CELEBRATING 30 YEARS
WATEREUSE | 1990 2020

Water reuse in Palestine, current situation, challenges and future perspectives

A. Rasem Hasan, Ph.D.

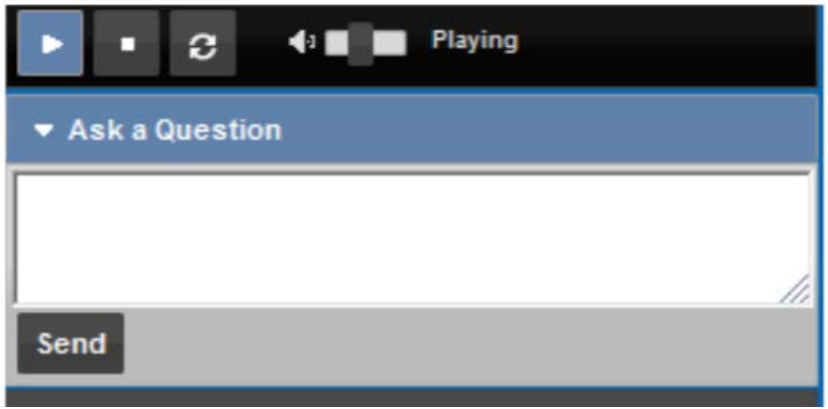
9 December 2020

Reaching New Heights in Water Reuse

2020

A Few Notes Before We Start…

- Today's webcast will be 60 minutes.
- There is one (1) Professional Development Hour (PDH) available for this webcast.
- A PDF of today's presentation will be shared via email
- Please type questions for the presenters into the chat box located on the panel on the left side of your screen.



Today's Presenter

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Director of Water and Environmental Studies Institute

An-Najah National University

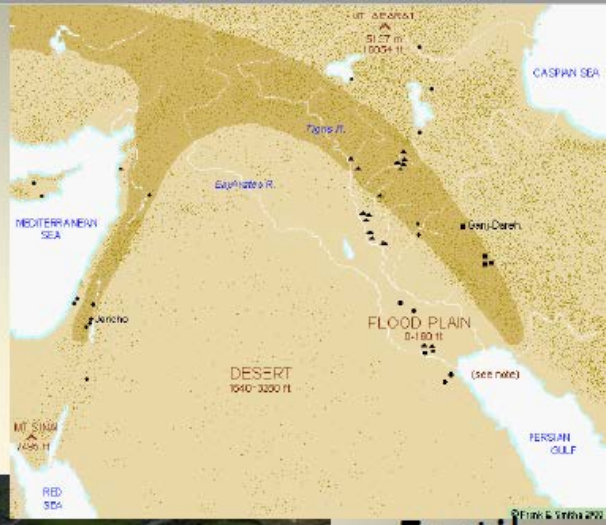
Nablus, Palestine

Contents

- Background
- Major Issues
  - Water Resources and supply
  - Brackish water and seawater intrusion
  - Wastewater
- Solutions
- Current Wastewater Management and Treatment
- Water Reuse Regulations
- Current Reuse Projects for Irrigation
- Current research and capacity building projects - ANU
- Closing

Case study from Palestine

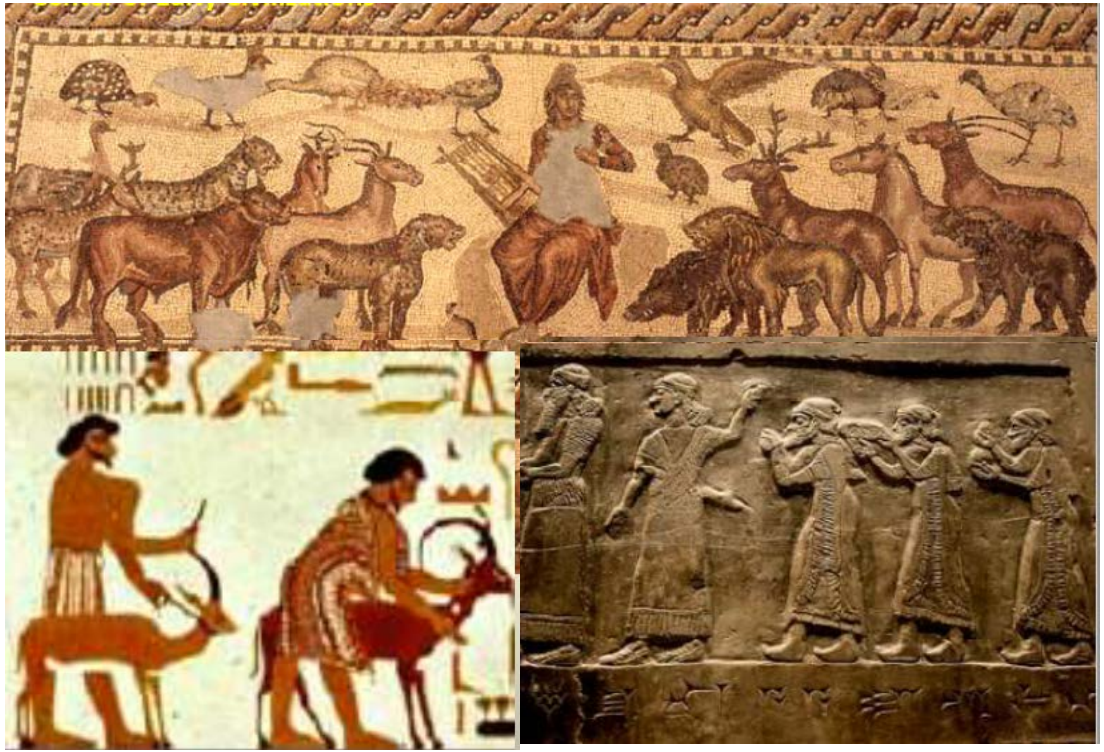
Unique area with significant challenges today but rich diverse history



Fertile Crescent

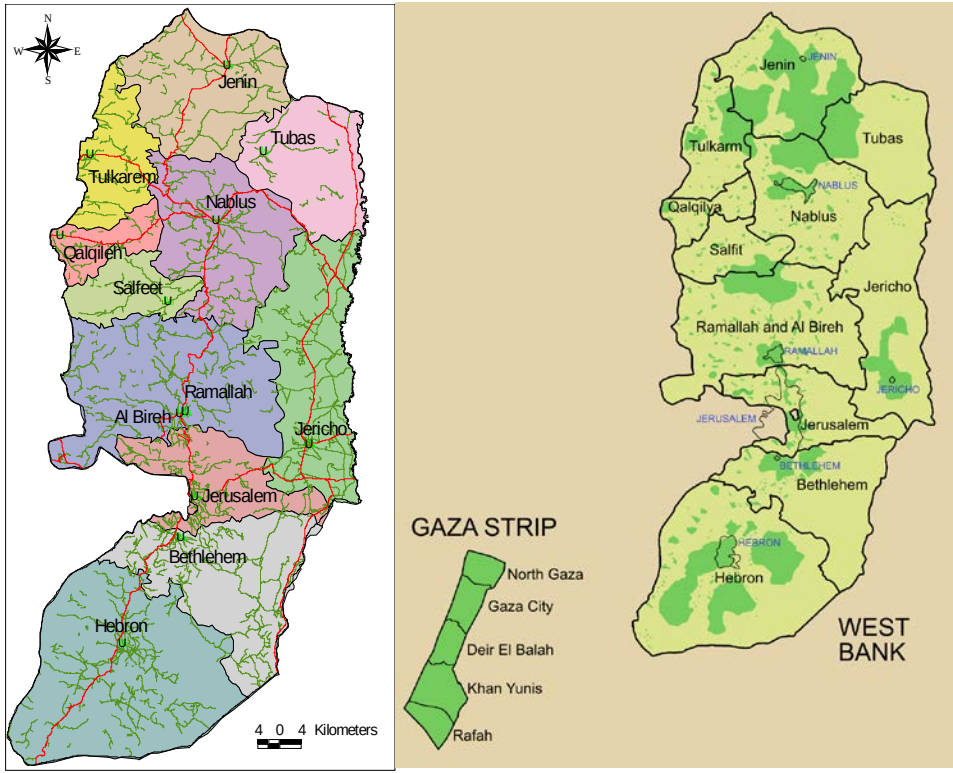
الهلال الخصيب

Farming is the Oldest Economic Activity in Palestine since12,000 BC



The West Bank

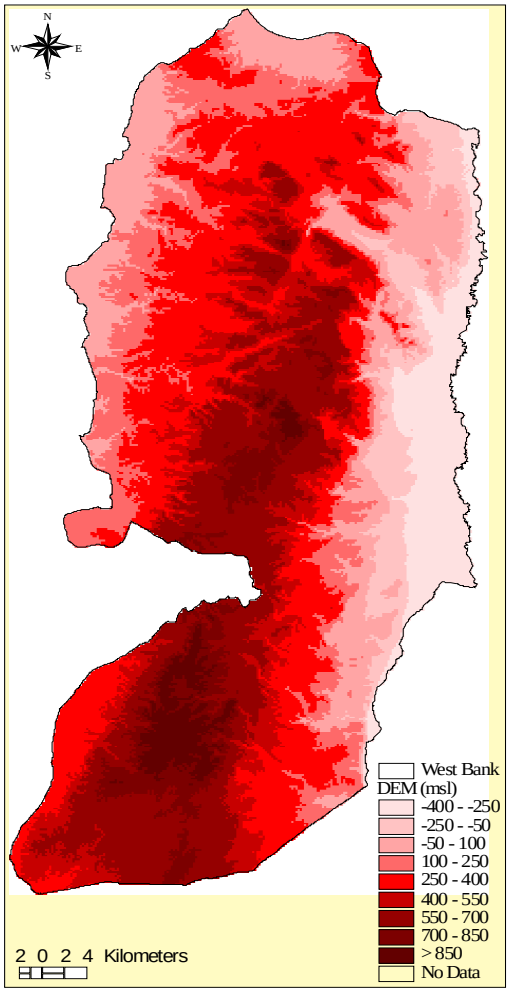
- Area: 5,650 km2
- Maximum length is 130 km and 54 km in width, approximately
- 11 Governorates in West Bank (5 in Gaza Strip)
- Population (2020)
  - West Bank: 3 Million
  - Gaza: 1.9 Million



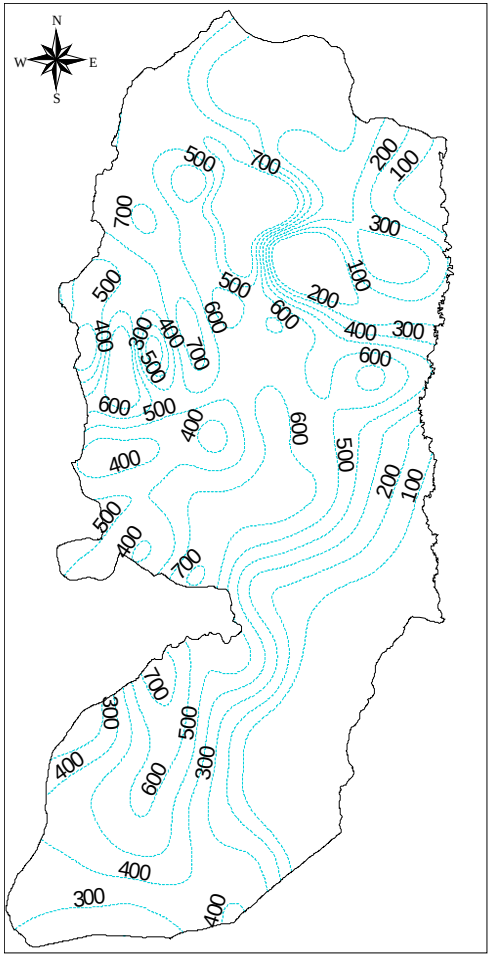
Topography

- Ground surface elevation in the West Bank is as high as 950 m in Nablus and Hebron

- The lowest ground surface elevation is near Jericho (adjacent to the Dead Sea) 370 m below msl



Rainfall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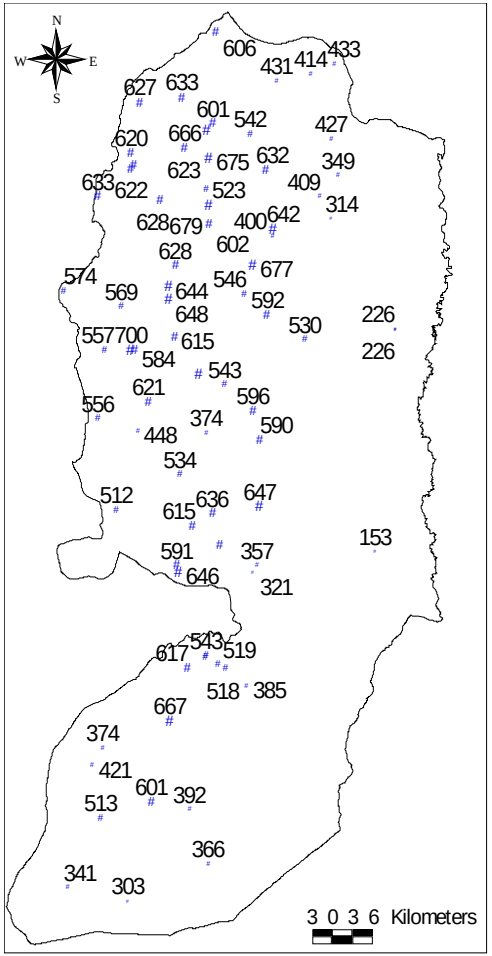
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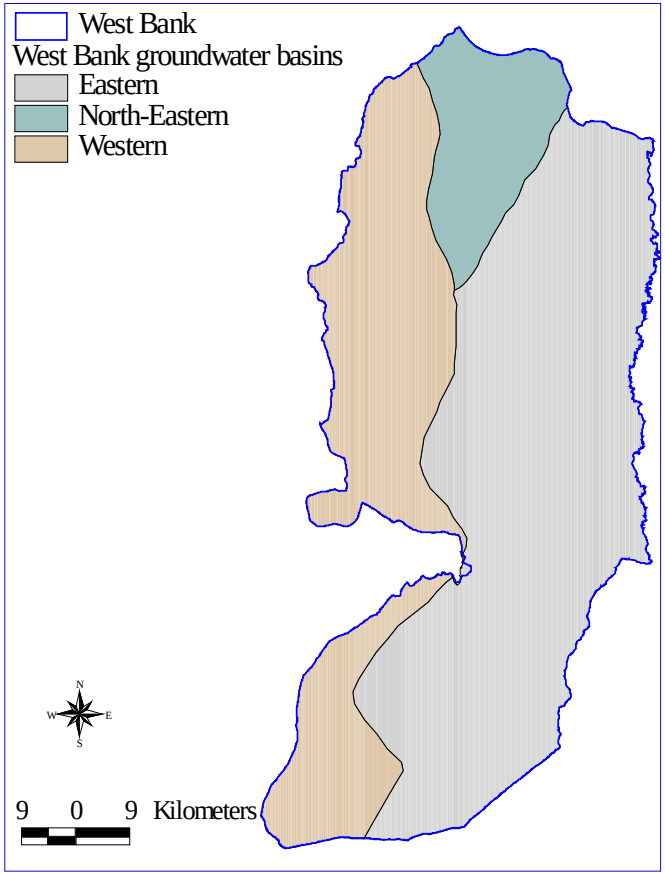
General Facts

- 70% of the population is below the age of 30 (PCBS, 2018).
- Around 27% of the Palestinian population is unemployed of which 44% of the Palestinian women (UN Country Team, 2016).
- 34% of Palestinian households were classified in 2012 as food insecure; this percentage jumped to 57% in Gaza Strip due to humanitarian and socioeconomic conditions
- The annual water share of Palestinians is less than 200 m3/capita

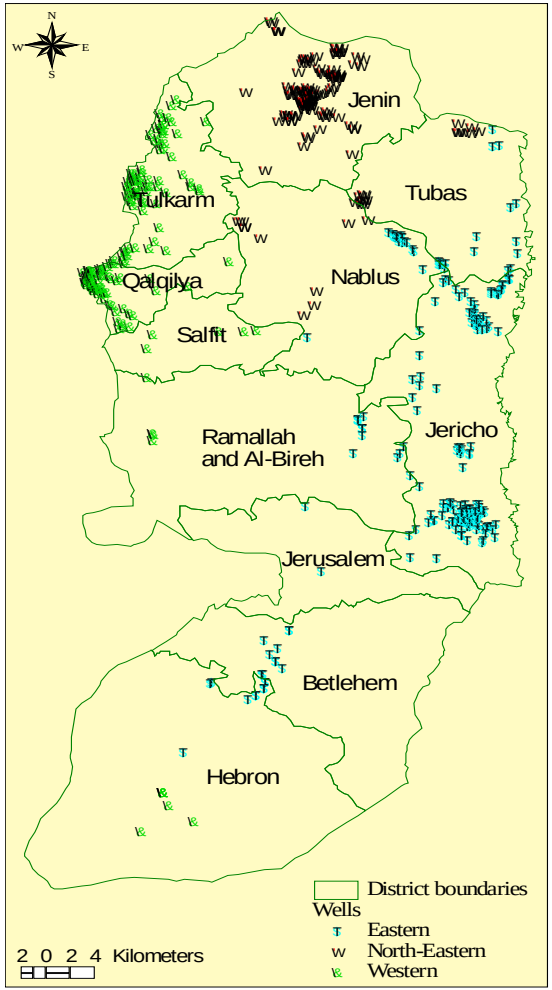
Water Resources in the West Bank

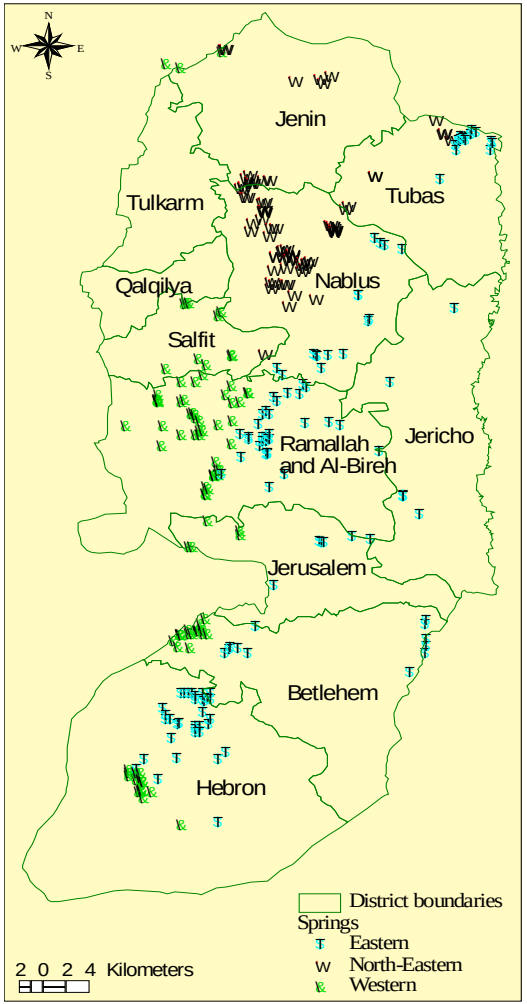
- The principal water resources available to Palestinians include:
  - Groundwater (more than 95%)
  - Surface water
  - Harvested rainwater

Groundwater basins



Wells and springs





Water Supply and Sanitation in Palestine

- Lack of control over West Bank/Gaza water resources and infrastructure development
- Water supply and sanitation infrastructure and services suffer from deficits and operational inefficiencies
- Only 10 towns in WB and 60% of households in Gaza are served by collective sewer system
- Water supply distribution is arranged by 300+ service providers, including semi-regional Service Providers, municipal SPs in urban areas, VCs water departments and JSCs in rural areas.
- Fees collection rate in WB is 65-75% and 25-50% in Gaza.

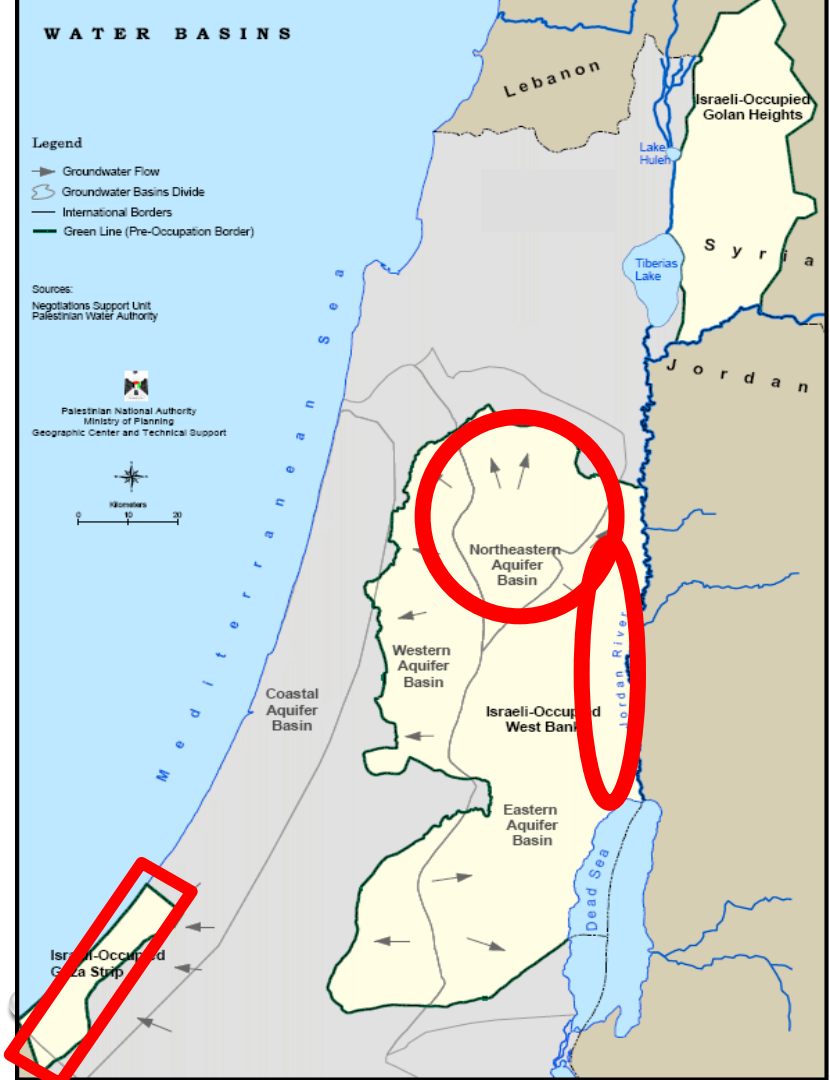
Water Supply and Sanitation in Palestine

- UFW and water losses are high (24%-55% in WB, 41%-46% in Gaza)
- Irrigation consumes 60-70% of water resources in WB/GZ through inefficient practices and deteriorating infrastructure, contributing 12% to GDP
- Governance and capacity weaknesses in water sector, incl. of LGU service providers, in need of institutional reform, reorganization and capacity building to define clearer roles and accountability and increase organizational effectiveness

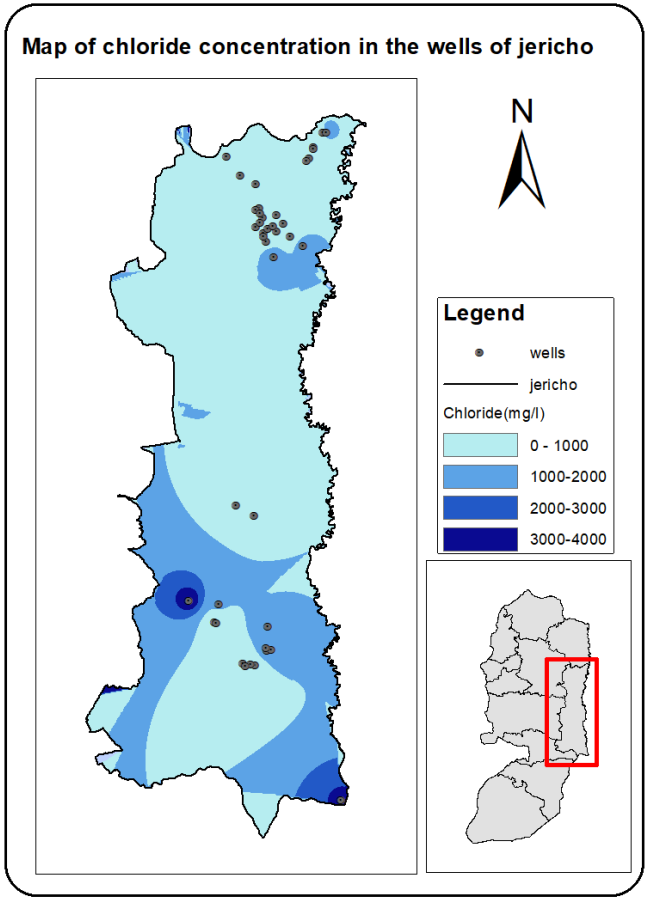
Impaired Water Aquifers

3 Main areas:

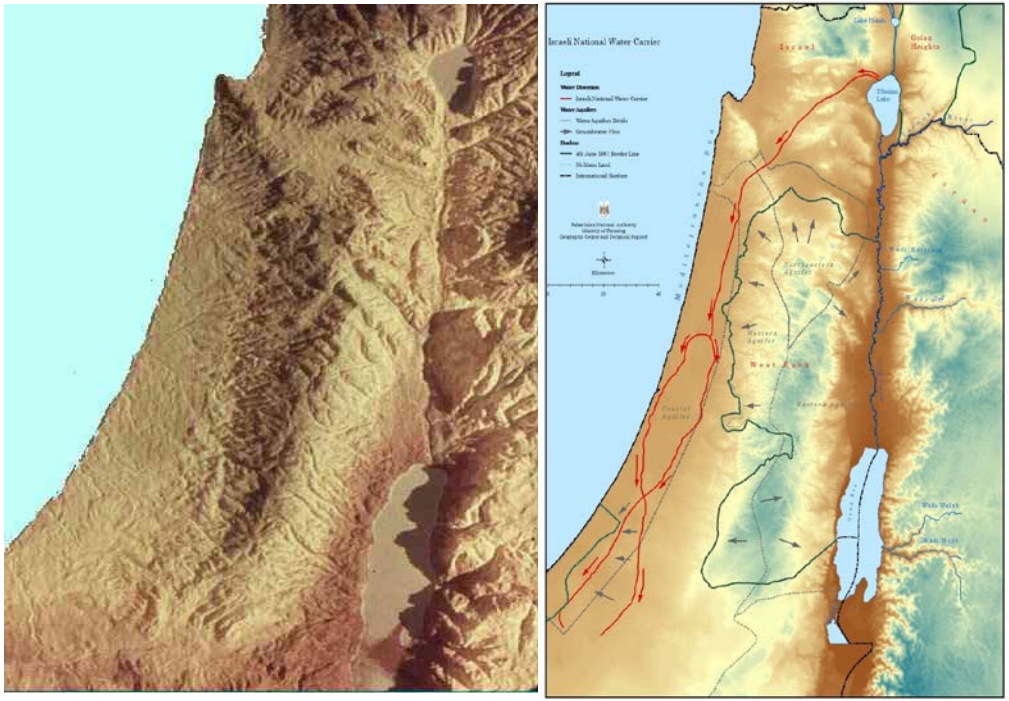
- Jenin and part of Nablus
  - Polluted Groundwater
    - NO_3 pollution
    - Hardness
- Jericho and Aghwar (below sea-level areas)
  - Salinity
  - Hardness
  - NO_3 pollution
- Gaza
  - SALINITY
  - NO3
  - Damaged Aquifer



Groundwater Salinity - Jericho



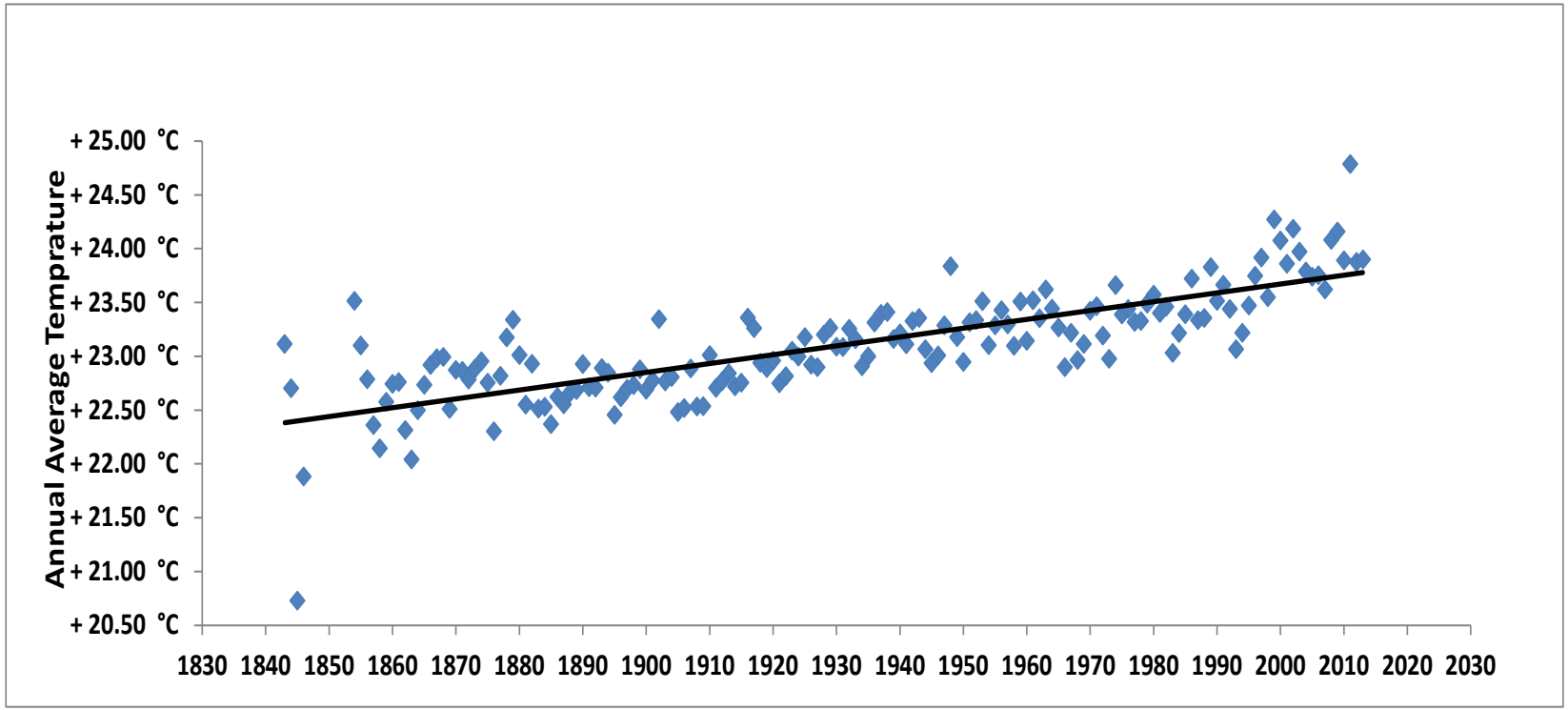
Surface water resources in the West Bank



Jordan River

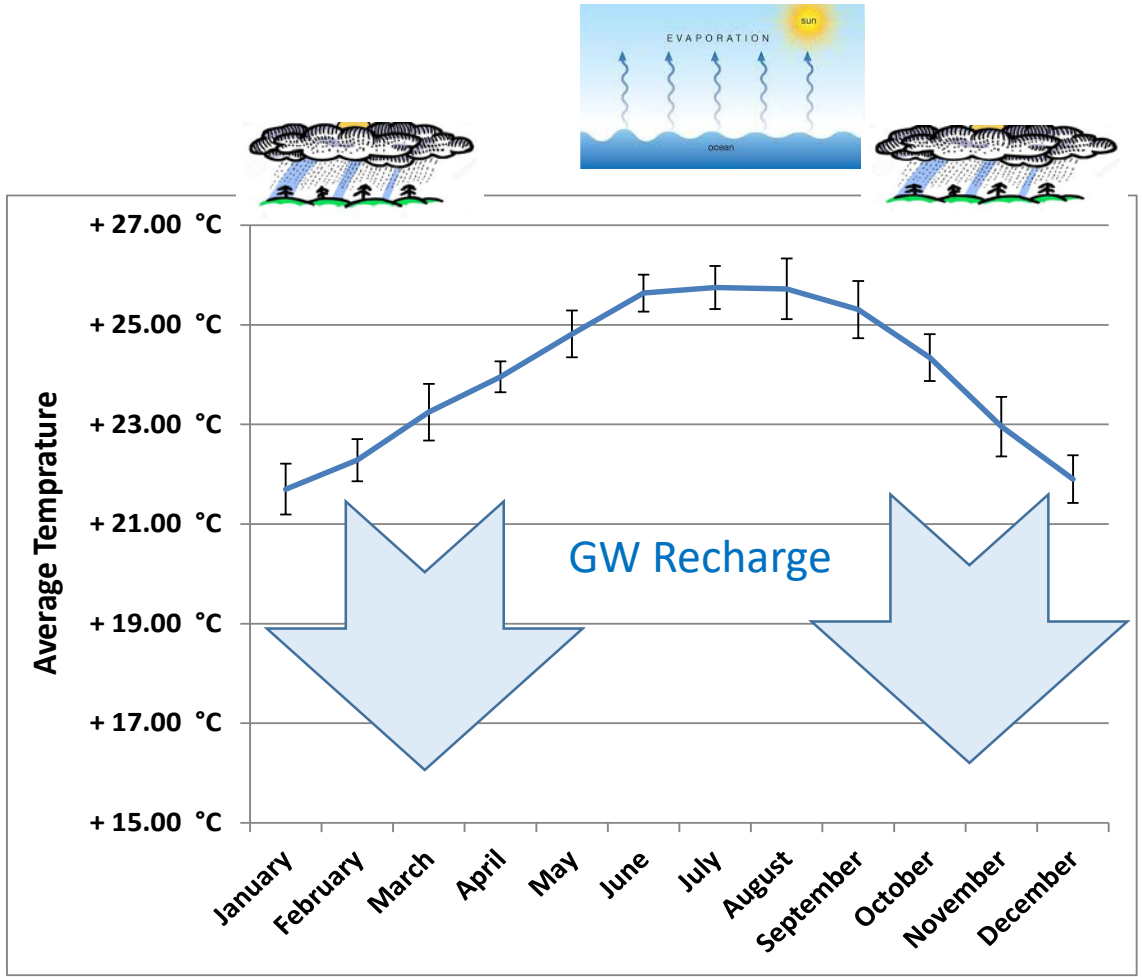
- Israel and Palestine share the Jordan River with three other riparian countries: Lebanon, Syria and Jordan
- However, Jordan River water has not been a significant water source for West Bank

Climate Change – Annual Average Temperature

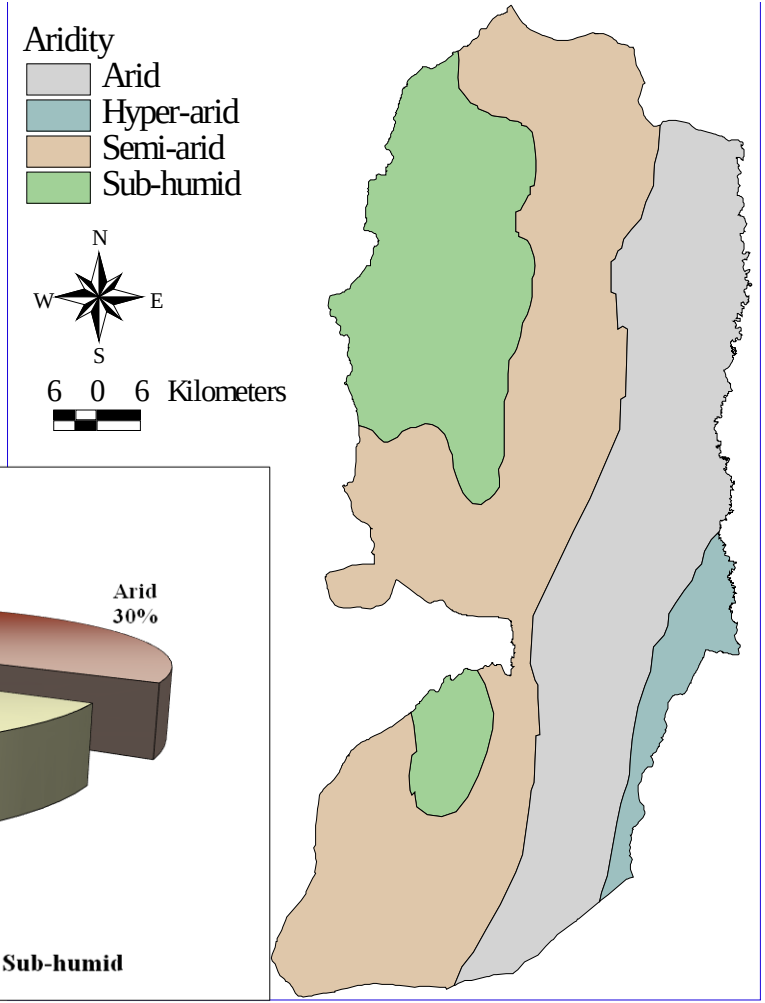


Climate Change: Values are average for WB

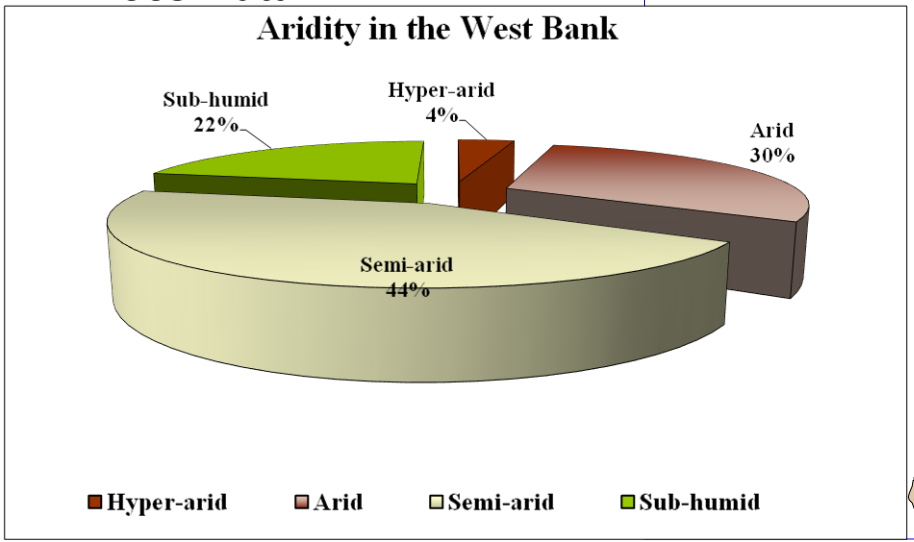
- Changing in the amount and patterns of precipitation.
- More frequent heat waves
- Increase in the number of droughts
- Reduction in Potential GW Recharge



Aridity



2009 Data



Spatiotemporal trend in Aridity Index (AI)

- **AI = (**annual precipitation **) P /**
  (potential evapotranspiration **) PET**

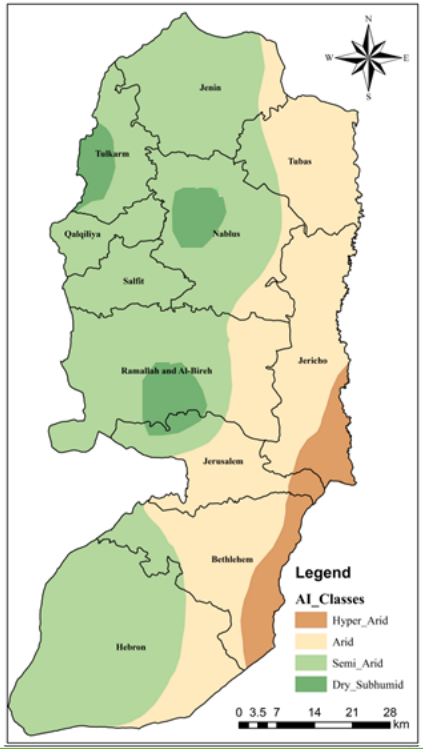
(2010-2019)

Aridity class	AI
Hyper-arid	AI < 0.05
Arid	0.05 < AI < 0.2
Semiarid	0.2 < AI < 0.5
Dry-subhumid	0.5 < AI <0.65

Legend

AI_Classes

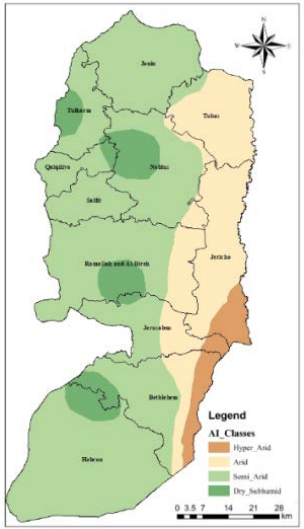
- Hyper_Arid **(AI < 0.05)**
- Arid **(0.05 < AI < 0.20)**
- Semi_Arid **(0.20 < AI < 0.50)**
- Dry_Subhumid **(0.50 < AI < 0.65)**



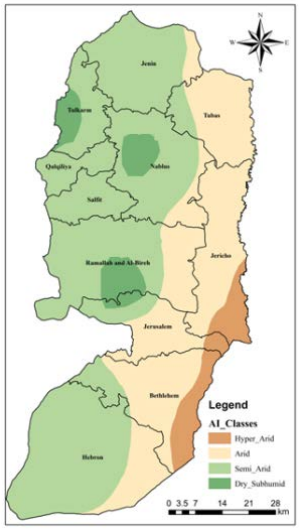
Spatiotemporal trend in AI

Governorate	AI-Class	2000-2009 Percent (%)	2010-2019 Percent (%)
Hebron	Hyper-Arid	0	0
	Arid	17	20
	Semi-Arid	76	80
	Dry-Subhumid	7	0
Nablus	Hyper-Arid	0	0
	Arid	12	16
	Semi-Arid	65	68
	Dry-Subhumid	23	16
Jenin	Hyper-Arid	0	0
	Arid	0	9
	Semi-Arid	100	91
	Dry-Subhumid	0	0
Jericho	Hyper-Arid	18.6	20
	Arid	81	80
	Semi-Arid	0.4	0
	Dry-Subhumid	0	0
Ramallah	Hyper-Arid	0	0
	Arid	19	24
	Semi-Arid	68	64
	Dry-Subhumid	13	12

2000-2009



2010-2019



Vulnerability to Climate Change (and Aridity)

- Exaggerate water scarcity
- Rate of **vegetation has decreased** in 42.7% of the West Bank area, especially in the Jordan Valley region.
- Approximately 22.3% of the Jordan Valley area is under the effect of active degradation.
- **Growing season** has become shorter
- Stocks and grazing ranges have declined and Food price has become higher

Vulnerability to Climate Change

- **Salinity** of groundwater has increased
- Reduction in groundwater recharge
- Shift in **cropping patters**, to more salinity tolerant crops.
- **Livelihoods** of inhabitants has been negatively impacted
- **Decline in the population** of the Northern Jordan Valley region

Recommendations to Combat and Adapt to Climate Change and to Enhance Food Security

To do this, the Palestinian authority should :

- Invest in expanding Wastewater Collection and Treatment
- Invest in implementing
  Treated Wastewater Reuse Projects
- Institutionalize and capacity build of the reuse sector

Barriers for TWW reuse (2003 exercise; MSc Thesis)

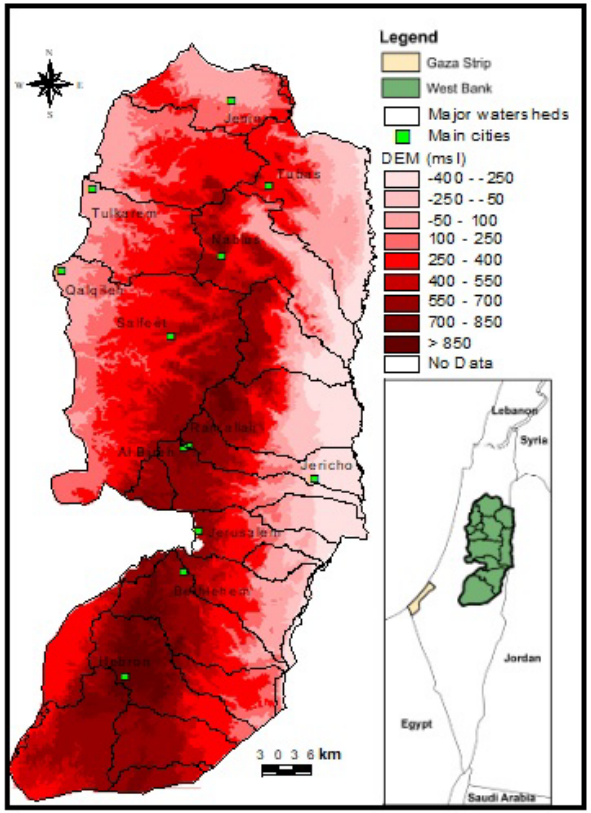
- Political – issue of licensure
- Institutional - weakness
- Policy and regulatory framework - absence
- Socioeconomic – public acceptance and purchasing power
- Infrastructure - lack
- Financing - priority
- Cultural – religious beliefs
- Human resources – levels of education and training

Current WW Management and Treatment

Map of WWTPs in the West Bank

West Bank Population (2017)	**2,881,687 capita (PCBS, 2017)**
Area	5,860 km^2
No. of households	792,589 (PCBS, 2017)
% of pop. served by sewage collection systems	41%
No. of WWTPs	51 (Large to medium)
Unserved Population Mainly in Rural areas	**Use Cesspits**
% of pop. served by WWTPs	**18%**
Management	Local Councils

Major Problem of Treated and Untreated WW – transboundary water issue

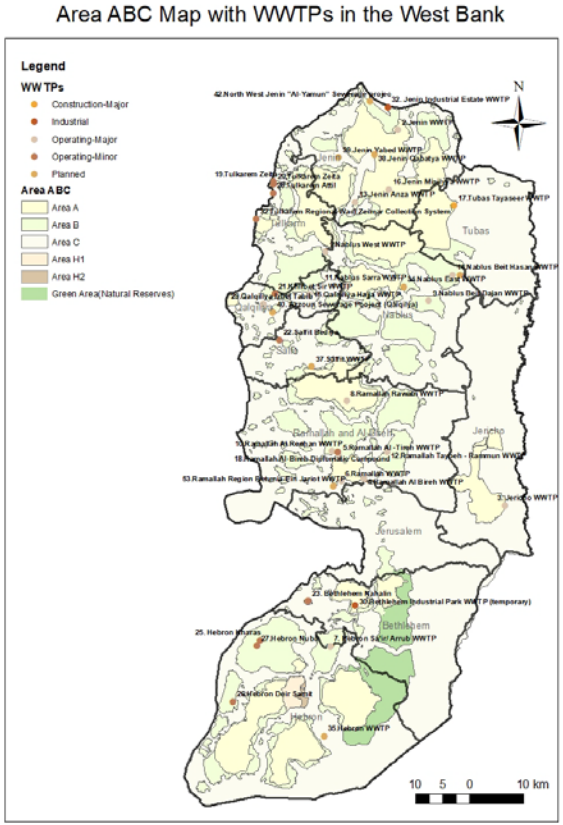


Due to Topography, most of the flows destines in Israeli Lands

Israel charge the PA for the (extra)treatment of the WW

Interest by both ends to improve Palestine's WW management and promote reuse

Major Problem of Treated and Untreated WW – Area C and Potential Use of Treated WW



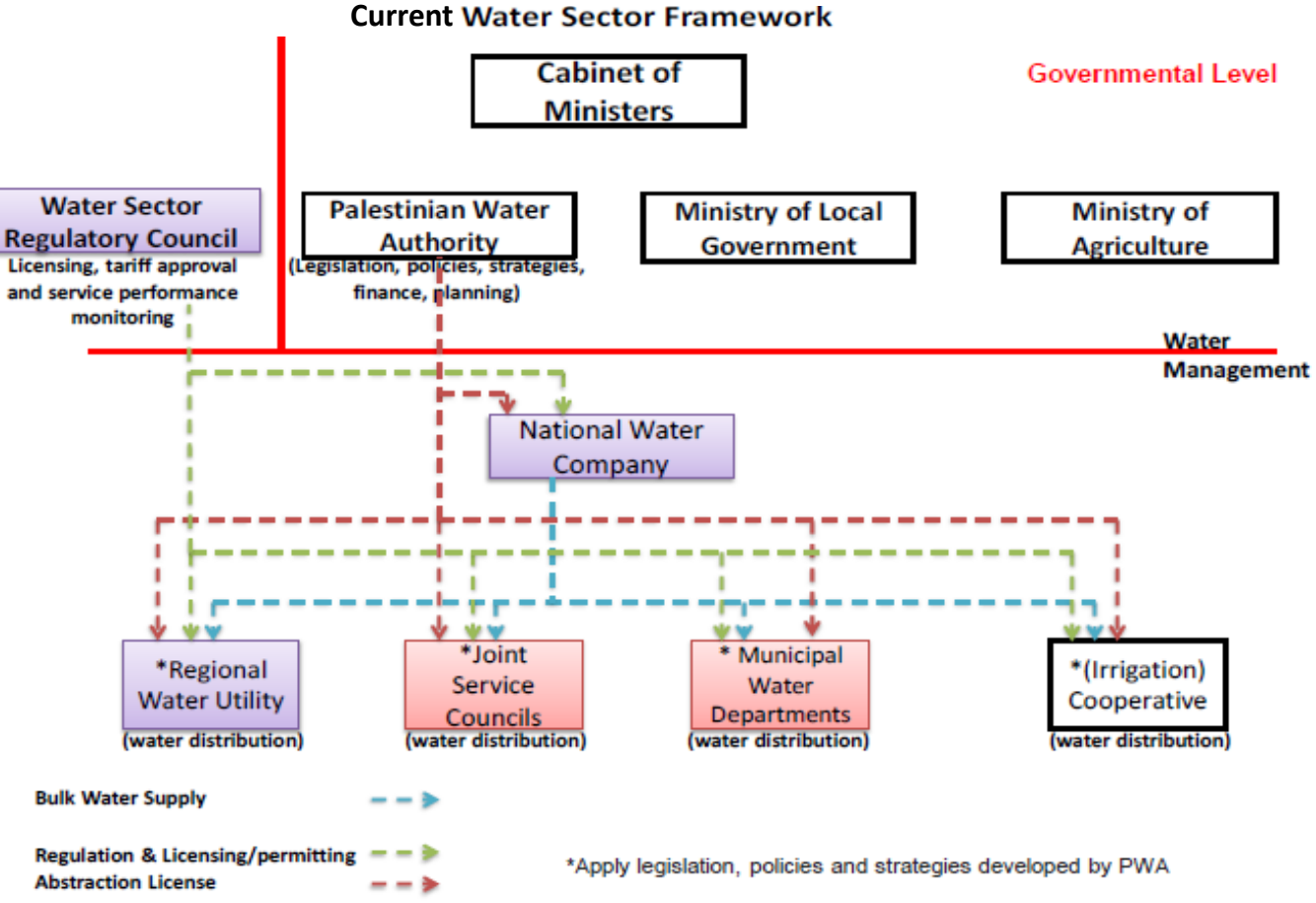
Most of Suitable Locations for New WWTPs are in Area C

Same for Reuse in Irrigation Projects

Palestinian Water Authority Reuse-Laws, Policies and Strategies

- In 2000, Efforts of reuse of treated WW started at small scale with no success
- In 2012 Water and Wastewater Strategy published and encouraged Reuse in Irrigation
- 2012 Also, Regulation for treated wastewater reuse were released
- In 2014 New water law was released with clauses for Reuse
- In 2018 New Water Policies released that include PPP1; PPP2; Non-Conventional Sources; Sustainability; and Accountability

Water and Wastewater Governance



Palestinian Cabinet
- Overall supervision, policy making

Palestinian Water Authority (PWA)
- National level Master Plans
- Policy and legislation

Water Sector Regulatory Council (WSRC)
- Tariff approval, licensing
- Consumer protection

National Water Company (NWC)
- Bulk provider of water

Regional/Local Service Providers
- Regional Water Utilities
- Municipalities, Village Councils
- Joint Service Councils

Water and Wastewater Funding

Funding

Foreign Aid Agencies, International Organizations

- Master planning, design, construction of infrastructure

Local Government Tariffs

- Operation and maintenance of treatment

Water Reuse Regulations

Technical Regulation 34-2012

- For agricultural irrigation
- Four categories
  A. High quality
  B. Good quality
  C. Medium quality
  D. Low quality

Standard	Category	Reuse Condition, category	Intestinal nematodes (mean no. of eggs per liter)	Fecal coliforms (mean no. per 100)	TSS (mg/l)	BOD_5 (mg/l)	TN (mg/l)
WHO Guidelines (1989)	A	Irrigation of crops likely to be eaten uncooked, sports fields, public parks	≤ 1	≤ 1000			
	B	Irrigation of cereal crops, industrial crops, pasture and trees	≤ 1	-			
	C	Localized irrigation of crops in category B if exposure of workers and public does not occur	-	-			
Palestinian Guidelines (PSI, 2012)	A	High	≤ 1	200	30	20	30
	B	Good	≤ 1	1000	30	20	30
	C	Average	≤ 1	1000	50	40	50
	D	Low	≤ 1	1000	90	60	90

Palestinian Standard 742-2015

- Quality requirements
- Monitoring requirements
- Additional barriers requirements

Current Reuse In Irrigation

- Master plans for wastewater collection, treatment and reuse supported primarily by the donor agencies who provides both financial and technical inputs.

- Local experts and academics have been working with the experts from overseas providing site-specific knowledge

- By 2018 Master plans covered the whole WB and Gaza strip

Current Reuse In Irrigation (Jenin)

Efforts to utilize treated effluent started initially as a small pilot program implemented in the region of Jenin

- Marj Ibn Amer Cooperative for Irrigation as Reused Water Association was Established in 2015

Current Reuse In Irrigation (Jenin)

First water reuse scheme in Palestine

Current WW Treatment Plant since 2013

- Aerated lagoon system
- 3,500 m3/day

Reuse Project

- Funded by OPEC Fund for International Development
- Implemented by American Near East Refugee Aid (ANERA)
- 300 hectares
- First establishment of Cooperative for Irrigation to Reused Water Association
- Distribute water
- Collect fees
- Municipality responsible for operation of treatment plant

Current Reuse In Irrigation (Nablus)

Nablus Project followed and still in development

- The wastewater treatment plant in Nablus included a pilot system to include tertiary filtration and disinfection to introduce irrigated farming to the region where rain-fed farming was dominant before the development of the water reuse project

Current Reuse In Irrigation (Nablus)

Nablus Project followed and still in development

WW Treatment Plant in operation since 2013

Educational Reuse Pilot Project (KfW)

- 4 hectares
- ~ 1% of effluent

Reuse Pilot (USAID)

- 18 hectares
- ~4% of effluent

Reuse Pilot (KfW)

- 12 hectares
- ~5% of effluent

Reuse Project (KfW)

- 280 hectares
- ~70% of effluent
- Planning phase

Current Reuse In Irrigation (Jericho)

Unique reuse projects also emerging

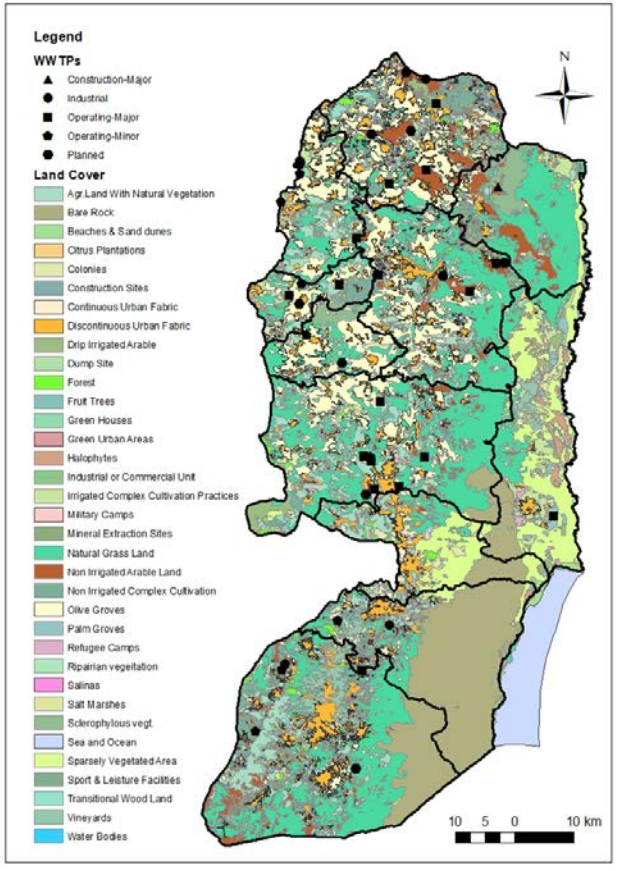
WW Treatment Plant in operation since 2014

Water reuse project – no external funding

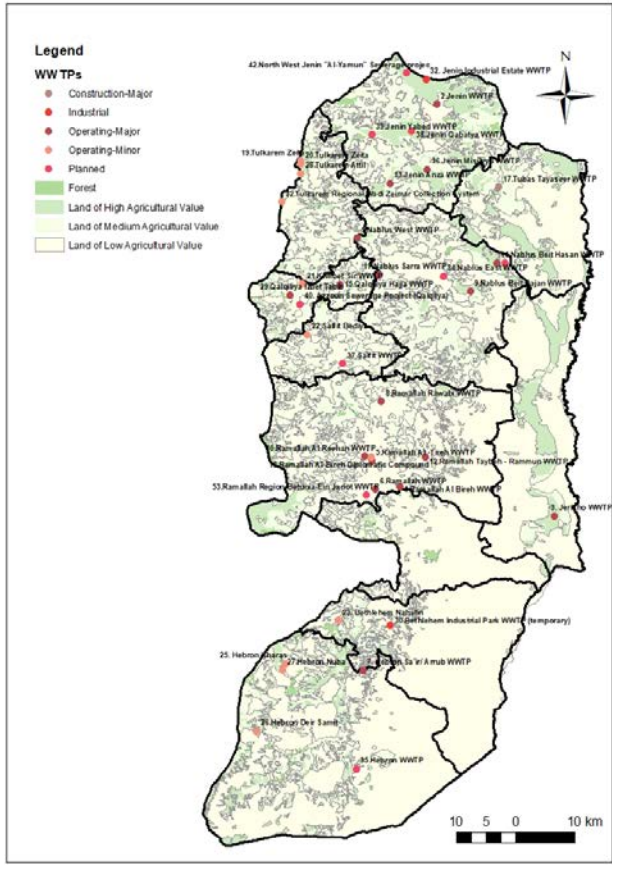
- Nearby farmers take all treated effluent for date palm farming
- Managed by Jericho Municipality

Current Reuse in Irrigation

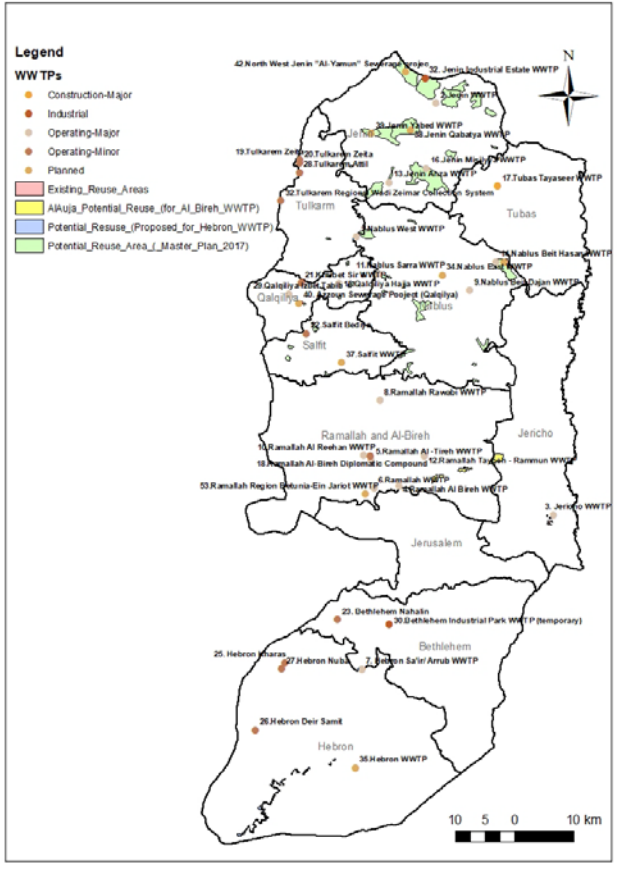
Land Cover Map with WWTPs in the West Bank



Agricultural Land Map of the West Bank

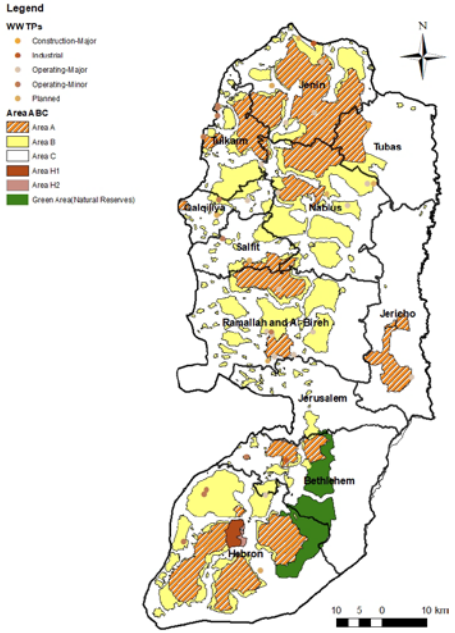


Potential reuse Map with WWTPs in the West Bank



Current Challenges with Reuse

- Existing/new/planned treatment plants not always near agricultural demand
  - Need to develop new demand (example in Nablus)
- Geopolitical boundary
  - Approval process can take years
  - Not able to cross boundaries to convey effluent to the area with high demand
- Monitoring and enforcement are not fully implemented
- Ongoing effort to improve farmers' acceptance (generally successful)



Growing Reuse Knowledge in the Country

- Growing depth of local experts including local universities, government agencies and private sector experts within Palestine have been involved deeply in multiple programs, accumulating knowledge and experience.

- These local experts are taking key roles in understanding specific and detailed conditions and challenges faced by each region's water issues. Whereas experts from the donor agencies' home countries bring fresh views on potential solutions.

- Local experts and ongoing projects are helping farmers and public acceptance of water reuse.

Ongoing research/capacity building projects on reuse by An-Najah National University and its Partners

Rapprochement
PCR.PS

BETHLEHEM UNIVERSITY
جامعة بيت لحم

معهد فلسطين للتنوع الحيوي والاستدامة
Palestine Institute for Biodiversity and Sustainability

معهد الأبحاث التطبيقية جمعية الجليل
The Institute of Applied Research Galilee Society

This Project is Funded by
EUROPEAN UNION
الاتحاد الأوروبي

Net-Zero Discharge of Rural Wastewater using Smart Aquaculture Pilots for Production of Ornamental Fish and Commercial Flowers

جامعة النجاح الوطنية - نابلس

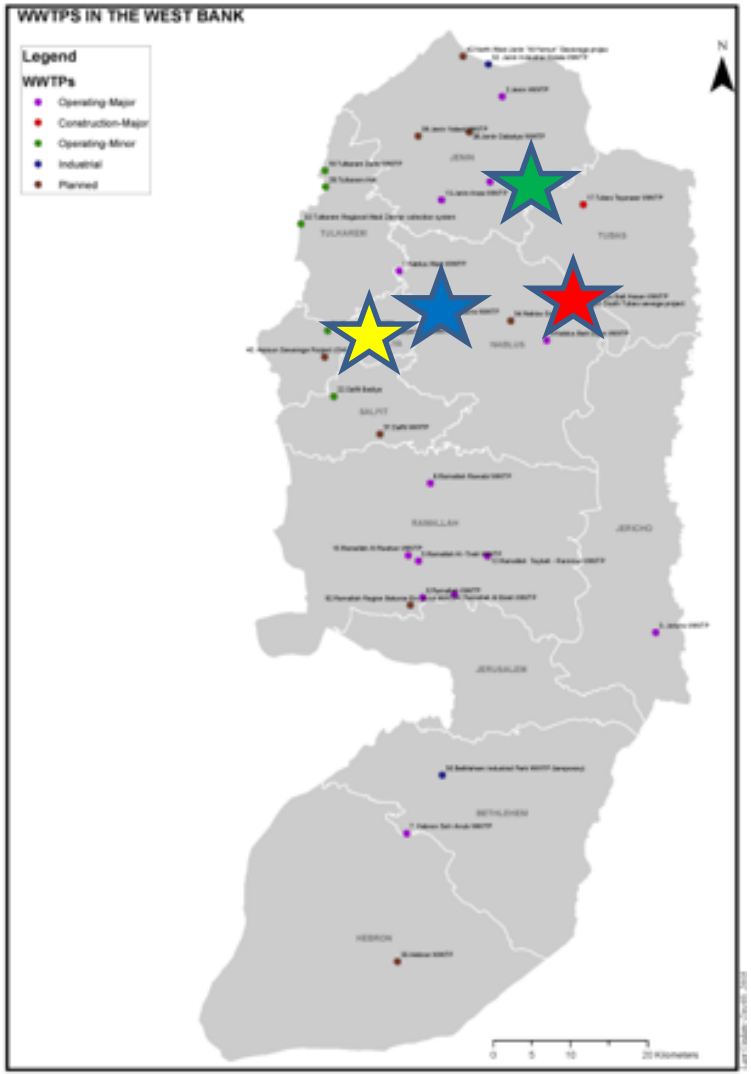
WESI

FAO
FIAT PANIS

Current Reuse In Irrigation - Rural Areas

Research on Existing Wetlands

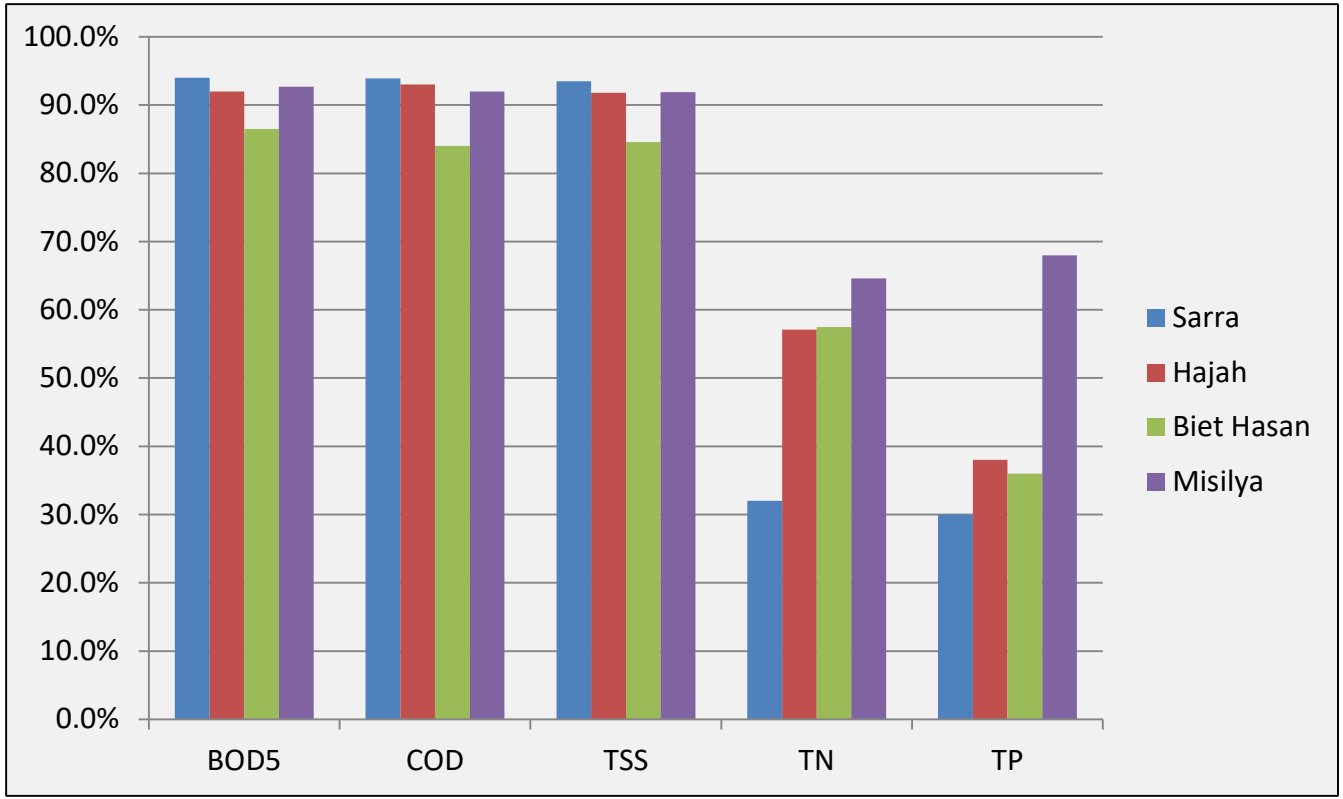
Misilya CWL



- ❑ Constructed Wetlands (WWTPs) in Palestine

- Sarra
- Hajja
- Beit Hasan
- Misilya

Overall performance efficiency of studied CWL-WWTPs

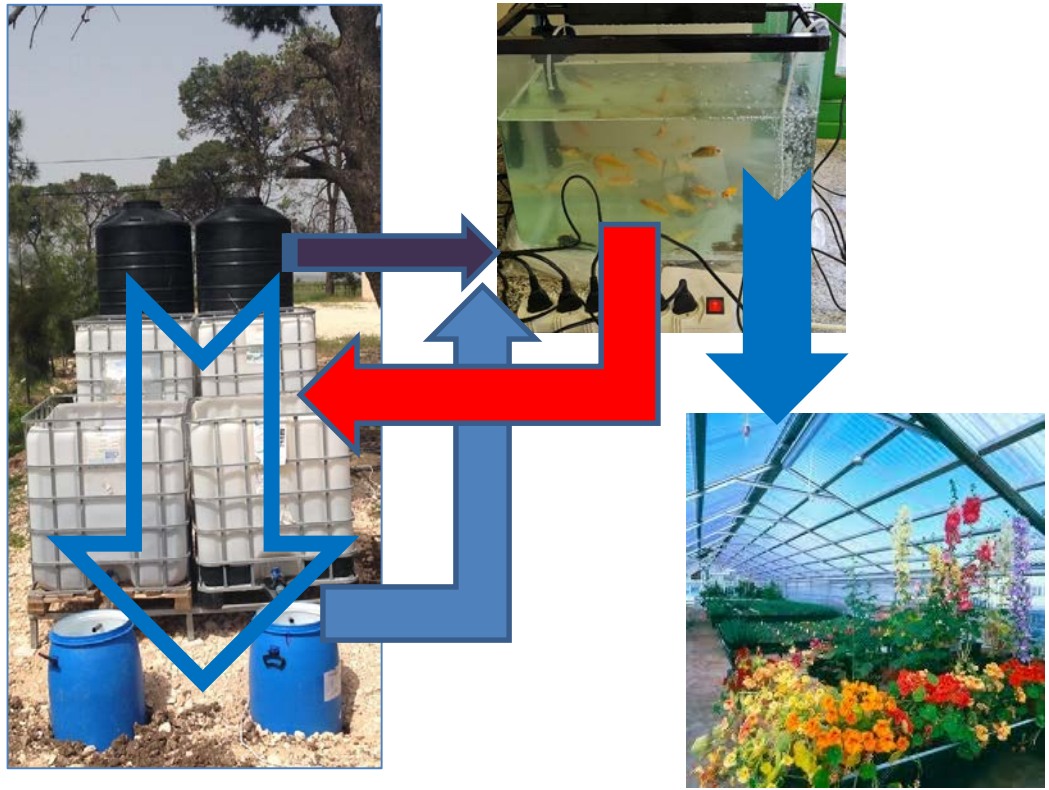


(mg/L)	Effluent Quality of Studied WWTPs				Palestinian Guidelines			
	Biet Hasan Plant	Mesilya Plant	Hajjah Plant	Sarra Plant	A	B	C	D
BOD_5	65	66.6	39	43	20	20	40	60
COD	150.6	131	74.6	94.3	50	50	100	150
TSS	180	78.4	82.3	83.3	30	30	50	90
TN	54.5	44.5	72	119.4	30	30	45	60
TDS	1259.3	1079.4	1054.3	1276.3	1200	1500	1500	1500
pH	7.93	7.58	7.54	7.24	6-9	6-9	6-9	6-9

Main idea: Net Zero Discharges

WW

Source



Existing CWL Pilot

at NARC Jenin

Advancing Wastewater Reuse in Palestine: A Framework for Enhancing Sector Governance, Livelihood, Food Security, and Environmental Ethics in the case of North West Bank (ARTWW-P)

Bundesministerium für Bildung und Forschung

DLR Projektträger

وزارة التربية والتعليم العالي

Partnership

Cologne University of Applied Sciences/

Institute for Technology and Resources Management

in the Tropics and Subtropics (ITT)

Prof. Dr. Lars Ribbe *Dr. Suha Al-Madbouh*

An-Najah National University/

Water and Environmental Studies Institute (WESI)

Dr. Abdel Fattah Hasan *Dr . Amer Elhamouz*

Dr. Shehdeh Jodeh

Ministry of Agriculture/

National Agricultural Research Center (NARC)

Dr. Zaher Barghouthi *Dr. Abdallah Alimari*

Technology Arts Sciences TH Köln

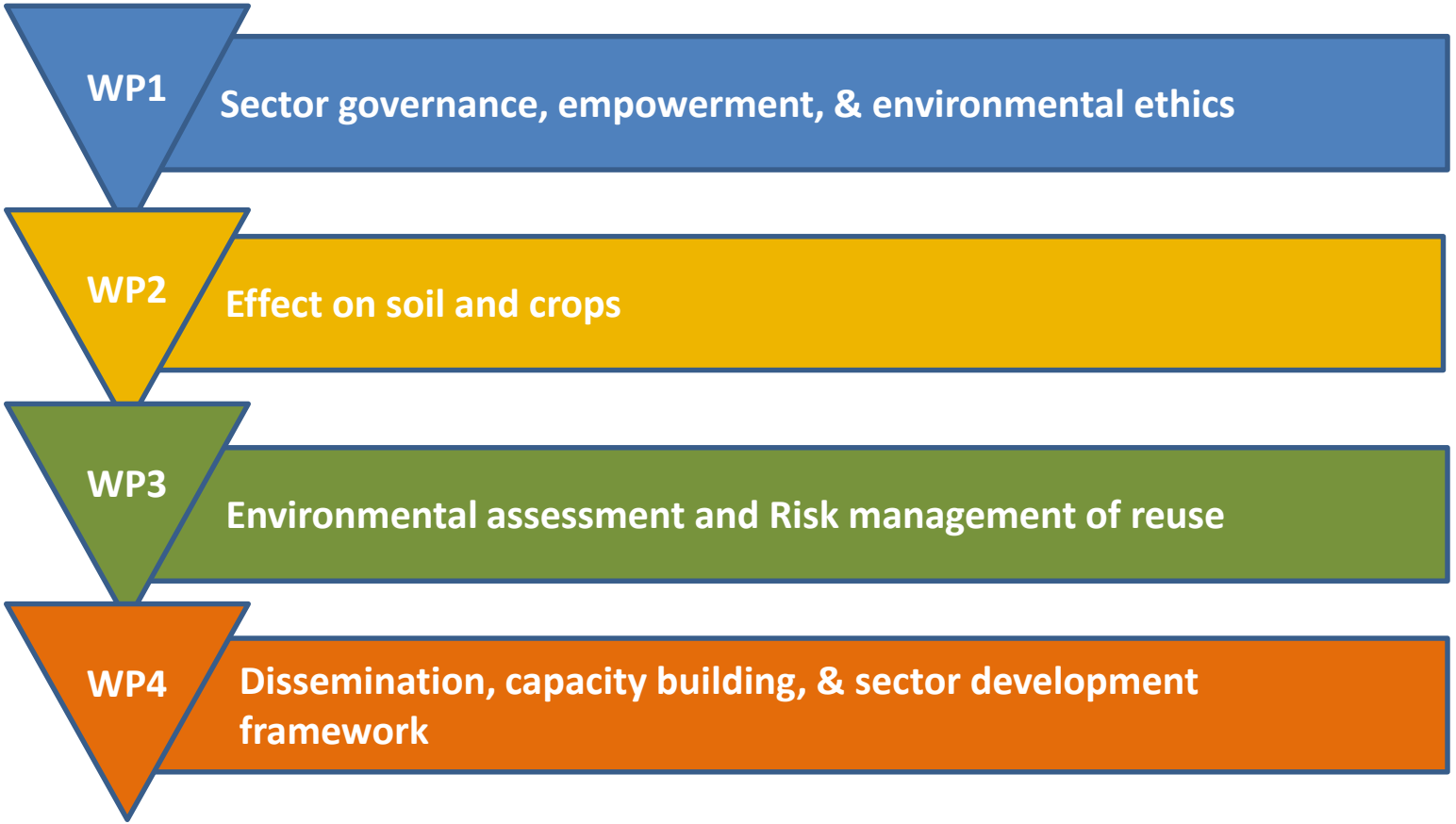
ITT

WESI

10-12 Sept 2019

Kick-off meeting

Research work plan



Project Title: **Testing the feasibility of small and affordable water desalination and purification systems in the West bank**

- Work packages and Team:

- Technical
  - Abdel Fattah hasan
  - Willem van Baak
  - Emad khatibzadeh

- Governance
  - Patrick Huntjens
  - Joris Voorhoeve

- entrepreneurial business planning
  - Otto kroesen

Purpose

- To develop a water treatment technology for:
  - humanitarian purposes
  - Remote areas and Bedouins
  - Small scale farming and agriculture

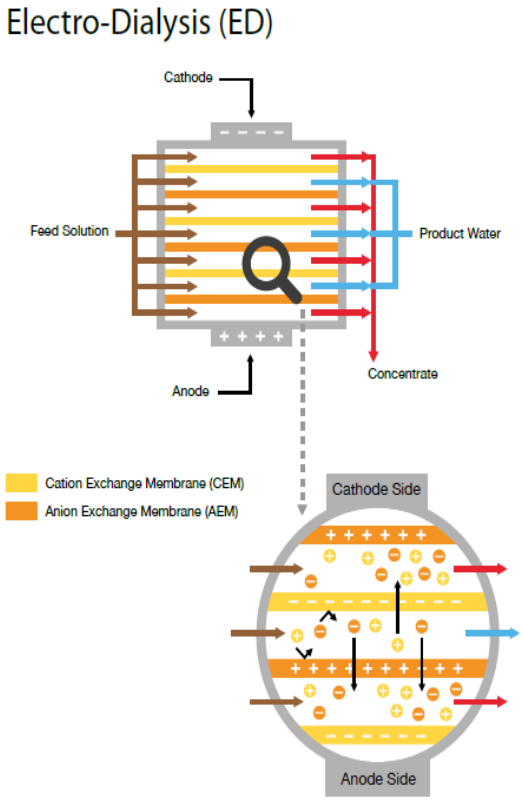
Uses:

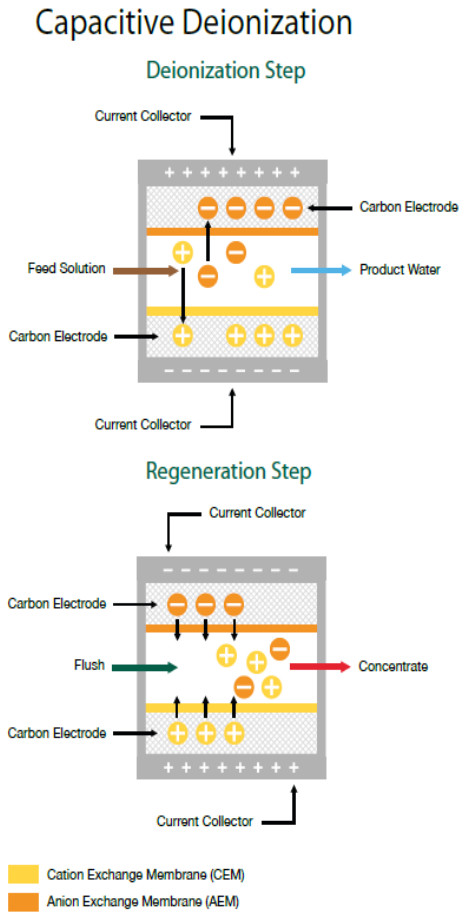
- drinking
- irrigation

- Scale:
  - Handheld
  - stationery
- Water:
  - Brackish
  - Contaminated groundwater
- Technology to be:
  - Cost effective
  - Energy efficient
  - Easy to operate and maintain

Capacitive electro-dialysis

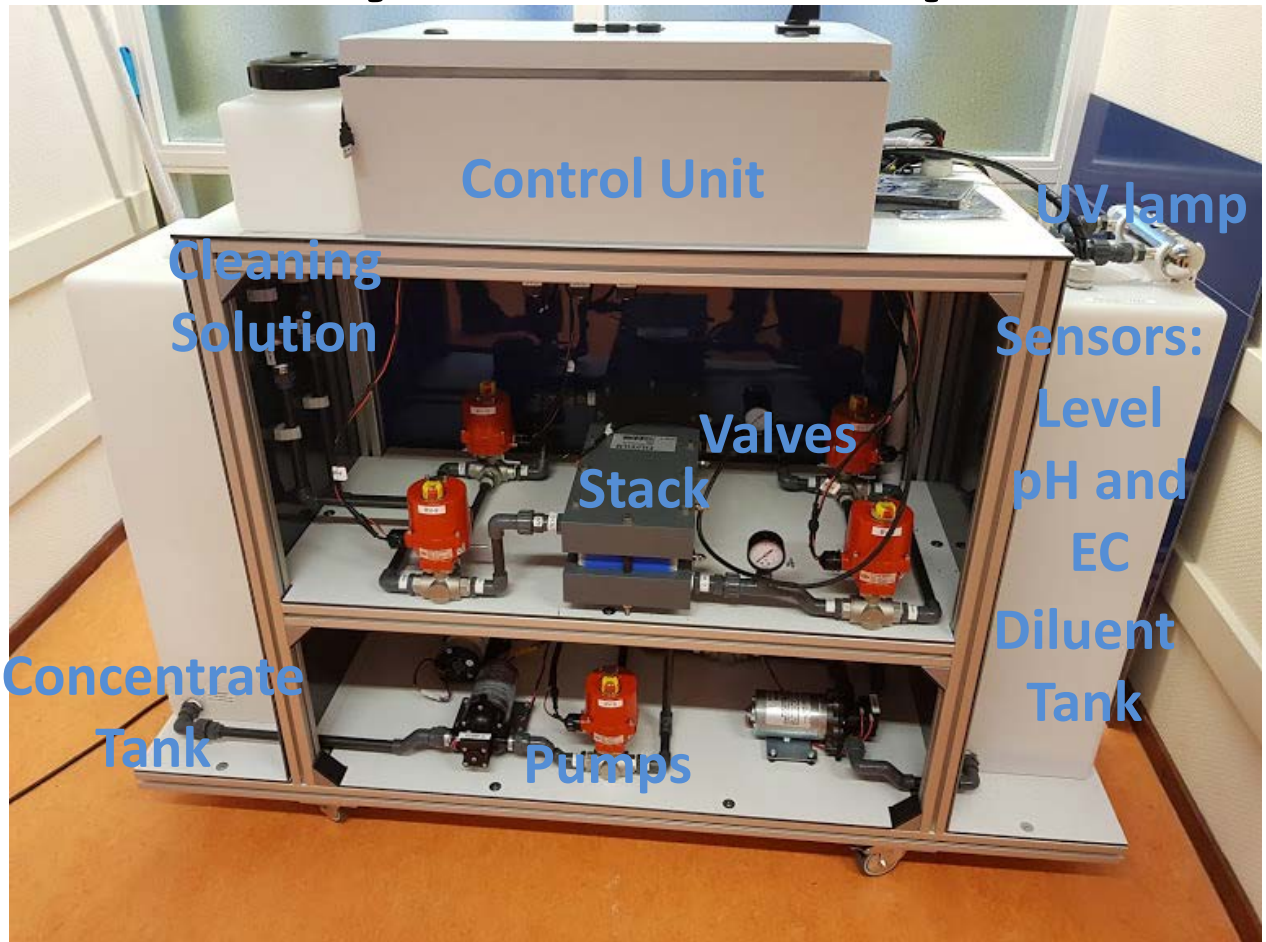
- Combination of 3 technologies:
  - **Electro-dialysis**
  - **Electro-dialysis reversal**
  - **Capacitive deionization**



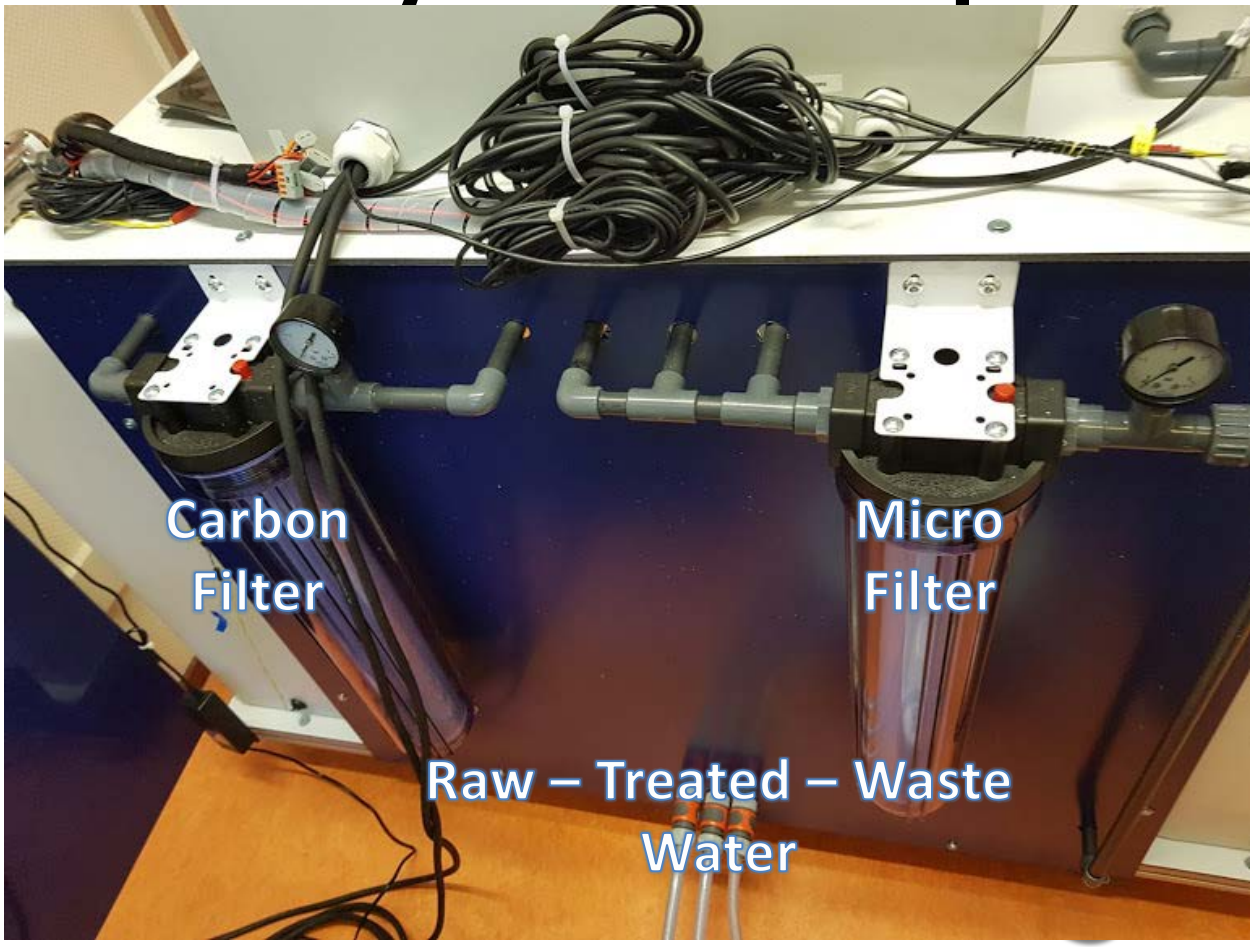


Source: Fujifilm.com

CED System Description

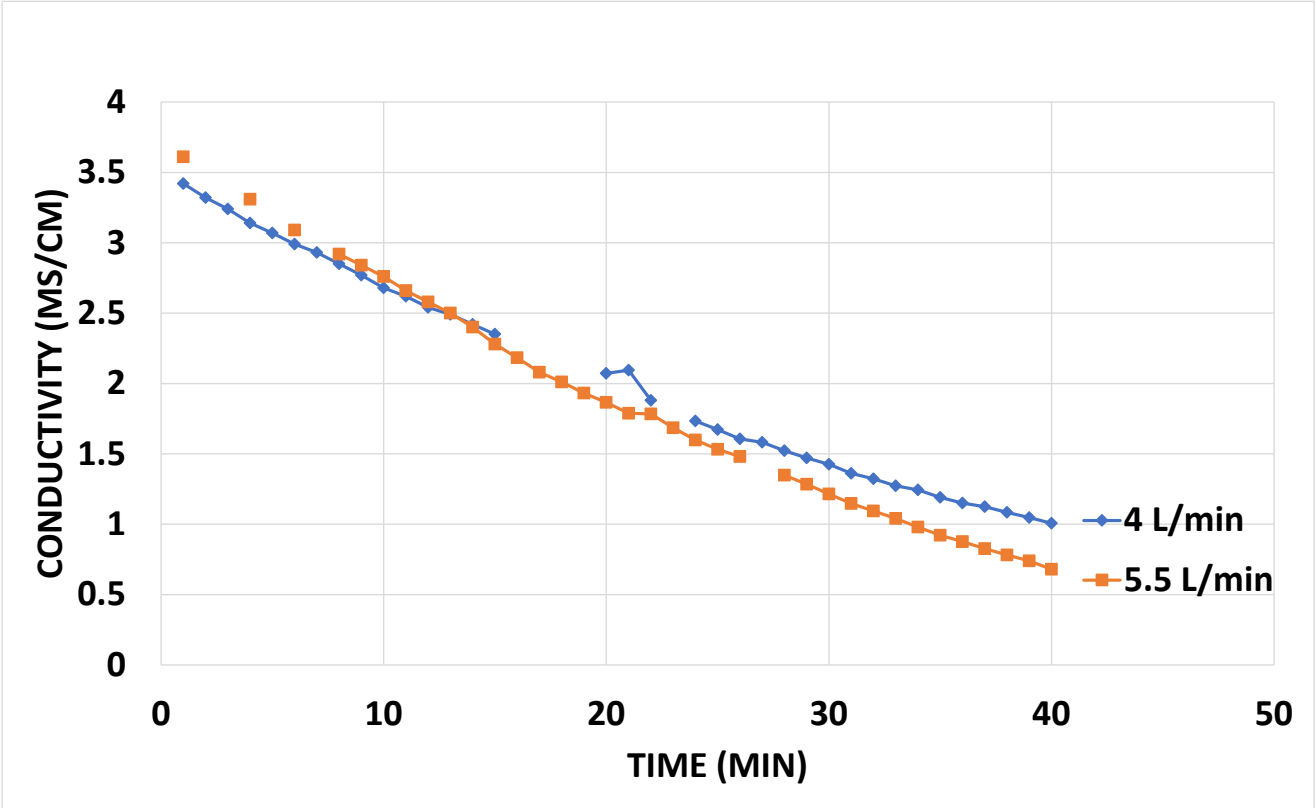


CED System Description

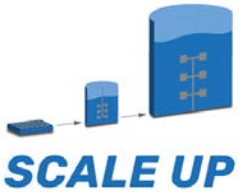


Ced performance

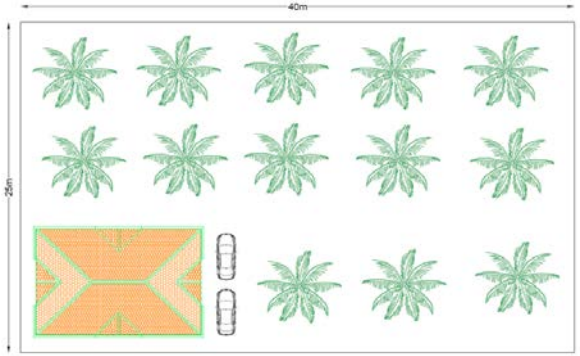
- **STACK: 40X10 CM, 48 CELL PAIRS, 24 V**
  - **1 CYCLE, 40 MIN**



Challenges for CED



Sizing



Implementation

CAPACITY BUILDING IN WASH AND CSA EDUCATION AND RESEARCH IN PALESTINE

OKP-PAA-103455

CAPACITY BUILDING IN WASH AND CSA EDUCATION AND RESEARCH IN PALESTINE

2019 - 2021

Aim

to strengthen education and research in water, specifically efficient water management for climate smart agriculture CSA, and improved access to water and sanitation (WASH) through good governance and sound technical management.

By the end of the project,

the Palestinian universities will have their;

- ❑ Curricula in CSA and WASH updated to match the labour market requirements,
- ❑ Research translated into national policies,
- ❑ Improved the teaching methodologies (smart profession oriented)
- ❑ Enhanced the capacity of the academic/ non-academic staff and water stakeholders
- ❑ Alumni associations activated and involved in the education process.

Final Message

- Current challenges at individual project level include monitoring and enforcement of water quality requirements and financial sustainability of water user's association.
- In terms of incorporating wastewater effluent into regional water balance, many of the West Bank's cities are in limited land areas not necessarily close to where majority of agricultural water demand exist, which makes rapid expansion of water reuse practice challenging.
- Development of water reuse projects, therefore, would need to be balanced with technical and political feasibility to convey effluent.
- Water reuse applications other than irrigation of selected agricultural crops are being considered, include the use for industrial purposes.
- Though, in the last 10 years, most of the reuse (internal) barriers have been tackled, yet the external (political and financing) are still crucial for the success of the sector.

Questions?

Please type your questions into the Q&A box

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