# **Draft Strategic Research and Innovation Agenda**

07/12/2020

# **European Partnership WATER4ALL“Water Security for the Planet”**

This document **contains a preliminary version** of the Strategic Research and Innovation (SRIA) of the future Water4All Partnership. A consolidated and enhanced version of the agenda is due by May 2021, when the full proposal for the Partnership will be submitted to the Horizon Europe’s Work Programme 2021 call. The current description of the Water4All Partnership candidate is available at:

<https://ec.europa.eu/info/sites/info/files/research_and_innovation/funding/documents/ec_rtd_he-partnerships-water4all.pdf>

The purpose of this preliminary version is to provide a general overview of the Research and Innovation water priorities of Water4All in order to respond to the challenge of “**enabling water security for all on the long term**”. The structure of the document is as follows:

* Section 1: Vision of Water4All.
* Section 2: Aims of Water4All’s SRIA and development process.
* Section 3: Water4All’s added value in the European context.
* Section 4. Detailed outline of Water4All’s research and innovation areas to be addressed in order to respond to the overall challenge of enabling water security.
* Section 5: Links between the Water4All’s research and innovation areas outlined in Section 4 and EU and international policy frameworks (the EU Green Deal and the Sustainable Development Goals, SDGs) and other EU programs and initiatives (notably, Horizon Europe).

This document has been drafted by a Working Group bringing together representatives of the European Commission and main water-related initiatives, networks of experts and associations in Europe (*Water JPI, EurAqua, EurEau, Aqua Publica Europea, Water Europe, European Water Association*).

Guided by the principles of inclusiveness, openness and participation, core partners of Water4All have been invited to express their views on the contents of the SRIA. The next consultation steps will allow gathering the views of water experts and relevant stakeholders on both the scope and the priorities set in the SRIA. A description of Water4All’s first 2 years priorities will be drawn from the outputs of these activities.

## **Water4All’s Vision**

The Water4All Partnership’ Vision is to “***boost the systemic transformations and changes across the entire research – water innovation pipeline, fostering the matchmaking between problem owners and solution providers for ensuring water security for all in the long term***” through:

* Conservation, restoration and optimization of the natural functions of ground and surface water and ecosystems.
* Support to the European and international priorities and regulatory framework (e.g. EU Green Deal, Water Framework Directive and daughter directives, SDGs) through the provision of scientific evidence.
* Support to efficient collaboration and integration of European and international RDI activities.
* Demonstration and implementation of solutions.

**Figure 1** depicts Water4All’s **thematic fields of interest as well as potential drivers and enablers**. Water4All themes respond to specific needs of society at large, ecosystems, infrastructures and water management. A specific theme on health will tackle specific issues potentially compromising water quality and quantity and human wellbeing. Two cross-cutting RDI areas have been identified – governance and international cooperation.



**Figure 1.** Water4All’s RDI themes (pentagons), drivers (text lines coming out of the big circle) and enablers (listed in the blue squared text box).

**Drivers** refer to possible factors that may trigger changes in the strategic priorities identified in the SRIA for the next 7 years of the programme. Possible drivers for change include:

* Climate change: Water is the primary medium through which we feel the effects of climate change (UN Water). Current weather projections predict more hydrological extreme events inside and outside Europe. More floods and severe droughts are expected, impacting both water quality and quantity and ultimately triggering food shortage, migration dynamics and political instability. Climate change is a driver for biodiversity loss, water scarcity, water quality reduction, population impoverishment, economic crisis and political instability.
* Health: As we recently experienced with the recent COVID-19 pandemic, but also during several climatic shocks that were accompanied by epidemic, health is a key driver for water security. Health issues can generate chronic risks. Health issues may undermine secure water availability and jeopardize washing and sanitation.
* Migration: Migration phenomena are likely to intensify in certain regions of the world due to climate change, economic crisis or political instability. Migration may result in higher pressure on water resources in destination areas.
* Urbanisation and population increase: Population dynamics towards urban areas account for water stress, water quality degradation and water sanitation needs. Global trends indicate that this phenomenon is expected to exacerbate. In the same vein, population growth will compromise water availability and food security. In this sense, efficient agricultural water management has a crucial role in sustaining agricultural systems productivity and in buffering the year-to-year fluctuations due to variable climatic conditions.

**Enablers** represent any factors facilitating activities and the attainment of objectives:

* The digital revolution (big data, AI, IoT).
* Existing/ future research infrastructures (see Table 3)
* Global and European initiatives that support Open Research and Responsible Research and Innovation. Technologies and new regulatory and economic frameworks enabling more efficient water management.
* Changes in people’s vision towards natural resources.

Joint activities in Water4All should contribute to:

* Increased protection of water resources and ecosystems.
* Enhanced resilience, mitigation and adaptation of water systems to climate change and to mitigate biodiversity loss.
* Pooling of resources and alignment of water agendas.
* Development and implementation of instruments for cooperation.
* Fast-track to implementation of new technologies and provide evidence for water policies
* Reinforcement of the EU’s role in the international water agenda.
* Fostering the relationship between solution developers and providers and problem owners.

## **SRIA: Aims and development process**

A SRIA allows having a better understanding of Research and Innovation priority areas to be funded and explored within the timeline of the Partnership, its objectives and expected impacts. The SRIA will guide stakeholders from national/ regional funding agencies, research operators, academia, industry, policy and society in addressing water security challenges. The SRIA is therefore conceived as the **“strategic backbone” of the upcoming Water4All Partnership**.

**The Water4All Partnership will address freshwater security challenges, and therefore inland waters (surface waters, transitional waters, coastal waters and groundwater) as covered by EU water policies**.

Being water security (both in terms of quality and quantity) an issue in many Member States and at European level, water is the object of numerous initiatives (cf. figure 14 of Water4All candidate description). Some of these initiatives have established their own strategic RDI agenda as a way to guide their activities and influence the EU Research and Innovation setting. Water4All does not aim at developing a SRIA from scratch. On the contrary, **it builds upon these agendas**. Following a mapping exercise carried out by the Drafting Group of Water4All, existing SRIAs from major water initiatives, networks of experts and associations were identified and critically reviewed (i.e. agendas from the Water JPI, EurAqua, WaterEurope, EurEau, PRIMA, FACCE JPI). All RDI needs identified in those agendas were grouped together into different themes according to the overarching aim they refer to. RDI needs identified in recent conferences (EuroGeoSurveys, ESA EO4Water) have also been considered.

For the sake of exhaustivity and synergies between initiatives, strategic agendas of other water-related initiatives will be analysed at a later stage (JPI Climate; upcoming EU Partnerships within the framework of Horizon Europe in Cluster 6 – notably Blue Economy and Biodiversity – and other clusters – such as Driving Urban Transition or Chemical Risk Assessment; EU-India Partnership, China-Europe Water Platform, PEER strategic paper).

**Water4All participating countries are consulted on this first draft**. The next stages in the development of the agenda and their provisional schedule are summarised in the figure (**Figure 2**) ****below. The resulting SRIA, expected for publication by May 2021, will be periodically re-evaluated and updated.

**Figure 2.** Water4All’s SRIA development process.

The results of the review and assessment of RDI needs in EU water agendas were presented in the Advisory Boards meeting of the Water JPI at the beginning of October 2020. Representatives of most of the institutions involved in the Water4All SRIA Drafting Group were as well present in the meeting.

The current consultation is open at national level and through an online open consultation. It will be followed by interviews and a consultation to water experts and stakeholders.

## **Water4All’s added value in the European context**

“*Europe’s environment is at a tipping point. We have a narrow window of opportunity in the next decade to scale up measures to protect nature, lessen the impacts of climate change and radically reduce our consumption of natural resources*”. These are the words of the EEA Executive Director, Hans Bruyninckx. It reflects the concerns of high-level EU environmental policy actors. Water is scarce in many European regions (especially in southern areas) and projections indicate that **water scarcity episodes will exacerbate** in the future. Around 40% of surface waters (those of interest for Water4All, i.e. rivers, lakes and transitional and coastal waters) are in good ecological status and only 38% are in good chemical status (EC COM(2019) 95 final). To make matter worse, **water quality is expected to further decrease** due to higher diffuse pollution loading released during precipitation events and/ or reduced dilution capacity of rivers in low flow periods. Results are better for groundwater resources as 74% of them achieve good chemical status. However, uncontrolled and even illegal abstraction puts at risk water availability of this resource in certain European regions and for specific uses (e.g. ecosystem maintenance, agriculture, tourism, hydropower sector).

**Enough fit-for-purpose water is a prerequisite for achieving the Green Deal**. Water is essential in all its 9 policy components: Biodiversity, From Farm to Fork, Sustainable agriculture, Clean energy, Sustainable industry, Building and renovating, Sustainable mobility, Eliminating pollution, Climate action. Water is also an essential asset in at least **4 of the 5 Horizon Europe Missions** on:

* Adaptation to climate change including societal transformation (*A Climate Resilient Europe*);
* Climate-neutral and smart cities (*100 Climate-neutral Cities by 2030 – by and for the Citizens*);
* Soils health and food (*Caring for soil is caring for life*); and
* Healthy oceans, seas, coastal and inland waters (*Mission Starfish 2030: Restore our Ocean and Waters).*

**Current trends in water quantity and quality will also undermine progress towards EU policy targets and Sustainable Development Goals (SDGs)** on Water (SDG6), Poverty (1), Hunger (2), Health (3), Clean Energy (7), Cities (11), Responsible Consumption and Production (12), Climate (13), Life below Water (14) and on Land (15), Peace, justice and strong institutions (16).

The rationale for Water4All is to **gather water actors at scale and appropriate duration to generate the necessary transformations** to solve the water-related issues**. Water4All will address water quantity and water quality issues through different instruments**, including but not restricted to, joint research and innovation calls, networking, public awareness, capacity-building, science-policy interface, demonstration of solutions and knowledge transfer to implementation.

**The European water sector is strongly fragmented. The experience accumulated by existing initiatives, and quite notably that of the Water JPI, will be seized to spark up cooperation amongst national/ regional funding agencies, academia, research operators, water utilities, and the water private sector. Key lessons will be exploited at most in order to capitalise human and financial resources**.

Being water security a global challenge, Water4All will boost synergies and cooperation with other water international initiatives. Cooperation agreements with international partners and strategic geographical regions for Europe will be sought. Water4All will build upon the work carried out within the frame of the EU-India Partnership and the China-EU Water Platform. **Transboundary water management and diplomacy issues will be explored**.

Water4All will seek synergies and collaboration opportunities with other EU initiatives tackling water and aquatic ecosystems challenges, such as the **One Health European Joint Programming**, **JPI Climate, JPI Oceans, FACCE JPI, PRIMA, KIC Climate and the future Partnerships on:**

* Climate Neutral and Sustainable and Productive Blue Economy
* Chemical Risk Assessment Rescuing biodiversity to safeguard life on Earth
* European Metrology
* Processes4Planet
* Driving Urban Transition to a sustainable future
* Zero-emission Water Borne transport
* Safe and Sustainable Food System
* Agro-ecology living labs and research infrastructures
* Circular bio-based Europe
* Environmental observations for a sustainable EU agriculture
* European Open Science Cloud

## **Water4All proposed RDI themes**

This section outlines Water4All’s RDI themes, broken down into specific sub-themes and some of the RDI questions that could be addressed by the initiative. The RDI themes of Water4All will be:

1. **Water for circular economy: smart water value.**
2. **Water for ecosystems and biodiversity.**
3. **Water for the future: sustainable water management.**
4. **Water and health.**
5. **Infrastructures for water.**
6. **International cooperation (cross-cutting issue)**
7. **Governance (cross-cutting issue)**

**The list of RDI themes here proposed is based upon the UN Water’s framework of water security**, where “water security” stands for “*the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability*”.

Based upon this framework, **enabling water security** is not only about ensuring access to safe and sufficient drinking water at an affordable cost in order to meet basic needs, including sanitation and hygiene. **Water security embraces as well:**

* **The protection of livelihoods and human rights** (especially tackled in Themes 1 and 4);
* **The safeguard of human health** (Theme 4);
* **The conservation and restoration of ecosystems and biodiversity** (Theme 2);
* **The maintenance of economic development and activities (such as energy, agriculture, industry)** (Theme I)
* **The protection of society and related infrastructures against natural hazards** (Theme 5);
* **Collaborative approaches to transboundary water management** (Theme 6);
* **Good governance** (Theme 7).

**Theme I: Water for circular economy: smart water value**

**Why this theme?** Climate conditions and water demand are the two key factors driving water stress. Being people-centred, this theme will look at tools, methodologies and approaches enabling water allocation and water use optimisation for different sectors through the promotion of innovative technologies, management practices and governance models. Water4All will seek synergies across water uses and needs whilst reducing the need for trade-offs as a way to overcome water conflicts. The environmental impacts of water use will be further analysed. In a context of global changes, Water4All will favour the development and implementation of best available solutions for water treatment and reuse, and resource recovery. Water4All will strive to develop new circular feedstocks and value chains from water and industrial sectors through water technologies to enable the circular and bio-based economy while maintaining the optimal balance in the nexus between water, food, energy and health. This theme is linked to all the Green Deal policy areas, the Mission on Adaptation to climate change including societal transformation and the proposed Partnership Processes4Planet (Cluster 4). This theme is strongly linked to the Theme VII on Governance.

**Key words**: circular economy, fit for use, WEFE nexus, water value, partnerships and business models, water pricing, , bio-based feedstocks, value chains, resource recovery.

**Sub-themes**:

I.I. **Water supplies for socio-economic development and activities (such as agricultural, urban, industrial and energy uses)**.

* Advancing water resource efficiency and allocation across sectors for reducing resource interdependencies and increasing climate change resilience. *Link to Theme VII*.
* Developing innovative water allocation policies and management practices. *Link to Theme VII*.
* Developing a new water demand management approach including long-term water demand forecasting and scenarios. *Link to Theme VII*.
* Developing smart water resources and efficient technologies for irrigation purposes.
* Mitigation of the impacts from energy and raw materials production.
* Developing and testing scalable and affordable solutions to allow the prioritisation of investment and activities for climate change resilience.

I.II. **Circular economy**.

* Developing circular economy approaches to urban and industrial wastewater treatment plants.
* Water –Energy – Food – Ecosystems (WEFE) Nexus:
	+ Assess the interlinkages and interdependencies of water, food and energy sectors and ecosystems in different water bodies, in particular transboundary ones (from monitoring schemes, demand forecasting, socio-economic assessments, scenario planning, behavioural change, cost-benefit analysis), to implement a real water-energy-food nexus approach and increase efficiencies, equity and sustainability.
	+ Advancing a holistic approach in the WEFE Nexus through the inclusion of health (One Health concept).
	+ Identifying and investigating drivers, pathways, nature and types of barriers of the Nexus.
* Developing and implementing the Fit-for-use concept for water-dependent sectors.
* Understand and quantify trade-offs between alternative interventions (i.e. use network analysis to inform the decision-making process) for a better integration in the implementation of interventions. *Linked to Theme VII*.
* Developing and optimizing technologies for the recovery and valorization of resources (including minerals, metals, salts, nutrients, cellulose) from (waste) water, and the production of novel feedstocks from wastewater (e.g. bio-plastics, PHA, natural flocculants, kaumera gum, etc.), brines and sludges.
* Developing innovative traceability systems to guarantee the quality of recovered products and improve confidence of the market.
* Quantifying the long-term implications of water reuse on environmental compartments.
* Developing robust methods and indicators for measuring transition to circularity, its benefits, challenges and trade-offs.
* Developing new management tools and methodologies, partnerships and business models for industrial processes and agricultural water reuse and recycling . This topic will also look at the development of matchmaking platforms for the valorisation of wastewater based on its value for different industries (and sectors), and the implementation of decentralised treatment systems in synergy with existing centralised treatments.

I.III. **Empowering the public, water users and stakeholders in valuing water**. *Linked to Theme VII.*

* Developing a bottom-up approach for co-design and co-construction of solutions for water users.
* Understanding and assessing the values of water for the public and stakeholders to guarantee sustainability of water and limit use conflicts.
* Developing methodologies to assess stakeholder responsibilities in setting the right prices to reflect the marginal value of water.
* Developing participatory foresight approaches to raise stakeholders’ awareness of the long-term value of water resource protection.
* Exploring the possible routes to conduct paradigm changes to be innovative for water governance.
* Developing holistic and sustainable water footprint production and consumption systems.
* Developing methodologies of accounting for natural capital.

**Theme II: Water for ecosystems and Biodiversity**

**Why this theme?** The presence of pollutants and the risks posed by climate change threatens the quality of surface and subsurface aquatic ecosystems. More than half of river and lake water bodies in Europe are reported to hold less than good ecological status (EEA, 2018), which impacts both the structure and functioning of surface water ecosystems. Aquatic ecosystems play a key role in water purification and biodiversity. Low ecological status of these ecosystems can therefore result in the loss of biodiversity, water quality and ecosystem services. The achievement of good quality in aquatic ecosystems cannot happen without an appropriate management of catchments. It is for this reason that this Theme and Theme III are intrinsically linked. With this theme, Water4all wants to directly contribute mainly to the Green Deal Biodiversity strategy, the Water Framework Directive and the related “daughter” directives, the Mission Starfish 2030.

**Key words**: ecosystems quality, multiple pressures, resilience, ecosystem restoration, ecosystem services

**Sub-themes**:

II.I. **Functioning and biodiversity**.

* Monitoring and assessing the functioning of ecosystems, ecosystem goods and services, with in particular a better understanding of the relationships with the C, O2, P, N, S (and in a lesser extent Fe) and energy cycles by better seizing the opportunities provided by big data, computing power, artificial intelligence, innovative molecular methods and biosensors.
* Understanding and predicting multiple pressure–impact–response relationships in aquatic ecosystems (cumulative effects, domino effects)
* Developing evaluation and prediction methodologies to assess the economic and social value of ecosystem services and biodiversity.
* Adapting and integrating aquatic and artificial ecosystem services into management of water resources, including analysing trade-offs and synergies between water quality objectives, targets and land use planning and governance systems. *Linked to Theme 7*.
* Managing the risks posed by invasive species and options for remediation.
* Innovative biodiversity and ecosystems monitoring tools at different scales (from eDNA in water to Earth observations).
* Achieving Net Carbon Zero: enhancing the role of inland and coastal aquatic ecosystems in carbon sequestration and the reduction of GHG emissions, and its link to the ecological status (sensu WFD), the conservation status (sensu Habitats Directive) and the pressure levels experienced.

II.II. **Resilience, mitigation and adaptation of aquatic ecosystems and ecosystem services to global changes**.

* Determining pressure factors on biodiversity, ecosystem services and genetic resources in a global change context.
* Developing prediction models of ecosystem “tipping points” in response to hydro-climatic extreme events in different ecosystems. Models quantifying and forecasting how global perturbations can affect ecosystem’s sustainability, productivity and resilience against environmental stressors.
* Exploring the connection between biodiversity, ecosystems services and pandemics.
* Developing innovative (or improved) tools for adaptation and mitigation to hydro-climatic extreme events, especially floods (including “flash-floods”) and drought in a catchment context.

II.III. **Developing and applying ecological engineering and ecohydrology for ecosystems restoration**.

* Understanding, managing and restoring ecological and morphological continuity, sediments flows, hydraulic connectivity and ecological flow.
* Developing NBS and engineered solutions (including hybrid grey-green) for the remediation and mitigation of degraded water bodies and aquatic ecosystems.
* Understanding the environmental and societal impacts of proposed solutions for ecosystems restoration.

II.IV. **Integrating ecosystem services into the management of water resources** (*linked to Theme 3*):

* Linking measures to their effects on ecosystems (including biodiversity) and to their societal impacts.
* Methodologies for the valuation of ecosystems services, including non-financial such as well-being, social and cultural values and benefits of healthy ecosystems.
* Mainstreaming frameworks and methods for assessing ecosystem services in support of water management, policy and implementation.
* Adapting and integrating aquatic and artificial ecosystem services into management of water resources, including analysing trade-offs and synergies between water quality objectives, targets and land use planning and governance systems.
* Exploring land-sea interactions with a ‘source-to-sea’ perspective for biodiversity and ecosystem services conservation at global scale.

**Theme III: Water for the future: sustainable water management**

**Why this theme?** The remit of EU water policy is to ensure access to good quality water for all and the good status of water bodies/ ecosystems across Europe. Considerable policy efforts have been made by the European Commission and Member States to support the achievement of this objective but experience shows that many obstacles remain in the implementation of the Water Framework Directive and other pieces of legislation. Water4All will seek to provide models, approaches, tools and methodologies to underpin the implementation of EU policy and EU water management plans/ strategies for natural resource efficiency, natural resource protection, and adaptation and resilience to hydroclimatic extreme events. This theme is directly related to the Mission Area on Oceans and Waters.

Relevant tools for decision support will be developed or improved in order to respond more efficiently to emerging water issues and hydroclimatic hazards.

**Key words**: river basin management, groundwater management, hydroclimatic hazards and extreme events, decision support tools.

**Sub-themes**:

III.I **Water Resources Management.**

* Developing integrated and multiscale numerical tools for designing integrative approaches and ensure their efficiency and robustness.
* Assessing water management and its consequences to erosion, soil / subsoil stability, sediment transport, and soil/water quality.
* Multi-disciplinary approach for assessing the effect of land use on the maintenance of healthy water resources (including e.g. nutrients, hazardous substances and brownification).
* Developing and demonstrating Integrated management and monitoring of the whole water cycle (including water reuse, storage and managed aquifer recharge) in the framework of the land-water interface.
* Understanding the dynamics and functioning of rare water ecosystems (e.g. intermittent rivers, wetlands, lagoons, glaciers, peatlands).

III.II. **River Basin Management**.

* Understanding the connection between Programmes of Measures (PoMs) and their effect on ecological indicators (flora, fauna) as well as the temporal and spatial cumulative effects of measures in regard to the goals of the WFD (water quantity and quality, ecosystem quality).
* Develop decision support tools at the River Basin scale to help simulating and predicting the effect of PoMs to reach the objectives both for water management and climate change mitigation.

III.III. **Groundwater management**.

* Estimating aquifer resources at various space and time scales for assessing qualification of groundwater resources in terms of resource (recharge water) versus reserve (stored water) and contribution to hydrological cycle as well as to protect groundwater dependent ecosystems to support decision-making.
* Supporting aquifer management through a better understanding of abstraction and recharge volumes, seawater intrusion and salinization and contamination.

III.IV. **Resilience, adaptation and mitigation to hydroclimatic extreme events**.

* Understanding the causes of drought/scarcity, predicting drought events and water scarcity for developing climate change adaptation and mitigation measures. This topic will focus on both groundwater and surface water.
* Developing a multi-risk approach and decision support tools (including costs valuation) to deal with extreme events.
* Water scarcity management: Developing forecasting systems for the monitoring of anthropogenic impacts on the integrated water cycle.
* Improving water management to mitigate the harmful impacts of extreme events.
* Developing innovative (or improved) tools for adaptation and mitigation to hydro-climatic extreme events, especially floods and drought in a catchment context.
* Understanding the disaster management cycle in the face of climate change, effects on society and mitigation measures
* Progressing towards more resilient cities and communities in the face of climate change and increasing natural hazards.

III.V. **Tools for water management, including big data, Earth observation, sensors/ monitoring tools, artificial intelligence, DSS, scenario analysis, research infrastructures, living labs**.

* Developing innovative (or improved) tools for adaptation and mitigation to hydro-climatic extreme events, especially floods and droughts in a catchment context.
* Improving monitoring tools, monitoring schemes and global strategies for the WFD implementation
* Connecting physical and digital facilities.
* Connecting Earth Observation to local / regional monitoring of water resources for improved water quality assessments.
* Developing Large scale and real-time assessments for water storage in the sub-surface (both water availability and water quality)
* Developing integrated models of high-resolution temporal and spatial data on the water cycle, ecosystems and economic systems to address water resource management.
* “Smartening the water system”: sensor networks, big data, information and control systems for water, network communications, advanced technologies and capabilities (i.e. HPC – high performance computing) for quasi-real time data analysis, forecasting, visualisation technologies for advanced decision support tools, digital twin models and solutions to optimise asset performance
* Extending applications of water resources data (geospatial data, quantitative and qualitative flows, local data, …) and approaches to support priority setting and management actions.
* Developing new tools and models for water resources assessment to be extrapolated to water bodies in scarcely monitored areas (link to Theme VI)

**Theme IV: Water and health**

**Why this theme?** Water quality is threatened by pollutants from diverse sources (urban consumption, agriculture, industry, etc.). The presence of certain pollutants such as endocrine disruptors has become an area of emerging concern because of their effect on human and animal health. At the time of writing this draft agenda, the Covid-19 pandemic is at its highest point since spring in numerous countries. Pandemic episodes like this one pose new challenges for water management and health. Innovative water technologies should be developed to guarantee high water quality. This theme is strongly related to the Zero pollution Action Plan and to the Mission area on Oceans and Waters by, among other, developing smart monitoring and control systems.

**Key words**: drinking water and sanitation, contaminants of emerging concern, risk assessment, treatment technologies

**Sub-themes**:

IV.I. **Behaviour and effects of contaminants of emerging concern, litter, plastics, endocrine disruptors**.

* Understanding and predicting the environmental occurrence, concentration, behaviour and effects of transformation products, contaminants and pathogens, and their responses to water treatments.
* Understanding and predicting opportunistic pathogens in water, water distribution networks and other engineered water systems due to climate change.

IV.II. **Water dimension of anti-microbial resistance**.

* Understanding the role of the environment in the selection and spread of AMR genes: transmission mechanisms.
* Developing new tools for monitoring AMR genes and the use of surveillance of AMR data in aquatic environments.
* Developing technologies and innovative interventions that rapidly reduce and control AMR in wastewater treatment.

IV.III. **Innovative water tools and technologies for water quality monitoring and water treatment, remediation and disinfection**.

* Monitoring:
	+ Developing and testing reliable, affordable and low impact methods for monitoring water quality, with a focus on substances of emerging concern and micropollutants, and assessing related risks (rapid screening, real-time, online, …)
	+ Developing new approaches to analyse the combined effects of chemicals (i.e. chemical mixtures, “cocktail” effects), integrative bio-assessment tools and new biomarkers and bioassays.
	+ Setting up a long-term strategy aimed at developing analytical approaches that could be deployed in situ for challenging measurements.
	+ Enhanced knowledge about pollution sources (including sources discrimination, environmental forensics), processes (transformation, degradation, natural attenuation) and fate in order to attenuate the impact of anthropogenic activities on water resources availability and quality. (*Link to Theme I)*.
* Water treatment, remediation and disinfection for drinking water and sanitation:
	+ Developing more efficient, cost-effective, less energy dependant, low carbon footprint and easier-to-implement technological solutions for drinking water and wastewater treatment. A particular focus would be on real-time solutions for the detection of emerging contaminants and emerging risks of established contaminants.
	+ Developing methodologies and strategies to remediate and reduce contaminants of concern at point and non-point sources, including their environmental effects in water, soil, sediment and sludge.
	+ Developing new process and product controls for small decentralised drinking water treatment systems.
	+ Sustainable management of residues from desalination plants to protect land, water and sea ecosystems altogether.
	+ Improving wastewater technologies in the removal of ARB (anti-biotic resistant bacteria), the inactivation of ARGs (anti-biotic resistant genes), viruses and contaminants of emerging concern.

IV.IV. **Risk Assessment**.

* Assessing possible effects on humans and ecosystems of (chronic) exposure to low levels of chemical substances and mixtures.
* Integrated water exposure (chemicals, plastics, bacteria, …) and its integration in global exposure (air, water, food, social and psychological effects/stressors) – One Health concept.
* Developing integrated risk assessment procedures, including the effects of long-term exposure and cocktail effects, for antibiotics and other emerging pollutants (both regulated and unregulated).
* Quantifying risks in a “one health” conceptual model – AMR and genes.

**Theme V: Infrastructures for water**

**Why this theme?** European water distribution networks and critical infrastructures need to adapt to emerging needs and environmental and socioeconomic challenges. Water distribution networks are ageing in many European countries and the risks posed by climate change, extreme weather events and other external factors call for innovative infrastructure adaptation plans (e.g. storm management plans, cybersecurity). This theme has a direct link with the building and renovation strategy of the Green Deal, making cities climate resilient and circular, and to the Mission “A Climate Resilient Europe”.

**Key words**: water infrastructures adaptation, resilience, security,

**Sub-themes**:

V.I. **Adaptation of existing water infrastructures to new challenges**.

* Developing methodologies to organise effectively and in a cost-effective and energy-neutral manner the replacement and large-scale renovation of water infrastructure.
* Assessing the efficiency of existing wastewater treatment technologies in the inactivation of chemical and biological contaminants of emerging concern (link to Theme IV).
* New sustainable treatment processing solutions and related strategies to secure water quality (robustness, security, operable, less demanding in energy and chemical consumption, at lower cost)
* Developing new strategies based on smart metering to optimise distribution networks (consumption patterns, pumping strategies, leakage or contamination detection...)
* Developing emergency treatment units for drinking water production in emergency responses situation.

V.II. **Water infrastructures resilience**.

* Assessing and mitigating the impacts of multiple anthropogenic stresses on water system services to society, economy and the environment.
* Improving the security and performance of water assets and infrastructures – water sources reservoir, source to tap.
* Developing smart monitoring and control systems, from assets to water supply, and reclaimed water networks, including methodologies for extending the technological and functional lifespan of water infrastructures.,
* Improving models and solutions for systems interoperability to allow critical infrastructures to exchange data and enhance compatibility.
* Progressing towards more water-resilient cities and communities in the face of climate change and increasing natural hazards and the issues associated with older and ageing infrastructure.
* Studying the effects of increasing population density caused by mass migration due to climate change on existing water infrastructure.
* Understanding and minimising the risks associated with water infrastructures and increasing their resilience in response to climate change effects and natural hazards.

V.III. **Water Infrastructures security (including cyber and terrorism security)**.

* Developing or improving existing technologies able to differentiate attacks and propose mitigation measures to protect IT/OT (Information Technology/ Operational Technology) infrastructures of water services.
* Developing innovative approaches to assets management, including the security (i.e. cyber-security) of critical infrastructure and the valuation of long-term benefits vs current costs and benefits.

**Cross-cutting issues:**

**Theme VI. International cooperation**

**Why this theme?** Water challenges are global and as such, Water4All will encourage participation with international partners. Water4All will promote knowledge and technology transfer, networking, capacity-building, education, technical advocacy, expertise and in general any other tools in support of water security for all, both in Europe and abroad. It is in this context that Water4All will look for specific agreements with priority countries/ regions.

Trans-boundary cooperation will be coupled with joint actions in water diplomacy, coming in support of activities within the governance cross-cutting theme.

**Key words**: water diplomacy, trans-boundary cooperation, mass migrations, water access

**Sub-themes**:

VI.I. **Water diplomacy**.

* Developing new concepts of benefit sharing, trust building and issue-linkage for water related conflict management.
* Designing inclusive, partnership oriented, multi-track approaches (political, technical, practices) for water diplomacy processes.
* Assessing the opportunity of an Early Warning system as a preventive diplomacy measure.

VI.II. **Establishing tools for trans-boundary cooperation**.

* Developing a human rights-based approach for transboundary water management, encompassing inclusive participatory approaches, information transparency and improved accountability.
* Strengthening international cooperation through the support to cohesive policy making (and financing) around UN SDGs – SDGs on water and on Partnerships.

VI.III. **Developing integrated, fair and adaptive water resource management systems**.

* Understanding the effects of mass migration due to climate change on existing water resources and infrastructures.
* Understanding the underlying power dynamics and structural barriers that reinforce gender inequalities in safe water access.
* Supporting worldwide access rights to water and sanitation: considering the economic value of resources and services as well as their impacts on consumers.
* Assessing the impacts and risks of extreme weather events and global change on the water cycle and uses.
* Developing and testing improved plans and methodologies for integrated adaptive water management in relation to global change.
* Development of indicators of spatial vulnerability to global change.

**Theme VII. Governance**

**Why this theme?** Water demand will increase 55% by 2050 due to growing demand from manufacturing, thermal electricity and domestic use (OECD Water Governance Programme). Higher demands for these sectors, coupled with higher population density in certain regions of the world and climate change effects, will increase water stress. This calls for innovative governance models for the development and implementation of rules, measures, good practices and processes that consider users’ water needs and environmental conditions, underpin decisions over the protection and use of the resource, and engage stakeholders effectively. The water crisis experienced today reveals mismanagement in the past which is linked to the absence of a good governance that can overarch the protection of water. Water governance ought to be the field which guarantees a platform to discuss best available approaches for water security. Governance plays a key role in each of the Water4All themes as it is good governance the main driver for the identification and implementation of best available measures for people, water and other systems. Innovative governance models will be sought by different activities and specific actions will be undertaken for each of the sub-themes indicated below. This theme is linked to all the Green Deal policy issues and is particularly related to the Mission areas on Oceans and Waters and on Adaptation to climate change including societal transformation.

Key words: participatory tools, stakeholder perception, enhancing policy integration and regulatory framework

**Sub-themes**:

VII.I. **Developing methods for more efficient citizen and wider stakeholder engagement**.

* Developing new participatory approaches and tools (including ICT tools) for water management.
* Raising social awareness of water challenges, including use of water resources, hazardous substances.
* Public responses to water reuse: Perceptions of risk, and particularly health risk, associated with the use of water from unconventional sources (recycled water, desalination, etc.)

VII.II. **Strengthening policy integration, alignment, coherence and water policy coordination in order to exert a real change in society**.

* Better understanding of the socioeconomic aspects, governance and behavioural changes, including impact of water prices on water consumption.
* Progressing in the understanding of the socioeconomic aspects, governance and behavioural changes for developing social acceptance of reused wastewater. Link to VII.I.

VII.III. **Enhancing the regulatory framework**.

* Exploring governance and management conditions impairing the adoption of innovations in water.

## **Existing links between Water4All’s themes and sub-themes and EU policies and other initiatives**

Table 1 - SRIA's Themes, sub-themes, key topics

| THEMES | I. Water for circular economy : smart water value | II. Water for ecosystems and biodiversity | III. Water for the future: sustainable water management | IV. Water and health | V. Infrastructures for water | VI. International cooperation | VII. Governance |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sub-themes | * Water supplies for socio-economic development and activities.
* Circular economy.
* Empowering the public, water users and stakeholders in valuing water.
 | * Functioning and biodiversity.
* Resilience, mitigation and adaptation of aquatic ecosystems and ecosystem services to global changes.
* Developing and applying ecological engineering and ecohydrology for ecosystems restoration.
* Integrating ecosystem services into the management of water resources.
 | * Water Resources Management.
* River basin management.
* Groundwater management.
* Resilience, adaptation and mitigation to hydroclimatic extreme events.
* Tools for water management.
 | * Behaviour and effects of contaminants of emerging concern, plastics, endocrine disruptors.
* Water dimension in antimicrobial resistance.
* Innovative water tools and technologies for water quality monitoring and water treatment, remediation and disinfection.
* Risk Assessment.
 | * Adaptation of existing water infrastructures to new challenges.
* Water infrastructures resilience.
* Water Infrastructures security (including cyber and terrorism security).
 | * Water diplomacy.
* Establishing tools for trans-boundary cooperation.
* Developing integrated, fair and adaptive water resource management systems.
 | * Developing methods for more efficient citizen and wider stakeholder engagement.
* Strengthening policy integration, alignment, coherence and water policy coordination in order to exert a real change in society.
* Enhancing the regulatory framework.
 |
| Links with HEU Destinations in WP 2021-2022 | **6.3.** Circular economy and bioeconomy sectors**6.7**. Innovative governance, environmental observations and digital solutions in support of the Green Deal**2.1.** Innovative Research on Democracy and Governance**2.3.** Innovative Research on Social and Economic Transformations**4.1.** Climate neutral, circular, and digitised production**4.2.** A digitised, resource-efficient and resilience industry**5.2.** Cross-sectoral solutions for the climate transition**5.5.** Clean and competitive solutions for all transport modes | **6.1.** Biodiversity and ecosystem services**6.5.** Land, oceans and water for climate action | **6.6.** Resilient, inclusive, healthy and green rural, coastal and urban communities**6.5.** Land, oceans and water for climate action**6.7.** Innovative governance, environmental observations and digital solutions in support of the Green Deal**4.3** World leading data and computing technologies**4.4.** Digital and emerging technologies for competitiveness and fit for the green deal | **6.4.** Clean environment and zero pollution**1.1.** Staying healthy in a rapidly changing society**1.2.** Living and working in a health-promoting environment**1.3** Tackling diseases and reducing disease burden**1.5.** Unlocking the full potential of new tools, technologies and digital solutions for a healthy society | **6.5.** Land, oceans and water for climate action**3.1.** Better protect the EU and its citizens against Crime and Terrorism**3.3.** Protected Infrastructure**3.4.** Increased Cybersecurity**3.5.** A Disaster-Resilient Society for Europe**3.6.** SSRI (Strengthened Security Research and Innovation)**5.2.** Cross-sectoral solutions for the climate transition | **5.2** Cross-sectoral solutions for the climate transition**6.6** Resilient, inclusive, healthy and green rural, coastal and urban communities**2.1.** Innovative Research on Democracy and Governance | **6.3.** Circular economy and bioeconomy sectors**6.6.** Resilient, inclusive, healthy and green rural, coastal and urban communities**6.7.** Innovative governance, environmental observations and digital solutions in support of the Green Deal**2.1.** Innovative Research on Democracy and Governance**2.3.** Innovative Research on Social and Economic Transformations |
| EU Policies supported by Water4All | EU Green DealWater Framework, Bathing Waters, Urban Waste Water Treatment, Groundwater DirectivesCommon Agricultural PolicyCircular Economy Action Plan | EU Green Deal Water Framework, Shellfish Waters, Dangerous Substances (and its 'daughter' directives), Nitrates, Freshwater Fisheries, Exchange of Information on the Quality of Surface Freshwaters, Groundwater Directives EU Biodiversity Strategy | EU Green DealWater Framework, Dangerous Substances (and its 'daughter' directives), Nitrates, Freshwater Fisheries, Exchange of Information on the Quality of Surface Freshwaters, Groundwater DirectivesShaping Europe’s Digital FutureEuropean strategy for data | EU Green DealWater Framework, Bathing Waters, Dangerous Substances (and its 'daughter' directives), Urban WasteWater Treatment DirectivesMarine Strategy | EU Green DealEU Adaptation Strategy | (EU Green Deal) | Common Agricultural Policy,EU Green Deal,EU Adaptation Strategy,Circular Economy Action Plan,Water Framework Directive |
|  | **Main links to other EU initiatives** |
| Mission Starfish 2030 | X | X | X | X |  |  | X |
| Mission A climate resilient Europe |  | X | X |  | X |  |  |
| Mission 100 Climate-Neutral Cities | X |  | X | X | X |  |  |
| Mission Caring for Soil is Caring for Life |  |  | X | X |  |  | X |
| Partnership Agro-Ecology LL | X | X |  |  |  |  |  |
| Partnership Biodiversity |  | X |  |  |  |  |  |
| Partnership Blue economy | X | X | X |  |  |  |  |
| Partnership Chemical Risks Assessment |  |  |  | X |  |  |  |
| Partnership Circular bio-based Europe | X |  |  | X |  |  |  |
| Partnership DUT | X |  |  |  | X |  |  |
| Partnership Environmental data for agriculture |  |  | X |  |  |  |  |
| Partnership European Metrology |  |  |  | X |  |  |  |
| Partnership Processes4Planet | X |  |  |  |  |  |  |
| Partnership Safe Food System | X |  |  | X |  |  |  |
| KIC Climate | X | X |  |  |  |  |  |
| JPI Climate | X | X |  |  |  |  |  |
| ESA – Copernicus |  |  | X |  |  |  |  |
| PRIMA | X |  | X |  |  | X |  |
| CSA European Geological Services |  |  | X |  |  |  |  |

Table 2 - Interactions between Water4All Pillars, SRIA's Themes and key Policy Issues

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Water4All Pillars |  A Joint Vision  | B Developing knowledge &solutions | C Transfer knowledge and innovations  | D Demonstrating innovative solutions | E International Cooperation  |
| Principal tools for implementation | SRIA | Research and Innovation Calls | Policy papers & Knowledge Hub | Demonstrators and pilots | International projects |
| Green Deal Key Policy Issues | Increasing climate ambition | I,II,III,IV,V,VI | I,II,III,IV,V,VI, VII | I,II,III,IV,V,VI | I,II,III,IV,V,VI | VI |
| Clean, affordable and secure energy | I,II,III | I,II,III | I,II,III |  | VI |
| Sustainable and smart mobility | I,V, VII | I,V | VII | I,V |  |
| Energy and resource efficient buildings | I,V | I,V |  | I,V |  |
| Farm to fork | I,II,III,IV,V,VI, VII | I,II,III,IV,V,VI, VII | I,II,III,IV,V,VI, VII | I,II,III,IV,V,VI, VII | VI |
| Biodiversity and ecosystems | I,II | I,II | I,II | I,II |  |
| Zero-pollution, toxic-free environments | I,IV | I,IV, VII | I,IV, VII | I,IV | VI |
| Water Framework Directive and daughter Directives |  | VII | I,II,III, VII |  | VI |
| Common Agricultural Policy | VII | VII | I,II,III,VII |  |  |
| International cooperation |  |  |  |  | VI |
|  |

**Legend** – Themes: I: Circular economy and bioeconomy; II: Water and ecosystems and biodiversity; III: Water for the future: sustainable water management; IV: Water and health; V: Infrastructures for water; VI. International cooperation ; VII Governance

Table 3 – Existing Research Infrastructures on water in EU

|  |  |
| --- | --- |
| **Water related Research Infrastructures** | **Status** |
| **DANUBIUS** – The international center for Advanced studies on river-sea systems | ESFRI-Roadmap 2016 |
| **LTER** – The Long-term Ecological Research Network | ESFRI-Roadmap 2018- Integration |
| **Aquacosm -** EU network of mesocosms facilities for research on marine and freshwater ecosystems open for global collaboration. | EU H2020-INFRAIA-project; RIA; 10 Mio. € |
| **AnaEE** – Infrastructure for Analysis and Experimentation on Ecosystems |   |
| **LifeWatch** – E-science European Infrastructure for Biodiversity and Ecosystem Research | ERIC |
| **ICOS** – Integrated Carbon Observation System | ERIC |
| **HYDRALAB+** Adapting to climate change (HYDRALAB-PLUS) |   |