Recharge conditions of Mediterranean mountain karst aquifers

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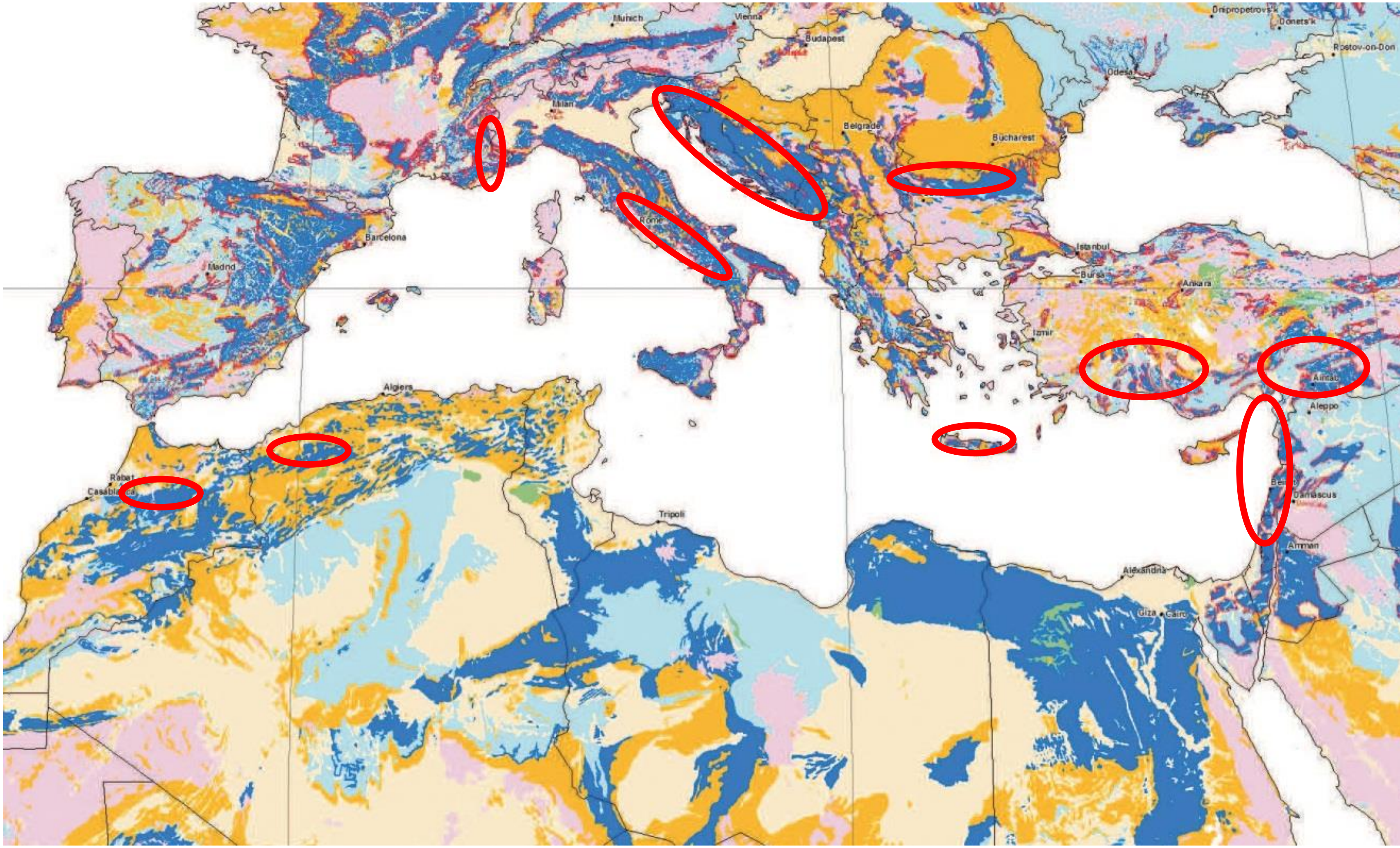


Mediterranean karst aquifers (in dark blue)
according to the World Karst Aquifer Map project Wokam
Red circles indicate high mountain karst areas

Mediterranean high mountain karsts

- areas where the recharge rates are the highest,
- areas where karst landforms are abundant,
- areas where the caves systems seem well developed (high hydraulic gradient, high recharge).

➔ ***However from some examples, it appears that the functionning of these aquifers is not clearly karstic.***

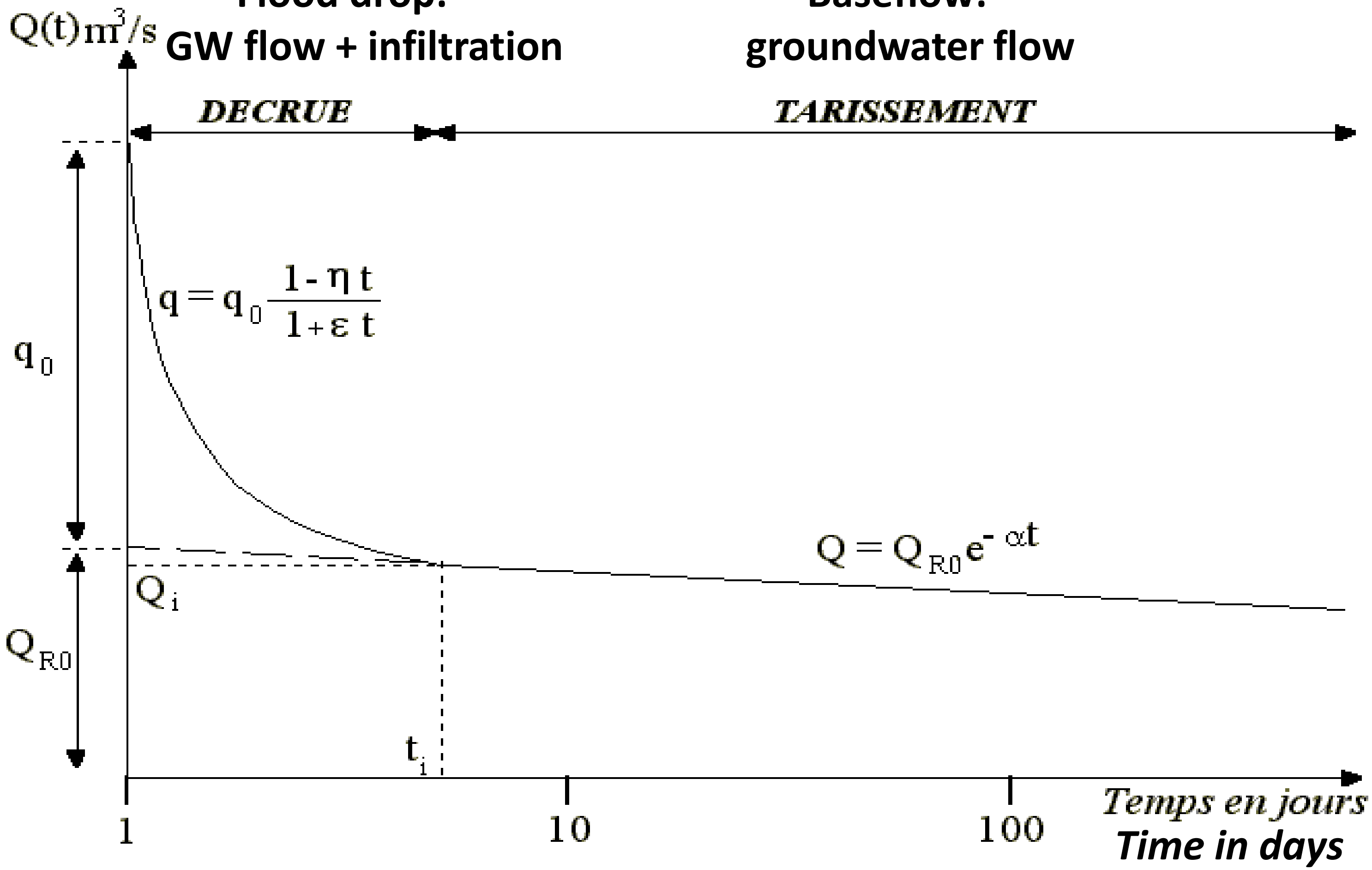
Two examples from Lebanon

- Lebanon Monts were actively uplifted during Pliocene and Quaternary. High karst plateaus above 1500 m asl are the recharge areas of large and small springs

Spring hydrograph analysis, according to Mangin’s method

Flood drop:
GW flow + infiltration

Baseflow:
groundwater flow



Afka spring characteristics

- **Afka sp.,** one of the 2 main sources of Ibrahim River
- Mean annual Q: 4.26 m^3/s Recharge area around 250 km^2
- Highest Q: 65 m^3/s
- Lowest Q: 0.1 m^3/s + around 0.5 m^3/s for water supply
- Baseflow coefficient (Maillet's law): alpha=0.003-0.009.
- **Moderate dynamic storage=22 hm^3**
- Infiltration coefficients (Mangin's method): epsilon=0.4-1.3; eta=0.009
- **Very long infiltration delay: i=0.63-0.90**

- **➔ The infiltration zone does not contribute to fast infiltration**

Small karst spring of the Lebanon Monts

- This small spring is used for water supply
- Mean annual Q: 5 L/s Recharge area around 1 km^2
- Highest Q: 16 L/s
- Lowest Q: 0.7 L/s
- Baseflow coefficient (Maillet's law): alpha=0.005.
- **Small dynamic storage=7,000-12,000 m^3**
- Infiltration coefficients (Mangin's method): epsilon=0.03-0.1; eta=0.008
- **Very long infiltration delay: i=0.8-0.93**
- **Infiltration duration: 3 to 5 months, not related to snow cover melting.**

➔ **The infiltration zone does not contribute to fast infiltration**

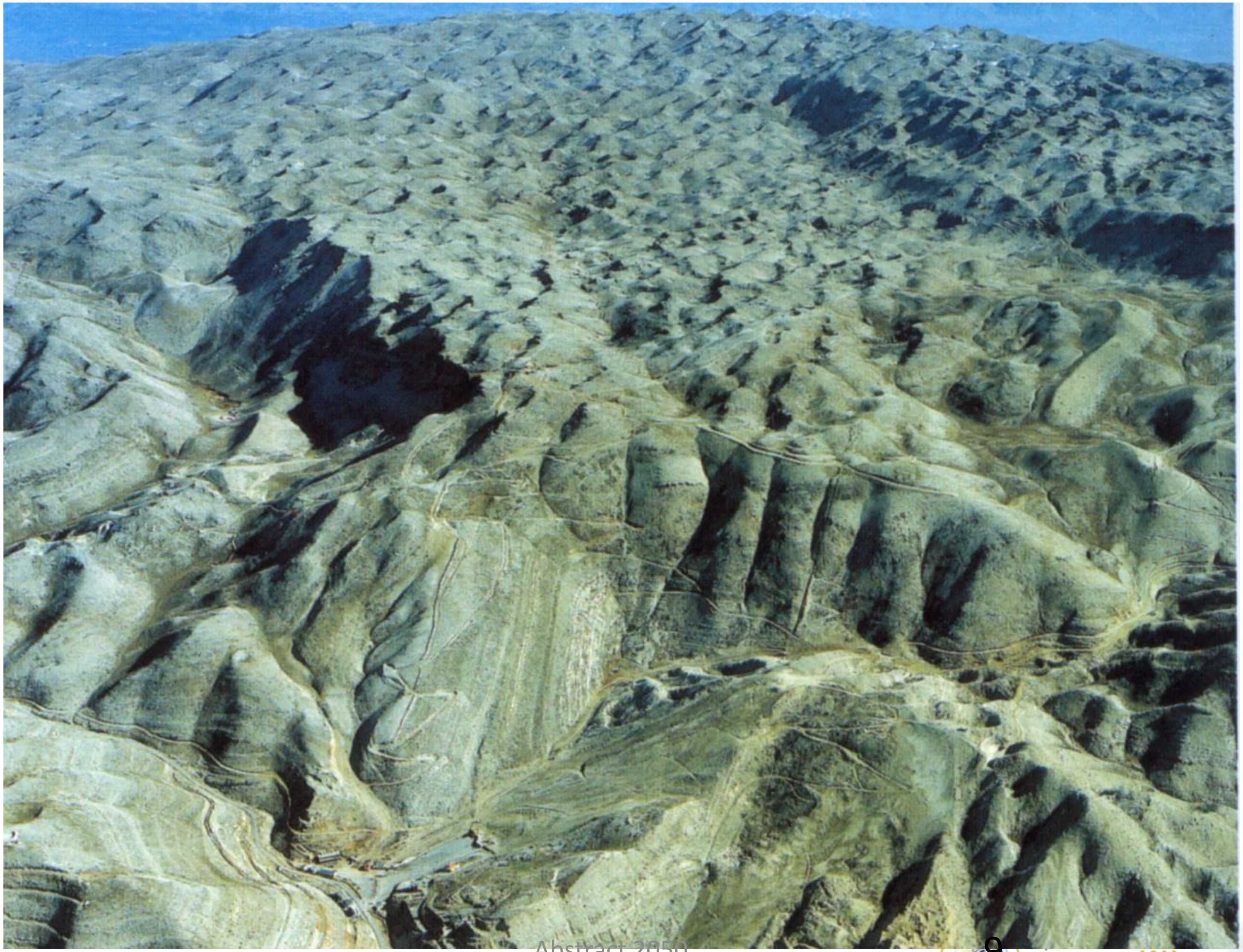
Karst landscape and aquifer functioning are conflicting!

- Some hydrological years with a poor snow cover show exactly the same characteristics
- ➔ ***snow cover not the cause of slow infiltration and long infiltration delay***.
- Other karst systems at lower elevation show a typical karst functioning with fast infiltration even after winters with significant snow cover.

Field investigations show important scree cover, pluging sinkholes and karrens.

Cave exploration also shows conduits partly pluged upstream the springs.

Aerial view of Mont Sannine Karst, North of Beirut



Pluging screes

At lower elevation karrens and epikarst are preserved from periglacial actions

The main agent of karren and epikarst weathering

- Freezing during cold periods of Quaternary (Würm) on humid mountain sides with muddy flows.
- Pluging of epikarst and sinkholes creates an efficient protection cover and diffuse infiltration conditions.
- This regulates the recharge flow to groundwater

➔ This shows that areas with a well developed epikarst and/or a sediment cover should avoid or limit direct infiltration through the sinkhole-conduit system and then should favour storage

➔ They are the best conditions for applying managed recharge to karst aquifers


Thank you so much
for your attention