INBO
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Session 5 Report

Circular water economy for basin resilience: diversifying the “water mix” with non-conventional resources

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Thematic Context

In the face of growing water scarcity and climate uncertainty, relying solely on conventional freshwater sources (surface and groundwater) is increasingly risky and unsustainable. Over-exploitation depletes ecosystems and creates vulnerability. The challenge is to transform our linear "take-use-discharge" model into a circular one that values every drop of water multiple times. This means diversifying the "water mix" by tapping into non-conventional resources like treated wastewater, managed rainwater, and, where appropriate, desalinated water. The barriers are not just technical but also related to governance, economics, and public acceptance. Basin management planning is the strategic instrument to mainstream this diversification. It can assess the potential of these alternative resources at the basin scale, establish the necessary regulatory and safety frameworks (especially for reuse), and identify strategic investments. By planning for the large-scale integration of non-conventional resources, basin organizations can reduce pressure on natural water bodies, enhance water security for all uses, and close the water loop, turning waste into a valuable asset for agricultural, industrial, and even potable use.

Speakers

Session Report

Integrated water resources management requires taking into account all resources. Surface water, groundwater, green waters, no-conventional waters (including rainwater use, desalination, reuse of treated wastewater, forced recharge of aquifers..) are part of water resources as a whole. In many countries, they are “moments” of the natural and anthropized water cycle. The water mix perspective allows us to consider all of them, to better align water availability with actual water needs for populations and sectors. It also gives the opportunity to evaluate the strength and weaknesses of mobilizing each of them, and allows the decision maker to use the most adapted resources to each needs, considering human health, environmental challenges, economic and energy cost, technical capacities and social acceptance.

This session brought together various case-studies from Algeria, Brazil, France, Mexico, Morocco, Spain, Turkey, and the Orange-Senqu Basin to think together on the role played and challenges of non-conventional resources to be part of basin resilience .

Non-Conventional Waters : Examples of implementation

Non conventional waters stand among cards played by decision makers at basin levels to enhance water availability. Especially (but not only) in water-scarce regions, they are not seen as “extra” water, they are already part of the Water Mix.

Morocco exemplifies this transformation by aiming for 50% of its water supply portfolio to come from non-conventional water resources by 2030. To achieve this goal, the country implemented a 67-km "water highway" in just six months, securing water supply for coastal regions, and establishing smart water hubs where citizens can purchase treated water for non-potable uses through electronic cards. In addition, Morocco harnesses solar energy from the desert to power large-scale desalination processes, integrating water security with the energy transition.

In Brazil, the state of Ceará initiated the country's first Water Credits Law, which uses blockchain technology to promote water-use efficiency. The state has also installed floating photovoltaic plants on reservoirs, reducing water evaporation while helping finance the pumping costs of an extensive network of more than 1,000 km of canals and water conveyance systems.

In Spain, the Júcar River Basin transformed water reuse into a strategic advantage through the so-called "Golden Irrigation Canal," which conveys treated wastewater from the Pinedo treatment plant to rice fields. This solution converts pollutants into nutrients for the soil, ensuring agricultural productivity even during periods of limited rainfall. Complementing this strategy, the Jávea desalination plant plays a vital role in maintaining urban water supply during peak tourist seasons.

In Mexico, the state of Chihuahua has focused its efforts on aquifer recovery. The Metropolitan Irrigation Unit replaces groundwater extraction with treated wastewater to irrigate approximately 3,000 hectares, while artificial aquifer recharge projects in Cuauhtémoc and Jiménez-Camargo promote the infiltration of rainwater into the subsurface through water retention infrastructure.

Algeria has structured its national water policy around three pillars: desalination, water reuse, and conservation. Among its most innovative initiatives is the recovery of lithium from the brine generated by the desalination process.

Turkey has replaced its traditional linear management model with a National Water Plan based on the integrated water-energy-food nexus. One of its main objectives is to reduce "non-revenue water", which is water losses within the distribution network, from 43% to 31%.

In France, the severe drought of 2022 prompted the launch of a national plan aimed at developing 1,000 treated wastewater reuse projects by 2027. Through this initiative, the country seeks to transform what was once a marginal practice into one of the fundamental pillars of long-term water resources management.

In Southern Africa, the Orange-Senqu River Basin Commission (ORASECOM) coordinates the Water Conservation and Water Demand Management (WCWDM) Project, which identifies the significant potential for water reuse in the mining and industrial sectors across Botswana, Lesotho, Namibia, and South Africa. The strategy prioritizes the use of marginal waters as a means of reducing regional vulnerability to climate variability and strengthening long-term water resilience.

Strengths and weaknesses

As with every measure in the field of water management, each type of non-conventional waters has strengths and weaknesses depending on the context. The discussions highlighted that the viability of Non-Conventional Water Resources depends on the geographical, economic, institutional, and social characteristics of each river basin. While there was broad agreement on the potential of these solutions to enhance water security, it became evident that their benefits and limitations vary considerably according to the implementation context.

Regarding production costs and social affordability, it was emphasized that technological advances have made desalination an increasingly competitive alternative. In Morocco, production costs have declined from approximately €2.0/m^3 to around €0.5/m^3, reflecting technological progress and improvements in operational efficiency. To ensure equitable access, the country has adopted a progressive tariff system, with prices ranging from €0.2 to €1.5/m^3 depending on consumption levels. In Spain, production costs range between €0.5 and €1.0/m^3. Although these values are considered competitive when compared with bottled water, they remain significantly higher than the cost of regulated surface water, which ranges from €0.1 to €0.2/m^3. In France, discussions highlighted that one of the main challenges lies in the financial sustainability of these solutions and in

ensuring their social affordability, particularly in balancing the high costs of advanced treatment with acceptable prices for consumers.

Energy demand was identified as one of the principal challenges to expanding the use of non-conventional water resources. In Ceará, Brazil, energy expenditures account for approximately 30% of the operating costs of the state's water management system, exceeding BRL 40 million annually for water pumping and transfer. In Spain, desalination requires between 2.5 and 3 kWh per cubic meter of water produced, a level comparable to the energy consumption of a household refrigerator. However, it was also noted that technological innovation has reduced this energy requirement by approximately 90% over the past 50 years, largely due to more efficient membranes and energy recovery systems. In Algeria, it was argued that the high energy demand for desalination can be mitigated through the integration of renewable energy sources and the use of biogas to power water treatment and supply systems, thereby improving both the economic and environmental sustainability of desalination systems.

Another major topic of discussion regarded infrastructure investments and the reduction of water losses within distribution networks. In the Orange-Senqu River Basin in Southern Africa, non-revenue water resulting primarily from distribution losses ranges between 40% and 50%, representing one of the main obstacles to efficient water management. The same hurdle is faced by Turkey. Overall it was emphasized that water reuse can only reach its full potential if accompanied by substantial investments in the rehabilitation and modernization of existing infrastructure.

Social acceptance also emerged as central issues during the discussions. In the state of Chihuahua, Mexico, the adoption of treated wastewater for agricultural irrigation continues to face resistance from farmers due to public perceptions regarding its sanitary safety. On the contrary, in Spain, agricultural water reuse was recognized for providing additional benefits by supplying naturally occurring nutrients in treated wastewater, reducing fertilizer requirements while enhancing agricultural productivity.

Regarding environmental impacts, it was argued that, when properly managed, the discharge of desalination brine has limited environmental impacts, with salinity levels becoming virtually indistinguishable from seawater only a short distance from the discharge point. In contrast, concerns were raised that diverting treated wastewater for reuse rather than returning it to rivers could reduce environmental flows and negatively affect downstream ecosystems.

Finally, the discussions underscored that governance and regulatory frameworks are fundamental to establishing non-conventional water resources as a permanent component of integrated water resources management. Indeed, the expansion of non-conventional water solutions depends on strengthening public confidence and establishing clear regulatory frameworks capable of defining quality and safety standards, thereby enabling the transition from isolated initiatives to the systematic integration of water circularity into long-term water resources planning.

Optimizing public choices at basin level

Integration of non-conventional water is the water mix is creating new challenges for articulation between water and…:

- Health, to preserve quality of water for human uses.
- Energy, to reduce emissions and operation costs of energy-intensive technologies.
- Agriculture, to manage quantity and quality of waters, depending on cultures and soils.
- Industry, to accompany socio-economic development in a sustainable way for territory and ecosystems.
- Environment, to ensure that technical processes are not triggering challenges for sensitive ecosystems (discharge, contaminations…).

To face all these challenges, Integrated Water Resources Management (IWRM) principles can be of great help:

- River basin governance allows to articulate among sectors, bringing together the visions of the territory in concertation bodies. River basin organizations have furthermore a key-role to play to align the technical options to respond to the concrete preferences of the sectors in the territory,
- Consultation of the public is necessary to take into account the perceptions of the population, increase social acceptance, and better know what users would prioritize among the various solutions, which is a key factor of success for public choices. It also creates a space for outreach and sensitization on key-messages (reducing water losses, optimizing uses in drought periods, etc.)
- Knowledge management and balancing monitoring of surface and groundwater resources
- Integrated river basin management planning, to include the water mix in the process of identification of needs and responses, at basin scale. Mobilizing non-conventional waters should be analyzed in all its components (assets and challenges) and be inserted, if relevant, in a program of measures associated with a river basin management plan. As a common reference to all institutions and users in the basin, the plan can be helpful to also promote structural and non-structural complementary measures that are needed to be fully effective (demand management, capacity building of technicians and operators, etc.)
- Implementing user-pay and polluter-pay principles, in a basin solidarity perspective, with city-basin dialogue, and upstream/upstream articulation. Otherwise, costs that are not included in proper financial mechanisms for water management would be paid anyway by citizens, in fiscality or in health and socio-economic development costs.

Further develop the discussion on the water mix by participating to **INBO's webinar on Wastewater REUSE** on November 3rd, 2026!

Credits: INBO and Fabiano Veneza/SEAS