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

Federal Institute for Geosciences
and Natural Resources (BGR),
Hannover, Germany

German-Lebanese Technical Cooperation Project

Public Awareness Campaign for Schools
Groundwater Protection Zones

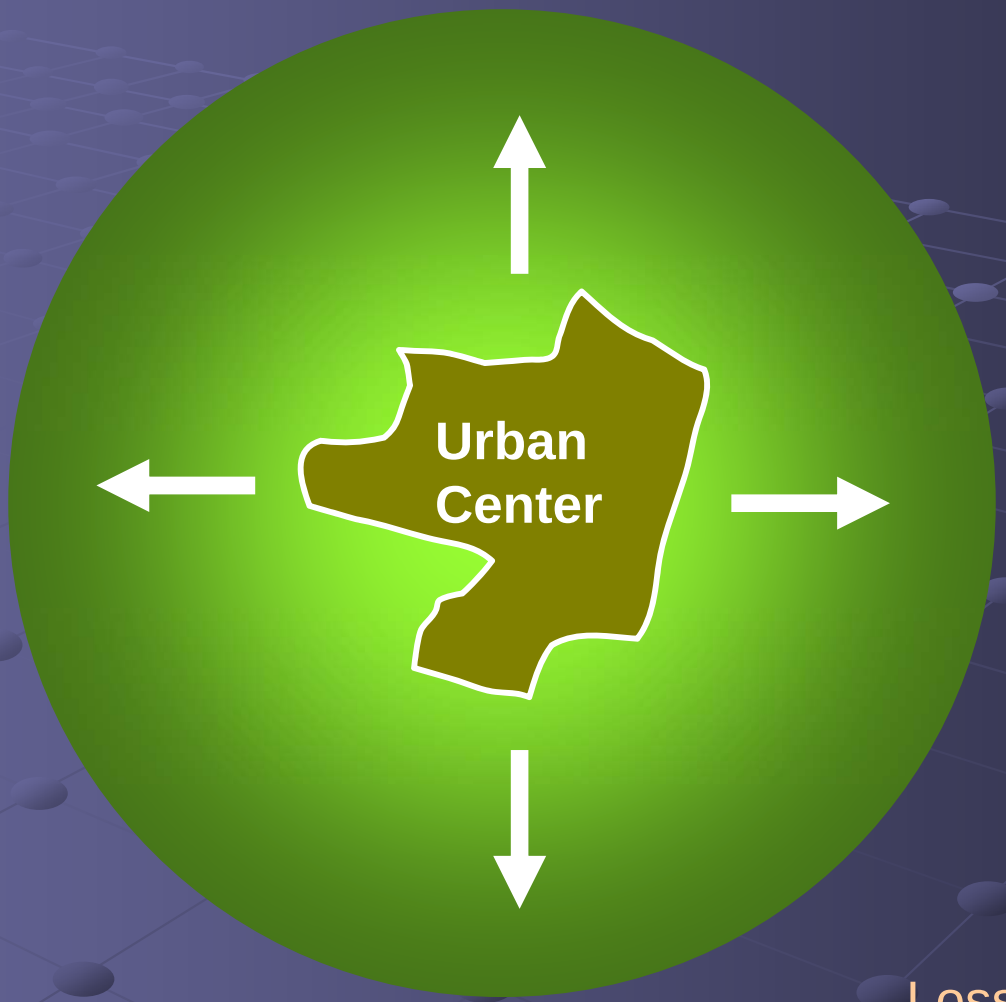
BGR
September 2012

Dr. Armin Margane, BGR

Problems of Fast Growing Regions

Competing Land Use Demands

- Settlement Areas
- Industries/Factories
- Waste Disposal
- GW-Extraction
- Mineral Exploitation
- Nature Preservation
- Agriculture
- Recreation



Negative Environmental Impacts

- GW- and Soil Pollution
- GW-Depletion
- Loss of fertile Soil
- Sealing of Raw-Materials
- Landscape Destruction
- Loss of Quality of Life

Land-use planning must integrate geoscientific information for an environmental friendly and controlled use of the natural resources

Ways of Drinking Water Contamination

Commercial activities

such as car repair facilities, laundromats and dry cleaners, airports, gas stations, photographic processors, and construction sites often use materials that are toxic

Industrial activities

such as chemical manufacturing and storage, machine or metalworking shops, and mining operations often use substances that can contaminate drinking water supplies

Urban activities

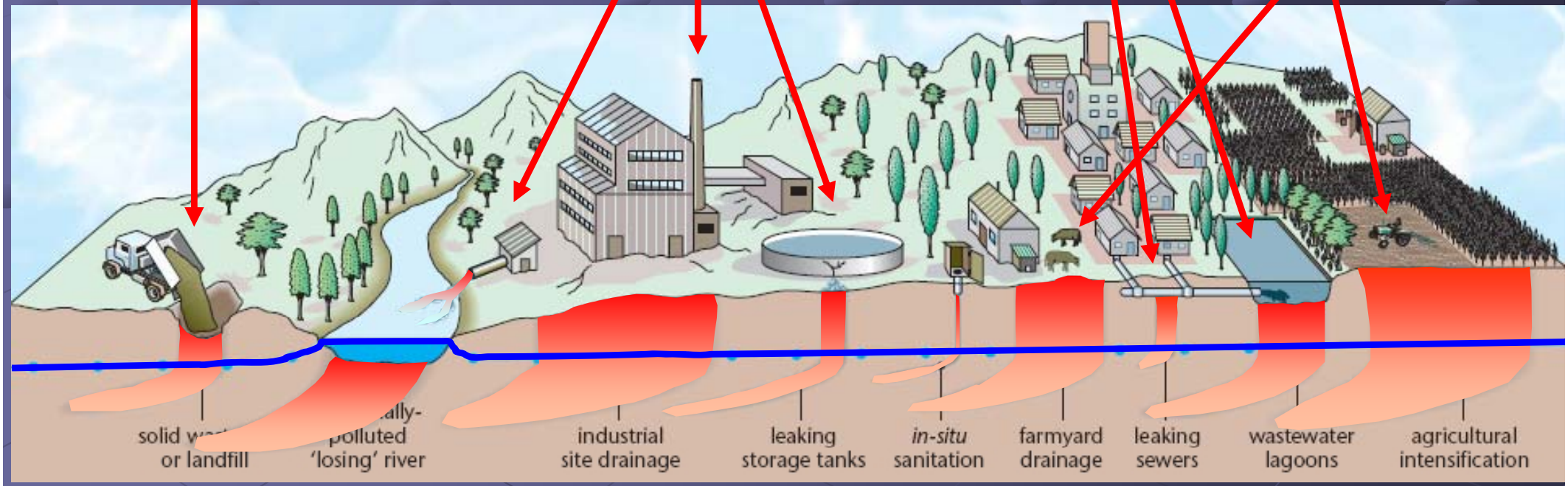
improper disposal or leaks of household hazardous wastes

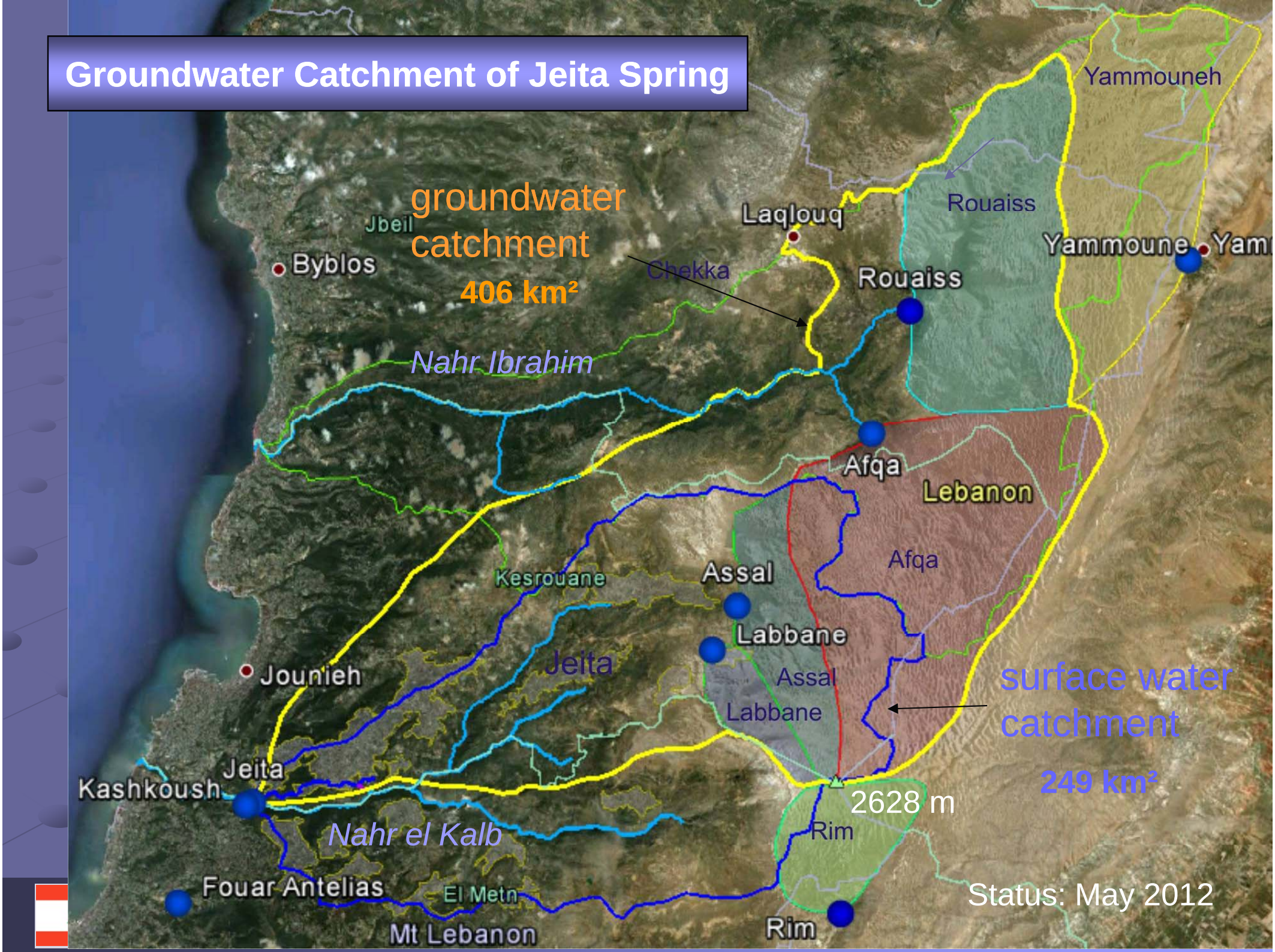
Agricultural activities

such as use of pesticides, herbicides, and fertilizers applied to crops on farmland may be highly toxic and can remain in soil and water for many months or years

Other sources of water contamination

include chemicals used for road de-icing and maintenance, landfills

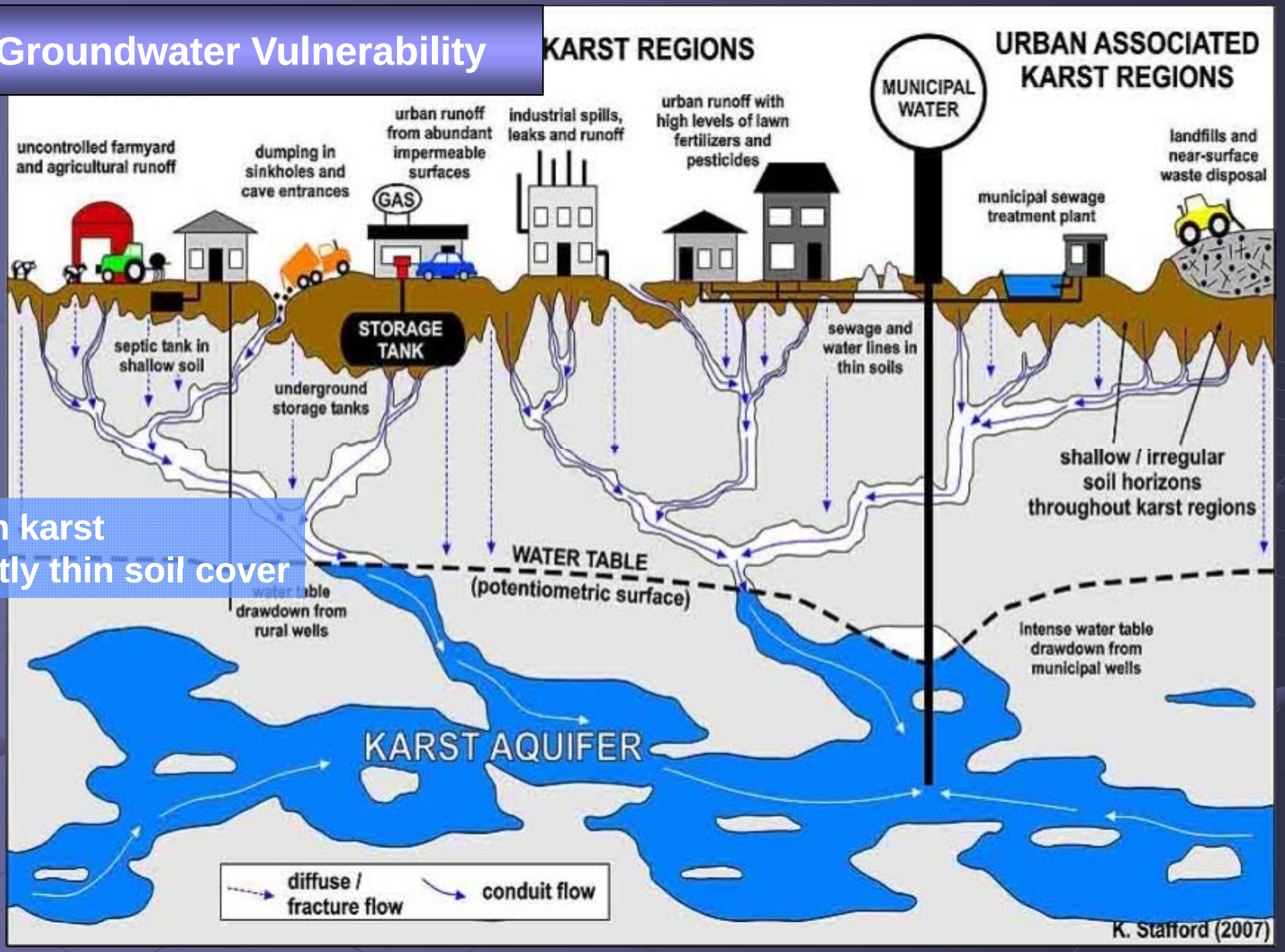



Groundwater Catchment of Jeita Spring
groundwater catchment
406 km²
Nahr Ibrahim
Jbeil
Byblos
Chekka
Laqlouq
Rouaiss
Yammouneh
Yammoune
Yam
Rouaiss
Afqa
Lebanon
Afqa
Kesrouane
Assal
Labbane
Assal
Labbane
Jeita
Jounieh
surface water catchment
249 km²
2628 m
Rim
Jeita
Kashkoush
Nahr el Kalb
Fouar Antelias
El Metn
Mt Lebanon
Rim
Status: May 2012

Groundwater Vulnerability

High karstification in Cretaceous limestone (Faqra)

Groundwater Vulnerability

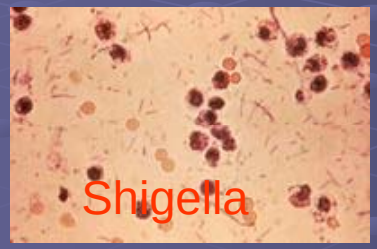


open karst
mostly thin soil cover

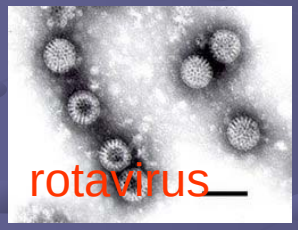
Acute Health Effects of Drinking Water Contamination

Contaminants causing acute effects:

- Bacteria



- Viruses



- Parasites

- Nitrate

Acute Health Effects of Drinking Water Contamination

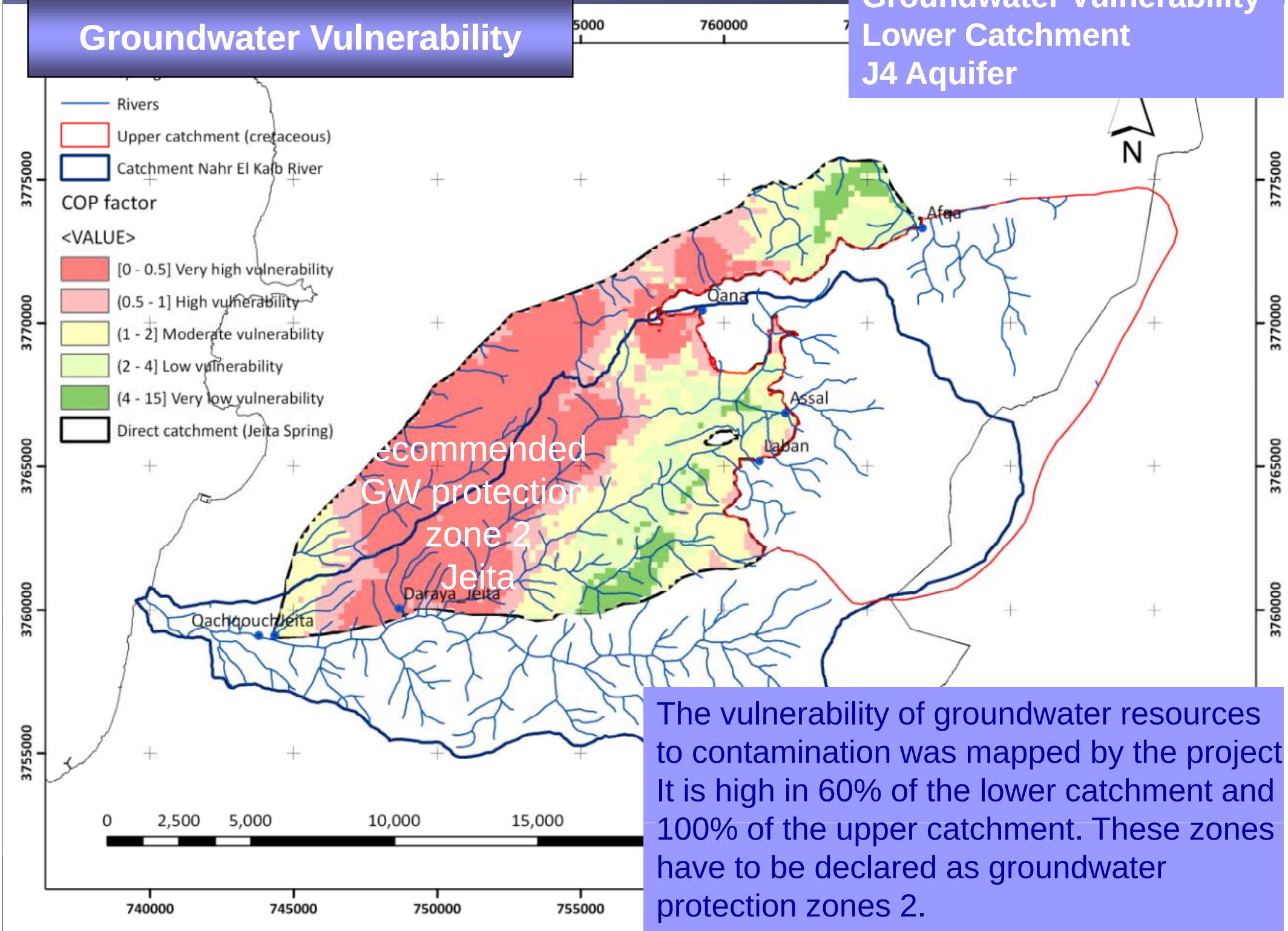
- Illnesses caused by pathogens most often have gastrointestinal symptoms
  - Abdominal discomfort or cramping
  - Fever
  - Vomiting
  - Diarrhea
  - Weight loss
  - Fatigue

Chronic Health Effects of Drinking Water Contamination

Pesticides / Herbicides

Groundwater Vulnerability

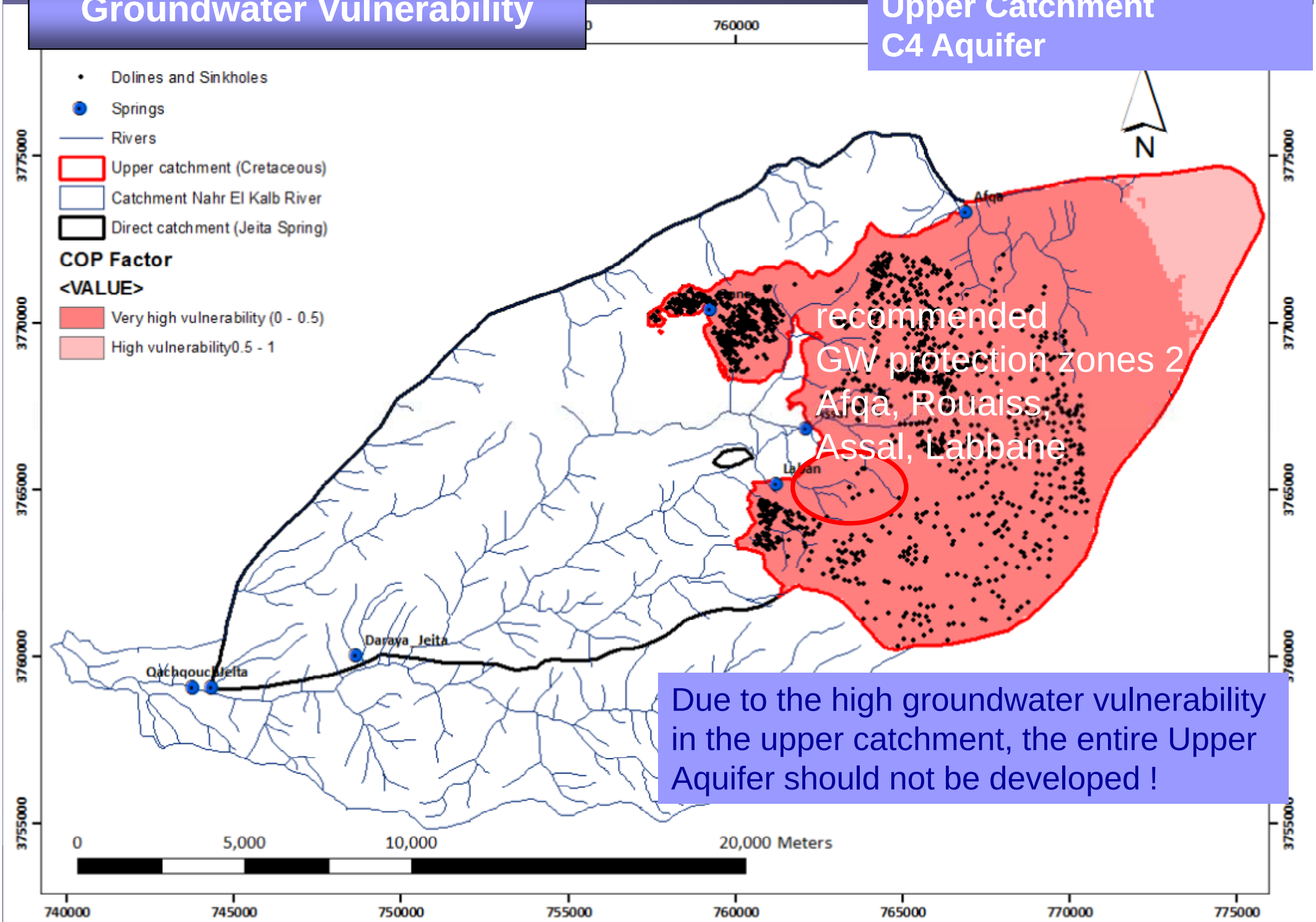
Groundwater Vulnerability Lower Catchment J4 Aquifer



The vulnerability of groundwater resources to contamination was mapped by the project It is high in 60% of the lower catchment and 100% of the upper catchment. These zones have to be declared as groundwater protection zones 2.

Groundwater Vulnerability

Groundwater Vulnerability Upper Catchment C4 Aquifer



Groundwater Protection Measures

What needs to be done to protect the groundwater resources ?

- An inventory of groundwater hazards helps to identify potential pollution sources
- A risk assessment for critical pollution sources must be done; it allows to define actions (where critical landuse activities must be abandoned)
- 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) may be necessary, if technically and financially feasible
- Contaminants from pollution sources must be collected and treated (wastewater, waste, hazardous substances)
- 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)

Groundwater Protection Zones

Objective

Groundwater protection zones define areas where certain landuses are not allowed in order to avoid groundwater contamination

The dimensioning of the protection zones has to be done very carefully in order to balance the competing interests:
- as large as necessary for safeguarding the water supply,
- as small as possible for avoiding inadequate restrictions.

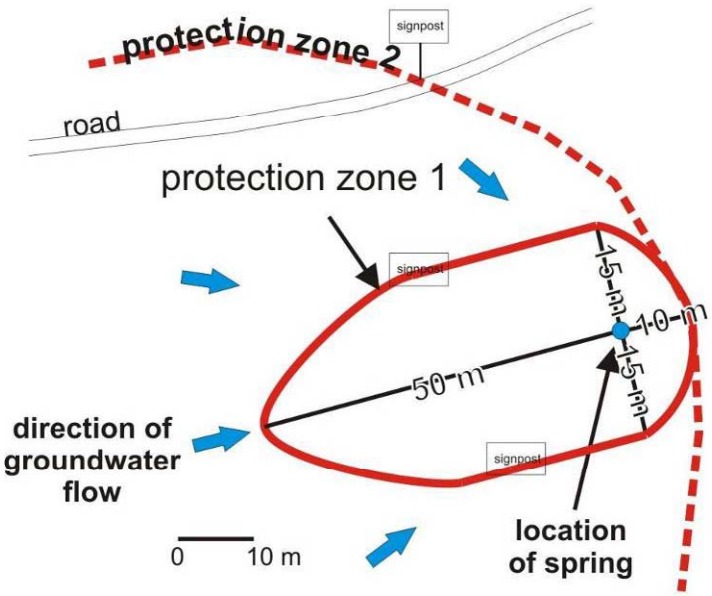
Jordanian Guideline 2006 (similar in Syria; proposed by MARGANE & SUNNA, 2002; modified after German guideline)

Zone I - Immediate Protection Zone
Protects the wells and their immediate environment from any contamination and interference. No access for the public allowed.

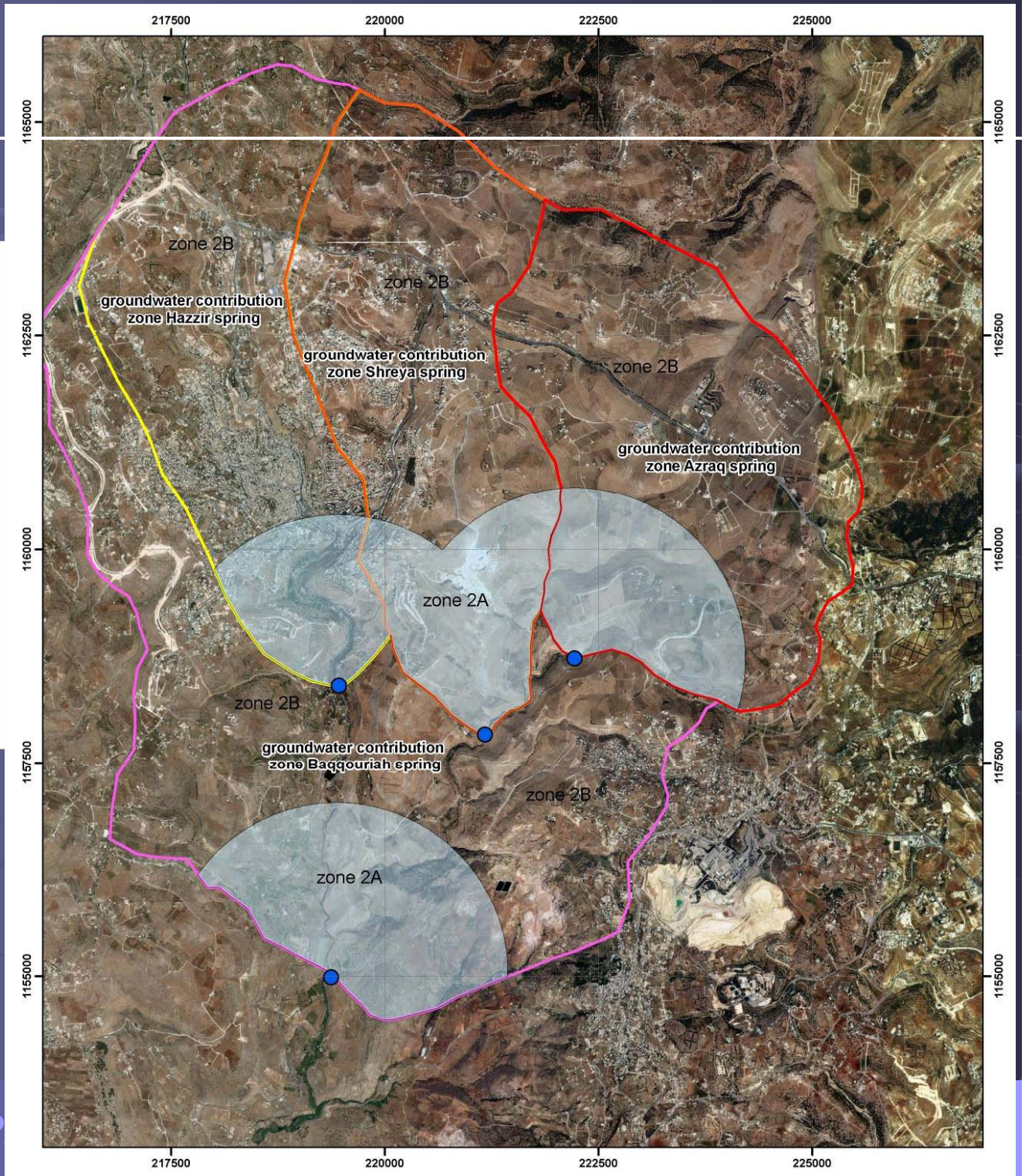
Zone II - Inner Protection Zone (50 days line)
Protection against pathogenic micro-biological constituents such as bacteria, viruses, parasites and worm eggs.

Zone III - Outer (Wider) Protection Zone
Protection from contamination affecting water over long distances such as contamination by chemicals which are non- or hardly degradable.

Delineation

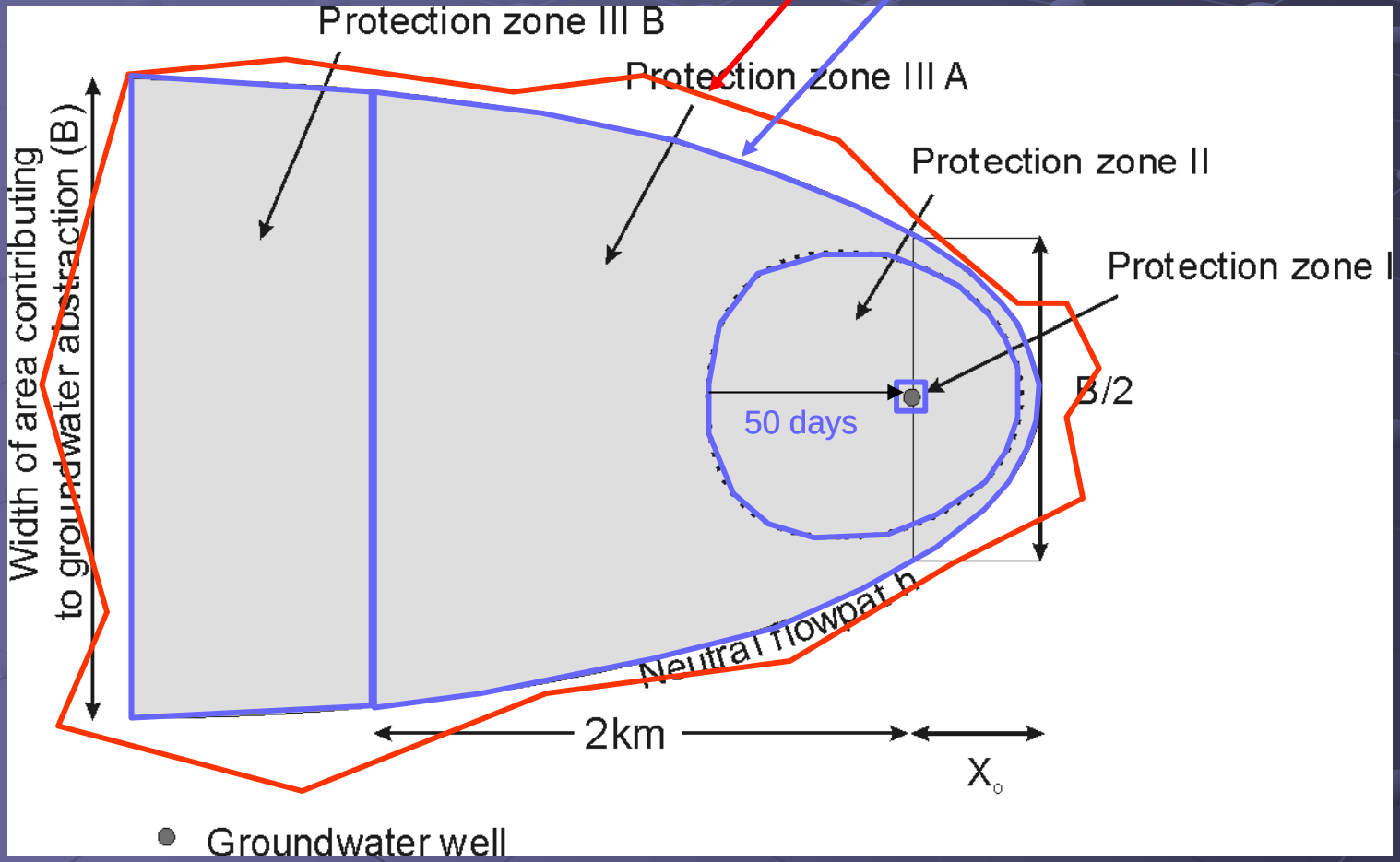


Example of groundwater protection zones from Jordan (Wadi Shuayb; MARGANE et al., 2010)

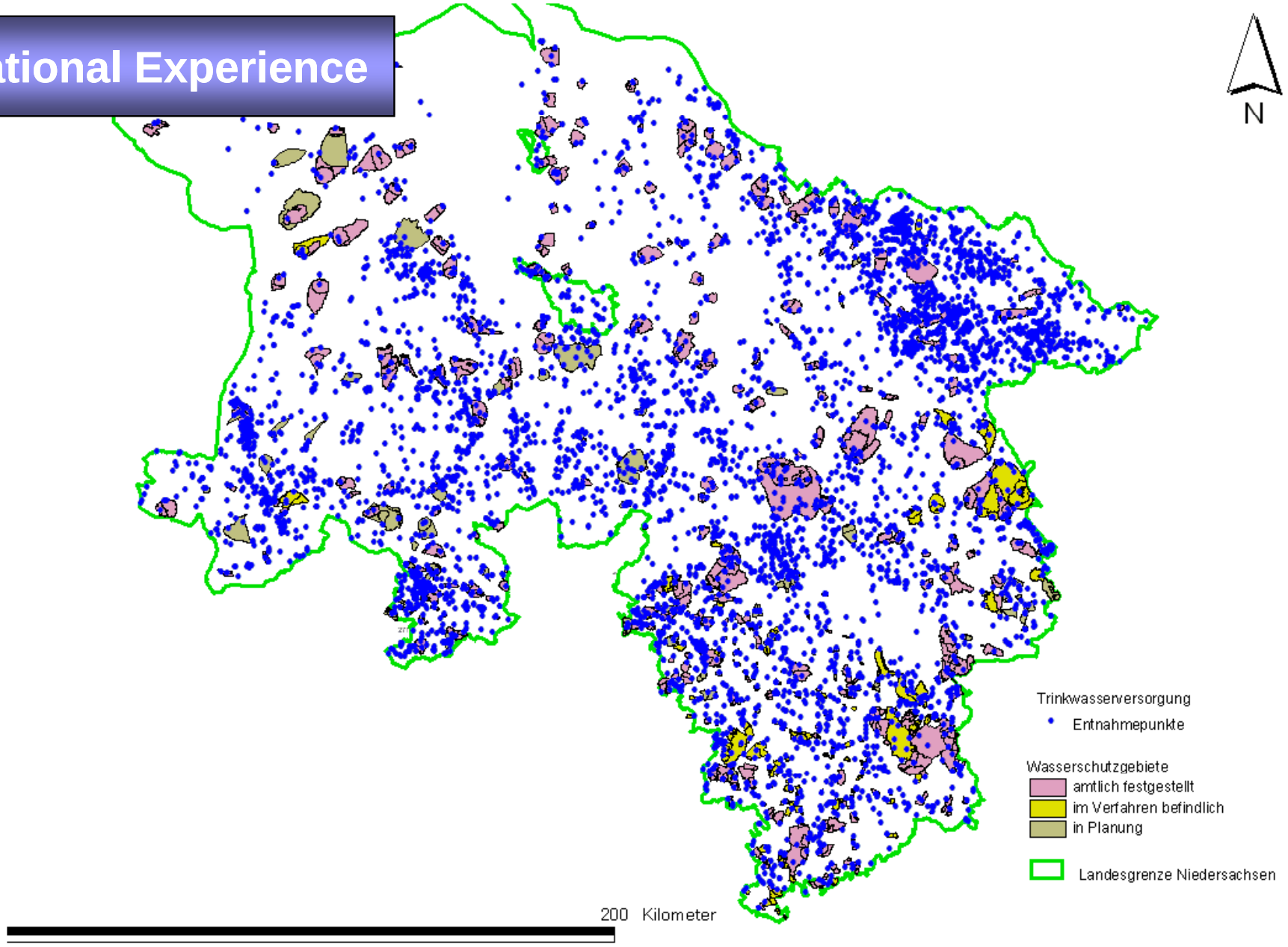


Delineation

Delineation of Groundwater Protection Zones



International Experience



Officially declared Groundwater Protection Zone in the State of Lower Saxony/Germany (15% of land surface; status May 2007)

Zoning Scheme

Criteria for delineation:

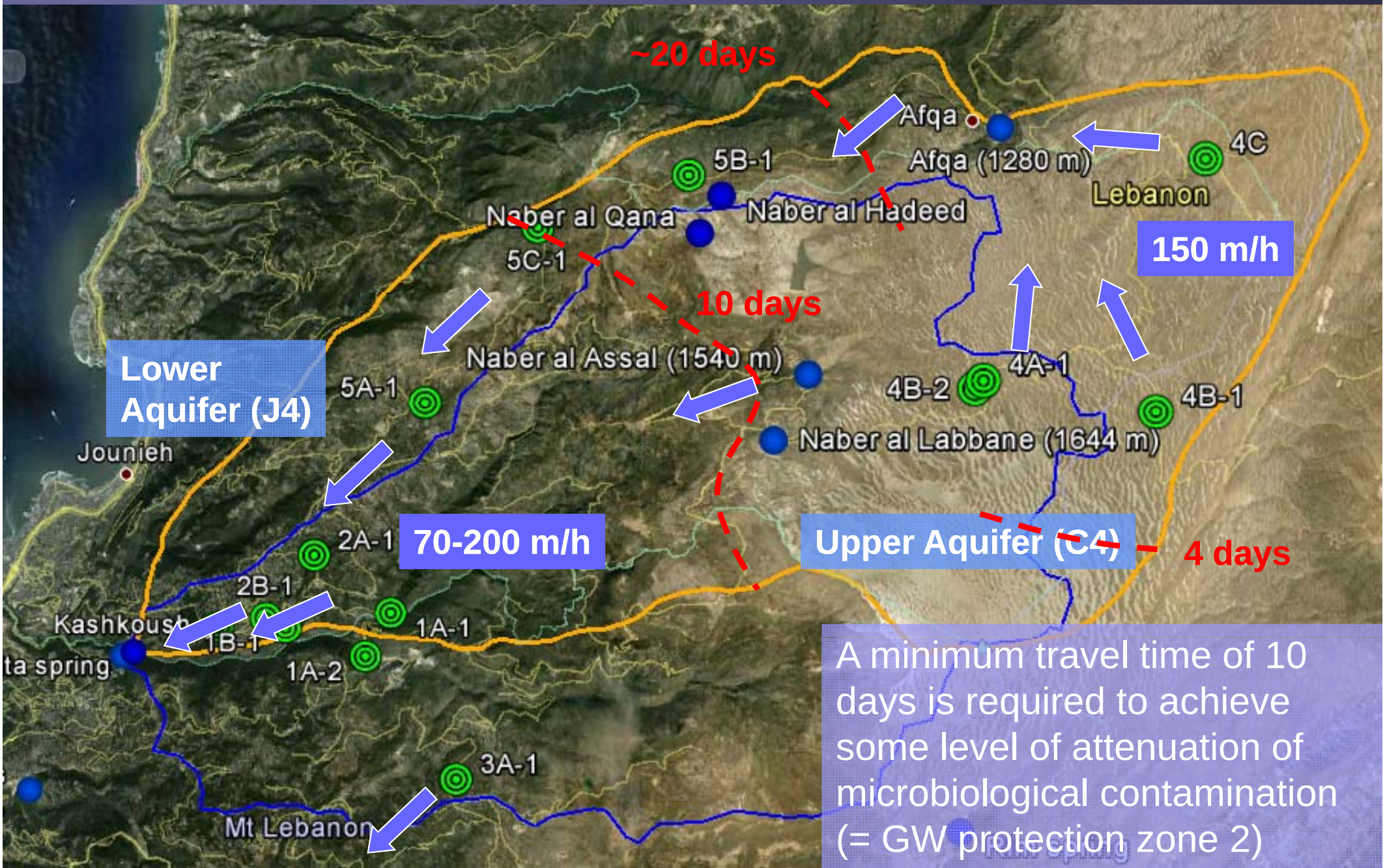
Zone 1: Area near water source (10 m distance) must be fenced off.
Access only for operational staff. Exception: Jeita grotto
Including water conveyor Jeita - Dbayeh
To avoid direct contamination

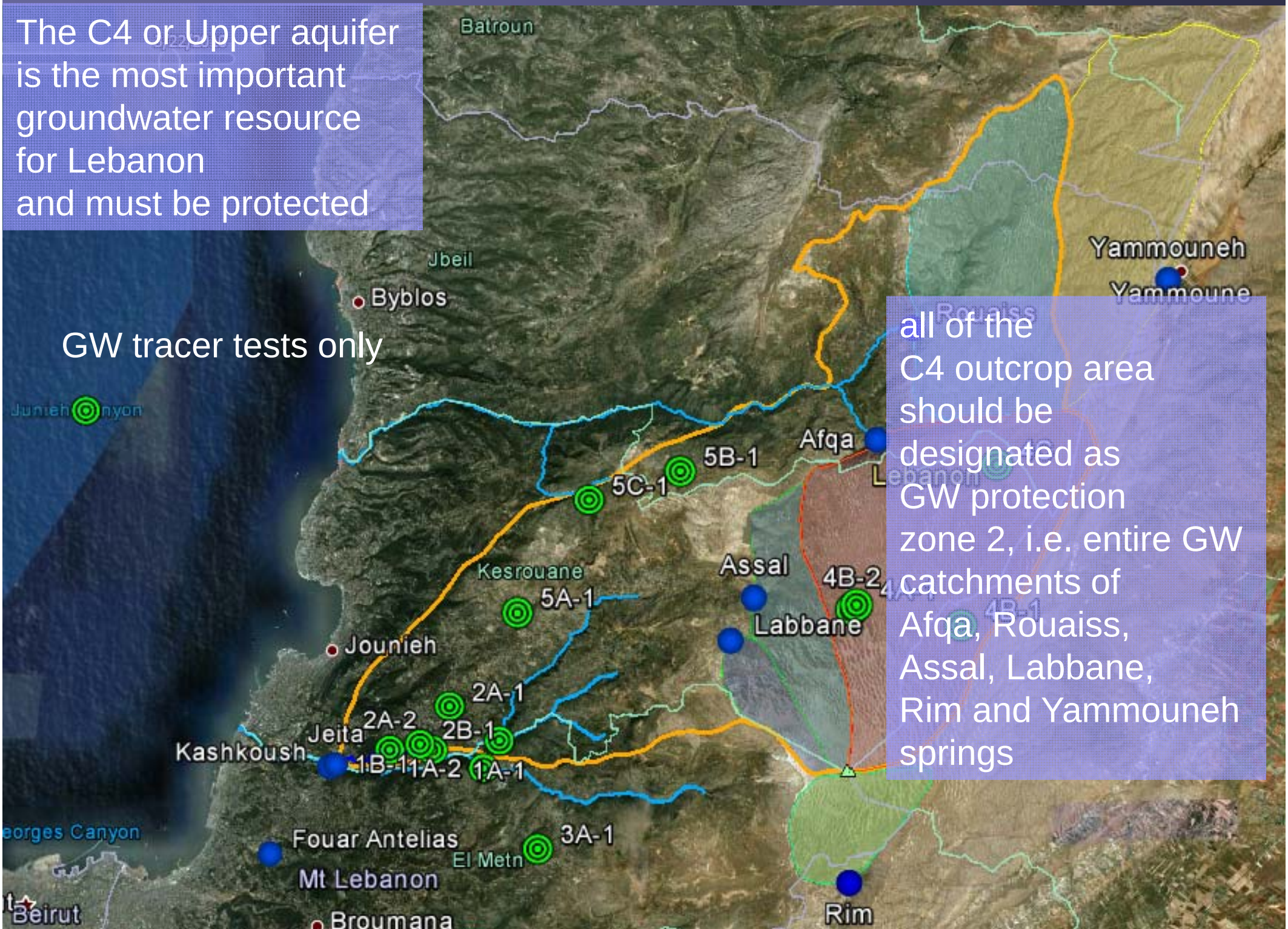
Zone 2: 10-days traveltime from land surface to Jeita spring,
surface water infiltration zones and
zones of high groundwater vulnerability (as mapped by COP method);
To reduce risk of microbiological contamination

Zone 3: entire groundwater catchment (contribution zone)
To reduce risk of contamination by long or hardly degradable substances

Delineation

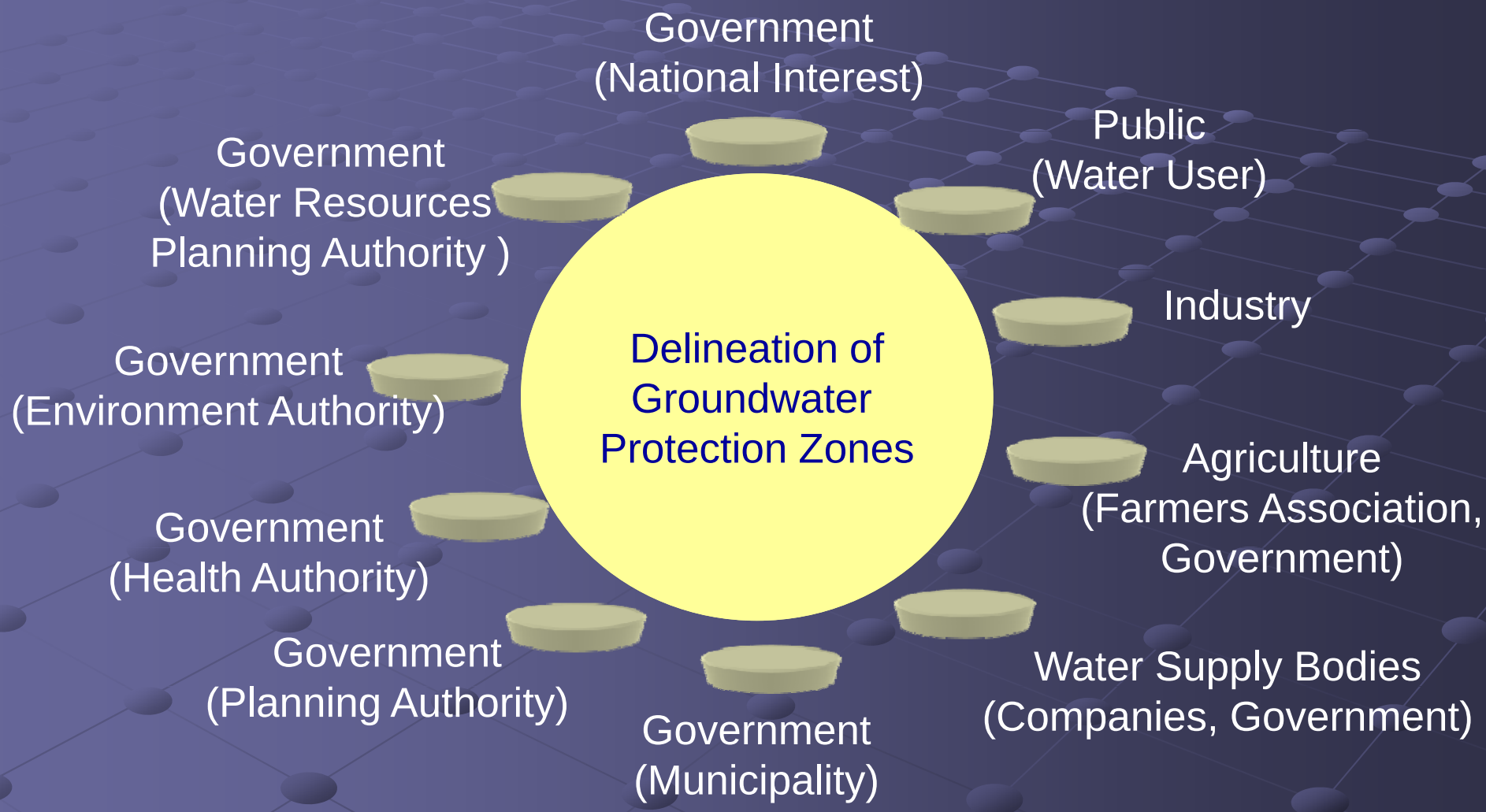
Groundwater Flow
Mean travel times




The C4 or Upper aquifer is the most important groundwater resource for Lebanon and must be protected
GW tracer tests only
all of the C4 outcrop area should be designated as GW protection zone 2, i.e. entire GW catchments of Afqa, Rouaiss, Assal, Labbane, Rim and Yammouneh springs
Batroun
Jbeil
Byblos
Yammouneh
Yammoune
Afqa
5B-1
5C-1
Kesrouane
5A-1
Assal
4B-2
Labbane
Jounieh
2A-1
2A-2
2B-1
Jeita
Kashkoush
1B-1
1A-2
1A-1
Fouar Antelias
3A-1
El Metn
Mt Lebanon
Beirut
Broumana
Rim

Balancing of Interests

Participation of all Stakeholders in the Delineation Process



Procedure

Steps towards Groundwater Protection Zones Implementation (France)

1. decision of the municipality or utility to undertake protection;
2. hydrogeological study;
3. public hearing;
4. registration of the protection zones as a public utility (land);
5. registration of land use restrictions, expropriation of land in the immediate protection zone;
6. conducting the technical measures to reduce the pollution risks.

Zoning System in Jordan

ZONE 1 Groundwater Protection

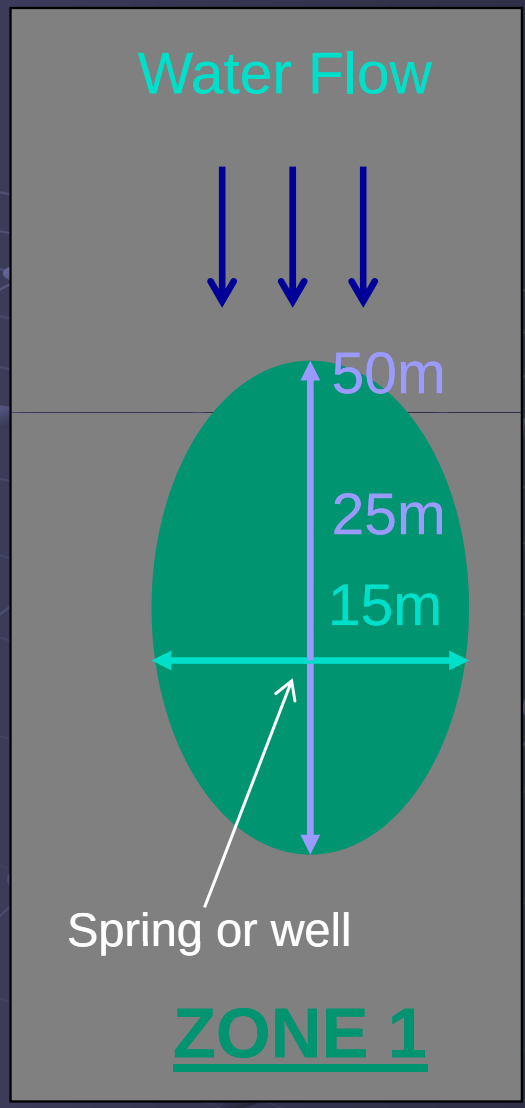
About 1 dunum around each well / about 2 dunum around each spring

→ for public water supply: WAJ will acquire the land and fence it

→ for private water supply: a similar land area should be protected

Restrictions:

- No activities are allowed other than those needed for water abstraction
- Any installation / construction required for groundwater resources operation has to be constructed downstream of the extraction point (generator, fuel/oil storage, chemical storage facility, cesspool etc.)



Zoning System in Jordan

ZONE 2 Groundwater Protection

Delineation is based on 50-days travel time but does not exceed 2 km upstream of a well or spring, and will be 50 to 150 m down-stream the extraction point.

Allowed activities (newly developed land)
- Residential areas with sewers or acceptable cesspit
- Organic farming

Allowed activities (already developed land)
- Residential areas (priority for sewering)
- Organic farming
- Other activities have to implement BMP's

Activities in Zone 2 will be intensively monitored

Zoning System in Jordan

ZONE 3 Groundwater Protection

Area:

Protection of the entire groundwater catchment area of the extraction point.

Allowed activities:

All development activities such as agricultural, industrial and social activities under the condition that they comply with the laws and by-laws applied in Jordan and environmentally sound practices

Landuse Restrictions

Germany

Restricted Landuse Activities in Groundwater Protection Zones

Hazardous Activities in Zone IIIB

-industrial estates;
-thermal power plants, unless gas-fired;
-sewerage, including water sewerage, as well as sewage treatment plants, unless checked for defects at regular intervals;
-release of wastewater to the ground …
-plants for the treatment and disposal of solid waste (other than plants for the handling and storage of such wastes);
-sites for the disposal of contaminated and uncontaminated loose and solid rocks (such as tailings) if decomposition and leaching may affect groundwater;
-use of fertilizers, unless in keeping with good agricultural practices as regards timing and quantities of fertilizer;
-use of liquid or solid manure and silage seepage on waste land;
-disposal of sludge from sewage treatment plants or cesspools and disposal of com-post;
-application of pesticides;
-storage of liquid or solid manure …
-mining, oil and gas production;
-underground facilities for storage of substances contaminating water;
-quarries, …
-military facilities and exercises;
...

Landuse Restrictions

Germany

Restricted Landuse Activities in Groundwater Protection Zones

Hazardous Activities in Zone IIIA

-activities, facilities and sites mentioned above for Zone IIIB;

-handling of substances contaminating groundwater…

-transformers and electricity lines …

-sewerage (except for sewerage satisfying high tightness standards checked for tightness at reasonable intervals);

-discharge of wastewater into surface water flowing into Zone II;

-plants for handling and storage of solid waste;

-new residential development zones;

-development and extension of graveyards;

-gasoline stations;

-drilling operations;

……

Landuse Restrictions

Germany

Restricted Landuse Activities in Groundwater Protection Zones

Hazardous Activities in Zone II

-activities, facilities and sites mentioned above 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 contaminating water;
-swimming, camping and sports facilities;
-shooting and blasting operations.
...

Landuse Restrictions

Germany

Restricted Landuse Activities in Groundwater Protection Zones

Hazardous Activities in Zone I

-activities, facilities and sites mentioned above for Zone III and Zone II;

-any type of traffic (neither vehicle nor pedestrian);

-use for agriculture, horticulture or forestry;

-use of fertilizers and pesticides.

...

Implementation

To achieve a successful implementation of GW protection zones the following measures are needed:

Zone I

Awareness campaigns

Boundaries of GW protection zones have to be clearly marked

Control mechanism (environmental rangers)

Zone II

Signposts for protection zones in Jordan implemented by MWI & BGR 1999-2010: 33% of national drinking water sources protected

Thank you for your kind attention

www.bgr.bund.de/jeita

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