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**Urban Water  
Management**  
**Brazil-EU  
Cooperation**

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## EXECUTIVE SUMMARY

Sector Dialogues is a cooperation instrument aimed at reinforcing the strategic partnership between the EU and Brazil, based on the principles of reciprocity, complementarity and mutual interest. Sector Dialogues aims to enhance exchange of knowledge, experiences and best practices at technical and political level, in key areas of interest for both sides.

The EU-Brazil Sector Dialogues Support Facility was launched in 2007 to improve bilateral relations and deepen structured sector dialogues in areas of mutual interest within the wider goal of building-up a strategic partnership between the EU and Brazil. Now in its fourth phase of implementation, covering the timeframe 2017-2019, the Facility strengthens its role in facilitating and supporting joint efforts to tackle global challenges.

The Facility is jointly coordinated by the Management Secretariat of the Brazilian Ministry of Economy (ME), the Delegation of the European Union to Brazil (DELBRA) and the Brazilian Ministry of Foreign Affairs (MRE). International partners, who are direct beneficiaries of the Facility, are the Brazilian Ministries and Federal Government Agencies and their corresponding EU General-Directorates and Agencies, which participate in specific dialogues. The supported activities range from the exchange of information and best practices, to the development of joint activities, which in turn approximate the cooperating parties within themes of strategic interest.

As a result of a joint collaborative effort between the European Commission, DG Research & Innovation and the Ministry of Science, Technology, Innovation and Communications of Brazil (MCTIC), implemented through both the MCTIC and with a contribution from the Joint Programming Initiative Water Challenges for a Changing World (Water JPI), the management of water resources in urban areas was identified as a primordial topic to be addressed and analysed.

The present mapping exercise and strategic recommendations to enhance research and innovation on the topic of urban water management builds on the ongoing cooperation between the EU and Brazil, the need to provide a defragmented view of a critically important area of scientific and

technological development, and to connect human resources and institutions of Brazil and the EU. The document presented herewith has been elaborated as a participatory and inclusive process, where research units under the umbrella of MCTIC were consulted from a thematic perspective as well as in the identification of relevant projects in this area.

The document follows a structure that respects both the independent developments made by the research and innovation communities from Brazil and from the EU, and the past and current collaborative projects where EU and Brazilian organisations have been involved. Global and water challenges are described, bridging the specific topic of urban water management, which constitutes the core of this report. A science policy context is provided, with the identification of recently implemented research and innovation agendas or directives, and how these reference documents relate to the theme.

Adding to the successful bilateral cooperation between Brazil and the EU, and aligned with the underlying objectives of:

- continuously strengthening the internationalisation of both the EU and the Brazilian scientific and technological systems;
- fomenting systems that promote a healthy circulation of highly qualified human capital;
- developing actions in Brazil that contribute to the strategic alignment on research and innovation agendas tackling challenges of common interest;
- stimulating the implementation of networks of networks, encouraging the sharing of common resources and infrastructures;
- leveraging nationally funded research and contribute to the defragmentation of knowledge,

a set of recommendations is established to maximize synergies and explore opportunities for both communities, which go beyond the sphere of urban water management, and may be applied universally to all domains of knowledge.

## SUMÁRIO EXECUTIVO

Os Diálogos Setoriais são instrumentos e mecanismos de cooperação com o objetivo de desenvolver parcerias estratégicas entre a União Europeia e o Brasil com base nos princípios de reciprocidade, complementaridade e interesse mútuo. O Diálogo Setorial tem foco no estímulo a troca de experiências, conhecimento científico e tecnológico e melhores práticas em nível técnico e político para áreas estratégicas de interesse entre a União Europeia e o Brasil.

A organização de suporte logístico (Escritório Logístico-Facility) dos Diálogos Setoriais União Europeia Brasil, iniciou-se em 2007 com a finalidade de aprofundar relações bilaterais, e desenvolver diálogos setoriais em áreas de interesse mutuo com o objetivo de construir uma parceria estratégica entre a União Europeia e o Brasil. Atualmente em sua quarta fase de implementação, que abrange o período de 2017-2019, o suporte logístico reforça seu papel ao facilitar e apoiar esforços conjuntos para enfrentar desafios globais.

O Escritório Logístico-Facility é coordenado em conjunto pela Secretaria de Gerenciamento do Ministério da Economia do Brasil, pela Delegação da União Europeia no Brasil, (DELBRA), e o Ministério Brasileiro de Relações Exteriores. Parceiros internacionais que são beneficiários diretos e indiretos do Escritório Logístico, são os Ministérios do Governo do Brasil, as Agências Federais do Governo Brasileiro, e suas correspondentes Diretorias e Agencias da União Europeia, os quais participam em diálogos específicos. As atividades apoiadas vão desde a troca de informações e práticas mais eficientes até ao desenvolvimento de atividades conjuntas que por sua vez aproximam as áreas de cooperação nos temas de interesse estratégico.

O gerenciamento de recursos hídricos em áreas urbanas foi identificado como um foco prioritário a ser avaliado e discutido como resultado de um esforço conjunto de cooperação entre a Comissão Europeia, Direção Geral de Pesquisa e Inovação e o Ministério de Ciência, Tecnologia, Inovação e Comunicação do Brasil (MCTIC) contando ainda com a contribuição da Iniciativa de Programação Conjunta *Water Challenges for a Changing World* (Water JPI).

O presente documento de análise e recomendações estratégicas para aprofundar e estimular a pesquisa e inovação no tema de gerenciamento

de recursos hídricos urbanos, baseia-se na cooperação já existente entre a União Europeia e o Brasil, e na necessidade de promover uma visão sistêmica e não fragmentada de áreas críticas de desenvolvimento científico e tecnológico, articular e conectar recursos humanos e instituições do Brasil e União Europeia. O documento pretende apresentar as conclusões e análises através de um processo participativo e inclusivo onde unidades de pesquisa do MCTIC e de outros Ministérios do Governo do Brasil foram consultados a partir de uma perspectiva temática bem como a identificação de projetos relevantes nessa área. O documento apresenta uma estrutura que respeita os desenvolvimentos independentes realizados pelas comunidades de pesquisa e inovação do Brasil e da União Europeia e os projetos já realizados e atuais de colaboração em que as organizações da União Europeia e do Brasil estão envolvidas.

Desafios globais e desafios nas áreas de recursos hídricas são descritos, contribuindo para o tópico específico de gerenciamento de recursos hídricos urbanos o que constitui o tema central deste relatório. Um contexto de política científica e inserido com a implementação de agendas de pesquisa e inovação e de que forma estes documentos se relacionam com o tema deste relatório. Este documento adiciona-se a bem-sucedida cooperação entre Brasil e União Europeia e está alinhado com os seguintes objetivos:

- Consolidando a internacionalização dos sistemas tecnológicos do Brasil e da União Europeia.
- Fomentando sistemas que promovam uma saudável circulação de capital humano altamente qualificado.
- Desenvolvendo ações no Brasil que contribuem para o alinhamento estratégico das agendas de pesquisa e inovação, enfrentando desafios de interesse comum.
- Estimulo a implementação de redes de redes e o uso de recursos comuns e de infraestrutura.
- Ampliando a capacidade de apoio financeiro a pesquisa científica e promovendo uma visão sistêmica e holística do conhecimento na área.

Uma série de recomendações e estabelecida com a finalidade de maximizar sinergias, explorar oportunidades para as comunidades de pesquisa e gerenciamento da União Europeia e Brasil. Estas recomendações avançam além da área gerenciamento de recursos hídricos em águas urbanas e podem ser aplicadas a todos os domínios do conhecimento.

# 1. FOREWORD

## Brazil-EU/EU-Brazil Collaboration

The EU-Brazil bilateral cooperation was formalised in 1992 with the signing of a Framework Agreement, which entered into force in 1995, aiming at expanding, diversifying and stepping up cooperation in different strategic vectors, including science and technology.<sup>1</sup>In relation to the latter, the objectives outlined then are nowadays as pertinent as before, namely the need to:

- strengthen the links between the scientific and technological communities;
- encourage healthy mobility schemes of researchers;
- foster the relations between institutions and research centres;
- promote mutually beneficial transfers of technology;
- stimulate innovation and define the framework for cooperation in the field of applied science;
- jointly select priority areas.

Brazil and Europe have been mutually benefiting from different forms of cooperation since the 1960s, which have been particularly strengthened in the 1980s and coinciding with the inclusion of Portugal and Spain in the European Economic Community (the forerunner of the EU).<sup>2,3</sup> This fact imparted a new dimension to the well-established bilateral relations between the Iberian countries and South America.

Arguably defined as the most significant step towards a more efficient and effective cooperation in science, research and innovation between the EU and Brazil, the Science & Technology Agreement (in force since 2007)<sup>4</sup> has

1. Official Journal of the European Communities, No L 264/54, 1.11.1995.

2. [http://ec.europa.eu/external\\_relations/brazil/index\\_en.htm](http://ec.europa.eu/external_relations/brazil/index_en.htm).

3. Poli, E., ISSN 2610-9603 | ISBN 978-88-9368-080-6, 2018.

4. Communication from the Commission to the European Parliament and the Council - Towards an EU-Brazil Strategic Partnership. COM/2007/0281.

allowed intensive collaboration in research and innovation with more than 350 common projects. These have been particularly prominent in marine research, information and communication technologies, health, mobility and transports, and environment. The agreement was reinforced in 2017, to signal the 10 years landmark, with both parties recognising the instrumental role of this cooperative effort for a smart and sustainable development.<sup>5,6</sup>

In general terms, Brazil ranks 5th (jointly with South Africa, and only behind to the USA, China, Canada and Australia) in terms of participation among non-EU and associated partners in the current Framework Programme for Research and Innovation Horizon 2020. Brazilian entities have 154 participations from 98 projects and 88 signed grants, including collaborative projects, Marie Skłodowska-Curie researcher mobility actions and European Research Council projects. The success rate of proposals with Brazilian partners is 17.6%, higher than the overall success rate under Horizon 2020 of 15%.<sup>7,8</sup>

EU-Brazil cooperation in frontier research, in all fields of knowledge, has been strengthened through the “Implementing Arrangement”, signed in 2016 between European Commission and the Brazilian National Council of State Funding Agencies aiming to encourage the best Brazilian scientists to join research teams funded by the European Research Council (ERC).

More recently, the European Commission and three Brazilian funding agencies (the Brazilian National Council for Scientific and Technological Development, the Brazilian Funding Agency for Studies and Projects, and the Brazilian National Council of State Funding Agencies) have signed an “Administrative Agreement” to, according to the Commissioner Carlos Moedas, “*enhance Brazilian participation in Horizon 2020 (...) and foster cooperation between the two regions. It establishes three different mechanisms for cooperation:*

5. Brazil-European Union Joint Statement – Ten years of the Strategic Partnership, <http://www.itamaraty.gov.br/en/press-releases/16749-brazil-european-union-joint-statement-ten-years-of-the-strategic-partnership>. <https://ec.europa.eu/research/iscp/index.cfm?pg=brazil>.

6. Wisniewski, B., Dahab, S., *Studia Eripejskie*, 4/2017, 55-71 and references therein.

7. INCOBRA, Deliverable 4.5, Ref. Ares (2019) 516212-29.01.2019. Increasing International Science, Technology and Innovation Cooperation Between Brazil and the European Union.

8. [https://ec.europa.eu/info/sites/info/files/research\\_and\\_innovation/knowledge\\_publications\\_tools\\_and\\_data/documents/h2020\\_monitoring\\_flash\\_022019.pdf](https://ec.europa.eu/info/sites/info/files/research_and_innovation/knowledge_publications_tools_and_data/documents/h2020_monitoring_flash_022019.pdf)

*greatly extending the national co-funding of Brazilian participation in projects under Horizon 2020, promoting cooperation between parallel projects under coordinated calls for proposals in Brazil and the EU, and twinning existing projects in areas of common interest.”<sup>9</sup>*

These facts reflect the quality of the scientific and technological communities in Brazil, and highlight the importance of unlocking their potential to jointly address the most important missions one faces on a global scale, and to establish stronger links between both sides of the Atlantic.<sup>10</sup>

At this level, scientific diplomacy has also been crucial in the framework of the promotion and valorisation of knowledge and the consolidation of the bilateral relations between Brazil and the EU. The general recognition that the challenges we face today (climate change, oceans or health, for example) are inextricably linked to research and innovation or to the internationalisation and globalisation of the systems of higher education, science and technology, has contributed to the increased need to develop synergies between science policy and external policy. Research and innovation, or science and technology, set a privileged stage for Brazil and the EU to develop common efforts to maximise resources, to diminish knowledge fragmentation, but also to obtain individual competitive advantages for their economic and social growth. Thus, strategic endeavours must be taken to assure the compatibility and dynamic balance between the cooperative and competitive vectors, which will allow for a responsible knowledge production and dissemination and to the consolidation of the EU-Brazil partnership.

9. [https://ec.europa.eu/info/news/eu-and-brazil-step-cooperation-research-and-innovation-2018-may-22\\_en](https://ec.europa.eu/info/news/eu-and-brazil-step-cooperation-research-and-innovation-2018-may-22_en).

10. implement and support the European Union-Brazil-South Africa Atlantic Ocean Research and Innovation Cooperation, as launched by the Belém Statement. [https://ec.europa.eu/research/iscp/pdf/belem\\_statement\\_2017\\_en.pdf](https://ec.europa.eu/research/iscp/pdf/belem_statement_2017_en.pdf).

## **Brazil-EU Mapping on Research, Innovation and Science & Technology Policies: Opportunities for Joint Collaborative Efforts**

The world is facing numerous challenges, which require coordinated efforts and joint initiatives to align priorities, to define specific pathways in knowledge production and knowledge dissemination, and to maximise impact.

To this end, it is critically important to identify common interests and values, and to be presented with structured data to take well-informed decisions. Mapping exercises, not only at the level of research and innovation, but also at the level of science and technology policies constitute a decisive mean to strengthen the scientific and technological systems in Brazil and within the EU, to build capacity at the institutional level, to the internationalisation of the scientific communities, and to promote mobility schemes for the circulation of highly skilled human resources.

Framed within the water domain, mapping exercises contribute to a better understanding of i) the EU and Brazil water-related RDI landscape, ii) deliver a targeted inventory of national and regional research strategies, policies and programmes within the EU and in Brazil, iii) examine the funding of research projects, infrastructures and mobility schemes in Water RDI, iv) describe relevant multi-national coordination activities, and v) provide a preliminary strategic analysis of the current water research strengths, weaknesses, gaps and barriers to cooperation.

The characterisation of both the EU and Brazilian systems allows for capitalising the outputs of the coordinated efforts developed in the strategic areas prioritised by both parties (Figure 3). Complementing the main targeted areas, namely i) marine research, ii) transport and aviation, iii) sustainable urbanisation, iv) energy, v) ICT, and vi) health, other topics have also been identified. These relate to joint activities on i) fusion energy, ii) space research on satellite navigation, iii) earth observation, iv) research infrastructures, v) environmental research, and vi) within the thematic context of Joint Programming Initiatives with Brazil participation.<sup>11</sup>

11. Priorities described in the Partnership Agreement of 2007, reinforced by the Joint Statements of 2017 on the 10-year landmark of the Agreement.

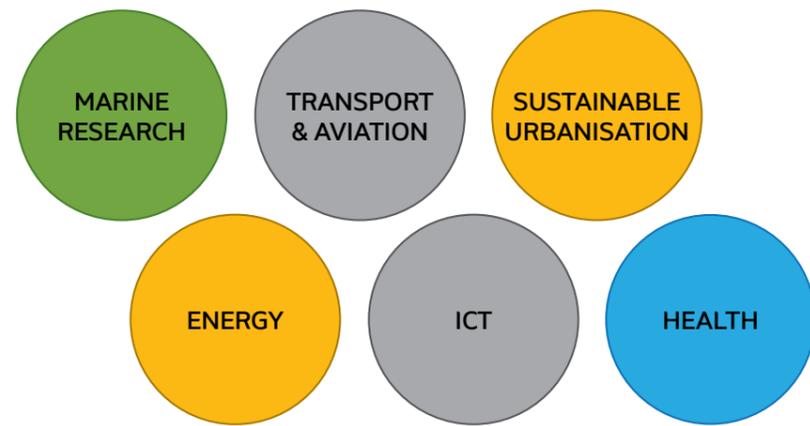


Figure 3. The EU-Brazil main targeted areas for RDI in order to develop national and regional research strategies, policies and programmes, and to produce and disseminate new knowledge and transfer of technology.

## The Research and Innovation System in Brazil: a global perspective on the environment sector

The institutional organisation of Science in Brazil started in the last decade of the XIX century and the first decade of the XX century. Research Institutes in the areas of Agronomy, Public Health and Biology were established.<sup>12</sup> The main driving force for these developments was the demand to solve problems such as coffee production, public health and parasitology. Another important step in the institutionalisation of science in Brazil was the creation in 1916 of the Brazilian Academy of Sciences.<sup>13</sup> It is also relevant to mention the creation of i) the Brazilian Society for Progress of Science (SBPC) in 1948, ii) the National Research Council (CNPq) in 1951 by the Federal Government, and iii) the Coordination for Capacity Building of Teachers and Lecturers (CAPES) in the same year. In 1967, the Federal Government of Brazil created FINEP, a Project Financing Company. These governmental initiatives were fundamental in the consolidation of the research ecosystem, and to the

12. Lima Silva, J. & Tundisi, J.G. (coords). 2018. Projeto de ciência para o Brasil Acad. Bras. De Ciências, 393pp. (Science for Brazil).

13. Lima e Silva J and Tundisi J. G. Introdução. In Lima e Silva J. 7 Tundisi J. G. Projeto de Ciência para o Brasil. Pp.27-38. Academia Brasileira de Ciências. 2018. Introduction. Science Project for Brazil.

global technological development of Brazil. In 1985, an additional step was taken with the implementation of the Ministry of Science and Technology.<sup>14</sup>

Several research institutes were created, namely the Mathematics Institute (Rio de Janeiro), the National Institute of Research in the Amazon (Manaus), the National Institute for Space Research (São José dos Campos), and others followed. At the State level, the São Paulo State Foundation (FAPESP) was created by law in 1948 and installed in 1962. Many other States implemented research foundations during the 1980 and 1990 decades.<sup>15</sup>

A capacity building programme (MSc and PhD.) was implemented in several universities in the beginning of 1970's coupled with a research grant system. These post graduate programmes still constitute an important support for the development and growth of the public and private Universities in Brazil.

The implementation of Science Parks and other organizations to support start-ups and new enterprises of technological origin started in 1980 and they are today an important development to promote innovation in Brazil. Incubators for start-ups are now present in several cities in Brazil, and are seen as a fundamental process in the technical and economic development of the country.

International cooperation is also relevant for the research and technological development of Brazil. As previously stated, international cooperation has always been supported and promoted by the agencies of the Federal Government and joint collaborative projects of scientific and technological exchange of knowledge and resources were implemented in the last 30 years. This is particularly visible with several countries in the Americas, Europe, Africa and South East Asia. Scientific and Technological cooperation among the BRICS (Brazil, Russia, India, China, and South Africa) have also been developing productive interactions in the areas of medicine, environment, and advanced technologies.<sup>16</sup>

14. Lima e Silva J & Tundisi J. G..2018 Projeto de Ciência para o Brasil. Academia Brasileira de Ciências.393pp 2018. Science Project for Brazil.

15. Confap- Conselho Nacional das Fundações Estaduais de Amparo a Pesquisa .confap.org.br/pt/comunicação. Council of State Research Foundations.

16. Brics 2019.itamaraty.gov.br/sobre -o-brics/principais areas de cooperação. - International Cooperation Brics.

Two new initiatives of extreme strategic importance were implemented in the years 2000 and 2001. One was the implementation of the Millennium Institutes by the Ministry of Science and Technology: 17 Institutes of high level were selected among 200 participants to be supported by substantial research grants. The total of resources invested was 100 M€ for a three-year period. These 17 institutes covered an ample range of science and technological areas. Further on, this programme was transformed in a vast project: the National Institutes of Science and Technology that today support 100 Institutes in several states of Brazil covering several priority areas of Science and Technology.<sup>17</sup>

The other important initiative was the creation of the Sectorial Funds for Research and Technology (2001) that consisted in the contribution of the private sector in several areas such as agriculture, energy, water resources, health or raw materials to research projects and technological development.<sup>18</sup>

Even recognising the existence of barriers that hampered more successful financial support of research in occasional years, the progress and the consolidation of the institutional organisation in Brazil has advanced considerably. Strategic long term goals are being set, namely the investment of 2% of the GDP in science and technology until 2025, and the increase in the number of scientists and engineers (per 1 million inhabitants) from 700 to 3,000.<sup>19</sup> Another is the implementation of projects in science initiation in first and second grade schools, in order to increase the interest and participation of the young generations in science, and to stimulate scientific careers.

Brazil is therefore facing important challenges in the consolidation of the support to research and innovation, assuming particular relevance the promotion and stimulus to the creation of jobs for a growing and highly qualified young generation, and the employment of the 16,000 PhDs who are entering the job market each year. The system of Science and Technology in Brazil has Secretaries of Science in practically all the 27 States, foundations for support of research and a consistent post graduate capacity building

17. 17Institutos Nacionais de Ciencia e Tecnologia.2019. #inct#cnpq#pesquisa#ciência#tecnologia#inovação

18. Codemec.org.br/geral/lei dos fundos setoriais;CTHidro Lei 9.993/00-Law of Sectorial Funds.

19. Lima e Silva j 7 Tundisi J. G ..2018.. Projeto de Ciencia para o Brasil. Academia Brasileira de Ciencias 393pp( Science Project for Brazil.)

program. The discussion and interest in innovation is intense in Brazil and has support of Federal Government, States and private initiatives.

The National Program of Incubations and Technological Parks has promoted the organization of almost 400 incubators of private companies of high technological profile and almost 100 Technological Parks all over Brazil. This program has stimulated the technological entrepreneurs and this has been one of the most recent objective of the Brazilian post-graduate programs

## Research and innovation: perspectives on urban water resources

The research and innovation ecosystem in Brazil, and the organisations which have the financial ability to support it is currently very focused on the promotion of innovation within the industry sector, services, and in public policy. In particular, research and innovation efforts development at the basis of the knowledge value chain can then be transposed into the effective promotion and advancement of public policies. This latter aspect constitutes a high priority in urban water management.

Considering the social, economic, and environmental needs of urban populations, and the fast growth of the urban and peri-urban areas, which nowadays encompass more than 80% of the population in Brazil, priorities for support of research and innovation in the management of urban waters can be summarised as follows:

- **Water security, water infrastructures and water services:** improve decision support systems and water governance, in its social, economic and environmental dimensions;
- **Water reuse:** science-based policy development, regulation, incentives, and educational programmes for water reuse in urban areas;
- **Water treatment and sanitation:** basic sanitation technologies for tertiary water treatment articulated with new technological approaches for the removal of resistant organic pollutants, other micropollutants, viruses, and improve water disinfection;

- **Urban big data:** invest in urban intelligence laboratories and observatories devoted to implement and use data banks to evaluate water demands, water availability, and to improve planning actions and strategies at the urban level;
- **Urban ecosystems:** invest in the recovery of degraded ecosystems (urban watersheds) mainly at peri-urban regions via the use of ecohydrological approaches and bio-based solutions;
- **Urban forestry and water management:** develop urban forest parks to improve water management, and to adapt to climate alterations and extreme events, and protect urban biodiversity, by establishing public-private systems for their maintenance.

## 2. INTRODUCTION TO WATER CHALLENGES

### Global Challenges and Water

With an **estimated population of 9.8 billion inhabitants by 2050**,<sup>20</sup> including a significant **concentration in urban areas**, it is imperative to develop and implement sustainable, inclusive, resilient and secure models for the cities of the future and, simultaneously, assure the sustainable management of our natural resources.

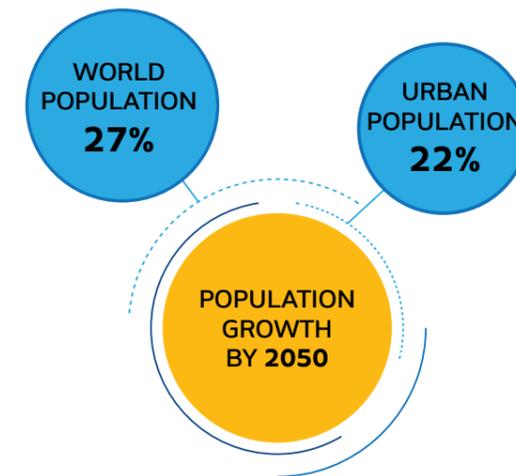


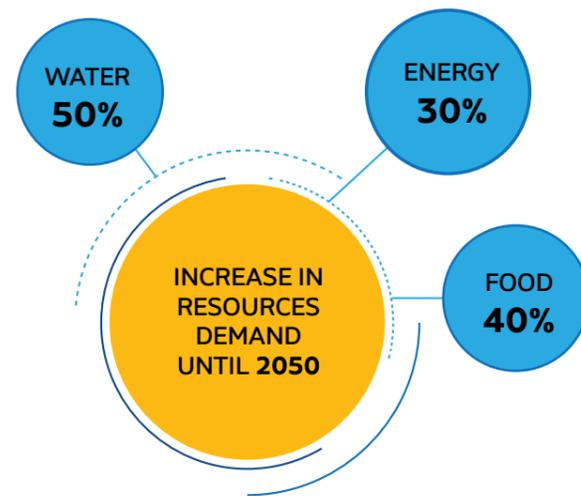
Figure 4. Global challenges: population growth by 2050 and the respective share that corresponds to population growth in urban areas.<sup>21</sup>

Demand for water, energy and food will necessarily rise, with obvious implications in human health and in the environment. In particular, **since 2015 that water crisis is being identified in the context of the World Economic Forum as one of the most relevant risks to economy and society.** Building

20. United Nations: <https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html>

21. <https://www.unwater.org/water-facts/water-food-and-energy/>. <http://www.fao.org/land-water/water/watergovernance/waterfoodenergynexus/en/>. <http://www.globalwaterforum.org/2012/05/21/water-outlook-to-2050-the-oecd-calls-for-early-and-strategic-action/>. <https://www.worldenergy.org/assets/images/imported/2016/10/World-Energy-Resources-Full-report-2016.10.03.pdf>.

resilience and adapting to climate change and variability are vital to ensure the improvement and modernisation of basic services and to increase the population well-being, in a context where floods, droughts (and windstorms) account for almost 90% of the 1,000 most disastrous events since 1990.<sup>22,23</sup>



**Figure 5.** Global challenges: increase in resources demand by 2050 and the respective share that corresponds to water, energy and food.

The recent adoption of the **2030 Agenda** by the UN Member States has set a universal basis for sustainable development.<sup>24</sup> Among its 17 transformative goals and 169 targets, water is particularly singled out in Goal 6 (*ensuring access to water and sanitation for all*). In 2018, UN-Water produced the SDG 6 Synthesis Report 2018 on Water and Sanitation to provide input to Member States on Goal 6, where the joint position on this goal and other water-related targets was reflected. Linkages within SDG 6 targets and interlinkages between SDG 6 and the other goals and targets are also explored in the document.<sup>25</sup>

22. World Economic Forum. Annual Report 2018-2019. [http://www3.weforum.org/docs/WEF\\_Annual\\_Report\\_18-19.pdf](http://www3.weforum.org/docs/WEF_Annual_Report_18-19.pdf).

World Economic Forum, Global Risks Report 2019 [http://www3.weforum.org/docs/WEF\\_Global\\_Risks\\_Report\\_2019.pdf](http://www3.weforum.org/docs/WEF_Global_Risks_Report_2019.pdf)

23. How to feed the world in 2050, [http://www.fao.org/fileadmin/templates/wsfs/docs/expert\\_paper/How\\_to\\_Feed\\_the\\_World\\_in\\_2050.pdf](http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf). Supply and Demand of Global Energy and Electricity, Zhenya Liu, in Global Energy Interconnection, 2015. <https://www.sciencedirect.com/topics/engineering/primary-energy-demand>.

24. Resolution adopted by the General Assembly on 25 September 2015. A/RES/70/1. [https://www.un.org/ga/search/view\\_doc.asp?symbol=A/RES/70/1&Lang=E](https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E).

25. SDG 6 Synthesis Report 2018. [https://www.unwater.org/app/uploads/2018/12/SDG6\\_SynthesisReport2018\\_WaterandSanitation\\_04122018.pdf](https://www.unwater.org/app/uploads/2018/12/SDG6_SynthesisReport2018_WaterandSanitation_04122018.pdf).

In the Synthesis Report 2018, the topics related to:

- basin sanitation;
- governmental structure;
- agricultural stress on water resources;
- technical capacity;
- ecosystem services;
- water pollution;
- basic sanitation and water funding,

have been identified as areas to be improved and prioritised, considering the difficulties in attaining the envisioned targets of the Agenda 2030. It is also important to highlight that these topics relate to urban water management, water access and water governance, which will be addressed throughout the present manuscript.

The EU Research and Innovation Programmes represent the main instrument for cooperation between Brazil and the EU, with Brazil participation ranking sixth among the International Partner Countries in FP7, and fifth in Horizon 2020. Cooperative efforts in research and innovation in the water domain is of particular relevance, as Brazil represents on its own **circa 12% of the world freshwater resources** and 21% of the world biodiversity.<sup>26</sup>

Despite Brazil owning the largest hydrographic system on Earth, currently **only about 40% of sewage is treated** and more than **60% of impatient care at hospitals is due to water borne diseases**.<sup>27</sup> Water quality, sanitation and emerging contaminants are topics that require joint efforts from the scientific community at large, including the technological and innovation sectors. In addition, it is of fundamental priority to ensure efficient and integrated management of water services and to maintain and develop the

26. ANA, GEO Brazil Water Resources. Component of a Series of Reports on the Status and Prospects for the Environment in Brazil. <http://arquivos.ana.gov.br/wfa/sa/GEO%20Brasil%20Recursos%20H%C3%ADricos%20-%20Executive%20Summary.pdf>. UN Environment: <https://www.unenvironment.org/news-and-stories/story/megadiverse-brazil-giving-biodiversity-online-boost>.

27. <https://iwaponline.com/jwh/article/14/2/340/28300/Waterborne-diseases-classification-and-publications.iadb.org/en/urban-wastewater-treatment-brazil>.

urban infrastructure systems to address the growing challenges associated to urban water security and urban water demand.

## Water Challenges

Water is a basic requirement for life, and it is central to numerous systems, namely the industrial, economic, environmental, societal, or political. As a precious natural resource, it constitutes a fundamental challenge to protect it both in terms of quantity and quality, and to foster responsible research and eco-innovation under climate change adaptation.

To this end, it is pivotal to raise public awareness on water use, to simultaneously foster economic growth and create jobs in all water sectors, and to set adequate prices on water services. The latter relates both to the complexity associated to water infrastructures and the fact water covers such a wide range of activities. It is then critical to address the challenges related to water valorization, to define compatible strategies between the investment needed to renovate aging infrastructures and mitigate risks related to water security and extreme natural events, and the pace technology develops in this area. The issue of water security may be considered as a primary challenge, in relation to water abstraction for agriculture and industry, to extreme events such as floods and droughts, to water-dependent energy demand, and to the pollution of surface and groundwaters.

Linked to the water efficiency topics the challenge of giving water its value within a context of green and circular economies, highlighting its importance to global socioeconomic development and to green growth, and the objectives of i) stimulating the industrial sector to water reuse and recycling, ii) address the interconnections between water-energy-food-land-use, and iii) foster innovation in the agriculture sector. The water-health nexus is particularly prevalent in most international research and innovation agendas, with the identification of emerging pollutants, the minimization of micropollutants in the environment, and the monitoring of the health-related risks being object of extensive collaborative efforts.

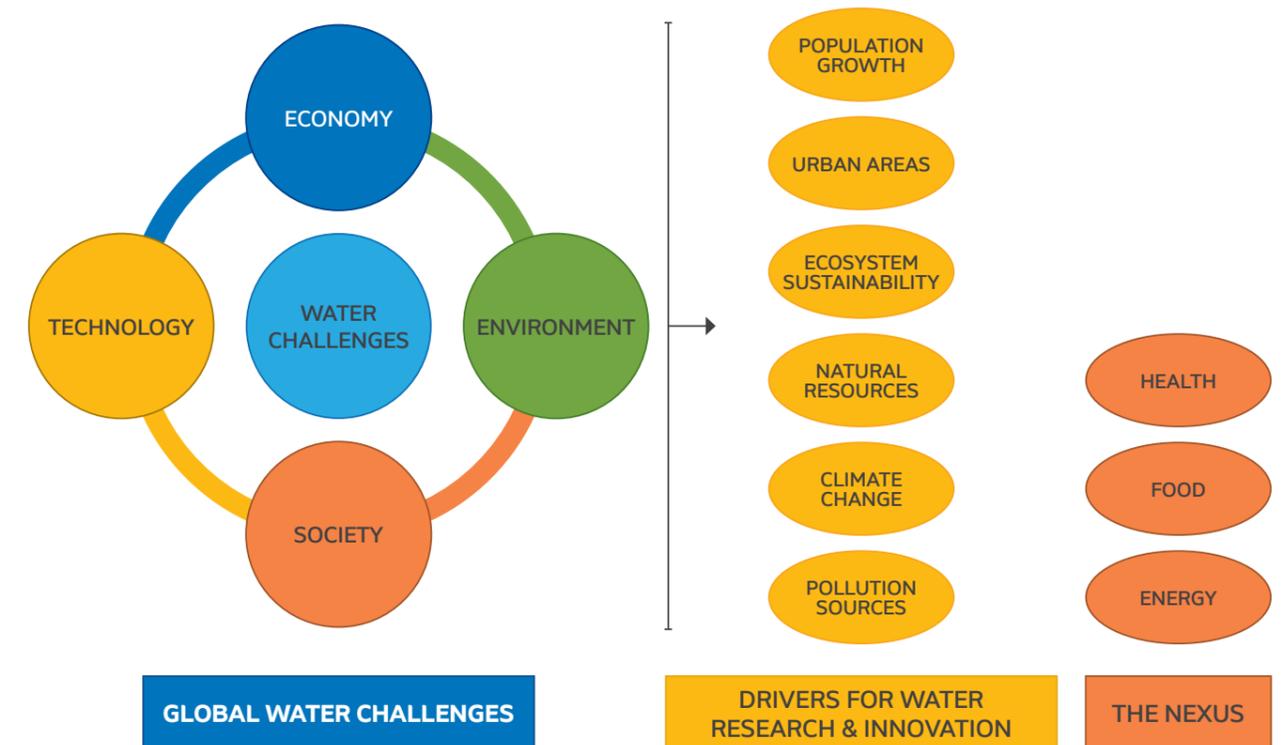
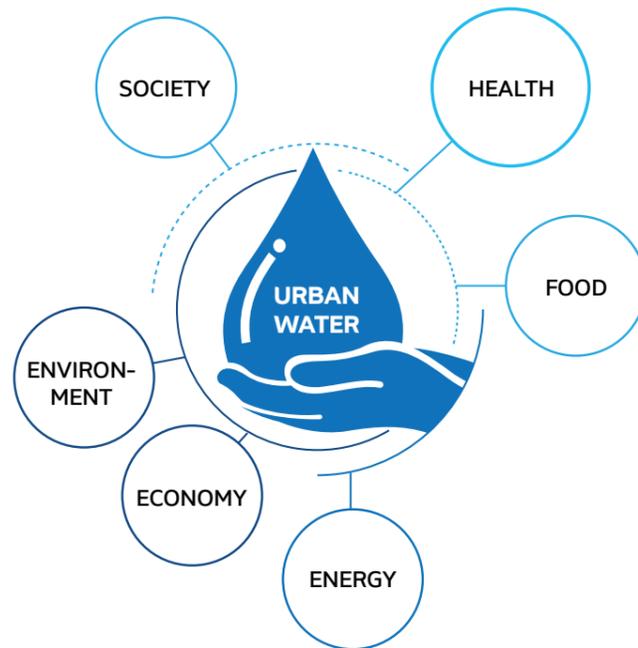


Figure 6. The main vectors related to the global water challenges, namely the economy, environment, technology and society. How these vectors relate to the main drivers for research and innovation in the water domain, and the health-energy-food nexus that provide an umbrella for producing and disseminating new knowledge and technological developments in this area.

### 3. INTRODUCTION TO URBAN WATER MANAGEMENT

#### Urban Water Management

Urban water management encloses a wide range of research and innovation topics with strong implications in the economic, environmental, societal and cultural sectors. The horizontal nature of this theme is associated to an inherent complexity of combining scientific and technological knowledge and to assure it is applied sustainably, namely on a dynamic equilibrium between economic growth, quality of life, and the environment (Figure 7). Fulfilling the abovementioned preconditions implies the adoption of a multidisciplinary vision and a holistic approach throughout the whole knowledge value chain, namely among academia, governmental, private and organised civil society sectors.



**Figure 7.**Urban water management and the main interlinks to research, innovation and governance areas.

The alignment of priorities on urban water management between the developed and the developing world is particularly challenging. While within the EU the main concern is related to preventing existing infrastructures from decay and to implement a transition from disposal-oriented regimes towards more sustainable approaches focused on reutilisation options, the situation in developing countries has a different degree of complexity. Developing regions face economic challenges and a rapid population growth, factors which are not compatible with the timely implementation of adequate infrastructures, water supply, and sanitation coverage. Under these circumstances, platforms promoting international collaboration, knowledge sharing and technology transfer are particularly relevant, not only to impact society at large in a shorter timeframe, but also to lead to mutually beneficial outcomes for developed and developing regions.

The **EU-Brazil Dialogues on Urban Water Management** project personifies the crescent collaboration between Brazil and the EU to aligning research and innovation agendas and mutual learning opportunities, connecting Brazilian and European R&I actors with the objective of i) leveraging nationally funded research in Brazil and within the EU, ii) connecting R&I centres and their communities, iii) empowering the young generations of researchers and innovators, iv) maximising/sharing resources and infrastructures, and v) actively involving governing bodies and encouraging citizen participation.

Under the umbrella of the Urban Water Management theme, it is important to first understand this topic is addressed independently either in the context of water challenges or within the discussions surrounding the development of urban areas.

Thus, it becomes relevant to emphasise a list of topics that stem from global agendas. Above, it was already addressed the main drivers included in the **2030 Agenda** of the UN; the recent adoption of the **New Urban Agenda** (Habitat III)<sup>28</sup> has also oriented the prioritisation of research and innovation topics and the co-creation of new knowledge in the urban water management domain (Figure 8). There is a common overarching framework on both agendas, which is defined by the need to implement an integrated and cross-sectoral approach dedicated to urban water management and its interlink to other

28. <http://habitat3.org/wp-content/uploads/NUA-English.pdf>.

measures and sectoral policies, including rural development, land use, food security, management of other natural resources, and the provision of public services. At the core of urban water management is the strengthening of the strategies for urbanisation and territorial planning, which in turn need to be articulated with the implementation of sustainable water management systems, public water and sanitation utilities, and urban infrastructure services. Connected to these topics, with particular emphasis to developing regions, it is primordial to promote universal and equitable access to safe and affordable drinking water and adequate and equitable sanitation and hygiene for all, which are the main target of SDG 6 of the 2030 Agenda.



**Figure 8.** The New Urban Agenda (Habitat III), and the objectives and targets within the urban water management domain.

Considering the above context, a series of research and innovation areas of action have been identified to strengthen the EU-Brazil and Brazil-EU cooperation:

- **Urban forestry:** addressing climate change and urban microclimates, finding education opportunities and new recreational values, and managing biodiversity;
- **Stormwater management:** tackling urban environment pollution, control of floods and drainage;
- **Urban regeneration and water management:** closing the water cycle gap, areas for recharge of ground waters;
- **The food-energy-water nexus:** water productivity and urban environmental services (capturing value from waste and nutrient recovery);
- **Water bio-based solutions:** urban biocycle economy;
- **Public health and environment protection:** urban wastewater treatment;
- **Urban big data:** developing urban intelligence and water monitoring technologies;
- **Water environmental challenges:** political and social awareness, recovery of degraded urban ecosystems, urban rivers and wetlands.

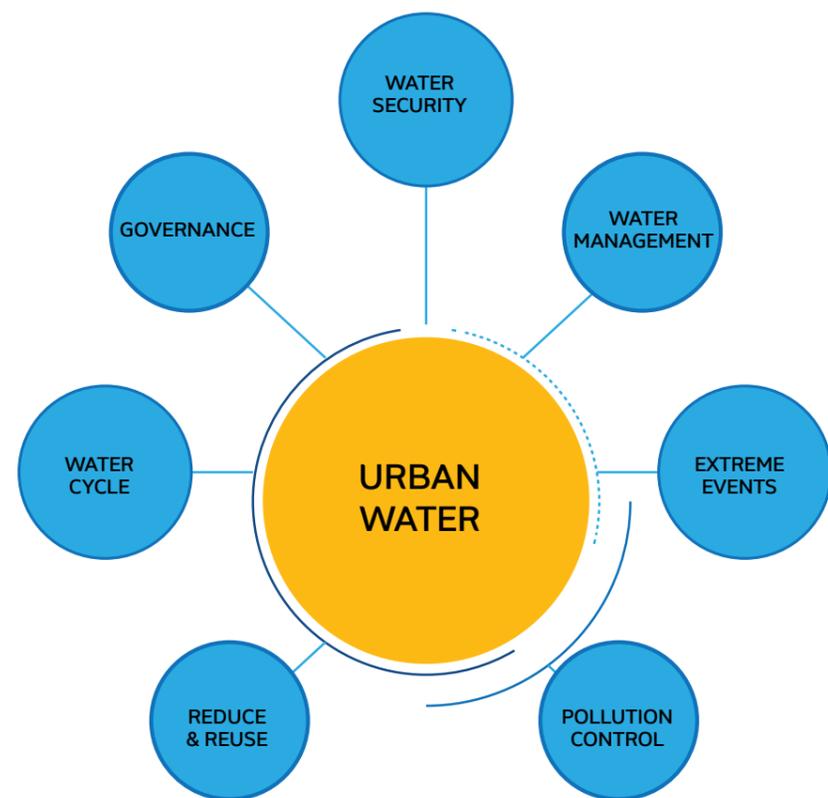


Figure 9. Tackling global urban water challenges through EU-Brazil and Brazil-EU cooperation in science, technology and innovation.

### Urban Forestry and water management

Urban forest areas are an important development in cities, as they protect urban biodiversity, promote recharge of aquifers, and contribute to improve air quality of urban areas. They also constitute an important component on the adaptation of cities to the effects of global changes (population, climate, etc.). On the other hand, urban forests are useful ecosystems for environmental education, recreation, public tourism, and scientific research. If placed in convenient and strategical areas in a city, they provide many opportunities for the development of social-environmental projects, and for the participation of society at large in the generation of new scientific knowledge. Comparative research on the implementation of urban forests in European cities and Brazilian cities would be a valuable effort to evaluate the short and long term effects of such collaborative projects.

### Water bio-based solutions: urban biocycle economy & public health and environment protection: urban wastewater treatment (water reuse and micropollutants)

#### Water reuse

Water reuse is a low cost opportunity to increase the water availability in cities.<sup>29</sup> It is also an environmental friendly access to water, and options for water reuse should be included in urban water planning. Adaptation of infrastructure for water reuse, economic incentives, and regulatory provisions should be considered in specific legislation. In Brazil, laws regarding quality parameters for water reuse are not established at federal, state or municipal level for non potable uses such as irrigation, industrial uses, or direct potable uses. Therefore, the inclusion of water reuse in urban water resources planning is a fundamental step to promote this initiative.

The improvement of technical efficiency of wastewater treatment is of crucial importance for the establishment of a water reuse program in urban regions. Specific investment needs to be made on the efficiency of wastewater treatment, the introduction of new legislation, infrastructure development, and the capacity building of planners and practitioners.

Another important development on water reuse is the decentralization of wastewater treatment in urban areas. Several cities in Brazil have a unique centralised wastewater treatment plant. If a decentralization process is introduced with several local wastewater treatment plants, the opportunity for water reuse increases.

#### Micropollutants

Pharmaceuticals, metals, pesticides, herbicides (carcinogenic or endocrine disruptions) are examples of micropollutants which need to be monitored and quantitatively evaluated. These contaminants impact freshwater ecosystems, surface and underground waters and are often not removed

29. Wilcox, J. ,Nasiri ,F.,Bell S.,Rahaman,M.S.2016 Urban Water Reuse:A triple bottom the assesment framework and review,Sustainable Cities and Society 27:448-456 .

by conventional wastewater treatment. The excessive use of antibiotics in health and agriculture contribute to the development of multi resistant bacteria strains. These pollutants occur mostly as complex mixtures that have synergistic, additive, and antagonistic effects on human health and on the environment. These organic compounds may undergo chemical and biological degradation which generates several and diverse metabolites that are often of unknown composition and impact.

Technical advanced measurements and monitoring of these micropollutants are needed. These measurements will be especially important in urban regions and in the effluents of the wastewater treatment stations, and of course the urban rivers themselves.

Improving risk assessment for micropollutants may form the basis for a scientifically sound, contaminant-directed management. A classification of micropollutants based on their chemical proprieties (metals, PCBs-polychlorinated bifenils), their function (usage: pharmaceuticals, agrochemicals) or public awareness (emerging persistent, organic pollutants) will be useful for assessing their fate, controlling their release, and the general dissemination of public information.

Innovative approaches should be developed to identify and mitigate the effects of environmental contaminants. Since there is a large number of micropollutants and their various potential effects on the biota and human health, it is important to understand their environmental behaviour and interactions with organisms in order to control their deleterious consequences.

### **Global changes and the water cycle in urban areas: implications for water security (stormwater management; urban regeneration and water management; the food-energy-water nexus; public health and environment protection)**

A significant burden of adaptation will be imposed to the population living in urban areas, due to climate perturbation.<sup>30</sup> It will be necessary an improved anticipation, more effective prevention efforts, and decisive emergency

30. Carta de São Paulo 2015: Recursos hídricos no Sudeste: segurança impacto e riscos. Revista da USP Vol.106 pp 11-20. ( Water Security in The Metropolitan Region of São Paulo.)

reactions, especially in the periphery of medium size cities or metropolitan regions. Single extreme events or clusters of extreme events also increase the vulnerability to water borne diseases (e.g. dengue fever or others), cause disruptions in cities mobility, and destroy houses and infrastructure with severe economic and societal impacts (e.g. S. Paulo State drought of 2014-2015). To understand the complexity of these processes, it is essential to understand the adaptability and changes in vulnerability to climate events. It is necessary i) to monitor the climate of the cities, ii) improve the infrastructures, iii) protect urban forests and water supply sources (surface and underground), iv) develop real time monitoring of water quality in surface and underground waters, and v) promote strategic studies on water security by understanding how global changes will affect water availability in cities.

The water-food-energy-health nexus in urban areas will have the potential to define critical climate related conflicts, which include societal adaptation to climate change.<sup>31</sup> Projections of future availability of freshwater suggest increasing imbalances between supply and demand.<sup>32</sup> Shifts in the frequency and distribution of precipitation, have been measured in several regions, and within this context, climate models projecting water availability are to be fomented and implemented.

Alert systems related to flooding, impacts on human health, and information technologies are important programmes to be developed, as well as studies and monitoring on the chemistry of the atmosphere in cities and its impacts on the quality of the water supply.

The establishment of guidelines for territorial organisation in cities which are undergoing a fast growth process is key.

### **Urban big data: developing urban intelligence and water monitoring technologies**

Urban areas are experiencing an ongoing rapid growth and several structural changes, particularly in Brazil, with an increased pressure on water resources.

31. 31Field et al (Editors),2014 Climate Change impacts adaptation, and vulnerability, 5th Report. IPCC. Cambridge. Cambridge University Press pp 35-94.

32. 32Tundisi J.G. et al 2015 Water availability, water quality and water governance : the future ahead. Hydrological Sciences and Water Security: past, present ; future. IAHS publ.Vol366 pp 75-79

In order to achieve city resilience, urban water management should be integrated into the watershed concept. Specific decision support systems are needed since this has to be adapted to local needs and challenges. All relevant links between water-related processes should be considered in the models that promote decision support systems. New model concepts that integrate bio-geo-physiographical analysis articulated with social and economic evaluations are essential. Basic components of decision support systems have to be implemented for each urban area. ICTs make possible the participative governance, as users become an active agent for the development of new processes and city configurations.

Some European cities are developing projects with the implementation of living labs following these concepts: Ghent (Belgium), Manchester (United Kingdom); Copenhagen (Denmark)<sup>33</sup> Technologies aggregating real time monitoring of environmental parameters (climate, air pollution, water pollution) connected and articulated with other information data on water supply, energy, mobility, education, public security, provide and promote a large amount of data that have to be processed and analysed accessing new and advanced technologies. Intelligent offices from city administrative services should operate these advanced programmes integrating data and qualified personnel.

#### **Water environmental challenges: political and social awareness.**

Urban populations should be stimulated to express their views on the management of water resources, and the appropriation of scientific and technological breakthroughs by citizens should be promoted. A well-informed and aware urban population will establish the environment as a cultural value, and will therefore generate a solid base of information.

Citizens may generate data, promote low cost solutions, participate actively in water cooperation; interactive processes incorporating district associations, industry and services societies represent important developments. Multidirectional communication structures are necessary, promoting participation of the population in efficient, systematic, sustainable and transparent activity. Data availability and scientific basis are essential for the creation of an efficient information flow. Identification of existing bottlenecks, lack of communication channels is fundamental to stimulate

the participation of all stakeholders (general public, industries, commerce, scientists, managers, water supply companies, local government agencies, lawmakers, and politicians).

The creation of platforms for dissemination of the information focusing on key issues such as water availability and water demand in urban areas, the loss of treated water in the city networks, water quality of surface and underground sources, water, and human health should constitute an advanced line of action. Incentives for participation of society can be created in connection with information flows. The payment for Environmental Services (PES- PSA in Portuguese) is a strong incentive for the participation of the population. In some regions of Brazil, this has been effective in the reforestation projects of water sources in urban areas.<sup>33</sup> Funds from water pricing must guarantee not only the operation of the water services but could be also used for supporting research and developments of new technologies of communication. Particular relevance should be given to comparative research on information flows and their effects on the society behaviour and commitment on environmental programmes and projects.

#### **Recovery of degraded urban ecosystems, urban rivers and wetlands**

In many urban regions of Brazil, there are degraded areas such as deforestation of riparian forests, river pollution, and strongly disturbed and modified ecosystems. Irregular occupation of space by inadequate urbanisation and sanitation are common in several peri-urban areas.

An interdisciplinary effort is necessary in order to explore new ways of restoration of basic ecosystem functions and services combined with community participation. The improvement of the understanding of the land use effects, the complex and dynamic pattern of changes due to inadequate occupation of space is critical, as well as an interaction of bio-geo-physiographical research with social sciences. The use of the concept of eco-hydrological approaches for recovery of degraded areas which is now relatively common in certain urban areas of European countries could be an important development in the recovery of degraded urban regions in Brazil.

<sup>33</sup> Boisson de Marca, J.R. & Marques, E. (coords) 2018. Cidades Sustentáveis Inteligentes, pp 185-205. In: Lima e Silva, & Tundisi, J.G. (coords). Projeto de Ciência para o Brasil. Acad. Brasileira de Ciências, 393 pp. (Sustainable Cities).

## Global and Transnational Strategic Agendas

The strategic documents adopted in the post-2015 era have been naturally influenced by the United Nations 2030 Agenda for Sustainable Development (**2030 Agenda**), not only from the thematic point of view, but also in relation to the timeline for its implementation. Sustainable urban development and water security has been in the forefront of EU priorities, and several member state driven initiatives have derived from the 2030 Agenda, and in particular, from the Sustainable Development Goal 11 “Make cities and human settlements inclusive, safe, resilient and sustainable” and SDG 6 “Ensure availability and sustainable management of water and sanitation for all”, which are at the core of this report.

It is not possible to dissociate European agendas from global international strategies, particularly those in the sphere of the United Nations. Thus, besides the abovementioned 2030 Agenda, it is important to highlight:

- The UN-Water platform, which coordinates the efforts of UN entities and international organisations working on water and sanitation issues. Annual reports are produced, **World Water Development Reports**, with the latest being published in March 2019, under the title “Leaving no one behind”.<sup>34</sup> Under the thematic umbrella of water demand increase and water stress, it focuses on the importance of improving water resources management and access to water supply and sanitation services, and how these factors are essential to addressing various social and economic inequities;<sup>35</sup>
- **New Urban Agenda** (2016), approved in the context of the United Nations Conference on Housing and Sustainable Urban Development, with a strategic approach for the next 20 years.<sup>36</sup> The main underlying principles where a correlation to water is established are described as “*Cities and human settlements that fulfil their social function, including the social and ecological function of land, with a view to progressively achieving the full realization of the right to universal access to safe and*

34. <https://www.unwater.org/publications/world-water-development-report-2019/>

35. <https://unesdoc.unesco.org/ark:/48223/pf0000367306>

36. <http://habitat3.org/wp-content/uploads/NUA-English.pdf>

*affordable drinking water and sanitation, and equal access for all public goods and quality services” and “Cities and human settlements that protect, restore and promote their ecosystems, water, natural habitat and biodiversity, minimize their environmental impact and change to sustainable consumption and production patterns”;*

In relation to the European framework, it is important to mention:

- **Joint Programming Initiative Urban Europe Strategic Research Agenda** (2019 version),<sup>37</sup> with four main pillars, namely i) digital transitions in urban governance, ii) from urban resilience to robustness, iii) sustainable land-use and urban infrastructures, iv) inclusive public spaces for urban liveability. Water management is mentioned in the governance pillar, and in the context of climate adaptation issues and the water-energy-food nexus. It is also highlighted the need for participatory development of new approaches, for testing new roles and new governance models under real-life conditions, promoting flexible and innovative ways to create arenas for co-creation in the whole knowledge value chain (science-policy-business-society);
- **Joint Programming Initiative Water Challenges for a Changing World** (2016 version),<sup>38</sup> with five main pillars, namely i) improving ecosystem sustainability and human well-being, ii) developing safe water systems for citizens, iii) promoting competitiveness in the water industry, iv) implementing a water-wise bio-based economy, and v) closing the water cycle-gap (improving sustainable water resource management). 5 Joint Calls have been implemented, more than 70 R&I projects funded, including Brazilian partners, 63 M€ of funds allocated, involving more than 300 R&I organisations;
- **Urban Agenda for the EU** (Pact of Amsterdam, 2016, signed by the EU Ministers responsible for urban matters),<sup>39</sup> elaborated under the principle of improving the quality of life in urban areas. It is based on an integrated and coordinated approach to deal with the urban dimension

37. <http://jpi-urbaneurope.eu/app/uploads/2016/05/JPI-Urban-Europe-SRIA-Strategic-Research-and-Innovation-Agenda.pdf>

38. <http://www.waterjpi.eu/water-jpi-sria-2.0/water-jpi-sria-2.0>

39. [https://ec.europa.eu/regional\\_policy/sources/policy/themes/urban-development/agenda/pact-of-amsterdam.pdf](https://ec.europa.eu/regional_policy/sources/policy/themes/urban-development/agenda/pact-of-amsterdam.pdf)

of the EU, its national policies and legislation. The main pillars and drivers: Regulation, Funding and Knowledge. Several partnerships have been defined since 2016: Inclusion of Migrants and Refugees; Air Quality; Housing; Urban Poverty; Circular Economy; Digital Transition; Urban Mobility; Jobs and Skills in the Local Economy; Energy Transition; Climate Adaptation; Innovative and Responsible Public Procurement; Sustainable Use of Land; Nature-Based Solutions;

- **European Urban Initiative (EUI) post-2020**,<sup>40a</sup> a new instrument providing coherent support for cities that builds on all thematic priorities of the Urban Agenda for the EU (UAEU) and covers all urban areas. This initiative aims to strengthen integrated and participatory approaches to sustainable urban development and provide a stronger link to relevant EU policies, and in particular, cohesion policy investments. It will do so by facilitating and supporting cooperation and capacity building of urban actors, innovative actions, knowledge, policy development and communication in the area of sustainable urban development. The proposed EUI is aligned with the Urban Agenda for the EU;
- **Urban Water Agenda 2030** (under implementation) is a joint initiative of the European Commission and local governments to safeguard Europe's water resources and strengthen the implementation of European Union water policies by fostering sustainable urban water management water in cities;<sup>41</sup>

## European Legislation

- The **7th Environment Action Programme (EAP)**,<sup>42</sup> the overarching framework for European environmental policy until 2020. It also provides a long-term direction and vision for 2050, namely to "live well, within the planet's ecological limits". Main keywords include prosperity; healthy environment; circular economy;<sup>43</sup> waste and natural resources

40. [https://ec.europa.eu/regional\\_policy/en/newsroom/news/2019/03/20-03-2019-european-urban-initiative-post-2020-the-commission-proposal](https://ec.europa.eu/regional_policy/en/newsroom/news/2019/03/20-03-2019-european-urban-initiative-post-2020-the-commission-proposal)

41. <http://urbanwateragenda2030.eu/>

42. <https://ec.europa.eu/environment/action-programme/>

43. [https://ec.europa.eu/research/environment/pdf/h2020\\_projects\\_circular\\_economy\\_2016-2018.pdf](https://ec.europa.eu/research/environment/pdf/h2020_projects_circular_economy_2016-2018.pdf)

sustainable management; biodiversity protection, value and restoration; society resilience. Two horizontal priorities complete the programme: sustainable cities, and international environment and climate challenges;

- The urban dimension of **Regional Development** and **Cohesion Policy**: the urban dimension has been at the heart of the EU Cohesion Policy. Cities are seen as both the source and solution to the present economic, environmental and social challenges. Urban policies have a cross-border significance, justifying the central role urban development has in the EU Regional Policy;<sup>44</sup>
- The **EU Water Framework Directive** (adopted in 2000),<sup>45</sup> with the goal of developing a global approach to water policy within the EU, decrease fragmentation, and harmonizing objectives. Within the key aims, it is highlighted the need to expand the scope of water protection to all waters, surface waters and groundwater; achieve "good status" for all waters by set deadlines; water management based on river basins; "combined approach" of emission limit values and quality standards; getting the prices right; getting the citizen involved more closely; streamlining legislation;<sup>46</sup>

## Complementary Legislation

For the sake of completeness, complementary legislation connected to the water and urban sectors are listed in the Table below (Table 1). Although they do not enclose research and innovation priorities, they do influence and orient in great extent the knowledge being produced and disseminated within the theme of urban water management.

**Table 1** – List of selected complementary legislation and relevant documentation related to the water sector. The documents are referenced, and the corresponding objectives described.

44. <https://ec.europa.eu/jrc/communities/en/community/european-tto-circle/news/regional-development-and-cohesion-policy-beyond-2020-new>

45. [https://ec.europa.eu/environment/water/water-framework/index\\_en.html](https://ec.europa.eu/environment/water/water-framework/index_en.html)

46. [http://ec.europa.eu/environment/water/water-framework/info/intro\\_en.htm](http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm); <http://ec.europa.eu/environment/pubs/pdf/factsheets/wfd/en.pdf>

Document Reference	Title	Year	Objective
2006/7/EC	Bathing Water Directive	2006	The management of bathing water quality and repealing Directive 76/160/EEC.
2006/118/EC	Groundwater Directive	2006	Protection of groundwater against pollution and deterioration.
98/83/EC	Drinking Water Directive	1998	Improve the quality of drinking water. Proposal for a revised drinking water directive approved in February 2018.
2007/60/EC	Flood Risks Directive	2007	Establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community.
91/676/EEC	Nitrates Directive	1991	Protection of waters against pollution caused by nitrates from agricultural sources.
2013/51/EURATOM	Radioactive Substances Drinking Water Directive	2013	Laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption.
2008/105/EC	Environmental Quality Standards Directive	2008	Environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC
91/271/EEC	Urban Waste Water Treatment Directive	1991	Protect the environment from the adverse effects of the abovementioned waste water discharges.
2006/12/EC	Waste Directive	2006	Measures to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment.
1999/31/EC	Landfill Waste Directive	1999	Meeting the requirements of Directive 75/442/EEC, and stringent operational and technical requirements on the waste and landfills.

2010/75/EU	Industrial Emissions Directive	2010	Industrial emissions (integrated pollution prevention and control) applied to the industrial activities giving rise to pollution.
96/61/EU	Integrated Pollution Prevention and Control Directive	1996	Achieve integrated prevention and control of pollution arising from the activities listed herein.
91/414/EEC	Plant Protection Products Directive	1991	Authorization, placing on the market, use and control within the Community of plant protection products and active substances intended for the use described herein.
89/106/EEC	Construction Products Directive	1989	The approximation of laws, regulations and administrative provisions of the Member States relating to construction products
2004/35/EC	Environment Liability Directive	2004	Establish a framework of environmental liability, based on the "polluter-pays" principle, to prevent and remedy environmental damage
2008/56/EC	Marine Strategy Framework Directive	2008	Establishes a framework for community action in the field of marine environmental policy to protect more effectively the marine environment across Europe.
EC Communication	The Water Framework Directive and the Floods Directive	2015	Actions towards the 'good status' of EU water and to reduce flood risks.
EC Communication	Water Scarcity and Droughts	2007	Addressing the challenge of water scarcity and droughts in the European Union; Policy orientations for future action.
EU Publication	A Water Blueprint for Europe	2014	The purpose of achieving a good water status, as the status of EU waters is not doing well enough.
EU Publication	Water: What's in it for you?	2016	The seriousness of water-related problems is recognized. Measures to manage water resources and the water environment.
EU Publication	Water is for life	2011	How the Water Framework Directive helps safeguard Europe's resources

## Overall Key Messages from an European Perspective

The above section on strategic agendas and current European legislation encompasses a series of key messages, which are in their essence common to Brazilian social, economic, technological and cultural development:

- **Smarter Europe** (innovation, digitization, information organization, economic transformation);
- **Greener, carbon-free Europe** (energy transition, resource efficiency management, and climate change adaptation);
- **Connected Europe** (sustainable mobility and digital networks);
- **Social Europe** (general well-being, quality in employment, education, and inclusion);
- **Europe closer to citizens** (locally-led development strategies, effective implementation of legislation, information dissemination, and sustainable urban development);

## Brazilian Legislation

In January, 1997 the Water Law was created by the Federal Government of Brazil (Law 9.433/97). This Law created the National Policy on Water Resources and the National System of Water Resources Management.<sup>47</sup>

The main components of the Water Law, are: I) Water is a public resource; II) Water is a limited natural resource with economic value; III) When water is scarce human consumption and animal consumption are priorities; IV) Water has to be managed in order to supply multiple uses (public supply, energy, irrigation, industry) in a sustainable way; V) The watershed is the territorial unit for the implementation of the Policy of Water Resources and The National System of management of Water Resources; VI) The water management is decentralized, with participation from all stakeholders, civil society and

47. BRASIL. Lei nº 9.433 de 8 de janeiro de 1997. Institui a Política Nacional de Recursos Hídricos, cria o sistema Nacional de Gerenciamento de Recursos Hídricos, regulamenta o inciso XIX do art. 21 da Constituição Federal e altera o artigo 1º da Lei nº 8.001 de 13 de março de 1990, que modificou a Lei nº 7.990 de 28 de dezembro de 1989. (National Law of Water Resources)

government.<sup>48</sup>The National System of Water Resources Management was included in this law.

In July, 17, 2.000 the ANA (Agencia Nacional das Aguas), the National Water Agency was created and its main function was to implement the National Policy on Water Resources and to coordinate the National System on Water Resources Management.

In March, 25, 2004, the Ministry of Health of Brazil implemented the Law: Water quality monitoring for human consumption. This law establishes that the water produced and distributed for human consumption must be monitored and controlled and its has to concur with the potability standards. By this law all the municipalities in Brazil have to monitor the water quality in the source, before treatment for potability, and after treatment. The occupation of the watersheds that supply water to cities should be monitored. This law for the first time in Brazil associated water supply and water quality with human health.

The National Water Agency implements the National Water Resources Management system in order to ensure the sustainable uses of water sources such as rivers and lakes. ANA has the task to regulate the Water Law of 1997, granting the right to use of water; ANA stimulates the creation of river basin committees particularly in rivers under the Federal Governments domains. These committees promote articulation of civil society, water users, public authorities. The activities of ANA, the National Water Agency of Brazil are to reinforce and coordinate the instruments for the management of water resources. They are:

- Water Resources Plans
- To classify water bodies accordingly to their uses
- The grating of rights to the use of water resources
- The charge (tax) for the use of water
- The system of information on water resources<sup>49</sup>

48. BRASIL–Resolução CONAMA nº 357/2005 de 17 de março de 2005. Dispõe sobre a classificação dos corpos de água e diretrizes ambientais para o seu enquadramento, bem como estabelece as condições e padrões de lançamento de efluentes; e dá outras providências. ( Waters classification and management directives)

49. Agencia Nacional de Aguas (ANA). 2017b. Atlas esgotos. Despoluição de bacia hidrográficas. Secretaria Nacional de Saneamento Ambiental. 88pp. ( Wastewater Atlas of Brazil)

The ANA promotes and participates of the National System of Water Resources Management (SINGREH), consisting of the National Council of Water Resources, the National Water Agency, the state councils on water resources, the watershed committees, federal, state and municipal institutions responsible for water resources management and water agencies. In several States of Brazil watershed committees were established in the last twenty years. In São Paulo State the funds for the management of the watersheds and research initiatives are accumulated from the penalties and taxes resulting from pollution and the polluter-pays principle established by law. Similar initiatives to secure financing of activities are in progress in several Brazilian States.<sup>50</sup>

## SWOT Analysis: Research and Innovation on Urban Water Management

The following SWOT matrix (Figure 10) provides a generic proposal of topics and present challenges posed to the water and urban sectors, which serve as a guideline to drive research and innovation in response to the current problems and provide a reference platform to potentiate the wide range of existing opportunities. The current matrix does not differ from the main messages included in the previously described strategic agendas, namely:

- Reduction, recycling, reuse, and efficiency of water consumption for urban, industrial or for the agro-food sector;
- Efficiency in water transport and infrastructures;
- Urban and industrial wastewater treatment;
- Eliminate sources of diffuse pollution and reduce erosion;
- Extreme events, namely flood risk;
- Define priorities for infrastructure investment;
- Involve users and general public in matters related to urban water management.

50. Agencia Nacional de Aguas (ANA). 2010. Atlas Brazil. Urban water supply. <http://atlas.ana.gov.br/Atlas/fprms/Home.aspx> ( in Portuguese).



**Figure 10.** SWOT analysis on research and innovation in urban water management.<sup>51</sup>

51. SWOT analysis is linked to the 2016 Water JPI Mapping Report, which is a non-public deliverable within the context of the Coordination and Support Action WatEUr.

## 4. RESEARCH AND INNOVATION ON URBAN WATER MANAGEMENT WITHIN THE EU

### The Joint Programming Initiative Water Challenges for a Changing World

The Water JPI is an intergovernmental initiative, which started in 2011, and currently comprising twenty-three partner countries and three countries as observers, and its membership accounts for 88 per cent of all European public RDI annual expenditure on water issues. Several projects support the Water JPI activities, and as mentioned earlier, 5 Joint Transnational Calls have been implemented over the last 5 years.

The first Joint Call (2013) with a total budget of € 9 million focused on “Emerging water contaminants-anthropogenic pollutants and pathogens” and 7 transnational collaborative research projects in the field of water quality have been recommended for funding, involving institutions from 10 European countries.

The Joint Calls that followed (2015, 2016 and 2018) have been implemented under the Cofund mechanism, where the European Commission contributes financially to promote the funding of more consortia. The three Joint Calls covered topics of the Strategic Research and Innovation of the Water JPI, with a particular collaboration from the FACCE JPI (Agriculture, Food Security and Climate Change), namely on challenges related to water use efficiency and resilience, soil and water pollution, social and economic dimensions of water management and governance. In addition, and on a wider spectrum, the development of new technology on water treatment, reuse, recycling and desalination, and the impacts of extreme events, and lately on *closing the water cycle gap*. The latter topic on water supply/water demand incorporates the dimensions of quantity, quality, space and time. It focuses on the sustainable management of water resources, the strengthening socio-

economic approaches to water management, and development of supporting tools for sustainable integrative management of water resources. In total, 55 projects have been funded with the participation of more than 25 countries, in Europe and beyond (including Brazil).

The international dimension of the Water JPI and its important interlink to the 2030 Agenda are reflected on the Joint Call solely driven by the Water JPI Members and international partners such as Brazil, on water resource management in support of the UN SDGs. A total of **8 projects, 6 of which with Brazilian participation, were funded**. Detailed information on the consortia can be found in the Water JPI website.<sup>52</sup>

Out of all the projects funded under the Water JPI umbrella, it is important to highlight the following, on the basis of their relation to the urban dimension of the challenges tackled:

- URBANWAT project, on tools and criteria for urban water management. URBANWAT “proposes an integrated approach for urban groundwater management using monitoring, measuring and modelling of ground water systems in urban areas with the overall aim to contribute to the healthy and safe use of urban ground water resources.”;
- IDOUM, on innovative decentralized and low cost treatment systems for optimal urban wastewater management. This project includes Brazil as partner (more information in Chapter 3);<sup>53</sup>
- ATENAS, under the principles of allying technology, nature and society for integrated urban water management;
- RAINOLUTION, on research to turn the cities more resilient to climate change and more circular to prevent material depletion. The goal is to create a model to cohere the spatial arrangement of nature-based solutions for urban runoffs (like green roofs & parks) and of emerging circular solutions (like heat recovery & urban farming). The outcome

52. <http://www.waterjpi.eu/joint-calls>

53. <http://www.fapesp.br/en/12836>

helps keep the urban water clean and healthy and enhance the recovery and reuse of resources like water and nutrients. This project includes Brazil as partner (more information in Chapter 3)<sup>54</sup>;

- FRAME, a novel framework to assess and manage contaminants of emerging concern in indirect potable reuse aiming at developing an overall evaluation procedure enabling a comprehensive assessment of efficient and cost-effective indirect potable reuse (INPR) measures to minimize the risks associated with emerging chemicals and microbial contaminants, while closing local and regional water cycles;
- INXCES, IMDROFLOOD, MUFFIN, are all projects tackling the challenge of climate change adaptation, and in particular the forecasting and early warning of extreme events such as floods and droughts. The projects aim at improving the mitigation of the impact of extreme events in light of ongoing urbanisation, implementing a holistic spatial and temporal approach to the urban water balance at a catchment scale (keywords: assessment, mitigation, city resilience, nature-based solutions, extreme hydroclimatic events);
- ENTRUGO, NEWTS are projects aiming at enhancing trust in government through effective water governance strategies, and on the other hand on different approaches (nudges *versus* education, legislation or enforcement);

54. <https://www.era-learn.eu/network-information/networks/waterworks2017/water-jpi-2018-joint-call-closing-the-water-cycle-gap/research-based-assessment-of-integrated-approaches-to-nature-based-solutions?SearchTerm=rainsolution>

## Key initiative for Brazil-Europe Cooperation

Project Title (Project Acronym)		
Water Works 2018-2022 in Support of the Water JPI and of the EC Call SC5-33-2017: Closing the water cycle gap (WaterWorks2017)		
Project Topic		
Water Supply; Water Demand; Water Quality; Water Availability; Bridge the Gap between Water Supply and Water Demand; Sustainable Water Management; Water Resources; Technological and Market-Oriented Solutions		
Project Start Date	Project End Date	Project ID and Programme
2018-01-01	2022-12-31	Project ID: 776692 Programme: H2020-EU.3.5.2.2.
Project Information		
<a href="https://cordis.europa.eu/project/rcn/213525_en.html">https://cordis.europa.eu/project/rcn/213525_en.html</a>		
Funding Scheme		
ERA-NET Cofund		
Project Partners from Brazil		
CONSELHO NACIONAL DAS FUNDAÇÕES ESTADUAIS DE AMPARO À PESQUISA		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Urban regeneration and water management: closing the water cycle gap;</li> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Urban big data: developing urban intelligence and water monitoring technologies;</li> </ul>		

## The Joint Programming Initiative Urban Europe

The Joint Programming Initiative Urban Europe was launched in 2010 to “address the global urban challenges of today with the ambition to develop a European research and innovation hub on urban matters and create European solutions by means of coordinated research”. Its mission is to develop a dialogue framework to improve urban life in general, through production and dissemination of knowledge, and implementation of tools and platforms to that end. Currently, JPI Urban Europe has 14 member countries and 6 countries as observers. More countries are involved in specific JPI Urban Europe activities.

In six joint calls (2012-2017) 73 research and development projects have been selected with almost 200 project partners including research institutes, municipalities, entrepreneurs and citizen platforms. Some of the projects are financed by funding agencies with top-up funding from the European Commission, under similar funding principles described above for the Water JPI. Currently the seventh joint call is being finalised with final outcomes to be made public soon.

From a thematic point of view, the first two pilot calls dedicated special attention to topics related to governance and social cohesion, focusing also on projects covering the dimensions of urban vulnerability, adaptability and resilience, and to urban systems and networks.

In the context of the ERA-NET Cofund mechanism, four different calls were launched, namely:

- Smart Cities and Communities on smart integrated urban energy and transport systems, smart tools and services for energy and transport systems, smart and big data, and smart governance and smart citizens;
- Smart Urban Futures on the urban condition and sustainable development through creation and testing of new methods, tools, and technologies required to overcome current economic, social, and environmental challenges;

- Urbanisation Global Initiative (SUGI)/Food-Water-Energy Nexus in cooperation with the Belmont Forum. This call dealt with an important nexus and its links to policy, science and the society at large, and the challenges connected with population increase, food shortages, scarce water and insufficient energy resources;
- Making Cities Work – Finding solutions to urban challenges through cooperation, where consortia were supported to create challenge-driven innovation projects for European urban areas that have the potential to result in commercially successful services and products;
- Sustainable and Liveable Cities and Urban Areas in cooperation with the National Natural Science Foundation of China (long-term cooperation under the strategic theme Sustainable Urbanisation in the Context of Economic Transformation and Climate Change). Sub-themes such as the i) reduction of the adverse environmental impact of cities, paying special attention to the quality of air, water and soil, and municipal and other waste management; ii) the access to safe, affordable, and sustainable housing, transportation and basic services; and c) integration of policies towards inclusion, resource efficiency, mitigation and adaptation to climate change and resilience to disasters.

Out of all the projects funded under the JPI Urban Europe umbrella, it is important to highlight the following, on the basis of their relation to the challenges tackled, which relate to the identified priorities described in Chapter 3:

- CITY FOOD<sup>55</sup>, on smart integrated multitrophic city food production systems (water and energy saving approach for global urbanisation), including UNESP (Universidade Estadual Paulista Julio de Mesquita Filho) as project partner;
- CREATING INTERFACES<sup>56</sup>, addressing capacity building for the urban food-water-energy nexus, linking the whole value chain (government, scientists, enterprises, and citizens), developing innovative

55. <https://jpi-urbaneurope.eu/project/cityfood/>

56. <https://jpi-urbaneurope.eu/project/creating-interfaces/>

approaches for local knowledge co-creation and participation through Urban Living Labs;

- CRUNCH<sup>57</sup> investigates the food-water-energy nexus complexity as a single system, combining an integrated decision support system and visualisation models, working closely with local stakeholders;
- DESCIPHER<sup>58</sup>, on integrated nature-based solutions within airshed and river basin management. It will address the issues related to sustainable urbanisation under climate change, and its relation to air, soil and water quality, evaluating the consequences for ecosystem services;
- ENLARGE<sup>59</sup> stands for enabling large-scale adaptive integration of technology hubs to enhance community resilience through decentralized urban food-water-energy nexus decision support;
- FEW-METER<sup>60</sup>, on the development of an integrative model to measure and improve urban agriculture towards circular urban metabolism. Farmers will measure the efficiency of urban agriculture case studies in five developed countries by quantifying usage of energy, water and other resources as well as production of produce and compost;
- FLOODCITISENSE<sup>61</sup>, FLOODLABEL<sup>62</sup>, GREEN BLUE CITIES<sup>63</sup> addressing the topic of urban floods, in different dimensions, namely the development of early warning services, or by combining storm water management with multi-functional green infrastructures, or developing smart tools for governance towards flood-resilient cities;

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57. <https://jpi-urbaneurope.eu/project/crunch/>

58. <https://jpi-urbaneurope.eu/project/descipher/>

59. <https://jpi-urbaneurope.eu/project/enlarge/>

60. <https://jpi-urbaneurope.eu/project/few-meter/>

61. <https://jpi-urbaneurope.eu/project/floodcitisense/>

62. <https://jpi-urbaneurope.eu/project/floodlabel/>

63. <https://jpi-urbaneurope.eu/project/green-blue-cities/>

- IN-SOURCE<sup>64</sup>, M-NEX<sup>65</sup>, RECREATE<sup>66</sup>, SMART-U-GREEN<sup>67</sup>, VERTICAL IN GREEN 2.0<sup>68</sup>, commonly address topics related to the food-water-energy nexus, but in particular the questions related to urban strategic planning, urban metabolism, circular economy and green infrastructures;
- FUSE<sup>69</sup> is a project on novel policies and governance forms to address competition for scarce resources in stressed urban food-water-energy systems;
- It is also relevant to group the projects with Brazil participation (or even leadership), as follows:
- IFWEN<sup>70</sup> combines the development of a framework and tools to assess changes in the food-water-energy nexus with the management of green and blue infrastructures at the urban level. The project is lead by the Getulio Vargas Foundation (FGV), São Paulo School of Management (FGV/EAESP);
- METABOLIC<sup>71</sup>, with the participation of the Universidade de São Paulo, deal with urban metabolism incorporating advanced tools such as Artificial Intelligence, data mining, system dynamics modelling, agro-logistics and scenario analysis;
- URBANISING IN PLACE<sup>72</sup>, with the contribution of Instituto de Urbanismo e Estudos para a Metrópole in São Paulo, seeks to define the components of a model of urbanization which places food, metabolic cycles and an ethics of land stewardship, equality and solidarity at its core;

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64. <https://jpi-urbaneurope.eu/project/in-source/>

65. <https://jpi-urbaneurope.eu/project/m-nex/>

66. <https://jpi-urbaneurope.eu/project/recreate/>

67. <https://jpi-urbaneurope.eu/project/smart-u-green/>

68. <https://jpi-urbaneurope.eu/project/vertical-green-2-0/>

69. <https://jpi-urbaneurope.eu/project/fuse/>

70. <https://jpi-urbaneurope.eu/project/ifwen/>

71. <https://jpi-urbaneurope.eu/project/metabolic/>

72. <https://jpi-urbaneurope.eu/project/urbanising-in-place/>

- WASTE FEW FULL<sup>73</sup> will contribute with policy decision support models for economically viable waste reduction, rethinking waste as a resource as well as establish entrepreneurship networks. It will map and substantially reduce waste in the food-energy-water nexus in cities across Europe, Africa and South America. Brazil is a partner (Universidade de Campinas).

#### Key initiative for Brazil-Europe cooperation:

Project Title (Project Acronym)		
ERA-NET Sustainable Urbanization Global Initiative (EN-SUGI)		
Project Topic		
Food-Energy-Water Nexus; innovation and technological solutions; market-oriented solutions; urban resilience; alignment of strategic priorities (Belmont Forum, Future Earth, UN-Habitat); Robust Knowledge, Indicators and Assessments; Multi-level Governance and Management of the Food-Water-Energy Nexus; Managing Potential Strategies and Solutions to address emerging Risk and Tradeoffs at the intersection of Sustainable Urbanization and the Food-Water-Energy Nexus; quality of life		
Project Start Date	Project End Date	Project ID and Programme
2016-12-01	2021-11-30	Project ID: 730254 Programme: H2020-EU.3.5.2.3.; H2020-EU.3.5.1.2.; H2020-EU.3.5.1.3.; H2020-EU.3.5.4.; H2020-EU.3.5.2.2..
Project Information		
<a href="https://cordis.europa.eu/project/rcn/207189/factsheet/en">https://cordis.europa.eu/project/rcn/207189/factsheet/en</a>		
Funding Scheme		
ERA-NET Cofund (Brazil only participates in the Joint Call)		
Project Partners from Brazil		
FUNDAÇÃO DE AMPARO À PESQUISA DO ESTADO DE SÃO PAULO (FAPESP)		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Urban regeneration and water management: closing the water cycle gap;</li> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> </ul>		

73. <https://jpi-urbaneurope.eu/project/waste-few-ull/>

## Other Research and Innovation Projects and International Cooperation Agreements on Urban Water Management

### EU funded projects

Water has been an important activity in successive European Research and Development Framework Programmes over the last decades generating important new knowledge and solutions on urban water management issues. Under Horizon 2013-2020 Framework Programme, demonstration/pilot activities of new or improved innovative water solutions in a real environment in urban areas have been promoted. Calls promoting circular economy principles in urban water management aiming to support water reuse and resource recovery and calls promoting the application of nature base solution in urban areas have been also launched. Some examples are mentioned below:

- The ICT4Water cluster is a hub for EU-funded research and innovation projects on ICT applied to water management.<sup>74</sup> It establishes permanent links between the 40 projects which are currently members of the clusters, increasing their visibility and knowledge sharing. They all somehow relate to urban water management, and in particular to some of the priorities set out in the Brazil-EU Cooperation Agreement, but out of these projects, it is important to highlight the following:
- INNOQUA<sup>75</sup>: it aims at answering the growing need for protection and improvement of natural water resources. An EU-funded project through H2020 initiated in 2016, aims at promoting sustainable water sanitation technologies. Ecuador and Peru are international partners in this project.
- NATure-based URbaninnoVATION (NATURAVATION)<sup>76</sup> is a 4-year project funded under H2020 involving 14 institutions across Europe in the fields of urban development, geography, innovation studies and

74. <https://www.ict4water.eu/index.php/about-us/>

75. <https://cordis.europa.eu/project/rcn/203388/factsheet/en>

76. <https://naturvation.eu/>

economics. It deals with the implementation of nature-based solutions for sustainable urbanization, including urban water management. A snapshot at water challenges and the resilience of urban areas has been elaborated recently.<sup>77</sup>

### **EU-India Cooperation**

The European Union, the Department of Science & Technology and the Department of Biotechnology of India funded seven projects, starting in 2019, that have been selected under the EU - India Joint Call on Research and Innovation for Water.<sup>78</sup> It comprises the urban and rural dimensions and they are expected to tackle the most prominent and urgent water challenges in India. This joint collaborative effort is under the umbrella of the EU-India Water Partnership signed in 2016.<sup>79</sup>

### **Australia: The Cooperative Research Centre for Water Sensitive Cities (CRCWSC)**

The CRCWSC is an Australian research centre that brings together many disciplines, world-renowned subject matter experts, and industry thought leaders who want to revolutionize urban water management in Australia and overseas.<sup>80</sup>

### **EU Water Initiative (EUWI): Water Policy Reforms in Eastern Europe, the Caucasus and Central Asia (EECCA)**

The European Union Water Initiative (EUWI)<sup>81</sup> supports the achievement of the water-related Sustainable Development Goals (SDGs) and takes a partnership approach with national governments, donors, the water industry, NGOs and other stakeholders. The OECD and UNECE are implementing partners of the EUWI in Eastern Europe, the Caucasus and Central Asia (EECCA). These

77. [https://naturvation.eu/sites/default/files/result/files/snapshot\\_water\\_challenges.pdf](https://naturvation.eu/sites/default/files/result/files/snapshot_water_challenges.pdf)

78. [https://eeas.europa.eu/delegations/india/58099/eu-india-jointly-fund-seven-research-and-innovation-projects-tune-eur-40-million-tackle-urgent\\_en](https://eeas.europa.eu/delegations/india/58099/eu-india-jointly-fund-seven-research-and-innovation-projects-tune-eur-40-million-tackle-urgent_en)

79. <https://www.consilium.europa.eu/media/23672/20160330-joint-declaration-iewp.pdf>

80. <https://watersensitivecities.org.au/>

81. <http://www.oecd.org/environment/outreach/partnership-eu-water-initiative-euwi.htm>

countries are adopting multiple policy reforms in water management in cooperation with the EUWI.

### **BORDA e.V. (Bremen Overseas Research & Development Association)**

BORDA e.V.<sup>82</sup> is an expert NGO specialising in full-cycle decentralised sanitation with an accumulated experience of over 40 years, with three main strategic pillars: people, innovative solutions and sanitation.

### **The ESFRI Roadmap and the links to R&I priorities in urban water management**

ESFRI, the European Strategy Forum on Research Infrastructures, is “a strategic instrument to develop the scientific integration of Europe and to strengthen its international outreach. The competitive and open access to high quality Research Infrastructures supports and benchmarks the quality of the activities of European scientists, and attracts the best researchers from around the world.”

The mission of ESFRI is “to support a coherent and strategy-led approach to policy-making on research infrastructures in Europe, and to facilitate multilateral initiatives leading to the better use and development of research infrastructures, at EU and international level.”

The ESFRI Roadmap 2018<sup>83</sup> contains 55 research infrastructures (18 projects and 35 landmarks), some of which related to the water sector. Although there is currently no project or landmark that addresses the topic of urban water management within its main sphere of action, it is certainly important to follow research infrastructures contributing to it, namely those on river-sea systems, pathogenic agents, and human behaviour (Table 2).

82. <https://www.borda.org/partnerships/>

83. <http://roadmap2018.esfri.eu/media/1049/roadmap18-part3.pdf>

**Table 2** –The ESFRI roadmap of 2018 and research infrastructures related to the water sector.

ESFRI-RI	Status	Preparation/ Implementation	Operation Phase	Name/Topic
DANUBIUS-RI	Project	2012-2022	2022	The International Centre for Advanced Studies on River-Sea Systems
ERINHA	Landmark	2010-2017	2018	European Research Infrastructure on Highly Pathogenic Agents
ESS ERIC	Landmark	1996-2012	2013	European Social Survey

In simple terms, research infrastructures provide the tools, resources, and also collaborative sites where researchers and innovators can jointly develop curiosity-driven science or apply the generated knowledge and related-innovative concepts to cause a direct positive impact on society. Not only research infrastructures encourage human resources mobility and the creation, development and diffusion of knowledge, but also allow for pooling resources and reducing costs by jointly tackling global challenges. These principles are fundamental for Brazil and the EU to access and share a myriad of resources and to its scientific and technological communities to jointly develop efforts at tackling current priorities in the area of urban water management.

## The COST Association: networking researchers and innovators, leveraging nationally-funded projects and organisations

The European Cooperation in Science and Technology (COST), has been helping people and institutions grow since 1971. Currently comprised by 38 Member Countries, 1 Cooperating State and 1 COST Partner Member,<sup>84</sup> “COST provides networking opportunities for researchers and innovators in order to strengthen Europe’s capacity to address scientific, technological and societal challenges.” However, COST is a global networking programme, open to all and fully inclusive, driven by three main priorities, i) promoting and spreading excellence, ii) fostering interdisciplinary research for breakthrough science, iii) empowering and retaining young researchers and innovators. COST implements its mission by “funding bottom-up, excellence-driven, open and inclusive networks for peaceful purposes in all areas of science and technology.”<sup>85</sup>

COST leverages nationally funded research and innovation by providing a platform to connect all relevant stakeholders, independently of their resources available, their career stage, and solely driven by the principle that excellence is everywhere. It is also through networking that joint efforts can be developed to diminish the fragmentation of knowledge, and it is by sharing resources common problems are tackled, and how solutions are reached together. The Partner Member status in COST, open to all COST international partners, could pave the way for a better integration of the research and innovation community in networks of reference in Europe. Close to the topic of urban water management, several ongoing COST Actions (the COST networks) are currently active (Table 3).

84. <https://www.cost.eu/who-we-are/members/>

85. <https://www.cost.eu/who-we-are/mission-vision-and-values/>

**Table 3** – Ongoing COST Actions which are related to urban water management.

Ongoing COST Actions related to urban water management			
Action Acronym and timeline	Action Title	Number of COST Countries	International partners
CA18225 (2019–2023) <sup>86</sup>	Taste and Odor in early diagnosis of source and drinking Water Problems	32	
CA17133 (2018–2022) <sup>87</sup>	Implementing nature based solutions for creating a resourceful circular city	39	Colombia, Taiwan
CA15206 (2016–2020) <sup>88</sup>	Payments for Ecosystem Services (Forests for Water)	33	China, New Zealand, Japan

86. <https://www.cost.eu/actions/CA18225/#tabs|Name:overview>

87. <https://www.cost.eu/actions/CA17133/#tabs|Name:overview>

88. <https://www.cost.eu/actions/CA15206/#tabs|Name:overview>

## 5. RESEARCH AND INNOVATION ON URBAN WATER MANAGEMENT IN BRAZIL

### 5.1 Research Developments in Freshwater Problems in Urban Areas in Brazil

At present there are several developments of research in Brazil related to water supply, protection of water sources, recovery of degraded areas. Other problems being tackled by research institutions, public services responsible for water treatment, and wastewater treatment, are monitoring of water, micropollutants such as endocrine disruptors, pharmaceutical and personal care products. The technologies for water re-uses are also being developed at some cities of south east region. In this chapter a detailed description of the issues that are important for cooperation European Union/Brazil are presented with the aim to contribute for the establishment of priorities in this cooperation. This section shows a general synthesis of main areas of research and technological development focused on the following problems:

#### 5.1.1 Urban Watersheds : Biodiversity Loss and Restoration.

Ecological features of urban freshwater biodiversity are related to the watersheds at cities. These studies are related to urban planning. Diversity, resilience, vulnerability and fragmentation of urban watersheds are at the center of these studies. Flood protection. River bio-restoration projects, buffer areas of vegetation and wetlands are matter of study and development of projects. These are included in urban water security programs. Vulnerability of urban watersheds related to flood damage, loss of biodiversity and fragmentation of river habitats are topics of great interest at present. Recovery of degraded watersheds and the use of hydro-ecological principles related to this interaction are being applied in some metropolitan areas and mid-size towns. (100.000 to 250.000 inhabitants) Restoration of riparian vegetation in urban rivers are also activities in development. The studies of new technologies for restoration of river water quality related to the recovery of biodiversity in urban watersheds are in progress. Decision

support systems applied to water management in cities are being developed in connection with watershed studies. Also, research for improving decision support systems and development of new model concepts that link all water related processes in urban areas is in progress. Control of water demands in relation to water availability is a priority. Research for basic components of Decision Support Systems. Impacts of Global changes in urban areas is another problem in discussion at some metropolitan regions and mid-sized towns.<sup>89</sup>

### 5.2.2 Ecosystems Services in Urban Areas

The analysis of ecosystem services of urban freshwater ecosystems such as rivers, watersheds, artificial reservoirs, ponds, is in progress. The economic evaluation of these services started to be developed in the last five years. There is much concern of the urban water managers and populations about the use of urban rivers for recreation, and even sport fisheries. These services were lost during the growth of urbanization, pollution and eutrophication. The “green cities” concept is becoming more common as an action and project to restore the water cycle, aquifer protection and good air quality. In these two issues urban micro-catchments studies and ecosystem services, the participation of all stakeholders has been a primary concern for the implementation of a consistent project. This is becoming recognized in Brazil as a necessary and fundamental step in the water management initiatives in urban areas. Bottom up participating approaches are fundamental decision making processes, and this is being adopted in several cities due to the introduction of the Councils for Environment (Conselhos Municipais do Meio Ambiente) that analyze all projects of interest to the municipality related to environmental issues. Among the areas for cooperation Brazil-European Union, ecosystem services in urban regions are of great interest. The implementation of urban forest parks in several cities in Brazil offers several opportunities for studies on ecosystem services and management as well as their use for education tourism and environmental education in these parks. Protection of watersheds that supply water to urban populations is being implemented and it is a concern for urban water managers. In connection with this Payment For Environmental Services(PSA) is becoming a public

89. Gomes, P.V. 2017. La gestion integrada y participativa de las aguas em Brasil y España. Inisterio da agricultura. Governo da España, Madri. 314 pp.( Comparative integrated Management of Water Resources – Brazil- Spain)

policy initiative at several urban areas. .Protection of underground sources of water supply is in progress.<sup>90</sup>

### I. Micropollutants

The fate of contaminants is determined by the combination of several anthropogenic, biotic and abiotic variables and processes that influence the contaminant environmental behavior (source, transport, concentrations and transformation). The management of effects of contaminants is a challenging task. The processes, the high number of unknown variables are complex and difficult to monitor and understanding.

The acquisition of field data on contaminant concentrations combined with information on environmental health, is essential to evaluate mechanisms and the resulting impacts of micro-pollutants.

In Brazil there are initiatives in progress for monitoring, to detection and quantitative evaluation of micro-pollutants such as pharmaceutical products, personal care products, pesticides and herbicides. Some of these products are suspected endocrine disruptors. The effects of exposure of endocrine disruptors in humans are still unclear but research using animals and studies with wildlife populations suggest that there is cause for concern. Future developments in this area of research with intensive cooperation with another research laboratories and Research Institutes is very important. Further research on the environmental behavior and potential effects of environmental micro-pollutants in wildlife and humans is needed. The control of micro-pollutants concentrations in surface and underground waters in progress in some cities in Brazil still in the beginning needs expansion, improvement of technologies and further laboratory tests and evaluation. Toxicity effects on humans and wildlife should be developed.

Guidelines for the scientifically sound establishment of the fate of priority contaminant mixtures in Europe are available (European Commission, 2012). Effective technologies to remove micro-pollutants should be developed.<sup>91</sup>

90. Hirata, R., Foster, S. & Oliveira, F. 2015. Urban groundwater in Brazil: evaluation for sustainable management. Instituto de Geociências e FAPESP, São Paulo, vol. 1, 112 p. 1st ed.

91. Academia Brasileira de Ciências/Leopoldina Nationale Akademie das Wissenchaften. 2017. How do we want to live tomorrow? Perspectives on water management in urban regions. Science Policy Report. 24 pp.

## II. Research on Pathogens and Water Toxicity

Untreated wastewater is a source of contamination. These waters are potential sites for the development of viruses that cause hepatitis and diarrhea diseases. Other diseases related to the indirect water management common in Brazil are: Dengue, Yellow Fever, Zika and Chikungunya.

At present in Brazil, intensive research on virus includes the identification of virus that grow in freshwater that supply cities. Identification of sources of contamination of Rotavirus A, B, C, D, E, F, G causing gastroenteritis in child, distribution across various animal species and evaluation of epidemiological relevance of these virus is in progress. Norovirus causing gastroenteritis diseases in adults; Astrovirus causing 2% to 5% gastroenteritis in Brazil were identified.

The need to develop technologies to implement disinfectants to inactivate viruses in drinking water is an important issue. Also there is a need to develop effective control protocols for drinking water and to support research that promote the construction of sensors that rapidly detect and quantify infectious viruses in drinking water. Research on viruses is relevant for Brazil – European Union cooperation.<sup>92</sup>

### 5.2.5 Research on Cyanobacteria

Distribution of cyanobacteria and water quality, and eutrophication in Brazil is well known and it is a research activity promoted by several Universities and Research Institutes. The development of technologies to identify toxic substances of cyanobacteria species is well developed.

Studies relating toxic water with cyanobacteria and human health are also in progress. Some studies in Brazil connected the cyanobacteria water blooms with global changes (deterioration of water quality and increase of surface temperature in lakes and reservoirs).

### 5.2.6 Research on Pathogens, Inorganic Contaminants, Organic Contaminants, Water- borne disease outbreaks.

92. Confalonieri, U., Heller, I. & Azevedo, S. 2010. Agua e Saúde: aspectos globais e nacionais. Cap. 2. In: Bicudo, C.E.M., Tundisi, J.G. & Sheuenstuh, M.C.B. (orgs.). Instituto de Botânica, São Paulo. 224 pp. (Water and Health)

This is a research area in expansion in Brazil, and it is developed at Universities, research Institutes, with support of private funds for some projects. These two main areas: Virus research, cyanobacteria, toxicity and impacts on human health are in expansion in Brazil and should be special topics of International Cooperation, with European community.<sup>93</sup>

### 5.2.7 Research and Management Initiatives on Water Resources at Institutions, Agencies and Academies of Sciences

A description and analysis of current research and applications in Water Resources in Brazil with emphasis on Urban Waters follows with the highlights of the major initiatives at institutes and agencies of Ministries of the Federal Government. The activities of Academies of Science and international cooperation in Water Resources Management in urban areas are also presented.

#### 5.2.7.1 Ministry of Regional Development:

##### National Water Agency (Agencia Nacional de Aguas-ANA)

Created by a federal law: 9984/2000 the National Water Agency has the following mission:

- To regulate the use of water resources in rivers and lakes, under control of federal government, implement the National System of Water Resources, Management providing sustainability, preventing pollution and secure water of good quality for the present and future generations. The National Water Agency has several programs. The most important programs are:
- **Water Conjecture in Brazil.** This is a reference for the systematic follow up of the situation of water resources in Brazil throughout quantitative and qualitative indicators, statistical analysis and management. It is a structured source of data and information for the Brazilian society. It is a yearly report on the water situation in Brazil: sanitation, availability

93. Azevedo, S.M.E.O. 2005. South and Central America: toxic cyanobacteria. In: Codd, G.A., Azevedo, S.M.E.O., Bagchi, S.N., Burch, M.D., Carmichael, W.W., Harding, W.R., Kaya, K. & Utikilen, H.C. (eds). Cyanonet: a global network for cyanobacterial bloom and toxin risk management. Paris: UNESCO-IHP. pp.115-126.

of water, pollution, water quality, water allocation in each region, and management initiatives and progress. It describes water crisis in different watersheds, flooding, drought and potential for re-use of water. The main objective of this report is to relate the water situation yearly (quantity and quality) related to the ODS6, objectives of Sustainable Development of United Nations.

- Water Resources Plans
- **Water Allocation.** The National Water Agency has the task to allocate water for use in the watersheds of Brazil, and to control the yearly declaration of the use of water resources, industries, farms and public users.
- **Special Projects:**
- Strategic plan of water resources of the South Bank tributaries of the Amazon Basin.
- **Strategic Plan** of water resources for the watersheds of Tocantins and Araguaia rivers.

ANA is the agency responsible for the development of the National Policy of Water Resources and National System of Management of Water Resources, both created by the Water Law in 1997. (Law: 9433/97). ANA has established a networks of collaboration in water resources, that incorporates more than 50 partners in all states of Brazilian Federation and several agencies in the federal government. Since 2019 the management of water resources is integrated in the Regional Development Ministry, therefore it is a permanent strategic evaluation of water quantity and quality and availability of water in all territory of Brazil.

#### 5.2.7.2 Ministry of Science, Technology, Communications and Innovation.

**FINEP – PROSAB.** PROSAB is a research program on basic sanitation and technological program to be applied in urban regions connected with a Program Technologies of Housing (Habitare). PROSAB supports financially the

development of several technologies in water supply systems; wastewater and solid waste treatment.<sup>94</sup>

Objectives of Prosab: to support financially projects of good applicability, with low cost for operation and maintenance, to provide better quality of life of vulnerable areas in urban regions. PROSAB and Habitare are projects with emphasis in urban areas. PROSAB supports 51 projects in 94 research groups, with a network of several universities and research Institutes. Main projects focused in urban areas:

- Development of systems of water supply utilizing advanced technologies, such as filtering membranes, in order to reduce micropollutants and micro-contaminants;
- Technologies for tertiary treatment of sewage combined with removal and recover of nutrients;
- Technologies for management of rainfall water in urban areas;
- Technologies for flood control in urban areas, control of vectors, and management of solid wastes in urban watersheds;
- Development of technologies for control of water loss in water distribution pipelines in urban areas;
- Technological development of sludge treatment from wastewater plants;
- Development of low cost technologies to decentralizes wastewater treatment in urban areas;
- Development of technologies for use of biogas production from wastewater treatment plants, and sanitary landfills;
- Network of 11 Universities to develop processes of disinfection of sanitary effluents, removal of pathogens, and applications in agriculture and vegetable production in urban areas;

94. <http://www.finep.gov.br/apoio-e-financiamento-externa/historico-de-programa/prosab/produtos>

- Treatment of water for public supply by filtration in multiple steps.

### **National Institutes of Science and Technology-CNPq**

The National Institutes of Science and Technology are a component of MCTIC and CNPq. These Institutes are networks of Science and Technology in several areas of research and application. In the Water Resources area, the following institutes were created:

Center West Region of Brazil:

- **National Institute of Wetlands**

North Region:

- **National Institute of Renewable Energies and Energy Efficiency in the Amazon**
- **National Institute on Adaptation of Aquatic Biota in the Amazon**

Northeast Region:

- **National Institute on Tropical diseases**

South and Southeast Region:

- **National Institute on Aquatic Toxicology**
- **National Institute on Metropolitan areas**
- **National Institute on Irrigation Engineering**
- **National Institute on Climatic Change**
- **National Institute on Mineral Resources, Water and Biodiversity**
- **National Institute on Dengue Fever,**

The National Institutes on **Climatic Changes; Mineral Resources Water and**

**Biodiversity; Studies in Metropolitan Regions** are promoting research and technological applications in Urban areas. Description of main projects of these Institutes is included.

### **National Institute of Science and Technology in Mineral Resources, Water and the Biodiversity (INCT-ACQUA)<sup>95</sup>**

Mineral Resources, Water and Biodiversity are competitive advantages and should provide initiatives, focused on capacity building, innovation, scientific, economic and social development. The research activities of INCT-ACQUA, encompasses three major areas: a) Assessment of the impact of mining activities on the quality of water, soil, air and conservation of biodiversity; capacity building in these areas; b) Adding value and environmental performance to mineral based products and processes. The design of industrial processes with the aim of minimizing the consumption of natural resources and production of wastes; c) Assist stakeholders in shaping the future of mining territories.

The INCT-ACQUA has a consolidated network of 22 Brazilian and international components. The international network has institutions in Australia, Argentina, Canada, USA.

Science mining activities are near urban regions and may affect urban watersheds and water supply for urban populations. This INCT-ACQUA has an important mission in order to control, recover and develop new initiatives for mining operations that affect urban regions.

One of the main projects of INCT-ACQUA is the **territorial qualification**, a sustainable future for the mining regions grounded in participative and integrated management systems of the territory. This project, includes the study of the interface of iron ore mining with the territorial assets, environmental and cultural. Target territory is internationally known mineral province *Quadrilatero Ferrífero* and its towns and regional areas.

Capacity building at all levels is one of the tasks of INCT-ACQUA. This includes scientific and technological support to towns in the mining territories.

95. Ciminelli, V.S.T., Salum, M.J.G., Rubio, J. & Peres, A.E.C. 2015. Water and Mining (Água e mineração). In: Braga, B. Tundisi, J.G., Matsumura-Tundisi, M. & Ciminelli, V.D.T. (orgs.). *Aguas Doces no Brasil: capital ecológico, uso e conservação*. 4ª. Ed. Escrituras Editora, pp.425-455 (in Portuguese).(Freshwater Resources of Brazil)

## National Institute of Climatic Change

This initiative of interdisciplinary research in climatic changes, incorporates Brazilian research groups and international centers of research. The objective of this Institute are:

- To provide scenarios of climatic changes and the interference of human activities upon them.
- To study the impact of climatic changes globally and regionally.
- To identify vulnerability in Brazil: ecosystems and biodiversity, urban areas, coastal zones, economy.
- To develop technologies of mitigation and adaptation.
- **Two large scale projects for the development of technological applications are in progress:**
- Water resources in Paraíba do Sul watershed: integrating natural and anthropic processes.
- Rainfall: create and explore data bank to improve the evaluation of rainfall by satellite and validate the parameterization of microphysics of clouds.

The National Institute of Climatic Changes participates in the Belmont Forum – International Network for Climatic Changes.

## National Institute –Observatory of Metropolitan Areas

This is a network of institutions that observe and evaluate the urban policies on sanitation, urban mobility and housing. The core institution is the Federal University of Rio de Janeiro, in the Planning Urban and Regional Institute of this University. The network is established with several institutions in Brazil. Of high relevance is the Laboratory of Amazonian Cities. The project evaluates social studies in the metropolitan regions, related to infrastructure, services, urban equipment, public health. Water infrastructure, sanitation,

water distribution, wastewater treatment are objectives of the study.

Analysis and evaluation of housing policies, basic sanitation at different metropolitan areas of Brazil is performed. There are regional nuclei articulated in a national network.

## 5.2.7.3 MINISTRY OF AGRICULTURE OF BRAZIL

**EMBRAPA** (Empresa Brasileira de Pesquisa agropecuária)

EMBRAPA is in charge of research and applications in agriculture in Brazil and its research institutes are present in several regions and states.

EMBRAPA is a consolidated institute of research and applications in agriculture and has several contributions for the improvement of agricultural production in Brazil. It is responsible for the large scale development in production of crops, meat, fruits, with great quality. Throughout the efforts and strategic research of EMBRAPA, today approximately 30% of Brazil's export is due to agricultural products.

### Areas of research and application in water resources

Even considering that the main interest of EMBRAPA in water resources is related to food production, the research and application developed encompass rural areas and peri-urban regions. In general, the focus of EMBRAPA's water resources research and applications are: **Water quantity; Water quality; Sanitation; Public policy; Food production and Water availability.** In all the projects the strategic objectives of EMBRAPA are related to the ODS 6 of United Nations Sustainable Development: clean water and sanitation. Priorities: Water and Society, Water and Environment, Capacity Building; Increase water-use efficiency and ensure freshwater supplies.

### Main Projects developed by EMBRAPA

- Rational uses of water in farms.
- Use of rainfall water to supply rural schools.

- Use of water in agriculture: technical solutions (irrigation efficiency, water reuse projects) publications, books, manuals.
- Decodification of information about water to the society.

In addition, EMBRAPA developed social technologies to be applied in rural and peri-urban regions: Biodigestor Septic Tank and the Filtering Garden (artificial wetland) and special and simple systems for Water Chlorination. Several States of Brazil, private initiatives support the implementation of these technologies and their installation. They are in operation in 11 States of Brazil and in several Municipalities. Capacity building programs for training technical staff in the installation and maintenance of this equipment is carried out regularly in the Embrapa institutes in several states of Brazil.

### 5.3 Water Resources Research and Management: International Cooperation

#### 5.3.1 International Cooperation of Academies of Science

The Brazilian Academy of Science and the German Leopoldina-Nationale Akademie der Wissenschaften have an agreement to develop joint seminars with young PhDs from Brazil and Germany. The focus of the first two Seminars was urban regions: Water in Urban Regions – Building future knowledge to integrate land use, ecosystem services and human health.<sup>96</sup>

The Symposium provided a setting for inter-disciplinary exchange of 26 young scientists from Brazil and Germany. It took place within the framework of the Germany/ Brazil (2013/2014) campaign initiated by the German Federal Foreign Office. The discussion was centered on urban regions with regard to land use, human health, ecosystem services, monitoring, micropollutants and policy implementation. The main topics discussed in the two Seminars (2014 in São Carlos, Brazil and 2017 in Essen, Germany) were:

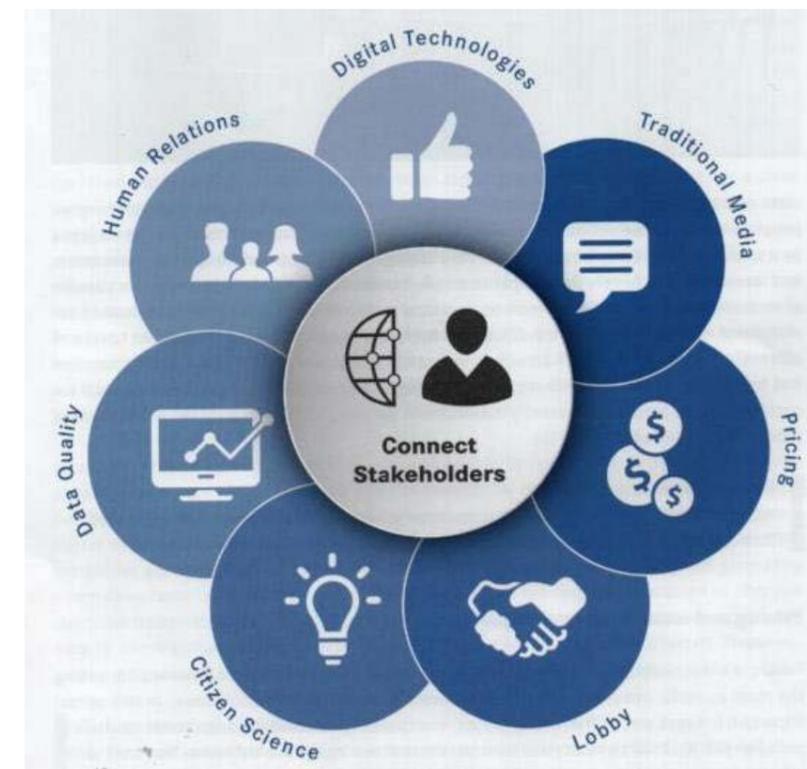
- a. Dynamic developments and spatial heterogeneity are specific characteristics that are shaping urban ecosystems.

<sup>96</sup> Academia Brasileira de Ciências/Leopoldina Nationale Akademie der Wissenschaften. .2014Water in Urban Regions: building future knowledge to integrate land use, ecosystem services and human health. Science Policy Report. 29pp ;

- b. Contextualized solutions for future water management require: spatially integrated concepts for the urban, peri-urban, rural continuum, multifunctional technologies.

Even considering the different location of urban areas, sustainable solutions require integrative trans-disciplinary approaches between and beyond natural sciences, social sciences and policy making. Information flows regarding land use, ecosystem services, and human health is fundamental.

Figure 1 shows the connection articulation and integration of different areas of interest in water resources in urban regions in the vision of this cooperation Brazil- Germany.



**Figure 11.** The vision of the Water Resources Management Program in the project Brazilian Academy of Sciences and Leopoldina Akademie Nationale. Akademie der Wissenschaften – Germany (Source: Water in Urban Regions. Science Policy Report 2017. BAS- Leopoldina Nationale Akademie).

### 5.3.2 Cooperation of the Academies of Science of the Americas.

The IANAS (Inter-American Network of Academies of Science) established Water Committees in every Academy of Science of North, Central and South America countries. These Water Committees have the task to develop strategic studies, evaluation of research, promote seminars and conferences and public policy reports, books and manuals in water resources management and research.<sup>97 98</sup>

In the last 5 years the focus of the Water Committees of IANAS has been urban waters. In Brasilia, in the Global Water Forum of 2018, a special conference of Urban Waters was promoted by IANAS and a synthesis report was published after the Conference. (see Annex).

In 2015 a book on Urban Waters in the Americas, was published by IANAS, with relevant contributions from all the South, Central and North America's countries. This book is an up to date synthesis of all the main issues of water research and management in urban areas of the Americas.

The main objectives of the Water Committees of IANAS is to bring evidence based Science to policy members and to build up scientific capacities in the American continents. The Water Committees of IANAS focus on key resources challenges and address the fundamental problems of urban water challenges.

The Water Committee in each Country/Academy of Science, promotes bridging of Science and policy stimulating a dialogue between science and policy members at regional level. It emphasizes effective communication skills among the specialized water community to convey scientific aspects to the nonscientific community. It highlights the need to provide reliable information for societies on public water problems and create accountable governance systems that engage the public on the planning and implementation of projects.

The following topics are key propositions for the urban priority projects of the water committee of IANAS:

97. IANAS. 2015. Urban Waters : Challenges in the Americas: a perspective from the Academies of Science. IAP, UNESCO. 620pp

98. Jimenez-Cisneros, B. & Tundisi, J.G. (eds). 2013. Diagnoses of Water in the Americas. IANAS, UNAM, Mexican academy of Sciences

Water resources in urban areas and the impacts of water from urbanization.

- The adequacy and accessibility of water supply services in urban areas
- The adequacy of waste water management in urban areas
- The importance of appropriate urban water service for community health.
- The potential impacts of climate change on water resources and water service for common health.
- The potential impact of climate change on water resources and water services in urban areas.

### 5.3.3 Recommendation

In a review sponsored by the IANAS (2015 ) the following recommendations for INTEGRATED URBAN WATER MANAGEMENT were:<sup>99</sup>

#### Goals and Targets

- Deliver safe water for humans, animal, commercial and industrial use.
- Improve conservation, avoid degradation of areas by erosion, treatment of sewage and storm water effluents, minimize solids in streams coming from urban settlements.
- Reduce vulnerability to disease and floods.

**The main actions to develop a sound strategy for an integrated urban water management are:**

- *Sustainable urban development. Development of new urban development standards taking into account the sustainability of water issues:*
- *Limits for densification and impervious areas.*
- *Reserve of areas for parks and flood management*

99. Spilk, F.R., Scheuentsul, M.C.B. & Tundisi, J.G. (orgs.) 2016. Enhancing Water Management Capacity in a Changing World: the challenge of increasing global access to water and sanitation. Univ. Feevale, Novo Hamburgo, RS, Brazilian Academy of Science, IANAS Water Committee, 691 pp.

- Restrictions and economic incentives for conservation of urban source basins.
- Protect the water supply sources. Regulate the occupation of the water supply basin; control of the load of water supply basin, improve its water quality.
- Improve the water supply distribution. Development of a program of investment in order to increase the water supply network, and improve the water supply quality.
- Develop a system of wastewater treatment. Investment in the collection and treatment systems in all urban areas.
- Flood control management. Develop regulations for new developments controlling the future flood increase.; develop flood management plan for each basin
- Total solids management: Develop sound services for total solids in order to decrease the amount of solids in the drainage system.
- Water and environmental conservation. Storm water pollution control, environmental recovery of selected areas.

In order to achieve these goals, the following steps should be taken;

- a. Assessment of urban water issues. Identification of problems.
- b. Plans and strategies. Development of the planning on water resources management integrated with the master plan for the town.
- c. Action Plan Implementing strategies for urban waters management in time, taking into account the economic and financial aspects of the investments.

Figure 2 shows the components of integrated urban water management that are the focus of IANAS Water Committees. The Water Committees of IANAS have developed also intensive training activities in capacity building in the Americas. Several capacity building programs were promoted in the countries of the South, Central and North America with a focus of integrating managers and scientists.

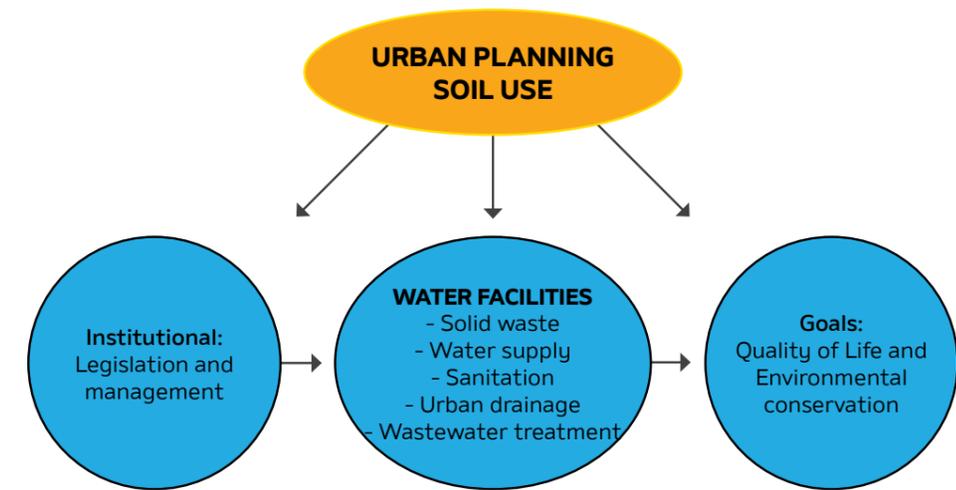


Fig 2. The focus of the IANAS Water Committees on Urban Waters (Adapted from Tucci 2010)<sup>100</sup>

#### 5.4 Cooperation FAPESP /DENMARK.

Recent program of international cooperation was launched: strategic research collaboration State São Paulo, Brazil and Denmark. Joint research collaboration under Scientific Cooperation Agreement between FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) and the Innovation Fund Denmark.

#### Research topics:

This call invites joint research and innovation proposals within the following topics:

- Industrial process water – aiming at zero-use;
- Handling and optimization of water supply, waste water;
- Circular economy;
- Digital Health, preventive care, Artificial Intelligence (AI) (Use of Big Data for Healthcare Management);

100. Tucci, C.E.M. 2010. Urbanização e Recursos Hídricos. pp 113-128. In: Bicudo, C.M., Tundisi, J.G., Scheuentsul, M.C.B. (orgs). Águas do Brasil: análises estratégicas. Acad. Bras. de Ciências, Inst. de Botânica, São Paulo, SP 222p. (Water in Urban Regions – A position paper)

- Smarter Cities;
- Renewable Energy;
- Precision Farming;
- FinTech (Financial Technology);
- Reduction of Emission, including agricultural emission.

FAPESP and the IFD expect to jointly fund maximum four projects with a total amount (sum of costs charged to FAPESP and the IFD) of around €2.500.000,00 (Two million and five hundred thousand Euros) for all projects.<sup>101</sup>

101. <https://innovationsfonden.dk/da/programmer/international-collaborations/call-proposals-strategic-research-collaboration-state-sao>

## 6. BRAZIL-EU SYNERGIES AND OPPORTUNITIES: POSSIBLE PATHWAYS AND CONCLUDING REMARKS

The sustainable, adequate and efficient use of water resources in urban regions is fundamental to provide the necessary quality of life for our future generations. Brazil and the European Union have many synergic initiatives to be implemented when considering the urban water management topic.

In order to provide adequate water services for the urban population, develop sustainable and long-term water infrastructures, and promote an integrated management of the water resources, it is necessary to foment and support cooperative projects within the whole knowledge value chain spanning from curiosity-driven research to technological and innovative solutions with direct impact on society. This is key to face the growing challenges associated to urban water security and balance the water availability/demand.

### Brazil-EU research and innovation needs on urban water management

In general, urban waters and its management are inextricably linked to processes related to **energy, food, the environment, health, and economy**, with a direct impact in the lives of the **citizens**. The strength of these links is related to the size of the urban areas, cultural backgrounds, economic development, and the environmental setup of the urban settlement. In the previous chapters it was provided an overview of the areas for collaborative efforts to be developed by researchers and innovators in Brazil and within the EU. In this section, it is important to raise particular issues linked to those areas, and topics where synergies should be established:

- Integrated watershed management *for urban areas: water security (provision of safe drinking water), wastewater treatment (protection of public health), and extreme events (prevention and protection against floods)*;

- Sustainable sanitation and rainwater management (*water resources playing an active role in urban planning, city master plans, and in the development and modernization of infrastructures*). *New technological solutions to manage rainwater in order to improve water availability. The use of Ecohydrological principles such as phyto technologies already applied within the European context should be mirrored in Brazil. Use of treated wastewater for fertilizers, production of algal biomass and metal recovery. Promote decentralized wastewater systems, creating opportunities for recycling wastewater and water reuse;*
- Micropollutants (*identification, characterization, and mitigation of the effects*). *Toxicological studies with key organisms as indicators, and its use for risk assessment;*
- Global Changes and Urban Regions (*urban areas as innovation hubs for water management and water availability*). *The implementation of urban forest parks (recharging aquifers and acting as buffer systems for flood and temperature control in urban areas);*
- Data and empowerment of citizens (*data availability and dissemination, promote participatory processes*). *Analyzing behaviors, raising awareness, develop water information policies, particularly focused on water security, water quality and water availability. Invest in the digitization of water information and its open access to population in general.*

## Recommendations and Concluding Remarks

In this chapter, a series of recommendations are made in order to i) leverage the funds attributed at a national level in Brazil or at a European level, ii) create the appropriate environment for collaborations to flourish between Brazil and the EU Member States, and iii) connect both scientific communities and enterprises. In general terms, these recommendations will serve the basis for investing in the development of scientific careers and create knowledge-based jobs for a knowledge-based economic growth. With a people-centered approach, several measures are listed in order to promote the establishment of new links between the scientific communities of both Brazil and the EU Member States, investing in the whole knowledge value-chain, including higher education, promoting mobility schemes and new partnerships and the integration of the communities in networks of reference. While the main

sphere of action related to this set of recommendations has the ultimate goal of empowering people and defragment knowledge, they provide the basis for the development of international cooperation between Brazil and the EU and to the alignment of national research and innovation systems.

## 1. Development of a database of projects and infrastructures

- Implement: Create a platform listing nationally funded research on urban water management and research infrastructures;
- Goal: develop a platform which can enable the twinning of ongoing research projects funded in Brazil and within the EU, and create new networks of researchers and innovators, sharing knowledge and resources;
- Methodology: to design and implement the database, contacts could be established with the Irish Environment Protection Agency (EPA), and analyses the feasibility of implementing a similar tool to DROPLET.<sup>102</sup>

## 2. Leverage nationally funded research

- Implement: Building on the database, coordinate efforts between national contact points within the EU and Brazil dealing with international cooperation in the environment pillar, and in particular water resources;
- Goal: Create linkages between researchers and innovators in Europe and Brazil. Channel national funds towards international cooperation, and avoid creating knowledge in isolated islands;
- Methodology: National Contact Points at the Ministerial and Funding Agency levels establish discussion forums and promote events targeting specific stakeholders depending on the sub-topics related to urban water management. These events will trigger the creation of networks of researchers funded at the national level. Specifically, for Brazil, it is important to create networks at the national level merging efforts and resources.

<sup>102</sup>. <http://erc.epa.ie/droplet/>

### 3. Scientific Diplomacy: EU Nationals in Brazil and Brazilian Nationals in Europe

- Implement: Build a database of foreign researchers and innovators affiliated to Brazilian institutions, and create the same type of database of Brazilian nationals in Europe;
- Goal: Create a global network of ambassadors of Brazil, highlighting the science developed in the country and the work developed abroad. Establish international networks composed by Brazilian nationals;
- Methodology: Contact Embassies, establish a Diaspora Council composed by Brazilian nationals working in Brazil and abroad, organize annual events under specific topics, including urban water management.

### 4. Participation levels of Brazil in the Research and Innovation European Framework Programme

- Implement: increase funding incentives to collaborative research. Build on successful P2P networks of H2020;
- Goal: increase the participation levels of researchers and institutions in the FP and in particular within the topics related to the environment, water resources, urban development and smart and carbon-neutral cities;
- Methodology: map research groups on urban water management, publications trends at the national level, use mapping exercises at the European level to develop synergies with Brazil (e.g. Water JPI mapping reports and Water JPI bibliometric analysis);

### 5. Brazil-EU collaborative projects involving city governing bodies

- Implement: Cities in Brazil as testbeds for infrastructure development and implementation. Implement a new science-policy interface in urban water management with active participation from the research communities and governing bodies;

- Goal: Involvement of city governing bodies and the general population in the design and implementation of research and innovation projects. Establish legal frameworks with specific targets on infrastructure development and management of water resources. Develop strategies for resource efficiency use in different cities;
- Methodology: Water planning projects in urban areas generally do not link the impact and demand of different sectors as agriculture, industry or water distribution for the population. Very often the challenges resulting from population growth, soil use, and the linked increase in the demand for housing, energy and transportation are not incorporated in the planning process. Integrated watershed management at town level includes all different sectors in water management decisions promoting a comprehensive water management strategy. The methodology to develop the actions described are a collection of experiences from different urban areas, from metropolitan to mid-sized and small towns.

### 6. Brazil-EU science communication activities

- *Implement: Build a national network of science communicators, raising particular awareness for water management;*
- *Goal: Raising population awareness for UN SDG6, and direct participation of Local and Regional Governing Bodies in the Research and Innovation process;*
- *Methodology: create mirror groups with science communication teams in Europe and Brazil. Build on the programme of raising awareness to scientific careers at schools.*

## 7. ANNEXES

### Brazil-EU Cooperation on UWM: a series of projects of reference

Project Title (Project Acronym)		
Smart integrated multitrophic city food production systems – a water and energy saving approach for global urbanization (CITY FOOD)		
Project Topic		
Feeding rapidly growing urban populations requires innovative solutions that ensure efficient water, energy, and nutrients management. CITYFOOD investigates quasi-closed loop integrated aqua-agriculture (IAAC) systems to address this global challenge.		
Project Start Date	Project End Date	Project ID and Programme
2018-04-01	2021-03-31	Project ID: 11205864
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/smart-integrated-multitrophic-city-food-production-systems-2013-a-water-and-energy-saving-approach-for-global-urbanisation">https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/smart-integrated-multitrophic-city-food-production-systems-2013-a-water-and-energy-saving-approach-for-global-urbanisation</a>		
Funding Scheme		
ERA-NET Cofund (FAPESP acts as Funding Agency)		
Project Partners from Brazil		
UNESP – UNIVERSIDADE ESTADUAL PAULISTA JULIO DE MESQUITA FILHO		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water bio-based solutions: urban biocycle economy;</li> </ul>		

Project Title (Project Acronym)		
Waste Food-Energy-Water Urban Living Lab - Mapping and Reducing Waste in the Food-Energy-Water Nexus (WASTE FEW FULL)		
Project Topic		
Mapping and reduction of waste in the food-energy-water nexus in cities across three continents: Europe, Africa and South America. Urban Living Labs (ULLs) of stakeholders. The project will contribute with policy decision support models for economically viable waste reduction, rethinking waste as a resource as well as establish entrepreneurship networks in each ULL to continue working after the formal end of the project.		
Project Start Date	Project End Date	Project ID and Programme
2018-01-01	2020-12-31	Project ID: 11328432
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/waste-food-energy-water-urban-living-lab-mapping-and-reducing-waste-in-the-food-energy-water-nexus">https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/waste-food-energy-water-urban-living-lab-mapping-and-reducing-waste-in-the-food-energy-water-nexus</a>		
Funding Scheme		
ERA-NET Cofund (FAPESP acts as Funding Agency)		
Project Partners from Brazil		
UNIVERSIDADE DE CAMPINAS – UNICAMP		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
Urbanizing in Place. Building the food water energy nexus from below (URBANISING IN PLACE)		
Project Topic		
Agroecological urbanism; Model of urbanization which places food, metabolic cycles and an ethics of land stewardship, equality and solidarity at its core; identify ways of structuring urbanization that value proximity, account for the reproduction of nutrients and soils, mobilize technologies and decommodified value chains in order to keep the control over resources localized.		
Project Start Date	Project End Date	Project ID and Programme
2018-03-01	2021-02-28	Project ID: 11326801
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/urbanising-in-place-building-the-food-water-energy-nexus-from-below">https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/urbanising-in-place-building-the-food-water-energy-nexus-from-below</a>		
Funding Scheme		
ERA-NET Cofund (FAPESP acts as Funding Agency)		
Project Partners from Brazil		
INSTITUTO DE URBANISMO E ESTUDOS PARA A METRÓPOLE - URBEM		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
Intelligent Urban Metabolic Systems for Green Cities of Tomorrow: an FWE Nexus-based Approach (METABOLIC)		
Project Topic		
Urban metabolism; identify critical factors and define critical pathways of FWE delivery to urban centers (via artificial intelligence, data mining, system dynamics modeling, agro-logistics and scenario analysis) to understand the intertwined nature of FWE in terms of lifecycles, including production, processing, delivery, consumption, and disposal. Rationale: FWE Nexus forms the basis of the urban metabolic system that sustains the development of urban centers.		
Project Start Date	Project End Date	Project ID and Programme
2018-02-01	2021-01-31	Project ID: 11299156
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/intelligent-urban-metabolic-systems-for-green-cities-of-tomorrow-an-fwe-nexus-based-approach">https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/intelligent-urban-metabolic-systems-for-green-cities-of-tomorrow-an-fwe-nexus-based-approach</a>		
Funding Scheme		
ERA-NET Cofund (FAPESP acts as Funding Agency)		
Project Partners from Brazil		
UNIVERSIDADE DE SÃO PAULO – ESALQ-LOG		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Urban big data: developing urban intelligence and water monitoring technologies;</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
Globally and Locally-sustainable food-water-energy innovation in Urban Living Labs (GLOCULL)		
Project Topic		
Develop an Urban Living Lab approach for innovations in the FWE nexus that are locally and globally sustainable. To support future implementation of this approach, guidelines and a participatory assessment tool kit will be developed through co-creation in seven Urban Living Labs based on an integrated assessment of local-global interactions in the FWE nexus and transdisciplinary action-research.		
Project Start Date	Project End Date	Project ID and Programme
2018-03-01	2021-02-28	Project ID: 11127096
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/globally-and-locally-sustainable-food-water-energy-innovation-in-urban-living-labs">https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/globally-and-locally-sustainable-food-water-energy-innovation-in-urban-living-labs</a>		
Funding Scheme		
ERA-NET Cofund (FAPESP acts as Funding Agency)		
Project Partners from Brazil		
FACULDADE DE SAÚDE PÚBLICA DA UNIVERSIDADE DE SÃO PAULO		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Urban big data: developing urban intelligence and water monitoring technologies.</li> </ul>		

Project Title (Project Acronym)		
Understanding Innovative Initiatives for Governing Food, Water and Energy Nexus in Cities (IFWEN)		
Project Topic		
Green and Blue Infrastructure (GBI); low cost, sustainable solutions; develop a framework and tools to assess changes in FWEN, their related trade-offs and the building of innovative capabilities in cities.		
Project Start Date	Project End Date	Project ID and Programme
2018-02-01	2021-01-31	Project ID: 11221480
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/understanding-innovative-initiatives-for-governing-food-water-and-energy-nexus-in-cities">https://www.era-learn.eu/network-information/networks/en-sugi/sugi-food-water-energy-nexus/understanding-innovative-initiatives-for-governing-food-water-and-energy-nexus-in-cities</a>		
Funding Scheme		
ERA-NET Cofund (FAPESP acts as Funding Agency)		
Project Partners from Brazil		
FUNDAÇÃO GETULIO VARGAS – ESCOLA DE ADMINISTRAÇÃO DE EMPRESAS DE SÃO PAULO (COORDINATOR)		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
Research-based Assessment of Integrated approaches to Nature-Based solutions (RAIN SOLUTIONS)		
Project Topic		
Close the demand and supply gap in terms of quantity and quality of water resources; develop an integrated framework of methodologies to manage nature-based solutions (NBS) for the restoration and rehabilitation of urban water resources systems		
Project Start Date	Project End Date	Project ID and Programme
N.A. (recently approved)	N.A.	Project ID: WaterJPI-JC-2018_11
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/waterworks2017/water-jpi-2018-joint-call-closing-the-water-cycle-gap/research-based-assessment-of-integrated-approaches-to-nature-based-solutions">https://www.era-learn.eu/network-information/networks/waterworks2017/water-jpi-2018-joint-call-closing-the-water-cycle-gap/research-based-assessment-of-integrated-approaches-to-nature-based-solutions</a>		
Funding Scheme		
ERA-NET Cofund (FAPESP acts as Funding Agency)		
Project Partners from Brazil		
UNIVERSIDADE TECNOLÓGICA FEDERAL DO PARANÁ (UTFPR)		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Urban forestry: addressing climate change and urban microclimates, finding education opportunities and new recreational values, managing biodiversity and extreme events.</li> </ul>		

Project Title (Project Acronym)		
Innovative Decentralized and low cost treatment systems for Optimal Urban wastewater Management (IDOUM)		
Project Topic		
Close the demand and supply gap in terms of quantity and quality of water resources; develop an integrated framework of methodologies to manage nature-based solutions (NBS) for the restoration and rehabilitation of urban water resources systems		
Project Start Date	Project End Date	Project ID and Programme
N.A. (recently approved)	N.A.	Project ID: WaterJPI-JC-2018_11
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/waterworks2017/water-jpi-2018-joint-call-closing-the-water-cycle-gap/research-based-assessment-of-integrated-approaches-to-nature-based-solutions">https://www.era-learn.eu/network-information/networks/waterworks2017/water-jpi-2018-joint-call-closing-the-water-cycle-gap/research-based-assessment-of-integrated-approaches-to-nature-based-solutions</a>		
Funding Scheme		
ERA-NET Cofund (FAPESP acts as Funding Agency)		
Project Partners from Brazil		
UNIVERSIDADE TECNOLÓGICA FEDERAL DO PARANÁ (UTFPR)		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Urban forestry: addressing climate change and urban microclimates, finding education opportunities and new recreational values, managing biodiversity and extreme events.</li> </ul>		

Project Title (Project Acronym)		
Digital-enabled green infrastructure for sustainable water resources management (DIGIRES)		
Project Topic		
Adapted technical infrastructure systems; Citizens participation; Regional/urban water resources management		
Project Start Date	Project End Date	Project ID and Programme
2019-01-01	2021-12-31	Project ID: ERANet17/ICT2-0196
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/eranet-lac/3rd-multi-thematic-joint-call-2017-2018/digital-enabled-green-infrastructure-for-sustainable-water-resources-management">https://www.era-learn.eu/network-information/networks/eranet-lac/3rd-multi-thematic-joint-call-2017-2018/digital-enabled-green-infrastructure-for-sustainable-water-resources-management</a>		
Funding Scheme		
ERA-NET (CNPQ acts as Funding Agency)		
Project Partners from Brazil		
UNIVERSIDADE FEDERAL DE PERNAMBUCO		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Urban regeneration and water management: closing the water cycle gap;</li> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
An ICT platform for sustainable energy ecosystem in smart Cities (ITCity)		
Project Topic		
Build an intelligent ICTplatform for smarter, inclusive and sustainable city needs, as energy components of ecosystem, to improve city services and quality of life by the means of high share of renewable energy sources (RES) and distribution energy resources (DER) integration and citizen involvement.		
Project Start Date	Project End Date	Project ID and Programme
2016-11-01	2019-11-01	Project ID: ELAC2015/T10-0643
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/eranet-lac/3rd-multi-thematic-joint-call-2017-2018/digital-enabled-green-infrastructure-for-sustainable-water-resources-management">https://www.era-learn.eu/network-information/networks/eranet-lac/3rd-multi-thematic-joint-call-2017-2018/digital-enabled-green-infrastructure-for-sustainable-water-resources-management</a>		
Funding Scheme		
ERA-NET (CNPQ acts as Funding Agency)		
Project Partners from Brazil		
UNIVERSIDADE FEDERAL DE PERNAMBUCO		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Urban big data: developing urban intelligence and water monitoring technologies;</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
Tools for Mapping Human Exposure to Risky Environmental Conditions by means of Ground and Earth Observation Data (EOXPOSURE)		
Project Topic		
Big Data; Monitoring Tools; Risk Exposure; Earth Observation		
Project Start Date	Project End Date	Project ID and Programme
2017-03-01	2021-02-28	Project ID: 734541 Programme: H2020-EU.1.3.3.
Project Information		
<a href="https://cordis.europa.eu/project/rcn/206771_en.html">https://cordis.europa.eu/project/rcn/206771_en.html</a>		
Funding Scheme		
MSCA-RISE - Marie Skłodowska-Curie Research and Innovation Staff Exchange (RISE)		
Project Partners from Brazil		
UNIVERSIDADE FEDERAL DE ALAGOAS		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>Urban big data: developing urban intelligence and water monitoring technologies;</li> </ul>		

Project Title (Project Acronym)		
Democratisation of Water and Sanitation Governance by means of Socio-Technical Innovation (DESAFIO)		
Project Topic		
Social Inequality in Water Access and Sanitation Services; Mapping and Strategic Development on Sustainable, Appropriate, and Innovative Socio-Technical Solutions; Economic and Social Development through Social Transformation; Access to Safe Water Supply and Sanitation in Urban, Peri-Urban, and Rural Areas of South America, with a particular emphasis on Brazil.		
Project Start Date	Project End Date	Project ID and Programme
2013-02-01	2015-07-31	Project ID: 320303 Programme: FP7-SSH
Project Information		
<a href="https://cordis.europa.eu/project/rcn/106722_en.html">https://cordis.europa.eu/project/rcn/106722_en.html</a>		
Funding Scheme		
CP-FP-SICA - Small/medium-scale focused research project for specific cooperation actions dedicated to international cooperation partner countries (SICA)		
Project Partners from Brazil		
UNIVERSIDADE FEDERAL DE MINAS GERAIS		
UNIVERSIDADE FEDERAL DE PERNAMBUCO		
UNIVERSIDADE FEDERAL DO RIO DE JANEIRO		
COMPANHIA DE AGUA E ESGOTO DE CEARA SEM CAGECE		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation(not exclusively)		
<ul style="list-style-type: none"> <li>Water bio-based solutions: urban biocycle economy;</li> <li>Public health and environment protection: urban wastewater treatment;</li> <li>Water environmental challenges: political and social awareness.</li> <li>Recovery of degraded urban ecosystems, urban rivers and wetlands</li> </ul>		

Project Title (Project Acronym)		
Role Of Biodiversity In Climate Change Mitigation (ROBIN)		
Project Topic		
Tropical Forests and Climate Change Mitigation; Ecosystem Services; Biodiversity and Socio-Ecological Processes; Big Data.		
Project Start Date	Project End Date	Project ID and Programme
2011-11-01	2015-10-31	Project ID: 283093 Programme: FP7-ENVIRONMENT
Project Information		
<a href="https://cordis.europa.eu/project/rcn/100815_en.html">https://cordis.europa.eu/project/rcn/100815_en.html</a>		
Funding Scheme		
CP-FP-SICA - Small/medium-scale focused research project for specific cooperation actions dedicated to international cooperation partner countries (SICA)		
Project Partners from Brazil		
EMBRAPA - EMPRESA BRASILEIRA DE PESQUISA AGROPECUARIA		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Urban forestry: addressing climate change and urban microclimates, finding education opportunities and new recreational values, managing biodiversity and extreme events;</li> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Water environmental challenges: political and social awareness.</li> <li>• Recovery of degraded urban ecosystems, urban rivers and wetlands.</li> </ul>		

Project Title (Project Acronym)		
Technologies for Water Recycling and Reuse in Latin American Context: Assessment, Decision Tools and Implementable Strategies under an Uncertain Future (COROADO)		
Project Topic		
Water Resources Management; Reuse and Recycling; Monitoring and Decision-Making Tools; Climate Change; Water Scarcity; Environment and Ecosystem Integrity.		
Project Start Date	Project End Date	Project ID and Programme
2011-10-01	2015-09-30	Project ID: 283025 Programme: FP7-ENVIRONMENT
Project Information		
<a href="http://www.coroado-project.eu/">http://www.coroado-project.eu/</a>		
Funding Scheme		
CP-FP-SICA - Small/medium-scale focused research project for specific cooperation actions dedicated to international cooperation partner countries (SICA)		
Project Partners from Brazil		
UNIVERSIDADE DE SÃO PAULO		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Urban regeneration and water management: closing the water cycle gap;</li> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Public health and environment protection: urban wastewater treatment;</li> <li>• Urban big data: developing urban intelligence and water monitoring technologies;</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
Comprehensive Modelling of the Earth System for better Climate Prediction and Projection (COMBINE)		
Project Topic		
Earth System Models (ESMs); Climate Projections; Climate and Climate Change Predictions; Social and Economic Impacts; Carbon and Nitrogen Cycle; Water Availability.		
Project Start Date	Project End Date	Project ID and Programme
2009-05-01	2013-03-31	Project ID: 226520 Programme: FP7-ENVIRONMENT
Project Information		
<a href="https://cordis.europa.eu/project/rcn/92901_en.html">https://cordis.europa.eu/project/rcn/92901_en.html</a>		
Funding Scheme		
CP-IP - Large-scale integrating project		
Project Partners from Brazil		
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Urban regeneration and water management: closing the water cycle gap;</li> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Public health and environment protection: urban wastewater treatment;</li> <li>• Urban big data: developing urban intelligence and water monitoring technologies;</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
Impact of Climate Change on the Transport, Fate and Risk Management of Viral Pathogens in Water (VIROCLIME)		
Project Topic		
Hydrological models; Effects of Climate Change on Viral Flux; Risk Associated with Viral Diseases; Management of Water-Related Diseases.		
Project Start Date	Project End Date	Project ID and Programme
01-01-2010	31-03-2013	Project ID: 243923 Programme: FP7-ENVIRONMENT
Project Information		
<a href="https://cordis.europa.eu/project/rcn/93522_en.html">https://cordis.europa.eu/project/rcn/93522_en.html</a>		
Funding Scheme		
CP-FP - Small or medium-scale focused research project		
Project Partners from Brazil		
FUNDAÇÃO OSVALDO CRUZ		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Urban big data: developing urban intelligence and water monitoring technologies;</li> <li>• Water environmental challenges: political and social awareness</li> </ul>		

Project Title (Project Acronym)		
Sustainable Water management Improves Tomorrow's Cities 'Health (SWITCH)		
Project Topic		
Innovation in Sustainable Urban Water Management; Integrated Urban Water Management; Sustainable Alternatives to Urban Water Management; Action-Orientated Research in Cities; Water Cycle: Water, Wastewater, Stormwater and Natural Systems.		
Project Start Date	Project End Date	Project ID and Programme
01-02-2006	30-04-2011	Project ID: 18530 Programme: FP6-SUSTDEV
Project Information		
<a href="https://cordis.europa.eu/project/rcn/79794_en.html">https://cordis.europa.eu/project/rcn/79794_en.html</a>		
Funding Scheme		
IP - Integrated Project		
Project Partners from Brazil		
UNIVERSIDADE FEDERAL DE MINAS GERAIS BELO HORIZONTE PREFEITURA		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Stormwater management: tackling urban environment pollution;</li> <li>• Urban regeneration and water management: closing the water cycle gap;</li> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Public health and environment protection: urban wastewater treatment;</li> <li>• Urban big data: developing urban intelligence and water monitoring technologies;</li> <li>• Water environmental challenges: political and social awareness.</li> <li>• Recovery of degraded urban ecosystems, urban rivers and wetlands.</li> </ul>		

Project Title (Project Acronym)		
Facilitating Negotiations over Land and Water Conflicts in Latin American Periurban Upstream Catchments : Combining Agent-Based Modelling with Role Game Playing (NEGOWAT)		
Project Topic		
Water Resources; Water Management; Water Availability; Periurban Areas; Urbanization; Water Services;		
Project Start Date	Project End Date	Project ID and Programme
01-01-2003	31-10-2006	Project ID: ICA4-CT-2002-10061 Programme: FP5-INCO 2
Project Information		
<a href="https://cordis.europa.eu/project/rcn/67268_en.html">https://cordis.europa.eu/project/rcn/67268_en.html</a>		
Funding Scheme		
CSC - Cost-sharing contracts		
Project Partners from Brazil		
UNIVERSIDADE DE SÃO PAULO INSTITUTO INTERNACIONAL DE ECOLOGIA INSTITUTO DE ESTUDOS, FORMAÇÃO E ASSESSORIA EM POLÍTICAS SOCIAIS FUNDAÇÃO ECONÓMICA DE CAMPINAS AGÊNCIA PAULISTA DE TECNOLOGIA DE AGRONEGÓCIOS		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Stormwater management: tackling urban environment pollution;</li> <li>• Urban regeneration and water management: closing the water cycle gap;</li> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Public health and environment protection: urban wastewater treatment;</li> <li>• Water environmental challenges: political and social awareness.</li> <li>• Recovery of degraded urban ecosystems, urban rivers and wetlands.</li> </ul>		

Project Title (Project Acronym)		
Telemonitoring and Advanced Telecontrol of High Yield Wastewater Treatment Plants (TELEMAC)		
Project Topic		
Remote Wastewater Treatment Management; Depollution Systems; Sensor Development and Advanced Control Systems; Database Management.		
Project Start Date	Project End Date	Project ID and Programme
01-09-2001	31-12-2004	Project ID: IST-2000-28156 Programme: FP5-IST
Project Information		
<a href="https://cordis.europa.eu/project/rcn/60435_en.html">https://cordis.europa.eu/project/rcn/60435_en.html</a>		
Funding Scheme		
CSC - Cost-sharing contracts		
Project Partners from Brazil		
ALLIED DOMEQ BRASIL INDUSTRIA E COMERCIO LIMITADA		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Public health and environment protection: urban wastewater treatment;</li> <li>• Urban big data: developing urban intelligence and water monitoring technologies;</li> </ul>		

Project Title (Project Acronym)		
Occurrence of Toxic Cyanobacteria Water blooms: impact on water environments and potential human health risk; environmental, physiological and genetic mechanisms involved in toxins production. (LINECYANO)		
Project Topic		
Water-Environment-Health Risks; Toxin Production; Water Pollutants; Water Blooms; Human Health		
Project Start Date	Project End Date	Project ID and Programme
01-11-1998	31-03-2002	Project ID: IC18980293 Programme: FP4-INCO
Project Information		
<a href="https://cordis.europa.eu/project/rcn/46440_en.html">https://cordis.europa.eu/project/rcn/46440_en.html</a>		
Funding Scheme		
CSC - Cost-sharing contracts		
Project Partners from Brazil		
FUNDAÇÃO BIO RIO		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• The food-energy-water nexus: water productivity and urban environmental services (capturing value from waste and nutrient recovery);</li> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Public health and environment protection: urban wastewater treatment;</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
Removal of Volatile Organic Contaminants from Ground and Waste Waters by Pervaporation		
Project Topic		
Water Pollutants; Ground Waters; Wastewater Management		
Project Start Date	Project End Date	Project ID and Programme
01-02-1993	31-01-1996	Project ID: CI1*920081 Programme: IC-ISC C
Project Information		
<a href="https://cordis.europa.eu/project/rcn/27903_en.html">https://cordis.europa.eu/project/rcn/27903_en.html</a>		
Funding Scheme		
CSC - Cost-sharing contracts		
Project Partners from Brazil		
UNIVERSIDADE FEDERAL DE RIO DE JANEIRO		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Public health and environment protection: urban wastewater treatment;</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

Project Title (Project Acronym)		
Nature Based Solutions for Sustainable and Resilient Water Management in the Anthropocene (NATWIP)		
Project Topic		
Closing the water cycle gap by exploring the potentials that Nature Based Solutions (NBS) offer to address water management challenges in landscape areas that have been neglected because they lie in the transition zones between the urban and the rural, hereby referred to as periurban areas. The main objective is to exchange learning experiences among the partnership and promote the debate between science and society in order to increase awareness among practitioners and users on the application of NBS to manage water scarcity, pollution, and risks related to extreme hydrological events.		
Project Start Date	Project End Date	Project ID and Programme
N.A.	N.A.	Project ID: WaterJPI-JC-2018_09
Project Information		
<a href="https://www.era-learn.eu/network-information/networks/waterworks2017/water-jpi-2018-joint-call-closing-the-water-cycle-gap/nature-based-solutions-for-sustainable-and-resilient-water-management-in-the-anthropocene">https://www.era-learn.eu/network-information/networks/waterworks2017/water-jpi-2018-joint-call-closing-the-water-cycle-gap/nature-based-solutions-for-sustainable-and-resilient-water-management-in-the-anthropocene</a>		
Funding Scheme		
ERA-NET Cofund		
Project Partners from Brazil		
CENTRO DE CIÊNCIAS DA CONSERVAÇÃO E SUSTENTABILIDADE DO RIO DA PONTIFÍCIA UNIVERSIDADE CATÓLICA DO RIO DE JANEIRO (PUC-Rio)		
Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)		
<ul style="list-style-type: none"> <li>• Urban forestry: addressing climate change and urban microclimates, finding education opportunities and new recreational values, managing biodiversity and extreme events;</li> <li>• Water bio-based solutions: urban biocycle economy;</li> <li>• Stormwater management: tackling urban environment pollution;</li> <li>• Urban regeneration and water management: closing the water cycle gap;</li> <li>• Public health and environment protection: urban wastewater treatment;</li> <li>• Water environmental challenges: political and social awareness.</li> </ul>		

### Project Title (Project Acronym)

Social Innovation in the Water Treatment Sector in the Amazon (AguaSociAL)

### Project Topic

AguaSociAL is a joint exchange programme aimed to strengthen research cooperation and knowledge sharing between Brazil and Europe within the water related sciences and social innovation, with focus on the Amazon Region. The project investigated and supported community-driven development techniques and technologies for improving access to Water. Its multidisciplinary approach embraced a wide range of issues among which: environmental protection, socio-economic factors and sustainable development, with a specific emphasis on water treatment and social innovations by local communities (especially vulnerable ones), energy-water-food nexus, among others. The research was target to identify existing and potential water treatment, reuse, recycling and sanitation technologies that are socially accepted and community owned, thus linking scientific and traditional local knowledge, while supporting a co-learning process towards sustainable development.

### Project Start Date

### Project End Date

### Project ID and Programme

01/12/2013

30/11/2017

Project ID: IRSES 612633

### Project Information

<https://cordis.europa.eu/project/id/612633>

### Funding Scheme

FP7 IRSES

### Project Partners from Brazil

UNIVERSITA DEGLI STUDI ROMA TRE

LEEDS BECKETT UNIVERSITY

UNIVERSIDAD AUTONOMA DE BARCELONA

UNIVERSIDADE FEDERAL DO PARÁ

UNIVERSIDADE ESTADUAL DO AMAZONAS

BRAZILIAN NATIONAL INSTITUTE ON THE AMAZON

### Link to Research and Innovation Topics outlined for Urban Water Management EU-Brazil Cooperation (not exclusively)

- Urban waters
- Sanitation
- Social Technologies
- Water bio-based solutions
- Urban regeneration and water management
- Public health and environment protection: urban wastewater treatment;
- Water environmental challenges: political and social awareness.

## 8. BIBLIOMETRIC ANALYSIS

The maps presented in this section were developed to illustrate the current status of Water RDI in Europe in terms of: i) raw data about scientific publications and patents (Figures XX and XX); ii) publications and patents normalised by GDP (Figures XX and XX); iii) publications and patents normalised by population (Figures XX and XX), and iv) increasing rate of publications and patents in Europe, from 1999 to 2015 (Figures XX and XX). This mapping exercise corresponds to the contribution of the Water JPI to this report, justifying the adoption of a thematic distribution consistent with an overall framework including all water-related issues, and the five Water JPI priorities of the Strategic Research and Innovation Agenda, namely:

1. Improving Ecosystem Sustainability and Human Well-being;
2. Developing Safe Water Systems for Citizens;
3. Promoting Competitiveness in the Water Industry;
4. Implementing a Water-wise Bio-based Economy;
5. Closing the Water Cycle Gap - Improving sustainable water resource management.

The intensity of Water RDI between European countries can be better understood using the normalised maps (Figures XX and XX for publications, and Figures XX and XX for patents), where the population and economic strength is taken into account. Normalised maps provide a more comparable classification of Water RDI in Europe, and also enable comparison with countries outside Europe. Countries also show different intensity on Water Research and Innovation in each SRIA theme. These maps also allow the visualisation of the present asymmetries between research and innovation among European countries and the existing gaps between scientific production and the application of the knowledge generated.

## Methodology

Each map exhibits a colour, the same in all the figures associated to a specific objective (publications, patents, normalised or non-normalised), with five different shades or classes. The darkest shade corresponds to the highest level on the ranking, which corresponds to the highest level of scientific publications and patents.

The ranking of European countries in terms of Water RDI differs depending on the used data set (raw or normalised). In general, countries with high economic capacity are expected to have a high intensity (dark colour) on Water RDI. This point of view can be checked in Figures XX and XX with raw data on publications and patents, respectively. Overall, and to clarify the terminology used in this section, the number of publications is related to Water Research and the number of patents to Water Innovation.

The number of publications and patents compiled per country were normalized per population and per Gross Domestic Product, so as to produce comparable indicators between countries of different sizes from the points of view of population and economic strength. For this purpose, we collected the ISO Codes as the standard country identifier, the Gross Domestic Product, and the Population.

### Methodology for the normalisation of data

The ISO 3166-1 alpha-2 – two-letter country official codes were used in all the tables, following the specifications of the Official Journal of the European Communities. These codes are the most prominently used for the Internet's country code top-level domains (with a few exceptions, such as GB, whose domain is UK). The European Commission generally uses ISO 3166-1 alpha-2 codes with two exceptions: EL (not GR) is used to represent Greece, and UK (not GB) is used to represent the United Kingdom.

The source data for the Gross Domestic Product was the GDP Nominal List by the United Nations (2015) ([http://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_GDP\\_%28nominal%29](http://en.wikipedia.org/wiki/List_of_countries_by_GDP_%28nominal%29)). Currency was calculated as 1.00 USD = 0.813 EUR (June 2015).

Population (data available on [http://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_population](http://en.wikipedia.org/wiki/List_of_countries_by_population)) is based on the most up to date estimate or projections] by the national census authority where available, and are usually rounded off.

**Table XX.** European countries with standard codes<sup>1</sup>, GDP and population data. MS: Member State; AC: Associated country.

ISO code	Country	Type	GDP (10 <sup>3</sup> M USD)	GDP (10 <sup>3</sup> M EUR)	Populations (M Inhabitants)
AL	Albania	AC	13,00	10,569	2,88
AM	Armenia	AC	11,00	8,943	2,92
AT	Austria	MS	391,00	317,883	8,77
BE	Belgium	MS	468,00	380,484	11,4
BA	Bosnia and Herzegovina	AC	18,00	14,634	3,53
BG	Bulgaria	MS	57,00	46,341	7,1
HR	Croatia	MS	57,00	46,341	4,15
CY	Cyprus	MS	23,00	18,699	0,85
CZ	Czech Republic	MS	205,00	166,665	10,58
DK	Denmark	MS	346,00	281,298	5,75
EE	Estonia	MS	26,00	21,138	1,31
FO	Faroe Islands	AC	2,60	2,1138	0,5
FI	Finland	MS	272,00	221,136	5,5
FR	France	MS	2465,00	2004,045	67,02
GE	Georgia	AC	16,00	13,008	3,91
DE	Germany	MS	3478,00	2827,614	82,8
GR	Greece	MS	236,00	191,868	10,76
HU	Hungary	MS	138,00	112,194	9,8
IS	Iceland	AC	17,00	13,821	0,33
IE	Ireland	MS	251,00	204,063	4,77
IL	Israel	AC	306,00	248,778	8,77
IT	Italy	MS	1859,00	1511,367	60,59
LV	Latvia	MS	31,00	25,203	1,95

LT	Lithuania	MS	48,00	39,024	2,85
LU	Luxembourg	MS	65,00	52,845	0,59
MK	Macedonia	MS	11,00	8,943	2,07
MT	Malta	MS	10,00	8,13	0,44
MD	Moldova	AC	7,90	6,4227	3
ME	Montenegro	AC	4,60	3,7398	0,68
NL	Netherlands	MS	777,00	631,701	17,08
NO	Norway	AC	371,00	301,623	5,27
PL	Poland	MS	471,00	382,923	37,97
PT	Portugal	MS	230,00	186,99	10,31
RO	Romania	MS	199,00	161,787	19,64
RS	Serbia	AC	44,00	35,772	7,06
SK	Slovakia	MS	100,00	81,3	5,44
SI	Slovenia	MS	49,00	39,837	2,07
ES	Spain	MS	1237,00	1005,681	46,53
SE	Sweden	MS	514,00	417,882	10
CH	Switzerland	AC	669,00	543,897	8,4
TN	Tunisia	AC	47,00	38,211	10,99
TR	Turkey	AC	864,00	702,432	79,81
UA	Ukraine	AC	132,00	107,316	42,54
GB	United Kingdom	MS	2648,00	2152,824	65,65

## Methodology for patent and publication analysis

Espacenet has changed its interface since the patent analysis made in June 2014. The site has merged several databases. The database is now called "The worldwide patent database collection of published applications from 100 countries". Historically, the site gave the choice to do a patent search in English on two main patent bases: WIPO (database resulting from the WIPO Office for PCT applications publications) and EP (database resulting from the European Patent Office EPO, for European patent application publications). Today, the database is wider. These bases are grouped in the full-text database. However, it is possible to perform a search only on PCT publications (search on WO publications). Patents were obtained in March 2018 from the PATBASE (FUIIPAT) database of QUESTEL. Data were extracted automatically per year and per Assignee country from the excel file downloaded. The query string used in the *Web of Science* was adapted for QUESTEL. Research on publications published between 1999 and 2013 and 2014-2017, the results were grouping in selecting the option the basis of FAMPAT.

Question				
Q1	Maintaining Ecosystem Sustainability	water AND (ecosystem OR ecohydrology OR (ecological engineering) OR flood OR drought OR (early warning) OR (ecosystem service))	((water)/ti/ab/iw and (ecosystem or ecohydrology or (ecological engineering) or flood or drought or (early warning) or (ecosystem service))/ti/ab/iw ) and (wo)/pn and pd=2014-01-01:2017-12-31	123
Q2	Developing safe water systems for the citizens	water AND (urban OR (emerging pollutants) OR flood OR (drinking water) OR (water treatment) OR (water distribution) OR (water storage))	((water)/ti/ab/iw and (urban or (emerging pollutants) or flood or (drinking water) or (water treatment) or (water distribution) or (water storage))/ti/ab/iw ) and (wo)/pn and pd=2014-01-01:2017-12-31	1844
Q3	Promoting competitiveness in the water industry	water AND (industry OR distribution OR measurement OR telemetry OR (remote control) OR reuse OR desalination OR sewage OR sludge OR (economic instrument) OR governance OR regulatory )	((water)/ti/ab/iw and (industry or distribution or measurement or telemetry or (remote control) or reuse or desalination or sewage or sludge or (economic instrument) or governance or regulatory)/ti/ab/iw ) and (wo)/pn and pd=2014-01-01:2017-12-31	2916
Q4	Implementing a water-wise bio-based economy	water AND (bio-based OR bio-economy OR bioeconomy OR agriculture OR (irrigation SAUF clinical) OR forestry OR (non-point AND pollution))	((water)/ti/ab/iw and (bio-based or bio-economy or bioeconomy or agriculture or (irrigation sauf clinical) or forestry or (non-point and pollution))/ti/ab/iw ) and (wo)/pn and pd=2014-01-01:2017-12-31	113
Q5		Water AND (water supply) OR (water demand) OR (water deficit) OR transboundary OR sustainable OR (hydrolog+ AND model+) OR (managed aquifer recharge) OR (soil_aquifer treatment) OR (socio+ AND econom+) OR (decision support system)	((water)/ti/ab/iw and ((water supply) or (water demand) or (water deficit) or transboundary or sustainable or (hydrolog+ and model+) or (managed aquifer recharge) or (soil_aquifer treatment) or (socio+ and econom+) or (decision support system))/ti/ab/iw ) and (wo)/pn and pd=2014-01-01:2017-12-31	1225
Q6		hydrology OR (Water AND agriculture) OR (irrigation NOT clinical) OR (river AND basin) OR watershed OR flood OR drought OR ((urban OR municipal OR residential OR industrial) and water)	((hydrology or (water and agriculture) or (irrigation not clinical) or (river and basin) or watershed or flood or drought or ((urban or municipal or residential or treatment) and water) or ((industry or industrial) and water))/ti/ab/iw and (wo)/pn and pd=2014-01-01:2017-12-31	5254

Figure X –

Figure 35. Intensity of publications in Europe (Member States and Associated Countries), from 1999 to 2015, based on raw data, for the five Water JPI SRIA priorities (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap) and Q6- All Water issues.

Figure 36. Intensity of publications in Europe (Member States and Associated Countries) normalised by GDP, from 1999 to 2015, for the five Water JPI SRIA priorities (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap) and Q6- All Water issues.

Figure 37. Intensity of publications in Europe (Member States and Associated Countries) normalised by population, from 1999 to 2015, for the five Water JPI SRIA priorities (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap) and Q6- All Water issues.

Figure 38. Intensity of patents in Europe (Member States and Associated Countries), from 1999 to 2015, based on raw data, for the five Water JPI SRIA priorities (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap) and Q6- All Water issues.

Figure 39. Intensity of patents in Europe (Member States and Associated Countries) normalised by GDP, from 1999 to 2015, for the five Water JPI SRIA priorities (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap) and Q6- All Water issues.

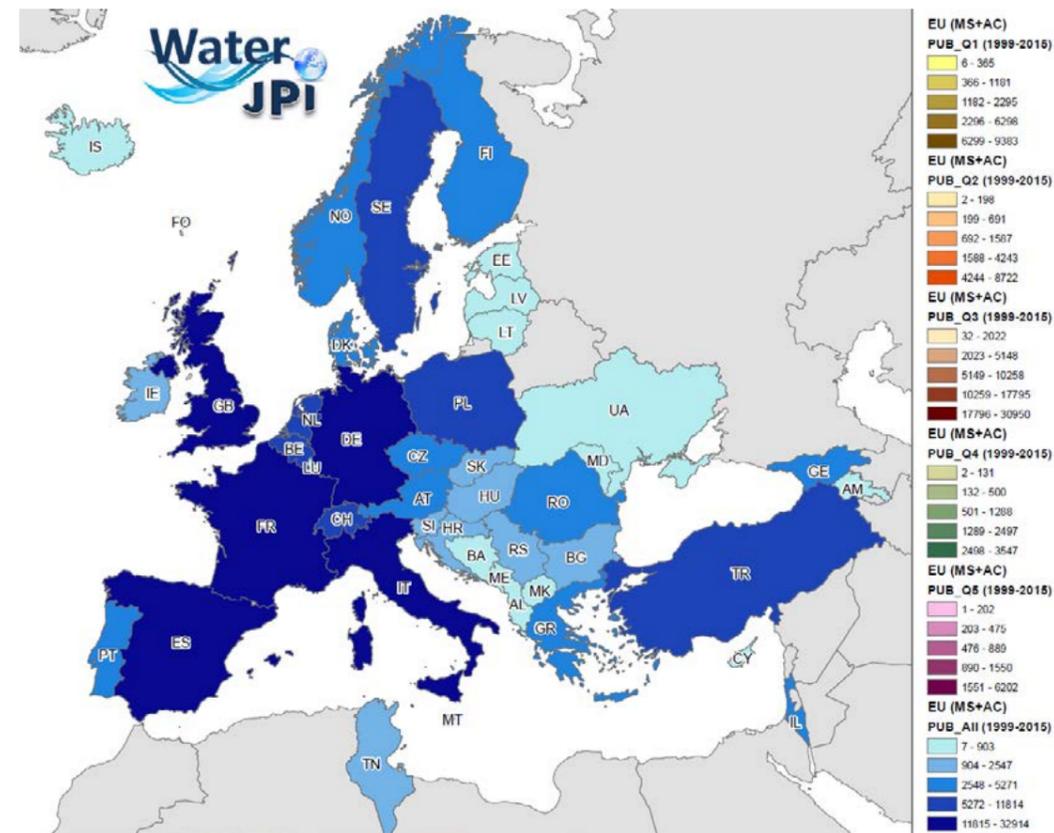
Figure 40. Intensity of patents in Europe (Member States and Associated Countries) normalised by population, from 1999 to 2015, for the five Water JPI SRIA priorities (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap) and Q6- All Water issues.

Figure 41. Increasing rate of publications in Europe, from 1999 to 2015, on Water SRIA themes (Q1- Sustainable Ecosystems, Q2- Safe Water for

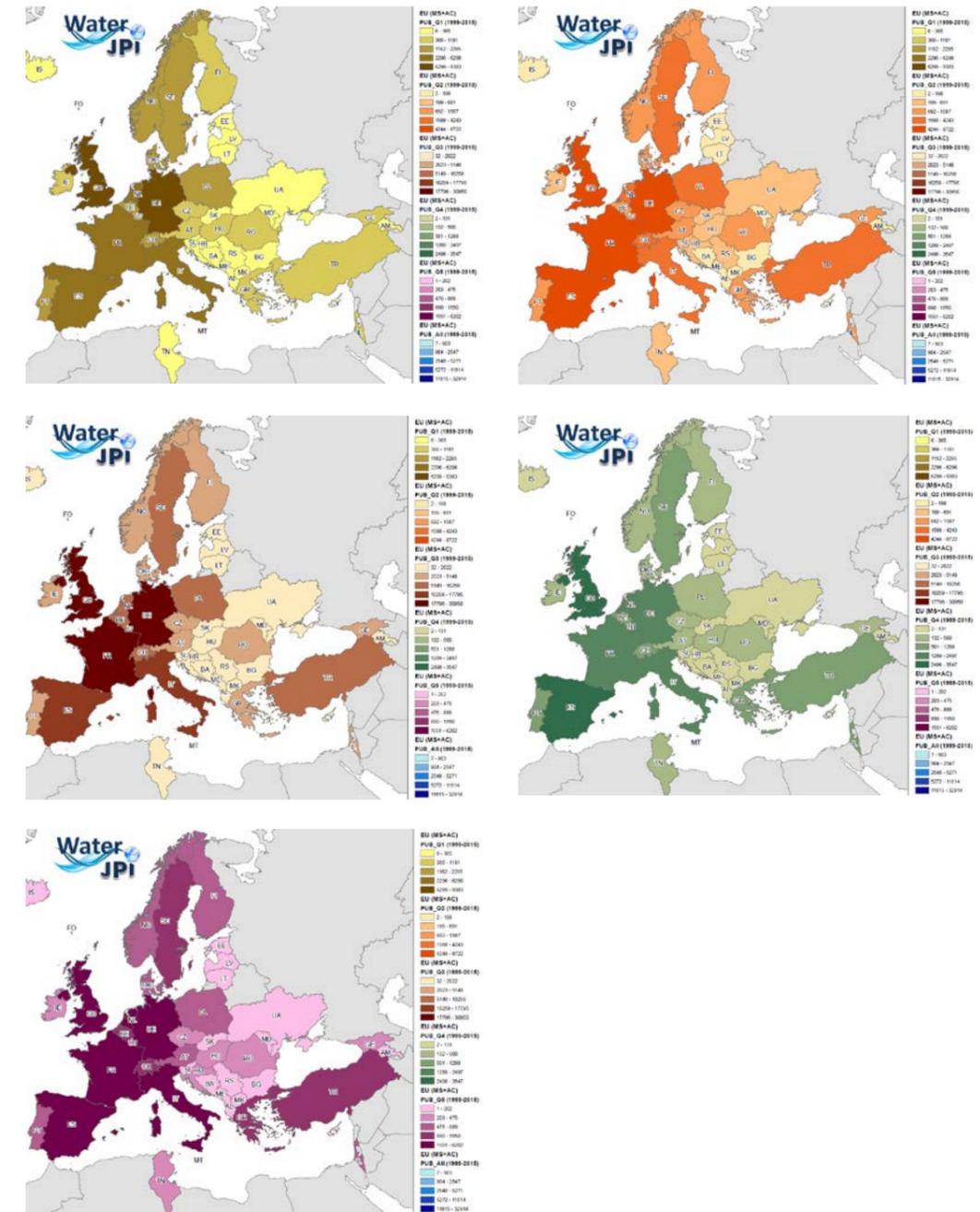
Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap) and Q6- All Water issues.

Figure 42. Number of patents per 1,000 publications in Europe, for the period 1999-2015, on Water SRIA themes (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap) and Q6- All Water issues.

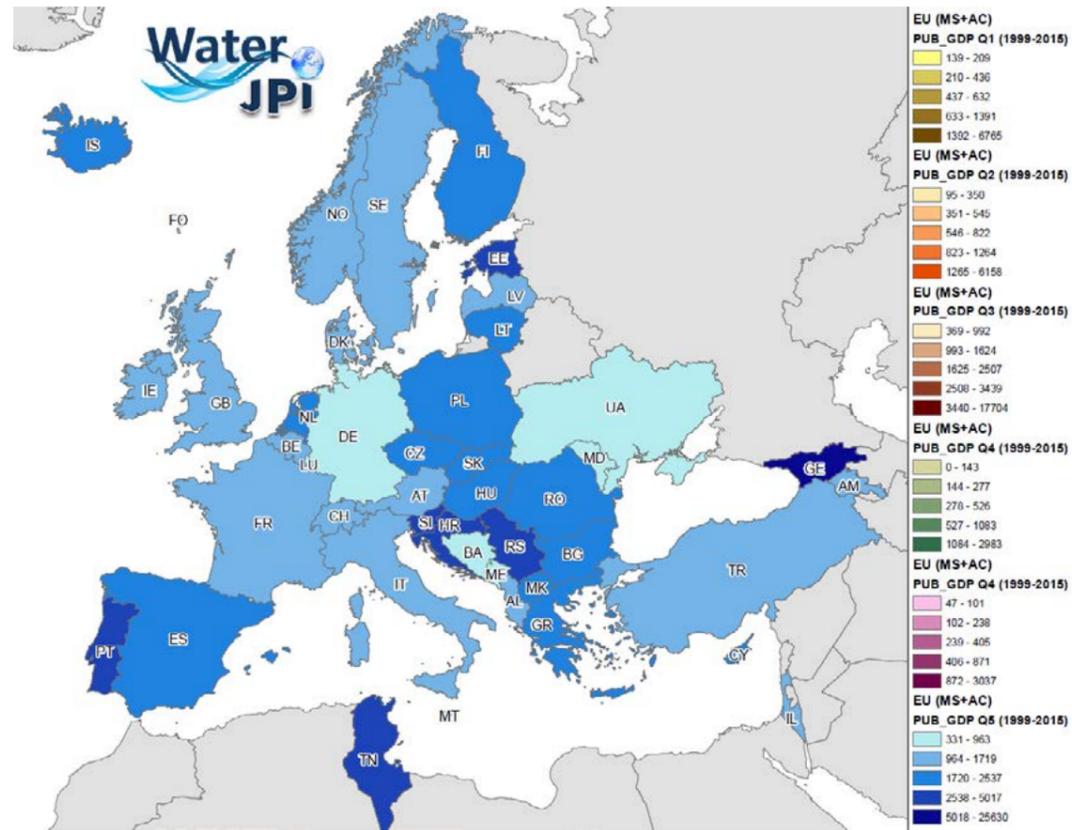
### Mapping on Water RDI in Europe: Publications



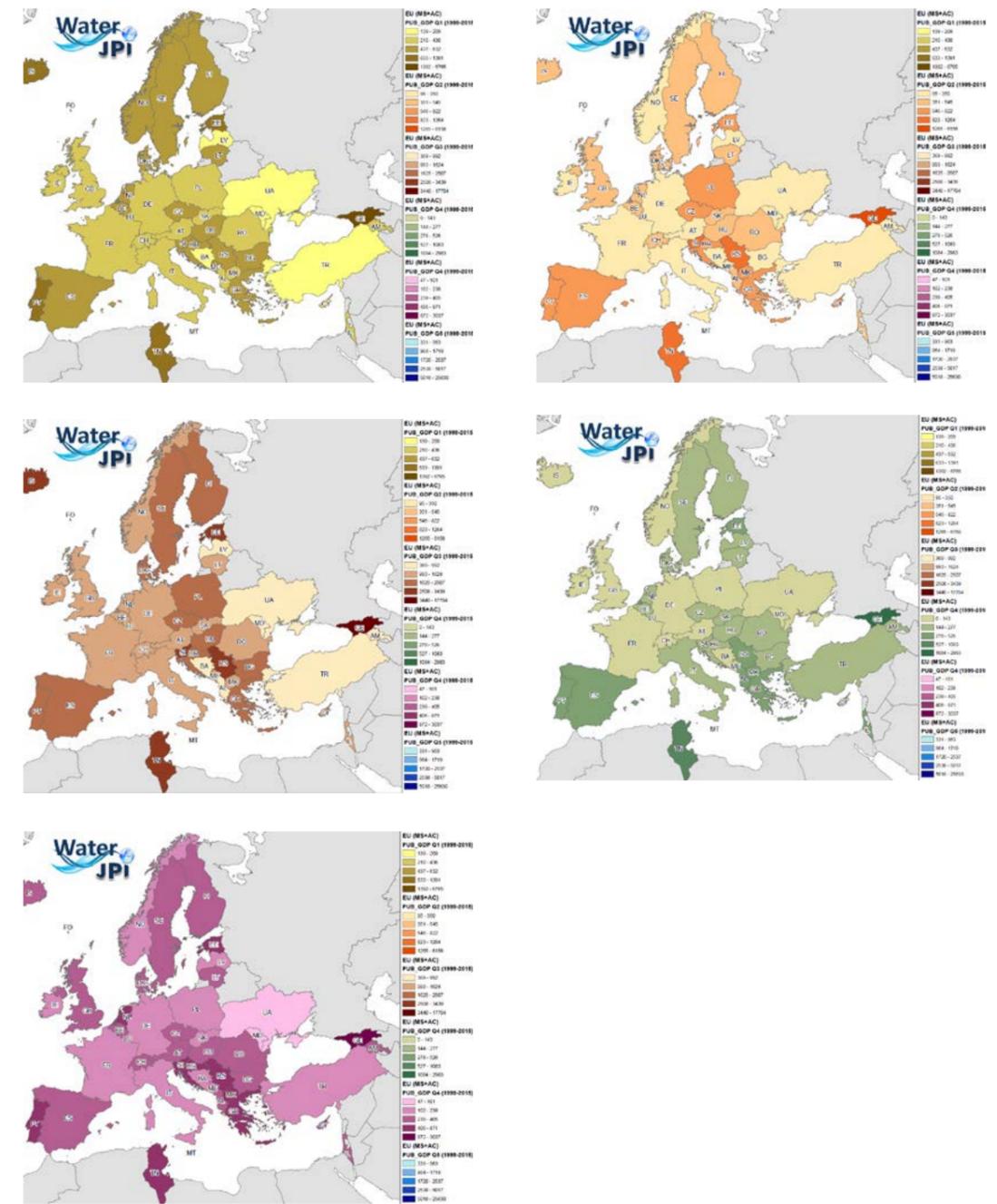
**Figure XX.** Intensity of publications in Europe (Member States and Associated Countries), from 1999 to 2015, based on raw data, for all Water issues (PUB\_All 1999-2015).



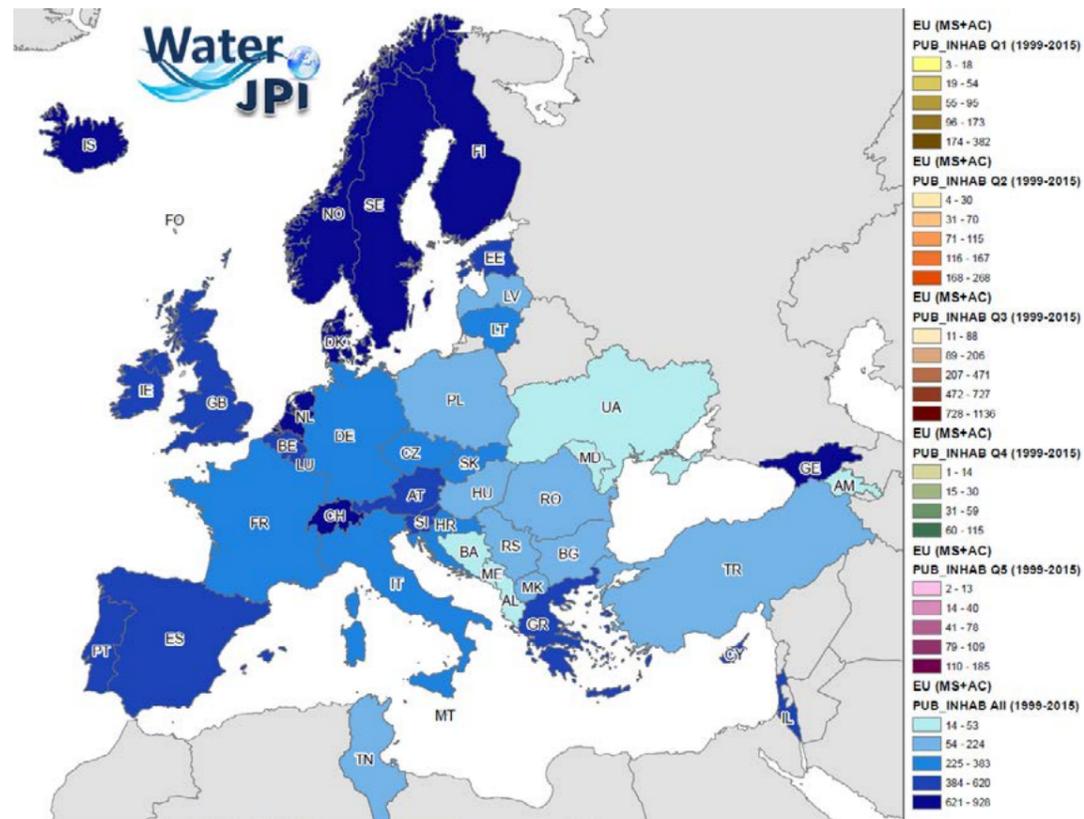
**Figure XX.** Intensity of publications in Europe (Member States and Associated Countries), from 1999 to 2015, based on raw data, for the five Water JPI SRIA priorities, from top to bottom and left to right (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap).



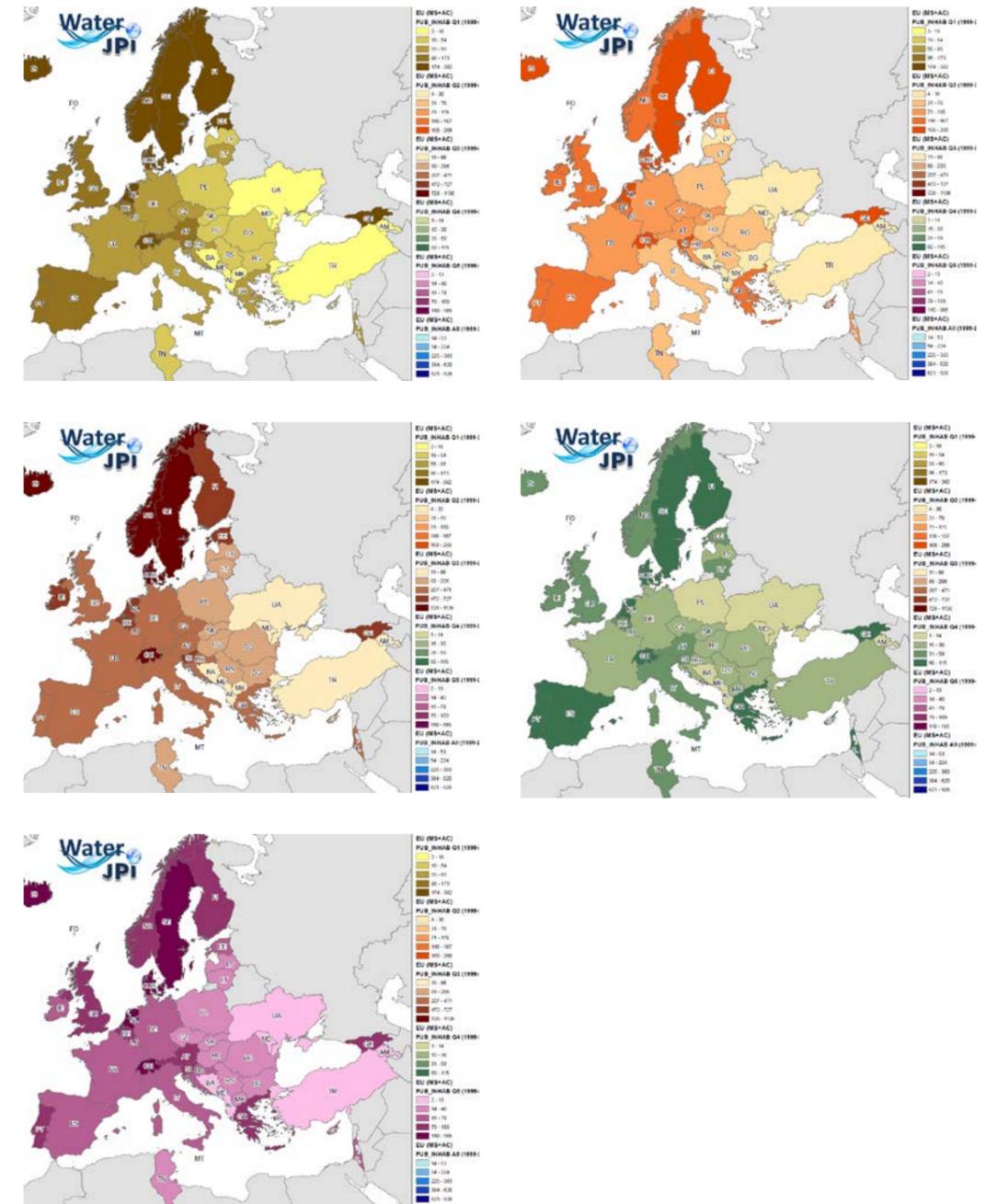
**Figure XX.** Intensity of publications in Europe (Member States and Associated Countries) normalised by GDP, from 1999 to 2015, for all Water issues (PUB\_All 1999-2015).



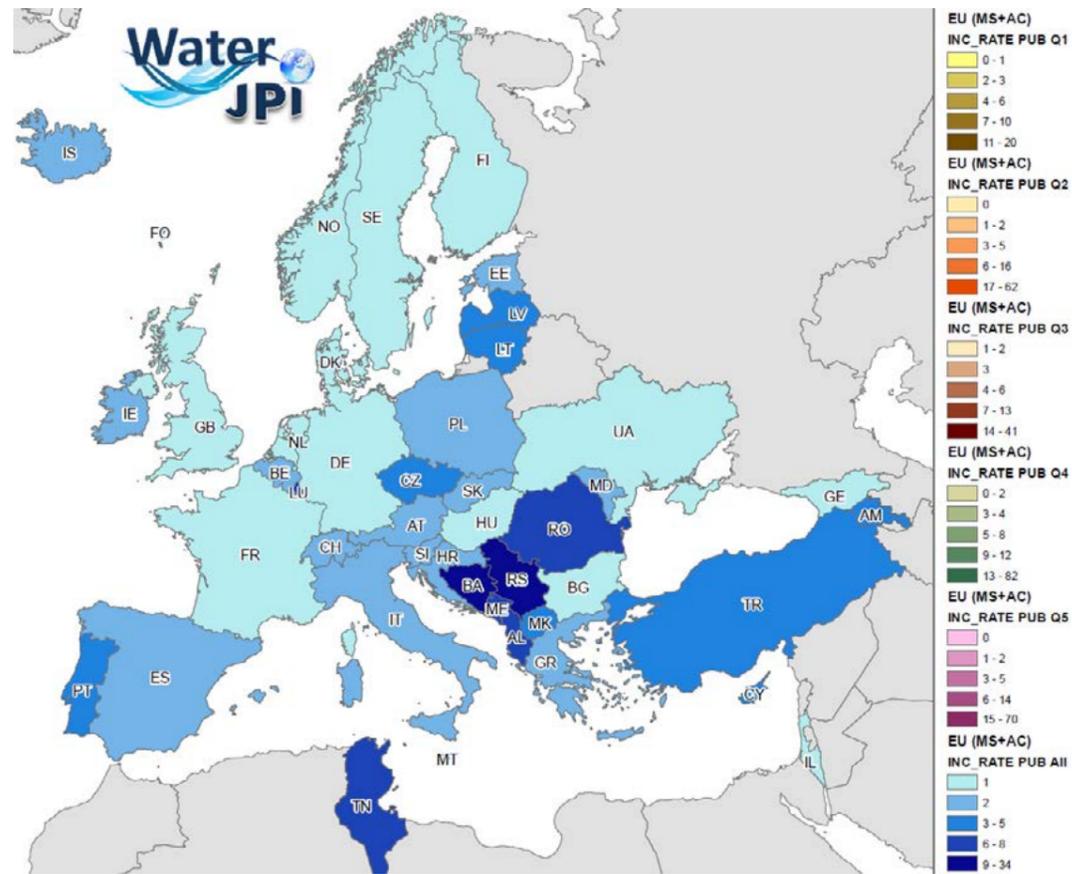
**Figure XX.** Intensity of publications in Europe (Member States and Associated Countries) normalised by GDP, from 1999 to 2015, for the five Water JPI SRIA priorities from top to bottom and from left to right (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap).



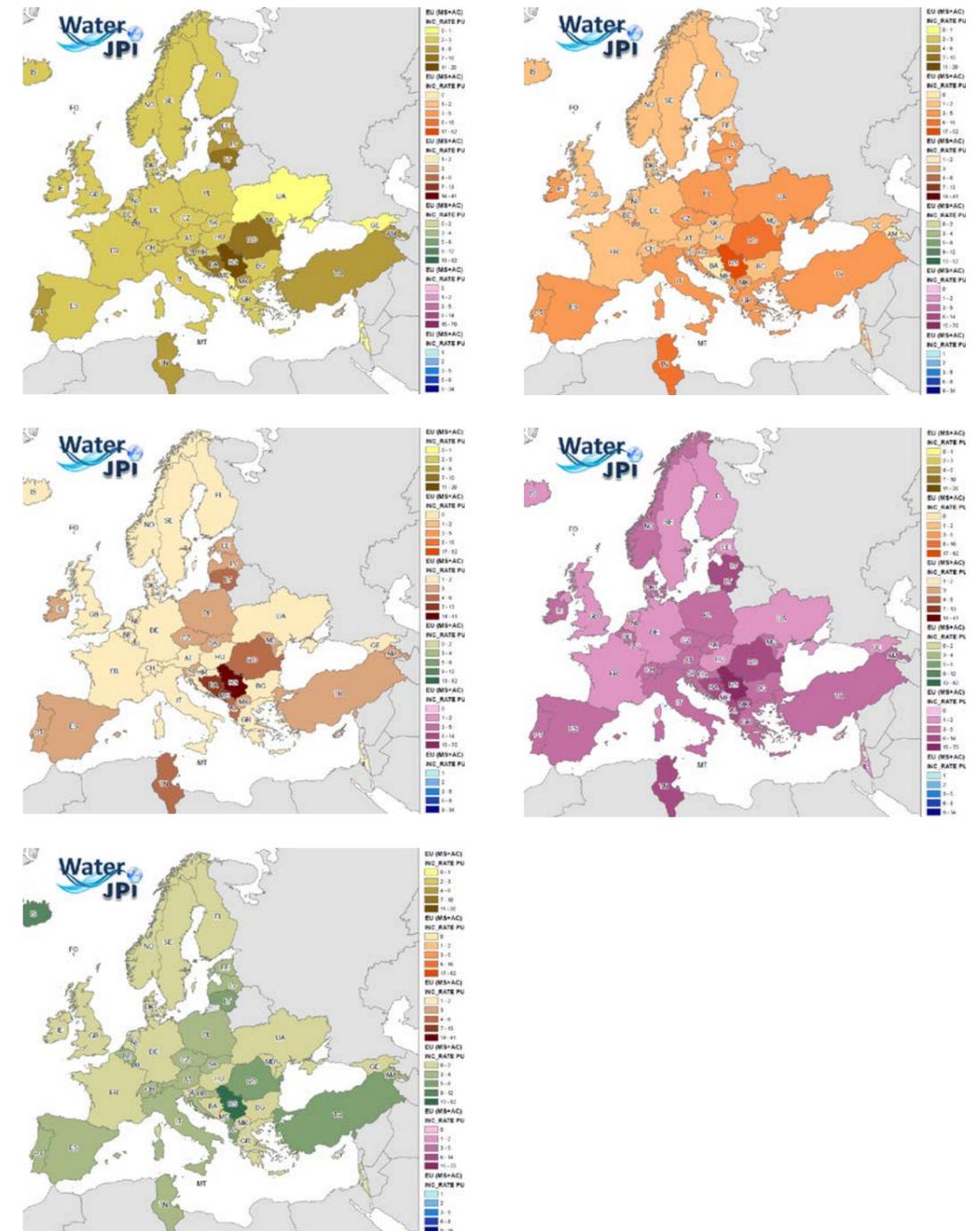
**Figure XX.** Intensity of publications in Europe (Member States and Associated Countries) normalised by population, from 1999 to 2015, for all Water issues (PUB\_All 1999-2015).



**Figure XX.** Intensity of publications in Europe (Member States and Associated Countries) normalised by population, from 1999 to 2015, for the five Water JPI SRIA priorities from top to bottom and from left to right (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap).

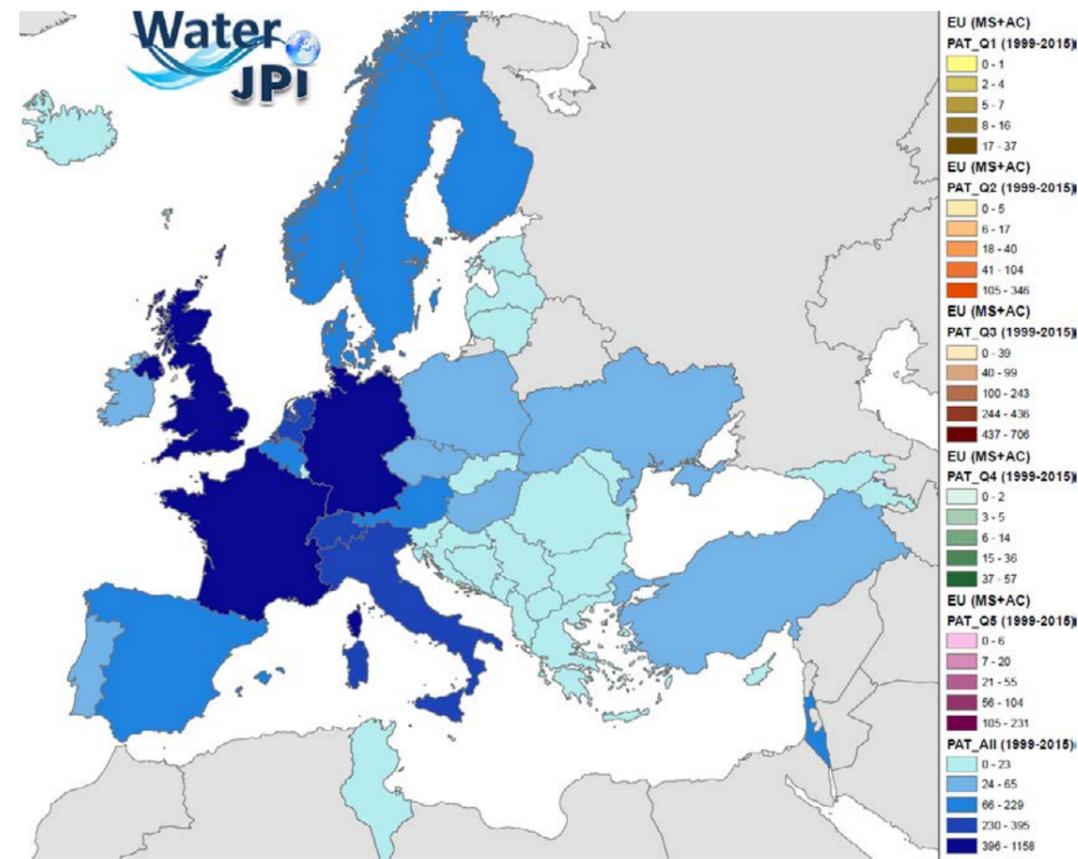


**Figure XX.** Increase rate of publications in Europe (Member States and Associated Countries) from 1999 to 2015, for all Water issues (PUB\_All 1999-2015).

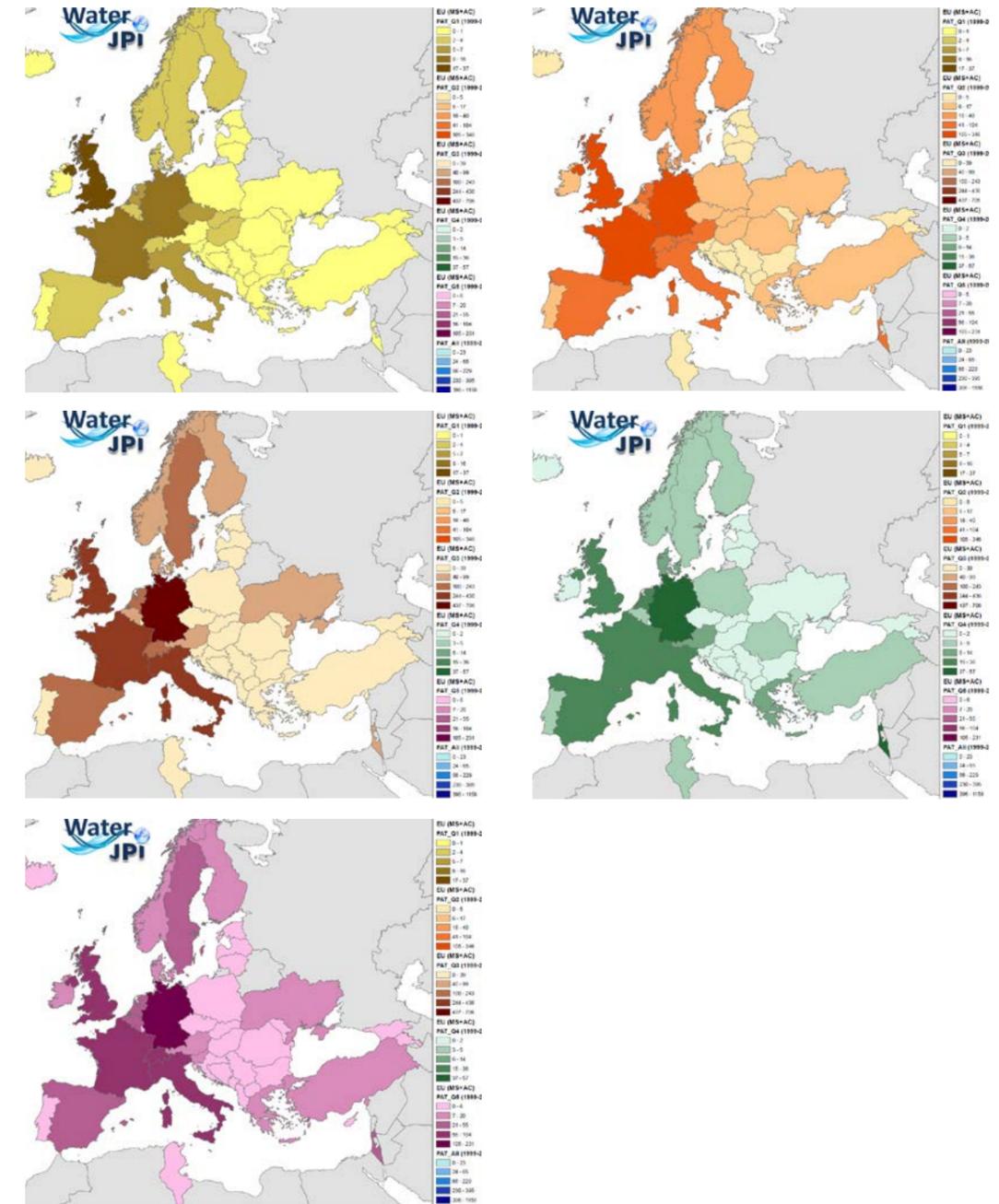


**Figure XX.** Increase rate of publications in Europe (Member States and Associated Countries) from 1999 to 2015, for the five Water JPI SRIA priorities from top to bottom and from left to right (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap).

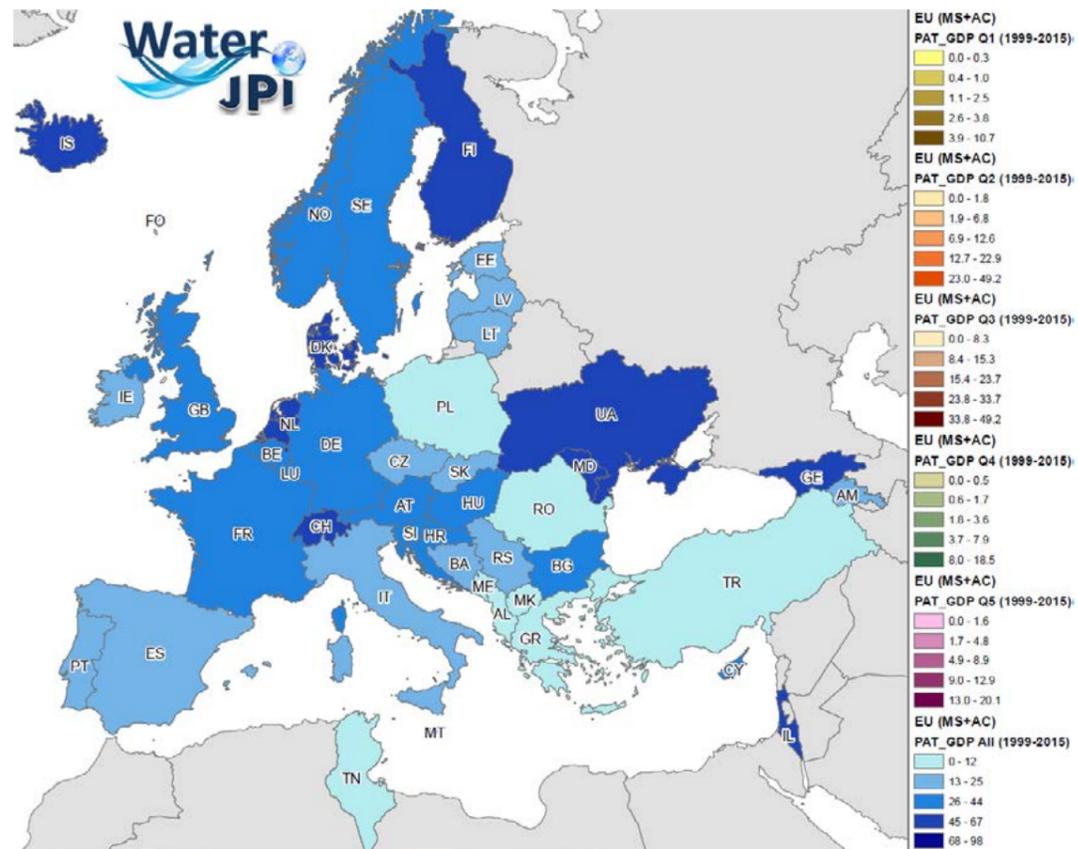
## Mapping on Water RDI in Europe: Patents



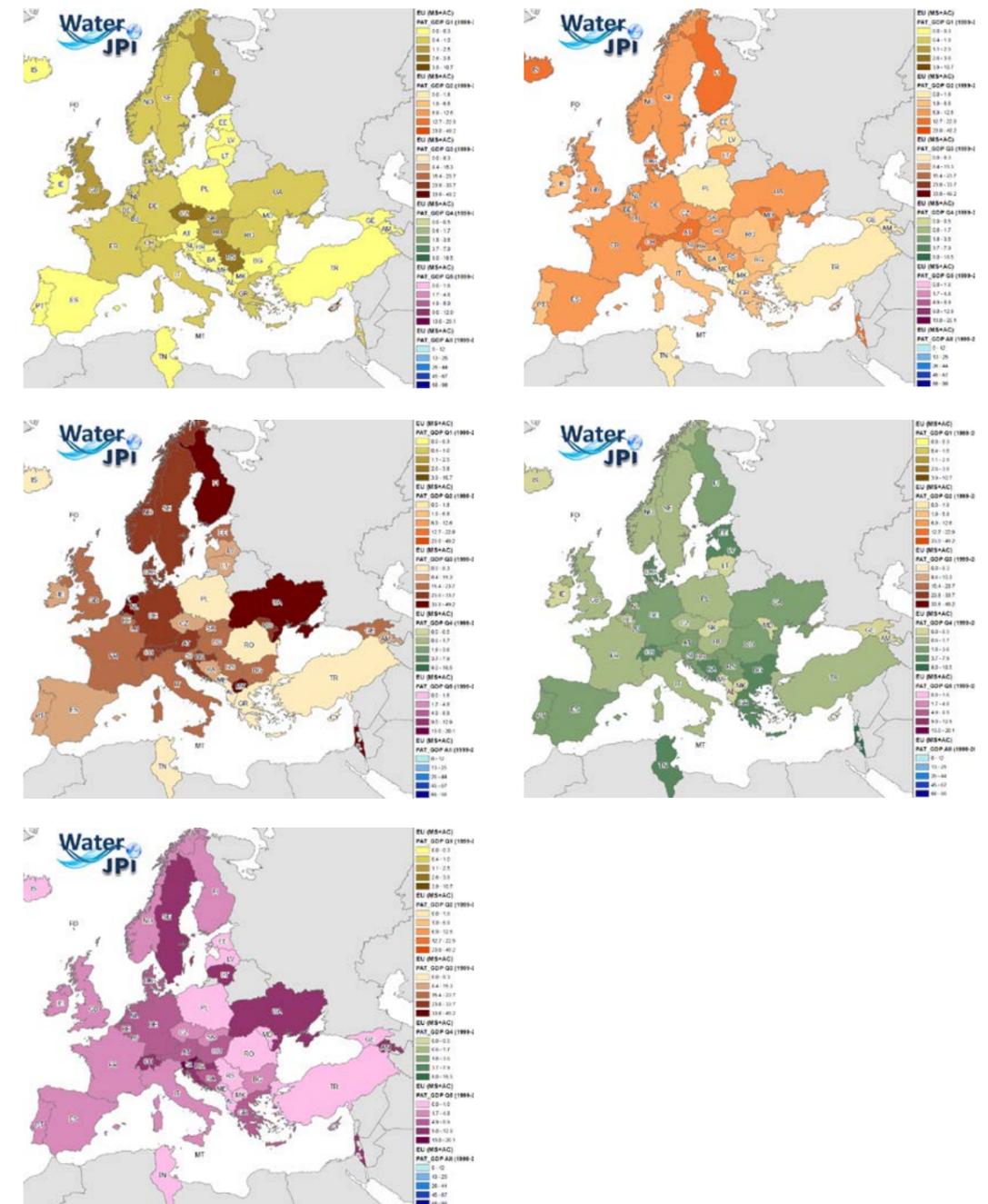
**Figure XX.** Intensity of patents in Europe (Member States and Associated Countries), from 1999 to 2015, based on raw data, for all Water issues (PAT\_All 1999-2015).



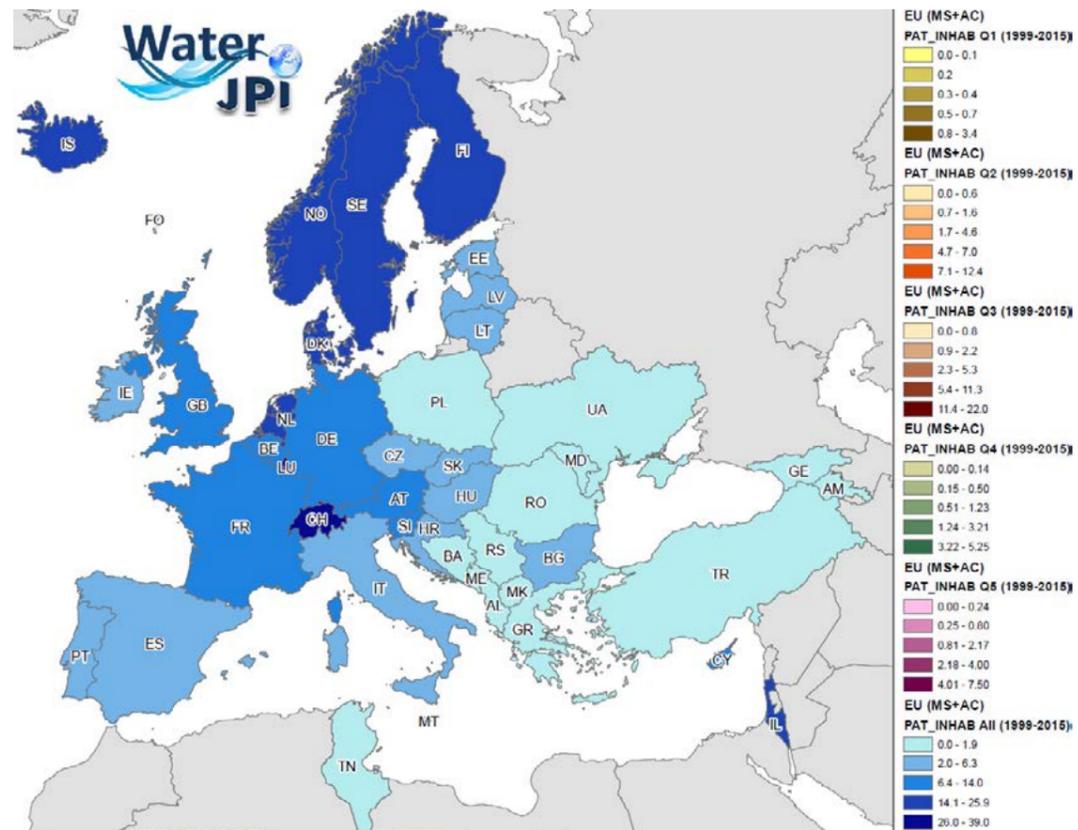
**Figure XX.** Intensity of patents in Europe (Member States and Associated Countries), from 1999 to 2015, based on raw data, for the five Water JPI SRIA priorities, from top to bottom and left to right (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap).



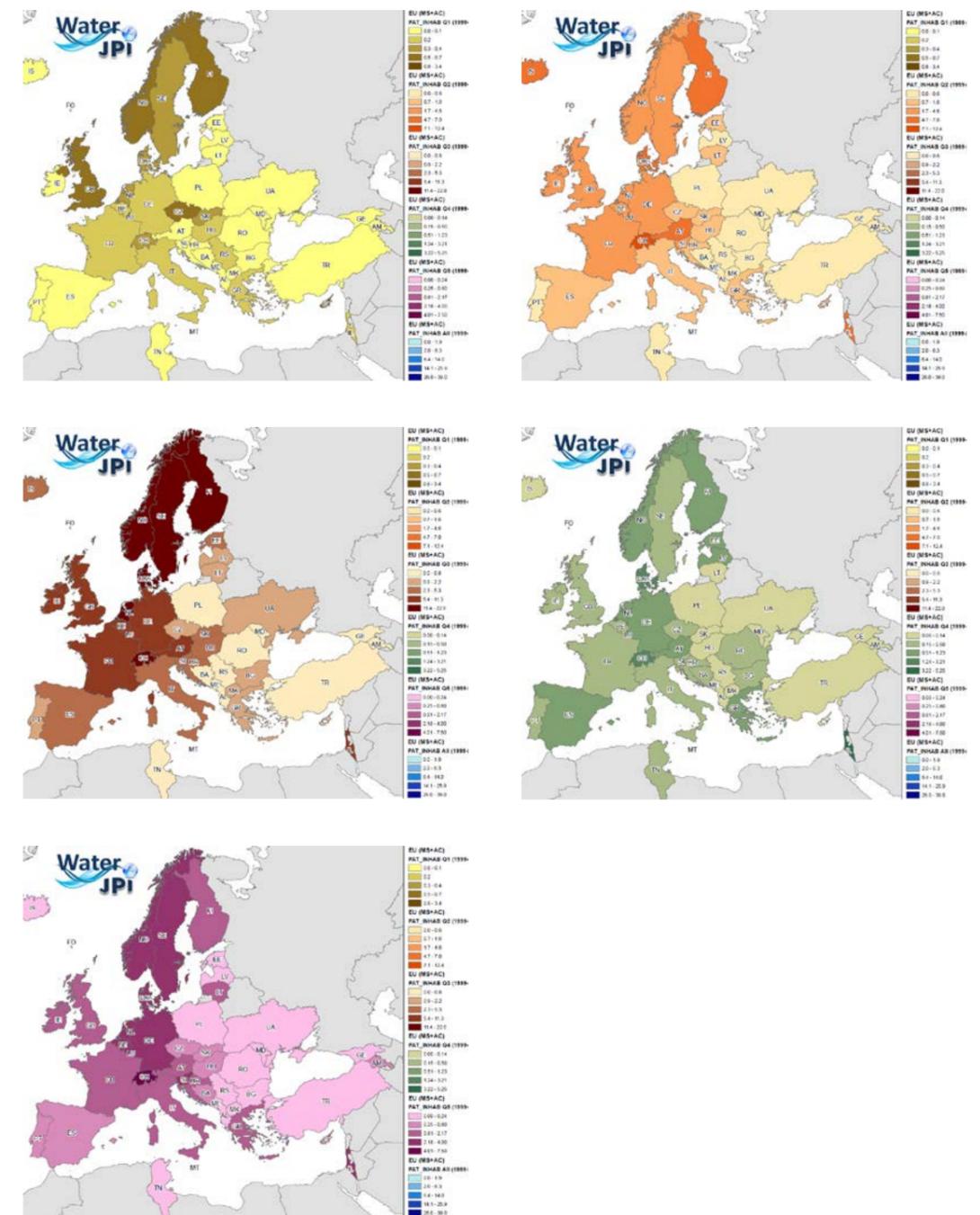
**Figure XX.** Intensity of patents in Europe (Member States and Associated Countries) normalised by GDP, from 1999 to 2015, for all Water issues (PUB\_All 1999-2015).



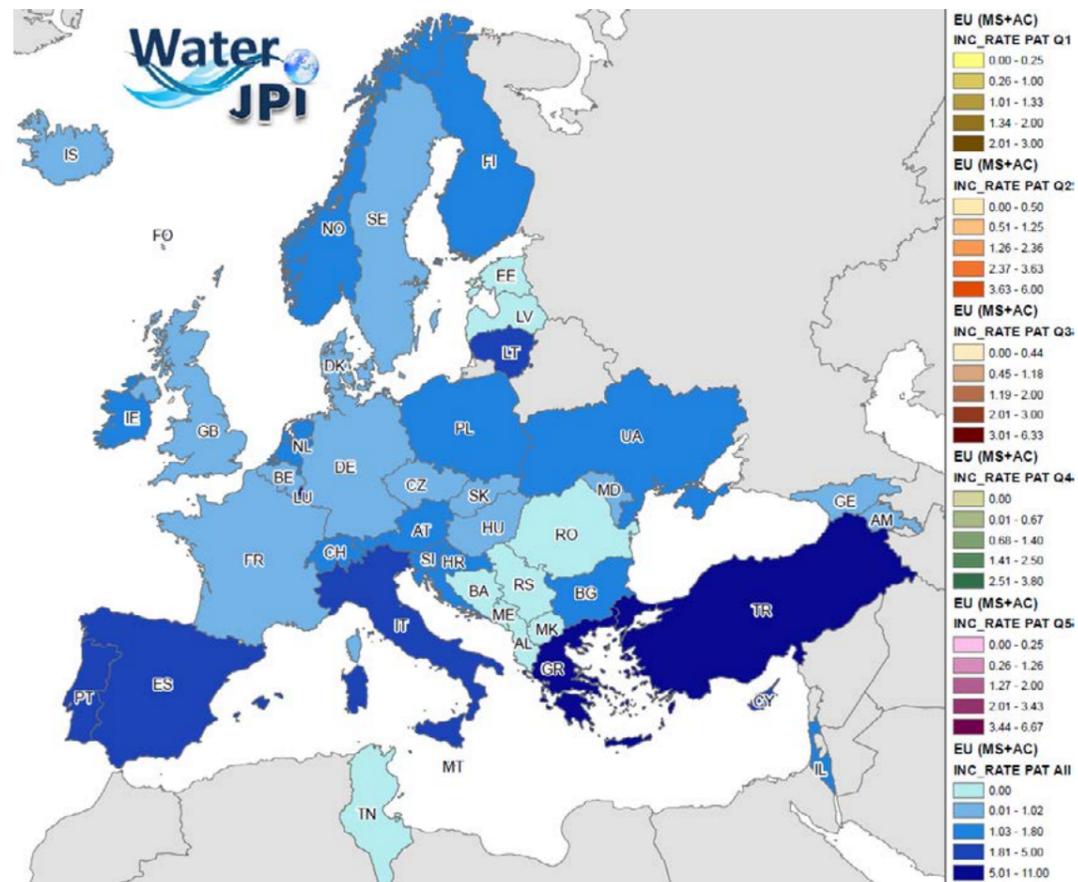
**Figure XX.** Intensity of patents in Europe (Member States and Associated Countries) normalised by GDP, from 1999 to 2015, for the five Water JPI SRIA priorities from top to bottom and from left to right (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap).



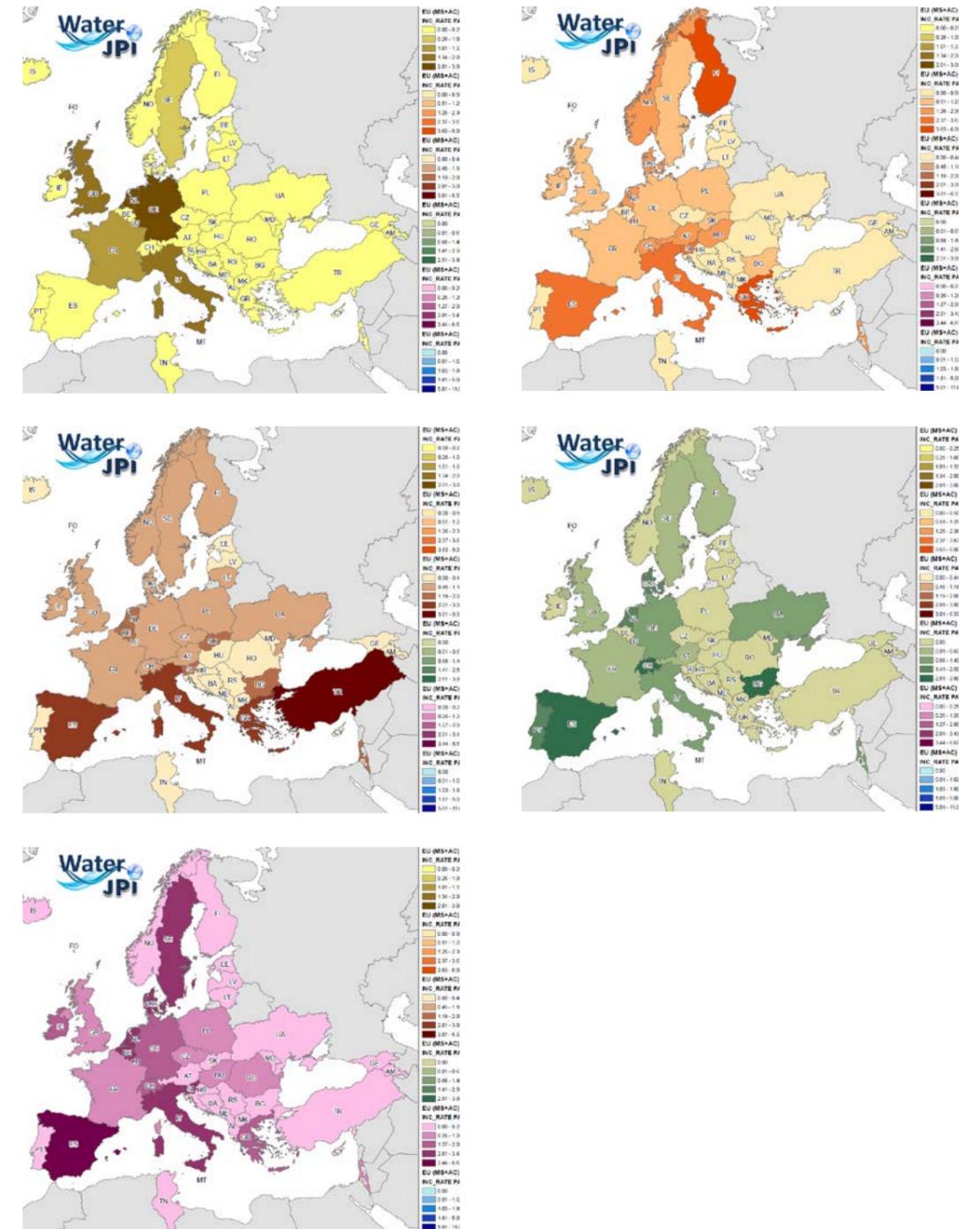
**Figure XX.** Intensity of patents in Europe (Member States and Associated Countries) normalised by population, from 1999 to 2015, for all Water issues (PUB\_All 1999-2015).



**Figure XX.** Intensity of patents in Europe (Member States and Associated Countries) normalised by population, from 1999 to 2015, for the five Water JPI SRIA priorities from top to bottom and from left to right (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle Gap).



**Figure XX.** Increase rate of publications in Europe (Member States and Associated Countries) from 1999 to 2015, for all Water issues (PUB\_All 1999-2015).



**Figure XX.** Increase rate of publications in Europe (Member States and Associated Countries) from 1999 to 2015, for the five Water JPI SRIs priorities from top to bottom and from left to right (Q1- Sustainable Ecosystems, Q2- Safe Water for Citizens, Q3- Water Industry, Q4- Water-wise Bio-economy, Q5- Water Cycle G)



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