German-Lebanese Technical Cooperation Project

Public Awareness Campaign for Schools
Groundwater Vulnerability

BGR
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Groundwater Catchment of Jeita Spring

- Groundwater catchment: 406 km²
- Surface water catchment: 249 km²
- Status: May 2012
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.
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.

- no major surface water runoff
- rapid infiltration into Cretaceous aquifer
- high GW recharge from snow melt
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.
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.
Not only the Upper Aquifer but also the Lower Aquifer is highly karstified.
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)

Protection of Jeita Spring
Currently wastewater is discharged into injection wells, open cess pits, or nearby creeks/rivers/wadis. Infiltration of untreated wastewater into highly karstified Jurassic limestone (Faitroun) leads to microbiological contamination of Jeita spring in the residences with no wastewater collection and treatment.
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.
the karst is open, i.e. it is not covered by a protective layer. There is only a thin soil cover. Therefore contaminants can reach groundwater easily.
High and continuous microbiological contamination

Dbayeh raw water (treatment plant)

Escherichia Coli

Maximum allowable limit: < 1 mpn/100 ml

Exceedances:

>1 100%
>50 97%
>100 85%

Because there are so many point-sources of contamination by wastewater, bacteriological contamination is continuously very extensive. The microbes contained in the groundwater are the cause for serious illnesses. Not all bacteria and viruses can be eliminated by chlorination. This is why even treated water is not safe.
Groundwater Flow

Mean travel times

- Lower Aquifer (J4): 
  - 70-200 m/h
  - ~20 days

- Upper Aquifer (C4): 
  - 150 m/h
  - 4 days

- Mean travel times:
  - ~20 days
  - 10 days
  - 4 days
Groundwater Vulnerability

Lower Catchment

Protection of Jeita Spring

COP factor

<VALUE>

- [0 - 0.5] Very high vulnerability
- (0.5 - 1] High vulnerability
- (1 - 2] Moderate vulnerability
- (2 - 4] Low vulnerability
- (4 - 15] Very low vulnerability
- Direct catchment (Jeita Spring)

High = Zone II
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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