LITANI RIVER BASIN MANAGEMENT PLAN

VOLUME 1: CURRENT SITUATION

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FOREWORD

"Proper management starts with knowledge."

This document is not a scientific encyclopedia on the status of water resources in the Litani River Basin (references are provided in chapter 6 to specific reports which provide more technical details). It has the modest ambition of being an overall assessment and pedagogic document to be read by any water user or resident of the Litani River Basin, and to alert decision makers of the serious water challenges threatening the Litani River.

As a quick overview, the **rushed reader can simply refer to the Executive Summary**, while:

- Chapter 1 is an introduction, with the definition of key terms;
- Chapter 2 presents basic information on the Litani River Basin and a visual journey along the River;
- Chapter 3 describes the legal, institutional and policy environment which guides (or constrains) water management in the Litani River Basin;
- Chapter 4 provides a summary of the key water challenges in the Litani River Basin, that is water quality, water quantity, and overall water management;
- Chapter 5 presents solutions, defines the Integrated Water Resource Management approach, and lists positive signs (opportunities) that already exist in the Litani River Basin;
- Chapter 6 proposes concrete next steps to plan the effective tackling of water issues; and
- Chapter 7 lists references of recent technical reports providing more in-depth information; these reports were the basis for the current document.

The **non-specialist reader should focus on chapter 2, 5 and 6 first**. Chapters 3 and 4 are somewhat more technical. **Section 1.3 provides key definitions.**

Note: While the management of water resources should cover the entire Litani River Basin, the current report tends to focus on the upper basin, as far south as Qaraoun Lake. The lower basin is difficult to access both for logistical and political reasons, and is much less impacted than the upper basin. Conversely improvements of the upper river basin will also benefit the lower basin.

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Note: All pictures and maps are from the USAID-funded Litani River Basin Management Support (LRBMS) program, except when credited otherwise.

ACRONYMS

BWE	Bekaa Water Establishment (one of the four RWEs)
CDR	Council for Reconstruction and Development
GoL	Government of Lebanon
IRBM-IWRM	Integrated River Basin Management – Integrated Water Resources Management
LRA	Litani River Authority (also known as "Office National du Litani")
LRBMS	Litani River Basin Management Support (USAID-funded project)
MoA	Ministry of Agriculture
MoEnv	Ministry of Environment
MoEW	Ministry of Energy and Water
MoF	Ministry of Finance
NGO	Non-governmental Organization
RBMP	River Basin Management Plan
RWE	Regional Water Establishment
UNDP	United Nations Development Program
USAID	United States Agency for International Development
WB	World Bank

LIST OF MAPS OF THE LITANI RIVER BASIN

EXECUTIVE SUMMARY

INTRODUCTION

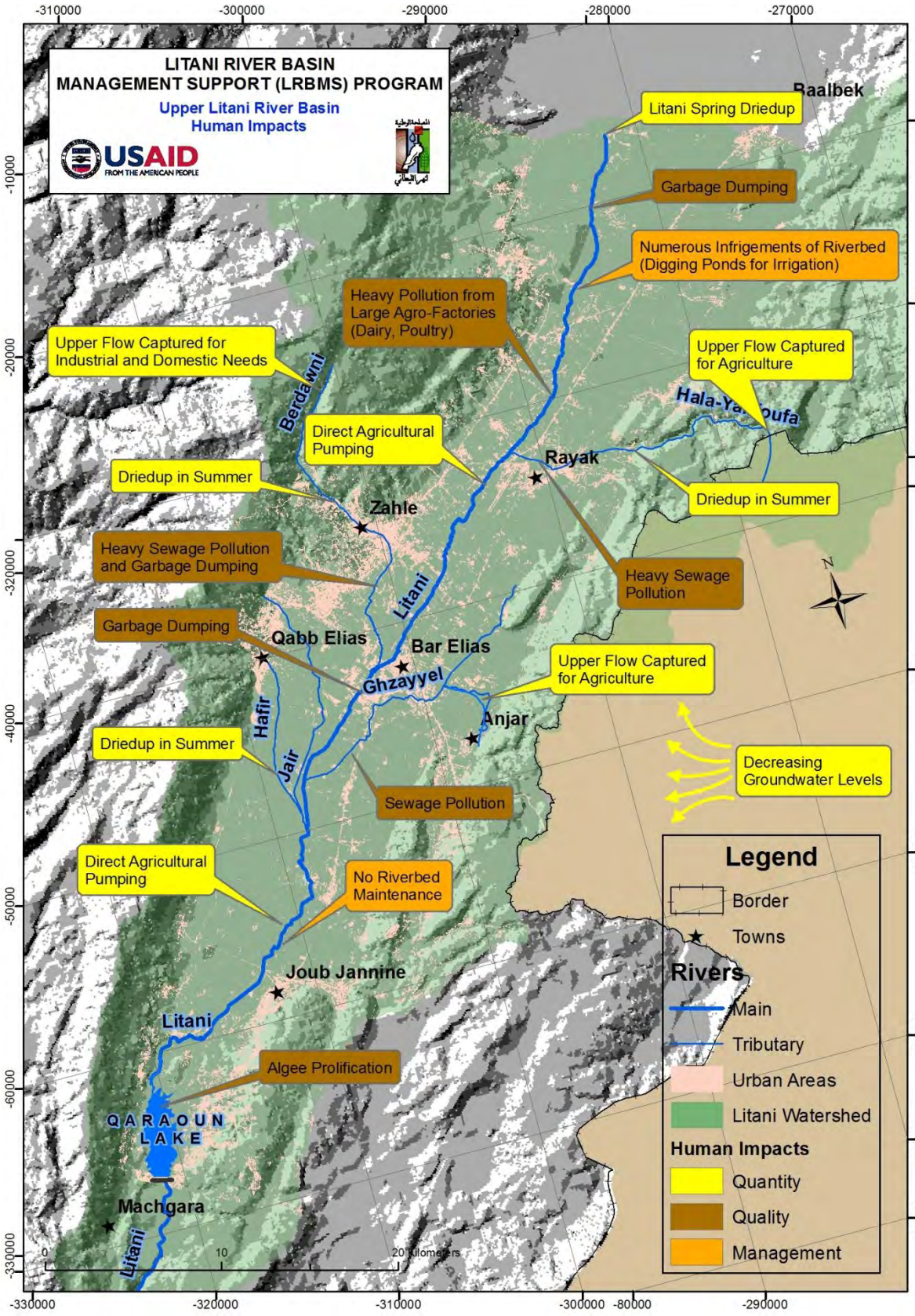
The Litani River is the largest river in Lebanon and drains the central and south Bekaa Valley. Its water resources have been harnessed for human uses since the 1960s through the construction of the Qaraoun Dam.

The Litani River Basin is today experiencing increasing water demands, groundwater over-exploitation, and extensive pollution. In summer, the Litani River shows a meager flow, much decreased from 40 years ago. The smell reveals its origin and contents: raw sewage, untreated industrial effluents and agricultural runoff. A walk along the river shows:

- Extensive garbage dumping;
- Direct release of urban wastewater;
- Uncontrolled industrial discharges;
- Lack of riverbed maintenance, infringements and unauthorized diversions.

These activities are often illegal but there are rarely available alternatives for water users to behave differently.

The river is now a threat to public health as water pollution propagates to soils, crops, and animals, **as well as an obstacle to the socio-economic development and well-being of riparian communities**. It is **also becoming a growing source of conflicts due to competing demands** from farmers, industries, and residents. Moreover the Litani River is asked to provide electricity for Lebanon, irrigation and domestic water for Marjayoun, Saida, and soon Beirut, while serious water shortages already exist in Zahle and the central Bekaa.


LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Upper Litani River Basin
Human Impacts
USAID
FROM THE AMERICAN PEOPLE
Baalbek
Litani Spring Driedup
Garbage Dumping
Numerous Infrigements of Riverbed (Digging Ponds for Irrigation)
Heavy Pollution from Large Agro-Factories (Dairy, Poultry)
Upper Flow Captured for Industrial and Domestic Needs
Upper Flow Captured for Agriculture
Berdawni
Direct Agricultural Pumping
Rayak
Driedup in Summer
Zahle
Driedup in Summer
Heavy Sewage Pollution and Garbage Dumping
Litani
Heavy Sewage Pollution
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Qabb Elias
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Ghzayyel
Upper Flow Captured for Agriculture
Hafir
Anjar
Jair
Driedup in Summer
Decreasing Groundwater Levels
Sewage Pollution
Direct Agricultural Pumping
No Riverbed Maintenance
Joub Jannine
Litani
Algee Prolification
QARAOUN LAKE
Machgara
Litani
Legend
Border
Towns
Rivers
Main
Tributary
Urban Areas
Litani Watershed
Human Impacts
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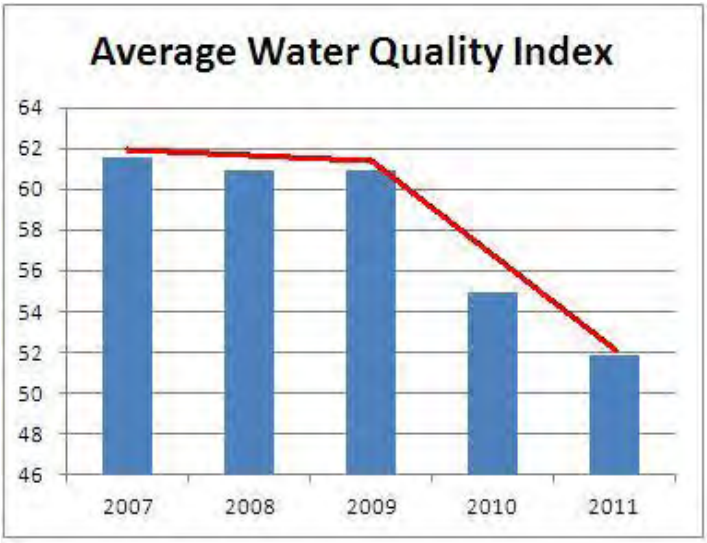
WATER QUALITY ISSUE

Water quality critically impacts and limits water use: polluted waters may be unfit for drinking, industrial, or irrigation uses, and only usable after costly treatment.

The quality of surface waters in the Litani River Basin varies seasonally and spatially, but is generally bad to very bad:



- The highest levels of contamination are in the mid-upper basin (between Rayak and Bar Elias) where there is a larger concentration of both residents and industries;
- Many summer water samples exceed drinking, bathing, domestic, and irrigation water quality standards;
- **Untreated wastewater discharges, both domestic and industrial, are one of the primary sources of pollution**, as confirmed by high biological oxygen demand and high levels of coliforms;
- **Agriculture over-fertilization is an important source of pollution**, as demonstrated by elevated levels of phosphates and nitrates (both are key constituents of fertilizers); and
- Some metal buildup is now observed in the upper Litani River Basin, with presence of cadmium and manganese sometimes above safe drinking water limits.

All these types of pollution are threats to public health, either directly, from drinking or being in contact with water, or indirectly: poor quality irrigation water contaminates crops and then human beings, leading to long-term deficiencies and diseases. **The quality of groundwater also starts showing signs of pollution, which are worrisome since groundwater is the main source of domestic water for residents, businesses and industries.**

Water diseases in the Bekaa

Poor water quality is a serious public health issue. Water-borne diseases are worldwide one of the leading causes of mortality. The occurrence of dysentery, typhoid fever and hepatitis A in the Bekaa is 7.5 annual cases per 10,000, that is twice the national average (2009 statistics from Ministry of Public Health). These are reported cases only, actual cases could be 5-10 times higher.

WATER QUANTITY ISSUE

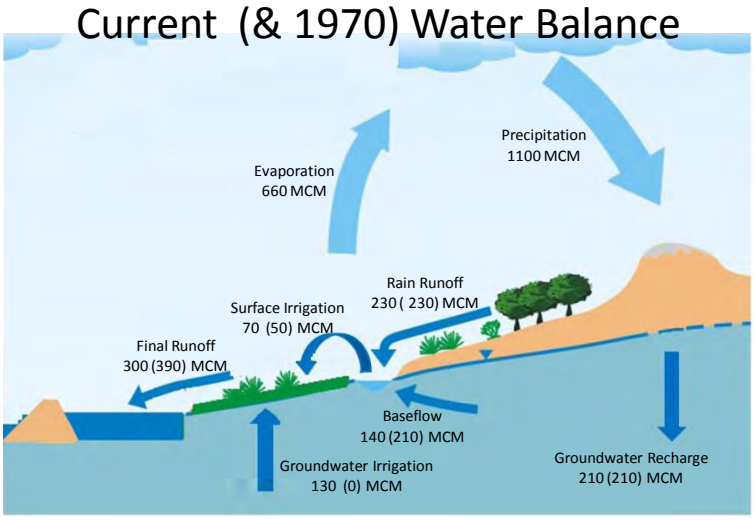
Water resources of the upper Litani River Basin are provided by winter rains and mostly used in summer for irrigation, with a smaller share being used for domestic and industrial needs. Unused winter rains are stored in Lake Qaraoun where they are currently diverted year-round to the Awali River for hydropower production.

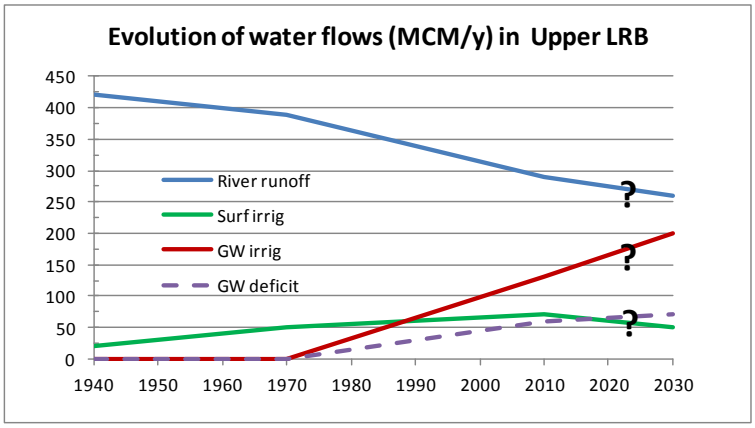
Water volumes and human needs

A human being needs on average a minimum of 1,000 m3 per year, out of which 900 is needed for food production, the rest being for domestic and industrial needs. One million m3 per year (Mm3/year) can thus provide for about 1,000 people.

A water balance of the upper Litani River Basin shows that **human pressure on water resources has increased drastically since the 1970s,** as confirmed by:

- **Significant decrease in river flows**, due to increased water withdrawals, through tapping of springs and direct pumping or diversion from the river, chiefly for irrigation purposes; and
- **Substantial groundwater depletion**, due to extensive pumping both for domestic and irrigation needs.





These are evident indicators of unsustainable water allocation practices in the Litani River Basin. **As population and water demands keep increasing, the question of fairly allocating decreasing water volumes is an increasingly difficult decision which calls for transparent discussions and planning, especially since the Litani waters are asked to provide other regions of Lebanon including Beirut and the South.**

WATER MANAGEMENT ISSUE

Water management in Lebanon is similar to other Middle-eastern countries. **Reforms and improvements are often hampered by:**

- **A political focus on engineering projects and constructions** as being tangible/visible outcomes, while management reforms are avoided as more difficult, even if much cheaper and often more efficient;
- **A lack of leadership and political will** to:
    - Follow through and enforce reforms (notably those impacting governmental staff);
    - Address critical issues and take difficult decisions (e.g. water tariffs), especially if these challenge special interests or risk unpopularity;
- **An overall lack of staff and capacity in governmental agencies**, both at technical and managerial levels;
- **The usual top-down management** which centralizes decision power and stifles initiative;

Much remains to be done to improve water management in Lebanon generally and in the Litani River Basin specifically. **The main requisite is to follow the universal principles of transparency, participation and accountability**, which are sorely lacking:

- **Information remains a source of power for government officials** and is hidden, toyed with, or ignored as suitable; decisions are taken at central level in a opaque manner;
- **Participation by water users, residents and other stakeholders is token at best**, with decisions and plans being presented when final; Municipalities which are the direct link with residents and the main vehicle for democracy are rarely involved in planning and decision processes; and
- **Accountability and performance monitoring are absent in the public sector**, governmental agencies, departments and staff do not have clear responsibilities, nor annual objectives or targets.

SOLUTIONS AND OPPORTUNITIES

Solutions do exist to reverse these trends and establish sustainable water management practices so that all water users can equitably access and benefit from water resources in the Litani River Basin:

- **Infrastructure development** (construction of dams, networks and plants) is much needed, but it is **far from enough**. Because the operation of these structures is sometimes inadequate, and because these cannot address issues such as industrial pollution, leaching from dumpsites, and agricultural pollution.
- **Monitoring and enforcement and are also necessary** to control withdrawals and releases, and to protect water resources from illegal uses and abuses such as industrial discharges and groundwater over-extraction.
- **Improving water governance (i.e. laws, institutional roles, policies) is critical in Lebanon** since incomplete laws, unclear institutional roles, staff and capacity shortages, centralization and inadequate coordination combine to prevent effective water management.
- Finally and essentially, the mitigation and eventual resolution of current and future water challenges require **awareness and stewardship**, i.e. changes in the behaviors of water users once they better understand the consequences of their actions, feel responsible and adapt their water use practices. **Water users are the issue since they pollute and waste water. How can one hope to solve the water issue without involving them?**

Only a combination of these four approaches, and **notably the empowerment and participation of water users**, can successfully address water issues in the Litani River Basin, mitigate their impacts and reverse their causes to ensure sustainable and equitable use of water resources. **This type of combined effort is called Integrated River Basin Management (IRBM).**

While donor support and GoL funds address infrastructure development, **excellent opportunities exist in the Litani River Basin** to implement the other three types of strategies.

- **Legal backing from the Water Code** being prepared by the MoEW; this code promotes IWRM and defines the contents of a RBMP; it has to be promulgated and implemented;
- **Field presence for enforcement and monitoring**, which is possible through the Litani River Authority ("Office National du Litani"); and

- **Awareness and participation of residents and water users:** this is possible due to growing concerns about the situation of the Litani River, as demonstrated by a **recent common declaration signed by 21 municipalities.**

NEXT STEPS

The **four essential tools for a planned, participative, coherent and effective approach to solving water issues in the Litani River Basin** are:

- **Establishment of a river basin committee** to bring together central agencies, local authorities, and representatives from residents and water users;
- **Preparation, implementation and monitoring of a River Basin Management Plan;**
- **Establishment and empowerment of a River Basin Agency;** and
- **Definition and implementation of priority and short-term activities** to raise public awareness, involve Municipalities and local actors, demonstrate quick results, and ensure credibility.

The **throughout adoption of participatory processes is essential**, in order to:

- Involve residents and water users, through their representatives, as key actors solving water issues by adapting their practices (in terms of water use efficiency and pollution control);
- Bring together central agencies, local authorities, and representatives from residents and water users, and teach them to coordinate and work collaboratively;
- Clarify roles and responsibilities and reduce overlaps and gaps;
- Ensure buy-in and commitment to the decisions; and
- Build capacity of all parties, improve performance and accountability.

Developing and using these four tools is not an easy or simple process. However now it the time to start. The rewards are significant while the cost of inaction is already high.

The **present report/assessment is a first step**. A second step would be the development of a realistic and focused 5-year Action Plan (a **River Basin Management Plan**), which would:

- Present a **deliberate choice of activities to achieve specific goals,** with clear implementation roles, allocated staff and resources, quantified targets and timetables, and monitoring mechanisms; and
- Be **developed and implemented along with representatives of water users and residents**, i.e. Municipalities, business/industrial associations, farmer groups and other non-governmental representative entities.

1. INTRODUCTION

"Water is life."

1.1. BACKGROUND

The Litani River is the largest river in Lebanon and presents characteristics rarely found in the Middle-East: it is perennial, has rather abundant water flows and is an entirely domestic river. Water resources of the Litani River Basin have been harnessed in the 1960s for the development of Lebanon through the construction of the Qaraoun Dam and associated structures (hydropower plants and irrigation systems). However the Litani River Basin is today experiencing increasing water demands, groundwater over-exploitation, unplanned urban sprawl, pollution from untreated wastewater effluents (both domestic and industrial), and contamination from uncontrolled garbage disposal and inadequate agricultural practices.

Qaraoun Dam storing flows from the Litani River in the southern Bekaa Valley

In summer, the Litani River presents a meager flow, much decreased from 40 years ago, whose odor reveals its source and contents: raw sewage, untreated industrial effluents and agricultural runoff.

Today the Litani River has indeed reached an unsustainable condition where instead of contributing to the socio-economic well-being of riparian communities, it constitutes a threat to public health as water pollution propagates to soils, crops, and animals, a factor of environmental degradation and a growing source of conflicts between competing demands from farmers, industries, and residents.

The Litani River in Bar Elias during the summer: a river or a sewer?

1.2. PURPOSE AND CONTENTS OF THIS DOCUMENT

The purpose of the present document is to provide a reasonably accurate picture of the current situation of the Litani River Basin, so that managers as well as water users and residents realize and understand the current and future status of water resources, both surface and ground-, both qualitatively and quantitatively.

To that end this document includes the following chapters:

1. Introduction: current chapter setting the context and explaining some definitions;
2. River Basin characteristics: description of the physical and human features of water resources and their uses in the Litani River Basin;

3. Water Management and Water Governance: review of the current legal, institutional and policy environments for water management in the Litani River Basin;
4. Water Challenges: overview of quality, quantity, and management issues that impact water use in the Litani River Basin;
5. Solutions and Opportunities: description of the four main themes needed for an effective integrated water management strategy, and identification of existing opportunities for the Litani River Basin to address these four themes;
6. Next Steps: identification of the four essential tools to effectively tackle water issues at river basin level; and
7. Select References: list of recent technical reports for better understanding of the water issues in the Litani River Basin.

This document is based on available data and information. Water data in Lebanon remains scarce and of uncertain accuracy. Lebanon used to have a reasonable water quantity monitoring network, but it was stopped during the 1975-1990 Civil War. Efforts to resume data collection have been carried out since but due to lack of staff, capacity and equipment, current water monitoring remains weak. However the possible lack of accuracy cannot be reasons for delaying action. Water resources in the Litani River Basin are under tremendous pressures and abuses, the Litani River itself is dying and idleness will only increase the magnitude of damage and the costs for mitigation and recovery.

1.3. KEY DEFINITIONS

1.3.1 GEOGRAPHICAL TERMS

A **river basin or watershed** is the area of land drained by a river and its tributaries. It encompasses all of the land surface drained by many streams that flow downhill into one another, and eventually into one river. The final destination is an estuary or an ocean. As a bathtub catches all the water that falls within its sides, likewise a river basin collects all the rain falling on the surrounding land into a central river and out to the sea.

The **water cycle** is the never ending circulation of water evaporating from the sea to the clouds, then falling as rain and snow, accumulating in rivers and lakes or recharging groundwater, being used for human activities and natural processes, and eventually flowing back to the sea.

Surface water: water collecting on the ground or in a stream, river, lake, wetland. It is naturally replenished by rain and naturally lost through evaporation, seepage into the ground, or discharge to a sea or ocean. Hydrology is the study of the distribution and movement of surface water.

Groundwater is water that collects and flows underground, filling the porous spaces in soil, sediment, and rocks. Groundwater originates from rain and from melting snow and ice and is the source of water for aquifers, springs, and wells. The upper surface of groundwater is referred to as the water table. This water table is rises and falls based on recharge from precipitations and on spring flows and withdrawals from wells. The study of the distribution and movement of groundwater is hydrogeology.

Irrigation is the artificial application of water to croplands to assist in the growing of agricultural crops, in dry areas and during periods of inadequate rainfall. In contrast, agriculture that relies only on rainfall is referred to as rainfed farming.

Wastewater or **sewage** is water that has been adversely affected in quality by human influence. It includes liquid waste discharged by domestic residences, commercial properties, industries and factories, agriculture and can encompass a wide range of potential contaminants and concentrations.

1.3.2 WATER MANAGEMENT TERMS

Water users or **stakeholders** are basically all the residents of a river basin, who all need water to live, and specifically those who need water for their economic activities (farmers, factories, businesses) and thus have a stake in the proper management and equitable allocation of water resources. Water engineers, water managers and water decision makers are not really stakeholders.

Integrated water Resources Management (IWRM) or **Integrated River Basin Management (IRBM):** Defined as a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment (source: Global Water Partnership). IWRM simply states that addressing water challenges requires more than the construction and operation of water structures, i.e a coordinated and planned approach to the management of the entire water cycle: monitoring availabilities and uses, enforcing withdrawal limits

and controlling releases, allocating fairly and transparently, coordinating among projects and agencies, and finally involving and making users accountable (principles of "user payer" and "polluter payer").

A River Basin Committee is a regional water assembly bringing together:

- Residents (mayors and other locally elected executive officials);
- Water users (businesses, farmers, industries, etc.); and
- Relevant administrations (water/public works, agriculture, environment, industry, etc.).

It is a platform mandated to discuss and define the strategy for managing water resources in a river basin, in conformity with the national water management plan. It is often the Board of Directors of a River Basin Agency.

A River Basin agency is a governmental agency with a cross-sectoral and geographical (river basin-focused) zone of action**, and mandated to**

- Locally manage water resources (notably the monitoring of water resources, withdrawals and releases, but also the operation and maintenance of water structures);
- Allow timely and better (because field-based) decision-making (notably regarding local allocation conflicts);
- Ensure better coordination between the various administrations (Water, Agriculture, Environment, Industry, etc.) and with local actors such as municipalities; and
- Promote improved water use practices through awareness activities.

A River Basin Management Plan is a participatory planning process producing a **multi-year realistic/achievable action plan** to:

- Prioritize and target water issues, identify clear objectives;
- Involve municipalities and water user representatives along with government agencies;
- Define roles and responsibilities;
- Allocate resources, equipment and staff; and
- Implement activities and monitor progress.

Water Governance: UNDP defines governance as the "exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes, and institutions through which citizens and groups articulate their interests, exercise their

legal rights, meet their obligations, and mediate their differences." Otherwise said water governance involves:

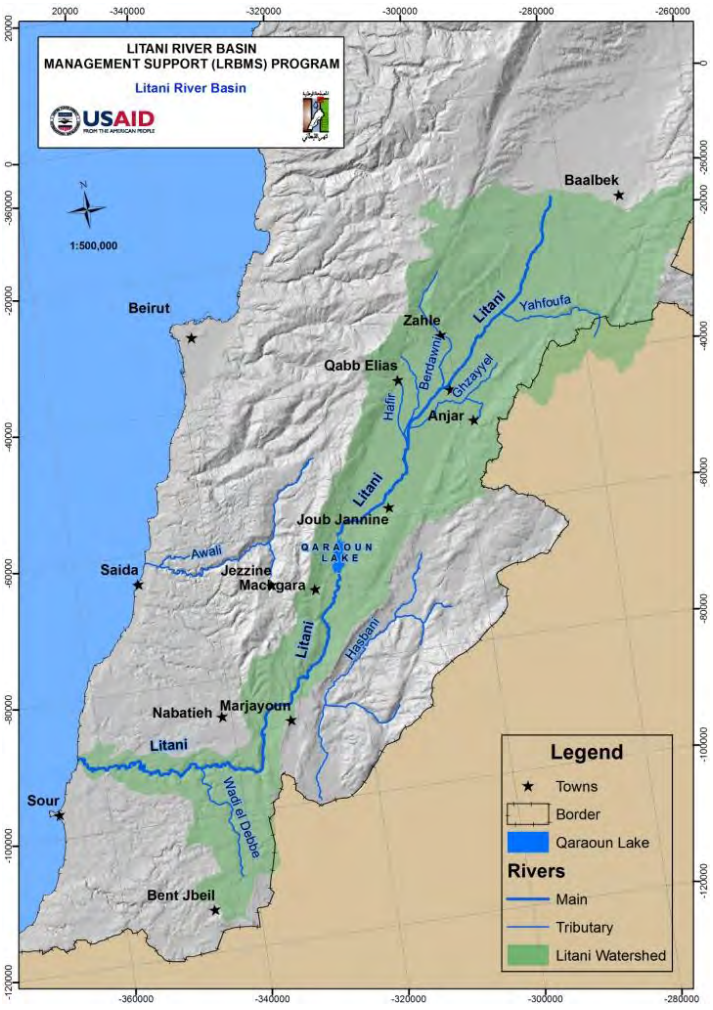
- The **legal framework**: the laws and bylaws that guide water management; these are promulgated by the Parliament;
- The **institutional setup**: the (mostly governmental) institutions involved in water management, and their roles and responsibilities;
- The **policies**: basically the decision-making processes, how the institutions concretely operate: how managers are appointed and supervised, how staff is recruited, trained and their performance monitored, how projects are designed and prioritized, how funds are allocated, how water resources are monitored, how water structures (dams, networks, plants) are operated and maintained, etc.

2. RIVER BASIN CHARACTERISTICS

"You cannot manage what you do not know and do not measure."

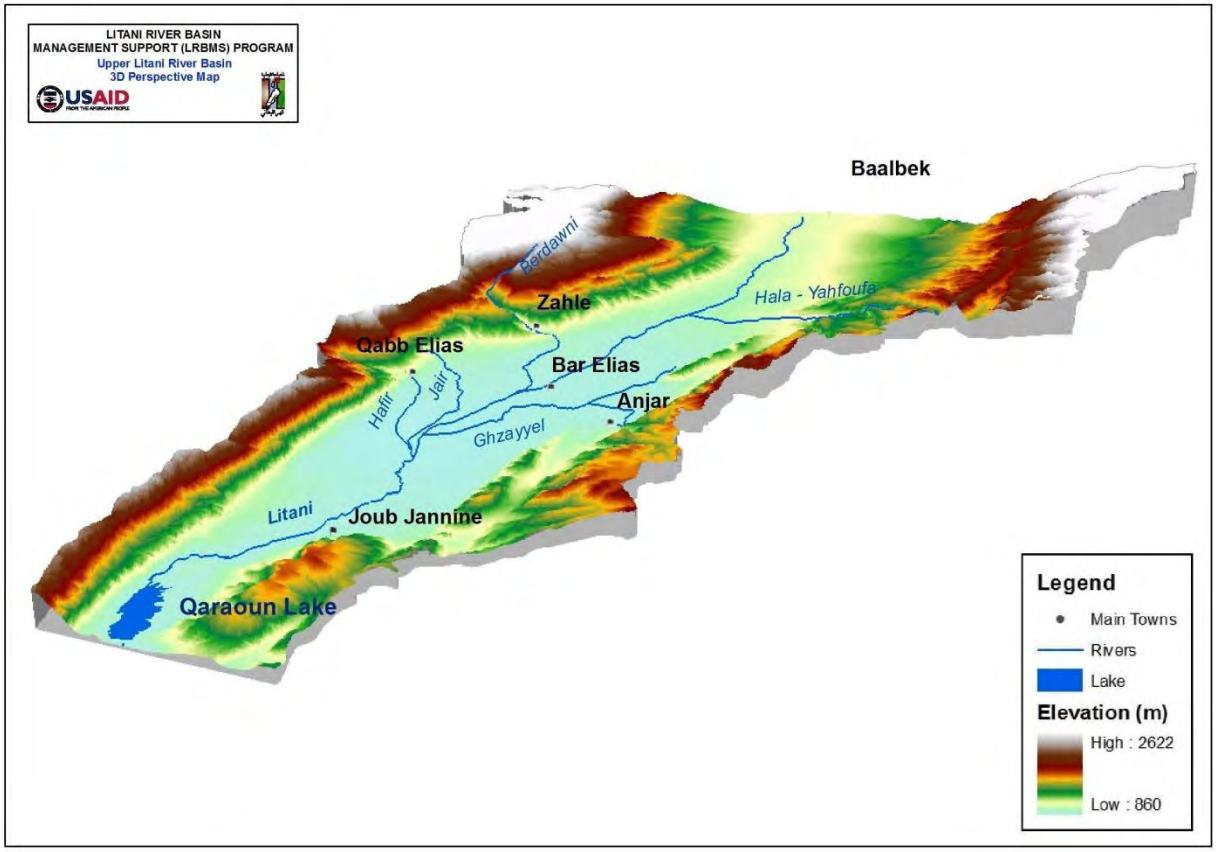
2.1. OVERVIEW

The Litani River Basin covers about 2000 km², that is 20% of the Lebanese territory. It drains the Central and South Bekaa Valley, while the northern Bekaa is drained by the Assi/Orontes River. The Litani River is thus the largest river in Lebanon, one of the very few perennial waterways. Water flowing in the Litani River represent about 30% of the total water running in all Lebanese rivers.



Originating at Aallayq springs near Haouch Barada and Baalbeck, the Litani River flows in a southeasterly direction for about 60 km in the Bekaa Valley. At this point the valley narrows drastically and the river enters a gorge. It then flows a further 30 km southwards before turning full west immediately south of Marjayoun. Another 30 km course brings it to the coastal plain and its Mediterranean Sea outlet. The river basin has a similar shape: up to 30 km wide in its upper part in the Bekaa valley, it then narrows down to a few km to the south of the Qaraoun reservoir.

Topography-wise, the Bekaa valley gently slopes southwards from Baalbeck (elevation 1000 m) to Qaraoun (elevation 800m). At this point, the Litani course becomes steeper, with a 500 m altitude drop until the westward bend. The Litani then returns to a gentler slope until its sea outlet.



Overview of the Litani River Basin

Water resources in the Litani River Basin were harnessed in the 1960s with the construction of the Qaraoun Dam, a 60m high rockfill structure that bars the Bekaa Valley at its southern extremity, where Mount Lebanon and Anti-Lebanon mountains meet. The Qaraoun Reservoir stores the annual inflows from the Litani River and allows their diversion through a cascade of three hydropower plants (Markabe-Joun-Awali) which together produces about 8% of Lebanon energy needs. The diverted volumes are then released to the West in the Awali-Bisri River.

The Qaraoun reservoir effectively divides the river basin into two sub-basins:

- The upper sub-basin covers about 1500 km^2 and covers the south half of the Bekaa valley; it is sandwiched between the Mount Lebanon and Anti-Lebanon ranges (both culminating

over 2000 m) and the valley floor rests between altitudes 800 m and 1000 m; in that area, the Litani River receives several minor tributaries which are:

    - The Hala/Yahfoufa and Ghzayel in the northeast, flowing respectively through Rayak and Anjar/Bar Elias;
    - The Berdaouni and Hafir in the northwest, flowing respectively through the city of Zahleh and Qabb Elias;

- The lower sub-basin covers about 500 km²; it is only a few km wide and constrained between the southern tip of Mount Lebanon and the Marjayoun hills which separate it from the Hasbani watershed to the East; the lower Litani is joined by only one significant tributary, Wadi el Debbe; the river presents there a steeper slope and drops within 60 km from an altitude of 800m to its outlet at sea level.

Most human activities are located in the Upper basin, with the main cities of Baalbeck (located on the watershed divide with the Assi River), Zahleh, Anjar, Bar Elias, Joub Jenine, Machghara, and Qabb Elias. River and associated aquifers supply water to 60,000 irrigated hectares as well as potable water to close to half a million residents. Downstream of the reservoir, very few human activities are located in the River Basin itself, even if some diversions exist to supply small irrigated areas and eventually several thousand hectares of irrigated lands on the coastal plain (Kasmieh area, south of Saida).

2.2. PHYSICAL DESCRIPTION

The Upper Litani River Basin can be divided into several zones in terms of river morphology and health as well as human interference:

- **From Haouch Barada to Rayak**, traversing the villages of Haouch Barada, Chmistar, Hizzine, Haouch Sneid, Nabi Chit, Haouch el Rafqa, Bednayel, Temneen, Nabi Ayla, and Ablah. This area mostly presents agricultural lands with a few urban areas and isolated industrial buildings.
- **From Rayak to the Damascus highway at Bar Elias**, traversing: Housh Sneid, Fourzol, Delhamiye, Saadnayel, Haouch El Omara. This area also presents mostly agricultural lands but with increasing urbanization and small to medium industries. One tributary, the Yahfoufa, joins the Litani south of Rayak.
- **From Bar Elias to Mansoura and Ghazze**, traversing Marj, Tell El Hakhdar, Haouch El Harime. This area is mostly urban with fewer agricultural activities. Three tributaries join the Litani: the Ghzayel on left bank, the Berdaouni and Hafir on right bank.
- **From Ghazze to Qaraoun Lake**, traversing Joub Jenine, Lala, Baloul, Kherbet Kanafar, Saghbine and Qaraoun. This area is predominantly agricultural.
- **Lake Qaraoun** represents a different zone, as well as the **lower Litani River** where the watershed is limited to the river gorge (except for Wadi el Debbe a southern tributary coming from Bent Jbeil in the south).

The following sections describe the Litani River as it can be observed in Summer (May to October). In winter, rains increase the flow of the Litani River and of its tributaries and the pollution described below is somewhat diluted.

2.2.1 HAOUCH BARADA TO RAYAK

The Litani River used to originate at the Aallayq springs next to Haoush Barada. Nowadays these springs dry out in Summer, due to groundwater over-exploitation and the resulting lowering of groundwater tables. The initial flow, when present, starts off clear and clean, but rapidly degrades downstream due to widespread garbage dumping in the river bed.

Riverbed being a dumpsite (Hizzine)

Heavily polluted river waters (Rayak)

Further downstream, untreated domestic sewage pipes discharge directly into the river from villages such as Tarayya, Hizzine, Britel, Talia, Haoush Sneid, Haoush Rafka, Haoush Nnabi, Beit Shama, Bednayil, Qsarnaba, Hillaniyeh, Timneen Faouka and Tahta, Ablah and finally Rayak. A few large industrial effluents are also present, generated by a couple of large dairy and chicken industries.

The riverine ecosystem is similarly impacted, with little biodiversity and a prevalence of reeds and aquatic weeds which strive on organic pollution, and basic aquatic life with few types of insects and some frogs as predators. In the lower half of this zone, the water odor ranges from slightly malodorous to pungently reeking.

Human interference is widespread along the river. There is heavy and regular tampering with the river bed to create a succession of ponds meant to store river and ground-waters for summer irrigation. These ponds are dug out directly in the riverbed or just beside it, reducing groundwater flows into the river and drying the river. Mobile pumps withdraw from these ponds to irrigate neighboring lands.

The river and its bed are legally public properties managed by the government for the benefit of all. These ponds are thus the first of a long series of illegal activities and constructions which appropriate public assets for private/individual benefits.

Riverbed excavated as a pond (Bednayel) **Untreated effluent from dairy factory (Hizzine)**

2.2.2 RAYAK TO BAR ELIAS

The river reaches this area already degraded in terms of both quantity and quality. It is further polluted by sewage releases and garbage dumping, as well as by effluents from human activities (dumpsites, slaughterhouses, sand quarries, metal workshops, etc.). The flow becomes perennial due to multiple sewage effluents that discharge into the river, and the confluence with the Yahfoufa River.

Quarry effluent (Delhamiye) **Sewage effluent (Delhamiye)**

The Yahfoufa comes partially from the Maaraboun area and partially from Syria. At the border, it is dry in Summer. Further downstream, small springs reconstitute a flow which is heavily polluted by garbage dumping, sewage releases from urban areas and from Rayak airport.

Garbage in the Yahfoufa (at Yahfoufa)

Yahfoufa before joining Litani (Rayak)

After joining the Yahfoufa, the Litani River remains black and viscous, with a strong decomposition smell. The river ecosystem barely exists, with some insects as well as frogs and turtles. Water fowls are absent. Water withdrawal for irrigation purposes continues nevertheless.

Industrial effluent (Ferzol)

Dumpsite on river bank & agricultural pump (Timnen el Tahta)

2.2.3 BAR ELIAS TO EL-MANSOURA

Downstream of the Damascus highway, the Litani River passes through urban areas, and joins with the Berdaouni River. Due to the heavy pollution and the continuous dumping of garbage, the river does not provide a healthy water environment, but is rather a sore sight and a public health concern that residents complain about.

Litani River through Bar Elias: a sewer, not a river

Berdaouni in Taanayel: a dump, not a river

The Berdaouni flows through Zahleh, the largest city in the river basin, whose wastewater treatment plant is under construction and thus not yet operational. The Berdaouni, similarly to the upstream Litani and the Yahfoufa, is thus heavily polluted from untreated sewage, industrial effluents, and direct (dumping) or indirect (leachate) contamination form garbage.

Further downstream, the Ghzayel and the Hafir are the two main tributaries which join the Litani River. Due to its relatively abundant flow, the Ghzayel improves somewhat the condition of the Litani, in quantity if not in quality: the river turns from brown-black and stagnating, to grayish and running. River flow is however hindered by the prevalence of reeds and aquatic weeds which strive on organic pollution.

At this point of the Bekaa Valley, the meeting of the Litani with several tributaries (Berdaouni then Hafir and Ghzayel) also causes recurrent floods during Spring around the towns of Marj and El Mansoura.

Flooding of the Litani in Marj (January 2010)

Polluted Ghzayel (in Marj)

2.2.4 EL-MANSOURA TO LAKE QUAROUN

Downstream of El Mansoura, the Litani River again flows through mostly agricultural lands but still some industrial activities whose effluents flow untreated towards the Litani. Some revival signs are visible, with some wildlife (egrets, wild geese, and water fowls can be spotted).

Industrial effluent (Aammiq)

Some rare signs of wildlife (Cheberqiyeh)

Pumping from the river is widespread in Summer, with farmers sometimes building retention ponds inside the riverbed for their private use. The riverbed is wider in this area as it has been enlarged in recent years to increase flow capacity and address the flooding issue which impacts regularly the Bar Elias-El Mansoura area. This river bed widening is unsustainable: due to lack of regular maintenance, vegetation and natural deposits develop and the riverbed narrows again, thus reducing flow capacity.

Substantial algal blooms appear due to perennial but slow moving flows, and as a consequence of pollution from untreated sewage and agricultural runoffs over-loaded with fertilizers.

Riverbed dammed for irrigation pumping (Ghazze), regardless of water quality

Over-widened riverbed but not maintained (Joub Jenine)

2.2.5 LAKE QUAROUN

Lake Qaraoun is the outlet of the Upper Litani River Basin. For all purposes it almost totally separates Upper and Lower Litani River Basins since releases from the reservoir are rare. Such releases only occur:

- During wet years in the Spring when the reservoir is already full and river flows make the free spillway operate; or
- Occasionally when water is needed by coastal irrigation schemes (around Kasmiyeh) which are supplied form the Lower Litani.

Qaraoun reservoir

Scum deposit on the bank of the reservoir

Water quality in the reservoir is visibly bad, as evident from floating garbage, scum deposits, algae patches and oily spots on the edges of the reservoir as it recedes during Summer. Consequently recreational activities are rare around the lake, and migratory birds tend to avoid the lake as well.

2.2.6 LOWER LITANI RIVER

Downstream of Qaraoun Dam, the Litani River enters a narrow gorge which guides the river 30km south then, and after a sharp westward turn, 30km towards its outlet on the Mediterranean Sea. In this area the Litani River is less disturbed as it is less accessible, due to the topography and to the political situation: the constant tension with Israel (and past incursions) discourage the development of human activities.

Litani River gorge downstream of Qaraoun Dam

Litani gorge under Chateau Beaufort

Despite the almost total storage of Litani waters behind the dam, the downstream river flow is slowly reconstituted by various springs and eventually by its one notable tributary, Wadi El Debbe. Consequently the quality of water, although not well known, is considered much better than in the Upper Litani River. Indeed in some areas the river is a real socio-economic asset, with presence of both diverse vegetation and recreational activities.

A reasonably healthy Litani River (Khardale) **Welcoming for residents & tourists (Khardale)**

2.2.7 SUMMARY OF FINDINGS

For the upper Litani:

Pollution types	Zone 1a: Ain el-Sawda to Rayak	Zone 1b: Rayak to Bar Elias	Zone 2: Bar Elias to el-Marj	Zone 3: el-Marj to Qaraoun Lake
Domestic Sewage	high to very high	very high	very high	low
Solid Waste	high	very high	very high	medium
Agr. Run-off	medium to high	high to medium	medium	high
Industrial Sewage	very high	high to very high	medium	low
Industrial Use (pumping)	high to very high	high to medium	low	low
Agr. Use & Infringement	Very high	high to medium	high	high

For the tributaries of the Litani River:

Pollution types	Berdawni	Ghzayyel	Yahfoufa (Hala)	Hafeer
Domestic Sewage	medium to high	low to high	low to high	low to high
Solid Waste	low to high	medium	high	medium
Agr. Run-off	low to medium	medium	medium	low to high
Industrial Sewage	medium to high	low	low to high	low to medium
Industrial Use (pumping)	high	low	low	low
Agr. Use & Infringement	low to high	low to medium	high	high

For Lake Qaraoun and the lower Litani River:

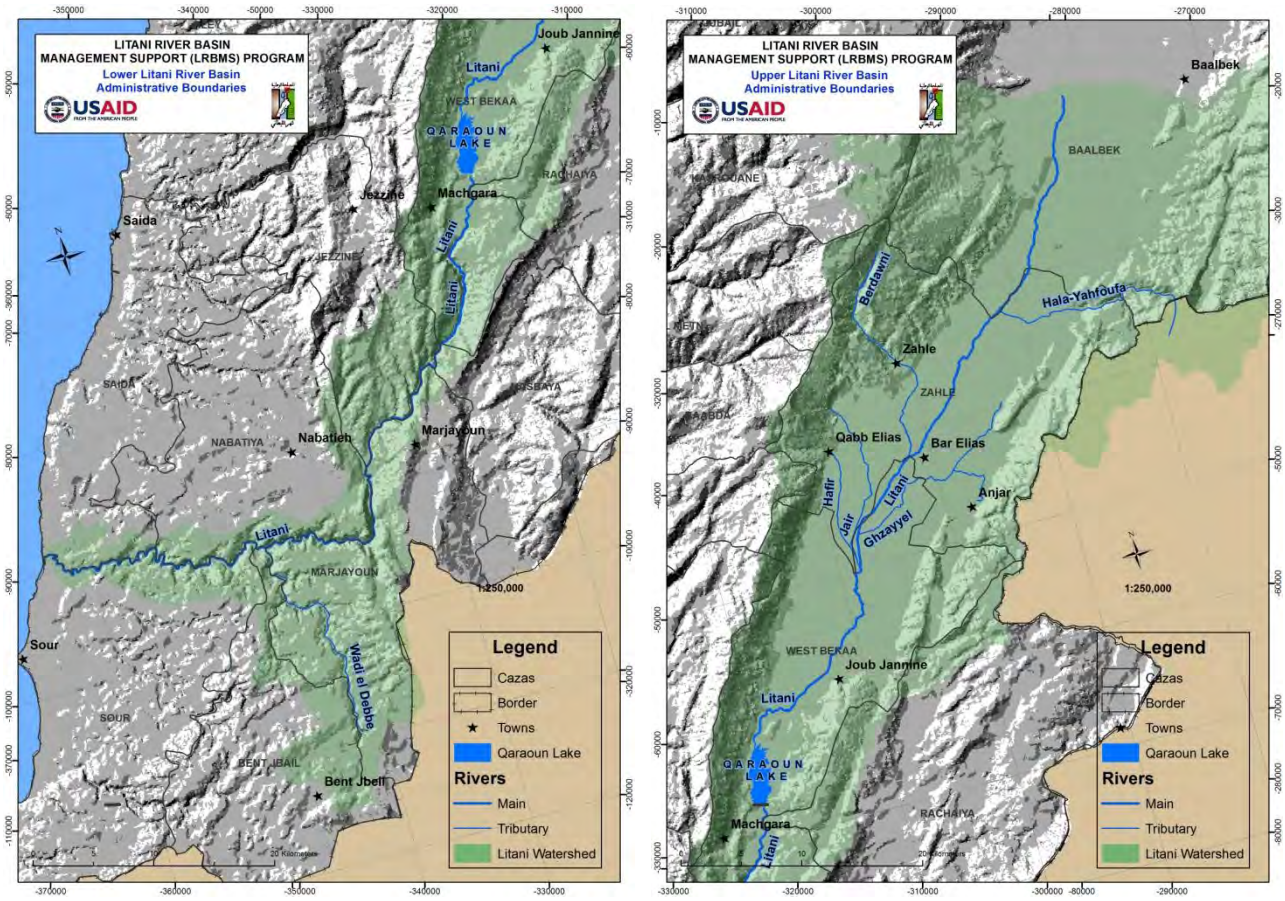
Pollution types	Lake Qaraoun	Lower Litani
Domestic Sewage	medium to high	low
Solid Waste	medium to high	low
Agr. Run-off	medium	low
Industrial Sewage	medium to high	low
Industrial Use (pumping)	low	low
Agr. Use & Infringement	low	low to medium

2.3. POPULATION AND LAND USE

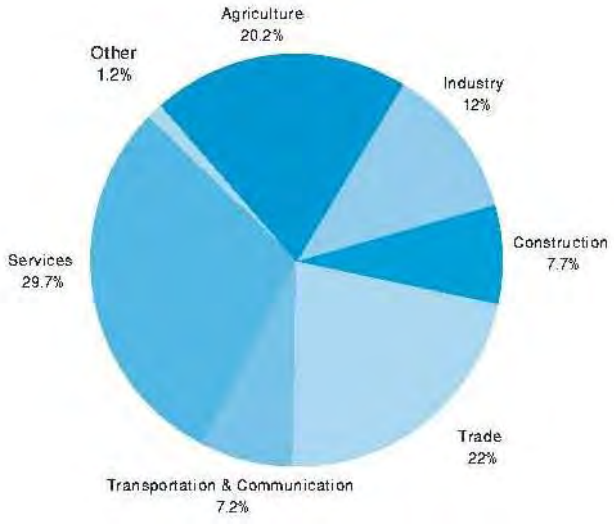
2.3.1 POPULATION

The Upper Litani River Basin covers most of the Mohafazat of Bekaa, that is most, if not all, of the Cazas of West Bekaa and Zahleh, as well as a third of the Caza of Baalbeck and a small part of the Caza of Rachaya. The Lower Litani River Basin covers minor areas of the cazaas of Bent Jbeil, Jezzine, Hasbaya, Marjayoun, Nabatiye, as well as Saida and Sour in the South. About 250 villages and small towns exist in the Litani River Basin, out of which the main cities are: Zahleh, Anjar, Bar Elias, Joub Jenine, and Qabb Elias, as well as the southwestern suburbs of Baalbeck.

The last comprehensive census in Lebanon was carried out in 1932 and present day population figures are estimates which vary depending on the publications. The population in the Litani River Basin is thus estimated to be around 375,000 in 2010, with a projected 1% annual increase until 2020. Almost all this population resides in the Upper Litani River Basin, while the Lower Litani River Basin does not present any urban centers apart from a few villages and the town of Bent Jbeil in the Wadi El Debbe watershed.



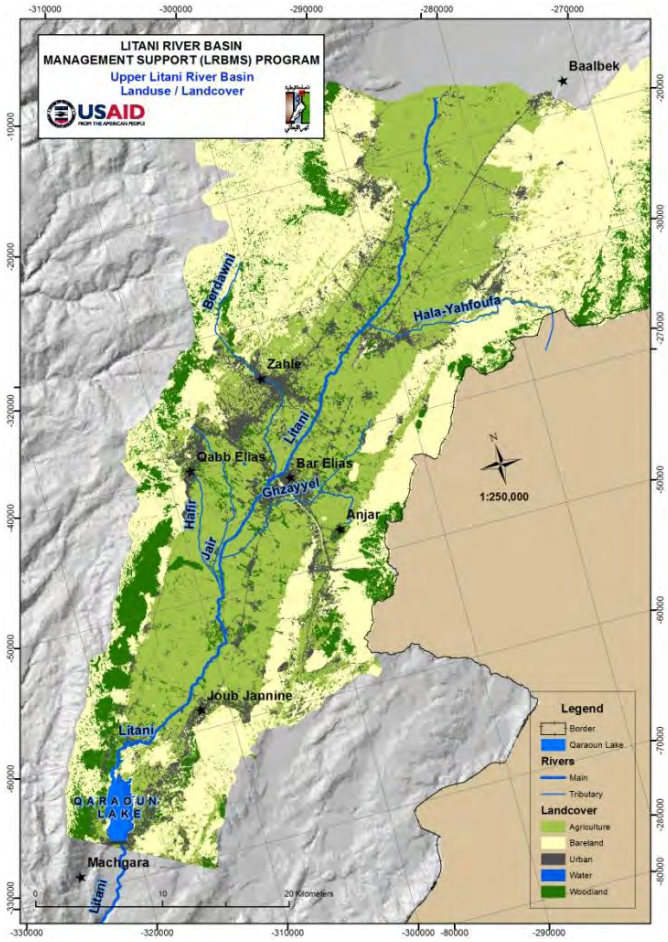
The population of the Litani River Basin presents a higher than national average prevalence of poverty, the region ranking third worse after the Tripoli-Akkar and Sour regions. 25% of the population is characterized as poor or very poor. Employment rate is below 40% (65% for males, 10% for females), with the main activities being services, trade, agriculture, and industries:



2.3.2 LAND USE

Land use in the upper Litani River Basin consists of:

- 50% natural lands, with bare rocky lands, isolated woods, notably on the hillsides of Mount Lebanon and Anti-Lebanon;
- 40% agricultural lands, mostly in the valley, which subdivide approximately into 20% of rainfed crops (mostly winter wheat), 15% of perennial crops (vineyards, olive and fruit trees), 5% of summer crops (vegetables, potato, watermelons, tobacco, etc.); and
- 10% urban and peri-urban areas, industrial areas, quarries, roads/highways and other man-made structures.



Land use in the Lower Litani River Basin is mostly natural lands, with the exception of:

- The coastal area around Qasmiye, which presents some intensive irrigation (notably bananas); and
- The Waddi el Debbe watershed, which has some sparse villages and traditional agriculture (fruit and olive trees, some tobacco).

The basin contains two important wetlands (Aammiq and Kfar Zabad) and the eastern portion of the Al Shouf Cedar Nature Reserve. The Bekaa Valley, much of which lies in the basin, is considered an important biological corridor, particularly significant for migratory bird species migrating between Africa and Europe.

2.4. WATER RESOURCES & AVAILABILITY

Water resources in the Litani River Basin come from the never ending circulation of water evaporating from the sea to the clouds, then falling as rain and snow, accumulating in rivers and lakes or recharging aquifers, being used for human activities and natural processes, and eventually

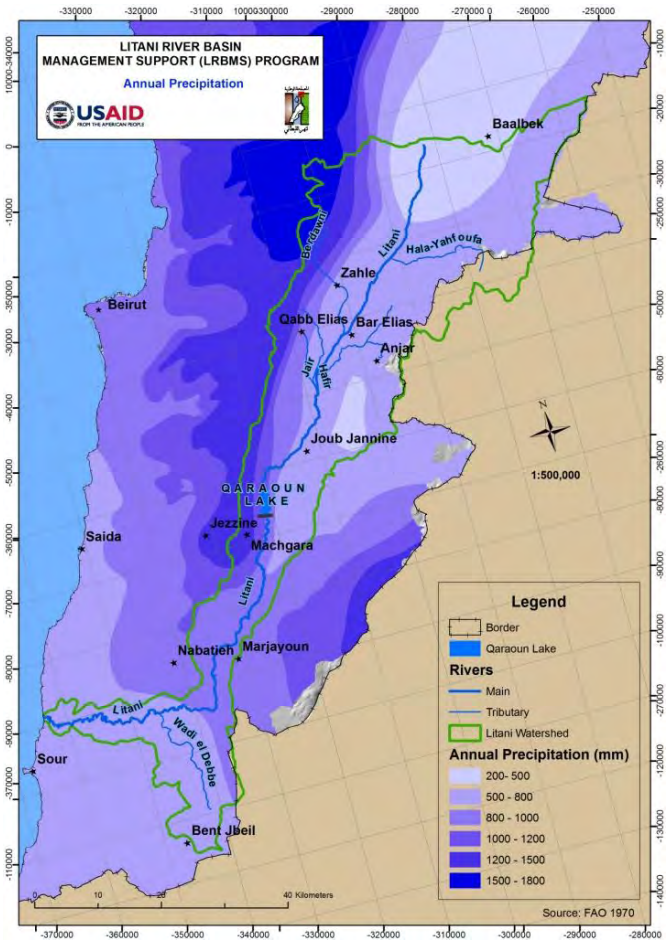
flowing back to the sea. It is the same molecules of water that continuously move through that cycle, have done so for millions of years and will continue doing so in the future. Water does not disappear in this cycle even if it can be stored in some places.

As mentioned earlier, water data in Lebanon is scarce and of uncertain accuracy. The following figures and conclusions are based on available data after reasonable assumptions regarding their relevance and accuracy.

2.4.1 PRECIPITATIONS

The climate in Lebanon is generally Mediterranean, with a rainy winter season (November-April) and a very dry summer season (May-October). Precipitations come from the Mediterranean Sea and fall in Lebanon as both rain and snow. Annual precipitations are on average 800 mm, equivalent to Europe and much more abundant than the rest of the Middle-East.

The Litani River Basin between Mount Lebanon and the Anti-Lebanon, each of these two mountain ranges blocking rain clouds coming from the Sea. Precipitations range from 400-600 mm in the eastern and central valley (Baalbeck, Anjar, Joub Jenine) to as much as 1400-1800 mm on the west ridge (Jabal Sannine to Jabal Niha), with an average of about 700 mm.

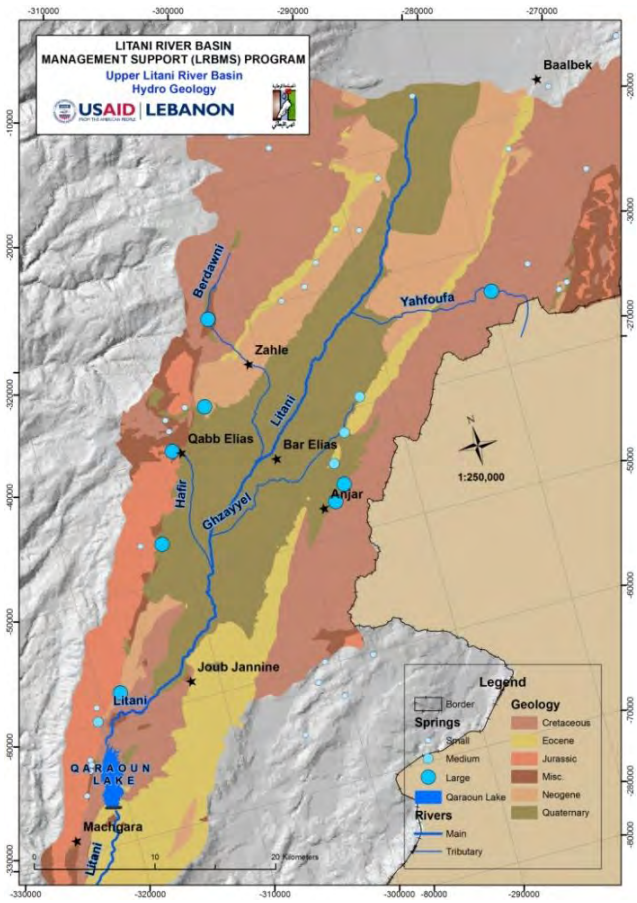


Some of the precipitations come as snow on altitudes higher than 1500-2000 m which can even cover (temporarily) the valley floor itself. Most of the precipitations come from winter showers and thunderstorms. Hourly data is not available but record precipitations of 50-80 mm in a few hours have been observed at the station of Zahle.

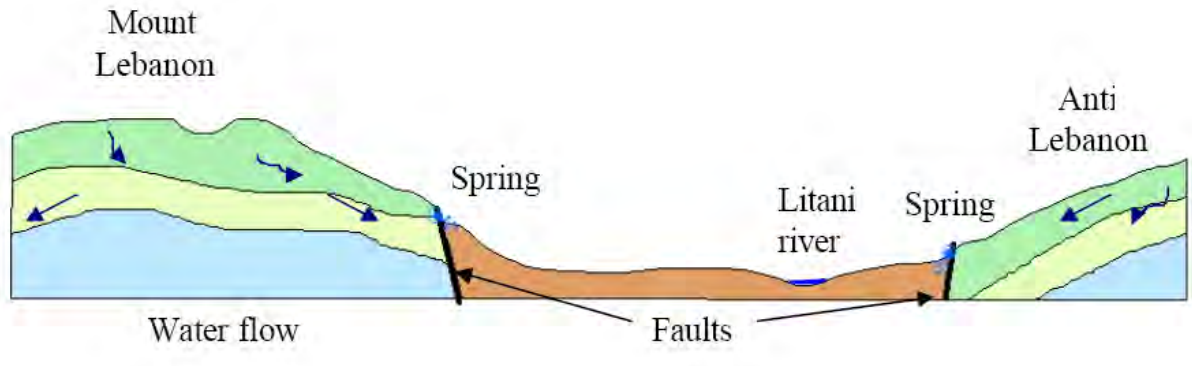
2.4.2 SURFACE WATERS

The surface network of the Litani River Basin can be described in four sub-areas:

- The uppermost Litani River Basin (north of Damascus highway), where a nascent Litani River drains the Central Bekaa valley south of Baalbeck; the only tributary is the Yahfoufa on the east bank, joining at Rayak;
- The central-upper Litani River Basin (Bar Elias to Mansoura), where the Litani River meets its three main tributaries, the Ghzayel on the east bank, the Berdaouni and the Hafir-Jair on the west bank;
- The central-lower Litani River Basin (Mansoura to Qaraoun Lake) where the Litani River has no significant tributary.
- The lower Litani (below Qaraoun Lake till the Sea) where only Wadi el Debbe joins the Litani from the South.

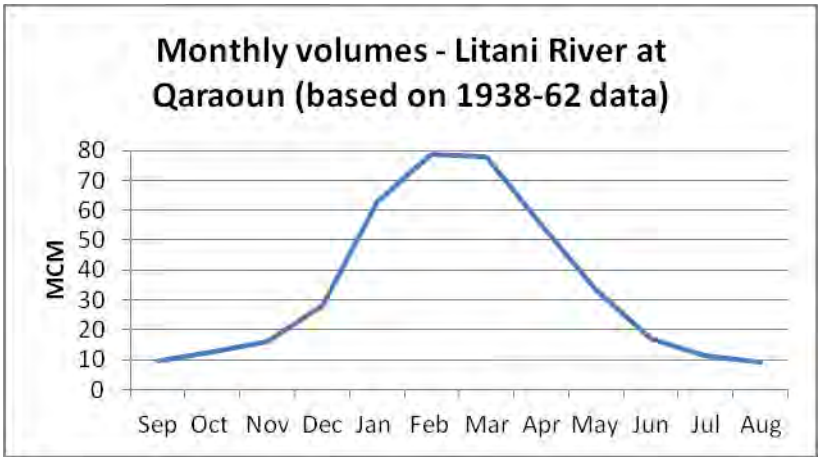


Most of the flow of the Litani and tributaries is supplied by springs located on both foothills, of which the main ones are in Anjar and Chamsine (supplying the Ghzayel), in QaaRim (above Zahleh, supplying the Berdaouni), in Qabb Elias and Jdita (supplying the Hafir and Jair), and in Aammiq. Today most of these springs are tapped for human uses, chiefly irrigation.



The flows of the Litani River and its tributaries match the precipitation regime:

- Augmented by rains in winter, they flow full or even flood neighboring lands; parts of the Litani plain were in the past described as "semi-lacustre" because of the common spring floods that occur when winter rains progressively saturate the clayey valley soils and thunderstorms over Mount Lebanon generate significant discharges;
- Diminishing greatly during the dry summer season when only springs provide water; this drying up is much amplified today with heavy withdrawals from springs and rivers (mostly for irrigation, but also for industrial needs).



source: LRA data

2.4.3 EXTREME EVENTS: DROUGHTS AND FLOODS

The Litani River flow varies depending on precipitations. Both dry and wet years occur. In recent dry years, such as 1999 and 2001, annual volumes fell to less than a third of the average. Conversely during wet years annual volumes can increase by 50% or even double, such as during the exceptional floods of 1968 and 2003.

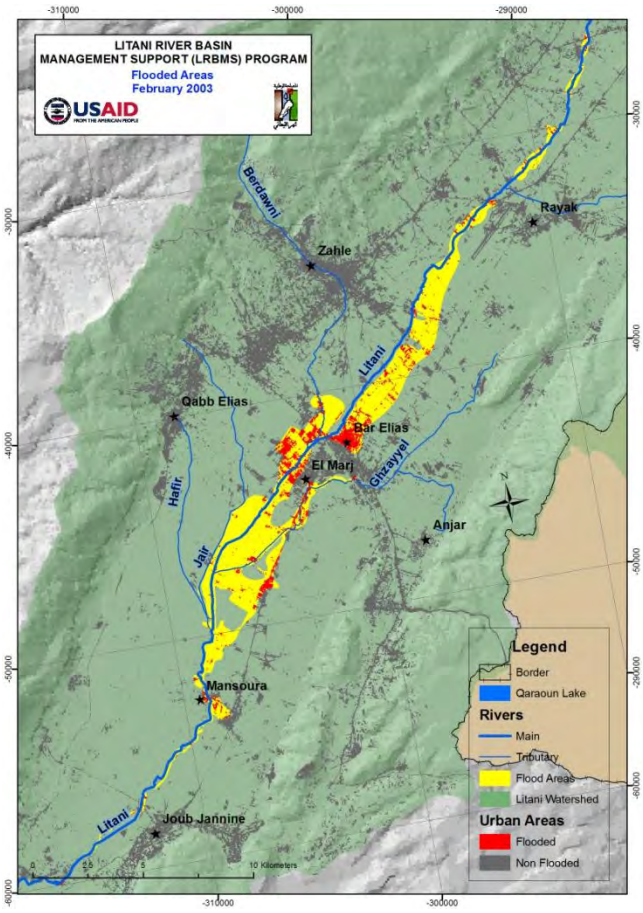
Water users are so far little impacted by droughts in the Litani River Basin, as most water sources in summer remain wells and springs (whose flows do not decrease directly and immediately with reduced volumes of winter precipitations). But this situation may change in the future as the drop in groundwater levels (see next section) will enhance the influence of reduced precipitations on spring flows. The competing demands between farmers and urban/industrial areas for water resources will increasingly become sources of potential conflicts, especially during dry years.

Floods are an issue in the upper Litani River Basin. Winter precipitations fall heavily on both Mount Lebanon and Anti-Lebanon ranges and generate heavy flows which then spread across the valley

whose bottom is almost flat and with a low north-south slope. Floods are thus common occurrences but with the expansion of human activities (farming and urban areas), their impacts are increasing.

Feb 2003 flood in Marj (Source: MoEW)

Flood damages are exacerbated by the lack of riverbed maintenance, the presence of obstructions such as narrow road bridges and riverbed infringements (small dams built by farmers) and the dumping of garbage and worksite refuse. February 2003 is the largest recent flood, with about 400 km2 (40,000 ha) of flooded areas in the Upper Litani (mostly in the municipalities of Rayak, Bar Elias, Marj, and Mansoura). Direct and indirect economic losses were evaluated at $ 2-5 M.



While large river floods remain rare, regular flooding occurs often in the Spring in the Bar Elias-Mansoura area due mostly to the impermeability of (mostly clayey) soils, the lack of urban drainage networks, and the poor

maintenance and disappearance of many drainage ditches in farm lands. The most affected areas are:

- Upstream of Bar Elias along the Howayzec tributary.
- Upstream of the Damascus Road bridge for the Berdawni River.
- Around the Mansoura Bridge on the Litani River.
- Around the village of Haouch El Harime along the Faregh tributary.

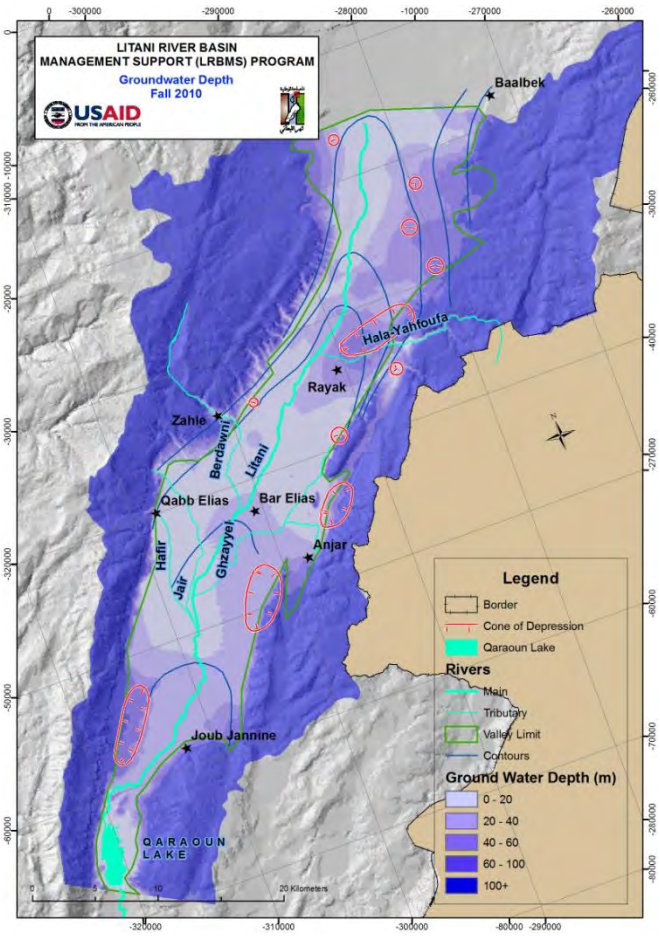
2.4.4 GROUNDWATER

Groundwater is water seeping underground and accumulating in soil/rock layers called aquifers. This water can resurface through springs or be pumped from wells.

There are five main aquifer systems in the Upper Litani River Basin, here described by chronology and depth (starting with quaternary being the youngest and the top layer):

Layer	Description and location	Capacity and evolution since 1970s
Quaternary	Unconsolidated alluvial deposits found in the valley north of Joub Jennine. These deposits can be up to 200 meters thick.	Wells here have limited yields (5-30 l/s) so the aquifer has not yet been much pumped. The groundwater tables have not decreased much.
Neogene	Older alluvial deposits which underlie the Quaternary in places and only surface along both foothills north of Zahle and Rayak	Wells here have limited yields (10-30 l/s). Groundwater tables have not decreased much, apart from some localized water level declines around Rayak where there are many irrigation wells.
Eocene	Rocks that surface in thin bands east of Rayak and in a broader area around Joub Jannine and Kamed El Laouz. The formation is up to 250 meters thick	Wells here can yield 50 l/s and more. Some localized water level declines in the eastern part near Baalbeck, near Terbol and north of Anjar.
Cretaceous	Rocks that surface extensively on both sides of the valley as main constituent of both mountain ranges.	Wells can yield up to 150 l/s. This aquifer is heavily tapped into and thus has much decreased on the east side of the valley (from Terbol down to Anjar) and in the southwest (near Kefraya and Kherbet Hanafar).
Jurassic	Rocks that surface only in the southwest area (Jabal Nihal and Jabal Barouk).	Wells can yield up to 100 l/s. This aquifer is used from Qabb Elais to Saghbine but has not lowered much.

The development of deep well pumps and mobile drilling rigs in the past 40 years has led in the upper Litani River Basin (as in many other regions of the world) to a drastic increase of groundwater extraction for irrigation. Today the number of wells in Lebanon is unknown, due to the proliferation of illegal (non-licensed) private wells. It is estimated that there are between 5,000 and 10,000 wells in the Litani River Basin, including about 2,000 licensed private wells, and 100 large public wells. Most public wells are used for potable purposes while most private wells are used for irrigation.



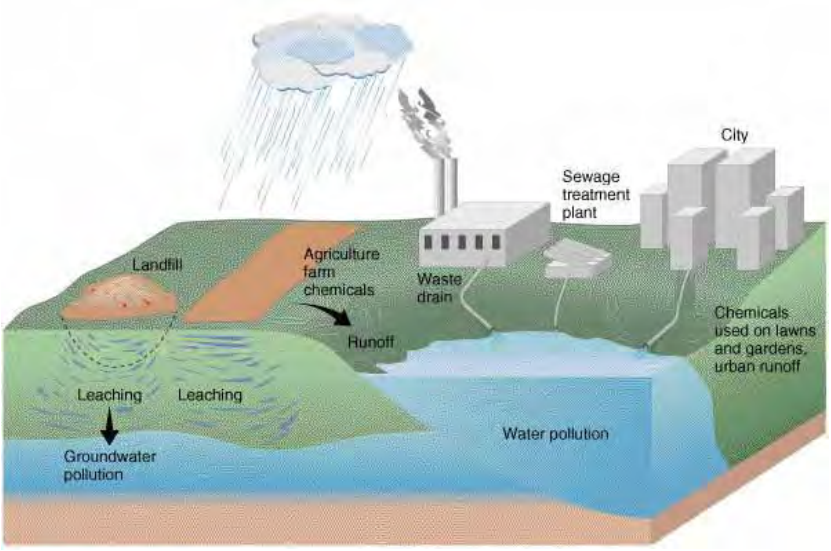
Although limited data exists on current groundwater levels, field investigations and interviews of well owners show that the upper Litani River Basin has seen a general decline of groundwater levels. In some critical areas (mostly along the valley edges) this decline has reached 30 meters or more and continues at a rate of 1-2 meters per year.

Due to the general lowering of groundwater tables in the central valley, some spring flows have decreased and several springs have disappeared:

- The Aallayq Spring (next to Haoush Barada), where the Litani River used to originate from, do not flow anymore;
- The Ras el Ain Spring (also called Terbol Spring) dried up in the 1990s;
- Similarly two nearby springs (El Faouar and Ain el Beida Springs) have been impacted: the Faouar Spring has not flowed for some years while that the Ain el Beida spring is generally dry and only flows at the end of the rainy season.

2.5. WATER QUALITY

2.5.1 BACKGROUND



Types of water pollutions

Water quality plays an essential role in the water cycle. Polluted waters may be unfit for most types of usages, from drinking to irrigation and water sports, and only usable after expensive treatment costs. There are different types of pollution which all are threats to public health, either directly (from drinking or being in contact with water), or indirectly (groundwaters and soils also get polluted, poor quality irrigation water contaminates crops and then human beings, leading to long-term deficiencies and diseases).

Water Pollutions	Causes/Sources	Impacts	Indicative Parameters
Biological (bacteriological)	• Untreated Sewage from **Urban Areas** • Fertilizers from **Agriculture**	• Threatened public health– dysentery and water-borne diseases • Deteriorated/decreasing aquatic life & vegetation • Algae growth	• Fecal Coliforms, Total Coliforms • Dissolved Oxygen (DO) • Nitrogen and Phosphorous
Chemical	• Leaching from **Dumpsites** • Untreated Sewage from **Industries**	• Threatened public health – water-borne and chronic or long-term diseases • Degraded aquatic life & vegetation • Accumulation of contaminants in soils	• Total Dissolved Solids (TDS) • Nitrogen and Phosphorous

	• Fertilizers & Pesticides from **Agriculture**	and fish • Algae growth	• Metals (cadmium, manganese, mercury, etc.)
Physical	• **Garbage** dumping • **Quarries** • Untreated Sewage • Infringements and lack of river maintenance	• Turbidity (unclear water) • Poor smell and taste, repulsive visual aspect • Deteriorated aquatic life • Unstable river banks	• Total Suspended Solids (TSS) • Odor & Color

2.5.2 WATER QUALITY MONITORING

Monitoring water quality is essential to protect public health, locate sources of pollution, identify trends over time, build and operate treatment facilities, develop and implement pollution prevention and mitigation activities and assess their impact.

Unfortunately few water quality monitoring activities are currently carried out in Lebanon in general and specifically in the Litani River Basin, due to lack of staff and resources within governmental agencies, inadequate coordination among these as well as unclear roles and responsibilities. Most recent water quality monitoring efforts in the Litani River Basin were unique efforts without follow-up or repeats, and usually funded by donors. Since sampling locations and methods varied, comparison between these results is difficult. Nowadays only the LRA has a sustained (but limited) monitoring activity with about 20 surface spots and wells being sampled monthly in the upper Litani River Basin.

2.5.3 CURRENT SURFACE WATER QUALITY

The quality of surface waters in the Litani River Basin varies:

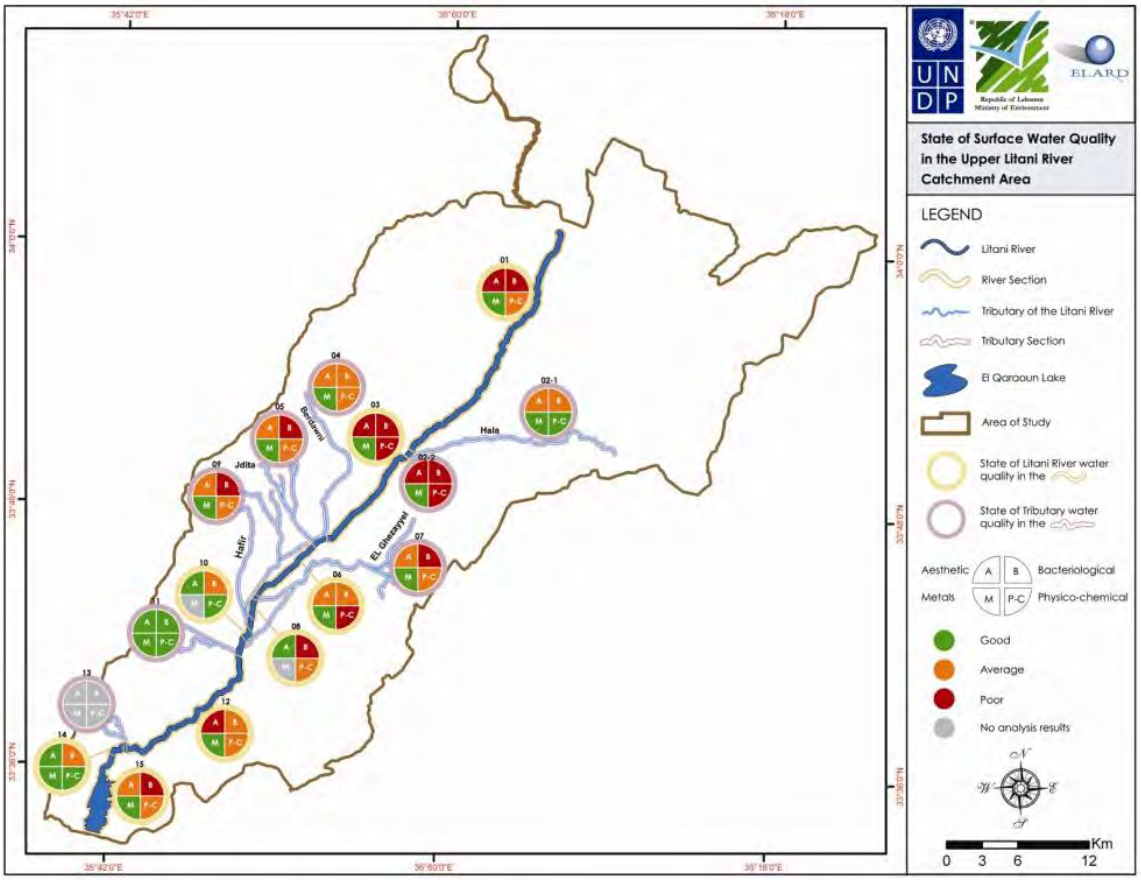
- Seasonally: river flows are more abundant in winter and thus dilute more the pollution, while some activities such as farming are less intensive; and
- Spatially: water quality decreases next to urban and industrial areas, and improves somewhat in rural areas.

Water quality along the river is locally good but often bad to very bad. In many places surface waters are inadequate in summer for any use, even irrigation:

Water diseases in the Bekaa

Poor water quality is a serious public health issue. Water-borne diseases are worldwide one of the leading causes of mortality among children. The occurrence of dysentery, typhoid fever and hepatitis A in the Bekaa is 7.5 annual cases per 10,000, twice the national average (2009 statistics from Ministry of Public Health). This rate is not high but still superior to US and European requirements for water safety (acceptable levels of 1 annual case per 10,000 consumers).

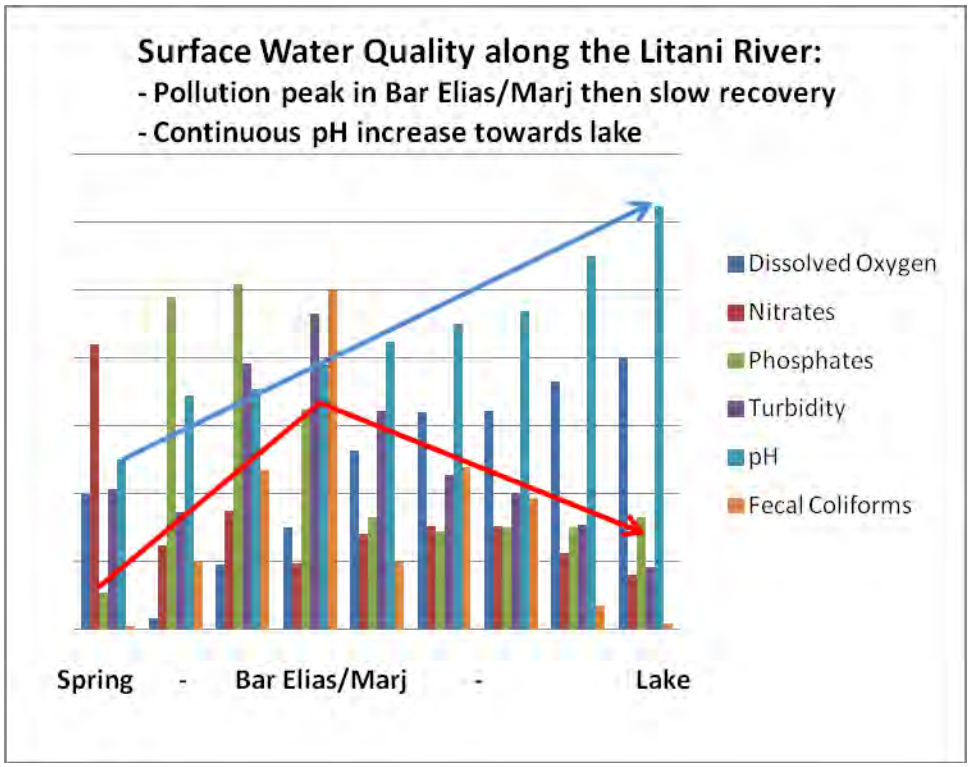
- The highest levels of contamination are in the mid-upper basin (Bar Elias) where there is a larger concentration of both residents and industries;
- Many summer water samples exceed drinking, domestic, and irrigation quality standards;
- Untreated wastewater discharges, both domestic and industrial, are one of the primary sources of bacteriological pollution, as confirmed by high levels of coliforms;
- Agriculture over-fertilization is an important source of pollution, as demonstrated by elevated levels of phosphates and nitrates; and
- Some metal buildup is now observed in the upper Litani River Basin, with notably levels of cadmium and manganese which are in some cases above safe drinking water limits.



Three zones can be indentified in the Upper Litani River Basin:

- **From Ain El Sawda spring till Damascus highway at Bar Elias**: this area presents mostly agricultural lands and small to medium industries. The pollution increases rapidly on the Litani River and its tributary the Yahfoufa and reaches a peak at the highway.

- **From Bar Elias to Mansoura**: this area is mostly urban with few agricultural activities. The pollution remains high to very high with three tributaries joining the Litani: the Ghzayel on left bank, the Berdaouni and Hafir on right bank; the Berdaouni flowing down from Zahleh provides the highest pollution load, the Hafir being also polluted, while the Ghzayyel is more diluted and allows the Litani to somewhat improve downstream.
- **From Mansoura to Qaraoun Lake**: This area is mostly agricultural, the Litani River recovers somewhat from the upstream contamination but pollution remains significant.



Lake Qaraoun itself is similarly contaminated, with high levels of coliforms and traces of metal buildup. The pH is now over 8 (leaning towards alkalinity) as a consequence of sewage pollution.

Limited data exists on the **lower Litani River**, due to the difficult logistics to access the river, lack of human activities and political tension. The lower Litani is essentially a separate river system since Upper Litani waters only reach it through occasional releases for irrigation purposes (on dry years) and overflows from Lake Qaraoun (on wet years). It is fed by springs and its quality is generally good (except for Lake Qaraoun releases), good enough to be a source of drinking water (after standard treatment). Some coliform contamination exists as a sign of domestic sewage, and nitrate concentrations increase towards the Sea due to agricultural runoff and over-fertilization.

2.5.4 CURRENT GROUNDWATER QUALITY

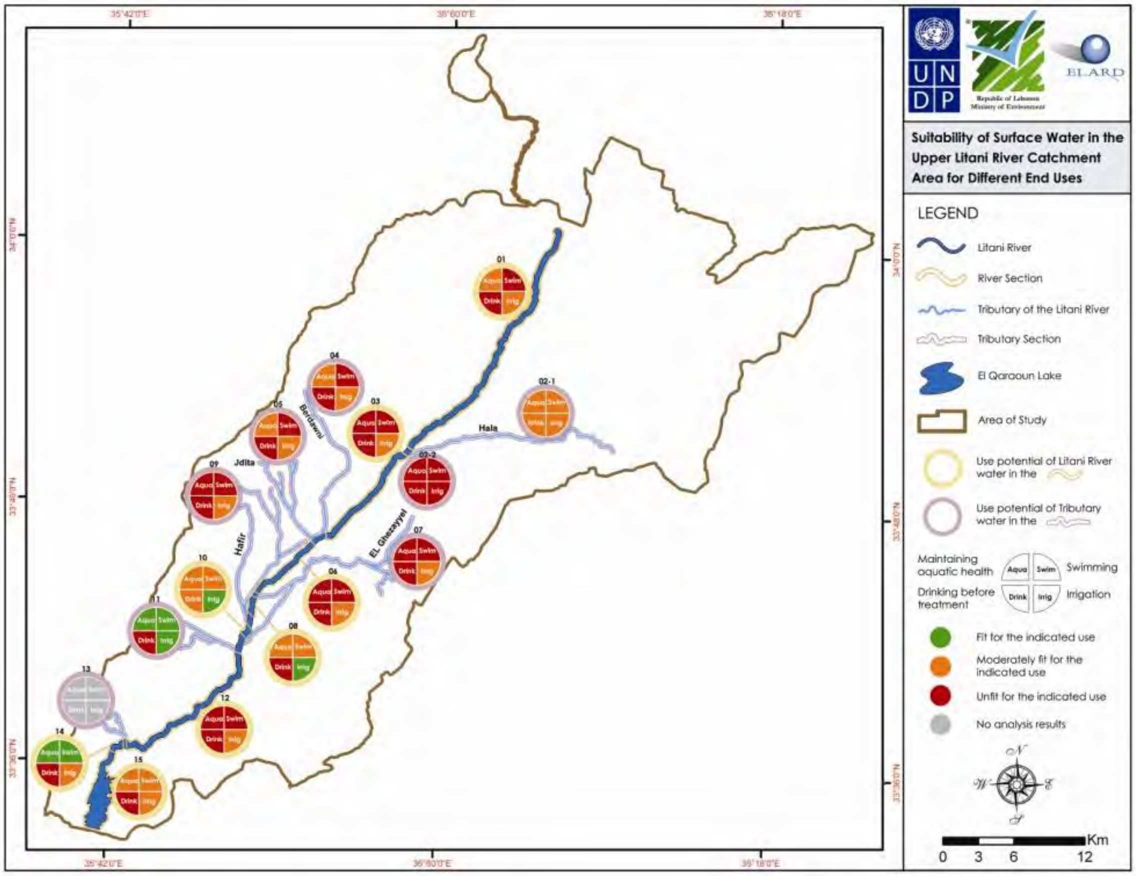
Groundwater also starts showing signs of pollution. This is worrisome since groundwater is the main source of domestic water for residents, businesses and industries. The main comments are that:

- Most samples are within general standards for most uses with the exception of nitrates which have been detected above drinking water standards in some wells;
- pH tends towards alkalinity, a sign of exposure to domestic and industrial wastewater;
- Levels of both fecal coliforms and metals (cadmium and manganese) have increased while still acceptable.

2.5.5 SUITABILITY FOR HUMAN USES

Can one eat fish from Lake Qaraoun, can one irrigate from the Ghzayyel, can one drink from the Machghara Spring? These questions are essential for residents and water users and rarely answered.

Based on water quality analyses, swimming in the Litani River or drinking directly from it is discouraged due to the high bacteriological content. Swimming and contact water sports in Qaraoun Lake should also be avoided for the same reasons. Direct irrigation from the Litani River, its tributaries, and Qaraoun Lake is commonly practiced, while it should generally be restricted to trees or else plants whose edible parts do not come in contact with the water.


Suitability of Surface Water in the Upper Litani River Catchment Area for Different End Uses
LEGEND
Litani River
River Section
Tributary of the Litani River
Tributary Section
El Qaraoun Lake
Area of Study
Use potential of Litani River water in the
Use potential of Tributary water in the
Maintaining aquatic health
Swimming
Drinking before treatment
Irrigation
Fit for the indicated use
Moderately fit for the indicated use
Unfit for the indicated use
No analysis results
Km
0 3 6 12
Hala
Berdawni
Jdita
Hafir
EL Ghazayyel
UNDP
ELARD

3. WATER MANAGEMENT

"Those in positions of authority should recognize that citizens have a right to be informed and participate in decisions that directly affect them."

3.1. WHAT IS MANAGEMENT? WHAT IS GOVERNANCE?

The use of water resources happens through everyday decisions and actions of water managers and water users. Water management is the activity of planning, developing, distributing and managing the optimum use of water resources. In an ideal world. water planning and management considers all competing water needs and seeks to allocate water equitably. This is rarely possible in practice.

Governance refers to the background of higher level regulations and policies which provide the context for day-to-day decision making. Water governance thus encompasses three pillars: water laws, water agencies (with their roles and capacities), and water policies and strategies.

Governance

UNDP defines governance as the "exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes, and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations, and mediate their differences."

Good water governance requires:

- **Legal support**: adequate laws and decrees to guide and support water management, e.g. clear duties and rights of all types of water uses;
- **Institutional coherence**: clear roles and responsibilities for water agencies, with accountable coordination mechanisms to prevent gaps and minimize overlaps in water management activities; e.g. streamlined decentralized decision processes; and
- **Visionary policies**: clear strategies with realistic objectives and targets, supported by adequate budget and resources, led by competent managers; e.g. management practices which empower staff and reward/promote them based on actual performance.

Ultimately water governance impacts the effectiveness and sustainability of water management. Only a transparent and accountable water governance framework can support flexible management approaches that are needed to deal successfully with current and future water challenges under ever-changing social, political and environmental factors and constraints.

3.2. WATER LEGAL FRAMEWORK

3.2.1 OVERVIEW

Laws in Lebanon are a patchwork inherited from past colonizing powers, the Ottoman Empire and then France. The first "water laws" were irrigation-related sections of the Medjelleh (Ottoman Code) in 1876 and then orders issued in 1925 and 1926 under the French Protectorate. These orders declared water resources as public property, aside from pre-established water rights. Water use could then occur only through withdrawal authorizations or concessions.

In the following decades, and especially after independence, 21 water authorities were authorized to tap springs and wells to provide potable water. In parallel more than 200 water committees were also formed (at municipality-level) to manage wells for domestic and irrigation purposes.

The Ministry of Energy and Water (formerly Ministry of Hydraulic and Electric Resources) was established in 1966, while the Office National du Litani was established in 1954. Decrees were promulgated over the years to:

- Delimitate water resources protection zones (1962);
- Police the prospection and use of ground water (1970);
- Control pollution from solid and liquid waste (1974); and
- Regulate water bottling (1983).

Law 221 was issued in May 2000 as the first comprehensive water law. It notably updated and clarified the regulatory authority of the MoEW and merged the 21 pre-existing water authorities into four Regional Water Establishments (North, South, Bekaa and Beirut-Mount Lebanon).

Since 2005, MoEW has been preparing a **draft Water Code** to complement Law 221. This draft Water Code involves a much more integrated approach to water resource management, providing for a "global approach" to water issues. The draft Code would:

- Provide GoL with the authority to oversee and regulate water quality (underground and surface), sanitation, potable water provision, drought and flood management, as well as water uses for agricultural and other sectoral needs, and to protect aquatic ecosystems;
- Create a National Water Council, consisting of representatives of all of relevant ministries, municipalities, and other professional and user groups, to act as national policy and planning institution for water resource management in Lebanon.

- Require MoEW to develop and implement a National Water Plan as well as River Basin Plans which define qualitative and quantitative needs by sector, allocate resources and delineate protected areas.

Draft Water Code is complemented by specific decrees to address:
- Water rights and water use fees (for withdrawals and releases);
- Provision of water delivery services by the private sector;
- Implementation of River Basin Plans;
- Mechanisms for crisis management (for example in case of drought); etc.

3.2.2 STRENGTHS AND WEAKNESSES

Law 221 represents a significant progress by mandating "a clear separation between policy-making and service provision through the establishment of financially and administrative autonomous Regional Water Authorities[1]". The merging into four RWEs does allow significant "economies of scale" for potable water supply and wastewater management. **But the reform process remains incomplete:**

- **Focus remains on water development**, i.e. the construction and operation of water infrastructure ("projects") to increase supply, with limited attention to water management, starting with the monitoring of water availability, quality and uses, and the regulation of both withdrawals and releases;
- **RWEs are defined as both water utilities and water management agencies**; this setup, which is rare worldwide, merges two very different functions and creates conflicts of interest (water utilities would be simultaneously "referees" managing equitably water resources and "vendors" supplying water against compensation). The current RWEs are, by nature (capacity, staff and assets), exclusively water utilities, currently struggling to provide reliable safe water, reach financial sustainability, develop trusting relationships with customers, and additionally handle wastewater collection and treatment. They are thus incapable in the near future to operate also as water management entities and interact effectively with farmers and other types of water users;

Water Utilities and Water Management Agencies

Water Utilities are service providers, meant to supply safe reliable water at fair prices to customers while being financially sustainable (utilities can be public or private).

Water management agencies are publicly mandated entities meant to protect and allocate water resources so as to satisfy water needs sustainably and equitably; such agencies monitor resources and their uses and enforce withdrawal and release authorizations; they are usually subsidized to operate and/or can sell bulk water to service providers (utilities, irrigation systems, etc.).

[1] World Bank, 2010: Republic of Lebanon - Water Sector: Public Expenditure Review

- **As emphasized by the World Bank: "The current regulatory instruments are inadequate to promote the sustainable management of water resources**. Laws and regulations governing water resource management are not up-to-date"[2]; significant water management functions remain unclearly assigned and inadequately regulated by old Ottoman and French codes, notably regarding acquired water rights and enforcement mechanisms for water withdrawals and releases (e.g. well drilling, spring protection, pollution control, etc.);
- **Essential mechanisms such as water user participation and inter-agency/inter-sectoral coordination are not legally defined**.

The draft Water Code attempts to address the institutional gaps of Law 221, notably by:

- Establishing a (cross-sectoral) National Water Council (NWC);
- Requiring the preparation of a (6-year) National Water Master Plan;
- Promoting the "user pays" and "polluter pays" principles; and
- Defining River Basin Plans, and thus promoting decentralized/regional water planning.

But this draft Water Code falls short as it does no assign clear responsibilities: who will develop and implement River Basin Plans, how will local actors (municipalities, water committees, NGOs, other water user entities and NGOs) be involved. The World Bank comments thus: "the preparation of sectoral development plans cannot be left to the sole responsibility of the line ministry as Lebanon shifts toward a delegated model of service provision. The Water Code does not specify the roles that the CDR and the RWEs would play in the preparation and vetting of the six-year development plan for the sector." [2];

3.3. WATER INSTITUTIONAL STRUCTURE

3.3.1 OVERVIEW

Management of water resources in Lebanon within the Litani River Basin is primarily, and by default, the responsibility of the Ministry of Energy and Water (MoEW), but several other agencies are involved:

MINISTRY OF ENERGY & WATER (MOEW) is mandated to:

- Monitor water resources and uses;
- Develop standards;
- Develop and implement a national Water Master Plan;

[2] World Bank, 2010: Republic of Lebanon - Water Sector: Public Expenditure Review

- Build and operate water structures;
- Protect water resources from wastage and pollution;
- Provide authorizations for water use (and releases?)
- Supervise Regional Water Establishments;
- Inform and raise awareness among citizens and water users.

REGIONAL WATER ESTABLISHMENTS (**RWE**, four of them) have the following responsibilities:

- Study, implement, and operate projects for drinking and irrigation water distribution, (except for irrigation water in the South and South Beqaa that remains under LRA);
- Control the quality of the drinking and irrigation distributed water;
- Propose tariffs for drinking and irrigation water services; and
- Collect and treat domestic wastewaters (Law 377 of Dec 2001).

LITANI RIVER AUTHORITY (LRA): was established in 1954 as project implementation authority to:

- Construct irrigation, drainage, and potable water projects on the Litani River (and operate them);
- Create a transmission network linking the major generating facilities in the country; and
- Create a nation-wide electrical distribution network.

Other responsibilities were added to the LRA's mandate over the years:

- In 1962 to develop and implement a regional water basin for the Litani River Basin from the Damascus highway till the south border;
- In 1963 to plan, design and build small dams and conduct all flow monitoring activities, (both of these responsibilities are nation-wide).
- In 1996 to study new irrigation schemes in the Litani River Basin and operate all irrigation projects, both large and small, in South Lebanon.

LOCAL WATER & IRRIGATION COMMITTEES: More than 200 were developed across the nation following the unrest of the 1980s, with about 40 in the Litani River Basin. Half were meant to manage irrigation networks, some potable water supply and a few both irrigation and potable water networks.

MINISTRY OF ENVIRONMENT (MOE): mandated to protect the environment with limited capacity and legal authority (mostly setting quality standards for wastewater releases).

MINISTRY OF FINANCE (MOF): approves annual budgets of LRA and municipalities, as well as fees for water services.

MINISTRY OF AGRICULTURE (MOA): provides extension services and training in irrigation techniques to farmers, notably through the Lebanese Agricultural Research Institute (LARI).

MINISTRY OF PUBLIC HEALTH: sets quality standards for potable water.

COUNCIL FOR DEVELOPMENT & RECONSTRUCTION (CDR): established in 1977 to fast-track investment intended to repair the civil war destructions; responsible for planning, funding, and supervising the construction of large infrastructure.

LOCAL GOVERNMENTS: Mohafazats (governorates), Cazas (districts), and Municipalities (and Unions of Municipalities) have legal responsibilities, notably regarding water uses and pollution

control, but limited staff, capacity, and funds to actually exercise these. Unfortunately their financial resources are limited and under close control by Ministry Of Interior.

3.3.2 STRENGTHS AND WEAKNESSES

The sector reform initiated with Law 221 represents a significant institutional improvement. The merging of the pre-existing 21 water authorities into four RWEs allows economies of scale and better oversight by the MEW. However the reform effort needs to be pursued as Law 221 does not address the fragmentation of responsibilities in the water sector. The World Bank recently identified four main institutional weaknesses:

(i) "a growing disconnect between legal and de facto sector responsibilities;
(ii) Lack of integration of policy-making with investment planning functions, accompanied by limited inter-agency coordination;
(iii) Inadequacy of regulatory instruments to exercise effective central oversight over the water sector; and
(iv) Limited management and financial autonomy devoted effectively to Regional Water Authorities."[3]

Otherwise said, the main institutional weaknesses, gaps and overlaps include:

- **Unclear responsibilities among water agencies**, with the three key roles of policy-maker, regulator and resource manager being by default assigned to the MoEW;
- **Lack of coordination** between sector strategy (set by MoEW) and actual project planning and execution (de facto by CDR), with very limited involvement of RWEs and LRA. The World Bank talks about "very weak interagency coordination"[4] and emphasizes that: "The lack of coordination is a major concern for the sustainability of investments, given that the RWEs (and LRA) are responsible for the operation and maintenance of the assets."
- **Excessive centralization of decision power** which is notably reflected in the lack of financial autonomy of many agencies (RWEs, LRA and municipalities) whose annual budgets have to be reviewed and approved (if not imposed) by the central ministries;
- **Overall lack of capacity**, as demonstrated through:

[3] World Bank, 2010: Republic of Lebanon - Water Sector: Public Expenditure Review

[4] World Bank, 2010: Republic of Lebanon - Water Sector: Public Expenditure Review

- **Deficient operation and maintenance of wastewater treatment plants**. The World Bank also observes that: "As a result of the lack of coordination and a lack of capacity to manage WWTPs, a number have been built but are not yet operational."[4]
- **Absence of effective monitoring and enforcement mechanisms**, regarding surface and groundwater withdrawals (many being unauthorized and unmonitored), or pollution control (again with many domestic and industrial releases being unmonitored while MoEW, MoEnv and municipalities all have legal responsibilities);
- **Limited provision of extension services** to farmers (although essential to reduce over-watering and over-use of chemical fertilizers and pesticides).

Simply said the current institutional setting in Lebanon remains very centralized with limited coordination among the main agencies, while local actors such as municipalities or water user groups have little to no say in water management.

Water Functions	Organizations												
	Parliament	Council of Min.	MoEW	MoFin	MoEnv	MoAgric	MoPHealth	MoInt & Munic.	Municipalities	RWEs	LRA	CDR	Farmers & wat users
1. Organizing and building capacity in the water sector	+	+++	+++	+	-	-	-	-	-	+	+	-	-
2. Planning strategically	-	+	+++	-	-	+	-	+	-	+	+	+	-
3. Allocating water	+	+++	+++	-	-	+	-	+	-	+	+	-	-
4. Developing and managing water resources	-	+	++	+	-	+	-	+	-	+	++	++	-
5. Regulating water resources and services	+	+	++	-	+	+	+	+	-	+	+	-	-

Water Functions and Relevant Organizations

3.4. WATER POLICY ENVIRONMENT

3.4.1 OVERVIEW

The MEW is the key water policy actor. Its main priority is understandably potable water, followed by sanitation (overall water governance and irrigation management are low priorities). Addressing the poor technical and financial situation of the water supply and sanitation structures and institutions requires indeed significant efforts and investments. Accordingly the MEW focuses on advocating and planning the construction of water supply and wastewater infrastructure.

At national level the two main planning documents for the water sector in Lebanon are:

- The **Work Plan of the Ministry of Electric and Hydraulic Resources for 2000-09** (also called "Plan Decanal" i.e. 10-year plan): this plan is based on harnessing additional water resources for drinking water, irrigation, wastewater collecting and treatment, and flood mitigation; it thus presents lists of projects, chiefly dams (and some wastewater treatment plants and wells);
- The more recent **National Water Sector Strategy (NWSS)**, prepared end of 2010: it focuses on improving water services through a financial investment program and 16 initiatives; this NWSS is now being complemented by regional water and energy development plans.

Strategic Planning

Management is an everyday activity that remains improvised if not within the framework of a strategy: management then solves only recurrent/common issues. When a new/unknown issue occurs, management takes time to understand the new situation and to address it by reallocating resources, staff, equipment, etc. This learning process is costly and time-consuming.

The goal of strategic planning is to identify potential future issues, envision solutions, anticipate by defining roles and processes and empowering local managers, and thus reduce the time and cost of addressing issues.

3.4.2 STRENGTHS AND WEAKNESSES

Both Work Plan and NWSS are reasonable efforts to identify and define capital investment needs. They provide lists of essential water projects. They however need:

- **Better strategic focus**, as they do not prioritize among projects, do not specify implementation roles, and specifically lack realistic objectives, quantified targets, timetables, and monitoring mechanisms, to turn a vision into concrete and feasible plans of action;
- **Water management considerations** beyond the simple harnessing of water resources; building water structures is a never ending race without demand management to ensure that water resources are not wasted; [5]
- **Decentralized perspectives**: these two documents are national plans which tend to favor standard solutions for the entire country regardless of local specificities and water situations;
- **Better coordination and user participation**, these national plans were prepared by MEW without much involvement (beyond presentations) of other ministries, municipalities or user representatives (business, farmer, tourism associations who need water resources to operate).

[5] The 2006 UNDP "Status of IWRM plans in the Arab Region" review commented that the 2000-09 Work Plan focuses only on water supply without much references to better water management. Similarly the NWSS refers to water management and water efficiency as objectives without defining specific targets, roles and steps.

The NWSS plans for future investments and also lists 16 initiatives to develop both enabling structure and environment for the water sector in Lebanon. Implementation details for these 16 initiatives are absent, while among the five key functions of water governance, the NWSS focuses mostly on (1) establishing the structure of the sector, (4) developing water resources, and (5) regulating water resources and services. Other essential functions are overlooked: (2) strategic planning, (3) water allocation, and (4) managing water resources:

	NWSS Initiatives	**Function**
#1	Complete restructuring of RWEs	1. Organizing
#2	Improve operations between RWEs & MEW to ensure IWRM	1. Organizing
#3	Restructure MEW's organization	1. Organizing
#4	Develop performance M&E for RWEs	5. Regulating
#5	Improve performance efficiency of RWEs	5. Regulating
#6	Provide required manpower levels and capabilities	1. Organizing
#7	Define & enforce planning & capital spending responsibilities	1. Organizing
#8	Involve stakeholder participation in design & management	1. Organizing
#9	Improve irrigation management and cost recovery	5. Regulating
#10	Design and implement water tariffs	4. Managing
#11	Develop adequate setting for PSP	4. Managing
#12	Finalize and implement Water Code	1. Organizing
#13	Strengthen legal framework to improve water services	1. Organizing
#14	Improve climate change knowledge	2. Planning
#15	Improve water quality and flood mitigation	4. and 5.
#16	Evaluate environmental impact of NWSS	2. Planning

4. MAIN WATER ISSUES

"When the well is dry, we know the worth of water."

There are three main challenges for the equitable, profitable, and sustainable use of water resources in the Litani River Basin:

- Pollution of both surface and ground-waters;
- Increasing water demands (from residents, industries, farmers and other water users) which are outpacing available resources (again both surface and ground-waters); and
- Defective water governance environment within which water managers and users operate.

4.1. PRESSURES ON WATER QUALITY

Water quality depends on the amount of pollution being discharged into a river or aquifer as compared to the natural capacity to dilute and decontaminate the pollution. If the pollution is too heavy or contains non-biodegradable components (chemicals, metals, etc.) then the quality of the river or aquifer declines and becomes unsuitable for direct use without costly treatment.

4.1.1 MAIN SOURCES OF POLLUTION

The poor quality of ground- and surface waters in the Litani River Basin result from several factors, by order of priority:

UNTREATED DOMESTIC SEWAGE discharging directly into the Litani River and its tributaries, with direct risks for public health (water-borne diseases such as diarrhea and dysentery), and natural fauna and flora.

AGRICULTURE runoff which conveys surplus fertilizers and pesticides to surface and ground-waters, again with direct risks for public health; the resulting increase in nutrients favors algal development (to the detriment of other aquatic forms) which blocks irrigation pipes.

Point and diffuse sources of pollution

Point sources of pollution such as sewage outlets or dumpsites can be identified and thus mitigated through the construction of treatment facilities. Conversely other sources of pollution are diffuse (or "non-point") as they are widespread and result from inadequate practices and behaviors from water users and residents. For example the over-use of fertilizers by farmers results in runoff and leaching of nitrates and phosphates which accumulate in ground- and surface waters. Other diffuse sources of pollution include quarries, garbage dumping, ineffective cesspits, use of poor quality detergents, etc.

UNTREATED INDUSTRIAL EFFLUENTS discharge concentrations of heavy metals, organic matter and other pollutants in surface and groundwater. These constituents are detrimental to public health directly (water pollution) and indirectly (soils and crops get in turn contaminated).

DUMPSITES are notably lacking in the Litani River Basin, mostly improvised, poorly managed, and located close to waterways. The Zahle waste disposal facility is the only properly built and operated dumpsite (with artificial bottom sealing and leachate collection). All other dumpsites are ad-hoc and burn waste. Waste decomposition releases the leachate directly into waterways and groundwater, with significant organic and chemical pollution. **DIRECT WASTE DUMPING** into (dry or flowing) riverbeds causes similar pollution as well as visual impact, smell and possible obstruction of bridges.

QUARRIES and stone cutting operations contribute significant amounts of sediment to the surface water courses causing turbidity and damage to the ecology.

These sources of pollution are reviewed in the following sections.

4.1.2 DOMESTIC SEWAGE FROM URBAN AREAS

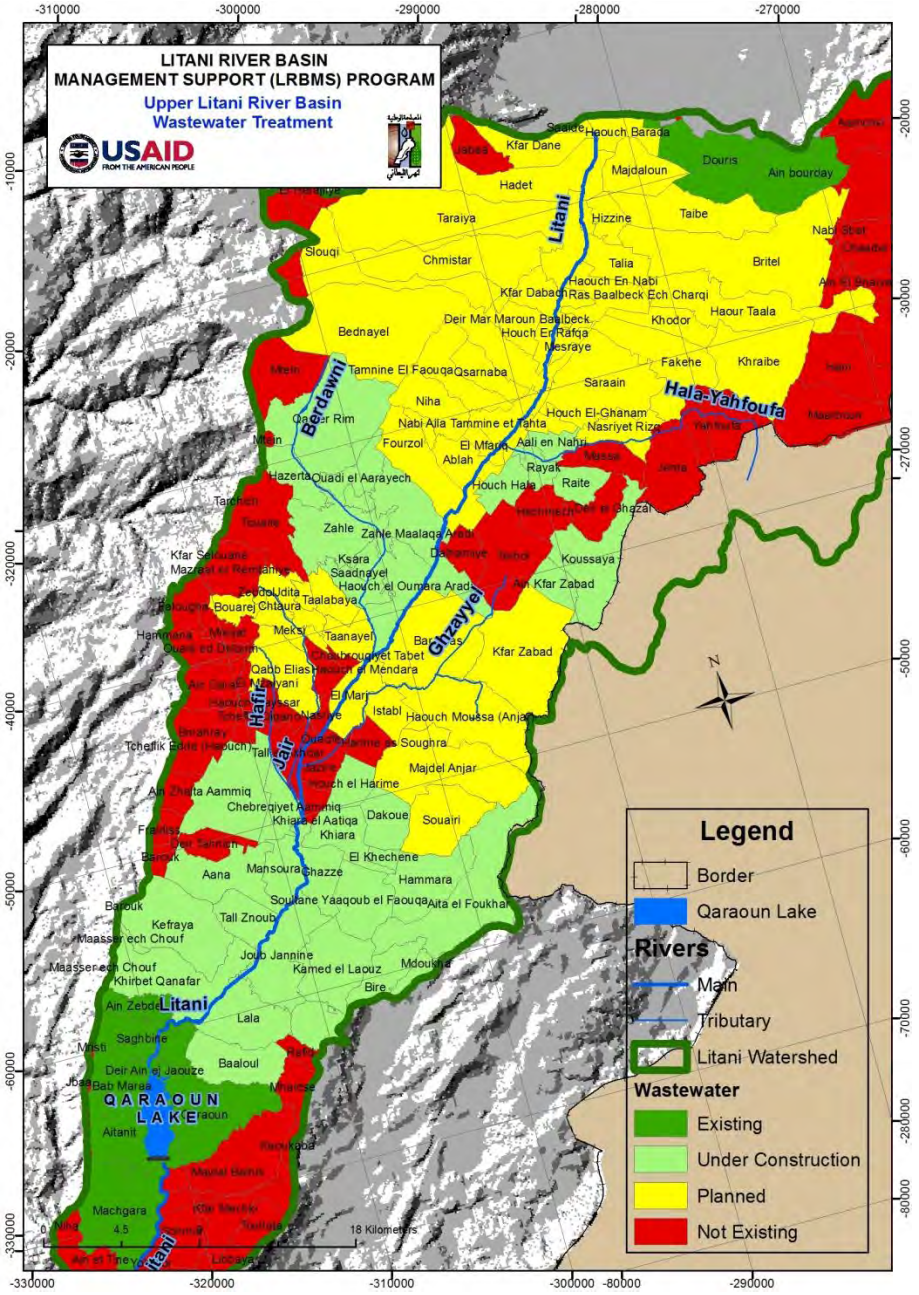
Wastewater in the Bekaa used to be handled through individual cesspools and septic tanks (basically holes in the ground, with or without filtering materials. Some simply leak to groundwater, while the most advanced are lined and occasionally emptied (with the collection trucks then going to the nearest stream/river to empty their tanks).

Until 2000, no treatment plant existed in the entire Bekaa. Since then several plants have been built while others are under construction or being planned/designed. There is thus reasonable hope that the situation will improve with an increasing proportion of wastewater being treated before release to natural waterways.

Status of Upper Litani Basin Wastewater Treatment Plants

Plant	Caza	Area Served	Capacity	Status (2011)
Ferzol	Ferzol	Ferzol	600 m^3/day	Operational, intermittent functionality
Ablah	Ablah	Ablah, Nabi Ayla	2,000 m^3/day	Under construction
Baalbek	Baalbek	Baalbek and Douris	12,000 m^3/day	Completed, awaiting network construction
Timnine Et-Tahta	Baalbek	Niha, Nabi Aila, Tanmine Et-Tahta, Saraain, Nabi Chit, Ablah, Fourzol, and Riyak	25,000 m^3/day	Planned
Zahle	Zahle	Hazerta, Zahle, Saadnayel, Taalabaya, Jdita, Bouarej, and Qabb Elias	18,000 m^3/day	Under Construction

Anjar / El Marej	Zahle	El-Marj, Majdel Anjar, and Souairi	44,500 m^3/day	Planned, just received financing
Joub Jenine	W Bekaa	Aana, Mansoura, Soultane Yaaqoub Al-Faouqa, Joub Janine, and Khamed El-Laouz	7,500 m^3/day	Finished, not yet operational
Saghbine / Bab Maraa	W Bekaa	Bire, Lala, and Saghbine	7,500 m^3/day	Under construction (2013 expected completion)
Aaitanit/Qaraoun	W Bekaa	Aitanit, Baaloul, Qaraoun, and Machghara	5,000 m^3/day	Partially operational



Status of WWTPs in the upper Litani River Basin

There are however several obstacles to adequate wastewater management:

- **Capable operation and maintenance of treatment plants**, which requires:
  - Clarification of responsibilities (between MEW, Bekaa RWE, and municipalities);
  - Adequate funds to pay staff and maintenance costs (Bekaa RWE and municipalities have limited funds to cover O&M costs while wastewater tariffs do not yet exist);
- **Existence and coherence of sewage structures**; due to lack of coordination:
  - Some existing networks empty directly into the Litani and tributaries, thus generating a local peak of pollution; while
  - Some plants are operating at low capacity because no network exists or supplies them.
- **Separate management of industrial sewage**: factory and industrial effluents have different characteristics from domestic effluents, with higher chemical and metal contents; since most treatment plants are designed and built to treat chiefly biological pollution, they are not suited to handle properly industrial effluents which can moreover damage the plant equipment; such effluents need to be either treated separately (onsite) before release in natural waterways or at least pre-treated (again onsite) before reaching treatment plants;
- **Diversion of untreated sewage flows**: uninformed water-deprived farmers divert effluents for irrigation purposes; several treatment plants continue to operate at very low capcity because of no incoming flows during summer flows; use of untreated sewage for irrigation can lead to direct (contact between crops and contaminated water) and indirect (soil buildup of contaminants) health issues.

4.1.3 AGRICULTURE

Agriculture is an important activity in the Bekaa Valley, contributing to 20% of the incomes. Unfortunately most agricultural practices are poorly regulated and monitored, and farmers receive almost no technical assistance apart from a few isolated centers (e.g. LARI, the Lebanon Agricultural Research Institute) and some pilot activities (chiefly funded by donors). It is estimated that:

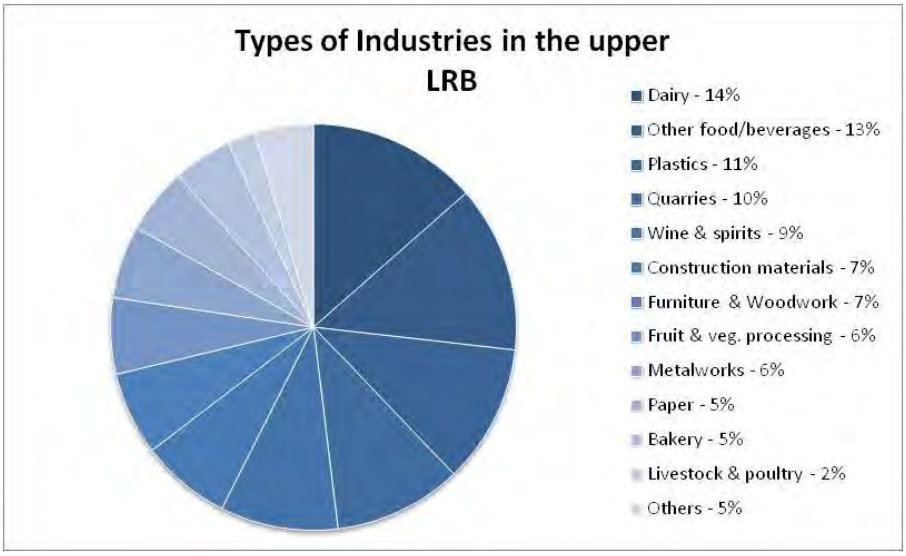
- **Fertilizer application rates routinely range from 1.5 to 3 times the needed doses**; indeed, over 90% of farmers do not practice soil analysis, referring instead to standard application rates as advised by agricultural dealers; and
- **Pesticide application rates are generally twice the needed doses**, with most farmers ignorant of pest management techniques and proper handling of pesticides.

Surplus fertilizers and pesticides either leach down to groundwater or are washed away with runoff flows into rivers and streams. Agriculture is thus the main contribution to non-point source pollution, that is that cannot be easily intercepted and treated but is widespread all over the fields.

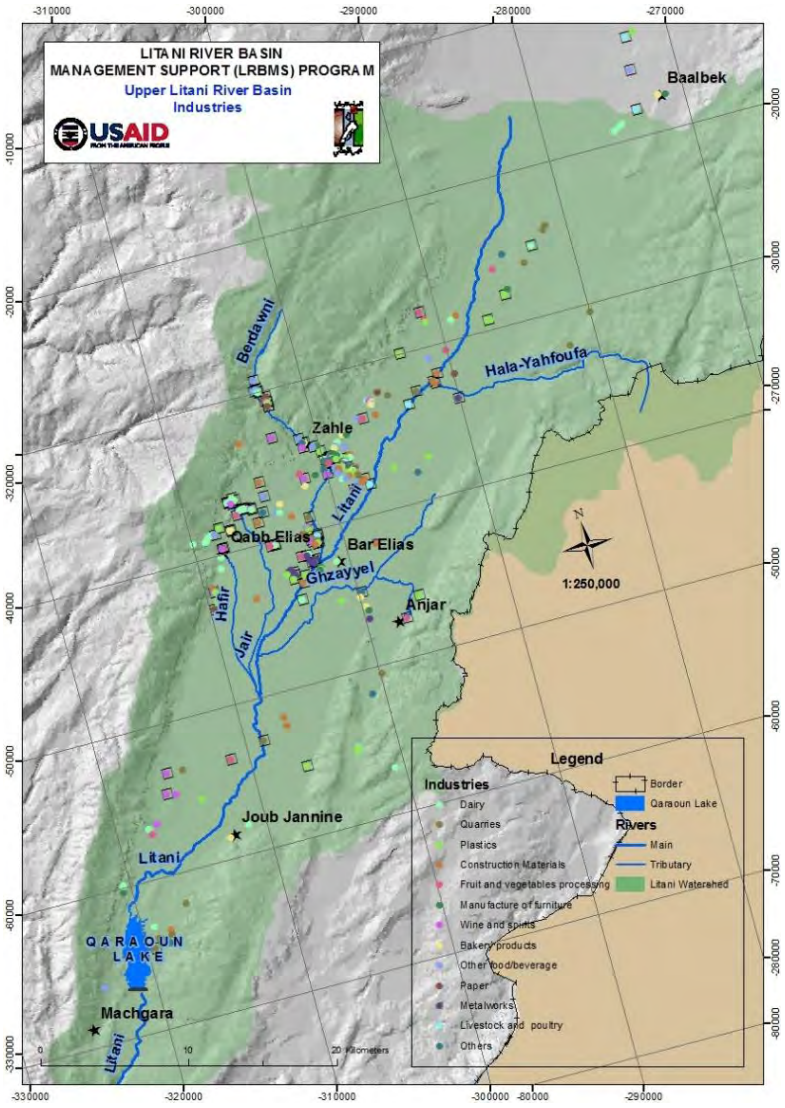
While farmers do generally understand that overuse of fertilizers and pesticides negatively influence water and soil quality and crop yields, most consider that wastewater and solid waste as the main sources of pollution, much more than agricultural practices.

4.1.4 INDUSTRIES AND QUARRIES

About 300 industries are identified in the upper Litani River Basin. Half of these industrial activities are concentrated in the industrial zones of Zahle and Tanayel. Agribusiness industries (dairy, wine, livestock and poultry, fruit and vegetable processing, etc.) count for about half of these industries.



Most of these industries operate without much consideration for simple hygienic and sanitary precautions and even large factories routinely discharge their effluents directly into the Litani River and other waterways, either directly or through sewage networks not connected to treatment plants.



Industrial activities produce both liquid effluents and solid wastes, which can contribute both organic and inorganic pollutants:

- **Organic pollutants** include sugars, oils and fats, proteins, hydrocarbons, phenols, detergents, and organic acids. Most of these are biodegradable, given sufficient water volumes to dilute and decompose them. When in high concentration, they decompose much slower and cause direct and indirect pollution.
- **Inorganic pollutants** include alkalis, mineral acids, inorganic salts, metal salts, chemicals such as chlorine, ammonia, phosphates, sulphates, nitrites and nitrates, etc. These are generally not easily biodegradable and thus accumulate in soils, crops, and living organisms

FOOD INDUSTRIES generate wastewater that is different from common municipal wastewater: while mostly biodegradable, it holds higher concentrations of biochemical oxygen demand (BOD) and suspended solids (SS).Such effluents vary depending on the products (fruits, vegetables, meat) and due to the seasonal nature of food processing and post-harvesting:

- Vegetable washing generates high loads of particulate matter and dissolved organics.
- Animal slaughter and processing produces strong organic wastewater that is possibly contaminated by significant levels of antibiotics and growth hormones and by pesticides used to control parasites.
- Food processing produces cooking wastes which contain quantities of oil or fats, are rich in organic material, and may also contain salts, coloring material and acids or alkali.

Effluents from **DAIRY FARMS** specifically have a high biological load. Cows are prolific producers of manure and urine; pollution-wise one cow is equivalent to 20-30 human beings, so a 1000-farm dairy farm pollutes as much as a small town.

PLASTIC particles are an increasing cause of water pollution. Plastics are not easily biodegradable, they break down into micro-particles that are ingested by small aquatic and land organisms and move up the food chain, eventually reaching human beings. Industrial practices in plastic manufacture can lead to polluting effluents and the use of toxic intermediates, the exposure to which can be hazardous.

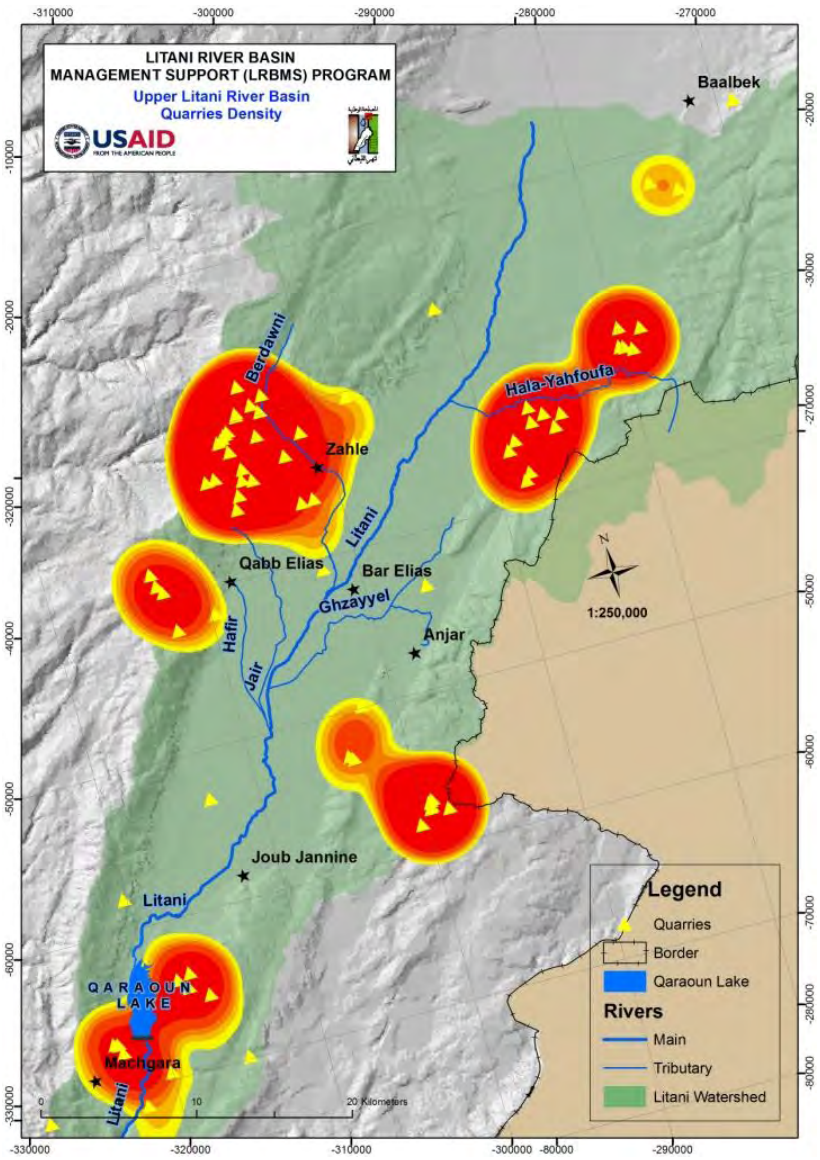
Of specific concern are the following large industries:

- The industrial area of Zahle, with notably food processing units, metal and mechanic workshops, a battery recycling unit, etc.
- The entire industrial area of Tanayel, with the Tanayel farms (dairy factory)…
- Libanlait, the largest dairy factory in the Bekaa,
- The Tanmieh chicken slaughterhouse;
- The Sicomo paper mill next to Aammiq;
- The Mimosa paper mill in Qaa Rim;
- The MasterChips factory in Ferzol;
- Other food processing workshops (Domanco, Tiba foods, etc.) as well as several olive oil presses;
- Etc.

Limestone quarries are present throughout the upper Litani River Basin, and notably on Jabal Sannine above Zahle, and along the Yahfoufa.

Quarries and Mines

They introduce large amounts of rock particles in water. These arise from rainfall washing exposed surfaces and also from rock washing and grading processes. Oils and hydraulic oils are also common contaminants.



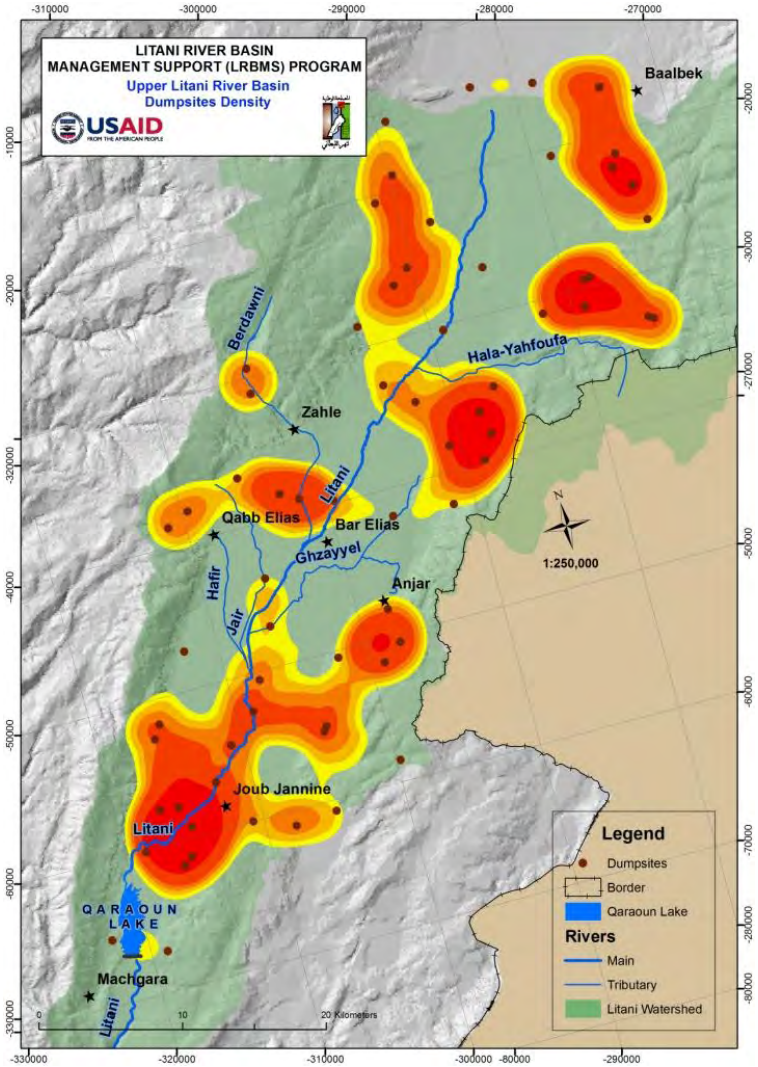
4.1.5 SOLID WASTE DUMPING

Littering is a serious concern along the Litani River and its tributaries. Only information and awareness can prevent this widespread behavior. Unfortunately even garbage disposal into dumpsites is no less polluting, as most dumpsites are unregulated and inadequately equipped and maintained. Maintenance is often limited to occasional burning (generating toxic gases and air pollution).

Dumpsites

They are a pollution source since hazardous, organic, and industrial wastes decompose and seep into the ground or a nearby river. The liquid product is called leachate and contains a variety of substances such as metals, minerals, organic chemicals, bacteria, viruses, explosives, flammables, and other toxic materials.

Dumpsites are spread all over the upper Liatni River, some big on the banks of the River of its tributaries. In all these dumpsites, wastes are indiscriminately piled up, and include all types of solid wastes: organic and packaging garbage, oil cans, wood and plastics, along with hazardous industrial wastes such as used oils, grease, used batteries, and wastes potentially contaminated with traces of heavy metals.



The only legal and adequate solid waste disposal facility is the Zahle landfill, which collects solid waste from Zahle and neighboring cities including Baalbeck. Although the landfill manages leachate (through recirculation and trucking to Beirut-Ghadir wastewater treatment plant), occasional overflow to the Litani River occurs.

Of specific concern are the following dumpsites:

Name	Waste (tons/day)	Comments
Temnin el Tahta	8	Directly on the Litani river bank, receives some hazardous medical waste from Temnin hospital
El Kayyal	50	Far from any waterway, but large and contaminates groundwaters
Baalbeck	-	Abandoned but large and continues to leach into groundwaters
Britel	10	Away from waterways, but significant and contaminates groundwaters
El Taybe	-	Abandoned but continues to leach into groundwaters
Douress	10	Away from waterways, but contaminates groundwaters
El Nabi Cheet	11	Away from waterways, but contaminates groundwaters
Riyaq-Hawch Hala	-	Abandoned but next to the Hala-Yahfoufa watercourse
Saadnayel	-	Abandoned but next to the Berdaouni watercourse
Qabb Elias	9	Close to the Jair watercourse
Qoussaya	-	Abandoned but continues to leach into groundwaters
Bar Elias	30	Away from waterways but large and contaminates groundwaters
El Khiyara	1.5	On the bank of the Faregh watercourse (derivation of the Ghzayyel)
Hawch el Harimi	4	On the bank of the Ghzayyel watercourse
Majdel Anjar	-	Abandoned but continues to leach into groundwaters
Joub Jennine	15	Directly on the Litani river bank, receives some hazardous medical waste from Farhat hospital
Ghazze	4	100m from the Litani River

Source: UNDP Business plan for Lake Qaraoun

4.2. PRESSURES ON WATER QUANTITY

4.2.1 AVAILABILITIES

Water resources in the Litani River Basin come from precipitations, that is rain and snow that fall on the central and south Bekaa. Annual rainfalls are estimated at 1100 Mm3 on an average year. About 60% of these evaporate and are not usable. The remainder are the available water resources, over 440 Mm3/year. Half of these

Water volumes and human needs

A human being needs a minimum of 1,000 m3 per year, out of which 900 is needed for food production, the rest being for domestic and industrial needs. One million m3 per year (Mm3/year) can thus provide for about 1,000 people.

waters recharge the groundwater (most of it resurfaces through springs) and the other half flows directly to the river.

4.2.2 WATER USES

Rivers and aquifers in the upper Litani River Basin are mostly used in summer for irrigation, with a smaller share being used for domestic and industrial needs. Unused winter rains are stored in Lake Qaraoun where they are currently diverted year-round to the Awali River for hydropower production. In more details, the main uses for water resources are:

- Domestic needs, where residents (and businesses) need potable water for drinking, hygiene and other household activities; most of the water volumes such used are not consumed but simply polluted and released as wastewater; these needs are around 20 Mm3/year for residents of the Litani River Basin);
- Industrial needs where factories or workshops use water for their industrial processes (washing, cooling, mixing, etc.); most of these water volumes are also not consumed but turned into wastewater; current needs in the Litani River Basin are about 5 Mm3/year;
- Irrigation needs where water is supplied to crops to support their development; the water volumes used that way are actually consumed through evapo-transpiration (part of the growth process of plants); current use in the Litani River Basin is close to 200 Mm3/year, the majority coming from groundwater pumping (from wells) during summer;
- Hydropower, where volumes of water are lowered through turbines to produce electricity; here also the volumes of water are not consumed but simply dropped altitude-wise; the majority of the volumes reaching Qaraoun lake are used that way, that is 250-300 Mm3/year;
- Other human uses such as boating, swimming, fishing or raising fish, hunting, walking along rivers or lakes, etc.; and
- Environmental uses (fish, wildlife, river vegetation, etc.).

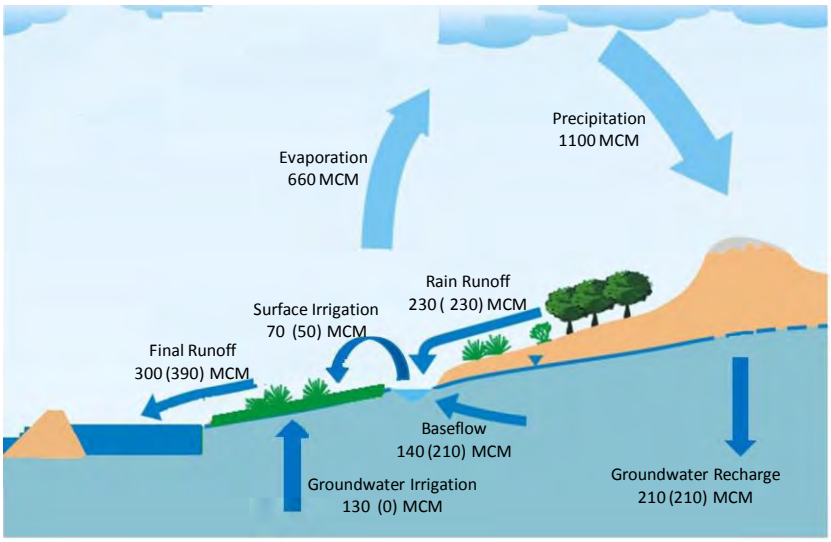
Environmental flow

An environmental flow is a reserved minimal amount of water that is kept in a river to ensure its survival and the provision of benefits such as:

- Natural dilution/treatment of polluted effluents
- Quality water for irrigation and other downstream users
- Attractive destination for residents, tourists, recreational fishers
- Economic activities and environmentally-based tourism
- Healthy wildlife including fish, amphibians, and water birds
- Healthy river vegetation, which reduces river maintenance costs

4.2.3 WATER BALANCE FOR THE UPPER BASIN

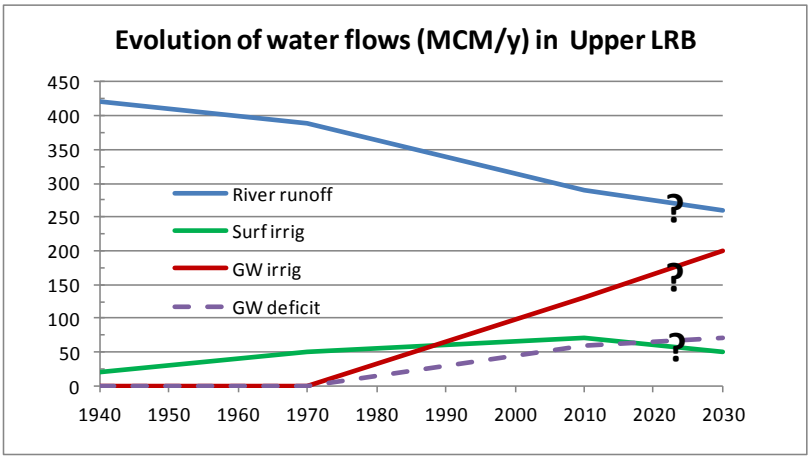
A water balance of the upper Litani River Basin shows that human pressure on water resources has increased drastically since the 1970s; the most important changes being:



Current (&1970) Water Balance

- Significant decrease of surface flows due to increased withdrawals, through [illegible] irrigation purposes;
- Substantial groundwater depletion, due to extensive pumping both for domestic and irrigation needs.

The issue of sustainable water management in the Litani River Basin clearly needs to be addressed, since:



- Current and future water balances for the upper basin show that demands are outpacing availability;
- Plans are being made to use the volumes stored within Qaraoun Lake to supply Beirut with potable water (Bisri-Awali project), and to irrigate large areas in the South (projects of Canal 800 and Canal 600); and
- Since population and water demands keep increasing in the Litani River Basin and in Lebanon as a whole, the question of allocating decreasing water volumes may turn into heated disputes, especially without transparent discussions and proper planning.

Water use practices and behaviors have to be improved in terms of water use efficiencies, which can only be addressed through awareness and stewardship/empowerment of water users, and improved performance and coordination among water management agencies.

Climatic variability and Climate Change

Climatic variability means that there are dry and wet years, but some climatic stability also exist over human-size periods of time (decades or centuries). This allows hydrologists to calculate (statistically) rain and flow averages (as well as extremes: floods and droughts). Such information is essential for water resource planning and the proper design of water structures. The assumption of climatic stability is of course not valid over longer periods of time: Earth's history and even recent human history has known Ice Ages and warmer weather periods. This assumption is also seriously challenged nowadays by the human-induced Climate Change: climate averages and extremes will probably change quite rapidly in the very near future.

4.2.4 OFFICIAL AND CURRENT WATER ALLOCATION

The allocation of water resources from the Litani River Basin is ruled by Decree 14522 dated May 10, 1970, which decided the allocation of water in the southern half of Lebanon, from Beirut to the southern and Syrian borders. That Decree considers for the Upper Litani River, that the average total volume available every summer is 270 Mm3:

Source	Volume available in summer (Mm3)	Allocation	Situation today
Various Bekaa springs	50	Irrigation and domestic needs in the Bekaa	Used so
Groundwater resources	60		Actual use is double at 130 Mm3
Summer storage in Qaraoun reservoir (*)	160 (from winter rains)	30 for Canal 900 34.5 for hydropower 95.5 for Canal 800 in the south	8 for Canal 900 150 for hydropower

Note: on an average year another 50-100Mm3 transit through the reservoir in winter and produce electricity.

A recent (Oct 2011) decision by the Council of Ministers updates the allocation of Litani waters for the upcoming 10 years to justify the Greater Beirut Water Supply Project (conveyor Awali-Beirut):

Project	Water needs after 10 years (Mm3)
Canal 900 irrigation project	10
Canal 800 irrigation project	110
West Bekaa drinking needs	25
Qasmiye irrigation project	30
Chouf drinking water	12
Leba irrigation project	10
Zahrani Nabatiye project	40
Beirut drinking water	80-120
Saida drinking water	9
Total	326-366

The governmental decision questions the feasibility (in terms of available water resources) to operate simultaneously Canal 800 and GBWS projects, but assumes that the latter project would be completed first and a new Dam on the Bisri River would increase water supply when Canal 800 gets under full operation.

Implied here are that:

- Most of the Litani waters will supply areas outside of the river basin, namely the South (canal 800) and Beirut (GBWS);
- Canal 900 is not to be expanded beyond its current (pilot) stage, since the Canal 900 allocation is now only 10 Mm3 (down from 30 Mm3); and
- Irrigation in the central and South Bekaa will have to rely on the (already over-used) springs and groundwater resources, as no additional resources are available.

As water needs increase while available resources and notably groundwater resources are possibly decreasing, the critical question of how much of Litani Water Resources should be kept in the River Basin and how much should be shared with the rest of Lebanon (and notably Beirut) is a question without easy answers but worth a transparent and accountable decision process.

4.3. WATER MANAGEMENT DEFICIENCIES

Water governance is in Lebanon similar to other Middle-eastern countries in that recent reforms and improvements are hampered by:

- A **political bias for engineering projects and constructions** (tangible outcomes), while management reforms are avoided as more difficult and riskier (while much cheaper and often more efficient);
- A **lack of leadership and political will** to:
  - **Follow though and enforce reforms**; the World Bank comments that recent reforms are: "unlikely to deliver the expected gains unless there is a strong political willingness to address the challenges facing the water sector"[6];

Need more water?

1) Build a new dam to increase supply. This is expensive but visible and somewhat effective.

Or

2) Address network leaks, illegal connections, and wasteful practices. This is much less visible, more difficult, less expensive and often more effective.

[6] World Bank, 2010: Republic of Lebanon - Water Sector: Public Expenditure Review

- **Address critical issues and take brave decisions**, even if these challenge special interests or are unpopular; a good example in Lebanon is the issue of water tariffs which remain low by world and regional standards, thus preventing RWEs from being financially healthy, modernize their networks, and improve their services;

- An **overall lack of staff capacity**, both at technical and managerial levels, due to:
  - A hiring freeze since the 90s (due to GoL indebtedness and concerns about over-staffing from patronage); the MoEW recently acknowledged a critical managerial gap: about half of department heads are "acting" (and sometimes head two departments);
  - Patronage/favoritism that reserves positions (notably at managerial levels) based on allegiances and family links, not capability;
  - Non-competitive salaries and promotions based on seniority or patronage, not performance;
  - Usual top-down type of management which centralizes (and delays) decision making and stifles initiative; and
  - A general lack of accountability and performance monitoring where units and individual staff do not have clear responsibilities, nor annual objectives/targets.

Accountable Management

Reform change happens when competent managers are appointed, empowered, and held accountable. In Lebanon, the highest career civil servants are the General Directors. These are appointed based on sectarian identity, not competence, and usually remain in place until retirement, regardless of performance.

Much remains to be done to provide solid water governance for improved water management in the Litani River Basin. The first requirement is to follow the universal principles of transparency, participation and accountability, which are lacking in the Middle-East:

- Information remains a source of power for government officials and is hidden, toyed with, or ignored as suitable; decisions are taken at central level in a opaque manner, are often implemented without public consultation;

Three essential processes for good water governance

1. **Transparency.** *Information should flow freely within a society. Governance processes and decisions should be open to the public.* Government officials should share water information related to policy, legal, and regulatory changes, development plans, allocation decisions, resources status and uses, etc.
2. **Participation.** *All citizens should have a voice, directly or through representative organizations, throughout water policy formulation and decision-making.* Government officials should solicit, consider, and use input from civil society and elected legislators.
3. **Accountability and Integrity**. *Governments, the private sector and civil society organizations should be accountable to the public.* Water officials and managers should be evaluated based on their performance/progress towards clear objectives. Local/regional officials should be empowered so that decisions are taken at the lowest competent level (subsidiarity).

- Participation by water users, residents and other stakeholders is token at best, with decisions and plans being presented when final;
- Accountability is as often with the public sector almost non-existent, with incompetent managers being kept in place and not even challenged to improve.

This is specifically true for the Litani River Basin where:

- Information remains elusive, with too few solid technical reports (see section 6), these not being presented to and discussed with local leaders such as mayors and other elected officials, farmer and business representatives, NGOs and other relevant parties;
- Participation is limited; indeed there is currently no platform for residents and water users to be informed and consulted on water issues and express their needs and concerns; and
- Projects (dam projects such as Khardale, Kfar Syr, irrigation ones such as Canal 900, Canal 800, Canal 600) are discussed and decided in Beirut without Litani River Basin residents and water users being consulted or informed.

Participation in water management

Participation is not about:
- Consensus (rarely achievable); or
- Citizens voting or deciding on projects.

Participation is about residents and water users being:
- Listened to so that their actual needs and concerns are properly understood;
- Informed at planning stage about the issue being addressed;
- Consulted when different/alternative solutions are considered and compared;
- Presented with the final decision/ project and its justification;
- Updated during project implementation.

It is about managers taking decisions in a transparent and accountable manner:
- **Accountability** forces decision makers to consider people concerns and not simply base decisions on special interests (lobbies), personal preferences, political agendas, or opportunities for personal wealth.
- **Transparency** allows citizens to understand how decisions are taken, why and by whom, and exercise their voting rights accordingly.

Participation in water management:
- **Addresses water issues** by involving residents and water users and leading them to adopt better water practices (in terms of water use efficiency and pollution control);
- **Improves coordination** among central agencies, local authorities, and representatives from residents and water users (notably by clarifying roles and responsibilities);
- **Ensures buy-in and commitment** of all parties to plans and decisions;
- **Builds the capacity** of all parties; and thus
- **Improves overall water management performance**.

5. SOLUTIONS AND OPPORTUNITIES

"Water users are the issue since they pollute and waste water. How can one hope to solve the water issue without involving them?"

5.1. WHAT SOLUTIONS?

5.1.1 REALISTIC AND EFFECTIVE SOLUTIONS

Solutions do exist to reverse the negative trends faced by water resources in the Litani River Basin and establish sustainable water management practices so that all water users can equitably access and benefit from water resources. Such solutions fall under four themes:

- **Infrastructure development such as the construction of water networks and wastewater treatment plants is much needed, but it is far from enough**. First because the operation and maintenance of these structures is often deficient (due to lack of coordination between financers/builders such as CDR and MoEW and operators such as RWEs and LRA). Second because these structures cannot address water issues such as industrial pollution, leaching from improvised dump sites, and agricultural pollutions (due to over-fertilization by farmers).
- **Improving water governance (i.e. laws, institutional roles, policies) is critical in Lebanon** since incomplete laws, unclear institutional roles, staff and capacity shortages, centralization and inadequate coordination combine to prevent effective water management and often even the simple operation of water structures.
- **Enforcement and measurements are also necessary** to monitor withdrawals and releases, and to protect the rivers from many abuses such as industrial effluents or bank infringements (farmer temporary dams or ponds). Some legal framework exists for that purpose, but monitoring and enforcement are difficult and costly while not sufficient since they cannot tackle widespread issues such as groundwater over-extraction.

- Finally and essentially, **the mitigation and eventual resolution of current water challenges require awareness and stewardship**, i.e. a change in the behaviors and practices by water users who better understand the consequences of their activities and actions, feel responsible and participate in the mitigation and resolution of water issues.

It is only through a combination of these four approaches, and notably the empowerment and participation of water users, that water issues can be tackled, their consequences addressed and their causes reversed to ensure sustainable and equitable use of water resources. This type of combined effort is called Integrated Water Resource Management (IWRM).

5.1.2 WHAT IS IWRM-IRBM?

In recent years a consensus has developed worldwide to conclude that proper water management should rest on the principles of Integrated Water Resources Management (IWRM) or Integrated River Basin Management (IRBM).

Integrated Water Resource Management (IWRM)

A process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment. (Global Water Partnership)

Addressing water challenges today requires more than the simple harnessing of water resources though the construction and operation of water structures. This "old school" engineering approach of water development narrowly focuses on improving the supply and remains still too frequent among water managers. This approach however fails in front of water challenges such as limited availability, wasteful overuse, and diffuse pollution.

IWRM emphasizes the **need for:**

- **Management of the water cycle (not simply of water infrastructures)**, acknowledging interactions between surface and groundwater resources, between quantity and quality issues, and between parallel projects and activities; such management obviously starts with proper monitoring;
- **Coordination among and between managers and users** because no water issue or project should be assessed individually due to impacts to other projects/users;
- **Attention to land use and related resources** because again of the interactions between these and water resources (for example in terms of pollution);

- **Consideration of equity issues in the allocation of resources** so that costs and benefits are shared equitably (e.g. principles of "user pays" and "polluter pays");

User pays and polluter pays Principles

Both of these legal principles are based on the assumption that the most efficient allocation of resources occurs when water users directly pay for the water they use or the pollution they cause.

The **user/beneficiary pays principle** is enacted to ensure that actual users pay the full cost of the goods or services that they consume. When water tariffs are low or wastewater tariffs inexistent, the government has to subsidize water delivery and wastewater treatment (using taxes collected from all citizens). While it seems OK for citizens and businesses to thus pay indirectly for water (though their taxes and not through their water fees) since they are also water users, in reality this approach usually benefits much more to large consumers such as industries or farms who do not necessarily pay more taxes but do use much larger volumes of water.

The **polluter pays principle** is enacted to make the party producing pollution pay for the remediation or depollution. If a factory pollutes the river, why should all downstream users suffer the consequences of bad water quality in terms of health and economic activities? Likewise why should it be up to the government (using taxes collected from citizens and businesses) to build a treatment facility for industrial releases?

- **Sustainability** as current solutions should not come at the detriment of longer term impacts, notably on the natural environment; and
- **Ownership and stewardship** since involving water users promotes better behaviors and practices and improves both project effectiveness and monitoring.

2000 European Water Framework Directive

It follows the principles of IRBM and is built on four main pillars:

1. Coordinated action to achieve 'good status' for all waters, surface and groundwater.
2. Setting up a water-management system based on natural river basin districts, crossing regional and national boundaries.
3. Integrated water management, bringing different water management issues into one framework.
4. Active involvement of interested parties and consultation of the public.

All river basins in the European Union were to have River Basin Management Plans by 2009.

5.2. OPPORTUNITIES IN THE LITANI RIVER BASIN

Addressing the water challenges and improving the management of water in the Litani River Basin requires the four types of activities described earlier:

- **Infrastructure development**, which is chiefly the responsibility of CDR and MoEW but would greatly benefit from better coordination with operators (RWEs and LRA) and with Municipalities to inform residents, and ensure their support and contribution.

- **Legal backing from the Water Code** being prepared by the MoEW; this draft code supports IWRM and even defines the contents of a RBMP;
- **Field presence for enforcement and monitoring**, which is possible through the Litani River Authority ("Office National du Litani"); and
- **Growing awareness and participation of residents and water users**.

While donor support and GoL funds address infrastructure development, excellent opportunities exist in the Litani River Basin to implement the other three types of activities.

5.2.1 WATER CODE AND RBMP

Within the context of IRBM, a River Basin Management Plan (RBMP) is a participatory planning process producing a **multi-year realistic/achievable action plan** to:

- Prioritize and target water issues;
- Identify clear objectives;
- Involve municipalities and water user entities along with government agencies;
- Define roles and responsibilities;
- Allocate resources, equipment and staff; and
- Implement activities and monitor progress.

The draft Water Code being prepared in Lebanon defines the contents of a RBMP:

1. A presentation report detailing the characteristics of the river basin, based on an assessment of water resources and ecosystems.
2. A management plan which sets:
    a. Qualitative and quantitative objectives and deadlines to reach those;
    b. Procedures for regulating releases and ensuring the protection of water resources, ecosystems and water fauna and flora;
    c. Procedures for allocation of water resources among all types of users;
    d. Management processes for crises such as pollutions, droughts, floods, fires, etc.
    e. Resources to be mobilized to reach the targets;
    f. Indicators to monitor progress of activities and compare to targets;
3. Maps to describe the areas of action.

The draft Water Code needs however to be expanded to define the development process and implementation procedures of the RBMP, and the corresponding roles of water agencies.

5.2.2 THE LITANI RIVER AUTHORITY (OFFICE NATIONAL DU LITANI)

The Litani River Authority (LRA) was established in 1954 on the model of the US Bureau of Reclamation to facilitate the integrated development of the Litani River Basin. Its purpose was to:

1. Execute irrigation and energy projects on the Litani River
2. Create a transmission network linking the major generating facilities in the country
3. Create a nation-wide electrical distribution network

Additional responsibilities were added over the years:

4. Surface water flow monitoring across the country
5. Water quality monitoring in the Litani Basin
6. Planning and studies for new irrigation schemes in the Litani River Basin and operation and maintenance of all irrigation projects, both large and small, in South Lebanon.

US Bureau of Reclamation (USBR)

Established in 1902 to water and settle the arid Western States, the USBR achieved major civil engineering works over the next 75 years:

- Hundreds of dams and hydropower plants, such as Hoover and Glen Canyon Dams;
- Large irrigation schemes such as the Central Valley Project; and
- Transfer canals such as the Central Arizona Aqueduct.

Three factors led in the 1980s to a major questioning of USBR's role:

- Readily available water resources had been exploited and costs of mobilizing remaining resources were very high;
- Rising management/allocation conflicts with and among water users as well as increasing pollution/environmental challenges due to inadequate practices (notably industries); and
- Lack of public support for funding of large water investment programs.

Major reforms in 1988 and 1994 changed USBR from water resource **development** agency to water resource **management** agency, and resulted in decreased but more diversely qualified staff, flattened organizational structure, simplified administrative processes, and greater delegation to the field.

All levels of USBR staff were involved and active in designing and implementing new operational modes and this invigorated the organization with a clear shared sense of purpose and mission. USBR's redefined official mission is to "manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public".

The Litani River Authority (LRA) is a unique opportunity to provide a decentralized management structure for the Litani River Basin. Under the guidance of the MoEW, LRA offers:

- Monitoring capacity and routine collection of water data;
- Technical staff with both presence in and knowledge of the Litani River Basin;
- Institutional structure that is meant to focus on the Litani River Basin; and
- Financial autonomy as the LRA earns all its revenues from Electricite du Liban through production of hydro-electricity.

5.2.3 RESIDENT AND USER MOBILIZATION

Residents and municipalities of the Litani River Basin are increasingly concerned about the situation of the River and of water resources in general. **Mayors recently met and signed a common document to voice their concern.** This document and the group of mayors involved in this initiative constitute an excellent opportunity to engage Municipalities and other local leaders.

Letter signed by 21 Municipalities of the upper Litani River Basin
(translation)

Vision
To establish a cooperative network including Litani Basin municipalities, LRA and other official entities involved in river water protection, now and in the future.

Objectives

- Complete wastewater systems: collection networks and treatment plants
- Establish systems for collecting, recycling, disposing solid waste
- Extend Canal 900 irrigation system, and equitably organize its use
- Limit over-use of agricultural chemical fertilizer/pesticides which are harmful to public health
- Prevent industrial pollution from factories

First steps

- Signing of this MOU by all Municipalities
- Engaging proper authorities starting with President, Prime Minister and Parliament Speaker, then MoEW, Ministry of Interior & Municipalities, CDR, etc.
- Initiate specific local activities in partnership with LRA, NGO and voluntary bodies
- Establishing monitoring and enforcing system to encourage best water use practices and hold accountable polluters and illegal activities

These Mayors should be supported and empowered to be part of the water management team for the Litani River Basin. They are an **essential link with water users** to:

- **Promote better practices and behaviors**, preventing pollution and water wastages through dialogue, awareness, and field enforcement;
- **Implement local activities** that build stewardship, i.e. the ownership feeling that gets residents and users involved and more responsible in their activities;
- **Provide information** to decision makers and managers to better plan and implement water activities and projects; and
- **Assist with the implementation and operation** of such activities and projects.

6. ROADMAP FORWARD

"Individual commitment to a group effort is what makes a team, a company, a community, or a civilization succeed."

6.1. FOUR TOOLS FOR AN IRBM APPROACH

Water issues in the Litani River Basin are significant, they impact both health and socio-economic welfare of residents and will likely grow over time if no pro-active decisions and measures are adopted and implemented. **Solutions do exist as long as they include the four essential themes** described in the previous section:

- **Infrastructure development** (construction of water structures, networks and wastewater treatment plants);
- **Improving water governance** (i.e. laws, institutional roles, policies);
- **Enforcement and monitoring**; and
- **Awareness and water user participation**.

How to address these four themes? How to define and implement relevant activities under each theme to confidently tackle the water issues in the Litani River Basin?

The **four essential tools for a planned, participative, coherent and effective approach to solving water issues in the Litani River Basin** are (see also table next page):

- **Establishment of a River Basin Committee** to involve in a coordinated manner central agencies, local authorities, and representatives from residents and water users;
- **Preparation, implementation and monitoring of a River Basin Management Plan,** to develop a clear, realistic and focused Action Plan;
- **Establishment and empowerment of a River Basin Agency to implement,** to monitor and manage water resources in the field; and
- **Definition and implementation of priority and short-term activities** to raise public awareness, demonstrate quick results, and ensure credibility.

Developing and using these four tools is not an easy or simple process. However now it the time to start. The rewards are significant while the cost of inaction is already high.

Four tools to implement Integrated River Basin Management and thus tackle effectively water issues in the Litani River Basin

Theme	Currently	Needed IRBM approach	Lead Actor	Supporting actor(s)
Infrastructure development	CDR plans and builds without sufficient coordination with MEW, BWE, LRA, and little if any consultation of local authorities (municipalities and others). Consequently operation and maintenance of water structures and networks is often inadequate due to lack of proper transfer and capacity-building.	Projects impacting Litani waters are designed: • Through consideration of alternative solutions; • With technical and socio-economic justifications; • In consultation with Litani River Basin representatives through **River Basin Committee**; • Within a **River Basin Management Plan** for strategic coherence between projects.	MEW in consultation with BWE/LRA	Municipality and water user representatives (businesses, industries, farmers) through **River Basin Committee**
Better water governance	Little has been done since Law 221, which improved water supply setup but not the overall water management. Water Code remains a draft and has yet to be finalized and promulgated.	• Legal: Promulgation of draft Water Code • Institutional: clarification of roles and responsibilities. • Policies: empowerment of managers and staff, setting of annual goals.	Parliament & MEW	
Enforcement and monitoring	Enforcement and monitoring of water authorizations, withdrawals and releases are field activities which require field staff.	Empowerment of LRA as **River Basin Agency** so that water resources and water uses are effectively monitored and managed in the field.	LRA as **River Basin Agency**, along with **River Basin Committee**	MEW, BWE
Awareness & water user participation	Very few activities are conducted towards and with residents and water users.	**Development and implementation of priority and short-term activities** that address critical but local water issues. Such activities would: • Involve residents and water users; and • Favor management and behavioral changes over infrastructural solutions.		

6.2. ESTABLISHMENT OF A RIVER BASIN COMMITTEE

6.2.1 OBJECTIVE

Most countries effectively applying IRBM have established River Basin Committees, and acknowledge their essential role. The river basin committee is meant as a **platform to discuss and define the strategy for managing water resources in a river basin**, in conformity with the national water management plan. The main responsibilities of a RBC involve (within the river basin):

- Advising central agencies on water infrastructure projects;
- Defining the main priorities for water management;
- Leading the development and supervising the implementation of the RBMP;
- Coordinating and promoting water resource awareness and participation; and
- Forming ad-hoc working groups to discuss/study specific issues (possibly inviting outside parties and experts to provide their advice or opinion).

Such a river Basin Committee meets 2 to 6 times a year (bi-annual to bimonthly).

The implementation of the RBMP and actual water management should remain the responsibility of a governmental River Basin Agency. However the River Basin Committee would in the future become the Board of Directors of the River Basin Agency (as done in Europe and other countries).

River Basin Committees in Brazil

River Basin committees in Brazil are an attempt to democratically represent water users and civil society in the water decision-making process. In addition to worldwide changes in water management thinking, the general political climate of Brazil influenced the reform process. After the end of the dictatorial period and the new constitution of 1988, committees and councils were established in many different sectors like healthcare and education to promote participation and to enhance democracy.

The official mandate of basin committees in Brazil is described in the water law and involves:

- Stimulating the debate on issues relating to water resources and coordinating the action of water management bodies,
- Serving as the first administrative level for arbitration of water-use conflicts,
- Approving the basin plan and monitoring its execution,
- Establishing mechanisms and values for instituting water use charges,
- Defining criteria for cost sharing of engineering works for the public good (collective interest).

6.2.2 NEXT STEPS

The river basin committee is an assembly bringing together the various public or private groups involved in the field of water (users, elected representatives, government):

- Residents (mayors and other locally elected executive officials);
- Water users (businesses, farmers, industries, and any other economic activities using water resources and water ways as an input or benefit, such as restaurants and other tourist activities, also fishermen and fish farms, etc.); and
- Relevant ministries (water/public works, agriculture, environment, industry, etc.).

The first two categories usually represent more than half of the total number. They are elected among their peers while government representatives are appointed.

In Mozambique: the Limpopo River Basin

The Limpopo River Basin Management Unit is a governmental agency led by a Director and supervised by a **Committee (Board of Directors).** This Committee is not involved in everyday management but in strategic planning and thus meets quarterly.

The Committee is composed of 12 members:

- Director of the River Basin Agency;
- Representative from Provincial Government
- Representative from MoEnv
- Representative from provincial service of Rural Extension
- 2 representatives from association of irrigators
- 2 representatives of private farmers
- 2 representatives of Agrarian companies
- 2 representatives from Irrigation Scheme companies.

The involvement of municipality representatives is being discussed.

For the Litani River Basin, the first step would be to form a group of Mayors who would meet on a regular basis with the water managers/engineers from LRA, Bekaa RWE and MoEW. Other representatives (notably of businesses, farmers, and other economic activities) should be involved in the near future.

6.3. PREPARATION AND IMPLEMENTATION OF A RIVER BASIN MANAGEMENT PLAN

6.3.1 OBJECTIVE

Management is an everyday activity that remains improvised if not within the framework of a strategy: management then can only solve recurrent/common issues. When a new/unknown issue occurs, management takes time to understand the new situation and to address it by reallocating resources, staff, equipment, etc. This learning process is costly and time-consuming.

The goal of strategic planning is to identify potential future issues, envision solutions, anticipate by defining roles and processes and empowering local managers, and thus reduce the time and cost of addressing issues. **A River Basin Management Plan is such a tool to guide and coordinate water management within a river basin, as required by the 2000 European Water Framework**

Directive, practiced in many countries around the world, and envisioned by the upcoming Water Code in Lebanon.

6.3.2 NEXT STEPS

The development of a RBMP involves the following steps:

- Definition of the committee guiding the development (ideally a River Basin Committee);
- Preparation of a river basin assessment (the current document is proposed as such an assessment);
- Review and approval of assessment;
- Prioritization of issues, based on their criticality and relevance to residents and water users
- Setting of objectives for each priority issue, review of alternative approaches to reach these objectives, assessing their effectiveness and resource needs (funds, staff and staff capacity, equipment, etc.) and comparing these to available resources;
- Choice of preferred approach for each priority issue, setting or precise targets, assignment of roles;
- Definition of coordination and monitoring mechanisms; and
- Implementation and monitoring; and
- Regular review of progress, updating after a period of time, usually five-six years.

RBMP Principles

To be effective, a RBMP needs to follow some principles:

- Be realistic and focused;
- Have clear priorities, targets and timetables;
- Be readable & pedagogic; and
- Be a management tool, not a souvenir.

This development and preparation process could take as much as one year due to its participatory nature, and should involve public meetings as well. The resulting action plan would definitely be more effective than any strategy prepared at national level due to its focus, ownership by local leaders, grounding on sound information, agreed upon objectives and realistic approaches and thus a much higher probability of success.

6.4. ESTABLISHMENT AND EMPOWERMENT OF A RIVER BASIN AGENCY

6.4.1 OBJECTIVE

The MoEW is in Lebanon by law or by default responsible for a wide range of water management activities. Some of these activities are national level policy and strategic tasks, while others, such as monitoring of water resources, releases and withdrawals, are field activities. Such field activities are

more efficiently carried by lower level agencies with field presence and staff, under the guidance and supervision of the MoEW.

In many countries, the model of River Basin Agency has been adopted to address water governance deficiencies and specifically to:

- Decentralize water management (notably the monitoring of water resources, withdrawals and releases, but also the operation and maintenance of water structures);
- Allow nimbler and better (because field-based) decision-making (notably regarding local allocation conflicts);
- Ensure better coordination in the field between the various administrations (Water, Agriculture, Environment, Industry, etc.) and with local actors such as municipalities; and
- Promote improved water use practices through awareness activities.

A River Basin agency is a governmental agency with field staff, a cross-sectoral and geographical (river basin-focused) mandate, and a river Basin Committee as board of directors.

6.4.2 NEXT STEPS

As mentioned earlier, Lebanon is blessed with having an already existing agency with the adequate size, presence and geographic mandate. The Litani River Authority offers:

- Monitoring capacity and routine collection of water data;
- Technical staff with both presence in and knowledge of the Litani River Basin;
- Institutional structure that is meant to focus on the Litani River Basin; and
- Financial autonomy through revenues from hydropower (Qaraoun Dam and plants).

The Litani River Authority (LRA) is a unique opportunity to provide a decentralized management structure for water managers and water users to collaboratively discuss the current and future water challenges, and for decision makers to get feedback, present their decisions, and get essential support for successful implementation. What is needed is a similar reform to what other water agencies have experienced worldwide, that is a change of mandate from building and operating projects to managing and monitoring water resources. A revised LRA mission statement could read as such:

> ***"The mission of the Litani River Authority is to develop, manage, and protect the surface and ground waters of the Litani River Basin from the headwaters to the sea."***

Concrete next steps would be to:

- Revise accordingly LRA's mandate, expand its role to water resource management;
- Review and adjust the LRA organigram and also support adequate LRA staffing;
- Define annual objectives for LRA;
- Build capacity of LRA staff; and
- Confirm LRA's financial autonomy; and
- Modernize the role of LRA's Board of Directors as a strategic planning entity, eventually involving water user representatives and merging with the River Basin Committee.

Expanded LRA mandate

In its 2003 Master Plan, the LRA defines its responsibilities under hydropower production and irrigation development, but also suggests additional missions for the preservation and protection of water resources within the River Basin. These additional functions should cover at least:

- **Water quality monitoring**;
- **Groundwater monitoring**;
- **Awareness raising** through direct interactions with municipalities and water user representatives;
- **Water use monitoring**, i.e. monitoring of withdrawals and releases, both quantitatively and qualitatively.

Most of these field activities are currently inadequate or inexistent while in the mandate of the MoEW. To carry them out, MoEW has no staff nor capacity, nor logical role: in most countries it is local agencies (or MoEW delegations) who perform such field activities out, while the Ministry focuses on national-level infrastructure, policies, and strategic planning.

6.5. DEFINITION AND IMPLEMENTATION OF PRIORITY AND SHORT-TERM ACTIVITIES

6.5.1 OBJECTIVE

Whatever the approach, it is essential to start addressing concretely water issues in the Litani River Basin. The development of a detailed and agreed upon River Basin Management Plan can be a lengthy process and participants may tire of the process if they do not see tangible actions in parallel. Such activities would:

- Address critical needs, notably in terms of data collection and awareness raising;
- Involve residents and water users when possible;
- Implement small-scale infrastructure with local funding; and
- Most importantly favor management and behavioral changes over infrastructural solutions.

Basically three generic types of activities should be considered:

- Coordination among water agencies and local authorities to share information, staff and equipment, combine parallel efforts, prevent conflicting/overlapping decisions, etc.
- Monitoring and awareness raising activities which improve the general knowledge of the status and future of water resources in the Litani River Basin, so that water managers can take better decisions, identify and design better projects and better operate existing structures, plants, networks; and
- Collaborative/participative activities (including small-scale infrastructure with local funding) where residents and water users are key actors and learn through experience about better water use practices, thus reducing pollution and wastage.

6.5.2 EXAMPLES OF COORDINATION ACTIVITIES

Such activities are critical to share information, staff and equipment, combine parallel efforts, prevent conflicting/overlapping decisions, ensure a smooth transfer of responsibilities between design, construction and operation of water structures, and can be:

- Regular meetings between MoEW/LRA/CDR/BWE to share information regarding status of water resources, progress of construction works, and of existing water structures in the Litani River Basin
- Regular meeting among and between water agencies (LRA, BWE) and municipalities to share information and equipment, discuss and address collaboratively local water issues
- Regular meetings between water agencies (LRA, BWE) and local organizations (NGOs, business representatives, farmer representatives, etc.) to share information, combine efforts, raise awareness, etc.

Precise coordination mechanisms would also be defined in the Litani River Basin Management Plan.

6.5.3 EXAMPLES OF MONITORING & AWARENESS RAISING ACTIVITIES

No forward strategy for addressing water issues in the Litani River Basin can ignore the necessity to produce routine/reliable information on the availability, quality and use of water resources.

Immediate monitoring efforts should cover:

- Improved surface monitoring, looking at both quality and quantity (this implies improved data collection, storage, verification and analysis);
- Improved groundwater monitoring, again looking at both quality and quantity;

- Improved water use monitoring (notably looking at groundwater pumping and irrigation use in terms of volumes and efficiency), with a view at engaging users and polluters to enforce withdrawal limits and release restrictions; and
- Regular (monthly or weekly) information reports for water managers.

Results from the monitoring efforts should also be transcribed into regular (twice a year?) bulletins that present the main water information in a pedagogic manner for residents and water users (such bulletins should be available on Internet, with water agencies, and with Municipalities) and answer essential questions from residents and water users such as:

- Can one eat fish from Lake Qaraoun?
- Can one irrigate from the Ghzayyel or Berdaouni?
- Can one drink from the Machghara Spring? etc.

Awareness raising activities for both managers and residents/users would:

- Assess the current level of knowledge among residents and water users regarding pollution and depletion, their impacts and causes, and the mitigation practices that can be individually adopted; such a survey would guide future activities;
- Investigate the economic impacts of pollution:
  - Losses from farmers and existing businesses (for example restaurants along the river that lose customers to the smell of the Litani River); and
  - Missed opportunities: water sports, tourism, fisheries, boating, that cannot operate because of the poor water quality of Litani River and Lake Qaraoun;
- Assess the health impacts in terms of identifying diseases, risk factors, transmission vectors, and targets for preventive actions;
- Promote best water use practices through contests (notably in schools) and awards (for industries or villages/neighborhoods); etc.

Additional awareness activities would also be defined in the Litani River Basin Management Plan.

6.5.4 COLLABORATIVE/PARTICIPATIVE ACTIVITIES

An optimal approach is to use the River Basin Committee not only as a platform leading the development of the RBMP, but also as the engine for defining, developing and implementing concrete activities such as:

- Industrial pollution:

    - Dialogue between municipalities and polluting factories to consider steps to install pre-treatment and eventually complete mitigation of pollution
    - Small construction works to pre-treat industrial effluents
    - Leadership of Chamber of Industry/Commerce to design award system for "green/good factories"
- Domestic sewage pollution:
    - Rapid but annual assessment of the operating status of wastewater treatment plants
    - Rapid but annual update on the level (per municipality) of connection to sewage network
    - Local construction works on the sewage network
- Solid waste pollution:
    - Annual review (per municipality) of garbage collection and disposal processes
    - Simple incentive schemes to promote recycling
    - Small construction works to improve dumpsites
- Esthetics:
    - River/canal clean up activities (by residents)
    - Development of walking paths along waterways
- Agriculture:
    - Simple incentive schemes to promote soil analysis and prevent fertilizer over-use
    - Review of functioning of local Water Committees (irrigation), definition of simple allocation/pricing rules to better use irrigation water and solve conflicts
- Flood risk mitigation:
    - Annual (Fall) riverbed maintenance to maintain conveyance capacity of channels and sluices (e.g. removing irrigation diversion dams, garbage, etc.)
    - Small construction works on riverbanks to prevent riverbed obstructions
- Urban planning:
    - Partnership with LRA to define floodable areas and better plan urban development
    - Simple measures (fencing and posting) to protect springs and water supply sources from contamination from garbage, livestock, etc.

Small-scale infrastructure can be built with local/donor funding to support these activities.

Additional concrete activities would also be defined in the Litani River Basin Management Plan.

7. SELECT REFERENCES

General Description of the river basin:

- Description of the selected non-EU river basin Litani (Lebanon), SPI-Water (EU-funded), 2007: an excellent overview of the river basin and its current condition.

Physical description of the River:

- Walk-through of the Litani and tributaries, LRBMS (USAID-funded), 2011

Groundwater:

- Les Eaux Souterraines au Liban, UNDP 1970: dated but last solid assessment of groundwater resources in Lebanon
- Resources en Eau de la Bekaa Centrale, FAO 1976
- Groundwater Assessment, LRBMS (USAID-funded), 2011

Water quality:

- Water Quality Surveys of the Upper Litani River Basin, Fall 2010 and Spring 2011, AUB for LRBMS (USAID-funded)
- Swedish
- BAMAS (USAID-funded)

Water quantity:

- Ibrahim Abd-El-Al, Le Litani Etude Hydrologique, 1948 (in Oeuvres completes, Editions de AFIAL): solid hydrologic and economic analysis (within the knowledge and limitations of the time) of the potential for harnessing the Litani River.
- Water Balance for the Upper Litani River Basin, LRBMS (USAID-funded), 2011

Water pressures:

- Business Plan for Combating Pollution of the Qaraoun Lake, ELARD (UNDP-funded), 2011: Comprehensive and thorough review of the water quality situation in the Upper Litani River Basin and Qaraoun Lake, with detailed inventories of pollution sources.