



**ESCWA**

United Nations Economic and Social Commission for Western Asia

# Review of transboundary waters in the Arab region: *Pressures and management issues*

**Carol Chouchani Cherfane**

Chief, Water Resources Section

Sustainable Development and Productivity Division, ESCWA

**Workshop on Legal frameworks for cooperation on transboundary waters:  
Key aspects and opportunities for the Arab countries**

Tunis, 11-12 June 2014



# Arab Regional Context



- Arid/semi-arid region
  - precipitation does not exceed the 50 mm/yr in some areas
- High dependency ratio on external waters
- Water is shared between Arab States and between Arab and Non-Arab States
- Territorial sovereignty, occupation
- Differing energy endowments to support access to water resource
- There are more shared water resources than generally understood
  - Surface water
  - Groundwater (renewable & non-renewable resources)

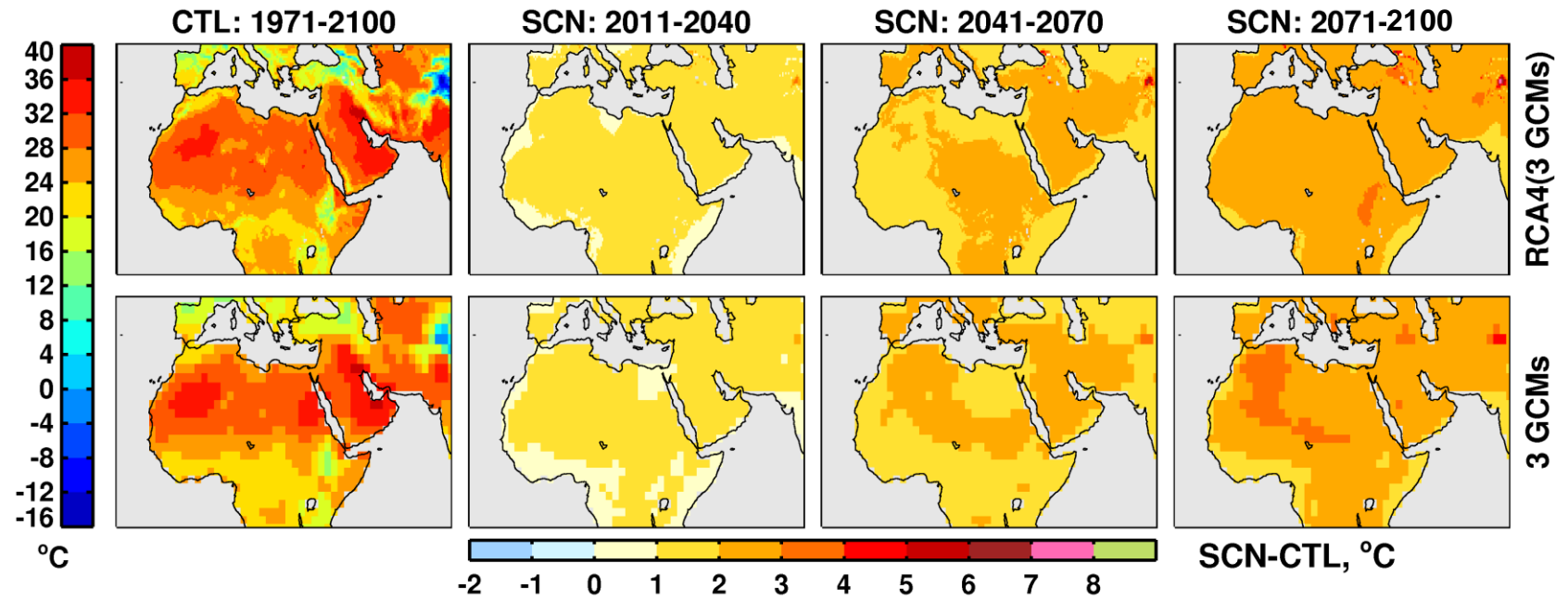
# Arab Region



# Projected changes in temperature: **RCP4.5**

## Global - GCMs and Regional – RCA4(GCMs) ensembles **SUMMER**

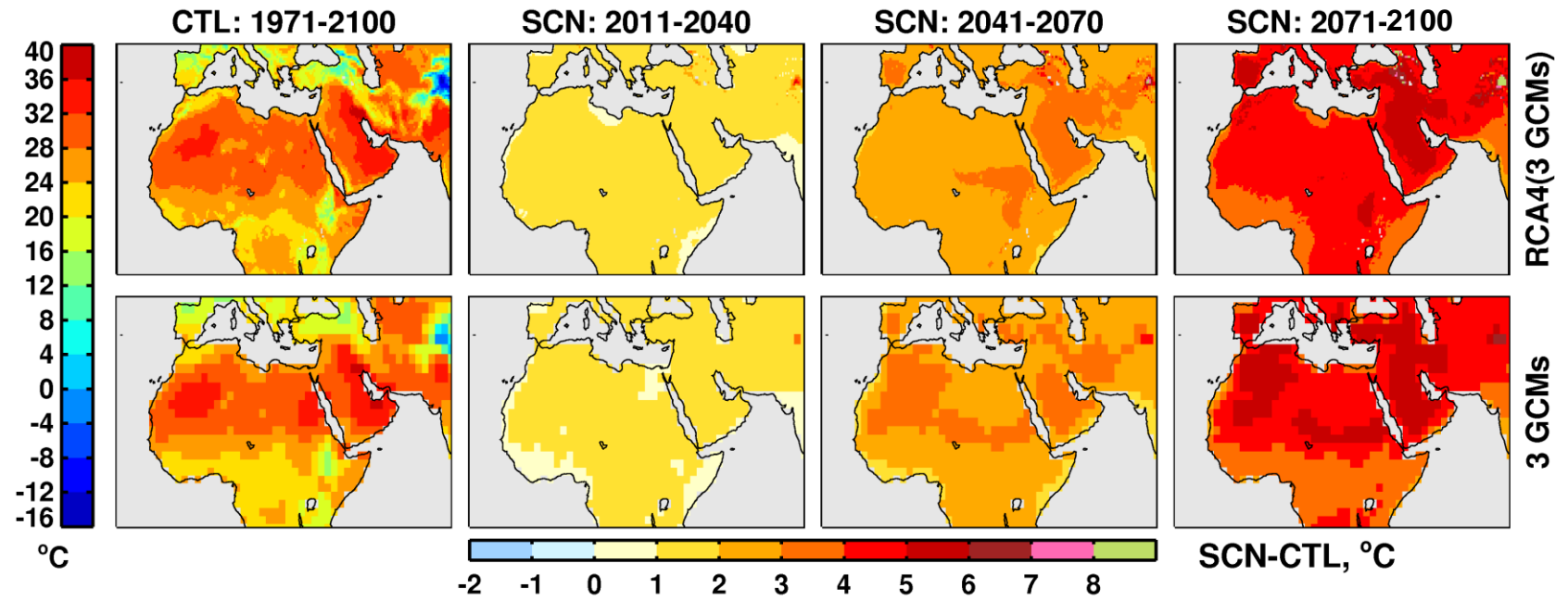
### 2m Temperature (tas) | JJA | rcp45



- similar patterns in both global and regional ensembles
- some differences on regional scale

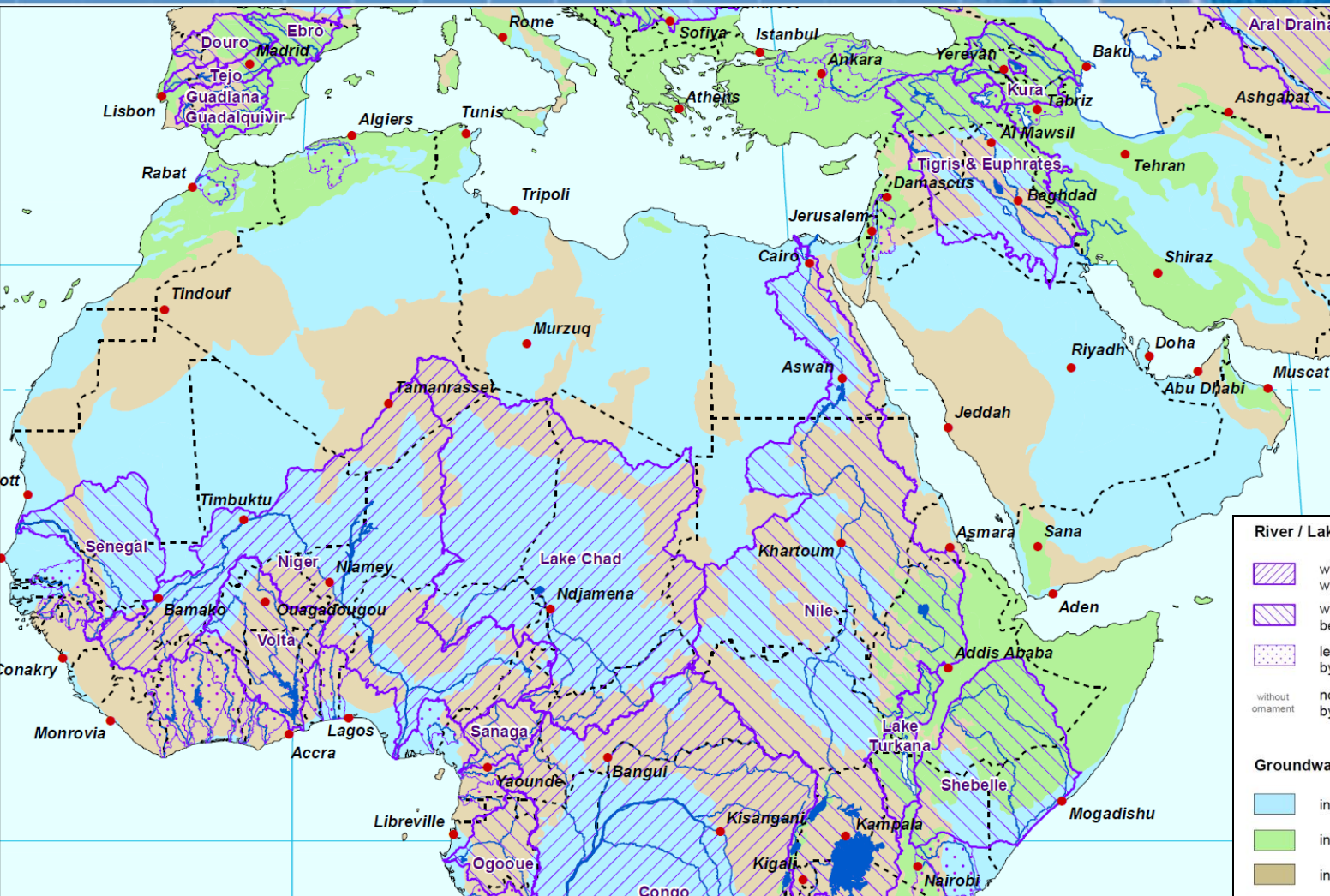
## Global - GCMs and Regional – RCA4(GCMs) ensembles **SUMMER**

2m Temperature (tas) | JJA | rcp85



- larger warming from 2041 for RCP85 than for RCP45
- in coming decades both RCP45 and RCP85 are similar

# Shared River & Groundwater Resources



**River / Lake basin**

- with underlying groundwater basin contained within the boundaries of river / lake basin
- with underlying groundwater basin extending beyond the boundaries of river / lake basin
- less important river / lake basin, partly underlain by groundwater basin
- without ornament

**Groundwater**

- in major aquifer basin
- in complex hydrogeological structures
- in local and shallow aquifers

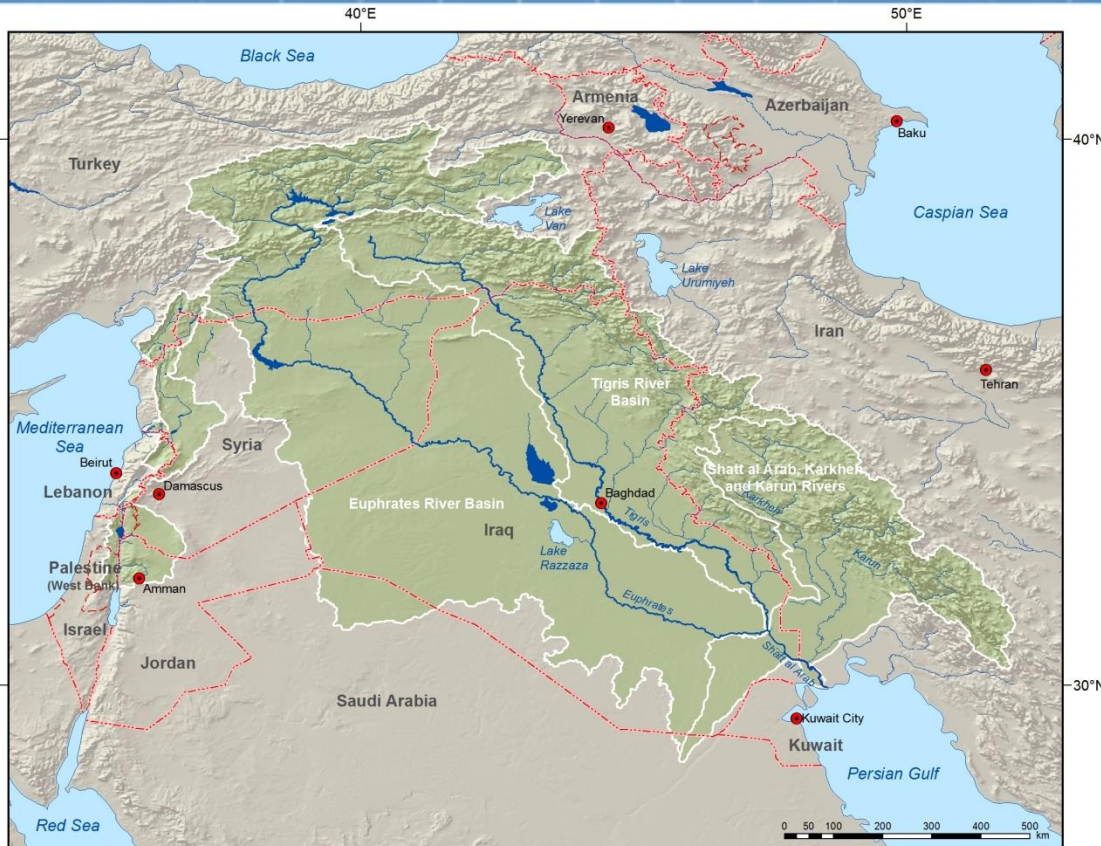
**Surface water**






- major river
- large freshwater lake
- large saltwater lake
- continuous ice sheet

**River and Groundwater Basins in the World**  
 © BGR Hannover/ UNESCO, Paris 2012

# ***Shared Surface Waters***

# Shared Surface Water Resources in Western Asia



-  Euphrates-Tigris-Shatt Al Arab
-  Jordan River Basin
-  Nahr El Kabir Basin
-  Orontes River
-  Qweik River Basin

## Surface Water Overview

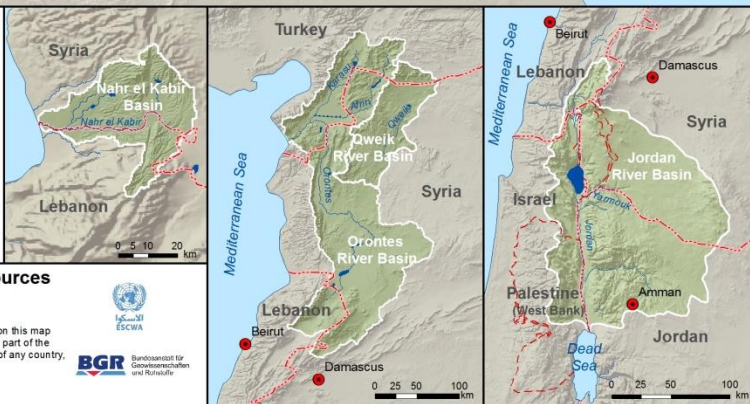
-  International boundary
-  Armistice Demarcation Line
-  Capital
-  River
-  River basin boundary
-  Freshwater lake
-  Saltwater lake

## Inventory of Shared Water Resources in Western Asia

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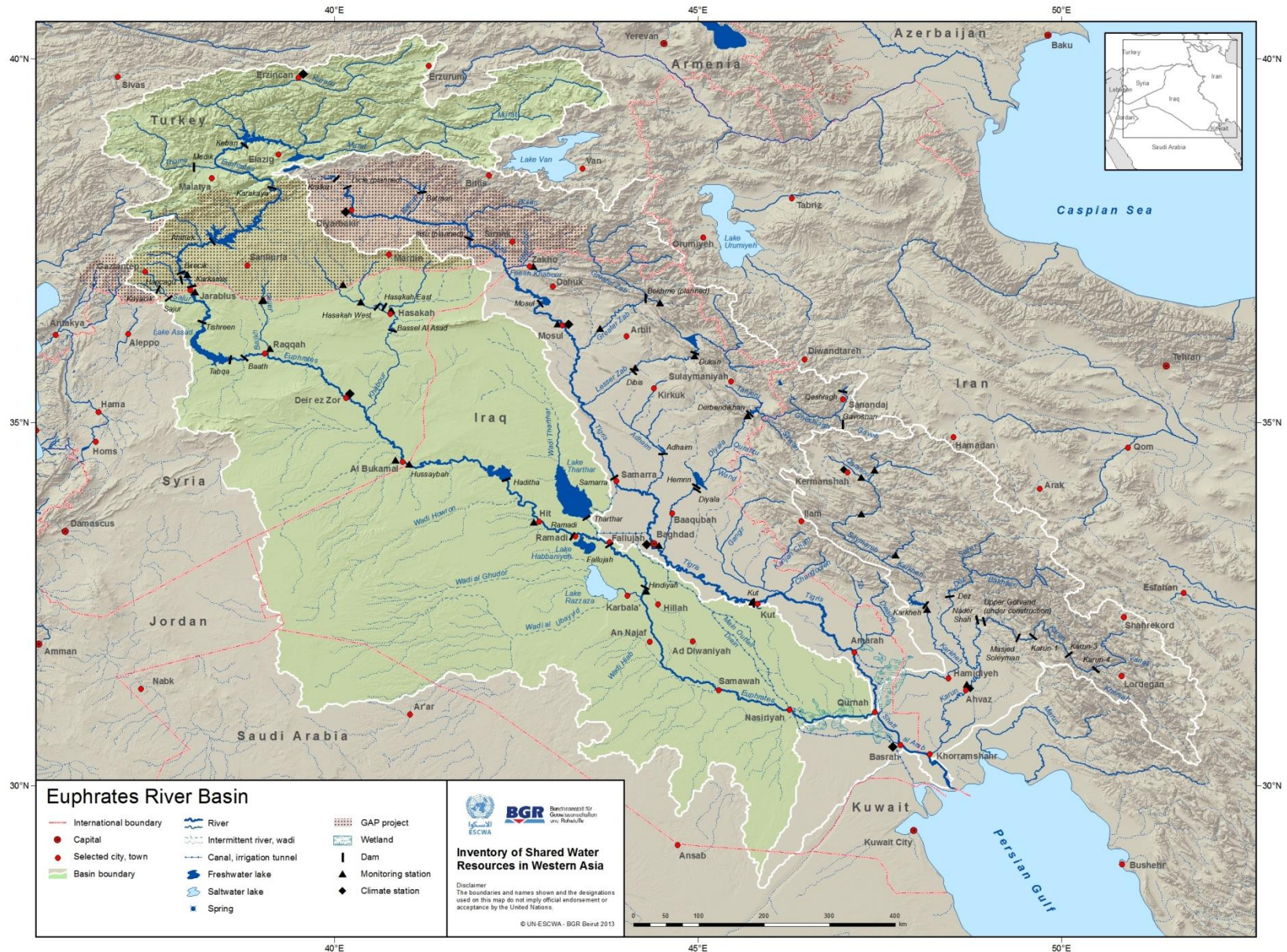
© UN-ESCWA - BGR Beirut 2013



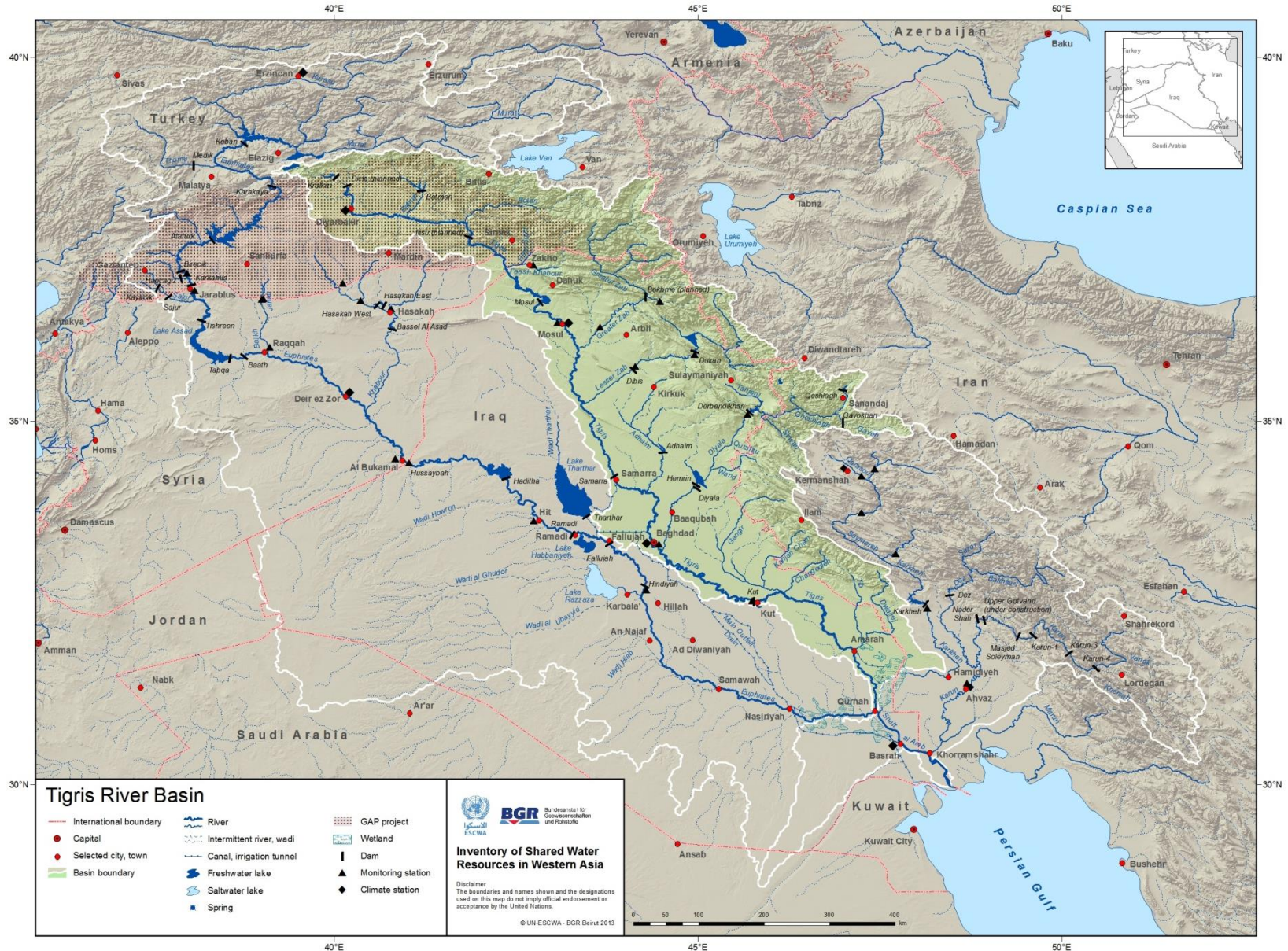
*Water resources management must consider technical and political aspects when managing transboundary rivers or basins*



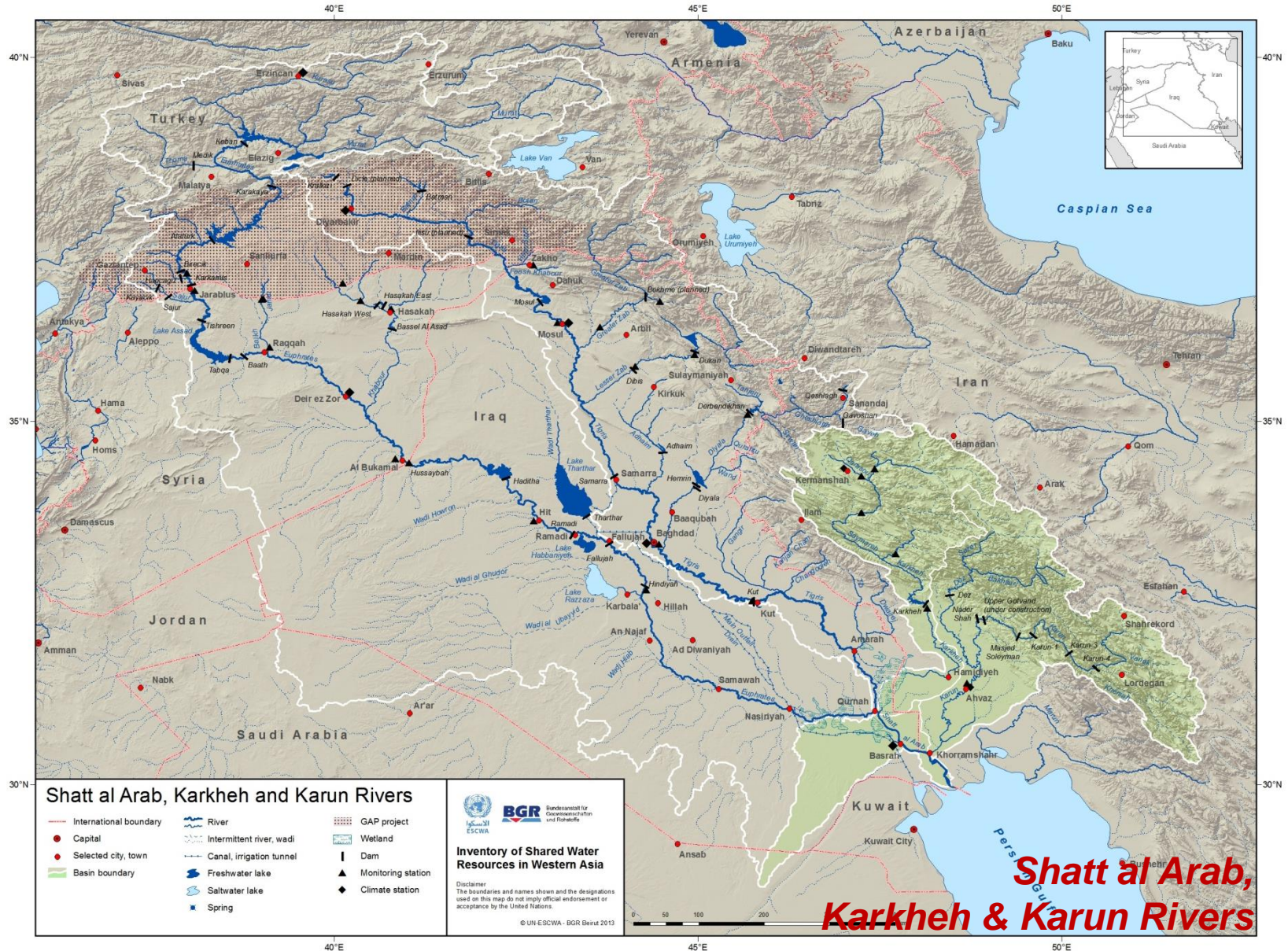
# Euphrates River Basin



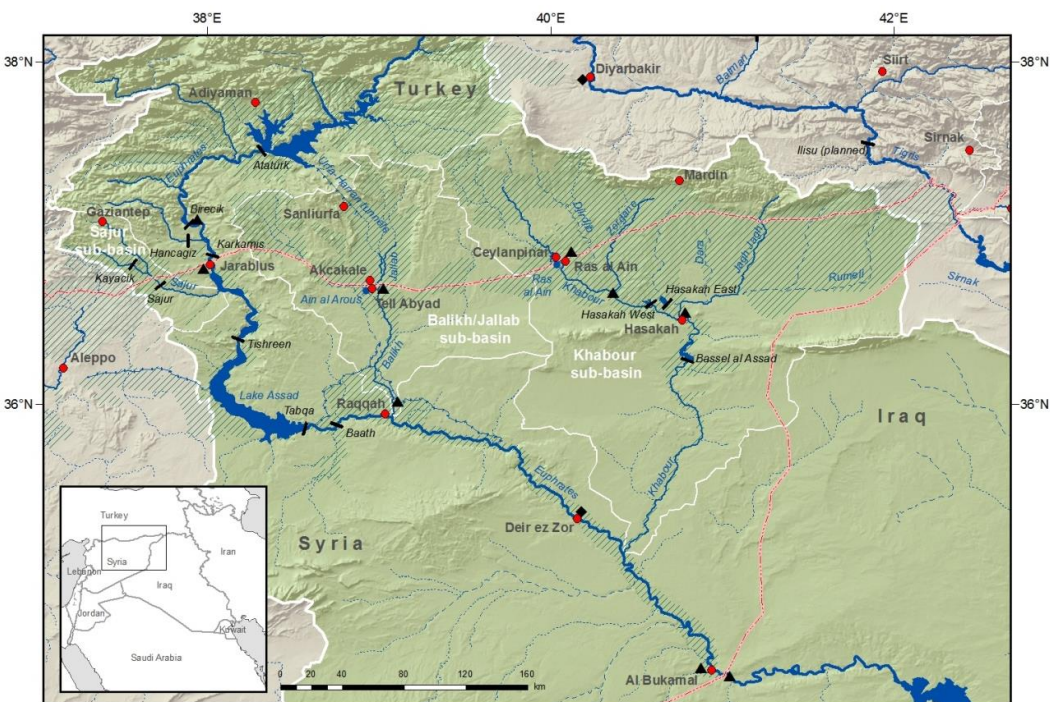
# Tigris River Basin



# The Euphrates-Tigris-Shatt al Arab Basins



## Shared Tributaries of the Euphrates River



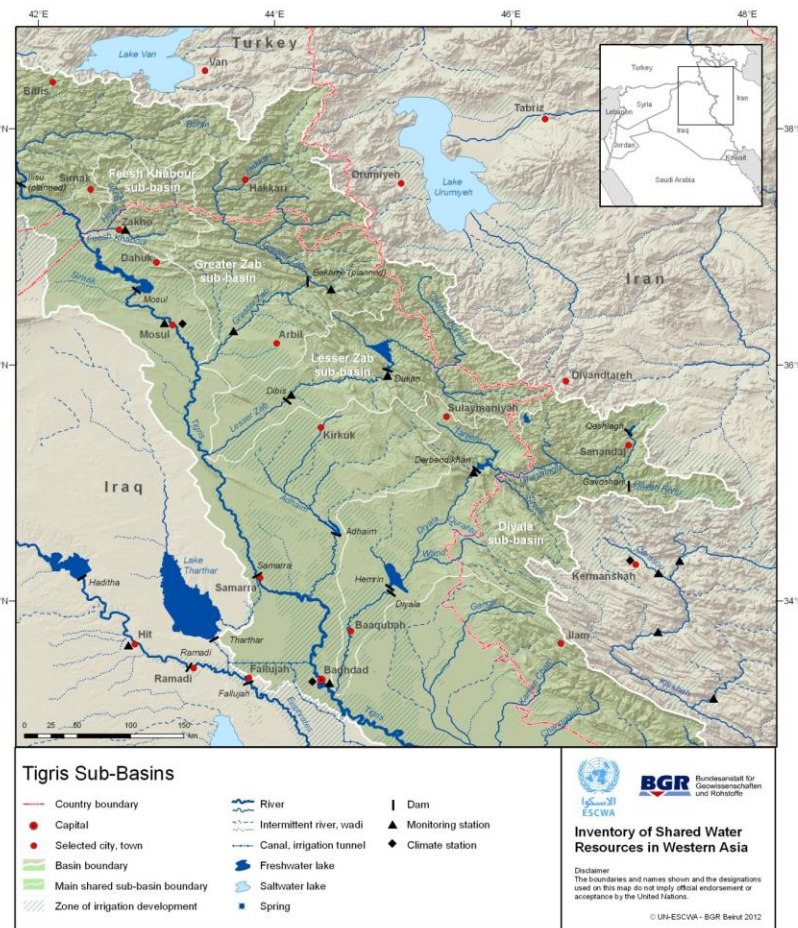
### Shared Tributaries of the Euphrates River

- International boundary
- Selected city, town
- Basin boundary
- Main shared sub-basin boundary
- Zone of agricultural development
- River
- - - Intermittent river, wadi
- Canal, irrigation tunnel
- Freshwater lake
- Spring
- Dam
- ▲ Monitoring station
- ◆ Climate station



### Inventory of Shared Water Resources in Western Asia

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### Tigris Sub-Basins

- Country boundary
- Capital
- Selected city, town
- Basin boundary
- Main shared sub-basin boundary
- Zone of irrigation development
- River
- - - Intermittent river, wadi
- Canal, irrigation tunnel
- Freshwater lake
- Saltwater lake
- Spring
- Dam
- ▲ Monitoring station
- ◆ Climate station



### Inventory of Shared Water Resources in Western Asia

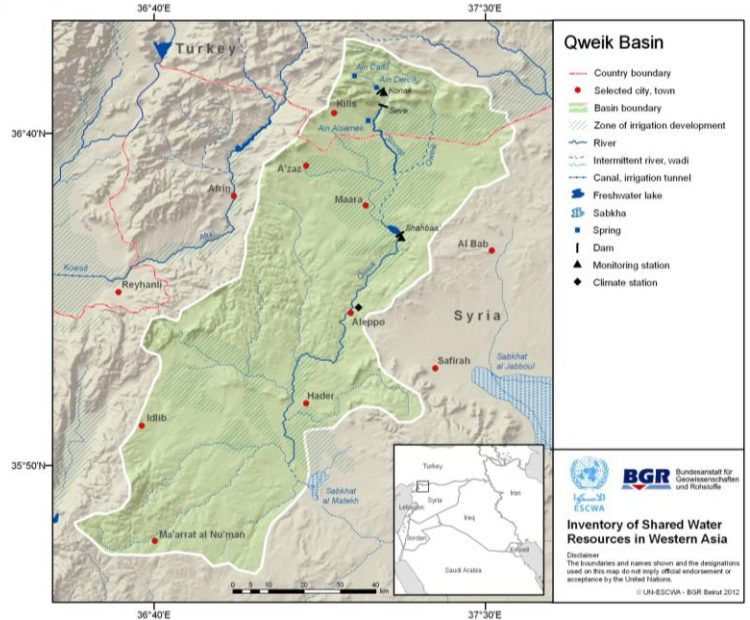
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## Shared Tributaries of the Tigris River

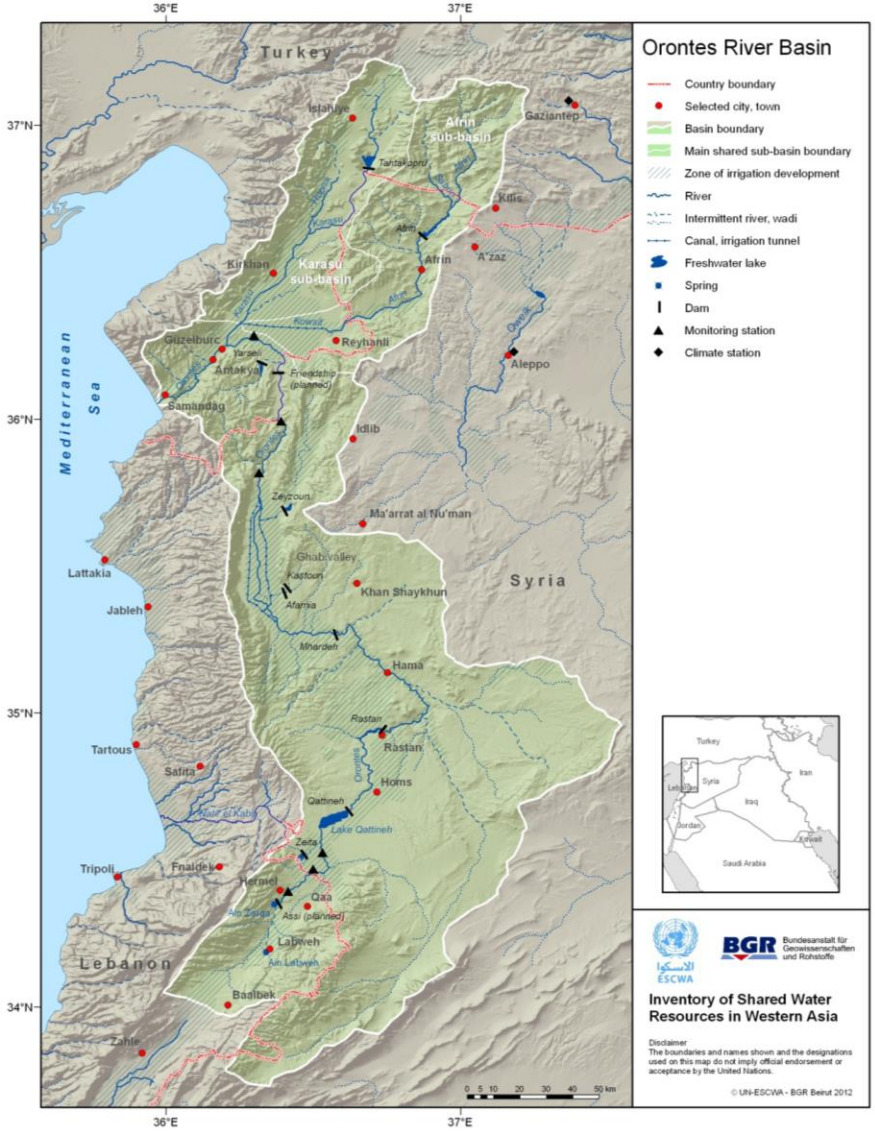
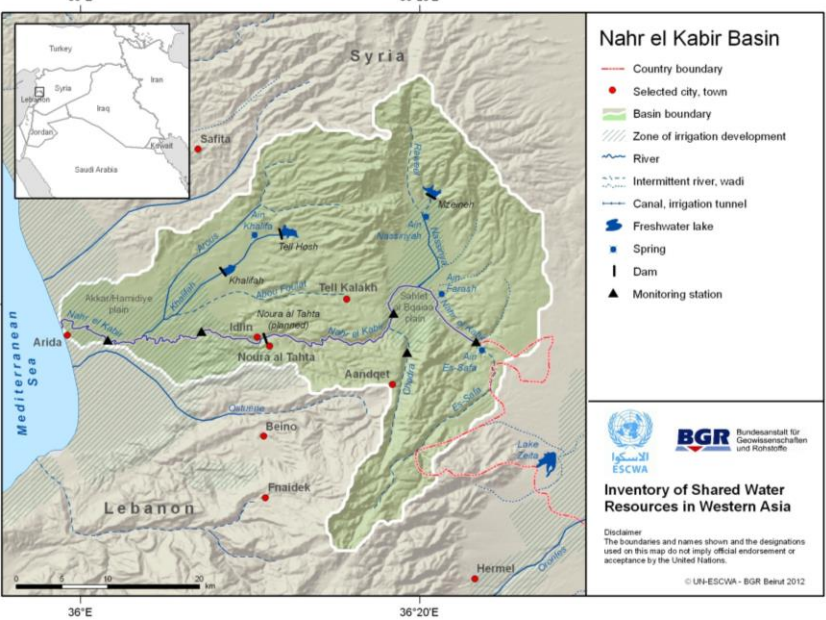
# Management Challenge: States Share different Shared Water Basins



Syria-Turkey



Lebanon - Syria



Lebanon-Syria-Turkey

# Management Challenge: Water Resources Management under Occupation



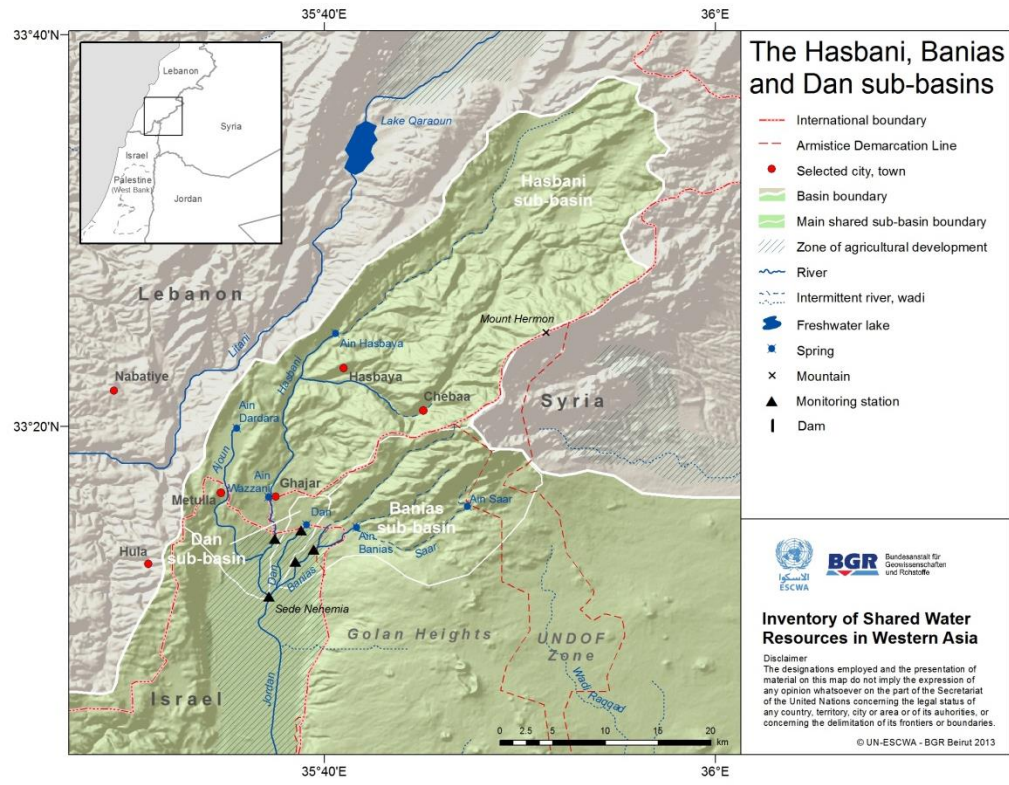
- Jordan River Basin**
- International boundary
  - - - Armistice Demarcation Line
  - Capital
  - Selected city, town
  - ▭ Basin boundary
  - ▭ Main shared sub-basin boundary
  - ▨ Zone of agricultural development
  - River
  - - - Intermittent river, wadi
  - Canal, irrigation tunnel
  - Freshwater lake
  - Spring
  - × Mountain
  - Dam
  - ▲ Monitoring station

**Inventory of Shared Water Resources in Western Asia**

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**Jordan River Basin**



**The Hasbani, Baniyas and Dan sub-basins**

- International boundary
- - - Armistice Demarcation Line
- Selected city, town
- ▭ Basin boundary
- ▭ Main shared sub-basin boundary
- ▨ Zone of agricultural development
- River
- - - Intermittent river, wadi
- Freshwater lake
- Spring
- × Mountain
- ▲ Monitoring station
- Dam

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**The Hasbani, Baniyas, and Dan sub-basins**

# Shared Surface Water Resources in Arab/North Africa States

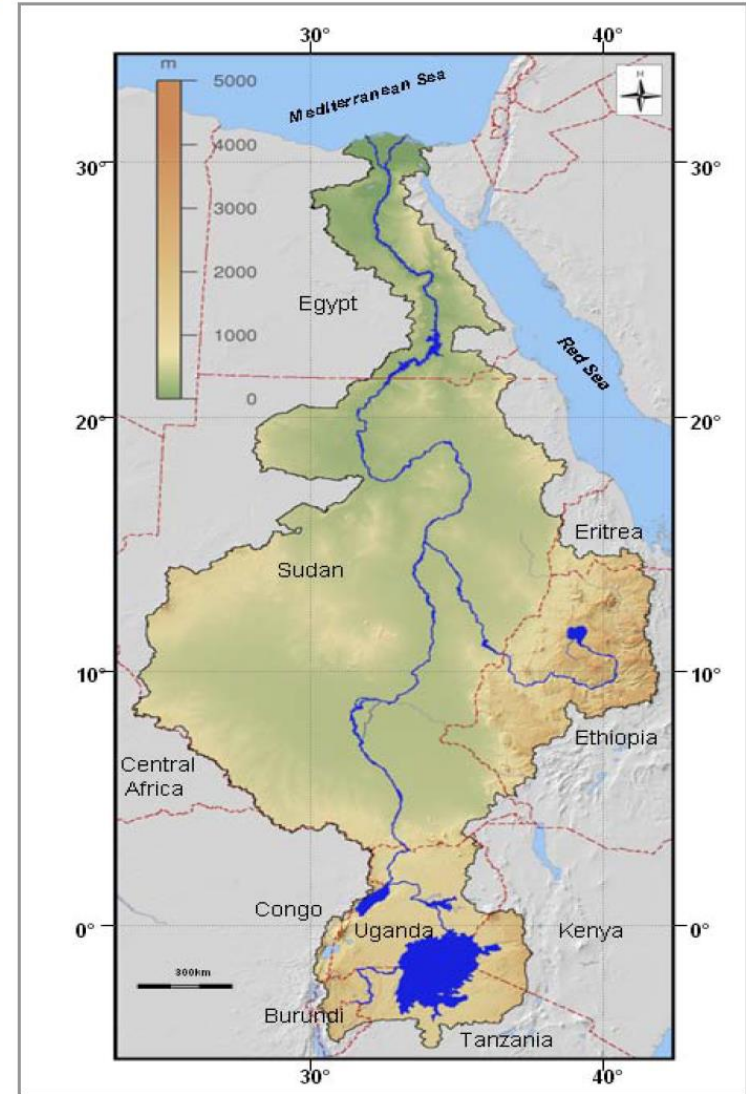


**International River Basins of  
AFRICA**

- ◆ Nile River Basin
- ◆ Medjerda
- ◆ Guir
- ◆ Daoura
- ◆ Dra
- ◆ Oued Bon Naima
- ◆ Senegal River Basin
- ◆ Niger River Basin
- ◆ Lake Chad

© Copyright Transboundary Freshwater Dispute Database, 2000

# Management Challenge: Water Security in large and complex river basins with many riparians



**UNESCO & IHP 2008**

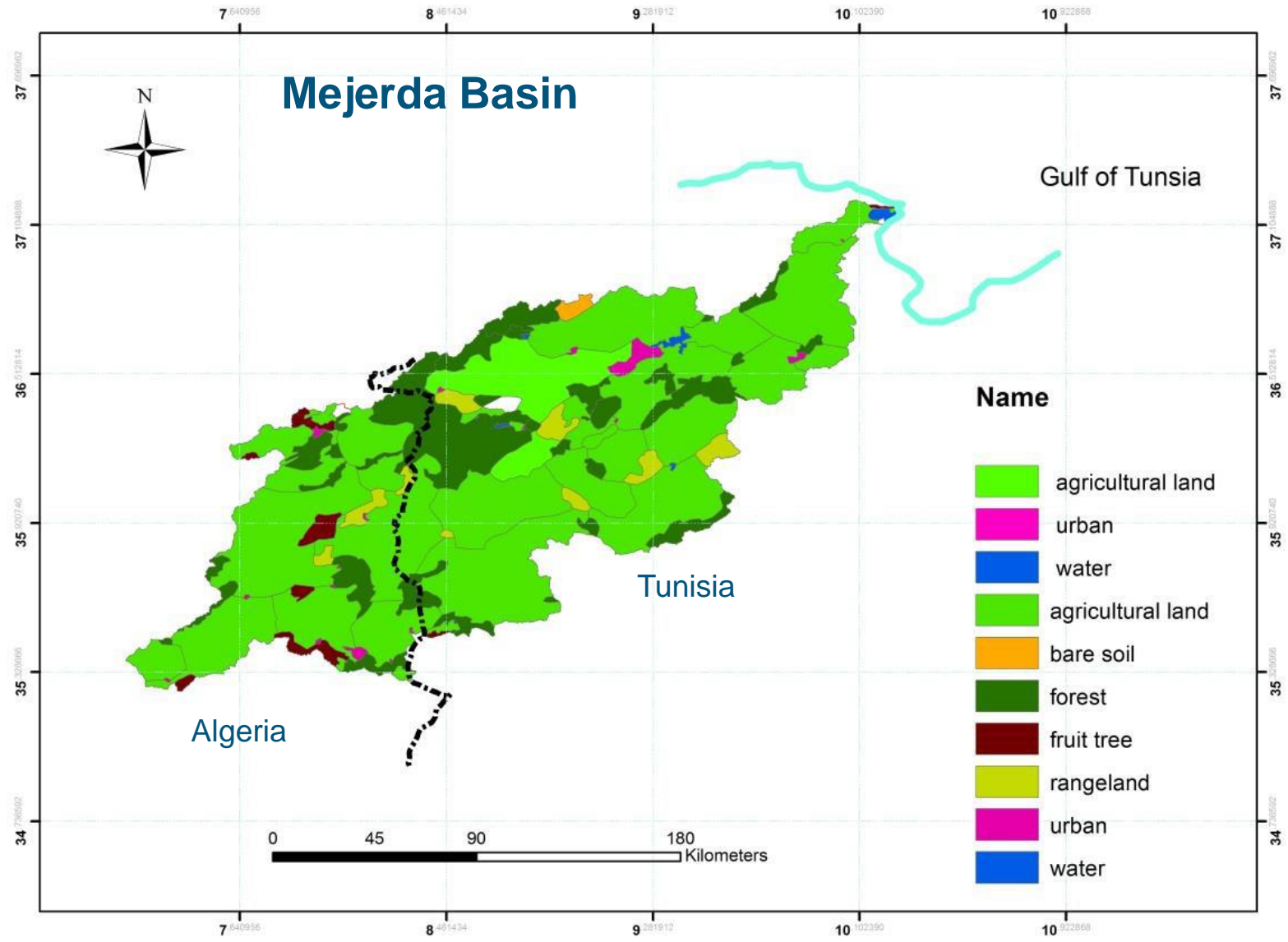
“Managing Shared Aquifer Resources in Africa”  
3rd International Conference Tripoli 25– 27 May 2008

**World Bank, 2000 cited in UN-ESCWA, 2009**

“Knowledge Management and Analysis of ESCWA Member Countries Capacities in Managing Shared Water Resources”

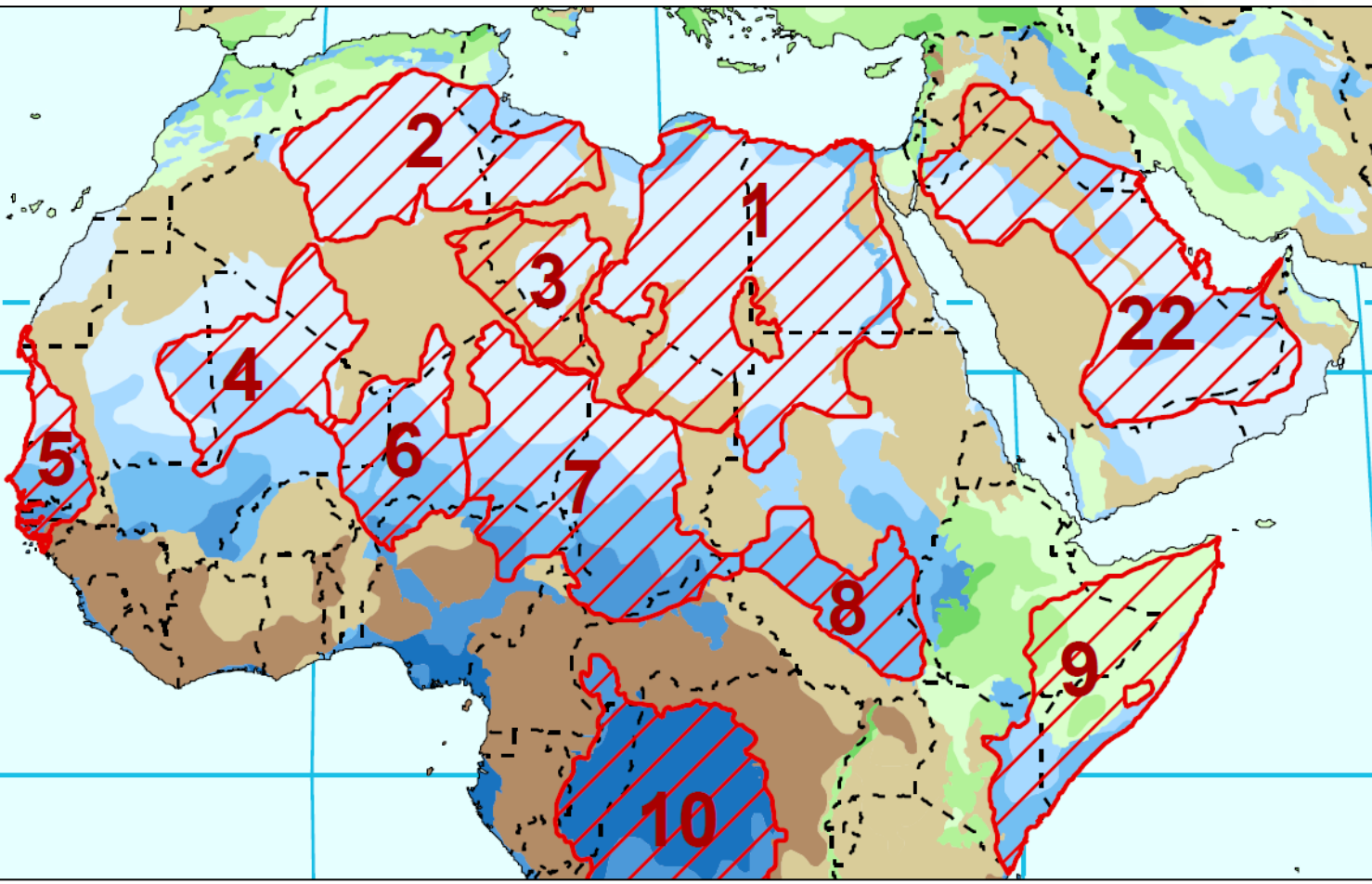


# Management Challenge: Shared Basins have multiple characteristics & use

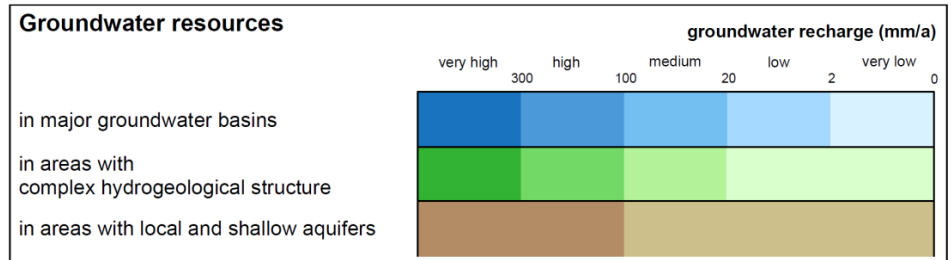


# ***Shared Aquifer Systems***

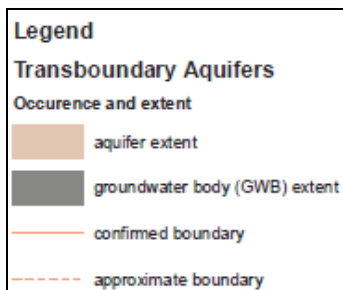
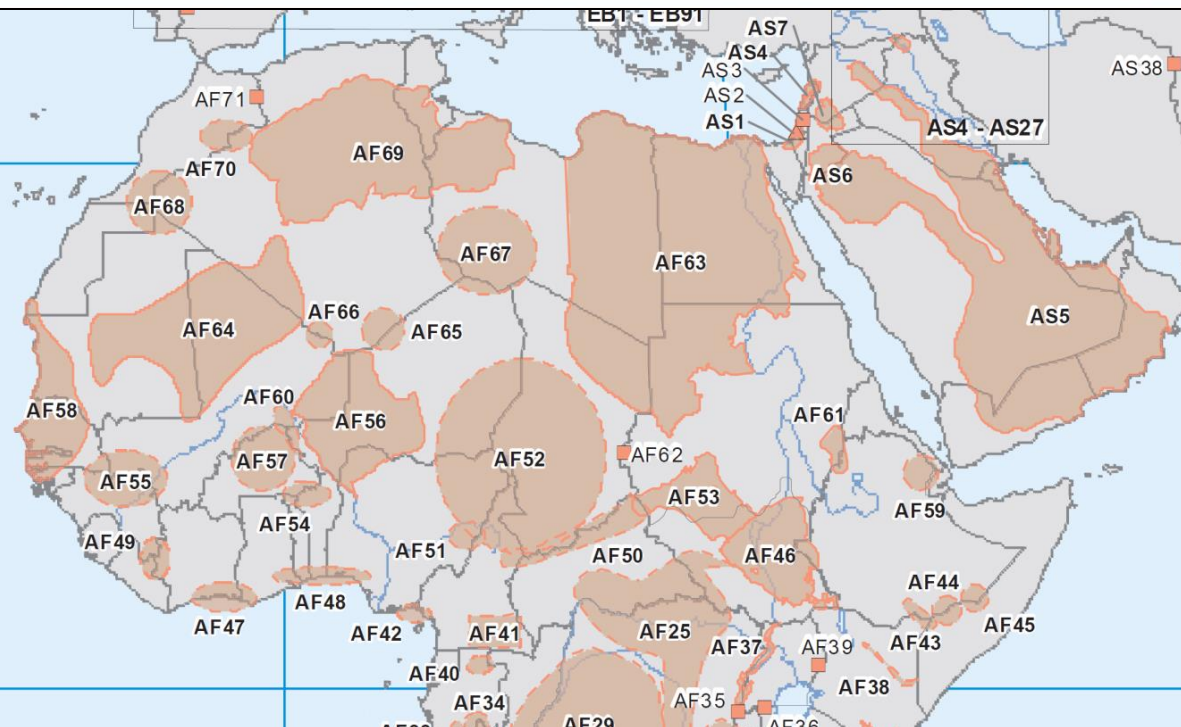
# Shared Groundwater Resources in the Arab Region: Large and Aggregated Systems



1. Nubian Aquifer System (NAS)
2. Northwest Sahara Aquifer System (NWSAS)
3. Murzul-Djado Basin
4. Taoudeni-Tanezrouft Basin
5. Senegalo-Mauritanian Basin
8. Sudd Basin (Umm Ruwaba Aquifer)
9. Ogaden-Juba Basin
22. Arabian Aquifer System



# Shared Groundwater Resources Management Challenge: Delineation Complex



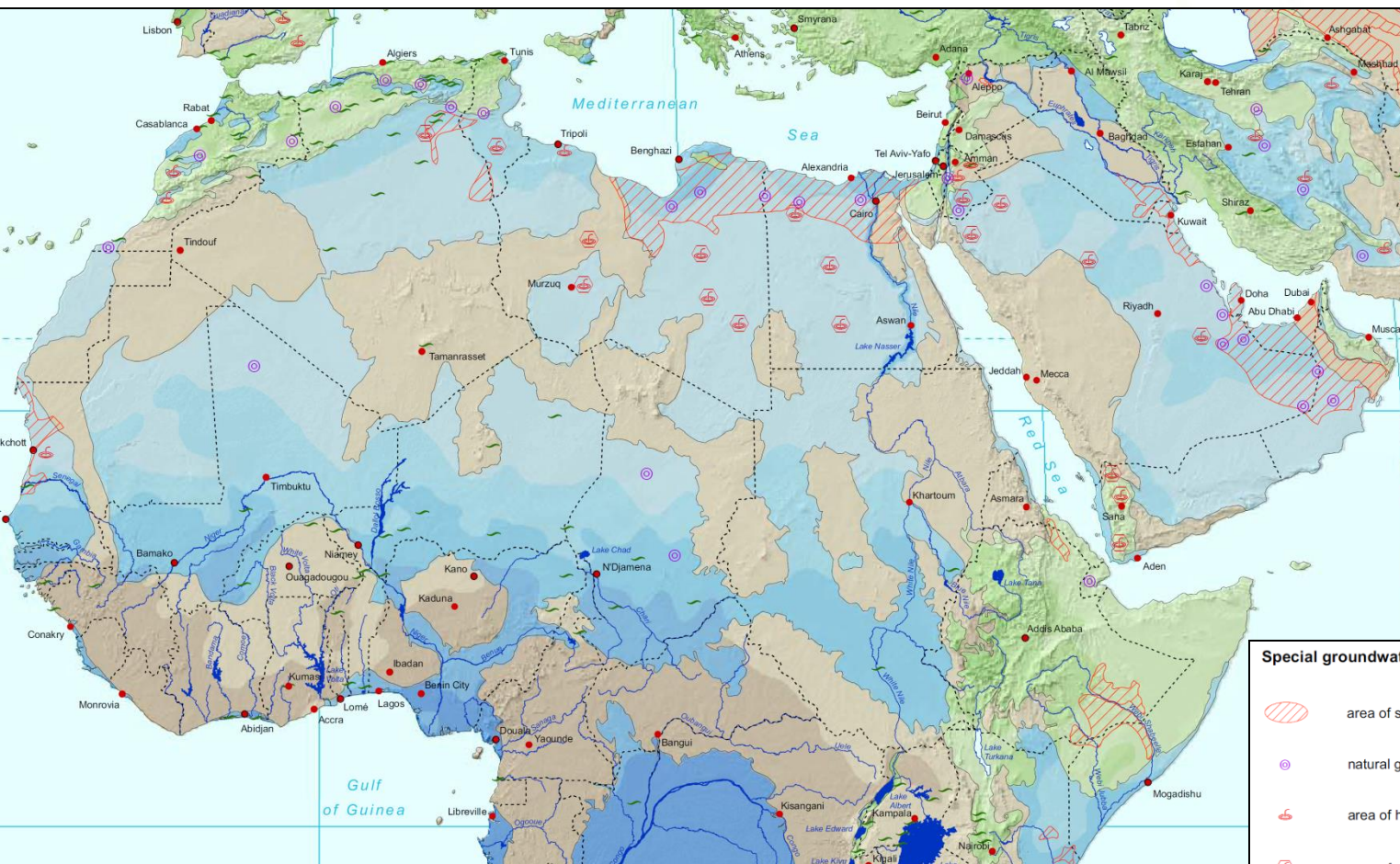
## ASIA

- AS1** Western Aquifer Egypt, Israel, Palestine
- AS2** Coastal Aquifer Israel, Palestine
- AS3** Northeastern Aquifer Israel, Palestine
- AS4** Nahr el Kabir (Cenemonian-Turonian) Israel, Lebanon, Syria
- AS5** Paleogene and Cretaceous aquifers Jordan, Saudi Arabia
- AS6** Paleogene Aquifer Bahrain, Iraq, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen
- AS7** Bazalt-Azraq Jordan, Syria

## AFRICA

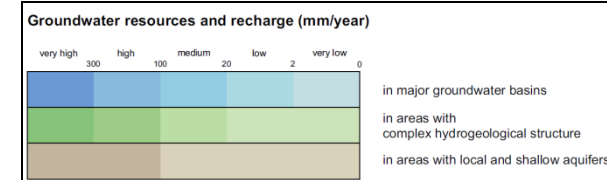
- AF43** Dawa Ethiopia, Kenya, Somalia
- AF44** Jubba Ethiopia, Somalia
- AF45** Shabelle Ethiopia, Somalia
- AF53** Baggara Basin CAR, South Sudan, Sudan
- AF59** African Rift Valley Aquifer Djibouti, Ethiopia
- AF61** Gedaref Ethiopia, Sudan
- AF62** Disa Chad, Sudan
- AF63** Nubian Sandstone Aquifer System Chad, Egypt, Libya, Sudan
- AF64** Taoudeni Basin Algeria, Mali, Mauritania
- AF65** Tin-Séririne Basin Algeria, Niger
- AF66** l'Air Crystalline Aquifer Algeria, Mali, Niger
- AF67** Mourzouk-Djado Basin Chad, Lybia, Tunisia
- AF68** Tindouf Aquifer Algeria, Morocco
- AF69** Northwest Sahara Aquifer System Algeria, Libya, Tunisia
- AF70** Errachidia Basin Algeria, Morocco
- AF71** Merti Aquifer Kenya, Somalia

# Shared Groundwater Resources Management: Delineation Complex, More Sophisticated



**Special groundwater features**

- area of saline groundwater (> 5 g/l total dissolved solids (TDS))
- natural groundwater discharge area in arid regions
- area of heavy groundwater abstraction with over-exploitation
- area of groundwater mining
- selected wetland, mostly groundwater related



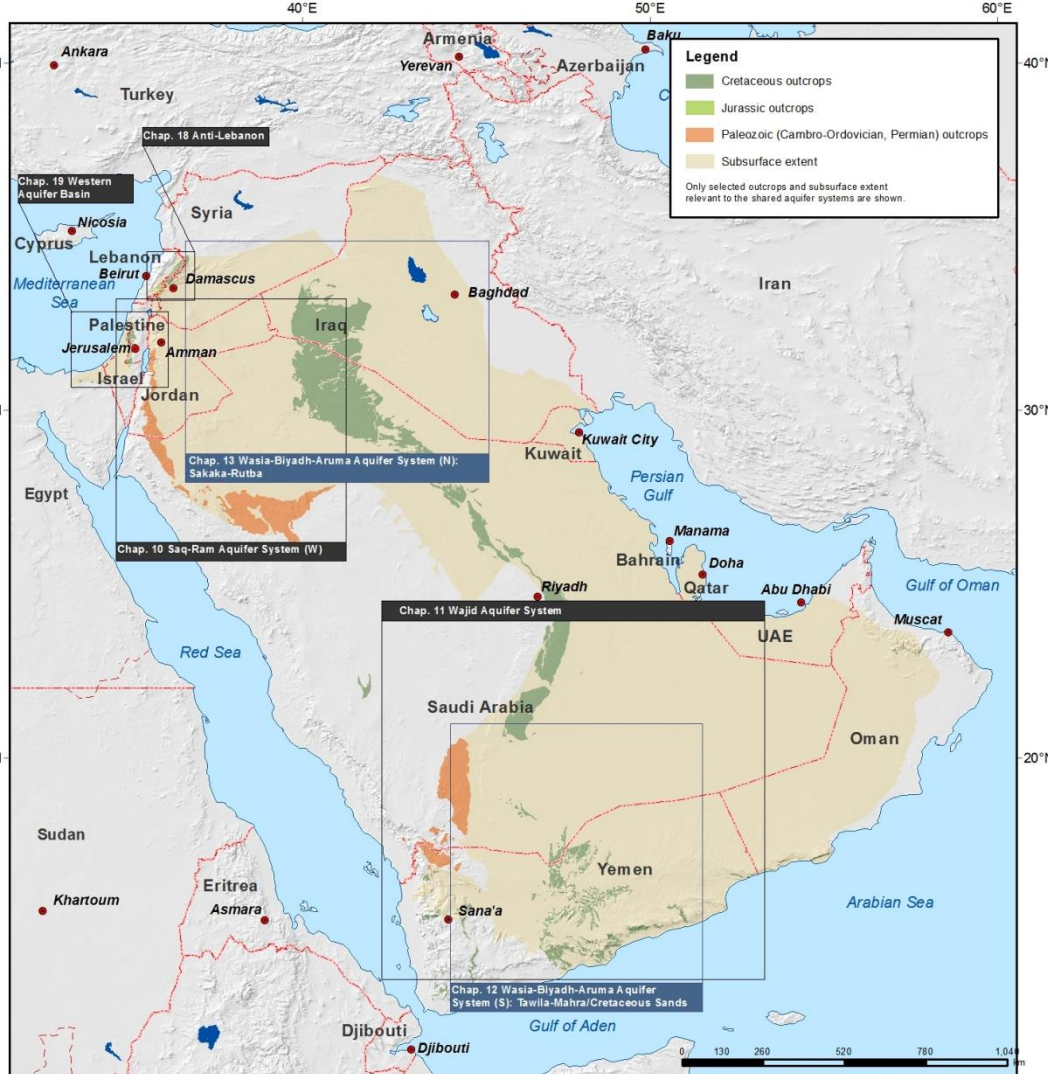
## GROUNDWATER RESOURCES OF THE WORLD 1 : 25 000 000

extracted from:  
World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP)

[www.whymap.org](http://www.whymap.org)



# More Shared Aquifers than generally understood in Western Asia (Mesozoic & Paleozoic Eras)



- 🔹 **Anti-Lebanon** - Lebanon, Syria
- 🔹 **Western Aquifer Basin** - Egypt, Israel, Palestine
- 🔹 **Wasia-Biyadh-Aruma Aquifer System (North): Sakaka-Rutba** - Iraq, Saudi Arabia
- 🔹 **Wasia-Biyadh-Aruma Aquifer System (South): Tawila-Mahra/Cretaceous Sands** - Saudi Arabia, Yemen
- 🔹 *Ga'ara Aquifer System* - Iraq, Jordan, Saudi Arabia, Syria
- 🔹 **Saq-Ram Aquifer System (West)** - Jordan, Saudi Arabia
- 🔹 **Wajid Aquifer System** - Saudi Arabia, Yemen

## Shared Aquifer Systems of the Mesozoic and Paleozoic Eras

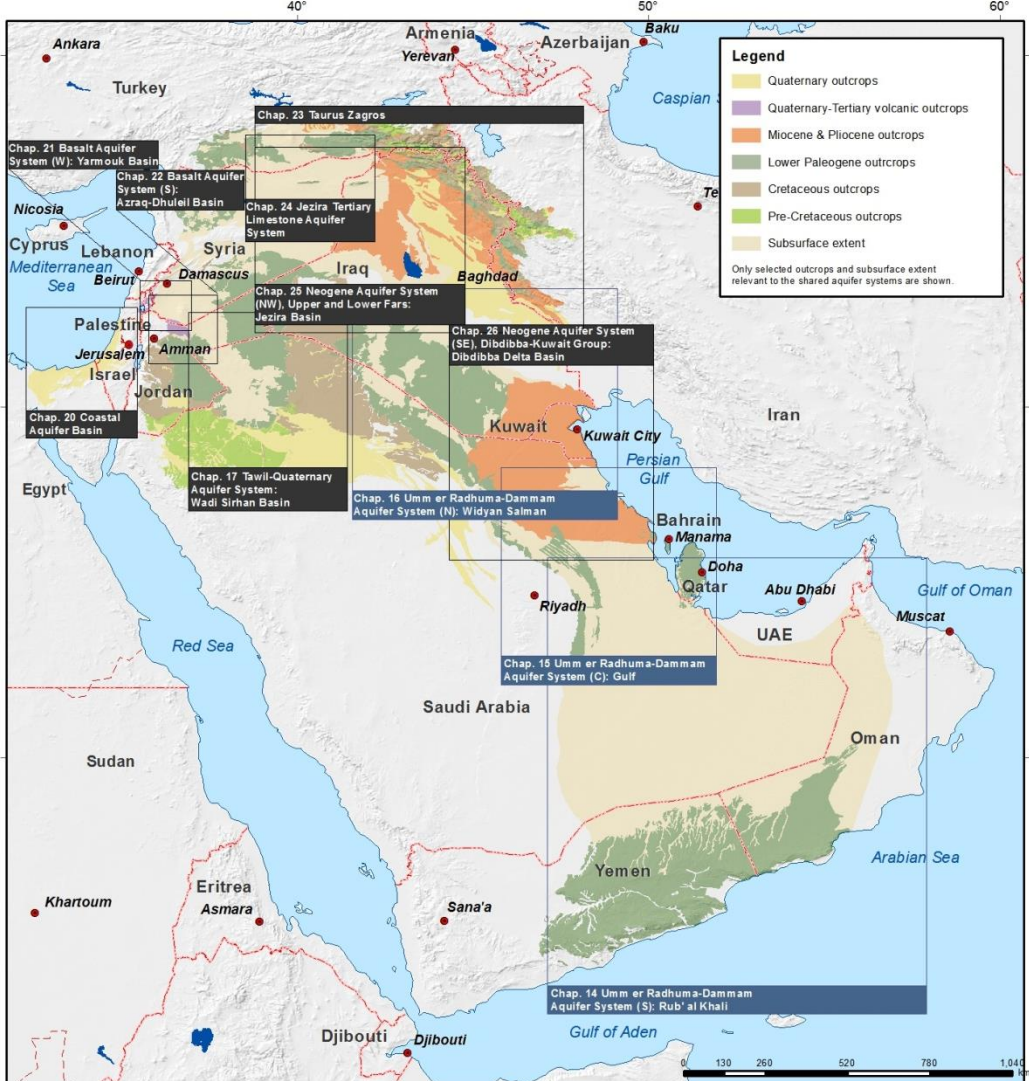
### Inventory of Shared Water Resources in Western Asia

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*Management Challenge:  
Deep Non-Renewable Aquifer  
Systems in Arab Region*

# More Shared Aquifers than generally understood in Western Asia (Cenozoic Era)



- ◆ **Umm er Radhuma-Dammam Aquifer System (North): Widyan-Salman** - Iraq, Kuwait, Saudi Arabia
- ◆ **Umm er Radhuma-Dammam Aquifer System (Centre): Gulf** - Bahrain, Qatar, Saudi Arabia
- ◆ **Umm er Radhuma-Dammam Aquifer System (South): Rub' al Khali** - Oman, Saudi Arabia, United Arab Emirates, Yemen
- ◆ **Neogene Aquifer System (South-East), Dibdibba-Kuwait Group: Dibdibba Delta Basin** - Iraq, Kuwait, Saudi Arabia
- ◆ **Neogene Aquifer System (North-West), Upper and Lower Fars: Jezira Basin** - Iraq, Syria
- ◆ **Tawil-Quaternary Aquifer System: Wadi Sirhan Basin** - Jordan, Saudi Arabia
- ◆ *Central Hammad Basin* - Jordan, Syria
- ◆ **Basalt Aquifer System (South): Azraq-Dhuleil Basin** - Jordan, Syria
- ◆ **Basalt Aquifer System (West): Yarmouk Basin** - Jordan, Syria
- ◆ **Coastal Aquifer Basin** - Egypt, Israel, Palestine
- ◆ *Eastern Aquifer Basin* - Israel, Palestine
- ◆ *North-Eastern Aquifer Basin* - Israel, Palestine
- ◆ **Jezira Tertiary Limestone Aquifer System** - Syria, Turkey
- ◆ *Western Galilee Basina* - Israel, Lebanon
- ◆ **Taurus-Zagros** - Iran, Iraq, Turkey

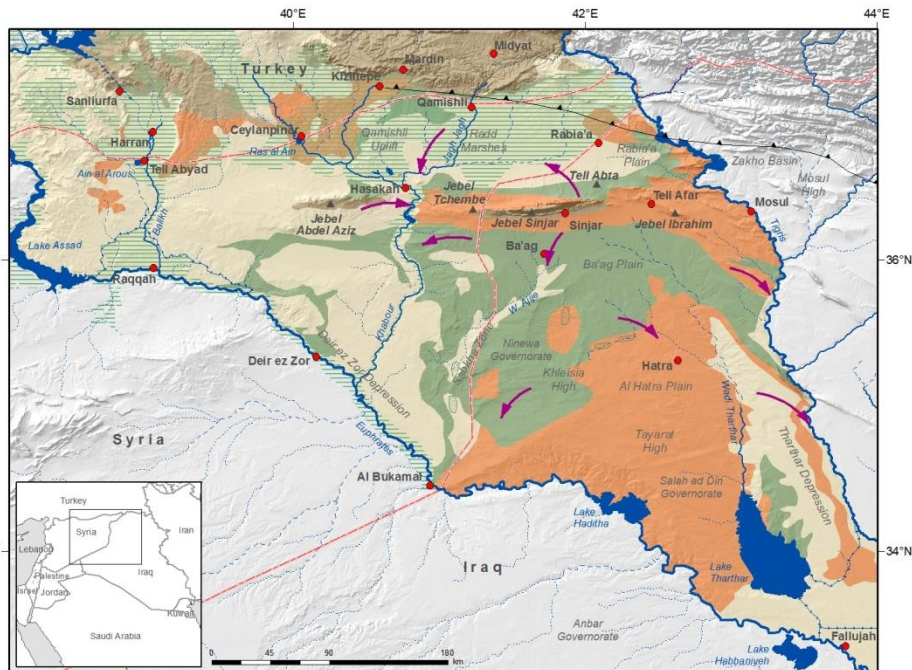
**Shared Aquifer Systems of the Cenozoic Era**  
(Quaternary, Neogene, Paleogene)

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# Shared Groundwater Basins: Mashrek



## Neogene Aquifer System (North-West), Upper and Lower Fars: Jezira Basin

- Selected city, town
- International boundary
- River
- Intermittent river, wadi
- Canal, irrigation tunnel
- Freshwater lake
- Sabkha
- ▲ Mountain
- Upper Fars Formation outcrop
- Lower Fars Formation outcrop
- Pre-Miocene outcrops
- Approximate subsurface extent of the aquifer formations
- Direction of groundwater flow
- ▨ Zone of agricultural development (selection)
- ▲ Thrust belt

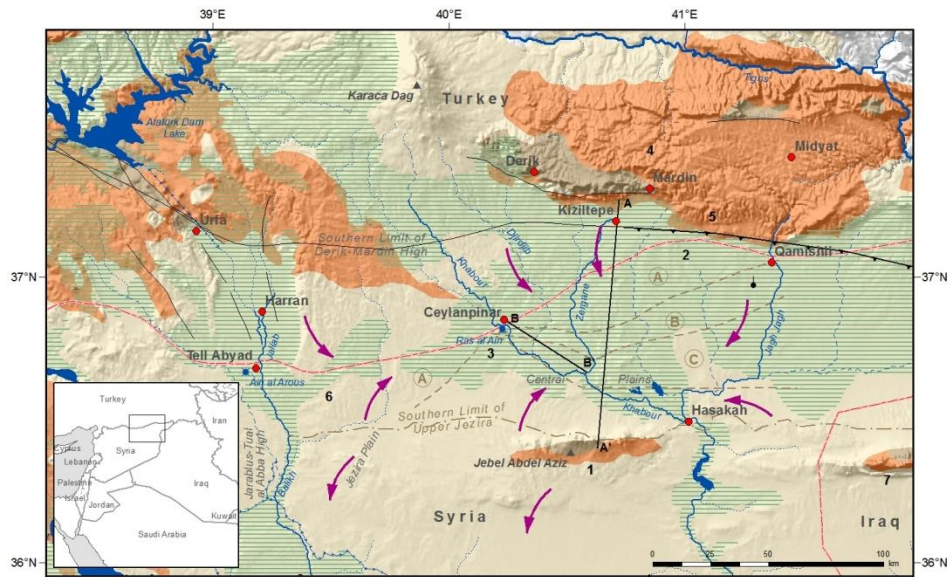
**BGR** Bundesanstalt für Geowissenschaften und Rohstoffe

**ESCWA** المجلس القطري للمياه

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## Jezira Tertiary Limestone Aquifer System

- Selected city, town
  - International boundary
  - River
  - Intermittent river, wadi
  - Canal, irrigation tunnel
  - Spring
  - Bore-hole
  - Freshwater lake
  - Direction of groundwater flow
  - Groundwater quality zones:
    - ▲ Fresh Ca-HCO<sub>3</sub> type water
    - ▲ Brackish CaSO<sub>4</sub> type water
    - ▲ Saline NaCl-CaCl type water
  - Ecocene, Oligocene outcrops of the aquifer system
  - Pre-Eocene Formation outcrops
  - Approximate subsurface extent of the aquifer system
  - ▨ Zone of agricultural development (selection)
  - Hydrogeological cross-section
  - Faults
  - ▲ Mountain
- Specific features:**
1. Jebel Abdel Aziz Anticline
  2. Gamishli Anticline
  3. Ras al Ain Anticline
  4. Mardin Anticline
  5. South Mardin Fault Zone
  6. Tell Abyad Anticline
  7. Sinjar Anticline

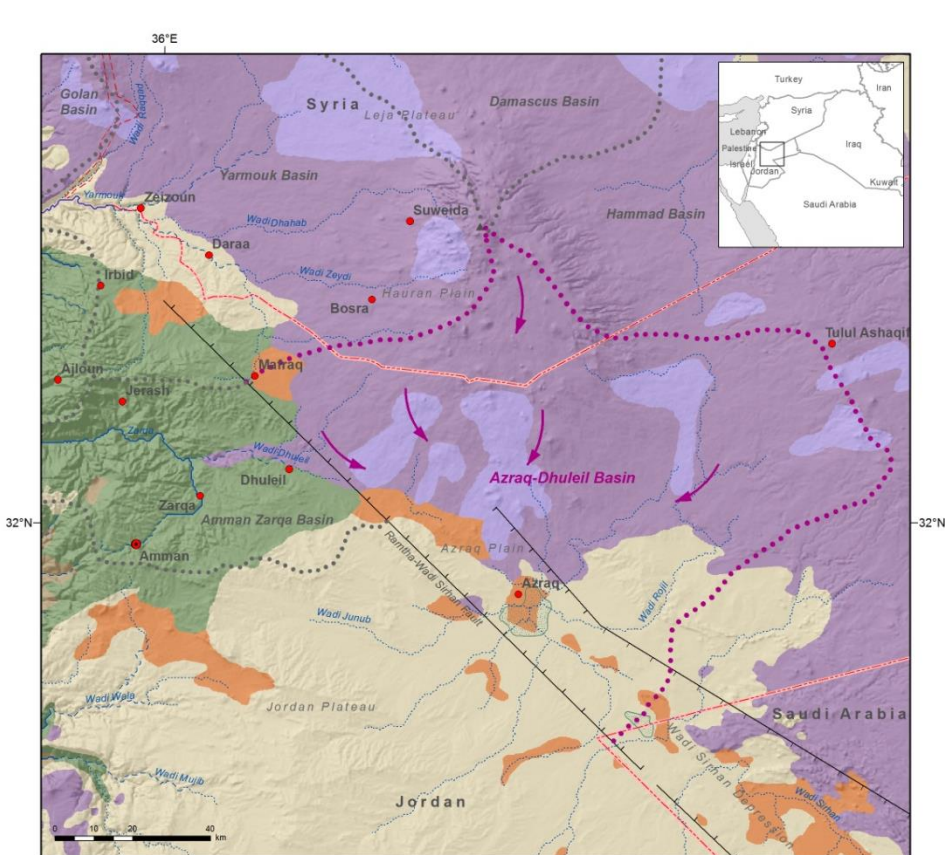
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# Shared Groundwater Management Challenge: Shared Groundwater can contribute to Shared Surface Water Basins



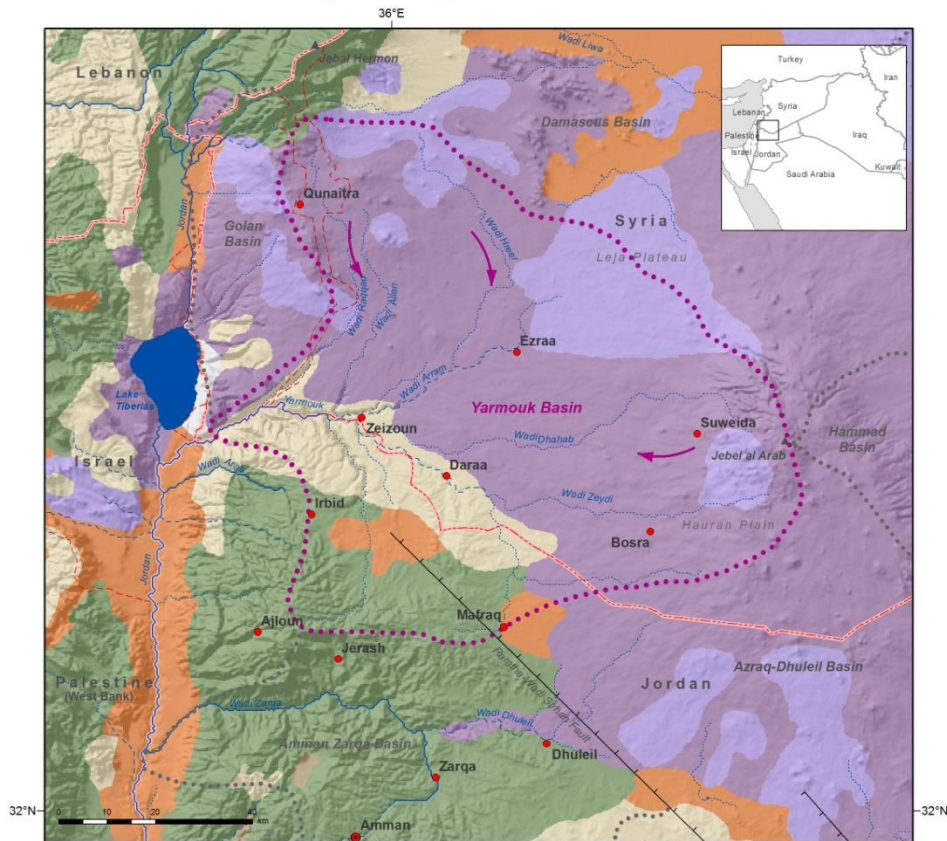
Basalt Aquifer System (South): Azraq-Dhuleil Basin

- Capital
- Selected city, town
- International boundary
- - - Armistice Demarcation Line
- ~ River
- ~ Intermittent river, wadi
- ☪ Freshwater lake
- ☪ Sabkha
- ▲ Mountain
- ▭ Graben
- Quaternary volcanics
- Neogene volcanics
- Quaternary-Neogene undifferentiated
- Paleogene (Wadi Shallala and Umm Rijam Formations)
- Cretaceous (Amman and Wadi as Sir Formations)
- Pre-Cambrian outcrops
- ➔ Direction of groundwater flow in Azraq-Dhuleil Basin
- ⋯ Boundary of Azraq-Dhuleil Basin
- ⋯ Basin boundary



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Basalt Aquifer System (West): Yarmouk Basin

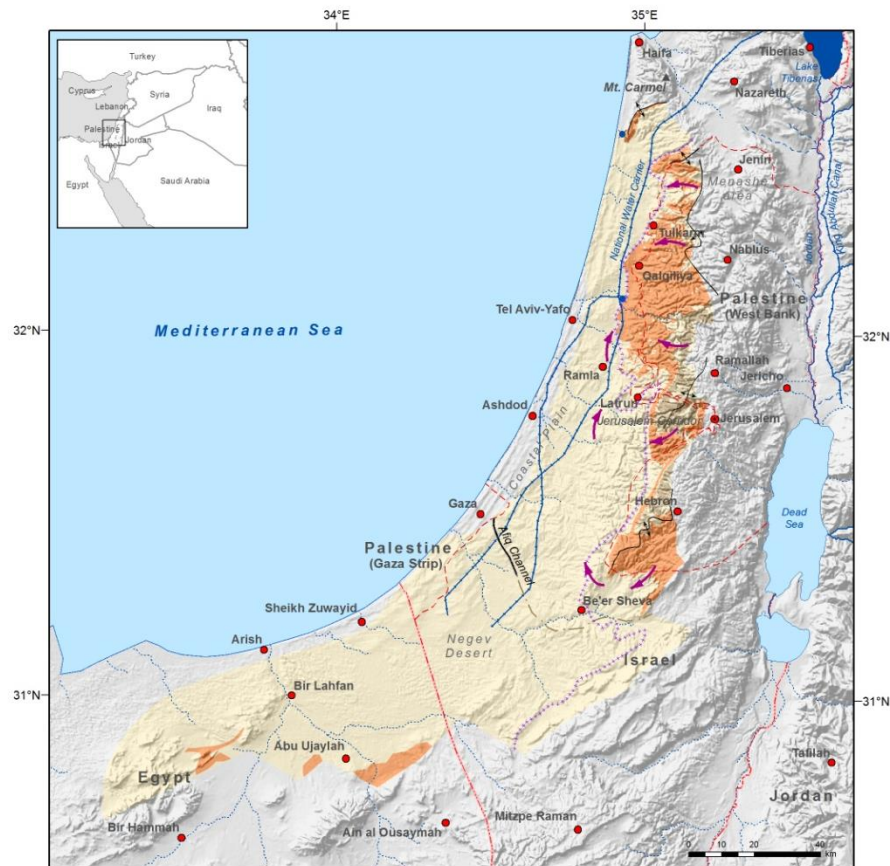
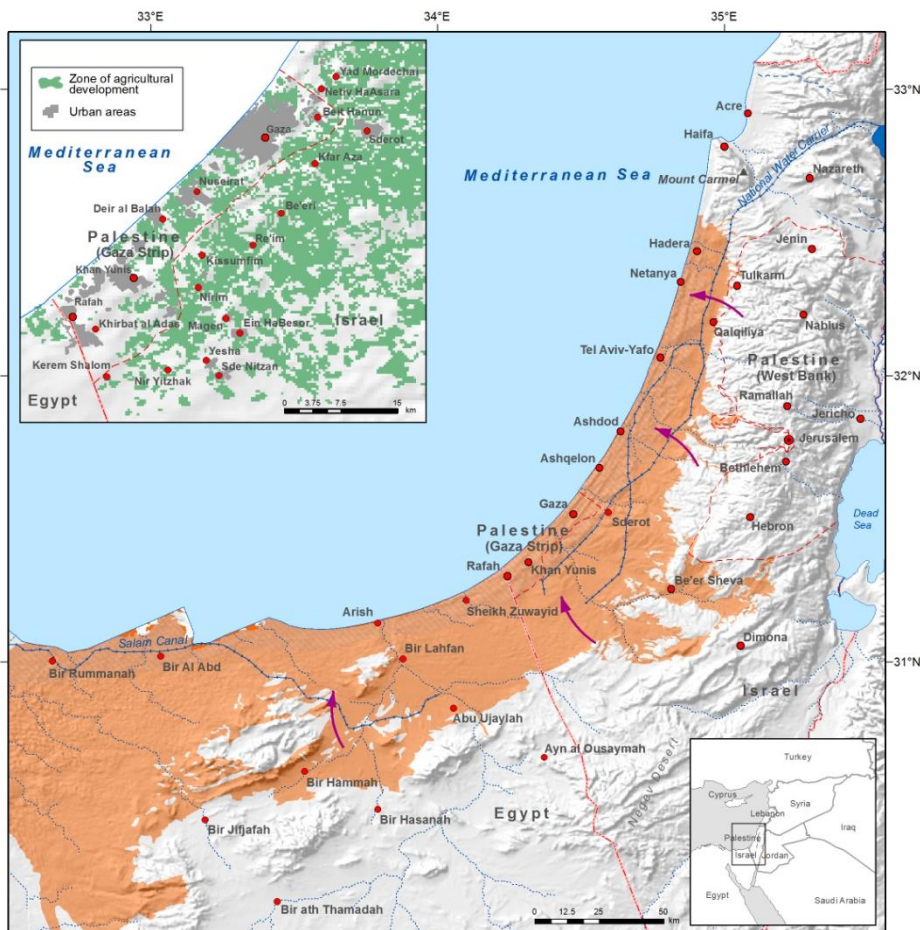
- Capital
- Selected city, town
- International boundary
- - - Armistice Demarcation Line
- ~ River
- ~ Intermittent river, wadi
- ☪ Freshwater lake
- ▲ Mountain
- ▭ Graben
- Quaternary volcanics
- Neogene volcanics
- Quaternary-Neogene undifferentiated
- Paleogene (Wadi Shallala and Umm Rijam Fms)
- Cretaceous (Amman and Wadi as Sir Fms)
- Pre-Cambrian outcrops
- ➔ Direction of groundwater flow in Yarmouk Basin
- ⋯ Boundary of Yarmouk Basin
- ⋯ Basin boundary



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# Shared Groundwater Management Challenge: Occupation, Over-extraction, Saltwater Intrusion in Coastal Aquifers, Salinity



## Coastal Aquifer Basin

- Capital
- Selected city, town
- International boundary
- - - Armistice Demarcation Line
- River
- - - Intermittent river, wadi
- Canal, irrigation tunnel
- Approximate outcrop extent of the aquifer formation
- Approximate extent of productive area
- ➔ General direction of groundwater flow



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## Western Aquifer Basin

- Capital
- Selected city, town
- International boundary
- - - Armistice Demarcation Line (Green Line)
- River
- - - Intermittent river, wadi
- Canal
- Spring
- Freshwater lake
- Saltwater lake
- Upper aquifer outcrop
- Lower aquifer outcrop
- Approximate subsurface extent of the aquifer
- Anticlines
- Afq Channel
- - - Assumed impermeable boundary
- ➔ Direction of groundwater flow
- - - Confinement line

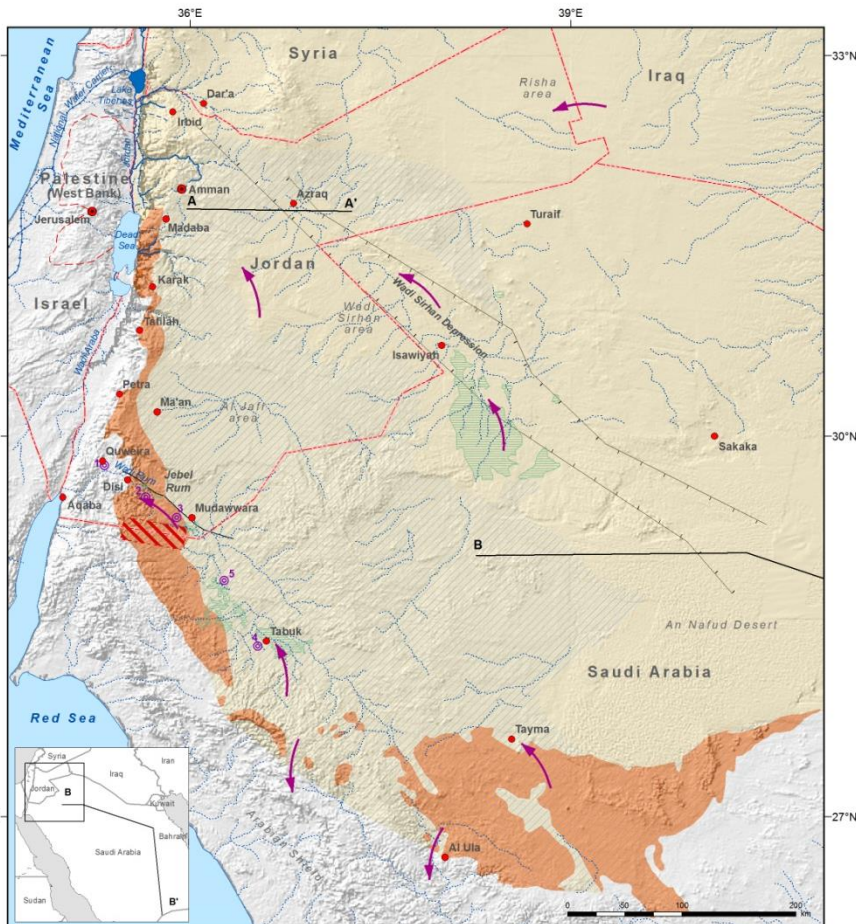


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# Shared Groundwater Management Challenge: Groundwater for Multiple Uses (Water-Energy-Food Nexus)



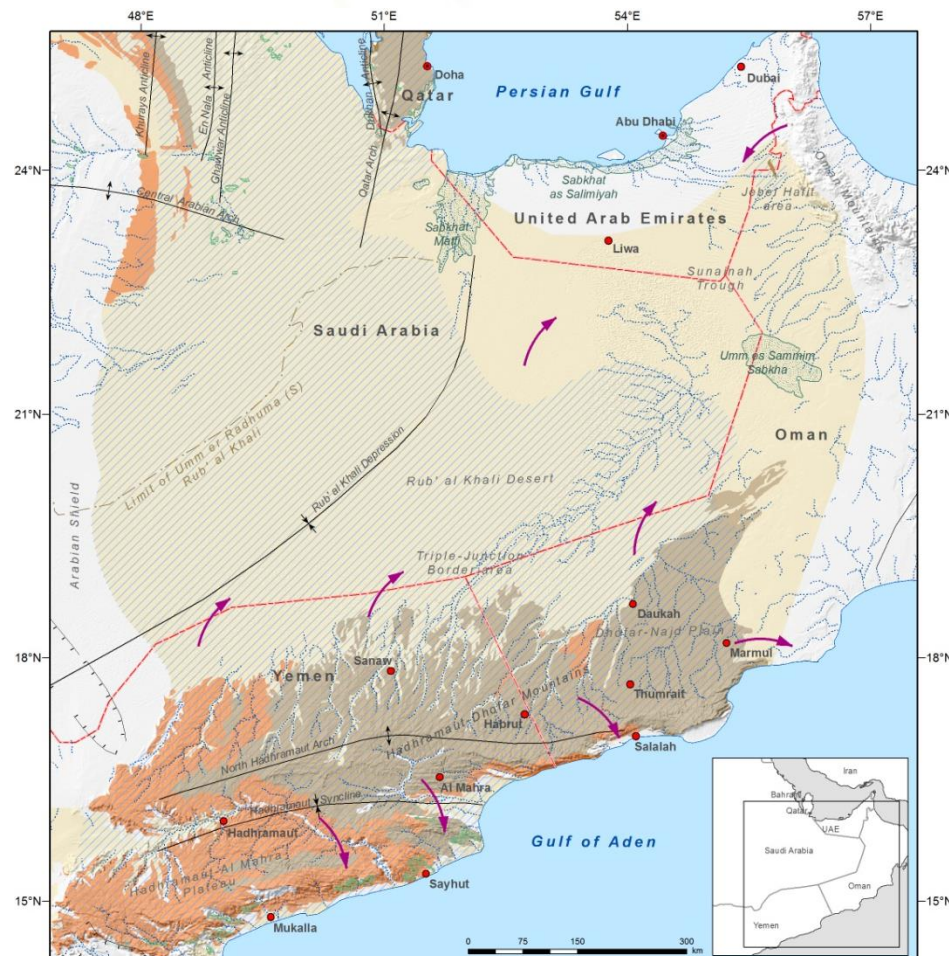
**Saq-Ram Aquifer System (West)**

- Capital
- Selected city, town
- International boundary
- - - Armistice Demarcation Line
- River
- ⋯ Intermittent river, wadi
- Canal
- Freshwater lake
- Dike
- A A' Approximate location of geological cross-section
- Graben
- Saq-Ram outcrop
- Approximate subsurface extent of the aquifer formations
- Approximate extent of exploitable area
- Zone of agricultural development (selection)
- No drilling zone
- Direction of groundwater flow
- ⊙ Water supply well fields
- 1 Quweira
- 2 Dubaiyib
- 3 Mudawwara
- 4 Tabuk
- 5 Uyanah



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**Umm er Radhuma-Dammam Aquifer System (South): Rub' al Khali**

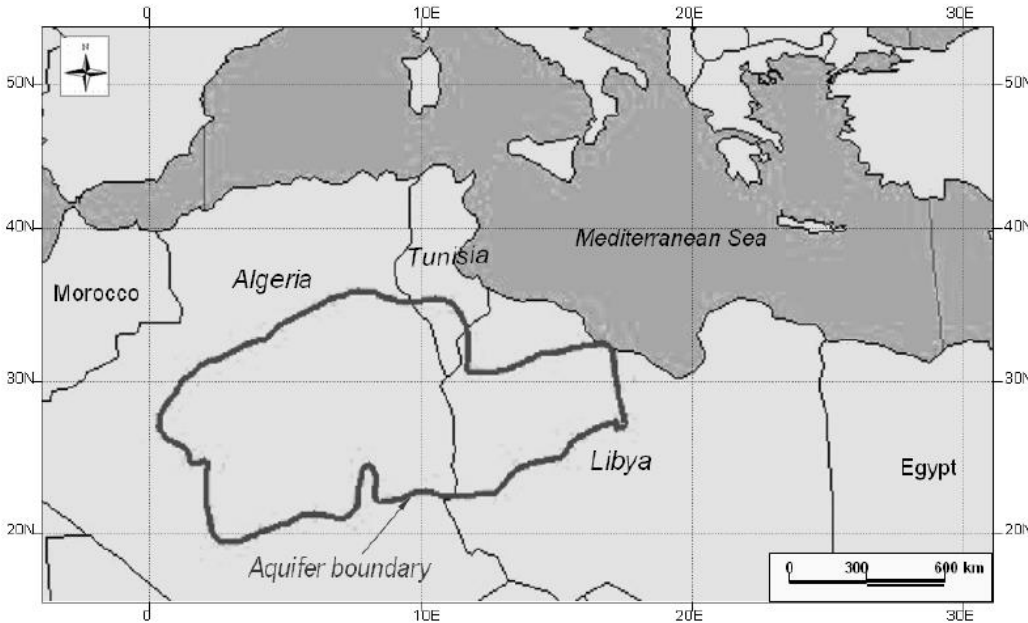
- Capital
- Selected city, town
- International boundary
- ⋯ Intermittent river, wadi
- Anticline
- Syncline
- Graben
- Umm er Radhuma and Jeza Formations outcrop
- Dammam and Rus Formations outcrop
- Approximate subsurface extent of the aquifer formations
- Approximate extent of exploitable area
- Direction of groundwater flow
- Zone of agricultural development (selection)
- Sabkha



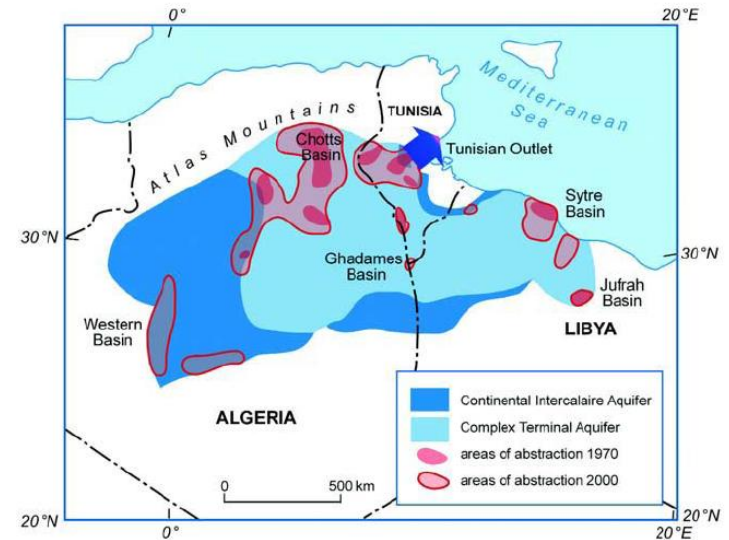
**Inventory of Shared Water Resources in Western Asia**

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

# Shared Aquifer Systems in Arab/North African Countries: Joint Data & Modeling for Joint Management



**Fezzani et al 2005** cited in **UN ESCWA, 2009**  
“Knowledge Management and Analysis of ESCWA Member Countries Capacities in Managing Shared Water Resources”



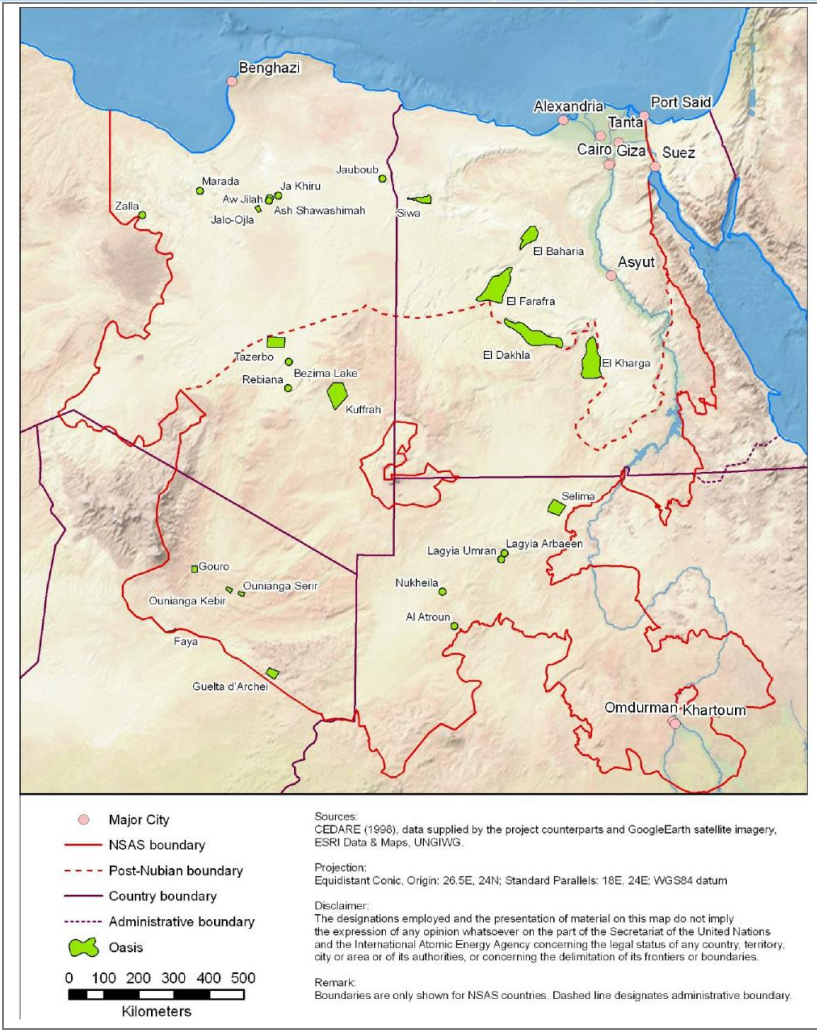
**Manou et al. (2006,69)** cited in **German Development Institute (DIE), 2008**  
“Conceptualizing cooperation on Africa’s transboundary groundwater resources”



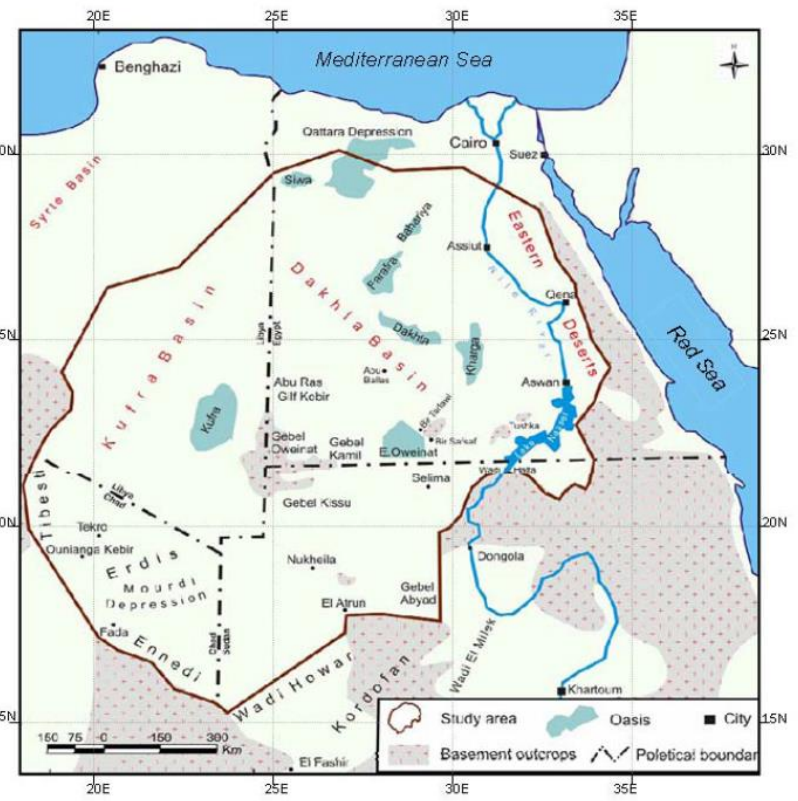
**North Saharan Aquifer System (SASS)**  
**Sahara and Sahel Observatory (OSS)**  
supporting data collection, modeling, capacity building with Algeria, Libya & Tunisia

**ISA TIGER Aquifer Project, 2007**  
is cited in **UNESCO, 2009**  
Atlas of Transboundary Aquifers”

# Shared Aquifer Systems in Arab/North African Countries: Joint Commission and Cooperation



**A Oases.png based on CEDARE 1998 as cited in International Atomic Energy Agency, 2012**  
 “Regional Strategic Action Programme For the Nubian Sandstone Aquifer System” Vienna, Austria



**Sefelnasr, 2007 cited in UN-ESCWA, 2009**  
 “Knowledge Management and Analysis of ESCWA Member Countries Capacities in Managing Shared Water Resources”

## Nubian Sandstone Aquifer System (NSAS) Joint Commission in 1999

CEDARE supporting Chad, Egypt, Libya & Sudan  
 with Agreements, Management, Monitoring,  
 Data Exchange, Capacity Building

# Key Pressures and Management Concerns for Sustainable Development for Shared Water Resources



- ◆ Population Growth
- ◆ Unemployment
- ◆ Food Security
- ◆ Rural to Urban Migration
- ◆ Conflict, crisis, occupation and insecurity
  
- ◆ Water Security
- ◆ Freshwater Scarcity
- ◆ Water Quality
- ◆ Water resource use & efficiency for sustainable resource management
- ◆ Despite assessment, more joint monitoring & management needed
- ◆ Different considerations for renewable & non-renewable resources when considering over-extraction of non-renewable groundwater resources.
- ◆ Water is shared between countries and communities.

***Most Arab States are water-stressed States facing growing socio-economic development pressures, making progress towards sustainable development a greater challenge.***

***Thank you for your attention!***

ESCWA-BGR

***Inventory of Shared Water Resources in Western Asia***

available at:

**[www.waterinventory.org](http://www.waterinventory.org)**

**Regional Initiative for the Assessment of the Impact of Climate Change  
on Water Resources and Socio-Economic Vulnerability in the  
Arab Region (RICCAR) *available at:***

**[www.escwa.un.org/RICCAR](http://www.escwa.un.org/RICCAR)**

email: [chouchanicherfane@un.org](mailto:chouchanicherfane@un.org)