Policies, Innovations and Networks for enhancing Opportunities for China Europe Water Cooperation

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Task 4: *Elaboration of a shared Strategic Research and Innovation Agendas (SRIA)*

PIANO Online Questionnaire

with

Domains and technologies

(Annex to the PIANO Online Questionnaire)

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PIANO Online Questionnaire

Introduction

The PIANO Strategic Research and Innovation Agenda (SRIA) will define the development and innovation needs in water sector and promote a balanced mix of innovation actions that will contribute to overcome the main bottlenecks towards adoption of innovative solutions in water sector.

In order to develop the Agenda, this PIANO Online Questionnaire has been prepared, with the aim of collecting the opinions of key actors, about the research priorities to be addressed, both in terms of objectives and topics, as well as suggesting which actions you would like primarily develop within each of the five PIANO water domains (Agriculture water management, Urban and Rural water management, Water in Industry, Energy production and Landscape management).

Concerning the list of the Research and Innovations needs and actions, a scheme "Main water drivers (water challenges) / Priority thematic areas (or Key water domain)" has been worked out.

The replies submitted to this survey will be analyzed, aggregated and taken into consideration during the development of the PIANO SRIA, foreseen for late 2017.

Instructions for filling out the questionnaire

Please note that the questionnaire consists of 6 Sections.

Section 1 asks for information about the respondent. Answers to some questions are mandatory.

Sections 2-3-4-5-6 correspond to each of the 5 water domains and require the following questions:

- the priority you assign to the following actions;
- whether you consider the following actions relevant for Research, Innovation or Research and Innovation;
- which, among the following actions, are the most appropriate to achieve PIANO objectives.

Annex to the PIANO online questionnaire

The Annex to the Piano online questionnaire, reported in the following, aims at helping in better understanding of the questionnaire and properly filling it.

The Annex contains:

- an introduction that describes the issues related to the five domains;
- the measures to be undertaken (objectives);
- the relevant research and innovation activities to be developed;
- the technologies to be adopted.

Background information on the PIANO project

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 resources, 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.

Its 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.

First activity of PIANO was the identification of European technological water innovations by means of an inventory of best technologies, with potential for effective implementation in CHINA, able to solve such water challenges.

PIANO selected the state-of-the-art of European technologies in the field of agricultural water management, municipal water management, industry and energy production and river basin water management.

Tools, devices, innovative decision-support-systems, new ECO-CITY technologies as well as new technologies for water distribution, treatment and re-use have been selected and compared with Chinese existing technologies.

Furthermore, PIANO will identify barriers that may impede the application of technologies in CHINA, and elaborate strategies for overcoming such barriers and taking advantages for replication of such technologies in CHINA.

A jointly elaborated Strategic Research and Innovation Agenda will include all potential research and innovation areas, strategies to facilitate and promote market entry in China, cooperation opportunities and further potential demonstration projects.

This Agenda will support the transfer to CHINA of European know-how, expertise and water technologies creating synergies between countries. In view of the objectives of the Europe 2020 “Innovation Union” initiative, the PIANO project intends to pursue the objective of increasing implementation and replication of European water know-how in CHINA.

PIANO Objectives Prioritization Survey

Section 1

Information about the respondent

1. **Are you responding to this questionnaire on behalf of/as:**

   _____

2. **Please enter your country of residence or where your organization is based**

   a. **Organization name** _____
   b. **Name** _____
   c. **Surname** _____
   d. **Telephone** _____
   e. **Email** _____
   f. **Country**_____

3. **Please indicate the type of organization represented:**

   _____

PIANO – Innovation Agenda Objectives Prioritization Survey

Section 2

Domain 1 – Agricultural water management

Challenge 1 – Water scarcity

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Irrigation technologies and irrigation management: DSS and modelling for water resources assessment (Technologies, tools, ICT platforms);					
Water reuse: new technologies (e.g. cascading systems); Safe reuse of treated wastewater reuse					
Efficiency of water use; Groundwater efficiency in irrigated agriculture (precision irrigation technologies; sensors and monitoring technologies; fertigation technologies)					
Water reuse in irrigated agriculture (promoting social acceptance, assessing costs and barriers)					
Develop water-conserving farming and forestry practices					
Modelling on future trends (resources availability, climate change conditions)					
Solutions for sustainable use of water resources in bio-economy sector					
Other topic (please specify)					

Challenge 2 – Water pollution

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Nutrients and pesticide technologies management; Technologies for pollution remediation (manure separation; manure treatment; precision irrigation; energy recovery technologies)					
Water-related soil degradation technologies (salinity, erosion, degradation, clogging, oxidation)					
Technology for pollution monitoring;					
Precision farming technologies (incl. manure treatment technologies)					
DSS and related technologies					
Methodologies to manage water and land-use (monitoring; management, measures)					
Other topic (please specify)					

Challenge 3 – Extreme events (droughts and floods)

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
On-line monitoring and forecasting of floods and droughts;					
Early warning system, forecasting of extreme events; floods control; DSS					
Remediation technologies					
Other topic (please specify)					

PIANO – Innovation Agenda Objectives Prioritization Survey

Domain 1 – Agricultural water management

Challenge 1 – Water scarcity

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Irrigation technologies and irrigation management: DSS and modelling for water resources assessment (Technologies, tools, ICT platforms);			
Water reuse: new technologies (e.g. cascading systems); Safe reuse of treated wastewater reuse			
Efficiency of water use; Groundwater efficiency in irrigated agriculture (precision irrigation technologies; sensors and monitoring technologies; fertigation technologies)			
Water reuse in irrigated agriculture (promoting social acceptance, assessing costs and barriers)			
Develop water-conserving farming and forestry practices			
Modelling on future trends (resources availability, climate change conditions)			
Solutions for sustainable use of water resources in bio-economy sector			
Other topic (please specify)			

Challenge 2 – Water pollution

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Nutrients and pesticide technologies management; Technologies for pollution remediation (manure separation; manure treatment; precision irrigation; energy recovery technologies)			
Water-related soil degradation technologies (salinity, erosion, degradation, clogging, oxidation)			
Technology for pollution monitoring;			
Precision farming technologies (incl. manure treatment technologies)			
DSS and related technologies			
Methodologies to manage water and land-use (monitoring; management, measures)			
Other topic (please specify)			

Challenge 3 – Extreme events (droughts and floods)

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
On-line monitoring and forecasting of floods and droughts;			
Early warning system, forecasting of extreme events; floods control; DSS			
Remediation technologies			
Other topic (please specify)			

PIANO Objectives Prioritization Survey

Section 3

Domain 2 – Municipal water management

Challenge 1 – Water scarcity

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Water saving technologies (taps, WCs, infrastructures, water reuse); Efficient Use of Water (EUW); metering technologies					
Tools to manage and predict water demand					
Reducing leakage from pipe networks (water infrastructure efficiency; leakage detection and monitoring technologies)					
Drinking water production from wastewater and alternative water resources (potential sources; Water reuse technologies; desalination technologies; rainwater harvesting technologies)					
Data integration technologies, to improve data availability					
Recovery energy and raw material technologies from sludge and wastewater (energy and nutrient recovery technologies)					
Other topic (please specify)					

Challenge 2 – Water pollution

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Microbiological Risk Assessment and management tools					
Sensors and monitoring technologies (microbiological-chemicals contamination)					
Technologies for emerging pollutants; Separation technologies and extraction technologies to harvest resources from wastewater and reused water; Wastewater treatment technologies (WWT); Remediation Strategies and technologies					
Monitoring technologies and methods to remove point and diffuse chemical – biological pollutants					
DSS for sustainable management of bio-solids; Energy production from bio-solids					
Real-time monitoring and control systems (wastewater network management): District metering areas					
Analytical techniques for detect and monitor chemical substances (pathogens, new pollutants, etc.)					
Assess the environmental behaviour of pollutants (modelling technologies; assessment methods; etc.)					
Other topic (please specify)					

Challenge 3 – Extreme events: Floods and droughts

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Modelling tools for integrated risk assessment and management of urban flooding and pollution					
Storm water management systems improve Sustainable Urban Drainage Systems (SUDSs)					
Forecasting technologies and technologies to predict and manage urban floods					
Natural hazards: Nature based solutions to mitigate urban floods					
Decision Support Systems					
Other topic (please specify)					

Challenge 4 – Ecosystem degradation

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Methods to determine environmental flow needs					
Other topic (please specify)					

Challenge 5 – Water infrastructures

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)	Very low priority	Low priority	Medium priority	High priority	Very High priority
Below ground assets: methods-technologies for identification (monitoring) and remediation of corrosion-aging					
Asset management tools for sustainable maintenance programmes					
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					
Other topic (please specify)					

PIANO Objectives Prioritization Survey

Domain 2 – Municipal water management

Challenge 1 – Water scarcity

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Water saving technologies (taps, WCs, infrastructures, water reuse); Efficient Use of Water (EUW); metering technologies			
Tools to manage and predict water demand			
Reducing leakage from pipe networks (water infrastructure efficiency; leakage detection and monitoring technologies)			
Drinking water production from wastewater and alternative water resources (potential sources; Water reuse technologies; desalination technologies; rainwater harvesting technologies)			
Data integration technologies, to improve data availability			
Recovery energy and raw material technologies from sludge and wastewater (energy and nutrient recovery technologies)			
Other topic (please specify)			

Challenge 2 – Water pollution

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Microbiological Risk Assessment and management tools			
Sensors and monitoring technologies (microbiological-chemicals contamination)			
Technologies for emerging pollutants; Separation technologies and extraction technologies to harvest resources from wastewater and reused water; Wastewater treatment technologies (WWT); Remediation Strategies and technologies			
Monitoring technologies and methods to remove point and diffuse chemical – biological pollutants			
DSS for sustainable management of bio-solids; Energy production from bio-solids			
Real-time monitoring and control systems (wastewater network management): District metering areas			
Analytical techniques for detect and monitor chemical substances (pathogens, new pollutants, etc.)			
Assess the environmental behaviour of pollutants (modelling technologies; assessment methods; etc.)			
Other topic (please specify)			

Challenge 3 – Extreme events: Floods and droughts

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Modelling tools for integrated risk assessment and management of urban flooding and pollution			
Storm water management systems improve Sustainable Urban Drainage Systems (SUDSs)			
Forecasting technologies and technologies to predict and manage urban floods			
Natural hazards: Nature based solutions to mitigate urban floods			
Decision Support Systems			
Other topic (please specify)			

Challenge 4 – Ecosystem degradation

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Methods to determine environmental flow needs			
Other topic (please specify)			

Challenge 5 – Water infrastructures

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Below ground assets: methods-technologies for identification (monitoring) and remediation of corrosion-aging			
Asset management tools for sustainable maintenance programmes			
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			
Other topic (please specify)			

PIANO Objectives Prioritization Survey

Section 4

Domain 3 – Industrial water management

Challenge 1 – Water scarcity

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Technologies to define and use water quality fit for use					
Technologies aimed to develop sustainable use of resources (discharge, waste, energy) and to close the water cycle (leading to zero discharge system)					
Monitoring systems and technologies					
Water saving technologies (energy efficient systems) and water reuse technologies (in irrigation and industry)					
Energy recovery technologies; Resources / raw material recovery technologies					
Recovery energy and raw material technologies from sludge and wastewater (energy and nutrient recovery technologies)					
Other topic (please specify)					

Challenge 2 – Water pollution

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Monitoring technologies to improve water quality control and discharges					
Advance water treatment technologies (energy efficient systems: small scale systems technologies to specific pollutants removal)					
Wastewater Treatment technologies: Membrane technologies; Advanced, biological, treatment, solid separation					
Other topic (please specify)					

PIANO Objectives Prioritization Survey

Domain 3 – Industrial water management

Challenge 1 – Water scarcity

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Technologies to define and use water quality fit for use			
Technologies aimed to develop sustainable use of resources (discharge, waste, energy) and to close the water cycle (leading to zero discharge system)			
Monitoring systems and technologies			
Water saving technologies (energy efficient systems) and water reuse technologies (in irrigation and industry)			
Energy recovery technologies; Resources / raw material recovery technologies			
Recovery energy and raw material technologies from sludge and wastewater (energy and nutrient recovery technologies)			
Other topic (please specify)			

Challenge 2 – Water pollution

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Monitoring technologies to improve water quality control and discharges			
Advance water treatment technologies (energy efficient systems: small scale systems technologies to specific pollutants removal)			
Wastewater Treatment technologies: Membrane technologies; Advanced, biological, treatment, solid separation			
Other topic (please specify)			

PIANO Objectives Prioritization Survey

Section 5

Domain 4 – River basin management and flood control

Challenge 1 – Water scarcity

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Mitigation strategies to face soil sealing (increasing runoff; reducing aquifer recharge); Forecasting technologies of water resources and water demands					
Optimisation of water uses and water saving and management of multiple water users; Water balance modelling systems and technologies, DSS					
Monitoring system to assess GW abstraction and recharge; Managed Aquifer Recharge Technologies Implementing MAR; Natural water retention measures (nature-based solutions)					
Freshwater bodies classification and matching alert system (physical – economical identifiers; water inflow changes; GW extraction rate); Freshwater overexploitation					
Research at catchment scale: assessment method of available water resources					
Water resources assessment: Monitoring technologies and sensors technologies; Research on hydrological processes (Monitoring; sensors technologies; Modelling tools; Remote observation systems; Data management technologies					
Develop of adaptive water management methods					
Other topic (please specify)					

Challenge 2 – Water pollution

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Technologies for contaminated areas remediation (passive and active technologies)					
Survey the state of degraded water resources systems; Studying and modelling the transfer of contaminants					
Develop risk assessment tools					
Treatment technologies					
Early Warning System and Technologies					
Data integration technologies (hydrological parameters, pollution loads, water quality chemical and microbiological)					
Other topic (please specify)					

Challenge 3 – Extreme events: Floods and droughts

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Mitigation strategies to face soil sealing					
Technologies for seasonal forecasting (Drought) and climate models (regional and local scale) for evaluation of uncertainty					
New remote sensing technologies (satellite, Doppler radar, wireless sensors etc.) for forecasting and monitoring					
Integrated modelling across SW and GW, coastal and fluvial systems, hydrological and meteorology, water and sediment transport					
Risk Based decision making and planning tools					
Land management project: flood plain and river banks restoration; asset resettlements;					
Develop tools and new technologies for adaptation to floods and droughts (Early Warning Systems; sensor technology; monitoring technologies)					
Water management methods and technologies: forecasting technologies, DSS; modelling technologies; Space-based technology (SBT);					

Other topic (please specify)					
Challenge 4 – Ecosystem degradation Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)					
	Very low priority	Low priority	Medium priority	High priority	Very High priority
DSS for system restoration, covering physical, ecological, social and economic benefits and costs					
Monitoring system to assess the ecological status of SW/GW					
Research on pressure-impact-response relationships					
Develop new Water Management scheme (policy, regulations, monetary model; governance)					
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: Use of new natural materials (flexible concrete, durable grass)					
Integrated river basin management tools: Bio-inspired dams for ecosystem degradation; smart buoy to monitor in-situ water quality;					
Other topic (please specify)					

PIANO Objectives Prioritization Survey

Domain 4 – River basin management and flood control

Challenge 1 – Water scarcity

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Mitigation strategies to face soil sealing (increasing runoff; reducing aquifer recharge); Forecasting technologies of water resources and water demands			
Optimisation of water uses and water saving and management of multiple water users; Water balance modelling systems and technologies, DSS			
Monitoring system to assess GW abstraction and recharge; Managed Aquifer Recharge Technologies Implementing MAR; Natural water retention measures (nature-based solutions)			
Freshwater bodies classification and matching alert system (physical – economical identifiers; water inflow changes; GW extraction rate); Freshwater overexploitation			
Research at catchment scale: assessment method of available water resources			
Water resources assessment: Monitoring technologies and sensors technologies; Research on hydrological processes (Monitoring; sensors technologies; Modelling tools; Remote observation systems; Data management technologies			
Develop of adaptive water management methods			
Other topic (please specify)			

Challenge 2 – Water pollution

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Technologies for contaminated areas remediation (passive and active technologies)			
Survey the state of degraded water resources systems; Studying and modelling the transfer of contaminants			
Develop risk assessment tools			
Treatment technologies			
Early Warning System and Technologies			
Data integration technologies (hydrological parameters, pollution loads, water quality chemical and microbiological)			
Other topic (please specify)			

Challenge 3 – Extreme events: Floods and droughts

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Mitigation strategies to face soil sealing			
Technologies for seasonal forecasting (Drought) and climate models (regional and local scale) for evaluation of uncertainty			
New remote sensing technologies (satellite, Doppler radar, wireless sensors etc.) for forecasting and monitoring			
Integrated modelling across SW and GW, coastal and fluvial systems, hydrological and meteorology, water and sediment transport			
Risk Based decision making and planning tools			
Land management project: flood plain and river banks restoration; asset resettlements;			
Develop tools and new technologies for adaptation to floods and droughts (Early Warning Systems; sensor technology; monitoring technologies)			
Water management methods and technologies: forecasting technologies, DSS; modelling technologies; Space-based technology (SBT);			
Other topic (please specify)			

Challenge 4 – Ecosystem degradation

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
DSS for system restoration, covering physical, ecological, social and economic benefits and costs			
Monitoring system to assess the ecological status of SW/GW			
Research on pressure-impact-response relationships			
Develop new Water Management scheme (policy, regulations, monetary model; governance)			
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: Use of new natural materials (flexible concrete, durable grass)			
Integrated river basin management tools: Bio-inspired dams for ecosystem degradation; smart buoy to monitor in-situ water quality;			
Other topic (please specify)			

PIANO Objectives Prioritization Survey

Section 6

Domain 5 – Water for energy

Challenge 1 – Water scarcity

Please indicate the priority you assign to each action in a scale from 1 (very low priority) to 5 (very high priority)

	Very low priority	Low priority	Medium priority	High priority	Very High priority
Improve industrial water reuse through water reuse technologies					
Water-energy nexus: Energy is needed for water supply; (stat: Water is crucial in power production)					
Other topic (please specify)					

PIANO Objectives Prioritization Survey

Domain 5 – Water for energy

Challenge 1 – Water scarcity

Please choose among the following actions as the most appropriate for the PIANO topic implementation: Innovation Action (IA), Research and Innovation Action (RIA), Research Action (RA)

	IA	RIA	RA
Improve industrial water reuse			
Water-energy nexus: Energy is needed for water supply; (stat: Water is crucial in power production)			
Water reuse technologies			
Other topic (please specify)			

Domains and technologies
(Annex to the PIANO Online Questionnaire)

PIANO Domain 1: Agricultural Water Management

Water use and water management in agriculture are strictly correlated. In 2013, the agricultural water sector used 63% of the total 618 billion m3 water used in China. Main challenges related to agricultural water management sector are water scarcity, water pollution and extreme events.

Due to different causes, such as the use of inefficient "flood irrigation" for farmland, a major priority 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) includes a target to increase the irrigation efficiency index from 0.5 to 0.53 within the period 2011-2015.

Another serious challenge is water pollution. In 2013, it has been estimated that ca. 60% of the groundwater in China is unsuitable for drinking water supply. Regarding surface water pollution, rural areas lack sewage collection and treatment systems, as well as a garbage collection and removal systems. It's, therefore, needed a specific focus on new irrigation technologies as DDS (Decision Support System) and techniques for water reuse and safety through wastewater reuse, groundwater efficiency in irrigated agriculture, irrigation management and modelling on future trends.

As specified in the "Three Red Line" document and lately refined in the Water Ten Regulations, improving the surface water quality is of high importance in China. In the Water Ten Regulations, China has set a national target to not exceed 15% extremely-bad quality groundwater.

Flood control and extreme events management are instrumental to human survival and economic development. Serious floods and droughts often hit farmland and agricultural areas that have resulted in major losses of life and property and exposed serious weaknesses in water conservancy infrastructure, including farmland irrigation and drainage.

PIANO PROJECT – DOMAIN 1

AGRICULTURAL WATER MANAGEMENT DOMAIN

The activities of Domain 1 aim to overcome the following objectives:

- to reduce water scarcity increasing water saving techniques and water management;
- to reduce water pollution 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 agricultural sector.

Technologies Inventory: TWIEU A36, TWIEU A8, TWIEU A30, TWIEU A16, TWIEU A24[1]

MAIN CHALLENGES	RELEVANT RESEARCH AND INNOVATION ACTIVITIES
Water Scarcity	• Implementation of precision irrigation technologies and irrigation management: DSS and modelling for water resources assessment (Technologies, tools, ICT platforms); • Implementation of water reuse new technologies (e.g. cascading systems); Safe reuse of treated wastewater reuse; • Efficiency of water use, in particular relating to groundwater efficiency in irrigated agriculture as precision irrigation technologies; sensors and monitoring technologies; fertigation technologies; • Water reuse in irrigated agriculture (promoting social acceptance, assessing costs and barriers); • Development of water-conserving farming and forestry practices; • Modelling on future trends (resources availability, climate change conditions); • Solutions for sustainable use of water resources in bio-economy sector
Water pollution	• Reducing soil and water pollution through nutrients and pesticide technologies management; Technologies for pollution remediation (manure separation; manure treatment; precision irrigation; energy recovery technologies) • Water-related soil degradation technologies (salinity, erosion, degradation, clogging, oxidation); • Technology for pollution monitoring • Precision farming technologies (incl. manure treatment technologies) • DSS and related technologies; • Methodologies to manage water and land-use (monitoring; management, measures)
Extreme events	• On-line monitoring and forecasting of floods and droughts; • Monitoring technologies for early warning system, forecasting of extreme events; floods control; DSS • Remediation technologies

[1] The prioritized and recommended TWIs are marked in bold

AGRICULTURAL WATER MANAGEMENT TECHNOLOGIES		
TWI	**TWI Category**	**TWI Subcategory**
TWIEU A36. Groundwater sampling system with passive samplers measuring volatile organic compounds such as chlorinated solvent sand constituents of petroleum fuels in groundwater, including sampler analysis. It could be used for extraction of soil-water from dry boreholes in contaminated site investigation.	**Groundwater technology**	**Monitoring technologies (incl. DSS)**
TWIEU A8. DSS: SCADA remote control system, based on the qualitative parameters of treated water to be used for irrigation purpose.	**Irrigation technology**	**Real-time estimation tools**
TWIEU A30. 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)**
TWIEU A16: DSS: Ground-based multisensory platforms, equipped with soil and plant sensors (geophysical sensors -EMI, GPR-, passive hyperspectral sensor and active radiometric sensor connected to a DGPS) for improving irrigation water use efficiency.	Irrigation technology	Integrated systems for irrigation/fertigation management (DSS + sensors)
TWIEU A24. Integrated water management system for forestry in arid lands. Coupling of phytotechnologies (e.g. constructed wetlands) with wastewater treatment, land recovery with multipurpose forestry and bioengineering	Irrigation technology	Integrated systems for irrigation/fertigation management (DSS + sensors)

PIANO Domain 2: Municipal Water Management

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 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 plant, aquifer recharge and riverbank 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 also the demand for water saving household technologies.

Another class of water use challenges are related to efficiency of the supply network. The average water loss due to leaks in the urban supply system network was reported to 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.

Municipal wastewater treatment is another major water challenge faced by the Chinese decision makers. According to the Water Ten Regulations, municipal wastewater treatment plants should meet the discharge standard of Class A (best) in key lakes areas, key reservoirs areas and offshore catchment areas by the end of 2017. In 2015, the rate of recycled water utilization has been targeted to 15% and the rate of harmless sludge disposal to 70% in cites and 30% in both counties and towns.

PIANO PROJECT – DOMAIN 2

MUNICIPAL WATER MANAGEMENT DOMAIN

The activities of Domain 2 aim to overcome the following objectives:

- to reduce water scarcity increasing public supply coverage, using water saving and water management technique;
- to reduce water pollution focusing on new municipal wastewater treatment;
- 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 trough management tools and monitoring system technologies

Technologies Inventory: TWIEU B50, TWIEU B63, TWIEU B52, TWIEU D10, TWIEU B59, TWIEU B64, TWIEU B20, TWIEU C1, TWIEU B46, TWIEU B47, TWIEU B70, TWIEU B37, TWIEU B54, TWIEU B41, TWIEU B58, TWIEU B39, TWIEU B62, TWIEU D11, TWIEU C18, TWIEU C46, TWIEU D13[2]

MAIN CHALLENGES	RELEVANT RESEARCH AND INNOVATION ACTIVITIES
Water Scarcity	• Water saving technologies implementation (taps, WCs, infrastructures, water reuse) and efficient use of water using also metering technologies; • Application of tools to manage and predict water demand; • Reducing leakage from pipe networks (water infrastructure efficiency; leakage detection and monitoring technologies)

[2] The prioritized and recommended TWIs are marked in bold.

	• Drinking water production from wastewater and alternative Water Resources (potential sources; Water reuse technologies; desalination technologies; rainwater harvesting technologies) • Data integration technologies, to improve data availability • Recovery energy and raw material technologies from sludge and wastewater (energy and nutrient recovery technologies)
Water pollution	• Microbiological Risk Assessment and management tools • Sensors and monitoring technologies (microbiological-chemicals contamination) • Technologies for emerging pollutants; Separation technologies and extraction technologies to harvest resources from wastewater and reused water; Wastewater treatment technologies (WWT); Remediation Strategies and technologies • Monitoring technologies and methods to remove point and diffuse chemical – biological pollutants • DSS for sustainable management of bio-solids; Energy production from bio-solids • Real-time monitoring and control systems (wastewater network management): District metering areas • Analytical techniques for detect and monitor chemical substances (pathogens, new pollutants, etc.) • Assess the environmental behaviour of pollutants (modelling technologies; assessment methods; etc.)
Extreme events	• Modelling tools for integrated risk assessment and management of urban flooding and pollution • Storm water management systems improving Sustainable Urban Drainage Systems (SUDSs) and Sponge Cities approach and methodologies • Forecasting technologies and technologies to predict and manage urban floods • Natural hazards: Nature based solutions to mitigate urban floods • Decision Support Systems (DSS)
Ecosystem degradation	• Methods and tools to determine environmentally sustainable river flows
Water infrastructures	• Below ground assets: methods-technologies for identification (monitoring) and remediation of corrosion-aging • Asset management tools for sustainable maintenance programmes • 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

MUNICIPAL WATER MANAGEMENT TECHNOLOGIES		
TWI	**TWI Category**	**TWI Subcategory**
TWIEU B50. Technology for monitoring of coliform bacteria and E. Coli in drinking water. The principle of the technology is measurement of color 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**
TWIEU B63. Vertical Sequencing Batch Reactor System	**Used Water**	**Bioprocesses – for Carbon**

for reducing cost and space of plant.	**Collection, Treatment, Disposal**	**(and more) removal**
TWIEU B52. UV-VIS multiparameter based measurement sensor for the measurement of nitrate and nitrite in wastewater.	**Used Water Collection, Treatment, Disposal**	**Monitoring/Sensors during Used Water Collection/Treatment**
TWIEU D10. Data-logging system that detects leakages in water pipelines by analysing sound waves, using a computer to collect and analyse data through a set of remote sensors.	(Source) Water Extraction, Treatment, Distribution	Control/DSS
TWIEU B59. Advanced chemical oxidation processes make use of chemical oxidants to reduce COD/BOD levels, and to remove both organic and oxidisable inorganic components. The processes can completely oxidise organic matter to carbon dioxide and water, although it is often not necessary to operate the processes to this level of treatment.	(Source) Water Extraction, Treatment, Distribution	Water treatment- chemical (incl. advanced oxidation, disinfection, etc)
TWIEU B64. Hydrothermal carbonization (HTC) technology to produce carbons from sewage sludge and for solution to recover phosphorous compounds from HTC-coal.	Biosolids from WWT	Treatment/Physical (Heat,…)
TWIEU B20. Biologically and ecologically balanced filtration system, to treat wastewater in areas that lack connections to a municipal sewer system.	Used Water Collection, Treatment, Disposal	Bioprocesses – for Carbon (and more) removal
TWIEU C1. Optical biosensor technology, for instant and ultra-sensitive detection of (bio-) chemical substances in drinking water.	(Source) Water Extraction, Treatment, Distribution	Monitoring/Sensors during Water Treatment
TWIEU B46. A treatment system including an iron generator, an aerator, sand filters and a tank for collection and removal of sludge to reduce arsenic in drinking water. In the iron generator, iron is added to the water as Fe (II). The water is pumped through the aerator, where iron(II) is oxidized to iron(III). Iron forms poorly soluble hydroxides which adsorb arsenic. In the sand filter, poorly soluble hydroxides and adsorbed arsenic compounds are removed.	(Source) Water Extraction, Treatment, Distribution	Water treatment- chemical (incl. advanced oxidation, disinfection, etc)
TWIEU B47. A combination of coagulation with direct filtration technology to remove natural organic matter, particles and microorganism for the production of drinking water from surface water sources.	(Source) Water Extraction, Treatment, Distribution	Water treatment- chemical (incl. advanced oxidation, disinfection, etc)
TWIEU B70. Variable Pore Structure Micro Filter to capture suspended solids using backwashable filters, without using chemical. The filters use low energy, small footprint and very high efficiency in a variety of sizes from 10 µ down to 0,2 µ.	Used Water Collection, Treatment, Disposal	Solids Separation/Filtration (incl. membranes)
TWIEU B37. Reduce solids production from biological wastewater treatment by adding an unaerated interchange tank and cycling biomass between this metabolic tank and the main bioreactor.	Biosolids from WWT	Treatment/Biological

TWIEU B54. UV-disinfection technology to treat effluent from fish farms.	Used Water Collection, Treatment, Disposal	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)
TWIEU B41. A mobile floating sensor to be placed in WWTP tanks to monitor ammonia, nitrate, oxygen, pH and suspended solids for measuring gaseous emissions to check the aeration efficiency and Data Integration Management System (DIMS) software for data storing and processing.	Used Water Collection, Treatment, Disposal	Monitoring/Sensors during Used Water Collection/Treatment
TWIEU B58. Decentral system with membranes for water treatment and greywater recycling. Special organic fibres are used in the membranes procedure, facilitating ultra- and micro-filtration for the treatment of wastewater. It produces germ-free, bacteriological high quality drinking water, irrespective of whether the input water comes from surface water, groundwater, runoff water from wastewater treatment plants, industrial wastewater or grey water from houses.	Used Water Collection, Treatment, Disposal	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)
TWIEU B39. Coupling Salinity Gradient Power (SGP) technologies with Desalination for an integrated WWT and fresh water production from the sea at 1 kWh/m^3 energy consumption.	(Source) Water Extraction, Treatment, Distribution	Water treatment – physical (incl. membranes, ion exchange, UV, etc..)
DSS		
TWIEU B62. Decision support systems for analysis and management of urban water distribution network are based on an integrated network of pipes, pumps, regulators, valves, monitoring, alert systems, and other network components integrated in a comprehensive and centralized control platform.	(Source) Water Extraction, Treatment, Distribution	Control/DSS
TWIEU D11. Decision support system (DSS), based on the implementation of district metered areas (dmas) and analysis of their flow and pressure data for water distribution network management and control water losses.	(Source) Water Extraction, Treatment, Distribution	Control/DSS
TWIEU C18. Web based S.C.A.D.A. application for controlling and monitoring Waste Water Treatment Plants (WWTP) via internet, including estimation of the WWTP indicators of Oxygen Uptake Rate, the oxygen transfer efficiency and KLa.	Used Water Collection, Treatment, Disposal	Control/DSS
TWIEU C46. Supervisory control strategy designed for activated sludge treatment plants with nutrient removal. The control strategy combines three complementary control loops to optimise the nitrogen removal in pre-denitrifying activated sludge plants.	Used Water Collection, Treatment, Disposal	Control/DSS
TWIEU D13. DSS: wastewater management tools which facilitates the wastewater utilities to dynamically combine and easily access multi-disciplinary data sources (including SCADA data and real time modelling forecasts).	Used Water Collection, Treatment, Disposal	Control/DSS

PIANO Domain 3: Industrial Water Management

Challenges are related to water use efficiency and water treatment in industry. In particular, 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 Beijing-Tianjin-Hebei region.

PIANO PROJECT – DOMAIN 3

INDUSTRIAL WATER MANAGEMENT DOMAIN

The activities of Domain 3 aim to overcome the following objectives:

- To reduce water scarcity through 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 advance water treatment technologies.

Technologies Inventory: TWIEU C25, TWIEU C29, TWIEU A6, TWIEU C11, TWIEU C13, TWIEU C2, TWIEU C63, TWIEU C30, TWIEU C31, TWIEU C60, TWIEU C58, TWIEU C59, TWIEU C62, TWIEU C37, TWIEU C15, TWIEU C27, **TWIEU C54**, TWIEU C55, TWIEU C53[3]

MAIN CHALLENGES	RELEVANT RESEARCH AND INNOVATION ACTIVITIES
Water Scarcity	• Technologies to define and use water quality fit for use • Technologies aimed to develop sustainable use of resources (discharge, waste, energy) and to close the water cycle (leading to zero discharge system) • Monitoring systems and technologies • Water saving technologies (energy efficient systems) and water reuse technologies (in irrigation and industry) • Energy recovery technologies; Resources / raw material recovery technologies • Recovery energy and raw material technologies from sludge and wastewater (energy and nutrient recovery technologies)
Water pollution	• • Monitoring technologies to improve water quality control and discharges; • Develop advance water treatment technologies (energy efficient systems: small scale systems technologies to

[3] The prioritized and recommended TWIs are marked in bold

	specific pollutants removal); • New Wastewater Treatment technologies: Membrane technologies; Advanced, biological, treatment, solid separation	
INDUSTRIAL WATER MANAGEMENT TECHNOLOGIES		
TWI	**TWI Category**	**TWI Subcategory**
TWIEU C25. Ultrasound based disinfection technology with combination of ozone.	**Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)**	**Used Water Collection, Treatment, Disposal**
TWIEU C29. 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**
TWIEU C6. High-rate anaerobic reactor for wastewater treatment (primarily organic constituents) and biogas production.	Bioprocesses for C (and more) removal	Used Water Collection, Treatment, Disposal
TWIEU C11. Hybrid aerated activated carbon filtration technology, developed to add accurate and efficient amount oxygen (from air) to a classic activated carbon contactor.	Bioprocesses for C (and more) removal	Used Water Collection, Treatment, Disposal
TWIEU C13. Periodical Air/water cleaning of spiral wound membrane modules to control membrane fouling to reduce use of chemicals. Lower energy, less operational intervention needed. Longer membrane lifetime.	Solids Separation/Filtration (incl. membranes)	Used Water Collection, Treatment, Disposal
TWIEU C2. Innovative stabilized hydrogen peroxide solution of food-grade quality to replace classical stabilizers or active substances.	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water Collection, Treatment, Disposal
TWIEU C63. Atmospheric evaporation enhancement technology uses a proprietary evaporation equipment, through the principle of equal-enthalpy evaporation of the waste water in most of the water (96-98%) into the surrounding atmosphere, the remaining amount of concentrate can be resource use according to concentrate recycling or final disposal.	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water Collection, Treatment, Disposal
TWIEU C30. Moving Bed Adsorption combines moving sand bed filtration and carbon adsorption to remove suspended particles and dissolved organics in one step on milligram and microgram per liter levels.	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water Collection, Treatment, Disposal
TWIEU C31. Spiralizer vertical plates separator, for separation or clarification in wastewater treatment with low energy demand and without using flocculants, chemicals or polymers.	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water Collection, Treatment, Disposal
TWIEU C60. Advanced oxidation technology combines the advantages of adsorption and oxidation within a single unit, using proprietary adsorbent of non-porous nature, to reduce recalcitrant Chemical Oxygen Demand (COD), remove color and destroy micro-pollutants.	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water Collection, Treatment, Disposal

TWIEU C58. An optical laser based online sensor system equipped with automatic sampler to monitor treated wastewater as an early warning system for reclaimed and recycled water.	Monitoring/Sensors (includes production of fit-for-use waters)	Production Water Reuse & Recovery
TWIEU C59. Combination of UV and chemical oxidation with dose control during the disinfection process in water reclamation for reuse, e.g. in fit-for-purpose production of reclaimed water.	Treatment (includes production of fit-for-use waters)	Production Water Reuse & Recovery
TWIEU C62. A tool for online monitoring of deposits build-up and removal on the inner surface of piping. It can be used as a permanent monitoring tool or has an auditing tool for fouling and cleaning potential of the systems. It provides online, real-time and integrated information about the deposit layers attached to the inner surface of the monitored piping.	Efficiency (incl. water savings, usage, minimization)	Water Use
TWIEU C37. Combined membrane filtration and sonochemical technologies for advanced purification of industrial and mixed wastewater.	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water Collection, Treatment, Disposal
TWIEU C15. Membrane distillation using (waste) heat as driving force.	Solids Separation/Filtration (incl. membranes)	Used Water Collection, Treatment, Disposal
TWIEU C27. Hybrid process based on heterogeneous crystallization and filtration for the removal of hardness by means of the precipitation of calcium carbonate on heterogeneous seeds.	Advanced treatment (Phys/Chem, incl. adv. oxidation, disinfection)	Used Water Collection, Treatment, Disposal
TWIEU C54. Combined Biologic process for removal of organic matter, sulphate and others nutrients in industrial wastewater.	**Bioprocesses for C (and more) removal**	**Used Water Collection, Treatment, Disposal**
TWIEU C55. Anaerobic hybrid filter for pretreatment of industrial or urban wastewater.	Bioprocesses for C (and more) removal	Used Water Collection, Treatment, Disposal
TWIEU C53. Sewer Mining, direct treatment of wastewater for water, energy and nutrients recovery. Using pre-treatment, forward osmosis and re-concentration process and digestion.	many subcategoreis combined	Used Water Collection, Treatment, Disposal

PIANO Domain 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 in China. At the same time, existing urban drainage systems in the major cities are relatively inefficient about capacity to cope with urban floods.

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

Rapid urbanization, uncontrolled land-use and development of industrial zones have increased both urban and river flooding risks and increased water pollution in the 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.

Major challenges, related to flooding risk, aim to associate integrated river basin management tools with application of sustainable urban drainage system, preventive tools of river training, canal construction, dyke performances as well as hydraulic infrastructures. Moreover, it should be developed integrated methods to deal with the coupled water challenges, decision support systems (DSS) and real-time monitoring tools associated with land-use aspects, chemical/ecological water quality, urbanization issues, industrial priority pollutants as well as storage and delayed run-off at the basin-scale.

PIANO PROJECT – DOMAIN 4

RIVER BASIN MANAGEMENT AND FLOOD CONTROL DOMAIN

The activities of Domain 4 aim to overcome the following objectives:

- Optimization of water uses, water saving and management, through mitigation strategies and monitoring system with the aim to reduce water scarcity
- Reducing water pollution through technologies for contaminated areas and data integration technologies
- Mitigation of extreme events using technologies for seasonal forecasting (Drought) and numerical models, through land management project, 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

Technologies Inventory: TWIEU D2, TWIEU E14, TWIEU D16, TWIEU D1, TWIEU D8, TWIEU D9, TWIEU D5, TWIEU D15, TWIEU D23, TWIEU D22, TWIEU D21[4]

MAIN CHALLENGES	RELEVANT RESEARCH AND INNOVATION ACTIVITIES
Water Scarcity	• Mitigation strategies to face soil sealing (increasing runoff; reducing aquifer recharge) which include forecasting technologies for water resources and water demands • Optimization of water uses, water saving and management of multiple water users including water balance modelling systems and technologies (DSS) • Monitoring system to assess GW abstraction and recharge; Managed Aquifer Recharge Technologies Implementing MAR; Natural water retention measures

[4] The prioritized and recommended TWIs are marked in bold

	(nature-based solutions) • Freshwater bodies classification and matching alert system (physical – economical identifiers; water inflow changes; GW extraction rate); Freshwater overexploitation • Research at catchment scale: assessment method of available water resources; • Water resources assessment: Monitoring technologies and sensors technologies; Research on hydrological processes (Monitoring; sensors technologies; Modelling tools; Remote observation systems; Data management technologies) • Develop of adaptive water management methods
Water pollution	• Technologies for contaminated areas remediation (passive and active technologies) • Survey the state of degraded water resources systems; study and modelling the transfer of contaminants • Develop risk assessment tools • Treatment technologies • Early Warning System and Technologies • Data integration technologies (hydrological parameters, pollution loads, water quality chemical and microbiological)
Extreme events	• Implementation of mitigation strategies to face soil sealing • Using of technologies for seasonal forecasting (Drought) and climate models (regional and local scale) for evaluation of uncertainty • Use of new remote sensing technologies (satellite, Doppler radar, wireless sensors etc.) for forecasting and monitoring • Use of integrated modelling across SW and GW, coastal and fluvial systems, hydrological and meteorology, water and sediment transport • Risk Based decision making and planning tools • Land management project: flood plain and river banks restoration; asset resettlements • Develop tools and new technologies for adaptation to floods and droughts (Early Warning Systems; sensor technology; monitoring technologies) • Water management methods and technologies: forecasting technologies, DSS; modelling technologies; Space-based technology (SBT)
Ecosystem degradation	• DSS for system restoration, covering physical, ecological, social and economic benefits and costs • Monitoring system to assess the ecological status of SW/GW • Research on pressure-impact-response relationships • Develop new Water Management scheme (policy, regulations, monetary model; governance) • 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: Use of new natural materials (flexible concrete, durable grass) • Integrated river basin management tools: Bio-inspired dams for ecosystem degradation; smart buoy to monitor in-situ water quality

RIVER BASIN MANAGEMENT AND FLOOD CONTROL TECHNOLOGIES		
TWI	**TWI Category**	**TWI Subcategory**
TWIEU D2 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**
TWIEU E14 Smart buoy to monitor in-situ water quality (like dissolved oxygen, pH, conductivity, temperature, redox potential, total dissolved solids and turbidity) and web platform to receive the information provided by the buoy.	**water management technologies**	**Integrated systems (monitoring tools + DSS)**
TWIEU D16. Bio-inspired dams for ecosystem degradation management (sustainable ecosystem restoration in semi-arid regions).	**Integrated river basin management tools (flood protection)**	**Preventative technologies**
TWIEU D1. River basin management including flood risk management using Space-based technology (SBT) and information and communication technology (ICT).	water management technologies	Integrated systems (monitoring tools + DSS)
TWIEU D8. Web Mobile Application to report river water bodies status.	water management technologies	Stand-alone DSS
TWIEU D9. Microalgae dual-head biosensors for selective detection of herbicides with fibre-optic luminescent oxygen transduction.	water management technologies	Sensors & other devices
TWIEU D5. Floating technology for water retention and flood resilience in the urban fabric, based on modular composite technology that consists of fibre reinforced EPS structural panels for floating systems.	Integrated river basin management tools (flood protection)	Reactive technologies
TWIEU D15. Natural Water Retention Measures (NWRM) with crowdsourcing for DSS for flood risk reduction.	water management technologies	Stand-alone DSS
TWIEU D23. Integrated water resources management (IWRM) tool that combines a hydrological (SWAT), a river basin management (MIKE Hydro Basin) and a groundwater model (FEEFLOW) to provide decision support on surface – groundwater interactions.	water management technologies	Integrated systems (monitoring tools + DSS)
TWIEU D22. Interactive simulation system for river basin management in areas where no or little data is available based on stochastic analysis that provides information on long-term water management planning.	water management technologies	Integrated systems (monitoring tools + DSS)

PIANO Domain 5: Water for Energy

China is world leading in 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 priority area in energy development as planned in 2007 Medium and Long-term Development Plan of Renewable Energy. Because of that, China has lunched 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 with poor quality of constructions and technology are common. Focus has been put mainly on expansion of the production capacity but challenges are related to the weak grid infrastructures that cause inefficient use of the water resources and to preserve natural ecosystem in dammed rivers. 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. Chinese government is now focusing on environmental impacts mitigation. Optimal river basin management and cascade power stations can safeguard the base flow required and, at same time, meeting the objective from water and electricity demands. Major challenges are associated with prediction and mapping of reservoir inflows, assessment trade-offs between the conflicting objectives and methods to monitor and document the effect of implementing more sustainable reservoir operation policies.

PIANO PROJECT – DOMAIN 5

WATER FOR ENERGY DOMAIN	
The activities of Domain 5 aim to overcome the following objectives: - Reducing water scarcity through industrial water reuse and water-energy nexus **Technologies Inventory: TWIEU E19, TWIEU E23, TWIEU E12**, TWIEU E5, TWIEU E1, TWIEU E3, TWIEU E4, TWIEU E6, TWIEU E13, TWIEU E15, TWIEU E17, TWIEU E20, TWIEU E9[5]	
MAIN CHALLENGES	**RELEVANT RESEARCH AND INNOVATION ACTIVITIES**
Water Scarcity	• Improve industrial water reuse through water reuse technologies • Water-energy nexus: Energy is needed for water supply and Water is crucial in power production.

WATER FOR ENERGY TECHNOLOGIES		
TWI	**TWI Category**	**TWI Subcategory**
TWIEU E19. Geothermal energy pump to harvest geothermal energy.	**energy production technologies**	**Other sources**
TWIEU E23. 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 in to 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**
TWIEU E12. Behavioural fish barrier (using a strobe light, sound and a bubble curtain as stimuli) to e.g. divert fish	**water management**	**Mitigation technologies**

[5] The prioritized and recommended TWIs are marked in bold

from turbine blades of hydroelectric structures.	**technologies**	
TWIEU E5. Very low head turbine generator (Kaplan type) for up to 4.5 m head.	energy production technologies: small-scale hydropower	Turbines and components
TWIEU E1. Hooped Pelton Turbine designed based on the separation of function between buckets and hoops.	energy production technologies: small-scale hydropower	Turbines and components
TWIEU E3. Screw Turbine Generating System, a screw type small (up to 300kW) hydro unit applicable to existing channel or weir.	energy production technologies: small-scale hydropower	Turbines and components
TWIEU E4. Vertical Micro Pelton Turbine with composite runner buckets in package type generating unit for small rivers with relatively low discharge and high head.	energy production technologies: small-scale hydropower	Turbines and components
TWIEU E6. Small turbines to be retrofitted e.g. intake towers, unused ship locks, canal weirs and navigation and irrigation dams to use these existing structures as a profitable and renewable energy resource.	energy production technologies: small-scale hydropower	Turbines and components
TWIEU E13. Water Lubricated Bearings guarantee the non-pollution of the river that can happen with the oil-lubricated alternatives.	energy production technologies: small-scale hydropower	Turbines and components
TWIEU E15. Earthquake safety assessment for concrete dams foundation failure by application of integrated numerical tools.	energy production technologies: small-scale hydropower	Decision support systems (DSS)
TWIEU E17. Integrated assessment and structural modelling of swelling processes in concrete dams: measurement of concrete stress, using flat jacks and over-coring techniques.	energy production technologies: small-scale hydropower	Decision support systems (DSS)
TWIEU E20. Oscillating water columns, device that generates electricity from waves.	energy production technologies	Other sources
TWIEU E9. DSS: Hydropower Plant Simulator (HPPS) for simulating the refurbishment and maintenance decisions of hydropower plant.	energy production technologies: small-scale hydropower	Tools to predict and map resource flows and assessing trade-offs between resources uses