



*Progress report: new
inputs for the revised SRIA
by integrating
stakeholders' views*

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List of acronyms

ACRONYM	FULL TITLE
AI	Artificial Intelligence
EC	European Commission
ERA	European Research Area
EU	European Union
IoT	Internet of Things
HE	Horizon Europe
NbS	Nature based Solutions
R&I	Research and Innovation
SRIA	Strategic Research and Innovation Agenda
SRL	Societal Readiness Level
TRL	Technology Readiness Level
UN SDGs	United Nations' Sustainable Development Goals
Water4All	European Partnership on Water Security for the Planet
WFD	Water Framework Directive

Introduction

As part of the process to revise and refine the Water4All's Strategic Research and Innovation Agenda (SRIA), a dedicated consultation session was held in Paris on the 3rd and 4th April 2025 to gather experts' feedback on the current structure, scope, and priorities of the agenda. This report includes a synthesis of key discussions, identified knowledge gaps, prioritised research needs, and recommendations for future actions. It will serve as a reference document for the update of the Water4All's SRIA but also for policymakers, funding agencies, and research institutions, helping to shape the direction of water research and innovation. **The report will be shared with all participants and relevant stakeholders, ensuring transparency and continued dialogue.**

1. Background: Water4All and its strategic agenda.

The **Water4All Partnership** is a Research and Innovation (R&I) programme for scientific research in freshwater. Co-funded by the European Commission under the framework of Horizon Europe, it aims to tackle water challenges to i) improve access to water resources; ii) ensure that adequate water supplies are available for food and energy production, agriculture, industry, transport and tourism; iii) enhance the resilience of populations to global changes and water-related hazards including floods, droughts and pollution. **To this end, the programme will boost systemic transformations and changes across the entire water research – innovation pipeline, fostering the matchmaking between problem owners and solution providers.** The **Water4All Partnership** adopts a systemic approach from the source to receiving water bodies.

The programme is structured around six action pillars, encompassing a wide portfolio of multi-national and cross-sectoral activities, from physical and biological sciences to human and social sciences. Results from those action pillars will not only offer innovative solutions to address most pressing challenges associated to inland and transitional waters, including water management, ecosystems, infrastructures and services provided. They will also support relevant European policies and international frameworks, quite notably the EU Green Deal, the Water Framework Directive (WFD), the Urban Wastewater Treatment Directive, the European Water Resilience Strategy, and the United Nations' Sustainable Development Goals (UN-SDGs).

Today, the **Water4All Partnership** brings together a group of 90 partners from 33 countries in the European Union and beyond (Brazil, Georgia, Israel, Moldova, Norway, South Africa, Switzerland, Turkey, Tunisia, United Kingdom). The partnership is coordinated by the French Research Agency (ANR, in French). The consortium has been strategically conceived to gather partners covering the whole water R&I chain including academia, R&I funders, water management authorities, water utilities and water associations. Moreover, partners will strive to collaborate with other R&I initiatives in the European Research Area (ERA) to enhance the impact of planned activities. Amongst others, collaboration will be sought with EU Missions, like the Mission "Restore our Ocean and Waters by 2030", and other Horizon Europe Partnerships such as the ones on Biodiversity, Sustainable Blue Economy and Driving Urban Transitions.

The expected outcomes of Water4All include:

- Strengthening the water **R&I collaboration and strategic coordination** for the conservation, restoration, regeneration and best use of the natural functions of groundwater, surface water and dependent or associated ecosystems.
- Supporting and promoting **demonstration and access to the market** of innovative solutions.
- **Communicating** water-related knowledge and data through open access.
- Providing **tools for water management** through innovative knowledge, methodologies and tools.

Launched in June 2022, **Water4All** will last seven years although some activities will extend till 2032.

Water4All's SRIA

Coordinated by the operational pillar “Pillar A”, the Water4All Partnership published its Strategic Research and Innovation Agenda (SRIA) in September 2022: <https://www.water4all-partnership.eu/publication/strategic-research-and-innovation-agenda>.

The SRIA is a strategic high-level document that offers a **comprehensive understanding of specific areas in which knowledge gaps persist and for which further R&I is recommended**. Its overarching aim is to guide the strategic activities of Water4All including upcoming calls for proposals, networks of experts, training, international cooperation or the Partnership’s position as regards water policies and R&I frameworks.

The SRIA’s structure is based upon a conceptual framework that distinguishes between (**Figure I**):

- **Themes:** Overarching categories that define key research areas. The Water4All’s SRIA identifies seven themes (listed in **Figure II**). For comprehension purposes, each theme contains a number of sub-themes.
- **Topics:** Specific focus areas within a theme that guide research efforts.
- **Knowledge gaps:** Areas where critical information is missing, preventing a full understanding of a topic.
- **Research needs:** Specific studies or investigations required to address knowledge gaps and advance the understanding of a topic.



Figure I. SRIA’s conceptual framework.

The Water4All’s SRIA lists more than 200 different topics, grouped into the different themes according to the domain they pertain. Such topics refer to the knowledge gaps identified in the literature, a public consultation launched in 2021, and stakeholder consultative events.

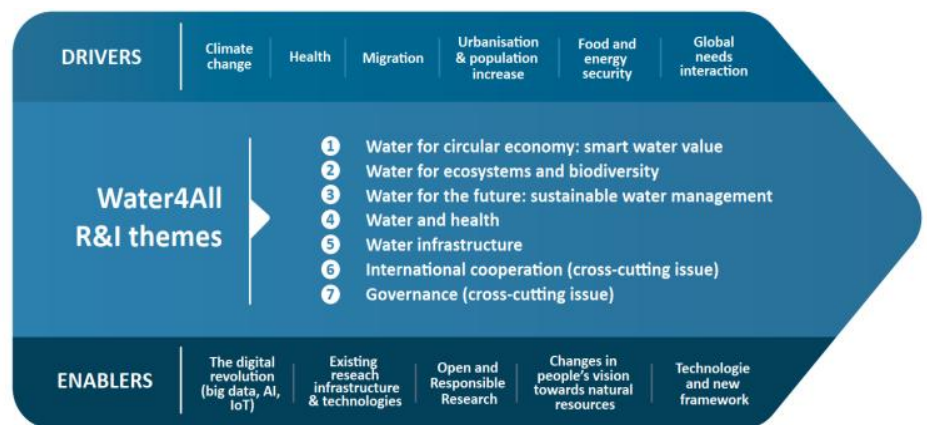


Figure II. Water4All’s R&I themes, drivers and enablers.

The SRIA also identifies drivers and enablers, as specific factors that may play a major role in the delineation of Water4All’s thematic orientations. One of the drivers is “**digital revolution (big data, AI, IoT)**”, on which a dedicated stakeholder consultative workshop was held in Lisbon in June 2024.

Our world is rapidly changing. Climate change seems to accelerate at great pace and recent geopolitical and health events call for new measures to guarantee water supply for all. **The Water4All’s SRIA needs to take on-board these emerging needs as well as latest scientific breakthroughs. It is for this reason that partners**

are currently working on an updated version of the SRIA that will be released in 2026. This update process will be based on a participatory approach in which different types of stakeholders and experts will be invited to provide their insights and views on water topics that should be included in the SRIA. As part of the SRIA update process, **partners have organised a comprehensive review of water information sources, a foresight exercise, two consultative workshops, and a public consultation**. Additionally, several countries have held national workshops and SRIA consultations. Interviews and a mapping exercise on water research programmes, including their thematic priorities, will come to complete the update process.

2. Purpose of the workshop

The expert workshop on the SRIA of Water4All will play a crucial role in refining and advancing Water4All's strategic direction. This event brought together **more than 30 experts** from diverse areas of expertise to collaboratively identify and prioritise critical knowledge gaps in the water domain. Experts were nominated following a call for applications launched at the end of 2024, with over 220 candidacies submitted from experts worldwide.

The purpose of the expert workshop was to collaboratively gather experts' **ideas and recommendations on the contents of the SRIA**. Specific objectives included:

- Examining the knowledge gaps, translated into specific R&I topics, listed in the current SRIA;
- Establishing priorities by aligning research priorities with policy goals;
- Creating an actionable roadmap for future activities of Water4All and Pillar A.
- Identifying possible new themes that could be included in the next version of the SRIA;
- Getting experts' feedback as regards the current structure of the SRIA.

The insights gathered will contribute to updating the SRIA, ensuring that research efforts align with pressing challenges, policy objectives, and societal needs.

3. Expected contribution from participants.

The expert workshop was a key opportunity to collaboratively refine and strengthen the SRIA. Participants brought their expertise, insights, and forward-thinking perspectives **to identify and prioritise critical knowledge gaps in water research**. Throughout the workshop, experts contributed to:

- **Identifying knowledge gaps.** Experts critically assessed the current state Water4All's SRIA, pinpointing where significant knowledge gaps remain. Discussions considered both fundamental and applied research needs, ensuring that the identified gaps align with real-world challenges and policy priorities.
- **Formulating R&I topics.** Experts collaborated to refine the identified knowledge gaps into concrete R&I topics. This process involved characterizing each topic based on its relevance, Technological Readiness Level (TRL), interdisciplinary connections, and potential impact on water resource management, policy, and industry. The aim was to ensure that the formulated topics were actionable, innovative, and capable of driving meaningful progress.
- **Prioritising research needs.** Given the breadth of challenges in the water domain, prioritisation is essential. Experts engaged in structured discussions to determine the most urgent and high-impact research needs, ensuring alignment with European and global policy frameworks. The outcomes of these discussions will shape the next version of the SRIA, guiding future research investments and collaborations.

In anticipation of the workshop, experts were invited to reply to an online questionnaire. The questionnaire contained the following questions:

1. Which knowledge gaps, to be reformulated as topics, should be included in the SRIA?

2. For each of the knowledge gaps you propose in Question 1, please indicate:

- Links to other sub-themes of the Water4All's SRIA:

- Could this knowledge gap be properly addressed through a demonstration project? If "Yes", why?

- Potential outcomes (how does this knowledge gap relate to existing political frameworks?)

4. Outputs of the workshop

4.1. Drivers and Enablers

- Participants emphasised the importance of **clarifying the definitions** of *drivers*, *enablers*, and *cross-cutting themes*. These categories are currently not well-distinguished and may cause confusion.
- There was a strong consensus that **resilience** should be identified as the **main driver** of innovation in the water sector.
- The **geopolitical situation** (e.g. conflicts, migration, security) was also suggested as an additional driver.
- **Digital tools** were described more as **innovation drivers** than enablers.
- Participants suggested the inclusion of **industry involvement** as an important enabler.
- Some participants questioned the inclusion of **research infrastructures** as enablers and suggested that the current list needs revision or clearer justification.
- A few voices proposed to **remove the enablers section entirely**, while others advocated for its **refinement and better integration** into the rest of the agenda.

4.2. Structure and Strategic Value of Themes

- The existing seven themes were seen as **generally adequate**, but their **coherence, articulation, and strategic clarity** need improvement.
- Rather than restructuring the themes, participants called for:
 - Strengthening **linkages between themes**, using a **nexus approach**.
 - Ensuring that **governance** is addressed **across all themes**, rather than being isolated in Theme 7.
 - Recognizing that **Theme 3** represents a **central goal or umbrella** for the entire agenda, rather than a stand-alone theme.
- There was a strong push to articulate the **strategic intent of each theme**, including the **main challenges, barriers, or blockers** they aim to address.
- It was also suggested that more attention be paid to **overarching goals** and the **interactions between themes**, especially in terms of implementation.

4.3. Refinement of Topics

- Participants agreed that the current list of topics is **too long** and may reduce the agenda's usability. A limit of **50–60 topics** was proposed.
- Other thematic gaps highlighted included:
 - **Wastewater and sanitation.**
 - **Access to water**, which should be placed **at the top of the agenda.**
 - **Economic instruments** (taxes, pricing, incentives) and **financial mechanisms** to support innovation and implementation.

4.4. From Research to Implementation

- A recurring concern was the **"implementation gap"**—the disconnection between research outputs and real-world uptake. Participants highlighted the importance of **connecting research to practical needs**, and of addressing why **R&I projects often stop short of implementation.**
- The agenda currently focuses heavily on the **process of innovation**, but lacks clarity on **how to support adoption**, especially by end-users and policymakers.
- **Living labs** and **networks of research infrastructures** were identified as tools that can support **long-term adoption** and **scaling up of results.**
- A suggestion was made to **enable competition for the scaling of results**, to maintain momentum after the end of research projects.
- The group emphasised the need for a **problem-driven approach**, with the agenda grounded in **real challenges** and **societal needs.**

4.5. Strategic Goals and Impact Orientation

- It was recommended that the SRIA be structured around **clear strategic goals and expected impacts**, which would then inform:
 - Thematic and topic prioritisation
 - The timeline for implementation
 - Indicators for monitoring success
- Participants also encouraged to **work with the current structure** and focus on **strengthening its internal logic and priorities**, rather than starting from scratch.

4.6. Other Key Messages

- There was strong support for:
 - A **dedicated editorial group** to guide the revision of the SRIA.
 - **International cooperation** as a cross-cutting priority.
 - Continued support for **fundamental research**, in addition to applied, policy-oriented research.
 - Addressing the **lack of incentives** for researchers to pursue implementation, beyond academic outputs.

5. Revision process following the workshop

The expert workshop served as a key milestone in the ongoing update of the SRIA. By bringing together experts from diverse backgrounds, the event will ensure that the revised SRIA is not only scientifically robust but also aligned with current and emerging water-related challenges. **The discussions helped refine and prioritise**

knowledge gaps, ensuring that future research efforts are well-targeted and capable of delivering tangible benefits for water management, policy, and innovation.

A critical impact of the workshop will be its role in shaping future research funding activities. **By identifying the most urgent and high-impact research needs, the outcomes will inform funding priorities within the Water4All Partnership and beyond.** This will help ensure that available resources are directed toward addressing pressing water challenges, fostering interdisciplinary collaboration, and bridging the gap between research and real-world application.

Furthermore, the insights gathered will contribute to refining strategic recommendations for European and global water policies, supporting initiatives such as the EU Green Deal, the Water Framework Directive, and the Sustainable Development Goals.

Finally, the conclusions drawn will not only feed into the updated SRIA but will also set the stage for follow-up consultations, collaborative projects, and strategic initiatives that will extend the impact of Water4All beyond the event itself.

Annex 1 – Contribution of the Working Group 1 “Circular economy: smart water value”

Participants

Stella Tsani, Mona Arnold, Aurora Santos Lopez, Andrea Sbandat, Kris de Craene, Gaëtane Suzenet, Juan Antonio Álvarez Rodríguez.

Strategic goals

Strategic goal 1. To mainstream, including the upscaling of, circular economy models for water security and resilience.

Strategic goal 2. To optimise water reuse and water recycling from an economic, financial, social, technical and environmental point of view.

Strategic goal 3. To develop top-down (training, equity, justice, affordability) and bottom-up approaches (engagement, behavioural changes) for the adoption of circular economy models.

New topics identified by the WG 1

(A) Social acceptance and public perception of water reuse and recycling.

SRL: 2

End-users: citizens, farmers, industrial partners.

Related sub-themes: I.II and I.III

(B) Making the water-related circular economy market more efficient through the identification of new markets and incentives.

SRL: 2; TRL: 4-5

End-users: water utilities, industries, financing communities, water managers.

Related sub-themes: I.II and I.III

(C) Net zero water production in future energy systems.

TRL: 6

End-users: water and energy utilities.

Related sub-themes: I.II

(D) Lack of data on water supply, demand and use at local scale. Accounting of water circular schemes.

TRL: 3

End-users: water utilities, water authorities, industries.

Related sub-themes: I.I

(E) Implementation and scaling of cost-effective treatment technologies.

TRL: 6

End-users: water utilities, municipalities.

Related sub-themes: I.II

(F) Development and integration of cost-effective monitoring systems into early warning frameworks.

TRL: 4

End-users: water utilities, municipalities, water authorities and agencies.

Related sub-themes: I.I (III.I)

(G) Assessment of nature-positive circular economy models in order to better understand the effects of circular economy models in reversing biodiversity loss and degradation.

TRL: 3

End-users: scientific community, policymakers, financial institutions.

Related sub-themes: Theme II.

(H) Defining water quality standards tailored to different uses and regulatory needs (fit-for-purpose), to support harmonised policies and realistic risk assessments.

TRL: 5

End-users: policymakers, authorities, municipalities, utilities, industries.

Related sub-themes: I.II.

(I) Understanding the “groundwater–soil–surface water nexus” and modelling contaminant and nutrient transport across these compartments.

TRL: 4-5

End-users: policymakers, authorities, municipalities, utilities.

Related sub-themes: III.I.

(J) Establishing science-based limits for sustainable water abstraction, including the integration of water reuse practices.

TRL: 3

End-users: policymakers, authorities, municipalities, utilities.

Related sub-themes: ---.

(K) Understanding the nature of water as a resource: investigating the Implications of public versus private good frameworks for sustainable water use.

SRL: 2

End-users: policymakers, local communities, industries, etc.

Related sub-themes: I.I.

(L) Economic feasibility and risk assessment of industrial symbiosis.

TRL: 6

End-users: industries.

Related sub-themes: I.II.

(M) Exploring circular economy models for water: advancing supply security, market access, and equitable technology transfer in the European Union.

SRL: 3

End-users: social communities, policymakers, financial communities.

Related sub-themes: I.II.

(N) Overcoming Barriers to Small-Scale Decentralised Water Systems: Exploring Implementation, Scalability, and Successful Applications Across Diverse Contexts.

SRL: 6

End-users: municipalities, utilities, water agencies, communities, citizens.

Related sub-themes: I.II.

Priority topics identified by the WG 1

- Public acceptance.
- Make the circular economy water-related market more efficient. The aims of this priority topic are to give incentives to adopt circular economy, and to create the conditions for a water-related circular economy market.
- Lack of data and introduction of new tools for the collection and analysis of data.
- Nature-positive circular economy.
- Research on the nature of water (public vs private)

Revision of topics

Sub-theme I. Water supplies for socio-economic development and activities, such as agricultural, aquaculture, urban, industrial and energy uses.

- To replace topics I and II: Developing scalable and innovative water allocation and demand management strategies to support long-term water planning: Enhancing efficiency, equity, and climate resilience through technological, scientific, and public participation approaches. TRL: 4
- To replace topics III and IV: Developing and adapting smart water management technologies: from source separation and precision irrigation to integrated digital solutions for agriculture, urban, and industrial applications in water-stressed regions. TRL: 8
- Delete the topic: Mitigating impacts from energy and raw materials production on water and water ecosystems.
- No changes to the topic: Advancing in new water sources to reduce water stress, e.g. harvesting water from water vapour, saline sources, etc. TRL: 6-7

Sub-theme II. Circular economy.

- No changes: Progressing in circular economy approaches in urban and industrial wastewater treatment plants through the development and optimisation of technologies for: - The recovery and valorisation of resources from wastewater and sediments (including energy, minerals, metals, salts, nutrients, cellulose). – The production of novel feedstocks from wastewater (e.g. nutrients, fertilisers,

hydrogen, VFA, ethanol, ammonia, bio-plastics, PHA, natural flocculants, kaumera), brines and sludges. TRL: 4-7 (for bioplastics), higher for nutrients.

- One minor change: Water-energy-food-ecosystems (WEFE) nexus: – Assess the interlinkages and interdependencies of water, food and energy sectors and ecosystems in a context of climate change in different water bodies, in particular cross-border ones, to implement a real water-energy-food nexus approach and increase efficiencies, social equity and sustainability. – Advancing in the development of a more holistic approach in the WEFE nexus through the inclusion of health (One Health concept). – Identifying and investigating drivers, pathways, nature and types of sectoral barriers of the nexus. TRL: 6-7.
- No changes: Enabling the transition to circular water systems through the integration of NBS. R&I actions in this topic should address current challenges, requirements, limitations and barriers. TRL: 6-7.
- Consider the phrasing above for the topics: Developing and implementing the fit-for-use concept for water-dependent sectors. & Developing innovative traceability systems to guarantee the quality of recovered products and improve confidence of the market.
- No changes: Quantifying and guiding the management of environmental and health risks associated with water reuse. TRL: 5
- Delete the topic: Providing efficient pathways (technological, policy, and / or economic) for end of waste status for recovered products from waste streams.
- One minor change: Developing new management tools and methodologies, partnerships and business models within the market topic, for measuring transition to circularity, its benefits, challenges and trade-offs for industrial processes and agricultural water reuse and recycling.
- Consider the phrasing above for the topic: (...) and the implementation of decentralised treatment systems in synergy with existing centralised treatments.
- No changes: Sustainable management and valorisation of residues from desalination plants to protect land, water and sea ecosystems altogether. TRL: 5-5
- Consider the phrasing above for the topic: Progressing in the understanding of the factors that explain the acceptability of water reuse.

Sub-theme III: Empowering the public, water users and stakeholders in valuing water.

- Minor changes: Developing a bottom-up participatory approach for the co-design and co-construction of solutions for water users (e.g. living labs). TRL: 6-7
- Delete the topic: Raising awareness about, understanding and assessing the value of water for the public and stakeholders.
- No changes: Developing methodologies to help stakeholders set appropriate pricing policies that reflect full cost and the economic value of water. TRL: 5-6
- No changes (maybe to be moved to Theme III): Exploring the possible routes to conduct paradigm changes to be innovative for water governance. Concepts like water value, water footprint and virtual water will be explored. TRL: 5-6
- No changes: Developing ICT tools (sensors, smart meters, smart phone applications) combined with citizen science to increase information and transparency over water use (awareness raising). TRL: 5-6

General comments: Need to reinforce the aspect of value of water. Moreover, the title of the theme “smart water value” is confusing.

Annex 2 – Contribution of the Working Group 2 “Water for ecosystems and biodiversity”

Participants

Alan Jenkins (moderator), Cécile Hérivaux, Leonard Sandin, Pablo Urrutia Cordero, Dina Del Tosto, Anca-Iulia Stoica.

Strategic goal

Successful implementation of environmental policies for a just and sustainable protection and restoration of water ecosystem services and biodiversity.

New topics defined by the WG 2

With the mind set on achieving this overarching goal, the group then proceeded to define a new set of topics that fitted within each of the 4 major sub-themes from the SRIA 2022-2025. In total, the group identified **12 new pressing topics** for the 4 existing Sub-themes, named from the letters A to L:

- (A) (in Sub-theme II.I) Assessment and definition of appropriate temporal and spatial scales for ecosystems monitoring.
- (B) (in Sub-theme II.I) Introducing biodiversity monitoring to assess the ecological status of Groundwater and Groundwater Dependent Ecosystems (GDE).
- (C) (in Sub-theme II.I) Understanding the impacts of freshwater availability and quality on biodiversity and ecosystem services beyond the freshwater ecosystem boundary (i.e., terrestrial and marine environments).
- (D) (in Sub-theme II.II) Protection and restoration of aquatic ecosystems in the face of climate change from a multi-stressor perspective.
- (E) (in Sub-theme II.III) Assessment of the impact and efficiency of NBS at a large basin scale.
- (F) (in Sub-theme II.I) Knowledge on meta-ecosystem dynamics (incl. connectivity) for biodiversity conservation and ecosystem service delivery.
- (G) (in Sub-theme II.II) Understanding which and how ecological traits contribute to different ecological stability components (resilience, resistance, recovery, temporal stability) in freshwater ecosystems.
- (H) (in Sub-theme II.IV) Improving the links between the Nature Restoration Law and other water-related policies.
- (I) (in Sub-theme II.IV) Expanding the scope of the WEF Nexus to integrate common goods and a wider scope of societal challenges (biodiversity, health and climate).
- (J) (in Sub-theme II.IV) Integration of the concept of environmental justice in the design of environmental programs and decision-making.
- (K) (in Sub-theme II.IV) Developing interdisciplinarity between life and social sciences in the assessment of biodiversity and ecosystem services.
- (L) (in Subtheme II.II) Integration of risk assessment across different disciplines (climate sciences, ecology, social sciences, natural hazards).

Priority topics identified by the WG2

Finally, the group completed the work with a prioritization exercise to select those topics that were considered the most pressing for the new SRIA version:

- **Rank 1:**
- Subtheme II.II: Merged from the existing Topic 2.1 and new Topic D.

- Subtheme II.II: New Topic L “Integration of risk assessment across different disciplines (climate sciences, ecology, social sciences, natural hazards)”.
- Subtheme II.III: Rephrased Topic 3.3. “Understanding social impacts and enhancing stakeholder engagement (including citizens) in the design of solutions for ecosystem restorations”
- Subtheme II.III: Merged from the existing Topic 3.2 and the New Topic E.
- Subtheme II.IV: New Topic F “Knowledge on meta-ecosystem dynamics (incl. connectivity) for biodiversity conservation and ecosystem service delivery”.
- Subtheme II.IV: New Topic I “Expanding the scope of the WEF Nexus to integrate common goods and a wider scope of societal challenges (biodiversity, health and climate)”.

- **Rank 2:**

- Subtheme II.II: Merged from the existing Topics 1.2-1.4 and Topic A.
- Subtheme II.III: Rephrased Topic 2.3 “Improved ecosystem-based tools for adaptation and mitigation to hydroclimatic extreme events”.
- Subtheme II.I: New topic C “Understanding the impacts of freshwater availability and quality on biodiversity and ecosystem services beyond the freshwater ecosystem boundary (i.e., terrestrial and marine environments)”.

- **Rank 3:**

- (in Subtheme II.IV): New Topic J “Integration of the concept of environmental justice in the design of environmental programmes and decision-making”.

- **Rank 4:**

- (in Subtheme II.I): Merged from existing Topics 1.7 and 1.8
- (in Subtheme II.II): Existing Topic 2.4: “Exploring synergies between green and blue NBS to both mitigate and adapt to water related natural hazards, providing water quality, water quantity, biodiversity and GHG mitigation both in natural and urban environments”.
- (in Subtheme II.III): Rephrased Topic 3.4: “Evaluate the effects of restoration and protection measures on ecosystems and biodiversity”
- (in Subtheme II.I): New Topic B “Introducing biodiversity monitoring to assess the ecological status of groundwaters and groundwater-related ecosystems (Subtheme II.I)”.

• **Rank 5:** Remaining topics

TRLs, links to other Themes and End-users:

- A) TRL 1-3. Links to other Themes; 2(i), 2(iv), 3 (all), 4(iii), 7(i). End Users; **Water/Environment Agencies**, Local/Regional/National Authorities, Research Providers, Private Sector, NGOs, Citizens
- B) TRL 4-5. Links; 1(i), 2(i), 2(ii), 2(iv), 3(all), 4(iii), 5(iii), 6(iii). End Users; **Water/Environment Agencies, Water Companies**
- C) TRL 1-3. Links; 2(i), 2(iv), 3(all), 4(i), 4(iv). End Users; **Water/Environment Agencies, Farming Community, Water Managers**
- D) TRL 3-5. Links; 1(iii), 2(ii), 2(iv), 3(i), 3(iv),4(i), 7(i). End Users; Water/Environment Agencies, **Farming Community, Citizens (fishermen)**, Local/Regional/National Authorities
- E) TRL 5-6. Links; 1(all), 2(iv), 3(all), 4(iii), 5(i). End Users; **Water/Environment Agencies, Local/Regional/National Authorities**, Land Owners

- F) TRL1-3. Links; 2(i), 2(iii), 2(iv), 3(all). End Users; **Water/Environment Agencies**, Local/Regional/National Authorities, Land Owners
- G) TRL 1-3. Links; 2(i), 2(iii), 2(iv), 3(all). End Users; **Water/Environment Agencies**, Local/Regional/National Authorities, Ecosystem Managers
- H) TRL 1-3. Links; 2(i), 2(iii), 2(iv), 3(i), 6(i), 7(ii). End Users; **Local/Regional/National Authorities**, Land Users/Managers, NGOs
- I) TRL 4-6. Links; 1(ii), 2(iv), 3(all), 7(ii). End Users; **Local Authorities**, Citizens, Health Agencies, EC/Member States
- J) TRL 4-6. Links; 2(iv), 6(iii), 7(i), 7(ii). End Users; **Citizens, Local Authorities, Vulnerable Communities**
- K) TRL 4-6. Links; 1(i), 1(iii), 2(all), 3(all), 7(i). End Users; **Citizens**, Research Community, Local Stakeholders
- L) TRL 1-3. Links; 2(ii), 4(iv), 5(i), 5(ii), 5(iii). End Users; **Water/Environment Agencies**, Local/Regional/National Authorities

Revision of topics

Following this work, the group centred on providing the following **suggestions to update the current version of Theme II in the SRIA 2022-2025** (please note that the group has named each topic from the current SRIA version as: Topic 1.1 to Topic 1.12 are those within the *Sub-theme II.I. Functioning and Biodiversity*; Topics 2.1 to Topic 2.4 are those in the second *Sub-theme II.II*; Topics 3.1 to Topic 3.4 are in the *Sub-theme II.III*; and Topics 4.1 to Topic 4.4. are in the *Sub-theme II.IV*):

- Within the Subtheme II.I. Functioning and Biodiversity:
 - **Remove Topic 1.1:**
 - Topic 1.1: "Setting minimum requirements and standards for meta-data descriptions, data accuracy, data handling and processing for sequencing data produced by molecular methods".
 - Rationale: The group does not consider this topic a research priority any longer.
 - **Merge Topics 1.2-1.4 and Topic A (new topic, see list above) into one:**
 - Topic 1.2: "Monitoring and assessing the functioning and evolution of ecosystems, ecosystem goods and services.... biosensors"
 - Topic 1.3: "Implementing innovative and adaptive biodiversity and ecosystems monitoring tools at different scales (from eDNA in water to Earth observations) and systems (from ponds to large rivers) and their integration into information technology observatories that combine data and model prediction".
 - Topic 1.4: "Using novel monitoring methods for managing the risks posed by invasive species and monitoring remediation options".
 - Topic A: "Assessment and definition of appropriate temporal and spatial scales for ecosystem assessment"
 - Potential Topic: "Improving the monitoring and assessment of biodiversity and ecosystem services at appropriate temporal and spatial scales through most recent advances in technology and predictive modelling"
 - Rationale: Synthesis purposes.
 - **Rephrase Topic 1.5:**
 - Topic 1.5: "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".
 - New topic: "Exploring the link between the ecological status (WFD) and conservation status (Habitats Directive) and the role of aquatic systems in climate mitigation (C sequestration, GHG emissions)".
 - Rationale: There was something wrong with the way Topic 5 was expressed.

- **Move Topic 1.6 to Theme III** on “Water for the future: Sustainable Water Management”:
 - Topic 1.6: “Developing and testing scalable and affordable solutions to support water planning, in particular in the face of climate change and climate change resilience (i.e. water planning is understood as the medium and long-term strategy dealing with water availability and provision in a particular area vs water management deals with short-term measures for optimized water use)”.
 - Rationale: This topic has a better fit with Theme III.
- **Merge Topics 1.7 and 1.8 into a new one:**
 - Topic 1.7: “Understanding and predicting multiple pressure (including anthropogenic pressures)–impact–response relationships in aquatic ecosystems (cumulative effects, domino effects) and ecosystem services through advanced methods and techniques”.
 - Topic 1.8: “Developing prediction models of ecosystem “tipping points”, sustainability, productivity and resilience in response to environmental stressors e.g. hydro-climatic extreme events”.
 - New Topic: “Modelling and forecasting of the state of biodiversity and ecosystem services in a multi-stressor scenario”.
 - Rationale: Synthesis purposes.
- **Rephrase Topic 1.9:**
 - Topic 1.9: “Understanding the dynamics and functioning of a range of vulnerable water ecosystems of regional interest (including intermittent rivers, wetlands, lagoons, alpine areas and glaciers, Arctic and boreal water systems, peatlands, estuaries)”.
 - New Topic: “Exploring the dynamics and understanding of vulnerable water ecosystems of regional interest”.
 - Rationale: Synthesis purposes.
- **Remove Topic 1.10:**
 - Topic 1.10: “Developing evaluation and prediction methodologies to assess the economic and social value of ecosystem services and the intrinsic value of biodiversity across the diverse regions of the EU. Concepts and indicators of ecological economics will be explored”.
 - Rationale: Now incorporated in other topics (in sub-theme II.IV).
- **Replace Topic 1.11 with Topic F (new topic, see list above):**
 - Topic 1.11: “Analyzing the linkage between upstream and downstream areas, the role and functional importance of floodplain/ lateral connectivity and channel dynamics, and the interaction zones (capillary fringe, vadose zone, hyporheic zone, sediment-water, air-water)”.
 - Topic F: “Knowledge on meta-ecosystem dynamics (including connectivity) for biodiversity conservation and ecosystem service delivery”.
 - Rationale: Many of the processes and linkages in Topic 11 are already covered in the broader concept of “meta-ecosystem dynamics”
- **Rephrase Topic 1.12:**
 - Topic 1.12: “Improving knowledge on the quantity and quality of matter flowing across the various reactive zones between soil-plant systems and the different water bodies (vadose zone, capillary fringe, hyporheic zone, estuary continuum and coastal zone)”.
 - New Topic: “Improving knowledge on the quantity and quality of matter flowing between ecosystems and different water bodies”.
 - Rationale: The new topic expands the ecological processes suggested to other ecosystems.
- **Add new Topic (B)** Introducing biodiversity monitoring to assess the ecological status of Groundwater and Groundwater Dependent Ecosystems (GDE).
- **Add new Topic (C)** Understanding the impacts of freshwater availability and quality on biodiversity and ecosystem services beyond the freshwater ecosystem boundary (i.e., terrestrial and marine environments).

- Within the Subtheme II.II. Resilience, mitigation and adaptation of aquatic ecosystems and ecosystem services to global changes:
 - **Rephrase Sub-theme II.II title to:** “Stability, mitigation and adaptation of aquatic ecosystems and ecosystem services to global changes”
 - Rationale: Ecological stability is the overarching concept capturing an ecosystem's ability to absorb and recover from change, integrating a family of metrics, such as resistance, resilience, recovery, and spatio-temporal invariance. Hence, resilience is only one component of ecological stability, and so expanding the sub-theme title to more components of stability is recommended, as resilience is no more important than the others in the face of global environmental changes.
 - **Replace Topic 2.1 with Topic D (new topic, see list above):**
 - Topic 2.1: “Using the understanding gained in multiple pressure-impact-response relationships to counteract pressure factors/ stressors in ecosystems (including biodiversity)”.
 - Topic D: “Protection and restoration of aquatic ecosystems in the face of climate change in a multi-stressor perspective”.
 - Rationale: Synthesis purposes.
 - **Keep Topic 2.2 as it is:**
 - Topic 2.2: “Exploring the connection between biodiversity (in particular invasive species), ecosystems services and waterborne diseases as a result of climate change”.
 - Rationale: Well-formulated and pressing topic.
 - **Rephrase Topic 2.3:**
 - Topic 2.3: “Developing improved tools for adaptation and mitigation to hydro-climatic extreme events, especially floods (including “flash-floods”), heat waves and droughts in a catchment to sea context”.
 - New topic: “Improved ecosystem-based tools for adaptation and mitigation to hydroclimatic extreme events”
 - Rationale: Need to place the focus on ecosystem-based tools for a better link with the theme on “Water for ecosystems and biodiversity”
 - **Keep Topic 2.4:**
 - Topic 2.4: “Exploring synergies between green and blue NBS to both mitigate and adapt to water related natural hazards, providing water quality, water quantity, biodiversity and GHG mitigation both in natural and urban environments”.
 - Rationale: Well-formulated and pressing topic.
 - **Add new Topic (G)** Understanding which and how ecological traits contribute to different ecological stability components (resilience, resistance, recovery, temporal stability) in freshwater ecosystems.
 - **Add new Topic (L)** Integration of risk assessment across different disciplines (climate sciences, ecology, social sciences, natural hazards).
- Within Sub-theme II.III. Developing and applying ecological engineering and ecohydrology for ecosystems restoration:
 - **Rephrase sub-theme title to:** “Developing and applying solutions for ecosystem restoration”.
 - Rationale: Simpler topic. Also, it widens its scope to all kinds of solutions for aquatic ecosystems and not only those involving ecological engineering and ecohydrology.
 - **Rephrase Topic 3.1:**
 - Topic 3.1: “Understanding, managing and restoring the ecological functioning of aquatic systems (morphological conditions, river continuity and connectivity, sediment flows, hydraulic connectivity, habitat dynamics and ecological flow), ecosystem services and biodiversity. Opportunities provided by technology (sensors, digitally derived biodiversity indicators, artificial intelligence, digital platforms) will be seized”.
 - New Topic: “Exploring opportunities provided by technology to manage and restore aquatic ecosystems”
 - Rationale: Simpler and wider topic.

- **Merge Topic 3.2 and Topic E (new topic, see list above):**
 - Topic 3.2: “Developing and evaluating in the short- and long-term NBS and engineered solutions (including hybrid grey-green) for the remediation and mitigation of degraded water bodies and aquatic ecosystems”.
 - Topic E: “Assessment of the impact and efficacy of NBS at large basin scale”.
 - New topic: “Developing and assessing the impact and efficiency of NBS and engineered solutions (including hybrid grey-green infrastructures) for improved freshwater security at a large basin scale”
 - Rationale: Synthesis purposes.
- **Rephrase Topic 3.3:**
 - Topic 3.3: “Understanding the social and environmental impacts of proposed solutions for ecosystems restoration.
 - New Topic: “Understanding social impacts and enhancing stakeholder engagement (including citizens) in the design of solutions for ecosystem restorations”.
 - Rationale: Need to consider the engagement of citizens.
- **Rephrase Topic 3.4:**
 - Topic 3.4: “Analyzing the effect of current conservation practices and new approaches based on ecological engineering and ecohydrology to mitigate current pressures and impacts on aquatic biodiversity, especially at longer time scales and larger spatial scales”.
 - New Topic: “Evaluate the effects of conservation and restoration measures on ecosystems and biodiversity”
 - Rationale: Synthesis purposes
- Within the Sub-theme II.IV. Integrating ecosystem services into the management of water resources and aquatic ecosystems:
 - **Keep Topic 4.1:** “Monitoring the effects of water management and water planning measures on ecosystems (including biodiversity)”.
 - Rationale: Pressing issue
 - **Keep Topic 4.2:** “Developing methodologies for the valuation of ecosystems services, including intrinsic social and economic values as well as approaches to include the intrinsic value of ecosystem services in decision-making”.
 - Rationale: Pressing issue
 - **Remove Topic 4.3:** “Exploring land-sea continuity and interactions above and below the surface for biodiversity and ecosystem services conservation at global scale”.
 - Rationale: Already covered in Topic F.
 - **Keep 4.3:** “Exploring innovative policy instruments to ensure cost-efficient, flexible and fair regulation of water and aquatic ecosystems”.
 - Rationale: Pressing issue
 - **Add new Topic (H)** Improving the links between the Nature Restoration Law and other water-related policies.
 - **Add new Topic (I)** Expanding the scope of the WEF E Nexus to integrate common goods and a wider scope of societal challenges (biodiversity, health and climate).
 - **Add new Topic (J)** Integration of the concept of environmental justice in the design of environmental programs and decision-making, .
 - **Add new Topic (K)** Developing interdisciplinarity between natural and social sciences in the assessment of biodiversity and ecosystem services.

Annex 3 - Contribution of the Working Group 3 “Water for the future: sustainable water management”

Participants

Jesus Manuel Morales Martinez, Marie Pettenati, Amanda Loeffen, Inga Retike, Edoardo Borgomeo, Maria Borrego-Marin, Dr. Robert Luetkemeier, Marco Petitta.

Strategic Goals

Strategic goal. Building economic, socio-cultural and environmental resilience based on sustainable integrated water resources management through:

Better preparedness to hydro-climatic extremes;

Improved uptake and implementation of socio-economic, nature-based and technological solutions for long-term adaptation (e.g., water allocation, public entities better able to manage change);

Conserve and enhance ecosystem services and environmental health for the long-term;

Encourage water-related data collection & sharing, knowledge generation and action to advance equity, gender, and inclusion of vulnerable groups.

Priority topics identified by the WG3

5 new topics and 1 existing:

- Supporting water rights and allocation reform under climate change [III.I]
- Assessing the global values of water (social and non-market values) – going beyond traditional economic valuation techniques and units of water management to identify solutions and interconnections for ‘problem sheds’ [III.I]
- Supporting timely public sector source-tap-loop strategies to water infrastructure design to delivery (same concept of time to market in a EU public policy context) [III.II and III.III]
- Understanding and raising awareness about groundwater systems and interconnections at local levels through recognition equity, gender, culture, and inclusion of vulnerable groups (making the invisible visible) [III.III]
- Improving hydro-climate services to respond to specific user needs at different levels, with a focus on impact-based hydro-climate services and forecasts [III.IV]
- Topic 4.3: Developing innovative participatory approaches to design socially and economically acceptable adaptation and mitigation strategies to cope with hydro-climatic extreme events, especially floods and droughts [III.IV]

During day 1 the group discussed the following topics, and then identified them as already existing in SRIA but not under Theme III. The group concluded that these existing topics are inter-related and important to sub-themes under Theme III.

- Making citizen science activities meaningful and better integrated within policy-making and scientific processes (linked to III.I and III.III)
- Enhancing citizen science engagement through AI, transparency and communication (linked to III.V)
- Creating new research and innovation pipelines that accelerate uptake of existing solutions and products (linked to III.I and III.V)
- Developing new (circular) business models that better connect supply and demand for optimal/equitable resource and waste utilization and management across sectors (linked to III.IV)

Theme III should be all about developing ways/knowledge to enhance accountability and transparency of water service providers (duty-bearers, such as water utilities, river basin authorities, local authorities, ...)

Revision of topics

- Within the Subtheme III.I. Integrated water resources management:
 - **Enhance the interrelationships among Topics 1.1, 1.3, 1.4**
 - Topic 1.1: “Developing integrated, robust and multiscale numerical modelling tools on the water cycle, ecosystems and economic systems to simulate and predict the long-term co-evolution of water resources, ecosystems and economy, and support water resource management and planning.”
 - Topic 1.3: “Developing tools and multi-disciplinary approaches to link landscape management to water management and planning, to understand and manage land-water-ecosystem-human relationships and to assess the effect of different land uses on groundwater, inland and coastal water resources (including e.g. nutrients, hazardous substances and brownification).”
 - Topic 1.4: “Developing new methodologies, tools and models for assessing/ modelling water resources in scarcely monitored /data scarce areas. Opportunities provided by citizen science should be considered.”
 - **Rephrase Topic 1.4:** “Developing new methodologies, tools and models for assessing/ modelling water resources in scarcely monitored /data scarce areas. Opportunities provided by citizen science should be considered.” to add sentence with following wording “advance equity, gender, and inclusion of vulnerable groups”
 - **Add new Topics**
 - “Supporting water rights and allocation reform under climate change” [Priority] (linked with III.IV, I.III)
 - “Assessing the global values of water (social and non-market values) – going beyond traditional economic valuation techniques and units of water management to identify solutions and interconnections for limiting the problem expansion” [Priority] (linked with I.I, II.IV)
- Within the Subtheme III.II. River basin management:
 - **Add new Topic:** “Supporting timely public sector source-tap-loop strategies to water infrastructure design to delivery (same concept of time to market in a EU public policy context)” [Priority] (linked with I.II, V.II)
This topic is relevant for both river basin and groundwater management and could be included under both sub-themes.
- Within the Subtheme III.III. Groundwater management:
 - **Add new Topics**
 - “Understanding and raising awareness about groundwater systems and interconnections at local levels through recognition equity, gender, culture, and inclusion of vulnerable groups (making the invisible visible)” [Priority] (linked with II.III, IV.IV)
 - “Supporting timely public sector source-tap-loop strategies to water infrastructure design to delivery (same concept of time to market in a EU public policy context)” [Priority – duplicate from sub-theme II] (linked with I.II, V.II)
This topic is relevant for both river basin and groundwater management and could be included under both sub-themes
- Within the Subtheme III.IV. Resilience, adaptation and mitigation to hydroclimatic extreme events:
 - **Add new Topics:** “Improving hydro-climate services to respond to specific user needs at different levels, with a focus on impact-based hydro-climate services and forecasts” [Priority] (linked with II.I, V.II)
 - **Rephrase Topic 4.4:** “Understanding the disaster management cycle in the face of climate change, effects on society, gender, equity and social vulnerability and mitigation measures”

- Existing Topic 4.3 “Developing innovative (or improved) participatory approaches, including foresight techniques, to design economically and socially acceptable adaptation and mitigation strategies to cope with hydro-climatic extreme events, especially floods and droughts” is a [Priority].
- Within the Subtheme III.V. Tools for water management, including: Big data, Earth observation, sensor/monitoring tools, artificial intelligence, DSS and scenario analysis
- **Suggest to broaden the title of Subtheme III.V** to include “social, economic and behavioural sciences tools”.
- **Add new Topic:** “Understanding user responses and perceptions with regards to sustainable water management technologies and solutions/innovations using behavioural and social science methods.” (linked with I.III, IV.III)

Reached TRLs for each sub-theme

III.I: TRL6, with some peaks of TRL7

III.II: between TRL5 and TRL6

III.III: TRL5, with some peaks of TRL6

III.IV: between TRL5 and TRL6

III.V: close to TRL7

Annex 4 - Contribution of the Working Group 4 “Water and Health”

Participants

Bjorn Kaare Jensen (Moderator), Hans-Peter Grossart, Luca Cilumbriello, Marko Virta, Oche Joseph Otorkpa, Tarja Pitkänen, Sophie Gay, Henrik Dissing, Benjamin Lopez.

Strategic Goals

The overarching strategic goal of the Water and Health theme of the SRIA is to fill knowledge gaps regarding the occurrence, concentration and behaviour of pollutants that should affect environmental, animal and human health with a particular interest in Compounds of Emerging Concerns (CECs) in aquatic ecosystems. Advanced methods of water quality monitoring, conservation and treatment take a prominent role in this theme. In order to achieve these strategic objectives, the group has identified the following challenges in particular:

- Protect public health under water stress and crisis. Ensure safe water and sanitation during extreme events and political instabilities; strengthen preparedness and response capacities from catchment to tap (including remote/Arctic contexts).
- Close the evidence loop between water and health. Enable interoperable, FAIR and accessible water-quality and health data; turn data into actionable information for policy and services.
- Tackle CECs and One-Health risks at source and along the water cycle. Advance understanding, monitoring and cost-effective removal of PFAS and Persistent Mobile and Toxic pollutants in general, Micro Plastics/Nano Plastics, pharmaceuticals and pathogens; integrate Anti-Microbial Resistance (AMR and agri-water interfaces).
- Modernise monitoring and early warning systems. Deploy real-time, low-cost sensors, non-targeted omics/analytics, and AI-assisted detection; scale from experiments to catchment-level decision support.
- Strengthen risk assessment and communication. Progress on threshold values (e.g., pharmaceuticals/mixtures) and improve risk communication to citizens and decision-makers.

New topics defined by the WG 4

Some topics discussed by the group during the various working sessions or identified in the online survey appear to be new compared to the themes developed in the SRIA 2022-2025 Theme IV Water & Health. In total, the group identified **6 new topics (or sub-topics)** for the 4 existing Sub-themes, named from the letters A to F:

- (A) **Water & health under political instabilities/conflicts**, including contamination risks (e.g., radionuclides) and service disruptions; preparedness for safe water supply and sanitation. (Cross-cutting; aligns with IV.III & IV.IV)
- (B) **Open, citizen-oriented access to water & health data with FAIR principles**, interoperability and usability across regions/countries; turning data into decisions. (IV.III monitoring/data; IV.IV risk governance)
- (C) **Indoor/building water safety** (from supply to tap): controlling intrusion/regrowth of opportunistic pathogens and by-products in distribution networks; links to aging populations and efficiency measures. (IV.I, IV.III, IV.IV)
- (D) **Groundwater biodiversity** as a proxy of contamination/health risk, introducing GW bioindicators into surveillance. (IV.I with link to Theme II)
- (E) **Preparedness for emergencies in remote local areas**, ensuring pathogen-free water and sustainable sanitation under access constraints. (IV.III implementation; IV.IV risk)

- (F) **Wastewater/environmental monitoring for public-health epidemiology** (e.g. non-targeted omics) as a routine early-warning instrument. (IV.III monitoring; IV. II/IV. IV).

Priority topics identified by the WG4

The topics discussed during the seminar have been prioritised using policy influence, implementation, scalability/replicability, market potential, transdisciplinarity, and SDG contribution as main criteria.

Notes: SRIA linkages, end-users and TRL ranges mentioned in brackets in the ranked items reflect the experts' table prepared during the workshop.

Rank 1 (Top priorities)

- Interoperable, FAIR water-health data ecosystem enabling access, integration and decision-support across MS/regions; user-friendly for authorities, operators and citizens. (IV.III/IV.IV; end-users: agencies, authorities, researchers, companies, citizens; TRL 1-4).
- Real-time, low-cost sensors and early-warning systems for pathogens/priority contaminants from catchment to tap (including flood waters and utilities), with validated AI analytics. (IV.III; utilities, companies, labs; TRL 3-7).
- Cost-effective removal technologies for PFAS/PMT, MPs/NPs and pharmaceuticals, deployable at scale and with low energy/carbon footprints. (IV.III; utilities/tech providers; TRL 3-7).
- Preparedness and crisis management for safe water & sanitation (incl. remote local settings): plans, tools and training linking monitoring to action. (IV.III/IV.IV; authorities, utilities, schools/citizens; implementation focus).

Rank 2

- One-Health risks at the agri-water interface: minimise pharmaceuticals, pathogens, pesticides & metabolites; optimise water use and sludge/reuse practices; integrate AMR surveillance. (IV.II/IV.III; citizens, utilities, health authorities; TRL 3-9).
- Catchment-scale fate/transport and source detection (e.g., PFAS) with up-scaling from experimental data to real-world deployment. (IV.I/IV.III/IV.IV; agencies, policy, consultants).

Rank 3

- Building/indoor water safety: prevent intrusions/regrowth of opportunistic pathogens and manage by-products from distribution to tap, considering vulnerable populations. (IV.I/IV.III/IV.IV).
- Wastewater/environmental surveillance for public-health epidemiology, mainstreaming non-targeted omics and linking with health data systems. (IV.III/IV.II/IV.IV).

Rank 4

- Groundwater biodiversity as contamination/health proxy in routine monitoring and assessment. (IV.I with Theme II linkage).

Revision of topics

The group of expert proposed updates and clarifications mapped to current version of Theme IV in the SRIA 2022-2025:

- Within the Subtheme IV.I – Behaviour and effects of CECs, plastics, endocrine disruptors:
 - Broaden CECs scope to explicitly name PFAS/PMT and MPs/NPs, and their interplay with AMR (co-selection, biofilms); emphasise mixtures and cocktail effects already noted in SRIA.
 - Strengthen fate & transport from source-to-target (human/animal/ecosystem), including runoff (e.g., landfills/garbage piles) and catchment-scale pathways under climate and land-use change.
- Within the subtheme IV.II – Water dimension of antimicrobial resistance (AMR):
 - Tighten the agriculture-water One-Health link: selection/spread of ARGs/ARB via reuse, nutrients and pathogens; surveillance use of AMR data integrated with environmental and health datasets.

- Bridge clinical/experimental with field scales: design up- and down-scaling studies connecting lab findings to catchment-level interventions and vice-versa.
- Within the Subtheme IV.III – Innovative tools & technologies (monitoring, treatment, remediation, disinfection):
 - Water quality monitoring:
 - Accelerate real-time, low-cost sensing for pathogens and priority contaminants across natural waters, floods, utilities and at the tap; include source detection (e.g., PFAS) and proxy indicators.
 - Operationalise non-targeted analytics (metabolomics, metagenomics) for routine surveillance and early warning; ensure data quality/metadata and interoperability.
 - AI as an enabling tool (not a black box): anomaly detection, prediction, and integration with Earth Observation and legacy networks; promote model building despite data gaps, with transparent uncertainty.
 - Add groundwater biodiversity monitoring as an ecological proxy of contamination and health risk.
 - Water treatment, remediation and disinfection for drinking water and sanitation access:
 - Advance cost-effective removal technologies for PFAS/PMT, MPs/NPs, pharmaceuticals (including NBS/adsorption hybrids) with energy- and carbon-efficient designs.
 - Consider building-scale safety measures (materials, hydraulics, residuals) in distribution and indoor systems.
- Within Sub-theme IV.IV – Risk assessment & threshold values:
 - Progress on thresholds for pharmaceuticals/mixtures and microbial hazards under realistic exposure scenarios (chronic/low-dose; multi-stressors).
 - Improve risk communication to citizens and practitioners; link assessment to preparedness plans and prioritisation when quantity is scarce (quality vs quantity trade-offs).
 - Assess health benefits of NBS/green-blue engineering with explicit One-Health framing.

Annex 5 - Contribution of the Working Group 5 “Infrastructures for Water”

Participants

Frans van de Ven, José Matos Hidra, Helena Alegre.

Strategic goal

Transitioning water infrastructure to more effective, resource-efficient, sustainable and resilient while renewing existing aging assets.

Priority topics identified by the WG 5

- Transitioning existing infrastructure to more effective, efficient and resilient solutions (e.g. NbS, hybrid, circular and decentralized) while renewing aging assets. TRL: 2-6.
- New ways of planning and designing for resilience and adaptability to extreme events, including stress-testing and adapting water infrastructure across future scenarios. TRL: 2-4.
- Develop novel business and governance models for multi-purpose grey or nature-based water infrastructure (e.g. stormwater storage plus recreational / parking areas, ecosystems services of NbS). TRL: 2-4.
- Integration of grey infrastructure and NbS to provide continuous reliability of the water systems services to be sustained. TRL: 2-4.
- Intelligent monitoring for assessing condition of water infrastructure, early warning (for safety and security), and for supporting operation & planning. TRL: 2-4.

Revision of topics

- Within the Subtheme V.I. Adaptation of existing water infrastructures to new challenges:
 - **Delete topics:**
 - Topic 1.1: “Developing methodologies to organise effectively and in a cost-efficient and energy-neutral manner the replacement or large-scale renovation of water infrastructure by also considering the potential application of blue and green infrastructure.” – Because included in topics (“Developing emergency treatment units for drinking water production in emergency response situations” and “Adaptation of existing dams to climate change e.g. reservoir optimisation management for different uses and water availability scenarios, discharge capacity of dam spillways, etc.)
 - Topic 1.4: “Developing emergency treatment units for drinking water production in emergency response situations.”
 - Topic 1.5: “Adaptation of existing dams to climate change, (e.g. reservoir optimization management for different uses and water availability scenarios, discharge capacity of dam spillways, etc.)” – Because included in the topic “Studying the effects of increasing population density caused by mass migration due to climate change on existing water infrastructure” (TRL:9).
- Within the Subtheme V.II. Water infrastructures resilience:
 - **Delete because too confusing:** Topic 2.1: “Developing smart monitoring and control systems, from assets to water supply, and reclaimed water networks, including strategic asset management for extending the technological and functional lifespan of water infrastructures.”

- **Delete as included in new topic:** Topic 2.4: “Understanding and minimising the risks associated with water infrastructures and increasing their resilience in response to climate change effects and natural hazards, including design and implementation of green and blue infrastructure and NBS, including EH-NBS.” - Included in the topic “Understanding and minimising the risks associated with water infrastructures and increasing their resilience in response to climate change effects and natural hazards, including design and implementation of green and blue infrastructure and NBS (EH-NBS)”.
- Within the Subtheme V.III. Water Infrastructures security (including cyber and terrorism security):
 - **Transfer to Water and Health WG**
 - Topic 3.2: “Improving the security and performance of water assets and infrastructures – water sources reservoir, limiting the risk of any pollution including pathogens from source to tap.
 - Topic 3.3: “Developing surveillance system through sewage monitoring of potential virus circulation”.
 - **Delete as included in new topic**
 - Topic 3.4: “Addressing ageing water infrastructure, including water losses management through intelligent monitoring.” - Included in the topic “Improving the security and performance of water assets and infrastructures – water sources reservoir, limiting the risk of any pollution including pathogens from source to tap”.
- New topics
 1. Illicit inflows / water table Infiltration / tidal intrusion in sewer systems: identifying, monitoring, rehabilitation solutions.
 2. Transition of the water infrastructure systems towards more intermittent renewable (wind, solar) energy sources.
 3. Develop digital twins of the whole water infrastructures in order to understand their behaviour and impacts on the society under "what-if" scenarios to support Operations in normal and extreme situations as well as long-term investment planning.
 4. **Covers 1.1:** Transitioning existing infrastructure to more effective, efficient and resilient solutions (e.g. NbS, hybrid, circular and decentralized) while renewing aging assets.
 5. Sanitation in non-sewerage areas, including decentralized solutions.
 6. **Suggest move it to WG3:** Develop a framework of AI explainability, transparency and accountability for AI systems used for critical decisions around water management
 7. **Covers 1.1:** New ways of planning and designing for resilience and adaptability to extreme events, including stress-testing and adapting water infrastructure across future scenarios
 8. **Covers 1.5:** Adaptation of built and natural water storage (e.g. dams, reservoirs, aquifers) to increase resilience
 9. **Covers 2.4:** Develop novel business and governance models for multi-purpose grey or nature-based water infrastructure (e.g. stormwater storage plus recreational / parking areas, ecosystems services of NbS)
 10. Integration of grey infrastructure and NbS to provide continuous reliability of the water systems services to be sustained
 11. **Rephrasing of 3.4:** Intelligent monitoring for assessing condition of water infrastructure, early warning (for safety and security), and for supporting operation & planning.



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