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

Protection of Jeita Spring

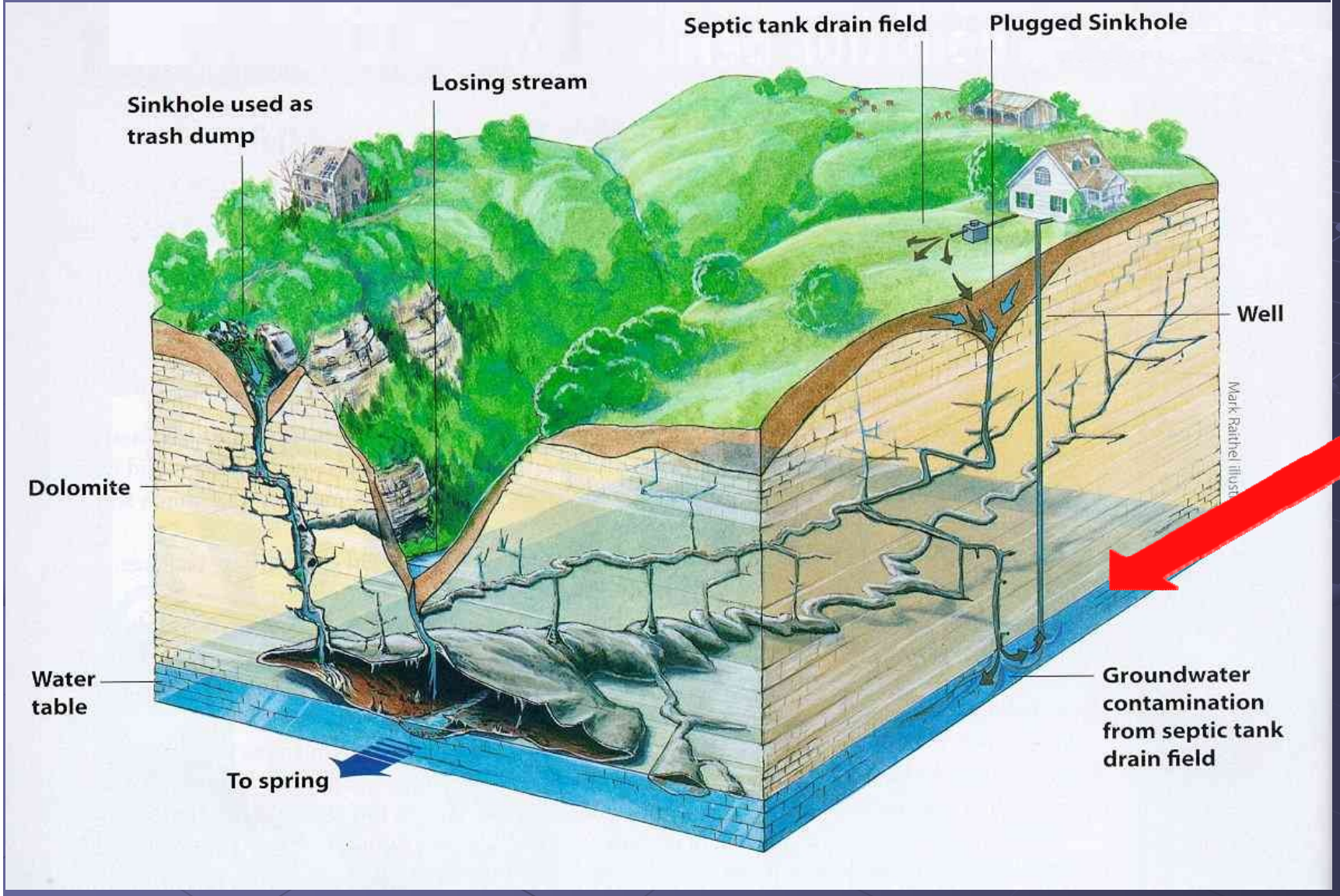
Hazards to Groundwater and Pollution Risk Assessment

Final Project Workshop
11 July 2014

Eng. Renata RAAD, BGR

How Karst works

Very short travel time of contaminants from land surface to groundwater & quick pollution spread in groundwater due to high speed flow



Be careful: drinking water below

Jeita Spring Groundwater: a Vital Resource at Risk

Hazards Point sources

- Gas stations
  Generators
  Car services
- Feedlots & Slaughterhouses
- Industries
- Buried radioactive wastes
- Wells
- Healthcare establishments.
- Illegal dumps & Municipal wastes
- Quarries
- Military barracks & maneuvers`
- Septic system
- Recreation: Restaurants, hotels, etc.

Hazards Non Point Sources

- Agriculture
- Urban runoff
- Air pollution

Each human activity conducted on earth have an impact on groundwater

Multiple risks require multiple barriers

- Risk prevention:
  - Hazards assessment
  - Health risk significance of related contaminant
  - GW Vulnerability evaluation
  - Risk assessment
- Risk management: Strategies & active measures for prevention & treatment
- Risk Monitoring and compliance

Methodology followed in the Hazard Assessment

- Identification of potential hazards in the study area
- Detailed review of related Legal framework and permitting systems
- Comparison between national guidelines & European ones
- Field assessment of hazards
  - Hazards inventory: (GIS)
  - Primary evaluation of groundwater contamination risks: according to current infrastructure status, operational & waste management practices,
  - Assessment of the existing monitoring & control of the sector, related stakeholders permitting system, etc.
  - Meetings with main stakeholders of identified hazards

Health risk significance of related contaminant

- Detailed review of contaminants generated by each source of hazards
- Evaluation of the potential risks on public health generated by related groundwater contamination
- Assessment of existence of subject contaminant :
  - water monitoring results conducted by BMLWE
  - assessment of micropollutants conducted by BGR project in collaboration with the university of Gottingen in 2010 – 2011

Main Identified Potential Hazards Point Sources

Septic disposal system: organic & inorganic contamination: viruses, microorganisms (i.e. Giardia lamblia, Cryptosporidium , Salmonella Nitrogen, heavy metals, organic matter, trace organics like endocrine disrupting compounds (EDCs) & pharmaceutically active compounds

Gas stations : Petroleum, chemical, etc.
Generators : Petroleum, chemical
Residential heating systems: Petroleum, chemical
Car service workshops : Petroleum, chemical

Quarries: Drill and blast operations: explosives, etc.,
Rocks Processing : Bitumen, Fillers, sludge,…
Equipment : Fuel, oils, …

Feedlots & slaughterhouses: Domestic, infectious, SRM, chemical, antibiotics, etc.

… Identified Potential Hazards Point Sources

Hospitals & clinics: infectious agents, chemicals, heavy metals, radioactive wastes, detergents , pharmaceuticals, etc.

Industries: Heavy metals, different kinds of chemicals

Including dry Cleans & painting factories: Dense non-aqueous phase liquids (DNAPLs), VOCs, etc.

Wells: Ease all nearby contamination

Dumpsites & Municipal wastes: Domestic, infectious, chemical, etc

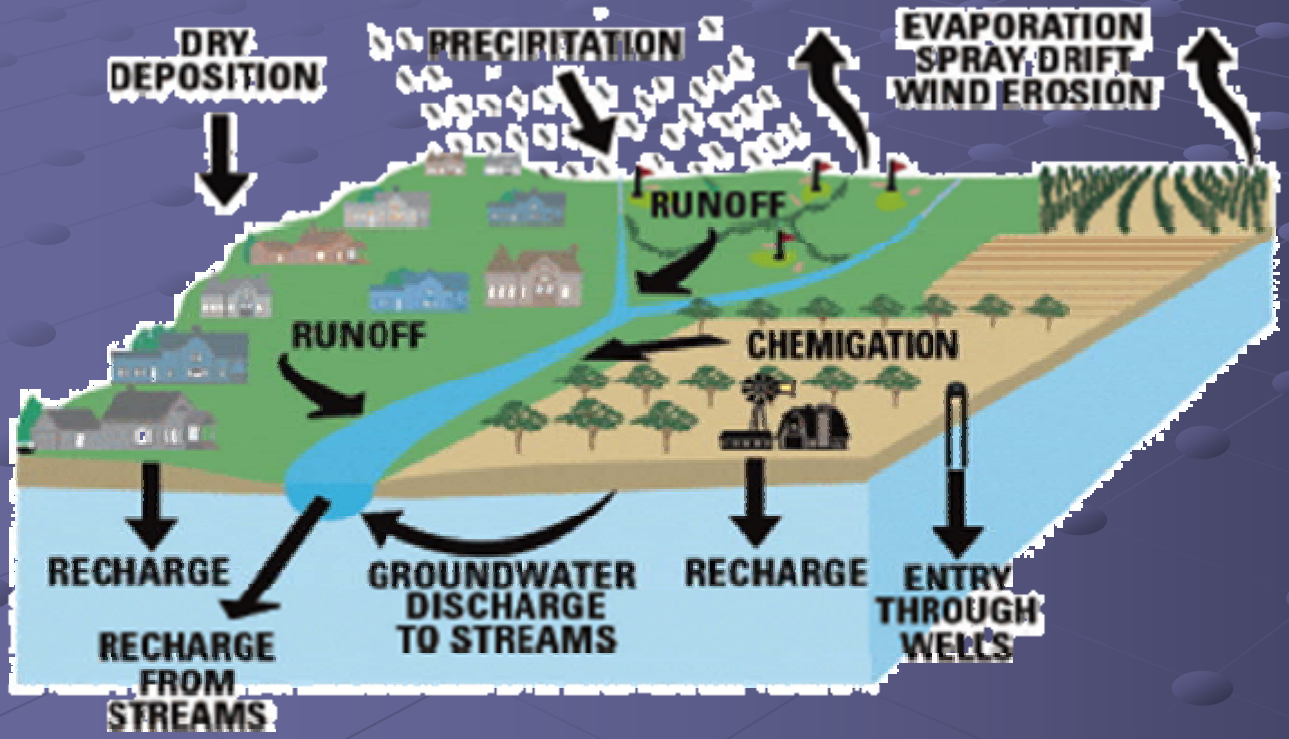
Recreation: Restaurants, hotels, etc. : Domestic, infectious, chemical, etc

Military maneuvers & Barracks: explosives, petroleum, domestic, healthcare, etc.

… Identified Non Point Sources of Hazards

Agriculture: Pesticides, Fertilizers, Chlorinated Solvents, plastics, P.E, Aflatoxins, etc.

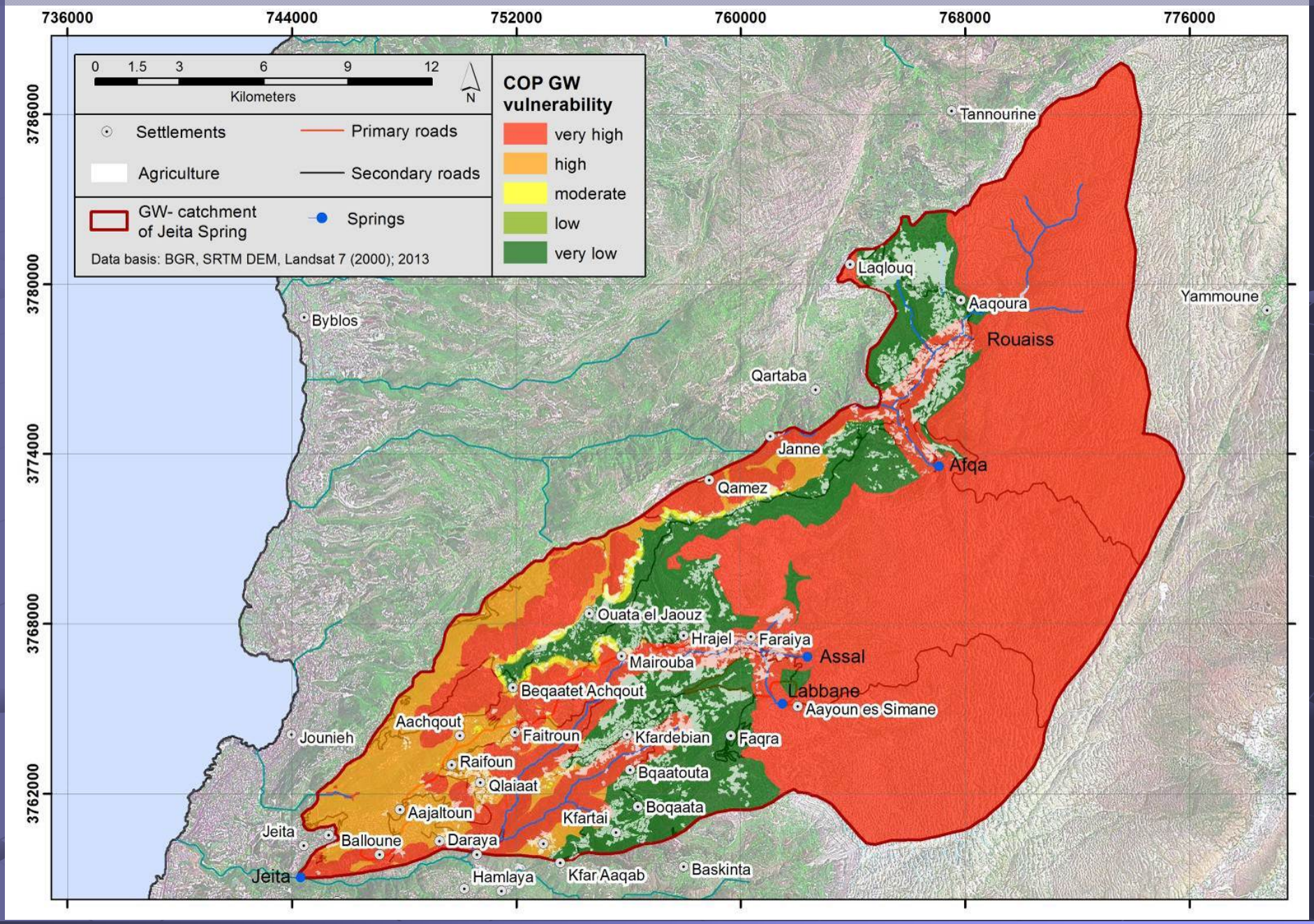
Urban runoff : chemicals, nutrients, sediments & other NPS



Agriculture

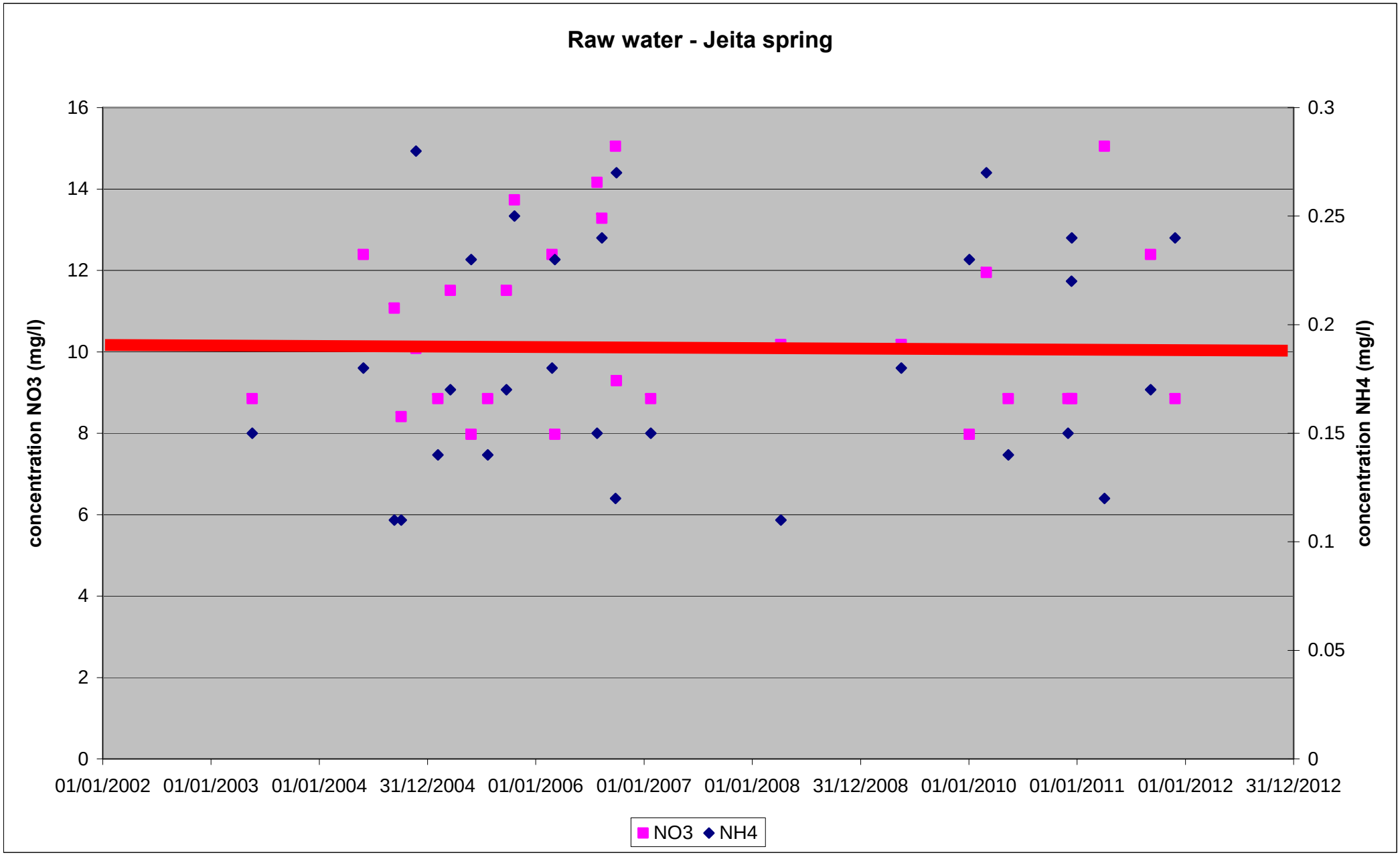
Around 32 ha (7.8%) are used for agricultural land cultivation in the Jeita catchment.

Repartition of the agricultural activity and the GW vulnerability in the JC



Pesticides and fertilizers containers are dumped in the nature in absence of proper assigned collection facilities

Ammonium and nitrate concentration in raw water of Jeita spring



NO laboratory in Lebanon able to conduct a continuous reliable monitoring of potential contaminants in Jeita Spring Waters due to various reasons e.g:

lack of equipment, staff, technical capability or financial means, etc.

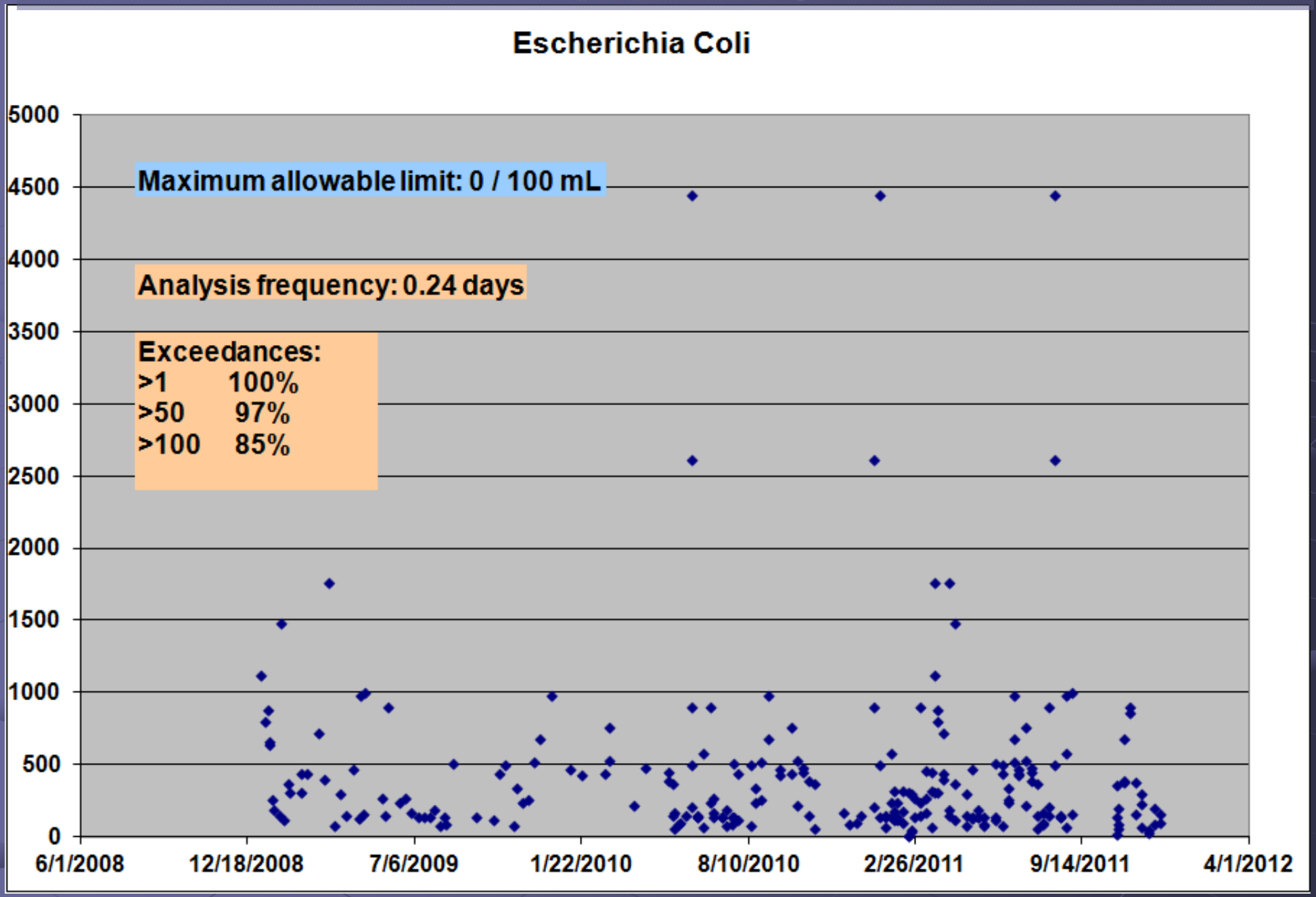
Monitoring must be continuous and based on a field assessment

Septic disposal system

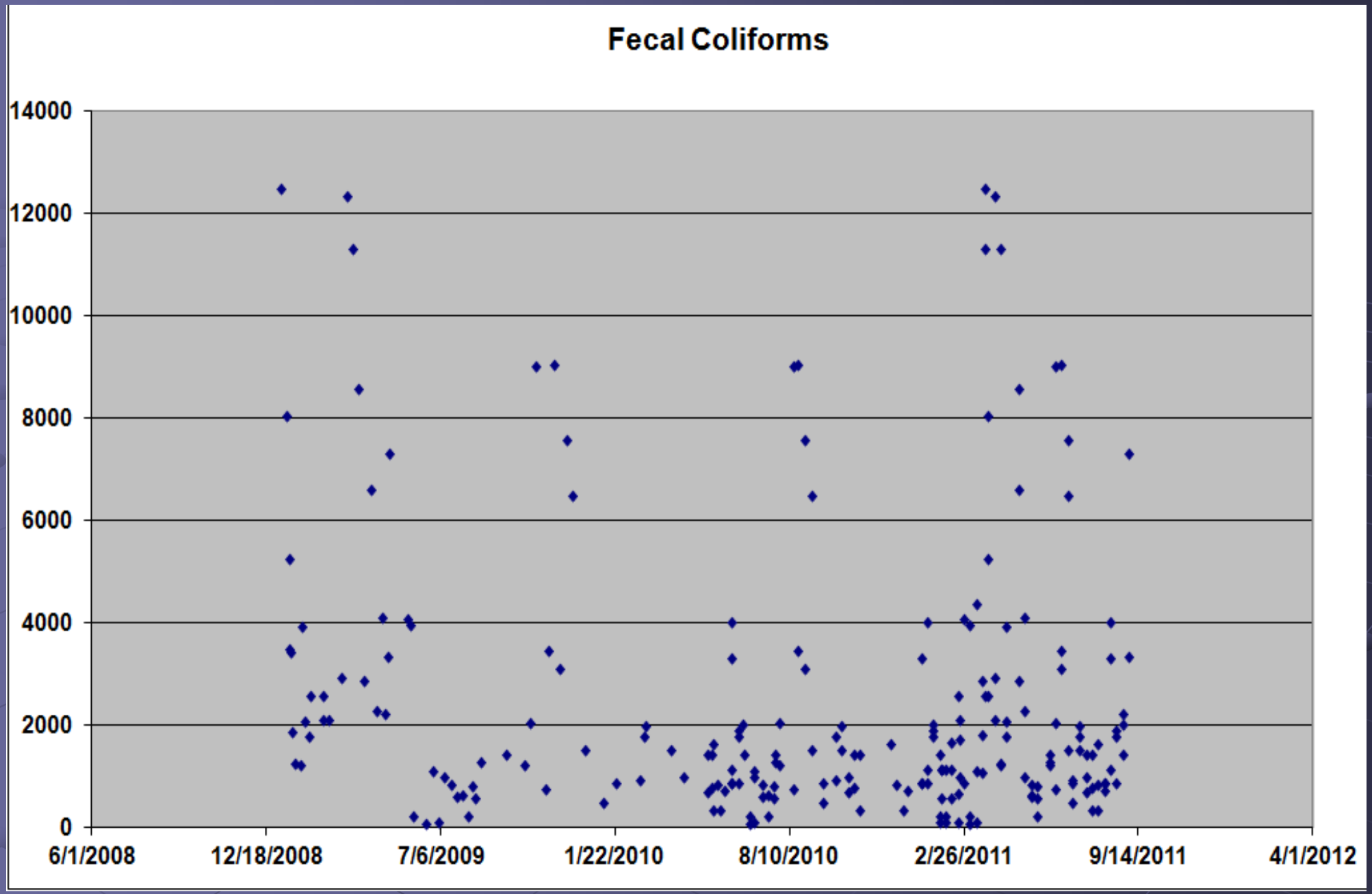
Untreated Wastewater is disposed in the environment. Thus to groundwater

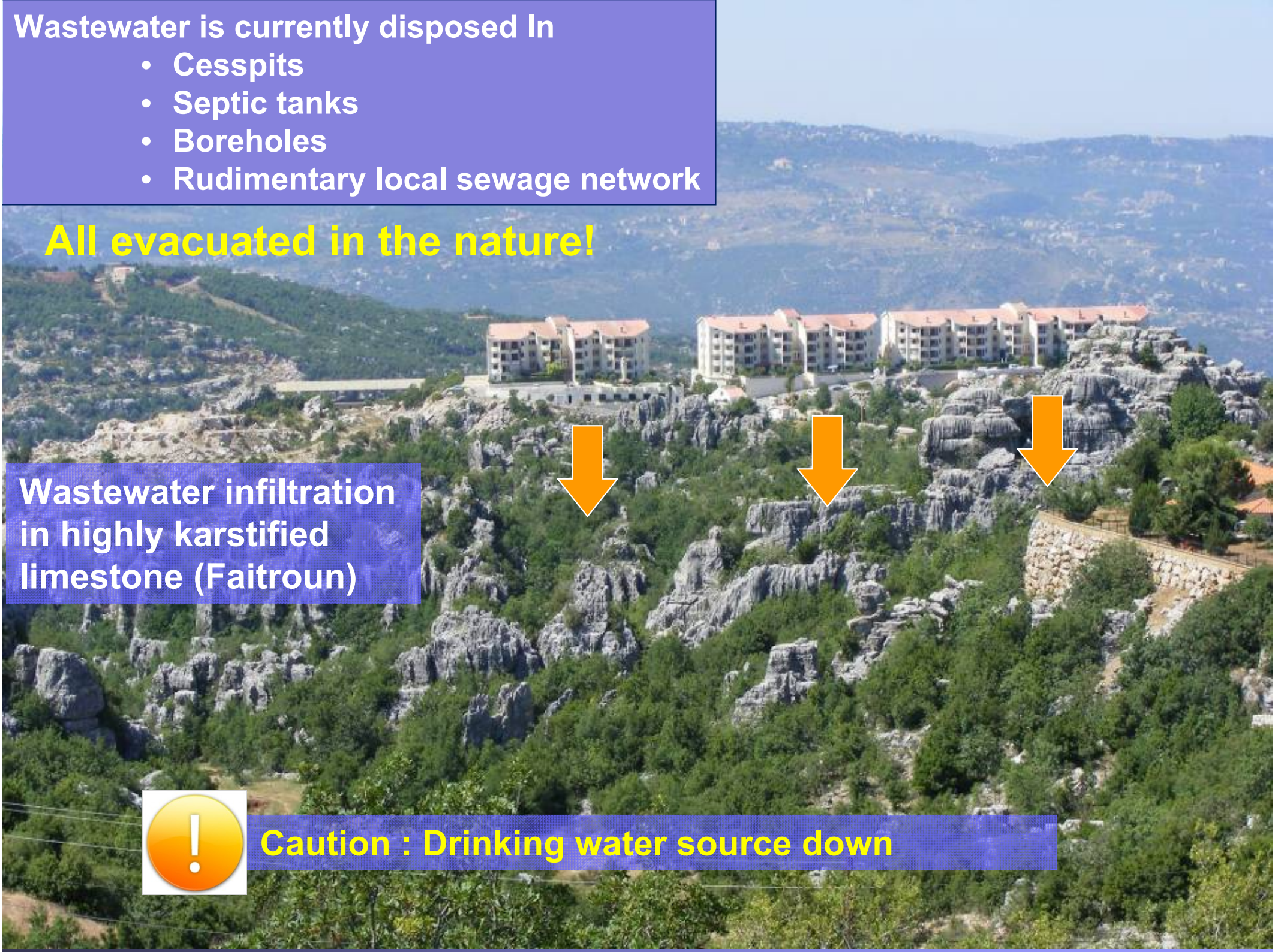
► Significant Contamination of Jeita Spring Groundwater

Contamination generated by Wastewater



… Contamination generated by Wastewater




Wastewater is currently disposed In
• Cesspits
• Septic tanks
• Boreholes
• Rudimentary local sewage network
All evacuated in the nature!
Wastewater infiltration in highly karstified limestone (Faitroun)
Caution : Drinking water source down

Wastewater illegal disposal in the environment

… using assigned tankers

… through unmaintained rudimentary local sewage networks

Wastewater is disposed in Water streams

Or in in Water canals

Wastewater contamination revealed by water analysis

- Wastewater discharge into groundwater is common practice in all areas.
- Only the Upper Aquifer is spared yet from pollution

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Protection of JSGW from contamination by sewage depends on:

- Proper execution and sustainable operation of the wastewater treatment plant which is financed by KFW and planned in close collaboration with BGR project partners ,
- Raising environmental awareness at the local society's level
- Connection of existing buildings to the planned wastewater collectors
- Enforcement of the laws and guidelines related to the allowed effluents discharged in the wastewater collection system

- Creation of small scale decentralized wastewater treatment plants for little villages that are located far from the wastewater collection network

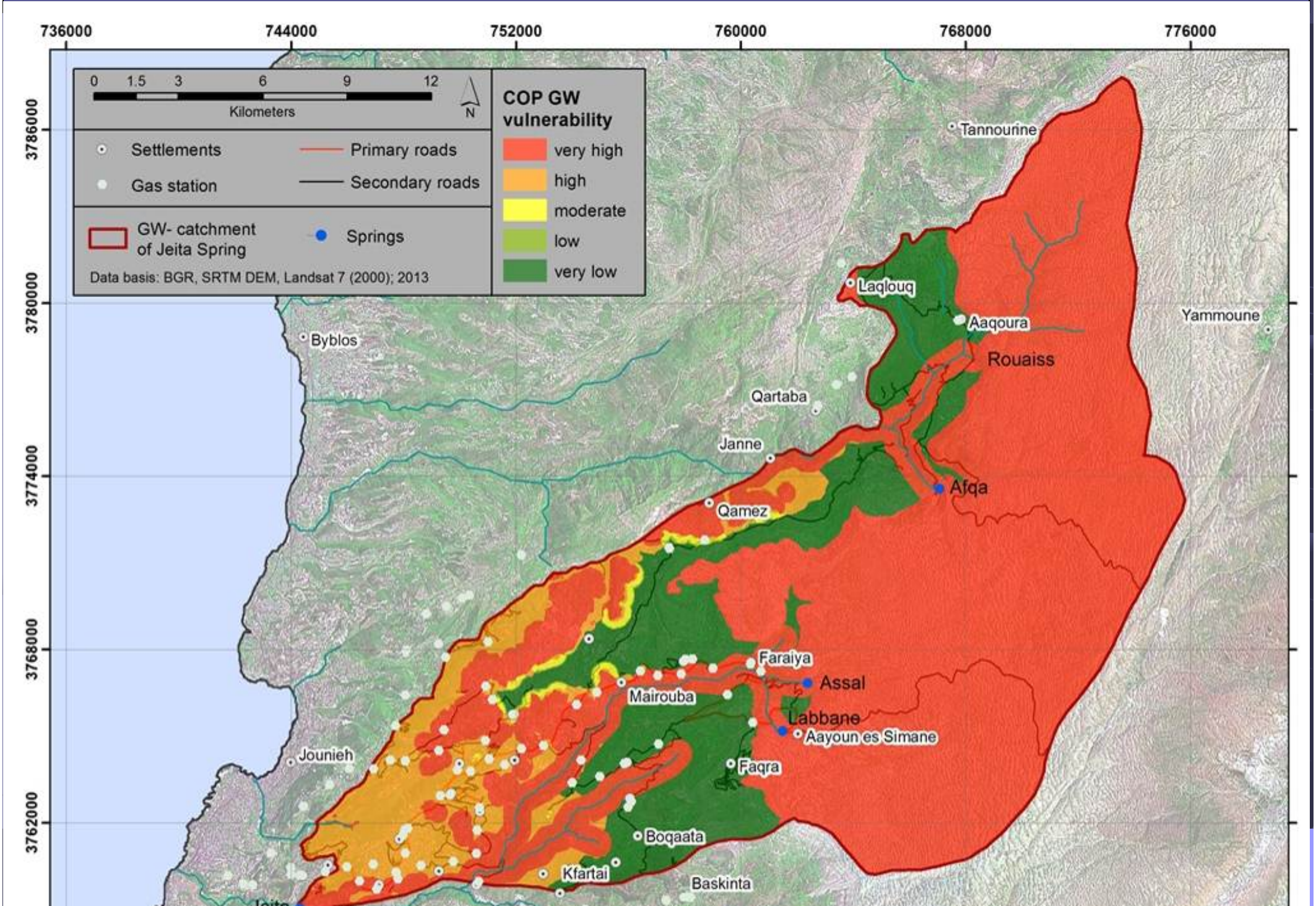
- provision by relevant municipalities of a regular service of emptying septic tanks and disposing the wastewater at assigned wastewater treatment plants

- Synchronization of efforts related to the wastewater planned schemes in the area (mainly with the EIB and the Italian cooperation for development)

Assessed point hazard sources inside JSC:

Hazards sources	Assessed hazard sources inside JC	Protection zone				
		1	2a	2b	3a	3b
Dumpsites	74		47	26		
Hospital	1			1		
Gas stations	59		22	23	1	13
Industries	33		12	13		8
Quarries	25		9	2		14
Slaughterhouses	2			2		
Feedlots & Poultry housing	33		7	9	1	16
Touristic resorts & restaurants	18		13	4		1

Gas stations



Gas stations

Protection zone	Number of gas stations	Groundwater vulnerability at the location
2a	22	J4/(J5 dolinas) within stream buffer above aquitard, travel times < 10 days
2b	23	High vulnerability J4/(J5 dolinas), travel times < 10 days
3a	1	and high vulnerability J4 with, travel times > 10 days
3b	13	very low vulnerability, Aquitard, no streams

BGR

Assessed status of gas stations sector in Jeita Spring Catchment

Most are older than 15 years with untreated single layer carbon USTs , installed in poor leakage prevention conditions

→ High risk of leakage

Lack of technical knowledge and infrastructure (no leakage detection systems, etc;

Bad waste (Liquid & solid) management practices

Non compliance with national standards (underground storage tanks [UST], pipelines and maintenance);

Deficient enforcement capacities at relevant governmental institutions

Absence of efficient control and monitoring by relevant institutions

Lack of enforcement of relevant actuated laws and guidelines

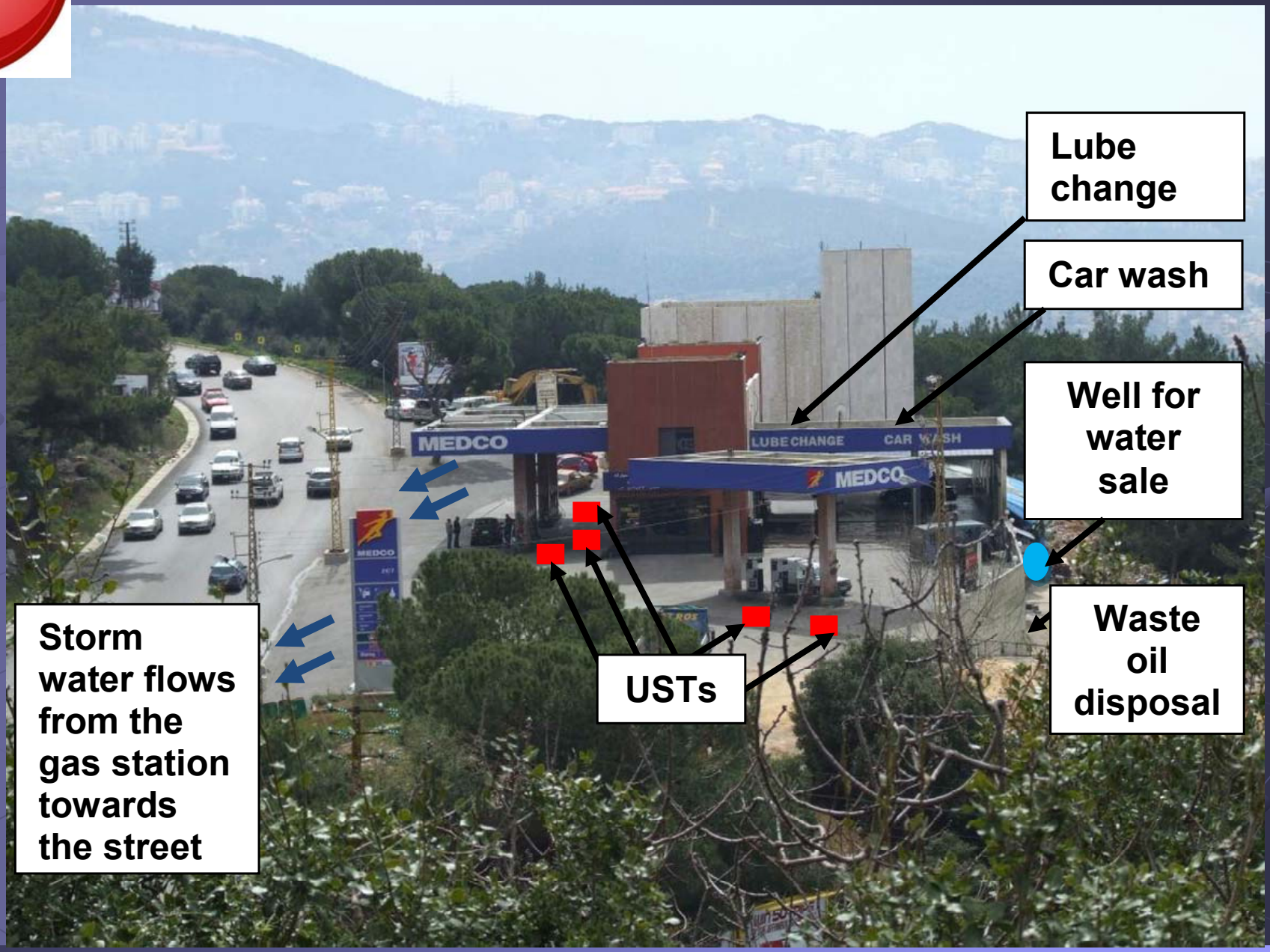
Gaps in related laws and guidelines as being in karstic area

Existing permitting frequently neglects environment protection consideration,.

Many are operating without permits

Absence of environmental awareness

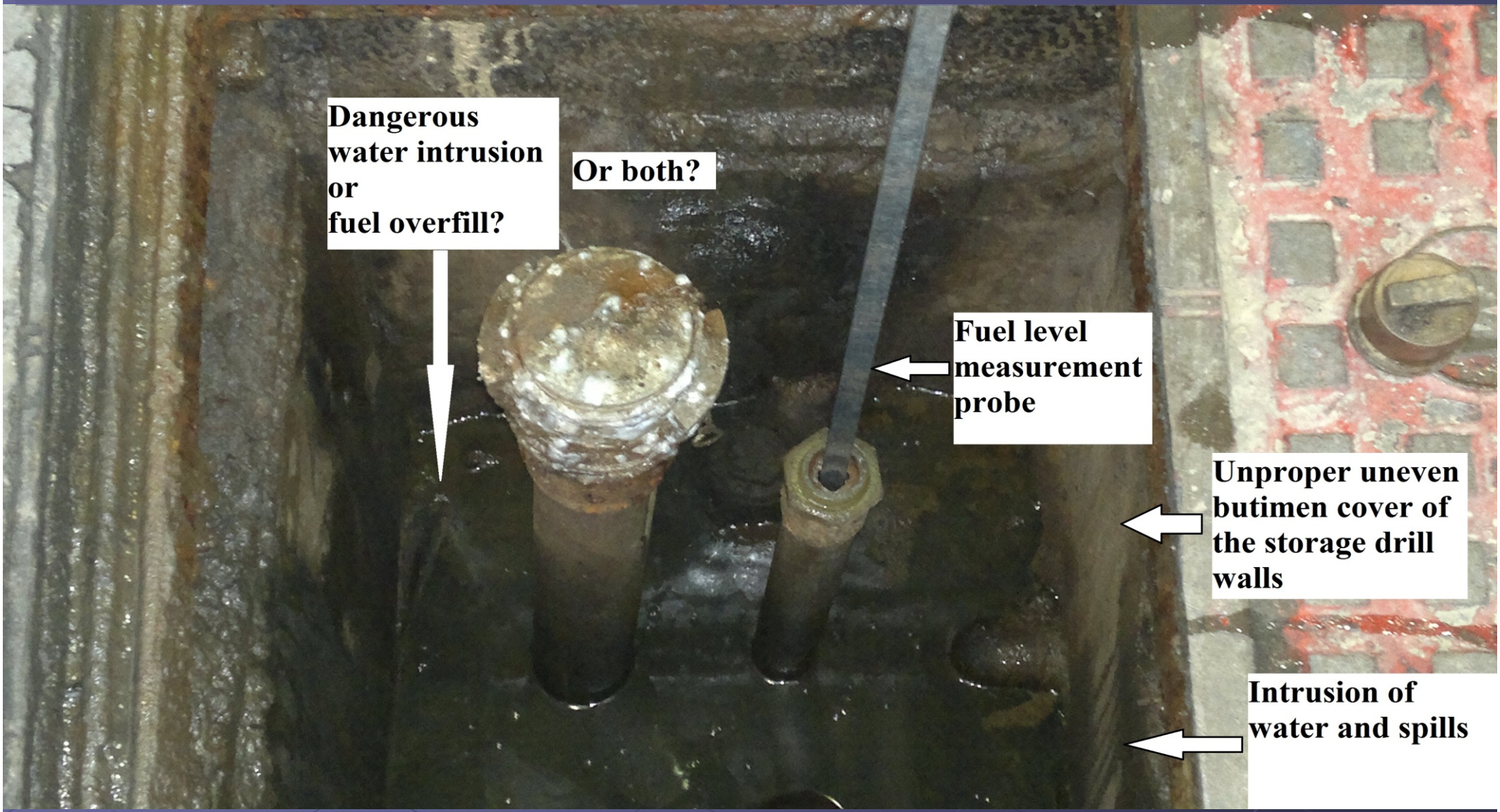
Some gas stations include wells dedicated for water sale



… Assessed status of gas stations sector in Jeita Spring Catchment

… Assessed status of gas stations sector in Jeita Spring Catchment

Status of the tanks in one of the best equipped stations located in JSC overfill and water intrusion, in addition to bad pit coating, etc



A leak as small as one drop per second will release about 400 gallons of gasoline in one year.
The contamination can spread over long distances (tens of Km) and would be extremely difficult and costly to remediate

Licensing Process for gas stations in Lebanon.

- Very long and complex permitting system, involving many stakeholders with overlapping roles and responsibilities
- Unclear TOR of related stakeholders
- Lack of abidance to environmental considerations
- A related draft decree was approved by the COM. Considering its content, if acted, the situation will be worse.

Complete absence of Petroleum Contamination Monitoring in Lebanon

- Blasting risks
- Health risks

Petroleum contamination is still neither monitored nor treated in Lebanon

Main assessed contaminant to detect Groundwater contamination by fuel

Methyl Tertiary-Butyl Ether MTBE

Not even one laboratory in Lebanon is able to carry out related analysis due to lack of equipment, reagents, staff and/or technical capabilities

Urgent assistance is required in this field

Diesel oil : Generators & Residential heating systems

Spread all over the catchment

Relevant oil spills and bad conditions (possibility of leakage) of diesel storage facilities

Non compliant to any environmental guidelines

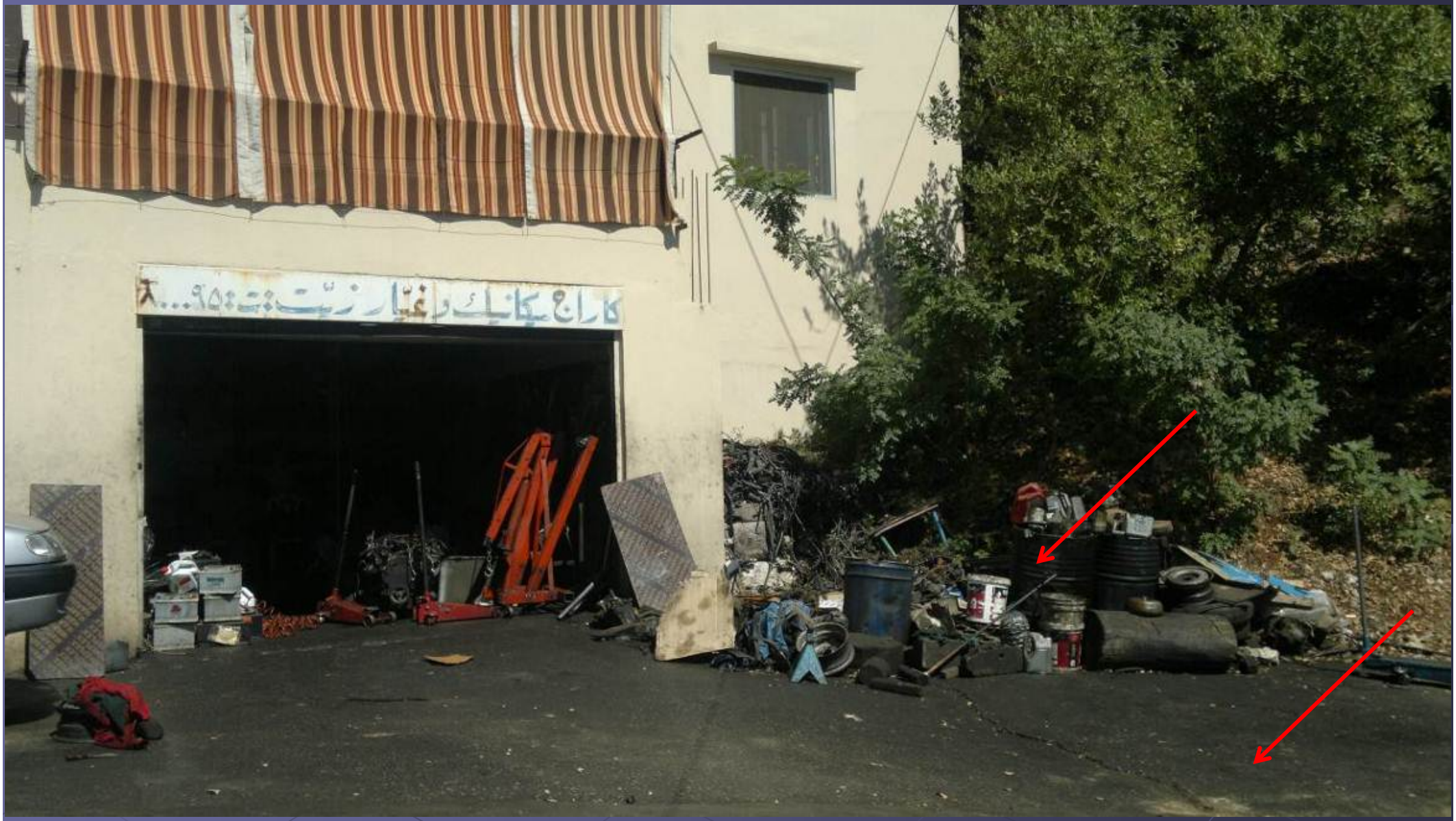
Bad waste management practices

Negligence and major lack of environmental awareness

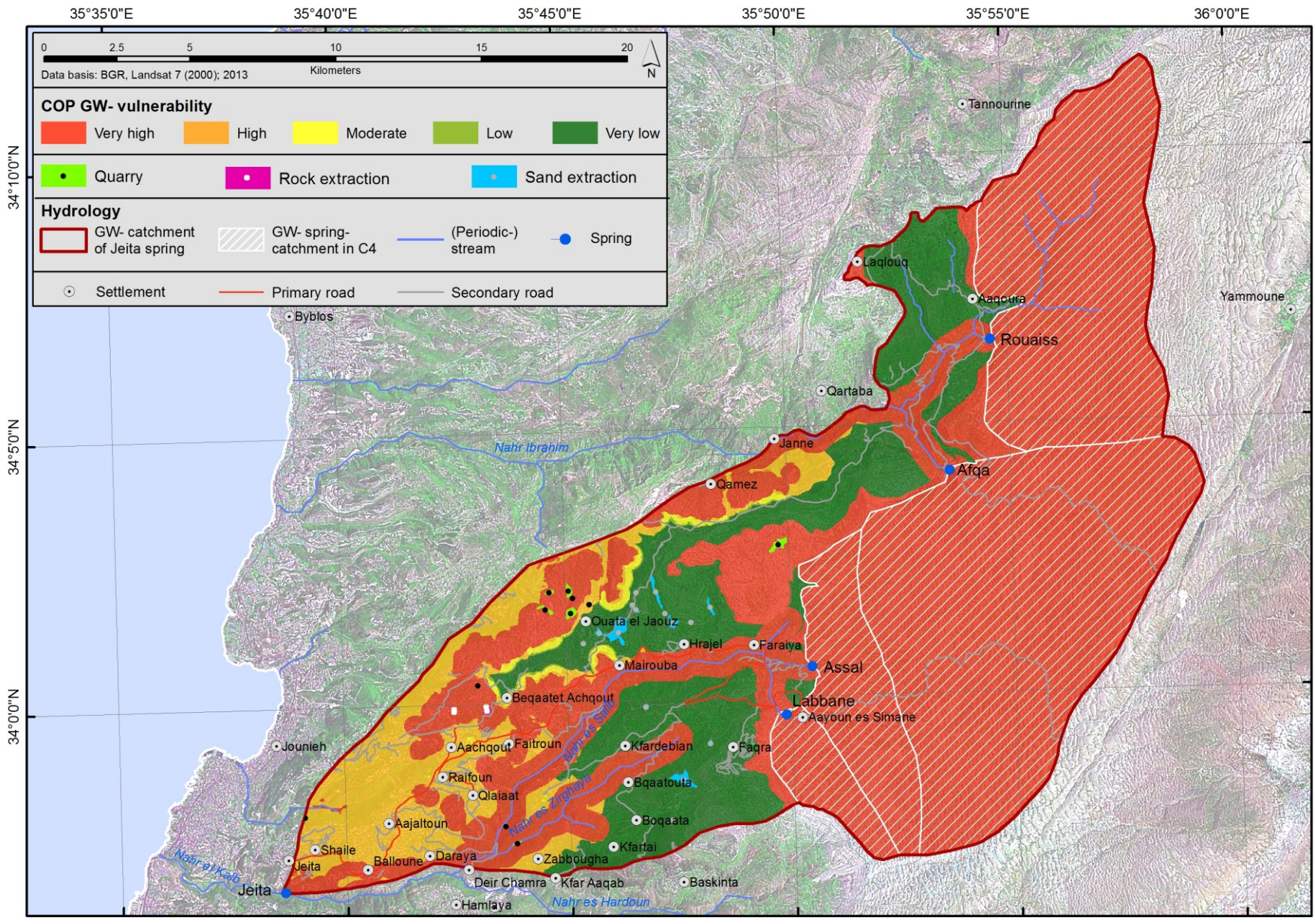
High potential risk of generating petroleum contamination and blast

Residential Heating Systems in JSC

Car reparation workshops in JSC



Quarries in The JS Groundwater Catchment



--- Quarries in The JS Groundwater Catchment

- Decrease or removal of protective cover leading to an increased access by pollutants to groundwater
- High erosion potential causes mobilization of fine material and washout towards streams. Tailings and sludge, reaching surface waters, increase their turbidity. Turbid surface water infiltrates into groundwater. Turbid groundwater is difficult to treat (chlorination becomes ineffective) which threaten the public health of Greater Beirut citizens, being fed by inefficiently treated drinking water.
- Unsound fuel storage
- Blasting operations increase cracks and fissures in the karst network, leading to potential of collapse of karst caves and dolinas
- Non-compliance with law to rehabilitate quarries after extraction. Abandoned quarries are often used as landfills.

Sludge generated by rock saws and quarries dumped in the nature

Quarries in the JSC

All quarries operating in Jeita catchment are working upon a yearly renewal of old operation permits.

The related actuated laws and guidelines are not applied due to political interferences and to the increasing need for construction raw materials

28 quarries are active inside Jeita Spring Groundwater catchment

All located in areas where the quarrying activity is actually banned by actuated national laws and urban planning decisions

Materials extracted are:
- Rocks
- Gravels
- Sand

Feedlots

Bovines: Small and medium scale
Ovines: Small and medium scale
Swine: Small and medium scale
Poultry: small, medium and big scale

Very bad wastes management

Permitting disregards water resources protection requirements despite being mentioned in related actuated laws and guidelines.

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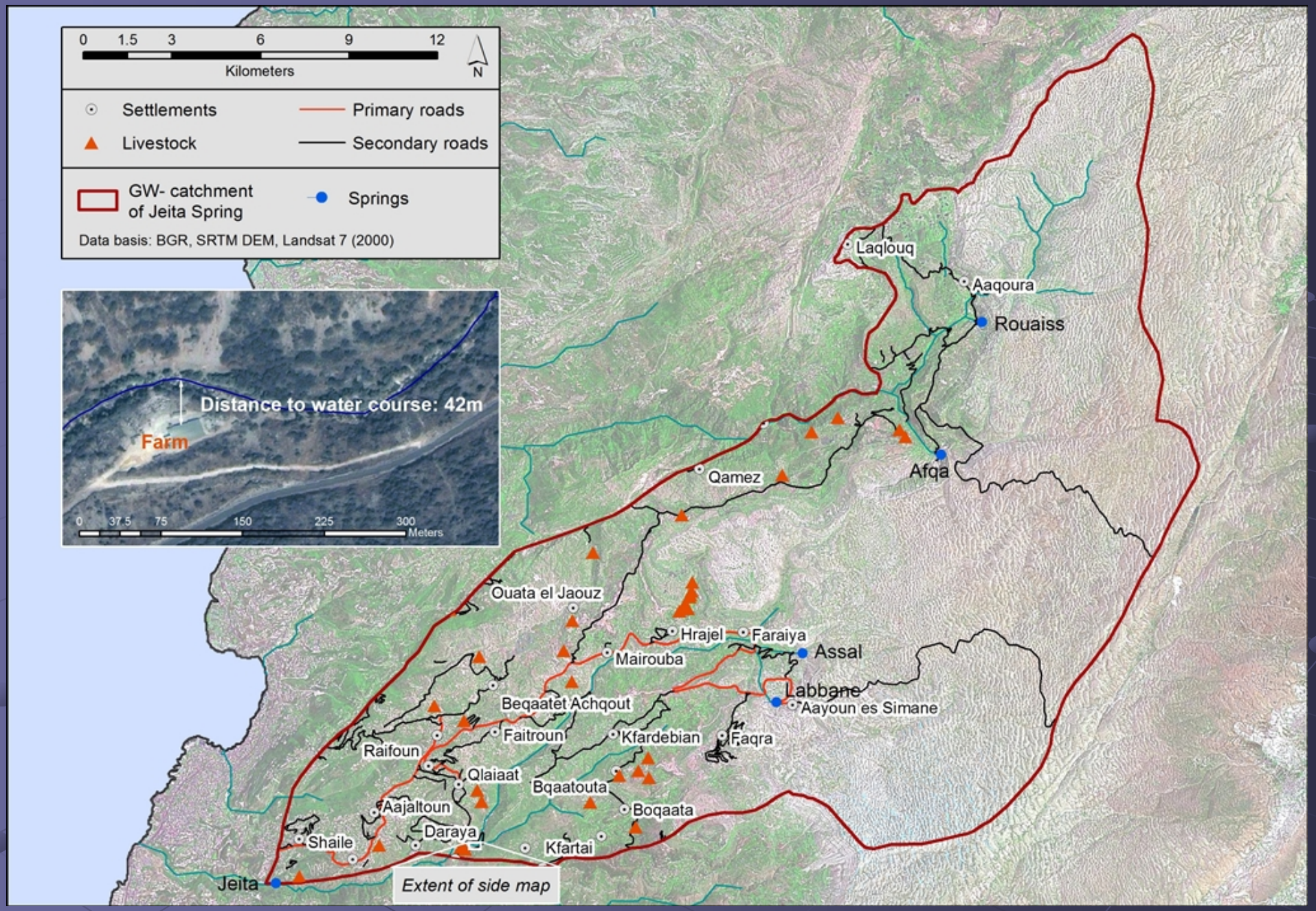
Feedlots


0 1.5 3 6 9 12
Kilometers
N
Settlements
Livestock
Primary roads
Secondary roads
GW- catchment of Jeita Spring
Springs
Data basis: BGR, SRTM DEM, Landsat 7 (2000)
Distance to water course: 42m
Farm
0 37.5 75 150 225 300
Meters
Laqlouq
Aaqoura
Rouaiss
Afqa
Qamez
Ouata el Jaouz
Hrajel
Faraiya
Assal
Mairouba
Labbane
Aayoun es Simane
Beqaatet Achqout
Faitroun
Kfardebian
Faqra
Raifoun
Qlaiaat
Bqaatouta
Aajaltoun
Boqaata
Daraya
Shaile
Kfartai
Jeita
Extent of side map

Feedlots locations in respect to Jeita groundwater's vulnerability

GW vulnerability	Number of feedlots	Protection zone	Site characteristics	Travel time to Jeita
	7	2a	J4/(J5 dolinas)	< 10 days
High	9	2b	J4/(J5 dolinas)	< 10 days
	1	3a	Very close to Nahr El Kalb riverbed	> 10 days
	3	3a	within stream buffer above aquitard	> 10 days
Very low	16	3b	aquitard, no streams	> 10 days

Poultry farm located in Nahr El Kalb supposed being protected area

Related wastes dumped in the nature

Liquid waste disposed in a borehole without treatment,

Truck load of unfermented manure disposed in the nature

Unhygienic open air butchering

Bones: Rests of animal carcasses

Contamination monitoring by BMLWE

Indicators for pollution from animal farming, such as Cryposporidium, Clostridium perfringens, Giardia lamblia (intestinalis) are frequently exceeding EPA limits in raw water, analysis regularly carried out by BMLWE. This indicates a significant contamination generated by the feedlots and slaughterhouses

Salmonella is frequently found in the Jeita/Kashkoush raw water.

Therefore high levels of chlorination are needed to treat the water.

Slaughtering

- 2 private slaughterhouses and numerous (more than 35) butcheries for Bovine, ovine and swine
- Poultry slaughtering is carried out outside the catchment

- Very bad wastes management: all generated wastes (including specific Risk Materials) are practically disposed in the nature without any relevant control

Urgent necessity to establish facilities able to use the significant produced quantity of wastes productively.

Hazardous Wastes generated by Slaughterhouses

Significant source of pathogens and bad odors generating

- Pesticides and antibiotics
- Intestines
- Fecal matter
- Blood
- Heads
- Decaying animal carcasses

Hundreds m^3 of solid waste/month are injected in Jeita catchment surface water courses and sinkholes

Due to:

- Lack of environmental awareness,
- Absence of law enforcement,
- Absence of composting factory able to recycle slaughtering & feedlots wastes (i.e., manure, wool, etc.)

Pit for evacuation of farm and slaughterhouse cleaning water flushes

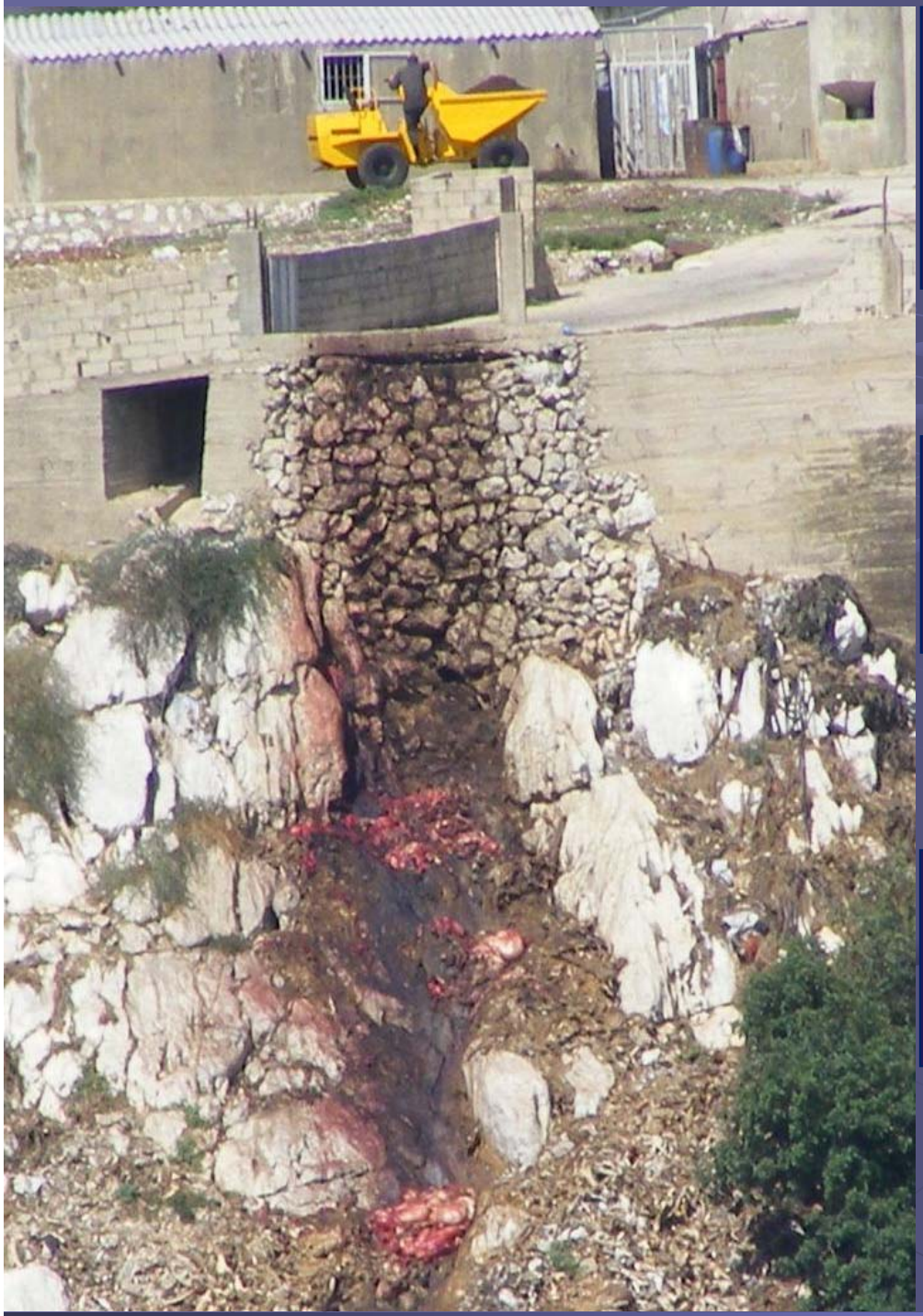
Pesticides pool

Faecal matter

The high volume of farm cleaning water is flushed with all the Fecal matter it can carry, directly to a pit drilled in a way to drain downwards.

Liquid wastes: blood, water, etc ., are directly evacuated in The environment without any prior treatment

Effluent flush out

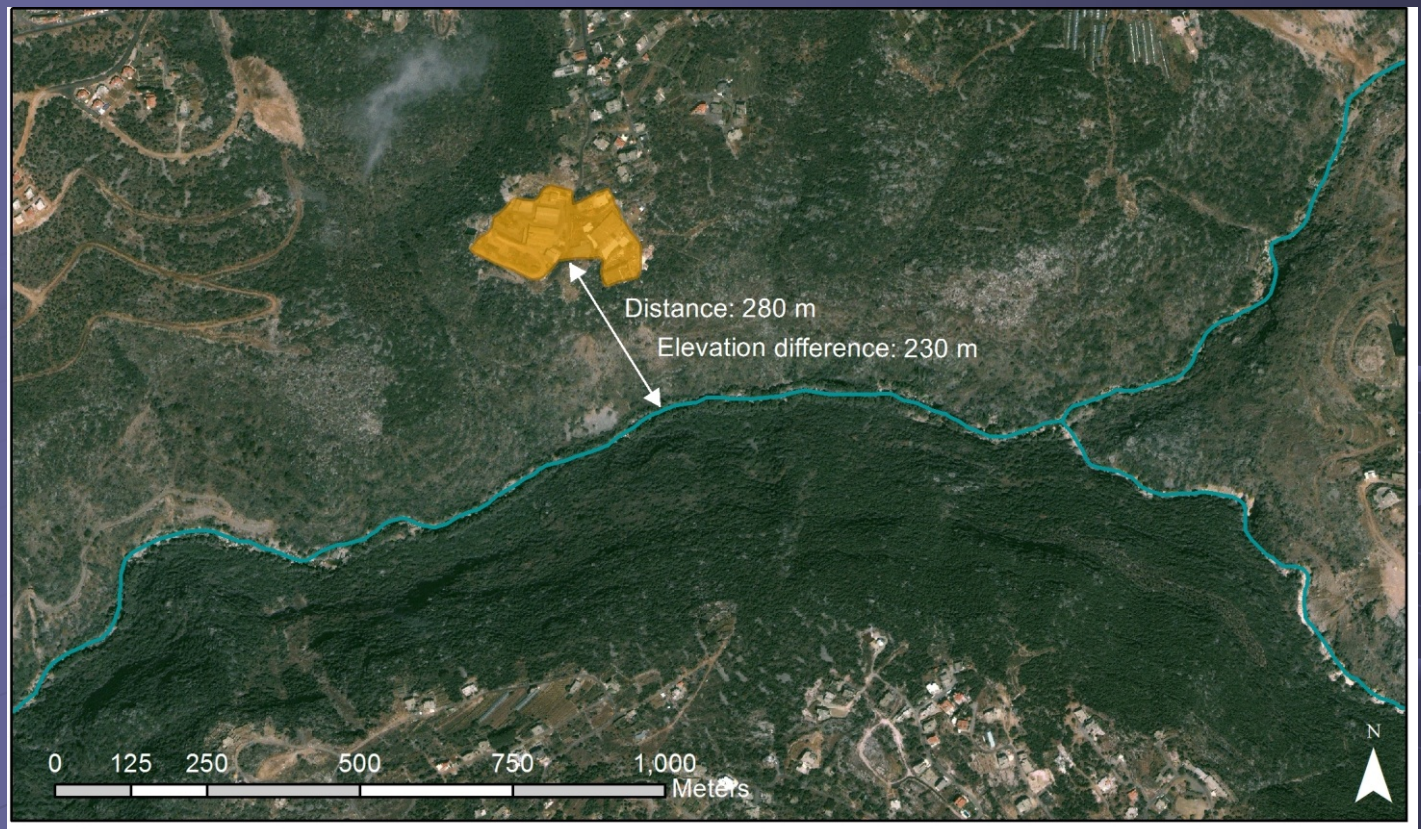


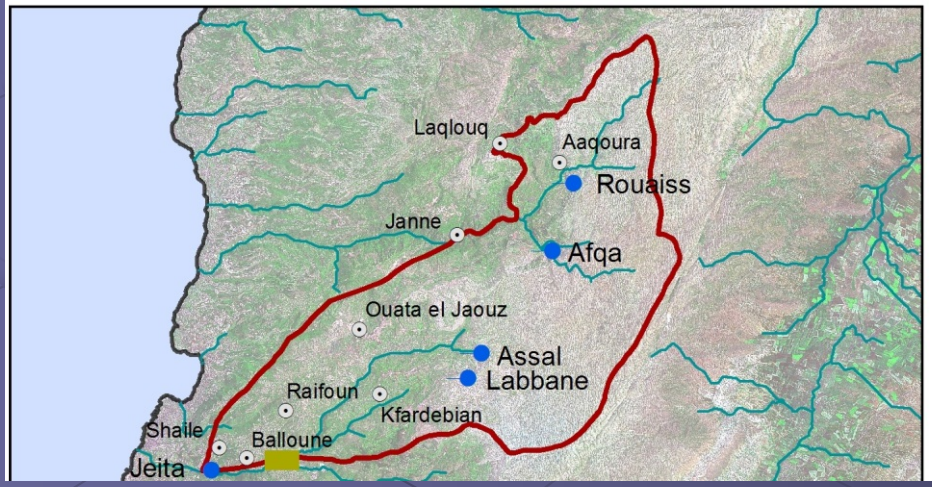
Blood, SRM, all other slaughtering wastes in addition to manure are disposed in the nature without any prior treatment

The two existing slaughterhouses in JSC are located at highly GW vulnerable locations

An urgent action is required to limit the significant contamination generated by these slaughterhouses

Factories and Industries assessed in JSC





Sub-surface catchment of Jeita Spring

Streams

Springs

Settlements

Clipping area

Industries

Data basis: BGR, SRTM DEM, IKONOS (2005), Landsat 7 (2000)

Factories and Industries

Daraya :
- 1 hunting cartridges factory
- 1 tissue factory
- 1 Polyethylene pipes factory
- 2 industrial climatisation factory
- 1 Trucks body factory

Ajaltoun:
- 1 furniture factory
- 1 plastic factory
- 1 Dry clean
- 1 steel factory
- 1 Bakery

- Dairy products workshops
- 8 construction stones workshops (Rock saws)
- 5 cement building stones workshops

Sheileh
1 Intravenous and dialysis solutions and medical devices manufacturing

Ghosta
1 Dry clean
9 printing factories

Generating heavy metals, different kinds of chemicals, Hydrocarbons, etc

Despite being located in GW vulnerable areas, they are operating without considering environment laws and guidelines

Wastes related to Ajaltoun industries dumped in the nature

Wastes related to Daraya industries dumped in the nature

Hospitals and Health Care Hazards to Groundwater

1 Hospital: Saint Georges Hospital located at Aajaltoun, in Protection zone 2b

Numerous health care clinics

Hazardous Wastes generated by Hospitals and Clinics

Domestic wastes

Dangerous infectious wastes:

Collected and Treated by Arc En Ciel project: DASRI

Dangerous non infectious wastes:

Used batteries and oils,

Used batteries and oils, Chemicals, Mercury, Dioxins etc.

Wastes requiring a special treatment

Pharmaceuticals, Recognizable organs, etc.

Radioactive

Untreatable in Lebanon

Waste Management at Ajaltoun Hospital

Information collected by informal means

Many Potentially infectious medical wastes(PIMWs) are nor collected nor treated by Arc en Ciel:

- Chemicals and laboratory solutions (Hg, formaldehyde ...)
- Mercury thermometers
- The liquid or gaseous pressure into bottles
- Cytotoxic and expired medicines
- Radioactive waste
- Recognizable organs
- Batteries, accumulators
- Waste oils

Many PIMWs are being illegally disposed of : (informal investigation)

- Liquid effluents (Chemicals and laboratory solutions, cytotoxic & radioactive effluents) etc., ⇒ unlined cesspit
- Hg thermometers & empty oil containers ⇒ municipal waste
- Recognizable organs ⇒ incinerated.
- Disposal and storage of radioactive solid waste unclear:
  - stored at closed areas
  - buried in the environment ?

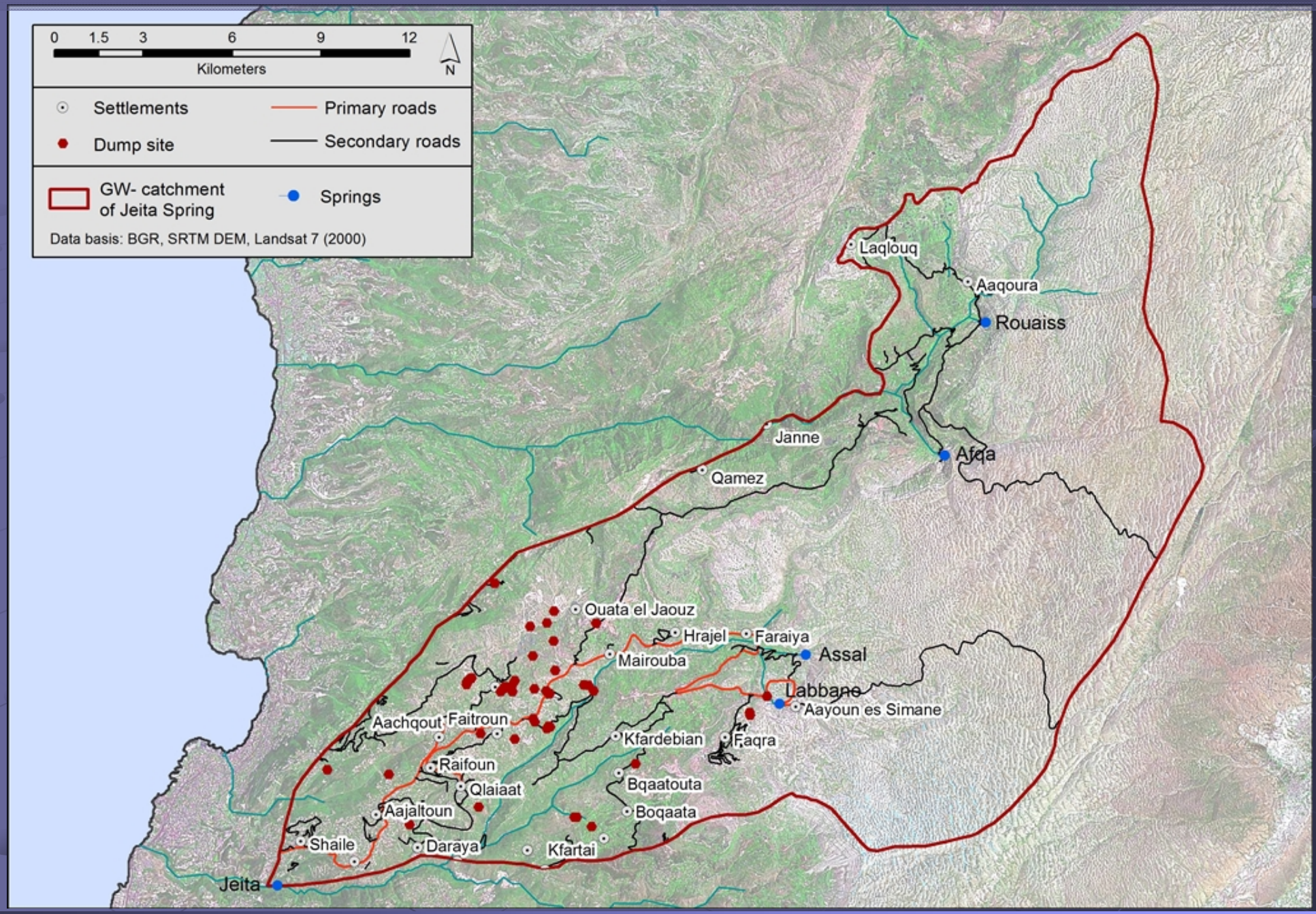
Significant chemical and toxic threats are generated by St Georges Ajaltoun hospital which is at 10 days travel time to Jeita Waters

Agriculture Hazards

- Pesticides (e.g. Endosulfan, arsenic, dicamba, etc) atrazine and prometon etc.
- Fertilizers (Mainly nitrate and phosphates)
- Herbicides (Paraquat, glyphosate, etc)
- Chlorinated Solvents (carbon tetrachloride)
- Hormones
- Solid wastes : Pesticides containers, Plastics, i.e. packaging and wrapping materials, used Poly Ethylene irrigation pipes & fittings, etc.
- Aflatoxins, etc

Wastes open air incineration, can generate a higher risk of contamination (more concentrated contaminants particles, easily infiltrated towards groundwater) + air pollution

Illegal Dumpsites in JSC



Dumpsites

Kind of wastes:

- Construction wastes (w)
- Domestic w.,
- Infectious w,
- Chemical w,
- Plastics w,
- Tires ,
- Agriculture wastes or green wastes
- Other

Are all **illegal** and must be urgently collected, separated , recycled, or disposed in an environmental sound manner

There are entities ready to valorize different wastes (electrical, etc.)

A proper municipal waste management is urgently needed
Wastes separation at source can generate income to municipalities and therefore must be encouraged

Construction wastes dumped in the nature

At the border of a riverbed

Dumps filling a sinkhole near Laqlouk

Visceral wastes at Lassa


Doritos

BGR project has located 74 illegal dumpsites within the JSGW catchment

Wastes separation at source and wastes recycling are the only possible means to get rid of huge loads of illegal dumps

Wastes open air incineration, generating a high risk of contamination is frequently practiced in absence of law enforcement

Wastes urial = unsound practice

Multiple risks require multiple barriers

- Risk prevention:
  - Hazards assessment : accomplished by BGR project
  - Health significance of related contaminant: done
  - Vulnerability evaluation: done by BGR project
  - Risk assessment : done by BGR project
- Risk management mainly through Implementation of GW protection zones and application of BMP for contamination prevention & treatment: Still to be accomplished by Lebanese authorities
- Risk Monitoring and compliance:

Requires important enforcement in Lebanon

RECOMMENDATIONS

Efficient collaboration is needed to reduce this pollution load
It might require big efforts and sacrifices but the result worth the pain.

It is about time to define a road map and start taking active measures to protect this vital Resource

…RECOMMENDATIONS

- Land use decisions must consider water resources vulnerability and mainly GW vulnerability
- Mapping of the whole country's groundwater vulnerability is required.
- GW protection areas recommended by the project & related activities restrictions must be applied
- This can be supported in the field by the Lebanese army, municipalities & other relevant governmental institutions awaiting for the creation of an enforced environmental police.
- Wastes separation at source & recycling are an urgent need- Related facilities are to be established
- Raising environmental awareness is crucial.

Need to improve the monitoring capacities at BMLWE and establish laboratories able to undertake the task

Special thanks go to:

Our Project Team leader	My colleagues
Dr. Armin Margane	Jean Abi Rizk Philip Schuler Rony Tabet Elias Saadeh

- Ministry of Environment (MoE)
- Ministry of Energy & Water
- CDR
- BMLWE
- Ministry of Agriculture
- Ministry of Public Health
- Urban planning
- Ministry of Industry

- Lebanese Armed Forces
- Municipalities of JSC
- Local society
- ECODIT
- UNDP @ MoE
- Arc en Ciel

Thank you for your kind attention

www.bgr.bund.de/jeita

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