

## 4th BEIRUT WATER WEEK

### Technological Tools and Financing Mechanisms for IWRM: Complementing Hydro-diplomacy & Climate Change Adaptation Efforts

Notre Dame University-Louaize

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# A Decision Support System for River Basin Management Insights on the MED EUWI service contract activities in Lebanon

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# Introduction

- Lebanon: 40 rivers and main water courses
  - 17 river-basins (area of around 8000 Km<sup>2</sup>).
- Two major aquifer-systems (coastal/inland)
  - 30 hydrogeological units or aquifer subdivisions
- Prevailing Mediterranean and semi-arid climates limit precipitation to the winter season
  - result in the seasonality of most rivers
- The geology of the country (i.e. karst system) results in little amount of groundwater available for exploitation
  - increased stress on the accessible water sources

# Environmental dilemma

- **Water scarcity** is believed to be one of the main problems currently facing the country
- The current situation is characterized by:
  - the **limitation of water sources**,
  - Increased water demands by all sectors
    - diminishing **water availability**,
    - increased pressure on the water sources, and
    - amplified competition between users
- **Socio-economic development** putting increased pressures on resources
  - population growth,
  - increased economic activity, and
  - increased urbanization trends
- **Pollution of water resources**
  - associated to human and agricultural activities and industrial processes,
  - water pollution is contributing to water scarcity
    - reducing the **availability and usability** of water
- **Projected climate change/variability** and recurring drought periods are putting additional concerns on the sustainability of the water system

# Institutional & Management Limitations

- There is a lack in
  - the collection and distribution of hydrologic and water resources data/information
  - the quantification and qualification of surface and ground water resources nationwide
  - water governance and legislative and institutional frameworks
    - inadequacy in the development of management and planning practices, and
    - inadequacy in the development of proper water plans

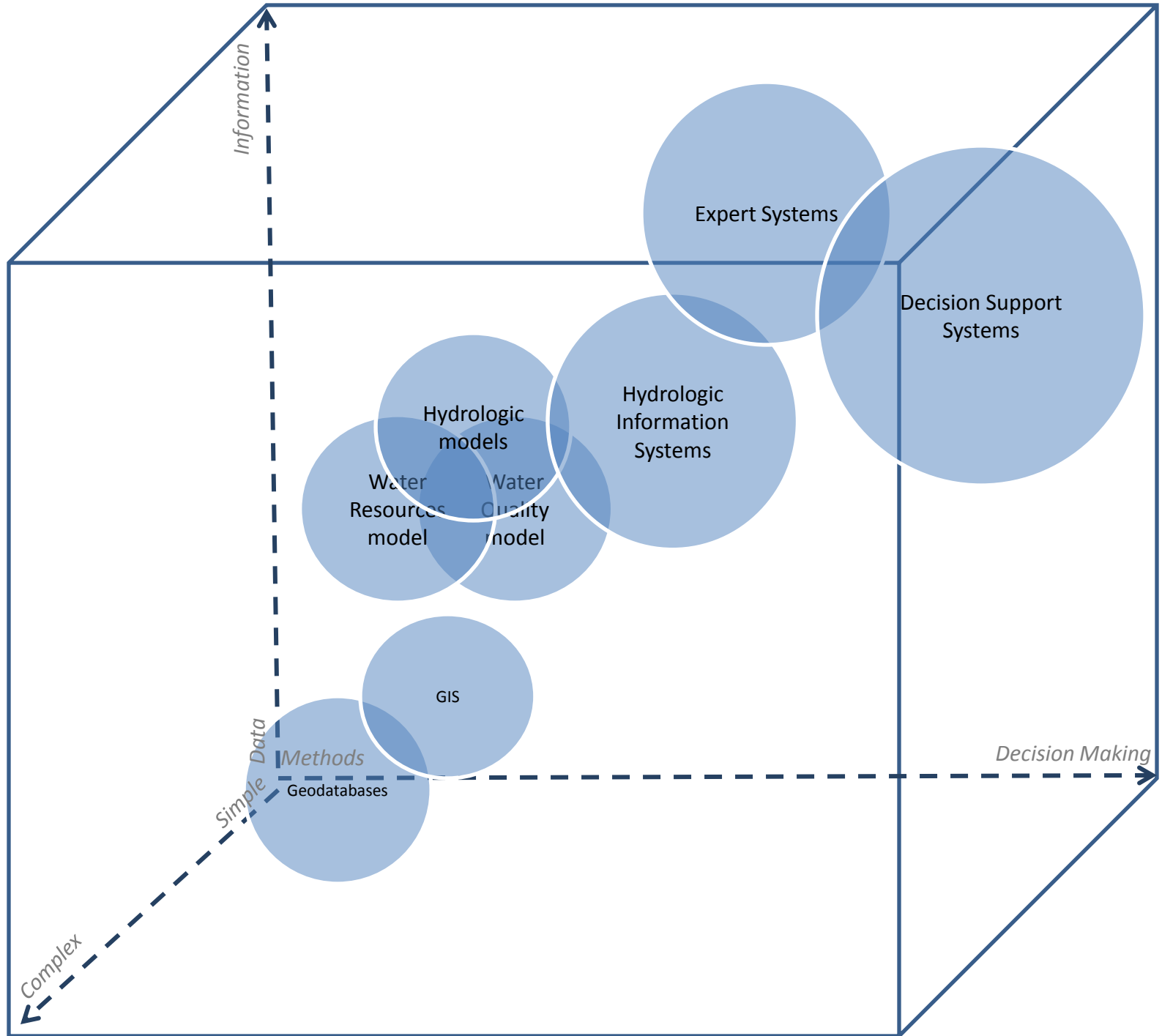
# Objectives

## MED EUWI Project for Lebanon

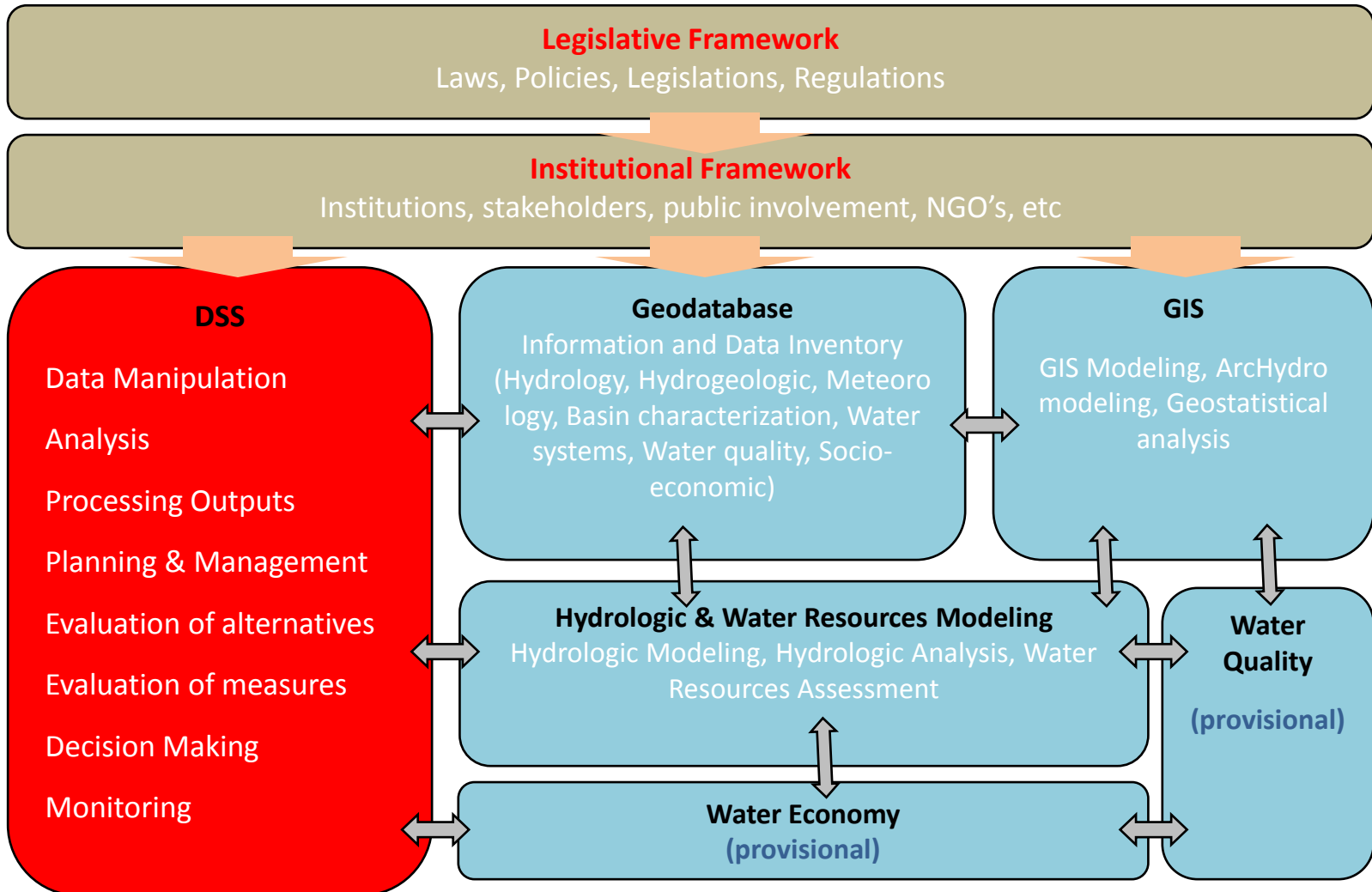
(Oct, 2011 – Dec, 2012)

- Develop a DSS for River Basin Management
  - The model is intended to **establish an integrated modeling approach** that supports watershed hydrology, water resources management/ planning and scenario evaluation in a **single model framework**
    - emphasis on the use of a coupled semi-distributed **hydrologic and water resources model**
    - **assess water balance** (e.g. runoff, evaporation, recharge, etc)
    - **identify water resources use/ management** (e.g., agricultural water demand, domestic and industrial water demand, water supply systems, water sources, etc);
    - **formulate future scenarios**
      - social/ agricultural projections (e.g. population growth, increased irrigation),
      - change in management (e.g. develop scenarios that presents different alternatives), and
      - environmental (e.g. recurring drought, climate change)





# DSS Framework for RBM

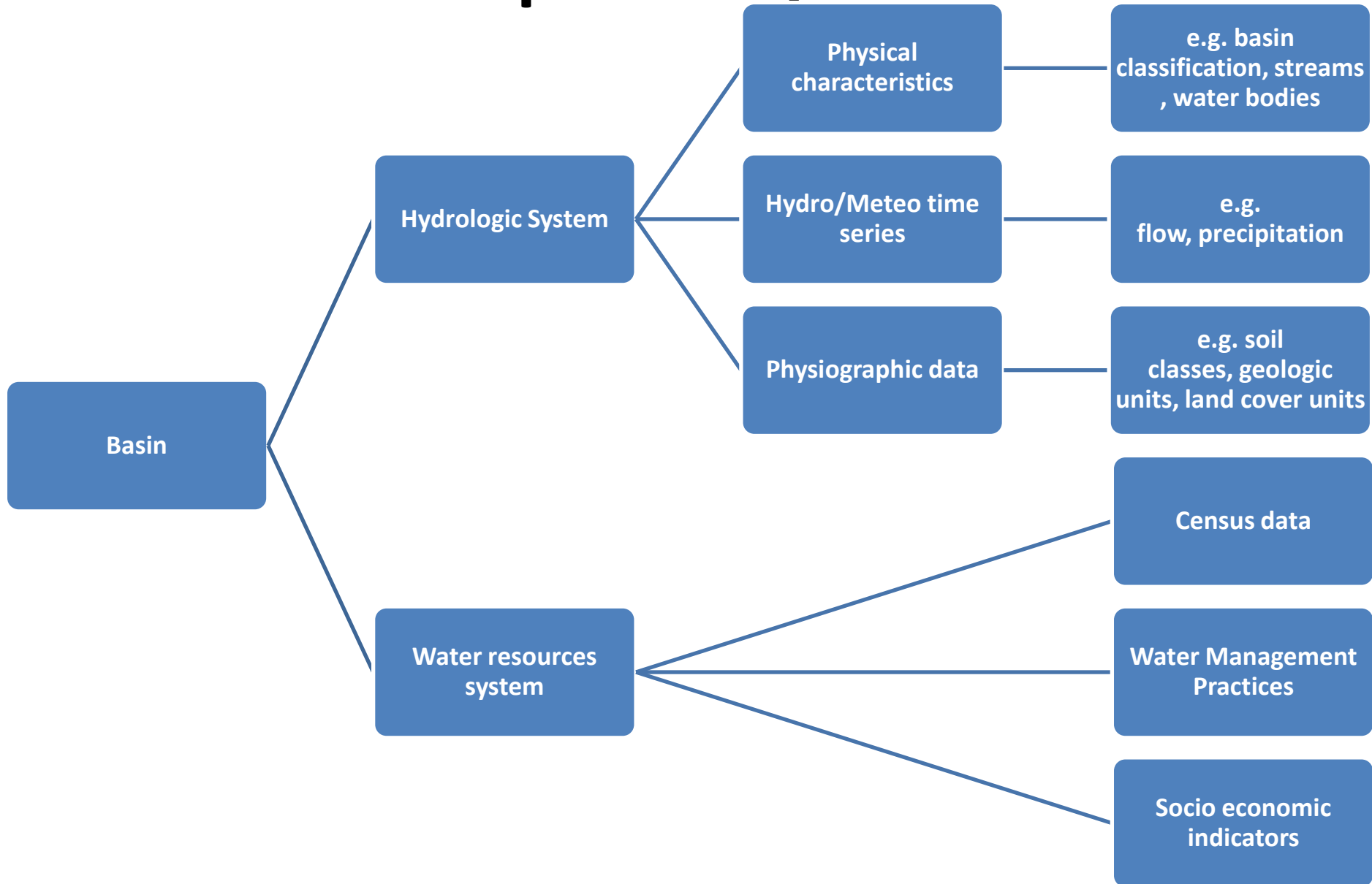




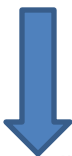
# DSS Modeling Component: SEI-WEAP!

- Fully integrated watershed analysis tool
- Water Balance Simulation
  - Different water balance models
- Simulation model with flexible representation of the water systems (hydrologic cycle) and water resources use (demand/supply)
- Priority-driven water allocation modeling
  - Water supply, Reservoirs, Hydropower
  - Water Quality (with link to QUAL2K)
  - Groundwater (with link to MODFLOW)
- Supports scenario investigations for planning and policy analysis
  - Management scenarios
  - Climate change impacts
- Financial routines

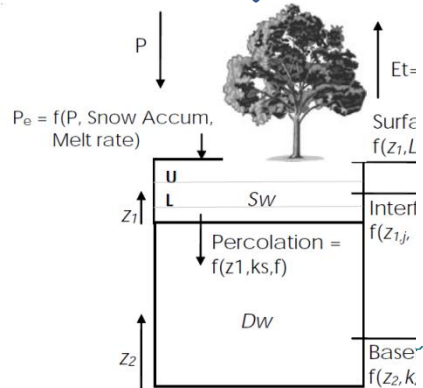
# DSS Conceptual Representation



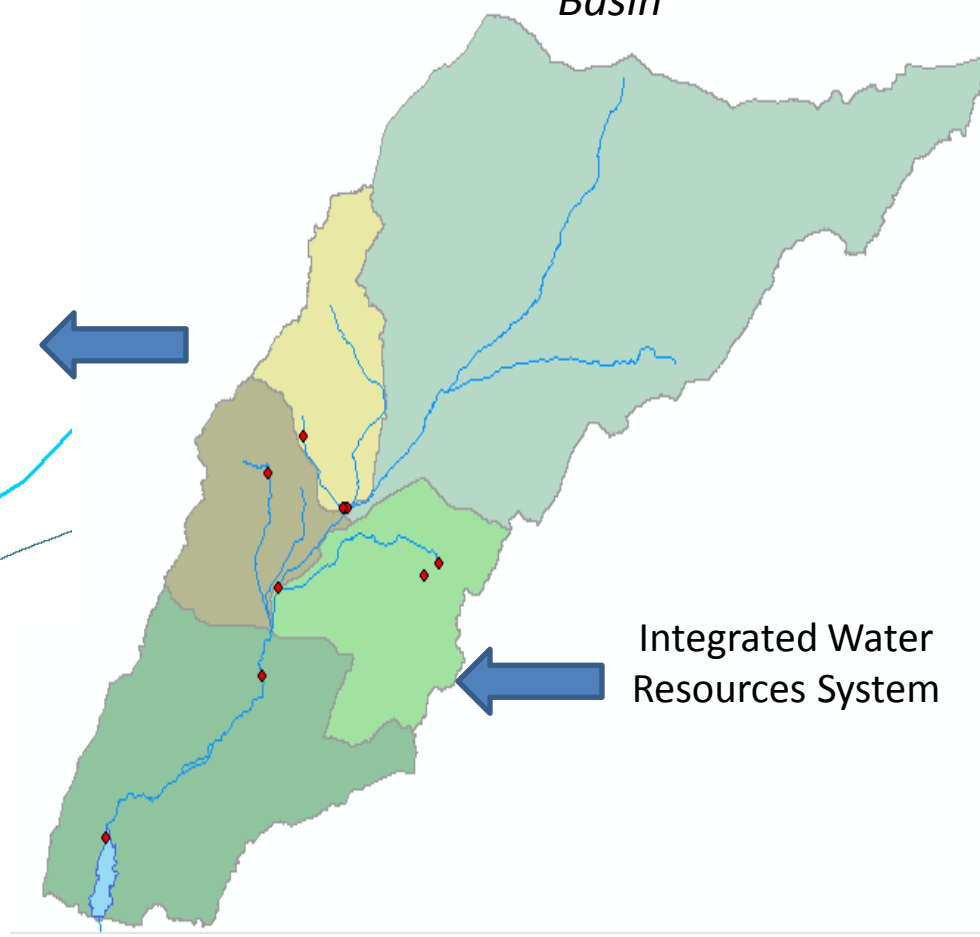
# Hydrologic & Metrologic Characterization



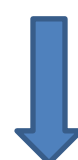
## Catchment



## Basin



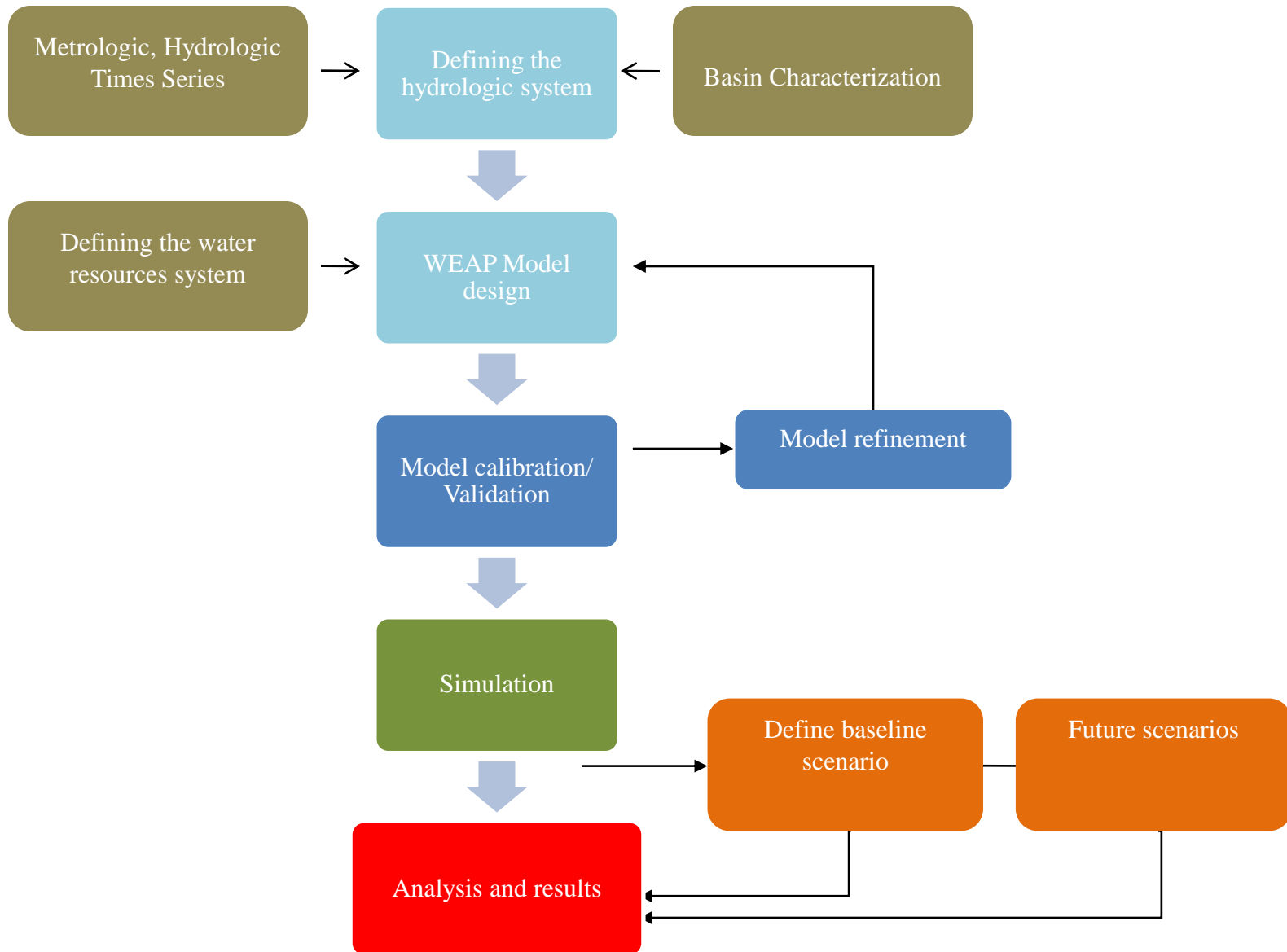
Integrated Water Resources System



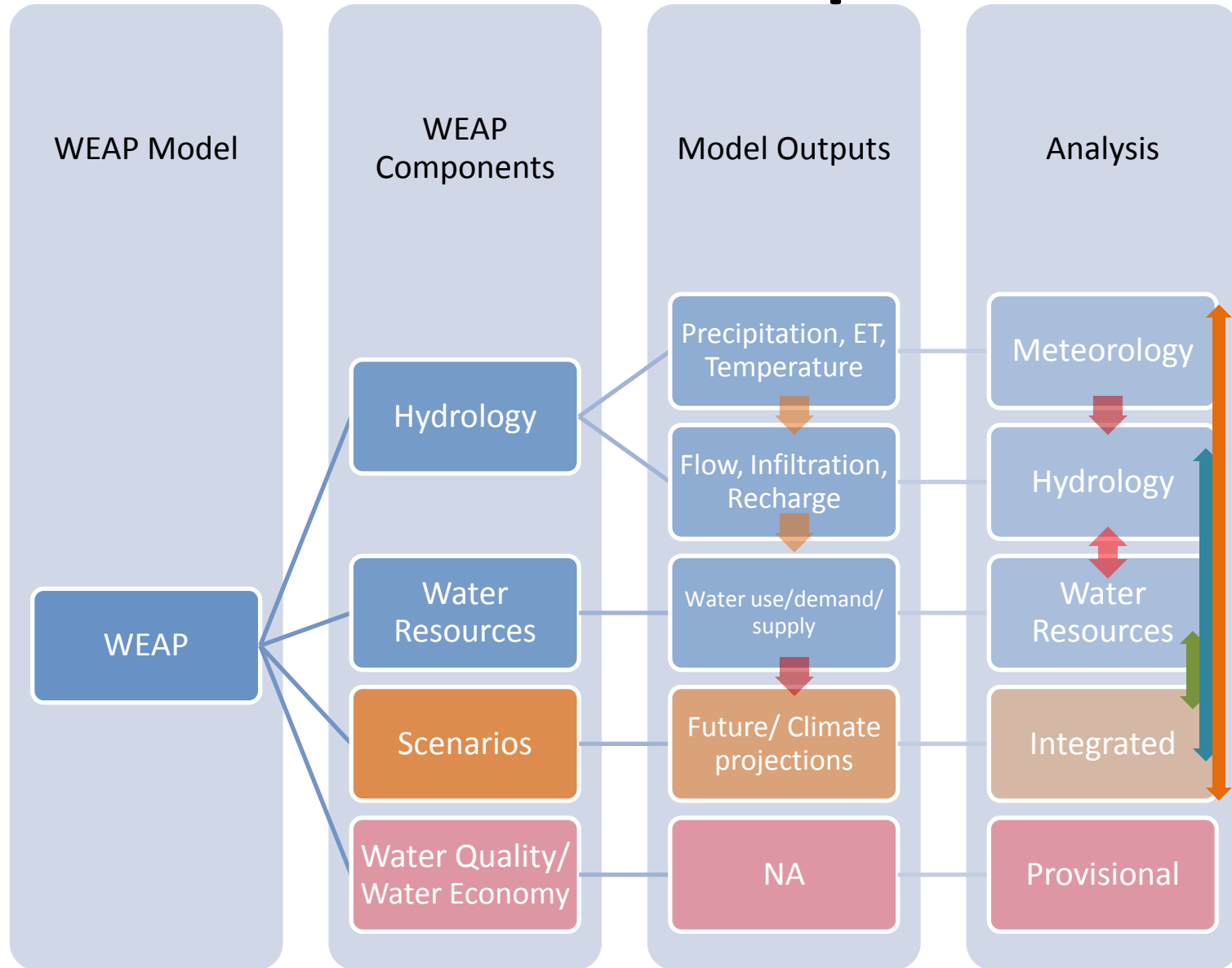
## Analysis

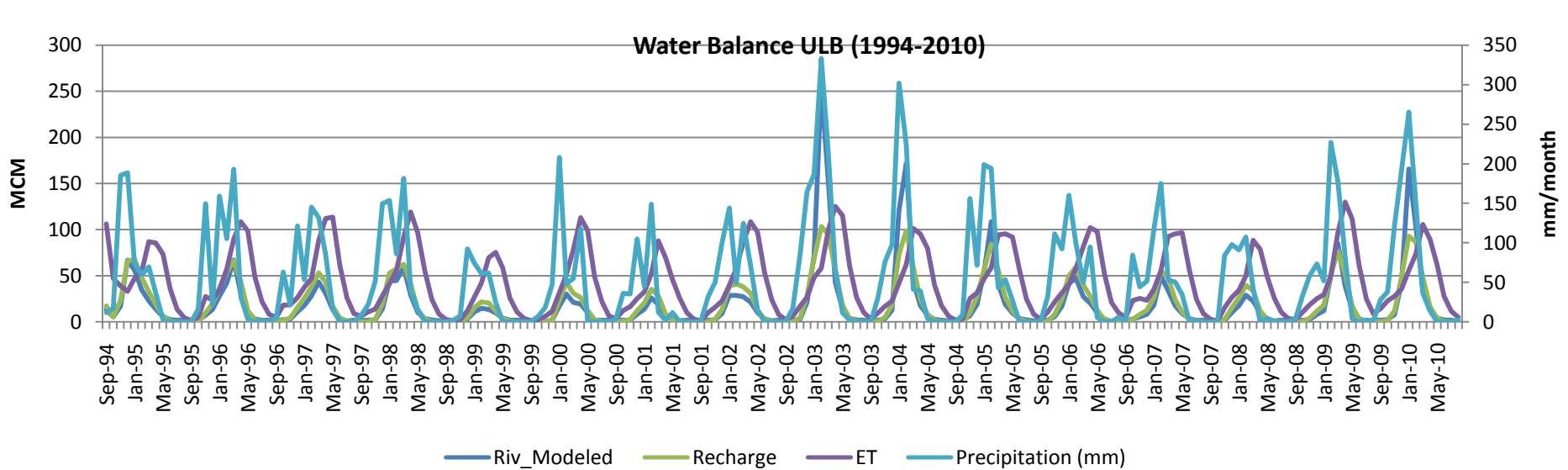
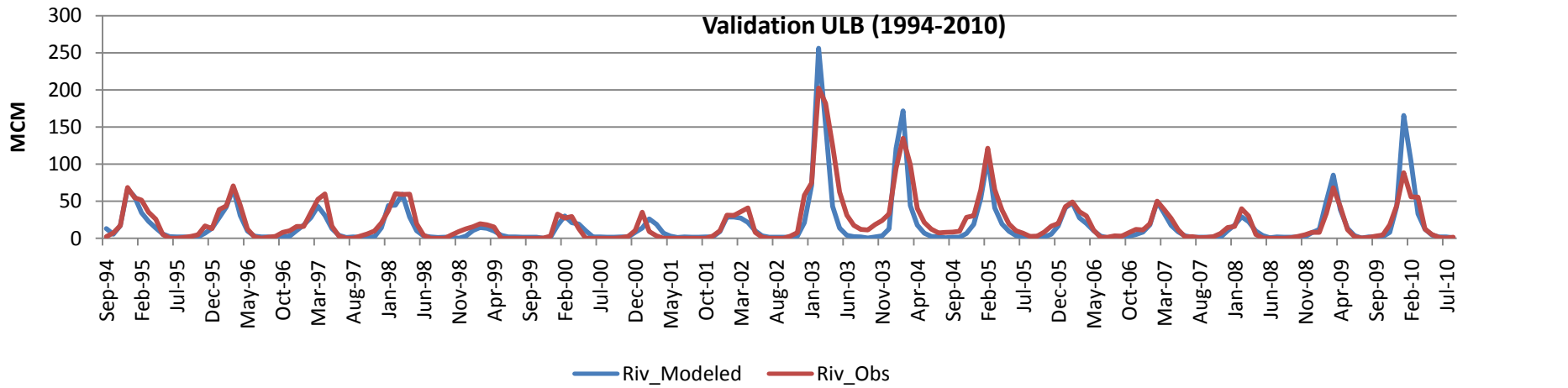
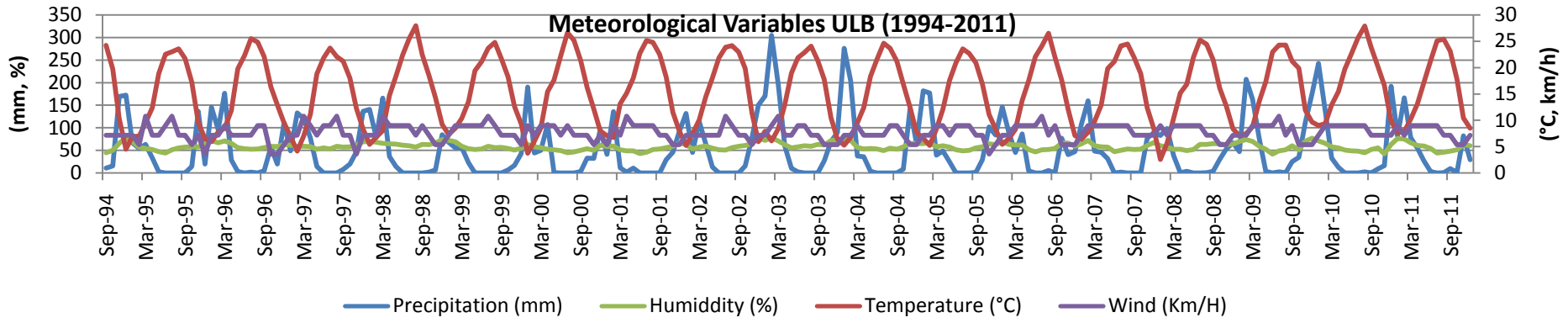


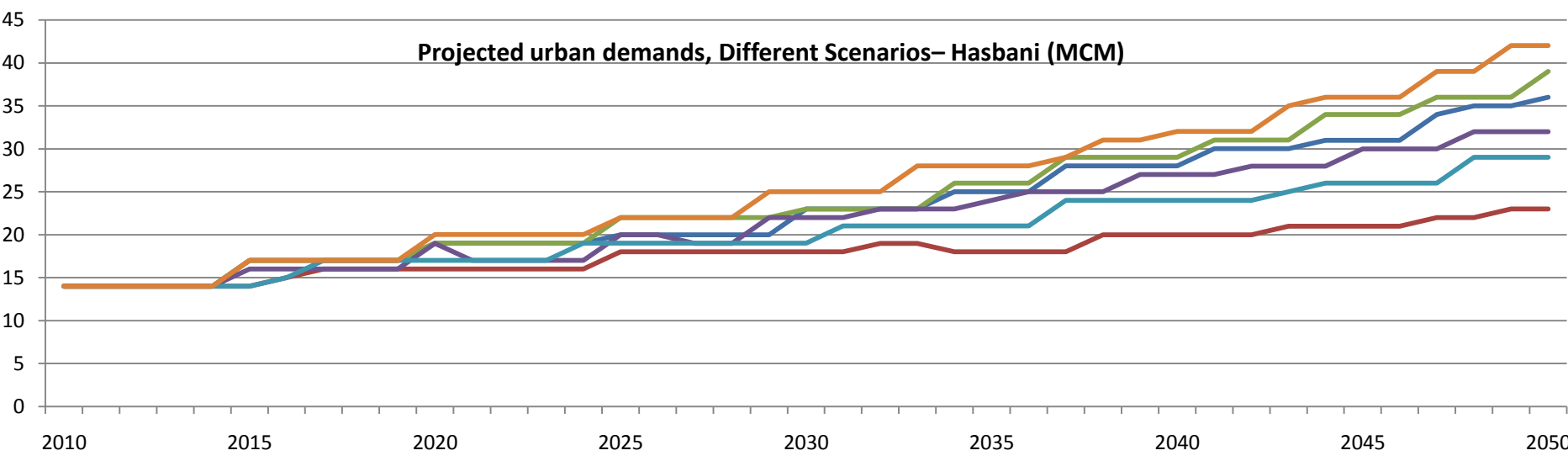
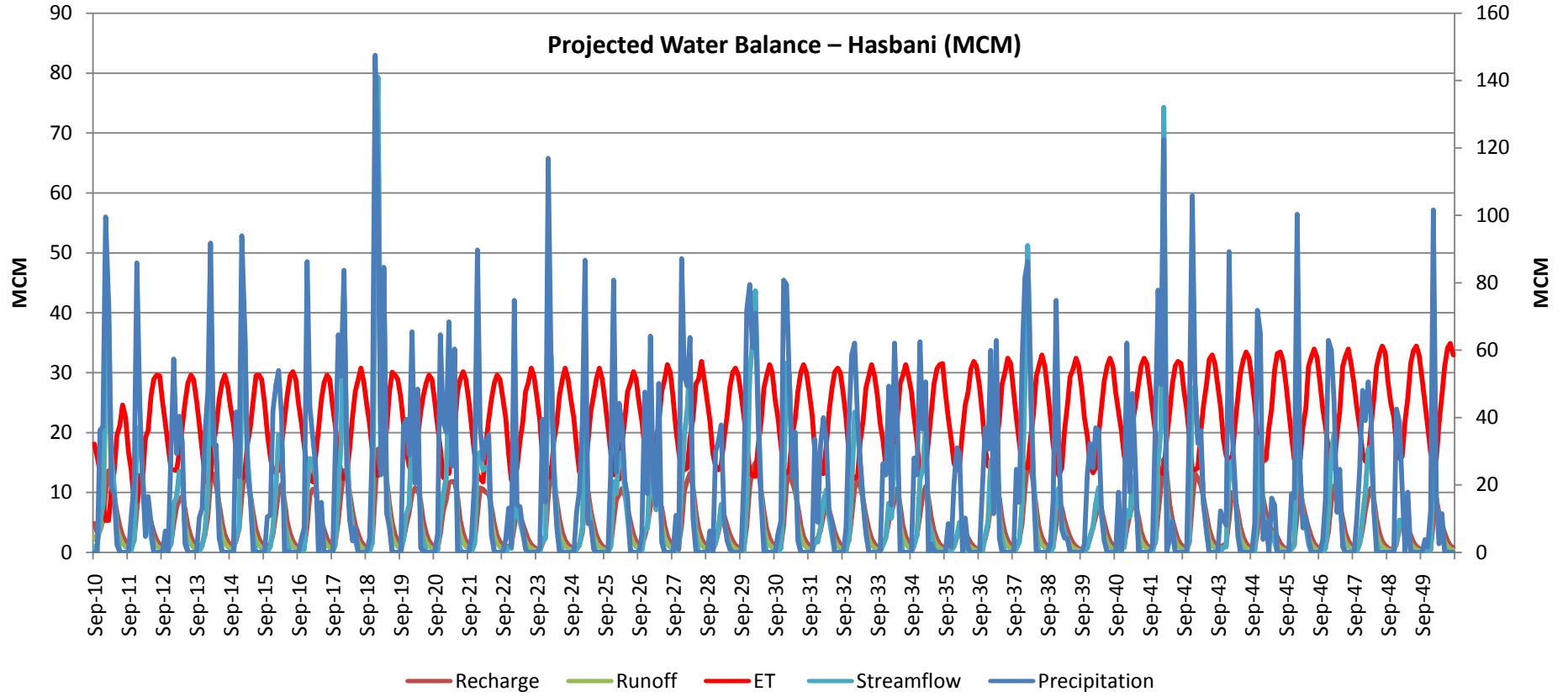
# Model formulation and simulation



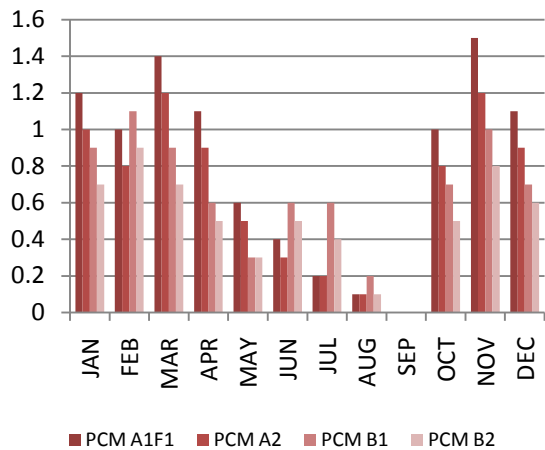
# DSS – WEAP Component



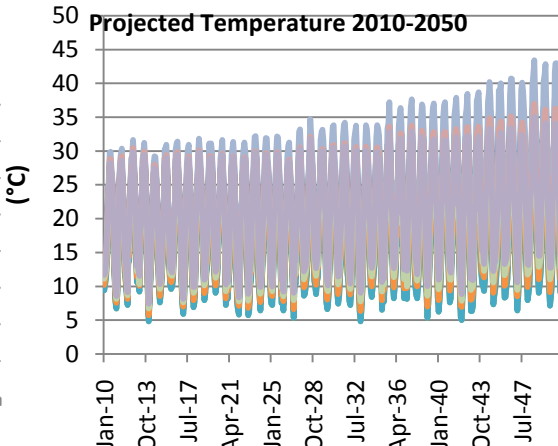




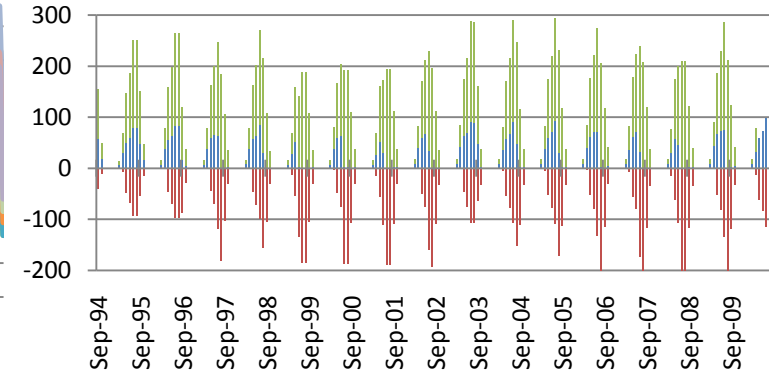
**Diurnal Temperature Range (°C) 2001-2100**



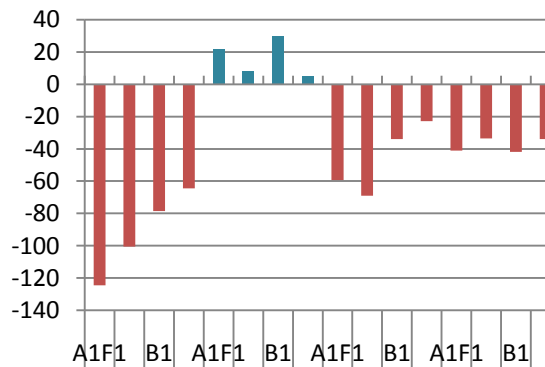
**Projected Temperature 2010-2050**



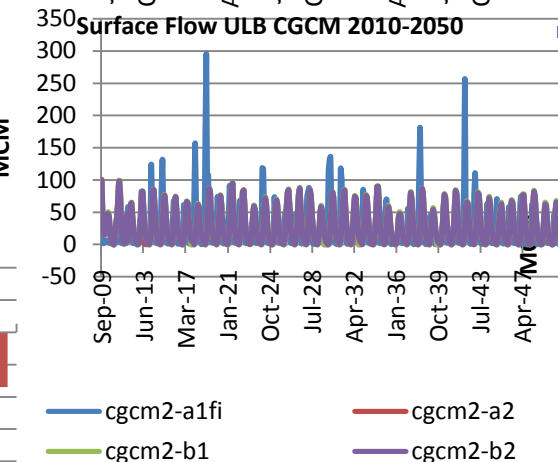
**Agriculture Water Demand (MCM)**



**Precipitation (mm) 2001-2100**

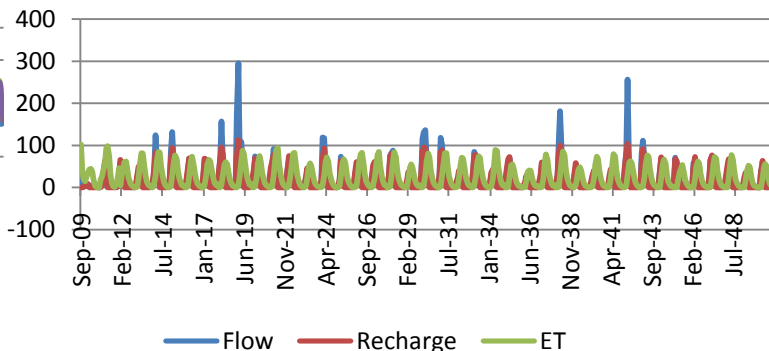


**Surface Flow ULB CGCM 2010-2050**

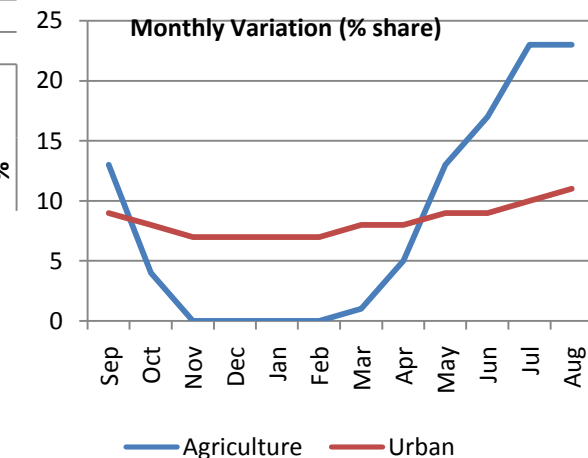


**Supply Delivered (MCM) Unmet Demand (MCM) Supply Requirement (MCM)**

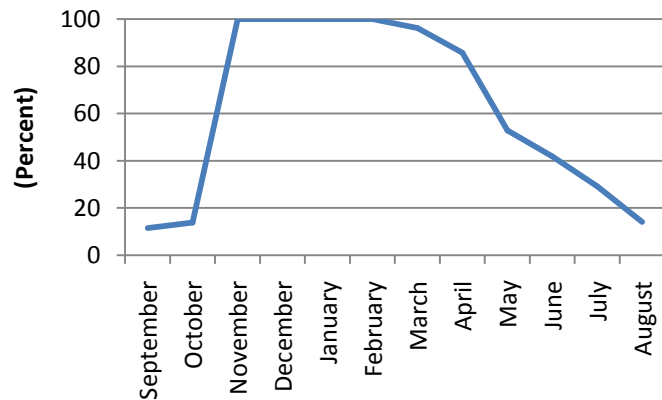
**Water Balance CGCM-A1F1**



**Monthly Variation (% share)**



**Demand Site Coverage (% of requirement met)**



- CGCM A1F1
- CGCM A2
- CGCM B1
- CGCM B2
- CSIRO A1F1
- CSIRO A2
- CSIRO B1
- CSIRO B2
- HadCM A1F1
- HadCM A2
- HadCM B1
- HadCM B2
- PCM A1F1
- PCM A2
- PCM B1
- PCM B2



# The Way Forward

## Beyond The MED EUWI Project for Lebanon

- Future work would focus on:
  - **Identification of direct stresses**
    - water shortage, pollution
  - **Identification of major drivers**
    - natural (e.g. drought),
    - man-made (e.g. pollution)
  - **Identification of indirect impacts**
    - human health, overexploitation of resources, degradation of environment/ecosystem
  - **Recognizing of long-term potential impacts**
    - cultural deterioration, land degradation, biodiversity loss
  - **Emphasizing driving forces**
    - natural, social, economical/capital, etc

agricultural alternatives **analysis** availability balance basin change  
characterization climate data decision defining demand development  
drought dss etc evaluation flow framework future gis groundwater  
**hydrologic** identification impacts increased information  
institutional integrated legislative **management model**  
outputs planning pollution precipitation pressure projected quality  
**resources** river scenarios simulation socio-economic sources  
supply supports **system water**



<http://www.waterhub.net>