Water Europe

Technology & Innovation

THE VALUE OF WATER

TOWARDS A WATER-SMART SOCIETY


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INTRODUCTION

This Vision document has been drawn up by Water Europe, with the input of its members and key stakeholders. It represents an update of the previous Vision document, which was produced in 2016 with the aim of charting a course of action to tackle the key societal challenges related to water, a vital resource underpinning our lives and economies.

The document outlines what the Water-Smart Society of the future should look like, based on emerging technologies and societal trends, which are expected to produce a paradigm shift in how we manage the planet's finite resources and the impact of climate change. By 2030, the transition to this Water-Smart Society should be in full swing, and be playing a major role in Europe's twin transformation to a green and digital society, and climate neutrality by 2050.

The document also outlines the higher-level innovations that will play a key role in realising this vision centred on the 'Value of Water'. It aims to inspire and indicate the course of action for policymakers, researchers, technology developers, water service providers and water management authorities, as well as regions, cities and citizens. It invites these stakeholders to work together in building a secure, sustainable and resilient Water-Smart Society, while contributing to meeting global societal challenges and the development of the global water market for innovative solutions. Lastly, it proposes a number of Key Impact Parameters to help monitor the advance in the transition to the Water-Smart Society in Europe.

EXECUTIVE SUMMARY

The human right to water encompasses five requirements: 1) availability, 2) accessibility, 3) affordability, 4) acceptability, and 5) quality and safety. These must be fulfilled to satisfy the human rights to water and sanitation, and protect the health of users and the general public, regardless of their identity, location or ability to pay.
Adapted from the UN Water website, 2022.

The Water Europe vision for a Water-Smart Society

This Water Europe Vision document charts the pathways towards society's better use, valorisation and stewardship of our water resources, and the development of resilient and sustainable solutions to address our key water challenges. It describes how these challenges can be transformed into opportunities for developing and deploying new European technologies, solutions, businesses and governance models for the Water-Smart Society of the future. It projects a future of comprehensive water security, sustainability and resilience for all societal functions, and of full environmental protection. It is a vision in which all relevant stakeholders are involved in the sustainable governance of our water system, in a way that meets ecological, social and economic needs, without compromising the ability to meet these needs in the future; water scarcity and pollution of European groundwater and surface water are avoided, while biodiversity is restored; water, energy and resource loops are largely closed to foster a circular economy; the water system is resilient and robust against demographic pressure and climate change events; and European water-dependent businesses thrive, thanks to forward-looking research and innovation. Although the vision is focused on the European situation, many of its features are relevant to realising Water-Smart Societies all over the world.

A paradigm shift towards an inclusive Water-Smart Society

The Water-Smart Society envisaged by Water Europe entails a paradigm shift in the way the value of water is recognised and realised, water-smart solutions are developed and deployed, and our future society organised and managed with regard to water. This shift calls for bold and courageous decisions, investments, changes, and new types of stakeholder partnerships at all levels of society, involving citizens, public authorities at all levels, scientists, industries and farmers, as well as the stewards of the natural environment. It will require the development of a dual migration path to introduce both new solutions and governance practices, with the involvement of all relevant stakeholders at urban, regional, inter-regional, national and international level.

The Water-Smart Society will leverage both the dramatically increased manageability made possible by the emerging cyber-physical environment and 'digital water' technologies, as well as the increased availability of 'multiple waters' to complement freshwater sources. It will also be characterised by much deeper levels of awareness, integration and collaboration between organisations and citizens.

Since the migration towards the Water-Smart Society will demand significant investment in redesigned and adapted infrastructure, as well as innovative technologies, it comprises a complex mix of challenges and opportunities for European industry. These will demand a longer-term programme to drive a stable and successful migration towards the future Water-Smart Society.

A Water-Smart Society is one in which the value of water is recognised and realised to ensure water security, sustainability, and resilience; all available water sources are managed so that water scarcity and pollution are avoided; water and resource loops are largely closed to foster a circular economy and optimal resource efficiency; the water system is resilient against the impact of climate and demographic change; and all relevant stakeholders are engaged in guaranteeing sustainable water governance.

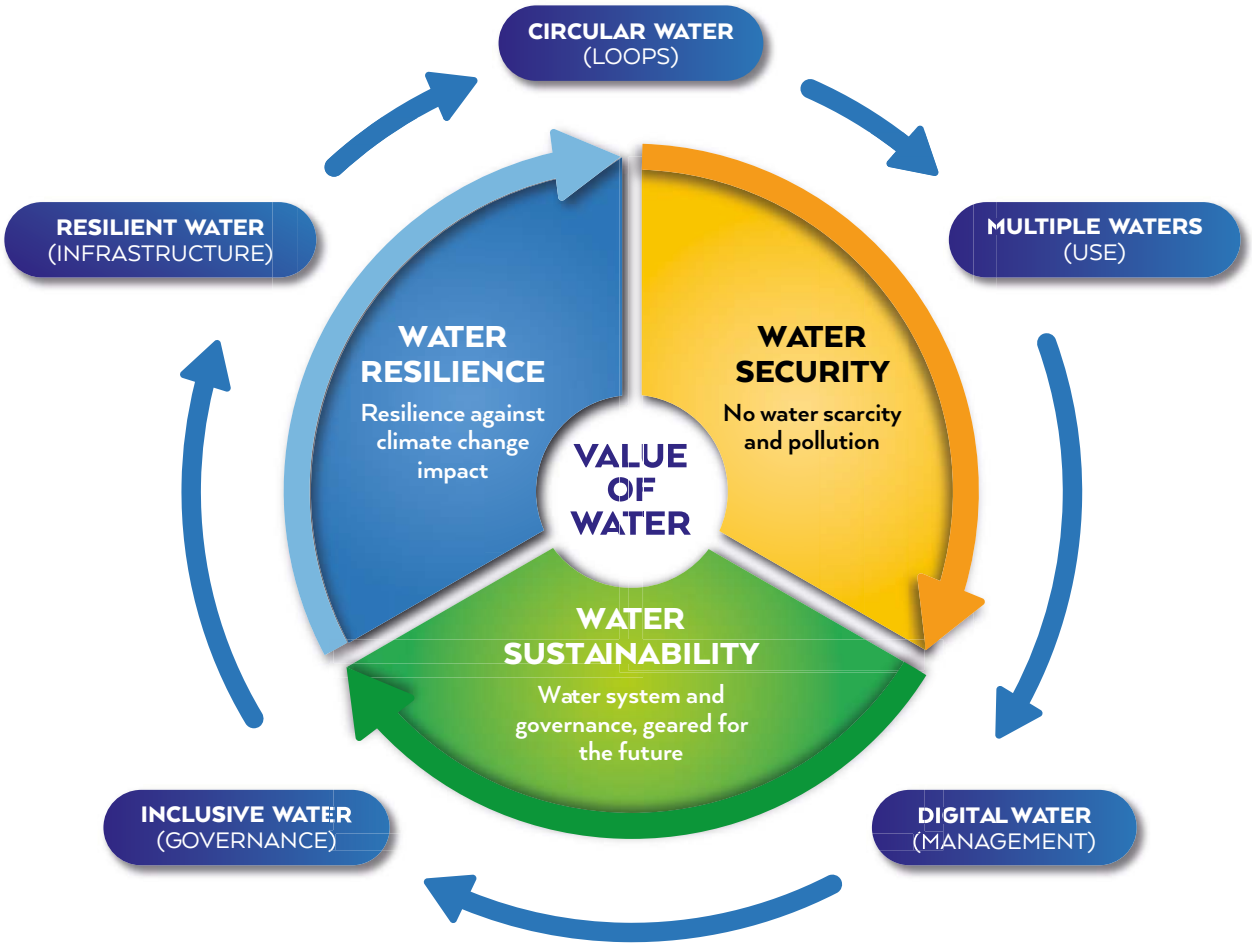
A Water-Smart Society

The human right to water encompasses five requirements: 1) availability, 2) accessibility, 3) affordability, 4) acceptability, and 5) quality and safety. These must be fulfilled to satisfy the human rights to water and sanitation, and protect the health of users and the general public, regardless of their identity, location or ability to pay.
Adapted from the UN Water website, 2022.

The Water-Smart Society Model

Water Europe has developed a model for a Water-Smart Society to illustrate its key objectives, and the different elements involved in the above paradigm shift as well as their inter-relationships. As presented below, the model consists of one core value, three key objectives that need to be achieved to realise the core value, and five specific innovation concepts that are crucial to realising the objectives. The model indicates how the innovation concepts and key objectives are interrelated, and together generate a 'flying wheel' effect that drives the process towards the Water-Smart Society.

Figure 1: The Water-Smart Society model



Source: Water Europe

One core value

The Value of Water is at the heart of Water Europe's vision for a Water-Smart Society. This core value reflects the centrality of water as a human right and its fundamental role in our society. A multifaceted role that includes enabling all economic activities, underpinning societal functions related to citizen health and well-being, while also representing a source of economic value generated from the extraction and valorisation of raw materials and energy contained in water systems, thereby offering a unique sustainable source to serve a circular economy.

Three key objectives

1. Water Security: safeguarding sustainable access to sufficient quantities of affordable and fit-for-purpose water, in order to preserve the health of the population and ecosystems, foster the socio-economic development of society, and ensure their protection against water-related disasters, such as those resulting from climate change.

2. Water Sustainability: ensuring water infrastructure, management and use that are economically and environmentally sustainable, in a way that meets current ecological, social and economic needs, without compromising the ability to meet these needs in the future.

3. Water Resilience: achieving long-term resilience, so that natural and anthropogenic water systems can withstand unexpected disruptive events, averting serious consequences, such as droughts and floods, while guaranteeing the reliability of the water system.

Five Innovation concepts

1. Circular Water: circular water system that minimises water losses, captures and exploits the value in water, and fosters water security, sustainability and resilience.

2. Multiple Waters: incorporate a wide range of water sources and qualities (groundwater and surface water, rainwater, brackish water, brine, grey water, black water, recycled water) into a water-secure, resilient and sustainable water system.

3. Digital Water: exploit the benefits of the extreme interconnectivity of people, devices and processes, and create capillary networks capable of monitoring the water system, starting at its multiple sources through to the individual end-user, thus generating continuous flows of valuable data for innovative decision-support systems at different governance levels.

4. Inclusive Water: establish a water system whose governance balances the interests of all stakeholders in its design, management and maintenance**.**

5. Resilient Water: create a resilient and reliable hybrid grey and green water system, designed to withstand severe external and internal shocks – such as climate-change induced floods and droughts – without compromising essential functions.

Transitioning to a Water-Smart Society

In short, Water Europe envisions a significant transformation of the current European water sector. The innovation concepts outlined above, along with measurable objectives and key impact parameters for water security, sustainability and resilience, will drive decision-makers to realise this transition and build new water-smart economies. This will be enabled primarily by innovative governance models, new technologies created within inclusive, open innovation environments, such as innovation-enhancing Water-Oriented Living Labs (WOLLs), and by a transformed and updated water infrastructure serving the Water-Smart Society.

Overall, the Water Europe water vision aims at the implementation of a set of innovations which will result in a 50% reduction in the demand pressure exerted on our groundwater and surface water resources, thereby eliminating water scarcity in Europe.

By 2030, the transition to a Water-Smart Society will be in full swing, driven by visionary front-running industries, cities and rural areas. These will have taken the lead in laying out the migration paths towards the Water-Smart Society of the future. They will have implemented ambitious long-term investment and innovation programmes, as well as real-life WOLL experimental areas. WOLLs will have created a European network of fertile and inclusive innovation ecosystems, where solution developers, researchers, forward-looking water users and water governing bodies will develop the leading solutions of the future. In Water Europe's vision WOLLs will play an important enabling role in driving the transition to the Water-Smart Society. They will boost Europe's competitiveness in the global water market, creating numerous new green jobs in Europe, while making significant contributions towards achieving Europe's Green Deal targets and the UN's Sustainable Development Goal 6 (Clean Water and Sanitation) and other water-related SDGs.

CONTENTS

1 • VISION BACKGROUND: SOCIETY'S WATER CHALLENGES

Water Challenges

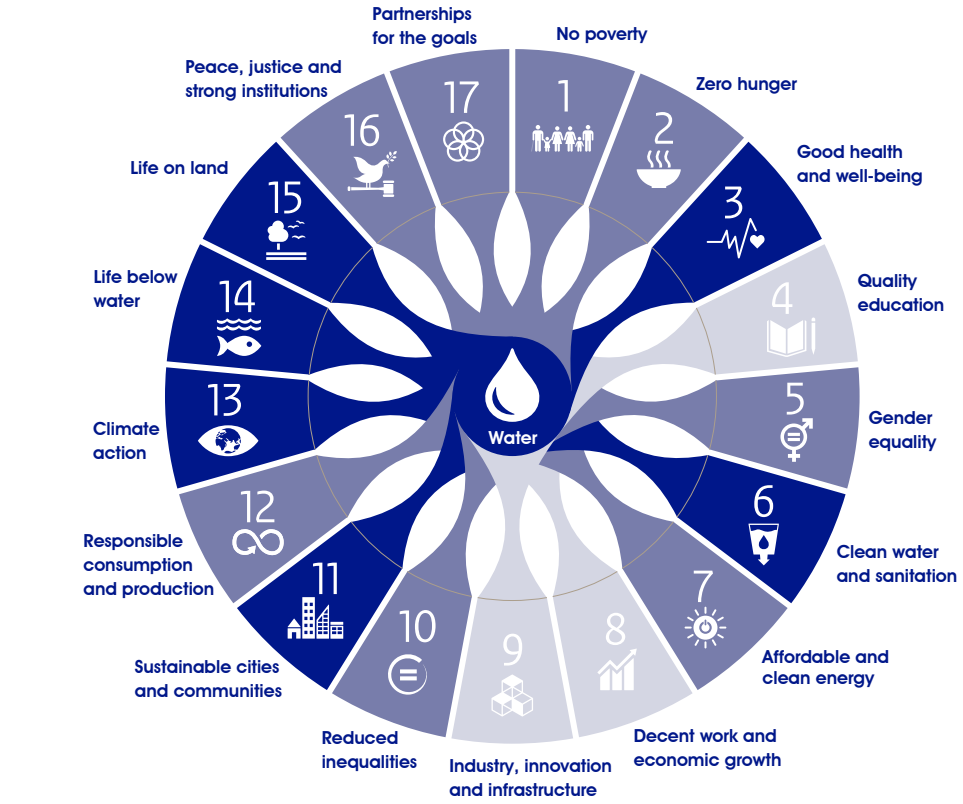
'Securing an adequate supply of clean water despite the damaging effects of climate change is one of the world's most urgent challenges.' **World Economic Forum, 2022**

The Value of Water is at the heart of Water Europe's vision for a Water-Smart Society. This core value reflects the centrality of water as a human right and its fundamental role in our society. A multifaceted role that includes enabling all economic activities, underpinning societal functions related to citizen health and well-being, while also representing a source of economic value generated from the extraction and valorisation of raw materials and kinetic and thermal energy contained in water systems, thereby offering a unique sustainable source to serve a circular economy. It is also closely aligned with the UN's Sustainable Development Goal 6 (Clean Water and Sanitation) and other water-related SDGs, as illustrated below[1].

Figure 2: Core value Water-Smart Society model

Source: Water Europe

Figure 3: Sustainable Development Goals related to water

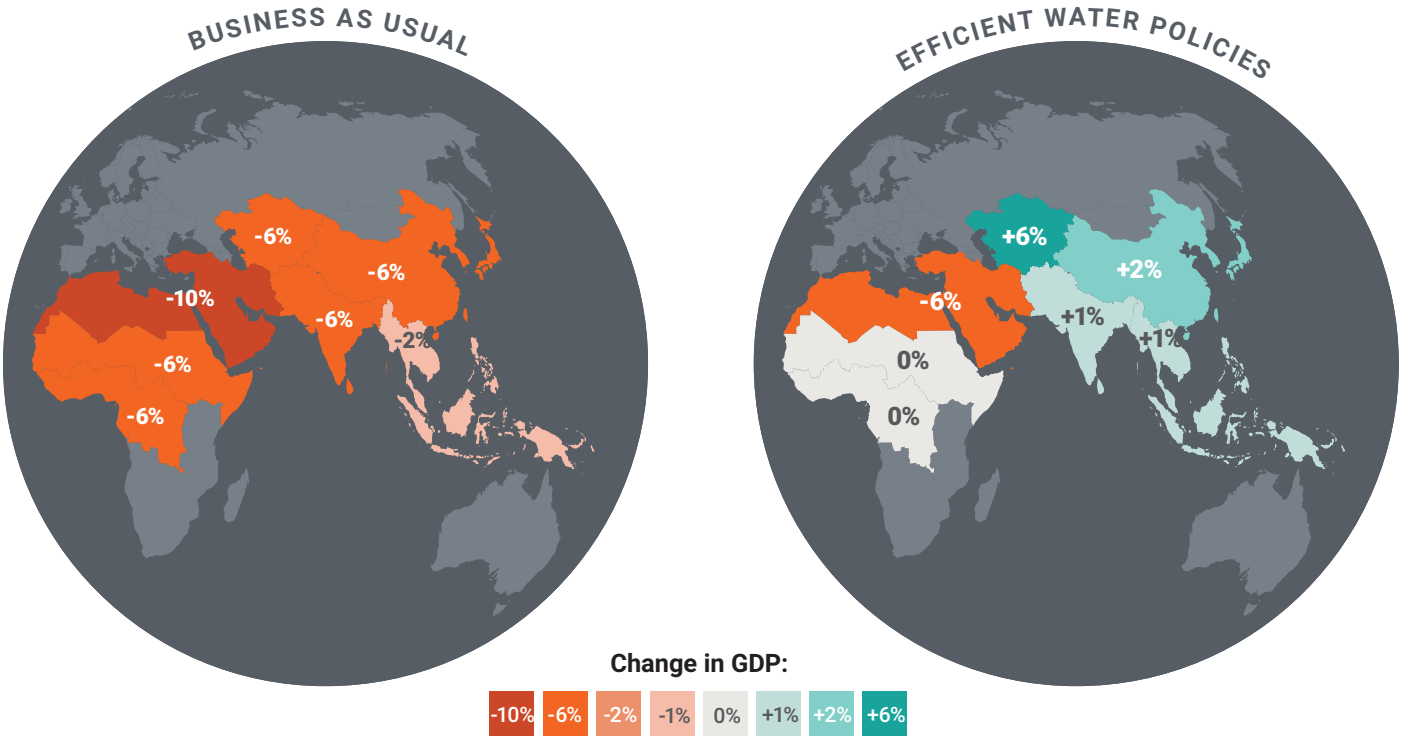


Group 1 targets: strongly related to water
Group 2 targets: related to water
Group 3 targets: indirectly related to water

Source: PBL

The realisation of this core value in today's world represents a major and growing societal challenge. The supply, treatment and distribution of water is critical to our society: it safeguards our food, sanitation, health and well-being. The management of this vital resource must therefore take all humans into consideration[2]. But climate change is having a critical impact on the availability and quality of water resources, and water security is increasingly at the centre of numerous pressing issues, from the loss of livelihoods, to slower economic growth, to the escalation of violent conflicts[3]. As shown in Figure 4, estimates indicate that, in the absence of efficient water allocation and policy measures, by 2050, water scarcity could cause declines of up to 10% in GDP in many regions of the world, while their implementation would have a significant mitigating impact[4]. In this regard, Europe is in a comparatively favourable position, since most of its countries would only need to invest 0.5% of their national GDP to deliver sustainable water management, while in other countries this can exceed 4% of GDP.

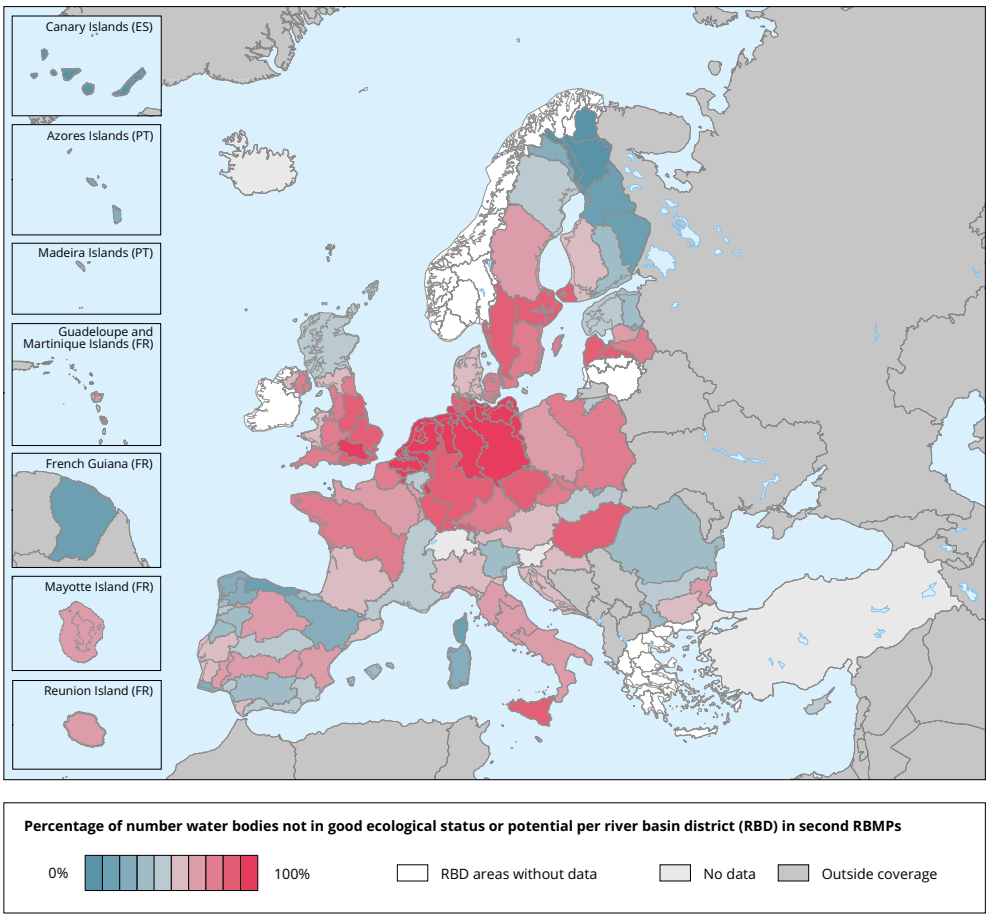
Figure 4: Estimated change in 2050 GDP due to water scarcity, under bussiness-as-usual policy regime



Source: Global Commisision on Adaptation 2019, World Bank 2016.

In more specific terms, water policies will, for instance, have to address the World Resource Institute's prediction of a 56% gap between water supply and demand in Europe by 2030[5]. The industrial sector, as one of the major water consumers in Europe is, for example, confronted with an urgent need to manage water scarcity. The ultimate cost of inaction would exceed by five times the investment required to tackle upfront the water risks related to industrial activities.

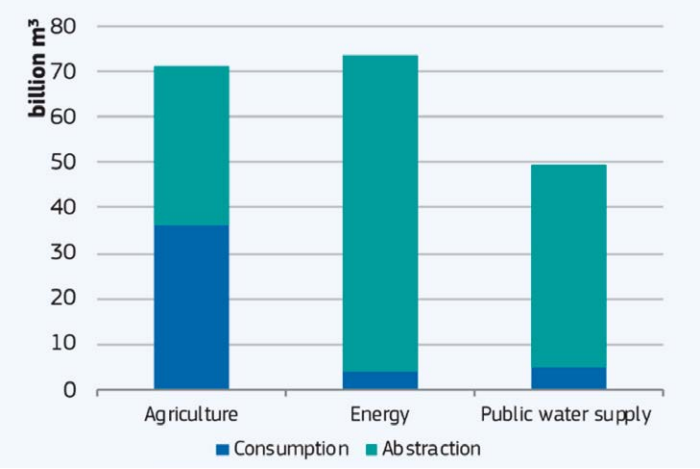
Figure 5: Percentage of water bodies in Europe's River Basin Districts that are not in good ecological status/potential: second River Basin Management Plans



Source: Results are based on WISE-SoW database including data from 24 Member States (EU-28 except Greece, Ireland, Lithuania and Slovenia). Water bodies failing to achieve good status.

Water quality also presents a considerable challenge. As shown in the map in Figure 5, only 40% of the European surface water bodies achieve good or better ecological status, while 60% did not achieve good status[7]. Urban, industrial and agricultural pollution is causing a deterioration in water quality and thus impacting water availability. Of the thousands of chemicals in use and potentially present in surface water, relatively few have been identified as the reason water bodies fail to achieve good status. It is not known how many other chemical pollutants are present in surface water and whether their concentrations should cause concern. It is, therefore, essential that research and innovation in the field of water contamination be promoted.

Figure 6: Comparison of water abstraction and consumption for energy



The nexus character of the challenge becomes apparent when one looks at the water abstracted and consumed on a sectoral basis. As shown in the figure below, for example, the energy sector in Europe only consumes 6% of abstracted water it receives: the remainder is returned to the hydrological system[8].

Source: JRC

Water security is, therefore, often closely paired with other policy objectives and strategies. The benefits to be reaped could be considerable. Indeed, it has been calculated that the decarbonisation of the energy system would be accompanied by a 38% reduction of its water needs by 2050[9].

According to the EEA, water scarcity affected 29% of the EU territory during at least one season in 2019. Moreover, there has been no overall reduction in the area affected by water scarcity conditions, despite the 15% decline in water abstraction over 2000-2019[10].

In some regions, when the available surface water resources are insufficient for food production, groundwater resources serve as a main source for irrigation. However, excessive groundwater abstraction often leads to overexploitation and thus to groundwater depletion, which constrains sustainable food production[11].

As elaborated in detail below in this Vision document, new, efficient, cross-sectorial and inclusive water policies and innovations are imperative if success is to be achieved in addressing society's water challenges, and the underlying questions of water security, water scarcity and water resilience.

2 • OPPORTUNITIES FOR EUROPE

The challenges outlined above are indeed considerable and urgent, but Europe is uniquely positioned to respond to them with efficient policies and innovative solutions. The response will confirm Europe's global leadership in water management, and boost the competitiveness and/or performance of water service providers, water users and technology providers.

Europe's wide climatic diversity makes it a unique testing ground for new governance and technologies. Besides the classic geographical contrast between a desiccating south and the traditionally water-secure north, Europe is also confronted with a number of phenomena associated with the more extreme weather events caused by climate change. This means that the north will also suffer from droughts and the south from extreme flooding. So, while the differences between European regions remain significant, there is a growing commonality in the problems and solutions ahead.

European society is increasingly aware that we need to change the way we manage our planet's limited natural resources. European industries are global leaders in water technologies. The continent features an advanced, highly populated society that is well-placed to develop and showcase the innovations needed for our future Water-Smart Society, in which the value of water is fully recognised and realised.

Europe has ample prospects for developing new combinations of innovative digital solutions, water treatment technologies, economic, governance and business models, as well as a redesigned hybrid grey and green water infrastructure. Together, these advances should offer integrated solutions to reduce the impact of our society on freshwater sources and create a resilient water system for the future. This will involve the transformation of real-life urban, industrial and rural areas into Water-Oriented Living Labs (WOLLs): fertile real-life open innovation environments, where these novel synergetic water concepts and solutions can be developed, tested and prepared for market introduction, in Europe and throughout the world[12].

Europe has the chance to turn water challenges into new technological, societal and business opportunities.

3• A WATER-SMART SOCIETY FOR EUROPE AND THE WORLD

Water Europe envisions a significant transformation of the current European water sector. This transformation will be driven by a number of key objectives and innovation concepts for a Water-Smart Society. Novel water solutions to achieve these objectives will be blueprinted within a network of inclusive, open innovation environments. New governance structures, solutions, and pricing mechanisms to capture the value of water, technologies to reduce, reuse, recycle and cascade water streams, a redesigned water infrastructure, as well as deeper water stewardship programmes, will all manoeuvre the water market towards a 50% reduction of demand pressure on our natural water system, and the development of resilience against the impact of demographic and climate change. Although the vision is focused on Europe, its different features are, of course, equally relevant to realising Water-Smart Societies all over the world.

Figure 7: Key objectives of the Water-Smart Society model

Source: Water Europe

Water Europe has developed a model to present the different elements involved in the paradigm shift to a Water-Smart Society. As illustrated above, this includes three key objectives that uphold the Value of Water, namely:

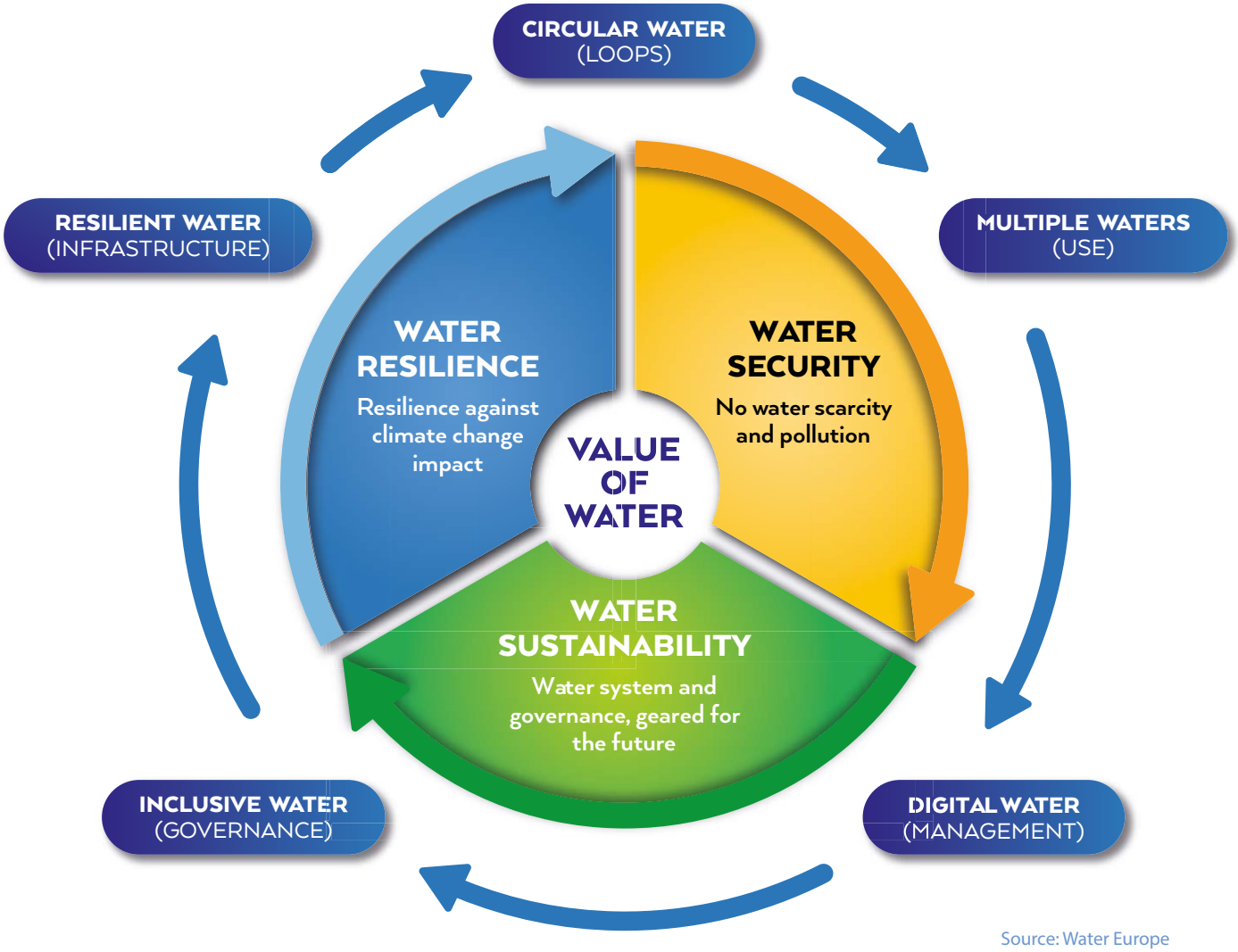
1. Water Security: safeguarding sustainable access to sufficient quantities of affordable and fit-for-purpose water, in order to preserve the health of the population and ecosystems, foster the socio-economic development of society, and ensure their protection against water-related disasters, such as those resulting from climate change.

2. Water Sustainability: ensuring water infrastructure, management and use that are economically and environmentally sustainable, in a way that meets current ecological, social and economic needs, without compromising the ability to meet these needs in the future.

3. Water Resilience: achieving long-term resilience, so that natural and anthropogenic water systems can withstand unexpected disruptive events, averting serious consequences, such as droughts and floods, while guaranteeing the reliability of the water system.

For Water Europe, the achievement of these key objectives depends essentially on the implementation of the following five innovation concepts: **1) Circular Water 2) Multiple Waters 3) Digital Water 4) Inclusive Water and 5) Resilient Water**. The relationship between the different elements – the core value, key objectives and innovation concepts – involved in the paradigm shift to a Water-Smart Society are presented in the complete model shown below. The model indicates how the innovation concepts and key objectives are interrelated, and together generate a 'flying wheel' effect that drives the process towards the Water-Smart Society.

Figure 8: Innovation concepts in the Water-Smart Society model



Source: Water Europe

The realisation of these key innovation concepts in the future Water-Smart Society is discussed below under the following headings:

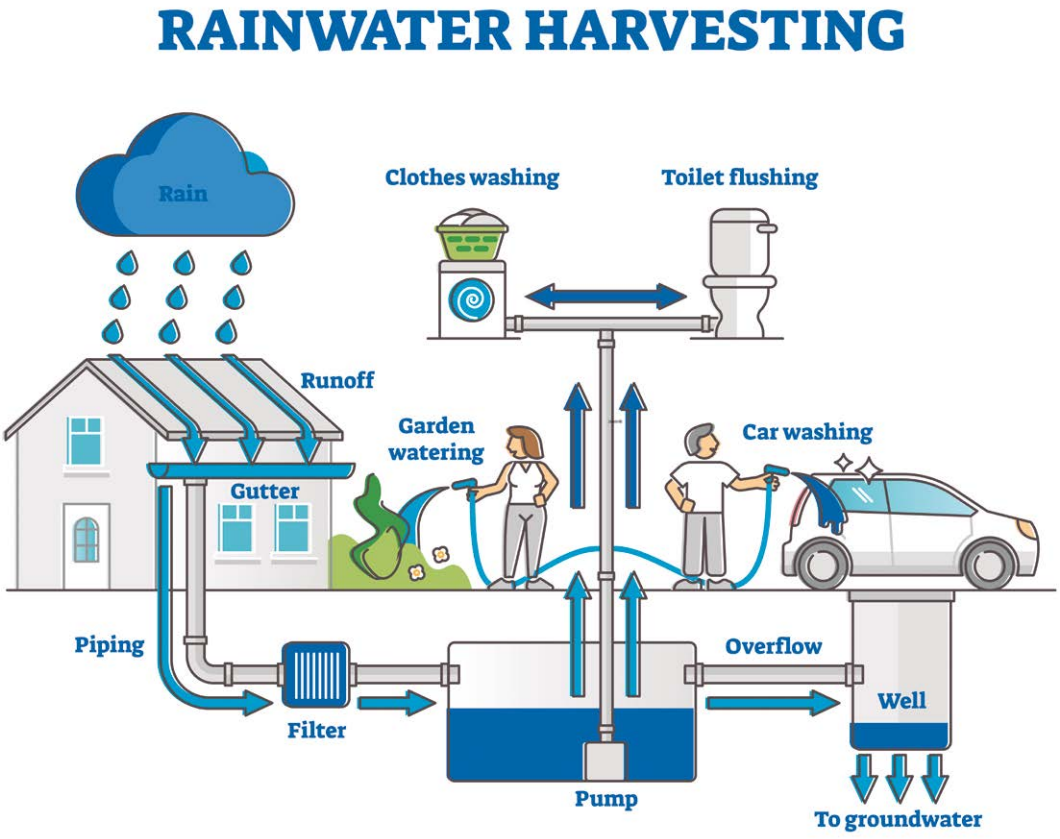
1. Sufficient good quality water.
2. Optimised water-system management.
3. Efficient flood and drought management.

3.1. Sufficient good quality water

Circular water and multiple water innovations in agriculture, industry and housing will be at the centre of ensuring the sufficient availability of good quality water in a Water-Smart Society.

INNOVATION CONCEPT #1
Circular Water: circular water system that minimises water losses, captures and exploits the value in water, and fosters water security, sustainability and resilience.

In a Water-Smart Society, water treatment innovations, water infrastructure redesign, increased awareness and better user-oriented management tools will produce significant reductions in water pollution, enable the recycling of more than 30% of water in Europe, and, in some areas, close water loops by almost 100% for important water users. New dual water systems will be integrated and retrofitted in houses, allowing for the double use of domestic water, as exemplified in the image below.



Water-smart industrial symbiosis solutions will be developed and deployed between urban areas, water utilities, industries and agriculture, leading to a decrease in the freshwater demand by industry and agriculture by up to 30-50%. New hybrid grey and green water infrastructures, including rainwater harvesting and new water allocation systems, will be in place to make multiple alternative water sources available for a wide range of purposes. Wastewater plants will have been transformed into resource factories to exploit the value in water. They will valorise organic and inorganic substances, such as increasingly scarce phosphates, and use novel techniques, such as fermentation, to produce hydrogen, thus supporting the energy transition.

INNOVATION CONCEPT #2
Multiple Waters: incorporate a wide range of water sources and qualities (groundwater and surface water, rainwater, brackish water, brine, grey water, black water, recycled water) into a water-secure, resilient and sustainable water system.

The future Water-Smart Society will efficiently manage precious multiple water sources from surface- and groundwater, but also alternative sources, such as rainwater, brackish and saline water, brines and used water, in a holistically integrated system. Water management and allocation will be optimised through the storage, treatment and distribution of the appropriate type of water, to the specific user at the right moment, in a synergetic combination of centralised and decentralised water treatment. Water use will be optimised, based on the circularity principle for water, including cascading, reuse, and recycling, while new economic mechanisms and models based on realising the value of water will be implemented.

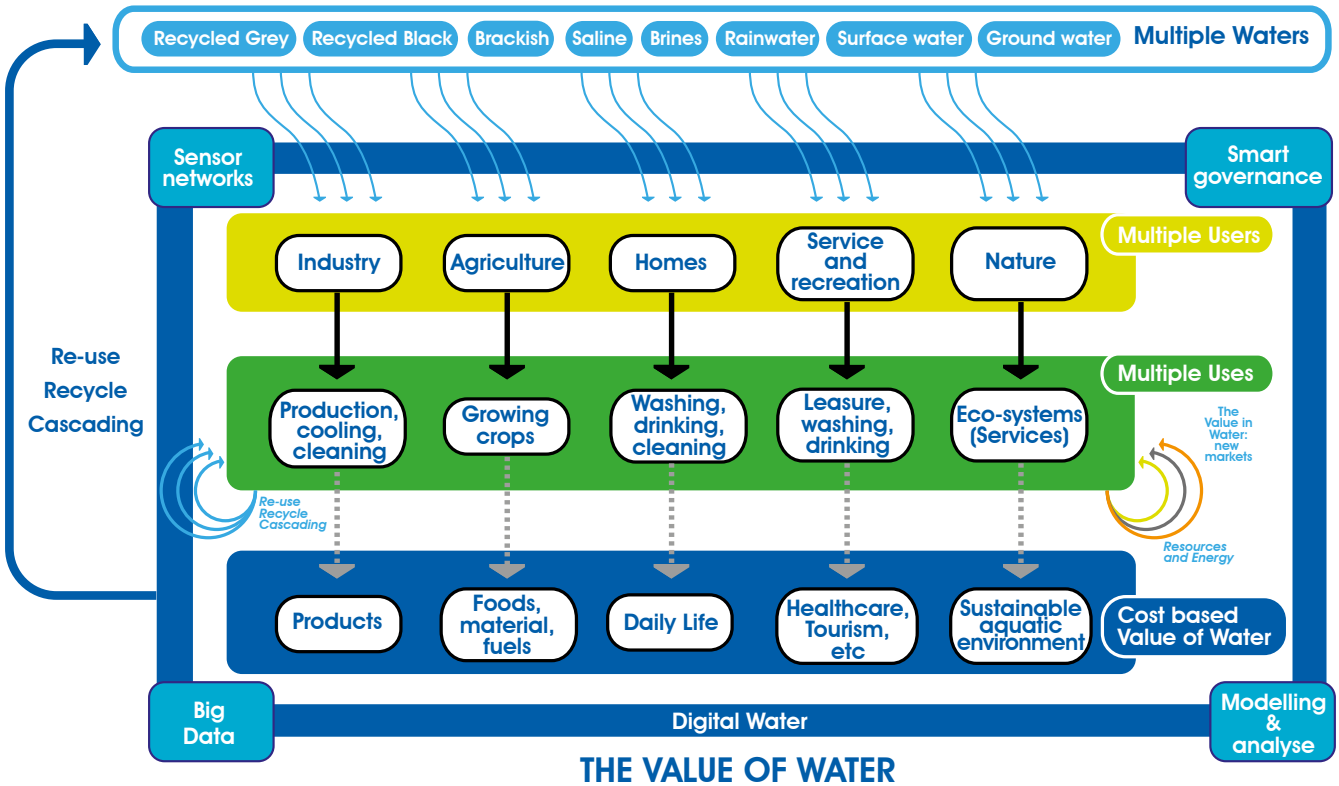
In the future, more than 30% of total water demand – hundreds of cubic kilometres annually – will be delivered by alternative water sources, supplementing and reducing the pressure on groundwater and surface water resources. Rainwater will be captured by green infrastructure, such as green roofs, in 'sponge' cities, and made available to users. New local loops and decentralised water treatment systems will ensure that used water from apartment blocks or living quarters can be recycled and reused; and options for extracting, valorising and using nutrients in the used water streams, for application as fertilisers in integrated urban natural environments, will have been implemented.

Innovative, cost-efficient desalination systems, combined with green infrastructure, will treat saline water as well as brackish water in coastal areas, and make it available for various urban and industrial applications such as cooling, while local loops will ensure the recycling and reuse of industrial waters. Hybrid centralised and decentralised systems will enable the application of the 'fit-for-use' concept to multiple waters, using different water qualities for multiple uses, depending on local availability and user needs.

Redesigning the water use system, for multiple and circular waters, specific uses and a timely delivery.

The water infrastructure has been redesigned, offering the flexibility needed for the dynamic allocation of multiple water resources for different purposes and to multiple users. Moreover, new digital technologies – discussed under the Digital Water innovation concept below – will enable detailed measurement and near real-time monitoring of water extraction, treatment, distribution, use and reuse, with the potential to distinguish between different water qualities, sources, quantities and users. New governance and decision-support systems will underpin the rational use of multiple waters, based on the value of water principle and new economic models, with minimised impact on natural water bodies. The interaction between multiple waters and the Water-Smart Society initiatives to realise the value of water is illustrated below.

Figure 9: Multiple waters in a digitally connected Water-Smart Society



Source: Water Europe

3.2. Optimised water-system management

The Water-Smart Society objectives of water security, resilience and sustainability will only be achieved if the overall management of the water system is optimised within the complex water-energy-food-ecosystem (WEFE) nexus. The governance of the water system will include a multitude of relevant stakeholders, and they will need to apply the latest management techniques and tools – such as digital twins, Big Data and Artificial Intelligence (AI) – in their consultations and decision-making. The two key innovation concepts involved in bringing this about are Digital Water and Inclusive Water.

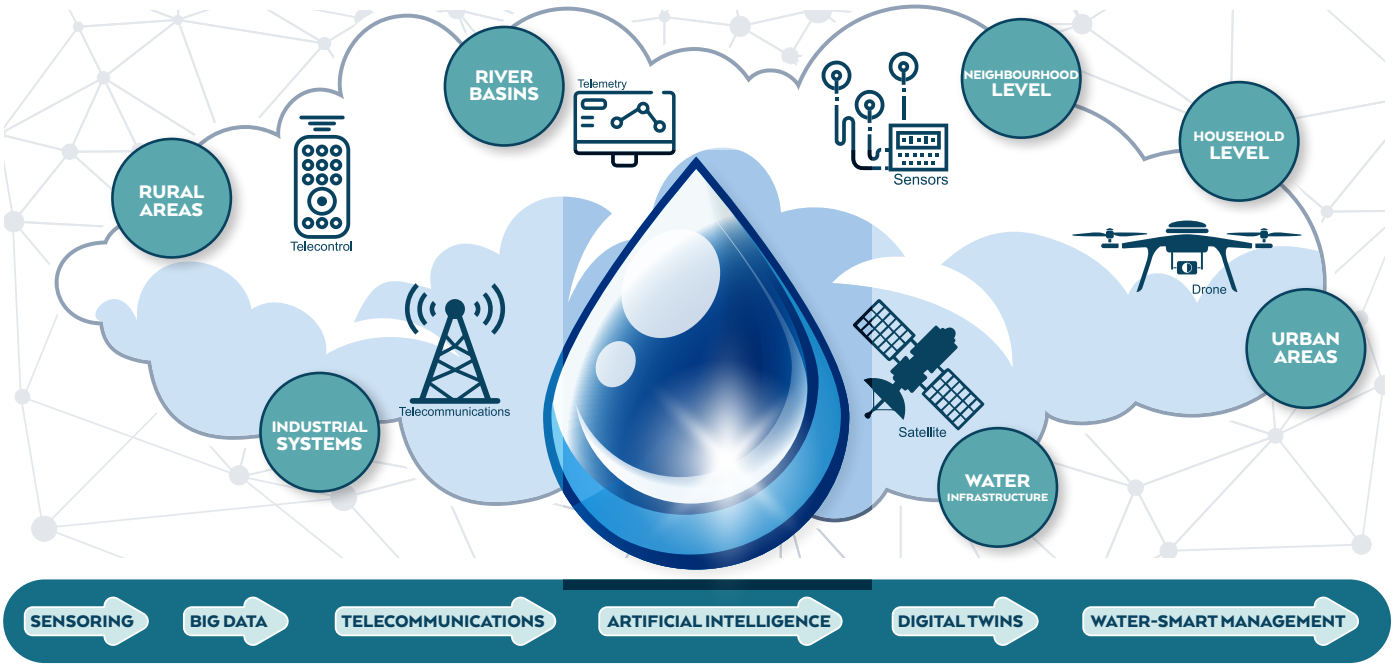
INNOVATION CONCEPT #3

Digital Waters: exploit the benefits of the extreme interconnectivity of people, devices and processes, and create capillary networks capable of monitoring the water system, starting at its multiple sources through to the individual end-user, thus generating continuous flows of valuable data for innovative decision-support systems at different governance levels.

In the future Water-Smart Society, new digital technologies in a fully connected world with remote sensing, AI, including machine learning, and the capabilities of 5G/6G technology, will provide integrated and detailed capillary insights into almost all aspects of the water system. As a result, at combined scale levels – from catchment through to the end-user – the amount of generated data will have increased dramatically. The water sector will be fully connected in near real-time to the situation in the field. The robustness and reliability of the water infrastructure will be closely monitored, by means of digital twins, for instance. The technologies will have created opportunities for innovative data-driven design, construction and management of water infrastructure.

This will entail a holistic approach, in which digital systems at different scale levels (end-user, regional, national and international) can be deployed concurrently in a safe and responsible manner by the various players in the system. These developments will also have been accompanied by appropriate cybersecurity measures, and by decisive and agile governance initiatives. The various elements of this future digital water process are shown in the illustration below.

Figure 10: Digital Water



THE DIGITAL WATER PROCESS

1. BUSINESS SYSTEMS
- WATER-SMART MINDSET
- DESIGN OF EMBEDDED SYSTEMS
- WATER-ORIENTED LIVING LAB SETTING

2. INFORMATION SYSTEMS
- INTERNET OF EVERYTHING FOR WATER
- DATA ANALYTICS
- REMOTE SENSING, TELEMETRY, CONTROL & COMMUNICATION
- SCADA
- DIGITAL TWINS

3. ADVANCED CONTROL SYSTEMS FOR
- NETWORK MANAGEMENT
- OPTIMIZATION, PREDICTION AND DIAGNOSIS
- MICROSYSTEMS, SMART METERS SENSORS
- MODELLING, VIZUALISATION TOOLS, ARCHITECTURES

4. NETWORK COMMUNICATIONS
- REAL-TIME MONITORING
- EARLY WARNING
- DIGITAL SYSTEMS SERVICES
- SYSTEM'S HEALTH MONITORING

5. ASSET TECHNOLOGIES
- PROACTIVE OPERATIONAL RESPONSE
- PREDICTIVE ANALYTICS FOR MAINTENANCE, PROCESS OPTIMIZATION, INVESTMENT PLANNING
- BIM: BUILDING INFORMATION MODELLING, INCLUDING THE ENERGY AND WATER-USE, AND CIRCULAR MATERIALS COMPONENT

Source: Water Europe

The strongly interconnected, nexus character of the Water-Smart Society will have prompted a reshuffling of the different societal tasks of the established water players, and also the creation of new entities tasked with addressing ongoing and future disruptive challenges. Specifically, in the light of climate change, the enduring objective is to achieve water management and governance that remains smart, dynamic and adaptable in near real-time, and that is also robust, resilient and minimally vulnerable to external events.

INNOVATION CONCEPT #4
Inclusive Waters: establish a water system whose governance balances the interests of all stakeholders in its design, management and maintenance.

In the governance of the future Water-Smart Society, enhanced stakeholder engagement plays a key role in water-related decision-making processes, stimulating active collaboration, public-private partnerships and increased trade-offs and (agro-industrial) symbiosis within the WEFE nexus. Participative decision-making and the inclusion of stakeholder views lead to improved services and transparency. Awareness-raising measures and digital technologies (open access to information, Big Data and AI) stimulate well-informed, smart water users and managers, who are aware of the value of water, water usage and the impact of their behaviour and decisions.

In the Water-Smart Society, new multi-stakeholder governance collaborations will have implemented new ways to combine smart water management and preservation of nature, even integrating natural systems as an opportunity to redevelop natural areas and restore biodiversity, within an integrated grey and green (natural and engineered) water infrastructure.

The majority of European cities, regions and countries will have adopted policies and implementation plans for climate change adaptation and mitigation across various sectors (industry, energy, agriculture, transport). They will have integrated multi-sector (urban/rural) planning and risk assessment strategies, inspired by new knowledge and insight based on the Digital Water innovation concept, and will incorporate nature as one of the resources to develop resilience against droughts and floods.

New, inclusive governance models to involve water users, public authorities and nature.

As hydrological boundaries cut across administrative perimeters, cross-border dependencies on water quality (e.g., downstream impacts of discharges) will require these multi-stakeholder governance set-ups to manage and exploit their adaptive water ecosystems through a network of internationally connected regional governance collaborations. They will jointly govern water management systems on a regional, national and cross-national level. This will have helped to achieve responsible use and discharge of water, securing good quality water sources for downstream users. Local characteristics will be addressed, while ensuring no water limitations for end-users and no disruption in supply to critical societal functions due to water scarcity.

Governance will be supported by real-time, continuously updated climate and water forecast models and maps, provided by high-end information technologies, such as global GIS-based knowledge management systems. Advanced decision-support systems will provide regional governance systems with capabilities to make informed decisions, recognising the value of water for their citizens and industries, including potential risks and uncertainties, by combining these advanced forecasting models with data from regional metering of water production, use and reuse activities. To manage and regulate the distribution, treatment, use and reuse of water, governance will also incorporate and use financial mechanisms and legal arrangements for these water-related activities at a regional and inter-regional level.

Ambitious Water-Oriented Living Labs (WOLLs) in cities, rural and industrial areas will involve different multi-stakeholder governance collaborations, as well as researchers and solution developers, to create and test new technological and non-tech solutions in the European model for the Water-Smart Society, and to bring about accelerated market introduction.

Appropriate Open Innovation, Open Science and Open Data will have harnessed Europe's global leadership in water technologies. Europe will lead in new cost-effective water treatment technologies. It will realise advanced irrigation and crop-growing technologies that radically reduce water use in agriculture in Europe and around the world, resulting in new water information systems, for near real-time decision support. Europe will also be exporting its model for a Water-Smart Society, which combines these new technological solutions with modern inclusive governance practices.

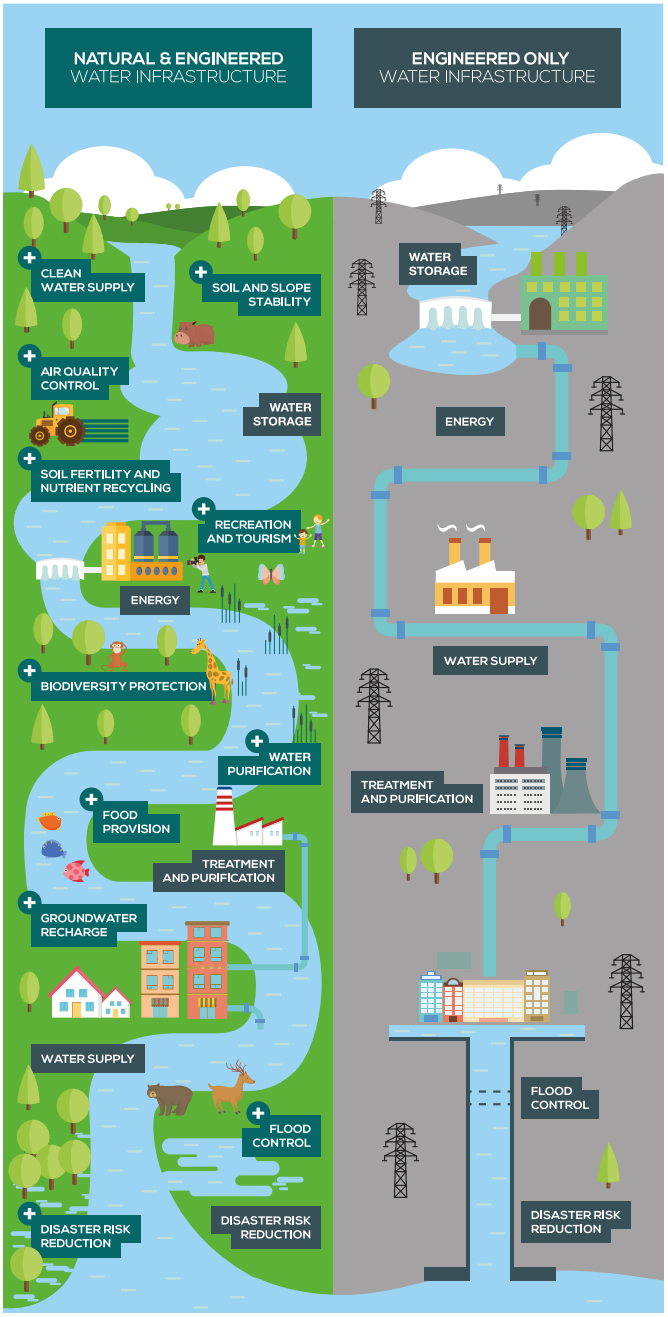
3.3. Efficient flood and drought management

The Resilient Water innovation concept is at the centre of the effort to anticipate, prevent, manage and mitigate the impact of flooding and droughts exacerbated by climate change.

INNOVATION CONCEPT #5
Resilient Waters: create a resilient and reliable hybrid grey and green water system, designed to withstand severe external and internal shocks – such as climate-change induced floods and droughts – without compromising essential functions.

In addressing the consequences of climate change and ensuring the multiple ecosystem services provided by water bodies, water planning in the future Water-Smart Society will be incorporated into comprehensive (supra) regional development plans, which encompass traditional water assets, green assets and ecosystems. In addition, the water system will be managed with the assistance of climate and water forecast maps, in order to support economic activities, growth and jobs as well as nature. Big Data, model-based simulation and virtual reality tools will enhance these management systems in planning maintenance and longer-term asset investments, ultimately aimed at ensuring the durable resilience of the adaptive water management ecosystem.

Figure 11: Grey and green infrastructures



Source: adapted from IUCN

Most cities will have implemented plans to adapt to climate change by 2030, and an increasing number of them will have instituted integrated urban planning and risk assessment strategies, and have emergency plans in place.

The future water infrastructure will be an integrated one, consisting of the human-built (engineered) grey and green infrastructure, as well as natural green assets, such as rivers, aquifers, green belts, infiltration areas and natural storage capacity, which will ensure the sustainability of multiple ecosystem services. It will also include constructed/designed green assets, such as constructed wetlands, green roofs and walls, water parks and habitats for heat wave reduction or shore protection.

By creating a more integrated water infrastructure, individual water-related assets will be shared across sector boundaries. This will result in a more energy- and environmentally efficient water infrastructure, better ensuring water quality and optimising the balance between supply and demand, but also providing protection from extreme water-related events or natural hazards (such as floods, droughts, heat waves or mud flows).

This holistic view of water assets brings about a more sustainable water system which, over time, will ensure and mutually leverage the benefits of both the engineered and natural assets. In the future system, nature plays a key role in contributing to overall system resilience and adaptability, based on the more effective use of natural cycles, as well as efficient, cost-effective and nature-based solutions.

4• SECURING THE ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY OF THE WATER SYSTEM

Since the water system includes all assets – built and natural – it is our vision that by 2030 the value of natural assets and ecosystems, and the way multiple waters are used, will be included in the total cost of infrastructure and pricing of water. Water-related development plans will be based on regional cost-benefit analyses and economic tools, including the cost of water resilience plans and the benefits of preventing damages caused by water disasters. Furthermore, new business models will have emerged that enable and support the costly redevelopment of the water infrastructure.

The true potential value of water has so far not come close to being fully explored or exploited. Water Europe, therefore, envisages the opening up of new pathways to recognising the value of water, and leveraging its economic importance to have a considerable economic impact in Europe. There are three dimensions to this effort: multiple-water use, resource extraction and climate-change impact management.

1. Various opportunities to use multiple water sources remain underexploited. One study concludes that: 'At present, only about 2.4% of the treated urban wastewater effluents, and less than 0.5% of annual EU freshwater withdrawals are reused annually, which accounts for approximately 1 billion m^3 of treated urban wastewater[13].' At the same time, brackish, seawater and rainwater offer large volumes of underexploited water sources that could be used to complement freshwater use. Innovative water treatment technologies are emerging that enable increasingly economically-viable solutions for adapting different water qualities for use, while avoiding pollution. A large number of industries in Europe depend on the water sector. This dependence is, of course, a global phenomenon: a UN report estimates that 'more than 40% of the world's total active workforce are heavily water-dependent[14].' This encompasses agriculture, forestry, inland fisheries, mining and resource extraction, power generation and water supply and sanitation, as well as several manufacturing and transformation industries, including food, pharmaceuticals and textiles. Mitigating water scarcity through circular and multiple water innovations would help to reconfirm the crucial value of water, while boosting the competitiveness of the water industry through innovation, including new investment in the capital-intensive water infrastructure.

2. New, more cost-efficient water treatment technologies will help to extract valuable resources from used waters, and thereby develop new markets, businesses and employment. Large metropolitan wastewater facilities at the European level every year produce 41.6 trillion litres of treated wastewater effluent, which contains high concentrations of nitrogen (N), phosphorus (P) and other resources, which are for the most part unexploited[15]. The application of state-of-the-art technologies to recover these resources from wastewater is therefore especially important. Phosphorus extraction is of particular interest, given that Europe depends on imports for more than 84% of its phosphorus requirements for fertiliser applications, rendering it vulnerable to supply shortfalls of this depleting mineral resource, which is, moreover, produced by only a few countries[16].

3. Significant economic impact can be achieved by avoiding the costs of climate change events for cities, industries and agriculture. Over the last 15 years, floods have led to at least €25 billion worth of insured damage[17]. To this must be added the uninsured costs, which are estimated to have reached €4.9 billion in 2014, and forecast to increase fivefold by 2050[18]. It is evident that the future development a hybrid grey and green water infrastructure, which is resilient to the effects of climate change, will have a considerable cost-saving economic impact in Europe, beyond the economic benefits from engineering and building such new infrastructure.

As discussed earlier, the Water Europe vision builds on the above opportunities, which should give a considerable impetus to Europe's water service providers, water users, and technology providers in a global market with an estimated value of circa €62.9 trillion. More specifically, the vision's realisation will contribute significantly to establishing a sustainable European water market, but also to economic development, growth and employment. The EU's 'traditional' water sector includes a large number of players, including 9000 active SMEs, and provides almost 500,000 full-time equivalent jobs[19]. Initiatives to stimulate various industries in the water value chain to develop novel solutions, business models and even new value chains will benefit all stakeholders by:

- Boosting the market for providers of water technology solutions (water treatment, software systems for decision-support systems, etc.).
- Boosting the market for providers of digital technology solutions that are directly applicable to, and/or specifically intended for, the water market.
- Reinventing utilities, including basin management authorities, so that they can also be Big Data and digital water service providers, offering completely new degrees of decision support at all levels of water management.
- Helping water-demanding and energy-intensive industries dramatically increase resource efficiency through the reuse of water, energy and other valuable resources in water, and the decoupling of nexus interdependencies.
- Opening new markets for entrepreneurial utilities and industries capable of converting the value contained in water into energy and valuable materials, and thus transform their business activity from waste treatment to resource supply.
- Generating new public (procurement) and private assignments for engineering companies that need to develop new advanced water distribution systems, including irrigation systems, that close the water loops, and enable dynamic allocation of the right quality of water for the right purpose to the right user.
- Adapting businesses active in flood infrastructure, shipping and harbour infrastructure to the effects of ever more frequent and intense climate-change induced events.
- Creating new engineering and consulting services for industry, water bodies and governments all over the world, based on the future-proof model for a Water-Smart Society.
- Strengthening nature preservation and integrating human and natural green infrastructure, while restoring and redeveloping the natural environment for dual use.

5• KEY IMPACT PARAMETERS

Water Europe intends to monitor and measure the advance towards the Water-Smart Society on the basis of three Key Impact Parameters; these KIPs and their component elements are detailed below[20].

1. Reducing the impact of European society on our natural water resources by:

- Increasing reuse levels from the current 5% to 30%, thereby making up to an additional 100 km^3/yr of water available for multiple uses and users.
- Reducing water 'loss' in the overall human-built water system, from the current estimated average of 20% across Europe to lower levels, taking into account regional differences of sustainable water availability (which could make another estimated 50 km^3/yr of water available for multiple uses).
- Valorising much higher levels of alternative water sources (brackish, saline water and rainwater), potentially making an additional 15-30 km^3/yr of water available for various purposes.
- Reducing water consumption in agriculture, industries and cities, through more effective irrigation and agriculture and increased user awareness, thereby decreasing overall water consumption by 50 km^3/yr.
- Reducing the amount of water used for energy production by 10-20% (currently accounting for 25% of overall water use), by promoting alternative energy sources and thereby breaking the water-energy nexus.
- Strengthening source protection and minimising residual contamination, in order to improve the quality of freshwater sources and ensure appropriate recharge of natural water reserves.

2. Recognising the value of water, and boosting the European water market and the global competitiveness of European water industries by:

- Developing new advanced water treatment technologies (for reducing water pollution and promoting reuse for various purposes), management models, infrastructure and systems, to exploit the value of multiple alternative water sources for multiple users and purposes. The outcomes would be commercialised in Europe, as well as in the global water management market (i.e., market for water-related equipment and services).
- Increasing the valorisation of water five-to-tenfold, by extracting and exploiting heat, energy, nutrients, minerals, metals, chemicals and other resources in used water, opening up various new multi-billion-euro markets in Europe for the recovered resources. This will create new businesses and jobs, while fostering a true circular economy for both biological and technical nutrients in used water streams[21].

3. Securing European society's long-term resilience, stability and sustainability with regard to water by:

- Making the water system robust, flexible and adaptable to external influences, such as droughts and floods, by combining engineered, man-made and natural green infrastructure with advanced digital solutions, such as sensoring, AI and machine learning. These efforts will lead to: 50% less flood damage, 50% fewer occasions in which droughts result in lower agricultural production, 50% fewer occasions in which droughts affect shipping capability, 50% fewer occasions in which heat waves endanger electricity production due to lack of cooling water.
- Reducing pollution and eutrophication drastically, and restoring biodiversity, while including nature as one more component asset of the durable future water system.
- Capitalising on the value of water through increased resource efficiency of our industrial system, and a five-to-tenfold increase in harvesting the value in water, as new sources of economic sustainability.
- Designing and implementing new economic, investment and governance models, and plans to secure long-term financial viability and manageability of our water system.

About Water Europe

Water Europe (WE) is the recognized voice and promotor of water-related innovation, research, and technology development in Europe. WE is a purpose-driven multi-stakeholder association with over 250 members, representing the entire range of actors in the innovative water ecosystem. WE was established by the European Commission as a European Technology Platform. WE is guided in all its activities by its Water Vision, with the ultimate ambition of achieving a Water-Smart Society, in which:

- the value of water is recognised and realised to ensure water security, sustainability, and resilience.
- all available water sources are managed so that water scarcity and pollution are avoided.
- water and resource loops are largely closed to foster a circular economy and optimal resource efficiency.
- the water system is resilient against the impact of climate and demographic change.
- all relevant stakeholders are engaged in guaranteeing sustainable water governance.

WE has grouped its activities under 3 key programmes:

- **WE Collaboration Programme**
  Allows our members to network, share knowledge and experiences, and collaborate along the whole water value chain, when addressing common challenges, developing and implementing new solutions, promoting the inclusion of water-related topics in European research and innovation funding programmes, and enabling them to shape successful project consortia.

- **WE Advocacy Programme**
  Raises the awareness of the value of water for our society and economy, and promotes the uptake of innovative solutions through European policy-making and legislation.

- **WE Implementation Programme**
  Assists our members in the implementation of their research results and innovative solutions, as well as their further uptake in markets in Europe and beyond. A key instrument in this implementation effort are Water-Oriented Living Labs (WOLLs).

COLOPHON

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END NOTES

1) 'Ligtvoet W. et al. (2018), The Geography of Future Water Challenges, The Hague: PBL Netherlands Environmental Assessment Agency'.

2) WWAP (UNESCO World Water Assessment Programme), 2019. The United Nations World Water Development Report 2019: Leaving No One Behind. Paris, UNESCO.

3) World Economic Forum (2023): The Global Risks Report 2023.

4)World Resource Institute (2019): Global Commission on Adaptation.

5) World Resource Institute (2020): Achieving abundance: Understanding the cost of a sustainable water future.

6) CDP (2021): A Wave of Change.

7) EEA (2018): European waters – Assessment of status and pressures.

8) JRC (2019): Water-Energy Nexus in Europe.

9) EASE & Water Europe (2021): Unleash the potential of the water-energy nexus in the energy efficiency directive.

10) EEA (2023): Water Scarcity Conditions in Europe (water exploitation index plus).

11) WWAP (UNESCO World Water Assessment Programme), 2021. The United Nations World Water Development Report 2021: Valuing Water. Paris, UNESCO.

12) Water Europe, 'Water-Oriented Living Lab Notebook Series', October 2022.

13) ***http://ec.europa.eu/environment/water/reuse.htm***

14) The United Nations World Water Development Report 2016.

15) The United Nations world water development report, 2017: Wastewater: the untapped resource.

16) European Commission, 2020. Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability. ***https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0474***

17) Water Information System for Europe, European Commission.

18) European Environmental Agency, 26 January 2016.

19) 'Water is too precious to waste', European Commission, 2017. ***https://ec.europa.eu/environment/water/pdf/water_reuse_factsheet_en.pdf***

20) The Key Impact Parameters have been elaborated from estimates made by the Water Europe expert stakeholder group of the benefits from the implementation of the Water Europe Vision 2030.

21) Based on the Cradle-to-Cradle concept of McDonough and Braungart.

NOTES


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