



# **Workshop on Climate Change Adaptation in the Economic Development Sector Using Integrated Water Resources Management (IWRM) Tools**

## **IWRM Tools within the context of climate Change**

**Eng. Mona Fakh  
Director of Water  
Ministry of Energy & Water**

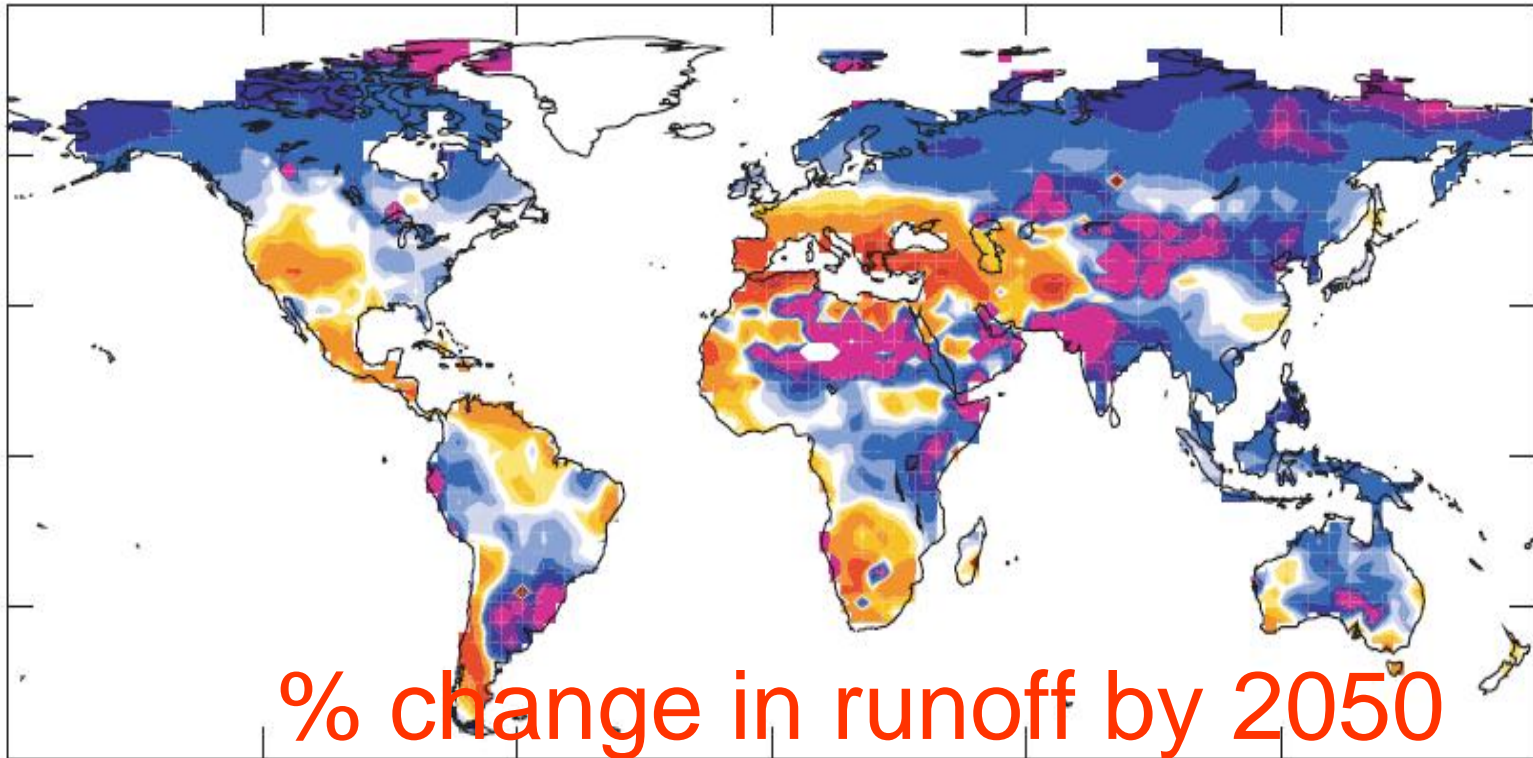
**Venue : Amman, 25-27 May 2016**

# Global warming cannot now be avoided.

Fresh water resources will be directly affected in the coming years!

water availability

a



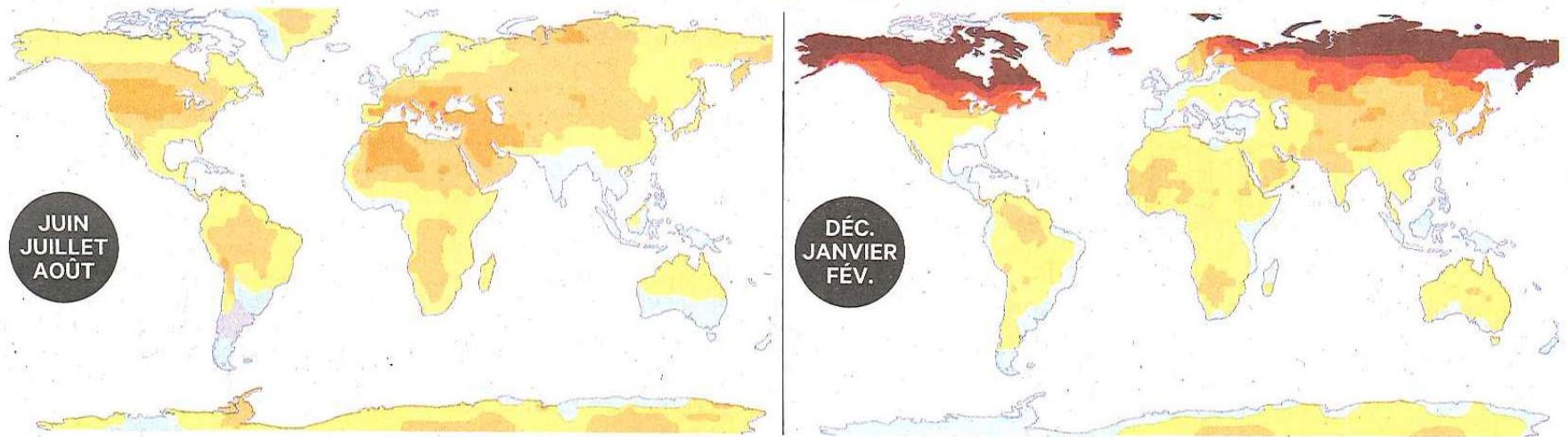
% change in runoff by 2050

# Global warming cannot now be avoided.

## Les régions les plus exposées au réchauffement climatique

Ecart des températures en 2080-2100 par rapport à la moyenne actuelle, en degrés

0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10



IDÉ / «LES ÉCHOS» / SOURCE : BANQUE MONDIALE

- Many of the major “food-bowls” of the world are projected to become significantly drier
- Globally there will be more precipitation
- Higher temperatures will tend to reduce run off
- A few important areas drier (Mediterranean, southern South America, northern Brazil, west and south Africa)

# **Climate change consequences**



**The climate change is likely to increase the frequency of extreme events, such as floods and droughts:**

# Knowledge on projected climate impacts on hydrologic system – Lebanon (1/2)

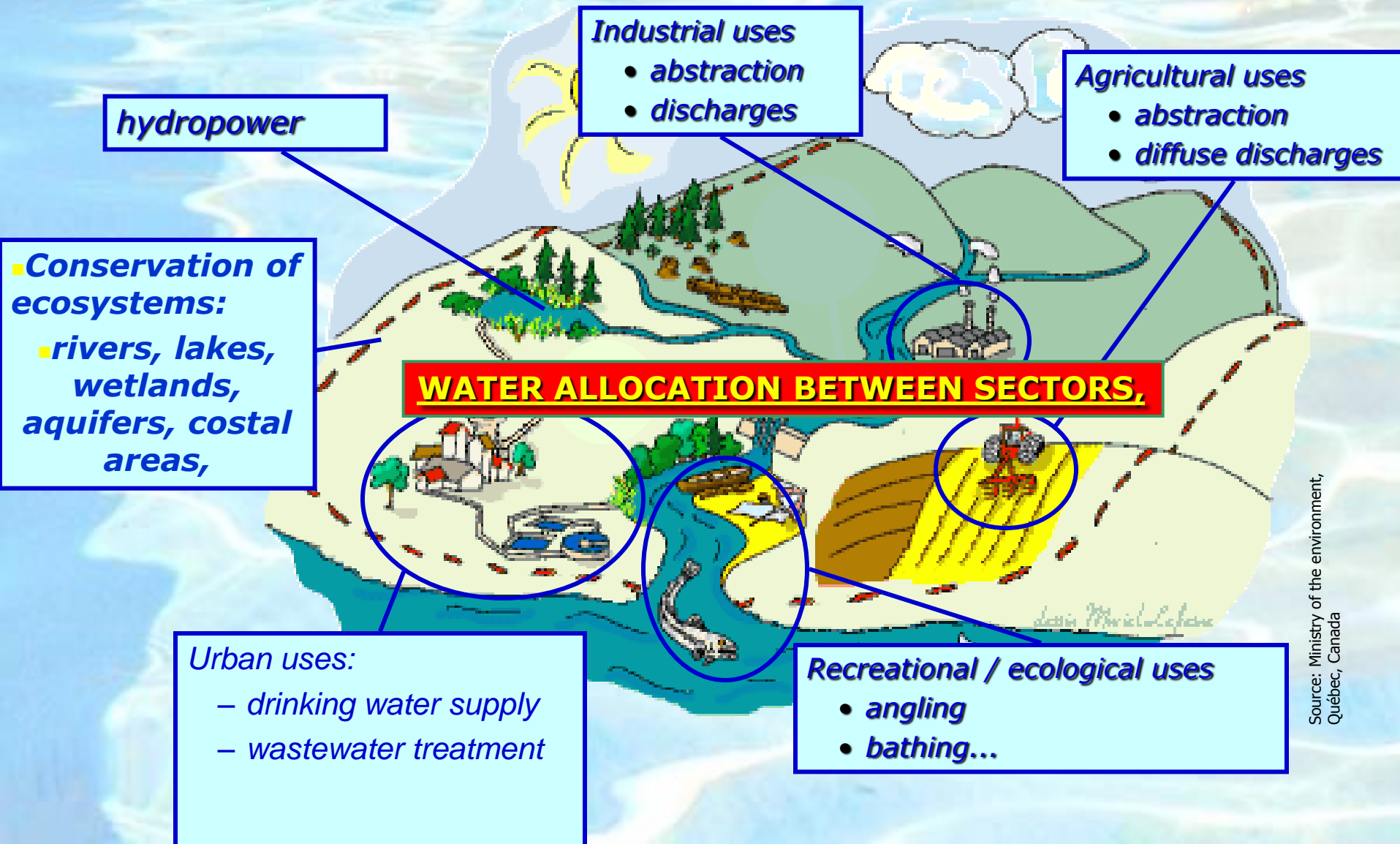
- **Temperature (Increase)**: +1 °C coastal & +2 °C inland by 2040
- **Precipitation (Decrease)**: Between 10% & 20% by 2040
  - **Snow:**
    - **Snowfall (Decrease)**: reduced season between 2 and 6 weeks
      - **Snow depth (Decrease)**: 50% w/ 2°C warming (~-20cm at 2,000m amsl)
    - **Snowfall (Retreat)**: from 1500 to 1700m w/2 °C warming
      - **Snowpack volume (Decrease)**: from 1200 to 700 MCM w/ +2°C

# Knowledge on projected climate impacts on hydrologic system – Lebanon (2/2)

- **Evapotranspiration (Increase):**
  - Coastal : 1% by 2044; Mountain: 5% by 2044; Inland: 26% by 2044
- **Hydrology and Hydrogeology (Decrease):**
  - Decreasing surface runoff and groundwater recharge
- **Water Resources (Decrease):** -12 to 16 % at 2 °C warming
- **Water supplying cost (Increase):** all sectors



# CLIMATE CHANGE CONCERNS ALL MAJOR WATER USES



# MEW & IWRM Planning in Lebanon

## Progress & achievements

- IWRM concepts: **Creation of a framework for broad stakeholder participation**
- **Revision of water Legislation** (2000) and its amendment (2001)
- **National 10-year Strategy Plan for the Water Sector**
- **National Water Sector Strategy (NWSS)** (approved March 2012)
- **Water Code**: cooperation programme between Lebanon and France. **The Water Code has been submitted to the Council of Ministers for approval.**



# Lebanon Strategic Plan 2000-2010-2018

## General Principles

- ➔ Ensure additional water storage installations (dams, lakes, recharge of aquifers...)
- ➔ Establish drinking water projects (Distribution **network and efficiency**, **Public Private Partnership** involvements,...)
- ➔ Consider various irrigation projects (Ensuring **food security**, network efficiency...)
- ➔ Ensure wastewater collecting projects and treatment plants (**water reuse** for irrigation, municipal use and artificial recharge of aquifers...).
- ➔ Consider infrastructures for flood mitigation, rectification and alignment of rivers beds.
- ➔ New Water Mass : Conventional and Non-conventional water

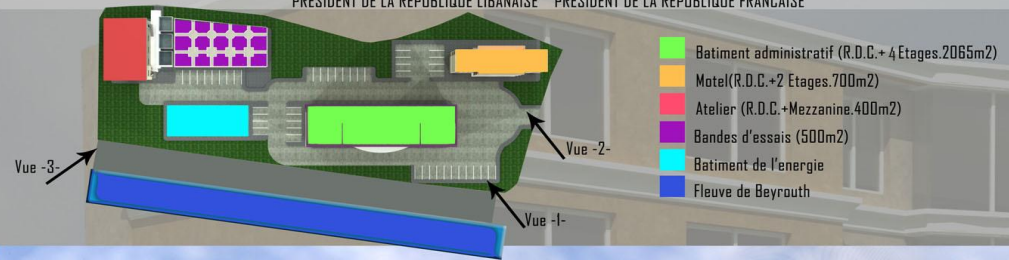
# Planning, Management, Decision Making

- **Projet de Centre d'Information et de Formation aux Métiers de l'Eau  
C.I.F.M.E au Liban**
  - This center has been labeled by UfM on 7th of April by a unanimous decision of 43 Member Countries of the Union, under project of title : “Towards a Mediterranean Knowledge Platform on Water”.
  - Feasibility study has been recently implemented by OIEau and Funded by AfD”.

# Projet de Centre d'Information et de Formation aux Métiers de l'Eau

## C.I.F.M.E au Liban

CENTRE D'INFORMATION ET DE FORMATION AUX MÉTIERS DE L'EAU (C.I.F.M.E.)  
 CENTRE MICHEL SLEIMAN ET NICOLAS SARKOZY  
 PRÉSIDENT DE LA RÉPUBLIQUE LIBANAISE PRÉSIDENT DE LA RÉPUBLIQUE FRANÇAISE



Vue aerienn



Hazmieh

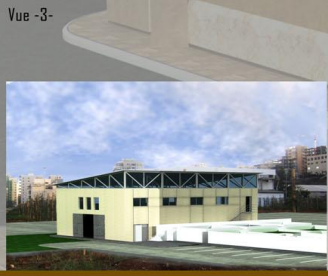
Vue -1-



Vue Atelier+ bandes d'essais



Vue Motel



Vue -3-



Vue -2-



Facade: Batiment administratif



Facade: Batiment motel



Maintenance



Operation



Operation

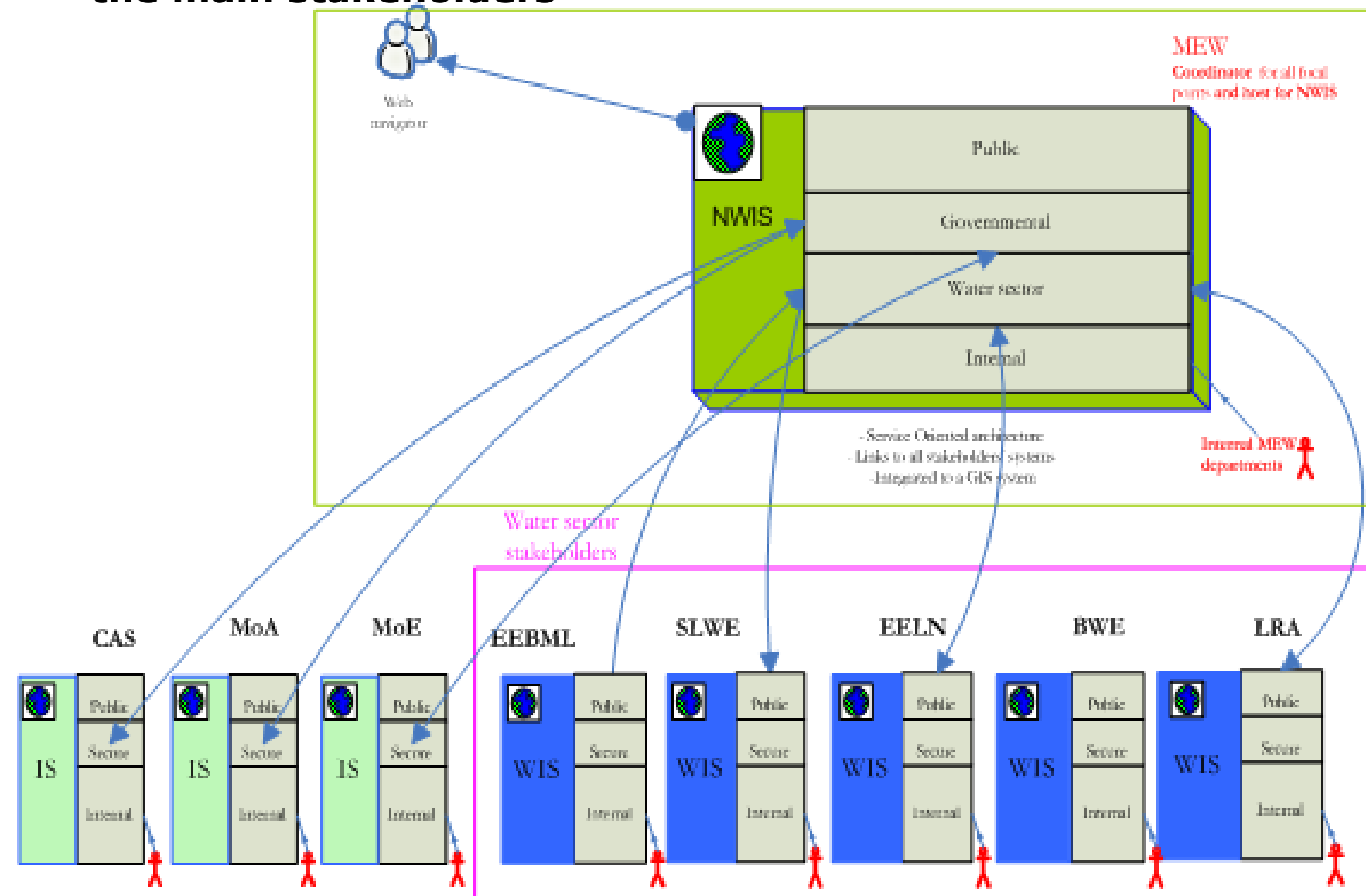


Water quality analysis

# On the field training and capacity building (for stuff)



# Overview of NWIS and sub-systems overall architecture with the main stakeholders



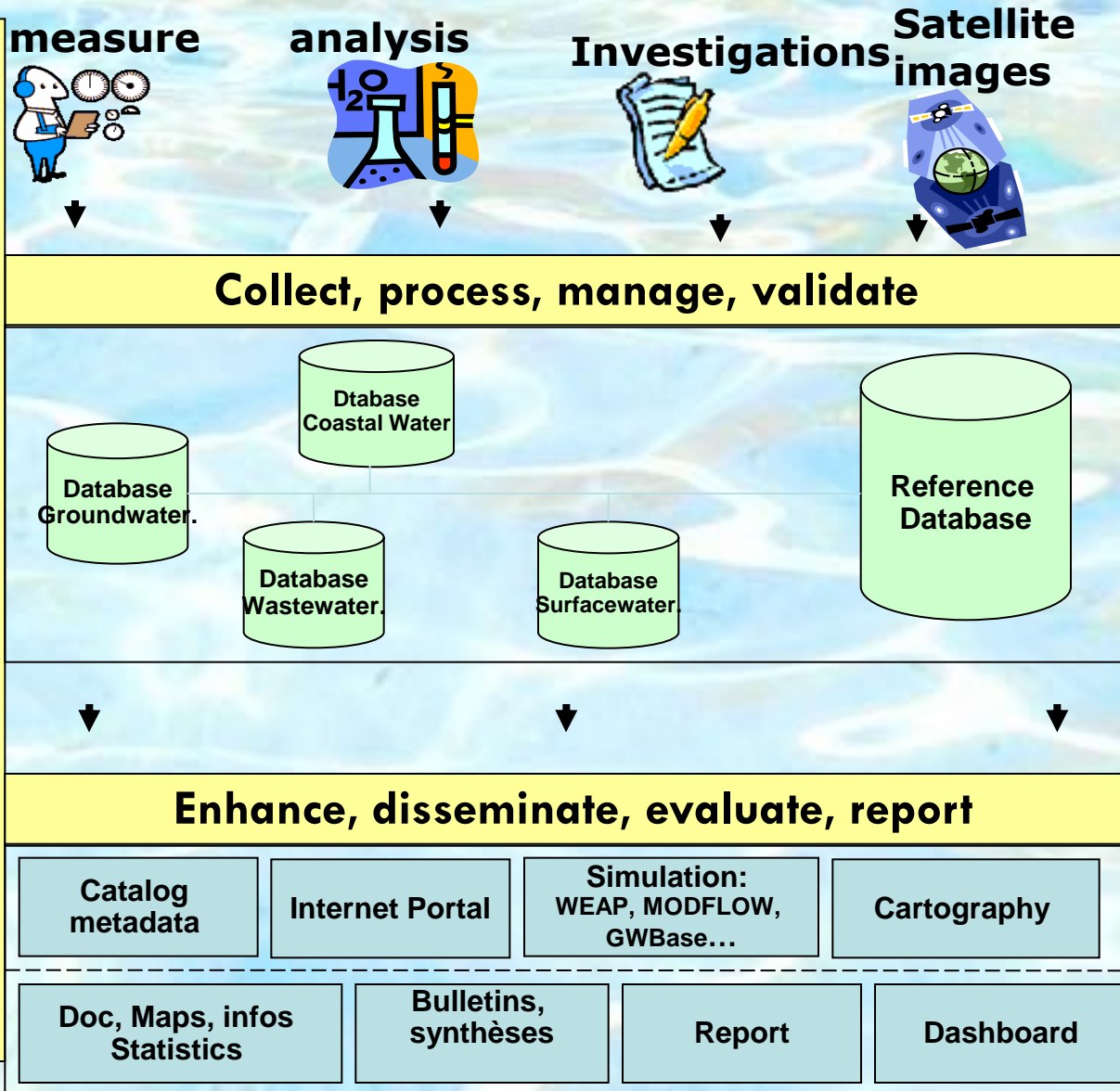
- Each stakeholder will be responsible managing its own system

- Data is distributed in databases maintained by each stakeholder

# Information Component – Principles

**Develop and implement an organization**

**Define the needs**



**Application of the International Standards**

# Database

## Groundwater Assessment and Database Project

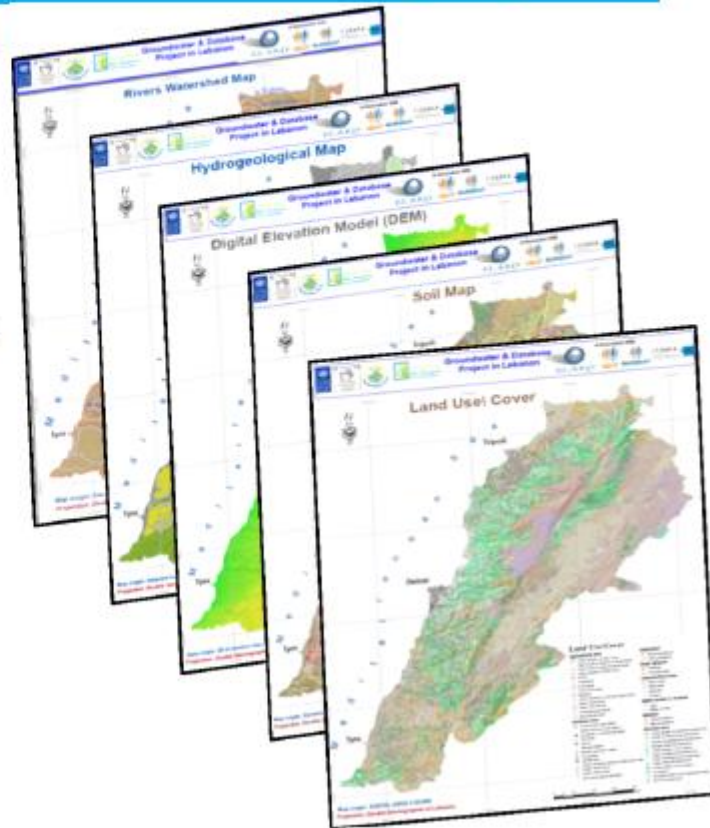
26-11-2013



### Preliminary Baseline Data Assessment

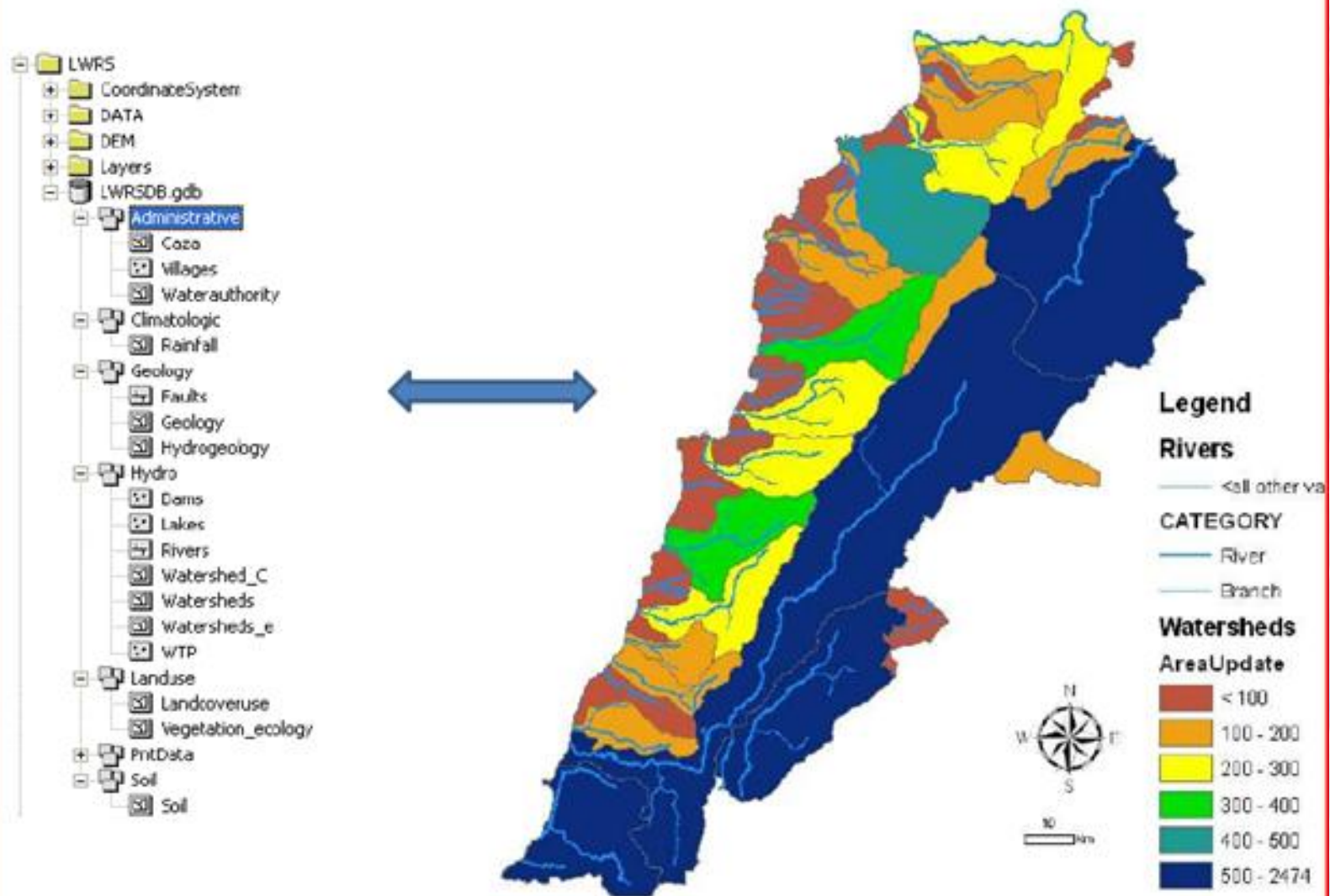


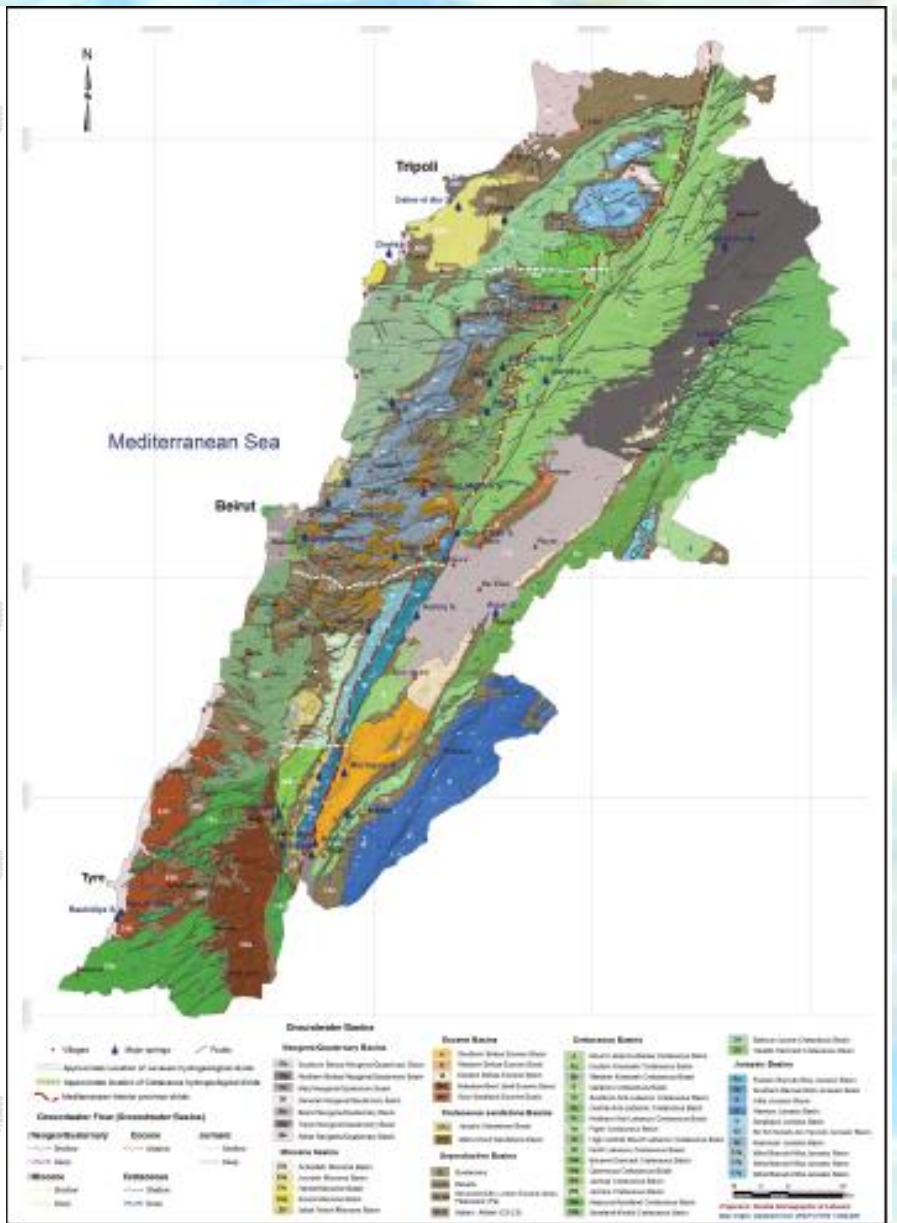
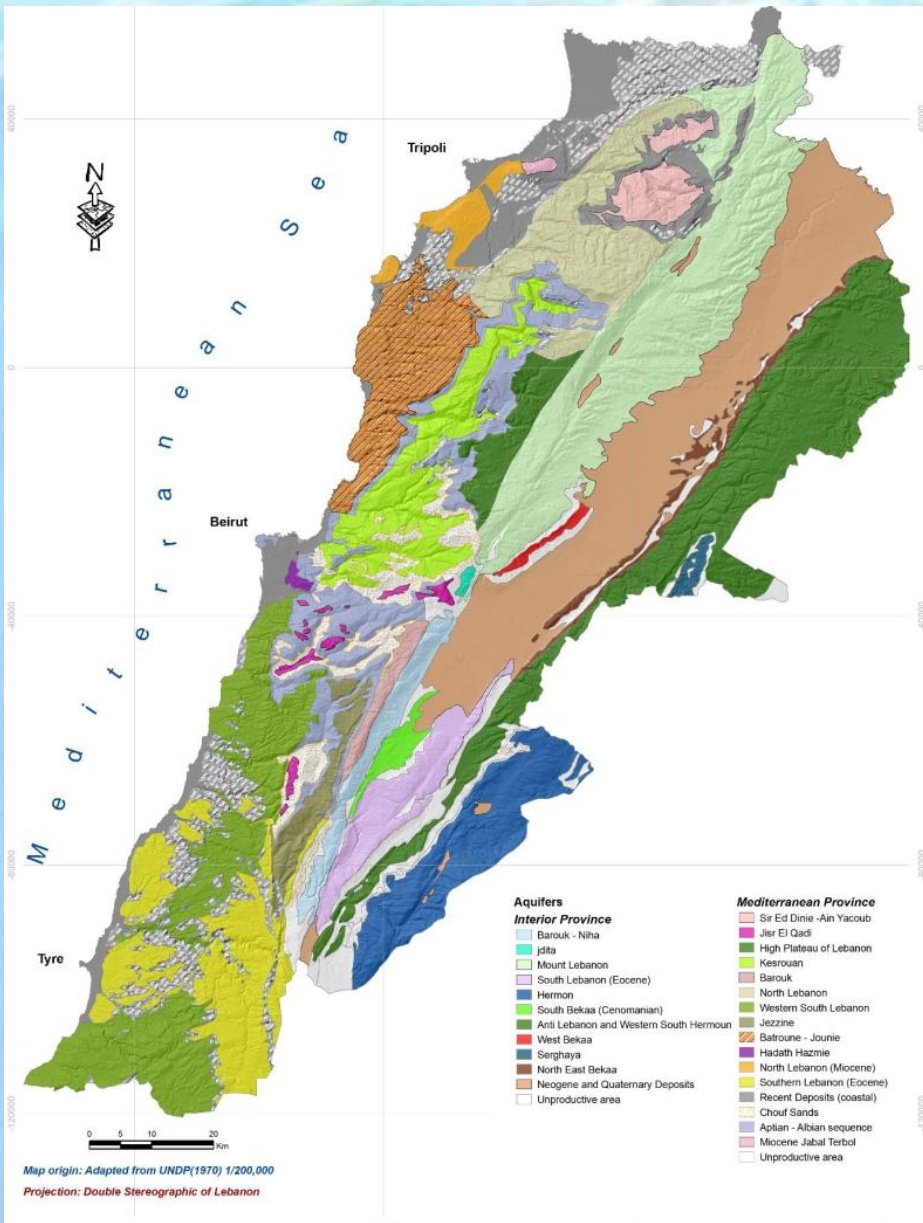
- Collection and assessment of data related to:
  - Meteorology
  - Hydrology
  - Hydrogeology
- A set of maps were generated at a scale 1/50,000 including:
  - Meteorology
  - Hydrology
  - Topography
  - Land use/cover
  - Soil
  - Geology
  - Hydrogeology
  - Snow





# Geodatabase Representation





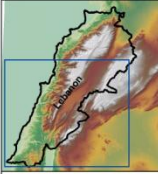
**basins are the natural territories,  
in which water runs,  
on the soil or in the sub-soil,  
whatever are the national or administrative boundaries  
or limits crossed.**



**An overall approach should be organized  
on the relevant scale  
of basin areas of rivers, lakes and aquifers,**

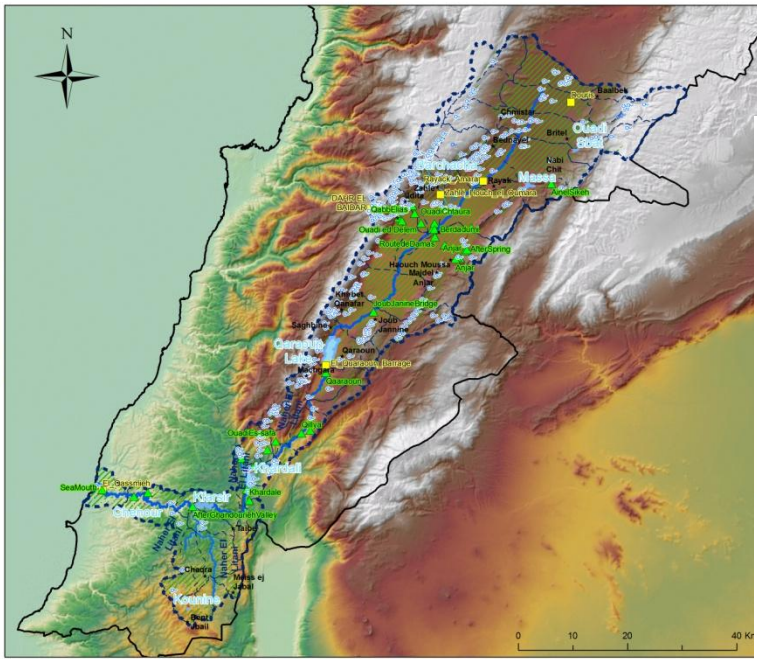


### Basin Overview Litani

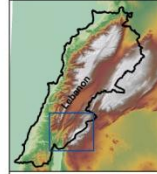


#### Legend

- Towns
- Springs
- Gauging Stations
- Weather Stations
- Dams
- Basin Limit
- Watersheds Limits
- River
- Main
- Sub-Main
- Secondary
- Agricultural Land
- Border
- Lakes

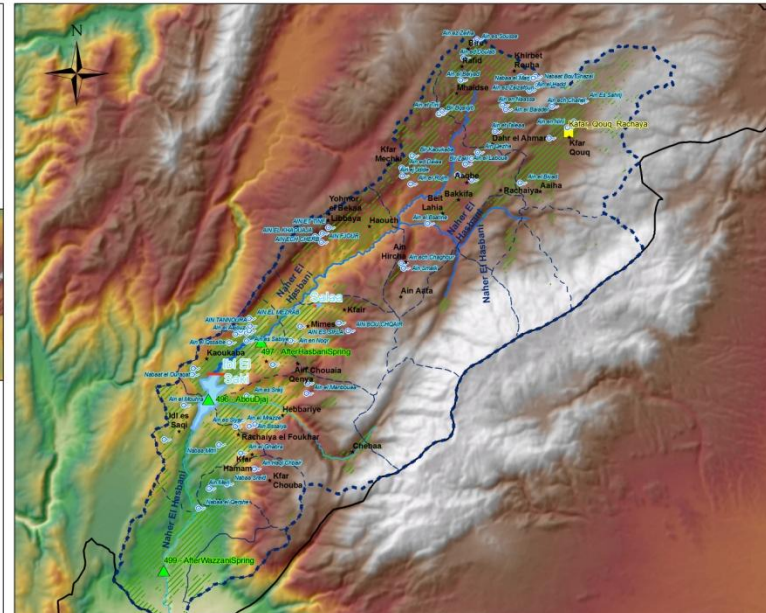


### Basin Overview El Hasbani

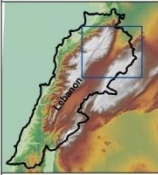


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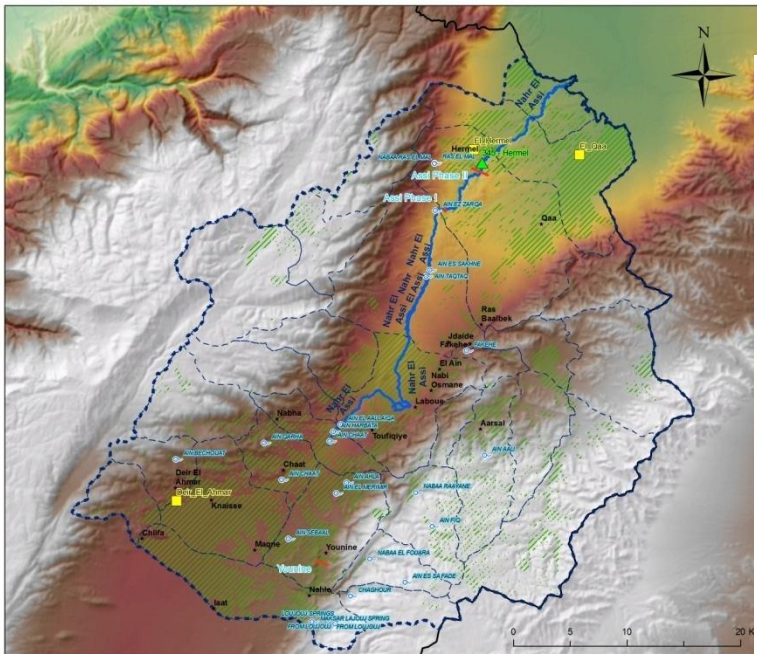


### Basin Overview Al Assi

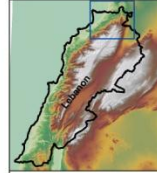


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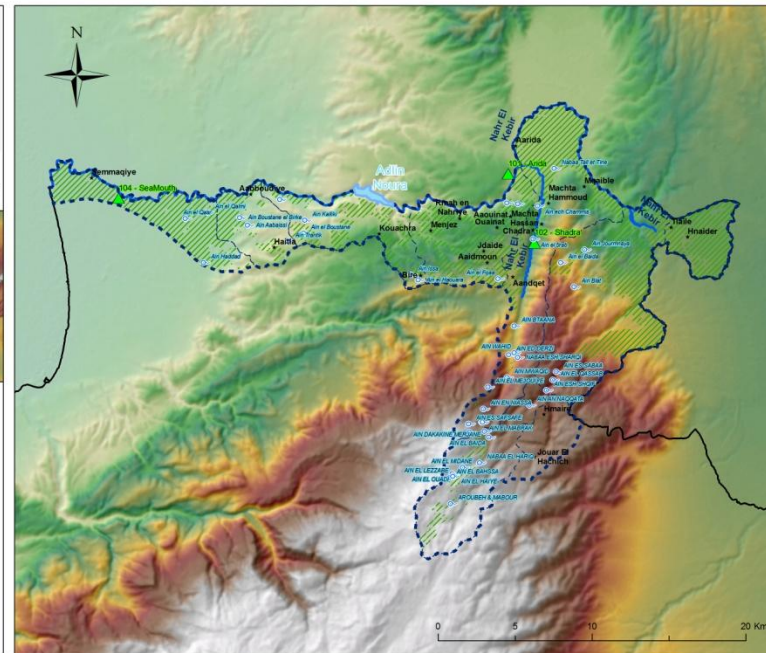


### Basin Overview Naher El Kebir



#### Legend

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# Simulation: WEAP, MODFLOW, GWBase...

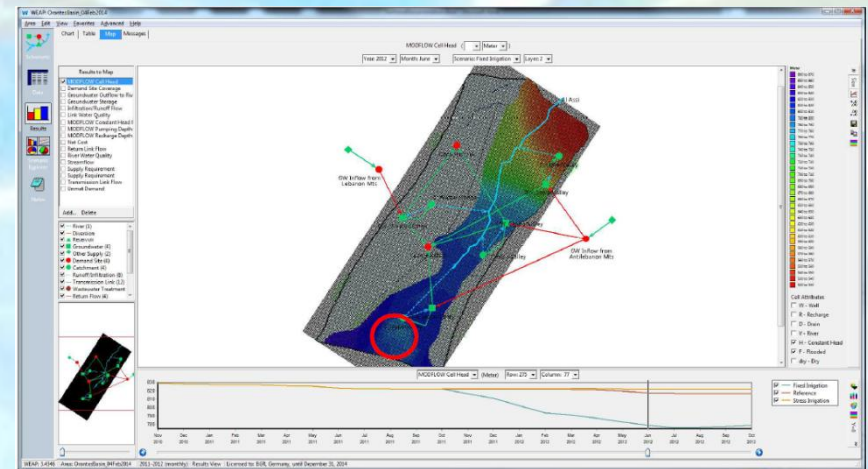
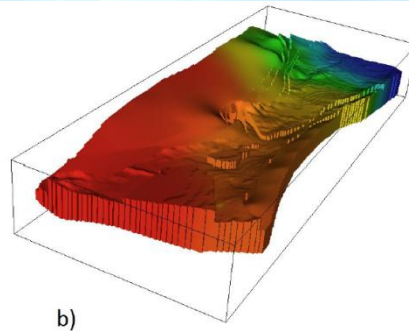
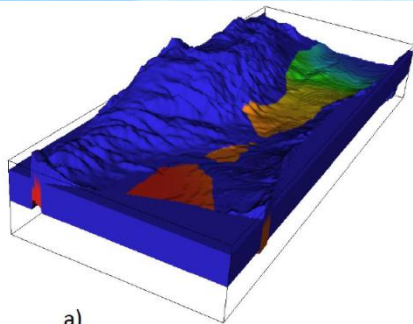
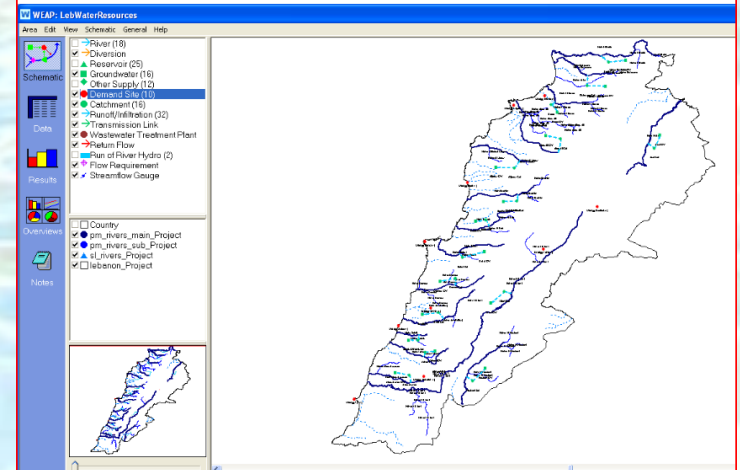
## GW-Base<sup>®</sup> 8.0

### Features:

- Map display
- Basic station data
- Water level data
- Logger data
- Sample and analysis data
- Geological data
- Climate data
- Evaluations
- Reports



## WEAP Model Interface



# WEAP & MODFLOW Combined Model



# Evaluation of scenarios

WEAP: OrontesBasin

Area Edit View Explorer Advanced Help

All  Auto Calculate Calculate Now

**Data Variables**

Click here to add a slider for a data variable

**Scenarios**

- Reference
- Fixed Irrigation
- Stress Irrigation

Default Manage  Show Data Variables? All Scenarios  Annual Total  Monthly Average

Charts Table

**Supply Requirement (including loss, reuse and DSM) All months (12)**

Year	Reference	Fixed Irrigation	Stress Irrigation
2011	0.7	0.7	0.7
2012	0.65	1.35	0.55

**Supply Requirement (including loss, reuse and DSM) All months (12)**

Year	Reference	Fixed Irrigation	Stress Irrigation
2011	0.7	0.7	0.7
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**MODFLOW Groundwater Inflow and Outflows by Aquifer Scenario: Reference, All months (12), All Groundwater (4), Aquifer: Aquifer 1 (Layer 1)**

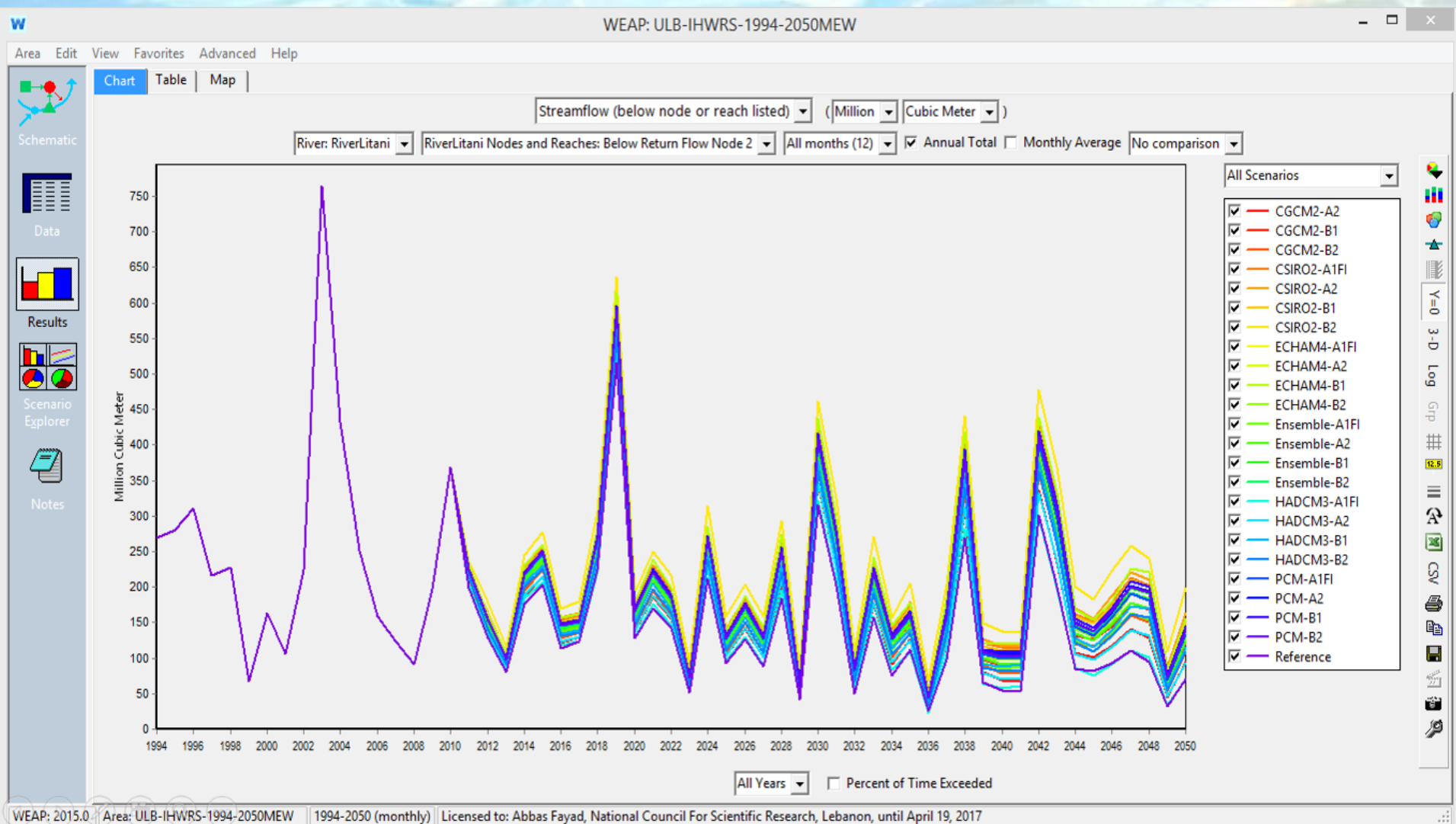
1,100  
1,000  
900  
800  
700  
600  
500  
400  
300  
200  
100  
0

2011 2012

— Reference — Fixed Irrigation — Stress Irrigation

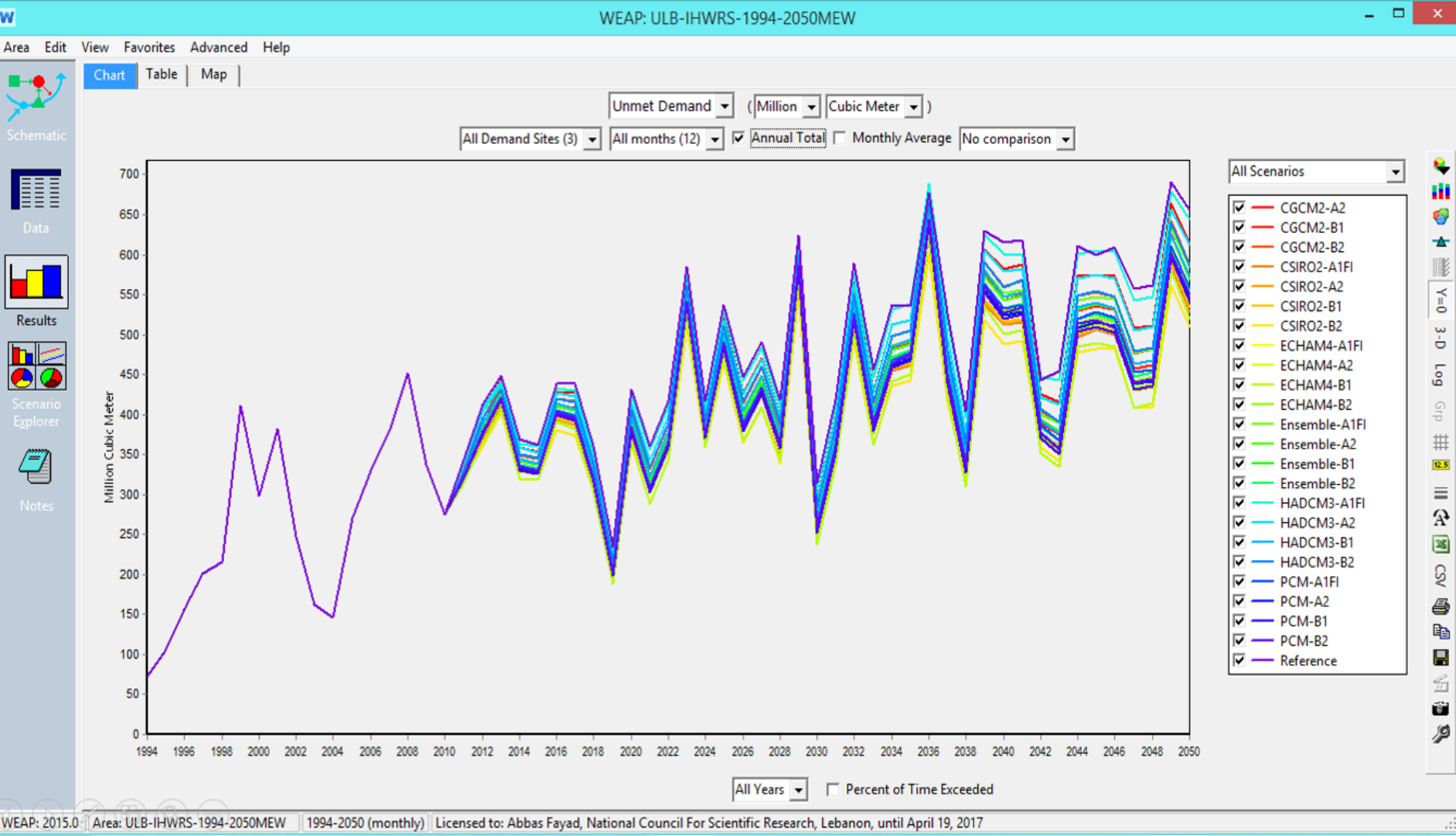
WEAP: 2015.0 Area: OrontesBasin 2011-2012 (monthly) Licensed to: Abbas Fayad, National Council For Scientific Research, Lebanon, until April 19, 2017

# Evaluation of scenarios – streamflow

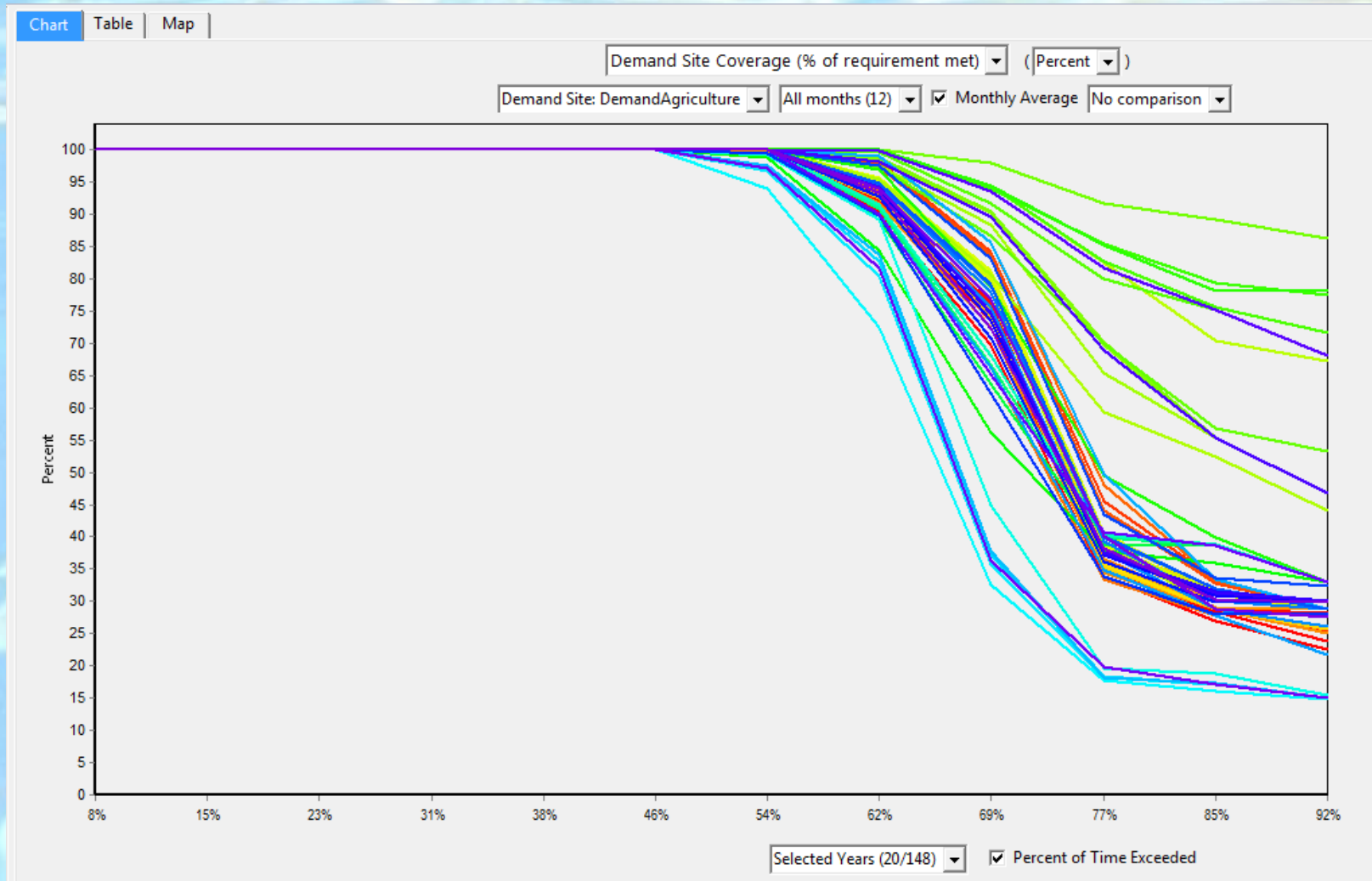




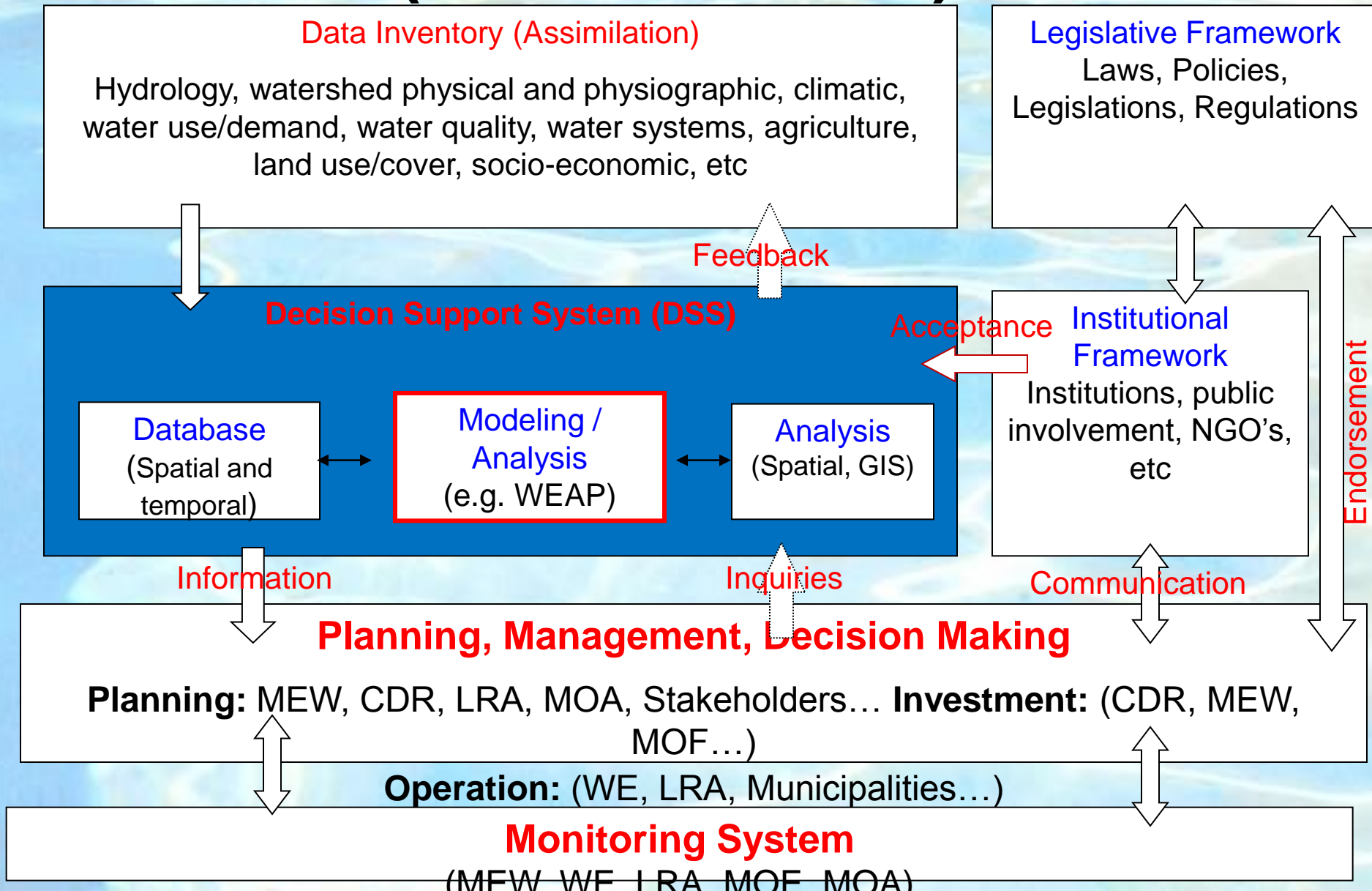
# Evaluation of scenarios – unmet demand



# Evaluation of water indicators using climate change scenarios



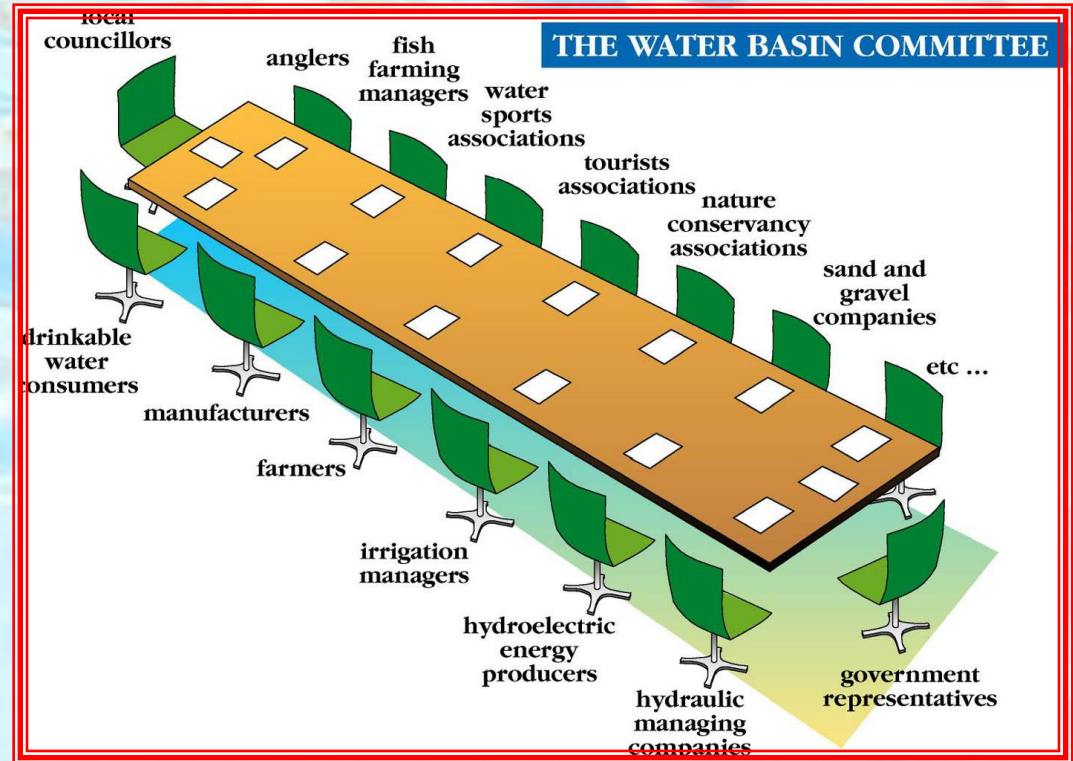
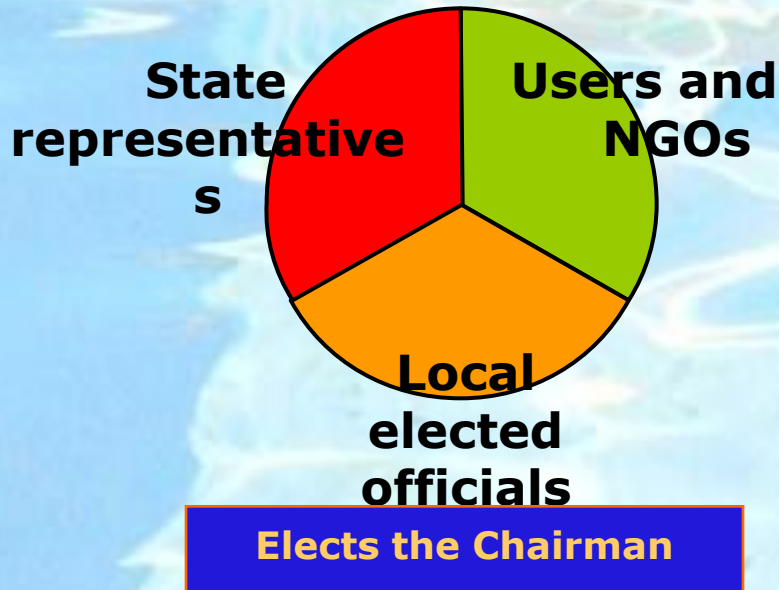
# IWRM Conceptual Framework (MEW Lebanon)



# Participation in decision-making

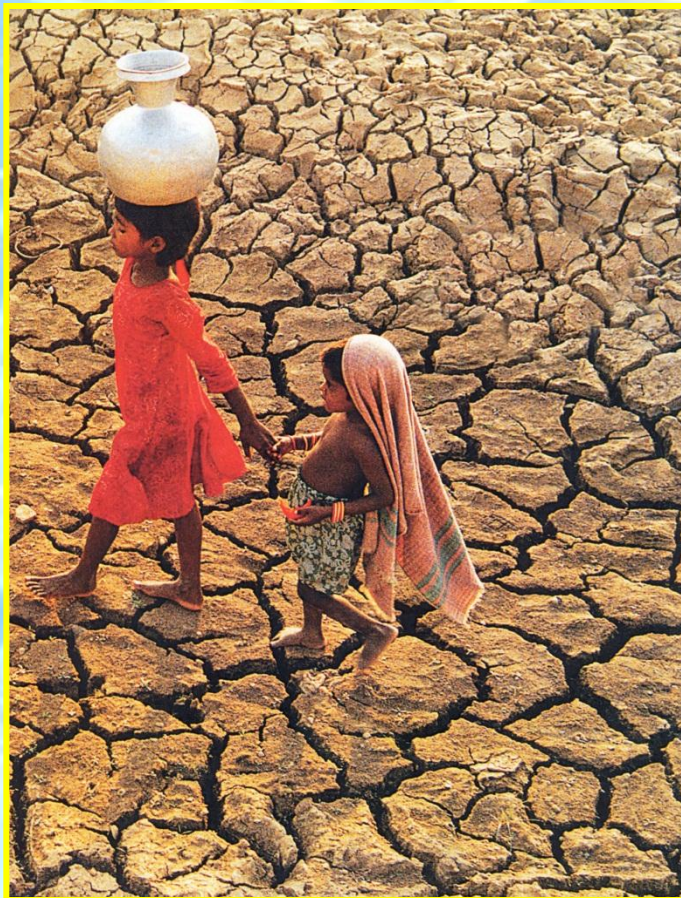
« THE WATER PARLIAMENT »

The River Basin Committee



- The representatives of populations and local authorities, water users or organizations representing collective interest should participate in basin management beside administrations, especially, in Basin Councils or Committees.

**IS WATER EQUITABLY AND SOUNDLY SHARED  
BETWEEN THE VARIOUS USES,  
ENSURING A BETTER OPTIMIZATION OF WATER  
AND AVOIDING WASTAGES?**



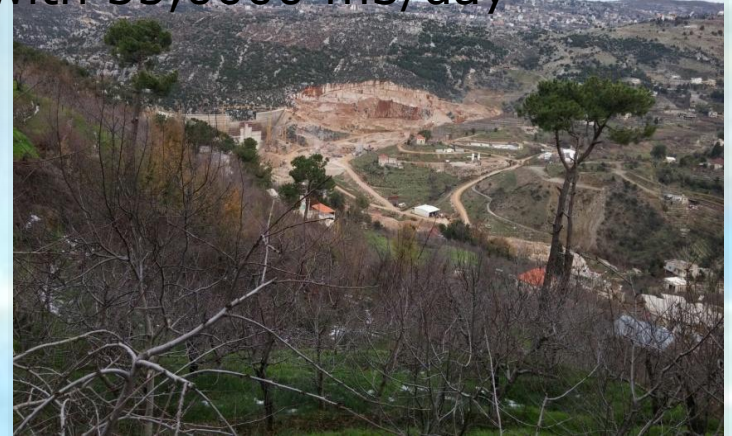
**MOBILIZING NEW RESOURCES  
SHOULD BE PLANNED  
WHEN THEY ARE ECOLOGICALLY ACCEPTABLE  
AND ECONOMICALLY REASONABLE.**



**Chabrouh Dam:**  
constructed, Storage capacity  
9 Mm<sup>3</sup>, supplying Qesrouan  
and Metn with 60,000  
m<sup>3</sup>/day

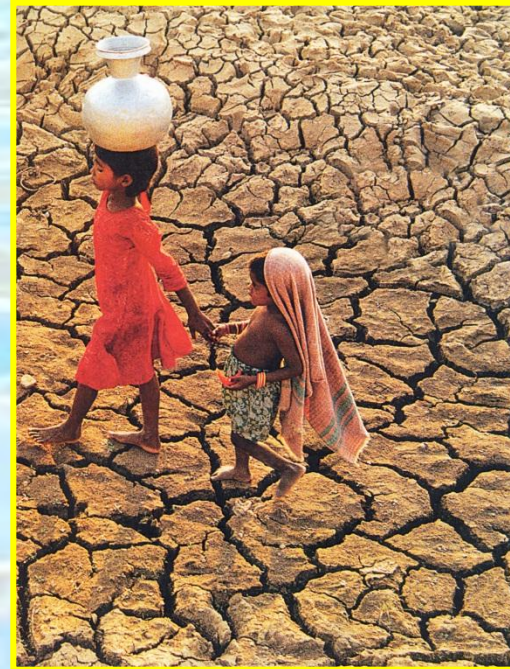


**Boqaata Dam:** under  
construction, Storage Capacity 6  
Mm<sup>3</sup> , supplying water for  
region of Metn (300m-900m)  
with 35,0000 m<sup>3</sup>/day



## WITH REGARD TO DROUGHTS:

### **AVOIDING WASTAGES!**



- WATER SAVING,
- LEAK DETECTION,
- RECYCLING,
- THE REUSE OF TREATED WASTE WATER,
- GROUNDWATER RECHARGE,
- THE DESALINATION OF SEA WATER,
- RESEARCH ON LOW-CONSUMPTION USES...

**... MUST BECOME PRIORITIES.**

**A NEW APPROACH TO WATER USES IN AGRICULTURE  
SHOULD BE LOOKED FOR.**

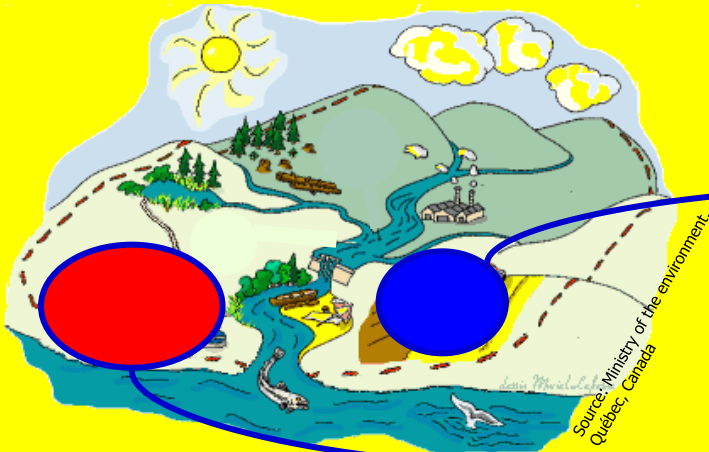




# water resources management should be organized:

2000

## Description of the initial situation

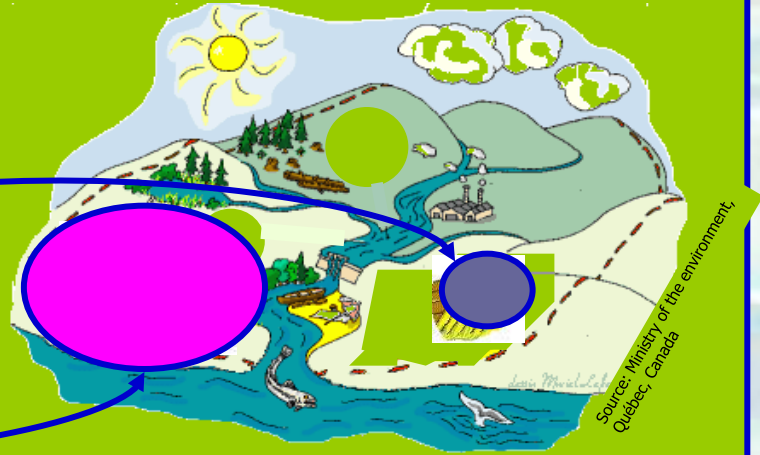


Focus on economic aspects:

- estimate the economic "weight" of water uses and services
- assess the level of recovery of costs of water services

2025

## Baseline scenario: projection for 2025



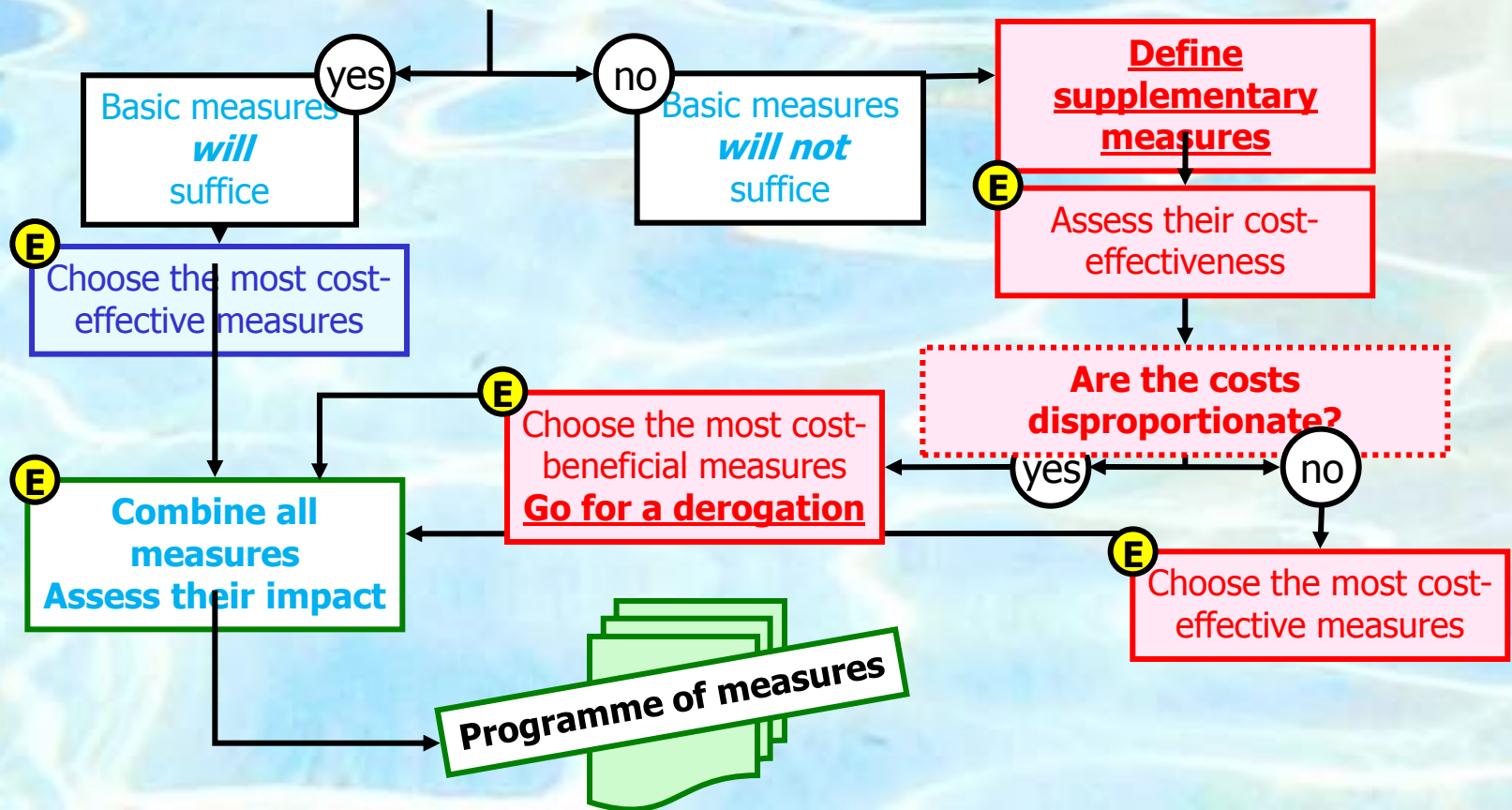
Baseline scenario:

- appraisal of evolutions of uses, pressures...
- identification of potential gaps in water status with GES

**based on management plans or master plans**  
that define the medium and long-term objectives to be achieved;

water resources management should be organized:

through the development  
of Programs of Measures  
and multiyear priority investments;



# Science diplomacy and transboundary water management The Orontes River case

## ➤ Technological Tools with decision support system applied for Orontes basin management :

- Water resources and security issues
- Technical outlook of ICT project for basin management
- Data base analysis and application of ICT system
- Decision support for best management and regional cooperation



# Recent important contributions of Lebanon for facing climate change

- ❑ A very **important symposium** under title of “**Hydrodiplomacy and climate change for peace in the Middle East**, which has been held at the **Senate in Paris on 1<sup>st</sup> of December 2015** and in whose framework solutions against water scarcity in South Mediterranean countries were debated;
- ❑ **The signature of the pact of Paris** during the International **Cop 21**, which highlighted importance of:
  - Adaptation actions at the basin level
  - Participative, integrated and sustainable water resources management to minimize the impacts of climate change on the populations’ health and safety; on economic development and the environment,
  - Importance of the protection of water-related ecosystems, on cooperation, coordination
  - Exchange of information, dialogue, consultation to prevent conflicts between stakeholders
  - Enhance the implementation of adaptation measures and the sharing of benefits on the basin scale;



## Paris Pact on water and adaptation to climate change in the basins of rivers, lakes and aquifers

At the twenty-first Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21 / CMP11) organized from 30 November to 11 December 2015 in Paris, **We**, representatives of governments, international organizations, donors, national and transboundary basin organizations of rivers, lakes or aquifers, local authorities, of the civil society and companies, support the integration of Water into the Climate change Action Agenda, especially for initiating or strengthening necessary adaptation actions in the basins of rivers, lakes, aquifers and large wetlands.

### GENERAL STATEMENT

Climate change is already affecting and will increasingly affect the quantity and quality of freshwater and aquatic ecosystems, especially through the intensity and greater frequency of extreme hydrological events, such as floods and droughts, as well as the increase in ocean level, which threaten security, economic and social development and the environment.

We recognize that adaptation actions should be undertaken without delay to minimize the impacts of climate change on the populations’ health and safety, on economic development and the environment, considering the importance of the protection of water-related ecosystems.

**The basins are natural areas where water flows on the surface and in the subsol: they are the relevant territories for organizing water resources management.**

In order to ensure more effectiveness, these actions to adapt to climate change should thus be implemented at the level of river, lake and aquifer basins, through a joint, participative, integrated and sustainable water resources management.

### We should act quickly before it is too late!

To that end, mobilizing new and increasing funding dedicated to climate change adaptation in basins is essential. Therefore, new basin organizations and existing ones should be financed and strengthened to facilitate the cooperation, coordination and exchange of information, dialogue, consultation and prevention of conflicts between stakeholders and to enhance the implementation of adaptation measures and the sharing of benefits on the basin scale.

We encourage donors to support prior assessments and actions for adaptation to climate change in basins.

Local authorities and communities, economic sectors and the civil society should be better associated and involved in basin management, including in the definition and implementation of adaptation measures.

Cooperation and exchange should increase between the institutions involved, especially among the basin organizations at the global and regional levels in order to facilitate the transfer of experience and know-how on best practices in basin management and adaptation to climate change.



PARIS2015  
CONFÉRENCE DES NATIONS UNIES  
SUR LES CHANGEMENTS CLIMATIQUES  
COP21-CMP11

# Recent important contributions of Lebanon for facing climate change

- Elaborate and operationalize a strategic Country work plan for the biennium 2016-2017 in addressing agriculture 'water consumption' (reduction), 'crop water productivity' (increase) and 'drought management' (preparedness), within the framework of the *Regional Initiative on Water Scarcity (WSI)* and its *Regional Collaborative Platform*.



Food and Agriculture Organization  
of the United Nations



National Council for Scientific Research



Republic of Lebanon  
MINISTRY OF AGRICULTURE



Republic of Lebanon  
Ministry of Environment

LITANI



River Authority



The background of the image is a close-up, top-down view of water. The water's surface is covered in a complex pattern of ripples and small waves, creating a shimmering effect. Sunlight reflects off the water, creating bright, golden-yellow and white highlights that contrast with the various shades of blue and cyan. The overall texture is fluid and dynamic.

***Thank you!***