

Unconventional Water Resourcese Reuse (Jordanian Success Stories)

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- More than 70% of the world is covered by water, but only 2.5% is fresh. Only 1% of freshwater is easily accessible — and agriculture consumes 70% of it globally.
- Jordan is the () most water scarce country in the world.
- Jordan's annual renewable water resources are reached to 60 m³ per person, significantly below the threshold of 500 m³ per person which define severe water scarcity.
- This will decline to less than 40 m³ annually by the year 2040 if the current water conditions may continue this way, given the available water resources and the expected increases in the natural demand for such

resources.

Freshwater makes up a very small fraction of the Earth's water



JORDAN WATER PER CAPITA

Water for Food



أسيوع المياه العربج السايع

https://d2zyf8ayvg1369.cloudfront.net/sites/default/files/MercyCorps_TappedOut_JordanWaterReport_March204.pdf

The Hashemite Kingdom of Jordan covers a territory of about 89,342 **km²** with (88.884) land area (99%), of which 95% receives less than **200 mm** rainfall annually. □ It lies within the **arid** and **semi**arid climatic zones and has a typical Mediterranean short rainy winter and a long dry summer. □ Jordan's renewable water resources are limited and insufficient to meet national demand.





Groundwater Level Decrease Between 1995 and 2017 (Source: BGR)

أستوع المياه العربج السايع

- The water crisis in Jordan is deep, and that its sources are represented in the:
- Population growth increase (2.5%).
- Natural increase (represented either by a natural increase, or by waves of migration, displacement, and asylum), hosting refugees.
- The scarcity of rain (climate change).
- The depletion of water resources.
- The increasing needs of different sectors for water, in addition to that the water resources are limited in general.





- With a fast growing population and an expanding agricultural sector, the demand for alternatives of fresh water resources remains imminent.
- □ Water Resources in Jordan:
- 1- Renewable resources (780) MCM\ Y:
- Surface water (505) MCM/Y.
- ≻ Groundwater Sources (275) MCM /Y.
- 2- Reclaimed water: (200) MCM 2022.
- **3- Non Renewable:**
- ► Fossil Water (140) MCM/Y.
- ➤ Brackish Water (50) MCM/Y.





Jordan's Water Supplies





Climate change: is expected to have a significant impact on Jordan, most likely leading to increased temperatures, variation in precipitation patterns, extreme weather events, and flash flooding.



Treated wastewater generated in wastewater treatment plants (WWTP) is an important component of Jordan's water resources (permanent and increasing).

In Jordan there are 29 wastewater treatment plants treating approx. 220 MCM in (2024) of wastewater in different type of treatment systems.

- The systems are divided into trickling filters, activated sludge and waste stabilization ponds.
- Most of the WWTP are small, except for the plant as As-Samra, which treats around 70% of this quantity (365.000 m³/ day).

















				الثفايات	مكونات						
متملة	الأخطار الكيميائية المحتملة الأخطار الفيزيائية المحتملة		الأخطار البيولوجية المحتملة								
الروائح الكريهة	مواد غير عضوية	اشياء حادة	المعادن الثقيلة	مواد کیمیائیة سامة	الامراض المنقولة	الديدان المعوية	الاوليات	بكتيريا	الفيروسات		
	12	<i>.</i>								اجزاء النفايات السائلة	
x						×	×	×	×	الفضلات المخففة (إنسان أو حيوان)	
×						×	×	×	×	البول (إنسان أو حيوان)	
×	×	×			×	×	×	×	×	مياه الصرف المنزلية	
		×	×	×	×	×	×	×	×	ياء الأمطار	
			×	×	×	×	×	x	×	ماء النهر	
			×	X						مياه العادمة الصناعية (ملاحظة 1)	
			0			<				اجزاء النفايات الصلبة	
×	×	×	1		×	×	×	×	×	الحمأة البرازية	
×	×	×	×	×	×	×	×	×	×	حمأة محطات معالجة مياه الصرف	
					×			×	×	نفايات المنزلية العضوية	
	×	×	×	×						النفايات المنزلية غير العضوية	
	×	×			×	×	×	×	X	مخلفات الزراعية (بقايا المحاصيل)	
	×				×		-			نفايات الحدائق	
×	×			-	×	×	×	×	×	السماد الحيواني/الطين	
×	×	×	×	×		×	×	×	×	النفايات الطبية	
×	×	×	×	×						المخلفات الصناعية	
×			×		×	×	×	×	×	نفايات المسلخ	
	×	×								مخلفات البناء والهدم	



Organics BOD, COD, TOC, O&G

TS, TVS, TSS, Solids TFS, TDS NH₃, TKN, N-N, TP Nutrients

pH, Temperature, Turbidity, Color, Odor Physical Properties Looking at the environment: the reuse of treated water allows for the conservation and allocation of freshwater and can enhance the restoration of streams, wetlands and ponds.

Nutrient rich and bio-solids: the aim of wastewater treatment has transformed from contaminant reduction to resource recovery in different forms including nutrient rich and bio-solids.









Electricity: outlet line from central treatment plant (a turbine plant). **Energy:** microbial fuel cell, which is capable of directly generating energy from substances such as waste water (If an electrode is placed in waste water, bacteria automatically begin to grow on it. These bacteria are capable of transforming the organic compounds present in the water into electricity).

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Sewage gas:

- which is generated in a wastewater treatment plant is purified to biogas and it is used as a fuel for CHP unit.
- The generated heat is used to heat the adjacent buildings and the electrical power is either utilized for internal needs of the wastewater treatment plant or it can be sold

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into the grid.





***** sewage sludge:

 In Jordan, more than 105,000 tons of dried sewage sludge were produced in
29 wastewater treatment plants in
2020 and are expected to increase to
up to 139,000 tons per year by 2035.





> Industrial Wastewater **Sludge**: this is the sludge that is obtained from warehouses, manufacturing premises industries and other businesses. It contains high amounts of heavy metals, pathogens and other chemicals, which can leach out if the sludge is not managed well.



Jordanian standards allow discharging treated wastewater to valleys and streams when it meets the specific criteria for many parameters such as BOD, COD, DO, TSS, Escherichia coli bacteria, and helminthes eggs.

In the present time, the reclaimed wastewater is used for restricted agriculture either near the plants or downstream after mixing with natural surface water. Jordanian Standard No. 893/2021.

			Standards for t irrigation p			
Indicator	Unit	Standards for discharge of water to streams or Wadis or water bodies (893/2021)	Parks play areas, road sides inside cities	Fruit trees, outer road sides, green lawn.	Fodder, industrial crops, forest trees.	Flowers
			А	В	С	D
BOD ₅		60	30	100	200	15
COD	mg/l	150	100	200	300	50
DO		>1	2<	_	-	2<
рН	_	6-9				
NO ₃		20	16			
Total N	ma/1	70	70 70			
Total phosphate	mg/1	5 10				
TSS		60	50	100		15
E. coli	MPN/ 100 ml	1000	100 1000			≤1.1
Nematode eggs	Egg/dm ³		<u><1</u>			

Name	Influent MM³/Y	Treatment System	Direct use M ³ /Y	Indirect use M ³ /Y	Flow End	Crop kind			
Alsamra	130		10	120	KTD				
			7	0.00	Special Tank		10%		
South Amman	8		28	0.00		Olive and Fodders	20%		
Madaba	3	Activated Sludge	tivated U.o.	0.00					
Al-Salt	4		1 3		Olive and Fruit trees				
					Wadi Shoab				
Al-Fuheis	1.5		0.00	1.4	Dam	Olive and Fodders			
Ain Al- Basha	6		0.1	5.6	KTD	Olive, Fodders and Nursery	■ Alfalfa 🛛 ■ Barl	ey ≡ Olive	
Kufranja	1.65	Filter	1.55	0.00		Olive, Fruit trees, Nursery	Cropping Pattern in Reuse Projects		
Maan	0.92		0.8	0.00	Wadi	Olive, Fodders	10	North	
Wadi Mousa	1.02	Activated Sludge	0.99	0.00		Olive, Fodders and Fruit trees	12	Madill	
Aqaba Mech.	10		9.3	0.00		Industrial uses, Landscaping	7	South	
Mafraq	2	Aerated Lagoons	1.9	0.00		Olive and Fodders			

Current situation of WW Reuse in Jordan:

- The percentage for reuse of reclaimed water in Jordan is more than 91% for the year 2022.
- □ Most of reclaimed water is used for:
- A) **Irrigation** as follows:
- 1- **Direct use**: for irrigating fodders in the surrounding areas of the treatment plants, about 50 MCM in the year 2022.
- 2- Indirect use: reclaimed water discharged to wadis such as Samra TP to Zarqa River reaching King Talal Dam (KTD) and blended with flood and base flow to be used in the Jordan valley about 150 MCM in 2022.
- B) Industrial activities: mainly for cooling as in Aqaba & south Amman.



> Influent reclaimed water 2016-2022: (153-200) MCM







➤ Number of Agreements with Farmer 2016-2022:

Number of Agreements







➤ Area planting 2016-2022:

Area (Dunam)







Biological Oxygen Demand (BOD) mg/l

- —JS (893/2021)Max. Limit for fruit trees,Sides of the outer roads and Green lanscapes.
- —JS (893/2021)Max. Limit for industrial crops,fiels crops and forest trees.
- —JS (893/2021)Max. Limit for collecting flowers



Water Quality of TWWPs



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Chemical Oxygen Demand (COD) mg/l

JS (893/2021)Max. Limit for fruit trees,Sides of the outer roads and Green lanscapes.

JS (893/2021)Max. Limit for industrial crops,fiels crops and forest trees.

—JS (893/2021)Max. Limit for collecting flowers









- Treated water price in Jordan:
- The main objective of MWI/WAJ is to encourage the farmers to reuse the treated water for restricted irrigation as stated in Jordan standard number 893/2021.
- In (22/4/2021) a new treated water price sold to farmers with (25 fills ≈ 0.035\$) per m³.

WWTP	Cost JD/ m ³
Alsamra	0.29
South Amman	0.25
Ma'an	0.91
Wade Moussa	0.97
Madhab	0.34
Al-Mafraq	0.22



We cannot just concentrate on producing more water without also addressing the energy used and the leakage in the old pipes.

We must redesign the pumps, so they are more efficient and use less energy (20% of total Jordanian energy).

We must redesign the WWTP and pumps, so they are more efficient and use less energy.





Following are Government's key objectives associated to wastewater management:

□ Sustainable Development.

Public health and environmental

protection.

Coping with water scarcity.

□ Improving quality.

Improving wastewater services.

□ Public & Private Sector Participation.

Adaptation to climate change impacts.





What Jordan do to overcome the current problems of water scarcity:

- There are couple of options to increase alternative water supply sources in Jordan:
- Desalination of seawater: Desalination can provide a safe drinking water to areas facing severe water scarcity, and may also help in resolving the conflict between urban and agricultural water requirement needs by providing a new independent water source.
- Reuse of wastewater: which is an attractive method in terms of water savings. In fact, the reuse of the treated wastewater in Jordan has reached one of the highest levels in the world.



National Water Carrier Project





Irrigation sector

Current and Future Water Resources for Irrigation in MCM



Industrial sector



- ***** Required actions and Recommendations:
- Adoption of the new technologies and techniques available including:
- Optimizing CWWTPs: reuse of treated wastewater and produce an effluent of WWTP fit for reuse in irrigation and in accordance with the quality guidelines and standards of WHO Increasing the quality and secure delivery of TWW will also create high quality reuse options.
- > Waste management and Re-evaluated all available projects.
- > Remove sediments from desert dams to improve infiltration.
- Decentralized wastewater management and enhance sewer access to the unserved population.
- Decreasing wastewater transfer losses: transfer and storage of TWW by river (wadi) runoff causes losses through infiltration and evapotranspiration.

المياه العربي السار



Rainwater Harvesting (RWH): An alternative option that offers substantial potential to increase available water supply is to expand national awareness and access to RWH to increase the network's supply.

RWH is a lower-cost, sustainable approach to diversify both agricultural and municipal water supply.

RWH is also one of the cheapest and greenest ways to increase the water supply, since there are few costs associated with transportation and energy.

يريجي التسايع



There has to be a proper combination between improvement of <u>irrigation methods</u> and selection of crop types.

- Application of updated water techniques, such as microsprinkling, drip and <u>sub-surface irrigation</u>, et., can reduce water loss and improve irrigation efficiency.
- Infrastructure improvement is also necessary to improving efficiency and reducing water loss.
- Crop substitution is another interesting method to increase water efficiency by growing new crop types that tolerate saline, brackish, and low irrigation requirements (by transfer foreign genes to plants).





- Building and operating of cost-effective and sustainable water and wastewater networks in all areas in Jordan and improving both the quality of the water supply and its equitable distribution.
- Scaling up alternative water technologies, including water saving and reuse, and engaging all family as agents of change on water conservation.
- Enforcement of sanitation safety planning.
- > Vertical agricultural (crops with less water and high yield).
- > Hydroponics agricultural.
- Indoor agricultural (greenhouses).





Some observations of the reuse of treated wastewater from different treatment plants:





Some observations of the reuse of treated wastewater from different treatment plants:



Reuse of treated wastewater in the area of the Wadi Musa wastewater treatment plant



أسبوع المياه العربي السابع













