SUSTAINABLE DEVELOPMENT OF NON-CONVENTIONAL WATER RESOURCES IN THE ARAB REGION
OVERALL POLICY BRIEF

المجلس العربي للمياه
Arab Water Council

United Nations Educational, Scientific and Cultural Organization
منظمة الأمم المتحدة للتربية والعلم والثقافة
Cairo Office
مكتب القاهرة

Key Messages

- The future of "Arab Water Security" will largely depend on the development of the non-conventional water resources (NCWR), which offer great potentials but also include many challenges. NCWR utilization is more multifaceted than conventional water resources with respect to the knowledge, expertise, consideration for the environment and the special governance structure.
- Desalinated water capacity in the Arab region will need to expand several folds by 2025 more than its current level. Recently, the cost of desalination has dropped due to major progress in its technologies and energy consumption. Still energy efficiency should be a key criterion in commissioning new plants and upgrading old ones. Building up local capacity in desalination technology development is also important.
- Within the Arab Region, reuse of treated wastewater and agricultural drainage water holds a great potential to reduce the gap between water supply and demand in agriculture. The development of untapped wastewater requires large investments in both domestic and industrial wastewater collection and treatment. Risks associated with drainage water reuse are mainly due to its salt, agricultural chemicals, and pollution from the disposal of untreated domestic and industrial wastewater.
- Brackish groundwater (BGW) can be utilized for municipal, industrial, aquaculture and for restricted irrigation of high salinity tolerant crops. However, the sustainable development of BGW resources requires better understanding of the location, potentiality and characterization of its reserve.
- In one of the driest regions of the world, sustainable water harvesting should be a priority. Improving water harvesting techniques requires additional support to research centres, efficient management, capacity building and adequate governance structure.
- One key recommendation is the establishment of NCWR-Arab regional initiative. It will help mobilize the political, financial, legal and technical support required to adopt and build up appropriate structures and human capacities necessary for NCWR sustainable development in the region.
- Actions for the way forward focus on building proper institutional and legal setup for NCWR development. Actions also include the identification of NCWR related portfolio of projects for subsequent financing through local, regional, and international funding institutions.

Context

A consultation workshop held in Cairo in December 2015, mandated the Arab Water Council (AWC) and the UNESCO's Bureau in Cairo to launch an initiative for the sustainable development and utilization of the non-conventional water resources in the Arab Region. The starting point was drafting policy briefs outlining the analytical framework of NCWR utilization and help in achieving a common Arab vision on issues of significant priority. The initiative will build on the Arab Water Security Strategy 2010-2030 and will complement the strategy action plan launched in 2014. The "Arab Non-Conventional Water Initiative" is intended to assist the Arab Countries in developing their strategies and action plans for the sustainable use of Non-Conventional water resources. The initiative will be aligned with efforts towards the Regional Collaborative Strategy on Sustainable Agricultural Water Management and Food Security in the Near East and North Africa Region led by FAO-RNE (Regional Office for Near East and North Africa of the Food and Agriculture Organization of the United Nations).
This document builds on the findings of the five policy briefs listed in the box with consolidated recommendations for policy statements on the sustainable development of the NCWR in the Arab Region. The document also provides recommendations on the way forward for the consideration by the Arab League- Ministerial Council on Water.

Water Resources Challenges in the Arab Region

The annual renewable water resources are limited, and estimated to be about 335 billion m^3 (CEDARE and AWC, 2014). While the annual per capita share in 2013 of the world water resources was about 6,400 m^3, the average level in the region was only 688 m^3 which is just one-third of those 50 years ago (ACSAD, 2013). The gap between supplies and demands in 2014 exceeded 50 BCM and is expected to be more than 100 BCM in 2025 and about 220 BCM in 2050 (Abderrahman, 2014).

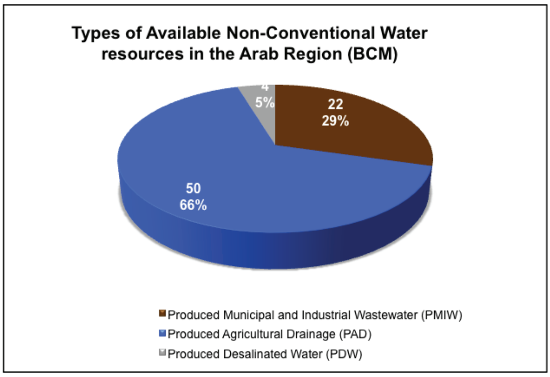
Records of the year 2010 showed that growers in rain-fed and irrigated agriculture have managed to produce only 50% of the food requirements of the Arab region and the rest of food commodities have been imported in the form of virtual water (CEDARE and AWC, 2014). Mobilization of financial resources to achieve water and food securities represents a serious concern for governments in the region. Presently, the volume of virtual water equivalent to the imported food in Arab countries is about 290 BCM and is expected to exceed 330 BCM in 2025 reaching about 550 BCM in 2050 (CEDARE and AWC, 2014).

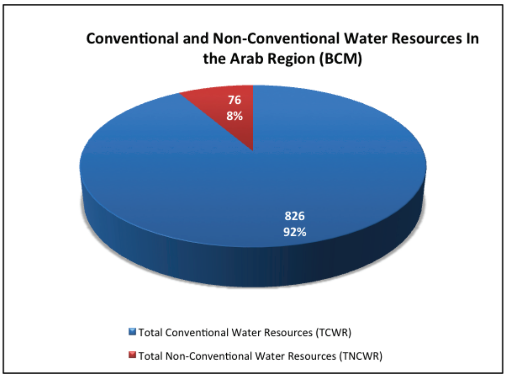
List of Related Policy Briefs

The following five themes for the non-conventional water resources development have been included in separate briefs:

1) Desalination Prospective in the Arab Region;
2) Reuse of Treated Wastewater: An Opportunity not to be Wasted;
3) Agricultural Drainage Water Reuse: An Opportunity for Increasing Water Use Efficiency;
4) Sustainable Brackish Groundwater Use in the Arab Region; and
5) Water Harvesting in the Arab Region.

AWC/UNESCO, 2016



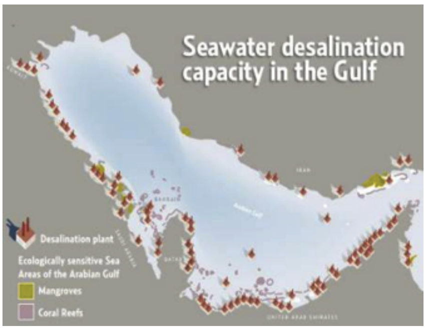


Source: CEDARE-AWC 2014

Challenges and Opportunities for NCWR Development in the Arab Region

The exploitation of the untapped non-conventional water resources (NCWR) in the Arab region will require significant infrastructure investments to modernize the water systems. Additionally, this will also call for a shift of paradigm in the policies and strategies towards demand management, cost recovery, and enhanced capacity to provide efficient services and address environmental issues related to the utilization of the non-conventional water resources. Proper legal and institutional setup will also need to be developed in addition to improved public awareness and the participation of major stakeholders in the planning and development of such precious resources. Furthermore, there are no economic or financial incentives in place to encourage the private sector participation in NCWR development.

The use of different types of NCWR depends on the local prevailing hydrological, hydrogeological, environmental and socio-economic conditions of each Arab country. In the Sultanate of Oman, conventional water resources (including surface and groundwater) represent about 87% of the nation's water resources, and nonconventional water resources, including desalination water and treated wastewater, account for the remaining13% (FAO-RNE, 2015). The NCWR-uses are more multifaceted than conventional water resources with respect to the knowledge, expertise and its special governance structure. Most Arab countries have adopted certain levels of integrated water resources management (IWRM) and governance frameworks. However, water governance in the region still suffers inefficiencies, which cripples mobilizing necessary financial resources for the sustainable development of NCWR.



Desalination: With the exception of the GCC-countries and Algeria, the desalination facilities in many Arab countries are either absent or in their early stages of development. They depend on imported technology in the absence of indigenous research and development capacity. Desalination plants in Arab countries have a cumulative capacity of about 24 million cubic metres a day. Desalinated water is expected to expand from 1.8% of the region's total water supply to an estimated 8.5% by 2025.

Desalination processes require high costs for capital investment, operation and maintenance and are also high energy-consuming. Saudi Arabia uses 25% of its oil and gas production to generate electricity and produce desalinated water. If water demand continues to grow at the current rate, this share will increase by 50 % by 2030.

T**reated wastewater:** The infrastructures for collection and treatment of domestic and industrial wastewater are far from being sufficient to cover demand particularly within the rural areas. Only 26% (6.3 BCM/y) of the 24 BCM/y of the produced wastewater in the Arab Region is treated, and only 25% (1.6 BCM/y) of the treated wastewater is reused (CEDARE and AWC , 2014). The utilization of these untapped resources requires large investments in the area of both domestic and industrial wastewater collection and treatment. A region-wide exchange of experience could help establish best practices and guidelines for economic reuse of treated wastewater. Regional or bilateral cooperation programs could also help with benchmarking, advanced cost-effective technologies, capacity building, applying standards and regulatory frameworks, etc.

Agricultural drainage water reuse holds great potential and offers an opportunity to reduce the gap between water supply and demand in agriculture, and enhance the economic viability of the farming community. Only 60% (208 BCM) of the water withdrawn for agriculture is actually consumed and the rest is returned to the hydrologic cycle in the form of run-off or groundwater recharge. In Egypt, the reuse of agricultural drainage water became a national policy since the 1980s. Currently, about 6 BCM of drainage water with an average salinity of 1.8 dS/m are being reused for agricultural purposes. This amount presents more than 10% of the country's total annual freshwater resources. The reuse program follows established criteria and an effective quantity and quality monitoring program. Usually, investment in drainage water reuse represents a low-cost water management opportunity with high economic return. On the other hand, large-scale drainage water reuse projects involve major socio-economic and environmental challenges and need to be properly planned and managed.

B**rackish groundwater (BGW)** with a salinity level of 3,000 to 10,000 ppm exists in shallow and deep aquifers along the coastal areas, and in some deep-aquifer inlands of many Arab Countries. The use of BGW could supplement the scarce freshwater sources and enhance Arab region water security. BGW can be utilized for municipal, industrial, aquaculture, and for restricted irrigation of high salinity tolerant crops. Some inlands desalination plants in GCC countries use BGW as a substitute for seawater desalination. This practice resulted in significant cost-saving for energy and transfer of desalinated water from coasts over long distance (Abderrahman, 2014). However, the use of brackish groundwater is usually associated with marginal lands and therefore, a relevant policy framework, strategic business plans and knowledge base should be developed. They will help expand the development of the resources and provide scientific, economic and environmental bases for making policy decisions and future investments.

Water harvesting: The importance of Water harvesting was highlighted in many regional and international declarations and strategies, including the Arab Water Strategy of 2012. There are also strong commitments among the Arab countries to adopt demand management strategies and develop water harvesting technologies. The aim is mainly to complement rather than replace the existing water-use system. The most commonly used conservation methods in the Arab countries include cisterns, micro-catchments which is adjacent to cultivated areas, small dams and underground storage. Adoption and upscaling of water harvesting interventions in the Arab region face many challenges including lack of information on sites with potential for technically and economically feasible water harvesting investments. High cost of infrastructure installation and maintenance represent a constraint in the expansion of water harvesting projects.

Policy Recommendations for Sustainable NCWR Development in the Arab Region

The following policy statements are recommended for consideration by the Arab League- Ministerial Council on Water. They aim to address various constraints for the sustainable NCWR development and management in the Arab region:

Enhanced Policy Framework

1. Develop sound policies, strategies, master and action plans for the use of NCWR. They should consider the differences in hydrologic, environmental, social and economic conditions of each country.
2. Develop a set of quality control measures including: certification of all types of water and wastewater treatment facilities and water operators; and develop sound and realistic key performance indicators (KPIs).

Legal and Institutional Enabling Environment

1. Create enabling legal environment to encourage the involvement of the private sector in developing NCWR.
2. Develop comprehensive environmental legislations to provide incentives to reduce the carbon footprint as well as environmental, ecological and health impacts.
3. Engagement of water regulators to regulate the use of NCWR independent from the operators.

Technical Capacity Building

1. Build capacity for scientific research and innovations in the different fields of NCWR to develop and promote technologies that suit the local socio-economic and environmental conditions of the region.
2. Develop capacity to locally produce desalinated water and wastewater treatment technologies.

Environmental and Social Considerations

1. Evaluate climate change impacts on all types of NCWR regularly and develop adaptation measures.
2. Involve all stakeholders and particularly water user's organizations as a vital requirement for the success of NCWR use programs.
3. Raise national awareness about the importance of the use of NCWR to help in gaining the public support for NCWR development.

Economic and Financial Measures

1. Prepare technically sound and economically and financially viable NCRW operations. Well prepared bankable projects would attract financing agencies and Ministries for Finance to support such operations.
2. Develop and/or modify feasible and fair tariff which reflects the economic costs of water. Balanced cost recovery tariff will enable the governments to provide sustainable water services.
3. Create a special incentive programs and enabling environment to attract the participation of private sector.
4. Develop national plans for the use of renewable energy such as solar energy in place of conventional energy for the production of NCWR.

The Way Forward

The proposed actions could take place at the following two levels:

1) Providing the enabling environment for NCWR development and operation through:

a) A shared Arab Region Vision for NCWR development and operation. This will include targets for the use of NCWR including improved institutional and governance systems; sustainability and social acceptance; and improved reused treated wastewater quantity and quality.
b) An NCWR- Arab regional initiative, which would help provide the financial, legal and technical support required to adopt and build up appropriate structures, human capacities and knowledge necessary for the sustainable development of NCWR. The initiative will target mainly low to medium income countries in the Arab Region.
c) NCWR national visions, strategies for poverty reduction and sustainable development.
d) A public policy to encourage water reuse by restricting untreated wastewater discharges and by setting incentives for water reuse through grants and tax breaks.

2) Identifying and building up NCWR related portfolio of projects which could be further supported to the feasibly level soliciting financing through local, regional, and international funding institutions. Proposed list of projects could cover the following:

a) Increased sanitation services coverage, wastewater treatment capacity and improved treatment quality to achieve full sanitation coverage by 2030 as indicated by Goal 6 of the United Nations Sustainable Development Goals.
b) Improved water demand management, water use efficiencies and conservation programs to reduce the water use losses in domestic, irrigation and industrial purposes.
c) Pilot projects in various countries utilizing advanced technologies and effective management approaches for the utilization of NCWR in the Arab Region.

For Further Reading

- Abderrahman, W. A. (2014). Towards Water Security in the Arab Region and GCC countries, Proceedings of IWA 11th Leading Edge Conference on Water and Wastewater Technologies, Abu Dhabi, 26-29 May, 2014.
- CEDARE and Arab Water Council (2014). "2nd Arab State of the Water Report - 2012", Water Resources Management Program - CEDARE & Arab Water Council, ISBN: 978 977 90 3806 3, ISSN: 2357 0318.
- FAO-RNE (FAO-Near East and North Africa Region), (2015). Towards a Regional Collaborative Strategy on Sustainable Agricultural Water Management and Food Security in the Near East and North Africa Region, Main Report, Second Edition, 2015.
- LAS (2014). The Arab Strategy for Water Security in the Arab Region- Meeting the Future Challenges and Needs of Sustainable Development (2010 – 2030), The Action Plan (2014).
- WRC (Water Research Centre), University of Khartoum (2015). Internal Documents.

DESALINATION PROSPECTIVE IN THE ARAB REGION

POLICY BRIEF

المجلس العربي للمياه
Arab Water Council

United Nations Educational, Scientific and Cultural Organization
منظمة الأمم المتحدة للتربية والعلم والثقافة

Cairo Office
مكتب القاهرة

Key Messages

- Desalination stands as the most promising sector to supply high quality water resource. The GCC-countries currently have the highest concentration of desalination capacity worldwide. Many other Arab countries also have plans to develop and expand their desalination capacities for meeting the escalating municipal water demands.

- Expansion of desalination has been associated with enormous financial, economic and environmental costs. In particular, the currently adopted technology is energy-intensive and consumes a sizable portion of the energy resources production in the region.

- Implementing energy efficiency programs and diversifying energy resources in desalination would enhance the sustainability of desalination and would help mitigate its associated environmental negative impacts.

- Despite the increasing reliance in the region on desalination, its technology remains imported with limited added value to the countries' local economy. It is important to build local and regional knowledge hubs in desalination technologies.

- There is a dire need to develop national plans for using renewable energy in desalination and provide incentive for the development and adoption of energy saving technologies.

- Governments should provide incentives to attract private sector and provide legal and regularity framework to strengthen government's regulatory role and improve sector governance.

Context

The role of desalination as a major source of domestic water supply will continue to increase in the Arab region due to population growth, urbanization, industrialization, and depletion of non-renewable groundwater resources. This policy brief outlines challenges, potentials and impacts in relation to desalination in the Arab region. The brief provides recommendations to meet the increasing demand for desalinated water; and to build necessary capacity and institutional structure. Economic and environmental issues are also addressed in relation to energy demands; and rejected water and brine impacts on marine life.

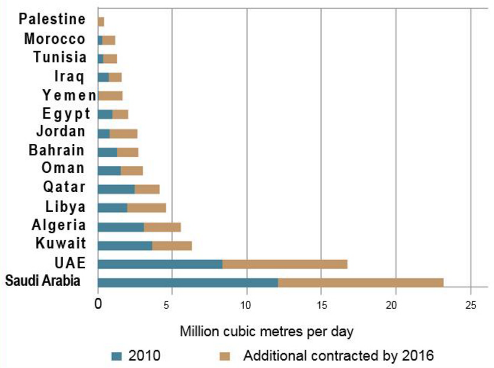
This effort is part of the mandate of the Arab Water Council and UNESCO to establish an Arab Regional Initiative in support of the non-conventional water resources (NCWR) development. The initiative will help mobilize the financial, legal and technical support required to adopt proper policies and build up appropriate structures and human capacities for the sustainable development of NCWR in the region, including desalination.

Trends in Desalination

Desalination of seawater has become a reliable method for water supply all over the world and has been practiced successfully for many decades and the technical and economic feasibility is well established. The worldwide desalination capacity has increased dramatically from around 35 million cubic meters daily in 2005 to about 80 million cubic meters daily in 2015, with the largest desalination plant of one million cubic meters per day at Ras AL-Khair project in Saudi Arabia.

With more than half the world's desalination capacity, the Arab region, particularly the GCC countries, lead the world in desalination. Although desalinated water contributes only a very small share of Arab countries' total water supply (1.8 %), it contributes nearly all the water supply for 70 % of cities in the Gulf countries. This share is expected to rise as groundwater resources continue to deteriorate.

Box 1. Accumulated Desalination Water in Selected Arab Countries in 2010 and 2016



Desalination plants in Arab countries have a cumulative capacity of about 36 million cubic meters a day in 2011. The highest desalination capacity is in the Gulf countries (81 %), Algeria (8.3 %), and Libya (4 %). Some countries, such as Jordan and Tunisia, desalinate brackish water at a low cost and promote it for domestic use. Arab countries total desalination capacity is expected to go up to 86 million cubic meter a day by 2025 with estimated investment of $38 billion, about 70% of it in the Gulf countries (UNDP 2013)

Potential and Challenges

Growth of desalination is expected to remain high for the next decade to meet escalating domestic water demand. Most of the anticipated increase in capacity will be concentrated in the region's high-income, energy-exporting countries, such as the Gulf countries, where it will be used to supply water to cities and industry.

Desalination is capital intensive and energy-intensive process, so energy efficiency should be a key criterion in commissioning new plants and upgrading old ones. Saudi Arabia, with 35 % of the Arab region's desalination capacity, uses 25 % of its oil and gas production to generate electricity and produce water. If water demand continues to grow at the current rate, this share will top 50 % by 2030.

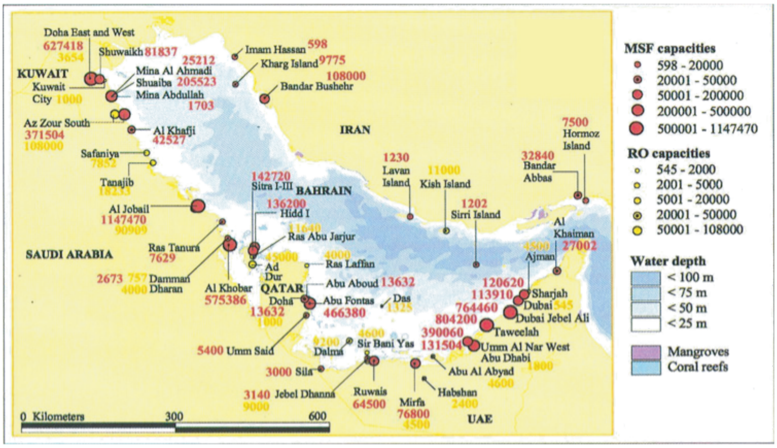
Costs per delivered cubic meter of desalinated water are as high as $1.50. Desalinated water is subsidized, however, and sold for as little as 4 cents per cubic meter in some Arab countries. With improvements in desalination technologies, production costs are dropping (see box 1). New technologies, such as reverse osmosis, electro dialysis and hybrids, are more energy efficient and better suited to different types of water. This downward trend in the cost of desalinated water indicates that desalination technology is becoming more viable for poorer countries.

Box 1. Desalination cost is dropping

Improved technologies, such as reverse osmosis, electrodialysis and hybrids, are more energy efficient and better suited to different types of water. These advances drove down global prices for multistage flash over 1999–2004, from an average of $1.0 per cubic meter to $0.50–$0.80. For reverse osmosis, the average cost of desalinated water is estimated at $0.99 per cubic meter for seawater and $0.20–$0.70 for brackish water.

Despite the many benefits the technology has to offer, concerns rise over potential negative impacts on the environment. New technologies have reduced some of these, but others remain such as the concentrates and chemical discharges to the marine environment, the emissions of air pollutants and the energy demand of the processes. The regional impacts of the water discharged from thermal desalination plants has not been studied in depth, raising concerns about the marine life and damage to the fragile marine ecosystem surrounding the Arab countries.

Despite having most of the world's desalination capacity, Arab countries devote little resources to research and development (R&D) and produce few products related to these technologies, which are all imported. In addition, the desalination industry contributes very limited added value in fabricating equipment, refurbishing plants, localizing op2erations and maintenance, manufacturing key spare parts and providing job opportunities for local labor.



Multi-stage flash (MSF) and reverse osmosis desalination in the Gulf, 2008

Source: UND 2013

The Way Forward

The large anticipated expansion in desalination plants requires a review of policies and practices, including ways to increase capacity, knowledge and value added to the local economy. In the Arab region, local capacity and knowledge focus on operations and maintenance, ignoring plant design, manufacturing and construction, even in countries that depend heavily on desalination to meet domestic water demand.

By designing incentives for local businesses, governments can attract local investments in manufacturing key desalination plant components and cultivating local innovations to attain economic sustainability. Government enterprises should value energy at world market prices and provide incentives for in-house R&D departments to promote innovations in technology and operation.

The energy requirements for desalination can be met through renewable sources, such as, solar power. Until recently, only small desalination plants in remote areas with no access to electricity from the grid used renewable energy. With its vast solar energy potential, developing solar-powered desalination technologies should be a top priority in Arab countries. R&D investments to identify optimal technical solutions and products for desalination and cogeneration powered by renewable energies can lower desalination costs and make it more sustainable.

The private sector could play a major role in building new desalination plants, increasing their efficiency and reducing their costs. Governments should provide incentives to attract the private sector and provide the legal and regularity framework to strengthen the governance and ensure sustainability of the sector.

Policy Recommendations

1. Enhanced Policies and Institutional Framework

a. Develop national plans for the use of renewable energy in desalination and provide incentive for the development and adoption of energy saving technologies.

b. Governments should provide incentives to attract private sector and provide legal and regularity framework to strengthen government's regulatory role and improve sector governance.

c. Develop a comprehensive environmental legislation related to desalination and provide incentives to reduce the carbon footprint as well as environmental impacts on the ecosystem

2. Capacity Building and Networking for Knowledge Sharing

a. Build regional capacity to design, manufacture, and construct desalination plants. This will help build local and regional knowledge in desalination technologies and provide value added to the economy. Incentive for hiring local and regional labor force will also enhance accumulated experiences.

b. Set-up extensive educational specializations and expand and support online self-training programs that offer technical and vocational training in desalination.

c. Develop of an "Arab portal desalination network" to exchange best experiences and technology development among institutions and experts working in desalination in the Arab region

For Further Reading

- AFED, 2010. Arab Environmment: Water-Sustainable Management of Scarce Resource. Edited by Mohamed El-Ashry, Najib Saab and Beshir Zeitoon, Capter 8, Desalination, Adel A. Bushnak, Beirut, Lebanon.
- Dawoud, M. and M. Al Mulla (2012). Environmental Impacts of Seawater Desalination: Arabian Gulf Case Study. International Journal of Environment and Sustainability. ISSN 1927-9566, Vol. 1 No. 3, pp. 22-37 (2012).
- FAO (2004). Water Desalination for Agricultural Applications. Land and Water Discussion Paper 5, Food and Agriculture Organization, Rome, Italy, ftp://ftp.fao.org/agl/aglw/docs/lwdp5_e.pdf.
- Lattemann,S. and T. Hopner, 2008. Environmental Impact and Impact assessment of Seawater Desalination. Desalination 220: 1-15. [www.desalination.com/articoli/8958.pdf]
- UNDP (2013). Water Governance in the Arab Region: Managing Scarcity and Securing the Future. United Nations Publications; New York, NY 10017 USA, http://www.undp.org/content/dam/rbas/doc/Energy%20and%20Environment/Arab_Water_Gov_Report/Arab_Water_Gov_Report_Full_Final_Nov_27.pdf.

REUSE OF TREATED WASTEWATER: AN OPPORTUNITY NOT TO BE WASTED

POLICY BRIEF

المجلس العربي للمياه
Arab Water Council

United Nations Educational, Scientific and Cultural Organization
منظمة الأمم المتحدة للتربيـة والعلم والثقافـة
Cairo Office
مكتب القاهرة

Key Messages

- It is becoming increasingly important to treat and reuse wastewater to reduce pollution and cope with water scarcity. Proper treatment and reuse of wastewater will increase the economic benefits of the treatment plants investment at least four-folds in addition to the other health and environmental benefits.

- Future expansion in reuse of treated wastewater requires the mobilization of huge financial resources for the construction of wastewater collection and treatment plants and conveyance infrastructure. Additionally, cross-sector regional and local collaboration with governmental and other agencies will help develop effective legislation, guidelines and innovative financial tools including the private sector.

- The Arab region policy-makers need to put on top of their agenda increasing the reuse of treated wastewater via five main pillars: Improved Governance and Leadership, Integrated Planning for Improved Sustainability, Advanced Research and Development, Enhanced Financial Sustainability and Improved Public Awareness and Acceptance.

Context

Reuse of treated wastewater was highlighted under Sustainable Development Goal 6 which targets universal sanitation services coverage, improved wastewater management, improved water quality and increased reuse, among other targets to meet the 2030 Sustainable Development Challenge (AWC and CEDARE, 2014).

The reuse of treated wastewater in the Arab region targets predominantly the agriculture sector particularly in Tunisia, Syria, Egypt and Jordan. Treated wastewater irrigation for landscaping and golf courses is also on the rise in member countries of the Gulf Cooperation Council (World Bank, 2007). However there are economic, institutional, health, and environmental constraints that hamper the sustainable and safe reuse of treated wastewater. Addressing these limitations will require concerted effort and commitment by the Arab governments, as well as support from relevant regional and international organizations, to improve water services, boost the volumes of wastewater treated as well as the quality of water produced.

This policy brief outlines challenges, potentials and impacts in relation to reuse of treated wastewater in the Arab region. The brief provides recommendations to make more treated wastewater resources available and improve their quality for various reuse purposes. This effort is part of the mandate of the Arab Water Council and UNESCO to establish an Arab Regional Initiative in support of the non-conventional water resources (NCWR) development. The initiative will help mobilize the financial, legal and technical support required to adopt proper policies and build up appropriate structures and human capacities for the sustainable development of NCWR, including reuse of treated wastewater.

Trends and Potentials

Traditionally, planned wastewater management interventions in the Arab region focused on the conventional objectives of protecting public health and the environment. The untreated wastewater is usually disposed to freshwater bodies, open seas, groundwater aquifers and agriculture drains, resulting in an increased amount of environmental degradation and reduced economic development. Pervasive water scarcity, urbanization and the increasing impacts of climate change, however, led to a shift in local perceptions to the importance of properly capturing and using treated wastewater.

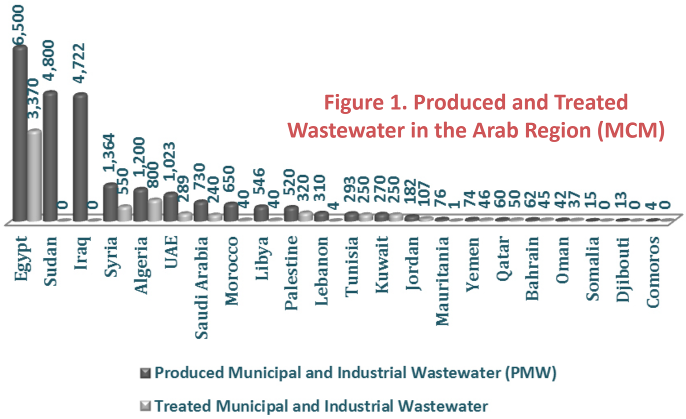


Figure 1. Produced and Treated Wastewater in the Arab Region (MCM)

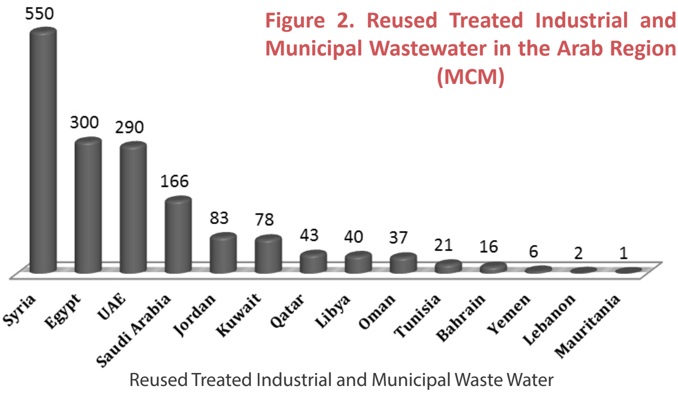


Figure 2. Reused Treated Industrial and Municipal Wastewater in the Arab Region (MCM)

In general in the Arab region, treatment and reuse of wastewater occurs on a limited scale and far from its potential sites of reuse. As of 2012, only 26% of the 24 BCM/y of produced wastewater in the Arab Region is treated and only 25% of the treated wastewater is reused. Thus, only 7% of the produced wastewater is reused (WHO, 2012). Tunisia, Jordan, Syria, Egypt, and the GCC counties are considered the leaders in the area of wastewater generation and reuse. However, the lack of political commitment and of a national policy and/or strategy to support wastewater treatment and reuse act as significant constraints in most Arab countries. Oman ranked highest in terms of percentage of reused treated wastewater among the Arab countries, reaching an 88% reuse of its produced wastewater. Egypt produces the highest treated wastewater volume and Syria reuses the largest treated wastewater volume.

Benefits and Risks of Treated Wastewater Reuse

Managing wastewater is obviously linked to the management of the entire water cycle. Inadequate wastewater management pollutes water bodies that are also important sources for drinking water, fisheries and other services. Therefore, the discharge of wastewater, without or with inadequate treatment, involves significant costs, including environmental and social ones. The reuse of treated wastewater entails a number of benefits and risks as well (Table 1):

Table 1. Benefits and Associated Risks of Treated Wastewater Reuse

Benefits (UNEP, 2005):	Risks (World Bank, 2011):
It is a low-cost method for sanitary disposal of municipal wastewater;	Health risks to agricultural workers resulting from fields irrigated with untreated or inadequately treated wastewater;
It converts wastewater that potentially damages the environment into a resource that can improve the water quality and environment, thus improving GDP;	Health risks to consumers of agricultural goods produced from untreated or inadequately treated wastewater;
Reduces pollution of rivers and other surface water;	Contamination of soils and plants through introduction of chemicals found in inadequately treated wastewater; and
Conserves nutrients, thereby reducing the need for artificial fertilizer; increases crop yields;	Ground and surface water pollution from infiltration of contaminated irrigation water.
Provides a reliable water supply to farmers and;	
Improves livelihood of the community, and reduces diseases and other health issues.	

An important element in the sustainable treatment and reuse of wastewater is the formulation of standards and regulations that are achievable and enforceable. Unrealistic standards and non-enforceable regulations may do more harm than having no standards and regulations at all, because they create an attitude of indifference towards rules and regulations in general, both among polluters and administrators. The regulations should be coupled with regular monitoring and evaluation of wastewater reuse systems to meet specified quality standards. Additionally, the lack of organization in-charge of the reuse sector should be addressed as a matter of urgency to identify the proper institutional structure needed to develop the sector and act as its regulatory regime.

Treatment and Conveyance Infrastructure for Treated Wastewater Reuse

High cost of wastewater treatment and conveyance infrastructure is an upstream investment challenge for treated wastewater reuse. Mixing industrial wastes with municipal sewage system is also a major cause for underperformance. Instead, industrial pollutants should be removed at the source which is more financially and technically feasible. The cost of transferring treated wastewater from urban centers to agricultural areas which is typically located in more distant rural setting is a further investment cost that can make water reuse plans difficult or even prohibitive in some cases.

Wastewater reuse in peri-urban agriculture can contribute to improved health of poor communities through income generation and increased access to food. While minimal transportation cost is usually associated with peri-urban agriculture, it also has its drawbacks and health hazards since most wastewater is untreated or contaminated with industrial and other wastes.

Policy Recommendations

The Arab Region should put on top of its political agenda to "Increase Reuse of Treated Wastewater in the Arab Region with Lower Cost Technologies in Wastewater Treatment and Reuse" via 5 main pillars:

1. Policy Change through Improved Governance and Leadership

a. Provide political support and strong leadership to overcome the challenges associated with effective wastewater reuse.
b. Ensure that water and wastewater are managed under the same governmental water resources planning and management body. This will ensure that wastewater is not considered as waste but as a resource.
c. Set clear time targets for wastewater treatment volumes, quality and reuse. This would be coupled with robust monitoring and evaluation systems to follow up on produced wastewater volumes, quality of treatment and reuse efficiency.

2. Integrated Planning for Improved Sustainability

a. Develop strategic and integrated plans at national and governorate levels incorporating treated wastewater among available water resources.
b. Consider treated wastewater for agricultural development, peri-agriculture, landscaping, and possible domestic use.
c. Consider the proximity to wastewater treatment plants in the selection of agricultural development lands for potential reuse.

3. Advanced Research and Development (R&D)

a. Provide incentive schemes for research and development (R&D) in cost-effective technologies and lower costs for treatment and reuse of treated wastewater in rural areas.
b. Develop and adopt new approaches in wastewater treatment and reuse to reduce energy consumption and increase dependency on renewable energy supplies.
c. Develop new crop varieties and irrigation techniques that would cope with the reuse of treated wastewater qualities and possible health hazards.

4. Enhanced Financial Sustainability

a. Adoption of feasible and fair tariff which would balance between the treated wastewater economic costs and incentives for reuse. Balanced cost recovery tariff will enable the governments to provide sustainable water services.
b. Create special incentive programs and enabling environment to attract the participation of private sector through public-private partnership (PPP) approaches.
c. Prepare wastewater treatment and reuse project proposals that can be financially supported through local, regional, and international funding institutions.

5. Improved Public Awareness and Acceptance

a. Launch public awareness campaigns to change the perception of wastewater from being a health risk and waste to being a valuable water resource. Regular information-sharing on water quality data will be helpful in confidence-building.
b. Establish stakeholders platforms with farmers, local community and local NGOs to promote treated wastewater reuse in agriculture.
c. Provide farmer assistance on selecting crop varieties and irrigation technologies.

For Further Reading

- Abu-Zeid, Khaled (2008). Integrated Water Resources Management & Water Demand Management Opportunities in the Arab Region, 1st Arab Water Forum, Arab Water Council, Riyadh, Saudi Arabia, 16-19 November, 2008. http://www.unwater.org/sdgs/en/
- AWC and IFAD (2013). Water, Food Security and Climate Change Nexus: Arab Water Council Assessment Study.
- CEDARE and Arab Water Council (2014). "2nd Arab State of the Water Report - 2012", Water Resources Management Program - CEDARE & Arab Water Council, ISBN: 978 977 90 3806 3, ISSN: 2357 0318.
- UNEP (2005). Economic Valuation of Wastewater, The Cost of Action and the Cost of No Action, http://unep.org/gpa/Documents/GWI/Wastewater%20Evaluation%20Report%20Mail.pdf
- WHO (2012). Global Costs and Benefits of drinking-water supply and sanitation interventions to reach the MDG target and universal coverage, http://www.who.int/water_sanitation_health/publications/2012/globalcosts.pdf
- World Bank (2011). Water Reuse in the Arab World: From Principle to Practice, Voices from the field, A Summary of Proceedings, Expert Consultation Wastewater Management in the Arab World, 22–24 May 2011, Dubai-UAE (http://www.arabwatercouncil.org/images/Publications/Technical-Reports/1212755_MENA_Wastewater_Report.pdf)
- World Bank (2007). Making the Most of Scarcity: Accountability for Better Water Management in the Middle East and North Africa. World Bank, Washington DC.

AGRICULTURAL DRAINAGE WATER REUSE: AN OPPORTUNITY FOR INCREASING WATER USE EFFICIENCY

POLICY BRIEF

المجلس العربي للمياه
Arab Water Council

United Nations
Educational, Scientific and
Cultural Organization
منظمة الأمم المتحدة
للتربية والعلم والثقافة

Cairo
Office
مكتب
القاهرة

Key Messages

- Reuse of agricultural drainage water in the Arab region holds great potential and offers an opportunity to reduce the gap between water supply and demand in agriculture, increase the overall water use efficiency, and preserve fresh water for higher-value uses.

- Investment in drainage water reuse represents a low-cost water management opportunity with high economic return. However, environmental risks exist due to the high contents of salts, residues of agro-chemicals and sometimes other biological and toxic pollutants.

- Agricultural water reuse has to be managed carefully to safeguard the environment and minimize the negative impacts on water, land, crops and the ecosystem. Similar to freshwater, policies to protect agricultural drainage water from pollution should be in place.

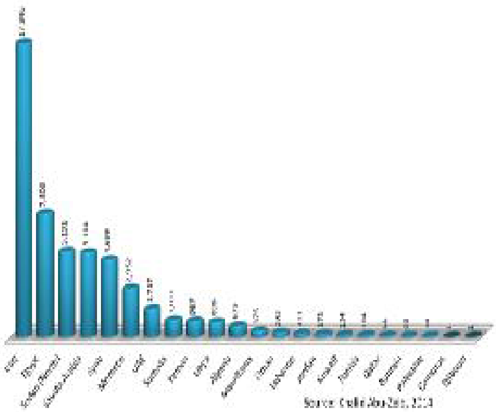
Policy recommendations aim to support drainage water reuse in terms of improved legal and institutional arrangements; financial and econ omic organizations; technology and infrastructure; and planning and management tools, and knowledge development.

Context

With growing demands on freshwater resources in the Arab region and increasing signs of climate change, pressure is mounting on the agriculture sector to give up part of its allocation to prime sectors such as domestic and industrial ones. This represents the greatest challenge to the agriculture sector that it has to continue producing more food and fiber, with less water, to satisfy current and future demands for food security (World Bank, 2006). For the Arab region, agricultural drainage water reuse is available in large values particularly in large scale irrigation countries (Figure 1). It offers an opportunity to reduce the gap between water supply and demand in agriculture and increase the overall water use efficiency.

This policy brief outlines challenges, trends and impacts related to agricultural water reuse in the Arab region. The brief provides recommendations that could form policy solutions. This effort is part of the mandate of the Arab Water Council and UNESCO to establish an Arab Regional Initiative in support of the non-conventional water resources (NCWR) development. The initiative will help mobilize the financial, legal and technical support required to adopt proper policies and build up appropriate structures and human capacities for the sustainable development of NCWR including agricultural drainage water reuse.

Figure 1: Available Agricultural Drainage Water in Arab Countries (BCM)



Seizing the Opportunity and Managing the Challenges

In addition to rain-fed areas, irrigated agriculture in 2010 produced only 50% of the total food requirements for the Arab region. The rest of food commodities have been imported in the form of virtual water (CEDARE and AWC, 2014). Mobilization of financial resources to achieve water and food securities possesses a serious concern for governments in the region. Water withdrawn for agriculture (208 billion cubic meters) represents 85 percent of the total available renewable water resources (AQUASTAT, FAO). Only 60 percent of the water withdrawn for agriculture is actually consumed and the rest is returned to the hydrologic cycle in the form of run-off or groundwater recharge.

Drainage water is often available in large volumes near or within the reuse sites. It is the lowest investment in all non-conventional water resources development opportunities. Investment ranges from just small diesel pumps privately operated by farmers to a large pump station publicly owned and managed by irrigation authority. Large scale of drainage water reuse is practiced in Egypt and on a more limited scale in Iraq, Saudi Arabia, and Syria, (CEDARE and AWC, 2014). (see Box 1). Agricultural drainage water could be used in conventional farm irrigation, saline agriculture, aquaculture, wildlife habitats and wetlands, and for initial reclamation of salt-affected soils (FAO, 2002). The choice of a certain reuse option depends largely on drainage water quality, plant tolerance to salinity, and availability of freshwater resources. The temporal and spatial availability of drainage water are also of major importance. In conventional irrigation practices, drainage water can be reused either as a sole source, mixed, or alternated with freshwater. The choice is mainly an agro-economic option.

Box 1. Drainage Water Reuse in Egypt and Iraq

In Egypt, reuse of agricultural drainage water became a national policy during the 1980s. Recently, around 6 billion m^3 of drainage water with an average salinity of 1.8 dS/m is reused on annual basis. Egypt's reuse strategy was achieved through drainage water mixing with freshwater that has low salinity content. Operational water quantity and quality monitoring systems have been developed for planning and management (World Bank, 2006).

The reuse of drainage water in Iraq is considered of strategic importance in helping Iraq meet the 2030 development goals. However, topography and poor water quality limit the options of re-using drainage water in agriculture. Reuse options include the development of green belts around cities, and re-injecting water into oil field. Drainage water could also help supporting the lateral extension of Hammar Marshes and providing the minimum flow along the Shatt al Arab River (Lecollinet and Cattarossi, 2015).

Good reuse practices could be guided by FAO and WHO guidelines (FAO, 2002 and WHO, 2006) that take into account the salt and biological elements of the drainage water. Meanwhile, laws and regulations on water quality and pollution control should provide a framework for safe drainage water management (Abdel-Gawad, 2013). Farmer awareness and training programs for managing the relatively saline water areas are also essential.

As in any complex water management system, planning drainage water reuse projects requires an integrated approach that looks into the functions of the natural resources systems (goods and services) and values attributed to these functions by people within and outside the reuse domain as well as at the short-and-long terms (Abdel-Dayem et al., 2007). Participatory approaches involving all stakeholders are essential for planning and management with full buying in from stakeholders.

Pollution Prevention Provides Clean Water for Wide Usability

Understanding the tradeoffs in reusing drainage water and its impacts on crops, soil, health and the environment will ensure that reuse programs can be designed and maintained in a way that meets the essential economic, social, and environmental requirements.

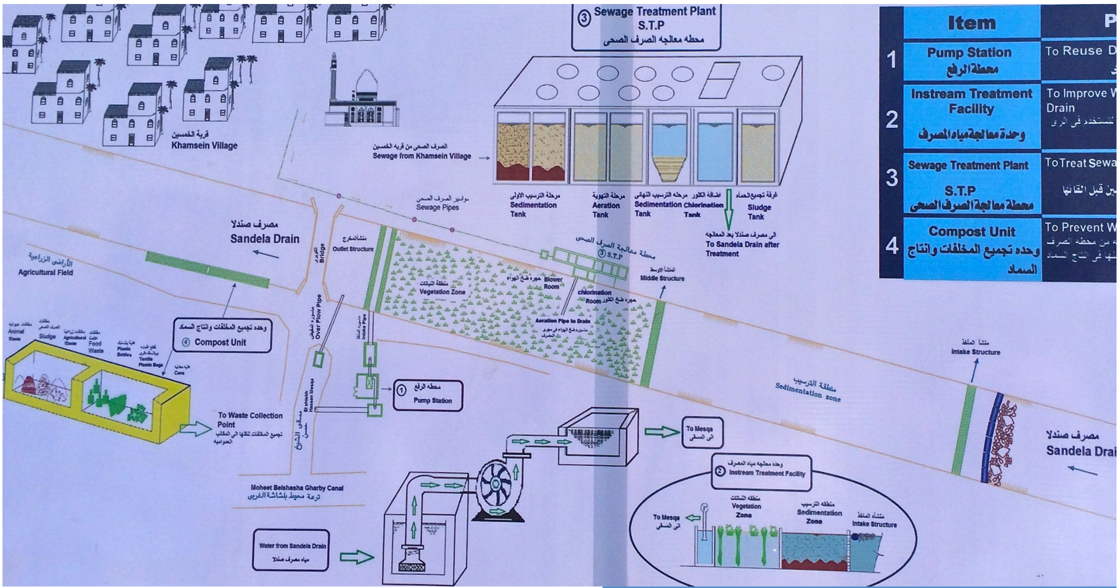


Figure 2: Decentralized wastewater treatment combined with in-stream wetland for reuse in irrigation in rural areas.

Risks associated with drainage water reuse are mainly due to its salt and agricultural chemical contents. However, risk increases when untreated domestic and industrial wastewater is disposed into agricultural drains. Pollution and contamination of agricultural drainage water manifest itself in the form of increased acidity, and higher concentration of nutrients, sediments, salts, trace metals, chemicals as well as pathogenic organisms. As water quality deteriorates, water usability diminishes, intensifying water scarcity, increasing health risks and damaging the environment, including fragile ecosystems. Prevention of pollution strategies should focus on reduction or prevention of pollution at source. Prevention is widely regarded as the cheapest, easiest and most effective way to protect water quality. Addressing the water pollution problem in the Arab region will significantly improve the usability of the agricultural drainage water. Meanwhile, research and pilots involving local communities for identifying cost-effective technologies for controlling pollution in agricultural drains should be encouraged (Figure 2).

Policy Recommendations

The following set of policy recommendations will support drainage water reuse in terms of improved legal and institutional arrangement; financial and economic returns; technology and infrastructure; and more effective tools for planning, management, and knowledge development.

Governments in the Arab region have to include agricultural drainage water management and reuse in their national water, and agricultural policies. Governments' relevant institutions should also develop technical criteria, use guidelines and legal and regulatory frameworks for agricultural drainage water reuse.

Governments also have the responsibility to support and encourage research to explore low-cost treatment options and reuse implications on freshwater quality, public health and the environment. This will help develop management options, evaluation criteria and guidelines for beneficial and safe reuse.

Policy-makers should use the updated evidence concerning crop production and health impacts associated with the use of drainage water in agriculture and develop rational and cost-effective policies for managing and protecting water quality to maximize the beneficial use of natural resources.

The Arab Water Council and its partners should support governments and users in developing drainage water reuse policies and guidelines, offer regional awareness and capacity building programs and disseminate information on good practices.

For Further Reading

- Abdel-Dayem, S., J. Hoevenaars, P. Molenga, W. Scheumann, R. Slootweg and F. van Steenbergen (2007). Making the Case for Integrated Water Resources Management: Drainage in Egypt. Water International, Volume 32, Number 5, pp. 674-685, Supplemental Issue.
- Abdel-Gawad, S. (2013). Operational Drainage Water Reuse Guidelines. NENA-LW, FAO, Amman.
- CEDARE and Arab Water Council (2014). "2nd Arab State of the Water Report - 2012", Water Resources Management Program - CEDARE & Arab Water Council, ISBN: 978 977 90 3806 3, ISSN: 2357 0318.
- FAO (2002). Agricultural Drainage Water Management in Arid and Semi-Arid Areas. FAO Irrigation and Drainage Paper No. 61, Rome, Italy.
- Lecollinet, J. and A. Cattarossi. (2015) Reuse of Drainage Water in Iraq. 26th Euro-Mediterranean Regional Conference and Workshops, International Commission on Irrigation and Drainage, 12-15 October 2015, Montpellier, France.
- MWRI/JICA (2016). Drainage Water Quality Control for Irrigation in Middle Delta, Egypt. A Pilot Project, Egyptian Public Authority for Drainage Projects.
- WHO (2006). Guidelines for the Safe Use of Wastewater, Excreta and Grey Water. Volume 1, Policy and Regulatory Aspects.
- World Bank (2005). Shaping the Future of Water for Agriculture: A Sourcebook for Investment in Agricultural Water Management. Washington, DC.
- World Bank (2006). Re-engaging in Agricultural Water Management Challenges and Options. Directions in Development, Washington, DC.

SUSTAINABLE BRACKISH GROUNDWATER USE IN THE ARAB REGION

POLICY BRIEF

المجلس العربي للمياه

Arab Water Council

United Nations Educational, Scientific and Cultural Organization

منظمة الأمم المتحدة للتربية والعلم والثقافة

Cairo Office

مكتب القاهرة

Key Messages

- The use of brackish groundwater (BGW) could supplement the use of scarce freshwater sources in the Arab region. Multiple uses of brackish groundwater include irrigation of salt tolerant plants; cooling systems in power generation plants; oil and gas drilling; and municipal supplies after desalination. Brackish groundwater utilization also allows the preservation of freshwater resources for higher water quality uses and postpones more costly water supply interventions including water transfer and expensive desalination schemes.

- In addition to climate change negative impacts, there are many practical challenges and risks facing the wide use of brackish groundwater including accumulation of salts in root zone and salt impacts on the well materials and pump lifetime. Disposal of waste brine in case of desalination is also another challenge for the fragile ecosystem.

- Better understanding of the location, potentiality and characterization of brackish groundwater reserves is needed to expand their development. Feasible BGW potentials would provide technical, economic and environmental bases for better policy-making and investment decisions.

- Taking stock of the availability and potentiality of brackish groundwater should be coupled with developing knowledge base, and technical capacity in BGW development and utilization. Efforts should also target innovations in climate change adaptation measures, aquaculture technologies, irrigation saving technologies and crop varieties that are tolerant to drought and salinity stresses.

This policy brief recommends developing sound policies, strategies, regulatory framework, streamlining research and development programs, financed action plans and cooperation platforms in relation to brackish groundwater utilization in the Arab region.

Context

Renewable groundwater resources in the Arab region are in general quite limited, estimated to be about 45 billion cubic meters annually, mostly in the form of shallow aquifers recharged from rainfall and different surrounding surface water activities (FAO, 2011). Non-renewable groundwater sources (or fossil groundwater) are available in relatively wide areas in the Arab region and at rather larger depths, particularly in the Sahara and the Arabian Peninsula, and are shared among many countries in the region (Al-Zubari, 2014). Due to over-abstraction, most of the groundwater reserve in the Arab region has deteriorated and has become brackish according to its salinity levels classification.

Brackish water or briny water is water that has more salinity than freshwater, but not as much as seawater. Brackish groundwater usually has dissolved solids concentrations between 3,000 and 10,000 mg/L (USGS, 2014). Brackish groundwater is directly used for purposes such as saline agriculture, aquaculture, cooling water for power generation, and for a variety of uses in the oil and gas industry such as drilling, enhancing recovery, and hydraulic fracturing. Brackish water aquaculture, also known as coastal aquaculture, is a rapidly expanding farming activity and could play an important role in the overall fisheries development and food security in the region. As such, brackish groundwater use is emerging as a high potential source of non-conventional water in the Arab water-stressed countries (see Box 1).

Box 1: Brackish Groundwater Reserve and Use in Egypt, Tunisia, UAE and Yemen

Recent studies in **EGYPT** is indicating that brackish groundwater exists in all aquifer systems with potential of about 325 million cubic meters (MCM). Using these resources is still limited to small-scale agricultural activities and as a drinking source for people and for cattle. Recently, medium to large farmers in the northern part of the Nile Delta started to transfer their agricultural land to fish farms based on brackish groundwater as a result of freshwater shortage (Attia et al., 2010).

In the South of **TUNISIA**, the authorities have been able to use reverse osmosis technology to convert brackish groundwater into drinking water. The government subsidizes the private sector to invest in desalination and considers this technology a key part of the long-term national water management strategy. Meanwhile, the government plans to increase public sector installed capacity from 44 MCM/day in 2009 to 50 MCM/day by 2030, (World Bank 2009).

In **UAE,** the brackish to saline groundwater aquifer potentiality is about 650 billion cubic meters. At present the brackish groundwater use contributes with about 50% of the total water use. It is used directly for irrigation of farms and forests and for domestic sector after using membrane desalination technology (Dawoud, 2014).

In **YEMEN**, the usable brackish water for agriculture in Yemen is about 300 MCM/year, mostly for irrigating some tolerant crops in the coastal areas. The total irrigated area by brackish water is about 38,500 ha. In highlands, brackish water is mainly used for rock cutting industry, In Taiz city, brackish water with high salinity is used for water supply by mixing with freshwater for domestic use without any desalination.

Better understanding of the location, potentiality and characterization of the brackish groundwater reserve is needed to expand the development of the resource and provide technical, economic and environmental bases for educated sound policy making-decisions and sustainable development interventions.

This policy brief discusses the brackish groundwater potentials, challenges, and its sustainable development in the Arab region. The brief also provides recommendations to meet the increasing demand for brackish groundwater, and to build necessary capacity and institutional structure. Ecosystem and environmental protection measures were also addressed in relation to brackish groundwater use in agriculture and aquaculture.

This effort is part of the mandate of the Arab Water Council and UNESCO to establish an Arab Regional Initiative in support of the non-conventional water resources (NCWR) development. The initiative aims to support the sustainable development of NCWR, including brackish groundwater. Support would include financial, legal and technical measures to adopt proper policies and build up appropriate structures and human capacities.

Brackish Groundwater Use : Challenges and Opportunities

There are many practical challenges facing the wide use of brackish groundwater such as accumulation of salts in the root zone and salt impacts on the well materials and pump lifetime. Disposal of waste brine in case of desalination is also another challenge. Brackish groundwater irrigation effect includes yield reductions due to salt accumulation, high cost of agricultural inputs due to the need for deeper plowing and pumping costs to cover the additional water requirement for leaching. However, in arid countries, it is not whether to use brackish/saline water to irrigate, but rather how best to use this “resource” in a sustainable manner and with as little detrimental effect as possible on the natural resource base (Box 2).

Box 2: Relevant and Creditable Guidelines for Brackish Water Irrigation

When brackish water is to be used at a large scale for irrigation, the interaction of the water, soil and crop must be well understood beforehand. Equally, suitable technology for using and managing brackish water for irrigation should be adopted. AWC, therefore, jointly with FAO, developed in 2015 “Guidelines for Brackish Water Use for Agricultural Production in the NENA Region”(FAO, 2015).
Algeria, Egypt, Iraq, Iran, Jordan, Saudi Arabia, Morocco, Tunisia and Yemen were involved in preparing the guidelines that were based on field data and best practices gathered from the participating countries. Field applications of the current knowledge and developed guidelines would be of great importance for further expansion in brackish water use in agriculture.

For purposes requiring lower dissolved-salt content, especially drinking water, brackish water is treated through reverse osmosis (RO) or other desalination processes. The energy, materials and equipment used for RO desalination of brackish groundwater is far less than those used for desalinating seawater. RO desalination technology has recovery efficiency of 60 to 85% for brackish groundwater.

Disposal of waste brine in case of using desalination with RO is also another challenge. Negative effects on the marine environment can occur especially when high wastewater discharges coincide with sensitive ecosystems. Improving recovery efficiencies to 90 or 95% would significantly reduce brine disposal volumes, extend the supply of brackish resources, and potentially reduce overall desalination costs.

Meanwhile, with climate change, there are fears of serious impacts on social and economic stability, biodiversity and sustainable development in general. Lands and people using marginal water –brackish groundwater- are considered the most vulnerable. As the quality of this water becomes degraded, the impact on people and the environment can be dreadful.

Brackish Groundwater Governance and Regional Cooperation

Water governance is the business of all levels of the government and is very sensitive to prevailing norms. Principles of good governance include transparency, accountability and participation. Several factors affect the success of governing brackish groundwater at the national level including political will, regulatory frameworks, and technical and institutional capacities. Developing regional cooperation programs will help exchange accumulated knowledge, experiences, education and awareness programs in brackish groundwater management. Participants include government staff in implementing agencies, private sector firms and individuals, civil society, and especially project beneficiaries in affected communities.

Policy Recommendations

Brackish groundwater resources represent a complementary source of the current and future water supply in the Arab region. BGW development requires careful planning and management to ensure their longevity in serving socio-economic development in the region. The following are recommendations for policy actions:

1. Governments should consider brackish groundwater irrigation as good agricultural practices. BGW therefore should be part of the governments' national policies and strategic integrated lands and water resources development plans.

2. Governments should map areas with high BGW potential identifying their economic feasibility and taking into account different hydrological and environmental factors. This should be coupled with developing knowledge base and technical and institutional capacity building.

3. Concerted efforts by regional organizations are needed to strengthen regional cooperation and applied research in BGW development. Possible areas of cooperation include capacity building activities, data and information sharing, and establishing knowledge hubs to support individuals and organizations working in BGW management and utilization.

4. Pilot scale BGW projects could be financed and constructed at potential areas to demonstrate new technologies utilizing indigenous regional knowledge.

For Further Reading

- CEDARE and Arab Water Council (2014). "2nd Arab State of the Water Report - 2012", Water Resource Management Program - CEDARE & Arab Water Council, ISBN: 978 977 90 3806 3, ISSN: 2357 0318.
- FAO (2011). Agriculture and Water Quality Interactions: A Global Overview, FAO, Rome, Italy.
- FAO and AWC (2015). Guidelines for Brackish Water Use for Agricultural Production in the NENA Region, FAO, Rome, Italy.
- Fatma A. Attia, Safaa M. Soliman and Maher A. El Shewiy (2010). Development of Groundwater Strategy for Use of Brackish Groundwater in Egypt.
- Mohamed Dawoud (2014). UAE Water Resources Assessment Report, Abu Dhabi, UAE.
- National Groundwater Association (NGWA) (2010). Brackish Groundwater Brief, USA.
- USGS (2014). USA National Groundwater Assessment Report.
- Waleed Al-Zubari (2014). Synthesis Report on Groundwater Governance Regional Diagnosis in the Arab Region, Groundwater Governance: A Global Framework for Action, Regional Consultation.
- World Bank (2009). Water in the Arab World: Management Perspectives and Innovation, Middle East and North Africa (MENA) Region, NW Washington, DC 20433, USA.
- World Bank, ICBA, AWC and Islamic Development Bank (2015). Expert Consultation Wastewater Management in the Arab World, 22–24 May, 2011, Dubai-UAE.

WATER HARVESTING IN THE ARAB REGION

POLICY BRIEF

Key Messages

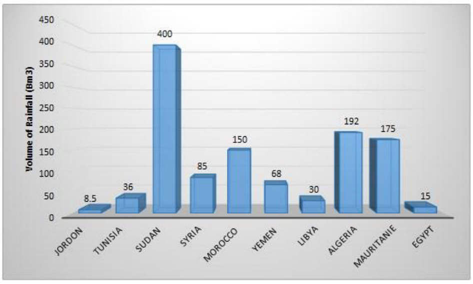
- Water harvesting augments water availability for domestic and agricultural uses and is also important for meeting ecosystem needs and sustainability. Though some forms of water harvesting had been successfully used in the region since ancient time, the technology has developed considerably in the last few decades.
- Adoption and upscaling of water harvesting interventions in the Arab region face many challenges including lack of information on sites with potential for technically and economically feasible water harvesting investments. High cost of installation and maintenance of water harvesting infrastructure is also a constraint to the expanding of pilot projects. Farmers' out-dated knowledge of water harvesting methods and land tenure problems reduce the motivation to invest in new water harvesting structures.

Policy recommendations include strengthening current water harvesting-related policies and hydrological monitoring systems, and developing maps for potential water harvesting areas in the region. Recommendations also cover supporting regional cooperation, applied research, and the construction of pilot scale water harvesting demonstration projects.

Context

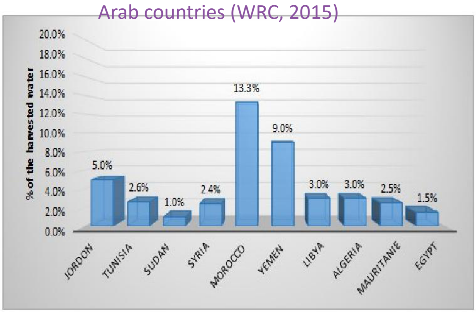
Water harvesting can be defined as "the collection and sustainable management of moisture, rainwater, floodwater and/or groundwater." Water harvesting is a complementary supply source and is considered by several scholars as a non-conventional water resource. Water harvesting supplements water availability for domestic and agricultural uses and is also important for maintaining ecosystem balance.

Amount of rainfall water in some Arab countries (WRC, 2015)



The need for water harvesting to cope with water scarcity has been explicitly recommended in the 2030 Agenda for Sustainable Development Goals (SDG 6, Target 7) and the 8th phase of the International Hydrological Program of UNESCO (IHP-VIII, 2014-2021). Water harvesting was also highlighted in many other regional and international declarations and strategies, including the Arab Water Strategy of 2012. There are also strong commitments among the Arab countries to adopt demand management strategy and develop non-conventional water resources including various water harvesting technologies.

Percent of harvested water in some Arab countries (WRC, 2015)



This policy brief outlines trends, challenges, and constraints related to water harvesting development in the Arab region. The brief provides recommendations for policy solutions. This effort is part of the mandate of the Arab Water Council and UNESCO to establish an Arab Regional Initiative in support of the non-conventional water resources (NCWR) development. The initiative will help mobilize the financial, legal and technical support required to adopt proper policies and build up appropriate structures and human capacities for the sustainable development of NCWR including water harvesting.

Challenges and Constraints

Constraints militating against the adoption and up scaling of water harvesting in the Arab region include inadequate data on rainfall and run-off, un-gauged catchment conditions and inefficient hydrological techniques, and the high cost of acquisition, installing, monitoring and maintaining water harvesting infrastructures. Water stress and rainfall variability risks caused by climate change have also remained a challenge to adopt various water harvesting technologies. Socio-economic constraints include farmers' out-dated knowledge of water harvesting methods and land tenure issues that reduce the motivation to invest in new water harvesting structures.

POLICY RECOMMENDATIONS

Developing the knowledge base and capacity in water harvesting means enhancing and integrating the utilization of this precious resource for better products in rain fed agriculture, rural development, domestic use and ecosystem sustenance. Improving water harvesting techniques requires the following:

- A long-term government policy with commitment to support related research centers and extension services, adequate institutional structures, beneficiary organizations (associations, cooperatives), and training programs for farmers, pastoralists and extension staff.
- Water harvesting policy and physical interventions must be complemented by socioeconomic and institutional measures. Sufficient involvement of local communities in the selection and design of water harvesting schemes is a major key to success.
- Countries should map areas with high water harvesting potential identifying their economic feasibility and taking into account different hydrological and environmental factors. Some of these sites may be used for pilot projects demonstrating new water harvesting technologies.

ACTION RECOMMENDATIONS

Adoption of the following abridged statements will be important steps towards the sustainable utilization of the water harvesting potential in the Arab region:

1. Enhanced Policies and Improved Hydrological Data Reliability

a. Governments should strengthen the existing hydrological monitoring systems and develop maps for potential feasible water harvesting areas in the region.
b. Water harvesting should be part of the government's policies and strategic integrated lands and water resources development plans. This should be coupled with creating incentive policies for public-private partnership.

2. Strengthen Regional Cooperation and Applied Research

a. Establishment of effective networks to increase the cooperation among stakeholders at the local, national and regional levels. Networks could be a platform to develop regional database, share related information, scientific knowledge and techniques for water harvesting;
b. Public awareness, capacity building, and scientific research programs should be implemented to sustain the development of water harvesting.

Trends and Potentials

About one quarter of the population of Arab countries are poor, and 76 percent of them live in rural areas, where the agriculture sector represents a considerable part of their economy.

The agriculture sector in the Arab region is highly dependent on rainfall with a rain-fed area of seasonal crops approximately equal to 40 million hectares in 2011 which represents 80% of the total cultivated area. Rainfall is also becoming increasingly erratic - across West Asian and North African, for instance, annual totals are generally below 250 mm, and sometimes as little as 50 mm. Meanwhile, temperatures can rise as high as 50 degrees. Because of the high fluctuation in precipitation rates due to climate variability and change in the arid Arab region, rainfall water harvesting is essential to ensure supplemental water supply for reliable rain-fed agricultural productivity.

FAO (1991) and ICARDA (2001) references refer to various forms of rain-water harvesting for supplementary irrigation. The aim is to complement rather than replace the existing water-use system. Improving crop yield in irrigated and rain-fed areas has a considerable potential for enhancing food security in the Arab region and source for drinking water in remote areas. Field results in some developing countries have shown that yields can be increased two to three times through rain-water harvesting, compared with conventional dry farming. Water harvesting helps in rehabilitating poor quality land by providing improved vegetation cover, thus mitigating degradation and erosion.

Box 1. Water Harvesting History in the Region

Floodwater harvesting was historically being used by building retarding or damming structures across Wadis since old times, including the famous Maarib Dam in Yemen and Sisud Dam in Saudi Arabia which was constructed in the year 58 AH. The system is still widely used in many countries by building recharge dams across Wadis (in Saudi Arabia and Oman). Moisture harvesting had been in use in the region from ancient times by the Nabatans and in Yemen, among other countries of the region.

The most commonly used conservation methods in the Arab countries include cisterns, micro-catchments which is adjacent to cultivated areas, small dams and underground storage. Spreading systems include terraces (masateh, in Oman, Saudi Arabia and Yemen), irrigation diversion dams, sloped catchment areas next to fields (meskat, in the Maghreb region), artificial recharge and check dams (Box 1). Shallow dug wells and pit galleries also abstract water from shallow aquifers and exploit groundwater in the coastal sand dunes. These diverse systems manage rainfall; protect soil moisture and control soil erosion and desertification.

Water collected from fog harvesting, and rooftops serve as a source of water for human consumption in areas where running water is not available for part of the year and fogs occur frequently. Weather modification technologies are also being tested in the region. United Arab Emirates, Jordan, and Saudi Arabia reported positive results with cloud seeding experiments.

Figure 1. Examples of water harvesting techniques

3. Improved Water Harvesting Sustainability

a. Establishment of an Arab regional initiative on water harvesting as part of the proposed initiative for non-conventional water resources utilization. The focus of the water harvesting component would be to provide the financial and technical support to adopt and build up appropriate water harvesting technologies and structures. This effort should build on the FAO Regional Water Scarcity Initiative (WSI) adopted and supported by the League of Arab States' Arab Water Ministerial Council; and
b. Pilot-scale water harvesting projects could be financed and constructed at potential areas to demonstrate new technologies utilizing indigenous regional knowledge.

For Further Reading

- AOAD (Arab Organization for Agricultural Development) (2002). Enhancing Water Harvesting Technology in the Arab Region. Khartoum, Sudan.
- CEDARE and Arab Water Council (2014). "2nd Arab State of the Water Report - 2012", Water Resources Management Program - CEDARE & Arab Water Council, ISBN: 978 977 90 3806 3, ISSN: 2357 0318.
- FAO (1991). A Manual for the Design and Construction of Water Harvesting Schemes for Plant Production; Food and Agriculture Organization of the United Nations - Rome, 1991
- ICARDA (2001). Water Harvesting Indigenous Knowledge for the Future of the Drier Environments, International Center for Agricultural Research in the Dry Areas (ICARDA).
- Salih, A.M.A. and A.G.A. Ali (1992). Water Scarcity and Sustainable Development, UNESCO Nature and Resources, Vol.28, No.1; pp.44-48.
- United Nations Development Program (UNDP) (2013). Water Governance in the Arab region. New York: United Nations Publications.
- WRC (Water Research Centre), University of Khartoum (2015). Internal Documents.