



7, 8 e 9
Março 2018
ÉVORA
Évora Hotel

GESTÃO DOS
RECURSOS HÍDRICOS:
**NOVOS
DESAFIOS**

THE STRATEGIC RESEARCH AND INNOVATION AGENDA OF THE H2020 PIANO PROJECT

Strengthening the international cooperation between Europe and China in the water sector by identifying thematic priorities for joint actions

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Abstract

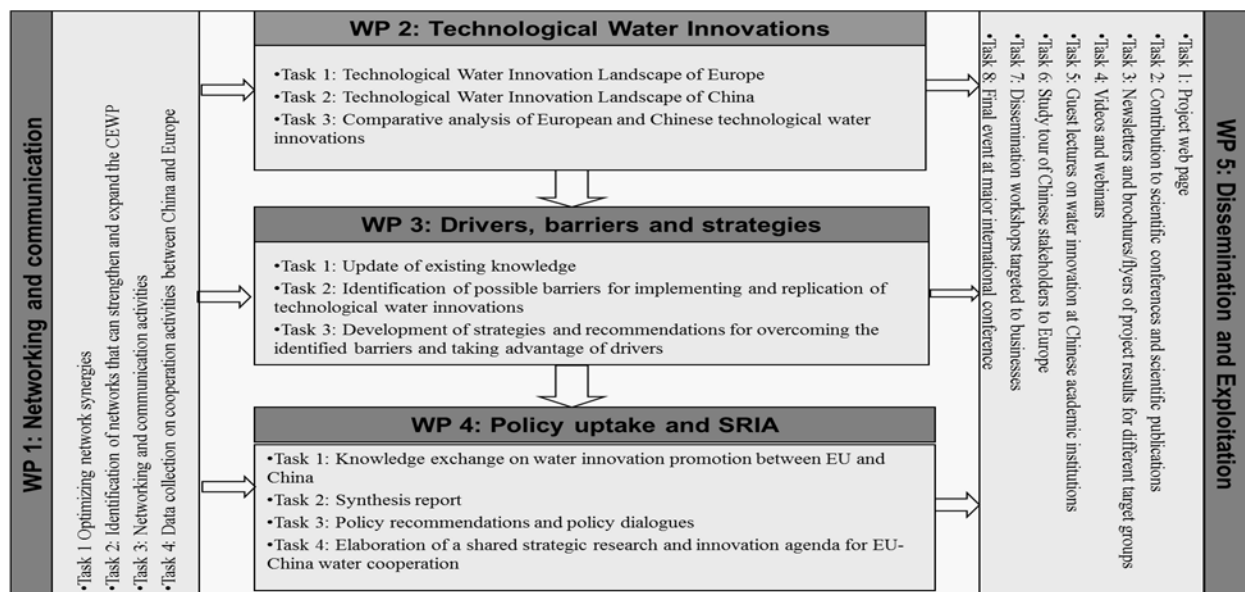
The Strategic Research and Innovation Agenda of the H2020 PIANO project is conceived to be a forward-looking document that sets out the direction of future collaborative EU-China research and innovation activities in the water sector with a special attention to the thematic areas identified and focused by the PIANO project: agricultural, municipal, industrial water management, river basin management, water for energy. This Strategic Research and Innovation Agenda (SRIA) builds on strategic agendas of European and international actors in water management and internal and external consultations among experts and relevant stakeholders of both areas of cooperation. The SRIA elaborated by the PIANO project partners aims to support the activities of the China-Europe Water Platform in its research pillar being the reference document for the implementation of further initiatives of joint international cooperation between Europe and China in water innovation, a sector which offers increasing opportunities to all interested actors, in particular European small and medium enterprises able to produce advanced technological solutions. Researchers, governmental agencies, innovative enterprises and private stakeholders should combine synergies to strengthen innovation capacity and promote social and economic cooperation in both areas of the world. The PIANO SRIA identifies needs and priorities in the EU-China cooperation in water innovation. It also highlights the main 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. Moreover, the PIANO SRIA intends to contribute to the achievement of the United Nations' Sustainable Development Goals.

Keywords: policies, innovation, networks, technological water innovations, strategic research and innovation agendas, China –Europe Water Platform, H2020 programme.

Theme: 9 - Investigação em hidráulica e recursos hídricos; Cooperação transfronteiriça (international cooperation in water innovation)

1. INTRODUCTION

The 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 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; identification of European technological water innovations and areas for joint development of innovative technological solutions that have a potential for their implementation in China; 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 technological water innovations in China; 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; effective dissemination and mainstreaming of the project results to Chinese, European stakeholders and international target audiences.



Picture 1. Table of the project activities

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 to their relationship in many topics, science, technology and innovation included. 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 areas have also been growing across themes such as environment, energy, climate issues and many others.

In 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 between People's Republic of China and the EU and its Member States. The European Commission has been supporting the China-Europe Platform and will continue to promote policy dialogue, joint research and business development in the water sector.

In March 2015 the project PIANO funded by the EU programme for research and innovation Horizon 2020 started its activities to be concluded at the end of May 2018.

The main research areas of this international cooperation focuses on the following water challenges: **agricultural water management; municipal water management; industrial water management; river basin management; water for energy.**

2. MAIN WATER CHALLENGES IN CHINA

Technological water innovations (TWIs) were mapped for both Europe and China for each of these five core thematic areas. A brief note describing the primary Chinese water challenges was developed in collaboration with the CEWP to support and guide the search for suitable TWIs within these domains.

With almost 20% of world's population and only about 6% of global freshwater resources China's water sector is a high priority for the development plans of that country. Urbanisation and rising environmental awareness are driving rapid growth in urban water supply and wastewater markets. At the same time, water resource restrictions and concerns about food security have underlined the need for water efficient agriculture and irrigation.

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. Although there has been some improvement in drinking water quality in recent years, water quality remains an issue especially in rural areas because of greater levels of pollution in lakes, rivers and groundwater from industries, non-point sources, such as agricultural run-off, and urban residential wastewater. 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. Floods have historically impacted China greatly and while many of the major rivers are now controlled with larger hydro-electric dams, extreme events and unregulated small and medium tributaries continue to pose flood risk.

Water availability per capita is only 2,220 cubic meters in China, which is 1/4 of the world average. In the total of 663 cities in China, there are more than 400 cities suffering from

water shortage problem, and above 110 cities are in severe water shortage. It is estimated that the daily water shortage of all cities in China is about 16 million cubic meter; the affected industrial production value due to water shortage may reach to more than 200 billion in a year; the affected urban population is about 40 million.

3. MAPPING WATER TECHNOLOGICAL INNOVATIONS

Taking into account these main water challenges in China technological water innovations (TWIs) were identified and prioritized by the PIANO partnership following a two-step procedure. In a first step, TWIs were identified according to the initial categories delineated by the project. The result was a series of 'fact sheets' for each individual technology identified, containing a brief description of the technological solution, expected scope of application, its level of readiness and cost data. The initial categories considered for technological solutions within the *agricultural water management* domain include **water use**: specifically technologies for improving irrigation efficiency and production of fit-for-use water; and **water management**: comprising technologies for groundwater management and pollution mitigation, aquifer recharge and reduction of groundwater mining practices.

Within the domain *municipal water management*, technologies were identified for: **water production** (supply, water use efficiency, alternative water supply); **water treatment** (wastewater management/sanitation, treatment trains); **water management** (integrated urban water management, water systems maintenance/retrofitting, mitigation of non-revenue water); and for **eco-city technological concepts**.

Technological solutions for *industrial water management* were sought focusing in particular on the following categories: **water use efficiency** (water saving technologies and processes); and **water treatment** (wastewater treatment, reuse/recycling technologies).

For the domain *river basin management and flood control*, the focus was on **flood protection technologies** for both urban and large-scale catchment settings (i.e. reactive early warning systems/prooing, e.g. flood abatement technologies, or preventative solutions concerning river training, canal construction, dike performance and hydraulic infrastructure); and decision support systems and monitoring tools to improve **water management** from both the qualitative and quantitative point of view (*cf.* Lobo-Ferreira, 2016a).

The categories considered for the domain *water for energy* were those related to **energy production** (small-scale hydropower, with a particular focus on its development, electricity efficiency, optimization, and retrofitting of existing schemes); and **water management** (tools to predict and map resource flows and assess trade-offs between resources uses; mitigation measures and maintenance of ecological flows, *cf.* Lobo-Ferreira, 2016b).

In a second step, an online survey was created in order to initially validate (i.e. complete) the original gross list of technological solutions, and then prioritize (score) the list of technological solutions collected. The survey was therefore sent out to a number of water technology experts in both Europe and China invited to score the mapped technologies. Experts were

asked to determine for each TWI – among other assessments – the degree of European technological leadership and of novelty to China, hence giving indications on the relative innovative performance of the two regions. The resulting inventories of the ranked TWIs thus provide a comparative perspective. Inventory I is the full inventory containing up to 20 European TWIs per sector (shortlisted from a total survey of 119 TWIs).

Sector	Category 1	Category 2	Category 3	Category 4	Category 5	Total
Agricultural water	-	-	15	5	-	20
Municipal water	2	-	14	11	-	27
Industrial water management	-	-	18	19	-	37
River basin management	-	-	6	11	-	17
Water for energy	-	-	5	13	-	18
Total	2	0	58	59		119

Picture 2. Overview of TWI numbers in inventory I for each sector

Inventory II is the targeted inventory containing European TWIs per sector belonging to category 4 (innovative TWIs available in Europe but not in China). It can also be seen in the above table. These are considered to have the highest potential for implementation in helping to solve relevant water challenges in China. With its “Water Sector Goals” laid down in the recent 5-year plans and the “Water Ten Action Plan”, and the adjoining more-than-huge investment plans exceeding 1 billion € per week, China will be the scene for new solutions in the water sector. Being present at the Chinese market will be of outmost strategic importance for European companies which with their innovative technologies could contribute to a fast-track achievement of the new Chinese goals for the water sector.

In total around 100 European technologies were identified by the PIANO survey, and 59 have been identified to belong to category 4. Hence, Europe offers a number of innovative technologies with a potential for application in China. These technologies, encompass the following types: monitoring tools to gather data on the state of the environment, infrastructure and process; modelling/DSS tools to interpret monitoring data and integrate with scientific understanding of the behaviour of systems over time to inform decisions on the design and operation of infrastructure and equipment; integrated management systems/controls tools to convey the conclusions from the modelling and DSS systems to the infrastructure-communications and automation; products/processes to improve actual infrastructure and equipment.

4. METHODOLOGY FOR THE ELABORATION OF THE PIANO STRTEGIC AGENDA

Based on this TWIs survey, on the studies performed on barriers and drivers to water innovation in the project research domains and on the guidance documents of European, Chinese and international water-related networks and initiatives, the jointly elaborated PIANO Strategic Research and Innovation Agenda is conceived to be a forward-looking document that sets out the direction of future collaborative EU-China research and innovation activities in the water sector with a special attention to the thematic areas identified and focused by the project.










A study comparing the existing strategic water and research innovation agendas in Europe and China was also carried out in 2016, and updated in 2017, to provide elements useful for the elaboration of the SRIA. This paper is based on the analysis of a set of national and international documents on water strategies. From each reviewed agenda, the priority ***“Development and innovation needs in the water sector”*** was extracted and highlighted. A series of tables for each agenda was prepared to list research and development actions and needs with the aim of allowing an easy access to the information which is interesting for the PIANO project aims.

Vision, needs and actions highlighted in the agenda of Acqueau, the water industrial cluster of the European programme EUREKA, in the SIRA 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 document on water resources management, the Chinese 13th Five Year Plan were also examined to extrapolate the main problems pointed out and to compare measures and solutions proposed. Further contributions to this mapping exercise were also provided by some representatives of the Chinese institutions involved in the PIANO activities.

All documents analysed emphasize the need to join implementation and development of best water technologies with policy and actions to promote proper integrated water management and social awareness.

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. Also 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 5 main sections, corresponding to the 5 water domains focused by the PIANO project. For each domain, it was required to give a priority level to the actions to be taken (challenges) to achieve the project goals and to state, depending on the actions selected, the application fields considered more relevant: IA – Innovation Actions, RIA – Research and Innovation Actions, RA – Research Actions.

Moreover, it has been considered relevant for the elaboration of the PIANO SRIA a cross analysis and identification of links with some of the Strategic Development Goals (SDGs) fostered by the United Nations. On 1 January 2016, the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development — adopted by 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 has 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

Picture 3. Table of the SDGs considered in the PIANO SRIA

5. NEEDS AND THEMATIC PRIORITIES IDENTIFIED

The PIANO SRIA identifies needs and priorities in the EU-China cooperation in water innovation considering the project core domains and some crosscutting themes.

In the agricultural domain these water challenges and actions are identified:

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 soil degradation technologies against salinity, erosion, clogging and oxidation. It will be just as necessary to develop appropriate tools (Decision Support Systems) 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.

For the domain municipal water management the PIANO SRIA highlights the following thematic priorities:

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 and 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.

In the industrial water management the priority actions for the following water challenges are:

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)

Tackling the water challenges identified to improve **the river basin management and flood control** the PIANO SRIA focuses the following actions:

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 domain water for energy is focused on these high priority actions:

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.

6. IMPLEMENTATION OF THE PIANO SRIA

A roadmap to implement the actions identified by the PIANO SRIA should highlight the main opportunities for the development of further collaborative actions 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 water management should be fostered. The Strategic Research and Innovation Action of the H2020 PIANO project calls for an increasing capacity of innovation through the creation of synergies, joint actions, regional networking and strengthening of relationships among public



and private actors, pinpointing the relevance of sharing technological knowledge and opportunities.

Moreover, through the co-design of innovations, the implementation of the PIANO SRIA will create new opportunities for private investments in the water sector, also providing a chance to capitalize on already on-going 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 China Europe Water Platform (CEWP) and ensure that its research, development and innovation (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 actions and trans-disciplinary research.

AKNOWLEDGMENTS

The PIANO project is funded by the EU Programme for Research and Innovation Horizon 2020 under the Grant Agreement n° 642433.

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