Groundwater Dependent Ecosystems

Water Resources Management in the Azraq Region

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Main Challenges

- The gap between the water supply and demand
- The population growth and the economical development
- The localities distance from the water resources
- The negative impact of the Syrian influx
- 40% of the kingdom water resources are shared
- Climate change and drought
- Limited financial resources to implement the needed projects
- The energy cost

Water situation in Jordan

Available resources

TYPE	AVAILABLE RESOURCES (MCM)
Surface water (currently exploitable)	288
Treated wastewater	163
Groundwater	418
Total	870

Current usage (2017)

RESOURCES	USES (MCM)				Total Uses
	Municipal	Industrial	Irrigation	Rural areas	
Surface water	131.3	2.4	149.4	5	288.1
Treated wastewater	0	2.5	144.2	0	146.7
Groundwater	338.4	27.2	251.1	2.1	618.8
Total	469.7	32.1	544.7	7.1	1053.6

Groundwater over abstraction: 200 MCM

Water Demand : 1400 MCM

Water situation in Jordan

Actions to close the gap

- ✓ Actions against illegal abstraction (more than 600 illegal wells in Azraq)
- ✓ Increasing irrigation efficiency
- ✓ Lowering the allowed free abstraction amount from private wells to 75,000 m3/yr and raising the tariff
- ✓ Extensive penalties related to drilling new illegal wells

Azraq Oasis – in the late 1970s

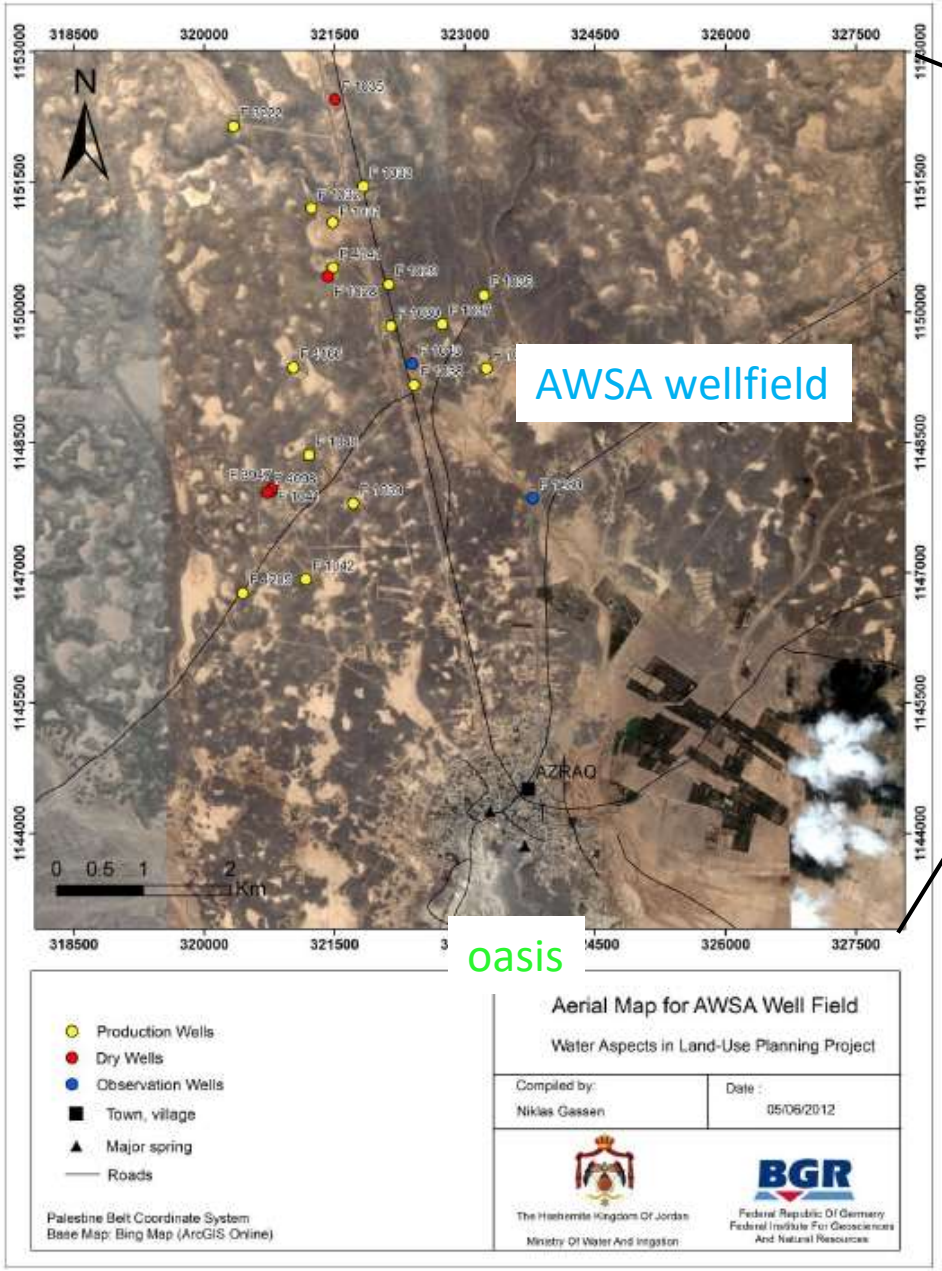
Azraq Oasis – RAMSAR convention

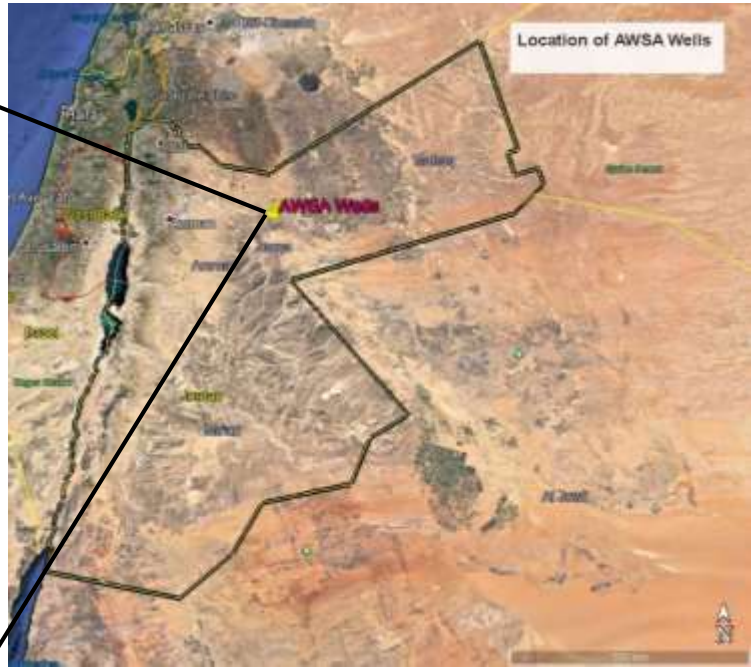
Azraq Oasis

Jordan signed the RAMSAR convention on wetlands in 1977
Oasis is a RAMSAR site since 1990
based on Ramsar Advisory Mission, Report No. 17, Azraq Oasis, Jordan (1990)
Water is pumped from AWSA wellfield to oasis since 1994 (1.5 – 2 MCM/yr)

RAMSAR
International Organization for the Convention on Wetlands of International Importance
The Convention on Wetlands was signed in Ramsar (Iran) in 1971

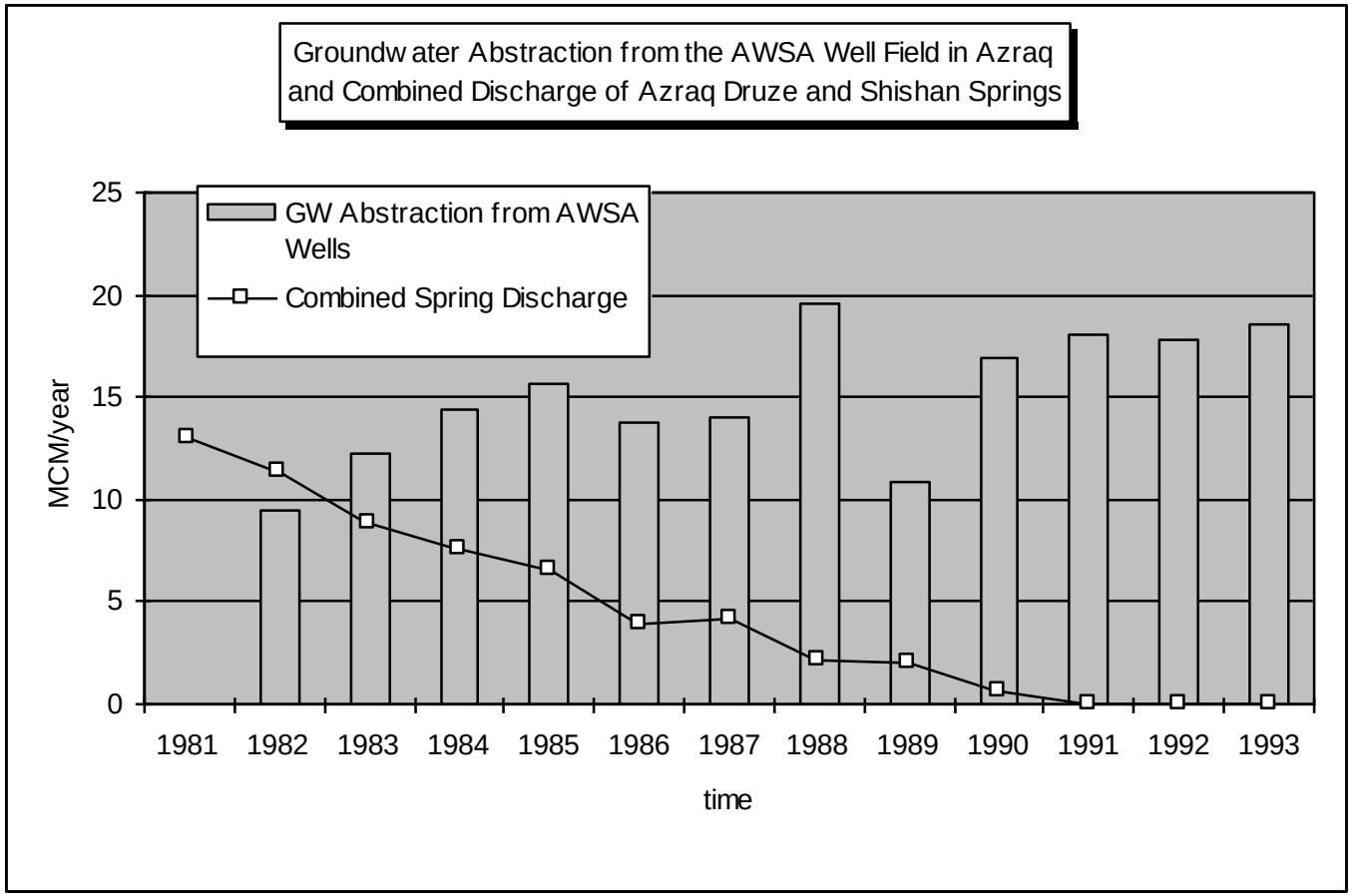
AWSA wellfield





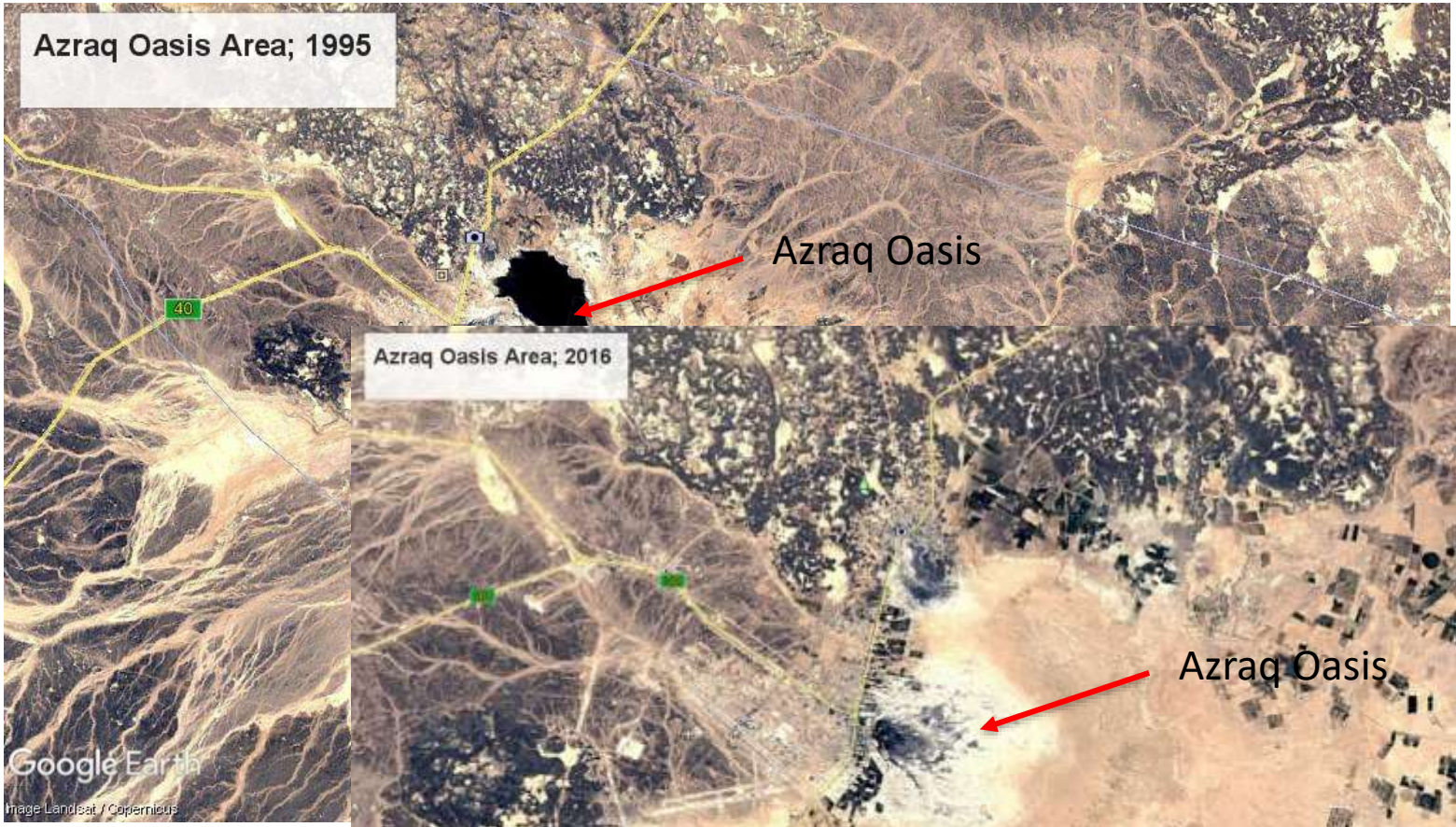
AWSA wellfield

Establishment of AWSA wellfield (water supply to Amman- now to Zarqa) in 1982
> decrease of spring discharge

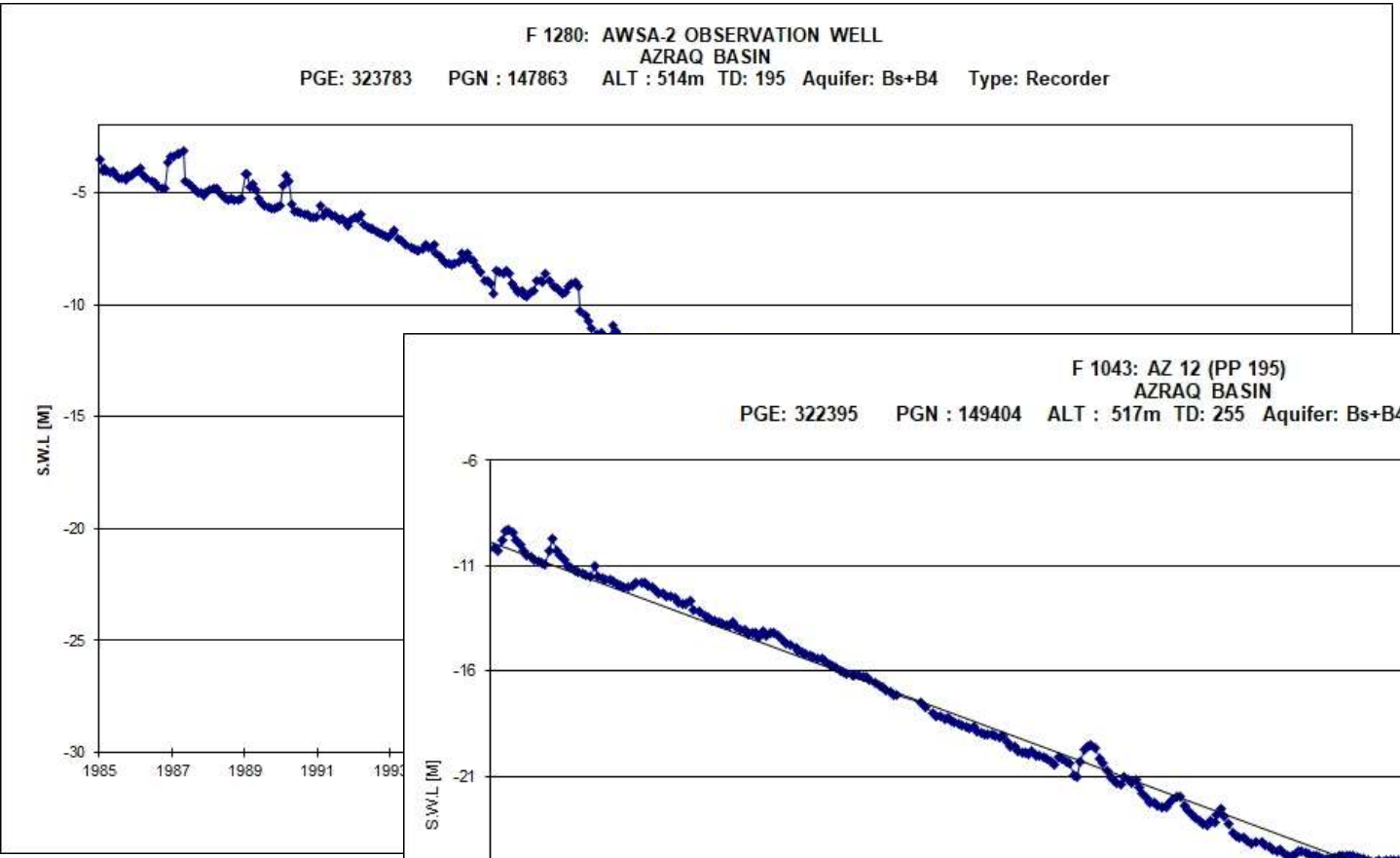


WAJ & BGR (1995)

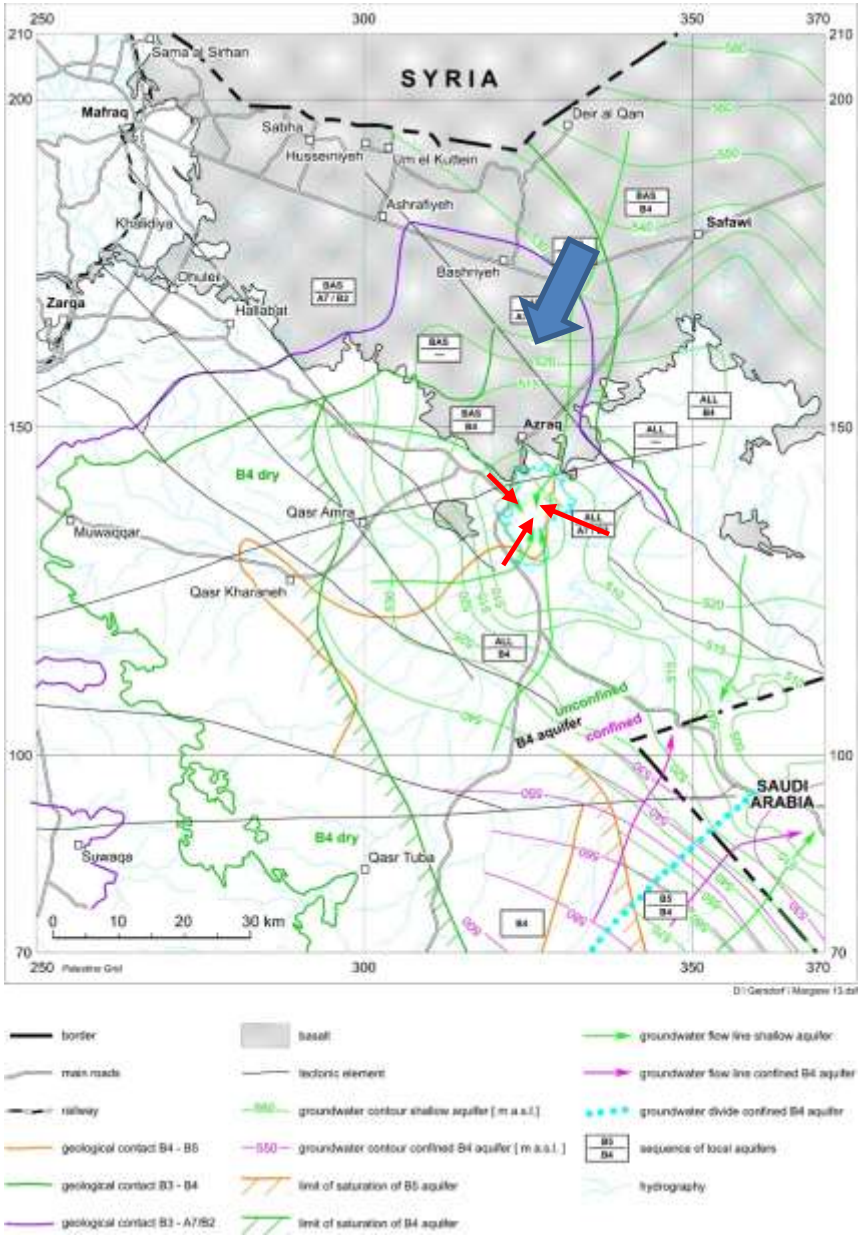
Azraq Oasis - current situation



Current status of the aquifer – groundwater monitoring



Groundwater flow on Azraq Oasis-1995

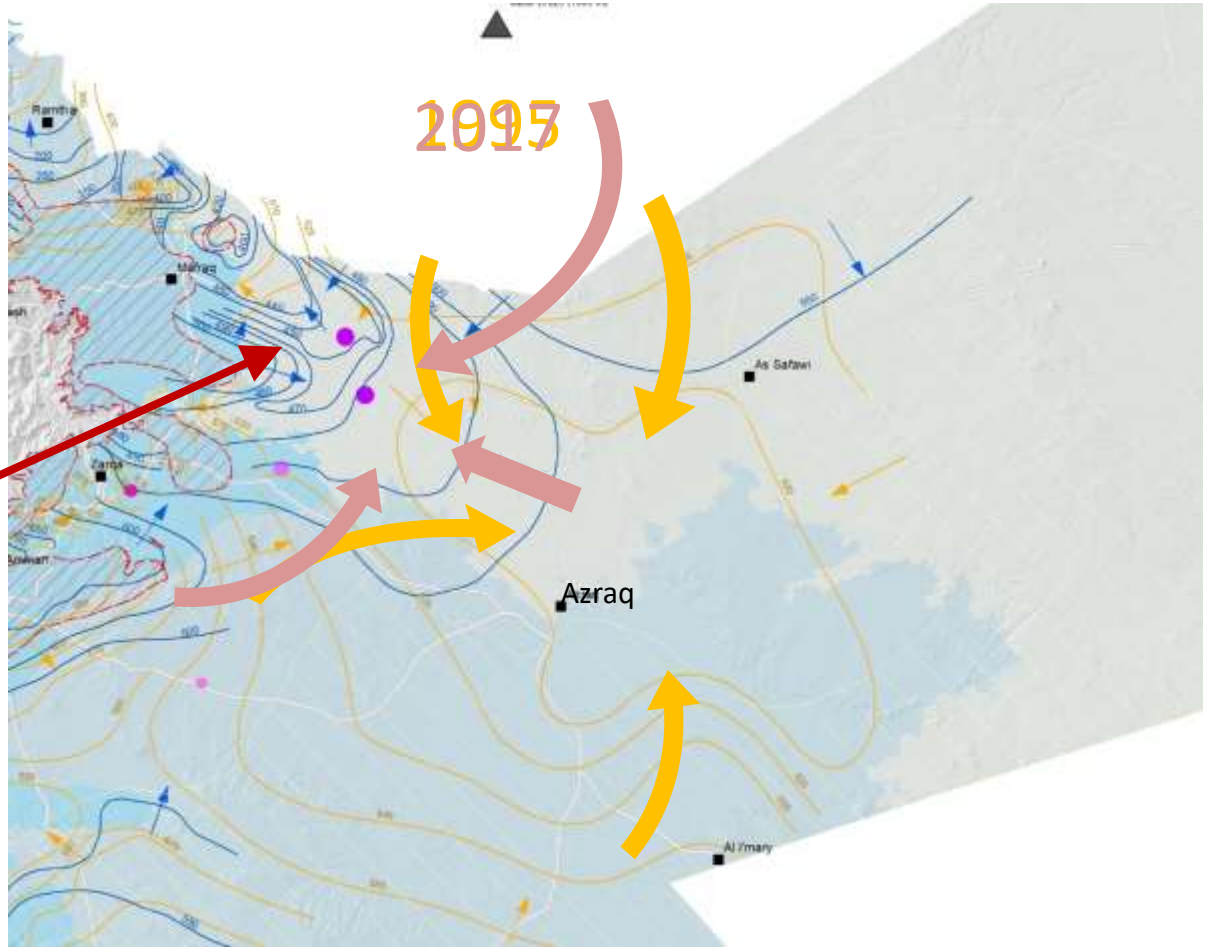


Shallow aquifer (bas+B4)
low local recharge
main inflow from N
inflow from main aquifer (A7/B2) across fault
Natural flow:
Towards oasis

Change in Groundwater Flow: GW assessments 1995 - 2017

Groundwater flow in main aquifer (A7/B2)
from Jebel Druze towards Azraq Oasis is reduced – main flow to Yarmouk
Reason: high abstractions E of Mafraq

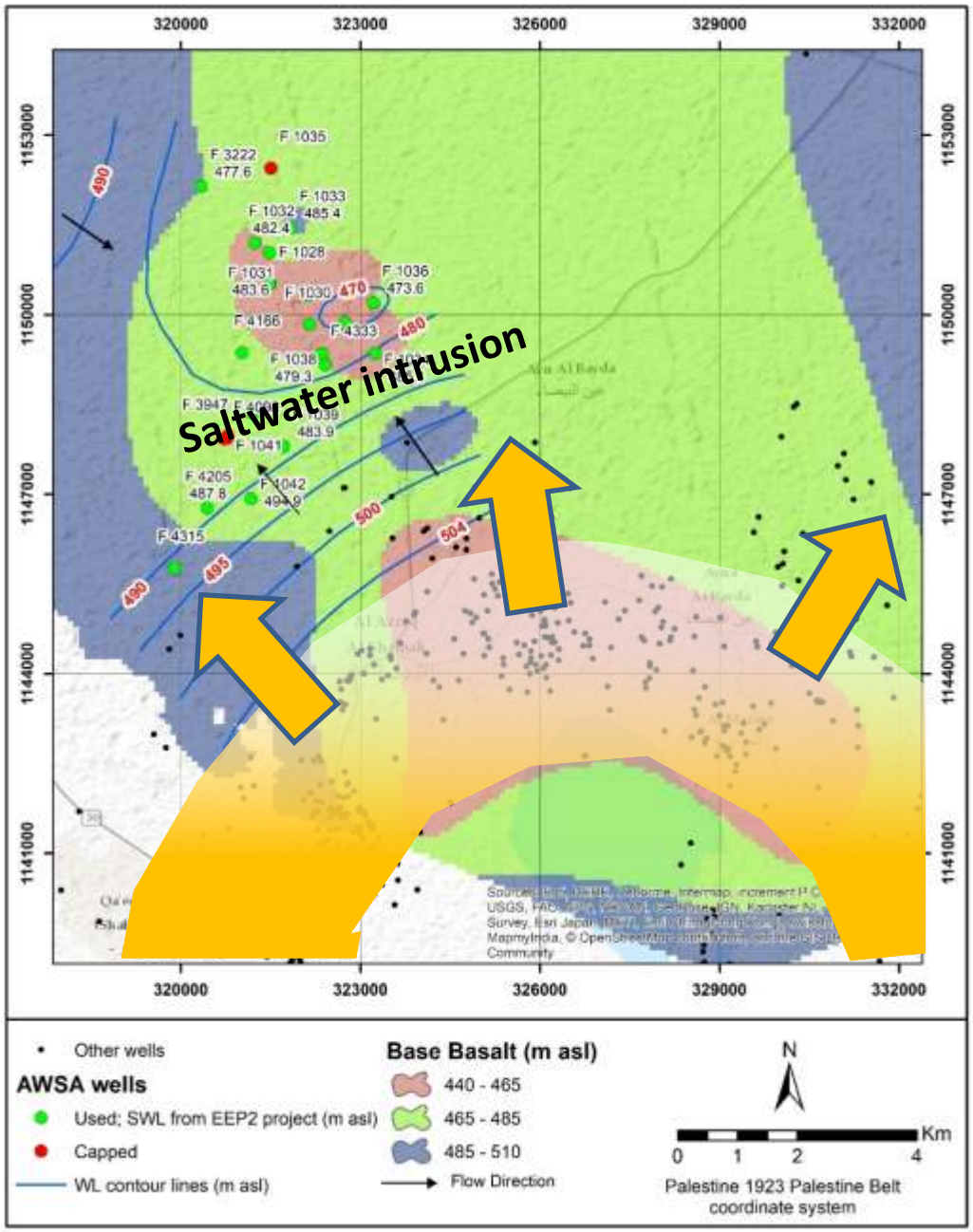
Water level decline ~100 m



Current Status of the Aquifer

AWSA wellfield is affected by saltwater intrusion from the oasis

Groundwater contours (blue lines; collected between March-May 2017) showing flow from the oasis towards NW

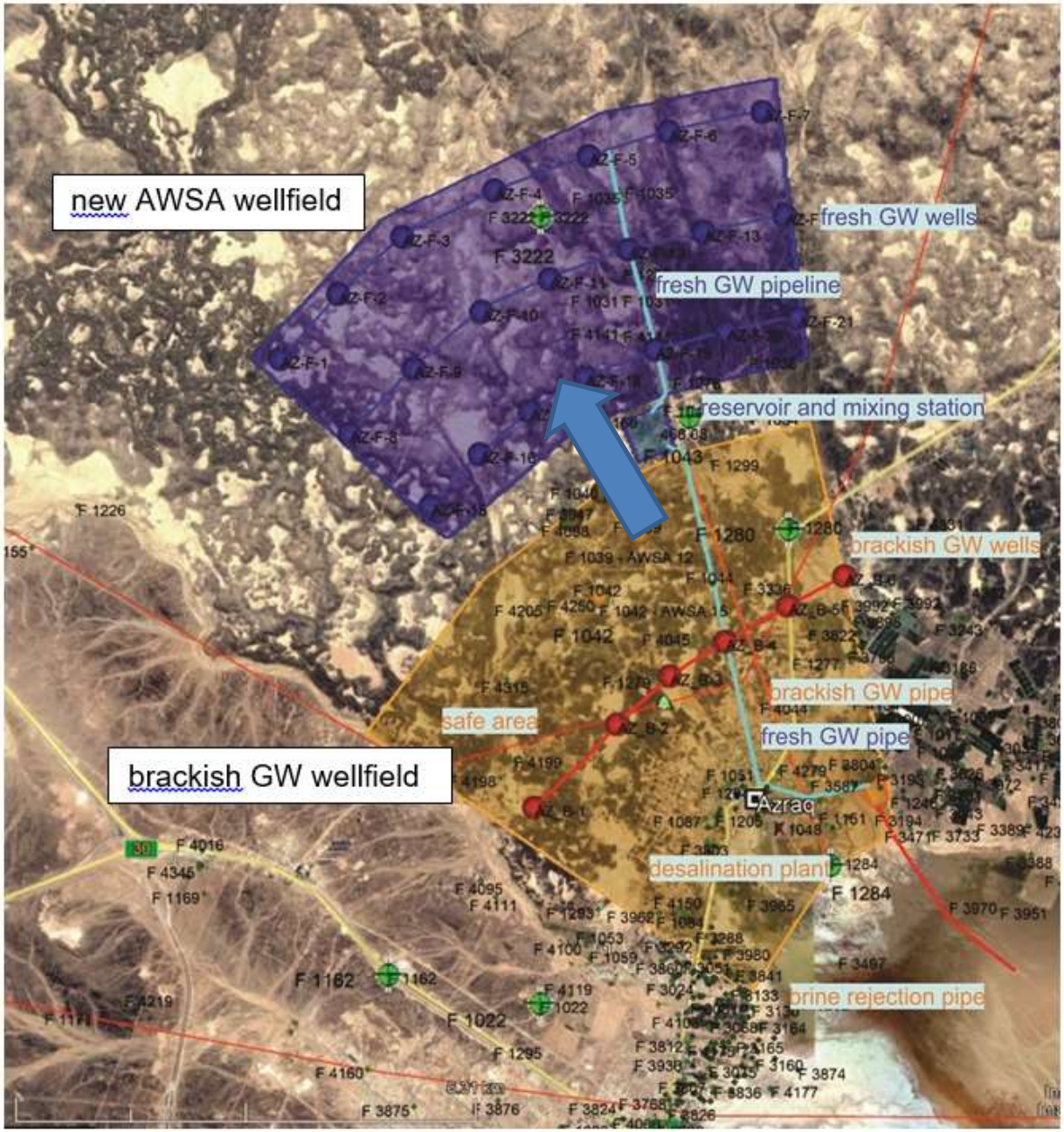


Azraq Aquifer Action Plan

with desalination	without desalination
Option A	Proposed action: Option B
conduct additional studies to determine the extent of the saltwater intrusion problem and optimal location for future groundwater extraction (water level and quality monitoring in the affected zone of AWSA wellfield, geophysical survey, study of MAR potential, geophysical piezometers and water quality observation wells on profile between Azraq oasis and AWSA wellfield)	
establish safe zone (no GW abstraction in area between AWSA wellfield and salt water body)	
establish new AWSA wellfield with pipes to reservoir (galleries 1 and 2) with internal network of roads and reservoir (7 wells each gallery, i.e. 7 / 14 wells) (~10 MCM/yr)	
Establish gallery for abstraction of brackish GW (6 wells) (brackish GW WF) in zone between oasis and new AWSA WF (5 MCM/yr)	
Pump and desalinate brackish groundwater reject brine to oasis (if allowed by RAMSAR convention) (4.5 MCM/yr freshwater or max. 0.5 g/l; 0.5 MCM brine)	
Establish 3rd gallery of new AWSA wellfield (another 7 wells) (combined: 15 MCM/yr)	
	establish new Basalt 2 wellfield with pipes to reservoir (galleries 5, 4 and 3 – 9 wells) (7 MCM/yr)
	Optional: establish new Basalt 2 wellfield (galleries 1 and 2 – 10 wells) (combined: up to 15 MCM/yr) (included in costs calculation)
Cost: 56.7 M JOD	Cost: 26.5 M JOD
Freshwater quantity: 19.5 MCM/yr	Freshwater quantity: 17 – 25 MCM/yr
Other activities implemented by other donors or MWI (GIZ: irrigation efficiency, monitoring equipment (quantity/quality); USAID/WMI: remote sensing study to determine abstraction for irrigation; MWI: combatting illegal groundwater abstractions)	

Azraq Aquifer Action Plan- Option A

Actions:
Shift AWSA wellfield towards N
Establish brackish GW
Abstraction scheme

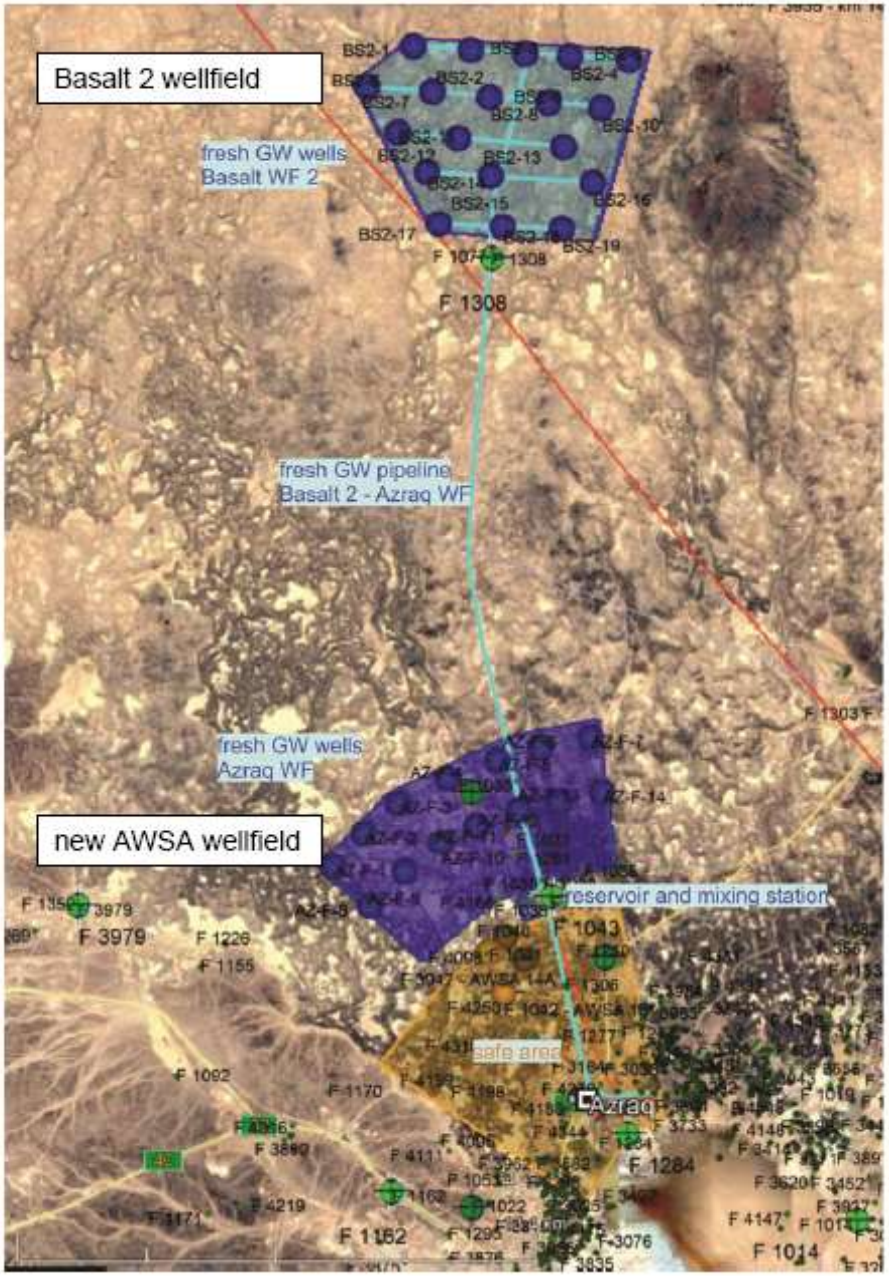


Disadvantages:

- ✓ The desalination option is associated with very high costs;
- ✓ Pumping brackish GW would not stop the saltwater intrusion process; it would only reduce the impact on AWSA wellfield;
- ✓ Massive environmental damage in the oasis (might not be allowed due to RAMSAR convention); also potentially affecting nearby farmers.
- ➢ **High cost.**

Azraq Aquifer Action Plan- Option B

Actions:
Shift AWSA wellfield towards N
Add another abstraction scheme farther N
Establish safe zone with no abstractions near oasis



Advantages:

- No desalination required
- Excellent quality and yield in Basalt 2 WF expected
- Much lower costs compared to water management option A
- Flow by gravity from Basalt 2 WF to Azraq;
- In Basalt 2 WF, wells could be added as needed, starting from S and progressing to N; WF can be extended laterally if result is good.

Disadvantages:

- Geology in Basalt 2 WF currently insufficiently known;
- Additional costs for conveyor from Basalt 2 WF to Azraq;
- Higher pumping costs in Basalt 2 WF (DWL ~ 200 – 240 m bgl).

Conclusion

- The demand for drinking water is steadily rising.
- The population to serve has risen by a factor of 2.5 over the past 20 years.
- Until the big solution comes at a feasible cost, we have to use groundwater.
- While doing so, we are trying to avoid impacts on the natural heritage sites.
- Also these come at a high cost.