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Expanding water reuse in the Middle East and North Africa

Policy Report

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NOTE: This report compiled data from 19 Arab countries of the MENA region (namely, Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, the United Arab Emirates and Yemen). Throughout this report, the terms 'MENA region' and/or 'the Region' refer only to those 19 countries.

COVER PHOTO: Hamish John Appleby/IWMI

About IWMI

The International Water Management Institute (IWMI) is an international, research-for-development organization that works with governments, civil society and the private sector to solve water problems in developing countries and scale up solutions. Through partnership, IWMI combines research on the sustainable use of water and land resources, knowledge services and products with capacity strengthening, dialogue and policy analysis to support implementation of water management solutions for agriculture, ecosystems, climate change and inclusive economic growth. Headquartered in Colombo, Sri Lanka, IWMI is a CGIAR Research Center with offices in 14 countries and a global network of scientists operating in more than 30 countries.

Contents

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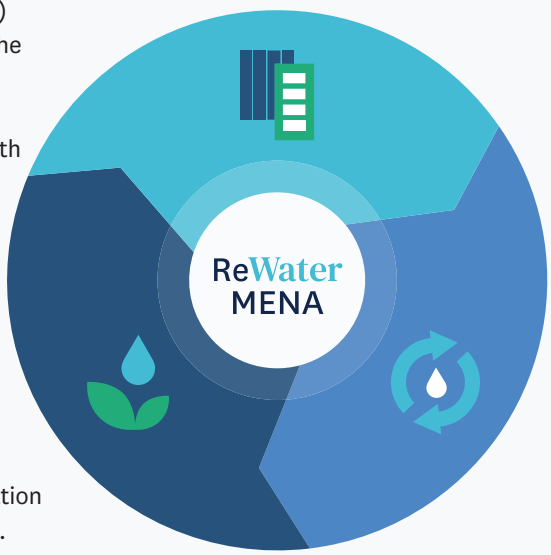
Javier Mateo-Sagasta / IWMI

Key messages

- ✓The region faces a severe water crisis. Efforts to resolve this crisis have been insufficient.
- ✓Wastewater is part of the problem *and* part of the solution. Untreated wastewater increases water pollution and aggravates water scarcity. On the other hand, wastewater is the only water source that is renewable, growing with time and contains resources that can be productive.
- ✓Indirect use of untreated wastewater is a common reality in the region. The health risks need to be assessed and mitigated.
- ✓Wastewater is only a waste if we decide to waste it. The potential for resource recovery from municipal wastewater in the region is still untapped.
- ✓The region needs to accelerate actions to meet the UN's Sustainable Development Goal #6, which addresses the recovery and reuse of wastewater and to make reuse safer and more productive.
- ✓The region needs to recover and reuse lost wastewater when feasible and make reuse, particularly indirect use, safer not only through better treatment methods but also with better agricultural practices.
- ✓The region needs to address the challenges that lock the potential, including high costs and poor financial sustainability, cultural barriers and distrust, institutional fragmentation, improper regulations and lack of political will.
- ✓The region needs to accelerate the replication of successful water reuse projects.

About ReWater MENA

In 2018, the International Water Management Institute (IWMI) and its partners embarked on a four-year project to expand the safe reuse of water in the Middle East and North Africa. The project addressed barriers to water reuse in the region and promoted safe reuse practices that improve food safety, health and livelihoods. Drawing on experience with water reuse strategies already developed in the region, the project identified promising innovations and validated reuse models, with the aim of resolving past management bottlenecks. These include cultural barriers, institutional fragmentation, inappropriate regulations and lack of financial models for cost recovery. With a focus on Egypt, Jordan and Lebanon, the project facilitated inclusive and participatory engagement with stakeholders, to support the development and uptake of project results. For more information about the ReWaterMENA project, visit: https://rewater-mena.iwmi.org/ or contact: Javier Mateo-Sagasta, ReWaterMENA project leader (J.Mateo-Sagasta@cgiar.org).



Executive summary

Arab countries in the Middle East and North Africa[1] (hereafter called "the region") generate around 21.5 billion cubic meters (BCM) of municipal wastewater each year. Many countries are substantially improving their wastewater treatment rate, however, about 40% of produced domestic wastewater and a substantial portion of industrial wastewater in the region are still left untreated.

Water reuse can help tackle the water scarcity problems of the region, which have been exacerbated by climate change. It also has the potential to play an important role in water resources management to lessen the present and long-term demand-supply imbalance. Addressing these challenges is particularly important when considering the increasing population and urbanization trends of the region, which will lead to an increase of domestic water use.

Many uncertainties remain regarding the reuse of water. It is strongly recommended that policies be pushed forward which holistically consider social, economic and environmental implications. This will also support governments in developing national strategies on water reuse through investigating the existing situation, evaluation of policy options in different areas and offering appropriate recommendations.

The successful and efficient use of treated water in agriculture will depend on its reliability, in quantity and quality, as an alternative source of water for irrigation. It will also depend on factors such as setting adequate national standards for reuse; improving public awareness and attitudes towards treated wastewater utilization; and its effective utilization in existing agriculture to replace unrenewable water resources.

The region needs to overcome the factors that limit the materialization of the regional full water reuse potential, including cultural barriers and distrust; institutional fragmentation; inadequate regulatory frameworks; and the lack of appropriate tariffs, economic incentives and financial models that undermine cost recovery and the sustainability of reuse projects. Governments should provide concrete financial mechanisms to support upscaling the sustainable use of non-conventional water related technologies.

In order to remove these barriers and reduce the investments risks, water reuse projects must strengthen international and multi-stakeholder cooperation. Public-private partnerships are essential in attenuating the risks of investments and share the complementary human, financial and technical resources to implement long-term non-conventional water projects. A sound and adequate policy, as well as an adequate legal and institutional framework is essential to provide an enabling environment for public and private sector investments in the water reuse sector. Cost benefit and cost recovery should be integrated for sustainability of any water reuse project. Greater attention should be given to the role of women in water reuse projects. The lack of political will in some countries must be addressed. Finally, efforts should be made to incentivize the adoption of on-farm practices for safe water reuse.

[1]This report includes data for these Arab countries in MENA: Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, United Arab Emirates and Yemen. Throughout this report the terms 'MENA region' and/or 'the Region' refer only to those 19 countries.

State of water reuse in the region

Per capita water availability reducing

In the past few decades, the region has experienced the fastest global decline in available water resources in the world. The situation is forecast to dramatically worsen in the future in view of population and economic growth and climate change. The region's population grew from 119 million inhabitants in 1970 to around 418 million in 2020 (UN 2019, UN 2018) (Figure 1). That rapid population growth has also led to a corresponding drop in per capita water availability. Since 1970, the annual per capita share of renewable water resources in the region has dropped by 70 percent, from 1,752 cubic meters to a low 530 cubic meters by 2020 (FAO 2022) (Figure 2).

This increased water scarcity will have a profound economic impact in the region and the livelihood of its people. For example, the water scarcity is forecast to reduce the average gross domestic product in the region by 6 to 14% by 2050 and reduce labor demand by up to 12% (World Bank 2018; Taheripour et al. 2020)

Wastewater is part of the problem and part of the solution

Wastewater production grows as population, urbanization and income per capita grow. In many countries of the region there is still a long way to go in wastewater treatment to catch up with wastewater production growth.

The 19 countries analyzed produce around 21.5 BCM of municipal wastewater every year (Mateo-Sagasta et al 2022a). The most recent data shows that at least 40% of the domestic wastewater that is generated is not safely treated and does not meet national standards for disposal (WHO 2021). The situation varies in between countries (Figure 3). Income per capita is a good indicator for the level of treatment. High-income countries such as Bahrain, Qatar, United Arab Emirates or Saudi Arabia treat most of the domestic wastewater they generate. Low- and lower-middle-income countries such as Yemen, Sudan, Mauritania and Morocco have more challenges.

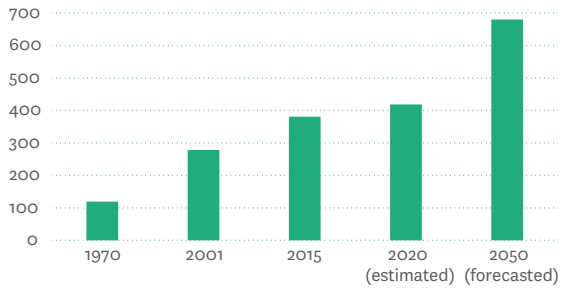


Figure 1. Population in the region (millions of inhabitants). Source: UN 2019; UN 2018.

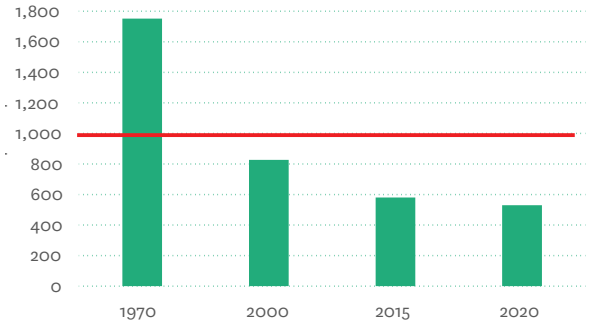


Figure 2. Water resources per capita in the region; red line shows threshold for water scarcity. Source: FAO 2022

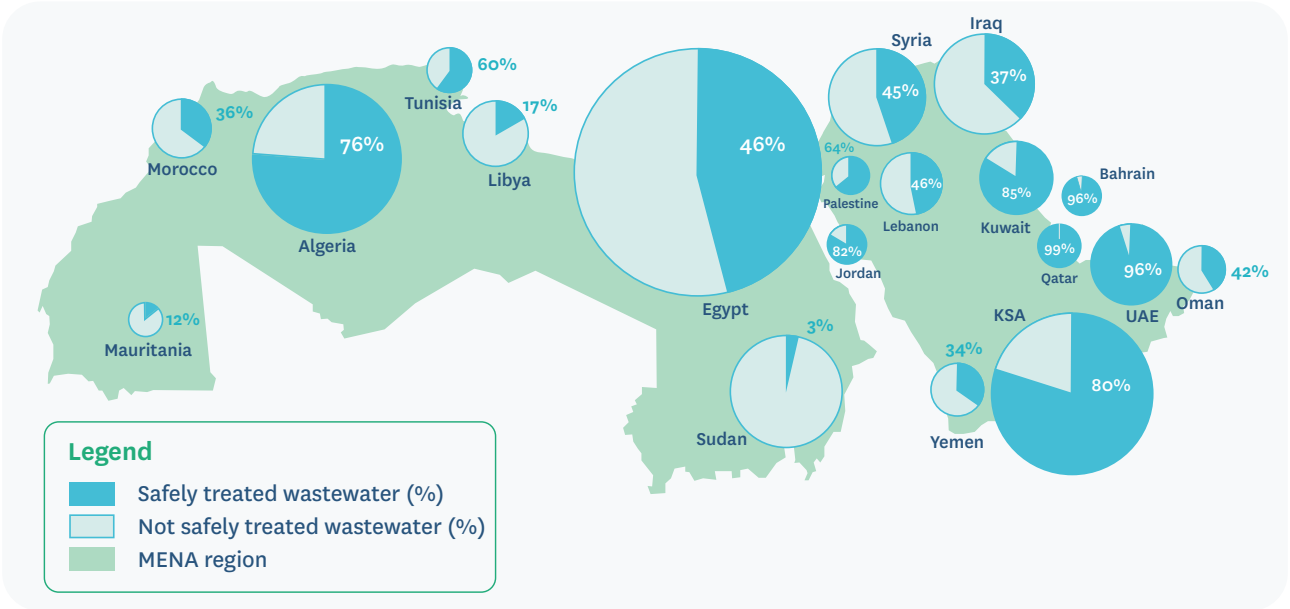


Figure 3. Proportion of domestic wastewater safely treated in 2020. Source: WHO 2021.

In many countries, the growth of wastewater produced outpaces the investment in treatment, which leads to increasing amounts of untreated wastewater and contaminating freshwater supplies. This reduces the amount of water that is safe to use and aggravates water scarcity.

Nevertheless, wastewater can be part of the solution to the water crisis. Wastewater is hardly 'waste' though, it contains valuable resources. Water is the most important and abundant asset in wastewater and can be used as a substitute for freshwater if appropriately treated. Nutrients such as nitrogen, phosphorus, potassium are valuable in agriculture and aquaculture. Organic carbon can be used as a soil conditioner or to generate energy (Figure 4).

The water and nutrients embedded in municipal wastewater generated in the 19 analyzed countries, if fully recovered, can irrigate and fertilize more than 2.6 million hectares. The carbon embedded in the generated wastewater, if recovered in the form of methane, would have a caloric value to provide electricity to millions of households (Mateo-Sagasta 2022a).

Part of the water and nutrients in wastewater are already being reused indirectly. This occurs when treated or untreated wastewater is discharged into freshwater streams where it becomes diluted and is subsequently used by downstream users (e.g., farmers, households or industries) (Figure 5). Substantial amounts of wastewater are lost when it is discharged to the sea or evaporates on land or along rivers with no productive use.

Figure 4. Types of resources recovered from wastewater. From left to right: biogas, plant nutrients and organic matter, and water. Source: Otoo and Drechsel 2018

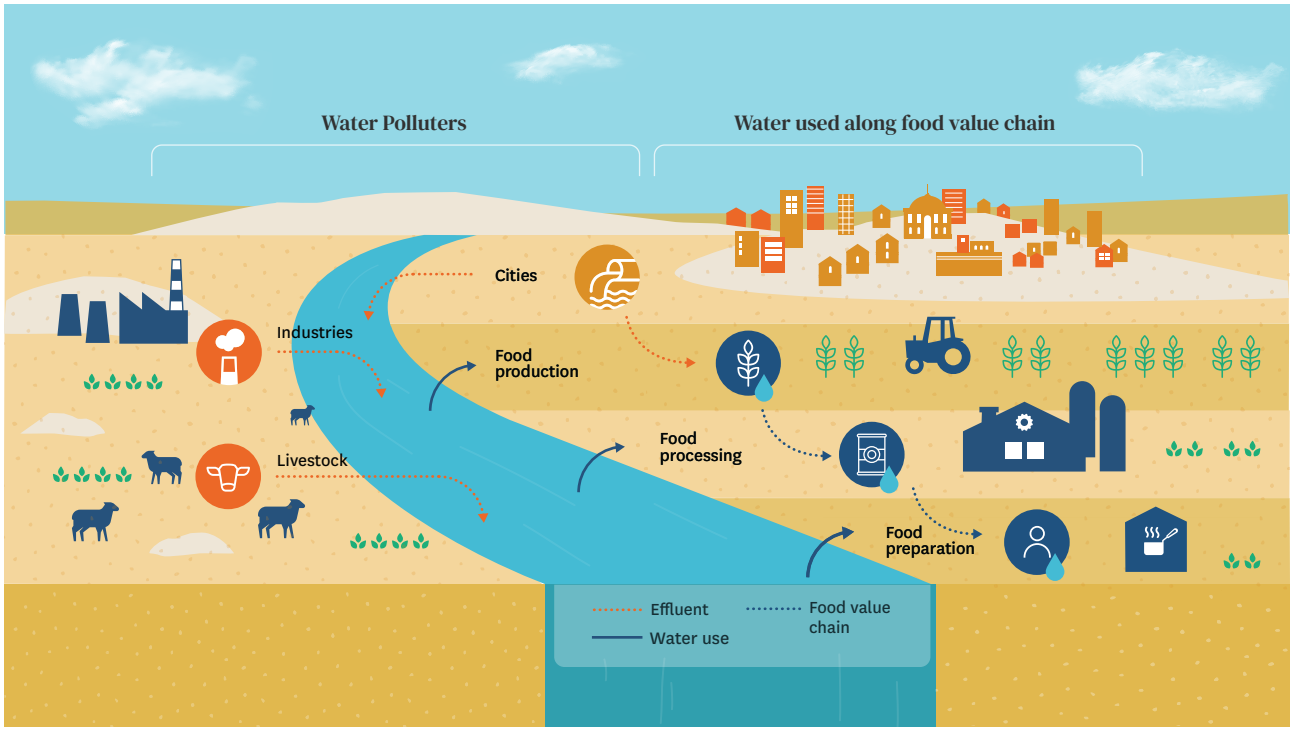


Figure 5. The fate of wastewater showing the sources of wastewater and its uses along the food value chain. Source: Mateo-Sagasta et al. 2022b

Direct and indirect use of untreated wastewater is a common reality in the region

It is estimated that about 36% of the municipal wastewater is reused indirectly after dilution in water bodies. Indirect water reuse is by far the most extensive type of reuse in the region (Velpuri et al. 2023). In areas where a large portion of the wastewater is still not safely treated the practice poses health risks to farmers and to consumers, particularly if such water is used to irrigate vegetables to be eaten raw (WHO 2021).

The use of raw wastewater in agriculture has also been reported in some countries of the region, although the exact extent of the practice is unknown. For example, untreated wastewater is used on farms because it is cheaper than using groundwater from deep boreholes, for which some farmers cannot afford. In other cases, farmers use wastewater from malfunctioning treatment plants or sewers, taking advantage of the already collected resource. In other cases, wastewater is the only water flowing in irrigation canals in the dry season and at the tail-ends of irrigation schemes. In some extreme cases, farmers rupture or plug sewage lines to access the wastewater (Lahham et al 2022).

Wastewater is only a waste if we decide to waste it: the potential is still untapped

The number of reuse projects in the region has doubled every decade since 1990, growing from 40 projects in 1990 to more than 400 in 2020 (Mateo-Sagasta et al 2022a) (Figure 6).

Despite the rapid growth of water reuse projects across the region, the amount of municipal wastewater that is treated and directly reused for beneficial purposes is still very limited in the region (Table 1). The main exceptions are in the GCC countries, namely Qatar, UAE, Kuwait, Oman and Bahrain. There is nevertheless a sizeable portion of the (treated or untreated) wastewater discharged into the environment, which evaporates or ends up in the sea with no productive use (Figure 7).

Some nutrients end up in non-productive sinks, such as weeds or algal blooms. Recent estimates from Velpuri et al. (2023) suggest that the wastewater evaporated (on land or along water courses) or lost in the sea can be as high as 54% of the total municipal wastewater produced in the region, while the rest is reused directly or indirectly.

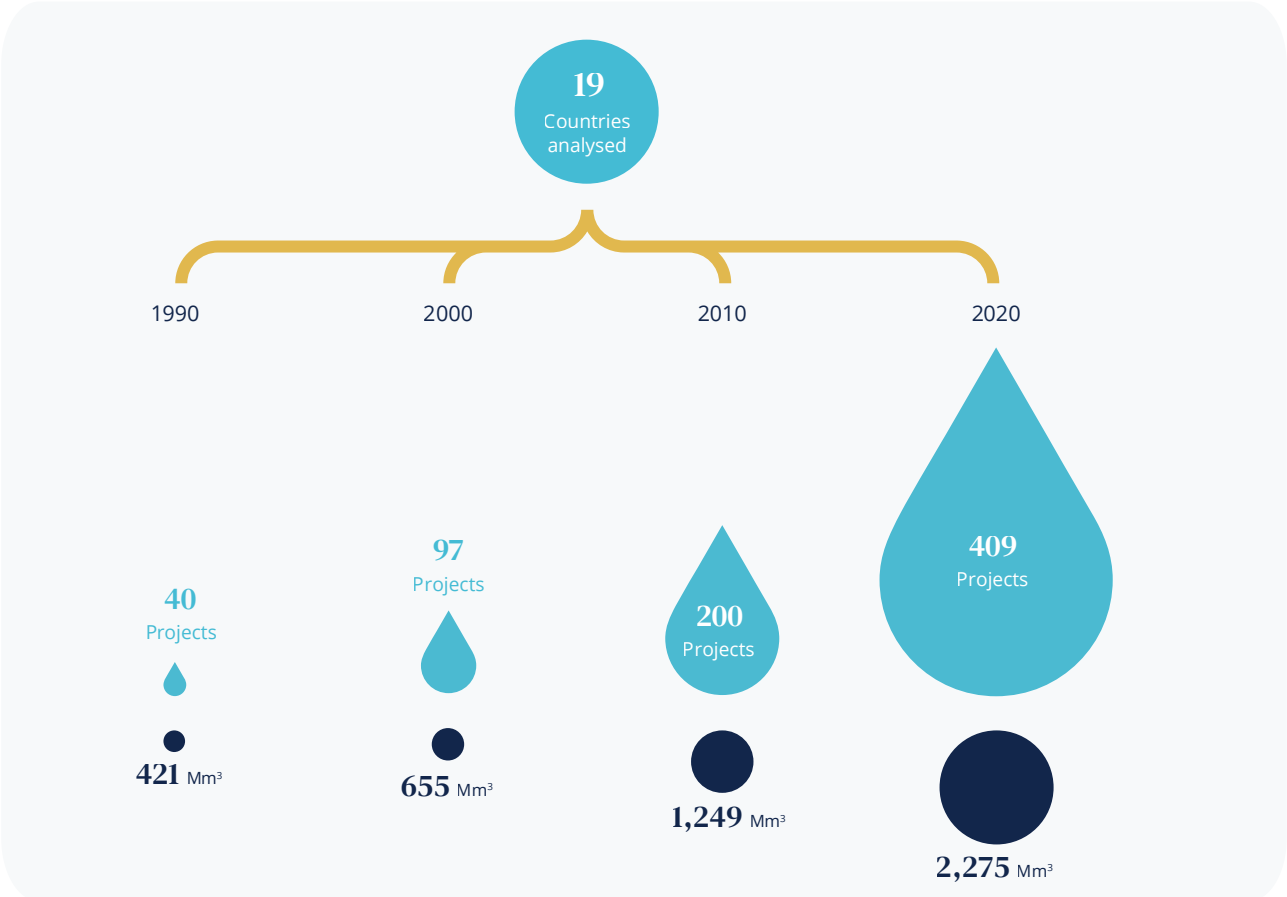


Figure 6. The number of reuse projects in the region has doubled every decade since 1990. Source: Mateo-Sagasta et al. 2022b

If all lost wastewater is recovered, the region can unlock new opportunities whilst enhancing the region's ability to adapt to changes in climate and enhance food security. If fully recovered, the 11.6 BCM of municipal wastewater estimated to be lost, could additionally irrigate and fertilize about 1.4 million hectares with a relatively high application rate of 8,000 m^3/ha/year (Steduto 2012). If no wastewater were lost and 70% of the COD was recovered in the form of methane, the energy produced could provide electricity to around 4 million households (Mateo-Sagasta et al 2022a).

For the region, treated wastewater constitutes a growing and perennial resource (Box 1). Most of national water strategies and plans in the region are relying on wastewater treatment as a key component in the national water resources plan (Box 2). However, before any water reuse plan can become a reality, several challenges need to be addressed.

TABLE 1. Wastewater production, treatment and reuse in 19 countries within the region in 2020 (or latest available year)

Countries	Total municipal wastewater generated (BCM)	Municipal wastewater treated and directly reused (BCM)	Directly reused from municipal wastewater (%)	Number of projects where municipal wastewater is treated and directly reused
Algeria	2.649	0.100	3.8	22
Bahrain	0.186	0.045	24	4
Egypt	7.196	0.341	4.7	77
Iraq	1.232	NA	NA	NA
Jordan	0.187	0.071	37.9	25
Kuwait	0.666	0.271	40.7	6
Lebanon	0.481	0.002	0.4	4
Libya	0.514	0.040	7.8	1
Mauritania	0.138	NA	NA	NA
Morocco	0.415	0.076	18.3	22
Oman	0.275	0.079	28.6	30
Palestine	0.180	0.007	3.7	24
Qatar	0.225	0.165	73.6	17
Saudi Arabia	3.144	0.431*	13.7	40
Sudan	1.533	0.029	1.9	3
Syria	1.147	NA	NA	NA
Tunisia	0.254	0.034	13.4	63
UAE	0.801	0.549	68.6	64
Yemen	0.326	0.036*	11.1	7
The region	**21.549**	**2.275**	**10.5**	**409**

NA: data not available
Source: Mateo-Sagasta et al. 2022a

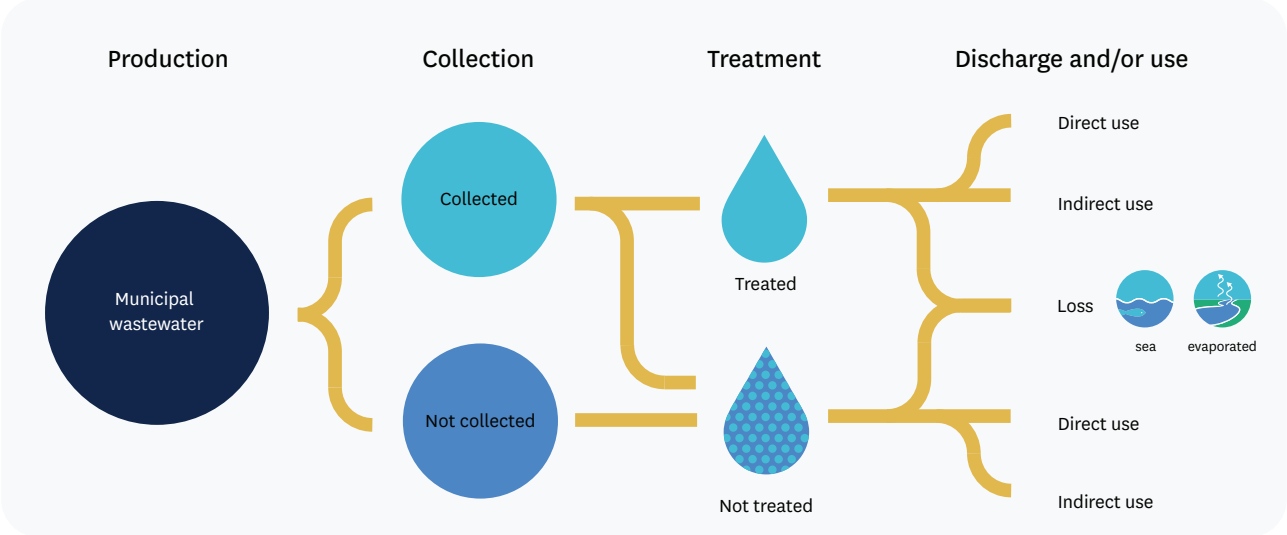
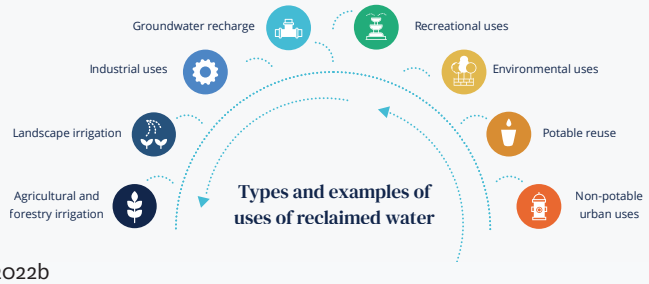


Figure 7. The fate of municipal wastewater. Source: adapted from Mateo-Sagasta et al. 2022a

BOX 1. Examples of uses of reclaimed water

The dominant uses of reclaimed water are for forestry, agriculture and landscaping, including irrigation of parks and gardens. Forestry and agriculture are the dominant users of reclaimed water for example in Egypt, Tunisia and Jordan while landscaping is the preferred option in countries like Morocco, United Arab Emirates, Oman and other GCC countries.



Source: Mateo-Sagasta et al. 2022b

BOX 2. A brief history of water reuse policies and development of guidelines in the region

	Policy orientation in agricultural water reuse	Main policies and quality regulations
1950		
1973 *WHO First water reuse health guidelines*	First legal tests prohibiting wastewater discharge in the environment and the use of polluted water.	• Jordan Municipality Law *(No. 29/1955)* • Egypt regulation *(No. 93/1962)* • Tunisia Water Code *(1975)* • Lebanon *(Decree 8735/1974 and Decree 8765/1976)*
1975		
1989 *WHO updated guidelines*	Development of national plans, projects and quality regulations for agricultural reuse in Jordan and Tunisia.	• Egypt first standards for drainage water reuse *(Law No. 48/1984)* • Jordan first standards for water reuse in agriculture *(Law No. 2/1982)* • Tunisia first standards for water reuse in agriculture and discharge of water in the environment *(1989)*
1990		
1992 *FAO Water reuse agronomic guidelines*	Water reuse starts being integrated in most countries national water strategies. Reuse projects expand. Some countries update their water reuse standards.	• Water Act in Morocco *(1995)* • Jordan Wastewater management strategy including reuse *(1998)* • Tunisia First strategy of mobilization of water resources including water reuse *(1990)*
2000		
2006 *WHO Multi-barrier approach*	Water reuse becomes a national goal in all countries. New strategies and regulations supported by International Organizations are developed to expand and improve reuse.	• Moroccan regulations on water quality for irrigation *(2002)* • Jordan update of reuse standards *(No. 893/2006)* • Egyptian Standards for Wastewater Reuse *(No. 501/2005)* revised in 2015; • First Lebanon water reuse guidelines under an FAO project *(2010)* • Ongoing Egypt Water Reuse Strategy supported by IWMI • Ongoing revision of Lebanon standards supported by IWMI *(2021)* • Ongoing revision of Tunisian standards *(2020)* • Jordan Water Substitution and Reuse Policy *(2016)*
Present		

Source: Nassif et al. 2022

Challenges for more and safer water reuse in the region

Challenges for more water reuse

Water reuse has low social acceptance

Water reuse can trigger rejection, especially when resulting in a possible direct exposure, like where reclaimed water is replenishing surface or groundwater for potable reuse or used within the household (Mateo-Sagasta and Drechsel 2022).

Both farmers and the public tend to perceive the potential presence of pollutants in recycled water as environmental, health or agronomic risks. Even in cases where the risks are negligible or non-existent, the public perception of risk increases depending on the appearance, color and odor of reclaimed water, but can even more be steered by gossip, fear and misinformation.

Farmers will be reluctant to change from freshwater to recycled water if they perceived they are going to lose with the change in terms of productivity (e.g., because of salinity), access to markets (e.g., because of the stigma associated to reuse) or any other way (Mateo-Sagasta and Drechsel 2022).

Incomplete economic analysis and limited financial sustainability of wastewater treatment and reuse options

Water reuse projects are developing at a relatively slow pace in part due to an incomplete economic analysis of wastewater treatment and reuse options, which can provide a sound justification to invest (Gebrezgabher and Darwish 2022). There is a lack of economic incentives (or the removal of economic barriers) to invest once the investment has been economically justified. There is also a tendency to keep investing in conventional wastewater treatment technologies that are not cost-effective and have large operation and maintenance costs, which are hard to recover and limits financial sustainability.

Additionally, the development and implementation of water reuse strategies across the region is challenged by factors such as a lack of water reuse cost recovery mechanisms, low pricing of irrigation water, need for creating financial incentives for safe water reuse and lack of understanding among the public about the perceived environmental benefits of wastewater treatment and reuse (Otoo and Drechsel 2018; World Bank 2011).

Challenges of safer water reuse

Unclear regulations and ineffective implementation

Water regulations are sometimes overly stringent. This is an internal barrier to productivity as sometimes recycled water is forbidden for many cash crops. At the same time meeting the standards requires investments in wastewater treatment that are prohibitive in some countries. There is also an issue of effectiveness and enforcement: stringent standards do not necessarily prevent informal direct and indirect use of wastewater. The enforcement of water quality standards is often ineffective with farmers who have poor incentives or support to find alternative practices. Regulations are only applied to planned reuse projects while informal reuse remains poorly monitored and risks left unmitigated. Some countries, such as Lebanon, do not have yet any regulations on water reuse and as a result there is no legal security for investments (Nassif et al. 2022).

Cross cutting challenges

Fragmented and partial planning and governance

Many sectors have a stake in water reuse including agriculture, water, health and environment sectors at national and local levels. Regulating, planning and managing agricultural water reuse require harmonizing a multiplicity of decision-making processes and activities performed by different stakeholders. Nevertheless, this harmonization and integration is not frequent because the stakeholders to be involved have different and often conflicting mandates, functions, goals and interests (Figure 8) and there is no process devoted to facilitate dialogue and agreement between them (Nassif and Tawfik 2022).

Water reuse projects can only work if socially accepted, technically reliable and financially profitable to farmers. This requires strong links between central institutions (and their donor partners) and local stakeholders to analyze local practices, develop appropriate infrastructure and negotiate adaptive management arrangements.

Gender biases

The wastewater and sanitation services are missing out to include a large segment of society. Women face considerable barriers in the recruitment process for employment in water and sanitation utilities. The World Bank (2019) Utility Survey over a 12-month period showed that only 20% of new hires were females. Some of the reasons for fewer women being recruited include biases in the recruitment process since certain roles are socially perceived as for male or female. The retention of women in water and sanitation utilities is affected by a lack of gender-sensitive policies and a discriminatory work environment (Mapedza et al. 2022).

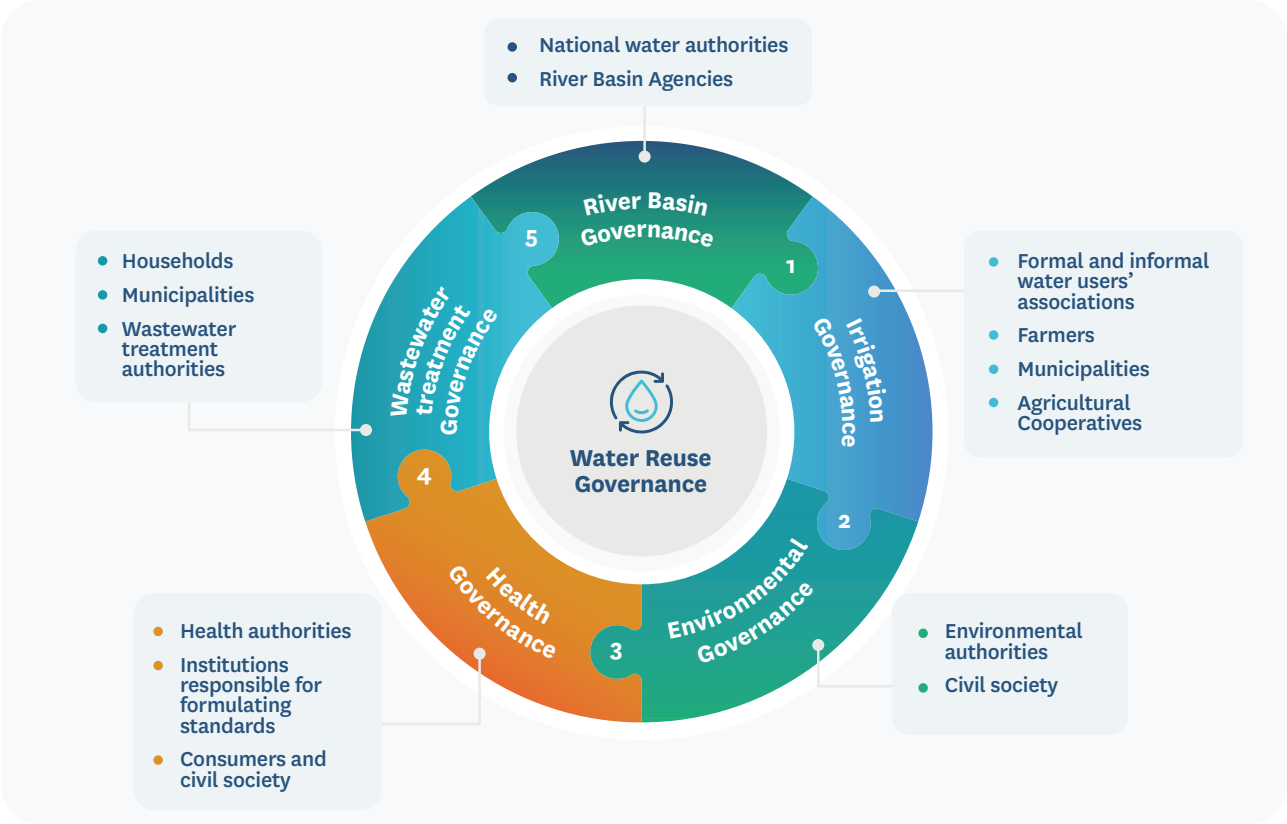


Figure 8. The large array of stakeholders involved in the governance of agricultural water reuse systems. Source: Nassif and Tawfik 2022

Recommendations for more and safer water reuse

Currently, the region has a serious imbalance between available water resources and agricultural needs to grow food for its population, while its groundwater is experiencing major depletion and deterioration. The reuse of treated water can significantly improve the situation. Additionally, it can provide nutrients, especially nitrogen and phosphorus, to the mostly nutrient-deficient soils in the region, and thus may reduce the total requirement of commercial fertilizers, which will increase the total economic return to farmers.

Recommendations for greater water reuse

Gain wider social acceptance

Good practices and adequate technical capacity are not enough to guarantee the success of water reuse interventions. Understanding the issues and concerns around perceptions and acceptance and addressing these with timely, effective communications and stakeholder engagement can significantly help to build trust and improve and support reclaimed water use initiatives (Mateo-Sagasta and Drechsel 2022).

Public involvement begins with early contact with potential users, and can involve the forming of an advisory committee, and public workshops on reasons, benefits and risks of reuse. The exchange of information between authorities and the public representatives should ensure that concerns on perceived health or environmental impacts and lower property values have been shared and addressed.

For a water reuse initiative to succeed, community attitudes need to be understood and addressed. It is necessary to consider instinctive and emotional responses that people have toward 'human excreta' and 'sewage'. Many people trust hearsay or their own impressions of water quality more than they trust medical and scientific evidence or advice. Once water has been in contact with contaminants, it can be psychologically very difficult for people to accept that it has been purified. There is also an association between religious beliefs and respondents' willingness to use treated wastewater (Mateo-Sagasta and Drechsel 2022).

Farmers and traders want to know if the use of reclaimed water is financially viable, from their perspective. In the case of use of recycled water for irrigation, for example, crop acceptance by the consumer (buyer) remains the most crucial criterion.

To improve acceptance of water reuse, project designers can:

- Encourage public participation and discourse
- Engage proactively in early and continuous communication to build trust
- Select messaging with the right terminology
- Communicate the benefits of water reuse and how risks are mitigated
- Address possible religious concerns
- Facilitate behavior change

Develop bankable water reuse models

Wastewater reuse projects, if adequately planned and properly implemented, can provide opportunities for sound investments and financial rewards (Figure 9) (Gebrezgabher and Darwish 2022). Studies on developing bankable wastewater reuse models, and studies focusing on the potential of implementing wastewater reuse models, must first identify and set priorities in terms of the target area. This priority setting is essential to identify potential wastewater reuse models that have high relevance and the likelihood of success in the local context. To develop a bankable wastewater reuse model, project designers should follow a stepwise approach consisting of five main phases:

- Identify potential wastewater reuse options.
- Develop a business model for wastewater reuse option.
- Identify innovative partnership and financing options.
- Identify risks and opportunities.
- Develop implementation plan.

Recommendations for safer water reuse

Assess health risks in informal and indirect water reuse

Water scarcity and pollution are driving thousands of farmers in the region to use raw or diluted (untreated) wastewater to irrigate, posing potential health, agronomic and environmental risks. These risks need to be assessed and mitigated. Health risks can be assessed for example with epidemiological studies or quantitative microbial risk assessments.

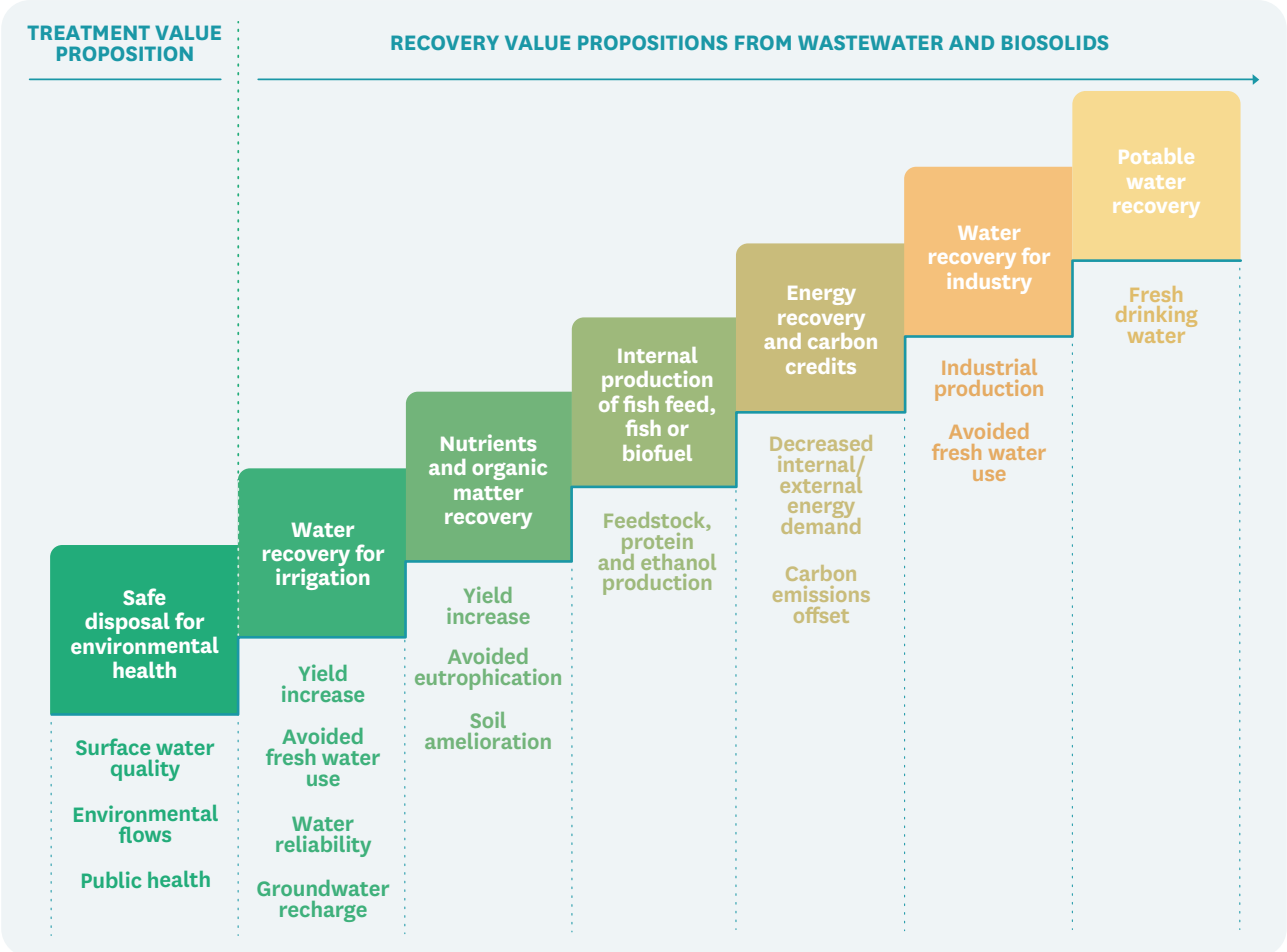


Figure 9. Ladder of increasing value propositions related to water reuse based on increasing investments in water quality and/or the value chain. Source: Drechsel et al. 2015

Accelerate wastewater treatment to cope with wastewater production growth

Wastewater treatment must keep pace with the increasing wastewater production. This requires a clear plan for sanitation and wastewater treatment that anticipates future needs in sewerage and treatment capacity. It is important to select cost-effective and affordable solutions, beyond activated sludge, that have clear plans for financial sustainability that anticipate potential future increases in energy or labor costs.

Incentivize the adoption of on-farm practices for safe water reuse

Project designers and relevant authorities need to ensure safety along the whole sanitation-food value chain. This calls for incentivizing the adoption of on-farm practices for safe water reuse. This means that food must be made safer not only by using better wastewater treatment methods but also with better agricultural practices which will provide an additional safety net if treatment proves insufficient as promoted by the WHO guidelines (WHO 2006). Crops need also to be kept safe with a combination of solutions from farm to fork (Figure 10) and avoid recontamination with polluted water in informal markets, food processing industries or households (Drechsel et al 2010).

Cross cutting recommendations

Improve planning and governance

Governance problems are often rooted in deeper socio-political structures that cannot simply be changed by implementing participatory processes and social engineering tools. Some key recommendations within this context include (Nassif and Tawfik 2022):

- Ensure buy-in by the key national players around clear goals
- Conduct a stakeholder mapping exercise
- Establish multi-stakeholder platforms and welcome epistemic communities to support
- Understand gaps and overlaps in roles and responsibilities
- Analyze stakeholders' influence and interest
- Clarify roles and responsibilities along questions such as who proposes or authorizes a project, who invests, who is responsible for operation and maintenance, who monitors, etc.
- Establish central coordination and regulatory institutions
- Allow for flexibility in institutional arrangements
- Empower stakeholders with existing know how and political leverage
- Understand and re-negotiate local water rights and

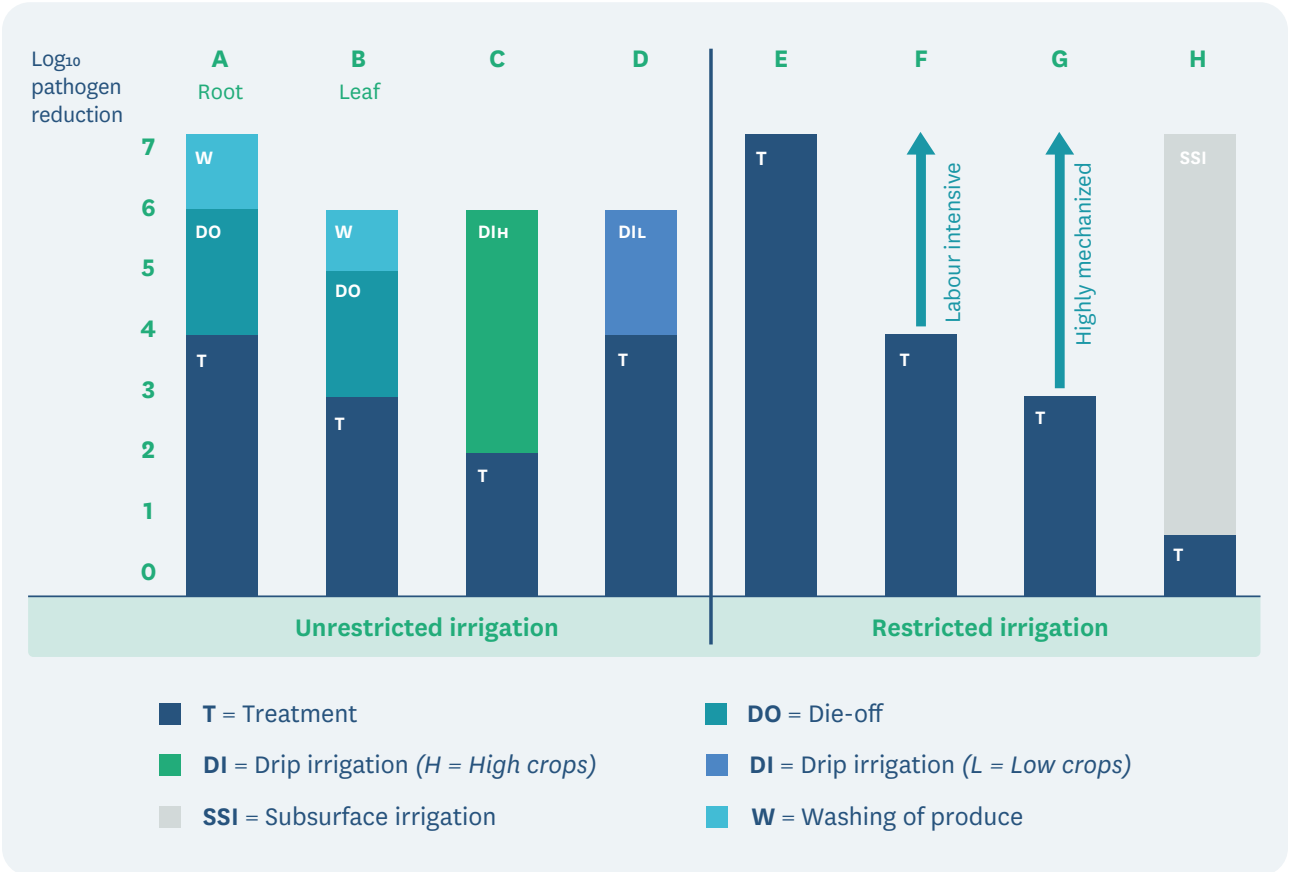


Figure 10. Examples of options for the reductions of pathogens by different combination of health measures that achieve the health-based target of <or = 10-6 DALYS per person and per year. Source: WHO 2006

entitlements when water reuse and exchange projects are promoted (e.g., when freshwater is intended to be reallocated from farms to cities and, in compensation, farms get nutrient rich recycled water from cities)
- Ensure access to information and data sharing between stakeholders and create a climate of trust and collaboration
- Develop the capacity of public utilities and local institutions
- Promote clear institutional framework to enable the involvement of the private sector in water reuse implementation.

Expand implementation of water quality standards

While water reuse offers multiple benefits, it also comes with concerns on its potential impact on health, crops and ecosystems. To manage these hazards, governments typically issue water quality 'standards' usually promulgated through regulations centered around several water quality parameters and thresholds, monitoring protocols and best practice. Some key recommendations in this space include (Nassif et al 2022):

- Every country should adapt international water reuse guidelines based on local conditions and derive corresponding national standards.
- Standards should be enforceable and enforced. Standard values should be achievable and allow for enforcement, based on existing and affordable control measures.
- Environmental agencies should license, and banks should fund measures, that allow for stepwise improvement in water quality.
- Technologies should reflect countries' financial conditions. The use of appropriate technology should always be pursued.
- Efficient implementation of standards requires adequate infrastructure and institutional capacity to license, guide, monitor and control polluting activities and enforce standards.
- Decision makers and the population at large should be well informed about the benefits and costs associated with keeping good water quality, as specified by the standards.

Incorporate gender transformative approaches

Water reuse projects should incorporate gender transformative approaches, which aim to address the root causes of gender inequality (Mapedza et al. 2022). A heightened level of awareness of gender issues will help project managers and implementers understand the complexities surrounding water reuse for agriculture. On the basis of such awareness targeted activities can be designed to meet the needs of the society as a whole – including men and women - and facilitate acceptability of this important water resource. Women who are well informed can be a force to address current social acceptance barriers towards water reuse. Some key recommendations within this context include (Mapedza et al. 2022):

- Disaggregation of all data in water reuse projects by sex, and whenever possible by age, economic status, ethnicity and other core social differentiating factors to account for differences in challenges and opportunities among different social groups.
- Women must not only be consulted, but they need to be represented at different levels of the service-providers tiers and contribute to decision-making.
- Women should be provided with adequate and timely access to essential information, including procedures and protocols for reuse in order to give them the opportunity to be involved in identifying and deciding on appropriate reuse options and be in full compliance with the rules thereby protecting themselves, their household and the environment from harm.
- The interactions among the different dimensions (culture and religion) and sources of inequality (sex, race and ethnicity) that can exasperate existing inequalities and put certain groups of the society at a more disadvantaged position, must be addressed.

Conclusion

The region needs to recover and reuse lost wastewater when feasible and make indirect reuse safer. To achieve this, the region needs to address the challenges that lock the potential of water reuse, which more importantly include fostering political will and bringing water reuse higher in the political agenda. Moreover, there is a need to address the institutional fragmentation, create platforms for negotiation and joint work between institutions and ensuring that the responsibilities and jurisdictions among national and local authorities and stakeholders are clear.

Ultimately, the factors that will contribute positively to the inclusive scaling and replication of safe water reuse projects are: participatory stakeholder processes and effective communication that increases acceptability; economic and finance models that improve cost recovery and sustainability; effective and harmonic policies that address institutional fragmentation; adequate regulations that are ambitious but affordable and enforceable; safety measures from farm to fork; and gender mainstreaming in water reuse projects and policies that ensures equitable participation and benefit sharing.

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