PROJECT DELIVERABLE REPORT

NAIADES

Greening the economy in line with the sustainable development goals

D2.4 ASSESSMENT OF POLICIES ON WATER DISTRIBUTION MANAGEMENT

A holistic water ecosystem for digitisation of urban water sector

SC5-11-2018

Digital solutions for water: linking the physical and digital world for water solutions

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Responsible Author	VAGELIS PAPAKONSTANTINOU	Email	evangelos.papakonstantinou@vub.be
	DIMITRA MARKOPOULOU	Email	dimitra.markopoulou@vub.be
	ANNA BREKINE	Email	abrekine@mandint.org
	AITOR CORCHERO RODRIGUEZ	Email	aitor.corchero@eurecat.org
Reviewer(s):	Elpiniki Papageorgiou (CERTH) Kristo Klesment (GT)		
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Abbreviations

DWD	Drinking Water Directive (Council Directive 98/83/EC)
EEA	European Environment Agency
EU Water Legislation	The WFD, the EQSD, the GWD and the FD, unless otherwise expressly clarified
EQSD	Environmental Quality Standards Directive (Directive 2008/105/EC)
FD	Floods Directive (Directive 2007/60/EC)
GDPR	General Data Protection Regulation (Regulation (EU) 2016/679)
GWD	Groundwater Directive (Directive 2006/118/EC)
NIS Directive	Directive on security of network and information systems (Directive (EU) 2016/1148)
OES	Operator of Essential Services (under the NIS Directive)
WDM	Water Distribution Management
WFD	Water Framework Directive (Directive 2000/60/EC)

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1 Executive Summary

This report, carried out under T2.3 of the NAIADES project, carries a twofold objective: First, the demarcation and identification of WDM policies applicable in the EU today; Second, their assessment from a legal point of view. In order to accomplish these objectives attention is first given to the EU regulatory framework applicable to water services, water resource management and environmental monitoring, in Chapter 3, with the aim of mapping the field and identifying the applicable legal requirements and international standards. Subsequently, the security incident management requirements from a legal point of view are analysed under Chapter 4; Because the EU Water Legislation framework for the moment lacks relevant specialized regulatory provisions guidance is sought in other EU fields of law that may have seemed unrelated in the past but today set concrete requirements upon water suppliers and other actors in the field. The EU WDM policies are then presented under Chapter 5; Special emphasis is placed upon smart water technologies and their role in strengthening and furthering these policies. Finally, their legal assessment takes place under Chapter 6 of this report: A common axis of analysis, including set criteria identified under Chapter 4, is examined against the policies identified under Chapter 5; Concrete EU policy findings and recommendations on the basis of this analysis constitute the main, final contribution of this report.

2 Introduction and scope delineation

This report carries a twofold objective: First, the demarcation and identification of WDM policies applicable in the EU today; Second, their assessment from a legal point of view. In order to accomplish these objectives attention will first be given to the EU regulatory framework applicable to water services, water resource management and environmental monitoring, in Chapter 3, with the aim of mapping the field and identifying the applicable legal requirements and international standards. Subsequently, the security incident management requirements from a legal point of view will be analysed under Chapter 4; Because the EU Water Legislation framework for the moment lacks relevant specialized regulatory provisions guidance will be sought in other EU fields of law that may have seemed unrelated in the past but today set concrete requirements upon water suppliers and other actors in the field. The EU WDM policies will then be presented under Chapter 5, as well as, policies applied by the NAIADES pilot cases; Special emphasis will be placed upon smart water technologies and their role in strengthening and furthering these policies. Finally, their legal assessment will take place under Chapter 6 of this report: A common axis of analysis, including set criteria identified under Chapter 4, will be examined against the policies identified under Chapter 5; Findings and recommendations on the basis of this analysis will constitute the main contribution of this chapter.

This report forms part of WP2 of the NAIADES project, under its T2.3, on the Legal, Ethical and Social Requirements and Policies for WDM. While as per its description a theoretical task that may appear at first instance not directly connected to the NAIADES project aims and objectives (essentially, to transform the water sector through automated and smarter water resource management and environmental monitoring, to achieve a high level of water services in both residential or commercial consumers, and to exploit the efficient use of physical and digital components of water ecosystem), closer examination demonstrates its importance within work carried out under the project: Not only are relevant frameworks identified in order to warrant compliance of the project's outcomes, but also policy recommendations taking account of the project's work may be formulated on the basis of this analysis. Similarly, although a specific connection (in the sense of a dedicated chapter, other than that referring to the NAIADES pilot cases) is missing from this report, its findings and assessments, as informed by the project's objectives and outcomes, will form useful policy and practical recommendations for the project consortium and also EU policy making.

A critical clarification before proceeding with the analysis under this report refers to its relationship, and the relationship of work carried out under this Task 2.3 of the NAIADES project, with T1.5, and its respective report D1.4. This report focuses on WDM policies and respective security incident management requirements; D1.4 analyses the general legal and ethical framework for the NAIADES project. From this point of view this report is subject-matter specific while D1.4 is generis (under a quasi *lex specialis/ lex generalis* relationship): Findings and assumptions made under D1.4 will be taken for granted and will be furthered into this report, but will not be repeated hereunder. Similarly, project partners are encouraged to consult the contents of this report when it comes to its specific topics only after having first examined D1.4, and in constant reference to it.

3 The EU Legal Framework Applicable to Water Services, Water Resource Management and Environmental Monitoring

Under this Chapter the EU regulatory framework on Water Services, Water Resource Management and (water) environmental monitoring will be mapped.

3.1 The applicable EU regulatory framework

The applicable EU policy instruments in the field of Water Management are as follows:

- Council directive 91/271/EEC concerning urban waste-water treatment
- Council directive 91/414/EEC concerning the placing of plant protection products on the market
- Council directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources
- Council directive 96/61/EC concerning Integrated Pollution Prevention and Control (IPPC)
- Council directive 1999/31/EC of 26 April 1999 on the landfill of waste
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy
- 2005/646/EC: Commission Decision of 17 August 2005 on the establishment of a register of sites to form the intercalibration network in accordance with Directive 2000/60/EC of the European Parliament and of the Council
- Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration
- Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC
- Regulation (EC) No 166/2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EEC
- Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (Text with EEA relevance)
- Communication from the Commission to the European Parliament and the Council - Addressing the challenge of water scarcity and droughts in the European Union {SEC(2007) 993} {SEC(2007) 996}/* COM/2007/0414 final */
- Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council
- Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance)
- Commission staff working document accompanying the White paper - Adapting to climate change : towards a European framework for action Climate Change and Water, Coasts and Marine Issues

{COM(2009) 147 final} {SEC(2009) 387} {SEC(2009) 388}/* SEC/2009/0386 final */

- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - An EU Strategy on adaptation to climate change /* COM/2013/0216 final */
- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Next steps for a sustainable European future European action for sustainability - COM/2016/0739 final
- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - The European Green Deal COM/2019/640 final

3.2 The applicable EU and international standards

This section is mainly devoted to describing the water applicable standards at EU and international level. A complete list of existing standards for water management and quality has been already documented under the D9.6 entitled as "Report on standards (a) used and (b) generated in NAIADES". Mentioned document is a first version of a series of deliverables aimed at elaborating a catalogue of standards for water domain including all international and EU standards regarding ICT on Water. Moreover, since M6 until now, the catalogue has been published in online version accessible from a webpage[1]. The main intention of this action has been to show main standards available for the water nexus and aligned with the different ICT layers such as physical systems, architecture, monitoring, APIs, customer relationship and nexus layers.

In the framework of this deliverable, we are going to expose a subset of EU and international standards applicable for STOP-IT considering the requirements gathered through WP2 and the architecture designed. In these regards, the presented standards are subdivided in different categories covering the entire water supply chain and their relationship with the environment. Thus, we envisioned to separate the applicable EU and international standards into water services, water resource management and environment monitoring.

3.2.1 Water Services International standards

The set of standards presented over this section corresponds to common guidelines and recommendations related to the elaboration of a high-level architecture and communication between water system to provide a support for the elaboration of the future digital services in the water domain. In these regards, the focus is nowadays on the compatibility with SmartM2M architecture driven with a FIWARE compatibility of the water systems. In terms of data exchange model and data representation, the focus is already divided between ETSI with NGSI-LD model and SAREF4WATR and the OGC with the representation of physical and hydrological elements through SensorAPI and WaterML series of standards.

Standard Name	Short Description about the standard
ISO/TC 224	**Service activities relating to drinking water supply, wastewater and stormwater systems**. Standardization of the management concepts for service

[1] Water Standardization Landscape. https://aolite.github.io/naiadesStandardization/#/

	activities relating to drinking water supply, wastewater and stormwater systems. These standards are associated with the relation with the customer and the subsequent services for operation and maintenance activities, service provision during crisis, water loss reduction and management, stormwater management, governance for water utilities, continuous service monitoring for water quality and asset management services linked to water supply and wastewater systems. **Domain level:** *Water-nexus services and customer relationship* **Water Nexus:** *All* **Url:** https://www.iso.org/committee/299764.html
OGC® WaterML2-HY_FEATURES	**WaterML2-HY_FEATURES (Part 3)**. Reference model defining real-world water-objects and the way they relate to each other according to hydro-science domain defined by semantics and network topology. **Domain level:** *High Level Architectures, APIs and Services* **Water Nexus:** *Water* **Url:** http://docs.opengeospatial.org/is/14-111r6/14-111r6.html
OGC® WaterML2-GroundWaterML2	**GroundwaterGML2 (Part4)**. This data exchange model that represent logical and encoding standard for representing groundwater data. This standard has been elaborated for exchange information about the management of groundwater resources, to make interoperable groundwater modelling systems and lately, enhance the interoperability diverse water informational systems. **Domain level:** *High Level Architectures, APIs and Services* **Water Nexus:** *Water* **Url:** http://docs.opengeospatial.org/is/16-032r2/16-032r2.html
SAREF4WATR	**SAREF extensions (SAREF4WATR)**. SAREF corresponds to a semantic model (ontology) for representing contextual information of water systems and their interrelation with the physical domain. SAREF will enable the cross-domain interoperability while offer a data model with context based metadata. **Domain level:** *High Level Architectures, APIs and Services* **Water Nexus:** *Water, Industry, Agriculture, Food.* **Url:** https://portal.etsi.org/STF/STFs/STF-HomePages/STF566
NGSI-LD	**NGSI-LD**. This reference model corresponds to an open API for the integration of smart city data at cross-domain whilst compliant with GDPR. NGSI-LD open API manages the information in form of graph-databases and serialize it in JSON-LD. Moreover, the open API specification is also compliant with FIWARE high level architecture. **Domain level:** *High Level Architectures, APIs and Services* **Water Nexus:** *Water, Industry, Agriculture, Food.* **Url:** https://www.etsi.org/newsroom/press-releases/1519-2019-01-etsi-cim-group-releases-full-feature-specification-for-context-information-exchange-in-smart-cities

3.2.2 Water Resource Management International standards

This section of the standards is focused on the description of managerial standards for the water domain. Indeed, this section is mainly focus on terminologies, guidelines and standard procedures related to water quality, water reuse and monitoring and control procedures for the water cycles including water distribution, waste-water networks.

Standard Name	Short Description about the standard
ISO/TC 147	**Water Quality**. This standard comprise the understanding of water quality terminology combined with a broad strategy for measuring, sampling and characterizing water quality (including physical, chemical, biochemical, biological and microbiological) procedures and measurements (including radioactivity measurements). **Domain level:** *Physical systems, methods and measurement* **Water Nexus:** *Water/Wastewater* **Url:** https://www.iso.org/committee/52834.html
ISO/TC 113	**Hydrometry**. Methods, procedures, instruments, and equipment relating to techniques for hydrometric determination of water level, velocity, discharge and sediment transport in open channels, precipitation and evapotranspiration, availability and movement of ground water. **Domain level:** *Physical systems, methods and measurement* **Water Nexus:** *Water* **Url:** https://www.iso.org/committee/51678.html
CEN/CLC/ETSI/TR 50572	**Functional reference architecture for communications in smart metering systems**. A European standard comprising a software and hardware open architecture for utility meters that supports secure bidirectional communication upstream and downstream through standardized interfaces and data exchange formats and allows advanced information and management and control systems for consumers and service suppliers. **Domain level:** *Water-nexus services and customer relationship* **Water Nexus:** *All* **Url:** ftp://ftp.cen.eu/cen/Sectors/List/Measurement/Smartmeters/CENCLCETSI_TR50572.pdf
ISO/TC 282	**Water reuse**. This standard covers technical, economic, environmental and societal aspects of water reuse. Considering water reuse topic, this standard covers all value-chain considering operations involved in collection, conveyance, processing, storage, distribution, consumption, drainage of wastewater, treated effluents and cascaded recycled cycles. Moreover, the standard also covers as important topic the impact of water quality in water use and recycling. **Domain level:** *Monitoring and Measurement Systems* **Water Nexus:** *Industry, Agriculture* **Url:** https://www.iso.org/committee/4856734.html

3.2.3 Environmental Monitoring International standards

This section is devoted to depicting and representing the existing environmental standards. In this regards, main aspects are focused on assessment methodologies for ensuring efficient use of the resources (water, raw materials, energy etc.). In this sense, main methodology is the well-known Life Cycle assessment. Moreover, there exist also methodologies, guidelines and procedures to ensure environmental performance at industrial level.

Standard Name	Short Description about the standard
ISO/TC 207/SC5	**Life cycle Assessment**. Standardization in the field of life cycle assessment and related environmental management tools for products and organizations. It includes life cycle-based resource efficiency and eco-efficiency assessment and encompasses consideration of a life cycle perspective in the assessment of impacts from the extraction of raw materials to the final disposal of waste. These standards directly contribute to circular economy, resource efficient and process/services symbioses about natural resources. **Domain level:** *Physical systems, methods and measurement* **Water Nexus:** *All* **Url:** https://www.iso.org/committee/54854.html
ISO 14000	**Environmental Management**. Standardization that focuses on the criteria for setting up an environmental management system. This set of standards is aimed at assisting companies in continually improving their environmental performance and complying with any applicable legislation. This could be useful in NAIADES project to determine KPIs and guidelines that can help on climate change mitigation at water industry level. **Domain level:** *Environmental systems* **Water Nexus:** *Climate Change* **Url:** https://www.iso.org/committee/54854.html

4 Security Incident Management Requirements

Water security incident management requirements, particularly within the NAIADES project context, may be found in a multitude of EU legal instruments. Indeed, EU law has taken a multi-faceted approach on Water Services, Water Resource Management and Environmental Monitoring. However, **a basic initial clarification refers to the fact that water services, resource management and WDM is taken into consideration in this report in all but a transport, context**. Shared use of the same term ("water") may cause confusion as to scope delineation of work carried out under this report. Indeed, the EU has devised until today comprehensive policies on both sectors (water transport and water services) that however do not intersect because of their different scope, actors, addressees and objectives. Under this report water transport will not be placed under scrutiny.

The standard-setting EU regulatory document in the field is the Water Framework Directive:[2] It constitutes the EU's unified approach on water regulation, and as such it constitutes its basic legal document. The WFD is a document that has remained already 20-years in effect and has been successful in setting up a governance framework for integrated water management for the more than 110,000 water bodies in the EU. Despite its age, a 2019 EU assessment (fitness check) of the EU water legislation (where the WFD holds the major role) established that "the Directive(s) are largely fit for purpose".[3] This finding demonstrates the soundness of the policy options and the provisions of the WFD, that remain relevant after a substantial amount of time has lapsed.

Other applicable fields of regulation refer to EU cybersecurity regulation and personal data protection law (essentially, the GDPR). As it will be seen in the analysis that follows, and also under Chapter 6, technological developments have affected the use, distribution and management of water in the EU, bringing to the fore fields of law that a few years ago appeared irrelevant to the EU Water Legislation.

4.1 Preliminary Clarifications: the notions of water security and security incident management

Before undertaking a mapping of the water security incident management requirements imposed by EU law a critical preliminary clarification, at least from a legal point of view, refers to the notion of "water

[2] See Correlje A/Francois D/Verbeke T, Integrating Water Management and Principles of Policy: Towards an EU Framework? Journal of Cleaner Production, V15.16, Moss T, Solving Problems of 'Fit' at the Expense of Problems of 'Interplay'? The Spatial Reorganisation of Water Management Following the EU Water Framework Directive, in Breit H/Engels A/Moss T/Troja M, How Institutions Change, Perspectives on Social Learning in Global and Local Environmental Contexts, VS Verlag für Sozialwissenschaften, 2003, Page B/Kaika M, The EU Water Framework Directive: Policy Innovation and the Shifting Choreography of Governance, Environmental Policy and Governance, V13.6, November/December 2003

[3] Information from the EU Commission website (DG Environment), https://ec.europa.eu/environment/water/fitness_check_of_the_eu_water_legislation/index_en.htm

security".[4] As such, it has been developed to be connected to "human security".[5] In this context "the three most common understandings of this notion" have been identified in the relevant literature deriving from formal policy documents as follows:

(a) A safe water supply and sanitation, including water for food production and hydrosolidarity between those living upstream and those living downstream in a river basin, and water pollution avoidance;

(b) Adequate protection from water-related disasters and diseases and access to sufficient quantity and quality of water, at affordable cost, to meet the basic food, energy, and other requirements essential for leading a healthy and productive without compromising the sustainability of vital ecosystems;

(c) The reliable availability of an acceptable quantity and quality of water for health, livelihoods, and production, coupled with an acceptable level of water-related risks.[6]

Nevertheless, none of the above understandings of the "water security" notion will be referred to in this report. On the contrary, the term of "water security incident" will be taken at face value, denoting exactly that, security incidents that are relevant to water distribution and management systems. This is therefore a fundamentally different approach whereby such issues as risk identification, security breaches and notifications mechanisms need to be examined.

While the notion of "water security" is indeed relevant and useful in order to place the term onto its social, ethical and legal backgrounds, an analysis of its relationship to be basic fundamental right of "human security" exceeds the purposes of this analysis. In the words of Scocca, "as emerging from these definitions, water security is a complex concept informed by a diverse set of international, human, environmental, economic, and political security concerns", making therefore necessary a focus of this report on incident management requirements, so as to make it pertinent to the NAIADES aims and purposes, it essentially being a digitization of the water sector research project.

4.2 Water security incident management under the WFD

The WFD was introduced on October 2000; Taking into account that "citizens, environmental organisations, nature, water-using sectors in the economy all need cleaner rivers and lakes, groundwater and bathing waters", water protection became "one of the priorities of the Commission".[7] The policy background against which the WFD took form is also provided by the Commission: "Historically, there has been a dichotomy in approach to pollution control at European level, with some controls concentrating on what is achievable at source, through the application of technology; and some dealing with the needs of the receiving environment in the form of quality objectives. Each approach has potential flaws. Source controls alone can allow a cumulative pollution load which is severely detrimental to the environment,

[4] See also Wheater H S/Gober P, Water security and the science agenda, 50th Anniversary of Water Resources Research, June 2015, Bakker K/Morinville C, The governance dimensions of water security: A review, Phil. Trans. R. Soc., 2013

[5] Scocca G, Strengthening International Water Security: The European Union's proposal, World Water Policy, Volume 5 Issue 2, November 2019.

[6] Ibid, with further references.

[7] Information from the relevant European Commission's webpages, https://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

where there is a concentration of pollution sources. And quality standards can underestimate the effect of a particular substance on the ecosystem, due to the limitations in scientific knowledge regarding dose-response relationships and the mechanics of transport within the environment. For this reason, a consensus has developed that both are needed in practice - a combined approach. The Water Framework Directive formalises this".[8]

In this context the WFD achieves its aims and purposes through a multi-faceted approach, as complemented over the years by other regulatory instruments as well: The Urban Waste Water Treatment Directive and the Nitrates Directive tackle the problem of eutrophication; The Industrial Emissions Directive deals with chemical pollution. The aim is to co-ordinate the application of these so as to meet the objectives established above. The WFD itself established objectives for the river basin, as particularized in the above Directives.

Nevertheless, the above delineate at the same time the purpose of the WFD, namely to "establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater" (Art. 1). Because the WFD is aimed at devising a comprehensive and coherent EU policy on water quality and protection, security incident management, that is the focus of this analysis, does not appear prominently among its provisions. Incident management, being a technical issue *per se*, takes for granted a well-regulated environment where rights, obligations and breaches are well-defined. Unless such an environment exists, incident management cannot take place. From its part, the WFD is aimed at achieved exactly that, creating a generally agreed upon, well-regulated environment; Managing security incidents within its text would have appeared most likely too technical an objective to deal with.

From this point of view, the WFD is a text oriented more towards the notion of "water security" as described in the preceding chapter (in the sense of safe water supply and sanitation, adequate protection from water-related disasters and diseases, and acceptable cost, quality and quantity of water) than the notion of security incident management. As seen above, the latter is too technical a notion to be included in a text that, admittedly as denoted by its title, is aimed at setting framework conditions that case-specific requirements. Indeed, as far as the purposes of this report are concerned, there is no mention of security concerns in the text of the WFD; Incidents, whenever found in its text are only related to pollution of water (thus, being connected to the "water security" notion above). The same is the case with its Guidance Documents[9] or in other related implementation documentation,[10] but also in other implementation EU legislation such as, for example, the EU Floods Directive.[11] It is from this point of view the WFD is considered as not relevant to the purposes of this analysis.

The same is also the case with the DWD, that was introduced two years before the WFD but adopts a similar approach. Its aim is to "protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean", concerning essentially

[8] Ibid.
[9] Available at https://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm
[10] Information from the relevant Commission's webpages (https://ec.europa.eu/environment/water/water-framework/objectives/implementation_en.htm) accessed at the time of submission of this report.
[11] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.

"the quality of water intended for human consumption" (Art. 1). Here too neither security nor security incidents constitute a concern of the DWD.

Similarly, also under the remaining legal instruments of the EU Water Legislation no security incident management legal requirements could be identified in their respective texts.

Consequently, any security-related concerns and incident management requirements are not to be found under EU Water Legislation. On the contrary, as it will be seen in the analysis that follows, they are to be found incidentally at other legislation that place water management, among other public facilities management, within its scope. This constitutes one of the basic findings of this report, that at the same time forms a recommendation for future development of (water-specific) EU legislation (see below, under Chapter 6).

4.3 Water security incident management under EU cybersecurity law

For the purposes of this analysis EU cybersecurity law shall be understood as comprising (a) the NIS Directive,[12] and (b) the EU Cybersecurity Act;[13] The latter essentially including only provisions on ENISA, the EU Cybersecurity Agency, and on the establishment of an EU cybersecurity standardization system, it will be the NIS Directive that will constitute the basis of analysis as regards water security incident management under the EU cybersecurity legal framework.

The NIS Directive is the first (official) legislative measure undertaken at EU level for the protection of network and information systems across the Union. It is by now common perception that network and information systems (NIS) are open to, constantly rising, deliberate harmful actions that intend to damage their operation. Given their transnational nature, their disruption can affect Member States and as a result the Union in its totality. Consequently, their reliability and security are essential to the proper functioning of the Internal Market.

At the time of its release existing capabilities in the EU in terms of security tools and procedures were not deemed sufficient and certainly not found at a common level among Member States. As a result, network and information systems did not enjoy the same level of security within the Union. This is what the NIS Directive attempts to address, namely the need for a global approach at Union level concerning the security of network and information systems. In this context, Article 1 of the Directive, titled "*Subject Matter and Scope*", states that "*the Directive lays down the measures with a view to achieving a high common level of security of network and information systems within the Union so as to improve the functioning of the internal market*".

In this context the Directive:

[12] Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union.
[13] Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act).

a) Lays down obligations for all Member States to adopt a national strategy on the security of network and information systems;

b) Creates a Cooperation Group;

c) Creates a computer security incidents response teams network (CSIRTs network);

d) Establishes security and notification requirements;

e) Lays down obligations for all Member States to designate national competent authorities, single points of contact and CSIRTSs with tasks related to the security of network and information systems.

According to the report published by ENISA ("Incident notification for DSPs in the context of the NIS Directive", February 2017) "*the main points of the NIS Directive can be summarized as follows: improved cybersecurity capabilities at national level, increased EU-level cooperation, security measures and incident reporting obligations for Operators of Essential Services (OES) and Digital Service Providers (DSP)*".

Water management is a notion frequently found in the NIS Directive text: In this context Recitals 10 and 11 state that

> "*10. In the water transport sector, security requirements for companies, ships, port facilities, ports and vessel traffic services under Union legal acts cover all operations, including radio and telecommunication systems, computer systems and networks. Part of the mandatory procedures to be followed includes the reporting of all incidents and should therefore be considered as lex specialis, in so far as those requirements are at least equivalent to the corresponding provisions of this Directive.*
>
> *11. When identifying operators in the water transport sector, Member States should take into account existing and future international codes and guidelines developed in particular by the International Maritime Organisation, with a view to providing individual maritime operators with a coherent approach".*

Similarly, under Recital 28:

> *"In addition to the cross-sectoral factors, sector-specific factors should also be considered in order to determine whether an incident would have a significant disruptive effect on the provision of an essential service. […] for water production, processing and supply, the volume and number and types of users supplied, including, for example, hospitals, public service organisations, or individuals, and the existence of alternative sources of water to cover the same geographical area".*

The NIS Directive approaches water in a twofold manner: Within the context of transport and within the context of drinking water. Both are placed under of its Art. 4(4), and its basic distinction of Operators of Essential Services (OES): "*Art. 4. For the purposes of this Directive the following definitions apply: (4) operator of essential services' means a public or private entity of a type referred to in Annex II, which meets the criteria laid down in Article 5(2)*". Accordingly, under its Annex II, 2(c) refers to water transport and 6 refers to drinking water supply and distribution ("*suppliers and distributors of water intended for human consumption as defined in point (1)(a) of Article 2 of Council Directive 98/83/EC but excluding distributors for whom distribution of water for human consumption is only part of their general activity of distributing other commodities and goods which are not considered essential services*").

For the purposes of this analysis, therefore, the NIS Directive applies on providers of water, considering each one of them as an OES, under its Annex II(6). However, project partners are encouraged to establish that indeed, within their Member State of establishment, they have been indeed identified as OESes; This is a task presumably carried out at Member State level, that should have been completed by 9 November 2018, as per Art. 5 of the NIS Directive.

Having established that the NIS Directive applies to water distribution management, the focus will not turn on its incident notification requirements that, as a result of the above assumption, are applicable for the purposes of this analysis. Art. 14 of the NIS Directive sets that

Security requirements and incident notification

1. Member States shall ensure that operators of essential services take appropriate and proportionate technical and organisational measures to manage the risks posed to the security of network and information systems which they use in their operations. Having regard to the state of the art, those measures shall ensure a level of security of network and information systems appropriate to the risk posed.

2. Member States shall ensure that operators of essential services take appropriate measures to prevent and minimise the impact of incidents affecting the security of the network and information systems used for the provision of such essential services, with a view to ensuring the continuity of those services.

3. Member States shall ensure that operators of essential services notify, without undue delay, the competent authority or the CSIRT of incidents having a significant impact on the continuity of the essential services they provide. Notifications shall include information enabling the competent authority or the CSIRT to determine any cross-border impact of the incident. Notification shall not make the notifying party subject to increased liability.

4. In order to determine the significance of the impact of an incident, the following parameters in particular shall be taken into account:

(a) the number of users affected by the disruption of the essential service;

(b) the duration of the incident;

(c) the geographical spread with regard to the area affected by the incident.

5. On the basis of the information provided in the notification by the operator of essential services, the competent authority or the CSIRT shall inform the other affected Member State(s) if the incident has a significant impact on the continuity of essential services in that Member State. In so doing, the competent authority or the CSIRT shall, in accordance with Union law or national legislation that complies with Union law, preserve the security and commercial interests of the operator of essential services, as well as the confidentiality of the information provided in its notification.

Where the circumstances allow, the competent authority or the CSIRT shall provide the notifying operator of essential services with relevant information regarding the follow-up of its notification, such as information that could support the effective incident handling.

At the request of the competent authority or the CSIRT, the single point of contact shall forward notifications as referred to in the first subparagraph to single points of contact of other affected Member States.

6. After consulting the notifying operator of essential services, the competent authority or the CSIRT may inform the public about individual incidents, where public awareness is necessary in order to prevent an incident or to deal with an ongoing incident.

7. Competent authorities acting together within the Cooperation Group may develop and adopt guidelines concerning the circumstances in which operators of essential services are required to notify incidents, including on the parameters to determine the significance of the impact of an incident as referred to in paragraph 4.

Consequently, all of the above need to apply in the event of a water security-related incident, as part of any EU WDM. In addition, the NIS Cooperation Group has issued a *Reference Document on Incident Notification for Operators of Essential Services – Circumstances of notification*,[14] providing concrete details and guidance, that also needs to be taken into consideration in the same regard.

The NIS CG Document 02/2018 includes a useful example as to its applicability in the water sector, that is relevant to the purposes of this analysis and at the same time clarifies exactly how the NIS Directive is connected to EU Water Legislation and services: "*Where the essential services are critical for societal and/or economic activities, continuity should be understood as the provision of a service at an agreed/reasonable standard of quality. For example, in the case of the Drinking Water subsector, the lack of water due to cyber issues certainly represents an incident, but also the improper provision of water (due to cyber issues) in terms of quantity, quality (health) or other relevant parameters*".[15]

The above, Art. 14 of the NIS Directive, and the Reference Document on Incident Notification will constitute the cybersecurity basis of reference for Part 6 of this report, on the legal assessment of WDM policies.

4.4 Water security incident management under EU personal data protection law

As described under D1.4 (NAIADES Data Collection and Ethical Plan), the GDPR regulates the processing by an individual, a company or an organization of personal data relating to individuals in the EU. The Regulation does not apply to the processing of personal data of deceased persons or of legal entities. Its provisions do not apply to data processing by an individual for purely personal reasons or for activities carried out in one's home provided there is no connection to a professional or commercial activity. At the same time the protection of natural persons in relation to the processing of personal data is a fundamental right. Article 8(1) of the Charter of Fundamental Rights of the European Union (the 'Charter') and Article 16(1) of the Treaty on the Functioning of the European Union (TFEU) provide that everyone has the right to the protection of personal data concerning him or her.

Similarly, the GDPR provides in its text the basic EU personal data protection definitions: For the purposes of this analysis, the definition of "personal data" is included in its Article 4(1): personal data means any information relating to an identified or identifiable natural person ('data subject'); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person.

The notion of identifiability of personal data under the GDPR is further addressed under recital 26 of the Regulation which reads as follows: "To determine whether a natural person is identifiable, account should

[14] CG Publication 02/2018 (henceforth, the "NIS CG Document 02/2018").
[15] In p. 10.

be taken of all the means reasonably likely to be used, such as singling out, either by the controller or by another person to identify the natural person directly or indirectly. To ascertain whether means are reasonably likely to be used to identify the natural person, account should be taken of all objective factors, such as the costs of and the amount of time required for identification, taking into consideration the available technology at the time of the processing and technological developments". The recital clarifies that personal data which have undergone pseudonymisation, which could be attributed to a natural person by the use of additional information, should be considered to be information on an identifiable natural person. The GDPR does not apply to anonymous information, that is information which does not relate to an identified or identifiable natural person. The same rule governs any data that were rendered anonymous in such a manner that the data subject is not or no longer identifiable.

To the extent that WDM processes personal data under the above classification for its own aims and purposes, the GDPR finds application. This report assumes that such is the case, meaning that indeed personal data processing, of for example users' water consumption habits and preferences, are part of contemporary WDM. From this point of view, any security and incident notification requirements posed by the GDPR are applicable onto WDM as well.

Security of personal data processing, both at a general GDPR level and placed upon the NAIADES particulars, has taken place under D1.4. For the purposes of this analysis attention shall be given only to incident notification, that under the GDPR corresponds to a "personal data breach" and its relevant provisions.

In this context, data breach notifications are regulated under Art. 33 of the GDPR. A "personal data breach" is defined in the text of the GDPR, in Article 4(12), as "*a breach of security leading to the accidental or unlawful destruction, loss, alteration, unauthorized disclosure of, or access to, personal data transmitted, stored or otherwise processed*". When this happens, controllers shall, according to Art. 33.1 "*without undue delay and, where feasible, not later than 72 hours after having become aware of it, notify the personal data breach to the supervisory authority competent in accordance with Article 55, unless the personal data breach is unlikely to result in a risk to the rights and freedoms of natural persons. Where the notification to the supervisory authority is not made within 72 hours, it shall be accompanied by reasons for the delay*". The obligation of notification burdens the processor as well, who, shall notify the controller without undue delay after becoming aware of a personal data breach (Art. 33.2). Paragraph 3 of the same article lists the minimum information the notification must contain, such as the nature of the data breach, the name and contact details of the data protection officer, the likely consequences of the personal data breach and the measures taken or proposed to be taken by the controller to address the personal data breach.

Communication of a data breach to the data subject is regulated under Art. 34. This obligation burdens the controller in any case where the personal data breach is likely to result in a high risk to the rights and freedoms of natural persons. The communication to the data subject shall describe in clear and plain language the nature of the personal data breach and contain at least the information and measures referred to in Art. 33.2. Paragraph 3 of article 34 sets the conditions under which the communication to the data subject is not required. In particular par. 3 reads as follows "*The communication to the data subject referred to in paragraph 1 shall not be required if any of the following conditions are met: a) the controller has implemented appropriate technical and organisational protection measures, and those measures were applied to the personal data affected by the personal data breach, in particular those that render the personal data unintelligible to any person who is not authorised to access it, such as encryption b) the controller has taken subsequent measures which ensure that the high risk to the rights and freedoms of data subjects referred to in paragraph 1 is no longer likely to materialise; c) it would involve disproportionate effort. In such a case, there shall instead be a public communication or similar measure whereby the data subjects are informed in an equally effective manner*".

The above, meaning data breach notifications under the GDPR, will constitute the EU data protection

basis of reference for Part 6 of this report, on the legal assessment of WDM policies, under the assumption that personal data processing is an integral part of WDM today.

4.5 Ethical principles for water security incident management

The topic of water ethics is a vast subject whose analysis largely exceeds the purposes of this report. For comprehensiveness purposes only the best ethical practices, as identified by UNESCO,[16] are noted here:

- Human dignity: for there is no life without water and those to whom it is denied are denied life;
- Participation: for all individuals, especially the poor, must be involved in water planning and management with gender and poverty issues recognized in fostering this process;
- Solidarity: for upstream and downstream interdependence within a watershed continually poses challenges for water management resulting in the need for an integrated water management approach;
- Human equality: for all persons ought to be provided with the basic necessities of life on an equitable basis;
- Common Good: for water is a common good, and without proper water management human potential and dignity diminishes;
- Stewardship: for protection and careful use of water resources is needed for intergenerational and intra-generational equity and promotes the sustainable use of life-enabling ecosystems;
- Transparency and universal access to information: for if data is not accessible in a form that can be understood, an opportunity will arise for an interested party to disadvantage others;
- Inclusiveness: water management policies must address the interests of all who live in a water catchment area. Minority interests must be protected as well as those of the poor and other disadvantaged sectors;
- Empowerment: for the requirement to facilitate participation in planning and management means much more than to allow an opportunity for consultation. Best ethical practice will enable stakeholders to influence management.

Even when the wide topic of water ethics is brought down to security and incident management within the context of WDM, still important questions prevail prior to formulating applicable ethics: As identified by Bogardi, "*When a water resources expert is asked to address the ethical aspects of water resources management in general, and flood control and drought alleviation in particular, she/he first requires an interdisciplinary excursion and collection of different ethical views and approaches in order to avoid treating the subject entirely along his/her professional ethical standards or/and by his/her individual value judgements. Various flood control and drought management activities should be juxtaposed within a broader social ethical framework representing how societies (or several stake- holder groups) perceive the issue rather than impose the moral codes of a specific professional group in decision making.*

This requirement implies a number of questions:

- *Do we have different professional ethics?*

[16] UNESCO, Water Ethics and Water Resource Management, 2011.

- *Do we have different ethical scales? Do people behave according to different rules in their private life, within their immediate social environment, at regional, national and global scales?*
- *Do we have different problem-related ethics*?".[17]

The above demonstrate the substantial difficulties in formulating a list of ethical requirements as regards incident management within WDM policies. Bogardi concludes that "*There is no common water ethics (yet). Consequently one can not speak of a consolidated water disasters management ethics*".[18]

Nevertheless, in absence of concrete guidance, the following list is deemed relevant,[19] and shall constitute the ethical basis of reference for Part 6 of this report:

- *Ethics of Preparedness* (invest into awareness, trained human capacity, but also infrastructure and institutions).
- *Ethics of (early) Warning* (tell people the truth in a timely matter, even if it reveals institutional weakness).
- *Ethics of Disaster Response* (save lives, shift into anemergency mode of operation with possibly different ethical principles and standards than in regular mode).
- *Ethics of Recovery* (provide help for self help and to strengthen preparedness, also honour local habits of solidarity).
- *Ethics of Solidarity* (as its reflection the example the introduction of national solidarity based obligatory risk insurance of flood losses could be mentioned).
- *Ethics of Subsidiarity* (whichcouldpracticallyimplythestrengtheningoftheresponsibilityand response capacity of the threatened people and their direct administrative organs at the lowest possible administrative level);
- *Ethics of use the* window of opportunity.

[17] See Bogardi J J, Water disasters and Ethics, in Water Ethics, Marcelino Botín Water Forum 2007, Llamas R/Martinez-Cortina L/Mukherji A (eds.), CRC Press, 2009.
[18] Ibid.
[19] Ibid.

5 The EU WDM Policies

Under this Chapter the EU WDM policies will be identified, the drivers behind their development will be elaborated and input on the role and potential of smart water technologies within the framework of these policies will be attempted.

5.1 WDM policies aimed at network maintenance and rehabilitation

Section 3.1 allowed identifying the existing EU directives in the field of Water Management. The section included multiple WDM policies aimed at network maintenance and rehabilitation, which have been put into place at the EU level. While some of the policies are European, it is important to also note that the European Union is also working on implementing the UN 2030 Agenda, which also guides the scope of the European WDM policies. The following section provides an overview of the most relevant policies in the field.

Policy Name	Short Description of the policy
Water Framework Directive (Directive 2000/60/EC)	The "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy", otherwise known as the EU Water Framework Directive (WFD) is one of the leading documents regulating the EU water policy. It provides an overall framework for integrated water management in Europe. Introduced in 2000, the WFD covers the following aspects: • expanding the scope of water protection to all waters, surface waters and groundwater • achieving "good status" for all waters by a set deadline • basic measures (directives on urban wastewater, nitrate pollution, industry pollution and others) • water management based on river basins • "combined approach" of emission limit values and quality standards • getting the prices right • protected areas (directives on bathing water, habitats, drinking water and others) • getting the citizen involved more closely • streamlining legislation[20]

[20] European Commission, 'Introduction to the EU Water Framework Directive - Environment - European Commission'. Accessed 20 May 2020. https://ec.europa.eu/environment/water/water-framework/info/intro_en.htm.

	Url: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32000L0060
Groundwater Directive 80/68/EEC and Groundwater directive 2006/118/EC	Groundwater Directive 80/68/EEC requires that Member States take the necessary measures, including a special authorisation system, to prevent "List I" substances from entering groundwater, and to limit the entry of "List II" substances so as to prevent pollution of the groundwater.[21] This Groundwater directive 2006/118/EC (also known as the New Groundwater Directive, NGD), complements the WFD and defines a regime which sets groundwater quality standards and presents measures to stop or limit inputs of pollutants into groundwater. The Directive outlines chemical status criteria that the member-states need to follow to monitor and assess groundwater quality on the basis of common criteria. Moreover, the member-states need to identify and reverse trends in groundwater pollution, in line with local characteristics, thus enabling further improvements.[22] **Url:** https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex:31980L0068 **Url:** https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:372:0019:0031:EN:PDF
Marine Strategy Framework Directive 2008/56/EC	The Marine Strategy Framework Directive was adopted by the EU in 2008 in order to improve the protection of the marine environment. Concretely, the Marine Strategy Framework Directive strives for the EU's marine waters to reach a 'Good Environmental Status' (GES) by 2020. The Directive addresses the topic through a multidisciplinary approach, encompassing notions of environmental protection and sustainability. Key points of the Marine Strategy include: • The establishment of environmental targets and associated indicators to achieve GES by 2020 • The establishment of a monitoring programme for the ongoing assessment and the regular update of targets • The development of a programme of measures designed to achieve or maintain GES by 2020.[23] **Url:**https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056
Council Directive 91/271/EEC	Council Directive 91/271/EEC concerning urban waste water treatment was adopted by the EU in 1991 to protect the water ecosystems from the negative effects of discharges of urban waste water and from certain industrial discharges. The Directive is guided by four principles of: planning, regulation, monitoring and information and reporting. More concretely, the Council Directive requires: • The collection and treatment of waste water in all agglomerations of >2000 population equivalents (p.e.); • Secondary treatment of all discharges from agglomerations of > 2000 p.e., and more advanced treatment for agglomerations >10 000 population equivalents in designated sensitive areas and their catchments;

[21] EUR-Lex, 'EUR-Lex - 31980L0068 - EN - EUR-Lex'. Accessed 20 May 2020. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex:31980L0068.
[22] European Commission, 'Groundwater Policy - River Basin - Environment - European Commission'. Accessed 20 May 2020. https://ec.europa.eu/environment/water/water-framework/groundwater/framework.htm.
[23] European Commission, 'Law - EU Coastal and Marine Policy - Environment - European Commission'. Accessed 20 May 2020. https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm.

	• A requirement for pre-authorisation of all discharges of urban wastewater, of discharges from the food-processing industry and of industrial discharges into urban wastewater collection systems; • Monitoring of the performance of treatment plants and receiving waters; and • Controls of sewage sludge disposal and re-use, and treated waste water re-use whenever it is appropriate.[24] **Url:**https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31991L0271
Directive 2008/105/EC	Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 outlines environmental quality standards in the field of water policy. The Directive specifies 33 substances or groups of substances for which environmental quality standards were set in 2008, including selected existing chemicals, plant protection products, biocides, metals and other groups like Polyaromatic Hydrocarbons (PAH) that are mainly incineration by-products and Polybrominated Biphenylethers (PBDE) that are used as flame retardants.[25] **Url:** https://eur-lex.europa.eu/eli/dir/2008/105/oj
The EU Strategy on Adaption to Climate Change	The 2013 EU Strategy on Adaption to Climate Change seeks to improve Europe's climate-resilience. Taking a coherent approach by complementing the activities of Member States, it supports action by promoting greater coordination and information-sharing, and by ensuring that adaptation considerations are addressed in all relevant EU policies and funding programmes.[26] WDM is an important component of the EU Strategy on Adaption to Climate Change, which calls for sustainable water management in order to support climate adaptation initiatives. **Url**:https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0216
The UN 2030 Agenda	The UN 2030 Agenda is a universal call to action to achieve Sustainable Development Goals (SDGs). The 17 Goals were adopted by all UN Member States in 2015, as part of the 2030 Agenda for Sustainable Development which set out a 15-year plan to achieve the Goals. The EU has committed to implementing the 2030 Agenda internally and globally. The EU Communication 'Next steps for a sustainable European future', present a response to the 2030 Agenda and the SDGs. WDM is included in the Communication, particularly in reference to circular economy. The Investment Plan for Europe is a financial instrument targeting water as a 'strategic sector', and facilitating investments in the field. Furthermore, the Communication stipulates that the EU shall decide on the minimum requirements for reused water (SDG 6) in order to promote safe reuse of treated wastewater.[27] **Url**:https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2016%3A739%3AFIN

[24] European Commission, 'Water Pollution - Environment - European Commission'. Accessed 20 May 2020. https://ec.europa.eu/environment/water/water-urbanwaste/index_en.html.
[25] European Commission, 'Priority Substances and Certain Other Pollutants According to Annex II of Directive 2008/105/EC - Environment - European Commission'. Accessed 20 May 2020. https://ec.europa.eu/environment/water/water-framework/priority_substances.htm.
[26] Climate-ADAPT, 'EU Adaptation Strategy — Climate-ADAPT'. Accessed 22 May 2020. https://climate-adapt.eea.europa.eu/eu-adaptation-policy/strategy.
[27] EUR-Lex, 'EUR-Lex - 52016DC0739 - EN - EUR-Lex'. Accessed 22 May 2020. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2016%3A739%3AFIN.

The European Green Deal	The European Green Deal implemented in 2019 by the European Commission offers a roadmap with actions to boost the efficient use of resources by moving to a clean, circular economy restore biodiversity and cut pollution**.** The Green Deal is part of the European Commission's strategy to implement the UN 2030 Agenda and the sustainable development goals. Amongst the multiple areas covered by the Green Deal, the following are particularly related to WDM: o Mobilising industry for a clean and circular economy o From 'Farm to Fork': designing a fair, healthy and environmentally-friendly food system o A zero-pollution ambition for a toxic-free environment **Url:**https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN

5.2 The drivers behind the EU WDM policies

We have identified that the WDM policies in the EU are underpinned by three main categories of drivers: Environmental, economic and political. The following section provides additional insights into each one of them.

- **Environmental drivers**

Water is a precious, sensitive and vulnerable resource. Indeed, the World Economic Forum Global Risks Report 2020 lists water crises as one of the largest and highest impact risks in the next decade, ensuing "a significant decline in the available quality and quantity of fresh water, resulting in harmful effects on human health and/or economic activity"[28]. The increase in economic development and the rise in pollution levels are responsible for many water supply problems encountered globally. Environmental stress and climate change are driving the water-related crises around the world. Humanity may face a water crisis, with demand expected to surpass supply by 40% in 2030, if current trends continue.[29] In this context, the environmental factor is an important driver behind the WDM policies for the EU. This is not only confirmed at the regional level, but also at the member-state level. Indeed, according to a survey conducted by the European Environment Agency (EEA) across the member-states, resource efficiency is seen as a priority in nearly all countries, as the concern about environmental degradation is on the rise. Member-states highlight the critical role of the environment plays for their economy and societies as well as the interconnection between resource management, climate change and energy.[30]

In the past decade, the EU has secured a leadership position in global environmental discussions, acting as a pioneer in UN environmental conferences and as a frontrunner in enforcing the 2030 Agenda through a

[28] World Economic Forum, 'Global Risks Report 2020' 15th edition, http://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf

[29] World Economic Forum. 'How Do We Prevent Today's Water Crisis Becoming Tomorrow's Catastrophe?' Accessed 22 May 2020. https://www.weforum.org/agenda/2017/03/building-freshwater-resilience-to-anticipate-and-address-water-crises/.

[30] European Environment Agency, 'Resource Efficiency in Europe — Policies and Approaches in 31 EEA Member and Cooperating Countries'. Publication. Accessed 22 May 2020. https://www.eea.europa.eu/publications/resource-efficiency-in-europe.

close collaboration between the EU and the member-states. In order to achieve the objectives of the 2030 Agenda, the European Commission has called for the inclusion of the UN SDGs into all of the EU policies and initiatives, closely supported by the three pillars of sustainability (environmental protection, social equity and economic viability).

In the WDM sphere, the Water Framework Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy is one of the first environmental policies in the EU, and offers the adequate legal framework for the protection of water resources and ecosystems, particularly in regard to drinking water, bathing water, urban wastewater management and pollution prevention.

Additionally, the EU Strategy on Adaption to Climate Change is also a reference document which places sustainable water management as critical to globally tackle climate change-related issues, particularly in the Mediterranean region, where there is an increasing water demand for agriculture.

- **Economic drivers**

The economic drivers behind WDM policies and, by extension, the SDGs are clear: According to research for the Business and Sustainable Development Commission, achieving the SDGs across the world could be worth up to US$12 trillion a year for the private sector and 380 million new jobs by 2030.[31]. From a member state level, most EU countries fear that the potential scarcity of resources may put important stress on the economy, particularly in light of possible increases in price and price volatility, including in the water sector[32].

The Blue2 study on 'the socio-economic assessment of policies aiming to improve the quality of freshwater and the marine environment' conducted by the European Commission has demonstrated that the water sector is highly profitable – in the EU, the costs of water as an input are negligible compared to the Gross Value Added (GVA)[33] that is generated from the sector. Indeed, the report stipulates that the total expenses related to acquisition, recirculation and pre- and post-treatment of water by the water dependent sectors are estimated to be around EUR 175 billion per year, which is relatively small compared to the value added that is created by these sectors (the expenses are equal to 5% of GVA). Moreover, research reveals that 26% of the EU's GVA is generated by economic sectors that are highly dependent on water in sufficient quantity and/or quality. Furthermore, these same sectors also provide 44 million jobs.[34]

[31] Business & Sustainable Development Commission, 'Better Business, Better World', n.d., 122.
[32] European Environment Agency, ibid.
[33] Gross value-added: output (at basic prices) minus intermediate consumption (at purchaser prices); it is the balancing item of the national accounts' production account. (source: European Commission, Blue2 study)
[34] Schellekens, Joachim, Laura Heidecke, Nga Nguyen, and Wim Spit. 'Task A2 of the BLUE2 Project "Study on EU Integrated Policy Assessment for the Freshwater and Marine Environment, on the Economic Benefits of EU Water Policy and on the Costs of Its Non- Implementation"', n.d., 69.

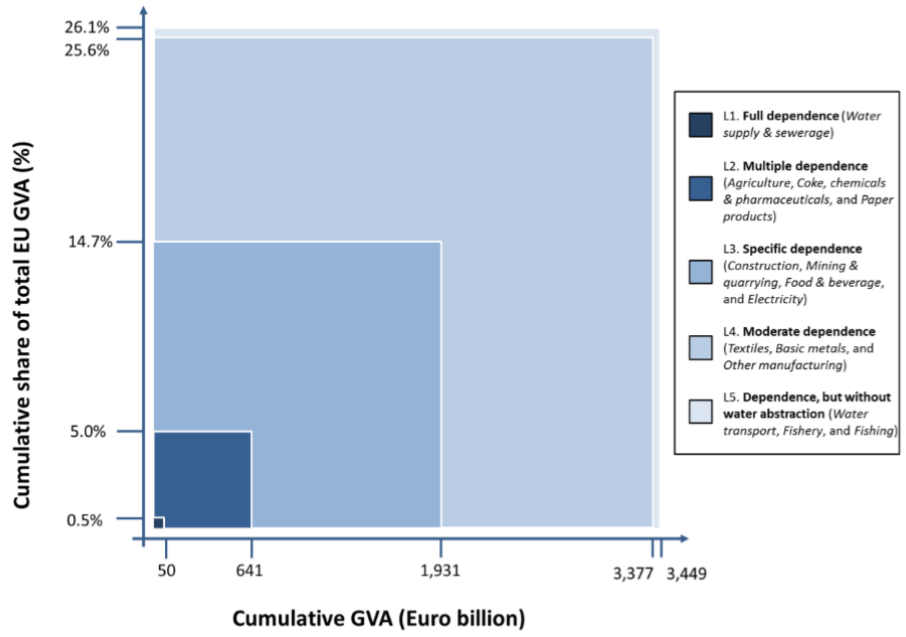

Figure 1: Gross Value Added of the EU's water-dependent sectors by layer, 2015[35]

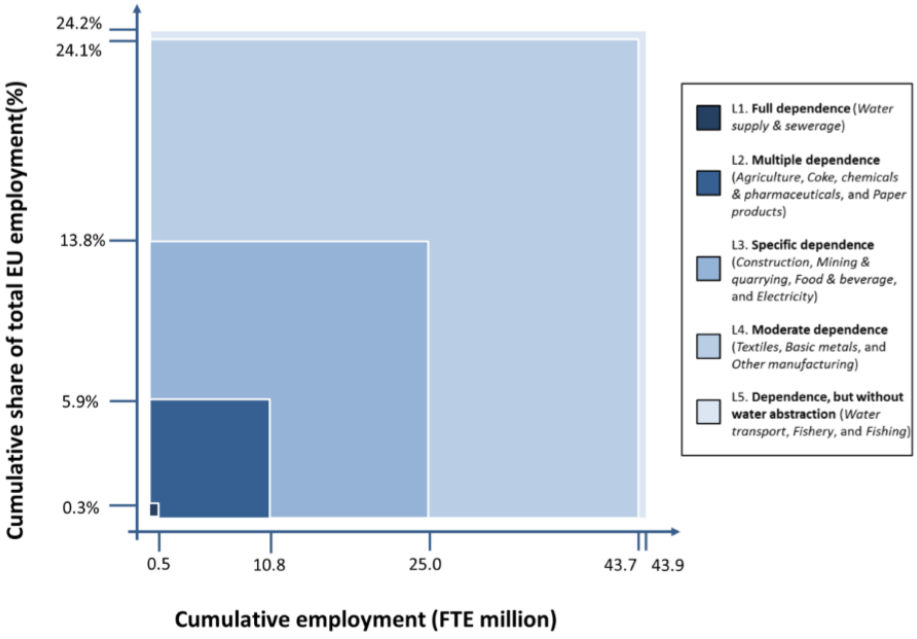

Figure 2: Employment generated by the EU's water-dependent sectors (million FTE and % of total EU), 2015[36]

Additionally, European leadership and pioneer status in the field of water legislation, has positioned the EU as a competitive global actor in the field of water innovation. The EU holds a share of 41% in internationally granted water technology patents. Although in the last decade, the EU's share in the field has been overtaken by Asian countries (Japan in particular), the EU has maintained a stable role.

[35] Ibid.
[36] Ibid.

With the adoption of the EU Green Deal in 2019, which puts a high stress on a resource-efficient and competitive Europe, green growth has been placed at the forefront of the strategy. WDM plays an essential role in green growth and innovation. Indeed, in regard to SDG6 on Water and Sanitation, Water Europe identifies the following aspects to be considered to stimulate green growth[37]:

- Investment and innovation focused on areas which lower costs and enhance water efficiency, like water recycling, reusing or exploring alternative sources (SDG 6.3 and 6.4);
- Investment in water storage technologies and practices (including grey and green solutions), to secure access in the face of uncertainty (SDG 6.4) and improved access to water supply and sanitation, results in huge economic, social and environmental benefits (SDG 6.1, 6.2 and 6.6);
- Investing in water supply, sanitation and wastewater infrastructure brings important dividends, in particular in urban slums where unsafe water and lack of sanitation generates huge health costs and lost economic opportunities (SDG 6.3), which can be minimized through innovative solutions and business models with private sector involvement (SDG 6.5, 6a, 6b);
- Investing in the expansion of international cooperation as well as in capacity-building support to developing countries in the field of water and sanitation (SDG 6.a).

- **Political drivers**

Political factors, particularly in relation to cooperation and development also drive WDM policies in the European Union. Water stress is still a reality in Europe, leading to serious issues such as water shortages, flooding, pollution and ecosystem disruption. In 2007 the European Commission has estimated that at least 11 % of Europe's population and 17 % of its territory had been affected by water scarcity, putting the cost of droughts in Europe over the past thirty years at EUR 100 billion.[38] The EEA acknowledges that although the overall water quality in the EU has significantly improved over the past 20 years, there is still progress to be done on the integrated management of water resources. EU water legislation requires revision and harmonization to better address water stress-related issues, while also accounting for the large discrepancy in water supply and use across European regions.[39] In this regard, WDM policies are and will be politically-driven, not only at the EU supranational level, but also dynamically reacting to the demand of the member-states to find holistic and regional solutions. The aforementioned EEA survey on resource efficiency has shown that EU policies are a strong driver for policy development at the member-state level, and that the member-states are mainstreaming elements of EU resource policies directly into their national legislations.[40]

Additionally, from a global governance perspective, it is important to point out that the EU's political implication in WDM policies, not only at a regional, but also at an international level, is a preventive response to global water insecurity issues, which often result in social unrest and global migration.

[37] Water Europe, 'Water in the 2030 Agenda for Sustainable Development: How Can Europe Act?', 2019, https://watereurope.eu/wp-content/uploads/2019/07/Waterin-the-2030-Agenda-for-Sustainable-Development.pdf

[38] European Commission, 'Water Scarcity and Drought - Environment - European Commission'. Accessed 22 May 2020. https://ec.europa.eu/environment/water/quantity/scarcity_en.htm.

[39] European Environment Agency. 'The Problems of Water Stress'. Page. Accessed 22 May 2020. https://www.eea.europa.eu/publications/92-9167-025-1/page003.html.

[40] European Environment Agency, ibid.

Addressing water insecurity issues will positively impact migration patterns, which today constitute a major preoccupation of the EU, and are a foundation for European wellbeing and growth[41].

5.3 The role and potential of smart water technologies in the context of WDM policies

The increasing advance on next generation of internet technology (IoT, Big Data, Blockchain, etc.) has derived on an evolvement of water technology towards smarter and autonomous system. In this regard, the role of smart water technologies into water domain has marked the strategy towards the modernization and digitalization of the sector. Thus, smart water technologies permit to reduce sector fragmentation by a common understanding of water information. This technology facilitates the knowledge extraction towards accurate decision making related to water resource planning, operational decision in water distribution, water quality mechanism, strengthen relationship between water companies and their customers or even, a recommendation of future investments on the water infrastructure based on their specific needs and objectives at medium and long term.

Therefore, the role of the ICT inside the Smart Water Technology in the water value chain is essential to increase the confidence on innovation potential of the technology and also engage the interest of utilities, companies, governments and citizens. Considering the prosperous role of the technology inside the water domain, the "The Digital Single Market for Water Services Action Plan" for the EC[42] and "Towards a Future-Proof Model for a European Water-Smart Society"[43] and "Strategic Innovation and Research Agenda"[44] from WssTP are key documents that reflects future directions of ICT in the water domain. During the section, we will proceed to analyze the documents to finally derive future directions and research in ICT for the water domain.

The "The Digital Single Market for Water Services Action Plan" was published by the European Commission in 2018. The document has the objective of contributing to "the Connected Digital Single Market and the Resilient Energy Union objectives by promoting energy efficient smart ICT technologies in the water sector". Contributing to this objective, the Action Plan focuses on the following aspects:

- Transparent information exchange and free flow of non-personal data to ensure the data sharing between different services at cross domain and also establish data analytics layers to improve decision-making.
- Semantic Platforms to ensure interoperability and data integration between domains providing a context for the information.
- Open, secure and robust architectures providing Open Data interfaces and establishing Open Data Policies to promote and foster the co-generation of data-driven algorithms and knowledge sharing through reliable data sets that finally permit to advance in new decision-making strategies.
- Smart Water Solutions in order to obtain real-time data using different timeframes to improve the monitoring and control and sustain data analytics and decision-making in the water domain.

[41] Water Europe, ibid.
[42] The Digital Single Market for Water Services Action Plan. https://ec.europa.eu/futurium/en/system/files/ged/ict4wateractionplan2018.pdf
[43] Towards a Future-Proof Model for a European Water-Smart Society. https://watereurope.eu/wp-content/uploads/2020/04/WE-Water-Vision-english_online.pdf
[44] Strategic Innovation and Research Agenda (WssTP). https://watereurope.eu/wp-content/uploads/2019/07/Water-Europe-SIRA.pdf

- Smart Water Awareness to ensure the involvement of all actors across water value chains towards ensuring the digital transformation in the water domain.

In the document, these main aspects have been technically derived in a proper strategy for the upcoming years (Figure 3). This strategy is divided into 6 specific working group actions:

- Interoperability and Standardization (I&S) that is aimed at providing common data harmonization mechanism and strategies to the water sector like semantic interoperability, common data exchange languages, etc.
- Data Sharing (DS) focuses on recommendations to sharing information across services making emphasis on the free flow of non-personal data.
- Smart Water (SW) main challenge is to drive innovations on real-time monitoring and control, including their analytics and data intensive nature.
- Cybersecurity (CS) main aim is to ensure robust and secure mechanism to protect digital infrastructures.
- Actors Awareness (AW) is a social-driven working group to perform training to the different actors and raise awareness on the importance of adopting digitalization in water infrastructure.
- Policy (POL) focuses on the promotion of digital water approaches and skills inside the policies. Moreover, this working group also focuses on the privacy management of data sharing and the corresponding alignment with existing and future regulations.
- Business Models (BM) main aim is to distill the benefits of digital solutions and smart water since the economic perspective.

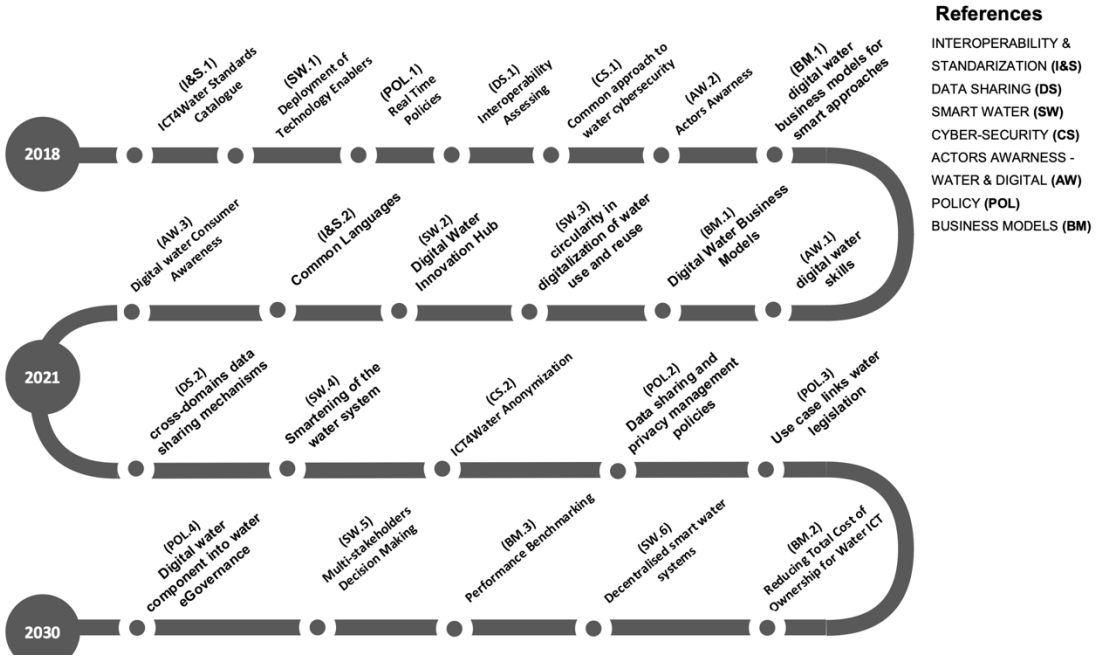

Figure 3. Roadmap of the Digital Single Market for the water domain

The "Strategic Innovation and Research Agenda" of the WssTP was published on 2016 and its main objective is to "show the routes towards a better exploitation and stewardship of our water sources by society and businesses while developing resilient and sustainable solutions for our key global water challenges". Considering this general objective, the WssTP vision focuses on the development of new

technologies, solutions, business and governance models for constructing the water-smart-society of the future.

The SIRA strategy (Figure 4) is divided in 6 different key components or pillars as described below:

- The Value of Water. Development of the water smart society for Europe by enabling new technologies, economic and business models.
- Technologies. Digital and treatment water technologies to enable clean waters, higher levels of insight and manageability of the water systems and closing loops between multiple waters that exist in the domain.
- Hybrid Grey and Green Infrastructure. Elaboration of new materials and technologies aimed at maintaining, improving and redesigning the water infrastructure into a smart and economically sustainable system.
- Governance. Development of governance practices for the future aligning it with the future technology and decision-making tools.
- Living Labs Pilots. Development of enabling technologies and innovations that include smaller scale trials and demonstrations.
- Horizontal. All technologies and schemes covering cross-user stewardship, water footprint, assessment methodologies, water-nexus, etc.

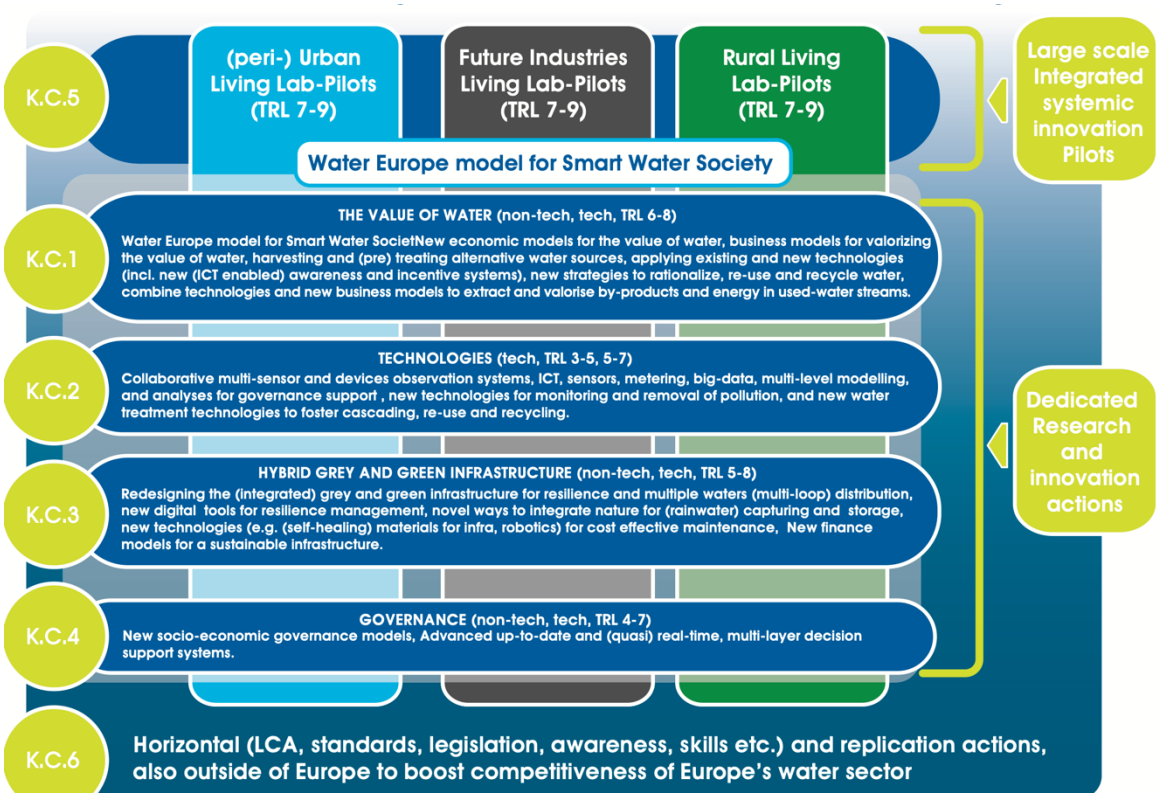

Figure 4. SIRA schema of the WssTP for bringing smart water technologies to water sector

Considering these main pillars, the SIRA document of the WssTP recommends the following smart water technology promotion for the next coming years:

Pillar	Smart Water technology

Smart Sensors and Water Technology	Zero Liquid Discharge (ZLD) approaches in industrial applications. Drain Water Management techniques to optimise water in aquaculture ICT tools for sustainable agriculture (smart metering and monitoring, smart irrigation, etc) Membrane and other separation technologies in water. Nano-membranes for water purification and treatment. Nanotechnologies to ensure clean water. UV technology for the measurement of water quality Autonomous monitoring of energy in water networks. New sensors for the detection of chemical and pollutans Passive and Active sampling techniques New sensors for the biological measurement of micro-organisms New sensors for the protection and security of the water critical infrastructure. Low-cost monitoring systems for the detection of failures in the water network.
Data Analytics Tools	Optimization algorithms for water use in cooling and heating Forecasting techniques extreme climate events Early warning systems for water quality and pollution Newer data integration and fusion techniques to improve water data visualization. Advance modelling, simulation, control and optimization techniques Techniques for the detection of storm water overflows Big data analytic techniques for managing disasters and threats (floods, extreme events, etc)
Decision Support and Management Tools	Industrial Matchmaking platforms for valorisation of wastewater. Tools to support the industrial symbiosis (sustainable development tools, LCA Water, LCA Waste, etc). Smart urban management and planning solutions Smart energy management systems ICT tools for nutrient management and recycling Nexus Decision support systems Serious Games to develop multi-stakeholder water diplomacy Advanced multiscale modelling, and river-basing management in compliance with the WFD.

Complementing this table and vision of smart water technologies towards building water smart society, the WssTP on 2017 make an update and detail on the technologies to be used to manage waters in urban areas. In this regards the document entitled as "Towards a Future-Proof Model for a European Water-Smart Society" and envisions the following technology to improve symbiosis between water and the related domains:

- Advanced technologies that make various new alternative water sources available for multiple uses
- Innovative digital technologies (e.g. sensors, data analysis and support tools) to enable measurements and near real-time monitoring of -and insight into- water extraction, treatment, distribution, quality and use; new digital technologies for better planning of water infrastructure and allocation aiming at resilience under changing circumstances;
- New solutions for source control measures to prevent water cycle pollution (or to prevent pollution from entering water cycles) and prevent pollution through water discharge.
- Advanced irrigation and crop-growing technologies that drastically reduce water use in agriculture.
- Advanced and cost-effective solutions to extract and exploit the value that is in water: from energy to nutrients, micro-pollutants, chemicals, minerals and metals.

As it can be appreciated from the relevant research strategical documents related to smart water technology, the the next coming years will proliferate the use of nano-sensors, new intelligent materials, water quality and assessment tools, nexus decision-making and also management tools in relation with the cross-domains. In these regards, the table below reflects the technology to be promoted by the different water value chains:

Water value chain/Technology	Treatment Tech	Smart Sensors	DLT	AR	Models/Simulations	RT Tools	Big-Data	Robotics
Source Management		x				x	x	
Abstraction & Treatment	x	x			x	x	X	x
(Re-) Distribution		x			x	x	x	
Consumption	x	x	x	x		x	x	
WasteWater	x	x			x	x	x	x

Considering this table, the final remarks on Smart Water Management tools are gathered in the followed points:

- Advancement on the detection, categorization and mitigation of water quality and pathogens in water.
- Advancements in smart sensors for the optimization on the use of water considering the different interrelated domains (agriculture, energy, etc).
- Advancements on innovative water technology (new membranes, ZLD) that permit to regenerate and recycle water from specific cases to large scale.
- Proliferation of data injection and integration tools guaranteeing the information during time by the use of digital ledger technologies.

- Proliferation of autonomous and immersive tools to manage the water infrastructure (Augmented Reality, robotics and autonomous vehicles).
- Newer data-driven algorithms, models and simulations tools that consider cross-domain information to derive accurate decisions.

5.4 WDM in the NAIADES pilot cases

This part of the report is aimed at presenting the role of the smart management technologies that the NAIADES case-studies are willing to apply in order to be compliant with the current and existing directives and standards.

In order to perform such analysis, we requested the NAIADES demo-cases (Alicante, Carouge and Braila) to fulfil a survey that compress information about the technologies in order to overcome specific EU directives and most common standards that are potentially prone to be adopted in each of the demo-cases (see Annex 1).

Considering the information received, Table 1 is aimed at providing an overview of the smart water technology adopted in the demo-cases in order to accomplish the different standards and data exchange models. As can be appreciated within the table, there is no standard data exchange model being adopted to make the different tools interoperable. Thus, it makes plausible the dependency of specific vendors to transmit the information to the control center and also, the vendor-based information consumption where it is publicly provided. In this regard, NAIADES will offer a much needed mechanism and information integration technology to make the information interoperable and explored in a common way in order to sustain smart digital services.

Table 1. SmartWater Technology aligned with standards

Standard	Technology that uses the standard
Service activities relating to drinking water supply, wastewater and stormwater systems (ISO/TC 224)	○ Methods and procedures to measure water quality.
WaterML2-HY_FEATURES (OGC WaterML2-HY_FEATURES)	N/A
GroundwaterGML2 (OGC WaterML2-GroundWaterML2)	N/A
SensorThings (OGC-Sensor Things)	N/A
SAREF4WATR	N/A
NGSI-LD	N/A
Water Quality (ISO/TC 147)	N/A
Hydrometry (ISO/TC 113)	N/A

Functional reference architecture for communications in smart metering systems (CEN/CLC/ETSI/TR50572)	N/A
Water reuse (ISO/TC 282)	N/A
Life cycle Assessment (ISO/TC 207/SC5)	N/A
Environmental management (ISO 14000)	N/A

Similarly, the EU Directives adopted in the demo-sites mainly cover the WFD and the GWD based on the nature of the case-studies. Considering these Directives, they are willing to mention the procedures to measure water quality (not totally related with technology). This aspect mainly reinforces the need to continuous monitor and control water quality in the water infrastructure in order to tackle rapid decisions in case of appearance harmful water quality events.

Table 2. Smart Water Technology aligned with existing directives

Directive	Technology that uses the directive
Water Framework Directive (Directive 2000/60/EC)	○ Procedures to measure water quality and potential contaminants.
Groundwater directive (Directive 2006/118/EC)	N/A
Priority Substances & Pollutants (Directive 2008/105/)	N/A
Marine Strategy Framework Directive (Directive 2008/56/EC)	N/A
Urban Wastewater Treatment Directive (COUNCIL DIRECTIVE 91/271/EEC)	○ Procedures to measure water quality and potential contaminants.

As a conclusion of this section, the Smart Water Technologies adopted in the demo-cases showed the need to reinforce interoperability and standardization procedures in order to tackle efficient decisions based on the information collected in the water critical infrastructure. Moreover, there is also a need from the directives in terms of measuring water quality, especially with the current lived situation where COVID-19 is forcing cross-domain water infrastructures to minimise their effects and impact into the society.

6 Legal Assessment of the EU WDM Policies

Under this Chapter the EU WDM policies will be assessed against a legal background, in particular within a security and security incident management context.

6.1 A common axis of analysis for the legal assessment of the EU WDM policies

Through combined reading of Chapters 4 and 5 of this report, and in order to be able to assess from a legal point of view the EU WDM policies in effect today, a common axis of analysis needs to be applied to them. In particular, polices under Chapter 5 will be placed under the criteria identified under Chapter 4. This theoretical exercise is believed will enable the identification of findings and conclusions that will be useful not only for the NAIADES purposes but also as valid general EU policy recommendations within the topic of security incident management in the water services.

According to Chapter 4 the following legal topics are of concern during a WDM legal assessment exercise:

- Under the WFD and the GWD no security incident management legal requirements could be identified;

- Water security incident management under EU cybersecurity law (the NIS Directive) requires that, in order to avoid incidents due to cyber issues:

  - Suppliers take appropriate and proportional technical and organizational measures to manage the risks posed to the security of network and information systems in their operations (Art. 14 of the NIS Directive);
  - Suppliers take appropriate measures to prevent and minimize the impact of incidents affecting the security of the network and information systems used for the provision of their services (Art. 14 of the NIS Directive);
  - Competent authorities are notified of any incidents without delay (Art. 14 of the NIS Directive);
  - The significant of an incident is assessed in terms of number of users affected, duration of the incident and its geographical spread (Art. 14 of the NIS Directive and (NIS Cooperation Group Document 02/2018)

- Water security incident management under EU personal data protection law (the GDPR) requires that, in order to avoid infringements of the individual right to personal data in the event of personalised data processing in the EU (smart) WDM:

  - GDPR compliance mechanism is installed (that depending on the type and level of processing may require such internal mechanisms as a Data Protection Officer or a Data Protection Impact Assessment);
  - Personal data breach notifications mechanisms are in place (Art. 33 of the GDPR);
  - Security policies for personal data processing are in place (Art. 32 of the GDPR).

It is therefore against the above criteria that the WDM policies identified under Chapter 5 will be assessed from a legal point of view in the analysis that follows.

6.2 WDM policies placed under the applicable EU regulatory framework

Under chapter 5.1 of this report, the following WDM policies, each corresponding to an EU legal instrument, have been identified as more pertinent and relevant to this analysis:

(1) The WFD;
(2) The GWD;
(3) The EQSD; and
(4) The Marine Strategy Framework Directive and the Urban Waste Water Directive.

Each one of the above EU Directives applies WDM policies at EU and Member State level. If placed under the applicable EU regulatory framework the following legal assessment can be derived:

- **The WFD**

As noted above the Water Framework Directive aims at:

- expanding the scope of water protection to all waters, surface waters and groundwater;
- achieving "good status" for all waters by a set deadline;
- water management based on river basins;
- "combined approach" of emission limit values and quality standards;
- getting the prices right;
- getting the citizen involved more closely;
- streamlining legislation.

Accordingly, its Article 1 on its purpose sets that:

> *The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:*
>
> *(a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;*
>
> *(b) promotes sustainable water use based on a long-term protection of available water resources;*

(c) aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;

(d) ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and

(e) contributes to mitigating the effects of floods and droughts

and thereby contributes to:

– the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use,

– a significant reduction in pollution of groundwater,

– the protection of territorial and marine waters, and

– achieving the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment, by Community action under Article 16(3) to cease or phase out discharges, emissions and losses of priority hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.

As regards security issues, and in particular security incident management, when applying the criteria or chapter 6.1 the following can be established:

- Under a NIS Directive perspective, no technical and organizational measures are prescribed in the text of the WFD that suppliers or other competent authorities would need to take in order to manage security incidents and risks; Similarly, no list of threats or other incidents can be found in the text of the WFD, neither is there any notification policy requirements set for competent authorities or supplies with regard to incidents;
- Under a GDPR perspective, no mention is made to smart water management, a personal data compliance mechanism as regards personal data processing involved in such a system, or to any particular security policies or incident notification mechanisms against security breach incidents.

- **The GWD**

As noted above the Groundwater Directive (in particular, the New Groundwater Directive) complements the WFD and defines a regime which sets groundwater quality standards and presents measures to stop or limit inputs of pollutants into groundwater. In essence the GWD requires:

- groundwater quality standards to be established;
- pollution trend studies to be carried out by using existing data and data which is mandatory by the WFD;
- pollution trends to be reversed so that environmental objectives are achieved by using the measures set out in the WFD;

- measures to prevent or limit inputs of pollutants into groundwater to be operational so that WFD environmental objectives can be achieved;
- reviews of technical provisions of the directive to be carried out in 2013 and every six years thereafter;
- compliance with good chemical status criteria (based on EU standards of nitrates and pesticides and on threshold values established by Member States).

The above policies are referred to under its Article 1, setting the purposes of the GWD.

As regards security issues, and in particular security incident management, when applying the criteria or chapter 6.1 the following can be established:

- Under a NIS Directive perspective, no technical and organizational measures are prescribed in the text of the GWD that suppliers or other competent authorities would need to take in order to manage security incidents and risks; Similarly, no list of threats or other incidents can be found in the text of the GWD, neither is there any notification policy requirements set for competent authorities or supplies with regard to incidents;
- Under a GDPR perspective, no mention is made to smart water management, a personal data compliance mechanism as regards personal data processing involved in such a system, or to any particular security policies or incident notification mechanisms against security breach incidents.

- **The EQSD**

As noted above the Directive 2008/105/EC (also known as the Priority Substances Directive) outlines environmental quality standards (EQS) in the field of water policy; It specifies 33 substances or groups of substances for which environmental quality standards were set back in 2008. As such, the EQSD complements the WFD, in particular its Article 16 setting out strategies against water pollution and outlining the steps to be taken. According to Annex V, point 1.4.3 of the WFD and Article 1 of the EQSD, good chemical status is reached for a water body when it complies with the EQS for all the priority substances and other pollutants listed in Annex I of the EQSD.

The EQSD repealed five older Directives, thus contributing itself to the EU better regulation standards. Nevertheless, the 2012 European Commission's proposal for a Directive amending the EQSD and the WFD (COM(2011)876) is yet to be concluded.

As regards security issues, and in particular security incident management, when applying the criteria or chapter 6.1 the following can be established:

- Under a NIS Directive perspective, no technical and organizational measures are prescribed in the text of the EQSD that suppliers or other competent authorities would need to take in order to manage security incidents and risks; Similarly, no list of threats or other incidents can be found in

the text of the EQSD, neither is there any notification policy requirements set for competent authorities or supplies with regard to incidents;
- Under a GDPR perspective, no mention is made to smart water management, a personal data compliance mechanism as regards personal data processing involved in such a system, or to any particular security policies or incident notification mechanisms against security breach incidents.

- **The Marine Strategy Framework Directive and the Urban Waste Water Treatment Directive**

The above two Directives, as noted above, aim at achieving Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend, as well as, at protecting the water ecosystems from the negative effects of discharges of urban waste water and from certain industrial discharges respectively.

In view of the different subject-matter, security concerns not being within their scope or subject-matter, and in order to avoid repetition, the above findings on the EFD, the GWD and the EQSD are also applicable in this case as well.

6.3 Findings and recommendations

Although the EU regulatory framework in the water services field is several decades old, formal fitness checks run by the Commission as late as in 2019 demonstrate its robustness: The basic finding is that "*the Directives [the WFD, the EQSD, the GWD and the FD] are largely fit for purpose*". Accordingly, the Commission identified the factors that have contributed to the effectiveness of these Directives in progressing towards their objectives as:

- the list of priority substances;
- the (binding) cross-references to the WFD's objectives in other EU policies;
- EU funding;
- the widely applicable non-deterioration principle; and
- the Directives' monitoring requirements.[45]

On the other hand, the Commission also identified as factors that "hindered the achievement of better results", among others:

- lack of a governance framework that takes into account the specific conditions in each Member State;
- lack of restoration measures to address pressures from the past;
- full implementation of other pieces of EU legislation, such as the Nitrates Directive and the Urban Waste Water Treatment Directive not yet achieved; and
- — better integration of water objectives in other policy areas such as agriculture, energy or transport

[45] Information from the EU Commission's website (DG Environment), available at https://ec.europa.eu/environment/water/fitness_check_of_the_eu_water_legislation/index_en.htm

that has not happened yet at the scale necessary.

However, it has been the findings of this analysis that the above assessment is single-sided and introvert. The provisions of the EU Water Legislation are assessed by themselves, according to their aims and purposes and taking into account the general water environment and conditions in the EU since their release. As such, meaning within their own merit, they indeed seem to remain relevant and pertinent several years after their release, demonstrating thus the robustness of EU law-making work at the time of their drafting.

Nevertheless, by now other fields of law, as assisted by technology, also affect water services in the EU. While these fields appeared irrelevant and remote twenty years ago, technological developments have shifted the focus towards them as well. In essence, smart water services technologies and new ICT used for water management and distribution have altered WDM substantially since the time the above Directives were released. Smart water services have made water use personal, thus enabling EU personal data protection. Network information systems, in the meaning of the NIS Directive, that are used today for WDM, making each relevant supplier an OES under the same Directive, means that its terms and provisions also apply in full in EU water services. This is why, from a legal point of view, the EU applicable regulatory framework needs to take these developments into account and devise, possibly, a new, uniform, comprehensive and updated approach that would tackle challenges and create new development opportunities.

Consequently, the main policy recommendation under this report is the need to align the EU Water Legislation with the EU cybersecurity and personal data protection frameworks. This can be achieved either by means of a new, specialized EU legal instrument (in the form of a Directive or other) to be added to the list of the basic EU Water Legislation Directives, as identified above under 3.1, or through specific mention and treatment in the already issued EU Water Legislation.

The specific topics that will need to be treated under this new instrument or specialized provisions are, indicatively, the following:

- Management of cyber risks; Taking basic EU cybersecurity law into account and the relevant legal obligations placed upon water suppliers (as OES), specific guidance is required so as to place general requirements onto the water sector;
- Identification of incidents: Within a cybersecurity and smart water context security-related incidents in the water sector may affect quality or quantity of water or management of water distribution in ways that were previously, at the time of release of the basic EU Water Legislation, unforeseen: New regulation ought to take these incidents into account;
- Designation of competent authorities and other actors in the water sector: Because smart water technologies are expected to enlarge the circle of actors within the EU water services field, essentially opening-up the traditional model of a water supplier, concrete guidance will be required as to the role, rights and obligations of each one;
- Personal data processing in the smart water technologies context: Employment of smart water technologies unavoidably leads to larger volumes of personal data processing: Consumption habits and traits of individuals as well as other personal information and circumstances may be combined in order to improve overall water supply, distribution and quality. The risks and challenges of such increased personal data processing, taking into account that water is a basic element of life, need to be elaborated and placed within the existing EU personal data protection regulatory framework;
- Accountability: Involvement of additional, new actors in WDM within a smart water technologies context means a new allocation of roles. This inevitably leads to a new model of obligations and liabilities. Within this new environment the principle of accountability, whereby each actor needs to apply concrete measures that warrant compliance as regards its role in WDM, is of central

importance in order to acquire public trust;
- Transparency: Smart water technologies, and the inevitable involvement of Artificial Intelligence and the development of new alorightms particular to WDM make a transparent WDM model imperative, in order to mitigate risks and warrant legal and ethical compliance/

All of the above recommendations amount to a need for a technological overhaul and update of the existing EU Water Legislation, in order for it to take into account recent technological and regulatory developments. Water legislation in the EU no longer develops in isolation, dealing exclusively with its own (admittedly, of fundamental importance) subject-matter, challenges and requirements, but is also directly affected by other fields of law. Rather than these other fields of law, unrelated as they are to the particular needs and circumstances of EU Water Legislation, dealing incidentally with water issues, it is hereby submitted that the best suited actor to face these regulatory and technological challenges would be the EU Water Legislation itself.

7 Conclusions

This report carries the twofold objective of demarcation and identification of the EU WDM policies applicable today, as well as, their assessment from a legal point of view. In order to accomplish this the relevant EU policies and applicable regulatory framework were mapped in great detail, and a standard, common axis of analysis serving the purposes of the NAIADES project (essentially, to transform the water sector through automated and smarter water resource management and environmental monitoring) was placed against them. Findings were perhaps unexpected, in the sense that, while the robustness and relevance of the basic EU Water Legislation remains beyond doubt, little has been done until today, at least from a law-making point of view, to address the advent of new technologies in the water sector. Essentially, smart water technologies pose new challenges to EU water policy and regulation, that until today have been left unanswered in the relevant specialized legislation, and are therefore currently treated under the general EU regulatory framework of cybersecurity and personal data protection law.

This finding constitutes the basic contribution of this report: While not directly related to the NAIADES technological solution, it improves its compliance with the applicable regulatory framework, taking into account fields of law that at first sight may appear unrelated to the EU Water Legislation. In addition, taking into account work carried out under the NAIADES project, this report makes concrete recommendations for future EU policy- and law-making. The relatively recent convergence of new technologies with traditional water distribution management policies appears to have the potential to substantially change the relevant field, affecting its basic assumptions and understandings; This report aims at constituting a first step in identification of this trend and in the drafting of possible and effective remedies.

References

Bakker K/Morinville C, The governance dimensions of water security: A review, Phil. Trans. R. Soc., 2013

Correlje A/Francois D/Verbeke T, Integrating Water Management and Principles of Policy: Towards an EU Framework? Journal of Cleaner Production, V15.16, November 2007

European Commission, The Digital Single Market for Water Services Action Plan, https://ec.europa.eu/futurium/en/system/files/ged/ict4wateractionplan2018.pdf

European Commission, Towards a Future-Proof Model for a European Water-Smart Society, https://watereurope.eu/wp-content/uploads/2020/04/WE-Water-Vision-english_online.pdf

European Commission, Strategic Innovation and Research Agenda (WssTP), https://watereurope.eu/wp-content/uploads/2019/07/Water-Europe-SIRA.pdf

European Commission, Water Scarcity and Drought, https://ec.europa.eu/environment/water/quantity/scarcity_en.htm.

European Environment Agency, The Problems of Water Stress, https://www.eea.europa.eu/publications/92-9167-025-1/page003.html.

European Environment Agency, Resource Efficiency in Europe — Policies and Approaches in 31 EEA Member and Cooperating Countries, https://www.eea.europa.eu/publications/resource-efficiency-in-europe.

NIS Cooperation Group, Reference document on Incident Notification for Operators of Essential Services Circumstances of notification, CG Publication 02/2018, February 2018

Moss T, Solving Problems of 'Fit' at the Expense of Problems of 'Interplay'? The Spatial Reorganisation of Water Management Following the EU Water Framework Directive, in Breit H/Engels A/Moss T/Troja M, How Institutions Change, Perspectives on Social Learning in Global and Local Environmental Contexts, VS Verlag für Sozialwissenschaften, 2003

Page B/Kaika M, The EU Water Framework Directive: Policy Innovation and the Shifting Choreography of Governance, Environmental Policy and Governance, V13.6, November/December 2003

Schellekens J/Heidecke L/Nguyen N/Spit W, Task A2 of the BLUE2 Project "Study on EU Integrated Policy Assessment for the Freshwater and Marine Environment, on the Economic Benefits of EU Water Policy and on the Costs of Its Non- Implementation" '.

Scocca G, Strengthening International Water Security: The European Union's proposal, World Water Policy, Volume 5 Issue 2, November 2019 (https://onlinelibrary.wiley.com/doi/full/10.1002/wwp2.12014)

Water Europe, Water in the 2030 Agenda for Sustainable Development: How Can Europe Act?, https://watereurope.eu/wp-content/uploads/2019/07/Waterin-the-2030-Agenda-for-Sustainable-Development.pdf

Wheater H S/Gober P, Water security and the science agenda, 50th Anniversary of Water Resources Research, June 2015

World Economic Forum, How Do We Prevent Today's Water Crisis Becoming Tomorrow's Catastrophe? https://www.weforum.org/agenda/2017/03/building-freshwater-resilience-to-anticipate-and-address-water-crises/.

Annex I. Survey about Policies and applicable law at EU level

PROJECT DELIVERABLE REPORT

Greening the economy in line with the sustainable development goals

Demo-Case Consultation about policies and directives at EU level

A holistic water ecosystem for digitisation of urban water sector

SC5-11-2018

Digital solutions for water: linking the physical and digital world for water solutions

Introduction & instructions to questionnaire recipients

This document is mainly devoted to gather information about the used standards and requirements in the different NAIADES demo-cases. The questionnaire/consultation presented in the following sections takes 15 min to be filled.

The Section 2 is mainly focused on the used standards in the water infrastructure. The consultation is willing to determine the used technologic standards and the technology capable of implement it.

Similarly, the Section 3 is aimed at identified the directives considered in the water infrastructure at EU level and their alignment with the technology that support to their implementation.

Thank you very much in advance for collaborating with us.

Questionnaire

Please mark with a cross those EU directives that apply to your demo-case and the technology used to satisfy the directive (if any).

Standard	Is this standard used in demo-case?	Technology that uses the standard
Service activities relating to drinking water supply, wastewater and stormwater systems (ISO/TC 224)		
WaterML2-HY_FEATURES (OGC WaterML2-HY_FEATURES)		
GroundwaterGML2 (OGC WaterML2-GroundWaterML2)		
SensorThings (OGC-Sensor Things)		
SAREF4WATR		
NGSI-LD		
Water Quality (ISO/TC 147)		
Hydrometry (ISO/TC 113)		
Functional reference architecture for communications in smart metering systems (CEN/CLC/ETSI/TR50572)		
Water reuse (ISO/TC 282)		
Life cycle Assessment (ISO/TC 207/SC5)		
Environmental management (ISO 14000)		
Other (if any, specify the name):		

Please mark with a cross those EU directives that apply to your demo-case and the technology used to satisfy the directive (if any).

Directive	Is this standard used in demo-case?	Technology that uses the directive
Water Framework Directive (Directive 2000/60/EC)		
Groundwater directive (Directive 2006/118/EC)		
Priority Substances & Pollutants (Directive 2008/105/)		
Marine Strategy Framework Directive (Directive 2008/56/EC)		
Urban Waste Water Treatment Directive (COUNCIL DIRECTIVE 91/271/EEC)		
Other (if any, specify the name):		