3R analysis Wadi Ratamah - Azraq

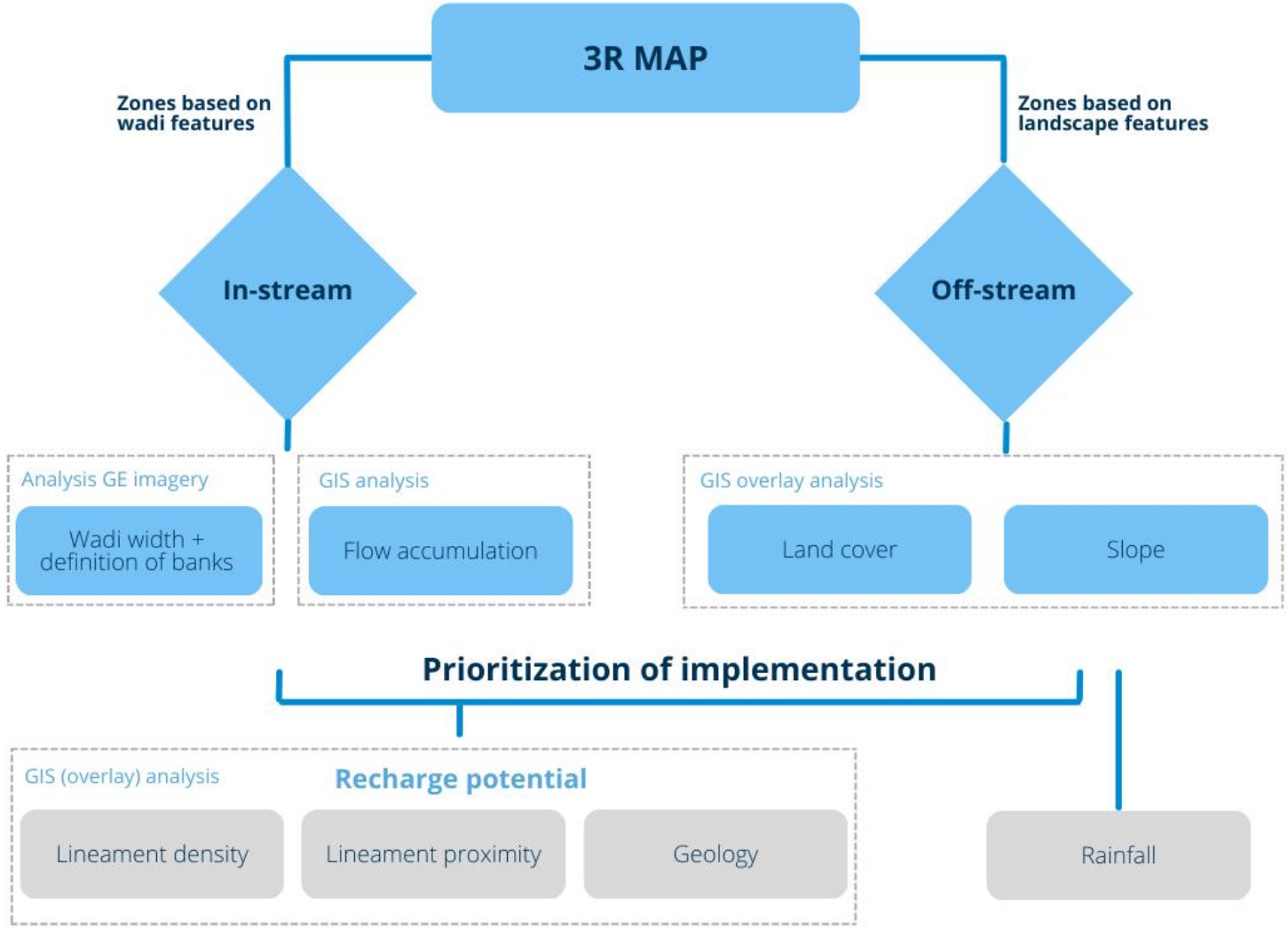
Analysis and concepts

January, 2024

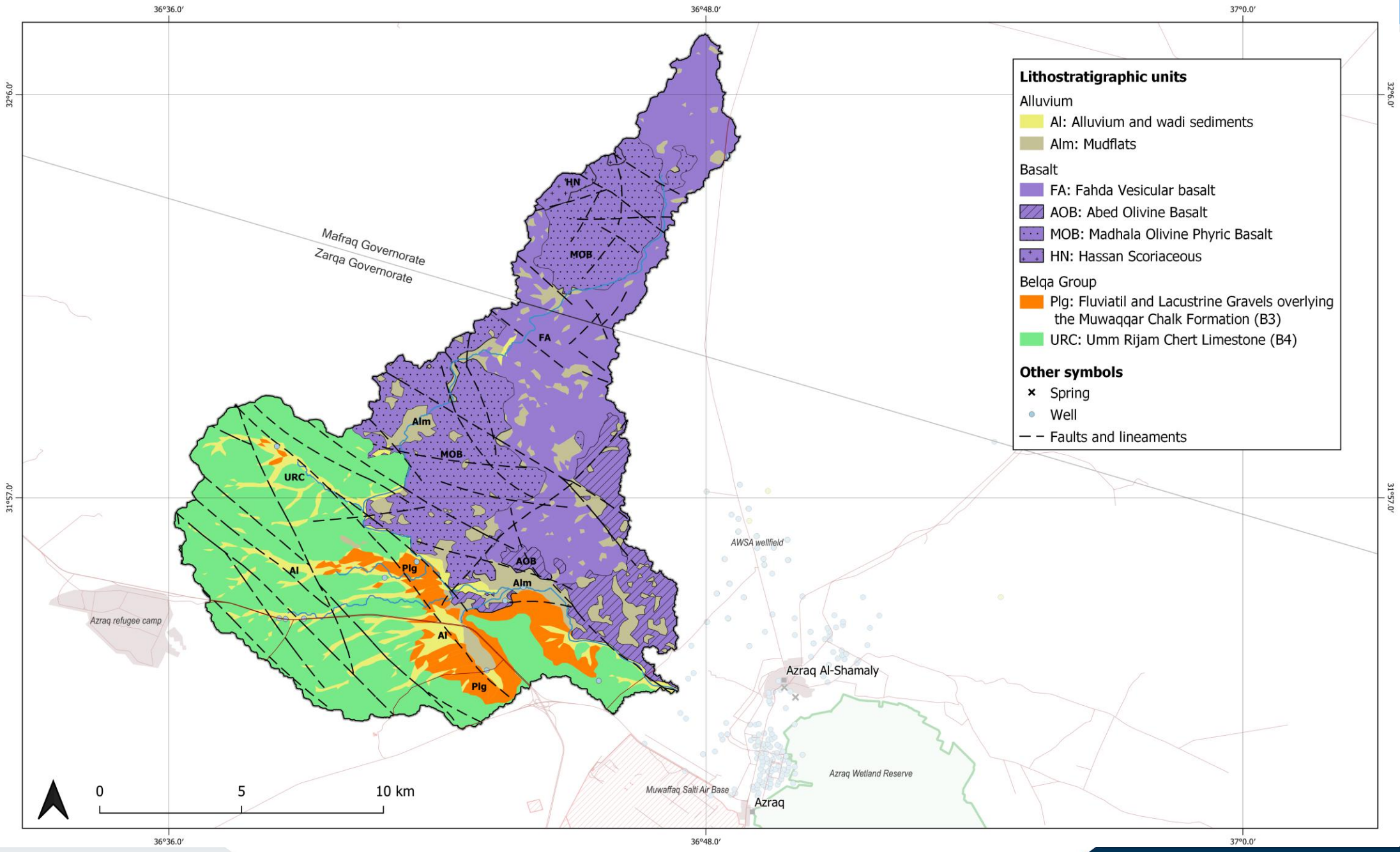
ACACIA WATER

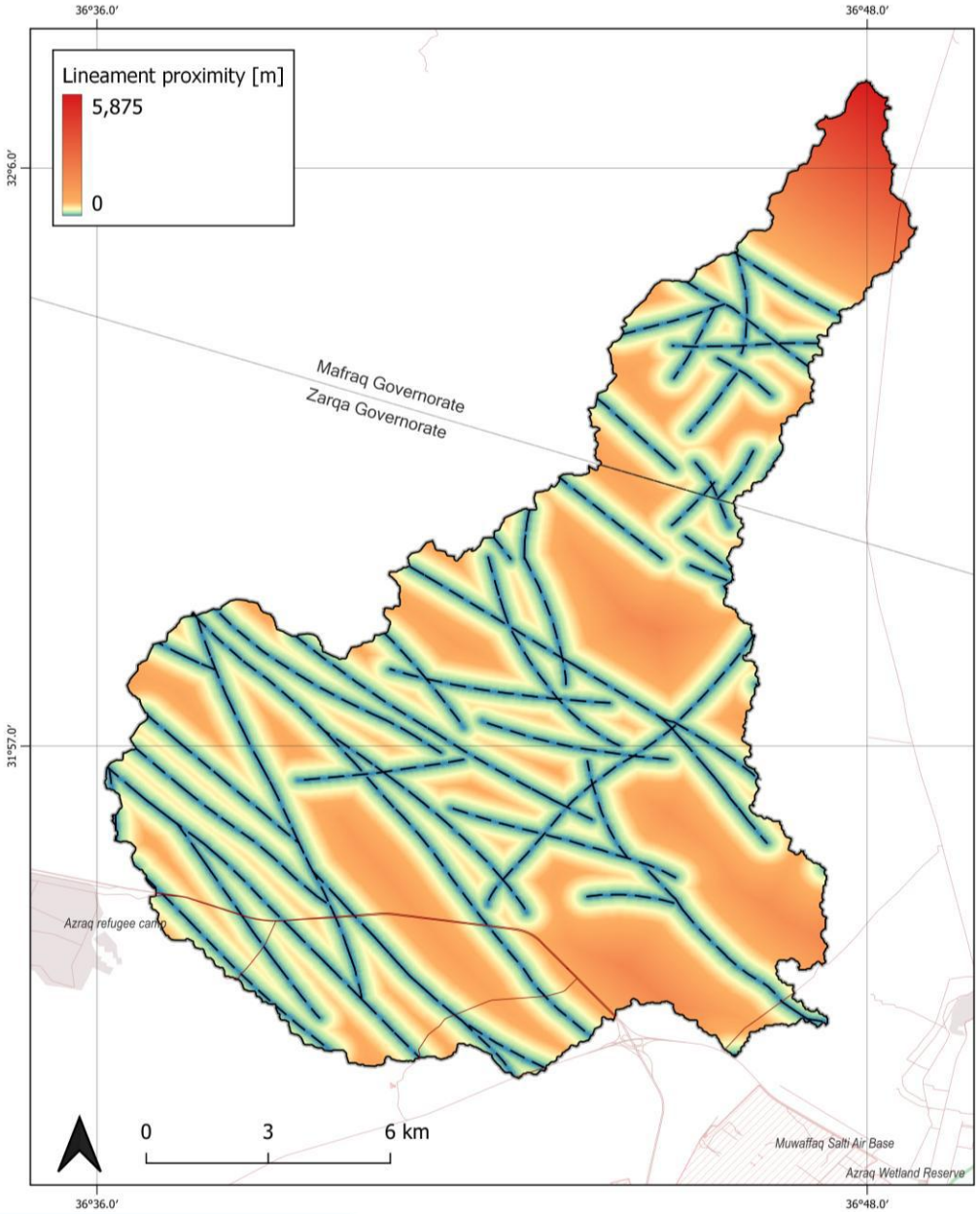
Steps of analysis

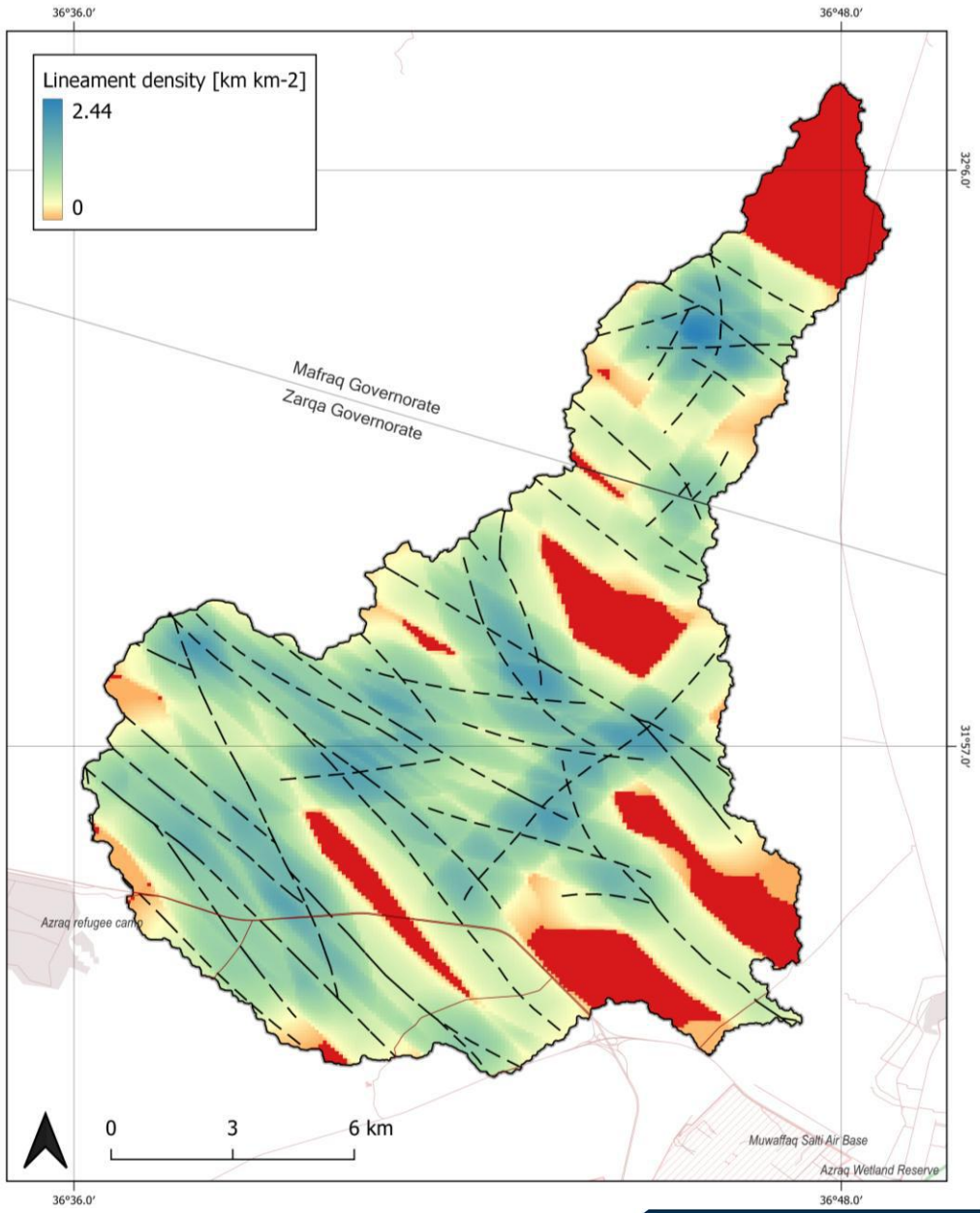
- Final product 3R map with prioritized locations for implementation
- Aim of interventions:
  - **Flood risk reduction** downstream
  - **Groundwater recharge**



Inputs


36°36.0′
36°48.0′
37°0.0′
32°6.0′
31°57.0′
Lithostratigraphic units
Alluvium
Al: Alluvium and wadi sediments
Alm: Mudflats
Basalt
FA: Fahda Vesicular basalt
AOB: Abed Olivine Basalt
MOB: Madhala Olivine Phyric Basalt
HN: Hassan Scoriaceous
Belqa Group
Plg: Fluviatil and Lacustrine Gravels overlying the Muwaqqar Chalk Formation (B3)
URC: Umm Rijam Chert Limestone (B4)
Other symbols
Spring
Well
Faults and lineaments
Mafraq Governorate
Zarqa Governorate
HN
MOB
FA
Alm
MOB
URC
Al
Plg
AOB
Alm
Al
Plg
AWSA wellfield
Azraq refugee camp
Azraq Al-Shamaly
Azraq Wetland Reserve
Muwaffaq Salti Air Base
Azraq
0
5
10 km


Lineament proximity [m]
5,875
0
36°36.0′
36°48.0′
32°6.0′
31°57.0′
Mafraq Governorate
Zarqa Governorate
Azraq refugee camp
Muwaffaq Salti Air Base
Azraq Wetland Reserve
0
3
6 km


Lineament density [km km-2]
2.44
0
36°36.0′
36°48.0′
32°6.0′
31°57.0′
Mafraq Governorate
Zarqa Governorate
Azraq refugee camp
Muwaffaq Salti Air Base
Azraq Wetland Reserve
0
3
6 km

Recharge potential

- **High recharge potential**
  - Basalts and B4 (both productive aquifers)
  - Combined with:

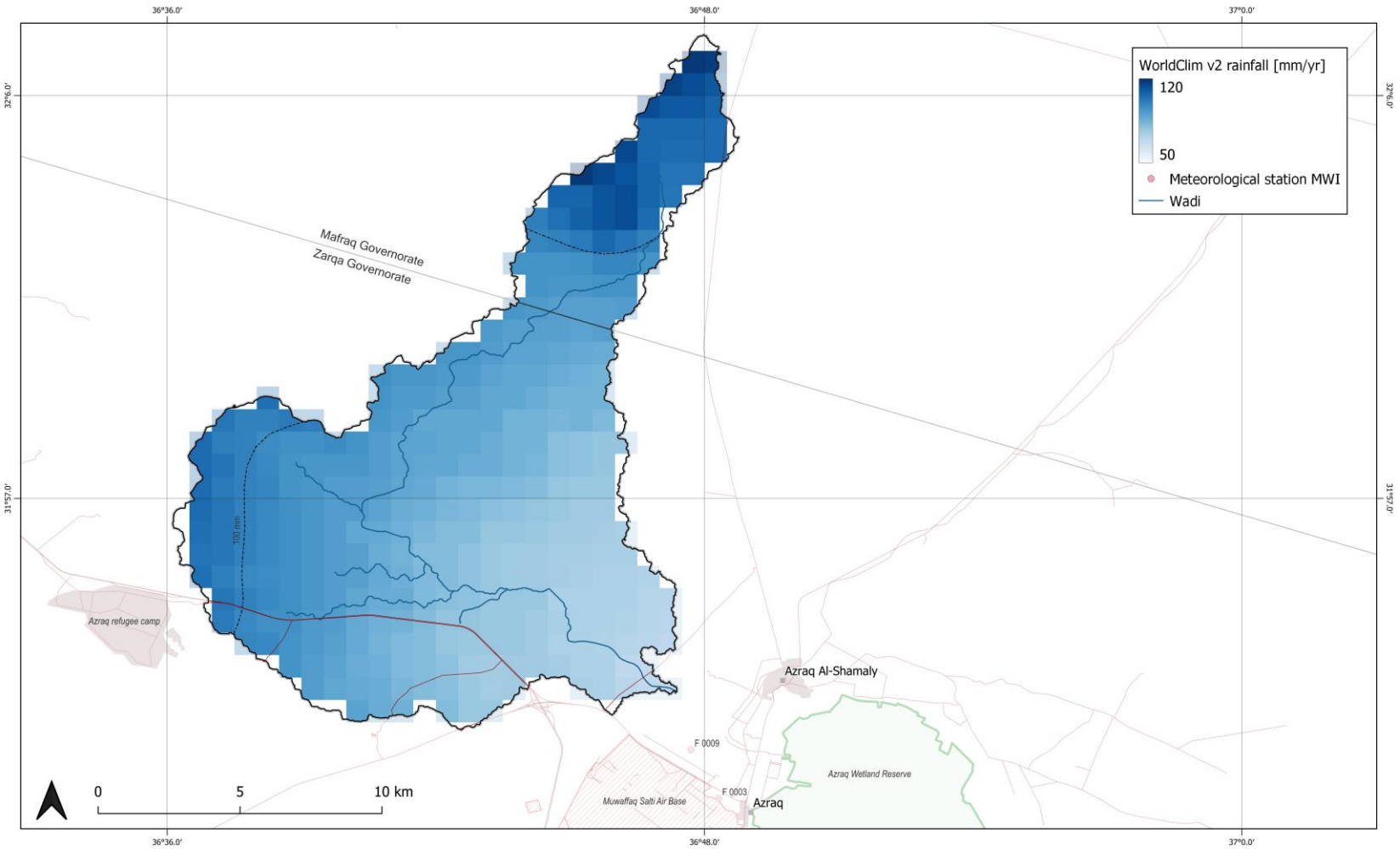
```
("lineament_density@1">1.75) AND ("lineament_proximity@1"<500)
```

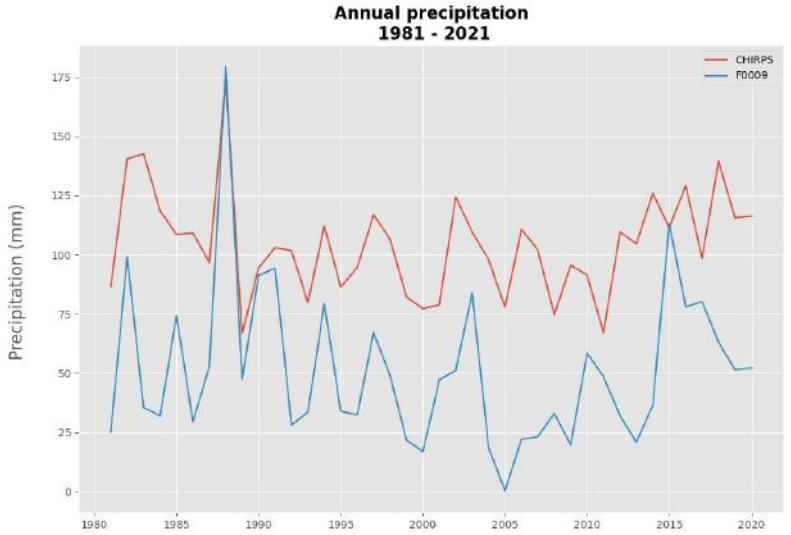
- **Medium recharge potential**
  - Basalts and B4 (both productive aquifers)
  - Combined with:

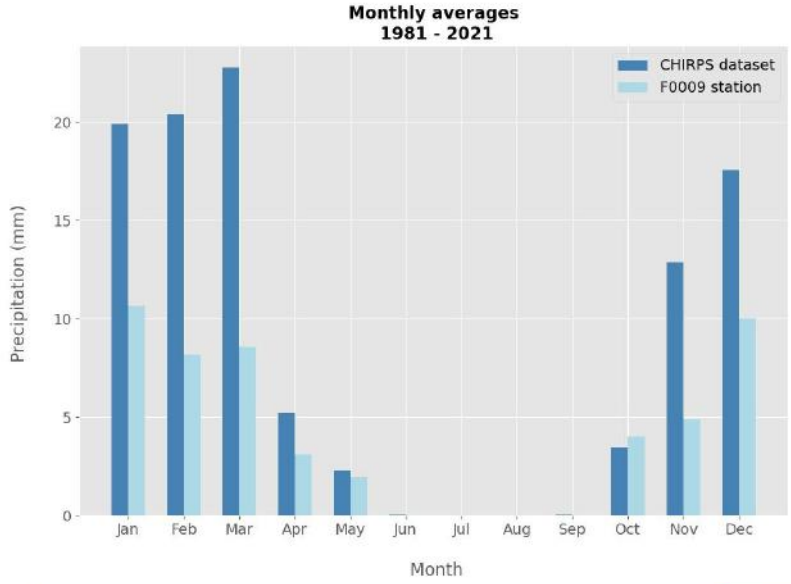
```
("lineament_density@1">1) AND ("lineament_proximity@1"<1000)
```

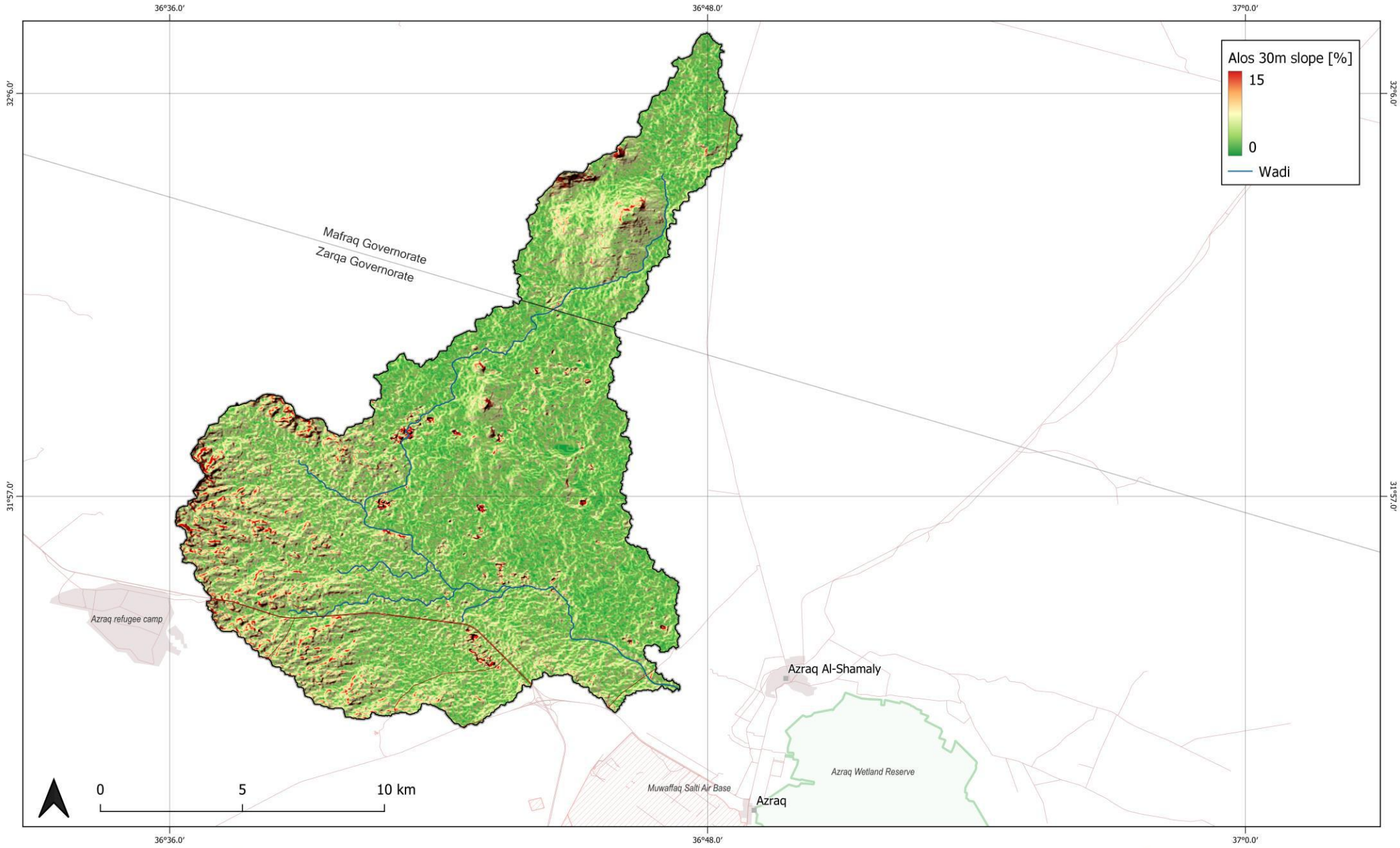
- **Low recharge potential**
  - B3 outcrops (aquitard)
  - Combined with:

```
("lineament_density@1"<1) AND ("lineament_proximity@1">1000)
```


36°36.0′
36°48.0′
37°0.0′
32°6.0′
31°57.0′
WorldClim v2 rainfall [mm/yr]
120
50
Meteorological station MWI
Wadi
Mafraq Governorate
Zarqa Governorate
100 mm
Azraq refugee camp
Azraq Al-Shamaly
F 0009
Azraq Wetland Reserve
Muwaffaq Salti Air Base
F 0003
Azraq
0
5
10 km

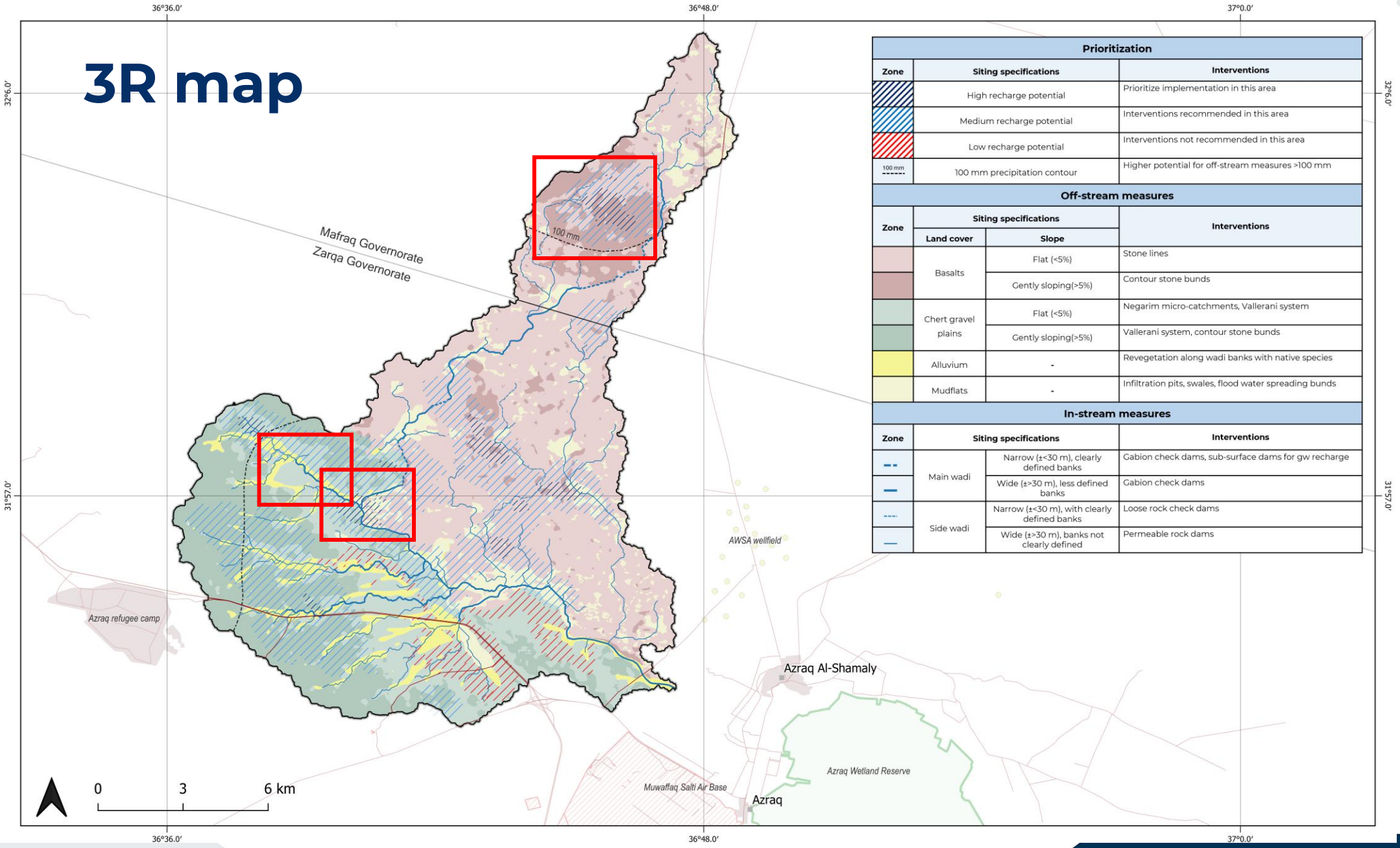

Annual precipitation
1981 - 2021
CHIRPS
F0009
Precipitation (mm)
0
25
50
75
100
125
150
175
1980
1985
1990
1995
2000
2005
2010
2015
2020


Monthly averages
1981 - 2021
CHIRPS dataset
F0009 station
Precipitation (mm)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


36°36.0′
36°48.0′
37°0.0′
32°6.0′
31°57.0′
Alos 30m slope [%]
15
0
Wadi
Mafraq Governorate
Zarqa Governorate
Azraq refugee camp
Azraq Al-Shamaly
Azraq Wetland Reserve
Muwaffaq Salti Air Base
Azraq
0
5
10 km

Results

3R map



Prioritization		
Zone	**Siting specifications**	**Interventions**
	High recharge potential	Prioritize implementation in this area
	Medium recharge potential	Interventions recommended in this area
	Low recharge potential	Interventions not recommended in this area
100 mm	100 mm precipitation contour	Higher potential for off-stream measures >100 mm

Off-stream measures			
Zone	**Siting specifications**		**Interventions**
	Land cover	**Slope**	
	Basalts	Flat (<5%)	Stone lines
		Gently sloping(>5%)	Contour stone bunds
	Chert gravel plains	Flat (<5%)	Negarim micro-catchments, Vallerani system
		Gently sloping(>5%)	Vallerani system, contour stone bunds
	Alluvium	-	Revegetation along wadi banks with native species
	Mudflats	-	Infiltration pits, swales, flood water spreading bunds

In-stream measures			
Zone	**Siting specifications**		**Interventions**
	Main wadi	Narrow (±<30 m), clearly defined banks	Gabion check dams, sub-surface dams for gw recharge
		Wide (±>30 m), less defined banks	Gabion check dams
	Side wadi	Narrow (±<30 m), with clearly defined banks	Loose rock check dams
		Wide (±>30 m), banks not clearly defined	Permeable rock dams

Links to interventions

- https://www.fao.org/3/u3160e/u3160e07.htm#5.%20water%20harvesting%20techniques
- https://www.greener.land/index.php/product/stone-lines/
- https://www.greener.land/index.php/product/contour-bunds/

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Zone	**Siting specifications**		**Interventions**
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		Wide (±>30 m), less defined banks	Gabion check dams, permeable rock dams
	Side wadi	Narrow (±<30 m), with clearly defined banks	Loose rock check dams
		Wide (±>30 m), banks not clearly defined	Permeable rock dams

Potential location 1

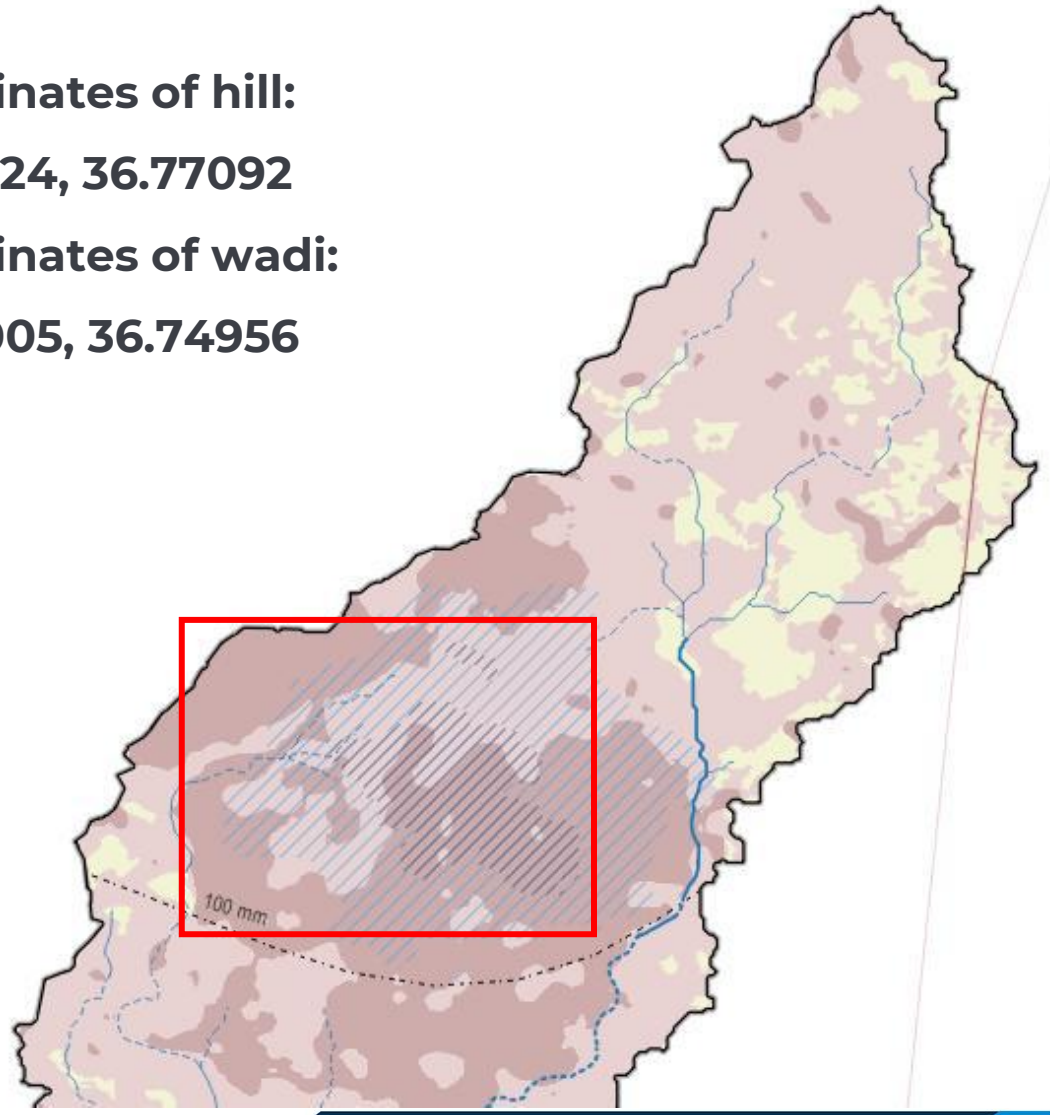
- Basalt hill upstream
- Most upstream part of catchment
- Narrow wadi, with clearly defined banks
- Medium to high recharge potential
- Rainfall >100 mm
- **Interventions:** stone contour bunds + cascade of (loose rock) check dams

Coordinates of hill:

32.05524, 36.77092

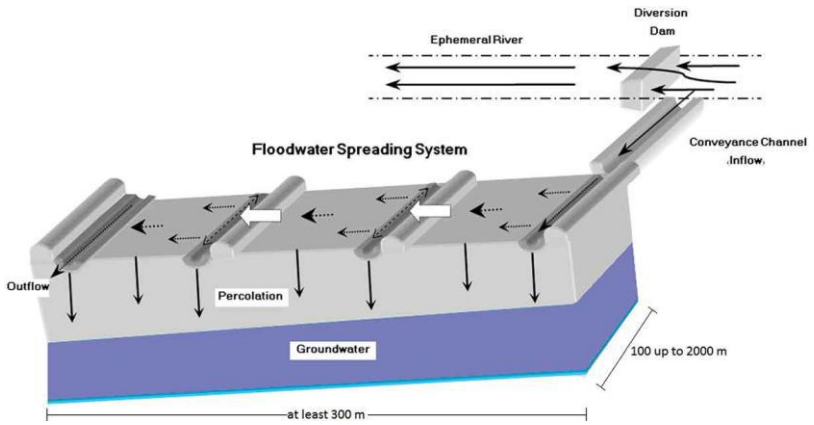
Coordinates of wadi:

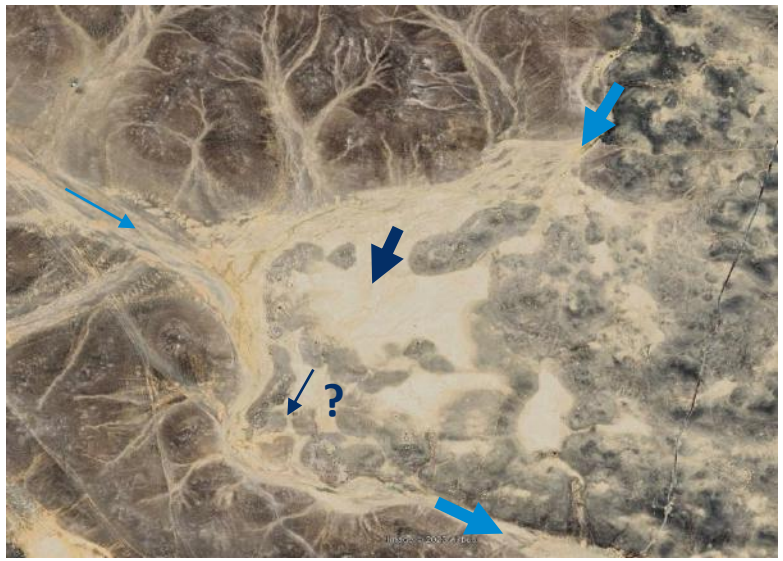
32.06005, 36.74956



Potential location 2

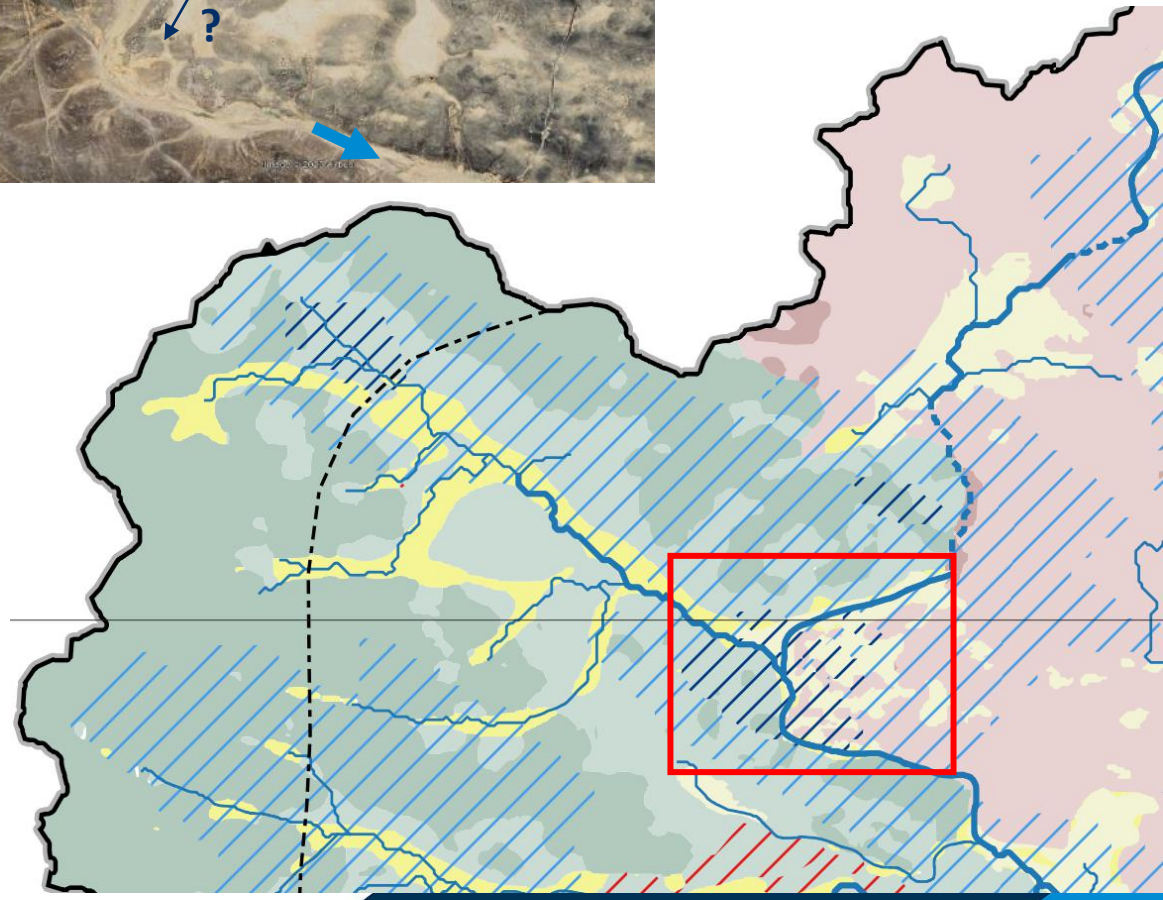
- Mudflat (local depression) along main wadi
- Medium to high recharge potential
- **Interventions:** Water spreading bunds + infiltration pits or swales/trenches + gabions in upstream wadi
- Field visit necessary





Coordinates:

31.94705, 36.67866



Potential location 3

Coordinates:

31.95907, 36.65325

- Wider flat wadi on limestone-chert
- Medium recharge potential
- **Permeable rock dams**: long, low dam walls to spread water across whole valley floor
- Combined with interventions in the landscape?

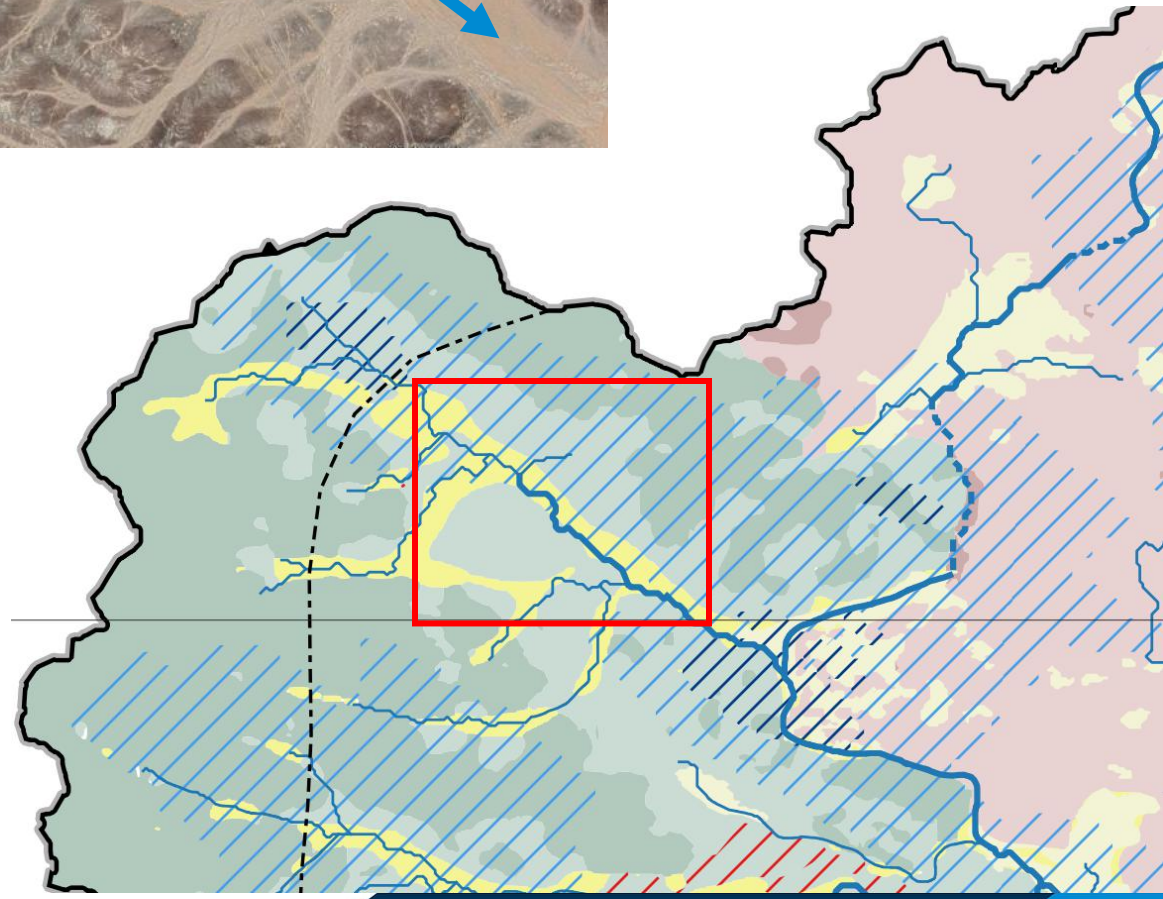
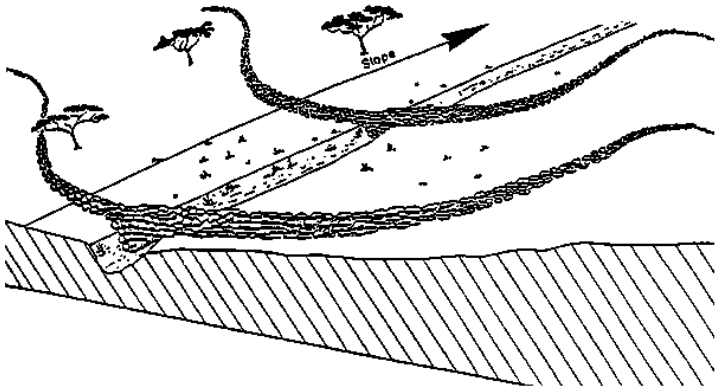


Figure 50. Permeable rock dams: general layout (Source: Critchley and Reij 1989)



Data sources

Dataset	Source
Rainfall	**WorldClim v2**
DEM + slope	**ALOS 30m**
Geology	**MWI**
Faults and lineaments	**MWI**

Global Head Office
Gouda - The Netherlands

Regional Office East Africa
Addis Ababa – Ethiopia

Regional Office Northern Netherlands
Leeuwarden – The Netherlands

www.acaciawater.com
info@acaciawater.com

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