



Council for Development and Reconstruction (CDR)
Ministry of Energy and Water (MoEW)
Water Establishment Beirut and Mount Lebanon (WEBML)

Federal Institute for Geosciences
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Hannover, Germany

German-Lebanese Technical Cooperation Project

Public Awareness Campaign for Schools Groundwater Vulnerability

BGR
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Groundwater Catchment of Jeita Spring



Groundwater System

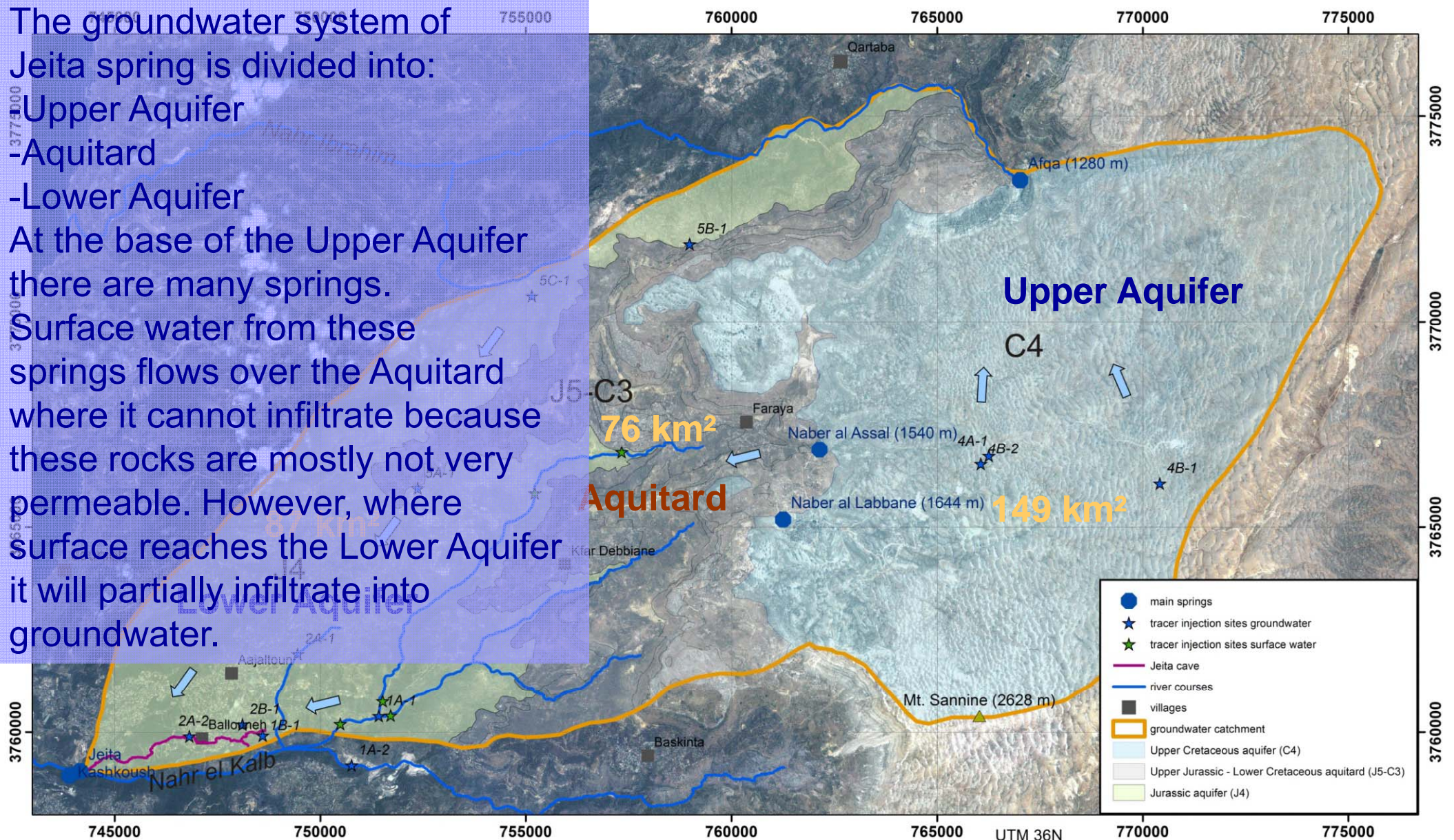
New geological map prepared by BGR

The groundwater system of Jeita spring is divided into:

- Upper Aquifer
- Aquitard
- Lower Aquifer

At the base of the Upper Aquifer there are many springs.

Surface water from these springs flows over the Aquitard where it cannot infiltrate because these rocks are mostly not very permeable. However, where surface reaches the Lower Aquifer it will partially infiltrate into groundwater.



Protection of Jeita Spring



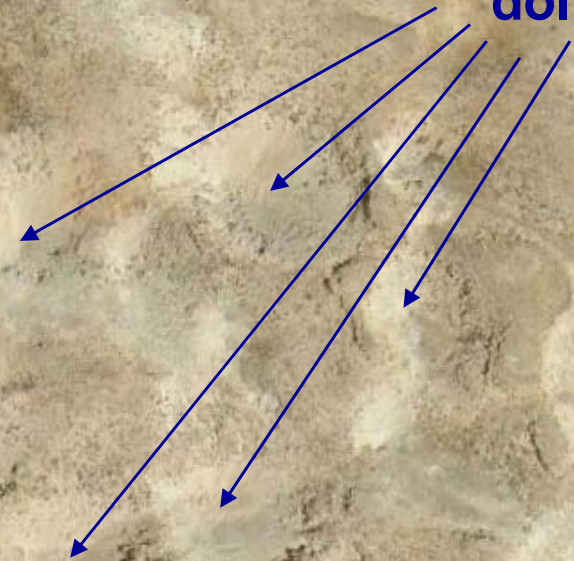
What is karst and how Groundwater is recharged

The high plateau (1800-3000 m) is most important for groundwater recharge and thus for drinking water supply. There are more than 2,000 dolines in the high plateau where the melting snow can easily infiltrate.

**C4 limestone near Wardeh
(upper aquifer)**

- no major surface water runoff
- rapid infiltration into Cretaceous aquifer
- high GW recharge from snow melt

dolines



What is karst and how Groundwater is recharged

When snow melts between March and June, water rapidly infiltrates into the underground (dolines). Because there are very few pollution sources on the plateau, the quality of this water is very good at the springs where it is discharged. The main springs are: Assal, Labbane, Afqa and Rouaiss

doline

assumed GW recharge 80% in C4



What is karst and how Groundwater is recharged

**High karstification in
Cretaceous limestone
(Faqra)**

The limestone units have been exposed since a long time so that they are highly karstified.

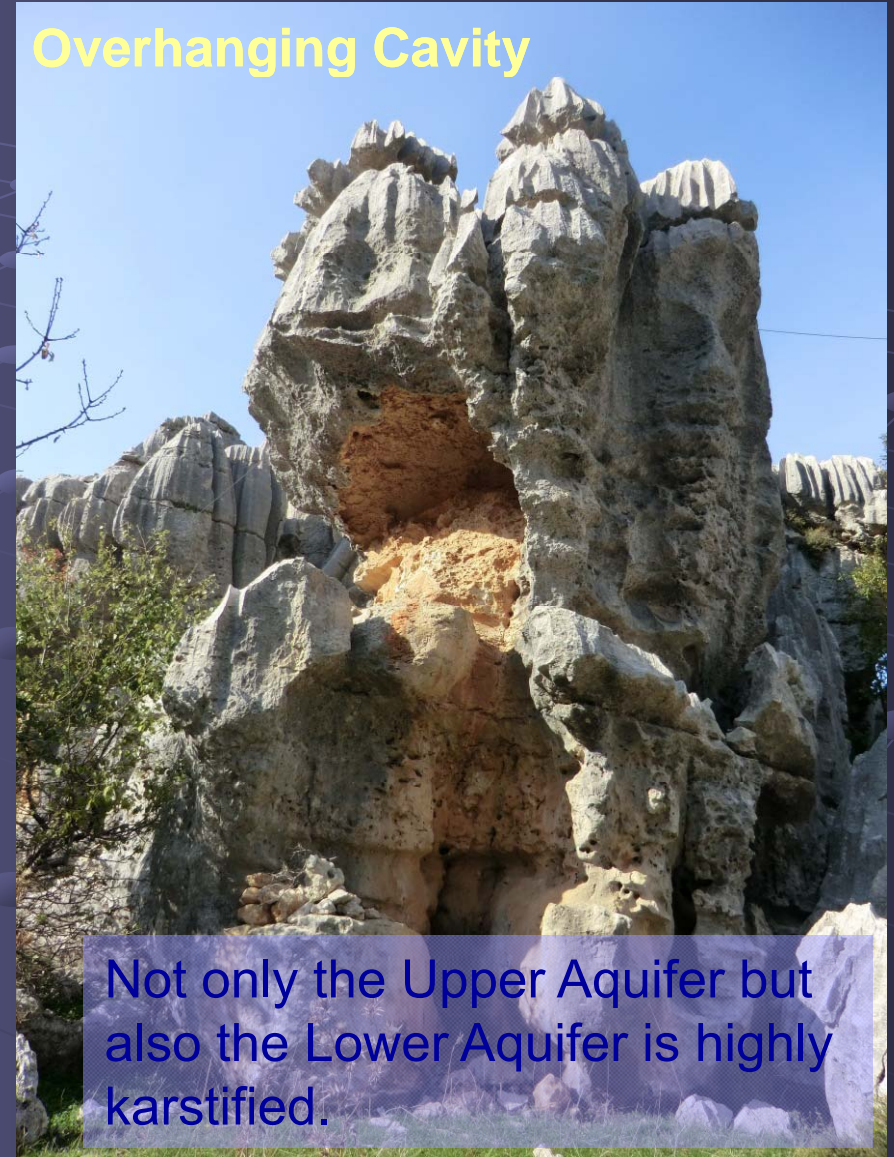


Karst Features

Karren Field (Tsinggi)



Overhanging Cavity



Not only the Upper Aquifer but also the Lower Aquifer is highly karstified.

Sinkhole

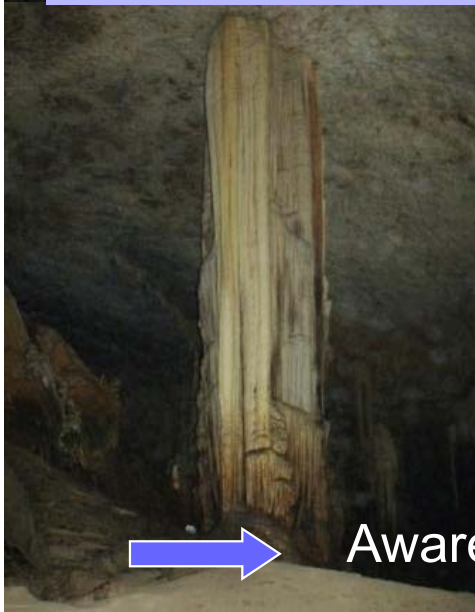


Where does Beirut's drinking water come from – Groundwater discharge



Jeita Spring
The main Source for Water Supply of Beirut

75 % of Beirut's water comes from Jeita



→ Awareness Movie „Beirut Waters“

How does Groundwater move ?

Groundwater infiltrates into the underground (recharge)

- **direct recharge** (at the place where it rains) or
- **indirect recharge** (along the surface water flow path)
e.g. in the river bed or depressions

Mount Lebanon: mainly karstified limestone (dissolution by carbonic acid)
groundwater moves along fractures, faults, dissolution channels
(conduits)

- high **flow velocities** (100-200 m/h; up to 2000 m/h in large conduits !)
- high water level fluctuations (dry/wet season)

How to determine groundwater flow directions/velocities,
groundwater contribution zone ?

- ▶ **tracer tests**
- ▶ **geochemical data**
- ▶ **isotope data (oxygen 18, deuterium, tritium)**



Contamination Risks from Wastewater

Currently wastewater is discharged

- into injection wells
- into open cess pits or
- into nearby creeks/rivers/wadis

residences with no wastewater collection and treatment

Infiltration of untreated wastewater into highly karstified Jurassic limestone (Faitroun)

► microbiological contamination of Jeita spring



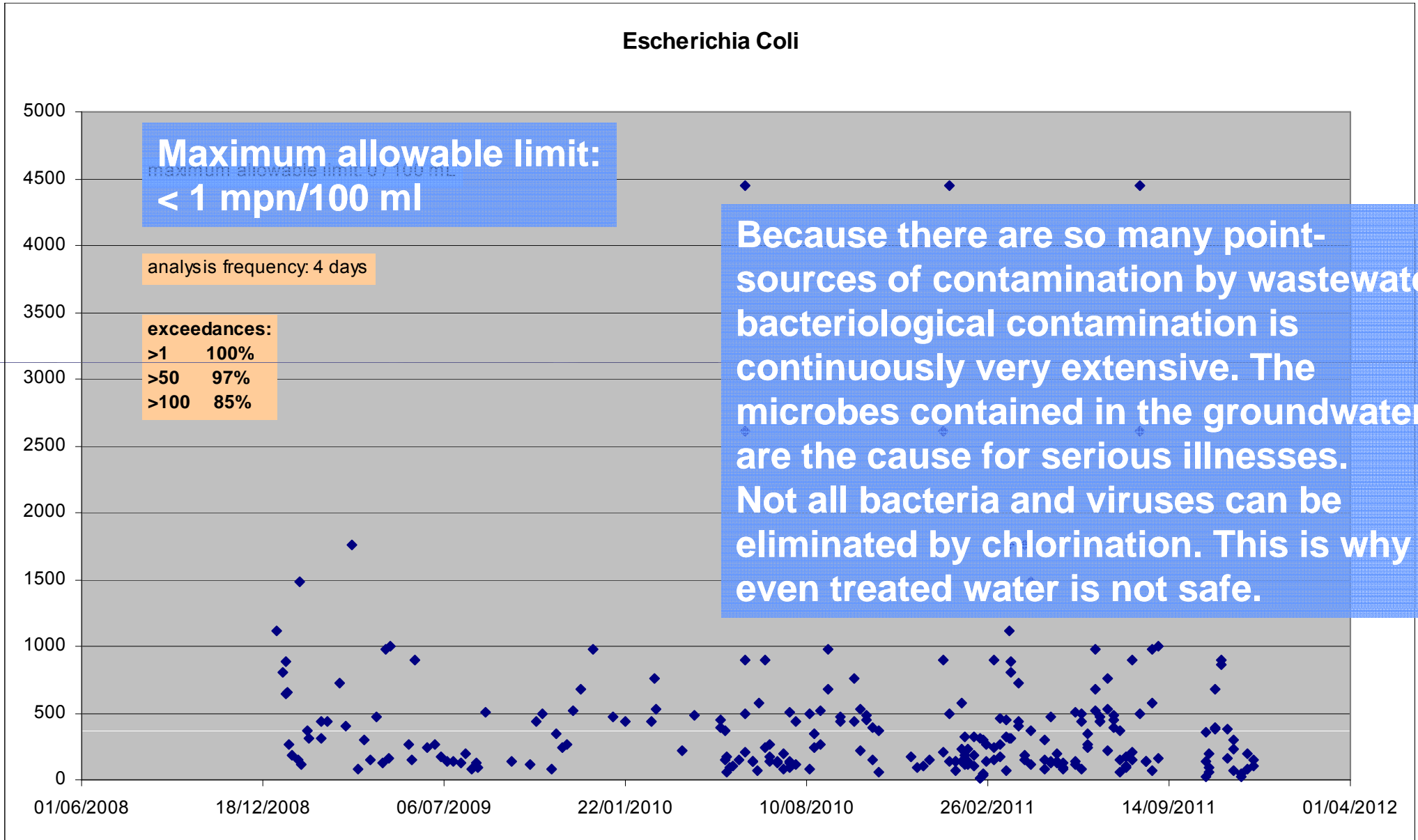


Fractures and dissolution channels (conduits) reach deep into the underground. Rain infiltrates along these pathways together with contaminants

Wastewater is typically discharged through open cess pits or injection wells

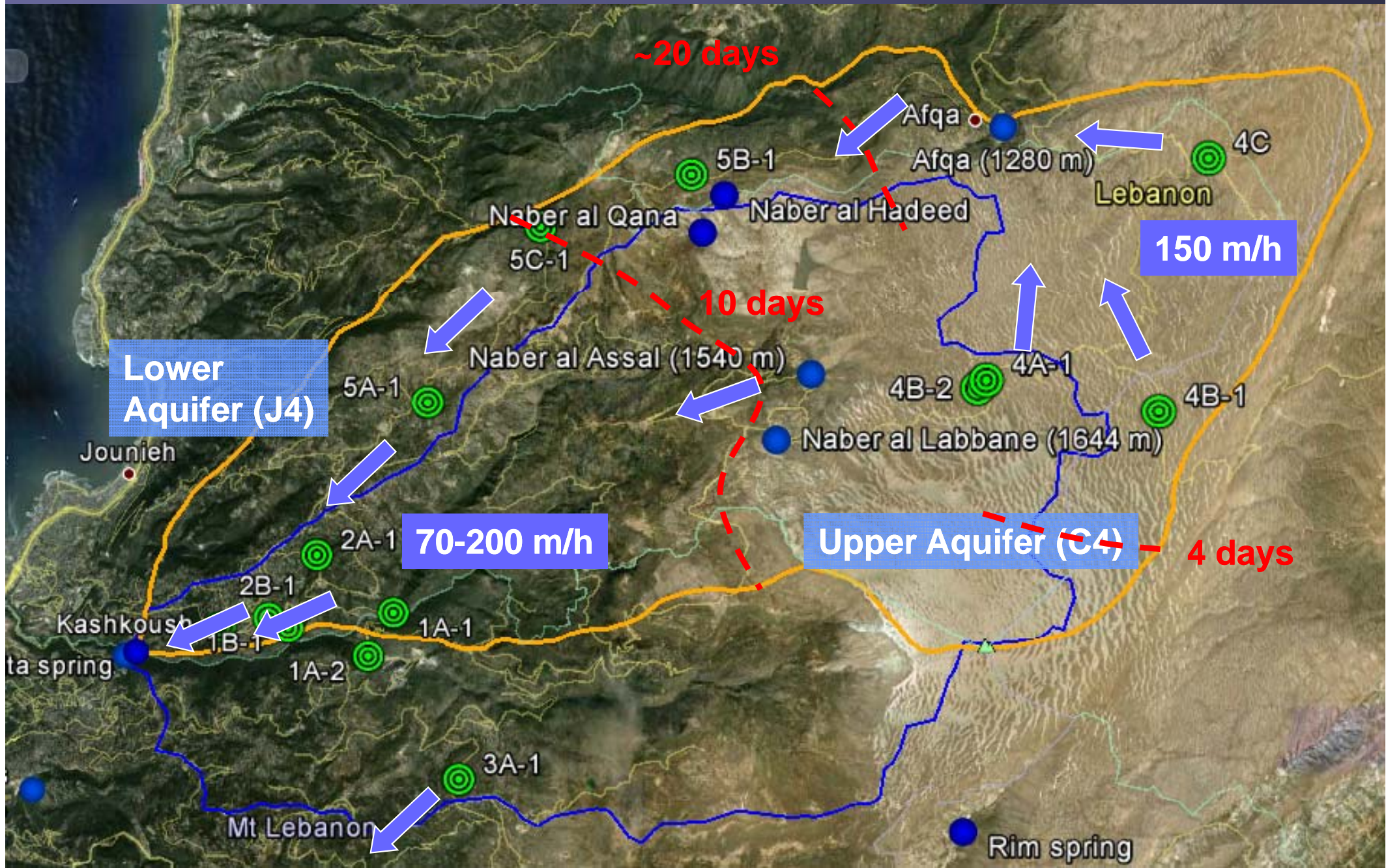


Permeable areas of the underground are selected so that the cess pits will not need to be emptied so often to save costs

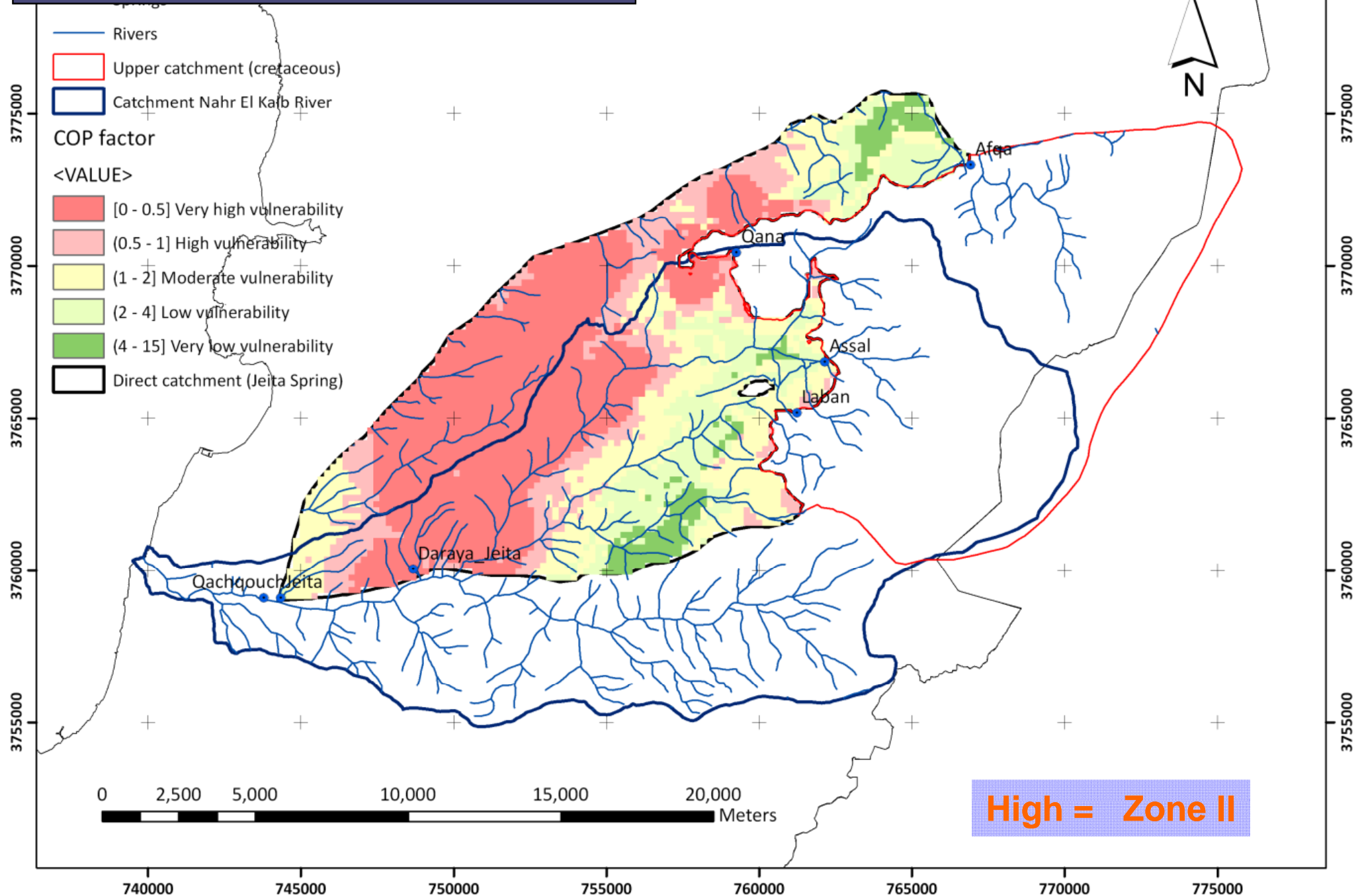


Groundwater Flow

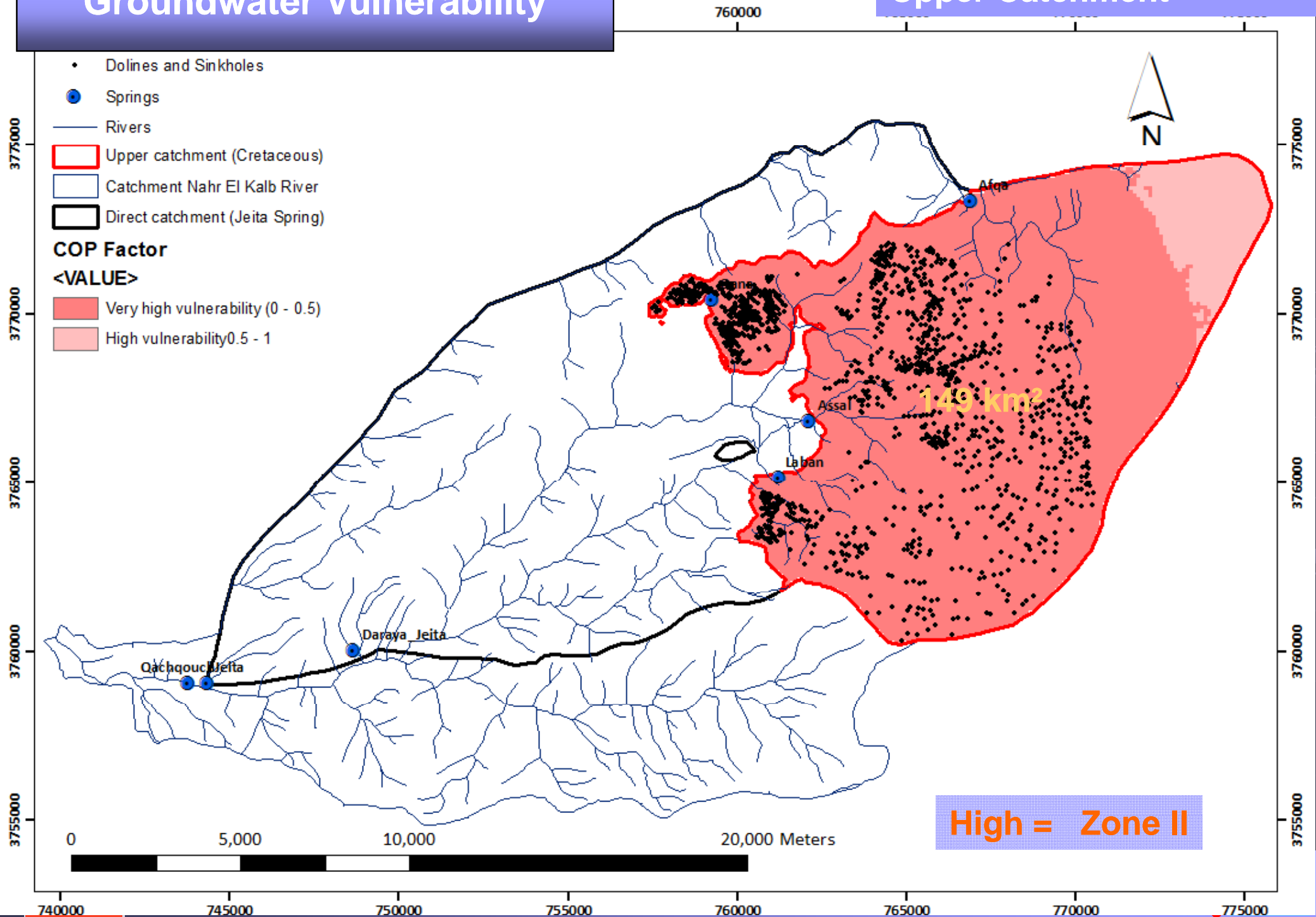
Mean travel times



Groundwater Vulnerability



Groundwater Vulnerability



Groundwater Protection Measures

What needs to be done to protect the groundwater resources ?

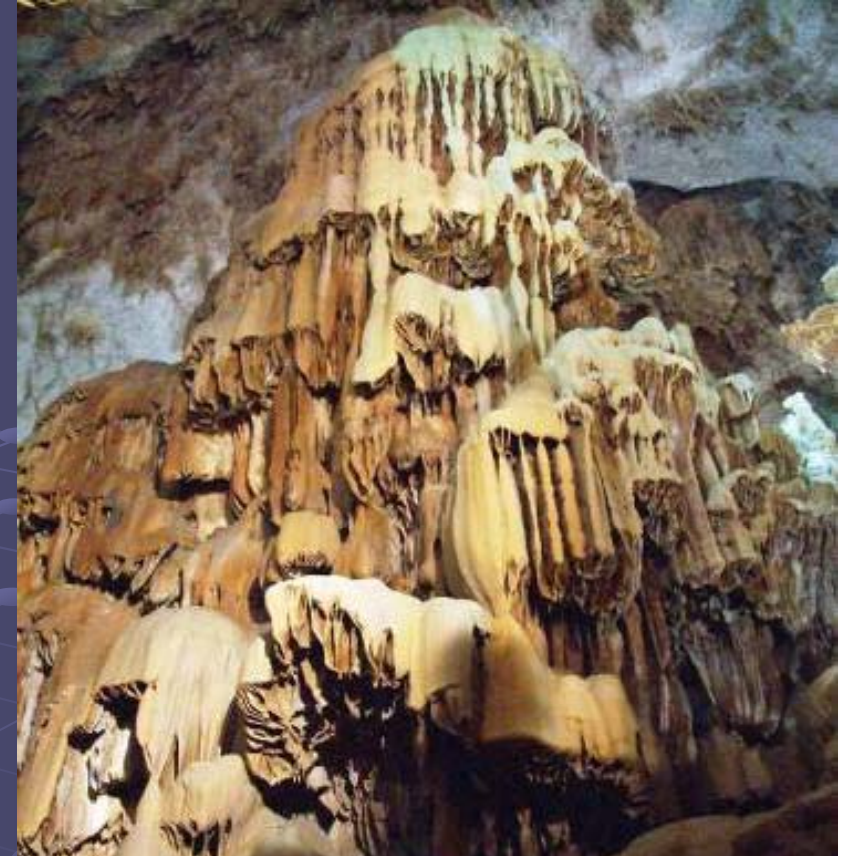
- An **inventory of groundwater hazards** helps to identify the pollution sources
- A **risk assessment** for critical pollution sources must be done
- The raw water quality must be controlled to find out whether there is an impact from the pollution source
- A **clean-up operation (land reclamation)** must be undertaken, if technically and financially feasible
- Contaminants from pollution sources must be collected and treated (**wastewater, waste**)
- **Groundwater protection zones** must be established and the related landuse restrictions be implemented and enforced. In protection zones certain landuses and practices are not allowed (new landuse licensing requests)



*Thank you for your
kind attention*

www.bgr.bund.de/jeita

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Protection of Jeita Spring

