

Groundwater Protection Zones

I. Introduction

- The natural protection of groundwater (GW) in the Jeita catchment is insufficient.
- Numerous pollution sources exist in the GW catchment.
- Groundwater protection zones are used worldwide to reduce the risk of pollution.
- The zoning scheme (zones 1-3) depends on the travel time in GW and the risk of contamination at the drinking water source to be protected.
- A set of different landuse restrictions are imposed in the delineated zones.
- A control mechanism is required (environmental police).

II. Problem Statement

- Rapid and uncontrolled development in the Jeita GW catchment lead to a considerable contamination load at Jeita spring.
- Current landuse licensing regulations and practices are inadequate.
- There is no collection and treatment system for wastewater in the catchment yet and wastewater is the main pollution source.
- Gas stations do not have double-layer tanks and are assumed to be leaking to the groundwater.
- There are many illegal waste dumps, especially containing commercial and construction waste.
- The responsible governmental institutions urgently have to take action before this important water resource is entirely lost because of pollution.
- Implementing landuse restrictions for water resources protection has social and economic benefits for the entire society and also for the local population. Tourism is more likely to develop in an ecologically sound landscape.

III. Protection Measures

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- Only through GW protection zones a meaningful reduction in the pollution risk can be achieved.
- A zoning system will be introduced, which should be applied to all major springs used for drinking water supply in Lebanon.
- The protection scheme comprises three zones with different level of protection needs, depending on travel time from the land surface to the water source.
- The required landuse restrictions will be specified in coordination with all related stakeholders in the water sector.
- Protection zone 1 is the area where water is directly accessible, e.g. Jeita grotto and the canal from Jeita to Dbayeh. Here a fence must be established and access to the public has to be banned (except at Jeita grotto).
- Protection zone 2 is the area of high groundwater vulnerability and travel times are less than 10 days (die-off of most bacteria in GW). Here no activities (application of pesticides use of hazardous substances, etc.) which may have a potentially negative impact on GW quality should be allowed.
- Protection zone 3 is the entire GW catchment. Here landuse practices must ensure that long or hardly degradable hazardous substances cannot reach Jeita spring.
- Landuse licensing regulations must be changed to ensure adequate protection of water resources, e.g. for gas stations, quarries, etc.

IV. Results

The GW protection zones of Jeita spring were delineated using GW vulnerability mapping and tracer tests in order to determine the boundaries of the GW contribution zone and the flow velocities in the GW system.

It was proven that the GW catchment of Jeita spring is very different from the surface water (SW) catchment.

Due to the high level of karstification and topographic gradient, groundwater flow velocities are very high. This makes groundwater protection a difficult task.

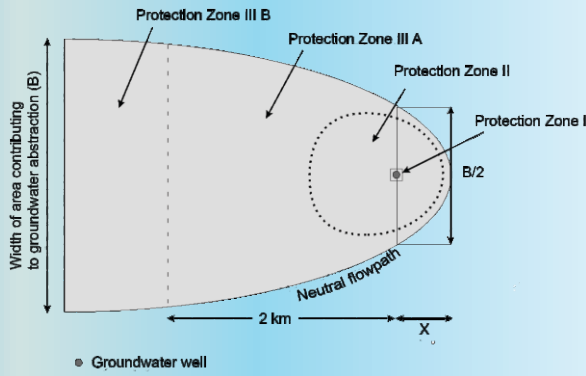
Large parts of the catchment must be declared as protection zone 2. Awareness of the local population must be raised to achieve acceptance.

V. Recommendations

- Monitoring of water quality in the catchment must be improved.
- An authority responsible for control and enforcement of water resources protection policies must be established (environmental police).
- Capacity building of the agencies responsible for water resources protection is urgently required.



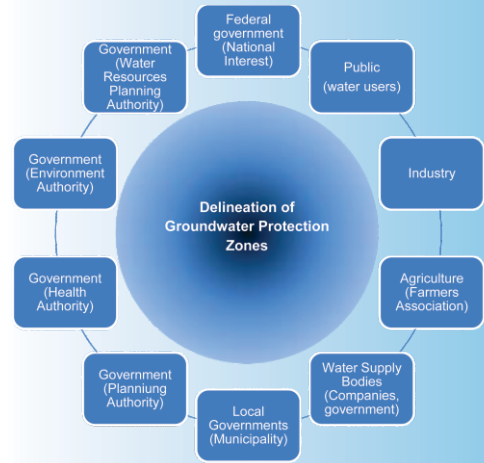
Groundwater Protection Zones



(in Germany)

The delineation of GW protection zones follows natural criteria, mainly the travel time to springs and wells used for drinking water supply. Zone 2 is most important for protection. Its boundary is mostly where microorganisms are inactivated in GW (approx. 50 days). In karst systems this limit is difficult to maintain.

Protection of Jeita Spring



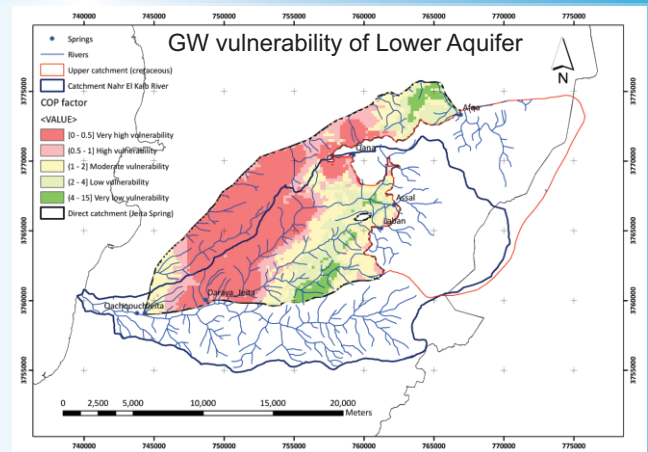
Water resources protection concerns many stakeholders both, governmental and non-governmental. A committee is needed to agree on the general procedure, the necessary landuse restrictions and the implementation and control mechanisms.

Restricted Landuse Activities in Groundwater Protection Zones Hazardous Activities in Zone II

- activities, facilities and sites mentioned already for Zone III;
- construction and extension of buildings such as for commercial and agricultural use;
- roads, railway lines and other similar facilities for transportation (except for trails);
- transportation of substances contaminating groundwater or radioactive substances, storage of fuel oil and diesel fuel;
- use of liquid or solid manure or silage seepage;
- livestock grazing
- installation and extension of liquid manure containers, solid manure sites or silos;
- storage of chemical fertilizers and pesticides;
- transportation of sewage or waste water;
- installation or extension of drains;
- surface water carrying waste water;
- transformers and electricity lines with cooling or insulating fluids containing water;
- swimming, camping and sports facilities;
- shooting and blasting operations;
- ...

(extract of landuse restrictions imposed in Germany)

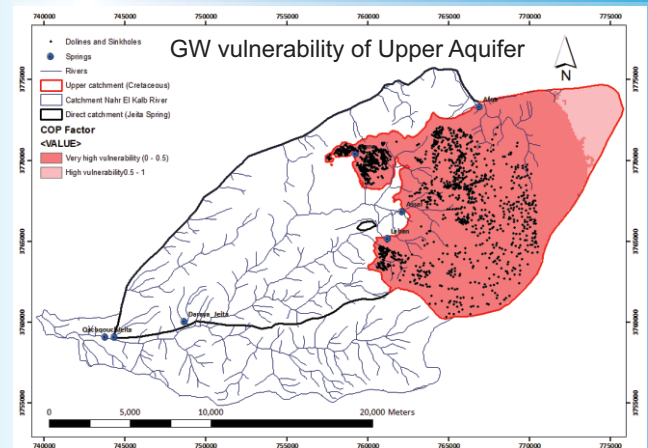
A comprehensive list of landuse restrictions has to be agreed on with all major stakeholders in the water sector. Landuse restrictions in protection zone 2 must be more comprehensive than in protection zone 3. Success of this measure depends on the implementation capacity of the governmental institutions responsible for this task. Penalties must be imposed for violation and a special police task force (environmental police) must be charged with control of the landuse restrictions.



The zone colored red indicates the area with a high groundwater vulnerability. It will be designated as GW protection zone 2. The remainder of the catchment will be declared as GW protection zone 3 (groundwater contribution zone). The Lower Aquifer supplies Beirut with drinking water.

Contact

German-Lebanese Technical Cooperation Project
 Protection of Jeita Spring
 German Federal Institute for Geosciences and Natural Resources (BGR)
 Dr. Armin Margane
 Project Team Leader, Senior Hydrogeologist
 Raifoun, Lebanon
 09/957348 - 70/398027
 armin.margane@bgr.de
 www.bgr.bund.de/jeita



The entire upper part of the GW catchment (Upper Aquifer) has a high GW vulnerability and needs to be very well protected. No further development should be allowed here. This is where currently drinking water in the Keserwan district mainly comes from.