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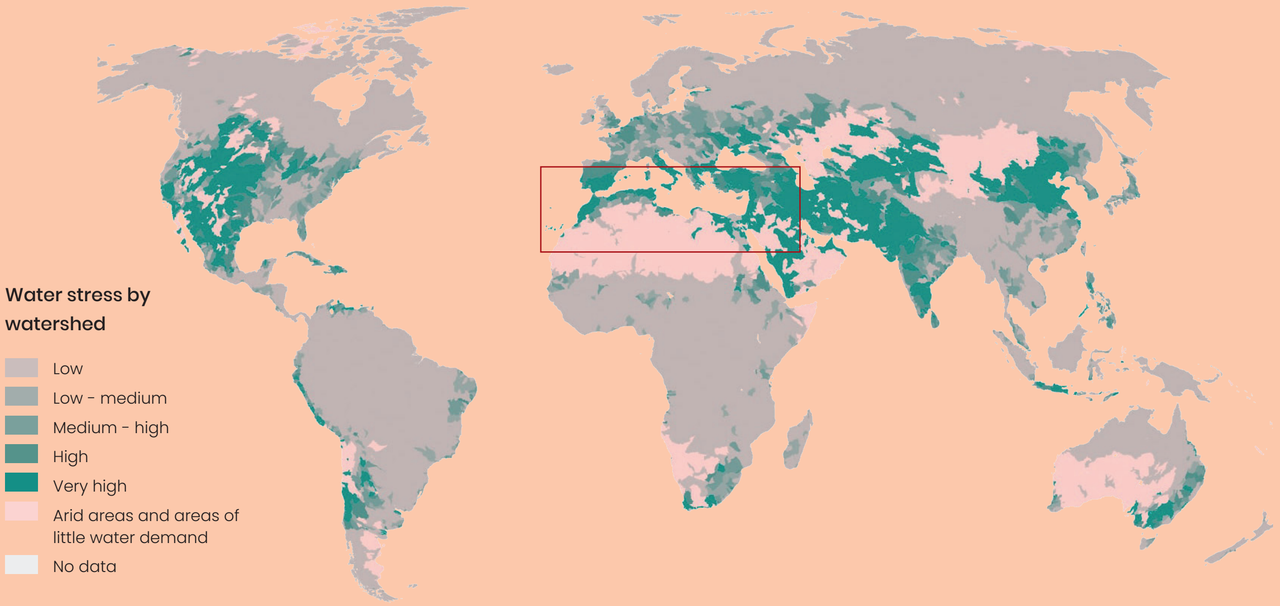
A Question of Development
Synthesis of AFD studies and research
NOVEMBER 2024
Nº 81

Water reuse, a strategic response to water stress?

Introduction: Faced with the effects of climate change…

The Mediterranean basin and the Middle East are particularly exposed to the effects of climate change (IPCC 2023). These countries, which are among the most vulnerable in the world in terms of water availability, are below the water scarcity threshold (1,000 m³ per person per year), while future projections point to rising temperatures, a significant reduction in rainfall, and more intense droughts. Combined with increasing demand and competition over water use, these conditions are likely to exacerbate water stress. Defined as a situation where the demand for water exceeds the available supply, water stress represents a threat to the economic, social, and environmental stability of these regions. This article explores the potential for water reuse as a response to water stress in the Mediterranean and the Middle East. Analyzing how this approach is deployed allows us to identify the factors that encourage its use, as well as the obstacles and constraints hampering it. Despite challenges around its implementation, there seems to be several possible ways to promote water reuse.

Map 1 - Projected water stress by basin in 2040 (the box shows the study area).



Source: FNSP - Sciences Po, Atelier de cartographie, 2018 (data: World Resources Institute).

Note on map 1: Benchmark water stress measures the ratio of total annual water withdrawals to total available renewable resources, taking into account water demand and consumptive use. Higher values indicate greater competition among users.

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... water reuse has numerous advantages

Faced with the increasing scarcity of water resources, water reuse emerges as a possible strategic solution. It involves reusing appropriately treated wastewater in various sectors, including agriculture and industry, and even, to a lesser extent, in domestic contexts. This practice can alleviate pressure on freshwater resources and therefore **reduce water stress**. When used in non-domestic contexts, it **supports economic development** by guaranteeing a stable supply of water to the primary and secondary sectors. This is already the case in the United Arab Emirates (UAE) and Saudi Arabia, where high reuse rates help to support robust economies despite extreme water stress. Finally, in countries where agriculture depends heavily on irrigation, like Tunisia or Egypt, water reuse increases **food and health security** by ensuring good-quality harvests, even in times of drought.

From an **environmental perspective**, water reuse can reduce groundwater extraction and thus alleviate pressure on groundwater levels and waterways, helping to preserve aquatic biodiversity and ecological balances. **Groundwater recharge projects** can prevent groundwater salinization and depletion. Nevertheless, they require in-depth upstream studies and adequate supervision to limit the pollution load of discharges into natural environments and ensure the quality of the injected water.

But its adoption remains patchy...

Worldwide, just **52% of the 359.4 billion m³ of wastewater** produced each year **is treated**. Although the reuse of wastewater is an established practice, it represents only a small percentage of total water consumption, mainly in urban agriculture. Generally speaking, water reuse remains limited and varies considerably from region to region. Within the region analyzed here, there is a clear divide between the countries of the Middle East, which are generally more advanced in this area, and those of North Africa.

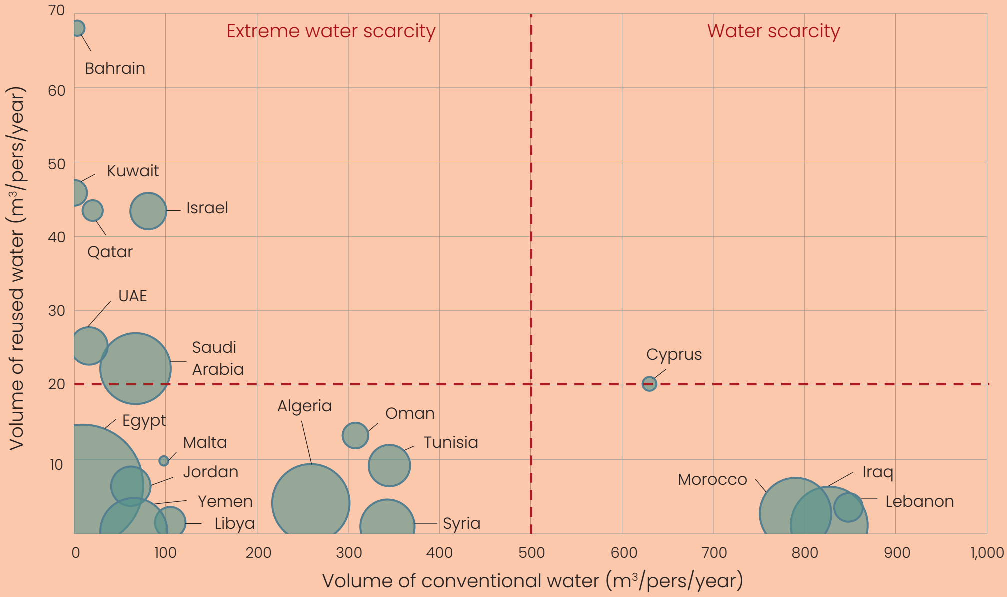
Box 1. Current usage of treated wastewater

Absorbing significant amounts of recycled water, agriculture remains the principal beneficiary of water reuse (e.g., in Jordan or Egypt), although the industrial sector is increasingly making use of it as well. In Tunisia, for example, recycled water is used to cool machines and clean equipment. In Morocco, the OCP Group uses it at its mining sites, but recreational and residential usage remains low and mostly limited to watering urban green spaces.[1] In Israel, recycled water is also used to recharge groundwater in arid areas. Direct human consumption remains rare because of health and regulatory issues, although pilot projects are starting to emerge.

Figures 1 and 2 present key data (from 2020) concerning water reuse and its connection with water stress. In Figure 1, the sample countries are categorized according to the availability of conventional water resources (scarcity or extreme scarcity), which is then compared with efforts undertaken to promote reuse.

Figure 2 introduces the concept of water demand in the form of the water stress indicator.[2] Expressed as a percentage, it illustrates the relationship between the total volume of fresh water extracted for human activities (demand) and the total volume of available renewable fresh water resources (supply). By comparing this indicator with the water reuse rate in Figure 1, we can evaluate the crucial role of water reuse in ensuring a sustainable balance. The figure shows that **Middle Eastern countries**, which have **extremely high water stress** (> 1,000%), have higher water reuse rates. Kuwait, for example, has a water stress indicator of 3,850% and a water reuse rate of 55%, while the UAE has water stress of around 1,600% and a reuse rate of 42%. The reuse rate is highest in Israel (85%). By contrast, in certain **North African countries**[3] with **high water stress** (> 100%), water reuse rates are lower: 23% in Egypt and 14% in Morocco.

Figure 1 - Comparison of volume of reused water per person per year and the volume of available renewable water per person per year (Mm³).

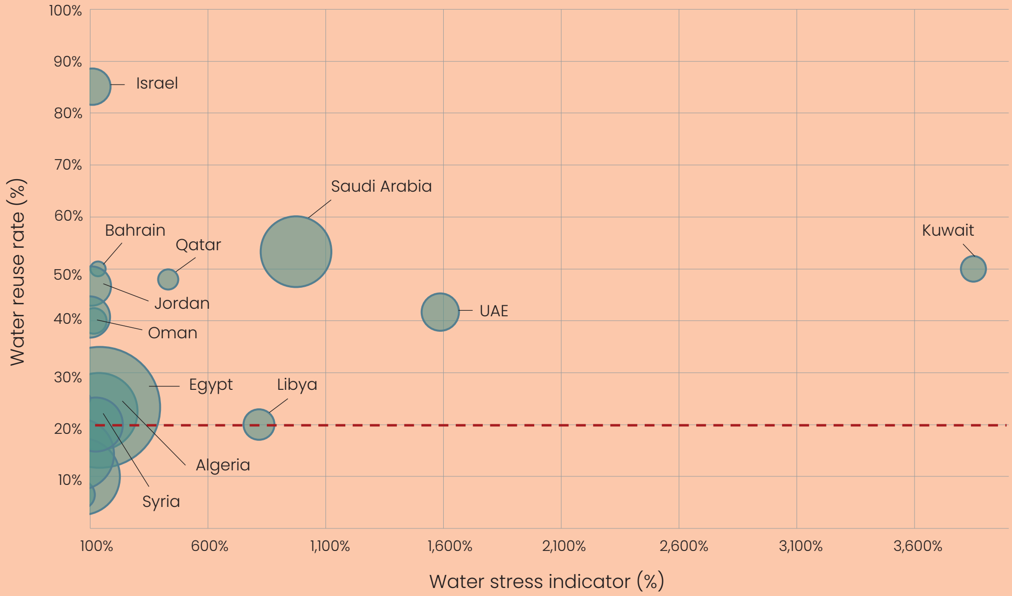


[1] This may also reflect a desire to allocate conventional water to other uses first.

[2] Measuring the level of water stress in a country or region, this is one of the UN Sustainable Development Goals (SDG) indicators, found in SDG 6.4.2.

[3] North Africa corresponds to Morocco, Algeria, Tunisia, Libya, and Egypt.

Figure 2 - Comparison of the water reuse rate and the water stress indicator for countries with water stress above 100%.



Source: authors (data: FAO).

Note on figures 1 and 2: Bubble size represents population.

... closely linked to the implementation of proactive public policies...

Although the adoption of water reuse is correlated with the level of water stress, it depends above all on the implementation of **public policies, a robust institutional and regulatory framework, and the allocation of resources *via* financial incentives**. For example, Kuwait seeks to compensate for water scarcity by facilitating investment in water reuse. Israel has introduced targeted financial incentives for farmers and preferential rates for recycled water, as well as establishing a regulatory framework that includes water reuse as a key component of national water management (Marin *et al.* 2017). The UAE has developed an integrated water management model that combines reuse with desalination, another source of "unconventional water," and in 2019 implemented a water recycling policy that imposes strict quality standards and encourages water companies to maximize the use of recycled water for non-drinkable uses.

Conversely, in North Africa, the implementation of effective water reuse policies and of large-scale projects is hampered by the institutional fragmentation of water management and the lack of coordination between institutions, as well as a lack of appropriate funding. In Morocco, for example, the absence of clear regulatory standards for certain critical aspects makes it particularly difficult to use treated wastewater in agriculture (Mayaux 2022).

Although agricultural water does not need to meet the same standards as drinkable water, the establishment of a clear and rigorous regulatory framework, defining appropriate but robust standards, makes it possible to gradually formalize informal (illicit) water reuse. It must be accompanied by thorough monitoring and economic incentives (subsidies or tax credits) to encourage investment while ensuring safe practices. Governance requires the involvement and careful coordination of numerous actors, from the central to the local level, and must be safeguarded by contractual arrangements and consistent technical interfaces.

... and still hampered by difficulties that need to be resolved

While the implementation of water reuse in the short term in Syria and Libya has been made more complicated by political instability and conflict, elsewhere it is being held back by a combination of other factors.

Technical challenges and associated financial investments

First, **the overall efficiency of wastewater treatment must be improved** to ensure that the reused water is of sufficiently high quality for various purposes, while also cutting operational costs. Strengthening environmental standards in order to reduce the use of toxic chemical inputs in industry[4] and to improve the pretreatment of wastewater at the source would help to decrease the pollution load arriving at water treatment plants. These changes in production processes and these upstream investments are crucial in developing countries, where treatment facilities are often undersized or obsolete.

In many of the countries studied, the inadequacy and dilapidation of existing facilities and networks limit their capacity to reuse wastewater. It is thus essential to **develop networks capable of conveying wastewater efficiently** from water treatment plants to often distant areas of use (sanitation systems generally convey wastewater downstream). The construction and modernization of new or existing networks, the installation of distribution systems, and the maintenance of all these infrastructures require substantial investment, which is often prohibitive for low- or middle-income countries, but justified by the long-term economic benefits.

[4] In industrial areas, wastewater can contain complex pollutants that are very expensive to treat.

Major sociocultural obstacles

The adoption of water reuse is also hindered by cultural barriers. Public perception is generally negative because of concerns about the purity and safety of the water. Social acceptance of water reuse, particularly for sensitive purposes like agricultural irrigation or human consumption, thus remains a major challenge. Promotion campaigns must be targeted at decision-makers in the agricultural world, while educational programs must be integrated into school *curricula* and community initiatives in order to raise public awareness. By providing safety guarantees and focusing on the advantages of water reuse and its crucial role in sustainable management, these steps would lead to a deeper understanding and wider acceptance of water reuse.

Conclusion

Water reuse maximizes the circular use of every drop of water. In Mediterranean and Middle Eastern countries, where resources are limited and diminishing as a result of climate change or high human pressure, water reuse has considerable potential for reducing water stress. Its adoption, still hampered by various obstacles, requires adequate investment in infrastructure and greater public awareness. As a **fundamental component of sustainable water management**, it is also used in the northern Mediterranean countries, like Spain, where droughts are becoming more intense.

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Agence française de développement (AFD)
5, rue Roland Barthes | 75012 Paris | France
Publishing director Rémy Rioux
Editor-in-chief Thomas Mélonio
Graphic design MeMo, Juliegilles, D. Cazeils
Layout PUB
Translation Cadenza Academic Translations

Legal deposit 4th quarter 2024 | **ISSN** 2428-8926
Credits and authorizations

Printed by the AFD reprographics department

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