P.I.A.N.O.

Policies, **I**nnovation **A**nd **N**etwork for enhancing **O**pportunities for China-Europe water cooperation

Strategic Research and Innovation Agenda | SRIA

Project supported by the European Commission within the Horizon 2020 Programme Grant Number 642433

Contents

1. Foreword

Relations between the EU and China have developed rapidly since the first diplomatic ties were established in 1975. Since 1998, EU-China summits have been held almost every year. The creation of the EU-China Comprehensive Strategic Partnership in 2003 has deepened and broadened collaboration in a wide range of areas.

The EU-China 2020 Strategic Agenda for cooperation, jointly signed and adopted in 2013, provides strategic guidance for the relations between these two regions of the world on many topics, including science, technology and innovation.

In fact, both the EU and China need to foster science, technology and innovation (STI) development to address the economic, social and sustainability challenges they encounter. Interactions between the two regions have also been growing across themes such as environment, energy, climate issues and many others.

Within the field of environment, water is a priority for the cooperation with China. An EU-China water platform (CEWP) was established in 2012 to promote policy dialogue, joint research and business development in the water sector.

The European partners of the PIANO project (***Policies, Innovation, And Network for enhancing Opportunities for China-Europe water cooperation***) have worked on the development of this Strategic Research and Innovation Agenda (SRIA) document in close cooperation with the representatives of the Chinese institutions, who signed a letter of intent to be involved in the project activities at the time the proposal was presented to the European Commission for its funding by the programme Horizon 2020. Then, in 2015, the EU-China Research and Innovation Co-funding mechanism was not yet in place and Chinese researchers could not be proper partners in the PIANO project activities. Nevertheless, they have provided a very relevant and effective contribution to this SRIA by providing inputs via questionnaires and through workshops held within the PIANO project.

2. Executive summary

This PIANO Strategic Research and Innovation Agenda (SRIA) is conceived to be a forward-looking document. It is meant to support and provide input to the dialogues between the EU and China that set out the direction of future collaborative EU-China research and innovation activities in the water sector. The PIANO SRIA aims to support the activities of the China-Europe Water Platform as a reference document that aids the implementation of further initiatives of joint international cooperation between Europe and China to spur innovation in the water sector. This offers increasing opportunities to all interested actors, in particular European small and medium enterprises (SMEs) able to produce advanced technological solutions.

This document builds on strategic agendas of European and international actors in water management and attempts to align the underlying priorities set out in those agendas with priority common water challenges areas between the EU and China. Those priorities and focus areas were determined following a mapping study of existing SRIA for water at the EU and member state level. Common challenge areas were identified by the PIANO project, and refined through internal and external consultations among experts and relevant stakeholders from Europe and China.

Moreover, the PIANO SRIA seeks to foster concrete contribution to the achievement of the United Nations' Sustainable Development Goals and thus made specific efforts to highlight how each priority area links to specific goals set out in the 2030 Agenda for Sustainable Development.

This SRIA identifies suggested priorities in the EU-China cooperation in water innovation and offers a possible framework for how this can be structured. It also highlights opportunities for the development of further collaborative actions engaging public and private partnerships based on the sharing of knowledge and good practices. In this way, strategic long-term agreements involving multi-stakeholders in research and innovation applied to water management will be fostered. Researchers, governmental agencies, innovative enterprises and private stakeholders should combine synergies to strengthen innovation capacity and promote social and economic cooperation in both regions of the world.

3. Overview of the PIANO project

The H2020 project PIANO (***Policies, Innovation, And Network for enhancing Opportunities for China-Europe water cooperation***) aims at strengthening the international cooperation in the field of water between Europe and China and promoting the creation of networks of companies, SMEs, entrepreneurs, NGOs, policy makers, regulators and funding agencies to create business and social opportunities. The project's main objectives are strengthening and expanding the existing network of the China-Europe Water Platform (CEWP) to cover all actors relevant for cooperation between China and Europe in the water research and innovation domain (*work package 1*); identification of European technological water innovations and areas for joint development of innovative technological solutions that have a potential for their implementation in China (*work package* 2); identification of drivers and barriers concerning this cooperation and elaboration of strategies to overcome such barriers and take advantage of drivers for the implementation and replication of tech-

WP 1: NETWORKING AND COMMUNICATION
- Task 1: Optimizing networks synergies
- Task 2: Identification of networks that can strengthen and expand the CEWP
- Task 3: Networking and communication activities
- Task 4: Data collection on cooperation activities between China and Europe

WP 2: TECHNOLOGICAL WATER INNOVATIONS
- Task 1: Technological Water Innovation Landscape of Europe
- Task 2: Technological Water Innovation Landscape of China
- Task 3: Comparative analysis of European and Chinese technological water innovations

WP 3: DRIVERS, BARRIERS AND STRATEGIES
- Task 1: Update of existing knowledge
- Task 2: Identification of possible barriers for implementing and replication of technological water innovations
- Task 3: Development of strategies and recommendations for overcoming the identified barriers and taking advantage of drivers

WP 4: POLICY UPTAKE AND SRIA
- Task 1: Knowledge exchange on water innovation promotion between EU and China
- Task 2: Synthesis report
- Task 3: Policy recommendations and policy dialogues
- Task 4: Elaboration of a shared strategic research and innovation agenda for EU-China water cooperation

WP 5: DISSEMINATION AND EXPLOITATION
- Task 1: Project web page
- Task 2: Contribution to scientific conferences and scientific publications
- Task 3: Newsletters and brochures / flyers of project results for different target groups
- Task 4: Videos and webinars
- Task 5: Guest lectures on water innovation at Chinese academic institutions
- Task 6: Study tour of Chinese stakeholders to Europe
- Task 7: Dissemination workshops targeted to businesses
- Task 8: Final event at major international conference

nological water innovations in China (*work package 3*); promotion of knowledge exchange and policy dialogue to build an enabling environment for the uptake of technological water innovations with a great potential for implementation, further replication and market uptake in China; consolidation of a shared strategic research and innovation agenda (SRIA) between Europe and China water sector (*work package 4*); effective dissemination and mainstreaming of the project results to Chinese, European stakeholders and international target audiences (*work package 5*).

The main research areas of this international cooperation between Europe and China have focused on the following water domains, as delineated within this project:

- **agricultural water management;**
- **municipal water management;**
- **industrial water management;**
- **river basin management;**
- **water for energy;**

which therefore also represent the core themes of this SRIA.

PIANO project consortium is structured by the following partners:

EU SIDE PARTNERSHIP:

- University of Natural Resources and Life Sciences (BOKU) Vienna, Austria
- Technical University of Denmark (DTU) Kgs. Lyngby, Denmark
- International Office for Water (OIEAU) Limoges, France
- Italian National Institute for Environmental Protection and Research (ISPRA) Rome, Italy
- National Laboratory for Civil Engineering (LNEC) Lisbon, Portugal
- Stockholm International Water Institute (SIWI) Stockholm, Sweden
- W.S. Atkins International Limited (ATKINS) London, UK
- European Water Association (EWA) Hennef, Germany
- European Union Chamber of Commerce in China Beijing, China

CHINESE PARTNERSHIP:

- Chinese Secretariat of the China Europe Water Platform hosted by the Ministry of Water Resources (CEWP-MWR)
- Foreign Economic Cooperation Office of the Ministry of Environmental Protection (FECO-MEP)
- Development Research Centre of the Ministry of Water Resources (DRC-MWR)
- Chinese Academy of Environmental Planning (CAEP)
- Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences (RCEES-CAS)

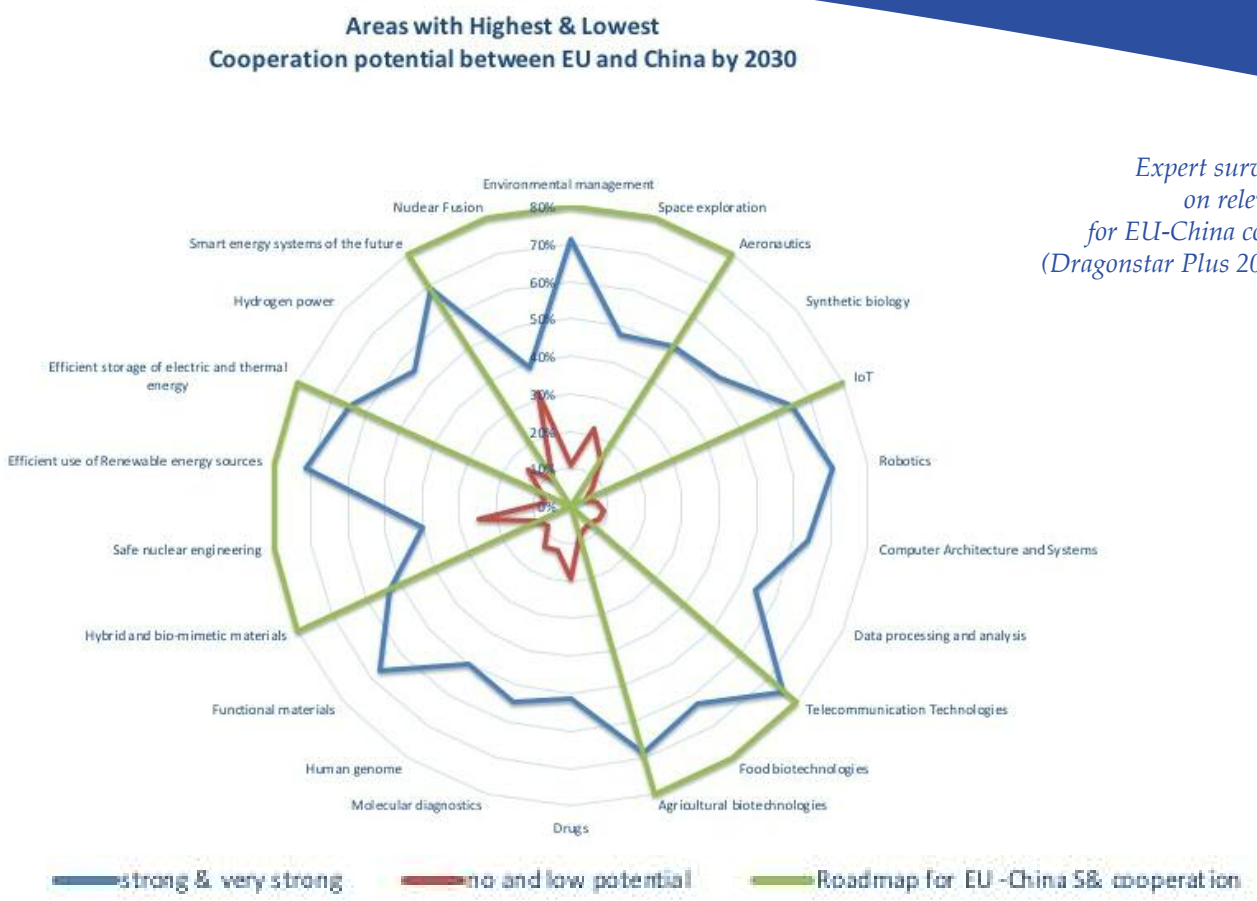
- China Institute of Water Resources and Hydropower Engineering (IWHR-MWR)
- Peking University, Center for Water Research (PKU-CWR)
- Tongji University, College of Environmental Engineering and Science (TU-CEES)
- Wuhan University, School of Water Resources and Hydropower Engineering (WHU-MOST)
- Institute of Hydroecology, Ministry of Water Resources & Chinese Academy of Sciences (IHE-CAS)
- Institute of Soil and Water Conservation, Chinese Academy of Science and Ministry of Water Resources, Yangling (ISWC-CAS)
- Center for Chinese Agricultural Policy, Chinese Academy of Sciences (CCAP-CAS)
- University of the Chinese Academy of Sciences, Sino-Danish Center for Education and Research, Beijing (UCAS-SDC)

Intense and proactive efforts were aimed to foster the promotion of knowledge exchange and policy dialogue between European and Chinese organizations dealing with water issues in order to build an enabling environment for the uptake of technological water innovations with a great potential for implementation and market uptake in China, and also for the elaboration of this shared Strategic Research and Innovation Agenda between Europe and China in the water sector.

4. Objectives

The PIANO Strategic Research and Innovation Agenda (SRIA) defines the innovation needs in the research domains of the project: agricultural water management, municipal water management, industrial water management, river basin management, water for energy. The document prioritizes objectives, topics and actions in the China-Europe water cooperation. It is based on key common challenges in the water sector identified by the PIANO consortium, and an analysis of the research, development and innovation needs reflected in major water-related research and innovation agendas in Europe and its member states.

The project Dragonstar Plus (2017) provided an assessment of areas with highest and lowest cooperation potential between the EU and China and made recommendations for areas to include in a roadmap for EU-China STI cooperation. Though not pointing out water specifically, it rates environmental management as a high potential cooperation area (see figure below). Both the volume and depth of cooperation on present and previous cooperation around water, through e.g. the China Europe Water Platform, as well as the Asia-Europe Meeting (ASEM) Water Network, demonstrate this is a topic of keen interest and importance to Chinese and European partners and could justify expanded SRIA cooperation in future.



Expert survey results on relevant areas for EU-China cooperation (Dragonstar Plus 2017, p. 57)

5. Challenges

Thus, the research and innovation priorities identified in the PIANO SRIA intends to serve as input and potential inspiration for the development of future collaborative actions between European and Chinese partners, including joint calls for funding R&I actions between researchers and relevant stakeholders in both regions of our globe. It aims to provide guidance to inform dialogue on future calls supported by the European Commission to strengthen the international cooperation between Europe and China as well as the activities implemented with the China Europe Platform. Those specific inputs into joint actions, or the exact selected framework for an agree EU-China SRIA on water, could be produced in future through dialogues brokered through platforms such as the CEWP, Dragonstar, ENRICH, etc.[1] According to the People's Republic of China's periodic plans for economic and social development, water is one of the most pressing

1 It is not the objective of the PIANO project or this document to provide those types of specific inputs to specific calls (e.g. to the FP-9, Urban or Water-JPI etc.), and as is provided by others e.g. Dragonstar Plus 2017.

concerns. About 20% of water resources are located in Northern China where 46% of the population lives, compared to about 80% of water resources which are located in Southern China, where 54% of the population lives and where only 35% of China's total arable land is located.

Population growth and rapid development of the Chinese economy have increased the demand for water and put their water resources under immense pressure. Since 1997, national water consumption has been slowly increasing. In 2013, it was 618.35 billion m^3, which is close to the control target of 635 billion m^3 by 2015. About 70% of China's population is expected to be urban by 2030, and there will be a higher demand for the consumption of clean water within the domestic water supply. Furthermore, increasing demand for grain will increase the pressure to secure national food production through improved water resources management.

In China water availability per capita is only 2,220 cubic meters, which is ¼ of the world average. For the 663 cities currently in China, there are more than 400 cities suffering from water shortage issues, and of these, >110 cities have severe water shortage. It is estimated that the daily water shortage for all cities in China is 16 million cubic meters; the affected industrial production value due to water shortage may reach more than RMB 200 billion per year; the affected urban population is about 400 million people.

In the Northern and Western Chinese regions, affected by frequent drought, water scarcity has caused the rapid decline of groundwater tables. Moreover, degrading water quality has put even further pressure on the available water resources across China and insufficient wastewater treatment capacity to clean the growing amount of wastewater, diffuse pollution from farmlands and uncontrolled discharges from industries have left surface water bodies heavily polluted with nutrients, xenobiotic organic chemicals and heavy metals.

In addition, floods in China have traditionally been a problem, while many of the major rivers are now controlled with large hydro-electric dams, impacts to downstream river ecology, extreme events and unregulated small and medium water bodies still pose a problem. Thousands of poorly constructed and aging dams, dykes, river training and irrigation schemes require risk assessment and rehabilitation to ensure safety, resilience and efficient hydropower.

Moreover, climate change is increasing the uncertainty of extreme weather events, making flood and drought risk management more difficult. In addition, rapid development

of the economy and population in China adds to the challenge of providing adequate flood control and drought relief. 60-80% of precipitation and river runoff are concentrated in the flood season, decreasing dramatically from southeast to northwest. In addition, there is a mismatch between water availability and sites of agro-industrial productivity with more land that is cultivated and fewer water resources in northern areas and less cultivated land and more water resources in southern areas.

To solve China's complex water issues, both hard and soft measures are needed: i) technological and engineering measures, etc. aiming at reinforcing water scientific and technological innovation; ii) soft measures including reform of policies, institutions and management aimed at deepening water management practices.

The Chinese government, through its Water Ten Action Plan (2015), is investing billions of RMB to tackle the main water challenges and provide enough and good quality water resources to its citizens, i.e. encompassing ca. 20% of world's population with only about 6% of the global freshwater resources available. With the aim of building an integrated water development system to support social, economic and environmental development by 2020, Water Ten Action Plan identifies six main general objectives:

- Build a command and Control System for Flood Control and Drought Relief,
- Limit Total Annual National Water Use to 670 billion m^3;
- Improve the Volume of Water Supply to 27 billion m^3;
- Build or renovate 434 Large-Scale Farmland Irrigation Schemes;
- Ensure that 80% of National Rivers and Lakes Exceed Water Quality Standards;
- Build a complete, Integrated Water Management System.

6. Methodology used for the development of the PIANO SRIA

6.1 - REVIEW OF EXISTING WATER-RELATED SRIAS

The PIANO SRIA results from a collective, forward-looking exercise that identified and set out an integrated vision of water priorities in order to create a strategic cooperation partnership for water research and innovation between Europe and China, promoting the creation of networks of companies, entrepreneurs, no-profit organizations, policy makers, regulators and funding bodies to create business and social opportunities for China Europe Water Cooperation.

Strategic agenda	Network	SRIA Priority
WssTp European Technological Platform on Water	**European Technology Platform for Water**: 179 members and a network of more than 700 individuals from industry, research, technology providers, policy makers and water users	Innovations
Water JPI Strategic Research and Innovation Agenda 2.0	**The Joint Programming Initiative on water (Water JPI) 'Water Challenges for a Changing World:** it is focused on successful European cooperation among Member State and other international countries in order to create synergies between science and policy, users and suppliers of water services, and also in order to create instruments for implementing European research programmes, overcoming the most difficult barriers if addressed to each member state, by creating common strategy, themes and joint research programmes	Research and innovation
EIP Partnership on Water	**European Innovation Partnerships (EIP):** it aims facilitates the development of innovative solutions to address major European and global water challenges, supporting the creation of market opportunities for these innovations, both inside and outside of Europe	Innovation
ACQUEAU Strategic Research Agenda	**Acqueau** is an industry cluster, driven by the Eureka initiative and related to water technologies and innovation. The Agenda of Acqueau focuses on key technological areas; the main objective is to map out specific technology needs and gaps within the whole water sector	Innovation
Blueprint to Safeguard Europe's Water Resources	**The Blueprint** focuses on EU water policy, in particular the WFD (*Water Framework Directive*, 2000/60/EC) and the related and linked other Directives (*Floods Directives*, Nitrate directive; Marine strategy Directive, Wastewater treatment directive, Drinking Water Directive, Bathing Water Directive), setting implementation strategies, guidelines and basic principles for water management	Research, development and innovation

To achieve this objective, the project first compared existing strategic water and research innovation agendas in Europe and China. From each reviewed agenda, the priority **"Research, development and innovation needs in the water sector"** was extracted and compiled into a list of research and innovation needs and actions. This provided information on existing prioritized areas, which where then compared against the PIANO project objectives and identified challenge areas. Based upon the objectives of the PIANO project, separate priority areas for a strategic research agenda and a strategic innovation agenda were produced (see annex 1). This document, however, merges these into a proposed Strategic Research and Innovation Agenda.

Vision, needs and actions highlighted in the agenda of ACQUEAU, the water industrial cluster of the Euro-

Strategic agenda	Network	SRIA Priority
ASEM documents on water	The **ASEM Water Resources Research and Development Centre** is an organization focused on water science research and development based in China, built under the ASEM (Asia-Europe Meeting) council. The main objective of the ASEM Water organization is to develop a collaborative platform in the sector of water resources research and innovation, involving all stakeholders interested in the water sectors related to the relationship between Europe and Asia, China in particular	Research, development and innovation
China's water resources management challenge: The three red lines	**The three red** line is the policy document related to State Council of China which recognizes and emphasized the strategic importance of the integrated water resources management approach (IWRM) in China, in order to face the critical water challenges and in particular in the Chinese context of strong and rapidly growing and social - infrastructural development	Research, development and innovation
Connect-EU Water Group 'Strategic Research Agenda (Spain)	**Connect-EU** is the strategic research agenda of Catalonia is built according to five main water thematic areas identified, within which the Research and Developments Priorities needs are classified according to the following matrix: Applications and R&D priorities - water challenges addressed	Research and development
International Strategy for Finland's Water Sector (Finland)	**The Finland International Strategy for Water Sector** is focused on freshwater and the sustainable use of natural resources. It establishes the priority areas for development and innovation actions on the integrated water management system and the research actions to be implemented through both national programmes and international partnerships	Innovation
Italian strategic research agenda: National strategy on adaptation to climate change (Italy)	**The Italian National Strategic Agenda on Water** is part of the national document of the action plan for adaptation to climate change, edited by the Ministry of the Environmental Land and Sea protection. The section dedicated to water resources protection sets a number of key thematic areas for further actions as well as priority actions in order to support the national strategies for water management	Innovation

pean programme EUREKA, in the SRIA of the Water Supply and Sanitation Technology Platform WssTP and the implementation plan of the European Innovation Partnership on water (EIP-Water) are close to the general conceptual framework of the PIANO project and are very relevant in identifying key technology areas of interest able to tackle the main present and future water challenges.

The Central Chinese Government policy documents on water resources management were also examined to extrapolate the main problems pointed out and to compare measures and solutions proposed. The Water Ten Actions Plan and the 12Th and 13th Five-Year Plan for economic and social development of People's Republic of China were also taken into consideration. Further contributions to this mapping exercise were also provided by some representatives of Chinese institutions who are involved in the PIANO activities.

The PIANO project also conducted an extensive exercise to identify and categorize European technological water innovations (TWI) that have potential for application in China (a full catalogue of the identified TWI's is available on the project website: www.project-piano.net and www.isprambiente.gov.it/files/progetti/piano/TWIscatalogue.pdf). This SRIA draws upon this analysis to provide examples of existing European TWI's in each domain area. These are meant to serve as representative examples to highlight the existence of new relevant technologies in Europe for piloting and/or commercial applications. They are not meant to serve as direct recommendations to those specific technologies.

Moreover, the elaboration of a research agenda based on the outcomes of the TWIs mapping exercise performed in PIANO WP 2 and on the analysis of drivers, barriers and strategies to improve water cooperation between Europe and China carried out by WP 3 was envisaged as follows:

For those TWIs which were identified of having a potential for application in China, it was investigated whether research is required to overcome any identified barriers;

For those water challenges where no suitable TWIs were identified, a joint EU-China research agenda (see annex) was proposed to develop TWIS.

An innovation agenda was also proposed (see annex 1) to help create market opportunities in China such as pilot and demonstration projects based on the strategies to overcome barriers to cooperation in water innovation between Europe and China highlighted in PIANO WP 3.

6.2 - CROSS CUTTING THEMES AND ACTIVITIES

Almost all water related challenges highlighted in the revised documents and analysed SRIAs could broadly be categorized as fitting within five broad categories of water management (water scarcity, water pollution, droughts and floods; ecosystem degradation; water infrastructure issues).

Furthermore, a sixth category, bringing together those cross-cutting issues, has been introduced in order to consider those actions not directly related to water technology, such as the implementation of environmental regulations and laws, actions to encourage social acceptance of the reuse of water, as well as water-saving policies, capacity-building activities and general social policies.

All Strategic Research and Innovation Agendas analyzed emphasize the need to join implementation and development of best water technologies on the one hand with policy and actions to promote proper integrated water management and social awareness on the other hand.

This integrated water management, for example, aims to manage in a proper way and limit the existing conflicts between different water uses in areas such as industrial, agricultural, urban water use as well as the production of energy. It also aims at implementing the sustainable use of the water resource in an eco-systemic approach, considering that water resource is a limited resource even if it is renewable with the natural hydrological water cycle.

The integrated management of water resources has also the compelling goal to increase water saving approaches, thus allowing the reduction of environmental pollution and improving in the meantime the quality of water-dependent ecosystems.

According to the strategic documents produced by the considered international initiatives, those concerning urban areas are the most critical issues for their impact on population: flash flooding, water scarcity and sanitation, water infrastructures – both aging and lacking infrastructures.

The technologies dedicated to the improvement of sustainable urban water drainage systems (SUDS) must be complemented by Decision Support Systems (DSS) for forecasting, control and urban water management, in order to face flash flooding both in cities and rural areas, safeguarding both human life and infrastructure.

Urban sustainable drainage systems rely on the capacity to contrast water pollution, for example due to storm water in cities and effects of the pollutant loads of first flush runoff water. New green technologies, nature-based solutions, new concepts such as that related to “Sponge Cities” and innovative technologies that are being implemented in China, are also closely linked to the climate change adaptation and mitigation actions.

Many of the analysed Agendas and Chinese documents on water point out the attention on the status (quality, aging, lacking) of water infrastructure (networks, pipes, water facilities, wastewater plants), and indicate that these critical elements limit the economic growth of China's (e.g. in industrial, agricultural and urban sector). The occurrence of these problems, therefore, requires further investments and implementing policies able to improve water infrastructure and facilities.

Such actions have also a direct benefit on water saving, leading to the improvement of water quality and availability, and increasing the capacity to tackle extreme events, both floods and droughts. Finally, these actions on water infrastructures indirectly bring benefits to ecosystems restoration (more quality of water, less pollution loads, lower emissions etc.).

From the analysis carried on the existing water-related SRIAs, their implementation plans, vision and guidance documents of international initiatives focused on water research and innovation main topics and actions were extrapolated for both domains.

6.3 - INTEGRATED APPROACH AND IDENTIFICATION OF PRIORITIES

The need to implement integrated water management and develop best water technological solutions to foster this holistic approach also through adequate policies and actions able to promote, at the same time, a better social awareness is highlighted in all strategic documents examined for the elaboration of the PIANO SRIA.

Inputs also came from the analysis of drivers, opportunities, barriers and strategies for innovative EU technologies in the Chinese water sector carried out within the activities of PIANO WP 3. This analysis was done for the water sector as a whole, and for specific types of technologies selected from those identified by the mapping exercise performed by PIANO WP2 as being well developed in Europe but not yet on the Chinese market.

Successively, relevant contributions were collected through a questionnaire circulated to water experts in China and in Europe. The survey addressed the five research areas of the PIANO project and the main water challenges identified for the joint development of the cooperation between Europe and China. The answers received to this questionnaire were analysed, aggregated and taken into consideration for the development of the PIANO SRIA.

In particular, the questionnaire was subdivided into five main sections, corresponding to the five water domains focused by the PIANO project.

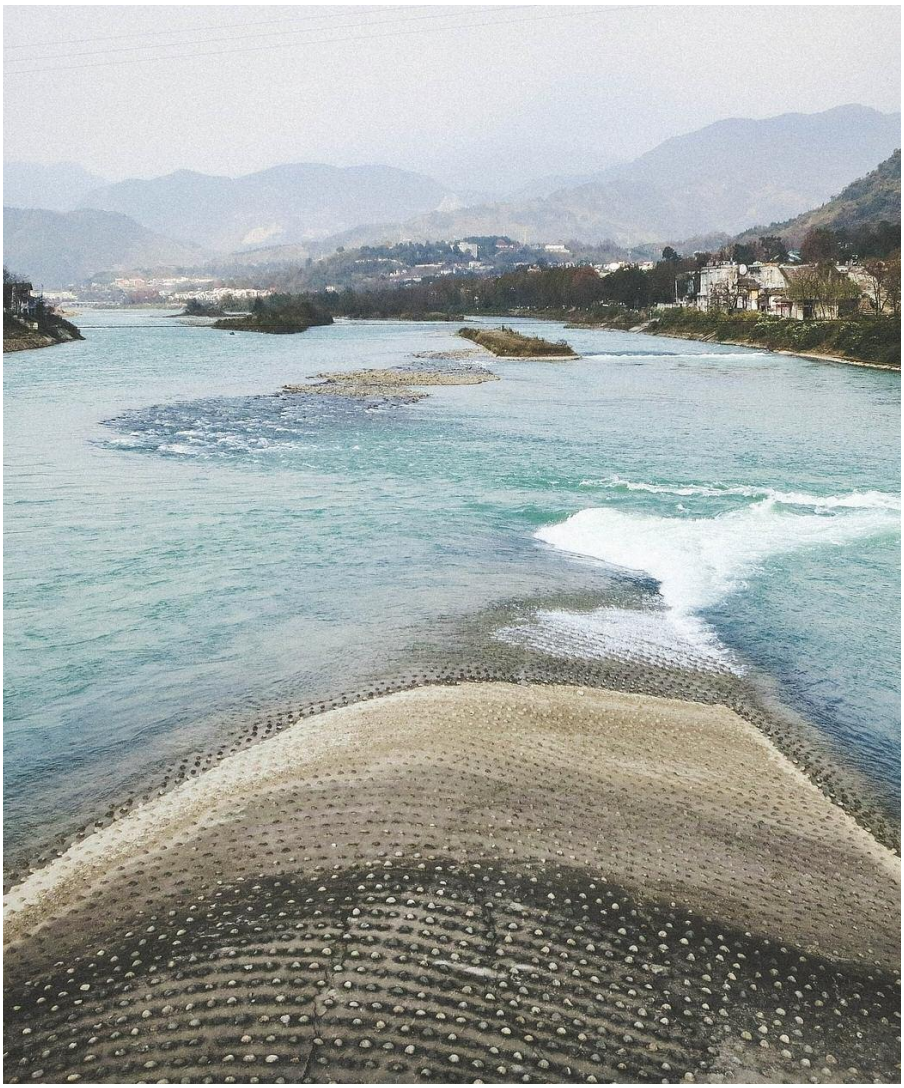
For each domain, it was required to give a priority level to the actions to be undertaken to better address each water challenge and achieve the project goals.

Depending on the actions selected, the survey also asked to state the application fields considered more relevant: innovation actions, research and innovation actions or a cross-cutting action.

- RIA (research and innovation actions): R&D to establish new knowledge or explore the feasibility of a new or improved technology, product, process, service or solution (including basic and applied research, technology development and integration, testing and validation on a small-scale prototype in a laboratory or simulated environment);
- IA (innovation actions): innovation activities directly aiming at producing plans and arrangements or designs for new, altered or improved products, processes or services (including prototyping, testing, demonstrating, piloting, large-scale product validation and market replication)

Moreover, a cross analysis and identification of links with Strategic Development Goals from United Nations have been considered very relevant for this SRIA focused on the international cooperation between Europe and China in the water sector.

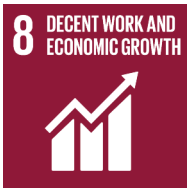
On 1 January 2016, the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development — adopted by hundreds of world leaders in September 2015 at an historic UN Summit — officially came into force. Sustainable development has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.



The following SDGs have been identified as priorities for the PIANO project:

SDG# 6: Ensure availability and sustainable management of water and sanitation for all

SDG# 7: Ensure access to affordable, reliable, sustainable and modern energy for all



SDG# 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

SDG# 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

SDG# 11: Make cities and human settlements inclusive, safe, resilient and sustainable

SDG# 12: Ensure sustainable consumption and production patterns

SDG# 13: Take urgent action to combat climate change and its impacts

SDG# 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development

SDG# 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and **reverse**

7. Core domains

7.1 AGRICULTURAL WATER MANAGEMENT

Agriculture has been identified as one of the main issues in China's 13th Five-year Plan (2016-2020). This document identifies the mechanization of agriculture, the promotion of more innovative technologies that respect environmental standards and better planning and management of agricultural areas as fundamental requirements for the future economic development of the country. Thanks to the irrigation works constructed in the past more than 60 years, the effective irrigation area has increased from 16 million ha in 1949 to 62 million ha. Irrigation projects have played a crucial role for China to feed 21% of the world population with 6% of the world's total fresh water resources and 9% of the world's total arable lands.

Water management and water use in agriculture are strictly correlated. At macro-level rural water and food security constitutes two of the greatest risks to social stability of China. In 2013, the agricultural water sector used 63% of the total 618 billion m^3 water used in China. Due to different causes, such as the use of inefficient "flood irrigation" for farmland, one of the major urgencies is to increase water use efficiency as a means to control the increasing water scarcity. In 2013, irrigation with water saving techniques accounted for only 43% of the irrigated farmland. China's 12th Five-year Plan (2011-2015) included a target to increase the irrigation efficiency index from 0.5 to 0.53, allowing to achieve an actual target corresponding to 0,532. (see Appendix II of the U.S. - China Economic and Security Review Commission "The 13th Five Year Plan")

In 2013, it has been estimated that ca. 60% of the groundwater in China is unsuitable for drinking water supply. In the Water Ten Regulations, China has set a national target to not exceed 15% of extremely bad quality groundwater.

The challenges requires new management approaches and measures to sustain continued socio-economic development and to ensure sustainable production for a rapidly growing population. The impact are particularly severe in northern China where the rainfall declines from 600 – 700 mm

As for the surface water pollution, rural areas lack sewage collection and treatment systems, as well as a garbage collection and removal systems.

As specified in the "Three Red Lines" document and lately refined in the Water Ten Regulations, improving the surface water quality represents a priority in China.

The already cited document (U.S. - China Economic and Security Re-

view Commission "The 13th Five Year Plan") taking into consideration the Surface Water Quality, sets at 66% the achieved target related to the percent of water meeting or exceeding Class III level at the end of 2015, with a forecast for > 70% by 2020 (target of the 13th Five Year Plan).

Moreover, serious floods and droughts often hit farmland and agricultural areas, resulting in major losses of life and property and exposing serious weaknesses in water conservancy infrastructure, including farmland irrigation and drainage.

The activities of domain 1 aim to tackle the following issues:

to reduce water scarcity by increasing water saving techniques and water management;

to reduce water pollution by focusing on new irrigation technologies as DDS and techniques for water reuse and safety through wastewater reuse;

to control and manage flood and extreme events for reducing impacts on the agricultural sector.

Expected impact of the action is described within the logical framework for all the different work package activities. The main impact will be in terms of providing a more sustainable management of water resources in rural areas affected by water scarcity and various types of pollution. An improved water management in rural areas will lead to more social welfare of people living and working in these areas, decreasing the probability of conflict between different interest in that domain.

In this perspective, the present domain will focus on the next high priority actions for the following challenges:

CHALLENGE 1
WATER SCARCITY

ACTIONS:
WATER REUSE, WATER SAVING AND EFFICIENCY IN IRRIGATION SYSTEMS

Listed among the main challenges facing the Chinese government are the implementation of water-saving policies and technologies, including

water recovery and recycling, the development of more efficient systems for abstracting underground water resources, and precision irrigation technologies.

CHALLENGE 2
WATER POLLUTION
ACTIONS:
NUTRIENT AND PESTICIDE MANAGEMENT AND REMOVAL FOR WATER POLLUTION REDUCTION

Nutrient and pesticide reduction through adequate management is based on technologies for pollution prevention, such as manure separation and treatment, precision irrigation and energy recovery technologies, as well as water-related technologies to tackle soil degradation due to salinity, erosion, clogging and oxidation. It will be just as necessary to develop appropriate tools (DSS) to support the management and extend technologies for pollution monitoring.

CHALLENGE 3
EXTREME EVENTS (DROUGHTS AND FLOODS)
ACTIONS:
MONITORING AND EXTREME EVENTS MANAGEMENT

With the aim of controlling floods and preventing drought, forecasting and early warning systems must be implemented; planning interventions with the related actions is also necessary.

The next table summarizes the challenges and corresponding actions according to their scale of priority, which emerged from the questionnaire analysis.

*(*) **IA**: Innovation Action.*
__RIA__: Research and Innovation Action. (See definition in chapter 6.3)
(**) The icons are referred to the "Sustainable Development Goals", also known as "Global Goals" identified by UNDP as universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The chosen icons are considered to be relevant to the actions listed in the domain.

Research and Innovation actions	Type of actions (*)	SDGs Goals (**)
CHALLENGE 1 - WATER SCARCITY		
Irrigation technologies and irrigation management: DSS and modelling for water resources assessment	RIA & IA	
Water reuse: new technologies (e.g. cascading systems); Safe reuse of treated wastewater reuse	IA	
Efficiency of water use; Groundwater efficiency in irrigated agriculture	IA	
CHALLENGE 2 - WATER POLLUTION		
Nutrients and pesticide technologies management; Technologies for pollution remediation - manure separation; manure treatment technologies	RIA & IA	
Water-related soil degradation technologies (salinity, erosion, degradation, clogging, oxidation)	RIA & IA	
Technology for pollution monitoring;	RIA & IA	
CHALLENGE 3 - EXTREME EVENTS: FLOODS AND DROUGHTS		
On-line monitoring and forecasting of floods and droughts;	RIA	
Early warning system, forecasting of extreme events; floods control; DSS	RIA	
Remediation technologies	RIA & IA	

AGRICULTURAL WATER MANAGEMENT AVAILABLE TECHNOLOGIES

Referring to Agricultural Water Management Technologies, the table below shows some of the principal available technological innovations to be taken into consideration in order to reach the priorities identified and discussed.

Technological Water Innovations (TWI)	TWI Category	TWI Subcategory
Groundwater sampling system with passive samplers measuring volatile organic compounds such as chlorinated solvents and constituents of petroleum fuels in groundwater, including sampler analysis. It could be used for extraction of soil-water from dry boreholes during contaminated site investigation	Groundwater technology	Monitoring technologies (incl. DSS)
DSS: SCADA remote control system, based on the qualitative parameters of treated water to be used for irrigation purposes	Irrigation technology	Real-time estimation tools
Software for nitrogen budgeting for each crop based on estimates of crop demand and nitrogen availability from various fertilizers	Irrigation technology	Real-time estimation tools (DSS)

7.2 MUNICIPAL WATER MANAGEMENT

China is a country that is particularly affected by water-related challenges in relation to and partly caused by rapid urbanisation and industrialisation. The water related challenges in the urban area are closely linked to the green urban policies and part of China's development strategy to move towards a green economy.

Water supply covered ca. 90% of domestic water demand in cities, so this supply deficit stimulates construction of private water supply facilities in areas where public water supply is unavailable. This results in extensive and uncontrolled use of water and risk for poor water quality. Water scarcity in Northern China has stimulated a search for alternatives to the overexploited local surface water and groundwater

resources, such as desalination plants, aquifer recharge and river-bank filtration but all these alternative sources are still at an early stage due to lack of advanced technology and governmental support. Furthermore, linking of water tariffs with local water scarcity will increase the raw water price and thereby the demand for water-saving household technologies.

Another class of water use challenges are related to efficiency in the supply network. The average water loss due to leaks in the urban supply system network was reported at 15% in 2010, which overtakes national standard limits of 12%. The increasing demand for clean drinking water brings a need for alternative or energy-efficient treatment technologies along with a safe distribution network to avoid contamination between the treatment plants and the end users.

According to the Water Ten Regulations, municipal wastewater treatment plants should meet the discharge standard of Class A (best) in key lake areas, reservoirs areas and catchment areas by the end of 2017. In 2015, the rate of recycled water utilization has been targeted at 15% and the rate of harmless sludge disposal to 70% in cites and 30% in both counties and towns.

The activities of Domain 2 aim to tackle the following issues:

- to reduce water scarcity while increasing public supply coverage, using water saving and water management techniques;
- to reduce water pollution focusing on new municipal wastewater treatment plants;
- to control and manage flood and extreme events through integrated risk assessment and management of urban flooding, forecasting technologies and DSS;
- to reduce ecosystem degradation developing better methods and tools to determine environmentally sustainable river flows;
- to increase water infrastructures through management tools and monitoring system technologies

In this perspective, the present domain will focus on the next high priority actions for the following challenges:

CHALLENGE 1
WATER SCARCITY
ACTIONS:
WATER SAVING TECHNOLOGIES AND WASTEWATER REUSE

Water reuse infrastructures and metering technologies, drinking water production from wastewater resources, desalination and rainwater harvesting technologies, recovery and raw material technologies from sludge and wastewater for energy purposes.

CHALLENGE 2
WATER POLLUTION
ACTIONS:
RISK ASSESSMENT AND MANAGEMENT TOOLS AGAINST WATER POLLUTION

Tools and management approaches to reduce water pollution in municipal areas such as microbiological risk assessment, monitoring technologies and development of methods to remove point, diffuse chemical-biological pollutants linked to real time monitoring and control systems.

CHALLENGE 3
EXTREME EVENTS (DROUGHTS AND FLOODS)
ACTIONS:
STORM WATER MANAGEMENT AND SYSTEMS FOR FLOOD AND DROUGHT ASSESSMENT

Using nature based solutions and management systems to improve the sustainable urban drainage system and DSS (Decision Support System).

CHALLENGE 4
ECOSYSTEM DEGRADATION
ACTIONS:
METHODS TO DETERMINE ENVIRONMENTAL FLOW NEEDS

Approaches and methods to determine environmental flow needs, which could decrease ecosystem degradation.

CHALLENGE 5
WATER INFRASTRUCTURES
ACTIONS:
IMPROVE WASTEWATER COLLECTION UNDER TREATMENT SYSTEMS THROUGH MONITORING AND MANAGEMENT TECHNOLOGIES

Methods-technologies for identification (monitoring) and remediation of corrosion aging related to below ground assets and asset management tools for sustainable maintenance programmes. Moreover, a priority is to improve wastewater collection within existing treatment systems through monitoring and management technologies.

The next table summarizes the challenges and the corresponding actions according to their scale of priority.

(*) IA: Innovation Action.
RIA: Research and Innovation Action.
(See definition in chapter 6.3)
(**) The icons are referred to the "Sustainable Development Goals", also known as "Global Goals" identified by UNDP as universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The chosen icons are considered to be relevant to the actions listed in the domain.

Research and Innovation actions	Type of actions (*)	SDGs Goals (**)
CHALLENGE 1 - WATER SCARCITY		
Reducing leakage from pipe networks	RIA & IA	
Drinking water production from wastewater and alternative water resources	IA	
Data integration technologies to improve data availability	RIA	
CHALLENGE 2 - WATER POLLUTION		
Technologies for emerging pollutants; technologies to harvest resources from wastewater and reused water; Wastewater treatment technologies (WWT)	RIA & IA	
Monitoring technologies and methods to remove point and diffuse chemical – biological pollutants	IA	
Real-time monitoring and control systems (wastewater network management): District metering areas	IA	
CHALLENGE 3 - EXTREME EVENTS: FLOODS AND DROUGHTS		
Storm water management systems improve Sustainable Urban Drainage Systems (SUDSs)	RIA & IA	
Natural hazards: Nature based solutions to mitigate urban floods	RIA & IA	
Decision Support Systems	RIA & IA	
CHALLENGE 4 - ECOSYSTEM DEGRADATION		
Methods to determine environmental flow needs	RIA & IA	
CHALLENGE 5 - WATER INFRASTRUCTURES		
Below ground assets: methods-technologies for identification and remediation of corrosion-aging	RIA & IA	
Asset management tools for sustainable maintenance programmes	RIA & IA	
Improve water systems: Monitoring technologies of water systems; Management technologies	RIA & IA	

MUNICIPAL WATER MANAGEMENT AVAILABLE TECHNOLOGIES

Referring to Municipal Water Management Technologies, the next Table reports some of the principal technological available innovations to be taken into consideration to reach the priorities identified and discussed above.

Technological Water Innovations (TWI)	TWI Category	TWI Subcategory
Technology for monitoring of coliform bacteria and E. Coli in drinking water. The principle of the technology is measurement of colour or fluorescence produced by the bacteria through cleavage of specific substrates added to the water. The technology is based on a chemical reaction between a substrate in the growth medium and enzymes produced by the coliform bacteria	(Source) Water Extraction, Treatment, Distribution	Monitoring/Sensors during Water Treatment
Vertical Sequencing Batch Reactor System for reducing cost and space of treatment plants	Used Water Collection, Treatment, Disposal	Bioprocesses for Carbon (and more) removal
UV-VIS multi-parameter-based measurement sensor for the measurement of nitrate and nitrite in wastewater	Used Water Collection, Treatment, Disposal	Monitoring/Sensors during Used Water Collection/Treatment

7.3 INDUSTRIAL WATER MANAGEMENT

Since the year 2000, the industrial water consumption has increased by a small margin, recycling rate has remarkably improved, but still higher than the average level of developed countries. The industries with high water use and discharge are quite concentrative.

Industrial water use in China is ca. 23% of the total water use and the industrial water consumption (water use minus return flow) rate was 23% of the industrial water use in the past. In 2012, the industrial water use was 69 m^3 per 10,000 Yuan of industrial added value.

Wastewater discharged from industrial sectors was 21 billion tons in China in 2013, corresponding to 30% of the total wastewater discharges. Industrial wastewater discharges are the cause of severe pollution challenges in Chinese rivers and lakes. Reuse and recycling of industrial water will be promoted in cities facing severe water scarcity and water quality challenges. According to the Action Plan on Water Pollution Prevention and Control by 2020, the recycled water utilization rate should reach 20% in cities with water shortages, and 30% in the Beijing-Tianjin-Hebei region.

The activities of Domain 3 aim to tackle the following issues:

- To reduce water scarcity through application of monitoring technologies, water saving and water management technologies with the aim to reuse industrial waste water and close the water cycle;
- To reduce water pollution through advanced water treatment technologies.

In this perspective, the present domain will focus on the next high priority actions for the following challenges:

CHALLENGE 1 WATER SCARCITY ACTIONS: TECHNOLOGIES AND SYSTEMS TO REDUCE WATER SCARCITY

With the aim to close the water cycle gap, developing sustainable use of resources through recovery energy and raw material technologies from sludge and wastewater.

CHALLENGE 2 WATER POLLUTION ACTIONS: MONITORING AND TREATMENT TECHNOLOGIES AGAINST WATER POLLUTION

New technologies and systems for monitoring water quality and advance water treatment technologies (energy efficient systems: small-scale system technologies for specific pollutants removal). Improving water quality through advanced water treatment technologies (Membrane technologies; Advanced, biological, treatment, solid separation).

The next table summarizes the challenges and the corresponding actions according to their scale of priority.

Research and Innovation actions	Type of actions (*)	SDGs Goals (**)
CHALLENGE 1 - WATER SCARCITY		
Technologies aimed to develop sustainable use of resources and to close the water cycle	RIA & IA	
Water saving technologies (energy efficient systems) and water reuse technologies	RIA & IA	
Recovery energy and raw material technologies from sludge and wastewater - energy and nutrient recovery technologies	RIA & IA	
CHALLENGE 2 - WATER POLLUTION		
Monitoring technologies to improve water quality control and discharges	RIA & IA	
Advance water treatment technologies - energy efficient systems: small scale systems technologies to specific pollutants removal	IA	
Wastewater Treatment technologies: Membrane technologies; Advanced, biological, treatment, solid separation	RIA	

(*) IA: Innovation Action. RIA: Research and Innovation Action. (See definition in chapter 6.3)

(**) The icons are referred to the "Sustainable Development Goals", also known as "Global Goals" identified by UNDP as universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The chosen icons are considered to be relevant to the actions listed in the domain.

INDUSTRIAL WATER MANAGEMENT AVAILABLE TECHNOLOGIES

Referring to Industrial Water Management Technologies, the next table reports some of the principal technological available innovations to be taken into consideration in order to reach the priorities identified and discussed above.

Technological Water Innovations (TWI)	TWI Category	TWI Subcategory
Ultrasound-based disinfection technology with combination of ozone	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water, Collection, Treatment, Disposal
Dynamic Vapour Recompression to concentrate salt and carbonate rich liquids up till concentration level	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water, Collection, Treatment, Disposal
High-rate anaerobic reactor for wastewater treatment (primarily organic constituents) and biogas production	Bioprocesses for C (and more) removal	Used Water, Collection, Treatment, Disposal

7.4 RIVER BASIN MANAGEMENT AND FLOOD CONTROL

Flood protection has always been a high priority in China. Small and large dams, temporary flood retention areas, dykes and river spillways have the purpose to control rivers throughout China. At the same time, existing urban drainage systems in the major cities are relatively inefficient regarding capacity to cope with urban floods.

Serious challenges with urban waterlogging during intense precipitation events due especially to high urbanization rate have led to the design of a new drainage pipeline network for 1-3 year rain events for general areas of the cities and 3-4 year events in key identified areas of the cities.

In an effort to avoid the huge economic, social and humanitarian damages caused by flooding, in 2013 the Chinese Central Government called for the widespread adoption of "the sponge city" approach, providing funds for pilot activities in 16 urban districts. Sponge cities are designed not only to funnel rainwater away but also to retain and reuse it to recharge depleted aquifers, irrigate parks and gardens, flush toilets and clean houses. Through enhanced infiltration, evapotranspiration and capturing methods, such as for instance replacing concrete drains with permeable green areas, water can again seep into the soil and replenish groundwater.

Rapid urbanization, uncontrolled land-use and development of industrial zones have increased both urban and river flooding risks and increased water pollution in Chinese rivers. Domestic and industrial discharge of untreated wastewater, diffuse pollution from agriculture and precipitation delivering persistent organic pollutants to the rivers, are some of the major pollution sources.

The activities of Domain 4 aim to tackle the following issues:

- Optimization of water uses, water saving and management, through mitigation strategies and monitoring systems with the aim to reduce water scarcity
- Reducing water pollution through remediation technologies for contaminated sites and data integration technologies
- Mitigation of extreme events using technologies for seasonal forecasting (drought) and numerical models, through land management projects, developing tools and new technologies for adaptation to floods and droughts
- Reducing ecosystem degradation through research on ecological flows, nature based solutions and integrated river basin management tools

In this perspective, the present domain will focus on the next high priority actions for the following challenges:

CHALLENGE 1
WATER SCARCITY
ACTIONS:
MONITORING AND MANAGEMENT FOR WATER SCARCITY

Through optimization of water uses and water saving management technologies such as modelling systems and DSS, water scarcity will be reduced. Moreover, monitoring systems and aquifer management technologies are important tools for reaching the goal.

CHALLENGE 2
WATER POLLUTION
ACTIONS:
NEW TECHNOLOGIES AGAINST WATER POLLUTION

Technologies for contaminated sites, remediation (passive and active), early warning systems and data integration technologies are important tools to combat water pollution and monitoring parameters such as hydrological parameters and water quality chemical and microbiological standards.

CHALLENGE 3
EXTREME EVENTS (DROUGHTS AND FLOODS)
ACTIONS: FLOOD PROTECTION AND EXTREME EVENTS PREVENTION

Through new remote sensing technologies such as Doppler radar and wireless sensors, integrated with coastal and fluvial DSS systems, such as hydrological and meteorological models and forecasting monitoring systems, flood and drought risk could be reduced, in particular through the application of risk based decision-making and planning tools.

CHALLENGE 4
ECOSYSTEM DEGRADATION
ACTIONS: ECOSYSTEM RESTORATION
The reduction of pressure impacts leading to ecosystem degradation is the main goal to be reached through a new water management scheme, new technologies and research on restoration methodologies for aquatic systems (hydraulic connectivity, sediment transport, etc.)

The next table summarizes the challenges and the corresponding actions according to their scale of priority.

(*) IA: Innovation Action. RIA: Research and Innovation Action. (See definition in chapter 6.3)
(**) The icons are referred to the "Sustainable Development Goals", also known as "Global Goals" identified by UNDP as universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The chosen icons are considered to be relevant to the actions listed in the domain.

Research and Innovation actions	Type of actions (*)	SDGs Goals (**)
CHALLENGE 1 - WATER SCARCITY		
Optimization of water uses and water saving; water balance modelling systems	IA	
Monitoring system to assess GW abstraction and recharge; Managed Aquifer Recharge Technologies	RIA & IA	
Freshwater bodies classification and matching alert system; Freshwater overexploitation	IA	
CHALLENGE 2 - WATER POLLUTION		
Technologies for contaminated areas remediation	RIA & IA	
Survey the state of degraded water resources systems; Studying and modelling the transfer of contaminants	RIA	
Data integration technologies - hydrological parameters, pollution loads, water quality	RIA	
CHALLENGE 3 - EXTREME EVENTS: FLOODS AND DROUGHTS		
New remote sensing technologies (satellite, Doppler radar, wireless sensors etc.)	RIA & IA	
Risk Based decision making and planning tools	RIA & IA	
Develop tools and new technologies for adaptation to floods and droughts - Early Warning Systems	RIA	
CHALLENGE 4 - EXTREME EVENTS: FLOODS AND DROUGHTS		
Develop new Water Management schemes - policy, regulations, monetary model, governance	RIA & IA	
Ecological engineering and Ecohydrology: research on restoration methodologies of aquatic systems	RIA & IA	
Nature Based Solutions: use of new natural materials	RIA & IA	

RIVER BASIN MANAGEMENT AND FLOOD CONTROL AVAILABLE TECHNOLOGIES

Referring to River Basin Management and Flood Control Technologies, the next table reports some of the principal available technological innovations to be taken into consideration to reach the priorities identified and discussed above.

Technological Water Innovations (TWI)	TWI Category	TWI Subcategory
Smart and sand engines (sensors that relay real-time status reports on the condition of the dike). Use of new natural materials (flexible concrete, durable grass) to bolster flood defences	Integrated river basin management tools (flood protection)	Preventative technologies
Smart buoy to monitor in-situ water quality (like dissolved oxygen, pH, conductivity, temperature, redox potential, total dissolved solids and turbidity) and web platforms to receive the information provided by the buoy	water management technologies	Integrated systems (monitoring tools + DSS)
Bio-inspired dams for ecosystem degradation management (sustainable ecosystem restoration in semi-arid regions)	Integrated river basin management tools (flood protection)	Preventative technologies

7.5 WATER FOR ENERGY

Hydropower has played and will continue to play a critical role in enhancing both water and energy securities. China is world leading in the construction and operation of large hydroelectric dams with hydropower accounting for 944 TWh or 17% of the annual power production. Small-scale hydropower plants generate 220 TWh of these. It is estimated that China has the highest potential for small-scale hydropower in the world and hydropower is included as a priority area in their energy development as planned in the 2007 Medium and Long-term Development Plan of Renewable Energy. Because of that, China has launched numerous projects for rural electricity supply and simultaneous ecology protection, replacing firewood with small-scale hydropower since 2012. Small-scale

hydropower stations are mostly located in poor rural mountainous areas, and problems related with a poor quality of constructions and technology are common.

Downstream river discharge is different from the natural flow regime due to dams, which are commonly operated to maximise hydropower production or irrigation water demands. The Chinese government is now focusing on environmental impacts mitigation. Optimal river basin management and cascade power stations can safeguard the required base-flow and, at the same time, meet the objective from water and electricity demands.

The activities of Domain 5 aim to overcome the following objectives:

- Reducing water scarcity through industrial water reuse and water-energy nexus

In this perspective, the present domain will focus on the next high priority actions for the following challenges:

CHALLENGE 1 WATER SCARCITY ACTIONS: EFFICIENCY AND NEW TECHNOLOGIES TO REDUCE WATER SCARCITY IN INDUSTRIAL SECTOR

Energy is needed for water supply and it is crucial for water production. Improving industrial water reuse also in hydropower plants could contribute to reduce water scarcity linked to industrial activities.

(*) IA: Innovation Action. RIA: Research and Innovation Action. (See definition in chapter 6.3)
(**) The icons are referred to the "Sustainable Development Goals", also known as "Global Goals" identified by UNDP as universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The chosen icons are considered to be relevant to the actions listed in the domain.

The next table summarizes the challenges and the corresponding actions according to their scale of priority.

Research and Innovation actions	Type of actions (*)	SDGs Goals (**)
CHALLENGE 1 - WATER SCARCITY		
Improve industrial water reuse through water reuse technologies	RIA & IA	
Water-energy nexus: energy is needed for water supply and water is crucial in power production	RIA & IA	

WATER FOR ENERGY AVAILABLE TECHNOLOGIES

Referring to Water for Energy Technologies, the next table reports some of the principal available technological innovations to be taken into consideration to reach the priorities above identified and discussed.

Technological Water Innovations (TWI)	TWI Category	TWI Subcategory
Geothermal energy pump to harvest geothermal energy.	energy production technologies	other sources
Micro-hydro generators: systems that do not require a dam or storage facility to be constructed. Instead, they divert water from the stream or river, channel it into a valley and drop it in to a turbine via a pipeline called a penstock. The turbine drives a generator that provides the electricity to the local community	energy production technologies: small-scale hydropower	other sources
Behavioural fish barrier (using a strobe light, sound and a bubble curtain as stimuli) to e.g. divert fish from turbine blades of hydroelectric structures	water management technologies	mitigation technologies

8. Steps towards the implementation of the PIANO SRIA

A roadmap to implement the priority actions identified by the PIANO Strategic Research and Innovation Agenda (SRIA) should highlight the main opportunities for the development of further collaborative initiatives engaging public and private partnerships based on the sharing of knowledge and good practices in international cooperation between Europe and China in the water sector.

In this way, strategic long-term agreements involving multi-stakeholders in research and innovation applied to integrated water management should be fostered.

The PIANO SRIA calls for an increasing capacity of innovation through the creation of synergies, joint actions, regional networking and strengthening of relationships among private and public actors, pinpointing the relevance of sharing technological knowledge and opportunities.

The implementation of the PIANO SRIA aims to create new opportunities for private investments in the water sector, also providing a chance to capitalize on already ongoing innovations and existing initiatives, while offering opportunities to exploit synergies within and across the different priorities and perspectives for longer-term research and development.

The implementation process of the PIANO SRIA should focus on best practices and activities aimed to identify opportunities and barriers to innovation, to develop policy recommendations and dissemination strategies such as:

- Webinars, info days, workshops and conferences: to support the CEWP platform and ensure that its RDI activities address issues of public interest and are made accessible through appropriate dissemination activities;
- Sharing good practices: workshops for sharing good practices among RDI programme owners and managers in order to provide an efficient instrument of programmes alignment and improve their efficiency across Europe;
- Calls for proposals in collaborative R&I projects: in case of financial agreement, joint calls will be implemented;
- Pilot studies and demonstration projects;
- Alignment of national programmes: to better support the EU-China Water Platform it is important to align water research national agendas through the gradual modification of national programmes, priorities or activities.

Moreover, the SRIA should be assimilated in the CEWP periodic work programme and implemented through common action and transdisciplinary research.

Specifically, an implementation plan of the PIANO SRIA should be focused on the different steps able to make water a formal component of the future EU-China RIA agenda. It should also consider a better exploitation of the existing RIA infrastructure related to European existing support mechanisms and networks, in synergy and complementarity with other initiatives such as EUREKA, ACQUEAU, JPI Water and JPI Facce, ERANET MED, PRIMA, EIP, WssTp.

In China international water research, innovation and development cooperation is fostered through existing and new support mechanisms within the Chinese RIA for water in specific challenge areas under the ministries for science (MOST), for water resources (MWR) and environmental protection (MEP) and new water innovation hubs outlined in the MWR water innovation plan.

Another important step will encompass all actions aimed to support a better alignment and utilization of existing EU-China RIA infrastructure in order to build on water challenges/opportunities through existing support mechanisms for EU-China cooperation on water, and integration into other EU-China collaboration platforms:

- EU-China Water Platform and Partnership Instrument supported projects; CEWP Secretariat; DragonSTAR; ASEM Water; new joint innovation hubs (e.g. at Tsinghua University)

- EU-China Sustainable Urbanization Partnership; EU-China Climate Agreement
- EU-China SME Center

Moreover, it is important to improve connections between EU Member States and Chinese RIA infrastructure, in particular by developing new specific partnerships between RIA institutions at the Member State level to facilitate bi-lateral mutually beneficial programming, joint innovation incubators; match-making activities; agreements between innovation hubs, as well as match-making institutions set up at national and provincial level and increasing support for pilot activities. It is also important to align multiple components of the EU water innovation support system with Chinese counterparts, facilitating a linkage to enable participation (supported by Chinese funding) to join actions from JPI, EUREKA, etc. similar to H2020 and other existing sources. Meetings could take place in conjunction with the China-Europe Water Platform (CEWP) annual conference.

A regular and steady flow and exchange to ensure productive collaboration could be enabled through a process for regular, annual dialogue among the Chinese ministries for water resources (MWR), for science (MOST), for environmental protection (MEP) together with the EU water-related initiatives ACQUEAU, Water-JPI, WSSTP, EUREKA, etc., discussing joint actions to overcome potential policy barriers to innovation development and uptake, and providing strategic support to overcome common market barriers.

In summary, EU and China represent two of the largest markets and RIA investors in water in the world. As international cooperation to tackle water issues is essential, these two areas of the world should focus on jointly developing innovation and uptake of innovations that can address global and developmental challenges beyond their markets with the aim to align the vision with the Sustainable Global Goals.

Following the policy dialogue established by the China-Europe Water Platform, the PIANO SRIA contributes to paving the way for building more supportive opportunities for research centers and enterprises of both regions for improving their economic, scientific, technological and societal exchanges.

ANNEX

9.1 - Research Agenda

Driver: Water challenges	1 - Agricultural water management	2 - Municipal water management	3 - Industrial water management	4 - River basin management and flood control	5 - Water for energy
1 - Water scarcity	***1.1 Efficiency of water use*** Groundwater efficiency in irrigated agriculture (precision irrigation technologies; sensors and monitoring technologies; fertigation technologies)	**Drinking water production** from wastewater	**Water reuse technologies** (in irrigation and industry)	**Managed Aquifer Recharge** Technologies Implementing MAR; Natural water retention measures (nature-based solutions)	**Water reuse technologies**
	Water reuse in irrigated agriculture (promoting social acceptance, assessing costs and barriers)	**Recovery energy and raw material** technologies from sludge and wastewater (energy and nutrient recovery technologies)	**Recovery energy and raw material** technologies from sludge and wastewater (energy and nutrient recovery technologies)	Research at catchment scale: assessment method of available water resources	
	Develop water-conserving farming and forestry practices	**Water desalination technologies**		Freshwater overexploitation	
	Tools for assessing water costs for agriculture and forestry	**Water-saving technologies**		**Water resources assessment:** Monitoring technologies and sensors technologies; Research on hydrological processes (Monitoring; sensors technologies; Modelling tools; Remote observation systems; Data management technologies	
	Modelling on future trends (resources availability, climate change conditions..)	Coastal zones: Methods and approach to manage stress water		Develop of adaptive water management methods	

9.1 - Research Agenda

Driver: Water challenges	1 - Agricultural water management	2 - Municipal water management	3 - Industrial water management	4 - River basin management and flood control	5 - Water for energy
	Solutions for sustainable use of water resources in bio-economy sector				
2 - Water pollution (multi-resistant micro-organism; reuse of phosphorous and nitrogenous fertilisers from wastewaters; deployment of water infrastructures; energy reduction)	***1.2 Reducing soil and water pollution*** Water-related soil degradation technologies (salinity, erosion, degradation, clogging, oxidation)	***2.2 Emerging pollutants*** Separation technologies and extraction technologies to harvest resources from wastewater and reused water	**Wastewater Treatment technologies:** Membrane technologies; Advanced, biological, treatment; Energy efficiency		
	Technology for pollution monitoring; Technologies for pollution remediation (manure separation; manure treatment; precision irrigation; energy recovery technologies)	Analytical techniques for detect and monitor chemical substances (pathogens, new pollutants, etc)			
	DSS and related technologies	Assess the environmental behaviour of pollutants (modelling technologies; assessment methods; etc.)			
	Methodologies to manage water and land-use (monitoring; management, measures..)	Remediation Strategies and technologies (water treatment; wastewater reuse; monitoring and removal technologies;			

ANNEX

9.1 - Research Agenda

Driver: Water challenges	1 - Agricultural water management	2 - Municipal water management	3 - Industrial water management	4 - River basin management and flood control	5 - Water for energy
3 - Extreme events: Floods and droughts		***2.3 Natural hazards*** Urban Drainage Systems technologies and *Sponge Cities* approach and methodologies		Develop tools and new technologies for adaptation to floods and droughts (Early Warning Systems; sensor technology; monitoring technologies)	
		Nature based solutions to mitigate urban floods		Water management methods and technologies (incl. forecasting technologies, DSS; modelling technologies)	
		Technologies to predict and manage urban floods			
		Decision Support Systems			
4 - Ecosystem degradation				***4.4.1 Value of Ecosystem services*** **Research** on ecological functioning of aquatic ecosystems	
				Develop new methodologies for assessment of ecosystem services;	
				Monitoring methodologies for the ecosystem services;	
				Research on pressure-impact-response relationships	

9.1 - Research Agenda

Driver: Water challenges	1 - Agricultural water management	2 - Municipal water management	3 - Industrial water management	4 - River basin management and flood control	5 - Water for energy
				Develop new Water Management scheme (policy, regulations, monetary model; governance)	
				4.4.2 Ecological engineering and Ecohydrology *(research and technologies)* Research on **restoration methodologies** of aquatic systems (morphology continuity; hydraulic connectivity; sediment transport)	
				Research on **ecological flows**	
				Nature Based Solutions	
5 – Water infrastructures		***2.5 Market-oriented solutions*** Water distribution and measurement technologies (water losses monitoring; sensors: DSS technologies for water distribution systems)			
		Improve water systems: Monitoring technologies of water systems; Management technologies			

ANNEX

9.2 - Innovation Agenda

Driver: Water challenges	1 - Agricultural water management	2 - Municipal water management	3 - Industrial water management	4 - River basin management and flood control	5 - Water for energy
1 - Water scarcity	Irrigation technologies: Decision Support Systems	Water saving technologies (taps, WCs, infrastructures, water reuse)	Technologies to define and use water quality fit for use	Mitigation strategies to face soil sealing (increasing runoff; reducing aquifer recharge)	Improve industrial water reuse
	Water reuse: new technologies (e.g. cascading systems); Safe reuse of treated wastewater reuse	Efficient Use of Water (EUW); metering technologies	Technologies aimed at close the water cycle (leading to zero discharge system)	Forecasting technologies of water resources and water demands	Water-energy nexus: Energy is needed for water supply; *(stat: Water is crucial in power production)*
	Precision irrigation technologies; Irrigation management	Tools to manage and predict water demand	Technologies to develop sustainable use of resources (discharge, waste, energy)	Optimisation of water uses and water saving and management of multiple water users	
		Reducing leakage from pipe networks (water infrastructure efficiency; leakage detection and monitoring technologies)	Monitoring systems and technologies	Water balance modelling systems and technologies, DSS	
		Alternative Water Resources (potential sources; Water reuse technologies; desalination technologies; rainwater harvesting techn..)	Water saving technologies (energy efficient systems)	Monitoring system to assess GW abstraction and recharge	
		Data integration technologies, to improve data availability	Energy recovery technologies; Resources / raw material recovery technologies:	Freshwater bodies classification and matching alert system (physical – economical identifiers; water inflow changes; GW extraction rate)	

9.2 - Innovation Agenda

Driver: Water challenges	1 - Agricultural water management	2 - Municipal water management	3 - Industrial water management	4 - River basin management and flood control	5 - Water for energy
2 - Water pollution	Nutrients and pesticide technologies management	Microbiological Risk Assessment and management tools	Monitoring technologies to improve water quality control and discharges	Technologies for contaminated areas remediation (passive and active technologies)	
	Water pollution reduction technologies	Sensors and monitoring technologies (microbiological-chemicals contamination)	Water treatment technologies (energy efficient systems: small scale systems techn to specific pollutants removal)	Survey the state of degraded water resources systems	
	Precision farming technologies (incl. manure treatment technologies)	Technologies for emerging contaminants (and microbial pollution) removal		Studying and modelling the transfer of contaminants	
		Monitoring technologies and methods to remove point and diffuse chemical - biological pollutants		Develop risk assessment tools	
		Wastewater treatment technologies (WWT) (with reduced energy and chemical usage)		Treatment technologies	
		DSS for sustainable management of bio-solids		Early Warning System and Technologies	
		Energy production from bio-solids		Data integration technologies (hydrological parameters, pollution loads, water quality chemical and microbiological)	

9.2 - Innovation Agenda

Driver: Water challenges	1 - Agricultural water management	2 - Municipal water management	3 - Industrial water management	4 - River basin management and flood control	5 - Water for energy
		Real-time monitoring and control systems (wastewater network management): District metering areas			
3 - Extreme events (droughts and floods); (Soil sealing; Climate changes..)	Forecasting technologies	Modelling tools for integrated risk assessment and management of urban flooding and pollution		Mitigation strategies to face soil sealing	
	Remediation technologies	Storm water management systems		Technologies for seasonal forecasting (Drought)	
		Forecasting technologies		New remote sensing technologies (satellite, Doppler radar, wireless sensors ecc) for forecasting and monitoring	
		Remediation technologies		Integrated modelling across SW and GW, coastal and fluvial systems, hydrological and meteorology, water and sediment transport	
		Improve Sustainable Urban Drainage Systems (SUDSs) and Sponge Cities approach and methodologies		Risk Based decision making and planning tools	

9.2 - Innovation Agenda

Driver: Water challenges	1 - Agricultural water management	2 - Municipal water management	3 - Industrial water management	4 - River basin management and flood control	5 - Water for energy
		monitoring systems and technologies		Early Warning Systems	
				Climate models (regional and local scale)	
				Evaluation of uncertainty	
				Land management project: flood plain and river banks restoration; asset resettlements;	
4 - Ecosystem degradation		Methods to determine environmental flow needs		DSS for system restoration, covering physical, ecological, social and economic benefits and costs	
				Monitoring system to assess the ecological status of SW/GW	
5 - Water Infrastructures		Below ground assets: methods-technologies for identification (monitoring) and remediation of corrosion-aging			
		Asset management tools for sustainable maintenance programmes			

9.3 Cross-cutting challenges

Cross-cutting challenges
The regulatory framework
Removing barriers to innovation (e.g.: societal acceptance of wastewater reuse and suitable regulatory framework)
Cross-cutting with all water challenges
Socio-economic approach to Water management
Action to develop the concept of socio-hydro-ecosystem
Improve the awareness of the role of IWRM (integrated Water Resources Management) in socio-economic development
Develop and promote economical and social analyses into decision-making processes
Develop planning tools, economic instruments, communication tools;
Develop methodologies to connect socio-economic and ecological issues
Develop new governance and knowledge management approaches
New approaches and methodologies; capacity building actions; etc.