities are managed by the environment authorities (Hansen et al., 2001).

Licensing and authorizations

In Italy, provinces release the permits for industrial and municipal discharges, independently by the WWTP size, whereas regions define the rules and standards (Hansen et al., 2001).

Fees and Tariff

Concerning economic aspects, EGAs, as local regulators, are responsible at local level for setting the tariff which needs to be approved at national level by the Regulatory Authority (ARERA) who is entrusted to determine the acceptable cost components of the tariff and the methodology for calculating the fee (OECD, 2013). In case the EGA does not handle the tariff setting, the water operators can directly propose tariff to the national regulator (ARERA) for agreement (EurEau, 2018).

An overview of the Institutional analysis for the Italian governance and relationships of the competent authorities are highlighted in Figure 4.11.

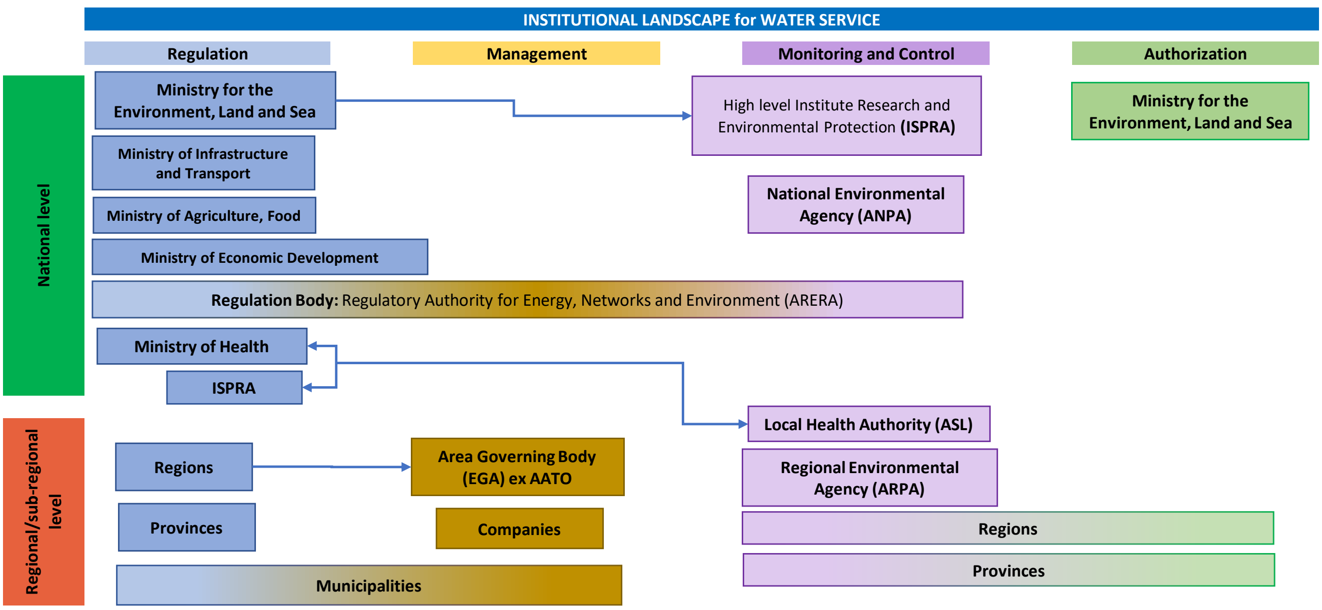

Figure 4.11 Italian Institutional landscape for water service

Italian Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.10 POLAND

In Poland the Act on the Collective Supply of Water and Collective Discharge of Waste Water regulates the drinking water and wastewater service sectors, including the water treatment, the supply of water intended for human consumption and wastewater collection and treatment (EurEau, 2018).

Regulation
In Poland, governance of water sector is divided between national and local level. Specifically, regulations and prescriptions for drinking water are set at national level by the Ministry of Health, according to the DWD. The support in defining standards on water quality for human consumption is given by the State Sanitary Inspectorate. This ministerial body is entrusted also of setting quality standards for wastewater treatment (Blagoeva and Rossing, 2015). Concerning the water resources, prescriptions and standards are set by the Ministry for Environmental Protection, which is entrusted also for the water management plans (EurEau, 2017). At local level municipalities are responsible for defining public service obligations and service standards (Blagoeva and Rossing, 2015).

Management
In Poland, implemented management models are: direct public management handled by municipalities (budgetary unit), delegated public management (municipal utilities i.e. limited liability utilities, joint stock utilities, etc…) and delegated private management through which private operators handle the service. In particular, the water and sewage sector are principally managed by public entities (direct public) whereas just in few cases mixed ownership model is adopted (Blagoeva and Rossing, 2015). Other management forms can be implemented such as ownership of small entities by consumers or private companies and ownership of wells by water consumers for the case of drinking water. In some cases, drinking water and wastewater services may be managed by the same company as well as other services like solid waste management, district heating etc. (EurEau, 2018). It has to be noticed that at local level municipalities are the main responsible for waterworks, water supply and sewage disposal services (Blagoeva and Rossing, 2015).

Monitoring and Control
Monitoring activities of water intended for human consumption must be performed al local level by every water utility in an accredited laboratory and results are overseen by the district Sanitary Epidemiological Office (EurEau, 2018). Concerning the effluent discharge, each WWTP must monitor the treated wastewater quality in an accredited laboratory while the quality of the effluent is supervised by the Inspectorate for Environmental Protection (EurEau, 2018).

Licensing and authorizations
In Poland, water supply and sewage disposal services are subjected to permit, according to the "Collective Water Supply and Collective Sewage Disposal Act". The permit for legally conducting the activity is released at local level by the mayor of the municipality where the company is located (Blagoeva and Rossing, 2015).

Fees and Tariff
Tariff is proposed at local level by the water company that works in each municipality for a three-year period and it should agree with the ministerial provisions on tariff settling method concerning the costs and profits to be included in the tariffs. From 2017 (Act on the Collective Supply in Water and Collective Discharge of Waste Water), tariffs are approved by the Central Tariff Regulator.

An overview of the Institutional analysis for the Polish governance and relationships of the competent authorities are highlighted in Figure 4.12.

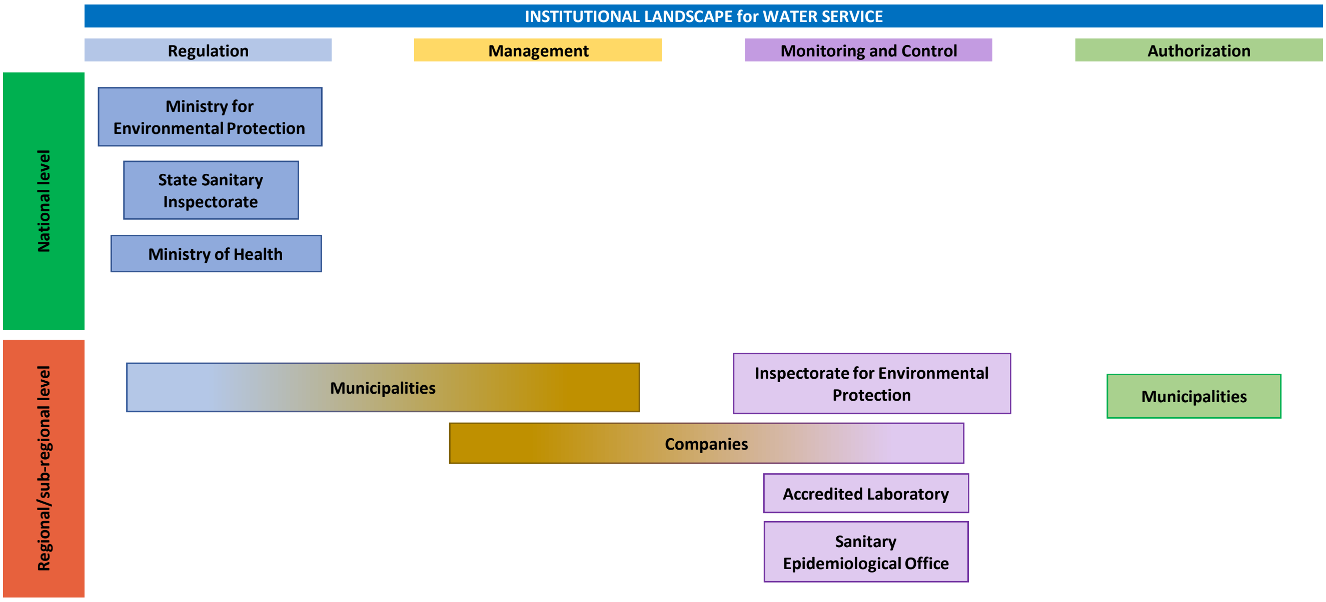

Figure 4.12 Polish Institutional landscape for water service

Polish Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.11 PORTUGAL

In Portugal, the definition of water service includes: the abstraction, treatment, transportation, collection and supply of drinking water; the storage, transport, treatment and discharge of urban wastewater as well as the storage, transport and final disposal of sludge from septic tanks. According to the regulation, urban wastewater is related to domestic wastewater or to a blend of domestic wastewater and rain water or industrial wastewater (EurEau, 2018).

Regulation

The institutional structure of Portuguese governance for policies setting develops at national scale. At this level, though the Ministry for Environment and Energy (MAOTE) is the main government body responsible for setting environmental policies, governance functions are entrusted also by the Environment Ministry agency, (APA - Agência Portuguesa do Ambiente), which is responsible for regulation of wastewater treatment, discharge monitoring and protection of water resources, by defining environmental standards. Through the several APA Departments (waste, environmental licensing, environmental management, water resouces etc.) and a specific Management Board, the agency is also in charge of overseen water resources, license and control of their uses (EurEau, 2018). Furthermore, Competition Authority (AdC) cooperates in water governance, by ensuring compliance with national rules, by developing laws to the competent institutions and approving regulations required to enforce a competitive environment (http://www.concorrencia.pt). A crucial role in the water governance is played by the Water and Waste Services Regulation Authority (ERSAR) which is entrusted of regulatory functions over all operators in Portugal concerning WWS and urban waste quality of service (https://www.wareg.org/members.php?q=view&id=20).

Management

Concerning the management of water services, three models are implemented: direct public management, delegated public management and delegated private management. The public management model is the most widely implemented and applied in different forms such as: direct municipal management; group of municipalities or autonomous water services of municipality (in large or medium-sized municipalities); state-owned water company (i.e. EPAL, in Lisbon). The delegated public model can be based on a municipal or regional appointing and can operate for a single municipality or group of them ("multi-municipal systems") in which systems are owned by both a Portuguese state-owned company (i.e. Águas de Portugal) and different municipalities. In this scenario, systems responsibilities at the regional level, include withdrawal, treatment and regional piping for drinking water, whereas distribution of water intended for human consumption is competence of municipality; in case of wastewater, the storage, distribution through pipes, treatment and discharge are handled at municipal level (EurEau, 2018).

At national level, the ERSAR, and its Board of Directors (Departments of Waste Systems, Water Systems, Contract Management, Direct Management, Legal and Quality) is entrusted of supplying water, managing urban wastewater and municipal waste management. Furthermore, it is also responsible for the protection of the water and waste sector users, granting the compliance of quality standards (http://www.ersar.pt/en/about-us/mission). Water resources management is at the responsibility of the Water Institute INAG which operates under the MAOTE according to the 2005 Water Law (transposition of the EU water framework directive into national law) (http://inag.pt/).

Monitoring and Control

At national level, the ERSAR monitors the quality of both drinking water and wastewater services (EurEau, 2018).

Licensing and authorizations

For discharge and water abstraction, licenses are issued at national level by the APA (OECD, 2015).

Fees and Tariff

At national level, the ERSAR is responsible for regulation and approval of the tariffs charged to the end-users (http://www.ersar.pt/en/about-us/mission) in cases of multi-municipal management system and in state-owned company management model. When other management models are applied, tariffs are approved at local level by municipalities (EurEau, 2018).

An overview of the Institutional analysis for the Portuguese governance and relationships of the competent authorities are highlighted in Figure 4.13.

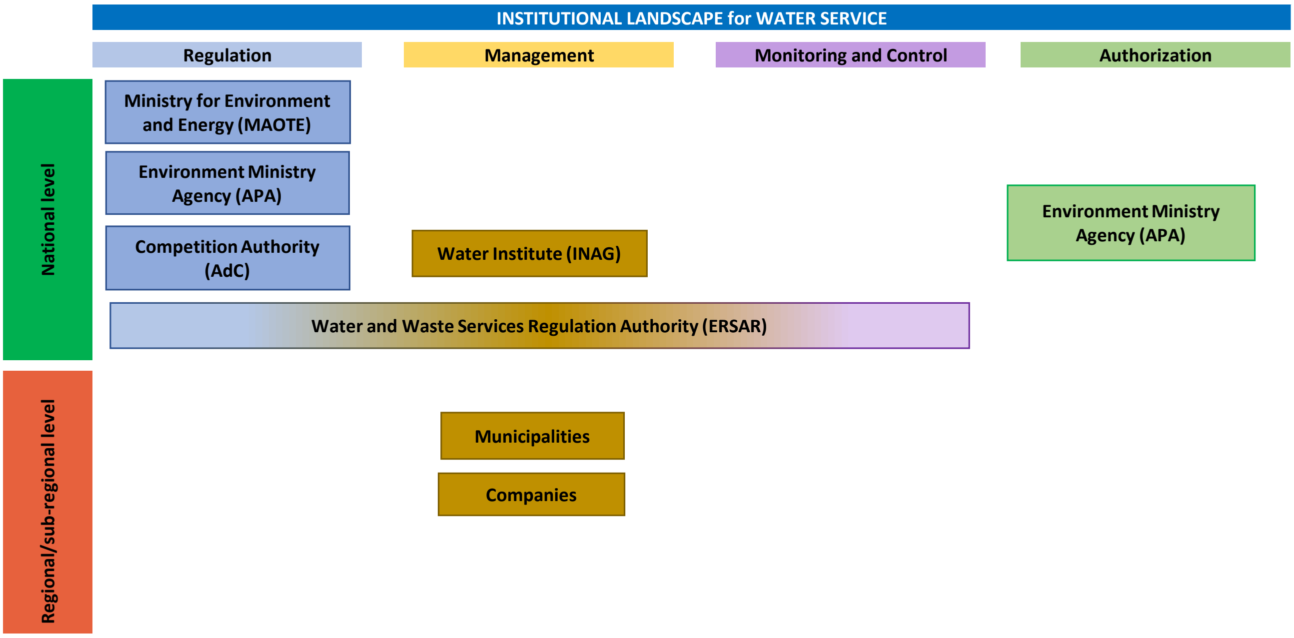

Figure 4.13 Portuguese Institutional landscape for water service

Portuguese Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.3.12 SPAIN

In Spain, according to the National Water Law 29/1985, water services are defined with respect to all activities concerning the water management and its uses (i.e. extraction, storage, supply, treatment and distribution of surface or groundwater together with the collection and treatment of wastewater, discharged in surface waters) as well as reuses of the treated wastewater that comply with national regulation (EurEau, 2018).

Regulation

Spain is a federal country where water governance is fragmented between national and local level and regulatory authorities vary according to the specific water category (i.e. wastewater, water resources, drinking water). In particular, several ministries share responsibilities for water supply, setting policies and regulation. Specifically, according to the Royal Decree 140/2003, the Ministry of Health, in cooperation with the Ministry of Agriculture, Food and the Environment and relatives regional bodies, defines the quality standards of water intended for human consumption and for wastewater treatment (Blagoeva and Rossing, 2015), while for water resources, environmental policies and protection of water bodies are under the national responsibility of the Water Directorate General, under the Ministry of Agriculture, Food and the Environment (EurEau, 2018). The Ministry of Environment is also responsible for strategic planning, setting water standard controls and organizing water supply services (Deloitte, 2014). At local level and specifically in river basins, River Basin Organizations (RBOs) are responsible to implement management plans for the administration and control of public water (OECD, 2015). In a deeper institutional level, regions are responsible for projects, constructions and utilization of channels and irrigation systems and municipalities are entrusted of defining public service obligations and standards (Blagoeva and Rossing, 2015).

Management

Water management models that are implemented in Spain are: direct public management, delegated public management and delegated private management. Specifically, at local level and for water supply, local entities (i.e municipalities) are responsible for supplying water for 10% of the population (direct public management), while 34% of the services are operated by public companies and 22% by public-private companies. Private companies supply the remaining fraction of services (delegated private management).

Regarding the sewage management, private companies) under the form of delegated private management) provide the service for 43% of the population while 56% is served both by public companies (41%) and by public-private companies (15%) following the delegated public management model. The remaining 1% is regulated by local entities (direct public management). For wastewater treatment most of the management is entrusted to public companies and supra-municipal consortia, while wastewater treatment activities are generally carried out by private companies (EurEau, 2018). Regardless of the management model (public, private or mixed legal nature), the Spanish Water and Wastewater Association (AEAS) is the technical and professional association of entities, institutions, operators and corporate partners and individual experts who are responsible for operation, maintenance and management of urban water supply and sanitation (http://www.eureau.org/about/members/spain-aeas).

Monitoring and Control

Regarding the monitoring activities, municipalities are the legal authority responsible for ensuring and setting the quality of service to the end-users at local level. Water quality, in terms of user protection, is at the responsibility of health offices in the regional governments, which affiliated with the Ministry of Health. Concerning the treated urban wastewater discharges into water bodies, monitoring activities are at the responsibility of the River Basin Authorities at local level, under the supervision of the Ministry of Agriculture, Food and Environment whereas, industrial wastewater discharges to urban collecting systems are under the responsibility of municipalities. (EurEau, 2018).

Licensing and authorizations

In Spain licenses for inter-regional water resources uses are entrusted to the National Government, while at local level water use rights permits are issued by the Regional or state-level RBOs (Blagoeva and Rossing, 2015), supervised by the Ministry of Agriculture, Food and Environment (OECD, 2015).

Fees and Tariff

In Spain the most used methods used for tariff approval can be:

- cooperation between municipalities, responsible for tariff approval, and price commissions (subjected to the relative regions), entrusted of authorization of price revisions;
- actions of regional public bodies or regional governments (EurEau, 2018).

It must be noticed that, regardless by the method used, tariff regulation is mainly at the responsibility of municipal and regional Administrations (Blagoeva and Rossing, 2015).

An overview of the Institutional analysis for the Spanish governance and relationships of the competent authorities are highlighted in Figure 4.14.

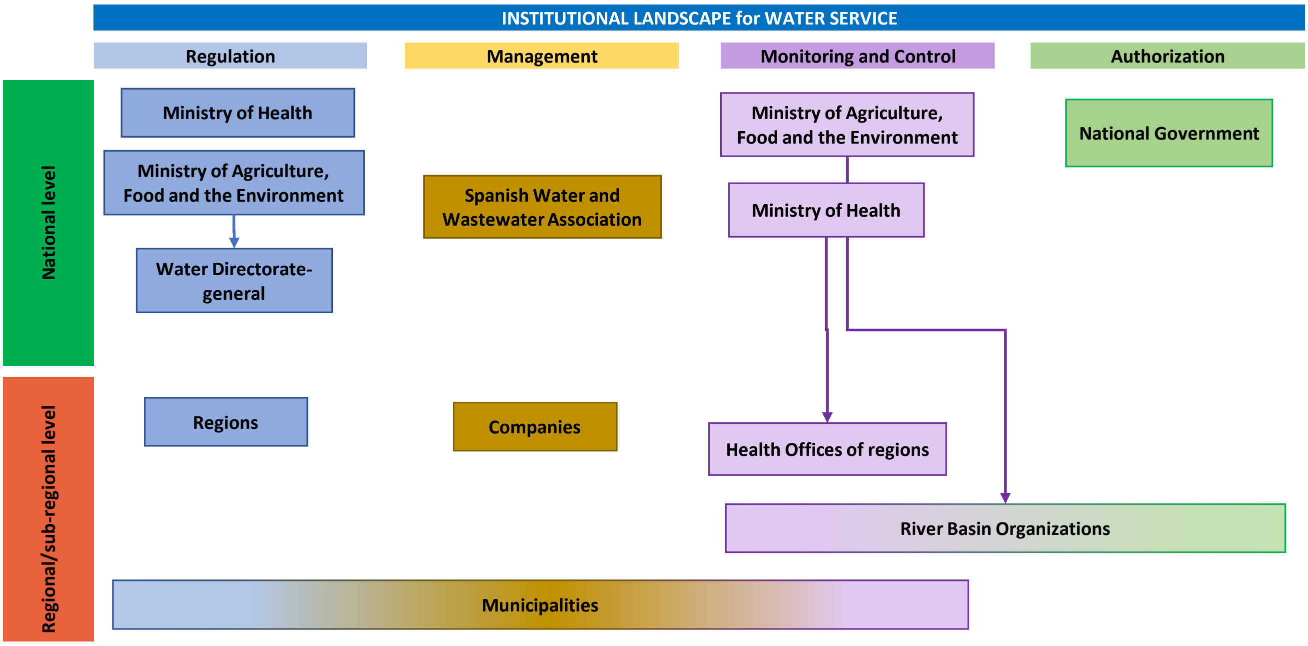

Figure 4.14 Spanish Institutional landscape for water service

Spanish Institutional schemes, specific for wastewater, water resources and drinking water are reported in Annex 9.2

4.4 Critical analysis of the Institutional Capacity and Highlights

After the study of the institutional responsibilities of all the actors involved in the water/wastewater sector, deeper analysis on the institutional structure has been implemented for each country, to identify possible incentives and/or barriers for the implementation of the HYDROUSA Technologies in the different territorial context.

Austria

The Austrian Institutional landscape is characterized by a significant decentralization of responsibilities, especially with respect to the implementation of environmental policies. The division of competences among all government bodies led to an institutional fragmentation that on one side brings advantages in terms of promoting co-operation between the different competent institutions, on the other side however it could result in conflicting goals of all various subsystems. Moreover, the independence of the regions in laws implementation contributes to increase the fragmentation and the discrepancies in environmental legislation (OECD, 2013).

Belgium

In Belgium the water governance is characterized by the absence of coordination among the regions. For this reason, an interregional coordination institution was established, but it is not clear the way in which the body operates (i.e. the great differences in preparatory and public consultation schedules) and furthermore, the coordination seems to be quite limited (European Commission, 2015).

Bulgaria

The water supply and sanitation service in Bulgaria is characterized by a dense fragmentation, especially for the ownership and management. Though institutional governance is theoretically in line with good European practice, practically the complex relationships in the water sector create blockages for water supply and sanitation development. In particular, the combined effect of the transparency absence in regulation (of service levels and tariffs) and the lack of means to construct necessary infrastructures to satisfy discharge requirements causes complexity and imbalance of water management. An example of this situation is the fact that water supply and sanitation companies appear to be much less efficient than most of their European ones, even though they are overstaffed (four to five times higher than other EU countries) (Republic of Bulgaria - Ministry of Regional Development, 2014).

Croatia

Croatian institutional landscape is organized to omit overlapping of responsibilities between the Ministry of Environmental Protection and Energy and Croatian Waters. According to the two governance models introduced in 2015 in the Water Services Act, local model (units of local self-government in the service area is the new provider) and centralistic model (the Republic of Croatia is the new provider) are responsible for managing economic activities, ownership of hydraulic structures and economic units and licensing new providers are given to different authorities. Despite a slow implementation phase, this government model brings advantages especially at local level in terms of reducing the number of independently managed water supply structures and increasing the public water suppliers. However, particular attention must be paid to the higher level of institution, because the development of water-services-related ministries sometimes may generate confusion or bring a lack of ownership for any company reform agenda (World Bank Group, 2018).

Cyprus

The Cypriot Institutional structure is characterized by fragmentation of responsibilities between different ministries in terms of water management. This division may result in an overlap of jurisdictions and sometimes in the replication of activities with possible consequences of failure in the application of necessary measures for the water management. In order to avoid this effect, a new Directory for Integrated Water Management is established with the main purpose of managing all waters of the island according to the national water policies. This task includes the supplying of water for domestic uses and agriculture as well as monitoring of water extraction from water bodies (i.e. surface and underground). Monitoring responsibilities are also given to this authority in terms of controlling the quality status of water bodies and application of conservation actions for the water ecosystems. The Directory is based on the existing Water Development Department under the control of the Ministry of Environment (Semide and Sogesid, 2005).

France

In France, the water sector is articulated according to three regulation types. This mix of models highlights a multi-level structure that engages stakeholders in observing specific regulation functions both at national and local levels, allowing in this way to develop a domain specific water sector regulation. The result of this institutional structure is a significant fragmentation in responsibilities as different stakeholders act not only at multiple level but also in different regulation areas. In fact, the Ministry of Health oversees setting the quality standards for drinking water, while the regional health agencies are entrusted to monitor the compliance with those parameters. For environmental protection, the Ministry of Environment is responsible to define standards while local services are entrusted to check compliance with prescriptions under its jurisdiction (Salvetti, 2014). At a medium governance level (i.e. between regions and municipalities) and for land-use planning, Departments are not entrusted to any official responsibilities, in fact they have limited influence on the construction of schools and departmental roads fields (OECD).

Concerning the management of water services and wastewater collection, municipalities are entrusted to provide the services but have to face the absence of technical and financial resources for the activities that,

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just in few cases, is overcome by the implementation of mixed management (i.e. cooperation between public authorities and the private sector) (Barraque and Le Bris, 2007).

In terms of monitoring aspects, water governance highlights some issues. In fact, although the Inspectors are one the most central environmental regulatory authorities in the country, only 1,200 Inspectors handle about 500,000 classified facilities, pointing out a lack of institutions which could negatively influence the implementation of activities. As a result of this, various non-compliance situations are unnoticed and, therefore, specific environmental requirements are not respected (Chance, 2012). As a final observation of the French institutional framework, it is evident that the strong fragmentation of the water sector brings difficulties in overlapping of responsibilities and thus to a complicated coordination for an efficient governance. From this perspective, efforts can be done to streamline the government structure in order to improve regulation application, efficiency and liability of water and wastewater companies (Salvetti, 2014).

Germany
In Germany the water sector organization is fragmented (about 13,364 municipalities regulate services at local level) and includes about 6,560 water supply utilities and 6,700 waste water companies (OECD, 2014). Although this multi-level governance guarantees a high level of official political legitimacy to institutions (both at federal, state and municipal level) in terms of water management, it is characterized by some advantages such as: insufficiency of spatial fit with river basins, problems of institutional diversity between the 16 Federal States and of vertical institutional coordination, in particular between federal and state levels (OECD, 2014). In this perspective one of the possible blockages in the water sector could be the identification of the competent body to which permit applications are made as they differ for specific types of facilities and from one state to another. Germany in fact does not have a central administrative organization.

Greece
Greece has a complex administrative and legislative background. In water resources management, the decentralization characterizes the water sector, allocating monitoring responsibilities and decision-making process to higher levels of governance (Podimata and Yannopoulos, 2014).

In terms of water policy, although competent authorities are defined (according to Law 3199/2003) their responsibilities in water management are not clearly defined. This situation creates a horizontal fragmentation among the government agencies in the application of regulatory framework in environmental policies (Podimata and Yannopoulos, 2014). In fact, although several organizational responsibilities have been given to local authorities, regional administrations did not reach fully operative independence, because of their slight experience in self-governance and absence of substantial financial resources and qualified staffs (Podimata and Yannopoulos, 2014). Specifically, their responsibilities are thus correlated to the implementation of regulatory standards (set at national level) or to the environmental impact assessments of economic activities.

Furthermore, at deeper level of administration, problems in legislation enforcement may be hindered as municipal policies (even in the case of land development policy) that may diverge from those followed at the regional level. In addition to this, conflicts among actors with different priorities, aims and approaches bring fragmentation. As result of this analysis, it can be concluded that Greek institutional landscape highlights a governance fragmentation, overlapping of responsibilities and lack of cooperation in bureaucratic functions that act as barriers in water planning and implementation of river basin management plans (Podimata and Yannopoulos, 2014).

Italy

The Italian Institutional structure is characterized by a highly complex water governance. Even after the reform in water management (transposition of the EU Water Framework Directive - FWD, in 2000) that introduced a river basin approach and a consolidation of water supply and sanitation services, the government framework remained focused on the short-term and emergency problem solving (OECD, 2013). In fact, the application of the WFD to the national context implicated the implementation of measures which have further complicated the water governance system, even though they consolidated water related policies, simplified water management institutions and improved water-use efficiency. Furthermore, even after the application of the river basin management plans prepared by regions to implement the WFD, the governance in terms of water supply and sanitation remains weak and is characterized by unpredictability and ambiguity (OECD, 2013). This effect, despite the enforcement of a various economic tools for water management, is mainly caused by the fact that activities sometimes do not produce a more efficient use of resources and a revenue needed to invest in infrastructures. In terms of tariff for water supply and sanitation, although they increased, are still much lower than in many other OECD countries (OECD, 2013).

Monitoring of water quality and collection of data at national level are still the main challenges in Italy as considerable gaps of information are highlighted, particularly concerning the water abstraction (OECD, 2013). As result of this analysis it can be highlighted that the main issues that affect the Italian regulatory system can be summarized in an overlapping competence of regulators at too many governance levels, often with opposed performance. This aspect may cause misunderstanding between “contractual counterpart” and “regulation” as well as blockage for regulations enforcement (Massarutto, 2010). Possible solutions for the governance issues can be implemented by a more efficient multi-level governance, improving the policy planning and coherence with national and local priorities, implementing a more efficient use of economic instruments and a better alignment of river basin authorities with hydrological boundaries (OECD, 2013).

Poland

Polish institutional governance has always been characterized by a historical tradition of regional public administration and no decentralization of government powered until 1990 when the delimitation of regions and decentralization of competencies became the key factor for the new model of governance. The biggest problem in the implementation of this model concerns the fact that the new regions were not “qualified” with proper competencies and funds and thus the reallocation of responsibilities from the national to the regional level was not followed by the reallocation of enough resources (Global Water Partneship, 2015). The limited resources available for the self-government demonstrated to be the major blockage of the initial performance of several subordinated institutions (Global Water Partneship, 2015). Furthermore, it should be noted that still today strong regional disparities persist**,** clarified in part by rural and urban separations (European Commission, 2019).

Spain

In Spain the present institutional governance is characterized by a vertical structure, counting governance both central and sub-central levels. Specifically, apart from central government, 17 autonomous regional governments and 2 autonomous Cities cooperate at the intermediate level, and 50 provinces and 8,124 municipalities cooperate at the local level. This institutional landscape highlights a fragmented and intricated governance for the water management, because different levels of administration are entrusted to several responsibilities connected to water policies. Consequently, coordination and cooperation procedures appear as considerable problems, mainly because of the significant diversity of economic and regulatory tools enforced in the different the regional realities (García-Valiñas, 2018). Moreover, the water policies planned by sub-central governments are not always coordinated with European Union requirements.

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As final observation, a new specific strategy for the institutional and regulatory framework could contribute to improve the water management and the efficient use of water bodies, as well as providing a solution to serious water stress and quality problems (García-Valiñas, 2018).

Overview

A synthesis of the European Institutional landscape is shown in Figure 4.15. The figure highlights:

- the ***vertical fragmentation of responsibilities***. It is evident more than one level on administration is involved for a specific water categories and *competences*, (i.e. state, region, province, municipality). It should be noted that for a specific level of administration, more than one government Body can act (i.e. different Ministries at national level);
- the ***horizontal fragmentation of responsibilities***. It is remarkable when institutions at the same level of administration are responsible for different *competences*.

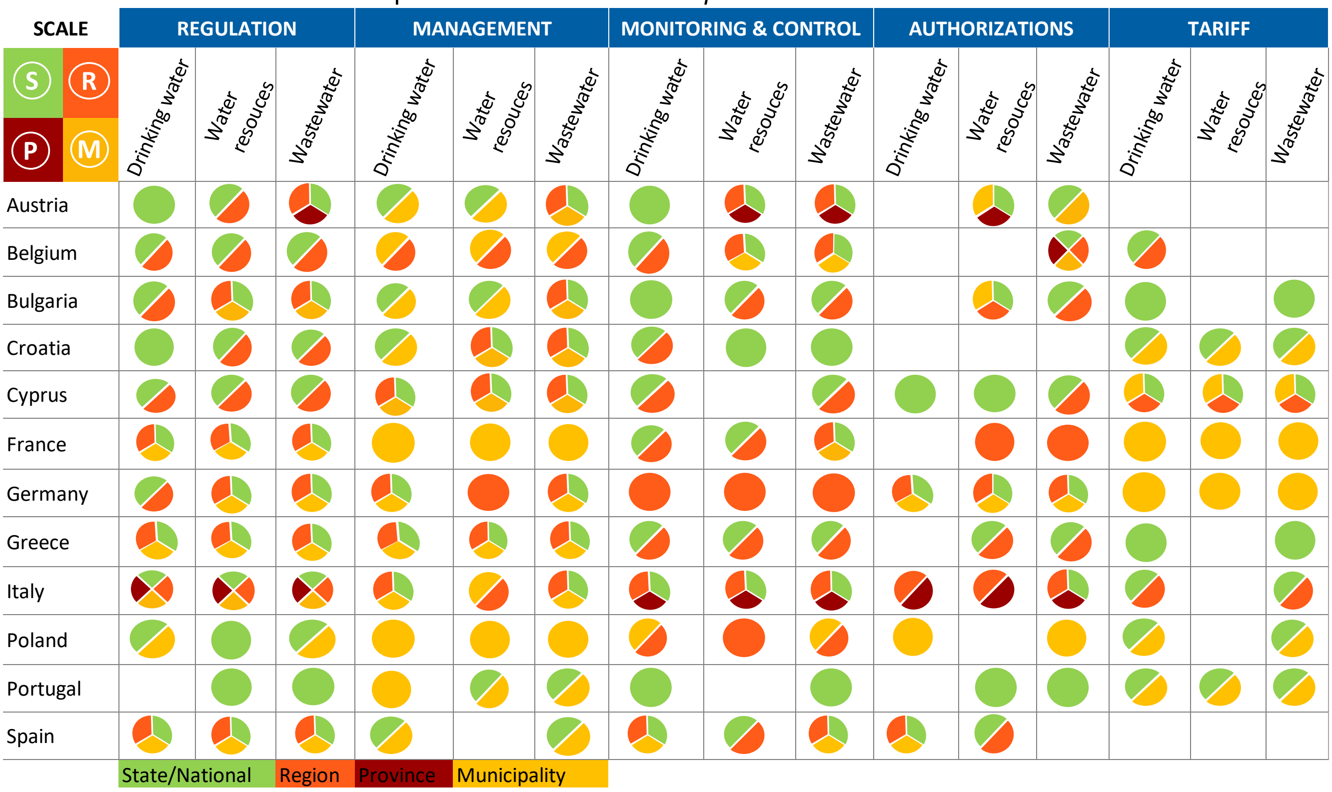

Figure 4.15 Institutional Analysis Overview

From the analysis it can be concluded that a common aspect of all countries in the water sector is the horizontal fragmentation of responsibility that distributes responsibilities mainly among the ministerial administrations and regional Departments. It can be concluded that the regulatory landscapes, not only at the EU level but also at the national and lower governance levels, is based on a wide national state and on national institutions. In terms of the vertical fragmentation, separation of responsibilities is quite evident almost in all analysed countries, particularly in Italy, Germany and Greece where each water category is regulated at different institutional level by different administrative interrelationships.

At this stage, no relevant explicit information where found to address small and decentralized closed and regenerative water loops, or support to small and local service operators. In general, local operator models and self-supply, that are relevant for HYDROUSA, have received little or no attention. In some Countries decentralization reforms have assigned the responsibility for water service provision to rural local governments, which often have poor capacities and financial resources. On the other hand, major interest and support is given to larger urban and regional utilities. In Task 7.3-7.5 each replication site will be analysed according to the elements described in Paragraph 4.1, so as to fill the current urban-rural service gap with specific concern to the HYDROUSA loops

5 FRAMEWORK FOR FINANCING HYDROUSA WATER LOOPS

In this section, framework for financing HYDROUSA water loops is widely analyzed. In particular, this study highlights the nature of financing arrangements, that depends on the institutional structure, to obtain a general overview of the financial mechanisms supporting the water/wastewater management. It focusses on financing investments, operation and maintenance cost of HYDROUSA solutions and not on further development or adaptation of these solutions. Therefore, the beneficiaries of the financing instruments are the customers of HYDROUSA solutions, i.e. the ones who will operate solution, e.g. (reclaimed) water supply, providing wastewater treatment. A more exhaustive review of financing instruments is under development within task 8.3 of the WP8 related to the exploitation of HYDROUSA solutions, they will be reported on D8.3 “funding opportunities” on M36.

5.1 Methodology of the Analysis

The analysis is based on the 3T approach proposed by the Organization for Economic Cooperation and Development (OECD), 3T represents Taxes, Tariffs, Transfers as a source of financing for the water and sewerage sector. Overall, 3T is the method for determining, increasing and balancing finances in three forms, and the most important challenge is to understand and strike the right balance between the three sources. The functioning of the sector according to this methodology is not based solely on tariffs. However, it seems that the most transparent way would be to rely solely on tariffs, in line with the principle of cost recovery and polluter pays set out in the Water Framework Directive (EEA, 2013). The 3 Ts are defined as

- Tariffs: user fees or contributions. Service providers can levy such fees for providing access to a service (connection charges) and for delivering the service (either a flat charge, a volumetric one, or a combination of both). Additional fees can be derived from meter rentals, penalties etc.
- Taxes: funds raised by national/regional/local governments through the tax base, which are subsequently diverted to the water sector. These are known as subsidies, i.e. a fiscal transfer to an organisation to allow its costs recovery;
- Transfers: payments from foreign sources, such as EU funds (e.g. Structural Funds, LIFE, EIB, EBRD), international financing institutions (e.g. Word Bank, member states development agencies, Green Climate Fund), or private philanthropic funds (e.g. Coca Cola foundation).

The main data source used for this analysis is the database on Policy Instruments for the Environment Jointly created by OECD and EEA (PINE database) (https://pinedatabase.oecd.org/). It contains information on the use of economic instruments such as environmentally related taxes and charges, environmentally motivated subsidies, tradable emission permits, and deposit refund systems.

Framework for financing HYDROUSA loops are firstly studied by assessing the general structure. The general scheme in Figure 5.1 is providing an overview of funding sources and how funding is delivered to the operator of water and wastewater services, in our case it can be substituted by the operator of the local HYDROUSA water loop.

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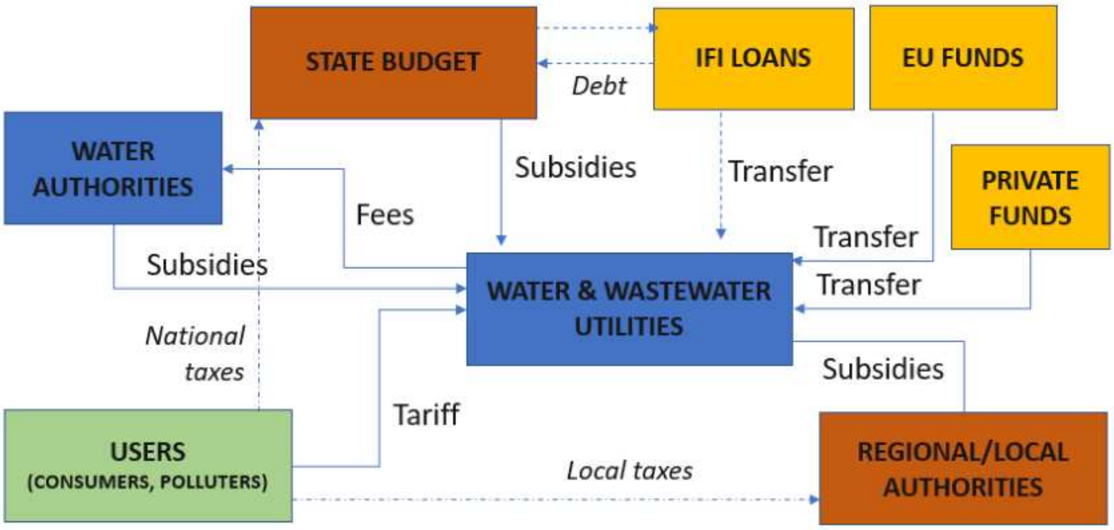

Figure 5.1 General structure of Financial Framework in Water Service Management

The presented scheme is related to municipal water cycle services (i.e. wastewater and domestic water) and represents the sources of financing to ensure costs recovery.

Specifically, for the utilities external funds (Transfers) can derive from different sources: they can be provided by IFI (International Financial Institutions) as financial support for economic and social development activities especially in case of developing countries (Bhargava, 2006), or they can be supplied in terms of grants and loans (with very low rates from public banks) in case of industrialized countries. Further, even users contribute to the financial statement, paying tariffs for the use of water and for wastewater collection and treatment. In this case, fees can be used for operation, maintenance and capital costs (i.e. purchase of land, buildings, construction, and equipment used in the activity) and new investments. Another form of financing derives indirectly from the national or local taxes that citizens have to pay. This economic contribution goes within the State budget, which is administrated by the government and can be supplied by national, regional or local Public Institutions to the utilities under the form of subsidies, these are not necessarily derived from taxes related to the water sector.

In some countries, Water Authorities collect fees for pollution or water abstraction, and can provide subsidies for water pollution reduction (e.g. wastewater treatment) or water efficiency measures (e.g. non-conventional water resources).

On the basis of this scheme, it was possible to analyze the specific financing paths in different countries. In particular, in this section financial analysis was done for: Austria, Belgium, Bulgaria, Cyprus, Croatia, France, Germany, Greece, Italy, Poland, Portugal and Spain. The information collected is highlighted in Figure 5.2 below.

WATER CATEGORIES	HYDRO INVOLVED	REPLICATION SITES	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING								Source of financing	
					National			Local					Tariffs, Taxes, and Transfers	
					Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/Corporations)	CAPEX	OPEX
Wastewater	1, 6	Austria			✓			✓	✓			✓		
Drinking water	4, 6				✓			✓	✓			✓		
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6													
Wastewater	1, 6	Belgium							✓	✓		✓		
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6								✓					
Drinking water	4, 6											✓		
Wastewater	1, 6	Bulgaria	✓	✓	✓			✓	✓			✓		
Drinking water	4, 6		✓	✓	✓			✓	✓			✓		
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6						✓							
Wastewater	1, 6	Cyprus		✓	✓	✓	✓					✓		
Drinking water	4, 6		✓			✓	✓					✓		
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6					✓								
Wastewater	1, 6	Croatia	✓	✓	✓	✓		✓	✓			✓		
Drinking water	4, 6		✓	✓	✓	✓		✓	✓			✓		
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6					✓								
Wastewater	1, 6	France						✓	✓	✓		✓		
Drinking water	4, 6							✓	✓	✓		✓		
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6									✓				
Wastewater	1, 6	Germany				✓						✓		
Drinking water	4, 6					✓						✓		
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6							✓						
Wastewater	1, 6	Greece					✓		✓					
Drinking water	4, 6						✓		✓					
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6									✓				
Wastewater	1, 6	Italy	✓	✓	✓			✓	✓					
Drinking water	4, 6		✓	✓	✓			✓	✓					
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6									✓				
Wastewater	1, 6	Poland			✓					✓	✓	✓		
Drinking water	4, 6				✓					✓	✓	✓		
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6						✓							
Wastewater	1, 6	Portugal			✓							✓		
Drinking water	4, 6				✓							✓		
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6								✓					
Wastewater	1, 6	Spain			✓			✓		✓				
Drinking water	4, 6				✓					✓				
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6									✓				

Figure 5.2 Information collected in the institutional context

Data on financing pathways are collected for each country and for the specific water categories analysed in the institutional analysis *(*See Section 4*)*. In particular, institutions involved in the financing context are highlighted both at the International, national and local/regional levels, defining the type of economic instrument (subsidies, transfers/loans, tariff) used for cost recovery.

Further data on the covered costs are showed for both fixed costs, Capital Expenditure - CAPEX (i.e. plant and equipment purchases, building expansion and improvements, etc.) and for variable costs, Operating Expenses – OPEX (i.e. rent, salaries and pension plan contributions, administrative expenses, property taxes, consumables, etc.). It has to be noticed that for international financing methods (i.e. by means of IFI and EU Funds), empty cells do not indicate a lack of information but rather they highlight good cost recovery that country applies to cover fixed and variable cost. Country specific analysis is reported in the following section.

5.2 Main Results

Austria

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/Corporations)
Wastewater	1, 6			*subsidies (4%)*			*subsidies*	*subsidies*			*Tariff (87%)*
Drinking water	4, 6										
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6								*permit/ charge*		

Figure 5.3 Austrian financing scheme

In Austria, almost all the OPEX on wastewater and drinking water is covered by tariffs. In fact, about the 87% of the costs are covered by the operators through the tariff that users pay.

Regarding the CAPEX, taxes are needed for water infrastructures to cover the fixed costs. Specifically, around 4% of the total costs are thus covered either by local taxes, collected by the municipality, and by subsidies provided by national government institutions and by local organizations.

Concerning the water resources, groundwater is privately owned by the owner of the property where is it located, while surface water is mainly publicly owned. The Provincial Government gives Permit for "major" water abstraction uses (abstraction for groundwater and springs >300l/min, from other waters >1.000 l/min, and for water supply of supply units with more than 15.000 inhabitants). The provincial government oversees the monitoring and enforcement and the resource protection for general water supplies (ordinances).

Belgium

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-government) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6							*subsidies*			*Tariff*
Drinking water	4, 6										*Tariff*
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6							*tax*			

Figure 5.4 Belgian financing scheme

In Belgium, for the wastewater sector, OPEX is entirely covered by the operators through the tariff and by the local Institutions that supply subsidies. For covering the total costs, CAPEX is also financed through taxes by local governments.

In the context of drinking water, tariff and taxes are enough to cover all the costs.

For what concerns water resources, there is a permitting system for the abstraction of groundwater (> 500 m3/year) that takes the quantitative status of the groundwater system into account. The price of the groundwater tax is differentiated by the aquifer and regional factors. For surface water abstraction, a decreasing block system is used so charges are lower than groundwater.

Bulgaria

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6	loan	transfers	*subsidies*			*subsidies*	*subsidies*			*Tariff*
Drinking water	4, 6										
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6					*Charges on water abstraction*					

Figure 5.5 Bulgarian financing scheme

In Bulgaria, for wastewater and drinking water, different financing sources are used. Subsidies both at the national and local levels are supplied to cover CAPEX and OPEX, as well as tariffs paid from users. Since these financing methods do not entirely cover the total costs (specifically the fixed costs) transfers from EU Funds and Loans from the IFI can be granted for water services.

For what concerns water resources, Bulgaria implemented its water abstraction charges in 2001. The charges have been reformed a couple of times since then in terms of the price charged for amounts and sources of water abstraction. The charges cover all aspects of abstraction and exclude some emergency situations such as firefighting and civil protection. The revenue from the charges is collected by the Enterprise for Management of Environmental Protection Activities (EMEPA) and is then redistributed to environmental projects and initiatives. The current Bulgarian Government aims to increase the charges from 2017 onwards, justified by the need to fulfil the requirements of the EU Water Framework Directive (WFD) (Water abstraction charges in Bulgaria, Denkstatt).

№	Usage type	Charge in 2001 (in BGN)	Charge in 2012 (in BGN)
1	Drinking and household needs	0.02 (EUR 0.01)	0.02 (EUR 0.01)
2	Irrigation, livestock, fish breeding	none	0.001 (EUR 0.0005)
3	From surface and spring waters	0.005 (EUR 0.00025)	other
4	From groundwater	0.005 (EUR 0.0025)	other
5	For cooling	0.0001 (EUR 0.000051)	0.0003 (EUR 0.00015)
6	For recreation and water sports	0.04 (EUR 0.02)	none
7	For industrial purposes	0.008 (EUR 0.004)	0.045 (EUR 0.023)
8	For other purposes	0.01 (EUR 0.005)	(EUR 0.033)
9	For production of energy	0.001 (EUR 0.0005)	0.0016 (EUR 0.0008)

Source: Ministry of Environment and Waters (2004, 2011)

Figure 5.6 Charges in nominal terms for surface water use in 2001 and 2012

Cyprus

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6		transfers	*subsidies*	*subsidies*	*subsidies*					*Tariff*
Drinking water	4, 6	loan									
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6				*Permit*						

Figure 5.7 Cypriot financing scheme

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In Cyprus, for the wastewater sector, tariffs paid by users are just a minimum part of the recovered fixed costs. In fact, almost the financing (from 80 to 100%) derives from transfers of EU Funds and subsidies provided at the national level by Government, Ministries and Water Authority. For recovering CAPEX in the drinking water sector, in addition to tariffs, loans from the IFI can be granted.

It must be noticed that investments for desalination infrastructures are done by the private sector based on BOT schemes (Build Operate and Transfer). In this type of contract, the public authority is committed by buy a minimum amount of water at a fixed price. For what concerns OPEX, for both wastewater and drinking water, tariffs are enough to cover the variable costs.

For what concerns water resources, the MANR&E Ministry of Agriculture, Natural Resources and Environment has technical responsibility for water resources policy, assessment and monitoring, but also for the development of water resources and the provision of bulk water supply to end-users. The Ministry of the Interior is responsible for the enforcement of water-related laws, including the issue of groundwater permits. The Ministry deliver groundwater abstraction permits but no charges are applied.

Croatia

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6	loan	transfers	*subsidies*	*subsidies*		*subsidies*	*subsidies*			*tariff*
Drinking water	4, 6	loan	transfers								
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6				*charge*						

Figure 5.8 Croatian financing scheme

In Croatia, water services (i.e. wastewater and drinking water) are equally financed. Specifically, CAPEX is recovered both by tariffs and subsidies. The latter is provided by either Water Authority and Government institutions at the national level and municipalities at the local level. Further fixed costs are covered by both transfers from EU Funds and by loans by the IFI. For what concerns variable costs (OPEX), tariffs and taxes granted the cost recovery. For what concerns water resources, Hrvatske vode is the legal entity for water management founded by the Republic of Croatia, this entity applies water protection charges and deliver permits for groundwater abstraction.

France

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6						*subsidies*	*subsidies*	*subsidies*		*tariff*
Drinking water	4, 6										
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6								*declaration/ permit/royalty fee*		

Figure 5.9 French financing scheme

This project has received funding from
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under Grant Agreement No 776643

In France CAPEX and OPEX for water services are recovered both by tariffs and taxes to citizens. Cost recovery is also granted by subsidies provided by local administrations at the municipal and regional levels. For what concerns groundwater resources, following the 2006 Water Law, groundwater management regulation in France relies on three main instruments: 1) a series of regulations related to the declaration of wells and the volumetric control of abstractions; 2) an environmental tax system; and 3) a series of mechanisms to prevent abstraction during periods of water shortage. Wells have to be declared and registered as well as fitted with meters. The declaration is compulsory for wells deeper than 10 meters for any use. Wells for private water supply (defined as abstracting less than 1,000 m3 per year) have also to be declared at the town hall. The declaration of wells is however not sufficient for wells abstracting more than 10,000 m^3 per year as the well owner also has to obtain an authorization which includes the amount of groundwater allowed to be abstracted. The owners of wells abstracting more than 200,000 m^3 are required to submit an impact assessment when they apply for the authorization (IWMI, 2016).

Type of instrument	*Instrument used*
Control of wells and abstractions	Registration of wells
Control of abstractions	Abstraction authorizations
	Installation of flow meters
	Declaration of limitation and abstraction bans in specific areas
	Definition of a total abstraction volume for an aquifer and individual quotas for users
Pricing incentives	Environmental tax on abstractions

Figure 5.10 Groundwater regulation instruments in France.
Source: Based on Montginoul and Rinaudo 2014

Germany

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6				*subsidies*						*tariff*
Drinking water	4, 6										
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6						*charge*				

Figure 5.11 German financing scheme

In Germany, for water services, total costs are recovered by tariffs, as in the case of operating costs, and taxes as additional financing for covering the fixed costs. Further, subsidies are provided by the Water Authority at the national level. For what concerns water resources, abstraction charges have been introduced since the end of the 1980s and are now in place in 11 of the 16 Federal States. The money is collected by regional administrations and goes usually into the state budgets. In Germany the charges are volumetric in most cases, with the user paying a unitary rate per cubic meter abstracted. The abstraction charge unitary rate range from 0.015 €/m^3 (Saxony) to 0.31 €/m^3 (Berlin) (OECD ,2010).

Greece

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6					*subsidies*		*subsidies*			
Drinking water	4, 6					*subsidies*		*subsidies*			
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6								*Permit*		

Figure 5.12 Greek financing scheme

In Greece, national and regional subsidies are necessary to support low tariffs to ensure OPEX, but they are not enough to support new investments. For what concerns water resources, since December 2003, a new legislative and institutional framework has been put into force in the country. It consists of Law 3199/9-12-2003 on water protection and the sustainable management of the water resources, with which the EU Water Framework Directive (WFD) (2000/60/EC) is transposed into the national legislation. According to this law water permits are delivered in the county, concessions (water use permits) are granted for 10 years by the Ministry of Development or the relevant prefect following a valid license, but no charges are applied for the abstraction.

Italy

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6	loan	transfers	*subsidies*			*subsidies*	*subsidies*			
Drinking water	4, 6	loan	transfers	*subsidies*			*subsidies*	*subsidies*			
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6								*Water Concession Fees*		

Figure 5.13 Italian financing scheme

In Italy, total costs associated with the water services are recovered mainly by subsidies provided by Government institutions at the national level and by municipalities and inter-municipal bodies at the local level. Further, transfers from EU Funds and loans by the IFI are granted. For what concerns water resources, the Act of 1991 delegated the task of issuing abstraction licenses to the Environment Agency. The payment of a fixed fee proceeds with the application whose amount is stated in the Abstraction Charges Scheme collected by the Environment Agency (EA). There are three types of licenses: a full license (>20 m^3/day); a temporary license (<20 m^3/day over a period of less than 28 days); and a transfer license (trading of full licenses). Only full licenses are charged the fixed fee by the Environment Agency (as of 2015, the minimum annual charge for full licenses is around €30.00) (Santato et al., 2016).

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 776643

Poland

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6			*subsidies*					*subsidies*	*subsidies*	*tariff*
Drinking water	4, 6										
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6					*charge*					

Figure 5.14 Polish financing scheme

In Poland, for water services, CAPEX and OPEX are recovered mainly by tariffs and taxes that users pay. In addition to this, subsidies can be provided by both the Government Institution at the national level and by basin authority and environmental Agency at the local level. For what concerns water resources, fees for withdrawal are applied to all users. Basic water fees start from 0.01 EUR/m^3 for surface water and 0.02 EUR/m^3 for ground water. Fees are however differentiated depending on water resources availability, their quality, regional dimension and purpose of water consumption, and can be as high as 0.038 EUR/m^3 (surface water) and 0.073 EUR/m^3 (groundwater) (Strategic Evaluation of Environment and Risk Prevention – Country Report – Poland).

Portugal

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6			*subsidies*							*tariff*
Drinking water	4, 6										
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6							*charge*			

Figure 5.15 Portuguese financing scheme

In Portugal, CAPEX in the context of water services is recovered not only by tariffs and subsidies provided by the Government Institution (tax money) at the national level. For what concerns water resources, the Economic and Financial Water Resources Management Regime (approved by Decree-Law 97/2008) created the Water Resources Tax (Taxa de Recursos Hídricos – TRH), which is a key instrument of national policy for water, in accordance with Water Law (Law 58/2005, which implemented the Directive 2000/60/CE of the European Parliament and the Council of 23 October).

Spain

WATER CATEGORIES	HYDRO INVOLVED	IFI	EU FUNDS	INSTITUTION INVOLVED in FINANCING							
				National			Local				
				Government Institution	Water Authority	Ministry	Municipalities	Government (& Semi-governement) Institution/Organization	Basin/Local Authority	Environmental Agency	Operators (Companies/ Corporations)
Wastewater	1, 6			*subsidies*			*subsidies*		*subsidies*		
Drinking water	4, 6										
Water resources (Groundwater, Surface water)	1, 2, 3, 4, 5, 6								*Fee*		

Figure 5.16 Spanish financing scheme

In Spain, CAPEX and OPEX for wastewater services are recovered either by tariffs and taxes. Further, other forms of financing can derive by subsidies provided by the Government Institution at the national level and by municipality and basin authority at the local level. For what concerns water resources, the River basin authority applies taxes for regulation and utilization, and for discharges. The costs are the same in all regions although regional acts that set the taxes for discharge. The Tax for regulation and utilization is only applied for facilities that benefit from infrastructures built by the state such as reservoirs, ditch, etc. It is calculated by adding operating cost, the cost of maintenance and administrative cost and the 4% of the value of the state investment. The total cost is divided between beneficiaries, considering the use of water. Also, sanctions/tax on environmental damage are applied by the river basin for groundwater use.

5.3 Critical Analysis and Main Results

The analysis carried out allows to understand how public water and wastewater services are financed and how groundwater use is regulated and charged today. For all EU member states, the general trend is cost recovery through tariffs but to maintain the affordability of tariffs, most countries are using taxpayers' money to subsidy investment costs (CAPEX). A few countries with less developed economy are using "Transfers" from foreign funds for their CAPEX. Table 5.1 below provides a synthetic view of the source of subsidies used in the different countries for cos recovery. Two main groups are appearing:

- Countries with a specific water financing scheme from the water sector, moving towards applying the concept of "water pays water";
- Countries where financing is coming from the general public budget at national or local/regional levels.

Table 5.1 Summary of subsidies source

COUNTRIES	NATIONAL ADMINISTRATION	WATER AUTHORITY	LOCAL / REGIONAL AUTHORITIES
Croatia	*1*	*1*	*1*
Spain	*1*	*1*	*1*
Cyprus	*1*	*1*	
France	*1*	*1*	
Germany		*1*	
Poland	*1*	*1*	
Belgium			*1*
Austria	*1*		*1*
Bulgaria	*1*		*1*
Greece	*1*		*1*
Italy	*1*		*1*
Portugal	*1*		

In the case of HYDROUSA, the owners and service providers of local water loops will be either a public or public owned entity (e.g. a municipality, group of municipalities or water utility) or local private entity (e.g. farmers, tourist hospitality owner, user association). Table 5.2 below presents a synthesis on financing sources for the HYDROUSA solutions based on the type of service provided. In most of the cases a mix of the 3 financing sources could be applied in particular to support the initial investment and therefore reduce the Return On Investment (ROI) period.

Table 5.2 Summary of financing sources

Service delivered	**Hydro**	**Type of costs**	**Tariff**	**Subsidies** (taxpayers' money)	**Transfers**
Wastewater treatment	1, 6	CAPEX	X	X	X
		OPEX	X	X	
Domestic water	4, 6	CAPEX	X	X	X
		OPEX	X	X	
Agriculture water	1, 3, 5, 6	CAPEX	X	X	X
		OPEX	X		

The service delivered i.e. water supply or wastewater treatment might not result in any financial transaction as it will be for their own use, so the "tariff" must be understood in a broader sense as payment by the end users (e.g. a farmer will pay to maintain/operate its own HYDROUSA water loop and the initial investment at least partly).

Subsidies can be provided by local, regional or national public bodies or water services operators in particular when providing drinking water supply (tap water) and sanitation services using public networks are too costly. The main argument for such subsidies is: the provision of universal and equitable access to drinking water and sanitation.

Transfers (foreign or EU funds) are mainly covering investment costs for building or renewing a water infrastructure. Such transfers are mainly targeting vulnerable and les developed areas in EU and worldwide.

6 FINANCING HYDROUSA SOLUTIONS THROUGH TARIFF

6.1 Theoretical Background on Water Tariffs

6.1.1 What are Water Tariffs?

Unlike "trade" tariffs, which are amounts payable by international trade operators, such as importers and exporters, that are often designed and administered to imported goods so as to protect domestic producers, "water" tariffs are amounts of money payable to those operators that deliver water to the point of use and collect waste water (effluent) to treat it before releasing it in the environment. In North America these amounts are more frequently called water "rates", because they are typically paid by water customers to local authorities (e.g. Municipalities), who in turn manage water supply systems and effluent treatment plants within their territory.

The main function of water tariffs is to recover the total costs of construction of a water infrastructure over its functional life, as well as to recover the operating costs of the water delivery and water sanitation system, inclusive of marginal costs of delivery, such as power and labour. The combination of the three activities of (1) water extraction from suitable sources, (2) delivering water suitable for drinking to end-users and (3) effluent treatment (sanitation) to ensure the return of the used water to the environment in a manner that does not pollute are often called "integrated water services".

Water extraction, provision and sanitation are all activities that are typically subsidised by various levels of government (at local, regional and national level) and their relevant agencies. The investments necessary for operating these services are part of those categories of primary investments made to ensure residential settlement in newly developed areas. Quite frequently the initial investment is part of a public expenditure plan, which anticipates the expense to enable early settlements, but then provisions are made to recover the initial layout by ensuring all expenses are included in the core tariff to be shared across all users of the system.

To understand why public expenditure is necessary to improve the public welfare one needs a brief introduction to a particular market structure that in economics goes under the technical name of "natural monopoly". A natural monopoly is an industry in which there are some specific cost characteristics that if left unregulated tend to induce a particularly undesirable market outcome. The characteristics in question are represented by very high infrastructural costs and economies of scale such that the production technology available, once implemented, provides the required amount of goods to the entire market, thereby satisfying all the existing demand. This makes marginal cost of delivery lower than the average cost. This fact enables the first firm entering the market, and hence sustaining the initial set-up cost, to operate as a monopolist. This because future entrants will have to face a barrier to entry only to share a fraction of the existing market. This makes entering such market unprofitable. In consequence, the quantity provided to consumers without government intervention will be set by the only firm in the market (the monopolist) at a production level that maximizes its profit.

This in turn creates strong inefficiency because too little of the good is provided and at a too high a unit price, so that some consumers will not be able to afford the good, even though they are willing to pay an amount higher than its production cost. The inability to satisfy demand leaves part of the population of buyers in the market unsatisfied and constitutes a market failure. More could be economically produced and supplied but it is not, because doing so would decrease the monopolist's profit. Government intervention is hence necessary to regulate the market in a manner that more efficient outcomes can be ensured for the population of customers. For a primary good, such as water, these efficient outcomes are even more important than other goods. For these reasons, politicians make public intervention a priority, and a necessary step in the early stages of economic development. Industries such as electricity, gas, phone, railways, wi-fi and water utilities are often natural monopolies because they need large investments to establish their functions in a market (just think in terms of the reticulate ensuring their delivery), but only face small delivery cost.

6.2 Water Services and Natural Monopoly

In nearly all circumstances the creation of an integrated water service will generate a natural monopoly and as such its operation is nearly always regulated by government intervention. This intervention often includes initial investments, which otherwise no private entrepreneur would be able to afford. But it most commonly extends to regulations on how to charge for water services, what type of quality the water needs to satisfy to be suitable for different uses, and what qualitative standard the effluent treatments need to achieve before water can be released again in the environment.

Apart from the objective of eliminating market inefficiencies generated from natural monopolies, politicians have often other reasons to regulate water markets and the way revenues from such markets are raised. Because water is necessary to everyone, in electoral competitions candidates to political offices often promise not to raise water prices, or even to lower them, to enlarge their electoral support. This tendency of politicians has been blamed for the so called “problem of the deteriorating baseline”. This happens when revenues that politicians allow water utilities to collect are insufficiently high to replace the deteriorating physical capital invested fast enough, or to upgrade to new and more efficient technologies when these become available.

6.3 Objectives of Water Tariffs and their Structures

Objective 1: revenue collection

From the perspective of a water service supplier, the main objective of water tariffs is to collect revenues. These are needed in order to pay for the financial, administrative and operating costs of providing clean water and treating wastewater via sanitation services. On the other hand, from the perspective of the customer base, there is an expectation for the tariff to be fair and to be affordable.

Obviously, the customer base responds to each tariff structure differently by modifying the demand for water and its use on the basis of the prices and quantities scheduled in the tariff. In consequence, the total revenue raised by the utility in charge of the service at each of the possible tariff structures may vary accordingly. Notably, the value of water to utility customers may provide important indications so that the utility can use this information to adequately calibrate the tariff structure. This is particularly important for economic agents that use water as a factor input, such as farmers with irrigation water, or bakeries, breweries and others. When such types of firms require water with specific quality then appropriate supply contracts are established with local water suppliers. Most of the HYDROUSA projects involved in this study are in fact small scale/output designed to provide water as a factor input to other production processes, mostly irrigation in drought prone and low water environments.

In general, utilities must raise adequate revenues to hire suitable resources, including provide career expectation and retain employees with the adequate technical expertise, to buy the inputs required by the process, to manage, administer and generally run the water service business efficiently and also to be financially independent and healthy in the long run. The issues of financial independence and of linking funding sources to service provision are particularly important. If much of the revenues come from subsidies or from government sources, then there is a de-coupling between sources of funds and customer base. As a result, the water supply organisation may focus its attention on maintaining good public relations with government officials and politicians, rather than focusing on satisfying the service expectations of its customer base. This creates a misalignment between function and funding sources. In the case of the HYDROUSA systems involved in this project, it is difficult to see how each project can be separately implemented on the basis of economic efficiency. This because the value of water in the production process is unlikely to cover the total cost of provision made up of fixed costs (independent of water use) plus operational costs (dependent of water use), but in some instances, it might cover the marginal cost of the unit of volume delivered, typically the cubic meter. There is therefore the expectation that the fixed cost of each of the HYDROUSA systems will be distributed across a large customer base, so that some cross subsidization can take place across costumers.

Objective 2: cost signalling

The structure of water tariffs must be such that the correct signal is sent to water customers about the marginal cost of water supply and effluent treatment, inclusive of the cost opportunity of using water in other economic activities. Water scarce environments make this last element focal, because water may have a whole hierarchy of alternative uses in water scarce environments. If this is the case efficiency of use requires water to be moved from cleaner uses to dirtier ones gradually. This is the case, for example, in the leather production districts located in the pre-alps where artesian wells are abundant. In the past, locations with abundance of high-quality water attracted leather producers who set-up factories. They use clean water for “dirty” industrial purposes, thereby producing heavily contaminated wastewater that requires intense and costly treatment before being released in the environment. Nevertheless, given its abundance, its opportunity cost is low because there are no foregone uses by other water operators locally. In water rich environments this hierarchy of use is less important. In the context of most of the HYDROUSA systems involved in this project the quality of the water produced is often below the specifications required for its cleanest use, such as drinkability. Additional expenses will be needed to bring the water up to that quality level, and this would require investments beyond the scope of the systems.

Operating costs may also vary in terms of how expensive it is to deliver water quantities across the reticulate. In some steep locations pumping cost can be high because of the need to move water in altitude or across a large distance. When this is an issue, water tariffs must be designed to signal this extra cost of infrastructure (longer reticulate transmission) and energy (higher pumping cost) to users. This is a provider-to-customer signal. Signals in the other directions are more difficult to design, and hence the need for regulation. However, if the price at which the unit of water is sold is too low, then the supplier will not have an incentive to decrease transmission losses, as measured by the proportion between water delivered to customers and water captured at source. Due to the lack of competition in water delivery services, suppliers have already little incentive to be efficient, even when unit price for delivered water is high enough. Water industry regulators have a dual task, on one side they need to provide incentives for suppliers to be efficient, and on the other to set prices that produce adequate, but not excessive revenues. A natural monopoly has marginal cost of production lower than average cost, and economic efficiency requires that price is set equal to marginal cost, but this implies that not all cost is covered. As a result, a subsidy is necessary to balance the accounts and retrieve the total cost, else the utility runs at a deficit. However, marginal cost of delivery may not be higher than average cost in certain conditions. For example, when water is scarce and there is a high opportunity cost for its use. Water poor locations will not see the need for subsidy to achieve economic efficiency. This is a possibility in many water-poor contexts in which the technologies behind the HYDROUSA systems under investigation in this project can be transferred and installed.

While the above is the case on the supply side, we also need to consider the wastewater management side. In this case some components of the cost of water treatment service can have decreasing marginal cost, while others may have rising marginal cost so that what prevails is an empirical question which cannot be answered from theory alone. Local conditions and operating circumstances will determine what is appropriate. However, since most HYDROUSA systems in this project produce water destined to irrigation, the waste management side is likely to be negligible in this type of systems.

Objective 3: social goals

Traditionally there are four components of the social goals of water tariff structure. These are:

1. Equity
2. Fairness
3. Affordability
4. Poverty alleviation

Social goal 1: Equity

Equity means that consumers in similar conditions should be facing same water charges, and at the same time consumers in different conditions should be facing different water charges. This comes down to measurable quantities, enumerating in what cases similar customers are charged differently and how large this difference is. In the context of considering the implementation of HYDROUSA systems to new locations this principle will require that within a district in which several system implementations are possible, the solution to be found is to ensure that consumers in similar conditions will face identical water charges. This might mean that an economic evaluation is to be made comparatively across systems and locations.

Social goal 2: Fairness

This concept is more difficult to measure objectively as it tends to be prone to subjective considerations and depends on social norms that can vary with time and place. For example, some group of people might be given particularly low water tariffs to make sure they have the water needed to maintain health standards. This is often the case in nomads’ camps organised to host gypsies, or migrants, in religious institutions such as churches, monasteries and synagogues, and in public institutions, such as orphanages and retirement, assisted living or nursing homes.

Social goal 3: Affordability

This aspect is particularly important for piped water destined to domestic use. The government typically want to provide the service in an inclusive manner, which obviously includes poor households as well. A popular rule of thumb is that 5% of household income destined to water provision and sanitation is an affordable amount. Overall most households pay much less than 5%. Obviously, this objective might violate the objective of full cost recovery.

Social goal 4: Poverty alleviation

This objective is often confused with the affordability objective. However, it is conceptually different as it relates to the desire to redistribute wealth from rich to poor households. This is a different goal from making tariffs affordable. Poverty alleviation can be achieved by low connection charges in crowded households, or even make connection free, as well as lowering water charges for households with income below a certain threshold or wealth below certain amounts (means-testing). This goal can push tariffs even below the levels of affordability but obviously can make full cost recovery more difficult to achieve.

Social goal 5: Transparency and simplicity
A water tariff must be easy to interpret and simple to understand by customers. If one wants the price signal to be the given clearly to water customers, the signal cannot be "noisy". This happens for example when there is complexity in determining the final value of the tariff with respect to the volume of water used or directed to waste treatment. In this case the signal can be obfuscated, and the customer cannot act on it by changing the pattern of water use. If households find the burden too high and want to modify their behaviour in order to lower their burden, with a complex tariff they would not know how to operate.

In general, governments care more about social objectives, while water utility managers care more about cost recovery. When government can lean on regulators tariffs will be lower, but then updating of technology and replacement of obsolete infrastructure suffers and inevitably there is a gradual decrease in efficiency.

6.4 Tariff Structures

a) Single Part Tariff
This type of structure is dependent on a single simple calculation and basically can be of two types (i) fixed charge (independent of volume) and (ii) water use charge (by volume).

The fixed charge tariff
Can be the same for all customers or vary according to customer categories (e.g. based on square footage of the house, value of the house, number of members of the household, location of the connection in the network, etc.).
A drawback of fixed charges is that no incentive is provided to save water.

The water use charge tariff
This type of charge promotes water conservation and can be divided into (i) uniform volumetric tariff, (ii) linear tariff, (iii) block tariff (increasing or decreasing by blocks).

In the uniform tariff, each unit of volume of water is charged the same price, regardless of the total amount consumed. With the linear tariff each subsequent unit of volume of water is sold at a charge that increases by a given amount or percentage. Finally, the block tariff charge can be increasing, when one unit of volume within an early consumption block is charged less than the same unit sold at a subsequent block, or decreasing, when a unit of volume has a charge that decreases in subsequent blocks. The latter works as a discount on quantity purchased, but is less frequently used than the increasing block, which is preferred because it induces more water conservation effort.

b) Two-Part Tariff
As the name suggests the total charge in this case is made up of two components: (i) a fixed charge (which can be a rebate), and (ii) a water use charge (function of the volume of water consumed) that can be of the three types discussed above.

The most commonly employed form of tariff is the Increasing Block Tariff (IBT). However, this has been criticized heavily for failing to reach the theoretical objectives of tariff design, especially in developing countries. The main reason for this failure in these countries is the lack of metering units at the point of consumption. The second reason is joint use of the same water outlet by main poor households due to multiple family occupancy of dwellings. The third reason is that many poor households buy water either from neighbours or from vendors when they do not have adequate water outlets at the household level. Finally, there is a poor correlation between household income and water consumption. Some poor households use lots of water. The consequence of all of the above is that many poor households end up buying at higher prices their water because it is supplied by outlet paying higher block prices. As a consequence, the desired transfer of wealth between rich and poor water customers on the basis of their consumption prices does not take place. Most households tend to be subsidized and the cost recovery objective tends to fail. Too much water is sold at the lowest block price (the lifeline block) to the wrong household target.

The type of tariff to be applied is a function of the type of people to be served, as well as the type of water infrastructure. The purpose of this section is to present a general process for creating water tariffs, based on the type of input. In the case of HYDROUSA systems, the main categories of water infrastructures are presented in the next section (Table 6.2 and Table 6.3).

6.5 Water governance (within service management by larger utilities)

The framework of the governance of water services in Europe, mainly in piped urban areas and by utilities, has recently been well reported by EurEau (2019).

As a way of simplification, EurEau distinguished four management models across Europe:

- Direct public management: under this system, the responsible public entity is entirely in charge of service provision and their management. In the past, this system was predominant in Europe.
- Delegated public management: under this system, a management entity is appointed by the responsible public entity to execute the management tasks. Management entities usually remain the ownership of the public sector, although in the EU, in some cases, there is the possibility of a minor private shareholding.
- Delegated private management: under this system the responsible public entity appoints a private company to manage tasks, on the basis of a time-bound contract in the form of lease or concession contract. In the countries where this type of management is common, municipalities subcontract their duties to private companies. The ownership of the infrastructure remains in the hands of public authorities.
- Direct private management: under this system all management tasks, responsibilities and ownership of water utilities are placed in the hands of private operators, while public entities limit their activities to control and regulation. This system is in place in very few European countries (England, Wales, and the Czech Republic).

In the majority of countries there is a mix of the first three models (direct public management, delegated public management and delegated private management), with a general trend, compared to 20 years ago, towards public and private delegated management. Apart from the general cases of England and Wales and specific cases in the Czech Republic, the ownership of water infrastructure across Europe is public. Public authorities are also in charge of approving the tariffs, determining the quality of service as well as setting and enforcing the environmental and health standards. Water tariffs contribute to recovering the costs almost everywhere in Europe: in some countries costs are still to be covered by a mix of tariffs, transfers and taxes (3Ts). The tariff structure differs from country to country, but in the majority of cases, the tariff is made up of a fixed component and a volumetric component. A tendency to set the 'tariff structure' at national level may be observed, while price setting still takes place at local level. Generally, water tariffs are proposed by the water operator to the competent authority (municipality, regional government or regional regulator, national ministry or independent national regulator) for approval. In a few cases customer involvement is foreseen in the process. In some examples, supervisory bodies carry out an ex-post check of the tariff. The quality of service may be defined by the competent authority according to some minimum requirements in some cases. If the minimum requirements are not met, water operators may be obliged to compensate customers.

Depending on the country and how services are organised, customers have different fora where they can file a complaint: the water utilities customers' service, the municipalities, consumers' boards, national regulators, ombudsmen, arbitrations and courts. The monitoring of the quality of drinking water is generally entrusted to health authorities (Ministry of Health and their regional/local bodies). The protection of water resources and the setting of environmental standards are usually the competence of the Ministry of the Environment and/or River Basin authorities and/or regional authorities as well as national environmental agencies.

Table 6.1 Framework of water governance in Europe (adapted from EurEau, 2018)

Countries	Water Service Management Model	Type of Tariff	Cost Recovery	Composition	Subsidies	Average Price (€/m³)	Authority Approval	Notes
Austria	Direct public Delegated public	-	Full Cost	Fixed Part + Volumetric Part	Possible, for Fixed Costs Recovery	3.67	Local municipal governments	
Belgium						4.53		
Flanders	Delegated public	Domestic and Non-Domestic		Fixed Part + Volumetric Part			Flemish Environment Agency (VMM)	Price reduction for large families and people in financial difficulties.
Wallonia	Delegated public with a small private shareholding*		Full Cost	Fixed Part + Volumetric Part			Walloonian Minister of the Economy	*For waste water treatment
Brussels	Delegated public Delegated private*		Full Cost	Fixed Part + Volumetric Part			Minister in charge of water	From 2018 the control is under pass the public agency Brugel; *For waste water treatment
Bulgaria	Direct public Delegated public Delegated private			Fixed Part + Volumetric Part			Water and Energy Regulator (national level)	
Croatia	Direct public Delegated private*			Fixed Part + Volumetric Part		1.98	Local government (the mayor of the municipality)	*Only in the city of Zagreb

Cyprus	Direct public	Drinking Water and Sewage		Fixed Part + Volumetric Part		2.9	***Drinking water:*** 1- Cypriot Council of Ministers (for urban area); 2- Minister of the Interior or community council and local district officer (for sub-urban area); ***Sewage:*** Council of Ministers and then by the House of Representatives.	
Czech Republic	Delegated private Delegated public Direct private Direct public			Fixed Part + Volumetric Part	Possible, cross-sector subsidies	3.27	Ministry of Finance; municipalities, associations of municipalities (for Delegated Public/Private management)	
Denmark	Delegated Public Private			Fixed Part + Volumetric Part		9	Municipal council	Only for water service and waste water operators (at least 200.000 m3/year): taking into account the demands from the national regulator. From 2016 the economic regulation for providers handling more than 800.000 m3/year is very complex and includes total economic benchmarking.
Estonia	Delegated public					3.16	For > 2000 p.e. relevant national regulator; For < 2000 p.e. local goverments.	

Finland	Direct public Delegated public Direct private*		Full Cost	Fixed Part + Volumetric Part		5.89	Management board of the company (for delegated public mangement); Local governments (for direct public management).	*In sparsely populated areas
France	Direct public Delegated private		Full Cost	Fixed Part + Volumetric Part		3.92	Local Authorities (municipal assemblies)	Variable/fixed ratio cannot exceed a maximum level set at national level. Tariffs must also include taxes set by the state and by basin authorities.
Germany	Direct public Delegated public Delegated private		Full Cost	Fixed Part + Volumetric Part			Utility supervisory board (for Delegated Private Management);	The antitrust review of water prices is the responsibility of the cartel authorities of the federal states or, in case of cross-border activity, the Federal Cartel Office.
Greece	Direct public Delegated public		Full Cost (including economic, environmental and resource costs)	Fixed Part + Volumetric Part		1.4	Municipal council (local level) and Department of the Regional Administration (regional level)*; Ministries (national level) of Finance, Environment and Energy and the Ministry of Macedonia and Thrace (for E.Y.A.TH. exclusively)**	*For cities with more than 10.000 inhabitants; **For Water and Sewerage Companies of Athens.
Hungary	Delegated private Delegated public			Fixed Part + Volumetric Part		2.65	Minister responsible at national level	There are currently around 10.000 different tariffs in use, and there are significant variations between these.

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Ireland	Delegated public Delegated private	Domestic and Non-Domestic		Fixed Part + Volumetric Part				From July 2019 a new regime of excessive usage charges was introduced for domestic customers. The non-domestic cutomers pay charges based on historic rates and set by the regulator (Commission for the Regulation of Utilities or CRU).
Italy	Direct public Delegated public			Fixed Part + Volumetric Part		1.5	National regulator ARERA (the Regulatory Authority for Energy Networks and the Environment)	
Luxembourg	Direct public		Full Cost	Fixed Part + Volumetric Part		5.5 - 6	Ministry of Sustainable Development and Infrastructure	
Malta	Delegated public		Full Cost	Fixed Part + Volumetric Part	Possible for cost recovery*	3.32	Regulator for Energy and Water Services (REWS)	Subsidies can be given for: a)depreciation, interest payments on borrowings; b) periodic repayments; c) creating reserves to finance a reasonable part of the cost of future expansion; d) providing a reasonable return on investment and expenditure incurred by the Water Services Corporation.

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Norway	Direct public		Full Cost	Fixed Part + Volumetric Part		5.7	Municipality politicians	
Poland	Direct public Delegated public Delegated private Direct private			Fixed Part + Volumetric Part		2.15	Central Tariffs Regulator	Ministerial regulation indicates that costs and profits can be included in the tariffs. From 2017 Water Law includes new types of water charges for industry, agriculture and public water services as well (for example fixed charges depending on the water permit).
Portugal	Direct public Delegated public Delegated private		Full Cost	Fixed Part + Volumetric Part		1.82	Entidade Reguladora de Serviços de Águas e Resíduos – ERSAR for biggest, state-owned, water company and ‘multi-municipal systems’; municipalities for the other models.	
Romania	Direct public Delegated public Delegated private		Full Cost	Fixed Part + Volumetric Part	Possible, grants from EU	1.42	National Regulating Authority and each local authority/Intercommunity Development Association (IDA).	
Serbia	Direct public Delegated public			Fixed Part + Volumetric Part			Local self-government	Government defines the basis for the tariff calculation, indicators for the utility service tariff, the highest tariffs, exemption from payment.

Slovakia	Delegated public Delegated private			Fixed Part + Volumetric Part		2.4	National regulation office	
Slovenia	Delegated public Direct public* Delegated private			Fixed Part + Volumetric Part		2.17	Municipalities	*By municipalities
Spain	Direct public Delegated public Delegated private			Fixed Part + Volumetric Part		1.78	Municipalities and regional entities	
Sweden	Direct public Delegated public		Full Cost	Fixed Part + Volumetric Part		4.44	Competent city council	
Switzerland	***For Drinking water:*** Direct public Delegated public Delegated private Direct private ***For waste water:*** Direct public Delegated public		tariffs cover all costs and the long term financial sustainability	Fixed Part + Volumetric Part		2.1	Local parliament	
The Netherlands	Direct public Delegated public			Fixed Part + Volumetric Part	Possible income tax rather than direct water taxes	3.91	Municipalities and/or provinces (for delegated public management); elected representatives of local councils (for direct public management)	The national inspectorate (advised by the national Authority for Consumers and Markets) supervises and advises the competent minister about the correctness of the tariffs; if necessary the minister can intervene.

United Kingdom	Direct private Delegated public*		Full Cost	Fixed Part + Volumetric Part		3.54		*In northern Ireland and Scotland The Water Services Regulation Authority (Ofwat) is the independent economic regulator which monitors performance and sets price limits within which companies have to operate.

6.6 EU Legislation and Current Tariff Implementation in Italy

Within the EU context, all tariffs must recover full costs according to the WFD 60/2000/CE, including:

- Operational costs due to management;
- Capital costs (cost of use of capital, and net return)
- Environmental costs (environmental and ecosystem damage caused by water abstraction, interception and use);
- Resource costs (such as the opportunity cost of resources or external costs imposed to others when intensive water extraction cause irreversible damage).

In Italy tariffs are regulated by ARERA (Italian Regulatory Authority for Electricity Gas and Water), under the indications provided in the "METODO TARIFFARIO IDRICO 2016-2019", consisting of 74 pages and 37 articles. This document is complex and it is operationally translated into an algorithm implemented in a spreadsheet to which we have gained access. Simulations can be run when all necessary inputs for the different HYDROUSA scenarios have been defined for application in Italian territories.

6.7 HYDROUSA Demo Sites

The tables below provide a summary of the water categories applied to the six HYDROUSA demo sites.

Table 6.2 HYDROUSA Categories

PERMITTING - COMMISSIONING - MONITORING			MARKETING
WP7			WP8
Policy framework (national legislation, EU directives)	**Applications**	**Regulations**	
Water categories	**HYDROUSA Systems**	**Recovered products**	**Marketed products**
Rainwater	Harvesting	Water for domestic non-drinking use	Service water
Groundwater	Recharge & Storage	Irrigation water	Mediterranean crops and derived products (e.g. essential oils)
Wastewater	Upflow Anaerobic Sludge Blanket (UASB) & Wetlands	Fertigation liquid	Plant-based products
Waste vapour	Vapour condensation	Biogas	Energy
Seawater	Tropical greenhouse	Drinking water	Drinking water
		Irrigation water	Tropical fruits
		Salt	Edible salt

The following table presents an overview of the categories applied to each of the HYDROUSA demo sites and a first quantification of inputs and outputs.

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Table 6.3 Summary of HYDROUSA demo sites

DEMO SITE	HYDRO 1	HYDRO 2	HYDRO 3	HYDRO 4	HYDRO 5	HYDRO 6
Water categories	**Wastewater**	**Wastewater**	**Rainwater**	**Rainwater**	**Seawater**	**Rainwater Air humidity**
						Wastewater
HYDROUSA Systems	Upflow Anaerobic Sludge Blanket (UASB) & wetlands	Upflow Anaerobic Sludge Blanket (UASB) & wetlands	Harvesting	Harvesting (already existing)	Vapour condensation	Vapour condensation
				Recharge & Storage	Tropical greenhouse	UASB & constructed wetlands
						Harvesting
INPUT	100 m^3/d Nutrient rich water in Summer	100 m^3/d raw sewage in Summer	50 m^3/year of harvested water	250 >m^3/year rainwater harvested	200m2 “Mangrove Greenhouse	20> m^3 /year condensed vapour water
	10 m^3/d Nutrient rich water in Winter	10 m^3/d of raw sewage in Winter	0.2 €/m^3 harvested water	0.2 €/m^3 harvested water	180-200m^3/year seawater	
	<0.3 kWh/m^3 of energy consumption					
RECOVERED PRODUCTS	Irrigation water	Fertigation liquid	Irrigation water	Drinking water	Irrigation water	Drinking/domestic water
	Biogas			Irrigation water	Salt	Irrigation water
OUTPUT	10,000 m^3/year of water reused in agriculture	Irrigation of 1 ha of crops/trees	0.4 ha irrigated	0.2 ha irrigated	75> m^3/year freshwater production from saltwater/brine	20 – 30m^3 /year of reclaimed water
	10 MWh/year of biogas production	Production of > 10 tons of fruits, herbs, vegetables	800 > kg/year oregano to produce essential oils	10 > m^3 /year drinking water	1.5> tons tropical fruits	0.15ha of irrigated crops
				200 m^3 /year water stored in aquifer	700 > kg/year recovered salt	50 m^3/year of rainwater harvested
				1000 kg/year lavender		
MARKETED PRODUCTS	Service water	Service water	Service water	Drinking water	irrigation water	Drinking & service water
	Energy	Mediterranean crops	Plant-based products	Plant-based products	Tropical fruits	Mediterranean crops
			Essential oils	Essential oils	Edible salt	

6.8 Small HYDROUSA Systems and Tariff

Some theoretical considerations need to be made with regards to the small-scale HYDROUSA systems under consideration in this study. Specifically, with regards to how these relate to the tariff design and water charges typically used for larger systems. The technical specifications of these small-scale solutions and their limited range of water quality production make these systems suitable to play only a role complementary to larger water delivery systems. The underlying assumption being that water authorities are in charge of water delivery administration in water scarce locations and hence have the mandate to invest in complementary water solutions to take advantage of local conditions and satisfy specific local needs.

7 CONCLUSIONS AND PROPOSAL FOR INNOVATION DEAL

7.1 CONCLUSIONS

This deliverable clearly shows how innovation to deliver HYDROUSA closed and regenerative water loops in European water sector is not only a technological issue. The enabling environment conditions in which HYDROUSA water loops can be applied are related to legislative and regulatory framework, institutional capacity and support, financing, asset management, monitoring and risk-based approach.

At this stage no general major barriers that can completely prevent the application and spreading of HYDROUSA loops have been found in the European legislative context. However, the achievement of required quality standard by not entailing excessive costs might be a challenge for economic sustainability of small and decentralized closed and regenerative loops, as long as holistic costs are not properly accounted.

Although decentralization has been suggested as a valuable shift, support to small and decentralized water and water-related services is less provided: in general, local operator models and self-supply, that are relevant for HYDROUSA, have received little or no attention. In some Countries decentralization reforms have assigned the responsibility for water service provision to rural local governments, which often have poor capacities and financial resources. On the other hand, major interest and support is given to larger urban and regional utilities, which are often prioritized in investment strategies.

While irrigation water recovery seems challenging but achievable, higher constraints might be found when the goal is to produce drinking water from alternative sources, it is crucial to have a risk-based and risk-assessment approach and deliver Water Safety Plans even to improve community engagement. Community composting to valorise sewage sludge can be problematic when EC-marked compost of organic farming is targeted. In addition, high attention should be paid to quality standard, probably with concern to pathogen removal and related indicators.

7.2 INNOVATION PRINCIPLE AND PROPOSAL FOR AN INNOVATION DEAL

When writing and revising the current deliverable, the call for submission of innovation deal proposals is not open. However, innovation deals are still considered important tools to ensure EU legislation supports innovation[1] by implementing the Innovation Principle along the policy lifecycle.

[1] https://ec.europa.eu/info/research-and-innovation/law-and-regulations/innovation-friendly-legislation_en

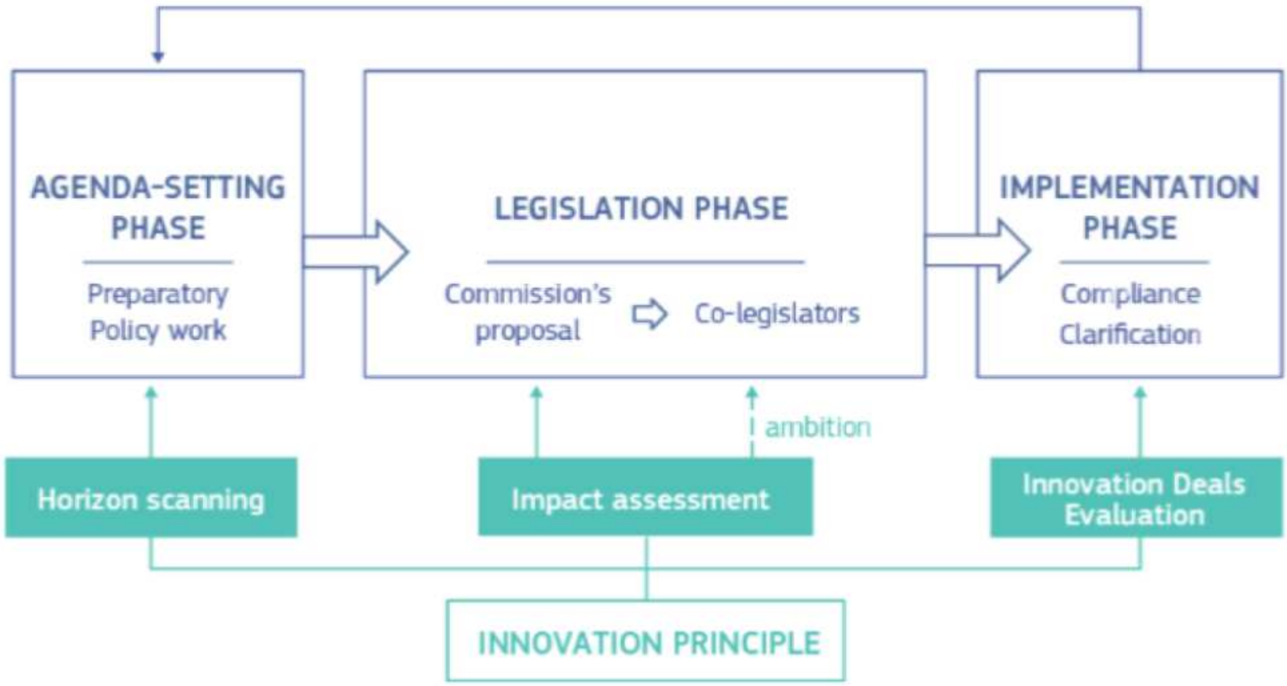

Figure 7.1 Innovation Principle Implementation along the policy lifecycle

Currently, clear EU (enabling or disabling) reference regulatory framework is missing with concern to sustainable solutions to close loops in small communities or agglomerations. Therefore, HYDROUSA consortium can support different phases of the implementation of the innovation principle towards innovation-friendly regulations. In particular, HYDROUSA has already responded to the consultation about the UWWTD revision. In addition, HYDROUSA consortium believes that an Innovation Deal can support European (and national) governments to recognize the role of innovations to deliver regenerated water and water-related closed loops in small communities. Possible further actions should be directed to creating regulatory and institutional clarity, a conducive enabling environment for the decentralized service delivery models.

Generally, and practically, being inspired by another urban service, we think that a framework similar to the community composting could work even for community-based water and water-related services management. In such a framework, the role of municipalities, local council and local authorities is crucial, and they must be engaged and formally responsible in planning, programming, implementing and assessing the HYDROs.

For example, in Italy simplified procedures are provided for the start-up of community composting activities according to the collective body ((which is the Community implementing the decentralized system) i.e., two or more domestic or non-domestic users established in a condominium, association, consortium, company or other forms of association governed by private law) reports the start of the activity to the local municipality. In case of parallel centralized waste management by a waste utility, the municipality informs the waste utility about the start of the community composting that will replace the centralized management system. The Ministerial Decree 266/2016 also establishes the requirements for composting in terms of not only of biodegradable materials and waste eligible for treatment (Annex 3), but also of the operating procedures and parameters of composting (Annex 4—part A and B).

In addition, still in Italy, according to the new draft proposal decree, the community composting activity is formally implemented by:

a. the Municipality initiate the decentralized system, which is then co-created with the citizens;
b. by the "Collective Body" after sending a certified notification of the start of activity to the territorially competent municipality, which notifies the company entrusted with the municipal waste management service.

The manager of the activity is identified by the local Municipality or by the "collective body". The manager, for clealy set treatment capacities (medium (maximum 60 ton/y treated) and large (maximum 130 ton/y treated)) systems, keeps in a special register, also electronic, with data relating to the quantities of waste delivered to the equipment, compost and waste produced and compost that does not comply with the characteristics established by the decree. The community composting control activities are carried out by the Provinces (pursuant to art. 197 of the Legislative Decree 3 April 2006, 152) and by the Municipalities. The outcome of the monitoring activities carried out pursuant to article 197 of the legislative decree 3 April 2006, 152, is communicated to the Municipality.

The implementation of the Community Composting could be schematically represented in the figure below.

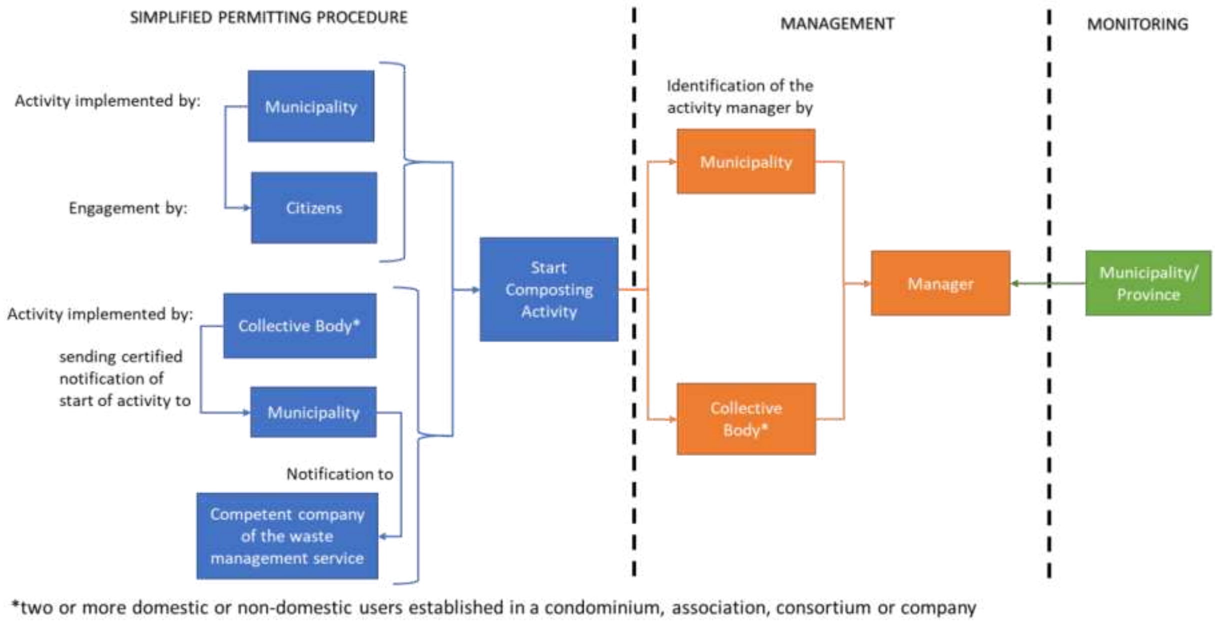

Figure 7.2 Implementation of the Community Composting Regulation in Italy

According to the represented scheme, HYDRO solutions at community level could be implemented as follows.

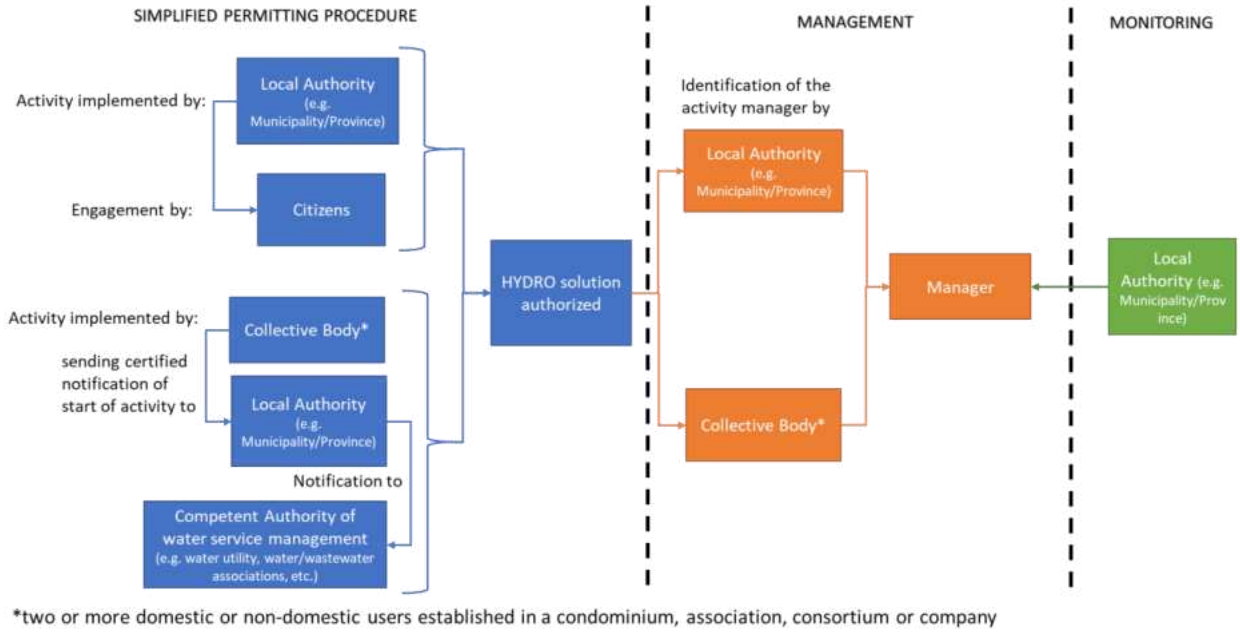

Figure 7.3 Implementation of Community regulation in the context of HYDRO solutions

Therefore, the general objective of the HYDROUSA Innovation Deal can be to evaluate whether community-based legislative and regulatory framework applied in waste management might inspire the water management.

Generally, the tasks would be:
- To identify legal barriers and obstacles for the small and decentralized closed water and water-related loops. This activity is already partially planned in WP7, so we can expect the Innovation Deal activity could be feasible even without additional funding.
- To promote coordination between entities and stakeholders involved in water management and use, water and water-related services.
- To disseminate results and conclusions to society.

Further to the EC relevant DGs (e.g RTD, ENV, AGRI), we propose to involve at least the following stakeholders:

HYDROUSA Consortium; Council of European Municipalities and Regions (CEMR) www.ccre.org; Water Europe; Ministry of Environment and Energy, Greece; Ministry/Department/Agency of Health and Safety – Greece; Ministry/Department/Agency of Agriculture – Greece ; Municipalities of Tinos, Mikonos and Lesvos; NGOs (e.g. Legambiente; Thames21).

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9 ANNEX

9.1 LEGISLATIVE ANALYSIS TABLES

Table 9.1 Limits for reclaimed water reuse in agriculture (colors represent the specific directive/regulation)

EUROPEAN SCALE							
Proposal 2018/337 for a Regulation of the European Parliament and of the Council on minimum requirements for water reuse and Council Directive 91/271/EEC1 The Urban Waste Water Treatment Directive and WHO 2006							**Notes**
Minimum reclaimed water quality class	**Crop category**	**Irrigation method**	**Indicative technology target**	**Parameters**	**Units**	**Limits**	WHO Guidelines for the Safe us of wastewater, excreta and greywater Volume I - Policy and regulatory aspects. 2006.
Class A	All food crops, including root crops consumed raw and **food crops** where the **edible part** is in direct contact with reclaimed water	All irrigation methods	Secondary treatment, **filtration**, and disinfection	E.coli	cfu/100 mL	≤10 or below detection limit	
				BOD_5	mgO_2/L	≤10	
				TSS	mg/L	≤10	
				Turbidity	NTU	≤5	
				Legionella	cfu/L*Only if there is risk of aerosolization	<1,000 cfu/lLwhere there is risk of aerosolization in greenhouses	
				Intestinal nematodes (helminth eggs)	egg/L	≤1 egg/l for irrigation of pastures or forage	
	Validation monitoring of reclaimed water for agricultural irrigation			**E. coli**	**log_{10} reduction**	**≥ 5.0**	Validation monitoring only included in class A
				Total coliphages/ F-specific coliphages/somatic coliphages/coliphages	**log_{10} reduction**	**≥ 6.0**	
				Clostridium perfringens spores/spore-forming sulphate-reducing bacteria	**log_{10} reduction**	**≥ 4.0** in case of spores;	

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						≥ 5.0 in case of spore-forming sulphate-reducing bacteria	
Class B	**Food crops** consumed raw where the **edible part** is produced **above ground** and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops to feed milk- or meat-producing animals	All irrigation methods	Secondary treatment, and disinfection	E. coli	cfu/100 mL	≤100	
				BOD_5	mgO_2/L	25	
				TSS	mg/L	35 mg/L (more than 10000 p.e .) 60 mg/L (2 000-10 000 p.e.)	
				Turbidity	NTU	-	
				Legionella	cfu/L*Only if there is risk of aerosolization	<1,000 cfu/L where there is risk of aerosolization in greenhouses	
				Intestinal nematodes (helminth eggs)	egg/L	≤1 egg/L for irrigation of pastures or forage	
Class C	**Food crops** consumed raw where the **edible part** is produced **above ground** and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops to feed milk- or meat-producing animals	Drip irrigation* only (micro-irrigation system capable of delivering water drops or tiny streams to the plants and involves dripping water onto the soil or directly under its surface at very low rates (2-20 litres/hour) from a system of small diameter plastic pipes fitted with outlets called emitters or drippers) **Or other method that avoids direct contact with the edible part of the crop.**	Secondary treatment, and disinfection	E. coli	cfu/100 mL	≤1000	
				BOD_5	mgO_2/L	25	
				TSS	mg/L	35 mg/L (more than 10000 p.e .) 60 mg/L (2 000-10 000 p.e.)	
				Turbidity	NTU	-	
				Legionella	cfu/L*Only if there is risk of aerosolization	<1,000 cfu/l where there is risk of aerosolization in greenhouses	
				Intestinal nematodes (helminth eggs)	egg/L	≤1 egg/L for irrigation of pastures or forage	
Class D	Industrial, energy, and seeded crops	All irrigation methods	Secondary treatment, and disinfection	E. coli	cfu/100 mL	≤10000	
				BOD_5	mgO_2/L	25	
				TSS	mg/L	35 mg/L (more than 10000 p.e .)	

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						60 mg/L (2 000-10 000 p.e.)	
				Turbidity	NTU	-	
				Legionella	cfu/L*Only if there is risk of aerosolization	<1,000 cfu/L where there is risk of aerosolization in greenhouses	
				Intestinal nematodes (helminth eggs)	egg/L	≤1 egg/L for irrigation of pastures or forage	
Trace Elements				Aluminium	mg/L	5.00	
				Arsenic	mg/L	0.1	
				Beryllium	mg/L	0.1	
				Boron	mg/L	0.7	
				Cadmium	mg/L	0.01	
				Chromium	mg/L	0.1	
				Cobalt	mg/L	0.05	
				Copper	mg/L	0.20	
				Fluoride	mg/L	1.00	
				Fluoride	mg/L	5	
				Lead	mg/L	5	
				Lithium	mg/L	2.5	
				Manganese	mg/L	0.2	
				Mercury	mg/L	n.r	
				Molybdenum	mg/L	0.01	
				Nickel	mg/L	0.20	
				Selenium	mg/L	0.02	
				Vanadium	mg/L	0.1	
				Zinc	mg/L	2.00	

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Table 9.2 Sampling and Methods for reclaimed water reuse in agriculture (colours represent the specific directive/regulation)

EUROPEAN SCALE					
Proposal 2018/337 for a Regulation of the European Parliament and of the Council on minimum requirements for water reuse and Council Directive 91/271/EEC1 The Urban Waste Water Treatment Directive and WHO 2006					**Notes**
Minimum reclaimed water quality class	**Crop category**	**Reference Method**	**Minimum monitoring frequencies**	**Specific preventive measures**	WHO Guidelines for the Safe us of wastewater, excreta and greywater. Volume I - Policy and regulatory aspects. 2006.
Class A	All food crops, including root crops consumed raw and **food crops** where the **edible part** is in direct contact with reclaimed water		Once a week	-Pigs must not be exposed to fodder irrigated with reclaimed water unless there is sufficient data to indicate that the risks for a specific case can be managed.	
			Once a week		
			Once a week		
			Continuous		
			Once a week		
			Twice a month or frequency determined by the reclamation plant operator according to the number of eggs in waste water entering the reclamation plant		
	Validation monitoring of reclaimed water for agricultural irrigation				Validation monitoring only included in class A
Class B	**Food crops** consumed raw where the **edible part** is produced **above ground** and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops to feed milk- or meat-producing animals		Once a week	- Prohibition of harvesting of wet irrigated or dropped produce. - Exclude lactating dairy cattle from pasture until pasture is dry. - Fodder has to be dried or ensiled before packaging. - Pigs must not be exposed to fodder irrigated with reclaimed water unless there is sufficient data to indicate that the risks for a specific case can be managed.	
			* 2000 to 9999 pe.: 12 samples during the first year. four samples in subsequent years, if it can be shown that the water during the first year complies with the provisions of the Directive ; if one sample of the four fails, 12 samples must be taken in the year that follows.*10000 to 49999 pe: 12 samples/year, *50000 pe or over:24 samples/year at regular intervals		
			-		
			Once a week		
			Same above		
Class C			Twice a month	- Prohibition of harvesting of wet irrigated or dropped produce. - Exclude grazing animals from pasture for five days after last	
		Homogenized, unfiltered, undecanted sample. Determination of dissolved oxygen before and after five-day incubation at 20 °C ± 1 °C, in	Same above		

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		complete darkness. Addition of a nitrification inhibitor — Filtering of a representative sample through a 0.45 µm filter membrane. Drying at 105 °C and weighing — Centrifuging of a representative sample (for at least five mins with mean acceleration of 2 800 to 3 200 g), drying ' at 105 °C and weighing		irrigation. - Fodder has to be dried or ensiled before packaging. - Pigs must not be exposed to fodder irrigated with reclaimed water unless there is sufficient data to indicate that the risks for a specific case can be managed.	
			-		
			Once a week		
			Same above		
Class D	Industrial, energy, and seeded crops		Twice a month	- Prohibition of harvesting of wet irrigated or dropped produce.	
		Same above	Same above		
		Same above			
			-		
			Once a week		
			Same above		

Table 9.3 Promotion of energy from renewable sources

EUROPEAN SCALE		
(EU) 2018/2001		
Application field	**Dispositions for energy in the transport sector**	
Art.2: "Energy from...sewage treatment plant gas, and biogas"; "**'biofuels'** means liquid fuel for transport produced from biomass"	*The final consumption of energy in the transport sector	
	Energy content of road- and rail- transport fuels from...biofuels	
	Amount of energy from renewable sources from...biofuels	
	The greenhouse gas emission savings from the use of biofuels	
Member States shall require the relevant economic operators to enter into that database information on the transactions made and the sustainability characteristics of those fuels, including their life-cycle greenhouse gas emissions, starting from their point of production to the fuel supplier that places the fuel on the market.		
Fuel suppliers shall enter the information necessary to verify compliance with the requirements laid down in the first and fourth subparagraphs of Article 25(1) (See*) into the relevant database.		
	Contribution of total renewable energy	at least 14 % by 2030

	The greenhouse gas emission savings from the use of biofuels	**at least 60 %** for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations starting operation from 6 October 2015 until 31 December 2020; **at least 65 %** for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations starting operation from 1 January 2021;	
	Greenhouse gas emissions savings for biomass fuels* (from BIOWASTE) **BIOMETHANE FOR TRANSPORT****	Greenhouse gas emissions savings – typical value (gCO_2eq/MJ)	Greenhouse gas emissions savings – default value g (CO_2eq/MJ)
	Close digestate, no off-gas combustion	70%	58%
energy from...sewage treatment plant gas, and biogas;	Close digestate, off-gas combustion	86%	80%
	Disaggregated default values for biomass fuels (from BIOWASTE) **BIOMETHANE**	TYPICAL VALUE [g CO2eq/MJ]	DEFAULT VALUE [g CO2eq/MJ]
	Close digestate, no off-gas combustion	0.5	0.5
	Close digestate, off-gas combustion	0.5	0.5
	Total typical and default values for biomass fuel pathways (from BIOWASTE) **BIOMETHANE**	Greenhouse gas emissions – typical value (g CO_2eq/MJ)	Greenhouse gas emissions – default value (g CO_2eq/MJ)
	Close digestate, no off-gas combustion	25	35
	Close digestate, off-gas combustion	10	14

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Table 9.4 Maximum levels for certain contaminants in food stuffs (colours represent the specific directive/regulation)

EUROPEAN SCALE						
Regulation (EC) 178/2002 + EC 1881/2006						**Notes**
Type of "food" regulated*		**Parameters**	**Units**	**Limits for compliance** **Parametric value**	**Food safety requirements**	*any substance or product, processed, partially processed or unprocessed, intended to be, or expected to be ingested by humans
Water incorporated in the food**						**intentionally incorporated into the food during its manufacture, preparation or treatment. It includes water after the point of compliance as defined in Art.6 of 98/83/EC and to the requirements of 80/778/EEC and 98/83/EC.
Any substances intended to be, or reasonably expected to be ingested by humans					No probable immediate and/or short-term and/or long-term effects on the health of a person consuming it, but also on subsequent generations;	
Maize to be subjected to sorting or other physical treatment before human consumption or use as an ingredient in food-Stuffs		Aflatoxins B1	µg/kg	5		
		Aflatoxins Sum of B1, B2 ,G1 and G2	µg/kg	10	No probable cumulative toxic effects;	
Unprocessed cereals		Ochratoxin A	µg/kg	5		
	Unprocessed cereals other than durum wheat, oats and Maize	Deoxynivalenol	µg/kg	1250	No particular health sensitivities of a specific category of consumers***	***where the food is intended for that category of consumers.
	Unprocessed durum wheat and oats	Deoxynivalenol	µg/kg	1750		
	Unprocessed maize	Deoxynivalenol	µg/kg	1750	No contamination, whether by extraneous matter or otherwise, or through putrefaction, deterioration or decay.	
		Zearalenone	µg/kg	200		
		Fumonisins	µg/kg	2000		
	Unprocessed cereals other than maize	Zearalenone	µg/kg	100		
Cereals, legumes and pulses		Lead	mg/kg wet weight	0.2		
Fruit, except berries and small fruit		Lead	mg/kg wet weight	0.1		
Berries and small fruit		Lead	mg/kg wet weight	0.2	It conforms to the specific provisions of national food law of the Member State in whose territory the food is marketed****	****such provisions being drawn up and applied without prejudice to the Treaty, in particular Articles 28 and 30 thereof.
Cereals excluding bran, germ, wheat and rice		Cadmium	mg/kg wet weight	0.1		
Bran, germ, wheat and rice		Cadmium	mg/kg wet weight	0.2		

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Vegetables and fruit, excluding leaf vegetables, fresh herbs, fungi, stem vegetables, pine nuts, root vegetables and Potatoes		Cadmium	**mg/kg wet weight**	0.05		

Table 9.5 Amount of water for irrigation

EUROPEAN SCALE	
From FAO Manual	
Type of crop	**Water needs**
-	mm/total growing period
Banana	1200-2200
Barley/Oats/Wheat	450-650
Maize	500-800
Melon	400-600
Cabbage	350-500
Citrus	900-1200
Onion	350-550
Peanut	500-700
Pea	350-500
Pepper	600-900
Potato	500-700
Soybean	450-700
Sugarbeet	550-750
Sugarcane	1500-2500
Sunflower	600-1000
Tomato	400-800

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Table 9.6 Rainwater reuse guidelines (colours represent the specific directive/regulation)

EUROPEAN SCALE							
EC Best Environmental Management Practice in the Tourism Sector, JRC Report - 2013 **Environment Agency Harvesting rainwater for domestic uses: an information guide**							NOTES
Purpose	**Basic Treatment for acceptable quality**	**Source**	**Parameters**	**Units**	**Limits**	**Treatment method for rainwater usage**	From JRC Report **Rainwater and grey water recycling**, developed according to Art. 46 of Eco-Management and Audit Scheme (EMAS) regulation (EC) No 1221/2009
Non potable demand such as: **1) toilet flushing; 2) washing machines; 3) irrigation; 4) cooling towers; 5) general cleaning purposes.**	Basic filtration for domestic uses: recommended fine wire mesh of e.g. 0.35 mm and optional additional micro-filtration layers. First-flush diverter may be fitted to reduce the concentration of pollutants in the collected rainwater.	Roof run-off	pH	mg/L	5.2 – 7.9	**Filtration (In some points it may be suitable for irrigation following installation of a first-flush diverter and appropriate filtration.)**	Treatment method: EC BEM document
			BOD	mgO_2/L	7 – 24		
			COD	mgO_2/L	44 – 120		
			TOC	mg/L	6 – 13		
			TS	mg/L	10 – 56		
			SS	mg/L	60 – 379		
			Turbidity	mg/L	3 – 281		
		Stored run-off	pH	mg/L	6 – 8.2		
			BOD	mg/L	3		
			COD	mg/L	6 – 151		
			TOC	mg/L	-		
			TS	mg/L	33 – 421		
			SS	mg/L	0 – 19		
			Turbidity	mg/L	1 – 23		
			DO		>10% saturation or > 1 mg/ l oxygen (whichever is least) for all uses		
		Garden watering and WC flushing	E. coli	number/ 100 mL	≤250		
			Intestinal enterococci	number/ 100 mL	≤100		
			Total coliforms	number/ 100 mL	≤1000		
		Pressure washers and garden sprinklers	E. coli	number/ 100 mL	1		
			Intestinal enterococci	number/ 100 mL	1		
			Legionella	number/ L	100		
			Total coliforms	number/ 100 mL	10		
			Residual chlorine	mg/L	<0.5 mg/L for garden watering <2 mg/L for all other uses		
			Residual bromine	mg/L	2		
			Colour		Not objectionable for all uses		

Table 9.7 Summary of experiences for rainwater reuse in different countries

GUIDELINES AND REPORT FROM WORLD-WIDE EXPERIENCES						
State	**Water source reuse**	**Specific uses**	**System used**	**Notes on Techs**	**Source**	**NOTES for special attention**
DK	Stormwater Runoff	-	Sedimentation + Aquatic Plant + Filtration+ Sorption to iron-enriched bottom soil or Coagulation/Flocculation by aluminium addition or Fixed media sorption)	-	LIFE-TREASURE: https://www.life-treasure.com/	
UK	Rainfall runoff	Domestic uses (non potable uses)	Filter + smoothing inlet + suction filter + pump + Control storage unit + Water level monitor + Automatic changeover + Type AA air gap + Overflow trap +Permeable pavement + Oil trap	-	Environment Agency Information Guide	
USA	Runoff from roofs (First flush diverted)	Irrigation (gardens and athletic field), fire protection, flushing toilet	Cistern/Rain Barrels/Vertical Storage*+ Pump + fine mesh Filter	Watertight Cisterns, with smooth interior surface; Covers (lids) should have a tight fit to keep out surface water, animals, dust and light	Pennsylvania Stormwater Best Management Practices Manual	
USA	Rainwater (conveyed from building roof; first 10 gall of rainwater diverted)	Water closets, urinals, hose bibbs, irrigation	Gutters + Roof washers (Filtration)+ Cisterns + Piping + air gap	Gutters with leaf screens <0.5"; Roof washers should contain 18" of sand, little fabric and 6" of pea gravel to proper filtration; Cistern material for potable use and be protected from sunlight.	Rainwater Harvesting Policies - Municipal Handbook (EPA)	**San Francisco:** allows rainwater to be used for toilet flushing without being treated to potable standards. **Texas:** requires filtration and disinfection for non-potable indoor uses. **Portland:** requires filtration for residential non-potable indoor uses but requires filtration and disinfection for multi-family and commercial applications.
DE	Rainwater from roofs (First flush diverted)	Domestic purposes (toilet flushing, garden watering, irrigation, cleaning and laundry washing); Potable uses.	Gutters + Drain pipes + Filter system + Storage tank/Cistern + Overflow trap + Covering of tank + Pump + Pressure tank + Tap + Disinfection (Slow sand filtration and/or ozone or UV)	Pipes made of PE, PP or stainless steel. Cistern made of inert material such as reinforced concrete, ferrocement, fibreglass, PE, Stainless Steel, Wood, Metal of Earth.	Overview from "Fachvereinigung betriebs- und regenwassernutzung (fbr)"	
AU	Rainwater from roofs	Potable uses	Gutter + Tank + Piping + Filtration or UV Disinfection or Chlorine disinfection	Tank should be vermin proof. Filtration with PE and Ceramic cartridge type filters or Activated carbon	Rainwater treatment guide from NSW Government Health	

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				filters or Micro/Ultra filtration (0.1-0.01 µm) or Reverse osmosis filter (0.001 µm)		
BOTWANA; NEPAL; TAJIKISTAN	Rainwater from roofs				Water Harvesting Guidelines to Good Practice- Centre for Development and Environment, CDE	
Burkina Faso, Ethiopia, Kenya, Mali, Nepal, Pakistan, Senegal and Uganda	Rainwater from roofs, paved surfaces and dry sandy river beds.	Potable and domestic	Gutters/inlet pipes/collection canal + Filter (sand)+ Tank + Pump + Tap ***(see Table 3)***	Conveyance and Storage made of non-toxic materials, frequently cleaned from debris. Protect storage from sunlight.	RAIN Water Quality Guidelines - RAINFOUNDATION	Attention to water quality (WHO Water Safety Plans, 2005) and possible (Micro)biological, Chemical and Physical contaminations and mosquitoes in the water. For addition of water from other sources, chlorination should be applied.
EUROPEAN	Rainwater from roofs (recommended First flush diversion); Runoff from car park	Domestic uses (toilet flushing ***(see Table 2)***, laundry facilities); irrigation; Potable uses (Kitchen taps, bathroom and shower taps); NO Indoor Uses	Gutters + plumbing + Debris screen + Filter + Tank with water level detector + Control unit + Distribution pipes + Header tank with pump(optional)	Plumbing should be separated for Domestic purposes and potable uses. Filter should have a mesh of 0.35 mm (optional additional micro-filtration layers).	JRC Report Best Environmental Management Practice in the Tourism Sector	35% of new buildings built in Germany in 2005 were equipped with rainwater harvesting systems (EC, 2012), and about 100 Accor hotels have been installed with rainwater recovery tanks to supply irrigation or car washing applications.

* All storage container should meet FDA Specifications for stored drinking water if potable water is the intended use.

Table 9.8 Guidelines values for use of collected water in single site and communal domestic system

The Federal Office for Information Security (BSI) 2009		
Use	**Minimum Water Quality Guidelines**	
	Parameter	**Value**
Flushing toilet	E coli	≤ 250/100mL
	Intestinal enterococci number	≤ 100/100mL
	Total coliforms	≤ 1000/100mL

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Table 9.9 Recommended treatment and filtering techniques

RAINs recommended treatment and filtering techniques for RWH systems (grey = not appropriate or necessary for this type of system)				
Treatment method		**Roof runoff**	**Surface runoff**	**Notes**
Solutions or substances to be added to water	Chlorination	Tank	Household[a]	Chlorine residual of at least 0.2 mg/L
	Silver coated ceramic balls	Tank	Household/Tank	Time for disinfection 3 hours
	Aluminium sulphate		Household/Tank	Time for settling 30 min
	Moringa oleifera and stenopetala		Household/Tank	Let treated water without disturbing for 1-2 hours
Filters	Ceramic pot filter	Household	Household	
	Bio-sand filter	Household	Household	
Heat and UV radiation	Boiling	Household	Household[a]	Time of 5 min.
	SODIS (solar disinfection)	Household	Household[a]	T > 50°C for 6 hours
[a]water needs to be almost sediment-free, other treatment method to remove sediments should be applied first				

Table 9.10 Drinking water parameters (colours represent the specific directive/regulation; Grey cells represent parameters no longer applied to water put into bottles or containers intended for sale; Light grey cells represent parameters removed from Next 2018 Proposal)

EUROPEAN SCALE						
Water Framework Directive 2000/60/CE		Council Directive (EU) 83/1998 EC (Implementation of 2018 Proposal), WHO Guidelines for drinking-water quality (GDWQ)				**Notes**
Water source bodies	**Treatment for the purpose and control measure**	**Parameters**		**Units**	**Limits for compliance**	[1] Based on Volume of water distributed or produced each day within a supply zone
					Parametric value	[1]Additional monitoring is carried out on a case-by-case basis of substances and micro-organisms for which no parametric value has been set in accordance with Art. 5
Art.7: Water bodies providing > 10 m^3/d or > 50 persons (entity supplying at least 10 m3/d of water for human consumption as an average)	Those necessary for removing dangerous substances for human health (take measures, such as appropriate conditioning techniques, in cooperation with water suppliers, to change the nature or properties of the water before it is supplied so as to eliminate or reduce the risk of non-	**A Group**	E. coli	n°/250 (100) mL	0	
			Enterococci	n°/250 (100) mL	0	No longer applies to water put into bottles or containers intended for sale
			Coliform bacteria	n°/100 mL	0	Removed from Next 2018 Proposal
			Somatic coliphages	n°/100 mL	0	Acc.&N.A.C. = Acceptable to consumers and no abnormal change
			Pseudomonas aeruginosa	n°/250 mL	0	[2] Member States that have decided to exempt individual supplies under Art.3(2)(b) of this Directive shall apply these frequencies only for supply zones that distribute between 10 and 100 m3 per day.
			Colony at 22°C	-	N.A.C.	[3] For each 1000 m3/d and part thereof of the total volume
			Colony at 36°C	-	N.A.C.	[4] For each 4500 m3/d and part thereof of the total volume
			Colour	-	Acc.&N.A.C.	[5] For each 10000 m3/d and part thereof of the total volume
			Turbidity****	NTU	Acc.&N.A.C. (<1)	[6] For each 25000 m3/d and part thereof of the total volume
			Taste	-	Acc.&N.A.C.	[7] Random daytime sample of 1 litre volume
			Odour	-	Acc.&N.A.C.	[8] Proposed by the WHO
			pH	-	6.5≤ x ≤ 9.5	[9] Proposed by the European Commission
			Conductivity	$\mu S\ cm^{-1}$	2500	[10] Proposed by the European Parliament and of the Council

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	compliance with the parametric values after supply) **WHO Guidelines** **1-Pretreatment: roughing filters, micro-strainers, off-stream storage and bankside filtration;** **2-coagulation,** **3-flocculation,** **4-sedimentation (or flotation),** **5-filtration (granular slow sand, precoat and membrane),** **6-disinfection (chlorination, ozonation, UV, chloramination and application of chlorine dioxide).**		Nitrite*	mg/L	-	*if chloramination is used
			Ammonium*	mg/L	-	*if chloramination is used
			Iron**	µg/L	-	**if chemicals treatment is used
			Aluminium**	µg/L	-	**if chemicals treatment is used
Art. 2: "all water either in its original state or after treatment...regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers"		**B Group**	Other parameters***	-	micro-organisms, parasites, substances which constitute a potential danger to human health	***all other parameters not analysed under Group A and set in accordance with Art. 5 "**A Member State shall set values for additional parameters not included in Annex I** where the protection of human health within its national territory or part of it so requires. The values set should, as a minimum, satisfy the requirements of Article 4(1)(a):
		Chemical and indicator parameters	Acrylamide	µg/L	0.1	
			Aluminium	µg/L	200	**a: all samples are to be taken during times when the risk of treatment breakthrough of enteric pathogens is high.**
			Ammonium	mg/L	0.5	**b: at least 10 samples are to be taken during times when the risk of treatment breakthrough of enteric pathogens is high.**
			Antimony	µg/L	5 **(20)**	******For sampling: 0.3 NTU (95%) and not >0.5 NTU for 15 consecutive minutes**
			Arsenic	µg/L	10	
			Benzo(a)pyrene	µg/L	0.01	If uncertainty cannot be met, the best available technique should be selected (up to 60 %).
			Benzene	µg/L	1	
			Beta-oestradiol	**µg/L**	**0.001** [8]	
			Bisphenol A	**µg/L**	**0.01** [8]	
			Boron	mg/L	1 **(2.4)**	
			Bromate	µg/L	10	
			Cadmium	µg/L	5	
			Chloride	mg/L	250	
			Chlorate	**mg/L**	**0.25** [9] **(0.7)**	
			Chlorite	**mg/L**	**0.25** [9] **(0.7)**	
			Chromium	µg/L	50 **(25)** [9]	**The value shall be met, at the latest, by [10 years after the entry into force of this Directive]. The parametric value for chromium until that date is 50 µg/l**
			Clostridium perfringens	n°/100 mL	0	
			Conductivity	µS/cm	2500	
			Copper	mg/L	2	
			Cyanide	µg/L	50	The method determines total cyanide in all forms.
			1,2-dichloroethane	µg/L	3	

			Epiclorohydrin	**μg/L**	**0,1**	
			Fluoride	mg/L	1,5	
			pH	-	6.5≤ x ≤ 9.5	Values for trueness, precision and uncertainty of measurement are expressed in pH units.
			Haloacetic acids (HAAs)	**μg/L**	**80**	**Sum of: monochloro-, dichloro-, and trichloro-acetic acid, mono- and dibromo-acetic acid, bromochloroacetic acid, bromodichloroacetic acid, dibromochloroaetic acid and tribromoacetic acid.**
			Iron	μg/L	200	
			Lead	μg/L	10 **(5)** [9]	**The value shall be met, at the latest, by [10 years after the entry into force of this Directive]. The parametric value for chromium until that date is 10 μg/l**
			Legionella	**n°/L**	**<1000**	**In case the parametric value <1000/l is not met for Legionella, resampling for Legionella pneumophila shall be done. If Legionella pneumophila is not present, the parametic value for Legionella is <10 000/l**
			Manganese	μg/L	50	
			Mercury	μg/L	1	
			Microcystin-LR	**μg/L**	**1**	
			Nickel	μg/L	20	
			Nitrate	mg/L	50	
			Nitrite	mg/L	0,5	
			Nonylphenol	**μg/L**	**0.3** [8]	
			Oxidisability	mgO_2/L	5	Reference method: EN ISO 8467
			Pesticides	μg/L	0,1	Given as an indication. Uncertainty of measurement ≤ 30 % for several pesticides, ≤ 80 % for many
			PFAS	**μg/L**	**0.1** [10]	**PFAS' means each individual per- and polyfluoroalkyl substance (chemical formula: C_nF_{2n+1}–R).**
			PFASs-TOT	**μg/L**	**0.5** [10]	**PFASs Total' means the sum of per- and polyfluoroalkyl substances (chemical formula: C_nF_{2n+1}–R).**
			Polycyclic aromatic hydrocarbons (PAHs)	μg/L	0,1	The performance characteristics apply to individual substances, specified at 25 % of the parametric value in Part B of Annex I.
			Selenium	μg/L	10 **(40)**	
			Sodium	mg/L	200	
			Sulphate	mg/L	250	
			Tetrachloroethene	μg/L	10	The performance characteristics apply to individual substances, specified at 50 % of the parametric value in Part B of Annex I.
			Trichloroethene	μg/L		The performance characteristics apply to individual substances, specified at 50 % of the parametric value in Part B of Annex I.

			Trihalomethanes—TOT	μg/L	100	The performance characteristics apply to individual substances, specified at 25 % of the parametric value in Part B of Annex I.
			Tritium	Bq/L	100	
			TOC	mg/L	No abnormal change	
			Total indicative dose	mSv/year	0,1	
			Turbidity	-	-	
			Uranium	**μg/L**	**30**	
			Vinyl chloride	**μg/L**	**0,5**	

Table 9.11 Drinking Water sampling and methods (colours represent the specific directive/regulation; Grey cells represent parameters no longer applied to water put into bottles or containers intended for sale; Light grey cells represent parameters removed from Next 2018 Proposal)

Council Directive (EU) 83/1998 EC (Implementation of 2018 Proposal), WHO Guidelines	**Commission Directive (EU) 2015/1787 (Implementation of 2018 Proposal)**											**Notes**
					Frequency of sampling[1] (m^3)					**Sampling for compliance[7]**		[1] Based on Volume of water distributed or produced each day within a supply zone
	Trueness % of the param. value	**Precision % of the param. value**	**Limit of detection % of the param. value**	**Uncertainty of measurement % of the param. value**	x ≤ 100	100 < x ≤ 1000	1000 < x ≤ 10000	10000 < x ≤ 100000	x>100000	**Origin of supply**	**Points of analysis**	[1]Additional monitoring is carried out on a case-by-case basis of substances and micro-organisms for which no parametric value has been set in accordance with Art. 5
E. coli	0	-	-	-	> 0[2] (10[a])	4 (10[a])	4 + 3[3] (50[b])	4 + 3[3] (365)	4 + 3[3] (365)	Distribution network	out from the taps	
Enterococci	0	-	-	-								No longer applies to water put into bottles or containers intended for sale
Coliform bacteria	-	-	-	-								Removed from Next 2018 Proposal
Somatic coliphagens	-	-	-	-								Acc.&N.A.C. = Acceptable to consumers and no abnormal change
Pseudomonas aeruginosa	0	-	-	-								[2] Member States that have decided to exempt individual supplies under Art.3(2)(b) of this Directive shall apply these frequencies only for supply zones that distribute between 10 and 100 m^3 per day.

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Colony at 22°C	100	-	-	-								[3] For each 1000 m^3/d and part thereof of the total volume
Colony at 36°C	20	-	-	-								[4] For each 4500 m^3/d and part thereof of the total volume
Colour	Acc.&N.A.C.	-	-	-								[5] For each 10000 m^3/d and part thereof of the total volume
Turbidity****	Acc.&N.A.C.	-	-	-								[6] For each 25000 m^3/d and part thereof of the total volume
Taste	Acc.&N.A.C.	-	-	-								[7]Random daytime sample of 1 litre volume
Odour	Acc.&N.A.C.	-	-	-								[8]Proposed by the WHO
pH	6.5≤ x ≤ 9.5	-	-	-								[9]Proposed by the European Commission
Conductivity	2500	-	-	-								[10]Proposed by the European Parliament and of the Council
Nitrite*	0.5	-	-	-								*if chloramination is used
Ammonium*	0.5	-	-	-								*if chloramination is used
Iron**	200	-	-	-								**if chemicals treatment is used
Aluminium**	200	-	-	-						Tanker	out from the tanker	**if chemicals treatment is used
Other parameters***	-	-	-	-	> 0[2] (10[a])	1 (10[a])	1+1[4] (50[b])	3+1[5] (365)	12+1[6] (365)			***all other parameters not analysed under Group A and set in accordance with Art. 5 **<u>A Member State shall set values for additional parameters not included in Annex I</u>** where the protection of human health within its national territory or part of it so requires. The values set should, as a minimum, satisfy the requirements of Article 4(1)(a)
Acrylamide	-	-	-	30	(10[a])	(10[a])	(50[b])	365	365			
Aluminium	10	10	10	40								**a: all samples are to be taken during times when the risk of treatment breakthrough of enteric pathogens is high.**
Ammonium	10	10	10	40								**b: at least 10 samples are to be taken during times when the risk of treatment breakthrough of enteric pathogens is high.**

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Antimony	25	25	25	30	(10[a])	(10[a])	(50[b])	365	365			****For sampling: 0.3 NTU (95%) and not >0.5 NTU for 15 consecutive minutes
Arsenic	10	10	10	50	(10[a])	(10[a])	(50[b])	365	365			
Benzo(a)pyrene	25	25	25	40	(10[a])	(10[a])	(50[b])	365	365			If uncertainty cannot be met, the best available technique should be selected (up to 60 %).
Benzene	25	25	25	25	(10[a])	(10[a])	(50[b])	365	365			
Beta-estradiol				**50**	(10[a])	(10[a])	(50[b])	365	365			
Bisphenol A				**50**	(10[a])	(10[a])	(50[b])	365	365			
Boron	10	10	10	40	(10[a])	(10[a])	(50[b])	365	365			
Bromate	25	25	25	25	(10[a])	(10[a])	(50[b])	365	365			
Cadmium	10	10	10	15								
Chloride	10	10	10	30	(10[a])	(10[a])	(50[b])	365	365			
Chlorate	-	-	-	**30**	(10[a])	(10[a])	(50[b])	365	365			
Chlorite	-	-	-	**30**	(10[a])	(10[a])	(50[b])	365	365			
Chromium	10	10	10	20	(10[a])	(10[a])	(50[b])	365	365			**The value shall be met, at the latest, by [10 years after the entry into force of this Directive]. The parametric value for chromium until that date is 50 μg/l**
Clostridium perfringens	-	-	-	-	(10[a])	(10[a])	(50[b])	365	365			
Conductivity	10	10	10	25								
Copper	10	10	10	30								
Cyanide	10	10	10	40	(10[a])	(10[a])	(50[b])	365	365			The method determines total cyanide in all forms.
1,2-dichloroethane	25	25	10	20	(10[a])	(10[a])	(50[b])	365	365	in food production	where it is used	
Epiclorohydrin	-	-	-	**30**	(10[a])	(10[a])	(50[b])	365	365			
Fluoride	10	10	10	0,2	(10[a])	(10[a])	(50[b])	365	365			
pH	0,2	0,2		30	(10[a])	(10[a])	(50[b])	365	365			Values for trueness, precision and uncertainty of measurement are expressed in pH units.
Haloacetic acids (HAAs)				**50**	(10[a])	(10[a])	(50[b])	365	365			**Sum of: monochloro-, dichloro-, and trichloro-acetic acid, mono- and dibromo-acetic acid, bromochloroacetic acid, bromodichloroacetic acid, dibromochloroaetic acid and tribromoacetic acid.**
Iron	10	10	10	25								

Lead	10	10	10	30	(10[a])	(10[a])	(50[b])	365	365			The value shall be met, at the latest, by [10 years after the entry into force of this Directive]. The parametric value for chromium until that date is 10 µg/L
Legionella					(10[a])	(10[a])	(50[b])	365	365			In case the parametric value <1000/l is not met for Legionella, resampling for Legionella pneumophila shall be done. If Legionella pneumophila is not present, the parametic value for Legionella is <10 000/L
Manganese	10	10	10	30								
Mercury	20	10	20	25	(10[a])	(10[a])	(50[b])	365	365			
Microcystin-LR				**30**	(10[a])	(10[a])	(50[b])	365	365			
Nickel	10	10	10	15	(10[a])	(10[a])	(50[b])	365	365			
Nitrate	10	10	10	20	(10[a])	(10[a])	(50[b])	365	365			
Nitrite	10	10	10	50	(10[a])	(10[a])	(50[b])	365	365			
Nonylphenol				**50**	(10[a])	(10[a])	(50[b])	365	365			
Oxidisability	25	25	10	30								Reference method: EN ISO 8467
Pesticides	25	25	25	50	(10[a])	(10[a])	(50[b])	365	365			Given as an indication. Uncertainty of measurement ≤ 30 % for several pesticides, ≤ 80 % for many
PFAS	-	-	-	**50**	(10[a])	(10[a])	(50[b])	365	365			PFAS' means each individual per- and polyfluoroalkyl substance (chemical formula: $C_nF_{2n+1}–R$).
PFASs-TOT	-	-	-	**30**	(10[a])	(10[a])	(50[b])	365	365	put in bottles/ container (spring water)	out from bottles/ ~~container~~	PFASs Total' means the sum of per- and polyfluoroalkyl substances (chemical formula: $C_nF_{2n+1}–R$).
Polycyclic aromatic hydrocarbons (PAHs)	25	25	25	40	(10[a])	(10[a])	(50[b])	365	365			The performance characteristics apply to individual substances, specified at 25 % of the parametric value in Part B of Annex I.
Selenium	10	10	10	15	(10[a])	(10[a])	(50[b])	365	365			
Sodium	10	10	10	15								
Sulphate	10	10	10	30								
Tetrachloroethene	25	25	10	40	(10[a])	(10[a])	(50[b])	365	365			The performance characteristics apply to individual substances,

												specified at 50 % of the parametric value in Part B of Annex I.
Trichloroethene	25	25	10	40	(10[a])	(10[a])	(50[b])	365	365			The performance characteristics apply to individual substances, specified at 50 % of the parametric value in Part B of Annex I.
Trihalomethanes—TOT	25	25	10	30	(10[a])	(10[a])	(50[b])	365	365			The performance characteristics apply to individual substances, specified at 25 % of the parametric value in Part B of Annex I.
Tritium	-	-	-	-								
TOC	-	-	-	-								
Total indicative dose	-	-	-	-								
Turbidity	25	25	25	30								
Uranium				**30**	**(10[a])**	**(10[a])**	**(50[b])**	**365**	**365**			
Vinyl chloride	**-**	**-**	**-**	**50**	**(10[a])**	**(10[a])**	**(50[b])**	**365**	**365**			

Table 9.12 Groundwater parameters (colours represent the specific directive/regulation)

EUROPEAN SCALE								
Water Framework Directive 2000/60/CE		**Council Directive 2006/118/EC (Commission Directive 2014/80/EU) + 91/271/EEC (JRC Report)**						**Notes**
Water source discharged into the aquifer	**Treatment for the purpose and control measure**	**Parameters**		**Units**	**Limits for compliance** **Parametric value**	**Density of monitoring sites**	**Monitoring frequency**	*Trend reversal shall take as its starting point a maximum of 75% of the quality standards set out in existing Community legislation, in the absence of criteria adopted at national level
Art. 11 (3) f: "...artificial recharge or augmentation of groundwater bodies. The water used may be derived from any surface water or groundwater, provided that the use of the		Quantitative Status	Groundwater level	Green/red	Good/Poor	sufficient density of monitoring points: - to assess the impact of abstractions and discharges on the groundwater level;	sufficient frequency of measurement: - to assess the impact of abstractions and discharges on the groundwater level; - to estimate the direction	
		Chemical Status	Conductivity	µS/cm				[1] Such injections shall not contain substances other than those resulting from the above operations.
			Concentrations of pollutants					
			Oxygen content					
			pH	-				
			Nitrate	mg/L	50			
			Ammonium	mg/L				
			Active substances in pesticides, including their relevant metabolites,	µg/L	0.1			[5] 'Pesticides' means plant protection products and biocidal products as defined in Article 2 of Directive 91/414/EEC and in Article 2 of Directive 98/8/EC, respectively.

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source does not compromise the achievement of the environmental objectives established for the source or the recharged or augmented body of groundwater.			degradation and reaction products. [5]			- estimate the direction and rate of groundwater flow across the Member State boundary.	and rate of groundwater flow across the Member State boundary	[6] 'Total' means the sum of all individual pesticides detected and quantified in the monitoring procedure, including their relevant metabolites, degradation and reaction products.
			Active substances in pesticides, including their relevant metabolites, degradation and reaction products_TOT [6]	μg/L	0.5			
			Arsenic	μg/L	Member States will establish threshold values for all pollutants and indicators which characterise bodies or groups of bodies of groundwater as being at risk of failing to achieve good groundwater chemical status. **			**pursuant to the characterisation performed in accordance with Article 5 of Directive 2000/60/EC
			Cadmium	μg/L				
			Lead	μg/L				
			Mercury	μg/L				[7] With regard to saline concentrations resulting from human activities, Member States may decide to establish threshold values either for sulphate and chloride or for conductivity.
			Chloride	mg/L				[2] Which for natural reasons are permanently unsuitable for other purposes.
			Sulphate	μg/L				
			Man-made synthetic substances	μg/L				[3] Where there is an overriding need for security of gas supply, and where the injection is such as to prevent any present or future danger of deterioration in the quality of any receiving groundwater.
			Thricloroethylene	μg/L				
			Tetrachloroethylene	μg/L				
			Parameters indicative of saline or other intrusions [7]					[4] Limited to the amount strictly necessary for the purposes concerned. Provided such discharges do not compromise the achievement of the environmental objectives established for that body of groundwater.
			Nitrite	mg/L				
			Phosphorus_TOT/ Phosphate [8]	mg/L				**[8] Member States may decide to establish threshold values either for phosphorus (total) or for phosphates.'**
Reclaimed water[9]: by means of	For discharges from urban WWTP subject	Concentration	**BOD5 at 20°C without nitrification[10]**	mgO_2/L	25			[9] Defined as domestic wastewater or the mixture of domestic wastewater with industrial wastewater and/or run-off rain water, Art.2.

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surface spreading and direct injection.	to Art. 4 and 5.		**COD**	mgO_2/L	125			
			TSS	mg/L	35* 35 under Art. 4(2) (more than 10000 p.e.) 60 under Art. 4(2) (2000 - 10000 p.e.)			[10]The parameter can be replaced by another parameter: total organic carbon (TOC) or total oxygen demand (TOD) if a relationship can be established between BODS and the substitute parameter. *This requirement is optional.
		Minimum % of reduction	**BOD_5 at 20°C without nitrification**	%	70 - 90 40 under Art. 4(2)			
			COD	%	75			
			TSS	%	90 90 under Art. 4(2) (more than 10000 p.e.) 70 under Art. 4(2) (2000 - 10000 p.e.)			
	For discharges from urban WWTP to sensitive areas which are subject to eutrophication as found in Annex II.A (a)[11].	Concentration	**N_{tot}**	mg/L	15 (10000 - 100000 p.e.) 10 (more than 100000 p.e.)**			[11]One or both parameters may be applied depending on the local situation.
			P_{tot}	mg/L	2 (10000 - 100000 p.e.) 1 (more than 100000 p.e.)			**Alternatively, the daily average must not exceed 20 mgN/l.
		Minimum % of reduction	**N_{tot}**	%	70 - 80			
			P_{tot}	%	80			

Table 9.13 Food grade Salt quality Parameters

EUROPEAN SCALE		
CODEX STANDARD FOR FOOD GRADE SALT, CXSTAN 150-1985		
Parameters	**Units**	**Values**
Minimum NaCl content	%	97
Arsenic	mg/kg	0.5
Copper	mg/kg	2
Lead	mg/kg	2
Cadmium	mg/kg	0.5
Mercury	mg/kg	0.1

Table 9.14 ISO/TC 282 Parameters of water for irrigation

ISO 16075 - Guidelines for treated wastewater use for irrigation projects - Part 2: Development of the project										
Minimum reclaimed water quality class	**Potential uses without barriers**	**Indicative technology target**	**Parameters**	**Units**	**Average Limit**	**Maximum Limit**	**Reference Method**	**Number of barriers for irrigation**	**Sprinkler irrigation systems (generate aerosol)**	**Notes**
A (very high quality treated wastewater*)	Unrestricted urban irrigation**** and agricultural irrigation of food crops consumed raw	Secondary treatment[a], contact filtration or membrane filtration[b], and disinfection[c]	Thermo-tolerant coliforms*	no. /100 mL	(95%ile) ≤10 or below detection limit	100	95 %ile	no needed	no restrictions	**Residual chlorine dosage between 0.2 mg/L and 1 mg/L (30 minutes contact time) can be necessary*
			BOD_5 (determined with 5 days test)	mgO_2/L	≤5	10				***Continuous measurement of the turbidity can be implemented. The average value should be based on a 24-time period. If suspended solids are used in lieu of turbidity, the average TSS should not exceed 5 mg/L. If membrane filtration is used for treatment, the turbidity should not exceed 0,2 NTU.*
			TSS	mg/L	≤5	10				
			Turbidity**	NTU	≤2	5				
			Intestinal nematodes (helminth eggs)***,****	egg/L	-	-				****Intestinal nematodes (helminth eggs) might not be routinely monitored if it was demonstrated that the number of helminth eggs in untreated wastewater is consistently below 10 eggs/L.;****If there is a risk of aerosolization, the Legionella spp should be less than 1 000 CFU/L for Greenhouses.*
B (high quality treated water*)	Restricted urban irrigation and agricultural irrigation of processed food crops	Secondary treatment[a], filtration[b], and disinfection[c]	Thermo-tolerant coliforms*	no./100 mL	(95%ile) ≤200	1000	95 %ile	-1 for irrigation of private gardens and gardens landscape with unrestricted public access -1 for irrigation of vegetables consumed raw	-Radius of throw <10 m: requires a maximum operating pressure ≤3.5 bar and a distance between wetted area and area to be protected of 5 m (with screen) and of 20 m (without screen)	*Residual chlorine dosage between 0.2 mg/L and 1 mg/L (30 minutes contact time) can be necessary*
			BOD_5 (determined with 5 days test)	mgO_2/L	≤10	20				*[a]Secondary treatment includes activated sludge, trickling filters, rotating biological contactors, biofilters, bioreactors, sequence batch reactors, etc.*

			TSS	mg/L	≤10	25			-Radius of throw 10 m to 20 m: requires a maximum operating pressure ≤4.0 bar and a distance between wetted area and area to be protected of 10 m (with screen) and of 30 m (without screen) -Radius of throw >20 m: requires a maximum operating pressure ≤5.5 bar and a distance between wetted area and area to be protected of 10 m (with screen) and of 40 m (without screen)	*[b]Filtration includes microscreening, cartridge filtration, high rate sand filtration, dual media filtration, cloth filters, and disc filters without or with chemical addition (contact filtration) as well as membrane processes including membrane bioreactors.*
			Turbidity**	NTU	-	-				*[c]Disinfection includes UV irradiation, ozonation, chlorination, or other chemical, physic chemical, or membrane processes.*
			Intestinal nematodes (helminth eggs)***,***	egg/L	-	-				*[d]High rate clarification includes coagulation, flocculation, and lamella settling.*
C (good quality treated wastewater)	Agricultural irrigation of non-food crops	Secondary treatment[a] and disinfection[c]	Thermo-tolerant coliforms	no./100 mL	(95%ile) ≤1000	10000		-forbidden for irrigation of private gardens and gardens landscape with unrestricted public access -1 for irrigation of gardens and landscape with restricted public access -3 for irrigation of vegetables consumed raw -2 for irrigation of vegetables after processing and pastures -1 for irrigation of food crops other than vegetables (orchards, vineyards) and horticulture	-Radius of throw <10 m: requires a maximum operating pressure ≤3.5 bar and a distance between wetted area and area to be protected of 10 m (with screen) and of 40 m (without screen) -Radius of throw 10 m to 20 m: requires a maximum operating pressure ≤4.0 bar and a distance between wetted area and area to be protected of 15 m (with screen) and of 50 m (without screen) -Radius of throw >20 m: requires a maximum operating pressure ≤5.5 bar and a distance between wetted area and area to be protected	*[e]Well-designed stabilization pond systems can meet coliform limits without additional disinfection. The soluble BOD values are considered.*
			BOD_5	mgO_2/L	≤20	35				
			TSS	mg/L	≤30	50				
			Turbidity	NTU	-	-				
			Intestinal nematodes (helminth eggs)	egg/L	≤1	-				

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									of 20 m (with screen) and of 60 m (without screen)	
D (medium quality treated wastewater)	Restricted irrigation of industrial and seeded crops	Secondary treatment[a] or high rate clarification with coagulation, flocculation[d]	Thermo-tolerant coliforms	no./100 mL	-	-		-forbidden for irrigation of private gardens and gardens landscape with unrestricted public access -2 for irrigation of gardens and landscape with restricted public access -forbidden for irrigation of vegetables consumed raw -forbidden for irrigation of vegetables after processing and pastures -3 for irrigation of food crops other than vegetables (orchards, vineyards) and horticulture -1 for irrigation of fodder and seeded crops	-Radius of throw <10 m: requires a maximum operating pressure ≤3.5 bar and a distance between wetted area and area to be protected of 20 m (with screen) and of 50 m (without screen) -Radius of throw 10 m to 20 m: requires a maximum operating pressure ≤4.0 bar and a distance between wetted area and area to be protected of 30 m (with screen) and of 60 m (without screen) -Radius of throw >20 m: requires a maximum operating pressure ≤5.5 bar and a distance between wetted area and area to be protected of 40 m (with screen) and of 70 m (without screen)	
			BOD_5	mgO_2/L	≤60	100				
			TSS	mg/L	≤90	140				
			Turbidity	NTU	-	-				
			Intestinal nematodes (helminth eggs)	egg/L	≤1	5				
E (extensively treated wastewater)	Restricted irrigation of industrial and seeded crops	Stabilization ponds and wetlands[e]	Thermo-tolerant coliforms	no./100 mL	-	-		-forbidden for irrigation of private gardens and gardens landscape with unrestricted public access -2 for irrigation of gardens and landscape with restricted public	Same requirements of D Group	
			BOD_5	mgO_2/L	≤20	35				
			TSS	mg/L	-	-				
			Turbidity	NTU	-	-				
			Intestinal nematodes (helminth eggs)	egg/L	≤1	5				

								access -forbidden for irrigation of vegetables consumed raw and for irrigation of vegetables after processing and pastures -3 for irrigation of food crops other than vegetables (orchards, vineyards) and horticulture -1 for irrigation of fodder and seeded crops		

Table 9.15 ISO/TC 282 Barriers that can be used for crops that can be irrigated with the treated wastewater

Suggested types and accredited number of barriers (adapted from wHO 2006 and USEPA 2012)				
Type of barrier	**Application**	**Pathogen reduction (log units)**	**Number of barriers**	**Notes**
Irrigation of food crops				
Drip irrigation	Drip irrigation of low-growing crops such as 25 cm or more above from the ground	2	1	
	Drip irrigation of low-growing crops such as 50 cm or more above from the ground	4	2	
	Subsurface drip irrigation where water does not ascend by capillary action to the ground surface	6	3	
Spray and sprinkler irrigation	Sprinkler and micro-sprinkler irrigation of low-growing crops such as 25 cm or more from the water jet	2	1	
	Sprinkler and micro-sprinkler irrigation of low-growing crops such as 50 cm or more from the water jet	4	2	
Additional disinfection in field	Low level disinfection	2	1	
	High level disinfection	4	2	
Sun resistant cover sheet	In drip irrigation, where the sheet separates the irrigation from the vegetables	2 to 4	1	

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Pathogens die-off	Die-off support through irrigation cessation or interruption before harvest	0.5 to 2 per day	1 to 2	According to crops and weather conditions
Produce washing before selling to the customers	Washing salad crops, vegetables, and fruits with drinking water	1	1	
Produce disinfection before selling to the customers	Washing salad crops, vegetables, and fruits with a weak disinfectant solution and rinsing with drinking water	2	1	
Produce peeling	Peeling of fruits and root crops	2	1	
Produce cooking	Immersion in boiling water or under high temperature until the product is cooked	6 to 7	3	
Irrigation of fodder and seeded crops				
Access control	Restricting entry into the irrigated field for 24 h and more after irrigation, for example, animal entering in pastures or entering of field workers	0.5 to 2	1	
	Restricting entry into the irrigated field five days and more after irrigation	2 to 4	2	
Irrigation of public gardens				
Access control	Irrigation by night when the public does not enter the irrigated parks, sport fields, and gardens	0.5 to 1	1	
Spray irrigation control	Spray irrigation at distances greater than 70 m from residential areas or places of public access	1	1	

Table 9.16 ISO/TC 282 example of calculation of the barriers

Examples of how to calculate the number and type of barriers													
Number of Required Barriers						Type of barrier (and number of barriers that can be attributed)							
Very high quality TWW (A)	High quality TWW (B)	Good quality TWW (D)	Medium quality TWW (D)	Extensively treated wastewater (E)	Example crops	TWW additional disinfection in field*		Distance from drip irrigation system using TWW**	Sun resistant cover sheet	Subsurface drip irrigation system	Inedible skin	Requires cooking	Prolonged air drying****
0	1	3	***	***	Food crops ingested raw, which grow above ground and edible portion is <25cm above soil surface (pepper, tomato, cucumber, zucchini, young beans)	1-2			1	3			
0	1	3	***	***	Food crops ingested raw, which grow above ground and edible portion is >25cm above soil surface (baby corn)	1-2	2		1	3	1		

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0	1	3	***	***	Leafy vegetables grown on the soil surface eaten raw (lettuce, spinach, Asian cabbages, cabbage, celery)	1-2		1	3			
0	1	3	***	***	Food crops that can be ingested raw, which grow in the soil (carrot, radish, onion)	1-2						
0	0	2	***	2	Food crops grown above ground where edible portion is <25cm above soil surface, eaten cooked or processed (eggplant, pumpkin, green beans, artichoke)	1-2		1	3	1	3	
0	0	2	***	2	Food crops eaten cooked, which grow in the soil (potato	1-2					3	
0	0	2	***	2	Food crops which grow in the soil than can be eaten after peeling (peanut)	1-2				1		1-2
0	0	2	***	2	Food crops grown above ground that can be eaten after drying and cooking (dry beans, lentils)	1-2				1	3	1-2
0	0	2	***	2	Food crops grown on the soil that can be eaten raw after peeling (watermelon, melon, pea)	1-2		1	3	1		
0	1	3	***	2	Food crops grown above ground where edible portion is >25cm above soil surface, eaten cooked or processed (corn)	1-2	2	1	3	1		
0	1	0	1	0	Seeded crops (cereals) eaten dried and cocked (wheat, oats, barley, rice)	1-2	1			1	3	1-2
0	0	1	3	2	Orchards for fruits with edible skin (apple, plum, pear, peach, apricot, persimmon, cherry, citrus fruits, dates)	1-2	2		3	1		
0	0	1	3	2	Orchards for fruits eaten after peeling (mango, avocado, papaya, pomegranate)	1-2	2	1	3	1		
0	0	1	3	2	Orchards for fruits eaten after processing (olives)	1-2	2	1	3		3	
0	0	1	3	2	Orchards for nuts (almonds, pistachios)	1-2	2		3	1		
0	0	1	3	2	Vineyards with trellising	1-2	1-2		3			
					Vineyards without trellising	1-2		1	3			

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0	0	1	3	2	Nurseries and horticulture	1-2	1	1	3	1		
NOTE 1 * Depending on the local conditions of storage and conveying, an additional disinfection system of TWW can be required for the irrigation of vegetables that must include constant control of residual chlorine, or other monitoring data. Low-level disinfection is considered as one barrier: high-level disinfection is considered as two barriers (see Table 2). NOTE 2 ** A distance of 50 cm of clean air between drip-irrigation and the vegetables and fruit is considered as two barriers. A distance of >25 cm of clean air between drip irrigation and the vegetables and fruit are considered as one barrier. When irrigation is by spraying, (or sprinklers under the canopy), the distance should be calculated from the height to which the sprayed effluents arises and is considered as only one barrier because of the aerosols in the air. NOTE 3 *** Effluents of medium quality and effluents of extensive TWW should not be used for the irrigation of vegetables. NOTE 4 **** According to crops and weather conditions.												

Table 9.17 ISO/TC 282 distance between irrigated borders and "protected" areas according to TWW quality considering wind speed of up to 4 m/s

		Sprinkler characteristics		**Distance between wetted area (a) and area to be protected(b)**	
		Radius of throw	**Maximum operating pressure (c)**	**With screen(d)**	**Without screen**
Very high quality TWW	A	No restrictions			
High quality TWW	B	Low radius: <10 m	≤3.5 bar	5 m	20 m
		Medium radius: 10 m to 20 m	≤4.0 bar	10 m	30 m
		Large radius: >20m	≤5.5 bar	10 m	40 m
Good quality TWW	C	Low radius: <10 m	≤3.5 bar	10 m	40 m
		Medium radius: 10 m to 20 m	≤4.0 bar	15 m	50 m
		Large radius: >20 m	≤5.5 bar	20 m	60 m
Medium quality and extensive TWW	D, E	Low radius: <10 m	≤3.5 bar	20 m	50 m
		Medium radius: 10 m to 20 m	≤4.0 bar	30 m	60 m
		Large radius: >20 m	≤5.5 bar	40 m	70 m
a) Area receiving water without wind. b) Residences, playgrounds, gardens, road, gardens open to the public (sport fields, etc.), and industrial buildings. c) It is recommended that the system will include device that prevent higher pressure than specified. d) Trees constituting a hedge or any other fixed or mobile screen (walls, wind breaking nets, etc.) which minimum height is jet maximum height					

Table 9.18 ISO/TC 282 guidelines for treated wastewater use for irrigation projects - Part 3: Components of a reuse project for irrigation

<table>
<tr><th>Types</th><th>Problems</th><th>Management strategies</th><th>Additional treatment facilities</th></tr>
<tr><td rowspan="6">Open tanks (reservoirs or ponds)</td><td>— Temperature stratification
— Low content of dissolved oxygen
— Release of odours</td><td>— Installation of aeration facilities
– submerged or surface mixers or recirculating pumps
— Maintaining elevated oxygen concentrations (positive redox) through the water column and mainly at the sediment water interface will prevent phosphorus from entering the water column and keep it in the sediment</td><td rowspan="6">Chlorine has a residual toxicity for fish so it's not possible to use it</td></tr>
<tr><td>— Sediments</td><td>— Periodic mechanical or hydraulic dredging of accumulated sediments (every one to five years)</td></tr>
<tr><td>— Excessive growth of algae and zooplankton
— Reduction of internal recycling of phosphorous</td><td>— Proper mixing of wastewater in order to improve the photo-oxidation of organic matter induced by the sunlight
— Addition of chemical algaecides. Copper sulphate should not be used due to the toxicity effects associated with copper accumulation (overdosing has adverse impacts on reservoir ecosystem)
— Maintenance of fish that eat algae and zooplankton Addition of chemical dyes to reduce sunlight penetration as well as the growth of algae.
— Biomanipulation of zooplankton (in shallow reservoirs)
— Ultrasonic emissions placed into the open reservoir</td></tr>
<tr><td>— High content of suspended solids</td><td>— Suspended solids removal depends on particle size and residence time so consideration should be given to these factors when designing the storage tanks</td></tr>
<tr><td>— Microorganisms regrowth</td><td>— Increase of disinfectant residual
— Decrease of residence time
— Improvement of storage quality and facilities
— Isolate and disinfect problematic sites in pipelines</td></tr>
<tr><td>— Increasing of insects namely mosquitoes</td><td>— Spraying of adequate insecticides
— Mechanical methods such as keeping the water moving
— Biological controls such as natural larvicides and use of larvae eating fish
— Keeping banks trimmed</td></tr>
<tr><td rowspan="3">Closed reservoirs (covered or underground)</td><td>— Wastewater stagnation</td><td>— Recirculation of wastewater (pumping and configuration of inlet and outlet piping promoting water recirculation)
— Maintaining elevated oxygen concentrations (positive redox) through the water column and especially at the sediment water interface will help prevent phosphorus from entering the water column and keep it locked in the sediment</td><td rowspan="3">Additional disinfection technologies may include oxidation materials to protect the irrigation system.</td></tr>
<tr><td>— Low content of dissolved oxygen
— Release of odours</td><td>— Aeration (aeration devices)</td></tr>
<tr><td>— Loss of disinfectant residual
— Regrowth of microorganisms</td><td>— Proper management of operational regime on the reservoirs</td></tr>
</table>

Table 9.19 ISO/TC 282 characteristics of filter types commonly used in pressurized irrigation systems

Filter type	Special Features	Pressure head losses
Strainer type filters Disc filters	— Irrigation systems with moderate level of suspended solids — Used in drip irrigation systems as back up of a media filter — Adequate to moderate level of filtration	Very low if screen or disks are clean
Granulated media filter (fine gravel or sand)	— Often used in drip systems	1,0 m to 1,20 m

Table 9.20 ISO/TC 282 irrigation systems and techniques used in common pressurized irrigation and gravity flow systems

Pressurized irrigation		Gravity flow irrigation
Using stationary sprinkler systems (Portable, semi portable, semi-permanent, solid set or permanent equipment)	Drip irrigation — Surface — Sub-surface	Border irrigation — Straight — Contour
Using stationary sprinkler systems (Portable, semi-portable, semi-permanent, solid set or permanent equipment)	Micro-spray irrigation	Check basin irrigation — Rectangular — Contour — Ring Furrow irrigation — Graded furrow — Corrugation

Table 9.21 ISO/TC 282 definitions of the suitability of water quality to the irrigation system according to clogging potential, pH, and redox potential

Water quality (a)	Parameter		
	Clogging potential – (1)[b]	pH (2)	Redox – (3)[c]
Good	Longer than 7 min	<7.2	Between 300 and 500
Medium	Between 3 min and 6 min	Between 7.2 and 8.0	Between 250 and between 500 and 600 300 and
Low	Shorter than 3 min	>8,0	<250 and >600
These levels are suitable f or water to maintain the irrigation system rather than f or irrigation water specified elsewhere in this guide. b The Clogging Potential Meter (CPM) tests using a 150 µm mesh. c The redox potential has been chosen as an index of the organic substances found in the water. A chlorine requirement test is not possible for continuous measurement since the instrument for such test is extremely costly and can be installed only in large irrigation systems. The redox has been chosen to be part of the monitor system as a default, although it is not an accurate index for organic material. It will be mentioned in the guide that if chlorination efficiency should be tested, a continuous chlorine meter will be used			

Country	Referenced guidelines and legislations
USA	• *Manual of septic tank practice*, U.S. Public Health Service, revised edition 1967. Available at https://nepis.epa.gov/Exe/ZyPDF.cgi/9101V1SI.PDF?Dockey=9101V1SI.PDF • For state specific guidelines see also https://www.epa.gov/septic/advanced-technology-onsite-treatment-wastewater-products-approved-state
Vietnam	• *Manual for septic tank design, installation and O&M* – Ministry of Health • Draft Design Code for Septic Tank Design and Construction — Ministry of Construction Both cited in http://www.susana.org/_resources/documents/default/2-1673-vietnam-fsm-study.pdf
The Philippines	• Revised National Plumbing Code of the Philippines. Available at http://www.itnphil.org.ph/docs/sanitation%20-%20wastewater%20-magtibay.pdf
Malaysia	• MS1228:1991 – Malaysian Standard Code of Practice for the Design and Installation of Sewerage Systems 1991. Available at https://kupdf.net/download/ms-1228-1991_58c77bccdc0d600452339028_pdf • *Malaysian Sewerage Industry Guidelines Vol.5: Septic tanks* (2008). Available at https://www.scribd.com/document/378170193/Malaysia-Sewerage-Industry-Guideline-Volume-5 • Malaysian Standard (MS) 2441-1:2012 - *On-site sewage treatment units, Part 1: Prefabricated septic tanks specifications*. Listed at https://www.jeces.or.jp/spread/pdf/02SPAN5ws.pdf
India	• IS 2470: 1985 Code of Practice for Installation of Septic Tanks—Construction of Sludge Containment Facilities. There are two parts to the code: (i) design criteria and construction and (ii) second secondary treatment and disposal of septic tank effluent. Available at http://www.indiawaterportal.org/articles/indian-standard-code-practice-installation-septic-tanks-2470-bureau-indian-standards-1986 • See also *Handbook on technical options for onsite sanitation* (2012) by the Ministry of Drinking Water and Sanitation. Available at http://mdm.nic.in/mdm_website/Files/WASH/handbook-on-_technical-options-for-on-site-sanitation-modws-2012_0.pdf
South Australia	• *Standard for the construction, installation and operation of septic tank systems in South Australia*. Available at https://www.lga.sa.gov.au/page.aspx?u=6640&c=59014
Canada	• The Ministry of Municipal Affairs and Housing is responsible for administering septic system approvals as outlined in the Building Code Act. See https://www.ontario.ca/laws/regulation/r12332
Ghana	• Ministry of Water Resources, Works and Housing; Community Water and Sanitation Agency. *Small towns sector guidelines (Design Guidelines)* Vol. III, 2010. Available at http://lgs.gov.gh/index.php/protocols/ (under CWSA's Operational Documents and Guidelines) • *Latrine technology manual* 2016 (UNICEF supported). Available at https://www.unicef.org/ghana/Latrine_technology_option_manual_final__a4_size.pdf
Sri Lanka	• SLS 745 part 1: 2004: Code of Practice for Design and Construction of Septic Tanks and Associated Effluent Disposal Systems. Part 1 — Small Systems Disposing to Ground • SLS 745 part 2: 2009: Code of Practice for the Design and Construction of Septic Tanks and Associated Effluent Disposal Systems. Part 2: Systems Disposing to Surface, Systems for Onsite Effluent Reuse and Larger Systems Disposing to Ground. Available at http://www.slsi.lk/index.php?lang=en (Search Standards with keyword Septic Tanks)

Category	Description	Method	Advantages	Disadvantages
Co-treatment at STP	Septage is added to a treatment plant for co-treatment. Septage volumes that can be accommodated depend on the plant capacity and types of processes employed	Sludge can be added to different stages of the treatment process including upstream sewer utility holes, plant head works, liquid stream and sludge handling processes	• Most plants are capable of handling moderate quantities of septage • Synergizes waste treatment operations	• Potential for plant dysfunction if input is not properly controlled • Increased residual handling and disposal requirements • As it is mixed with sewage sludge, likely unsafe for agricultural reuse
Treatment using own plant	• A facility is constructed solely for septage treatment • Treatments may generate residuals which need to be disposed of	Stabilization lagoon, composting, anaerobic digestion, lime stabilization, chlorine oxidation	• Provides a tailor-made solution to septage management • Allows resource recovery for agriculture or energy	Capital and O&M cost; additional compliance with regulatory requirements, compared to the option above
Land application (see Section 6)	• Septage is applied at secured sites away from the public • Stabilization to reduce odor, pathogens or vector attraction may be required, unless the FS has already been treated • Land application can be on surface soil or through injection into the soil	Surface application, subsurface application	• Simple, economical • Recycles organic material and nutrients to the land • If safety guidelines are followed, can be used as nutrient input in agriculture • Low energy demand	• Need for a holding facility during periods of frozen or saturated soil • Need for a relatively large land area, not visited by the public • Not possible where slopes are steep, and surface water or groundwater bodies can be affected

Source: USEPA (1994).

Figure 9.1 Faecal Sludge Reference and Treatment categories

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9.2. INSTITUTIONAL ANALYSIS SCHEMES

AUSTRIA

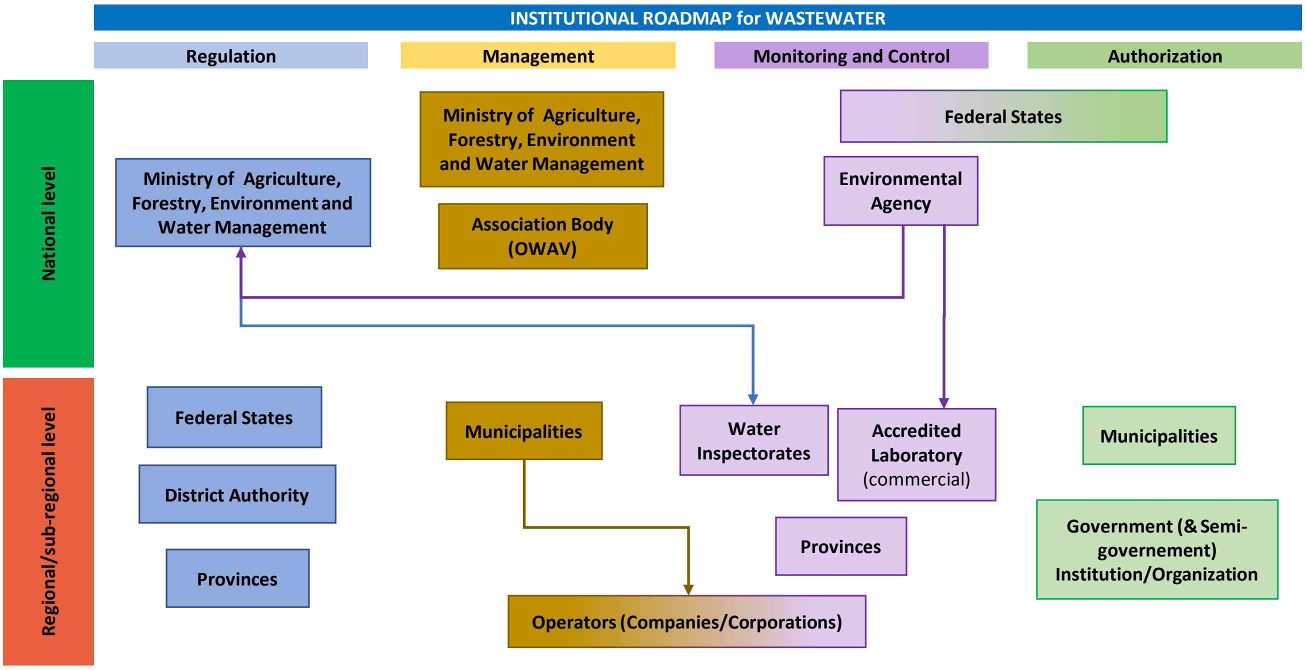

Figure 9.2 Austrian Institutional Structure for wastewater

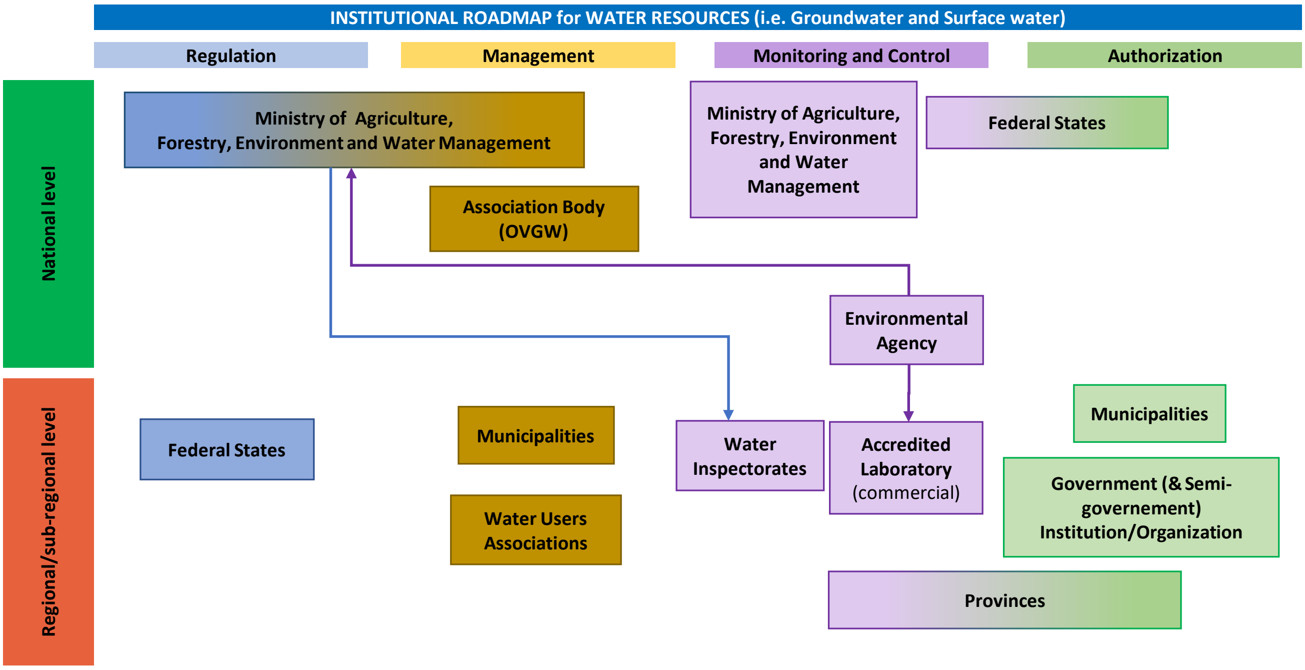

Figure 9.3 Austrian Institutional Structure for Water resources

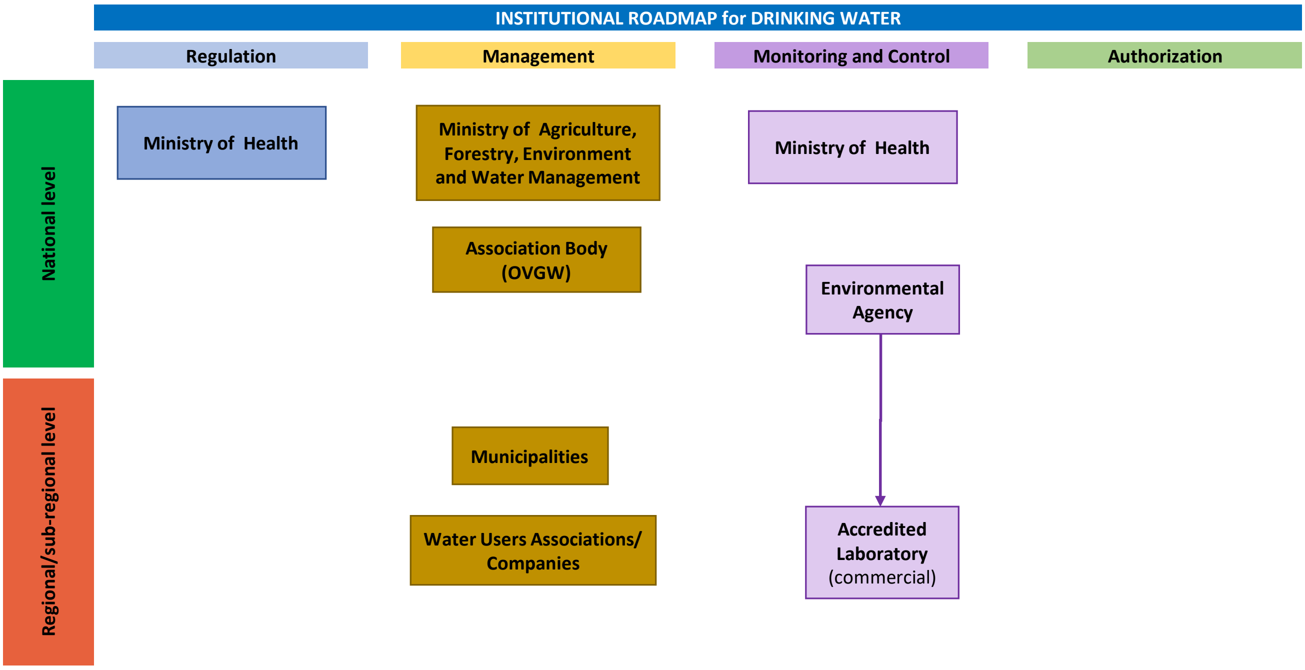

Figure 9.4 Austrian Institutional Structure for Drinking water

BELGIUM

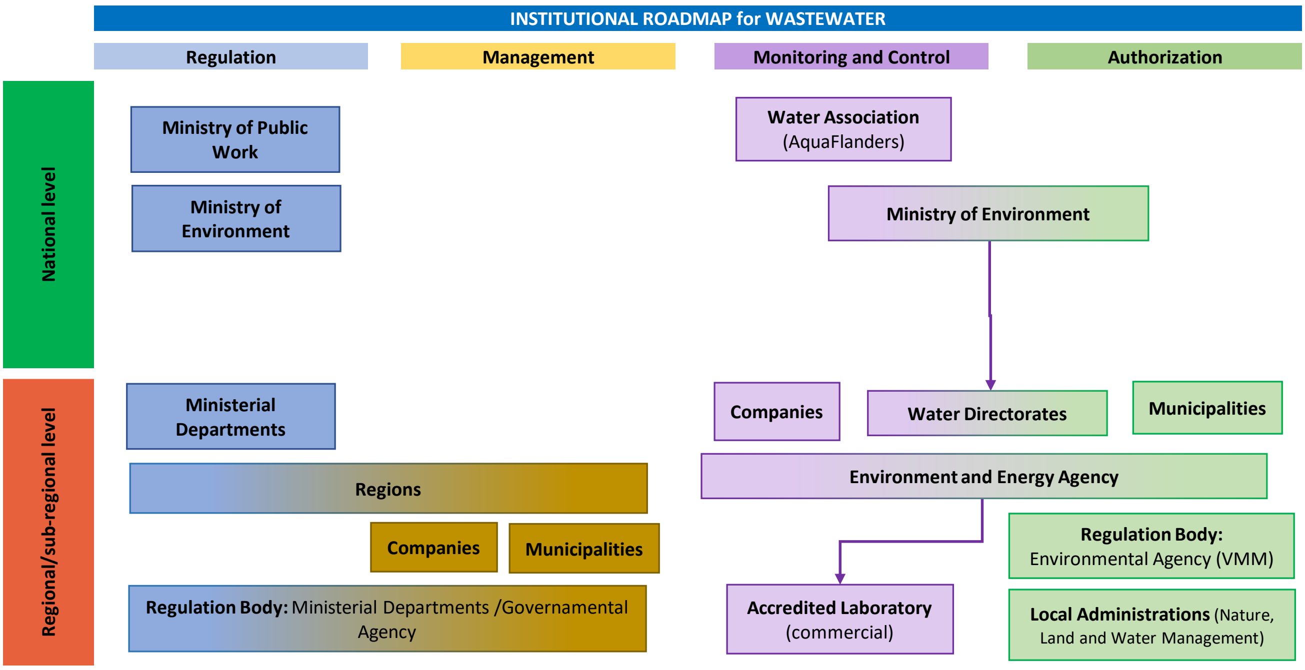

Figure 9.5 Belgian Institutional Structure for wastewater

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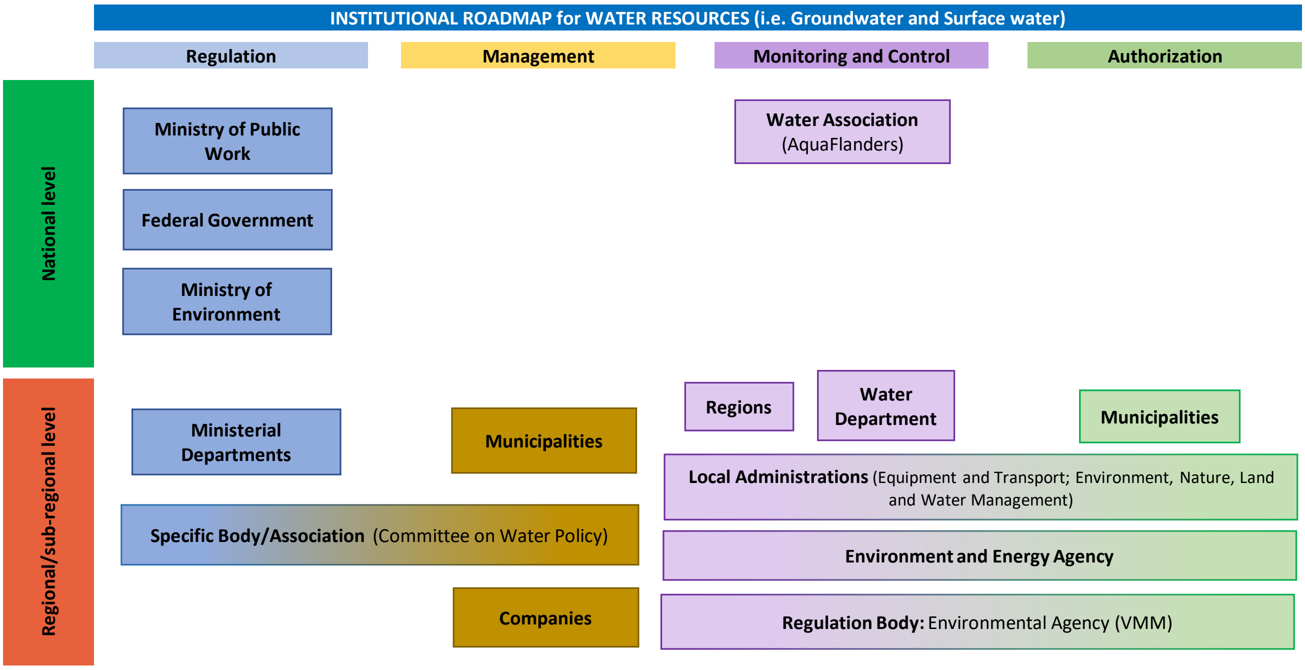

Figure 9.6 Belgian Institutional Structure for Water resources

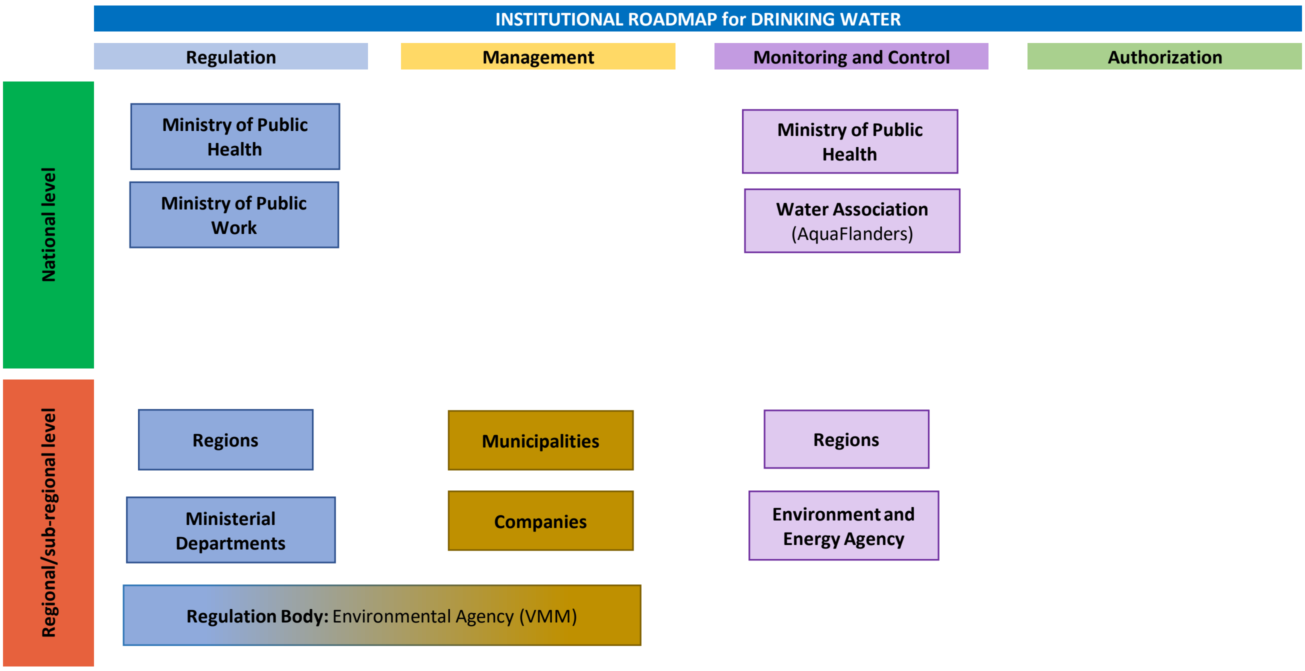

Figure 9.7 Belgian Institutional Structure for Drinking water

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BULGARIA

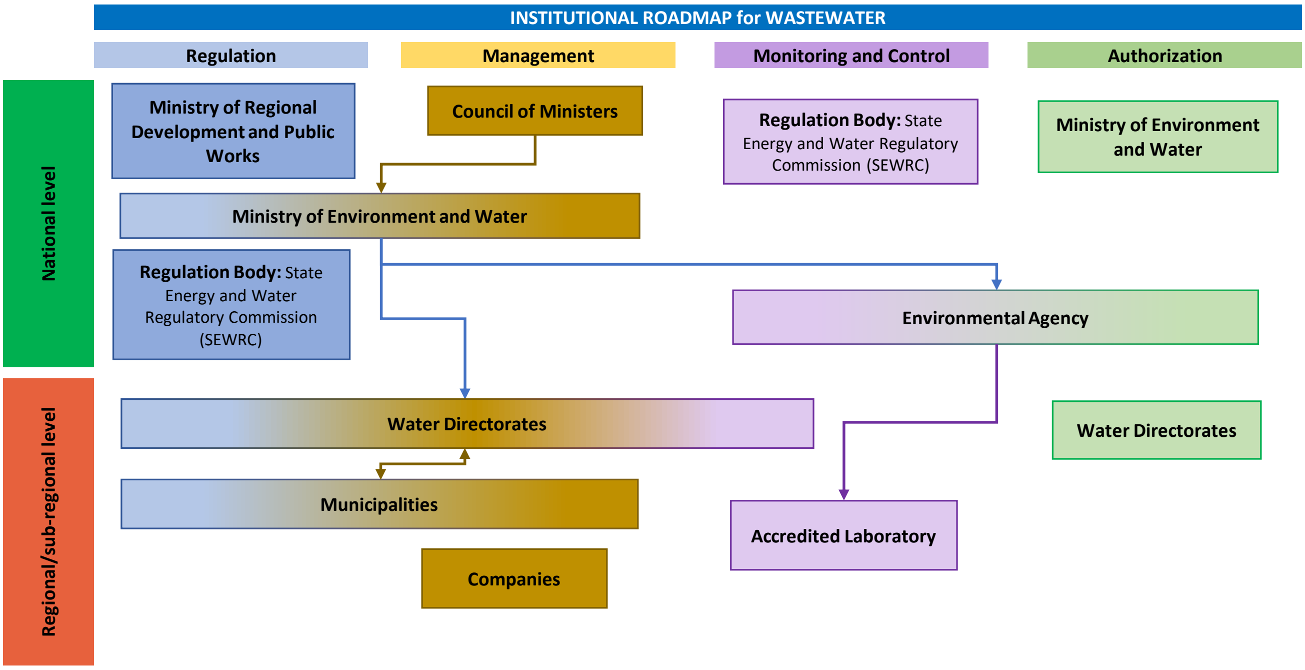

Figure 9.8 Bulgarian Institutional Structure for wastewater

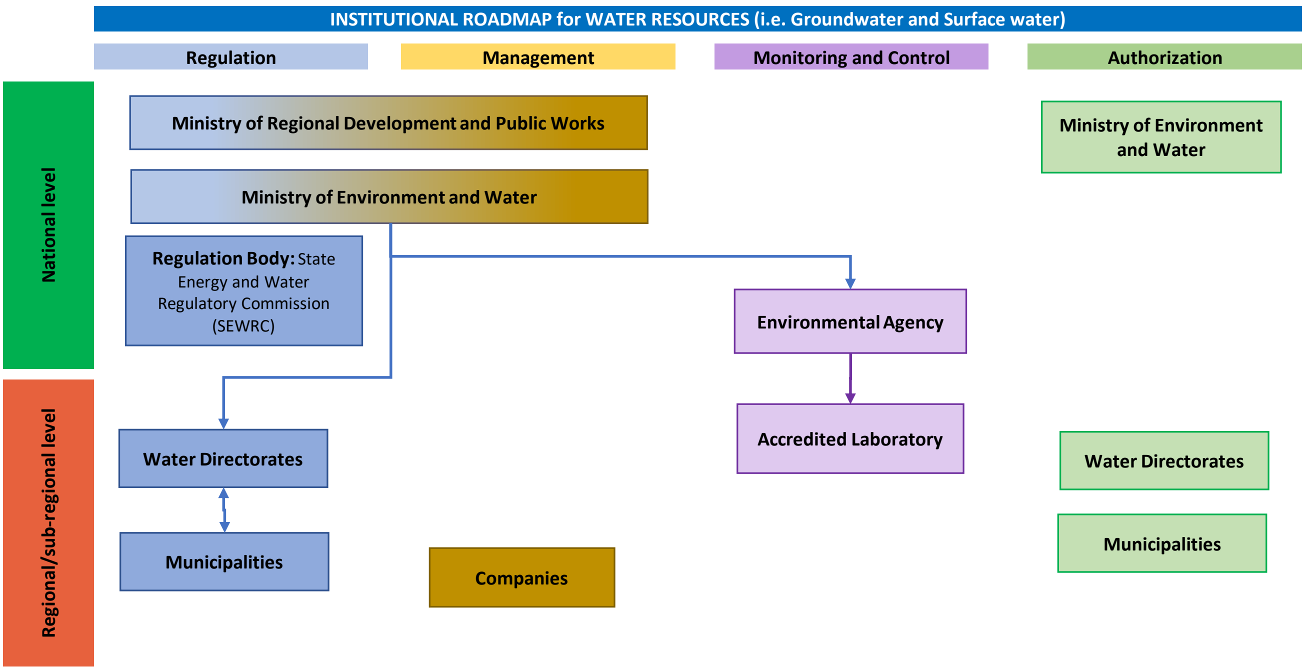

Figure 9.9 Bulgarian Institutional Structure for Water resources

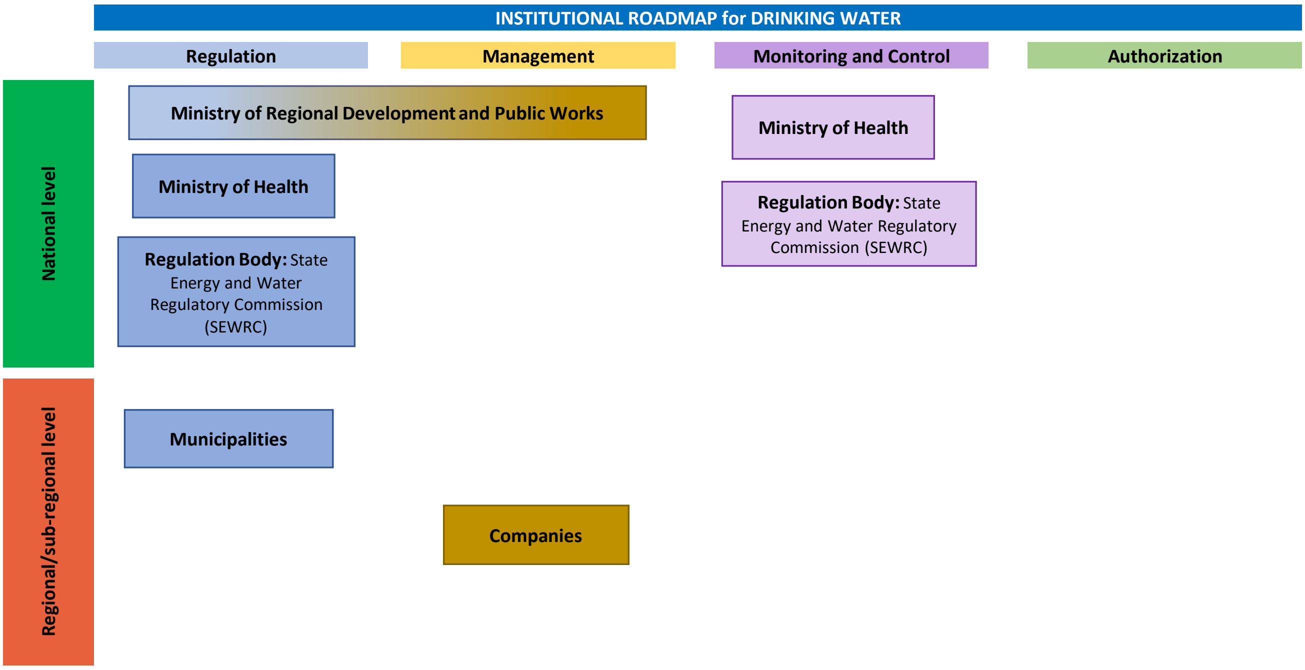

Figure 9.10 Bulgarian Institutional Structure for Drinking water

CROATIA

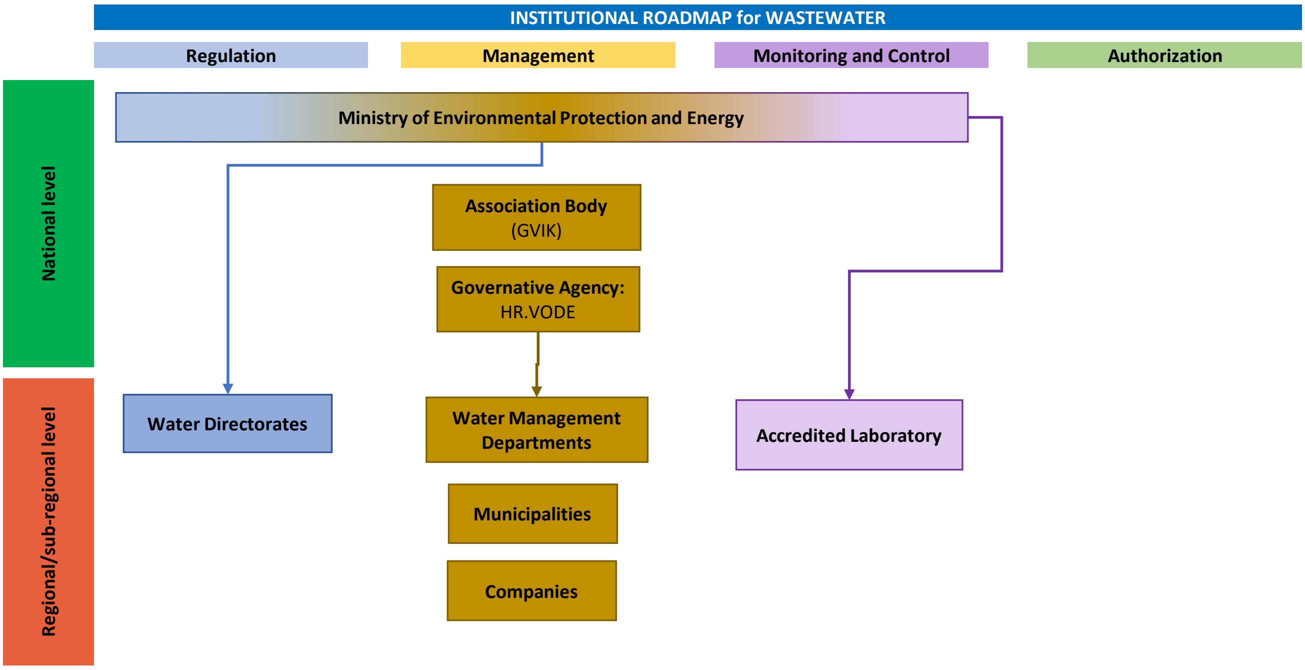

Figure 9.11 Croatian Institutional Structure for wastewater

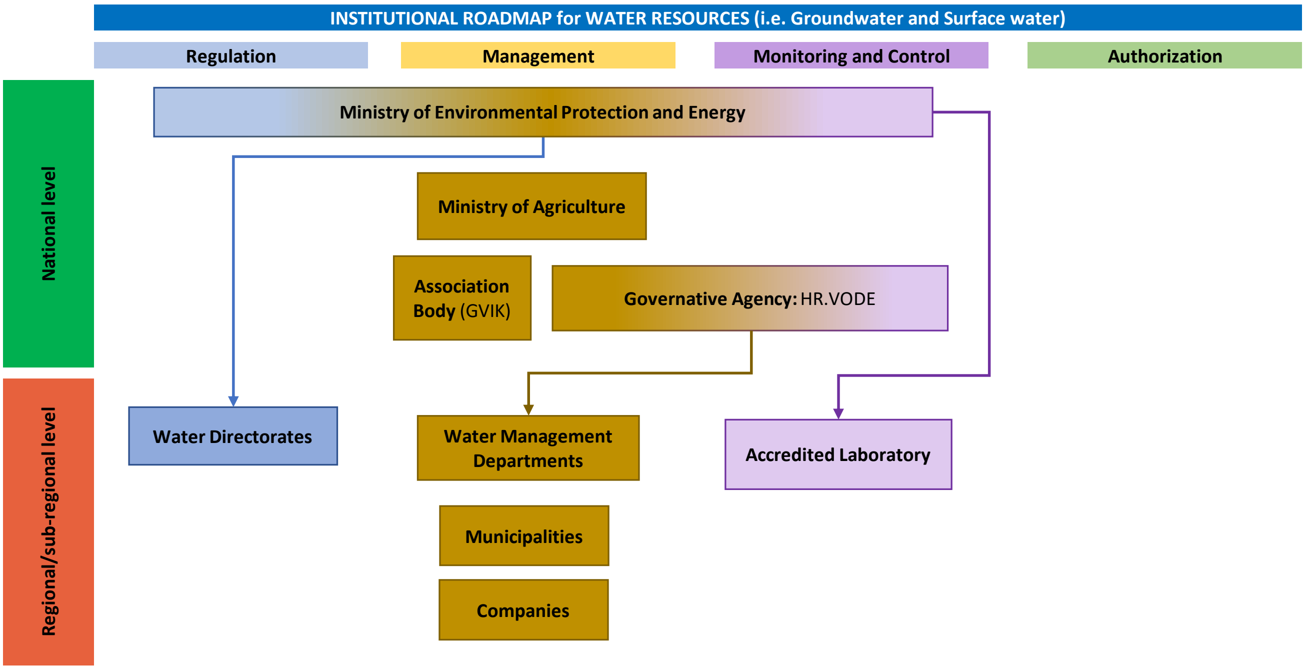

Figure 9.12 Croatian Institutional Structure for Water resources

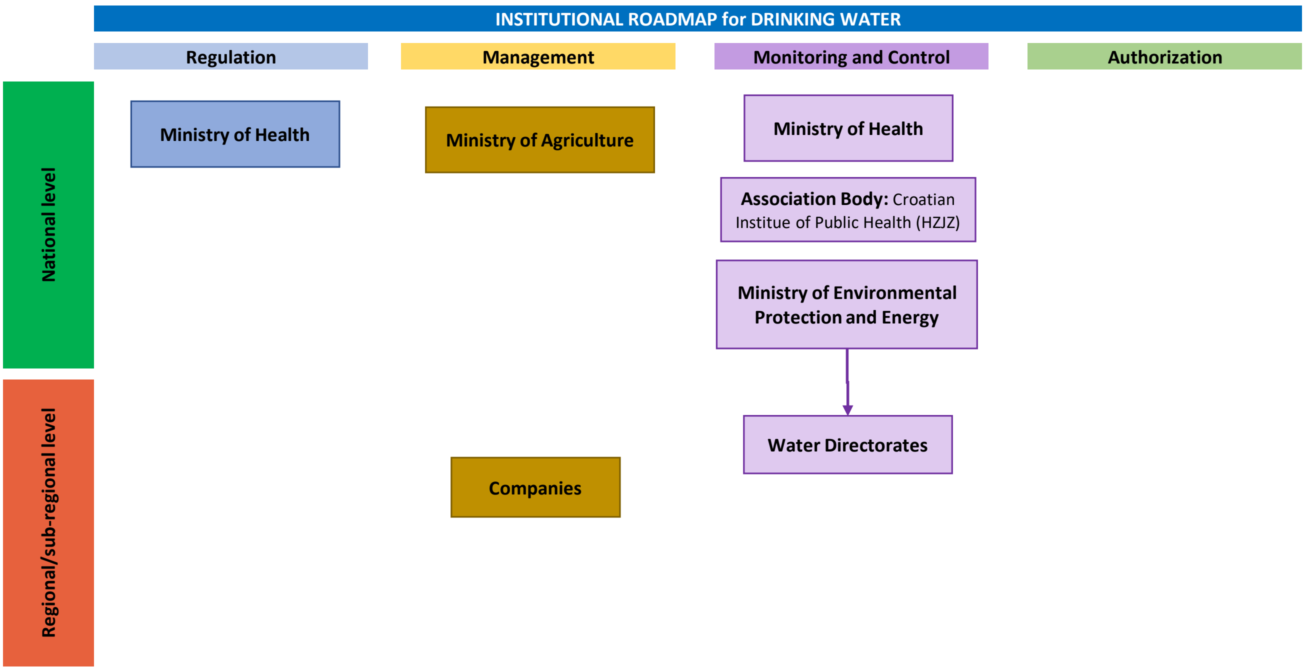

Figure 9.13 Croatian Institutional Structure for Drinking water

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CYPRUS

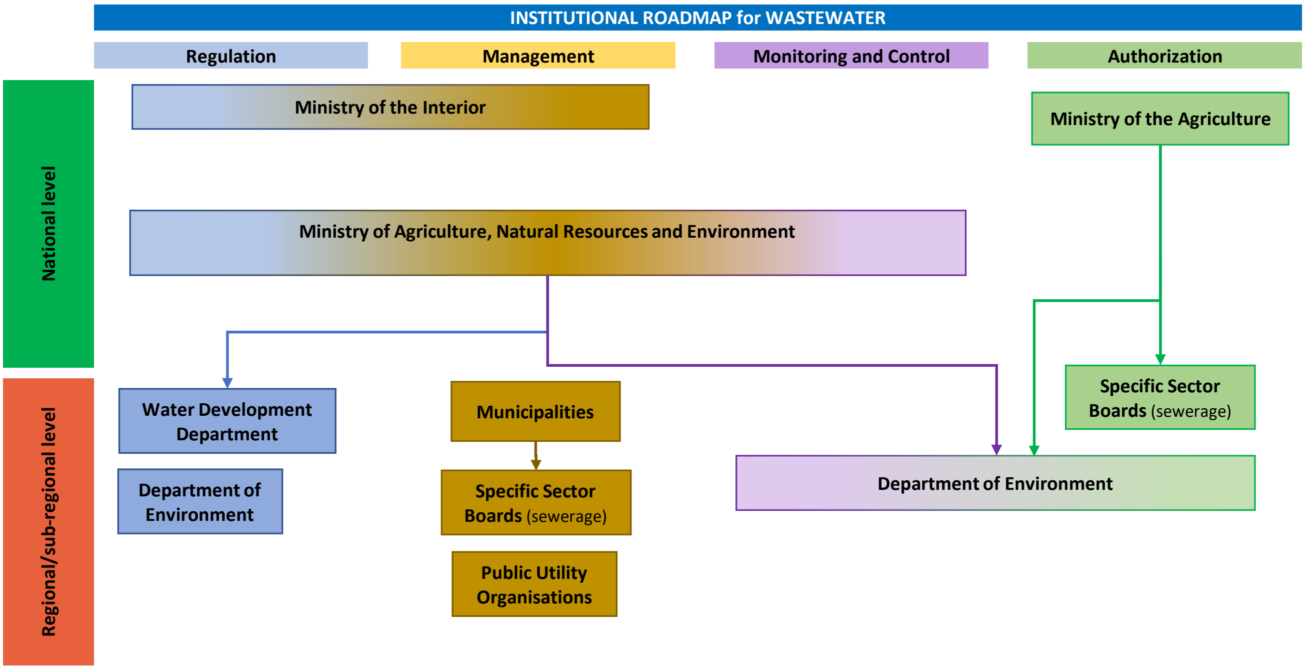

Figure 9.14 Cypriot Institutional Structure for wastewater

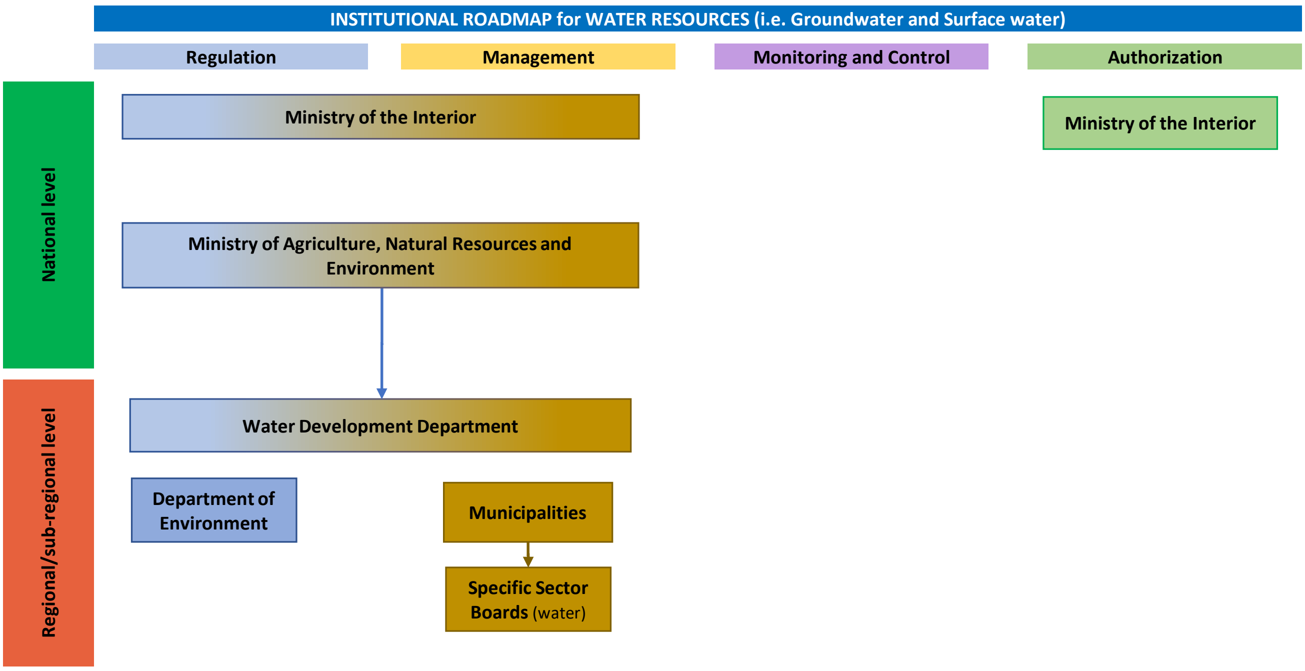

Figure 9.15 Cypriot Institutional Structure for Water resources

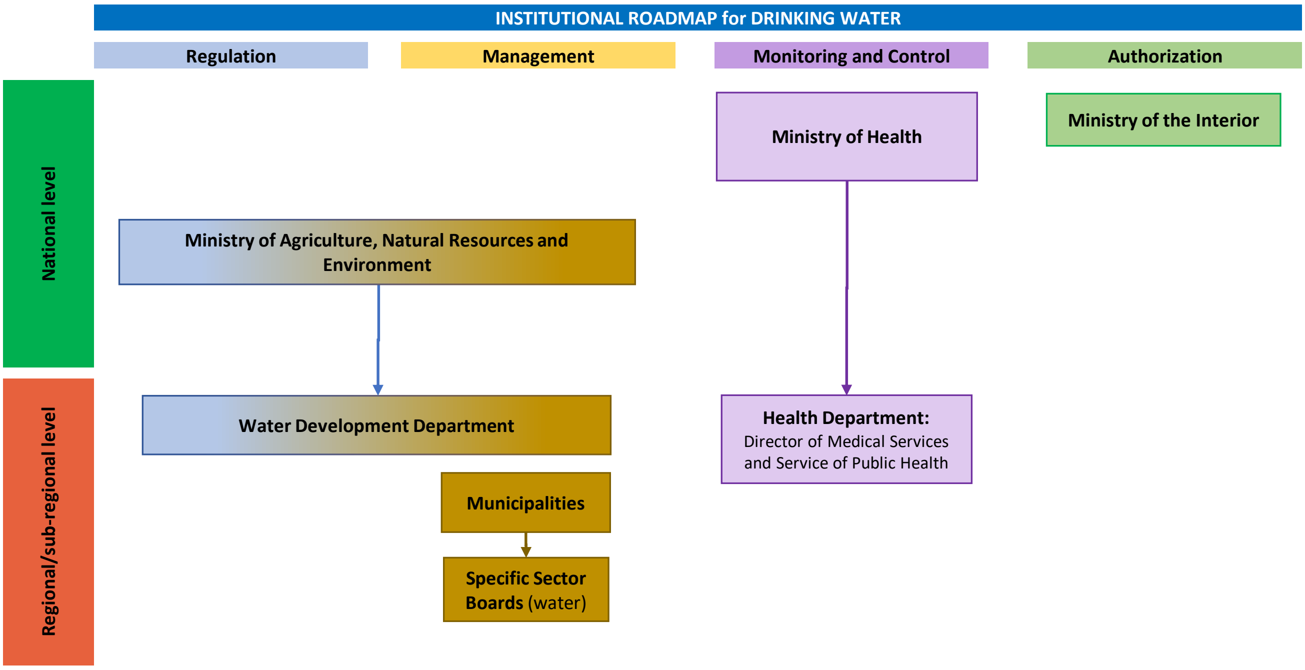

Figure 9.16 Cypriot Institutional Structure for Drinking water

FRANCE

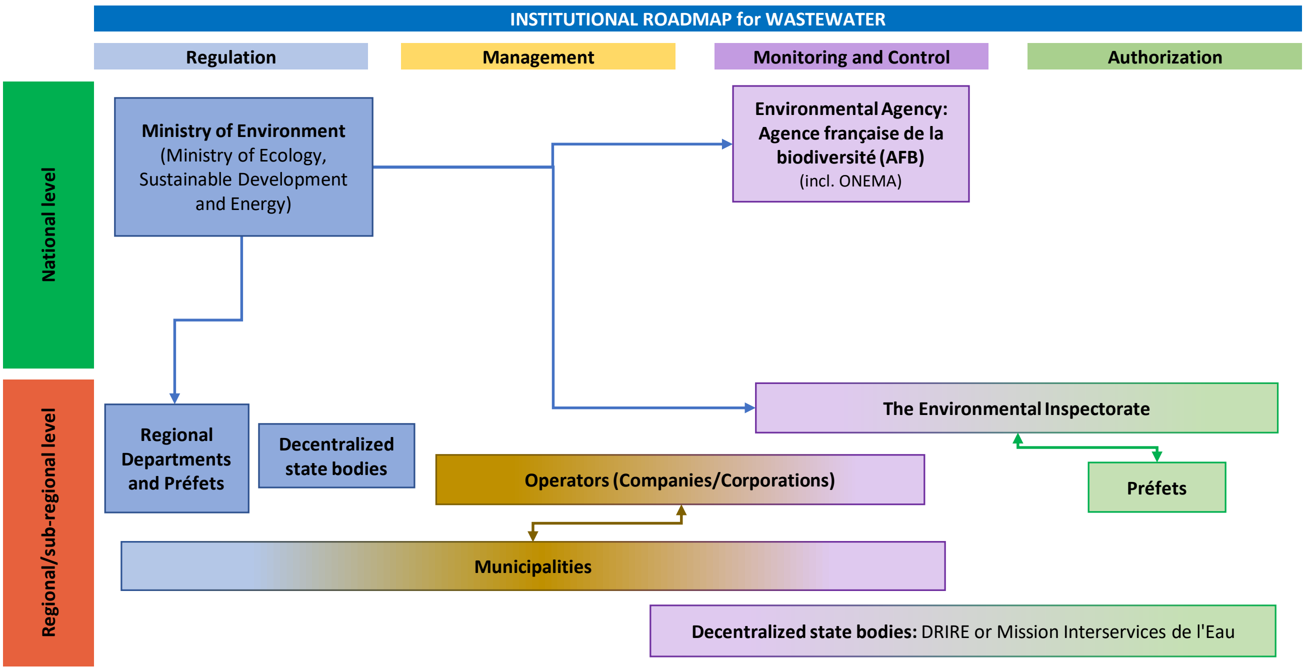

Figure 9.17 French Institutional Structure for wastewater

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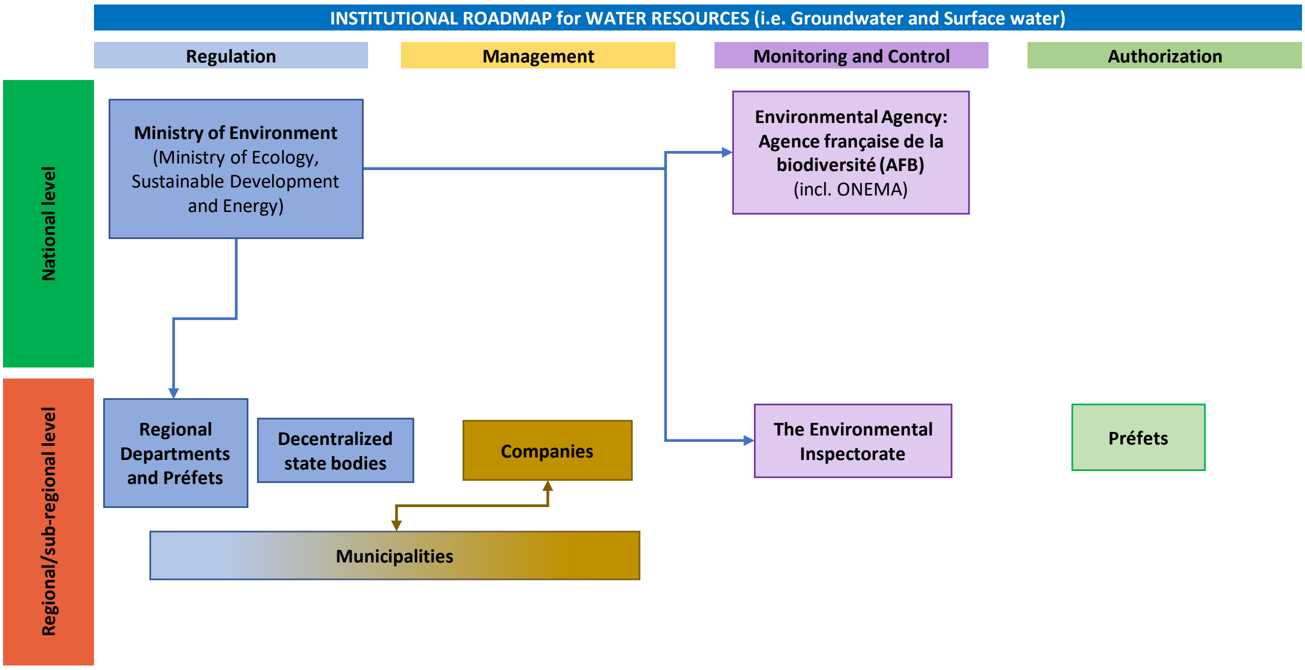

Figure 9.18 French Institutional Structure for Water resources

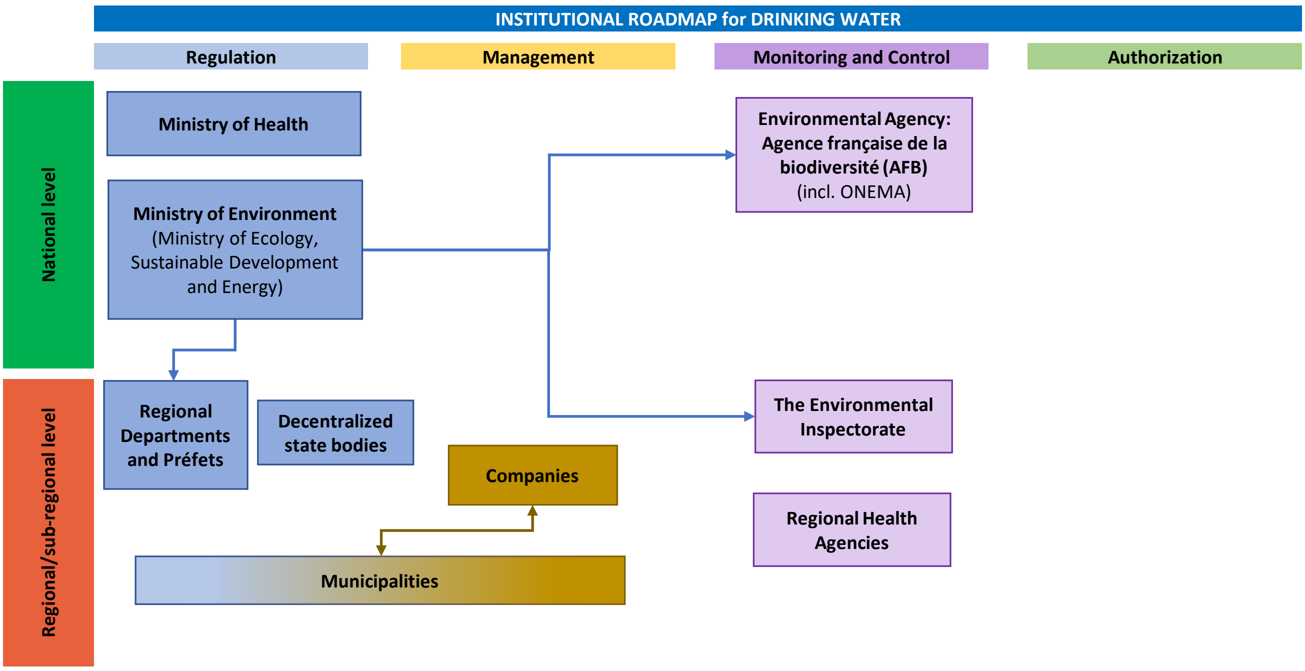

Figure 9.19 French Institutional Structure for Drinking water

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GERMANY

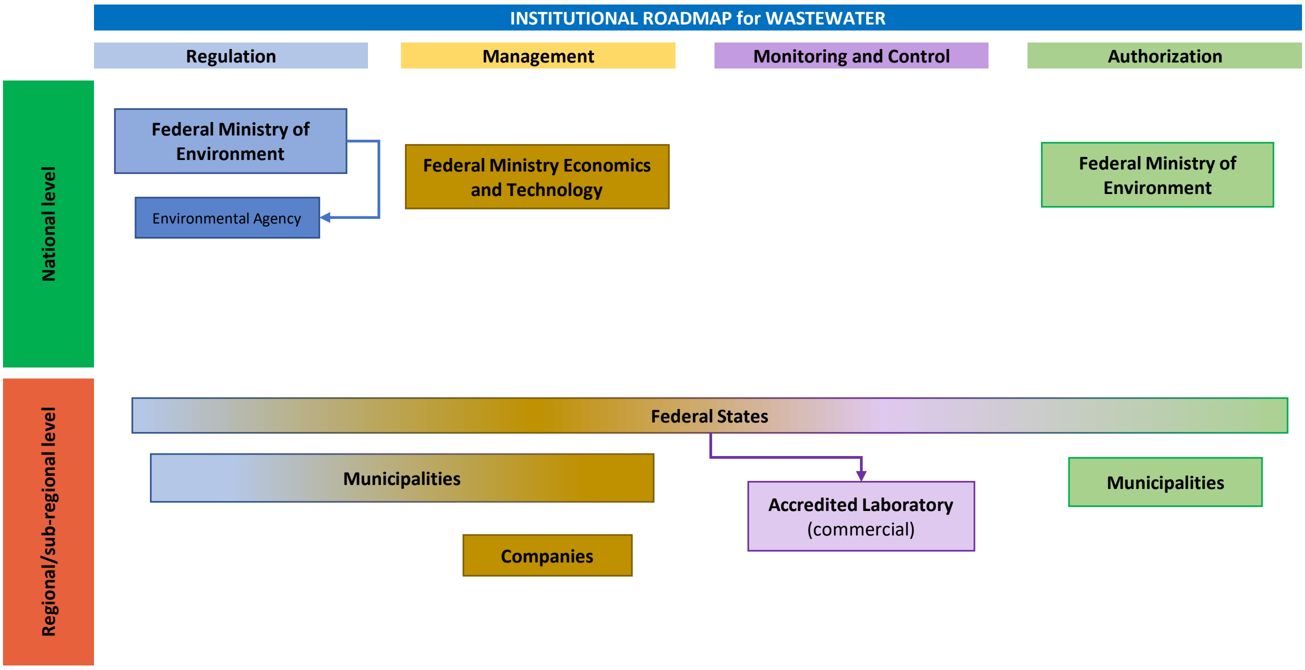

Figure 9.20 German Institutional Structure for wastewater

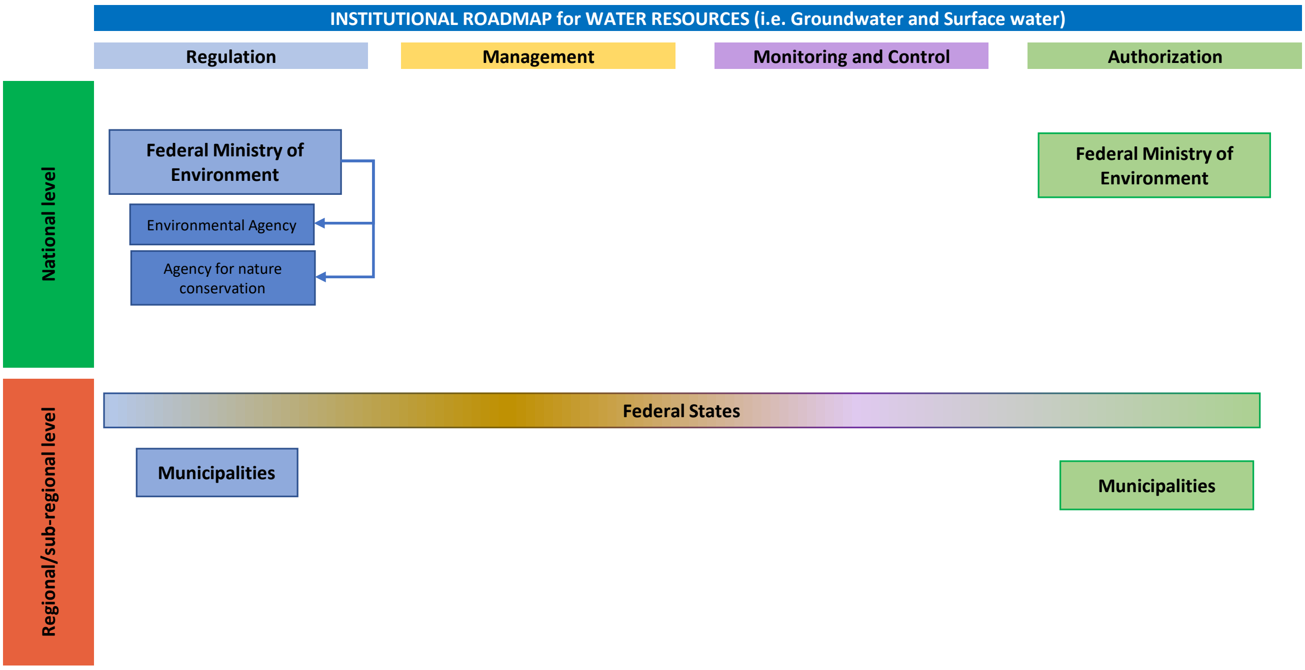

Figure 9.21 German Institutional Structure for Water resources

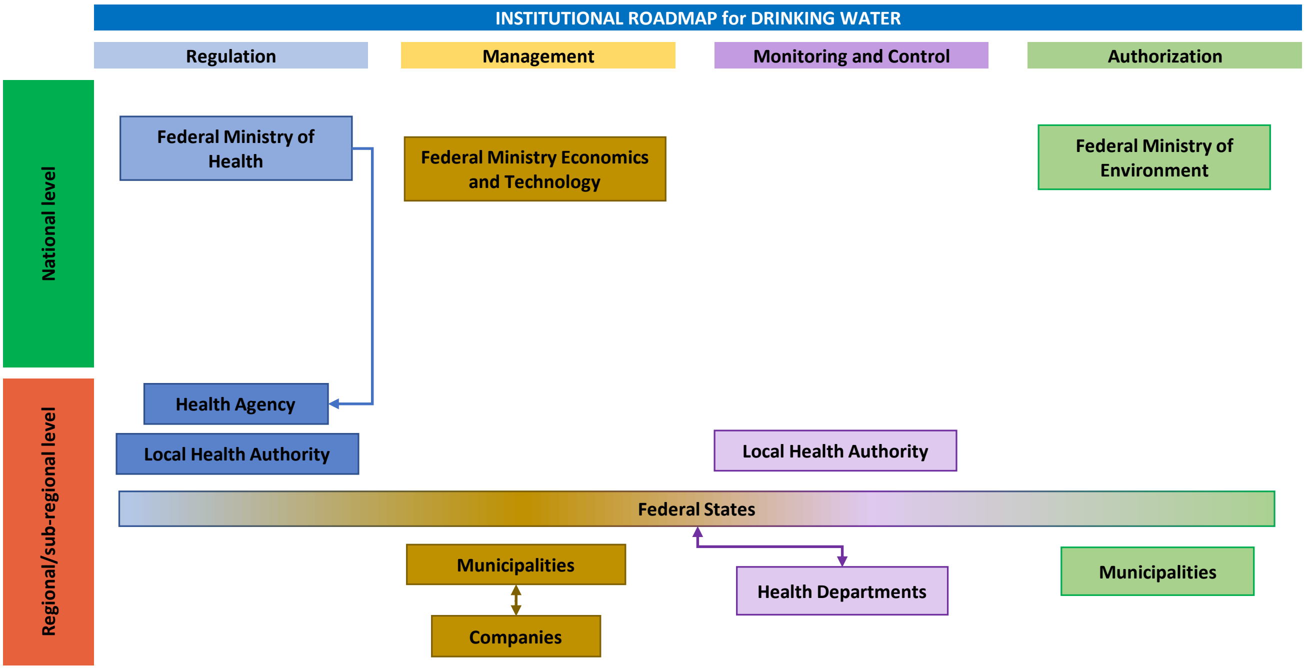

Figure 9.22 German Institutional Structure for Drinking water

GREECE

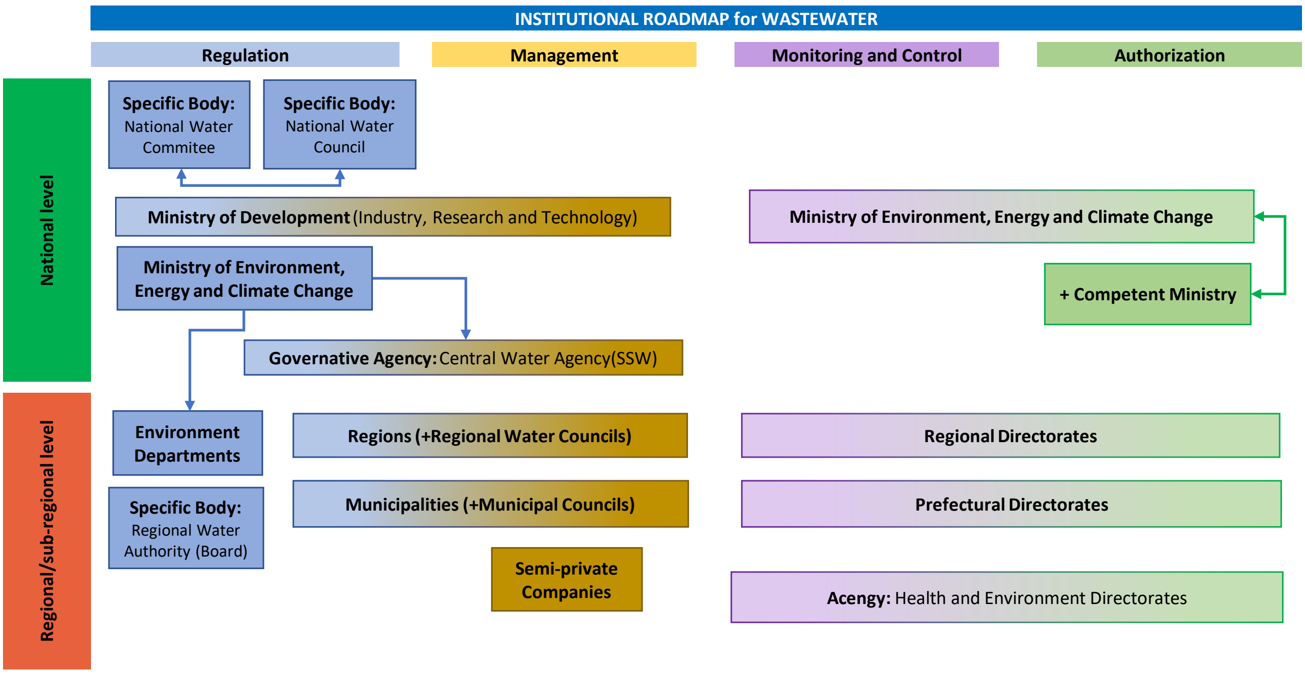

Figure 9.23 Greek Institutional Structure for wastewater

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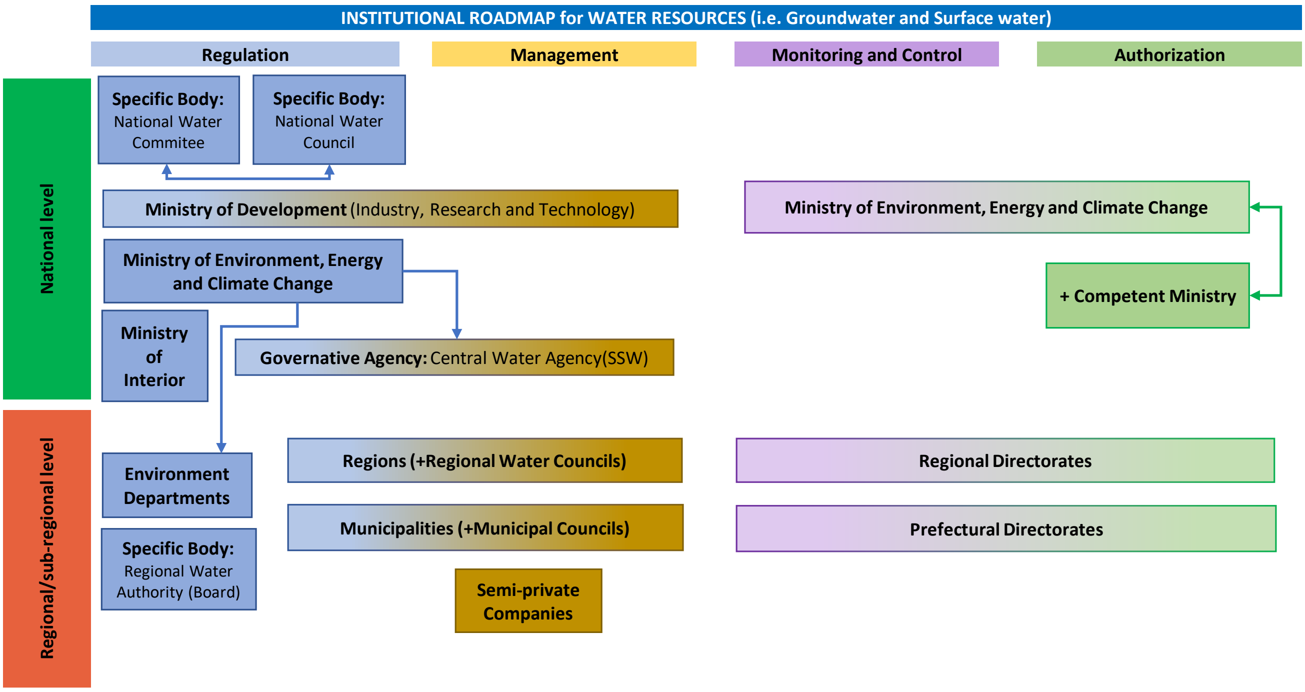

Figure 9.24 Greek Institutional Structure for Water resources

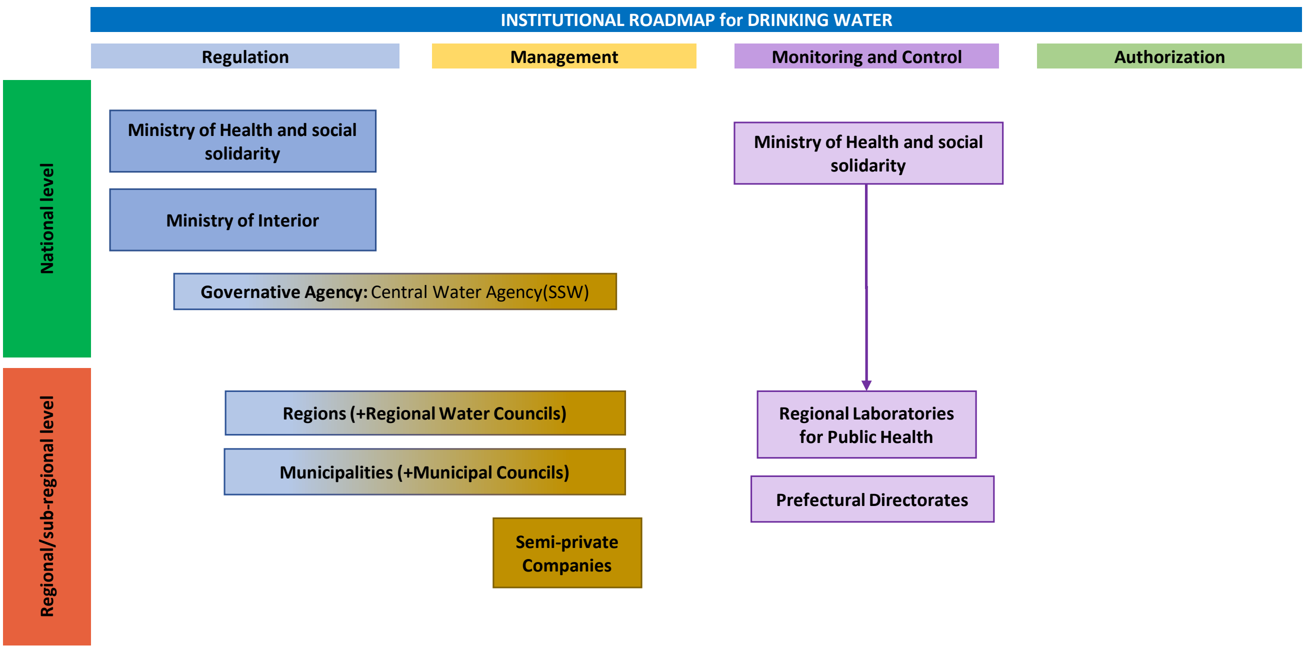

Figure 9.25 Greek Institutional Structure for Drinking water

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under Grant Agreement No 776643

ITALY

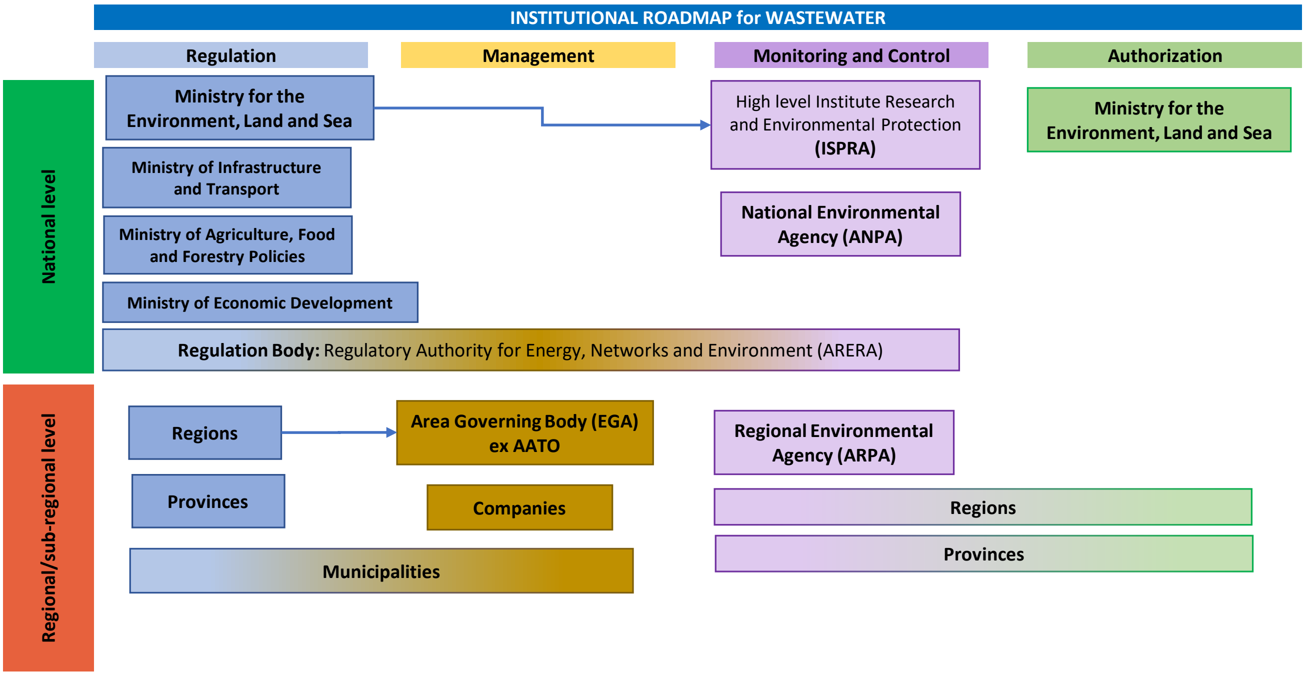

Figure 9.26 Italian Institutional Structure for wastewater

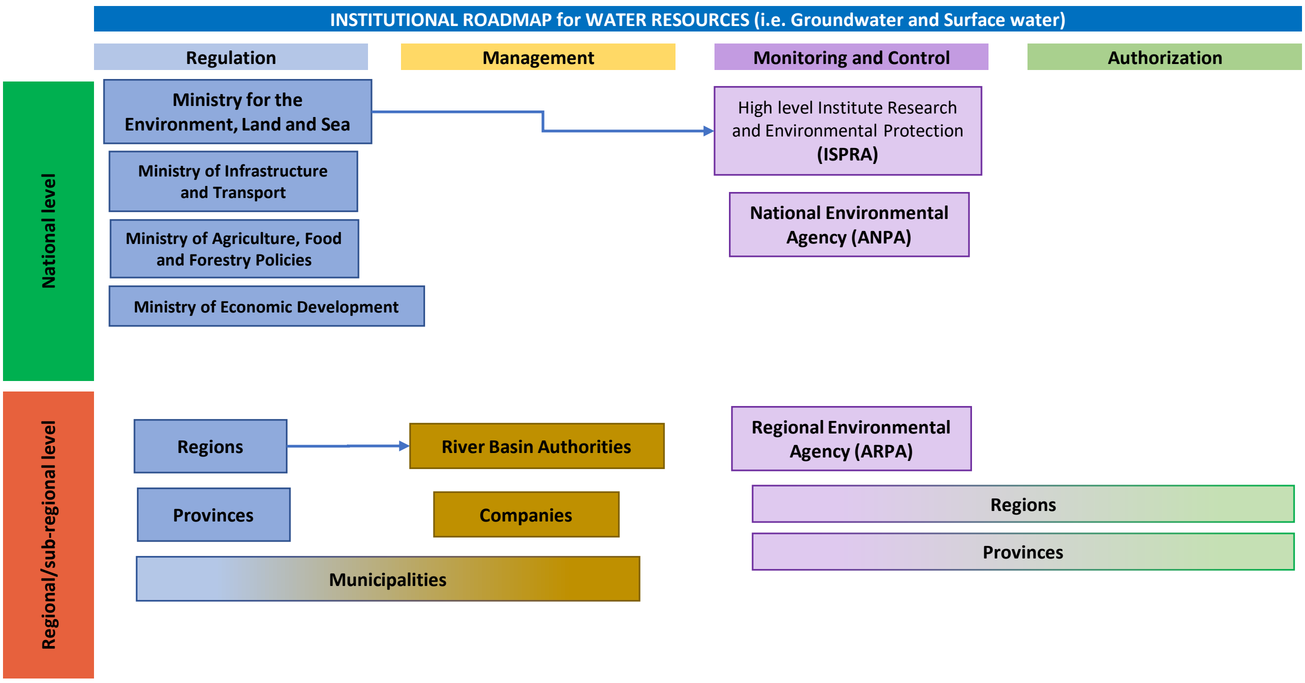

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Figure 9.27 Italian Institutional Structure for Water resources

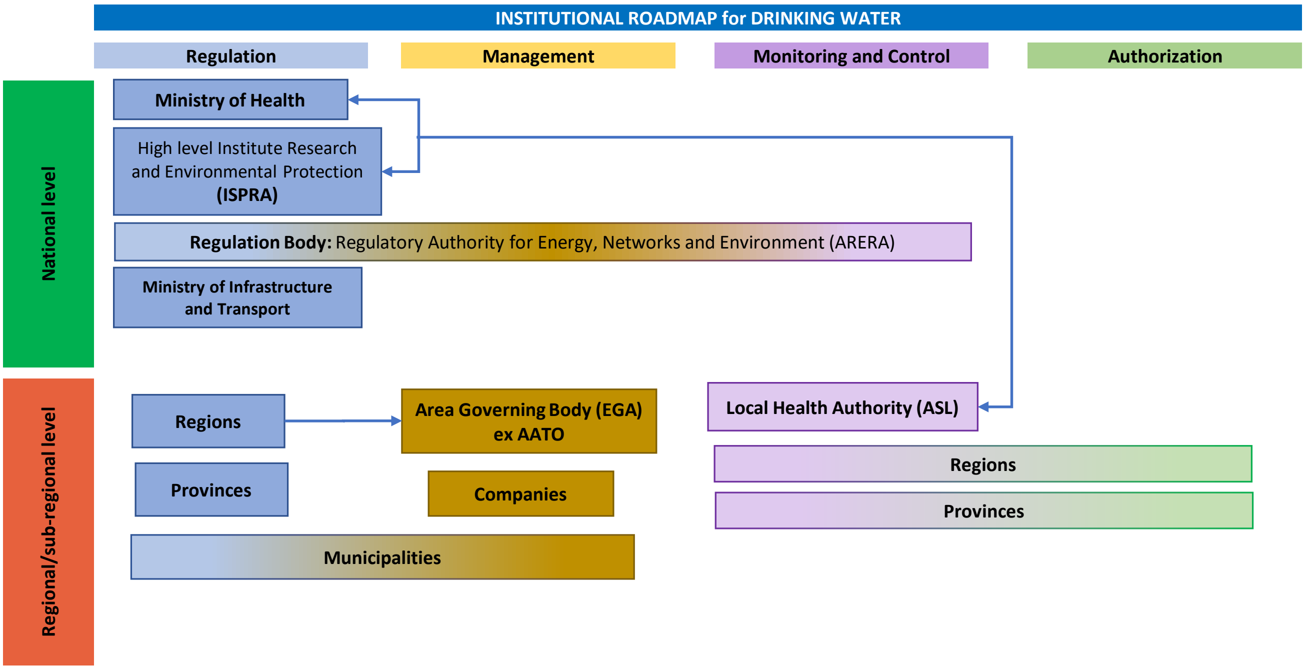

Figure 9.28 Italian Institutional Structure for Drinking water

POLAND

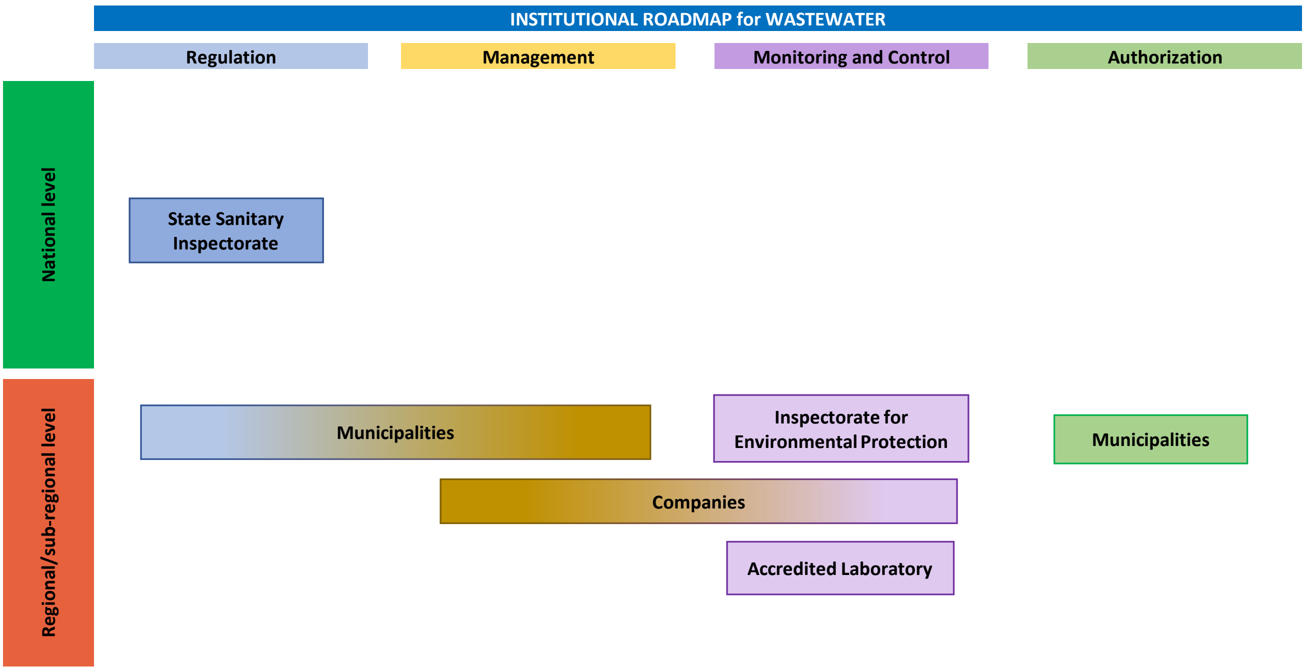

Figure 9.29 Polish Institutional Structure for wastewater

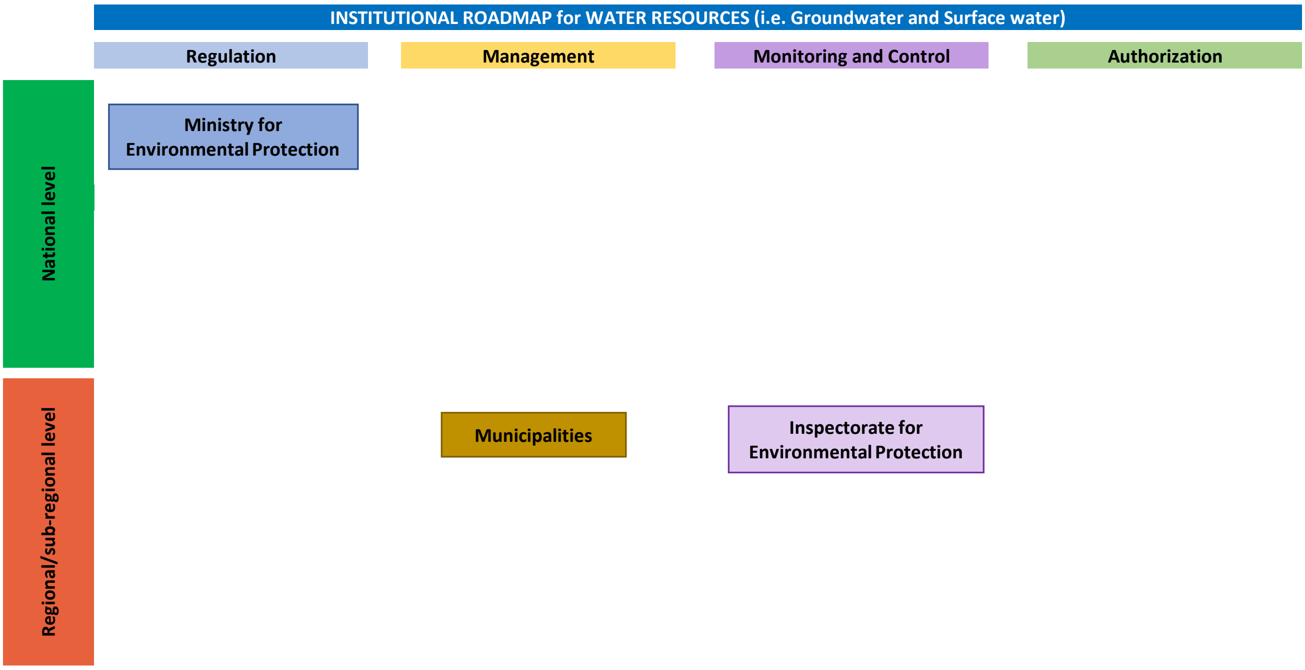

Figure 9.30 Polish Institutional Structure for Water resources

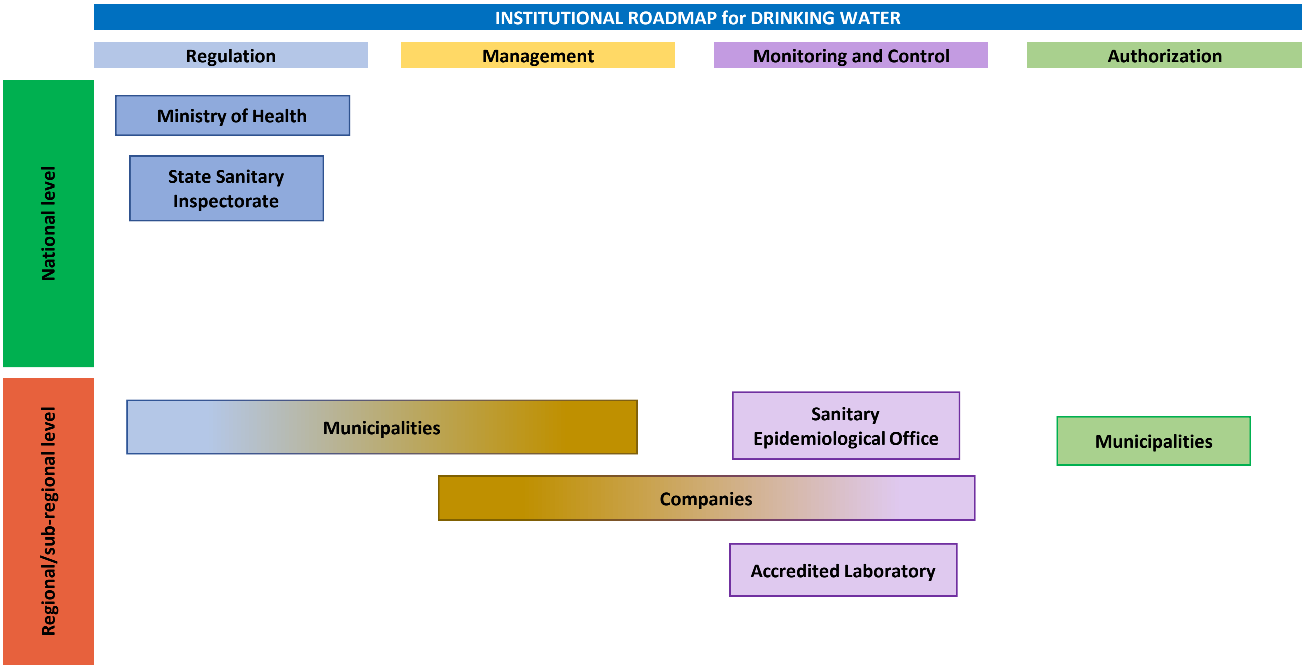

Figure 9.31 Polish Institutional Structure for Drinking water

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PORTUGAL

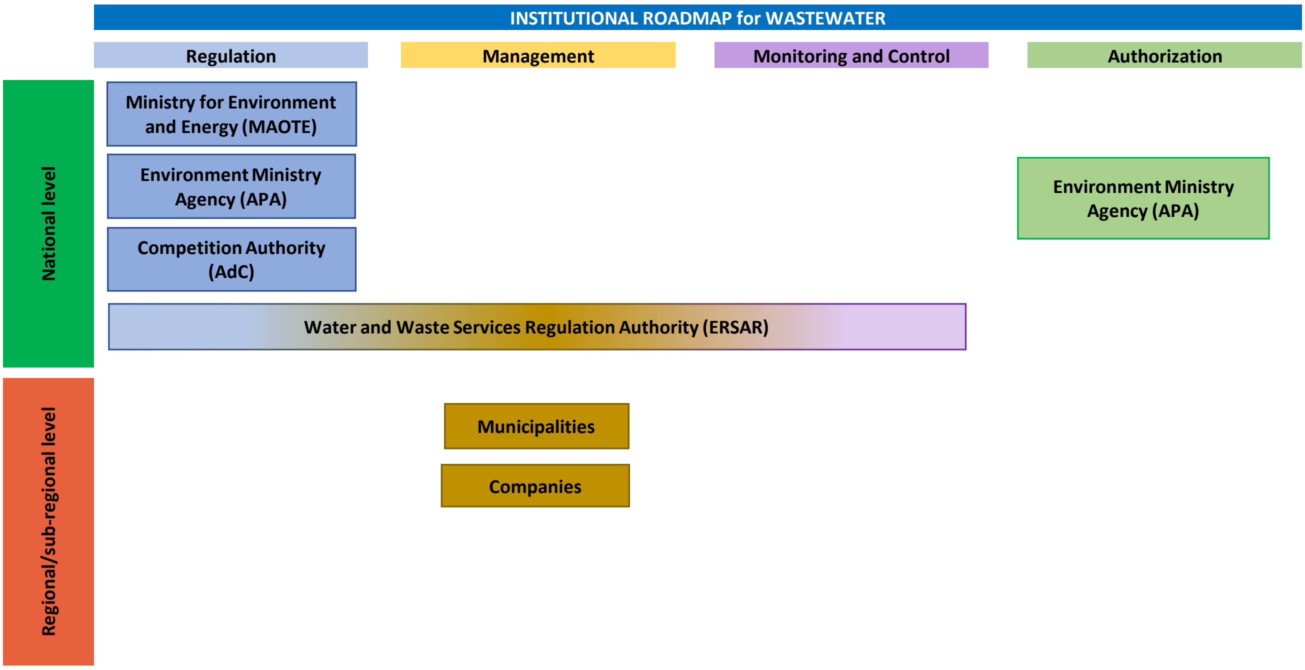

Figure 9.32 Portuguese Institutional Structure for wastewater

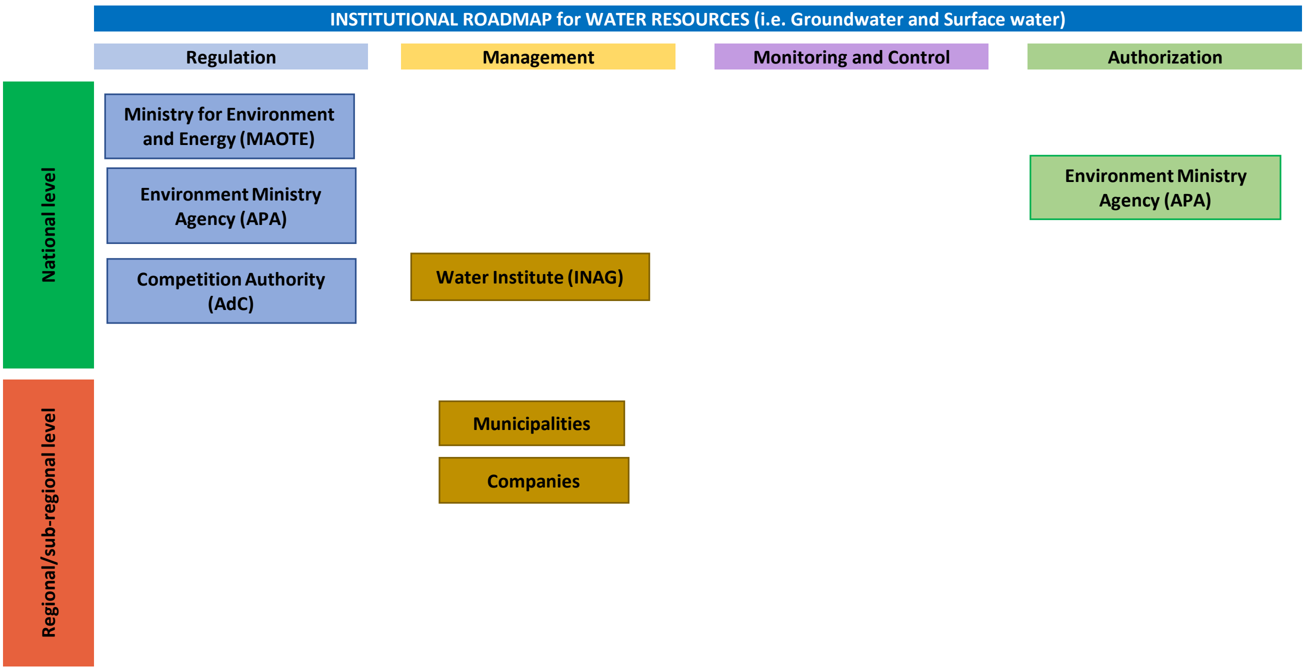

Figure 9.33 Portuguese Institutional Structure for Water resources

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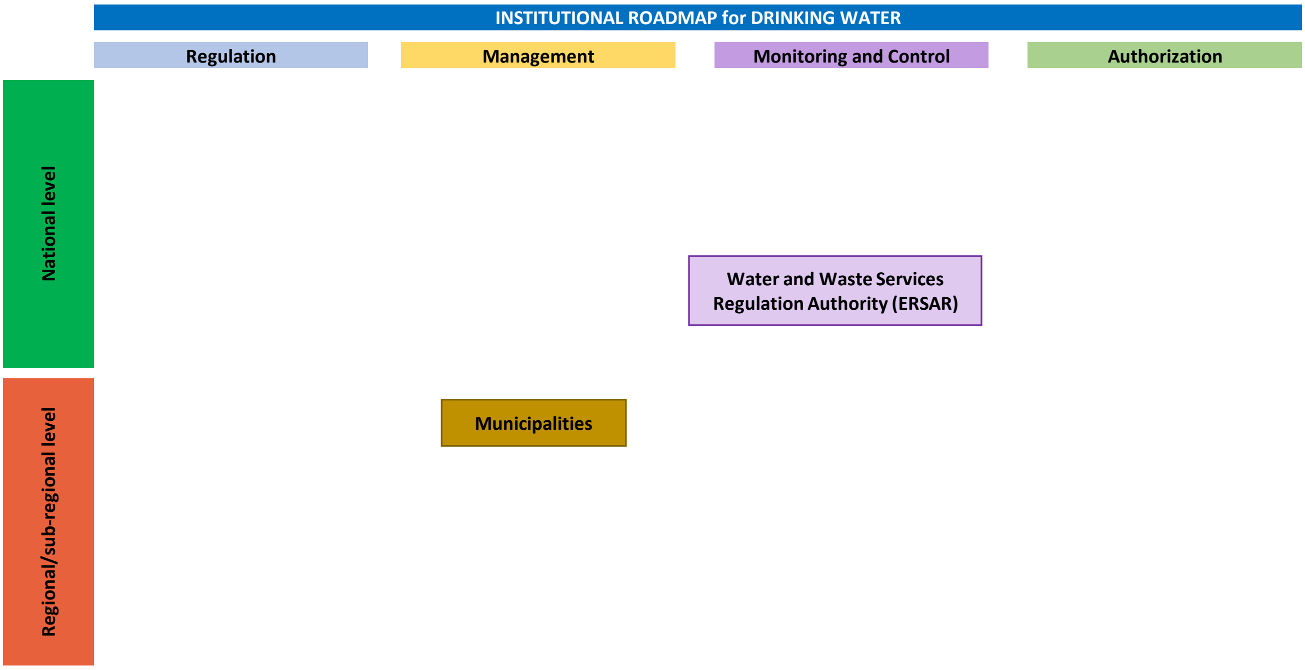

Figure 9.34 Portuguese Institutional Structure for Drinking water

SPAIN

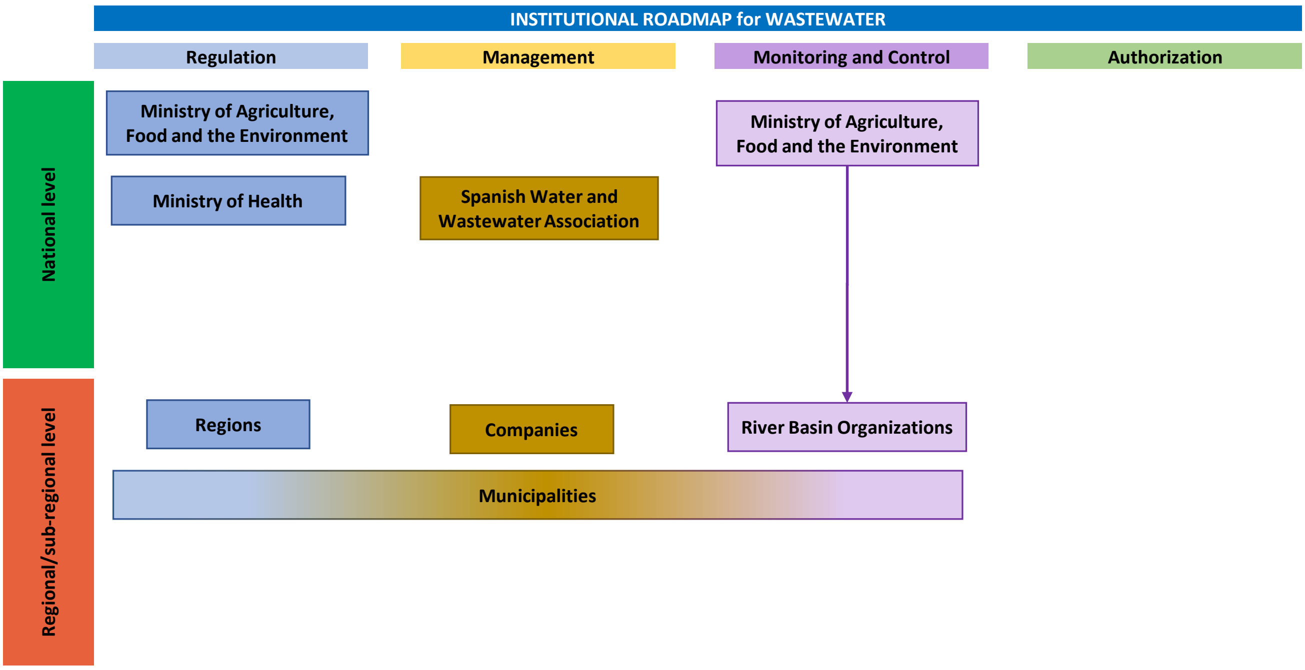

Figure 9.35 Spanish Institutional Structure for wastewater

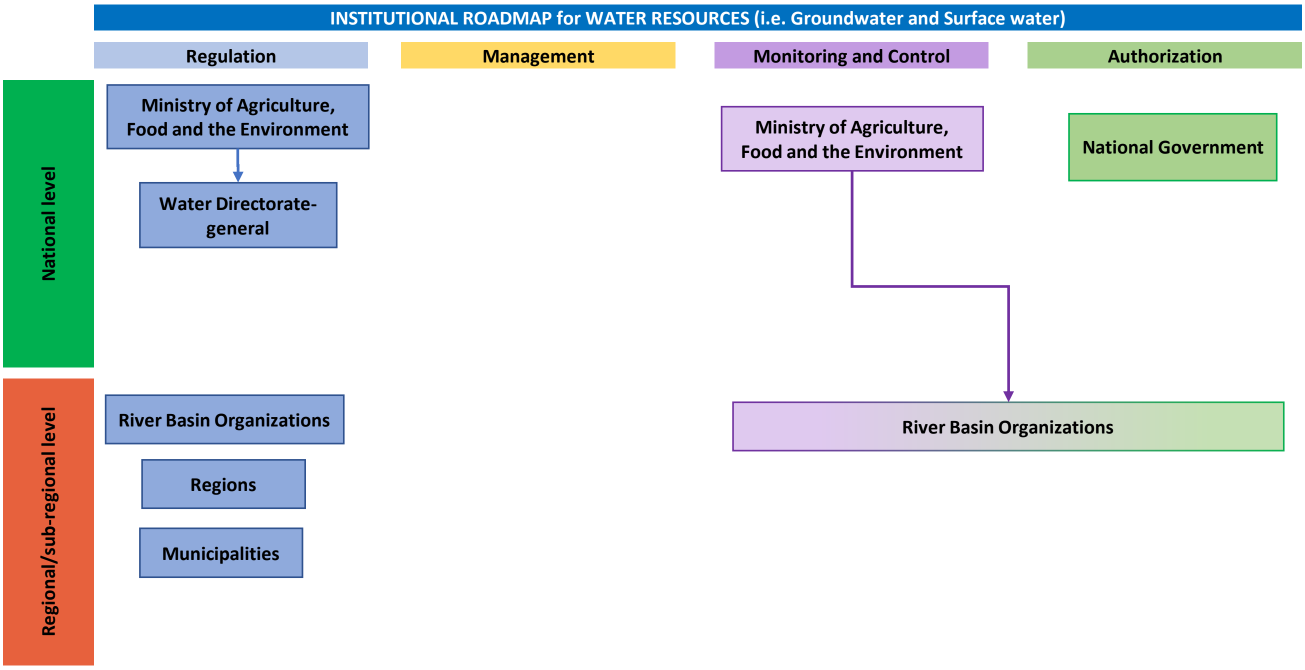

Figure 9.36 Spanish Institutional Structure for Water resources

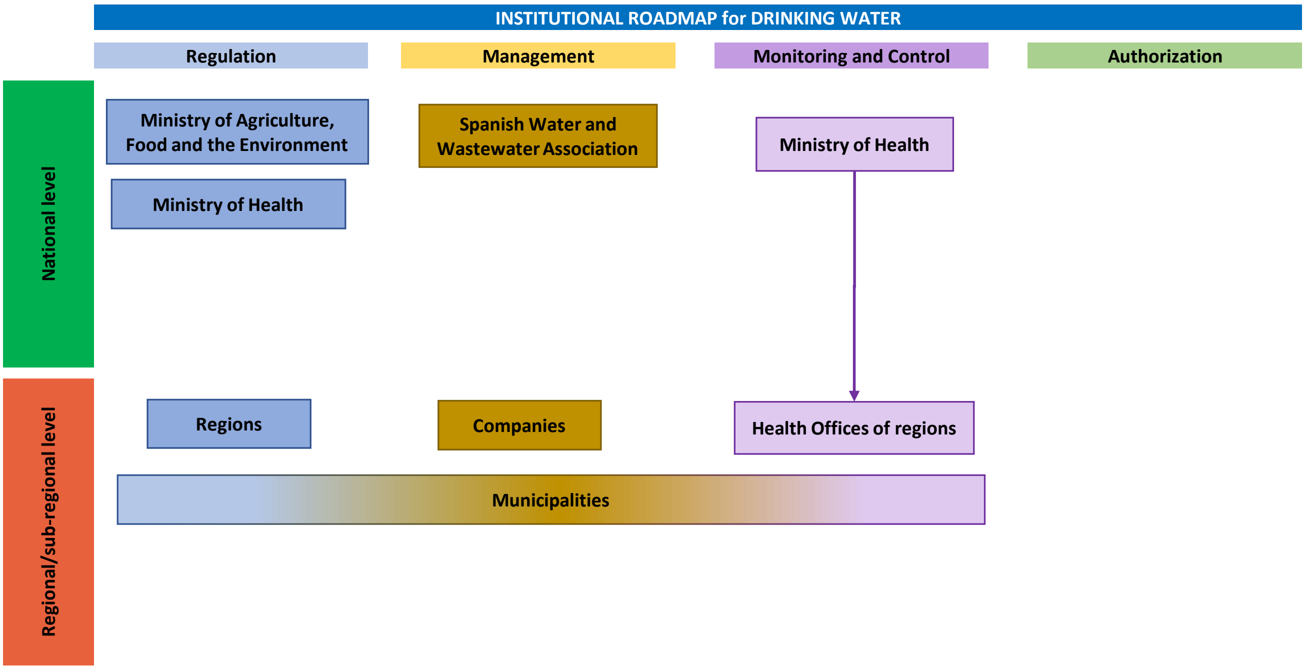

Figure 9.37 Spanish Institutional Structure for Drinking water