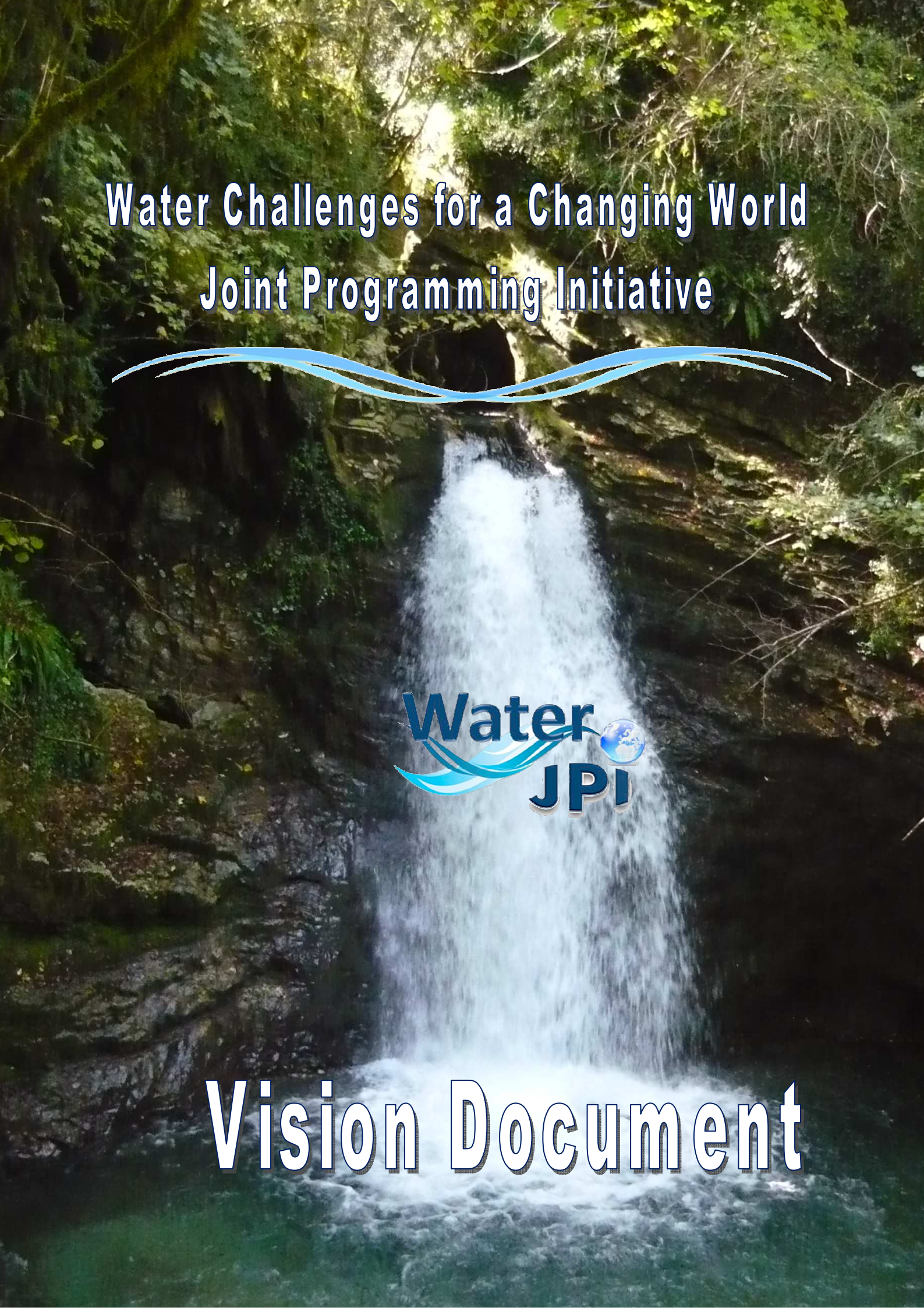

Water Challenges for a Changing World
Joint Programming Initiative
Water JPI
Vision Document

About the Vision

European water policy has ambitious goals and deals with complex and systemic issues. It sets challenges for European Research, Development and Innovation (RDI) in the field of water: developing new knowledge and reinforcing mechanisms for knowledge and technology transfer. Joint Programming Initiatives focus on the strengthening and harmonization of public research and innovation activities. The Joint Programming Initiative ***Water Challenges for a Changing World*** aims at tackling the ambitious challenge of achieving sustainable water systems for a sustainable economy in Europe and abroad. This will be obtained through a multi-disciplinary approach encompassing **economic**, **ecological**, **societal** and **technological** considerations.

The recent financial crisis and the still struggling European economies call for a change in approach. At the European and global levels, the world is much more interconnected and this leads to the need for globalised solutions across a range of policy areas – including through research. Joint Programming provides the possibility to combine research resources in a more strategic and effective way with a view to tackling grand societal challenges. This will be done by combining national research efforts and making better use of Europe's limited public RDI resources. The water JPI will undoubtedly strengthen Europe's economic position on water.

In May 4th 2010, the High Level Group (GPC) endorsed the Joint Programming Initiative (JPI) on *Water Challenges for a Changing World*. This Vision Document has been drafted by representatives of the JPI Partner and Observer countries. It provides the context to this proposal (Trends and Challenges) and outlines the JPI objectives and research questions responding onto the issues and challenges that the European water sector is facing.

The **Vision Document** identifies research needs on a high level, to be developed further in the JPI *Strategic Agenda*.

Major achievements of the proposed JPI is that, over the period September 2010 – April 2011, via the commitment of its Partner and Observer countries, it has been able to:

- Produce a common ***Vision***;
- Design an ***Implementation Plan***;
- Set up an ***interim Governance***; and
- Carry out the ***Mapping of Water Research in Europe***.

Contents

1 Water in a Changing World

1.1. Trends & Drivers

Water is fundamental for life, not only for direct consumption but also for sanitary requirements, and for the production of food, basic industrial goods and commodities. According to the 2010 State of the Environment Report from the European Environment Agency (EEA, 2010 SOER[1]), Europe's freshwaters are affected by water scarcity, droughts, floods and physical modifications. Many water bodies are at risk of failing to meet the aim of the EU Water Framework Directive (WFD, EC, 2000[2]) to achieve good status by 2015. This was the case for 40 % of surface waters and 30 % of groundwaters in 2004. On the other hand, agricultural emissions and wastewater discharges continue to be prominent pressures with respect to ecological and chemical status (EC, 2007[3]). The continuing presence of a range of pollutants in a number of Europe's freshwaters threatens aquatic ecosystems and raises concerns for public health. The recent communication on Resource Efficient Europe (EC, 2011[4]) - within the "Europe 2020 Strategy" - calls for the coordination of European Policy and RDI actions (among others) leading to an improvement of water availability and quality.

Overexploitation of resources originates from ***unbalances in water demand and availability***, and leads to ecosystem disruption. The 2007 Communication of the European Commission on Water Scarcity & Droughts[5] stated that water stress affects 130 million inhabitants (30% of population in Europe). Most of them are located in Southern Europe, but Northern countries such as Belgium, Denmark, Germany, Hungary and the United Kingdom suffer from similar problems.

The world population is projected to grow from 6.1 billion in 2000 to 8.9 billion in 2050, therefore increasing by 47 % (UN Report "World population to 2030"[6]). It is expected that the population will increase dramatically in urban and peri-urban areas. This will result in escalating demands for food and for water supply and sanitation services. This development does not only imply a greater need for agricultural and urban water and an increased capacity for discharge of pollutants. It also seriously impacts on water infrastructure. For instance, the increase in paved area will require additional storm water drainage capacity in order to protect human life and property.

International organizations such as the FAO have long warned about the water crisis hiding behind population growth and development[7]. Agricultural water use is more visible to society in irrigated areas, in which water is often scarce. However, rainfed agricultural systems are a relevant water sink even in temperate climates. FAO predicts more limitations to future world agriculture in water availability than in soil availability.

[1] http://www.eea.europa.eu/soer
[2] EC, 2000. Directive 2000/60/EC of The European Parliament and of the Council of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy.
[3] EC, 2007. Towards sustainable water management in the European Union. Accompanying document to the Communication from the Commission to the European Parliament and the Council. First stage in the implementation of the Water Framework Directive. 2000/60/EC, SEC(2007) 363.
[4] EC. 2011. A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy. COM(2011) 21 final.
[5] http://ec.europa.eu/environment/water/quantity/eu_action.htm#2007_com
[6] http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf
[7] Word agriculture. Towards 2015-2030. Summary report. 2002.

Urban areas around the world suffer from old and deteriorating water infrastructures that are vulnerable to failure due to aging, damage from excavations or over-loading. Leakage of water from supply systems in parts of Europe is substantial. According to the 2010 EEA State of the Environment Report[8], in some parts of Europe, leakage rates are less than 10 % and close to what is technically and economically feasible. In other parts, however, water loss remains considerable (20% and more). Countries face major challenges in the ***construction and maintenance of water-related infrastructure***. Investing in detection and repairing leaks is important. The World Business Council for Sustainable Development[9] estimates that OECD nations need to invest at least 200 billion $ per year to replace aging water infrastructure to guarantee supply, reduce leakage rates and protect water quality.

Increased urbanisation pressure pushes away agriculture, even from areas with high agronomical potential, but also provides opportunities for safe re-use of treated wastewater by peri-urban agriculture or landscape irrigation. As a result of soil sealing (e.g. more pavements), urbanization increases runoff. Reduced water infiltration in addition to groundwater depletion results in modified groundwater bodies (scarcity), rapidly changing river flows (floods) and the mobilisation of contaminants from point sources (2010 WssTP SRA Update[10]).

Large parts of Europe are now connected to municipal systems supplying treated water under quality-controlled conditions. As a result, health problems are infrequent and mainly limited to the rare coincidence of water source contamination and a failure in the treatment process. However, in some rural areas of Europe drinking water is taken from wells and consumed without any purification. In 2008, ten out of twelve waterborne disease outbreaks reported in the EU were linked to the contamination of private wells (EFSA, 2010[11]). Worldwide it was estimated that over ***880 million people use an unimproved drinking water source and 2.5 billion people are without improved sanitation*** (2008, WHO & UNICEF[12]). About 90 % of diarrhoeal diseases are caused by unsafe water and sanitation, leading to the death of about 2.2 million people annually. In the European Region, the annual burden of diarrhoeal disease attributable to poor water quality, sanitation and hygiene in children aged 0–14 years is estimated at 13,548 deaths (5.3% of all deaths) and 31.5 disability-adjusted life years (DALYs) per 10,000 children[13]. Contaminated drinking-water is a frequent cause of diseases such as cholera, typhoid, viral hepatitis A and dysentery. Water may be contaminated with naturally occurring inorganic elements such as arsenic, radon or fluoride. Human activity may also cause water to become contaminated with substances such as lead, nitrates and pesticides.

While municipal wastewater treatment has increasingly been implemented across Europe, the process does not remove all pollutants. Household and industrial chemicals and pharmaceuticals – for example – are being detected in treated effluent that is subsequently discharged to surface waters. Finally water quality is currently threatened by emerging

[8] http://www.eea.europa.eu/soer/europe/water-resources-quantity-and-flows

[9] http://www.wbcsd.org/DocRoot/ID1tMGiLZ7NL9mBOL2aQ/WaterFactsAndTrends-Update.pdf

[10] http://www.wsstp.eu/content/default.asp?PageId=911

[11] http://www.efsa.europa.eu/en/efsajournal/pub/1496.htm

[12] UNICEF & World Health Organization, "Progress on Drinking Water and Sanitation: Special Focus on Sanitation", 2008.

[13] *Study on environmental burden of disease in children: key findings. Copenhagen, WHO Regional Office for Europe, 2004 (Fact Sheet EURO/05/04) (http://www.euro.who.int/document/mediacentre/fs0504e.pdf, accessed 1 August 2009).*

pollutants as a consequence of population growth and accelerated urban concentrations, in addition to non-point pollutants such as pesticides. These ***pollutants may have effects on human and ecosystems health***.

Structures such as dams for hydropower or water supply have resulted in significant hydro-morphological modifications – physical changes – to many of Europe's waters. Navigation activities and navigation infrastructure such as cross profile construction – dams, weirs, locks, impoundments, canalisation, straightening, bank reinforcement and deepening – are typically associated with a range of hydro-morphological changes with potential adverse ecological consequences.

Changing demands from people, society, industry and agriculture are only some of the many factors that will influence the water sector in the future. Climate change is projected to increase water shortages, with more frequent and severe droughts projected for many parts of Europe (e.g. in the Mediterranean region). Flood hazards are also projected to increase across much of Europe, particularly in its central, eastern and northern parts. Climate change will further exacerbate ecosystems' disturbance. ***Droughts and floods have a clear impact on the status of European ecosystems***. They result in a variety of societal losses which are not always evident or easy to evaluate. According to the EU Report "Water Scarcity and Drought", increased drought was observed in the past 30 years, affecting 100 million inhabitants (20% of European population) in four major events since 1989. The report concluded that in the past 30 years, drought events had a cost of 100 billion € to the European economy (8.7 billion € have been attributed to the drought of 2003 alone). An additional effect of flooding is the pollution of rivers and aquifers resulting from an increase in the load of pollutants washed from soils, more overflows in the sewer systems and the overflow of toxic waste sites. In deltaic areas, floods from the sea will turn fresh groundwater into brackish groundwater.

Future ***changes in land use are likely to also influence water quality***. Agricultural irrigation requires massive amounts of water in temperate and semiarid climates, and consumes most of the used water through the process of crop evapotranspiration. This demand is often met by groundwater pumping. Some aquifers may compact when groundwater is depleted, resulting in permanent subsidence. In coastal areas, over-exploitation of aquifers can lead to salt-water intrusion and prolonged droughts. If this situation is combined with an unsustainable use of water, desertification may appear. In southern, central and eastern Europe, 8 % of the territory currently shows very high or high sensitivity to desertification, corresponding to about 14 million ha. If moderate sensitivity is included, more

than 40 million ha are affected (Source: DISMED[14], EEA 2010 SOER[15]).

A paradigm change is currently developing in the world economy: ***from a fossil fuel-economy towards a more bio-based economy***. In the years to come, biomass will become a key raw material for energy generation and the synthesis of bio-polymers. Biomass production will have a major effect on the water system. Intensive agriculture for the production of biofuels will increase the pressure on the water sector through higher agricultural water demand and aggravated phenomena of eutrophication, erosion and sedimentation. This is the case today in the Amazons, where rainforest is being replaced by fast-growing species like Eucalyptus.

The bio-based economy also focuses on reducing the input of fertilizers, herbicides and pesticides, among other agrochemicals, with positive effects on the aquatic environment. The development of a bio-based economy in Europe will also have an impact on the availability of water for private consumers and industrial purposes. There is thus a need to strike a balance between the benefits of such policies (e.g. renewable energy and raw materials) and the impact on the ecological status of water bodies, adjacent land ecosystems and wetlands.

[14] Domingues, F. and Fons-Esteve, J., 2008. *Mapping sensitivity to desertification (DISMED Project.* EEA-TC-LUSI. European Environment Agency, Copenhagen.

[15] http://www.eea.europa.eu/soer

1.2. The Grand Water Challenge

The grand challenge is to achieve sustainable water systems for a sustainable economy in Europe and abroad. This challenge is certainly very ambitious, as it addresses a number of issues of significant importance.

The challenge:
"Achieving Sustainable Water Systems for a Sustainable Economy in Europe and Abroad"

Firstly, there is a growing gap between global water demand and water supply. The fast approaching bio-based economy will exert pressure to enlarge this gap. Secondly, with growing water demand and the discharge of different types of pollutants to the environment, our ecosystems will be threatened by overexploitation of water sources and increased quality problems.

Thirdly, climate change is expected to intensify drought in some areas and flooding in others. This will result in damage to the ecosystems and to society as a whole. Addressing this challenge will require a ***multi-disciplinary approach, since economic, ecological, technological and societal challenges*** are to be addressed (Figure 1).

The JPI will contribute to the challenge through coordination of National and Regional RDI policies and programmes.

Figure 1. Drivers and multidisciplinary challenges to be addressed.

Economic challenges. The European water market will have an estimated turnover in 2015 of 43 billion $. The worldwide turnover will amount to 246 billion $ (source: Global Water Intelligence Report 2011[16]). This figure includes pumping stations, filters, conveyance structures and related purification and sanitation equipment. The European water sector is of prime economic importance, as it offers jobs for hundreds of thousands of citizens across Europe. Investments in water technology around the world increase every year, in a market which has become very competitive. The European water industry can benefit from this market, developing customized solutions for site-specific problems. To be competitive, investments in generating knowledge and its valorisation are essential. In fact, the analysis of water technology deployment in the last decades permits to conclude that the risk of ineffective investments is high if the water system is not properly understood. To remain at the forefront of this competitive business, innovation skills are essential. The sector must and should enhance its capacity to cope with

[16] http://www.globalwaterintel.com/publications-guide/market-intelligence-reports/global-water-market-2011/

economic, demographic, behavioural and climatic changes.

Making Europe the most competitive water sector in the world, lending RDI support to the EU 2020 strategy.

Ecological challenges. The anthropogenic pressures and the degradation of biological integrity of ecosystems contribute to a large extent to the decrease of water resources. Overexploitation and degradation of the biotic structure alter ecosystem processes, decreasing ecosystem ability to provide resources to society. Ecological challenges include the preservation and protection of waters as a crucial asset for sustainable development.

Significant examples of these challenges include:

- Increase of nutrient loads to lakes and streams, which can trigger the formation of toxic cyanobacterial blooms. The presence of these bacteria reduces water quality, increases the costs of water treatment, generates serious threats for human health and reduces the regional economic potential (i.e. ecosystem services such as biodiversity, tourism, recreation and landscape and aesthetical cultural values).
- Persistent inorganic and organic pollutants constitute a significant threat: these compounds tend to accumulate in the food chains and may affect fisheries and human health.
- Extreme events – such as droughts and floods – also have a clear impact on the health of European ecosystems (e.g. increased pollution, brackish groundwater, etc.).
- Anthropogenic morphological and land use changes and infrastructure works are a significant pressure factor on the ecological status of rivers and lakes.

Enhancing the absorbing and self-purification capacity of the landscape and water ecosystems to reduce the transfer and storage of pollutants. Maintaining and restoring biodiversity and ecosystem services.

Societal challenges. Access to water is a basic need. Its quantity and quality affect the health and well-being of citizens in Europe and abroad, and this is of course strongly related to economic strength. Raising awareness amongst water users is an important issue. For instance, European citizens need protection from new and emerging water pollutants. Sanitation needs to be extended and intensified, improving connections to centralized systems or implementation of decentralised systems and focusing on cities established near threatened water bodies. Water re-use and nutrient recovery from municipal,

industrial and agricultural waste water offer economic advantages and societal gains. Society has an ambivalent relation with water resources. On the one hand, water is a natural resource necessary for societal well-being. If adequately managed, water fulfils a multitude of services and functions for a sustainable livelihood. These encompass domestic and economic services (such as drinking water, hygiene, food, production, recreation, industry and agriculture) and collective services and functions (such as energy and ecology). On the other hand, considering the current pressure, water can no longer be considered an unlimited public resource.

Providing each citizen with clean drinking water and proper sanitation.

Securing protection from new and emerging water pollutants and from water hazards.

Technological challenges. The current development of water technology is insufficient to meet the grand challenge of achieving sustainable water systems. Consequently, major scientific and technological breakthroughs are needed in all areas of water use and management. Crossovers are required with related scientific fields, such as energy, sensors, nanotechnology and health.

Significant examples of these challenges include:

- The growing concern about multi-resistant micro-organisms in European water bodies;
- The need to recover phosphate and nitrate fertilizers from wastewater and make these substances suitable for reuse;
- New technologies for drinking water production and sanitation;
- The need for reduced energy input in all water processes, but particularly in desalination and water treatment. The prospects for energy co-generation in processes such as sewage treatment;
- The deployment of information and communication technologies in water management for monitoring as well as for decision making.

These challenges will force science to explore integrated processes in order to develop new water sources reducing energy input in desalination processes and co-generating energy in processes such as sewage treatment. Specific innovations in monitoring technologies and developments in information systems and methodologies are required to address the complexity of water systems and water issues. Finally, many capital-intensive water infrastructures require research to improve design and maintenance, maximize societal benefit and moderate costs.

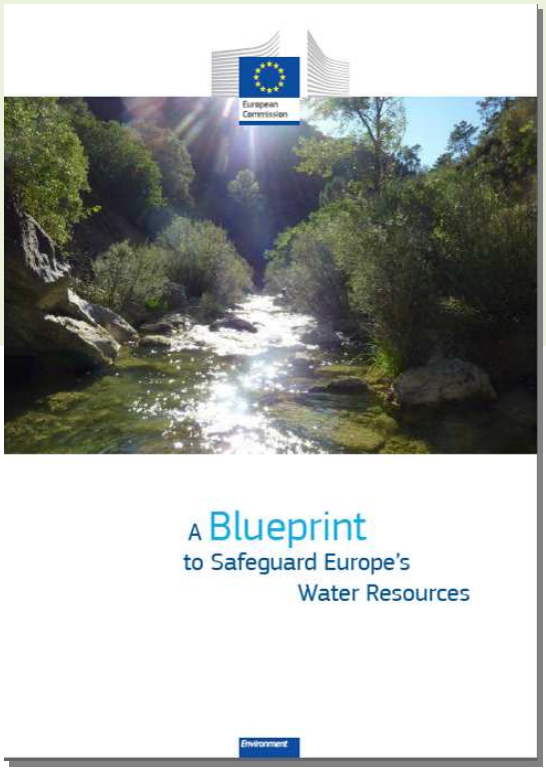
Ensuring adequate technology deployment in the water sector.

Tearing down barriers between scientific fields and European countries to perform adequate technological brokerage.

2 A Common Vision towards Achieving Sustainable Water Systems

To meet the needs of a resource-efficient future, to sustain human and economic development, and to maintain the essential functions of our water ecosystems, an integrated approach to water resource management is needed.

Full implementation of the WFD and other water policies will be required to reach good status by 2015.

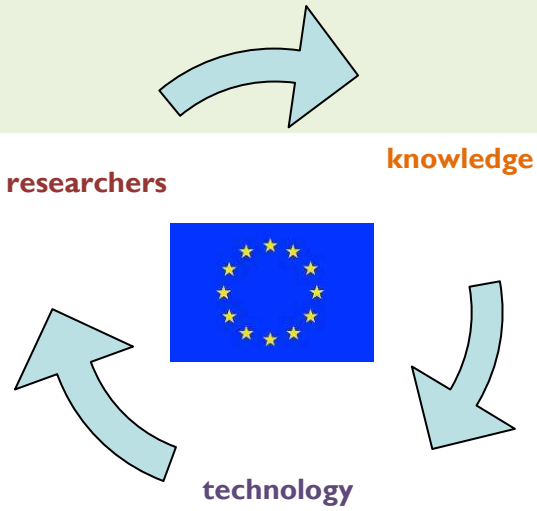


The EU 2020 Strategy and the European Commission's "Blueprint for safeguarding European waters", planned for 2012, further promote sound water management.

This Joint Programming Initiative will mobilise existing RDI programmes to harmonise their research agendas and infrastructures, defining common research needs and developing synergistic joint activities that increase their efficiency by avoiding duplications. This will permit to address the grand challenge with unprecedented effectivity. The JPI vision is structured through a set of objectives and a set of research questions being addressed.

2.1. JPI objectives

The 2020 vision for the European Research Area[17] claims for implementation of the "fifth freedom" across the ERA: free circulation of researchers, knowledge and technology.



It also calls for attractive conditions and effective and efficient governance for carrying out research and investing in RDI intensive sectors in Europe.

This JPI has designed a set of objectives representing a contribution to the 2020 vision for the ERA.

These objectives will be achieved by 2020, and address JPI performance through internal performance indicators:

2.1.1. **Involving water end-users for effective RDI results uptake**.

This objective is central to the JPI, since it addresses the core aspect of RDI activities: solving societal problems through dynamic interaction with end-users. This interaction will be sought at the JPI governance bodies, but also at the Partner country level. While Europe is the natural domain of this initiative, global impact will also be targeted.

2.1.2. **Attaining critical mass of research programmes.**

The goal is to involve at least two-thirds of the public National water RDI investment in Europe. This assessment will be based on the periodical update of the JPI mapping exercise[18] performed for the first time in March 15th, 2011. Current JPI partners fund RDI activities for an estimated amount of 225 M€/yr, representing 61 % of the 371 M€/yr estimated for EU Member States and Framework Programme Associated Countries. Progress in JPI implementation is expected to attract additional partners and RDI programmes.

[17] http://register.consilium.europa.eu/pdf/en/08/st16/st16767.en08.pdf

[18] The mapping exercise made part of the progress report dated March 15th, 2011.

2.1.3. **Reaching effective, sustainable coordination of European water RDI**.

A permanent dialogue will be established between Member States, Associated Countries and the European Commission. This dialogue will accelerate progress towards the ERA objectives, benchmark water RDI programmes within Europe, facilitate access to research and development results and scientific infrastructure, and promote innovation in the water sector.

2.1.4. **Harmonising National water RDI agendas in Partner Countries**.

This JPI does not intend to interfere with the proven capacity of individual programme owners and managers to respond to local challenges in a creative way. However, it is expected that by 2020 the water RDI agendas of Partner Countries and the JPI Strategic Agenda will show effective harmonization. This will make the most of national resources and increase the potential of national RDI groups. Continuous prioritization and stakeholder consultation will be required to reach this objective.

2.1.5. **Harmonising National water RDI activities in Partner Countries.**

The goal is to develop a catalogue of jointly programmed activities whose global budget amounts to at least 20 % of the total water RDI budget of partner Programmes. Activities may include joint calls for proposals, mobility schemes and infrastructure actions. The JPI will enable sharing research facilities, support the development of "rich data sets" over strategic pilot sites, engage in joint benchmarking of models, and develop a joint approach to open access to publications. All activities will be performed under the principle of variable geometry and using financial models to be discussed and defined by JPI partners on a case by case analysis.

2.1.6. **Supporting European leadership in science and technology**.

The primary target is to maintain the current European world leadership in water related scientific publications (29 %) and PCT patents (35 %). In both aspects Europe is followed by the USA and by Japan. European leadership will be threatened by 2020 by developed and emerging countries. A secondary target within this objective involves doubling multinational European authorship of scientific publications (from the current 5 % to 10 %). Despite the scientific and technological leadership in water in Europe, internal multinational cooperation remains surprisingly low.

2.2. Research questions being addressed

Discussions among JPI Partner & Observer countries have led to the identification of ***five types of research questions***, addressing different aspects of European society:

2.2.1. **Maintaining ecosystem sustainability**. An integrated, trans-disciplinary research approach is required to analyse the influence of external factors on the water cycle. Such factors include:

- Exhaustion, overexploitation and depletion of water resources;
- Pollution;
- Climate change, inducing short to long-term variations in water availability;
- Extreme events (droughts and floods),
- Sea water intrusion; and
- Morphological changes / infrastructures and works on rivers and lakes.

Pollutants are damaging the natural balance of European ecosystems. The development of ecological engineering approaches will permit to retain/degrade certain pollutants and re-use them as raw material for fertilizers and industrial by-products. This JPI aims at developing indicators and models for monitoring of threats, risk assessment and early warning. It will also enhance ecosystem resilience to stress with regards to human pressures. Additional actions will aim at integrating ecosystem regulation in the water management process, at identifying systemic restoration solutions taking into account the good ecological status concept, and at the implementation of ecohydrology.

2.2.2. **Developing safe water systems for the citizens**. Water quality and societal wellbeing are currently threatened by emerging pollutants and pathogens. Key knowledge gaps remain, including for example:

- What are the (new) contaminants, such as polar compounds, pharmaceuticals or emerging pathogens including viruses?
- How can we predict their environmental behaviour and treatment, and what impact do they have on human health?
- To what extent are these contaminants removed by natural processes in water and soil, or by physical techniques in drinking water treatment?
- How can the quality of the produced water be maintained in time and throughout the distribution system?
- Which health risks could result from new water concepts such as supply of hot water, cooling towers, water reuse and water in the city?

In addition to promoting societal health, this JPI aims at protecting the citizens' life and property from the devastating effects of natural hazards (also resulting in ecosystem degradation). Climate change may locally increase the frequency and intensity of floods and droughts, requiring increased RDI efforts from disciplines such as water resources, hydrodynamics, social sciences and geography.

New water management approaches will be required to address the research questions included in this category.

2.2.3. **Promoting competitiveness in the water industry**. The renewed EU Sustainable Development Strategy[19] reaffirms the strong political willingness from the EU to move into the sustainable path, where environmental protection goes hand in hand with economic prosperity and social cohesion. Innovative technologies are required by the water industry to create products and services for the citizens and their governments. This JPI will actively engage in the production of problem-solving knowledge leading to the development of market oriented solutions. Cooperation with stakeholders will be sought to ensure that water research results are transformed into business opportunities, so that the European water industry can develop and sustain a leadership position in the world. Technology will be developed for water storage, distribution, measurement, purification, treatment, desalination and irrigation. Focus will be set on new materials, processes, management tools, ICT, energy input and environmental profile.

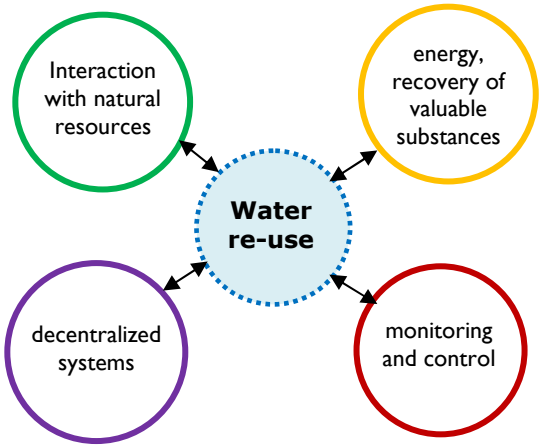
2.2.4. **Implementing a water-wise bio-based economy**. The most obvious effect of the bio-based economy is the intensification of agriculture. This means that more pressure will be exerted on natural resources to increase production of food and biomass, intensifying the use of water and agrochemicals.

Science and technology will be required to develop more efficient agricultural systems. Since the bio-based economy has not been fully deployed yet, joint research will arrive on time to make it water-wise. The complete understanding of agricultural water abstraction effects on European ecosystems and water delivery systems will be developed through joint research.

New techniques and plant materials resulting in increased irrigation efficiency and reduced consumptive use and water pollution will be developed.

2.2.5. **Closing the water cycle gap**. Growing freshwater scarcity currently emphasizes the need of closing the water cycle gap by reconciling water supply and demand. Financial water issues need to be analysed for different uses and regions. The demand for closed water systems is obvious in arid areas, where research institutes are currently working on new concepts and technologies.

Water scarcity requires new integrated concepts related to water re-use, energy, recovery of valuable substances, monitoring and control, decentralized systems, and the interaction with natural resources.



[19] Revised in 2009, http://ec.europa.eu/environment/eussd/

This technological and environmental research must be systematically combined with a socio-economic approach that will investigate the questions of participation, behaviour and commitment of stakeholders.

The costs and benefits of the different solutions (including environmental costs and benefits) must be systematically evaluated.
The concept of water foot-printing will be deepened, establishing practical methods and certifiable systems. Innovative concepts such as Management of Aquifer Recharge or Soil-Aquifer Treatment will be addressed. RDI activities will be required at different hydrological scales.

JPI objectives and research questions are schematically presented in Figure 2.

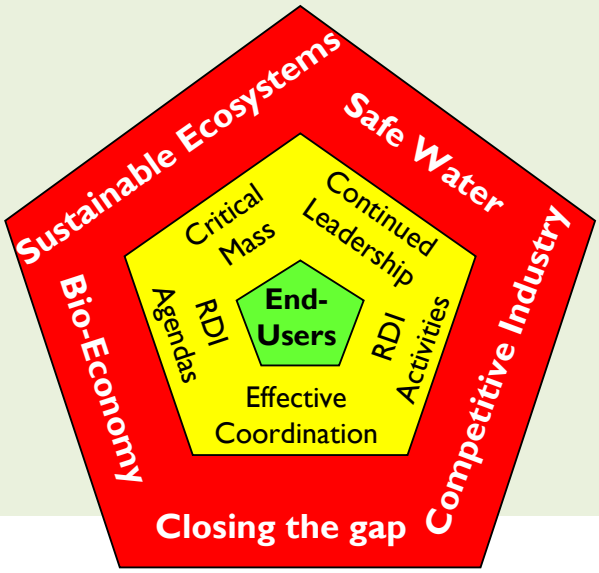
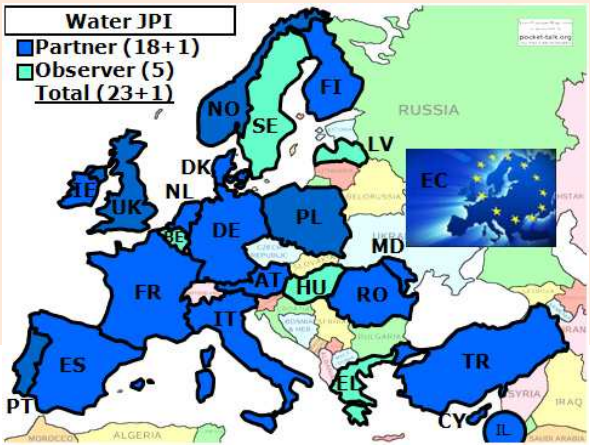


Figure 2. The vision: Integration of JPI objectives and Research Questions.

3 Working together to tackle the water challenges more effectively

Water knows no borders. This is particularly true in Europe, where most of the territory is occupied by our 72 transboundary watersheds (with the Danube watershed partly occupying 18 countries).



In the WFD, the need is expressed to build a comprehensive and shared vision of the water system such as to bridge its technological, environmental, political and institutional organisation, while taking into account geographical, historical, social and economical perspectives.

The aim:

"achieving the principles of integrated management in the field of water resources and systems"

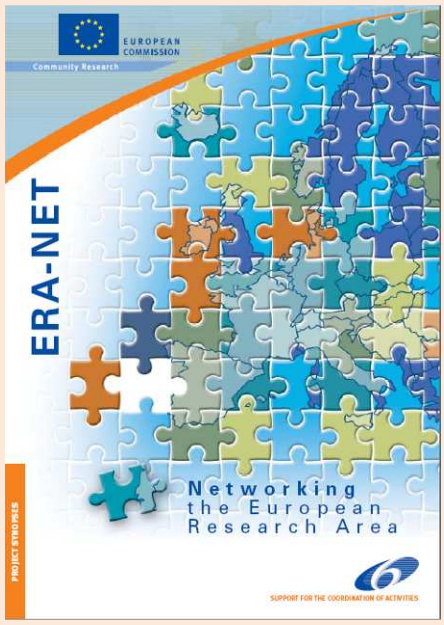
The WFD has introduced policies, decisions and actions aiming at achieving the principles of integrated management in the field of water resources and systems.

Complete fulfilment of WFD goals remain uncertain, mainly due to the difficulty to apprehend the intricacy and intertwining of:

- geographical boundaries,
- spatial scales,
- differences in governance modes,
- institutional and cultural settings,
- stakeholders,
- activities,
- state of aquatic environment,
- evolution of water bodies and the related pressures.

3.1. Fragmentation of the European water sector

The European water sector is highly fragmented: water resources, water supply and wastewater have often been locally managed. There is a huge diversity of stakeholders, in terms of ways of action, dimension, interaction with water, or water related skills. ***This fragmentation is an obstacle for developing a research strategy for a sustainable and competitive water sector.***



This fragmentation is an obstacle for developing a research strategy for a sustainable and competitive water sector.

RDI challenges and priorities are often defined in parallel (by regional or national entities). There are numerous research funding networks and organisations identifying key research questions and setting up strategic research agendas. These include networks (such as the ERANets), other transnational (regional) funding networks such as EUREKA (with AQUEAU in particular); the Framework Programme (FP), LIFE+, COST; Technology Platforms (such as the Water Supply and Sanitation Technology Platform, WssTP), the WFD Common Implementation Strategy Groups, the European Environment Agency, the EC Directorate-General Environment, the European Water Association, the European Water Partnership, the WISE-RTD association, the EurAqua institutes network; etc.

A EUREKA CLUSTER FOR GROWTH AND INNOVATION IN WATER

SEVENTH FRAMEWORK PROGRAMME

Life

WssTP The European Water Platform

EWA

WISE -RTD

This list is not exhaustive. Common funding activities have often remained very small-scaled. In addition, synergies between the different ERANets and other research funding networks dealing with water topics have been limited, inhibiting the establishment of a coherent water RDI framework within the European Research Area. This JPI will not add a new piece in this puzzle. On the contrary, it will promote coordination and cooperation in water RDI.

3.2. The International RDI Scene

Our non-European partners – both traditional (US, Japan) and emerging (China, India, etc.) – are launching large-scale targeted research programmes and are setting up effective collaborations (see Table 1 for the situation of the RDI systems in Europe, the USA and Japan).

A stronger, more coordinated and coherent European response is needed to meet the identified water challenges, where appropriate in collaboration with partners outside the European Research Area.

RDI activities are performed at universities, research institutes and in water technology companies to develop innovative water technologies.

While excellent research has been carried out throughout Europe, this has not been sufficiently transferred to relevant stakeholders, i.e. utilities, public authorities or industry.

Additionally, if Europe is to achieve a balanced and sustainable development and economic growth, Europe not only needs to invest more in research, but also needs to invest in improved coordination and harmonisation of research activities. Coordination of water research agendas will improve the competitiveness of the water sector.

Table 1. Comparison of selected indicators of the RDI systems between EU-25, US and Japan. Notes: [a)] 2003 for EU-25, 2004 for USA and Japan; [b)] 2004 for EU-25; 2002 for USA; 2003 for Japan; [c)] Triadic patents are filed at the European Patent Office (EPO), the United States Patent and Trademark Office (USPTO) and the Japan Patent Office (JPO), for the same invention, by the same applicant or inventor. Data obtained from EUROSTAT, OECD and DG Research and Innovation.

Concept	EU-25	USA	Japan
R&D intensity (% of GDP) (2004)	1.86	2.66	3.18
Share of R&D financed by industry (%) [(a)]	54.8	63.7	74.8
Researchers (FTE) per thousand labour force [(b)]	5.5	9.1	10.1
Share of world scientific publications (%) (2003)	38.3	31.3	9.6
Scientific publications per million population (2003)	639	809	569
Share of world triadic patents [(c)] (%) (2000)	31.5	34.3	26.9
Triadic patents per million population (2000)	30.5	53.1	92.6
High-tech exports (% of total manufacturing exports) (2003)	19.7	28.5	26.5
Share of world high-tech exports (%) (2003)	16.7	19.5	10.6

3.3. Water Joint Programming in the European context

Joint Programming is about tackling common European major societal challenges by combining national research efforts in a strategic and effective way and thereby making better use of Europe's limited public RDI resources. In the wake of the global financial and economic crisis, the need to ensure efficiency and effectiveness in the spending of public funds has become an even bigger imperative.

The need:

"to ensure efficiency and effectiveness in the spending of public funds"

Addressing the Grand Water Challenge requires a long-lasting, large-base research approach taking into account the great diversity characterizing water quality issues and management practices in Europe. The proposed JPI will facilitate synergies and complementarities of current EU, national and regional initiatives.

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This JPI will not only fight against duplications, it will also build on the benefits arising from the diversity of water issues in European countries, allowing for intercomparisons and ensuring a wider applicability of its outcomes and achievements.

An active policy on common water RDI in Europe will result in a strong and coordinated, scientific and economic position in the global water sector on the protection and value of water. This will be of mutual benefit and interest, and will be transferable to the rest of the world. Additionally, this can also contribute to meet the needs of developing countries.

The need for cooperation in water is not only motivated by efficiency and impact. Water issues lend themselves for cooperation between countries in an almost natural way: rivers, drought and pollution do not respect political boundaries.

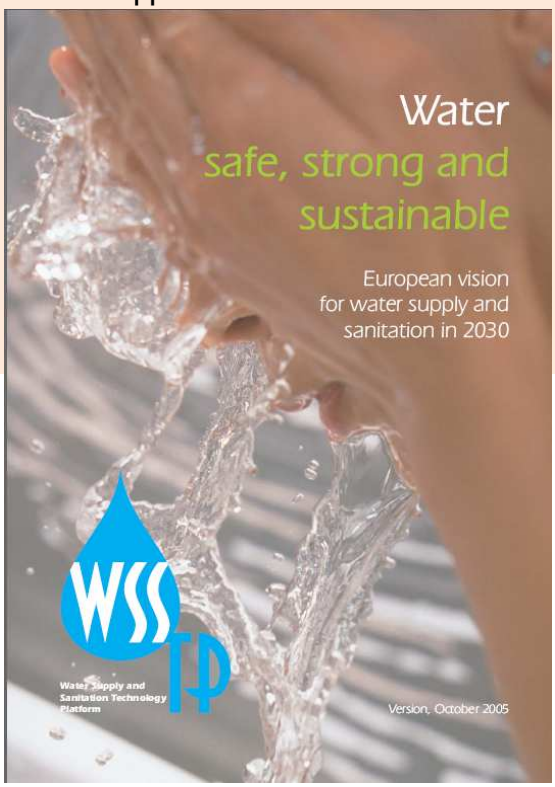
With the ***Europe 2020 Strategy***, the Commission proposed to the Member States a comprehensive and long-term partnership for addressing together major societal challenges. In the conclusions of its meeting of 4 February 2011, the European Council endorsed the Commission's proposal for an Innovation Union[20], and launched the European Innovation Partnerships. Europe's expertise and resources must be mobilized in a coherent manner.

Synergies between the EU and the Member States must be fostered in order to ensure that innovations with a societal benefit reach the market quickly.

[20] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Europe 2020 Flagship Initiative. Innovation Union. EC(2010) 1161

This JPI will become one of the building blocks of the "***Water Efficient Europe***" innovation partnership.

Close cooperation with the ***Water Supply and Sanitation Technology Platform*** (WssTP) is essential for bringing successful research to the market. WssTP was promoted by the European Commission to improve efficiency and financial opportunities in the water sector.



This Technology Platform is led by industries in collaboration with academics, research organisations and water users. The European industry is very well represented in WssTP, which is equally committed to meet global challenges and regional demands ensuring water and sanitation services, and to make significant and measurable contributions to the Millennium Development Goals.
The different nature of the JPI and WssTP will result in complementarities which will be exploited in both directions.
The JPI will guide the production of knowledge to the bottlenecks and areas of societal interest identified by WssTP (among other stakeholders).

As a consequence:

- WssTP's role is to voice industry needs, guiding research and development to innovations.
- The JPI's role is to harmonise national public research programmes, so that updated, ambitious, realistic, challenging and problem-solving objectives and research topics are investigated.

Starting from coherent Strategic Research Agendas is essential to exploit complementarities. While the JPI focuses on public-public cooperation, the WssTP explores complex interactions between public and private agents. Additionally, most of the programmes making part of this JPI focus on Research, with interests in development and innovation. Complementarily, WssTP focuses on innovation, although it treasures relevant research and development capacities. The WssTP and this JPI commit to cooperate to build a strong "Water Efficient Europe" innovation partnership.

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The nature of a JPI is similar to that of ***ERA-NET***s in a number of aspects. The past and present water ERA-NETs have established research networks in which European researchers and funding agencies have harmonized procedures and jointly managed coordinated research projects, thus setting the scene for this JPI. The ERA-NETs have overcome a number of legal and practical barriers, succeeding

in setting up common proposal submission and evaluation procedures.

The experience gathered through the ERA-NETs will be useful to implement effective water JPI governance, but also to foresee frontier research activities in the water field. Two recently completed ERA-NETs were directly related to this JPI:

- The ***IWRM*** ERA-NET, focusing on IWRM to sustain the WFD needs, has been considered in many instances as a model for the design of the water JPI. Both research actions are primarily interested in Europe and share the ambition of projecting research results to the world.

- The ***CRUE*** ERA-NET structured the area of European Flood Research by improving co-ordination between national programmes and establishing a joint research agenda.

The JPI has established fruitful contacts with both ERA-NETs in order to plan for continuity and transition.

Additionally, ***SPLASH*** is the European Union Water Initiative (EUWI) ERA-NET. It deals with the international aspects of water research in Europe. It is a consortium of 16 ministries, funding agencies and national research and technological development authorities from 11 European countries. SPLASH focuses on Africa and the Mekong region, and takes on board the challenge of providing poor people with access to safe water supplies and improved sanitation.

Previous research in the water sector has generally been programmed and managed in isolation by different donors such that overlap and duplication has occurred, and specific gaps and issues may not have been addressed.

Two additional ERA-NETs partially relate to this JPI. The ***SNOWMAN*** ERA-NET dealt with sustainable soil and groundwater management under the stress of pollution. These issues have been included in this proposal, with the intention of updating the challenges and the research responses focusing in a long-term vision.

The ***CIRCLE*** ERA-NET performed activities focusing on the adaptation to climate change, giving consideration to water scarcity. CIRCLE 2 continues this effort.

Technological and ecological solutions are an imperative condition, but do not represent a sufficient condition.

Research is also needed in societal aspects such as governance and behavioural sciences. Joint Programming is meant to tackle grand societal challenges and it is therefore crucial that its research results feed directly into the ***policy making process***. There is a need for strengthening the dialogue between policy-makers and researchers in order to maximise the policy-making impact of research projects.

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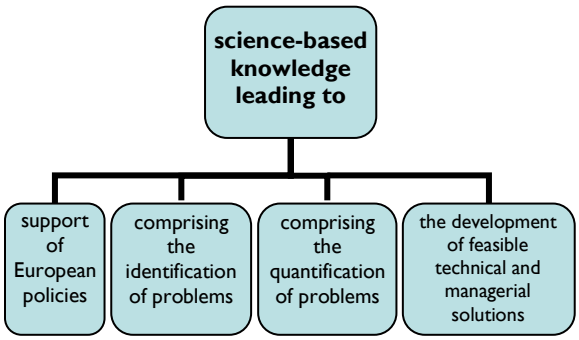
Close linkages with ***CIS Science Policy Interface*** will be crucial. In addition, there is scope for enhanced synergies between ***ESFRI*** and the JPI in relation to infrastructures that could be supportive to the societal challenges being addressed (e.g. EMSO, EUROARGO and LIFEWATCH).

Water research is related to a number of relevant European research actions. JPIs are not an exception. Links to other ***JPIs*** exploring water related issues will be established.

3.4. Added Value of the Water Joint Programming Initiative

The challenges identified in this JPI ***cannot be fully addressed by any individual partner country alone***. Although the National and Framework Programmes have provided relevant funding to European water research, the wide variety of situations and issues to be tackled and their complex dimension have limited the deployment of successful technologies and policies. The Water JPI provides an opportunity for economies of scale, larger critical mass of resources and for enhanced cross-border programme collaboration. This JPI will permit to widen up the scope of European proposals, and increase the impact of research by exploiting the multiplying effect of trans-national & multi-disciplinary cooperation in Europe and beyond. In addition to this, ***confronting the wide variety of water ecosystems in Europe already constitutes a relevant added value.***



The water JPI will produce science-based knowledge leading to ***support of European policies***, comprising the identification of problems, their quantification, and the development of feasible technical and managerial solutions. All these aspects will indirectly lead to European policies promoting better life standards for European citizens. The water JPI will also have the capacity to focus on local and regional scale problems, where the transfer from research to policy is more effective. The research questions identified in this document will permit to support the implementation and revision of key EU Directives, as well as to prepare new water-related EU policy documents.

The JPI has been designed to be ***sensitive to national, regional and municipal water problems***, thus responding to the large variability in European water issues. While the Framework Program has traditionally focused on a problem-solving approach, all aspects of water science and technology (from basic to pre-competitive; from industrial to sociological) will be targeted in the water JPI.

Among the ***RDI benefits of the JPI***, five have a clear European dimension:

- ***Align the national RDI agendas***, optimizing their scope and the resulting funding efficiency; effectively covering the wide variety of European water environments.
- Increase ***cooperation between European professionals***.
- Design, build and share ***large research and development facilities*** (i.e., experimental treatment plants).
- Create, maintain and co-operatively exploit ***networks of open-field experiments and scientific observatory systems*** (i.e., experimental watersheds).
- ***Multiply the scientific impact of European Research***, increasing its relevance and scientific leadership.

This JPI will target ***citizen well-being and personal development*** in Europe and beyond. Research actions to be adopted in the JPI will be required to demonstrate their contribution to improve the life of the citizens in urban and rural communities, in more and less developed regions, from the young to the senior citizens, and with respect for gender issues. Water is known for being at the centre of social conflicts which have historically hurt citizens in Europe and beyond. Water JPI actions will also be encouraged to focus on social agreement and on conflict resolution. Mediation and advocacy in water issues will be promoted at all levels to ensure that RDI activities are clearly perceived as contributing to improve the life of the citizens in all its dimensions.

Last, but not least, the knowledge produced by this JPI will serve the purpose of ***reinforcing Europe in the international context***.

The water JPI is an outward looking initiative of the Member States which builds upon previous actions in this area. It will provide a powerful framework for promoting the international interests of the European Union and its Member States in respect to economic growth and trade, foreign affairs, international development and humanitarian activities. European Member States are well recognized world leaders in water management, while the diversity of hydro-climatic, political and cultures has encouraged research and innovation to suit different conditions.

The Water JPI will build upon these strengths to increase international projection in water policy, regulation and management.

Significant impacts can be envisaged in the scientific and water policy communities, as well as in developing countries:

- The ***current European leadership in water research*** will be reinforced. Table 2 presents specific statistics for international water publications and patents. In the period 2006-2010, Europe produced 29 % of the world publications in the topic of this JPI. The USA ranked second, with 26 %. Fifteen years ago (1991-1995), the situation was reversed, with the USA leading (37 %) and Europe taking second place (18 %).
  As previously discussed, European scientists from different countries are increasing the percentage of co-authored papers, but this figure remains below 5 %.
  Finally, and making a difference with the general data presented in Table 1, Europe leads in the registration of international patents in water related topics.
- In coordination with the European Commission and SFIC[21], the JPI will establish ***bilateral contacts with major public RDI funding organizations in developed and emerging countries***, in order to further coordinate public water RDI activities.
  Such contacts have indeed already started, with participation at the Workshop and Conference held in India in November 2010.

[21] Strategic Forum for International S&T, http://register.consilium.europa.eu/pdf/en/10/st01/st01354.en10.pdf

These events paved the way for the upcoming co-ordinated and co-financed call for proposals in the field of water between the EU Framework Programme and India.

- The water management model implemented in Europe through the WFD will be analysed from the RDI perspective, and will be disseminated to the world as a ***European contribution to water management***.
- The ***international dimension of the Water JPI*** will contribute to such issues as the assessment of the water footprint of European imports and compliance with international biodiversity and other environmental conventions and protocols.
- The ***European Union Water Initiative*** (EUWI)[22] was launched to create the conditions for mobilising all available human and financial EU resources, aiming at achieving the water-related Millennium Development Goals (MDGs)[23] (particularly the one devoted to "*Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation*").

  The EUWI reinforces the political commitment and influences Poverty Reduction Strategies and allocation of resources. Efforts to achieve the MDGs embrace planning and action in both water resources development and management.

  Water JPI actions devoted to training and mobility, together with dissemination, will play a fundamental role to support the EUWI, since they are being designed with an International Scientific Cooperation perspective.

Only by: building on existing Resources, better pooling our efforts, focusing on excellence and by creating an efficient and fully integrated European Research Area in the field of water we will be able to tackle the grand challenge facing Europe's waters.

Table 2. Production of scientific papers (Web of Science) and PCT patents for Europe (Member States plus Associated Countries), USA and Japan in different periods of time.

Concept	Europe	USA	Japan
Production of Scientific papers (%)			
1996-2000	25	34	4
2001-2005	27	31	4
2006-2010	29	26	4
Multinational European Authorship (%)			
1996-2000	2.9	-	-
2001-2005	3.6	-	-
2006-2010	4.7	-	-
Production of PCT international patents (%)			
1995	48	38	7
2010	35	24	12

[22] http://www.euwi.net/

[23] http://www.un.org/millenniumgoals/