



TRANSCEND

Deliverable 1.1: STAKEHOLDER MAPPING BY PROJECT LABORATORIES

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Executive summary

This report, alongside its counterpart "Rules of Engagement" (D1.2), marks the initial phase of stakeholder engagement, promoting inclusive research and innovation, a defining characteristic of the TRANSCEND project. Stakeholder engagement is instrumental to the successful implementation of transformative water reforms. Considering water as a precious and limited resource, its efficient management necessitates active cooperation and coordination among a range of stakeholders, comprising government entities, civil society organizations, water consumers, and the private sector. The TRANSCEND consortium is committed to involving these stakeholders in a meaningful way to ensure our research reflects their needs and perspectives and is ultimately beneficial to those empowered by our outcomes. As part of this commitment, we will foster an interactive environment wherein stakeholders actively contribute to the creation of models and action plans, thereby fostering a sense of co-ownership over the results.

Water, being a pivotal resource in achieving Sustainable Development Goals, is faced with issues of scarcity, pollution, governance, climate change, and justice. The TRANSCEND project aims to address these challenges, implementing transformative agendas across seven pilot laboratories in various countries and fostering collaboration among different sectors. This report presents initial stakeholder mapping results from the 7 living laboratories, providing a succinct overview of the water governance arrangements in the countries encompassing the living laboratories. It also details the water organizations operating within these labs, describes their responsibilities in key aspects of water governance decision-making, and further elaborates on the roles, competences, skills, and expertise of these organizations.

The results of the mapping gives preliminary insights into the dynamics of water governance systems, helping in the identification of key experts, institutions, communities, and local action groups. These insights are crucial for aligning knowledge-sharing and mutual learning activities with diverse stakeholder groups' needs and perspectives. This process also contributes to understanding the stakeholder landscape, which will continuously be enhanced as the project progresses. The various roles of stakeholders in water governance across the pilot basins mirror the collaborative nature of water management. In-depth comparative analyses will be conducted to assess diverse water governance aspects and the potential barriers to transformative adaptation (see D5.1 for a first assessment). The project will proactively identify and address potential challenges, conflicts, and divergences, fostering synergies and promoting sustainable, resilient water management policies.

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1 Introduction

Water resources management faces daunting challenges of scarcity, pollution, governance, climate change, and justice. Water is a fundamental resource and a fundamental "deal maker" across the Sustainable Development Goals (SDGs), playing a critical role in eradicating poverty, ensuring food security, promoting health and well-being, supporting industry and infrastructure, taking action on climate change, and protecting ecosystems. The UN 2023 Water Conference held in March 2023 provided an opportunity to discuss progress on various dimensions of sustainable water management, encompassing transboundary water cooperation, scaling up investments, addressing climate-water interconnections, promoting data and innovation, as well as emphasizing community participation, circular water economy, education, and green and blue economies (UN, 2023).

The research and innovation activities of the TRANSCEND touch upon many of the above topics. The project, implemented across seven river basin pilot laboratories in Spain, Italy, Greece, and Slovakia, as well as transboundary basins stretching across Peru, Chile, Bolivia; Lebanon, Syria, and Turkey; and an interstate basin in India, seeks to develop and catalyse the adoption of transformative agendas. By fostering collaboration among policy and management bodies, the private sector, civil society, and research and innovation, the aim is to co-develop knowledge and promote equitable solutions that foster sustainable economic growth and environmental protection.

Water governance involves the management, allocation, and regulation of water resources to meet various societal needs while ensuring sustainability and equitable distribution, and maintaining ecosystem's health (OECD, 2011). Stakeholder mapping (OECD, 2015) is a technique used for identifying and understanding the diverse range of actors involved in water-related issues, such as government agencies, non-governmental organizations, community groups, private sector entities, and academic institutions. It is set to identify their roles, interests, relationships, and influence within the water governance landscape, as well as their management capacities and capabilities.

Water governance is an overarching term referring to a multitude of administrative frameworks, focusing on both formal (laws, official policies) and informal (power relations, practices) institutions, as well as the efficacy of organizational structures (OECD, 2011). In contrast, water management refers to the execution of activities aimed at achieving specific objectives, such as harmonizing water resources with supply, consumption, and recycling. Transparent, accountable, and coordinated institutional and policy frameworks are integral components of effective water governance. The diversity of water governance frameworks across the world reflects different geographical, social, economic, and political contexts. Each framework is uniquely tailored to its regional and national conditions and addresses a range of issues, from water quality and scarcity to equitable distribution and sustainability. In some countries, water governance is centralized, with national governments playing the dominant role in policy-making and implementation. Other countries follow a decentralized model, entrusting significant responsibilities to local authorities, communities, or private sectors. Some governance frameworks are better aligned with an integrated approach to water resources management, which advocates coordinated development of water, land, and related

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resources to balance economic and social welfare with ecosystem sustainability. The common thread among frameworks that build upon IWRM is the commitment to inclusive, participatory, and sustainable water management practices, which respect the right to water and address the needs of all stakeholders.

In the EU, the cornerstone of the "water acquis," which is built upon the principles of Integrated Water Resources Management (IWRM), is the Water Framework Directive (WFD—EC, 2000) enacted in 2000. The Directive provides a legislative framework for the protection, improvement, and sustainable use of rivers, lakes, estuaries, coastal waters, and groundwater bodies. Water management is organised around natural geographical and hydrological units (river basin districts), rather than political or administrative boundaries. The Directive mandates Member States to regularly review and update their river basin management plans and implement programs of measures aimed at achieving or maintaining the 'good status' of waters bodies. All EU Member States have transposed the WFD Directive into their national legislation and implemented the six-year-long water planning and management cycles, taking different approaches and facing unique challenges (Rowbottom et al., 2022). Among the TRANSCEND EU pilot basins, Italy and Slovakia have adopted their third cycle of River Basin Management Plans (RBMPs), whereas Spain has finalized public consultation and Greece is undergoing the public consultation process.

This document describes the results of an initial stakeholder mapping conducted in the seven pilot laboratories, building upon desk research and partner consultations. It provides an overview of organizations, their roles, and capabilities, serving as a valuable input for the project's collaborative efforts. Together with the Rules of Engagement report (D1.2), this report sets the stage for future stakeholder interactions, rather than summarizing past outcomes. Our goal is to foster a collaborative environment where diverse stakeholders can share complementary knowledge, expertise, and skills for mutual benefit. While this report serves to identify stakeholders, assess their competencies, and identify strategic synergies and complementarities, the D1.2 will provide guidelines and shared principles to govern the conduct of all involved parties, ensuring that the TRANSCEND research is conducted ethically, responsibly, and professionally. Building upon both, the pilot teams will invite and engage relevant stakeholders to participate in TRANSCEND research and establish knowledge networks to facilitate co-creation processes.

The stakeholder mapping provides initial insights into the dynamics of water governance systems in pilot living labs and helps to identify key experts, institutions communities and local action groups for inclusive and participatory methods that define this project. The results are crucial for designing knowledge-sharing and mutual learning activities that align with the needs and perspectives of diverse stakeholder groups. As the project activities progress, we will gain further insights about the relevant stakeholders, their capacities, and their roles in specific decisions to be explored within the pilot laboratories. A comparative analysis of the governance frameworks and the roles of various organizations will be conducted later in the project's timeline once deeper insights into ongoing transformational processes have been acquired.

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Sections 2-8 are dedicated to the seven pilot basins involved in the project, and are structured as follows:

- Each of these sections begins with a brief overview of the water governance arrangements in the country or countries encompassing the pilot basin. The objective is not a thorough analysis of governance arrangements but rather an exploration of diverse organizational structures and roles in water management, vital for understanding the contributions and legal responsibilities of different entities.
- The subsequent subsection gives a detailed account of the water organizations operating within the pilot basins. It identifies the organizations responsible for various key decisions intrinsic to a water governance system, including water allocation and rights/permits, water pricing, water quality and conservation, infrastructure development and management, stakeholder engagement and participation, emergency management, and environmental protection. This description will shed light on the diverse roles and responsibilities of these water organizations within the pilot basins.
- The concluding subsection elaborates on the role, competences, skills, and expertise of the aforementioned organizations, with emphasis on:
 - collecting data and monitoring water management decisions, which involves analysing water quantity and quality data and ensuring enforcement of decisions,
 - climate and hydrological modelling, where stakeholders with expertise in these areas help understand the impact of climate change on water resources,
 - scenario development and foresight skills, which involve assessing the potential impacts of water management decisions on the environment and society,
 - impact analysis, including economic, social, and environmental assessments, of relevance for understanding the consequences of water management decisions,
 - risk assessment, where stakeholders with expertise in this field identify and manage potential risks associated with water management decisions,
 - policy analysis, which involves evaluating the effectiveness of water management policies and proposing improvements,
 - participatory approaches to problem-solving, which involve engaging community-based organizations, non-governmental organizations, and government agencies in scoping and seeking solutions for water management issues.

2 Júcar River Basin, Spain

2.1 Water governance

Spain is a parliamentary constitutional monarchy. It has a bicameral parliament, the Cortes Generales, consisting of the Congress of Deputies and the Senate. Subnational government structure includes three levels: autonomous communities and cities; provinces; and municipalities. Each level exercises self-governance under the principle of constitutional devolution and individual autonomy statutes. The seventeen Autonomous Communities (*Comunidades Autónomas*) and two autonomous cities (Ceuta and Melilla, in North Africa) each have elected presidents, governments, and parliaments. Their responsibilities and powers are based on their individual Statutes of Autonomy, which include, among others, education, health, social services, housing, public transport, and environment. Autonomous Communities are further divided into 50 provinces with elected governments and certain administrative functions. The provinces are further divided into municipalities, the local governing bodies that represent cities and towns. Each municipality has a mayor and a municipal council, who oversee local infrastructure, planning, public spaces, and local services.

Water governance in Spain is complex, and each of the subnational levels plays a role and has specific responsibilities for the management of water resources. The central government sets the legal framework and overarching water policy guidelines, in alignment with European directives and frameworks. The Ministry of Ecological Transition and Demographic Challenge is responsible for defining overarching water policies, managing transboundary rivers, and coordinating actions related to international water issues. This ministry works through several agencies such as the State Meteorological Agency, the National Parks Autonomous Agency, and most importantly, the Hydrographic Confederations playing the role of river basin authorities. Established in 1926, the Hydrographic Confederations are public bodies that manage hydrological planning, water resource allocation, hydraulic infrastructure development, and environmental preservation, particularly of water quality and resources, in their respective basins. The Water Law of 1985, updated in 1999 and 2001, defines these responsibilities.

Spain is obligated to transpose and comply with the EU's Water Framework Directive (WFD), which mandates the protection and improvement of aquatic ecosystems, promotes sustainable water use, and aids in mitigating the effects of floods and droughts. The integration of the WFD into Spanish law was accomplished by the Article 129 of Law 62/2003, which amended the Water Act as outlined in Royal Legislative Decree 1/2001 of 25 July ("*Texto Refundido de la Ley de Aguas*"). The Ministerial Order for Hydrological Planning (Orden ARM/2656/2008 *sobre Instrucción de Planificación Hidrológica*, IPH) outlines the water management planning process, conditions for exceptions, and monitoring of ecological and chemical statuses of surface waters. It is only applicable to rivers that cross the boundaries of autonomous communities (regions). This is because, according to the Spanish Constitution, catchments that span multiple regions are managed by the state, while those within a single region fall under regional jurisdiction (autonomous communities).

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At the regional level, autonomous communities hold competencies over rivers, lakes, and groundwater that run entirely within their territorial boundaries. They are responsible for urban water supply and sanitation services, irrigation, environmental protection, and land use planning within their respective jurisdictions. At the local level, municipalities manage local water services, including drinking water supply and sanitation, and urban drainage.

2.2 Institutional mapping

The Júcar River in eastern Spain spans about 500 kilometres from its source in the Montes Universales to its mouth at the Mediterranean Sea. The Júcar River Basin spans four autonomous communities - Castilla-La Mancha, Valencia, Aragon, and Murcia - and the provinces of Teruel, Cuenca, Albacete, and Valencia. The Júcar Hydrographic Confederation (CHJ) oversees water management in the Júcar basin area. This involves tasks such as managing water resources, maintaining water quality, upkeeping infrastructure like reservoirs and canals, and mitigating flood risks. Historically, the Júcar River has been instrumental in supporting agriculture, particularly orange cultivation in the Valencian Community. However, as with many Mediterranean river basins, the Júcar confronts challenges including water scarcity, pollution, and climate change impacts that threaten future water supply to some of its uses. The Júcar River Basin Authority is addressing these issues through sustainable water management practices. The Júcar can also leverage on external resources through the Tagus-Segura Transfer System, which transports water from the Tagus River Basin (shared with Portugal) to the Segura River Basin (mostly within the Region of Murcia) to meet water demands along Spain's southeastern coast. The transfer is managed by the central government which can limit the transfer in those cases where the donor basin experiences water availability constraints. Besides the CHJ and the central government, other relevant institutions that play a role in water resources management are listed below.

The Center for Studies and Experimentation of Public Works (*Centro de Estudios y Experimentación de Obras Públicas*—CEDEX) is a Spanish research body specializing in civil engineering, environment, and housing. Under the Ministry of Transport, Mobility, and Urban Agenda and the Ministry for the Ecological Transition and the Demographic Challenge, CEDEX provides technical support for public works and environmental policy decisions. Its activities include research and development, technical consultation, and drafting technical regulations. CEDEX also contributes to national and international standardization in civil engineering and housing.

The Government of the Valencian Region has goals of preserving and where possible enhancing the economic productivity of the agricultural sector in the region, as well as improving the ecological status of protected areas. Sharing the same goals, the Government of the Castille – La Mancha Region is set to increase their portion of the Júcar's surface water, since this is considered a more cost-effective and cleaner option compared to the groundwater sourced from the Mancha Oriental aquifer in the Júcar Basin. The City of Valencia, largely reliant on the Júcar River for its water supply, aspires to maintain its current water share, potentially expand it, and tackle any issues relating to water quality. The City of Albacete, which has shifted from using groundwater to surface water due

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to concerns over water quality, strives to sustain and increase their utilization of surface water while trying to limit payments to the Júcar Users Union (USUJ) holding the historical water rights of some of the resources Albacete needs.

Other governance agents involved in water management include water user associations (particularly irrigation communities), environmental NGOs, research institutions, private companies, and the media. These stakeholders participate in water governance through consultation, collaboration, and advocacy mechanisms.

- The Júcar Users Union (*Unión de Usuarios del Júcar*, USUJ) represents downstream farmers with senior water rights and Iberdrola, a major Spanish multinational electric utility company serving around 31.67 million customers. It seeks to maintain the sustainability of their activities and uphold their senior water rights. The Union are the legal owners of the main reservoir (Alarcon).
- The Valencian Farmers' Association (*Asociación Valenciana de Agricultores*, AVA-ASAJA) advocates for the agricultural sector in the Valencian Community, promoting sustainable farming, defending member rights, and lobbying for beneficial policies. It also offers services like technical advice, training, and bureaucratic navigation support.
- Acequia Real Del Júcar (ARJ) is one of the most significant farmers associations among USUJ members, they aim to ensure the sustainability of their farming activities and maintain their senior water rights.
- Canal Júcar-Turia (CJT) represents farmers without senior water rights from the lower Júcar region who use both surface and groundwater. They aim to ensure the sustainability of their farming activities and strive for a more equitable allocation and larger share of surface water.
- Junta Central de Regantes de la Mancha Oriental (JCRMO) represents farmers without senior water rights from the middle Júcar region, primarily using groundwater. They aim to ensure the sustainability of their farming activities, reduce groundwater pumping rates, and increase their share of surface water.
- Iberdrola is an energy company and member of USUJ responsible for hydropower production in the basin.
- The Polytechnic University of Valencia (*Universitat Politècnica de València*, UPV) is a public university that conducts research and education in various fields related to water resource management, including hydrology, hydrogeology, water management, water quality, water economics, water governance, and climate change. Among other major contributions, they have developed and maintain the hydrologic Decision Support System used by the CHJ and all other interregional basins in Spain, AQUATOOL.
- Xúquer Viu is an environmental NGO platform aiming at improving the environmental status of the river, increase minimum environmental flows, and prevent water transfers from the Júcar to other basins.
- AEMS Ríos con Vida is a nationwide NGO focused on sustainable fish populations and fishing activity. They seek to improve the Júcar's environmental status to provide a healthier habitat for native species.

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Table 1 The stakeholders' community in the Júcar basin

Organization	Theme	Specific roles / competences
Júcar Hydrographic Confederation CHJ	Integrated river basin management	• manages water resources, maintains water quality, upkeeps infrastructure like reservoirs and canals, and mitigates flood risks, • manages issues of water scarcity, pollution, and climate change impacts through sustainable water management practices
Spain Central government	National policy framework	• regulates the Tagus-Segura Transfer System which transports water from the Tagus River Basin to the Segura River Basin
Governments of the Valencian and Castille – La Mancha Regions	Decentralised water resource management	• management of water bodies, oversee urban water services and irrigation, and handle environmental protection and land-use planning
Cities of Valencia and Albacete	Water supply and sanitation	• manage water supply & sanitation, water quality issues, and urban drainage
• USUJ , AVA-ASAJA , ARI , CIT , JCRMO	water users' associations	• communities of water users, protection of their rights, participation in resource planning
Iberdrola	Energy utility	• hydropower generation
UPV Valencia University	Research & innovation	• research and education in various fields related to water resource management
Xúquer Viu AEMS	Non-governmental organisations	• environmental flows and river health protection • sustainable fishing and fish populations

2.3 Mapping of competences

The CHJ coordinates water resources management in the basin following guidance from its river basin management plan. The river basin management plan, a requirement of the EU Water Framework Directive, defines objectives for each water body; reasons for not achieving objectives where relevant; and the programme of actions required to meet the objectives. River basin management plans are prolific documents that address several topics from climate change impacts to water demand management, and are approved following a public consultation process involving key stakeholders in the basin. The CHJ's river basin management plan (RBMP) includes an annex with climate change risk assessment and adaptation. It utilizes the latest IPCC report and CEDEX data to quantify the effects of climate change on water resources, ecosystems, and meeting water demands. The study focuses on temperature, rainfall, and hydrological cycle components. It considers the anticipated decrease in surface and groundwater resources and changes in extreme events like droughts and floods. The assessment examines the impact on fluvial ecosystems, including fish species, macroinvertebrates, and dissolved oxygen levels due to changing water temperature. It also identifies other environmental concerns such as desertification processes and the potential spread of invasive species in the basin. The RBMP's annexes also address the expected impact of rising sea levels on coastal wetlands, specifically Albufera, a prominent wetland in the Mediterranean coast. It also presents findings on water use and demands, including deficits or compliance for agricultural and urban purposes. The assessment considers potential losses in

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hydroelectric production and the implications for cooling the Cofrentes Nuclear Power Plant in light of climate change conditions.

The CHJ utilizes various models and tools, including the AQUATOOL model for water allocation and drought management, the SAIH system for real-time hydrological information, and the SIMGES module for water quality. They actively participate in water management processes, such as developing and implementing the River Basin Management Plan and the Drought Management Plan (DMP). Coordination and consultation with other administrations and stakeholders occur through the River Basin Committee (RBC) and the Learning and Action Alliance (LAA). The CHJ has a strong qualitative and quantitative capacity for water management. The challenges that the CHJ has to address include coordination issues, unregulated water abstractions, and the impact of climate change and droughts on water availability and quality. There is a potential gap in modelling with limited interaction with socio-economic models to assess impacts and trade-offs in water management scenarios.

The AVA-ASAJA has essential competences in promoting and supporting sustainable and profitable agriculture, while providing technical and economic advice to its members. They actively participate in water management processes, including the River Basin Committee (RBC), where they represent the irrigation users. The AVA-ASAJA possesses a moderate qualitative and quantitative capacity for water resources management and scenario development.

The UPV possesses essential competences in developing and applying models and tools for water resources management. These include the in-house developed AQUATOOL decision support system, hydroeconomic models for water distribution and planning, and the MODFLOW model for groundwater flow simulation. The UPV actively participates in water management processes, such as the GoNEXUS project, which focuses on the integrated management of water, energy, and food in the Jucar River Basin through a participatory approach. Collaboration takes place with institutions like the CHJ, MITECO, EU, and the Food and Agriculture Organization (FAO). The UPV demonstrates a high qualitative and quantitative capacity (3) for water resources management and scenario development.

The CHJ has key competences in assessing and evaluating the economic, social, and environmental impacts of water management decisions. This includes areas like water allocation, water pricing, water quality standards, and drought management.

3 Reno river basin, Italy

3.1 Water governance

Italy's governance system is a hybrid of both unitary and federal state, with a vertically decentralised structure. The Italian constitution grants significant autonomy to the subnational governments of the self-governing regions and autonomous provinces. These regions and provinces have their own elected governments and legislatures and are responsible for a wide range of policy areas, including water governance. This decentralisation has led to a complex and fragmented system of responsibilities for managing and governing water resources, which is articulated at the national, regional, and local levels.

The central government is responsible for establishing a national legislative framework and strategic objectives for water management, as well as ensuring compliance with EU directives on water and sanitation. The Ministry of Environment¹ sets policy direction, coordinates with regional authorities, and implements the national framework. The Ministry of Agriculture develops policies and strategies for land reclamation, irrigation, and rural development. The Ministry of Infrastructure oversees planning, construction, and maintenance of water infrastructure projects, including dams, reservoirs, treatment plants, distribution networks, and flood control. Additionally, the Inter-ministerial Committee for Economic Programming for Sustainable Development (CIPESS) plays a role in coordinating inter-ministerial efforts for sustainable development.

Italy, as an EU member state, is compelled to transpose and implement EU water-related legislation into its national legislative framework. The Water Framework Directive is the EU's primary legislation for safeguarding water resources, and it has been incorporated into Italian law through the Environmental Code, or Legislative Decree No. 152 of 3 April 2006. This Code established a single, coherent legislative framework and streamlined the legal and administrative procedures for environmental protection, including water resource management. The legislation also provided for the establishment of river basin districts and their corresponding authorities, reforming the previous system.

There are seven river basin districts in Italy, each with its own River Basin Authority (RBA). The RBAs are responsible for coordinating water management policies and practices in their respective districts, ensuring compliance with water legislation and promoting sustainable water use. The RBAs work closely with regional authorities, local communities, and other stakeholders to develop and implement integrated water management plans. They also monitor water quality and quantity, manage water allocation and distribution, and coordinate flood risk management efforts. RBAs play

¹ In the current first government of the XIX legislature the full names of the ministries are Ministry of Environment and Energy Security (Ministero dell'Ambiente e della Sicurezza Energetica, MASE), Ministry of Agriculture, Food Sovereignty and Forests (Agricoltura, sovranità alimentare e foreste MASAF), Ministry of Infrastructure and Transport (Ministero delle Infrastrutture e dei trasporti MIT). CIPESS in Italian stands for Comitato interministeriale per la programmazione economica e lo sviluppo sostenibile

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a coordination role. Its statutory bodies include the Permanent Institutional Conference as a decision-making body of the Authority, which consists of Ministers and Presidents of Regional Councils, chaired by the Minister of Environment. Its tasks include adopting criteria and methods for drafting the basin plan, defining times and methods for plan adoption, coordinating water recovery and protection plans, controlling plan implementation, and adopting safeguard measures until the plan is adopted.

Regions have competences in a range of areas related to water governance, such as monitoring and assessing water quality, regulating water use, and promoting sustainable practices in agriculture and industry. They also oversee the management of regional water authorities and coordinate with national and local authorities to ensure effective water management. Central government or regions also establish **water boards**² which are public entities that oversee the construction and operation of water infrastructure such as dams, canals, and treatment plants, and work to prevent pollution and degradation of water resources.

Italy boasts a long history of land reclamation, especially in low-lying plains that were once characterized by wetlands and coastal marshes. This legacy has led to the development of an extensive network of drainage and irrigation channels that safeguard the highly developed lowlands and support the irrigation of vast agricultural fields. As a country dominated by mountains, Italy is home to an extensive system of natural and regulated lakes, along with man-made water reservoirs, which contribute to its comprehensive water infrastructure. To manage, maintain, and enhance these water infrastructure systems, different types of water boards has been established. The water boards hold responsibility for the governance of natural and man-made water bodies, as well as for land reclamation and irrigation. The governance of these water boards is regulated by distinct legislation, ensuring proper management and sustainability of Italy's vital water resources. Water boards have the authority to levy charges and taxes on water users in their respective areas of responsibility. These charges and taxes are intended to cover the costs of providing water services and maintaining water infrastructure, as well as to fund investments in new infrastructure and environmental protection measures.

Water supply and sanitation (WSS) services in Italy are divided among national, regional, and local government bodies, operating within designated service areas. Both private and public companies owned by local authorities manage Italy's water supply. ARERA, the Italian Regulatory Authority for Energy, Networks, and Environment, oversees water and sanitation service providers by regulating tariffs, defining quality standards, and monitoring compliance. Fair and transparent tariffs take into account infrastructure investments, operational costs, and environmental sustainability. The authority enforces quality standards to provide consumers with reliable, safe, and high-quality services, while safeguarding consumer rights through complaint resolution, rights

² Water boards can take different form and denomination, such as land reclamation and irrigation board (consorzi di bonifica), water treatment board (consorzi per la depurazione acque), aqueduct board (consorzi di acquedotto), lake management board (consorzi di gestione dei laghi), channel board (consorzio per la gestione canale), etc.

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promotion, and encouraging regulatory process engagement. In recent years, Italy has seen a trend towards greater consolidation of water and sanitation services. Smaller and medium-sized companies have merged with larger ones to achieve economies of scale and enhance efficiency. Italy has made significant progress in recent decades, achieving nearly universal coverage in urban areas and substantial improvements in rural areas. Often, the same utilities manage both water supply and sanitation services, but separate companies may be responsible in some cases.

Stakeholder participation is a key aspect of water governance in Italy. Water user associations and other local organizations play an important role in managing water resources. There are numerous civil society organizations that work on water-related issues, including environmental protection and water conservation. Italy has a history of negotiated environmental agreements, such as river, coast, or aquifer contracts, that promote sustainable water management practices through participatory approaches involving local governments, water users, environmental organizations, and other stakeholders. These contracts establish a shared vision for managing water bodies, including goals and actions related to water use, conservation, and protection, and measures for monitoring progress towards those goals.

3.2 Institutional mapping

The Reno River, Italy's longest and largest south of the Po, originates in the Tuscan-Emilian Apennines, and flows 211 km to the Adriatic Sea. Previously, it was a right tributary of the Po River. Over time, hydrography changes have affected the Padan plain, including the Reno River. To mitigate urban flooding, the Reno was redirected to the Adriatic Sea. It's a vital water source for agriculture, industry, and urban areas, and home to many species, including otters and birds of prey. Water quality and quantity challenges remain due to pollution, irrigation, and climate change.

Reno falls within the Po River basin district and the competence area of the **Po River Basin District Authority** (AdbPo) responsible for managing the maintenance of the Po river and its tributaries. Established in 1989, the AdbPO is responsible for the maintenance of the Po River and its tributaries. In 2016, it was reorganized as part of a new system of basin district authorities. **Inter-regional agency for River Po** (Agenzia Interregionale per il fiume Po, AIPO) is an inter-regional agency established in 1989 to protect, manage, and enhance the Po River and its tributaries. AIPO is responsible for planning and implementing river basin management plans, monitoring water quality and quantity, managing hydraulic works and infrastructures, promoting sustainable agricultural practices, and coordinating emergency responses to flood and drought events. AIPO works to ensure the sustainable use of water resources, prevent and mitigate flood and hydrogeological risks, and promote the ecological and landscape values of the river basin.

The **Emilia-Romagna Regional Authority** oversees the implementation of water policies and coordinates with local authorities and stakeholders to manage water resources effectively. The Department for soil protection, coast and land reclamation is responsible for ensuring adequate levels of hydraulic and hydrogeological security. Its main goal is to reduce risks to safeguard the environment and landscape. This is achieved through planning the use of the territory and

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programming interventions to defend the soil, coast, and reclamation. The Department collaborates with Basin Authorities to form basin plans and is also responsible for drafting laws, regulations, guidance, and control acts for delegated matters.

In Emilia-Romagna, there are nine **water boards** responsible for managing public reclamation and irrigation works, including canals and dewatering plants. These works are primarily intended for managing water drainage in low-lying areas without a natural outlet, as well as irrigation and water conservation. Land and property owners contribute to the boards' expenses. Maintenance activities, such as weeding and purging channels, ensure hydraulic efficiency. Maintenance of dewatering systems and mountain reclamation works ensures hydraulic safety. Through their infrastructure, the boards irrigate approximately 220,000 hectares of agricultural land using water from the river Po and its tributaries. The network of artificial channels in Emilia-Romagna covers approximately 19,800 km, comprising of 5,700 km of drainage channels, 11,000 km of mixed channels that serve both drainage and irrigation functions, and around 3,100 km of irrigation channels exclusively.

The **Renana water board** is a public entity that manages an area of approximately 342,500 hectares in the province of Bologna. With over 145,000 property owners as consortium members, the board supplies water for irrigation and production through a network of 1,615 km of canals, 51 hydraulic lifting systems, and 16 expansion tanks. Annually, they distribute 70 million cubic meters of water for production purposes and allow the outflow of over 400 million cubic meters of rainwater while safeguarding buildings and infrastructure. The **Canale Emiliano Romagnolo (CER)**, managed by a secondary order water board, is a significant artificial waterway in Italy's Emilia-Romagna region. Primarily designed for irrigation and water supply, this canal system originates from the Cavo Napoleonico at Sant'Agostino, a connection between the Reno and Po rivers, and extends from Ferrara and Bologna to the province of Rimini. The canal is 135 km long, covering a basin of about 3000 km², and sources its water from both the Reno and Po rivers. Yet another water board operating within the pilot area is the Board **Canali di Bologna**, an alliance formed by the Reno and Savena Canals Consortiums built to ensure flood safety and environmental quality of the Bologna city. Their daily regulation tasks involve supplying water during droughts and draining it when in excess.

The **Agency for the regulation of local environmental public services** (ATERSIR, Agenzia di regolazione dei servizi pubblici locali ambientali) is the Emilia-Romagna regional agency regulating local environmental public services. The agency oversees integrated water services (aqueduct, sewerage, and purification) and waste management services (collection, transportation, recovery, and disposal). It was established by regional law 191/2009 and encompasses the entire regional territory, all municipalities and provinces of the Region being mandatory participants. **Romagna Acque-Società delle Fonti S.p.A** is a public shareholding company that manages all the potable water sources in the Romagna region of Italy. Romagna Acque is the sole manager of potable water sources in Romagna. Apart from the Ridracoli dam, which provides roughly half of the total potable water demand, the company also manages all other water sources in the region. These include various types of sources: predominantly groundwater in Rimini, mainly surface water in Ravenna, and both in Forlì and Cesena.

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Emilia-Romagna prioritizes the protection of biodiversity and sustainable management through its regional system of protected areas, Natura 2000 network, and ecological connection areas. These areas are managed by the Department for Protected Areas, Forests and Development of Mountain Area and form the regional ecological network, including parks, nature reserves, protected landscapes, and ecological rebalancing areas. Protected areas serve as natural buffer zones against floods and erosion and help maintain healthy ecosystems to support water availability and quality. The nature protection areas in the Reno basin play an essential role in water management by issuing permits and authorizations for activities that impact water resources and conducting monitoring activities to assess the quality and quantity of water resources. They also take measures to prevent and mitigate water pollution and other environmental threats.

ART-ER, a consortium in Emilia-Romagna, promotes sustainable growth via innovation, enhances regional appeal, and fosters territorial internationalization. With expertise in business, environmental analysis, and socio-economic scenario development, ARTER supports the region's progression and well-being through strategic initiatives.

Table 2 The stakeholders' community in the Reno basin

Organization	Theme	Specific roles / competences
Regional Government Emilia Romagna (RER), water services	decentralised competences for water resource management	• formulates regional water management policies and regulations • oversee infrastructure development, conservation and protection strategies, environmental services, protected areas, economic development
Po River Basin Authority PRBDA	river basin authority and respective roles	• planning and implementation of river basin management plans, monitoring water quality and quantity, emergency responses to flood and drought
Inter-regional agency for River Po AIPO	main infrastructure management	• planning, implementing and managing hydraulic works and infrastructures
Regional environment agency ARPAE	monitoring, modelling, reporting	• monitoring and early warning systems, • hydrological and impact modelling
ARERA Regulatory Authority for Energy, Networks, Environment	national regulator for water services & sanitation	• standards for service delivery, • regulates price schemes and retribution of invested capital
ATERSIR public services agency Romagna Acque	regional management of water services & sanitation	• oversees integrated water services and waste • management services across Emilia-Romagna • manages all the potable water sources in the Romagna region
Water Boards Renana Water Board Canale Emiliano Romagnolo CER Canali di Bologna	land reclamation and irrigation	• manage public reclamation and irrigation works, including canals and dewatering plants; • ensures maintenance activities ensure hydraulic efficiency and safety
University of Bologna	research & innovation	• research contributing to water resource management
ART-ER Innovation Hub		• innovation and territorial internationalization

3.3 Competence mapping

The Climate Observatory of ARPAE Emilia-Romagna conducts climate modelling, providing seasonal climate projections at regional and macro area levels. The projections are generated using a statistical downscaling scheme based on the Perfect Prog approach. Data from different global climate models (GCMs) participating in the CMIP5 experiment, under the RCP4.5 emission scenario, are used to feed the statistical downscaling scheme. The aim is to produce future precipitation projections specifically for the Reno basin. An Ensemble Mean technique is employed to reduce uncertainties and enhance the statistical robustness of the results.

The Hydrology Branch of ARPAE employs two systems for hydrological modelling. The Flood Early Warning System (FEWS) utilizes three rainfall-runoff modelling chains (Mike 11-NAM, HEC-HMS, Topkapi) and a hydraulic model for flood forecasts. These models rely on hydrometeorological observed data and products. The Drought Early Warning System (DEWS) is based on the Topkapi-Ribasin model chain, which also uses observed data and products for its operation.

The University of Bologna, specifically the Department of Civil, Chemical, Environmental, and Materials Engineering, conducts research on hydrological rainfall-runoff modelling. On the other hand, the University of Parma, within the Department of Engineering and Architecture, focuses on research related to groundwater, hydraulic modelling, and hydrology model calibration.

The Emilia-Romagna Region is the competent authority for conducting impact analysis using the Environmental Impact Assessment (EIA) administrative tool. ARPAE supports the Region with preliminary investigations, while AUSL and relevant municipalities provide their opinions. Public consultations and investigations involving various administrations, institutions, and parties may also be facilitated. The Region utilizes Strategic Environmental Evaluations (V.A.S.) for plans and programs. ARPAE has expertise in environmental scenario development.

Policy analysis is conducted by the Emilia-Romagna Region, specifically the Department for soil protection, coast and land reclamation, and the Department of Water Protection and Management. Support is provided by the State property area of ARPAE and Civil Protection. River contracts are engaged to involve multiple stakeholders.

Stakeholders with expertise in participatory approaches include the Emilia-Romagna Region, local authorities, and river contracts. River contracts are voluntary participatory processes among collaborating entities, focused on enhancing water-rich land areas. The Reno River and Bolognese canals contract aims to address specific issues related to environmental protection, water resource management, territory development, hydraulic risk, and local development. The contract has a document of intentions, with the signing of the contract itself planned for the future. The Santerno river contract is another river contract concerning the Reno River's tributary, Santerno.

4 Tympaki basin, Greece

4.1 Water governance

Greece is a parliamentary republic with two-tier subnational government structure. The unicameral Parliament consists of 300 members elected for a four-year term. Subnational government structure includes two levels: regions (Periféreies) and municipalities (Dímoi). Since the 2011 reform, Greece's regions are overseen by elected regional governors and regional councils, serving five-year terms. This change replaced the former system of government-appointed general secretaries. Some responsibilities previously held by the state have been transferred to the regions. The central government, through decentralized administrations under the Ministry of Interior, oversees the regions. The decentralised administrations are separate entities from the local government. The municipalities are headed by a mayor and a municipal council elected for 4 years. The local government entities are responsible for various sectors such as environmental policy, spatial planning, infrastructure development, and certain aspects of water resources management, among others. The overarching policies and large-scale infrastructure projects are typically managed by the national government.

The Greek Law was harmonised with the Water Framework Directive (WFD, 2000/60/EC) with Law 3199/2003 (Government Gazette 280/A/2003) and the Presidential Decree 51/2007 (Government Gazette 54/A/2007). The country was divided in 14 River Basin Districts (RBDs), defined according to No.706/2010 Decision of the National Water Committee (GG 1383/B/2010 and GG 1572/B/2010 - correction of Annex II) and River Basin Management Plans (RBMPs) have been developed for each of the 14 RBDs following the provisions of the WFD. The 1st River Basin Management Plan for the Crete River Basin District (EL 13) was approved by the Decision No. 163/31.03.2015 (GG 570/B/2015) of National Water Committee and concerned the 1st Management Cycle (2009-2015). The 1st Revision was approved in 2017 (Government Gazette approving the 1st Revision of the RBMP for the Crete RBD: 4666/B/29.12.2017), while the 2nd revision is currently in progress.

At the national level, the competent authorities for the protection and management of water resources are defined by Law 3199/2003 (GG 280/A/2003), as amended and in force, for the Protection and Management of Water Resources, which harmonizes the National Law with the provisions of the WFD. The competent authorities are:

The National Water Committee is defined as the high level interministerial body and has the responsibility of policymaking for the management and protection of water resources of the country and consists of the Ministers of: (a) Environment and Energy, as President, (b) Infrastructure and Transport, (c) Economy, (d) Economy and Development, (e) Interior, (f) Health, (g) Rural Development and Food, (h) Administrative Reconstruction. In the Committee other Ministers may participate, after invitation of the President, if issues of their responsibilities are discussed, while the Minister of Foreign Affairs participates when issues regarding transboundary water bodies are discussed.

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The National Water Council, delivers opinions to the National Water Committee for national programs related to the protection and management of the water resources of the country, while takes note of the Yearly Report, which the National Water Committee submits, regarding the status of water environment of the country, the implementation of the legislation for the protection and management of water resources, as well as the compatibility of Union's acquis. It consists of 26 members (parties and bodies representatives) and the Minister of Environment and Energy. The National Water Council is convened from its President at least once a year.

The Special Secretariat for Water (SSW) of the Ministry of Environment and Energy, which has the responsibility of the implementation of the Programs for Protection and Management of Water resources of the country and the coordination of agencies and national bodies for each issue regarding the protection and management of water resources. The provisions of its creation and definition of competencies are defined by Law 3199/2003 (GG 280/A/2003) for the Protection and Management of Water Resources, as amended and in force, specially by Law 4117/2013 (GG 29/A/2013) and Law 4315/2014 (GG 269/A/2014), and the Presidential Decree 132/2017 (GG 160/A/2017) "Organization of the Ministry of Environment and Energy" in combination with the JMD 322/2013 "Organization of the Special Secretariat for Water of the Ministry of Environment, Energy and Climate Change" (GG B' 679), as in force. The Secretariat, in collaboration with the Water Directorate of the Decentralized Administrations, sets up the national programmes for the protection and management of the water resources of the country and monitors and coordinates their implementation.

Additionally, on implementation issues of the WFD, the following Ministries are engaged: Ministry of Foreign Affairs, Ministry of Rural Development and Food, Ministry of Infrastructure and Transport, Ministry of Economy and Development, Ministry of Health, Ministry of Maritime Affairs and Island Policy, Ministry of Interior.

Following legislative documents are relevant with this respect: 51/2007 for the definition of measures and processes for the complete protection and water management, according to the Directive 2000/60/EC; the Presidential Decree 136 (GG 229/A/2010) "Organization of the Decentralized Administration of Crete", the Decision of the National Water Committee 706/2010 (GG B' 1383/2-9-2010 "Definition of the River Basins of the country and of the competent Regions for their management and protection" and GG B' 1572/28-9-2010 correction of Annex II), as in force after the approval of the individual River Basin Management Plan of the country's River Basin Districts.

In addition, Local Administration Authorities of Level A and B are involved in issues regarding the implementation of the WFD.

4.2 Institutional mapping

The Tympaki basin, located in the central-south area of Crete Island, constitutes one of the most important agricultural regions of Crete. Groundwater abstraction is causing a drop in the water table of due to overexploitation in some areas, as well as seawater intrusion, while nitrates pollution is present in some location. As such, water supply and allocation, sustainable management of the

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irrigation water, limiting overexploitation (and its adverse impacts) and controlling nitrates pollution are of main concern in the basin. In this respect, we have identified 4 key stakeholders with high influence and interest, as presented below:

- The Region of Crete, with a direct interest in the protection and management of water resources. As the Region of Crete bears the responsibility for the design and construction of infrastructure/ water works (dams, wells, water supply and distribution systems) it has a high influence on the overall water supply and allocation. It is also responsible for the design and implementation of measures, such as water use restrictions among others. Finally the Region of Crete is responsible for pollution monitoring and environmental protection (e.g. ecological flows, good water quality status, etc.), as well as for the development of the Regional Agricultural Development Plan. It is thus a stakeholder in a position to strongly influence decision-making and planning.
- The Water Directorate of Crete Decentralized Administration (WDC), with a direct interest in the proper implementation of the WFD River Basin Management Plans (RBMPs) and related Programme of Measures. As the WDC bears the responsibility for issuing the water use licenses it has a high influence on controlling groundwater abstraction and overexploitation.
- The Local Land Reclamation Organization (TOEV of Zone A' of Messara) has a direct interest on efficiently meeting irrigation water demand. This organization (TOEV) bears the responsibility of providing sufficient irrigation water to the farmers, as well as adequately operating and maintaining the irrigation water supply and distribution systems, including cost recovery. Among others TOEV defines the water tariffs for the farmers, is responsible for the collection of the water fees from the farmers and the monitoring of their water meters, monitors the levels of its pump stations, set irrigation rules. As such, the TOEV has a high influence on irrigation water supply and management, and on the Tympaki water productivity noting that agriculture is the dominant water use.
- The Municipal Water Supply and Sewerage Company of Faistos (DEYA Faistos) has a direct interest on the provision of adequate domestic water and wastewater treatment. As DEYA Faistos bears the responsibility to collect and treat domestic wastewater it also has an influence on irrigation water supply through the provision of treated wastewater for agricultural reuse.

In line with the above structure, a complete mapping of the stakeholders in the Tympaki basin, along with their main roles and competences, is presented in the Table below.

Table 3 The stakeholders' community in the Tympaki basin

Organization	Theme	Specific roles / competences
Region of Crete – Directorate of Environment and Spatial Planning – Department of Hydro economy	Protection and management of water resources	Responsible for the design and construction of infrastructure/ water works (dams, wells, water supply and distribution systems). Once these works are completed, the Region of Crete constitutes a local land reclamation organization (TOEB) to operate and maintain the system and to provide water to farmers. Design and implementation of measures Decisions on water use restrictions

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		Pollution monitoring and environmental protection (e.g. ecological flows, good water quality status, etc.).
Region of Crete - Directorate of Technical Works	Construction of infrastructure, water works	Responsible for the construction and maintenance of the dams Responsible for the water allocation system
Region of Crete - Directorate of Agricultural economy & Veterinary	Regional agricultural development	Responsible for the development of the Regional Agricultural Development Plan
Water Directorate of Crete Decentralized Administration (WDC)	Protection and management of water resources	Main role in the development and implementation of the WFD River Basin Management Plans (RBMPs) and Programme of Measures Responsible for issuing water use licenses: the water in Greece is considering as a public domain good and every user has to issue a license. The license describes the terms and conditions to use the water, the specific amount/volume of water to be abstracted and used within specific time (usually 10 yrs) Monitoring and data collection Regulation enforcement Coordination of stakeholders and public participation
Water Council of the Decentralized Administration	Social dialogue and consultation on water protection and management issues	Promotes and supports consultation with the general public and the various stakeholders, and dialogue with the civil society
Special Secretariat for Water (SSW) of the Ministry of Environment and Energy	Protection and management on the water resources	National focal point for the WFD Responsible for the development and implementation of the National Programs for the Protection and Management of Water Resources of the country, and the coordination of agencies and national bodies regarding the protection and management of water resources
Local Land Reclamation Organization - TOEV of Zone A' of Messara	Irrigation management and operation of irrigation water works	Responsible to operate the water supply and distribution system for local farmers (i.e provision of irrigation water to the farmers), including the maintenance of the pipeline network. Responsible to cover the full operational costs Collection of the water fees from the connected agricultural users / monitoring of the installed water meters
Municipality of Phaistos – Technical Services Department	Water supply for domestic use, municipal wastewater treatment	Responsible for the design of the domestic water supply system to cover domestic and touristic water use Responsible for the design of the sewage system

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Municipal Water Supply and Sewerage Company of Faistos (DEYA Faistos)	Water supply, wastewater treatment	Responsible to construct, operate and maintain the domestic water supply and sewage systems (i.e. supply water for domestic use and also for the tourist activities - resorts, hotels, etc.) Responsible for wastewater collection and treatment Cost recovery and collection of water fees from the users Analysis and monitoring of drinking water quality
Hellenic Survey of Geology & Mineral Exploration (EAGME)	Monitoring system, R&D in groundwater management and exploitation	Responsible for the monitoring system of the groundwater Research for water development
Agricultural School of Messara (under the auspices of ELGO-DIMITRA and the supervision of the Ministry of Rural Development and Food)	Education, training	Education Capacity building and training of farmers Dissemination of best agricultural practices
Individual Farmers	Irrigation water	Construction and operation of private wells for agricultural use, after having issued a valid water license from the WDC

4.3 Competence mapping

The Region of Crete has a direct interest in protecting and managing water resources. They are responsible for designing and constructing infrastructure such as dams, wells, and water supply systems. The Region also implements measures like water use restrictions and pollution monitoring for environmental protection. They collect necessary data for water works design and operation, as well as data on water quantity, quality, pollution, and land use.

The Water Directorate of Crete Decentralized Administration (WDC) is focused on proper implementation of the WFD River Basin Management Plans and related Programme of Measures. They issue water use licenses and have influence over controlling groundwater abstraction and preventing overexploitation. The WDC operates the national WFD monitoring network and collects data on water quality and ecological status. They maintain records of licensed groundwater abstractions and ensure compliance with license rules.

The Local Land Reclamation Organization (TOEV of Zone A' of Messara) is directly involved in meeting irrigation water demand efficiently. TOEV is responsible for providing sufficient irrigation water to farmers and maintaining irrigation water supply and distribution systems. They monitor pump station levels, abstraction rates, and local reservoirs. Additionally, TOEV monitors leakage, collects data from farmers' water meters for irrigation water use, and keeps records of water tariffs and bills.

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The Municipal Water Supply and Sewerage Company of Faistos (DEYA Faistos) is responsible for collecting and treating domestic wastewater. They gather domestic water use data from user water meters, maintain registers of water tariffs and bills, and hold data related to the operation of their wastewater treatment plant.

The Hellenic Survey of Geology & Mineral Exploration (EAGME) is responsible for the monitoring system of the groundwater, and thus they monitor groundwater levels and quality in observation wells.

The Technical University of Crete (TUC) collects ad-hoc data for research purposes. These data are mainly hydrometeorological data.

The Region of Crete has expertise in hydrological modelling, using the following models:

- RIBASIM model: A water management/water allocation model used for high-level basin planning. It estimates water demands under different scenarios, enables distributed water resource allocation, and performs impact analysis. Output parameters include water availability, demand, flow, deficit, and environmental requirements.
- SACRAMENTO model: A continuous rainfall-runoff model generating daily stream flow based on rainfall and evapotranspiration data. It simulates water balance within the catchment and provides output parameters such as surface and base flow and soil moisture.
- MODFLOW model: A groundwater model predicting groundwater conditions and interactions with surface water. It operates at a grid-based level and requires updating and running for recent years.

The ELGO-DIMITRA specializes in hydrological modelling, employing models like SWAT, MIKE SHE, and HSPF. The Technical University of Crete (TUC) also focuses on hydrological modelling, utilizing models such as MODFLOW, FEFLOW, and KARST SWAT. The National Observatory of Athens (NOA) specializes in climate modelling and has contributed to the development of the Regional Plan for Adaptation to Climate Change in Crete (PESPKA).

The Region of Crete is responsible for the design and construction of water infrastructure like dams, wells, and distribution systems. They play a crucial role in determining water supply and allocation. The Region also implements measures and considers various scenarios related to business, environment, and socio-economic factors. They collaborate with stakeholders and experts in this process.

Several stakeholders have expertise in pressure and impact analysis, including the Special Secretariat for Water of the Ministry of Environment & Energy, the Water Directorate of the Decentralized Administration (WDC), and the Region of Crete.

The Region of Crete specializes in risk assessment, incorporating it into different water projects and studies. Multiple stakeholders excel in policy analysis, such as the Special Secretariat for Water of the Ministry of Environment & Energy, the Water Directorate of the Decentralized Administration (WDC), and the Region of Crete.

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Several stakeholders are skilled in participatory approaches and conducting public consultations. These include the Special Secretariat for Water, the Water Directorate, the Region of Crete, the Local Land Reclamation Organization - TOEV of Zone A' of Messara, the Municipality of Phaistos, and the Municipal Water Supply and Sewerage Company of Faistos (DEYA Faistos). They engage with farmers, end-users, and the local community to ensure their involvement in irrigation management, water use monitoring, network issue identification, and decision-making processes.

5 Nitra basin in Slovakia

5.1 Water governance

Slovakia is a parliamentary republic with a decentralized governance system. The unicameral parliament is composed by 150 deputies elected for 4-years term. The subnational government structure consists of two levels, self-governing administrative regions and municipalities. The eight regions have a certain level of autonomy and are responsible for managing and overseeing various matters within their respective territories. Each region is led by a directly elected regional governor and a regional assembly responsible for making decisions on regional policies, budget allocation, and overseeing the regional administration. Regions were delegated certain powers and responsibilities, including those related to environmental issues like climate change adaptation. State control is implemented at the sub-regional district level. District authorities are responsible for enforcing national legislation at a local scale, spanning various domains including environmental protection, public administration, education, and healthcare. The crucial role they play ensures adherence to laws and regulations within their respective districts.

Central government, the Ministry of Environment (MoE), holds responsibility for establishing the legislative framework and implementing water management strategies at the national level, ensuring compliance with EU legislation. The Ministry orchestrates the execution of legislation and strategies in accordance with both national and EU laws, while concurrently supervising regional and local authorities in their water management endeavours. MoE also ensures that Slovakia, as a member state of the EU, effectively integrates and implements EU water-related legislation into its national framework. The Ministry of Agriculture and Rural Development is responsible for designating water sources that can be allocated for irrigation and for establishing the rules concerning irrigation water use.

The EU's Water Framework Directive (WFD) was transposed into the national legislation through the Water law Act No. 364/2004 (S-EPI, 2004), last updated in 2023. The Water law defines the institutions and their responsibilities in water resources management, protection, and monitoring; i.e. who is responsible for monitoring of the quantity and quality of the surface and groundwater, water management planning, management of the water courses and reservoirs, payments for water use, water infrastructure, etc. Water Plan of the Slovak republic (MZP, 2021) (i.e., RBMP) is the instrument to achieve the objectives of the Water Framework Directive and is updated every six years. The current Water plan runs through 2022 - 2027 and consists of the Danube and Vistula river basin districts (RBD). Another important law is the Act nr. 7/2010 for protection against floods (SR, 2010), which transposes the EU Directive 2007/60/EC on the assessment and management of flood risks.

The MoE coordinated the process of developing a 2022 *Water policy blueprint of the Slovak republic for 2030 with an outlook to 2050* (henceforward “Water Blueprint 2030”) (MZP, 2021), which is a strategic document that integrates national planning instruments and supports the integration of water policy objectives into all sectoral policies. The Water Blueprint 2030 sets specific objectives, measures, and

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indicators for those objectives within ten areas: water in landscape, water in settlements, sustainable water use, water for all citizens, clean water, living rivers, the Danube River, understanding water, responsible and informed water management, and water as a strategic investment. The objectives, measures, and the related indicators are consistent with the Water Plan and other strategic policy documents related to water protection, management and use, in particular with the Development Plan for Public Water Supply Systems and Sewerage Systems (MZP, 2021) and with the Flood Risk Management Plan. The common basis of the water policy is to achieve the environmental objectives, i.e. achieving good status of the water.

In addition to the Ministry of Environment (MoE), other government entities involved in water management include district authorities, which operate under the oversight of the Ministry of Interior (MoI). District authorities are tasked with various water management responsibilities, such as granting permissions for water use rights, protecting nature and biodiversity, preventing floods, conducting environmental impact assessments, and executing administrative procedures related to Water Act infringements. Moreover, district authorities hold the power to modify, limit, or ban water abstraction from surface water bodies, when necessary.

Regional governments (self-governing regions) play relatively minor role in the water resource management. On the other hand, the local administrations grant permits for the abstraction of surface water and groundwater for household and construction project usage. Municipalities, typically through municipally owned companies, are also in charge of ensuring a steady supply of drinking water, maintaining public sewers, and overseeing wastewater treatment. In their capacity, they perform state water protection supervision and regulate the use of small watercourses and other water bodies within their jurisdiction.

5.2 Institutional mapping

The Nitra River, located in western Slovakia, originates in the Malá Fatra (Lesser Fatra) mountains north of Prievidza and eventually converges with the Váh River in Komoča. Initially spanning 243 km, its length was reduced to 170 km in 1950 through the construction of a bypass to the Váh river. The river traverses through several mid-sized towns including Bojnice, which has a population of approximately 5,000 residents, Topoľčany with 25,000 residents, Nitra, home to 78,000 residents, and Nové Zámky, accommodating 37,000 residents. The basin of the Nitra River spans across an area of approximately 4,501 km². The river basin spans three regions and is under the authority of the Lower Váh River Basin, which is a part of the Danube river basin district. The Nitra RB is located within the Trenčín self-governing region, and the study site is located within the Prievidza district.

Mining has played a major role in the river basin's economy, primarily focusing on the extraction of mineral resources and brown coal. This low-rank type of coal, abundant in the Nitra region, is primarily used for electricity generation and serves as a domestic fuel source for Slovakia's energy sector. The extraction and utilization of brown coal not only support local employment and economic activity but also contribute to the diversification of the country's energy mix, thereby reducing reliance on foreign energy sources. However, the process of extracting and burning brown

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coal has significant environmental impacts, including CO₂ emissions that contribute to global warming, land degradation and water pollution.

Expert institutions such as the Slovak Water Management Enterprise (SVP), Slovak Hydrometeorological Institute (SHMÚ), and Water Research Institute (VÚVH) support the Ministry of Environment (MoE) in managing water resources.

- Slovak Water Management Enterprise (SVP) is the authority appointed by the Ministry of Environment and responsible for water management and planning in the six main river basin districts in Slovakia. SVP works with the national, regional, and local authorities and other stakeholders to develop a water management plan in each of the six RBD. SVP is mainly responsible for management and protection of the rivers and other water bodies within the basins, hydro plants, protection of the drinking water reservoirs as well as the water supply from these reservoirs and other water courses. SVP works to maintain the sufficient water level in the ecosystems and works to restore and protect important biotopes such as wetlands, old river channels, etc. SVP is partially responsible for monitoring of the surface water quality, and protection of the areas of natural water accumulation according to the Act 305/2018 Coll. Another important responsibility is flood prevention.
- Slovak Hydrometeorological Institute (SHMÚ) focuses on monitoring and analysing environmental and meteorological conditions, spanning meteorology, hydrology, climatology, and air quality. It also provides weather forecasts and early warnings for extreme weather. Monitoring of water levels, flow rates, and water quality in rivers and lakes contributes to water resource management, flood prediction, and water protection.
- Water Research Institute (VÚVH) specializes in investigating the qualitative and quantitative aspects of surface and groundwater, including hydromorphological studies of water bodies at risk or significantly altered. Its research activities encompass a wide array of topics like water quality assessment, hydrological modelling, and climate change impact on water resources.

MoE plays additional roles in nature conservation:

- State Nature Conservancy (Štátna Ochrana Prírody, ŠOP), a subordinate agency of the MoE, is responsible for managing protected areas. These include a range of ecosystems such as wetlands, rivers, lakes, and forests.
- Slovak Environment Agency (Slovenská Agentúra Životného Prostredia, SAŽP) is another specialized agency of MoE, playing a role in comprehensive research and monitoring of the environment across the country. SAŽP covers a broad spectrum of activities related to the environment, including monitoring and analysing environmental changes, evaluating the impacts of these changes, and proposing measures for environmental protection and improvement.
- The Slovak Environmental Inspectorate (Slovenská Inšpekcia Životného Prostredia, SEI) conducts regular inspections across a wide range of sectors, including air and water quality, waste management, biodiversity conservation, and chemical safety. SEI oversees compliance with the Water Act, including wastewater management, water protection, and the enforcement of decisions by the SVP.

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The allocation of responsibilities among various institutions involved in water management and monitoring in Slovakia is rather intricate. For instance, the Slovak Hydrometeorological Institute (Slovenský hydrometeorologický ústav, SHMÚ) not only monitors water quantity but also compiles annual reports on the quality of surface waters and the water balance. This task is coordinated in conjunction with the Water Research Institute (Výskumný ústav vodného hospodárstva, WRI) and Slovak Water Management Enterprise (Slovenský vodohospodársky podnik, SVP). Meanwhile, the Slovak Environmental Inspectorate (SAŽP) is tasked with reporting data in accordance with EU legislation. Both SHMÚ and WRI undertake the monitoring of hydromorphology. WRI oversees both the continuous and six-year ecological and chemical assessments of surface waters. The six-year evaluation informs the update of the Water Plan, which operates on a similar six-year cycle.

The Slovak government decided to phase out the coal subsidy by 2023 (OECD, 2022) and Upper Nitra region became one of the pilot regions of the Initiative for [Coal Regions in Transition](#). The process of coal extraction often requires the dewatering of mines, which involves pumping out groundwater that has infiltrated the mine shafts, thereby ensuring safe and efficient mining operations. This pumped water is then discharged into local waterways, significantly augmenting river flow. However, this increased water discharge can transport pollutants from the mining operation, including heavy metals and other toxins, potentially compromising the quality of water in the surrounding environment. Moreover, mining not only modifies landscapes but also builds water infrastructure. Even after mining operations conclude, this infrastructure can aid in the regeneration and revitalization of water systems.

Hornonitrianske Bane Prievidza (HBP), Inc., a joint-stock company, primarily focuses on the extraction of brown coal, a key resource for electricity generation within the country. As the largest coal mining enterprise in Slovakia, HBP provides 72% of the nation's brown coal supply. The company has made significant contributions to the industrial and economic growth of the region.

Table 4 The stakeholders' community in the Nitra basin

Organization	Theme	Specific roles / competences
Ministry of Environment (MoE)	central authority over water resource management	• establishes the legislative framework for water management at the national level, ensures that Slovakia effectively integrates and implements EU water-related legislation, supervises the regional and local authorities in their water management efforts
Water Management Enterprise (SVP)	river basin management	• manages rivers and water bodies, hydro plants, drinking water reservoirs, responsible for maintaining ecosystem water levels, monitoring surface water quality, flood prevention, and protecting areas of natural water accumulation
Slovak Hydrometeorological Institute (SHMÚ)	monitoring and early warning	• monitors and analyses environmental and meteorological conditions, including meteorology, hydrology, climatology, and water quality, flow rates, and issues early warning
Water Research Institute (VÚVH)	modelling and impact assessment	• research on the qualitative and quantitative aspects of surface and groundwater focussing on water

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		quality, hydrological modelling, and impacts of climate change on water resources
State Nature Conservancy (ŠOP SR), Slovak Environmental Inspectorate (SEI)	nature protection environmental inspection	• managing protected areas, including wetlands, rivers, lakes, and forests • enforcing environmental regulations
Slovak Environment Agency (SAŽP)	environmental monitoring	• comprehensive research and monitoring • monitoring and analysis of environmental changes,
Hornonitrianske Bane Prievidza (HBP)	mining and groundwater release	• water infrastructure and requalification of the mining water bodies

5.3 Competence mapping

Slovak Hydrometeorological Institute (SHMÚ) is responsible for hydrological and climatological monitoring in the national monitoring network. SHMÚ continuously monitors hydrological variables such as water level, flow, water temperature, ice events, water clarity, and hydromorphology (in natural water courses). SHMÚ also assesses trends and prepares prognoses of water quantity and regime and issues warnings for flood risk. In addition, the institute is responsible for analysing data from monitoring and compiling annual reports on the water balance and quality of the surface waters in coordination with other institutes, as well as annual report on water quality for the International Commission for Protection of the Danube River (ICPDR). The data are shared with the European Environment Agency (EEA), and the Global Runoff Data Centre (GRDC) - an international data centre under the auspices of the World Meteorological Organization (WMO). They use ensemble models for projecting mean annual, seasonal, monthly air temperature for 2021-2050 and 2071-2100. Variables such as daily precipitation, relative humidity (RH), wind speed, pore-water pressure (PWP), and global radiation are also modelled. This modelling also considers frequency and intensity of heatwaves and heavy rainfalls.

The Slovak Water Management Enterprise (SVP) shares the responsibility for monitoring the physical, chemical, biological, and microbiological properties of surface waters to ensure their quality. SVP also contributes to the annual water quality reports prepared by the Slovak Hydrometeorological Institute (SHMÚ). In addition, SVP is actively involved in flood protection efforts and has developed an online Geographic Information System (GIS) tool that visualizes areas at risk of flooding.

The Water Research Institute (WRI) oversees the hydromorphology of water courses that are significantly altered or at risk, while the Slovak Hydrometeorological Institute (SHMÚ) handles the monitoring of natural water courses. WRI is tasked with assessing the ecological and chemical status of surface waters every six years, in order to update the Water Plan of the Slovak Republic and river basin water management plans. In addition to this, WRI monitors radiological indicators. It is also responsible for preparing various reports required by EU directives, such as those pertaining to the European Environment Agency's (EEA) core set of indicators.

The Slovak Environmental Agency (SAŽP) primarily handles the compilation of data and the obligation of reporting under EU directives to the European Commission (EC) and the European

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Environment Agency (EEA). All this data and the corresponding reports are supplied to the Ministry of Environment, other water authorities, and the Statistical Office of the Slovak Republic, among other entities.

Water Patrol established by the state water authority on behalf of the water manager, owner of a waterwork, or by towns, controls compliance to the Water Act and reports to the water authority in case the water user is not following the law. In such case, water patrol reports to the water authority (usually the district authority) who processes the case. The water authority may then decide to terminate the water permit in case one was granted to the user who broke the rules.

Slovak Environmental Inspectorate (SEI) is the main controlling body overseeing the compliance with the Water Act. It sees that the water manager (SVP) decisions regarding water use and management are followed. This includes controlling the wastewater treatment and release, protection of the water, etc.

6 Caplina-Mauri-Desaguadero transboundary basin in Peru, Chile and Bolivia

6.1 Water governance

Peru, Bolivia and Chile are presidential representative democratic republics in South America, both Peru and Bolivia have regional and local governments with administrative autonomy while Chile has a two-tier subnational government - regions and municipalities (SNG-WOFI, 2023).

Peru, Chile, and Bolivia each present unique cases of water governance. While Peru emphasizes decentralization and integrated water resources management, Chile has established a water rights market that, despite its controversies, has boosted water use efficiency. Bolivia, meanwhile, stands out for its recognition of water as a universal right and the role of local communities in water management. Each model has its merits and challenges, reflecting the complexity of water governance amidst diverse geographical and socio-economic contexts.

- Chile's water governance is unique due to its robust water rights system. Its Water Code of 1981 established a market for water rights, encouraging private sector participation. While this approach has boosted the efficiency of water use, it has also led to conflicts over water access and rights, especially in regions with water scarcity and during droughts. The government's role has primarily consisted of regulating the water market and mitigating conflicts. However, recent debates have called for a more significant government role in ensuring equitable water access for both private businesses and local communities.
- Bolivia's water governance is marked by a strong community focus. The Ministry of Environment and Water is responsible for water governance, but local communities, especially indigenous ones, play a crucial role in water management. The "Law of the Rights of Mother Earth" of 2010 notably recognizes water as a fundamental right for all beings. Despite these progressive policies, Bolivia struggles with water contamination in most of its water bodies and main urban areas, as well as scarcity, especially in its high-altitude areas.
- Water governance in Peru is characterized by decentralization. The National Water Authority (ANA), under the Ministry of Agriculture and Irrigation, oversees water management at a national level, while local Water Resources Councils handle it regionally. Despite its rich water resources, Peru faces challenges like water scarcity in coastal areas and contamination due to mining activities. Peru has embarked since 2008 on reforms to promote integrated water resources management and encourage public participation in water governance under the new law of water resources (OECD, 2021).

6.2 Institutional mapping

The Caplina-Mauri-Desaguadero transboundary basin comprises several interconnected rivers and bodies of water, including the Mauri and Desaguadero rivers, and is home to a diverse array of flora and fauna. As a transboundary basin, the management of its water resources is complex due to the different regulatory frameworks and priorities of the three countries. Issues such as water scarcity,

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pollution, and climate change further complicate the water governance in the basins. In Peru, the basin is largely managed by the National Water Authority (ANA), while in Bolivia and Chile, it falls under the purview of the Ministry of Environment and Water, and the Directorate General of Water respectively.

Several initiatives have been undertaken to promote collaborative management of the basin's water resources. These include bilateral (Peru and Bolivia) agreements and the involvement of local communities in water management. Despite these efforts, challenges such as equitable water distribution, sustainable water use, and climate change resilience still remain.

ANA is the national authority for water management in Peru. It is an entity under the Ministry of Agriculture and Irrigation that exercises the technical and normative authority to ensure the integrated, sustainable and multisectoral management of water resources for the benefit of water users and the general population. It was created in 2008 by Law No. 29338, the Water Resources Law. ANA operates at different levels: national, regional and local. It has 14 decentralized bodies called Autoridades Administrativas del Agua (AAA), which are responsible for directing and executing water management in their territorial areas. Each AAA has one or more Administraciones Locales del Agua (ALA), which are the units that administer water resources and their associated goods at the local level. There are 65 ALAs in total in all Peru, three of them are related to Caplina, Mauri, and Desaguadero. ANA Peru also has a digital platform called “Observatorio del Agua”, which provides interactive information on water resources, such as statistics on water demand by basin, projects for formalizing water use, historical reservoir levels, inventory of wells and other data.

The Ministry of Environment and Water in Bolivia (MMAyA) is the government entity responsible for water and sanitation policies, regulation, and investment. It was created in 2009 by Supreme Decree No. 29894, as part of the constitutional reform that recognized water as a human right and a common good in the country. MMAyA's mission is to promote equitable development, reciprocal and in harmony with the environment, through the integrated management of water resources, access to drinking water and sanitation, irrigation for food security, as well as the integrated management of the environment and life systems. MMAyA operates at different levels: national, regional, and local. It has 3 vice-ministries that cover different areas of water and environment management, such as water resources and irrigation (VRHR), drinking water and sanitation (VAPSB), and biodiversity, climate change, environmental quality, planning and coordination (VMA). There are 14 prioritized hydrological regions in which they are initiating the development of regional water authorities, up to now only one is operational (water authority for Katari Basin which is part of the hydrological system of Titicaca Lake).

Dirección General de Aguas (DGA) from Chile is a public entity under the Ministry of Public Works that is responsible for promoting the water resources management and administration in a sustainable framework, public interest, and efficient allocation. It was created in 1975 by Supreme Decree No. 575, as part of the institutional reform of the water sector that introduced a market-based system for water rights allocation. DGA's main functions are to provide and disseminate the

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information generated by their hydrometric network, to exercise the policing and surveillance of natural channels and water users' organizations, to ensure the environmental role of water resources and to contribute to improving the people's life quality, and to promote sustainable and equitable water resources use through the provision of indicative planning and general information. DGA operates at different levels: national, regional, and local. It has a central office in Santiago and 15 regional offices throughout the country, one is related to the Mauri-Caquena River. It also has 101 hydrological stations that monitor surface water quantity and quality, and 1,200 piezometers that monitor groundwater levels and quality.

The Autonomous Binational Authority of the Lake Titicaca (ALT by its acronym in Spanish) is an entity of public international law that depends on the Ministries of Foreign Affairs of Peru and Bolivia, and it is coordinated with ANA in Peru and MMAyA in Bolivia. It was created in 1996 by a binational agreement between the two governments to promote and conduct actions, programs and projects for the conservation, control, and protection of the water resources of the TDPS Water System (Titicaca, Desaguadero, Poopo and of Coipasa Salt lakes) within the framework of the Binational Global Master Plan (PDGB) published in 1992 by the two governments. The ALT has a headquarters in La Paz, Bolivia, and two executive directorates in Puno, Peru, and Oruro, Bolivia. Some of the issues related to the agreements required between Bolivia and Peru are the management of water resources, the preservation of biodiversity, the prevention of pollution, the promotion of sustainable development, and the strengthening of cooperation and integration. ALT is a binational institution between Peru and Bolivia, but it does not have a relation or legal link with DGA or any other Chilean institution so far.

Table 5 The stakeholders' community in the Caplina-Mauri-Desaguadero basins

Organization	Specific roles / competences
Peru PE: National Water Authority (ANA)	• operates under the Ministry of Agriculture and Irrigation, ensuring integrated, sustainable, and multisectoral water management for the benefit of water users and the general population. • direct and execute water management national, regional, and local levels
Bolivia BO: Ministry of Environment and Water, (MMAyA)	• promotes equitable development, reciprocal and in harmony with the environment, through the integrated management of water resources, access to drinking water and sanitation, irrigation for food security, and the integrated management of the environment and life systems.
Chile CL: Dirección General de Aguas (DGA)	Under the Ministry of Public Works, DGA promotes sustainable, efficient water resources management. It disseminates information from its hydrometric network, exercises surveillance of natural channels and water users' organizations, ensures the environmental role of water resources, and promotes equitable water use
Autonomous Binational Authority of the Lake Titicaca (ALT)	• entity of public international law, depends on the Ministries of Foreign Affairs of Peru and Bolivia • promotes and conducts actions, programs, and projects for the conservation, control, and protection of the water resources

6.3 Competence mapping

In the binational region of Caplina-Mauri-Desaguadero, there are three entities which collect data from a monitoring network of stations to check climate and hydrology. The National Service of Climate and Hydrology (SENAMHI) from Peru collect data related to climate and hydrology around Puno, and Tacna provinces (Caplina, Locumba, Maure basins), in the same way SENAMHI from Bolivia collect data of climate and hydrology in La Paz and Oruro provinces (Mauri, Desaguadero basins). Last information related to diverted flows are monitored by the Proyecto Especial Tacna (PET) from Tacna which has a network from Tacna to Puno (Caplina, Locumba, Sama and Maure basins). Information in the area is available since 1960 to the present, with some meteorological and hydrological stations out of work due to maintenance issues.

ALT, which is the entity with binational jurisdiction, has faced difficulties in fulfilling its mandate due to political, institutional, and financial constraints. In recent years, there have been efforts to revitalize the ALT and strengthen its role as a platform for dialogue and cooperation among different stakeholders at local, national, and regional levels. The BRIDGE project (Building River Dialogue and Governance) has been working since 2011 to support this process by providing technical assistance, capacity building, knowledge sharing, and procedural advice to the ALT and other actors involved in the basin. The project aims to promote water diplomacy and governance based on equitable economic, environmental, and social benefits for all. The BRIDGE project also uses a combination of knowledge and information tools, capacity building and training, and dialogue facilitation to strengthen relations between stakeholders across local, provincial, national, and regional levels. The BRIDGE project has supported the development of a joint diagnostic study, a transboundary water resources management plan, and a Binational Commission for the Maure-Mauri basin which up to now is working under the supervision of both ministries of foreign affairs from Bolivia and Peru.

Other relevant actors are the Ministerio de Medio Ambiente y Agua (MMAyA) of Bolivia and the Ministerio del Ambiente (MINAM) of Peru, which are the national authorities in charge of environmental and water policies; and various public sector entities, civil society organizations, academic institutions, private companies, and local communities that participate in the data collection, analysis, and validation processes. Additionally, in the case of Peru, ANA has local secretaries to enforce the application of the law of water resources for almost 13 years since 2008, which has a water management plan for the Pacific and Maure (Titicaca) regions. Both countries considering the complexity of the transboundary region of Maure – Mauri decided to create a Technical Binational committee to build a specific water management plan for this basin in particular, this effort has been done since 2006.

In Peru the entities working with hydrological models are ANA and SENAMHI. In the case of ANA, they use the models for water distribution and control of licenses with its local water authorities in each region. SENAMHI has several models to feed the studies at climate and hydrological level, not only for national but for specific basins which required special studies such as the case of the Maure

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River basin due to presence of volcanic activities and the presence of transboundary aquifers in the region of Ayro in Uchusuma region in Puno.

In Bolivia, SENAMHI works with models to simulate the hydrology of the basins in all the country. In the case of the region of Mauri and Desaguadero River basins they have specific studies with some models developed to represent the climate to evaluate drought conditions. The binational commission of Maure-Mauri River basin developed a study to evaluate the water availability of the region, that was carried out using WEAP specifically to account for the representation and simulation of the basin.

The Binational Autonomous Authority of the TDPS Hydrological System (ALT), is the entity in charge of implementing the Transboundary Diagnostic Analysis (TDA) and Strategic Action Programme (SAP), as well as conducting studies and projects related to the system. The team of coordinators and participants contracted by UNDP to develop the TDA includes experts from different academic and professional backgrounds, such as hydrology, ecology, sociology, economics.

There are two different actors, bilateral and national. In the case of bilateral entities, The Ministries of Foreign Affairs, Environment, and Water of Bolivia and Peru, as well as the implementing entities of the Integrated Water Resources Management (IWRM) as ANA Peru, MMAyA Bolivia, MINAM Peru are entities with capabilities to evaluate scenarios under the context of the system. They have a high priority in updating the Global Binational Master Plan and the SAP of the regional TDPS system which Caplina – Maure – Desaguadero is part of, for managing and coordinating the activities agreed between both countries.

In the case of National entities, ANA Peru has experience in conducting and evaluating environmental instruments, granting water use rights, water licenses, authorizing works in natural water sources, conducting studies, inventories, monitoring and risk management in glaciers, lakes and groundwater sources, and supporting participatory processes for dialogue and consensus building among water stakeholders. MMAyA in Bolivia also provides environmental information (reports, statistics, indicators, maps) relevant to the Bolivian territory through its National Environmental Information System (SNIA), which facilitates access to data on environmental quality, climate change, biodiversity, water resources, soil degradation, solid waste management, among others. DGA Chile has experience in developing and applying water regulations, instruments, and standards, granting water use rights and concessions, authorizing uses in natural water sources areas, conducting studies, inventories, monitoring and risk management in water resources, and providing and disseminating the information generated by its hydrometric network and the Public Water Registry. They are entities which were contacted at the beginning of the project and may play an important role in the activities of the living lab.

MINAM Peru is the entity with capabilities to evaluate impact including, economic, social and environmental aspects. MMAyA Bolivia also provides environmental information (reports, statistics, indicators, maps) relevant to the Bolivian territory through its National Environmental Information System (SNIA).

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ALT, which oversees managing and coordinating the activities agreed between Peru and Bolivia, has jurisdiction to make actions to control international rivers in matters related to sedimentation and storm control, The operation of gates in the Desaguadero river at the exit of Lake Titicaca is in charge of ALT.

At national level in Peru, National Institute of Civil Defense (INDECI), which is responsible for coordinating disaster risk management at the national level. Other stakeholders include the private sector, civil society, academia, and international organizations such as the World Bank, the UNDP, and the Global Environment Facility (GEF). ANA as the national water authority of Peru is responsible also for water resources management and regulation and has declared states of emergency and created contingency funds for farmers affected by droughts in southern Peru, focused on improving or giving them alternative water sources but not directly on mitigating the losses in agricultural production.

In Bolivia, the Viceministry of civil defense (VIDECI) is responsible for coordinating disaster risk management at the national level, offering some protocols to empower local committees. Forecast of climatic and hydrological risk in Bolivia and Peru is in charge of SENAMHIs.

ALT oversees the managing and coordination of the activities agreed between both countries, and has jurisdiction to make actions to control international rivers in matters related to sedimentation and storm control, The operation of gates in the Desaguadero river at the exit of Lake Titicaca is in charge of ALT.

From the surveys and interviews conducted in TRANSCEND, it has emerged a number of institutions, entities, and sectors that are involved or have an interest in the policy analysis under binational agreements between Bolivia and Peru, such as: i) political-institutional entities at the binational, national, and subnational levels, such as the ALT, and the ministries of foreign affairs, environment, water, and mining of Bolivia and Peru; ii) civil society, such as local communities, indigenous peoples, farmers, fishermen, NGOs, and social movements, all of which have a relevant political position considering that much of the governance mechanisms rely on community associations (in pacific regional, there are water user committees, in Maure – Mauri there are municipal committees and in downstream Desaguadero there are irrigation committees); iii) scientific community, such as universities, research centers, experts, and consultants also have a very important role due to institutional memory about governance processes, which governmental entities do not have due to staff rotation or institutional reform in the case of transboundary agreements; iv) private sector, such as mining companies, and service providers; v) international cooperation, such as UNDP, GEF, FAO, UNESCO, IUCN, WWF, and multi- and bi-lateral donors also play an important role due to impartial status and implementation of funds to coordinate both countries to move forward in transboundary water management.

In the case of diplomatic talks to participatory approaches to problem scoping and solution seeking for international water resources, it is important to highlight the role of ALT, and the ministries of foreign affairs, environment, water, and mining of both countries (Bolivia and Peru).

7 Orontes transboundary basin in Lebanon, Syria and Turkey

7.1 Water governance

Lebanon is a unitary, semi-presidential democratic republic. The unicameral parliament with 128 members is elected for a term of five years. The parliament elects the president for a 6-years term. The subnational government includes governorates and municipalities. Governorates are led by appointed governors. Municipalities have elected councils and mayors, responsible for local governance, public services, and development. They handle tasks such as urban planning, infrastructure, waste management, public health, and taxation. Autonomy and powers of municipalities vary based on size, population, and resources.

The governance structure for water management involves a mix of centralized and decentralized approaches. The Ministry of Energy and Water (MoEW) is the main government agency responsible for water governance and management in Lebanon. MoEW, as part of the central government, plays a crucial role in formulating policies, establishing regulations, and offering general guidance for water management. It formulates national water strategies, develops master plans, and oversees the coordination and management of water resources at the national level. Meanwhile, at the local level, regional institutions such as water establishments and basin authorities are responsible for implementing water management initiatives within their specific regions (El-Awar, 2022).

MoEW retains the overall authority over the national water sector (El-Awar, 2022) and carries out a range of mandates including the protection of natural resources, assuming jurisdiction over the water resources, studying supply and demand, preparing the national water master plan, designing, implementing, and operating large hydraulic facilities, conserving and controlling water resources (surface and ground), and exercising administrative supervision over water authorities and Litani river authority (Republic Of Lebanon, Policy Note on Irrigation Sector Sustainability, 2003).

At the regional level, five public water utilities, namely Beirut and Mount Lebanon Water Establishment, Beqaa Water Establishment, North Lebanon Water Establishment, South Lebanon Water Establishment – collectively known as the Regional Water Establishments (RWEs), and the Litani River Authority (LRA) hold the operational control.

The RWEs are granted autonomy and accountability for various tasks within their designated regions. These include planning, construction, operating, and maintaining-potable and irrigation water transmission and distribution networks, along the sewage treatment plants collection networks. Furthermore, the RWEs are responsible for recommending water tariffs and wastewater charges taking into consideration the prevailing socioeconomic conditions in the operational regions (El-Awar, 2022). The LRA has the responsibility to plan and manage all potable and irrigation water networks. Additionally, they are responsible for measuring and monitoring all surface flows throughout the country and overseeing the establishment and management operation of hydroelectric power plants situated on the Litani River.

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In addition to the MoEW, the RWEs and the LRA, numerous other public sector entities are actively engaged in water management. These include the Ministries of Public Health, Environment, Agriculture, Industry, and Interior, along with the Council for Development and Reconstruction (CDR). For example, the ministry of Public Health supervises the protection of the consumer by controlling potable water, the ministry of Foreign Affairs plays a role in negotiations over international transboundary waters, the Ministry of Environment (MoE) monitors pollution, climate change, and overuse, and the CDR plans infrastructure development, mobilizes funds for project development and supervises project execution. In the decentralization of water management, municipalities and governorates are responsible for collecting water tariffs, maintaining water infrastructure, and delivering water services to their respective residents.

Lebanon's water sector has deep historical roots influenced by multiple civilizations that have governed the region. Over time, Lebanon has undergone major reforms that have impacted how water resources are managed and used (Gharios, Farajalla, & El Hajj, 2020). Multiple codes and laws have been implemented to manage, organize, and institutionalize the water sector from the Ottoman Mecelle in 1877 to the development of a 10-year Water Master Plan in 1999, which aimed to meet the water needs of the population through multiple projects and funding (Gharios et al., 2020). The current water management framework was established in 2000 through administrative reforms with the MoEW as the main authority responsible for water and sanitation. The adoption of the 10-Year Water Plan, the National Strategy for the Wastewater Sector and the Water Code by the Lebanese government have shaped the water policy reform in Lebanon.

7.2 Institutional mapping

The Orontes River, also known as the "Assi" in Arabic, is a vital water source for Lebanon. It is an international river flowing through Lebanon, Syria, and Turkey. It is the only river in the area that flows northward, originating in Lebanon's mountains, the river rises in the great springs of Labweh in the Beqaa Valley, runs through Syria, and empties into the Mediterranean Sea in Turkey. In Lebanon, the Orontes River Basin is situated in the northern region of the Beqaa Valley. The basin is essential for the agricultural sector due to the fertile land it nourishes, making it a significant center for farming activities (Comair, Eaton, & McKinney, 2015). The Orontes River basin encounters various challenges including the over-extraction of water for irrigation, pollution from agricultural runoffs, and inadequate waste management. These challenges are further complicated by climate change, population growth, and political instability.

The use of groundwater for agriculture has led to a depletion of aquifers, lowering the groundwater tables, and reduced spring yields. Water quality is good in the headwaters of the river but declines in the middle section due to agricultural activities, urbanization, and industrialization.

Water governance in the Orontes River Basin is managed by the Lebanese Ministry of Energy and Water and the Litani River Authority. The Litany River Authority (LRA) was established in 1954 under the Ministry of Energy and Water (MoEW). LRA's primary objective is to manage water

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resources, both surface and groundwater, across all of Lebanon, not limited to the Litani River. Both public institutions have the responsibility of overseeing water resources and formulating water policies in Lebanon. A key focus of governance is to ensure equitable and sustainable water utilization across borders, prompting agreements between Lebanon, Syria, and Turkey. Bilateral agreements exist between the countries, however there is no basin-wide agreement between the three countries. In 1994, the governments of Lebanon and Syria signed a water-sharing agreement concerning the Orontes River. As per the agreement, Lebanon allocated 80 million m³/year, while the Syria Arabic Republic receives the remaining 335 million m³ if the river's flow in Lebanon is 400 million m³ or more in a given year.

The Orontes River Basin falls under the Beqaa Water Establishment's (BWE) geographic service area. The responsibilities of the BWE include studying, constructing, maintaining, and renewing water projects for potable and irrigation water distribution, as well as collecting, treating, and disposing of wastewater according to the master plan or the approval of the MoEW. The BWE is also responsible for proposing tariffs for water services based on socio-economic conditions and monitoring quality of distributed water.

The Orontes River Joint Committee, formed under the Lebanese Syrian Joint Committee for Shared Water, is a central entity for bilateral cooperation on shared water resources between Lebanon and Syria (UN-ESCWA & BGR, 2013). This committee includes two sub-committees: the River Protection and Environmental Preservation Sub-Committee, responsible for overseeing river hydrology, pollution, and infringements, the Sub-Committee for the Expropriation of Lands in the areas of the Zeita Canals, which addresses issues related to lands straddling the Lebanese Syrian border near the Zeita Dam. Pre-conflict in Syria, regular meetings were held in Lebanon or Syria, where committee members discussed basin related matters, exchanged hydrological data, and shared water quality analysis results. The committee also collaborates on devising joint measures to address violations and infringements along the river's course, as well as tackling issues of pollution from sewage and fisheries. Additionally, the agreement outlines that Syria will compensate landowners for canal-related work on Lebanese territory, while Lebanon will utilize its local authorities to enforce the rule of law and safeguard the canals' infrastructure.

Water governance in Syria involves various governmental agencies, each with specific roles in water management. The Ministry of Water Resources (MoWR) oversees water resources, supply, irrigation, and hydropower through two directorates: the General Commission for Water Resources Management and the General Commission for Water Services. The Ministry of Agriculture and Agrarian Reform manages agricultural water use, while the Ministry of Environment focuses on sustainable water resource use and protection against pollution. River basin administrations and water users' associations, particularly in irrigation, also contribute to Syria's water governance structure. However, the ongoing conflict since 2011 has severely impacted water governance and infrastructure. Damaged water facilities have caused water shortages, sanitation issues, and increased waterborne disease risks. Displacement has further strained water resources. Post-conflict

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reconstruction and rehabilitation efforts will require significant resources and strategic planning to rebuild the water sector.

Water governance in Turkey involves multiple government agencies, with the Ministry of Agriculture and Forestry playing a key role in water resource management. The General Directorate of State Hydraulic Works (DSI) within the ministry oversees activities related to irrigation, hydroelectric power, flood control, and water supply. Other important institutions include the Ministry of Environment and Urbanization, which manages wastewater and prevents water pollution, and the Ministry of Health, responsible for drinking water quality. Turkey also implements river basin management plans to ensure sustainable and integrated water resource management.

Table 6 The stakeholders' community in the Orontes basin

Organization	Specific roles / competences
Lebanon LB • M of Energy and Water • Litani River Authority	• oversee water resources and formulate water policies in the Orontes River basin, ensuring equitable and sustainable water utilization across borders
Syria (SY) • M. of Water Resources • M. Agriculture & Agrarian Reform • M. Environment • River Basin Admin. • Water Users' Ass.	• water resources, supply, irrigation, and hydropower • agricultural water use • sustainable water resource use and quality protection • integrated water resource management •
Turkey (TR) • M. Agriculture and Forestry - DSI • M. Environment and Urbanization • M. Health	• manages activities related to irrigation, hydroelectric power, flood control, and water supply, • wastewater management and water pollution control • drinking water standards and control

7.3 Mapping of competences

The Lebanese Government and Parliament carry the responsibility of passing draft laws, implementation decrees and allocating budgets to ministries. Within the water sector, specific powers and duties lie with the Ministry of Energy and Water in Lebanon. These include establishing essential policies, regulations, strategies, and decrees. The ministry oversees and monitors the Regional Water Establishments (RWEs) and the Litani River Authority (LRA), ensuring compliance with water use and water security policies through licensing and regulation. It plays a significant role in managing national allocation and distribution of surface and groundwater for drinking and irrigation purposes. The ministry updates and formulates general directives for water and sanitation, while maintaining strict control over water quality.

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The BWE, MoEW, Ministry of Agriculture (MoA), and the Council for Development and Reconstruction (CDR) share the responsibility of studies, reports and projects related to irrigation in the area. Due to limited resources, the BWE has prioritized maintaining and operating existing potable water infrastructure to meet the growing population's needs in the Beqaa. Their role in irrigation has been limited, and they have mainly focused on crisis management. On the other hand, the MoEW has been responsible for irrigation system maintenance and development. The MoEW's latest project, the Irrigation Rehabilitation and Modernization Project (IEMP), aimed to improve agricultural incomes and welfare in rural areas.

The National Water Sector Strategy (NWSS), developed by the MoEW with the participation of national stakeholders and international donors, is a water policy strategy that has been first adopted in 2010 by the Lebanese Government, aiming to ensure water supply, irrigation, and sanitation services in the country. The NWSS was to be implemented in 10 years, however, an updated NWSS was released in 2020 because projects have not been completed due to multiple challenges such as lack of information, lack of coordination, and fragmented institutions. The NWSS 2020 (Ministry of Energy and Water, 2020) major plan aims to implement various projects in five key areas, including sector governance, financial and commercial aspects, reporting and monitoring, capacity building, and operation and management of facilities and services. The plan seeks to reform the legal and regulatory framework, improve performance monitoring, and introduce consumption-based tariffs for water services. In the updated NWSS 2020 plan, the MoEW is responsible for developing a basin management plan that takes into consideration climate change to achieve climate-resilient water resource management using Water Evaluation and Planning System (WEAP) that adopts an integrated water resource management approach. The Strategic Environmental and Social Assessment (SESA) of the updated NWSS-MoEW report assesses the socio-economic (population growth, poverty, urbanization) baseline conditions to understand the state of the environment and specifically the current situation of the water sector in Lebanon.

The Council for Development and Reconstruction (CDR) account to the prime minister, assess infrastructural needs arising from the civil war and allocate funding for reconstruction. It is the primary channel for overseas funding of water investment. Policy making, master planning, and implementation are the responsibilities of the MoEW, and the CDR. The MoEW, MOE, and CDR conduct environmental impact assessments. Water availability is assessed through a combination of field testing and modeling techniques, accounting for seasonal variability and projected changes in demand in the project area.

The American University of Beirut (AUB) plays a role in studying and analyzing the business, environmental, and socio-economic aspects of water management, with experience in conducting research, modeling scenarios, and assessing potential impacts.

AUB-IFI (American University of Beirut - Issam Fares Institute) collected data on conflict risk factors, including socioeconomic indicators, water and environment indicators, and socio-political and water-related conflict indicators. Socio-economic variables such as poverty indices, population growth, livelihood diversity, and food security indices were considered. Water and environmental

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indicators included measures of water availability, quality, supply network coverage, and wastewater. Climate and natural disaster sub-indicators included temperature, precipitation, seasonality change, and history of natural disasters. Tension indicators were derived from social tensions perception surveys and water conflict events recorded in the ACLED database. These spatial indicators were used to calculate a composite water-related conflict risk score for each district. Baalbek and West Bekaa were identified as high-scoring hotspots. Root tensions and stakeholder interactions within these districts were analyzed. A survey was designed to explore the typology and drivers of water-related tensions, using social network analysis (SNA) to examine conflict resolution, knowledge exchange, water supply, quality, network maintenance, compliance, disaster risk reduction, water project funding, and key players in potential peacebuilding projects.

The National Council for Scientific Research (CNRS) – Beirut developed a sustainable natural resources management platform and early warning system which includes flood hazard assessment and mapping.

8 Mahanadi basin in Indian states of Chhattisgarh & Odisha

8.1 Water governance

India is a federal parliamentary democratic republic with a multi-tiered political system. The bicameral parliament is composed by Council of States (Rajya Sabha) and the House of the People (Lok Sabha). The Rajya Sabha with 245 members is the upper house appointed by the President and elected by state legislators. The Lok Sabha with 543 members is the lower house directly elected by the people. Under the Union (federal) government, there are states and Union territories. Each state has its own government led by a Chief Minister, while Union territories are governed by administrators appointed by the Union government. States have legislative assemblies and councils responsible for making laws based on the Constitution. Districts, headed by Collectors or Magistrates, handle local administration. The Constitution distributes powers between the central and state governments, granting varying levels of autonomy to subnational entities. The central government shapes national policies and addresses nationwide issues, while each state or union territory manages region-specific matters. Local bodies, such as municipalities in urban areas and panchayats in rural areas, oversee local administration, including water and sanitation services. Village Panchayats also have the authority to formulate rules for local surface water resources management. This multilevel system enables both centralized policymaking and decentralized execution.

Water governance in India is a complex web of central, state, and local institutions, each with its own powers, roles and responsibilities. The main governmental bodies at the national level include the Ministry of Water Resources (Jal Shakti), and the Central Water Commission (CWC), and the Central Ground Water Board (CGWB) which come under the Ministry of WR (now known as the Ministry of Jal Shakti). These entities are responsible for water resource management, policy development, water supply regulation, and water resource surveillance.

The [Ministry of Water Resources](#) was established by amalgamating the former Ministry of Water Resources, River Development & Ganga Rejuvenation and the Ministry of Drinking Water and Sanitation, which now serve as two departments within the ministry. The [Department of Water Resources, River Development and Ganga Rejuvenation](#) formulates policy guidelines and programs for the conservation, management, and development of water as a national asset. The department oversees national water planning and coordination, water laws, and interstate or trans-boundary water issues. It also supervises bilateral and multilateral cooperation, as well as water quality assessments. A significant responsibility of the department is the transformation of the Ganga River and its tributaries, alongside pollution abatement in other rivers. Further, the department regulates and develops inter-state rivers, implements tribunal awards, and offers technical guidance for irrigation, flood control, and multi-purpose projects. It manages groundwater, oversees flood proofing, addresses water logging and sea erosion, and ensures dam safety.

- The Central Water Commission (CWC), under the Department of Water Resources, River Development and Ganga Rejuvenation, organizes nationwide initiatives for water resource

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management, including flood control, irrigation, navigation, drinking water supply, and hydro power.

- The Central Ground Water Authority (CGWA) oversees India's groundwater resources, focusing on sustainable usage, quality maintenance, and prevention of over-exploitation. It sets guidelines, grants extraction permissions, and implements strategies for groundwater management and conservation. It also helps regulate the development of groundwater resources through registration of structures and control of extraction.

The Department of [Drinking Water and Sanitation](#) is devoted to providing access to clean drinking water and enhancing sanitation facilities across the nation. It leads initiatives such as universal sanitation coverage ([Swachh Bharat Mission](#)) and rural water supply ([Jal Jeevan Mission](#)). The department's primary responsibilities include policy formulation, technical guidance, financial support, and oversight of drinking water and sanitation programs. Its goal is to achieve universal coverage of these crucial services, thus contributing to public health and overall quality of life.

At the state level, Water Resources Department (WRDs) - Chhattisgarh Water Resources Department and Water Resources Department, Government of Odisha - handle the planning, design, execution, and maintenance of water resources projects, such as reservoirs and diversion systems. Public Health Engineering Departments (PHEDs) manage rural water supply provisioning, including the development of groundwater resources for drinking water.

The local level of governance, represented by Panchayati Raj Institutions (PRIs), manages and develops water resources within their jurisdiction, a power granted to them through the Constitutional Amendment Act. PRIs can frame rules related to the development and management of water resources within their administrative boundaries.

The challenge of water governance today stems from the fact that rules regarding water resources' planning, development, allocation, and management can be set at various levels and by multiple agencies. State-level WRDs oversee water resources development planning in river valleys. In the absence of a dedicated state-level institution, the WRD sets rules for resource appropriation within a basin. It also formulates rules for water allocation from developed schemes across sectors like agriculture, industry, and municipal and rural domestic use, using its specific criteria.

The Gram Panchayats of the state also frame rules relating to the degree of development of surface water resources in their locality. According to the Panchayati Raj Act, passed through the 72nd Constitutional Amendment, the PRIs (Panchayati Raj Institutions) were given power to develop and manage surface water resources, within their administrative boundaries, and can frame rules. Also, the legally registered NGOs (societies and public Trusts) can undertake planning, development and management of small water harvesting/harnessing schemes, and watershed development activities in villages, even without the written permission of the Panchayats, so long as no objections are raised by the governing body of the Gram Panchayat to such activities.

Under the programme launched by the Ministry of Drinking Water and Sanitation to develop Water Safety and Security Plans for villages, the Gram Panchayats are entrusted with the responsibility of

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water resource evaluation (groundwater assessment at the GP level); water supply planning, including water budgeting; and selecting technologies for village level water supply. The methods and tools for resource monitoring and evaluation, water budgeting, and even procedure/process to be followed for water supply planning are all provided by the Ministry guidelines (see, WSP (2015)), and even tool kit also exist for preparation of drinking water security plan for villages.

Apart from this, the District Collector, who is administratively the highest authority in a district, has the judicial powers to freeze reservoirs and earmark the water for high priority, basic survival needs during emergencies such as droughts and other natural calamities.

8.2 Institutional mapping

The Mahanadi River, a major Indian river, with a length of around 900 km, beginning in Chhattisgarh and flowing through the state of Odisha, ends in the Bay of Bengal. It significantly contributes to different sectors of the region's economy viz., agriculture, fishing, and power generation, and is home to the Hirakud reservoir, one of the world's longest man-made reservoirs, crucial for irrigation, power generation and flood control. The entire basin has a total of 237 reservoirs under minor, medium, and major categories, some of which are not yet operational. Reservoirs with a gross storage capacity of less than 25 MCM (million cubic meters) make up nearly 90% (206) of these reservoirs. However, they account for only 4.2% of the live storage capacity, or 587.6 MCM, available in the basin.

Several agencies in Chhattisgarh are involved in water resource evaluation, planning, development, supply, and management. These include the State Water Resources Department, State Watershed Management Authority, Public Health Engineering Department, Groundwater Department, and the State Pollution Control Board at the state level, as well as the Central Water Commission and Central Ground Water Board at the union level. Despite these, the overall governance remains at the provincial level, provided by the governments of Odisha and Chhattisgarh.

The governance and management of surface water of the basin are undertaken by the respective states' Water Resources Departments. They hold the powers and responsibilities for the investigation, planning, design, execution, operation, and maintenance of water resources projects. These projects, primarily revolving around reservoirs and diversion systems, are based on surface water resources, including rivers and lakes. The Water Resources Departments handle inter-sectoral water allocation, particularly to meet the water needs of industries and the domestic sector, both rural and urban. The respective states' State Public Health Engineering Departments are responsible for provisioning rural water supply. They develop groundwater resources for rural drinking water supply by drilling wells.

The Central Water Commission (CWC) carries out the hydrological monitoring of the river basin, maintaining 39 stream-gauging stations across the river and its tributaries for recording water level, measuring discharge, sediment measurement, and water quality monitoring. The State Water Resources Departments maintain the reservoir mass balance data for the various major and medium reservoirs they've built in the basin.

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The Central Ground Water Board (CGWB) conducts groundwater monitoring, maintaining around 900 observation wells across the basin. Groundwater levels are recorded four times a year, and groundwater resource assessment is carried out annually based on water level fluctuation to estimate rainfall recharge.

While the Water Resources Department (WRD) is the primary entity, different line agencies involved with water supply, such as the State Public Health Engineering Department (PHED) and State Industrial Department, also independently develop water resources, both surface and groundwater, to meet their sectoral requirements. They often do not take into account how such usage affects other sectors that depend on the same water resources. This sectoral approach with lack of coordination amongst the various departments has resulted in growing dissent among farmers and the fishing community over the contracting of a private firm by the Chhattisgarh State Industrial Department to develop one of Mahanadi's tributaries and allocate water to an industrial area.

Simultaneously, the hundreds of village Panchayats in the states also have the authority to set rules regarding the extent of development of surface water resources in their areas. Under the Panchayati Raj Act, implemented via the 72nd Constitutional Amendment, the Panchayati Raj Institutions (PRIs) have power over the development and management of surface water resources within their administrative boundaries. Legally registered NGOs can plan, develop, and manage small water harvesting/harnessing schemes and watershed development activities in villages without explicit permission from the Panchayats, provided no objections are raised by the Gram Panchayat's governing body. This is due to a lack of clarity on which entities within a state can set rules regarding all aspects of planning, development, operation, and maintenance of water resources development and management projects.

Under a program launched by the Ministry of Drinking Water and Sanitation, Gram Panchayats are tasked with water resource evaluation, water supply planning, including water budgeting, and selecting technologies for village-level water supply. The Ministry provides methods and tools for resource monitoring and evaluation, water budgeting, and even the procedure to be followed for water supply planning (as per WSP (2015) guidelines). Tools also exist for preparing drinking water security plans for villages. This probably acknowledges the fact that in most cases, Gram Panchayats lack the technical capability to determine the criteria for resource evaluation and planning.

A quick review of the methods used for resource evaluation and water budgeting reveals that they are crude and highly unreliable. While the Gram Panchayat (GP) is the unit for groundwater assessment, there is no scientific rationale for considering this as the appropriate unit for resource evaluation and planning. Moreover, the methodology for resource evaluation, planning, and selection of water supply technology lacks a robust scientific basis. The estimation of natural groundwater recharge (annual groundwater availability) and water consumption in crop production, two crucial planning variables, are based on arbitrary norms. This results in an overestimation of the resource base and unrealistic estimates of irrigation water use in different sectors. The process of selecting technology for water supply focuses more on the institutional capability of the GP to run the scheme, rather than the physical sustainability of the water supply,

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as per a review of WSP (2015). The apparent consideration for these methods seems to be that the GP-level Water Supply and Sanitation Committee should be able to undertake groundwater assessment, water budgeting, and water supply planning exercises, and manage the schemes accordingly.

Given that the Mahanadi is an inter-state river basin, the allocation of water by the upper riparian state is already a contentious issue. Rapid industrialization in Odisha has resulted in many manufacturing units being promised water from the Mahanadi. By 2012, the river water accounted for nearly 62% of the total water allocation for industries by the water resources department in the state, a significant increase from just 13% five years prior (Mahapatra, R. and Lal Seth, B., 2023). Indeed, tensions have been escalating since 2006 between the water resources department, local governments, and farmers over the decision to increase the allocation of water from the Hirakud dam for industrial use. Given this scenario, Odisha has started opposing Chhattisgarh's plan to build more diversion systems within its territory. The government of Odisha has already approached the Ministry of Water Resources of the Government of India to establish a tribunal for adjudicating water allocation from the basin.

In a meeting held at the Ministry of Water Resources, Government of India, by the Minister for Water Resources, GoI, with the representatives of both states on 18th September 2016, the Chief Minister of Odisha expressed the opinion that work on all ongoing projects in the Mahanadi basin in Chhattisgarh should be halted for three months. He suggested forming an Expert Committee to study the impact of these projects and deliver a report within three months. However, the Chief Minister of Chhattisgarh contended that the river had sufficient water to meet the needs of both states and that 57% of it was still flowing uncaptured into the ocean. Furthermore, the Government of Chhattisgarh stated that most of the ongoing projects were initiated a decade ago and are in their final stages of completion. Therefore, it is not possible to halt the construction work on these projects. The government of Chhattisgarh suggested the establishment of a Joint Control Board for monitoring water diversions in the basin.

The meeting decided to establish a Special Committee under the chairmanship of Dr. Amarjit Singh, then Secretary of Water Resources. The Committee's task was to catalogue the water resources projects in Odisha and Chhattisgarh that were either constructed or under construction without the approval of the Technical Advisory Committee (TAC) of the Ministry of Water Resources, River Development & Ganga Rejuvenation. Different teams would be dispatched to these states for this task. The Honourable Union Minister requested the states to pause project construction work for one week. It was also decided that gauge and discharge sites would be installed at the inter-state border of Odisha and Chhattisgarh, to effectively measure the flows from the Chhattisgarh catchment into the Hirakud dam. Subsequently, in March 2018, a tribunal was established to adjudicate the dispute over the sharing of water from the Mahanadi basin between the two states. This was in response to an appeal from the Government of Odisha to the Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India.

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Table 7 The stakeholders' community in the Mahanadi basin

Organization	Theme	Specific roles / competences
Central Water Commission (CWC)	national water policies and regulation	• responsible for initiating, coordinating, and furthering the schemes for controlling, conserving, and utilizing water resources throughout India
Central Ground Water Board (CGWB)		• sustainable management and use of groundwater resources, quality control; • sets guidelines, grants permissions, and implements strategies for groundwater conservation
Chhattisgarh and Odisha state authorities: • State Water Resources Department WRD, • State Watershed Management Authority, • Public Health Engineering Department PHE, • Groundwater Department, • State Pollution Control Board	decentralised regional/state-level water policy and regulations	• oversee water allocations and project development - planning, design, execution - and maintenance • rural water supply provisioning • formulates watershed development projects coordinates their implementation, promotes sustainable land use practices • ensures rural water provisioning • implement central government policies and regulations on groundwater at the state level, monitors local groundwater levels and quality, regulate groundwater extraction within the state • ensuring environmental protection within their respective states
Panchayats	Decentralised local water management	• local water management within their jurisdiction

8.3 Mapping of competences

Though the water resources department has powers to allocate water from the reservoir and diversion schemes which it builds as per the allocation plans worked out at the time of planning of the scheme, during emergencies, the District Collectors have the powers to freeze such reservoirs and earmark the water for high priority, basic survival needs. Such allocations are not based on serious considerations of the socio-economic realities, but instead are knee jerk reactions to an imminent crisis. Often when water from reservoirs is frozen, on Collector orders, it only remains in these reservoirs, due to lack of adequate infrastructure for transporting to the place experiencing severe water shortages. While such decisions result in reduced allocation of water for irrigation, no rules exist and no mechanisms are in place for compensating for the farmers who are adversely affected.

The absence of an apex agency for water resource governance at the state level is conspicuous, like in many other states, as many conflicts emerge over allocation of water across sectors. Such an agency can be responsible for framing rules relating to: i) the resource evaluation and planning methodology, planning units, tools, processes and agencies to be employed for resource evaluation and planning; ii) the degree development of water resources, the potential sources of financing of water projects, the agencies which can execute water resource development projects, and agencies which can manage them; iii) the allocation of water from public systems to various sectors and the

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price that should be charged for water supplied to each sector; and, iv) the various considerations (criteria) used for framing such rules.

Framing of rules regarding the proportional allocation of water from a river basin to different sectors, including the environment itself is a major governance challenge. Good governance calls for using social, economic and environmental considerations in framing water allocation rules. This is crucial for reducing future conflicts. However, currently, such allocations are largely driven by political interests.

An equally difficult challenge is to evolve rules regarding the pricing of water in different sectors. There is no consensus on whether prices should be on the basis of the cost of production of water, or the affordability of water for the user communities, or the economic benefits produced by the use of water in a particular sector. The ideal pricing norm should be based on all these considerations. This means that in sectors such as industry, wherein water use efficiency (Rs/m³ of water) or the economic return from the use of unit volume of water is generally very high, the unit price of water could be much higher than that in irrigated agriculture, which has relatively much lower water use efficiency, owing to the higher ability to pay. In the case of basic survival needs such as drinking & domestic water supply, since the social benefits of consuming adequate quantities of water (in the form of preventing malnutrition, lower infant mortality and lower incidence of water borne diseases resulting in better human development) are high, subsidies will have to be provided to those who are poor to make water supply services affordable.

However, in the case of water sharing between Chhattisgarh and Odisha, the Central Water Commission is currently monitoring any further development of surface water resources in Chhattisgarh part of the basin and water releases from Hirakud reservoir for the lower riparian state of Odisha. A gauge and discharge sites had been opened at the inter-state border of Odisha and Chhattisgarh at a location, for effective measurement of flows from Chhattisgarh catchment into Hirakud dam

As regards hydrological simulation studies for assessing water resources and similar modelling studies which are required for river basin water resource allocation planning, at the state level, no government agency undertakes such works in the absence of the requisite expertise. However, at the central level the Central Water Commission, which has qualified professionals with proper training in the relevant fields, undertakes such specialized modelling studies. It has recently embarked on modelling of all the major river basins of the country to reassess water resources in the wake of the changing hydrometeorological conditions using a water accounting tool.

As regards scenario development of future water balance, generally such expertise are not available with any of the state or central agencies concerned with water resources in India. Such activities of scenario development that require multi-disciplinary skills are carried out through outsourcing to specialized consulting firms that engage experts from disciplines such as hydrology, hydrological modelling, climate modelling, water quality modelling, agricultural sciences, economics, etc.

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The National Environmental Engineering Research Institute (NEERI), Nagpur has expertise in environmental impact assessment. For social and economic impact assessments, there are several research institutions affiliated to the Indian Council of Social Science Research. Every state has one socioeconomic research institute which is affiliated to ICSSR.

The Central Water Commission has expertise in the assessment of risks associated with extreme rainfall events, i.e., floods. However the risk assessment involves assessment of the flood hazard in terms of the magnitude (of certain return period) and frequency of occurrence of floods (of certain magnitude) and not the exposure of the socioeconomic system to the flood hazards and the vulnerability of the communities to the disruptions in caused by the hazard which are essential for determining the degree of risk.

There are very few research institutions in India that have expertise in policy analysis. They are all in the non-governmental sector. The government agencies often engage them to understand the impacts of various policies introduced by them or to get ideas to frame new policies.

None of the government stakeholders, either at the state level or at the central level have expertise in employing participatory approaches to problem scoping and solution seeking. However, the local self-governing organizations in the rural areas (the Gram Panchayats) are mandated to engage with the village communities in micro planning of the developmental activities that they undertake. In the context of water, they include planning of watershed development interventions, water harvesting and artificial recharge of groundwater (under various schemes), and rural water supply.

9 Conclusions and outlook

This report includes an initial stakeholder mapping exercise to facilitate the selection and engagement of stakeholders in each pilot basin. The purpose is to identify and evaluate the variety of stakeholders, their contribution to water planning and management processes and their competences and skills. By mapping out the stakeholders, their interests, and their potential influence, this report contributes to understanding the stakeholder landscape. As the project progresses, the stakeholder mapping will continue to expand and be enhanced.

The range of roles undertaken by stakeholders in water governance across the river basin pilots reflects the intricate and collaborative nature of water management. As the project progresses, a comprehensive analysis will be conducted to assess the contribution of these diverse water governance features to the advancement of transformative adaptation policies, as well as any potential barriers they may pose. This analysis aims to provide insights into the specific ways in which stakeholder roles and interactions impact the design and implementation of transformative adaptation measures. It will enable the identification of areas where stakeholders can align and synergize their efforts to facilitate effective policy development and implementation. Moreover, the analysis will shed light on challenges and conflicts that may arise from divergent stakeholder perspectives, priorities, or capacities. By gaining a deep understanding of these dynamics, the project can proactively address obstacles, leverage stakeholder strengths, and foster sustainable and resilient water management policies.

The stakeholder engagement strategy aims to promote collaboration and knowledge sharing among stakeholders in the project. It involves raising awareness about the benefits of collaboration, organizing workshops and meetings for knowledge sharing, and creating a collaborative environment for stakeholders to contribute their ideas and expertise in developing transformative adaptation practices. Continuous learning and considering stakeholder needs are prioritized throughout the project.

This report contributes to establishing knowledge networks in each pilot basin. These networks involve key stakeholders in the co-creation of transformative adaptation practices. The diverse expertise and water governance roles of network members will contribute to the project's success. The knowledge networks will facilitate exchanges through scenathons, which are interactive workshops using serious gaming techniques to help stakeholders grasp complex scientific models and apply their findings in decision-making. The discussions within the knowledge networks will prioritize inclusivity, participation, and transparency, drawing inspiration from the Talanoa Dialogue approach, which promotes understanding, constructive debate, and respect.

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