# Integrated watershed management: modelling and monitoring water allocation

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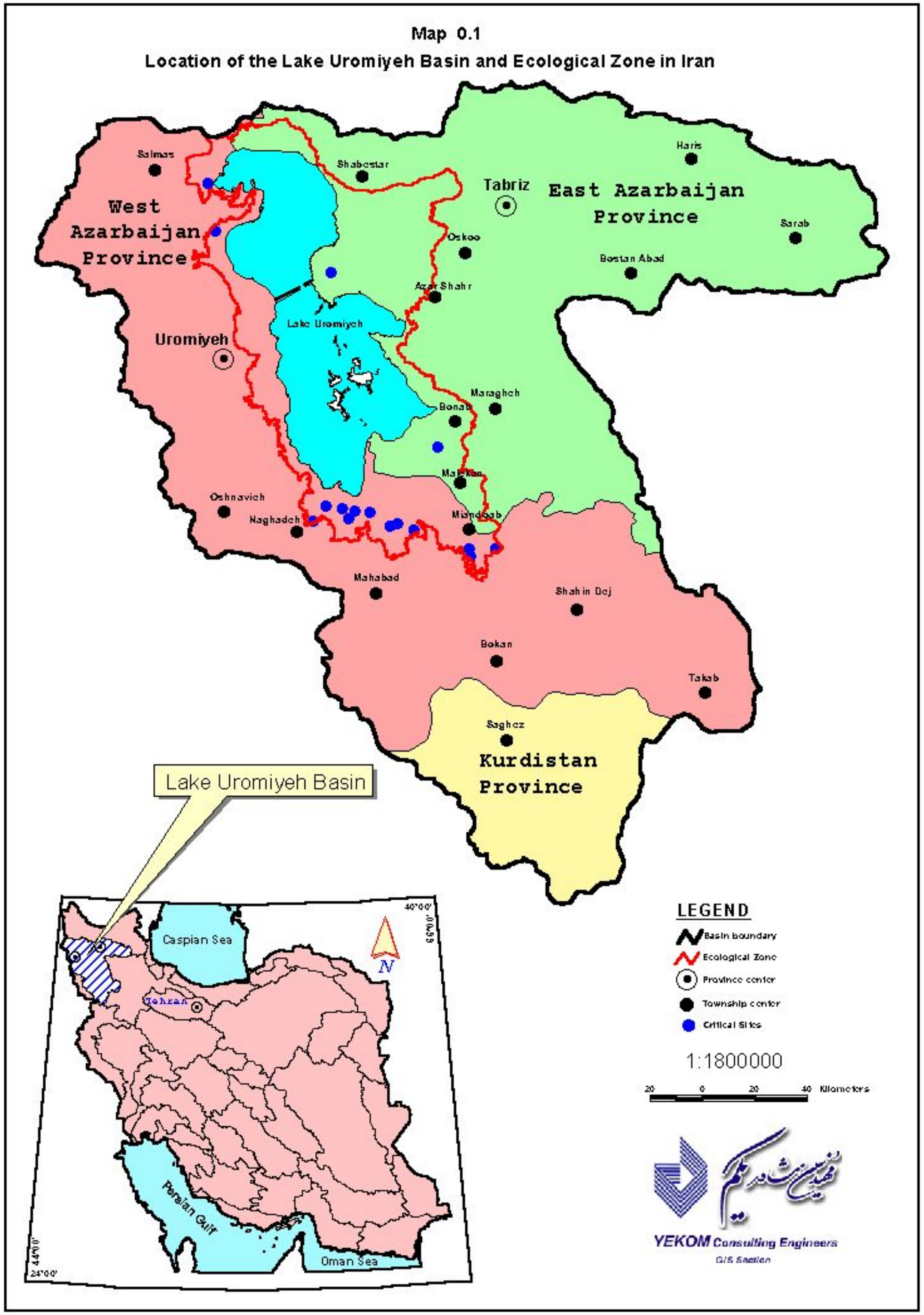
# Outline

- The conflict
- Wetlands
- Integrated water resources management: the Uromiyeh and the Sistan projects
- Some other examples



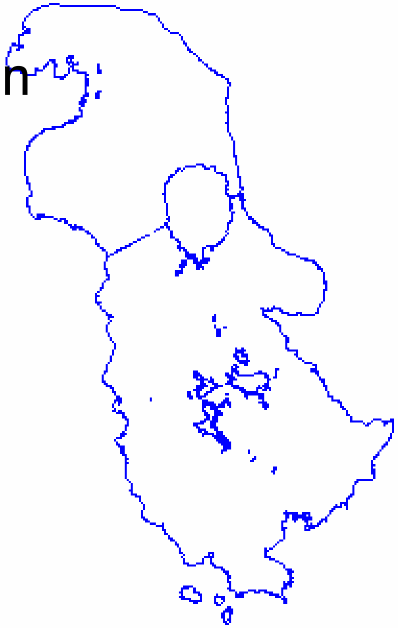
Map 0.1
Location of the Lake Uromiyeh Basin and Ecological Zone in Iran
West Azarbaijan Province
East Azarbaijan Province
Kurdistan Province
Tabriz
Uromiyeh
Lake Uromiyeh
Salmas
Shabestar
Haris
Sarab
Oskoo
Bostan Abad
Azar Shahr
Maragheh
Bonab
Malekan
Miandoab
Oshnavieh
Naghadeh
Mahabad
Shahin Dej
Bokan
Takab
Saghez
Lake Uromiyeh Basin
Caspian Sea
Tehran
Persian Gulf
Oman Sea
N
LEGEND
Basin boundary
Ecological Zone
Province center
Township center
Critical Sites
1:1800000
Kilometers
YEKOM Consulting Engineers
GIS Section

# Why Lake Uromiyeh is so vulnerable?

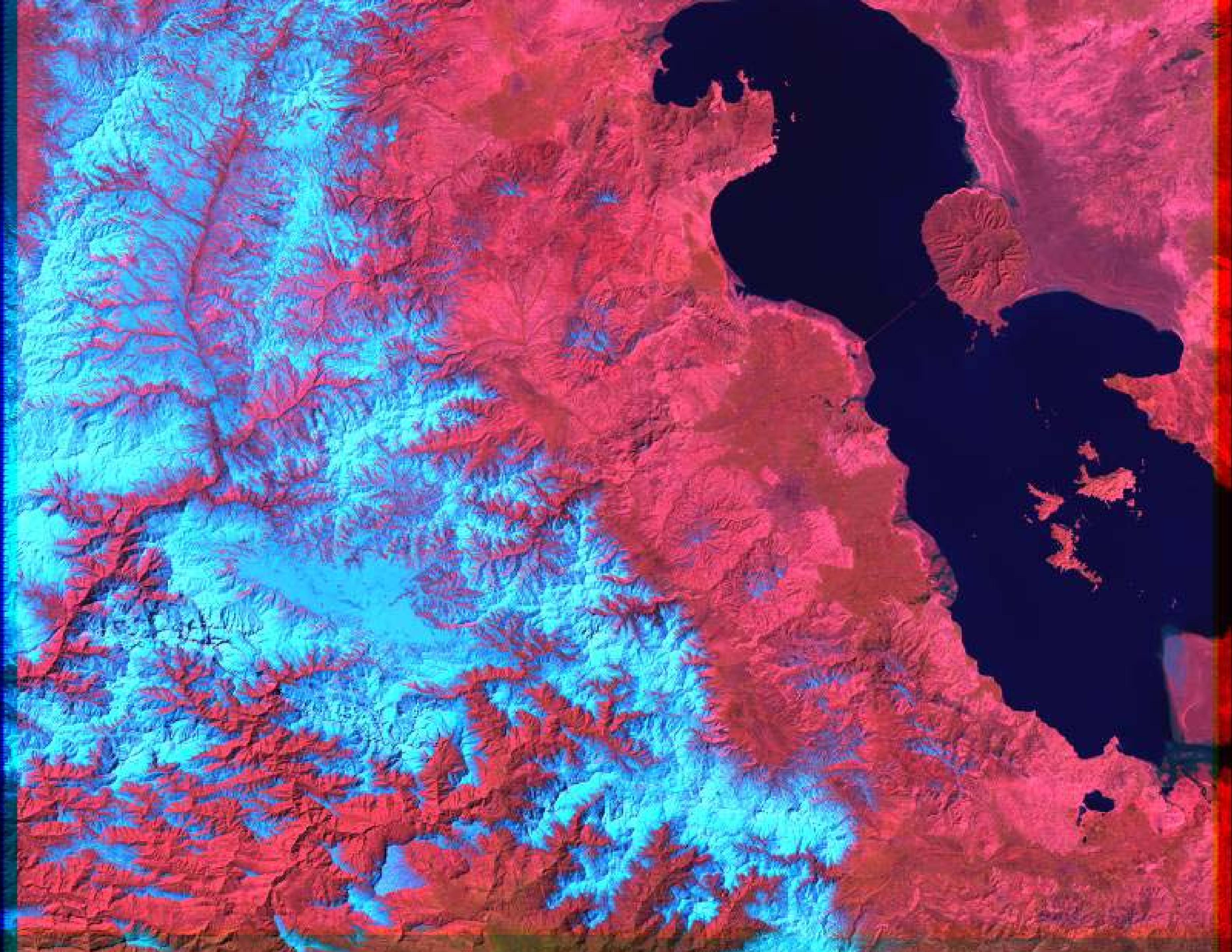
- The environmental health of wetlands is based on water.
- The water is shallow:

Large surface (evapotranspiration).

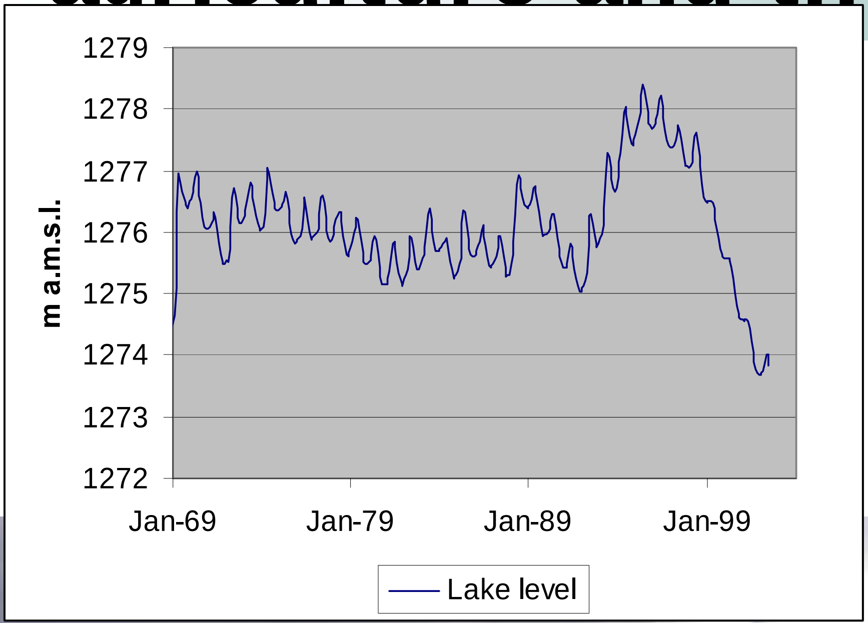
  - Shallow depth (temperature changes).
  - Relatively small quantity of water (high concentration of pollutants).
  - The surface area changes or even the whole wetland dries up.

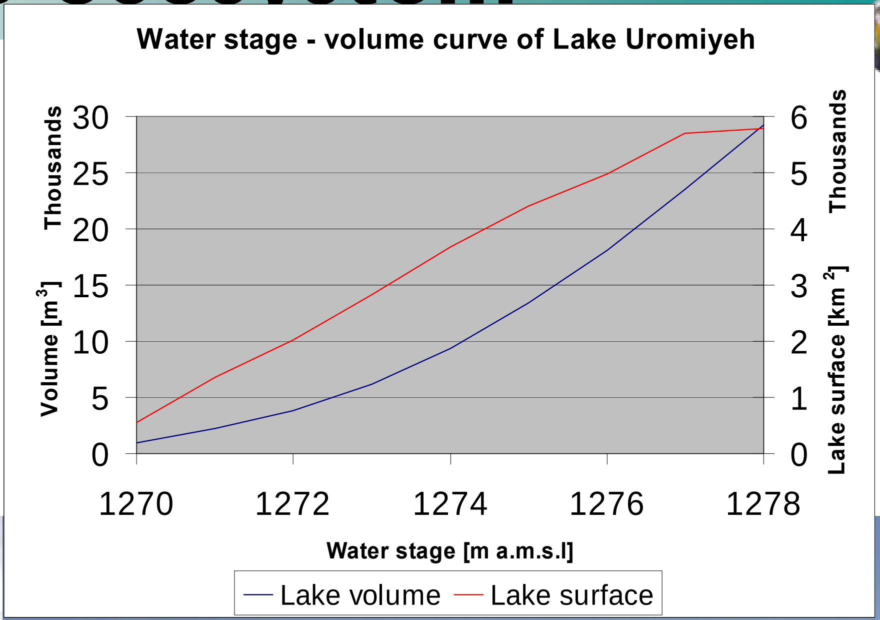


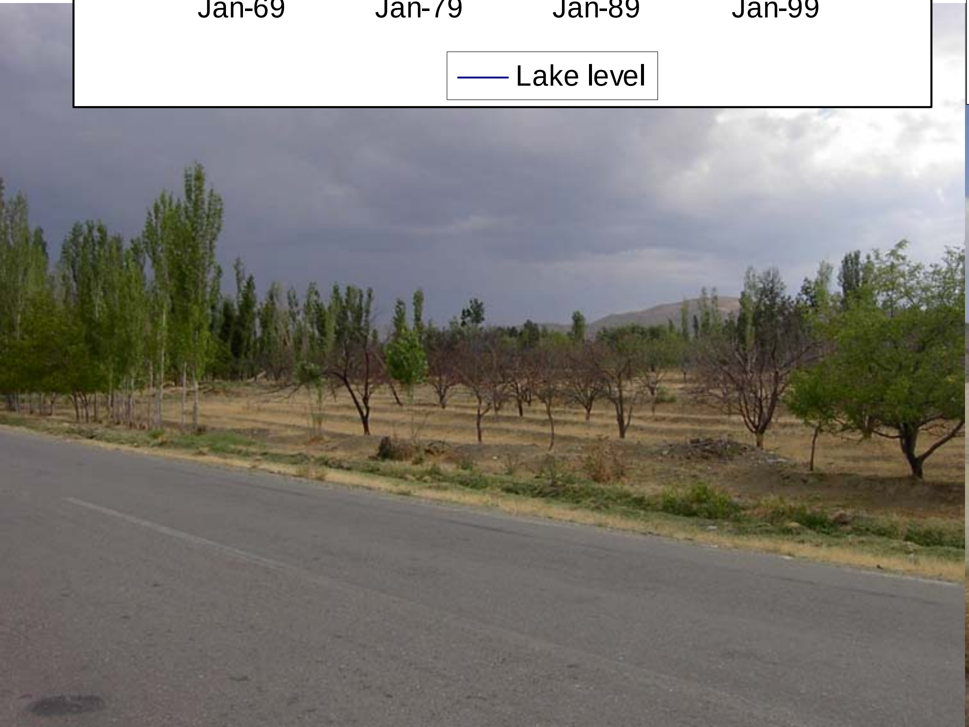
- Special problem of Lake Uromiyeh: no water outflow, i.e. saline lake (with some freshwater/brackish water wetlands on its shores)



# Problem: water allocation between agriculture and the ecosystem



Edit Layers Options Help

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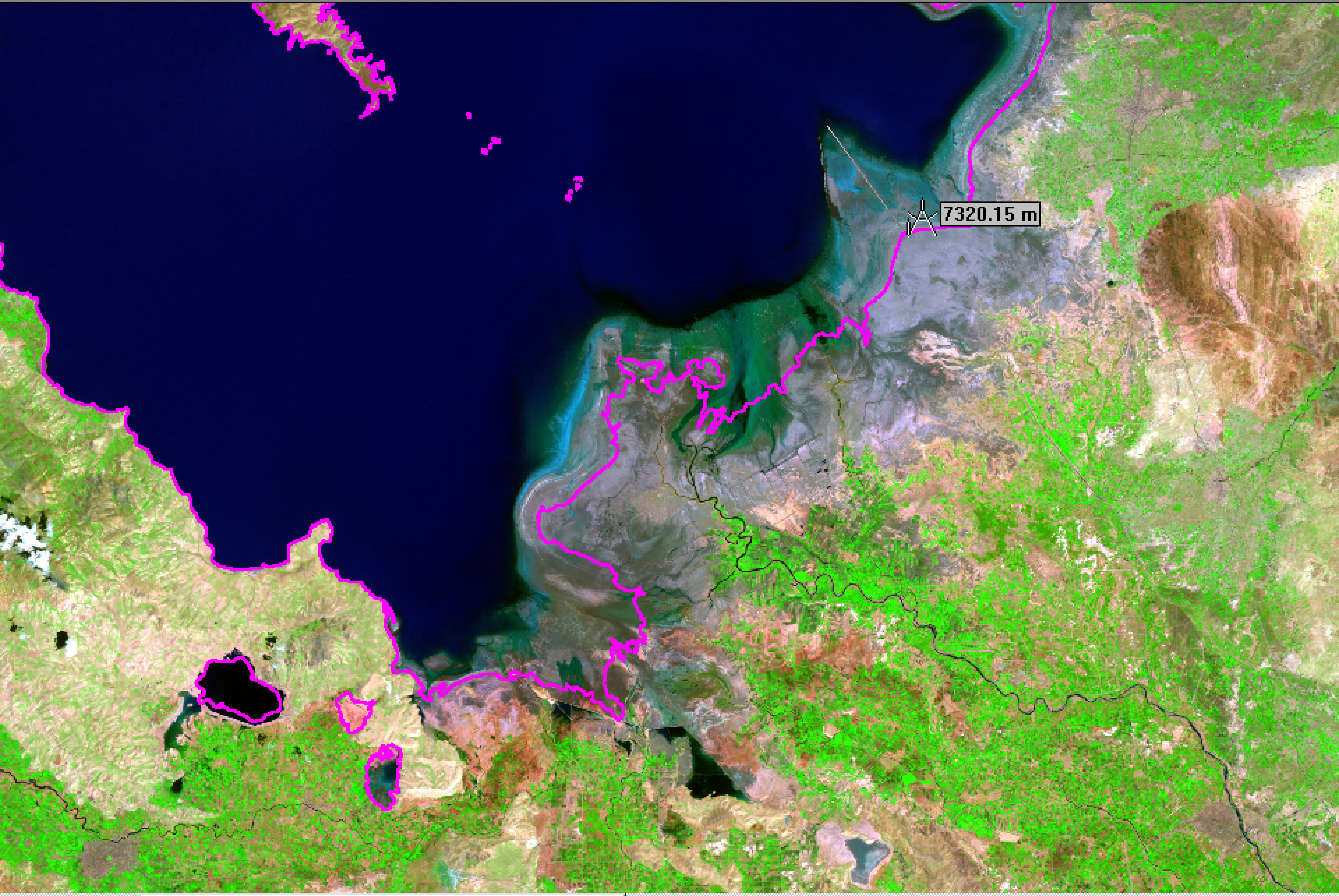
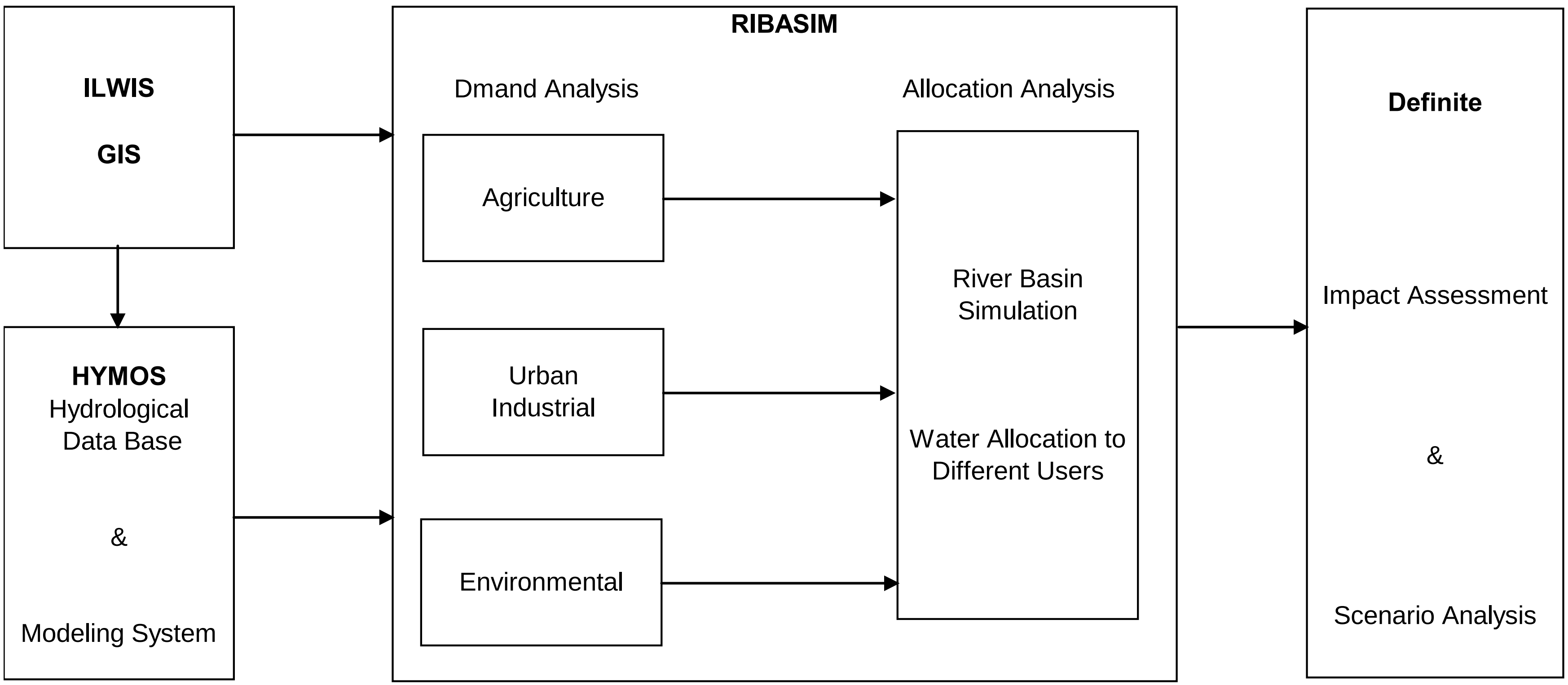
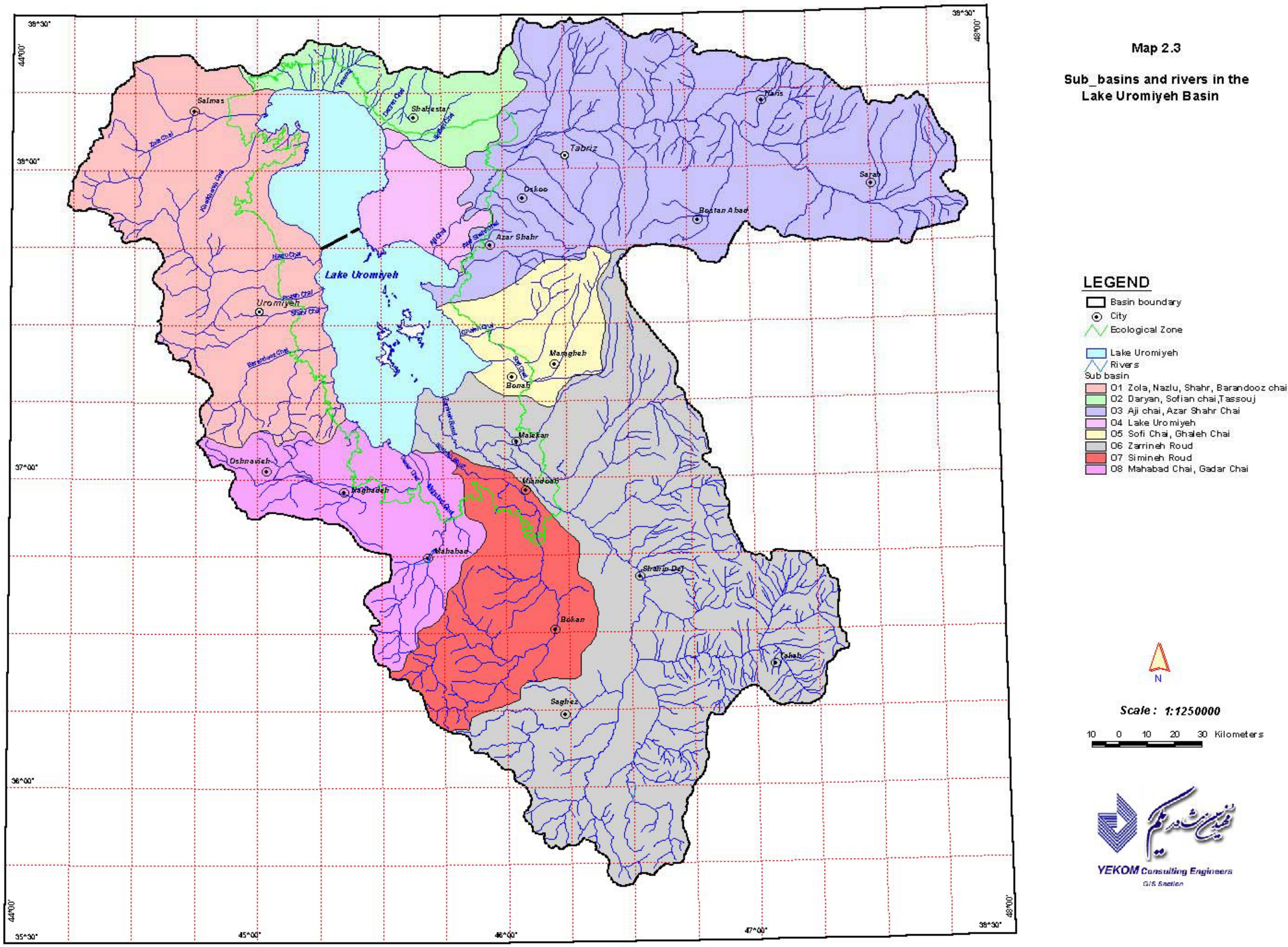


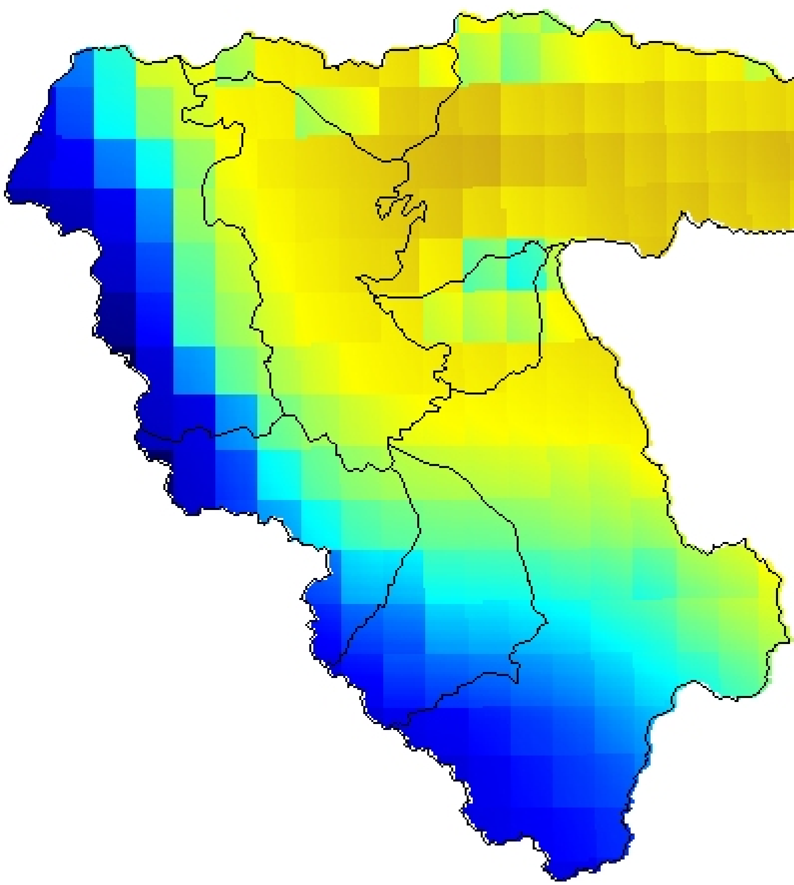
# Modelling approach to IWRM in Uromiyeh

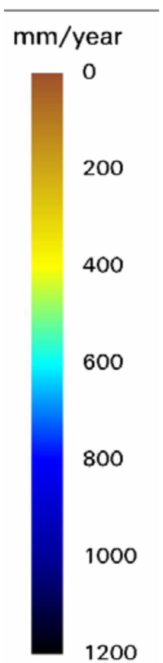


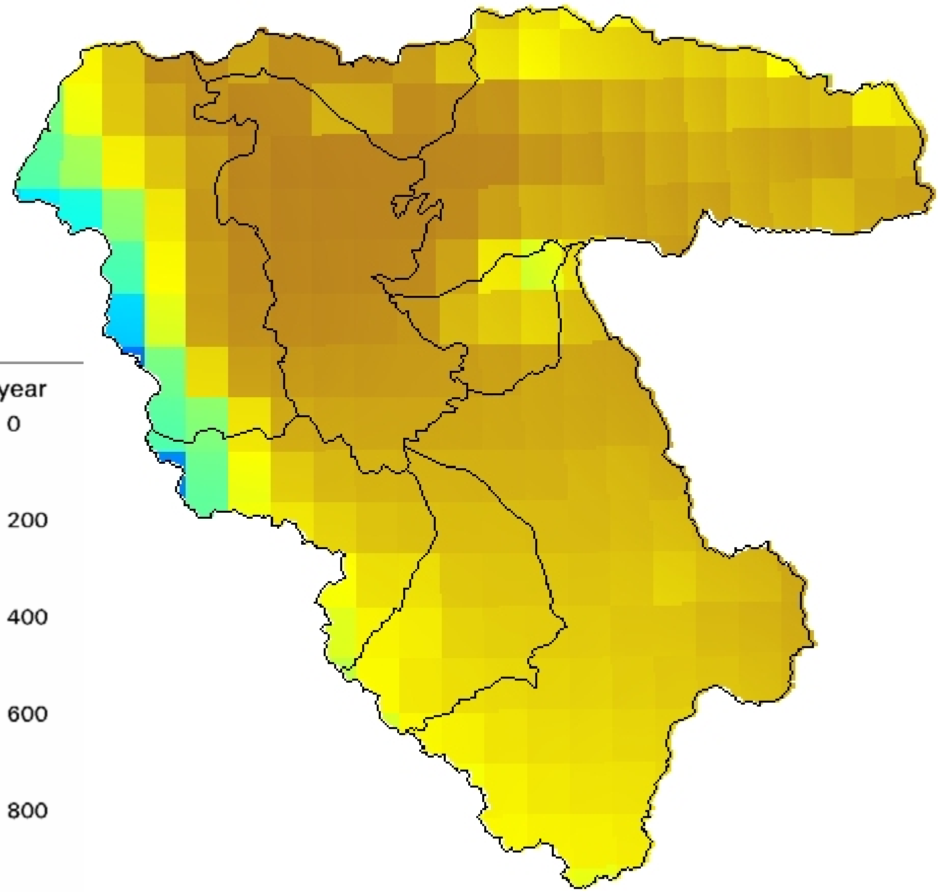
# Sub-watersheds in the Uromiyeh Basin



# Input to the system: precipitation





precipitation 1993-94

precipitation 1999-2000

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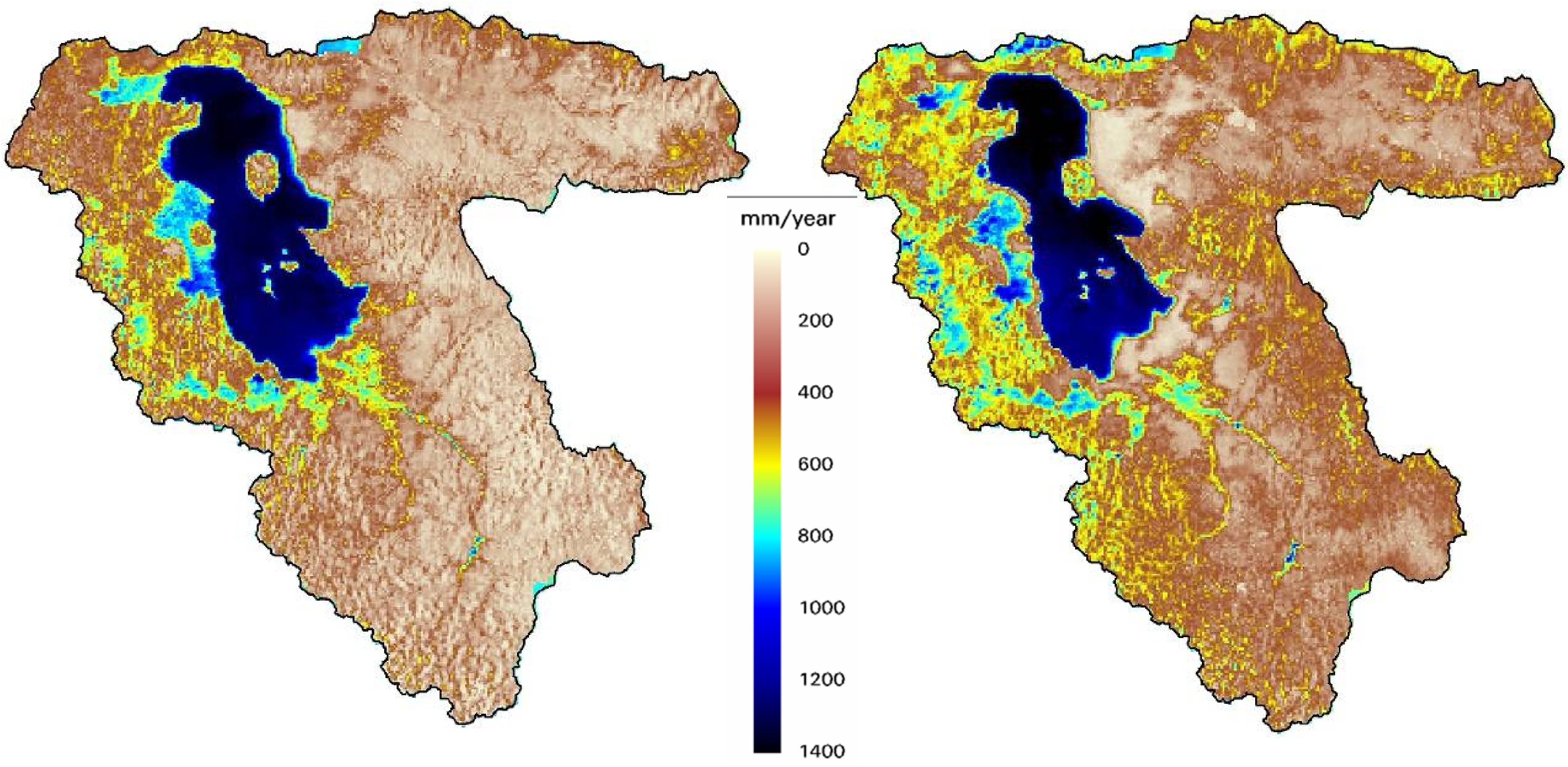
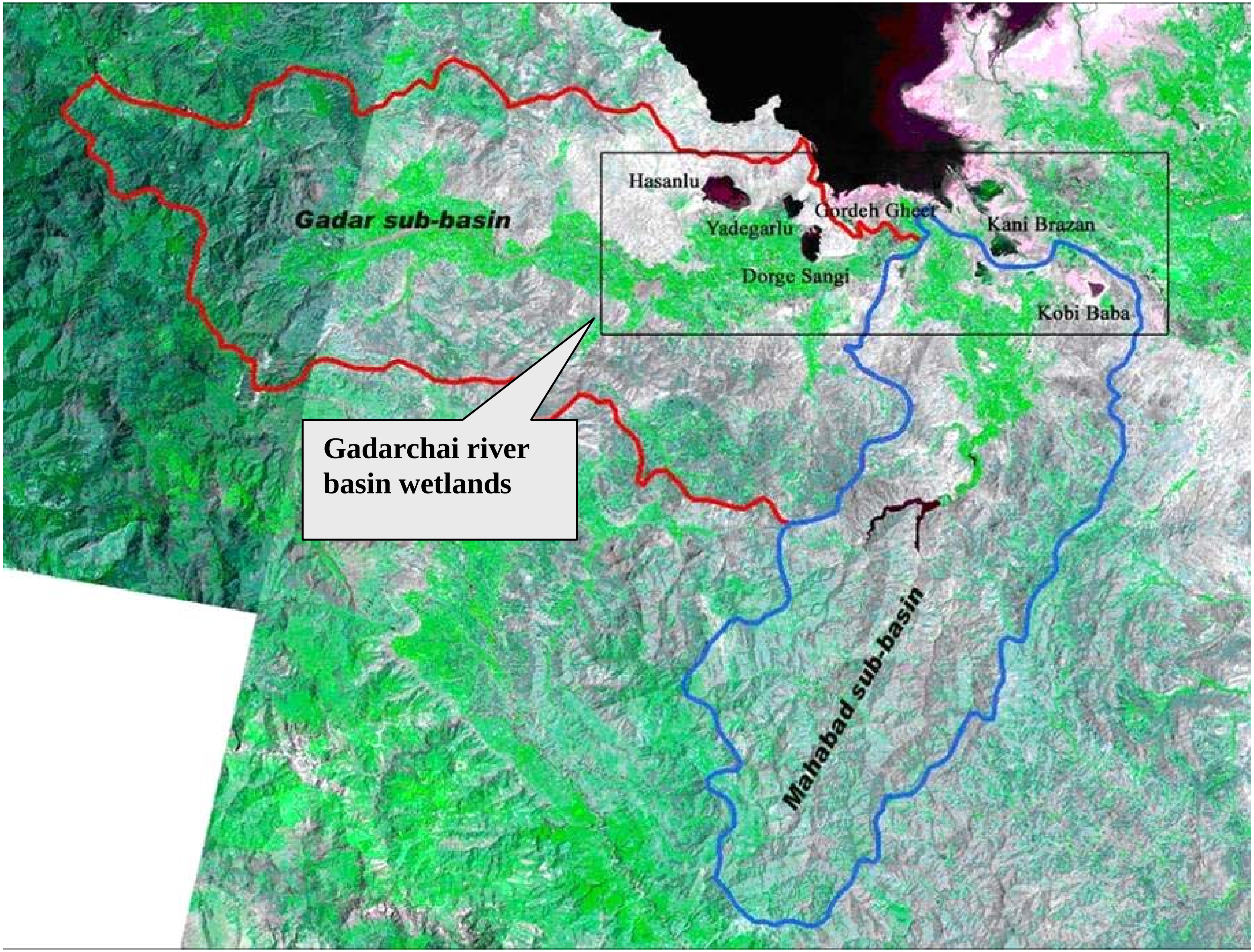
# Losses from the system using SEBAL



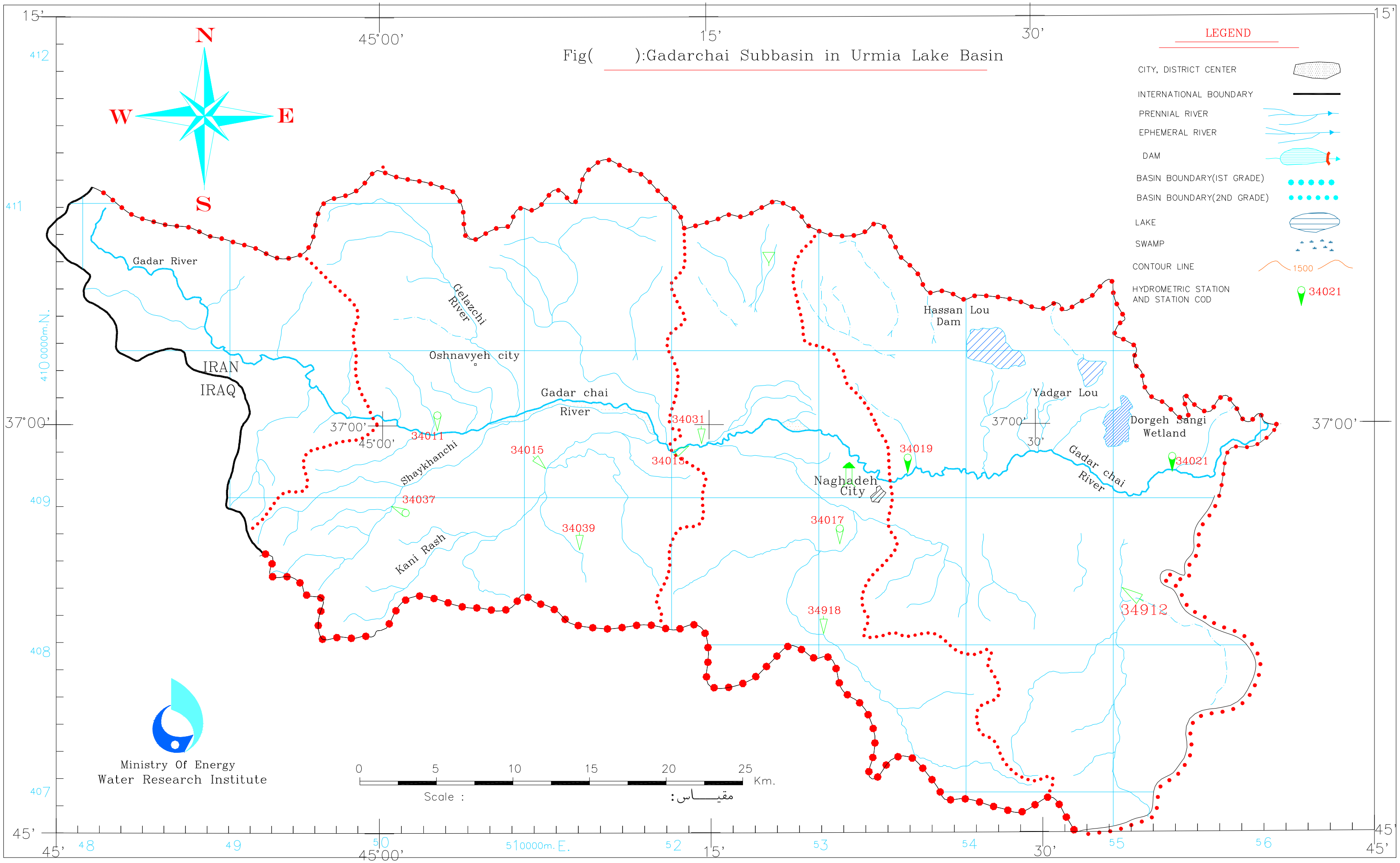

actual evapotranspiration 1993-94

actual evapotranspiration 1999-2000

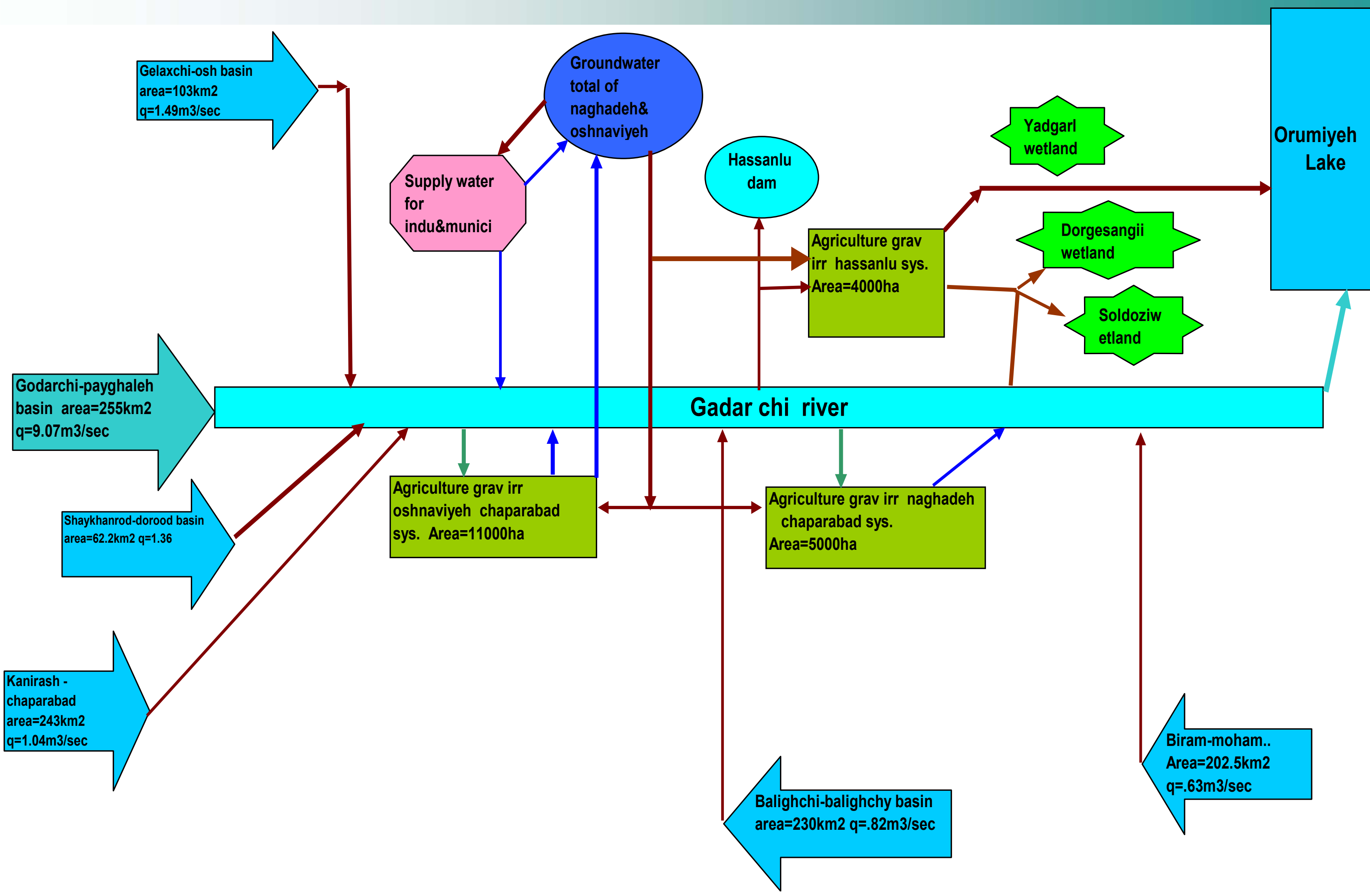
# Modelled sub-watershed: Gadar Chai



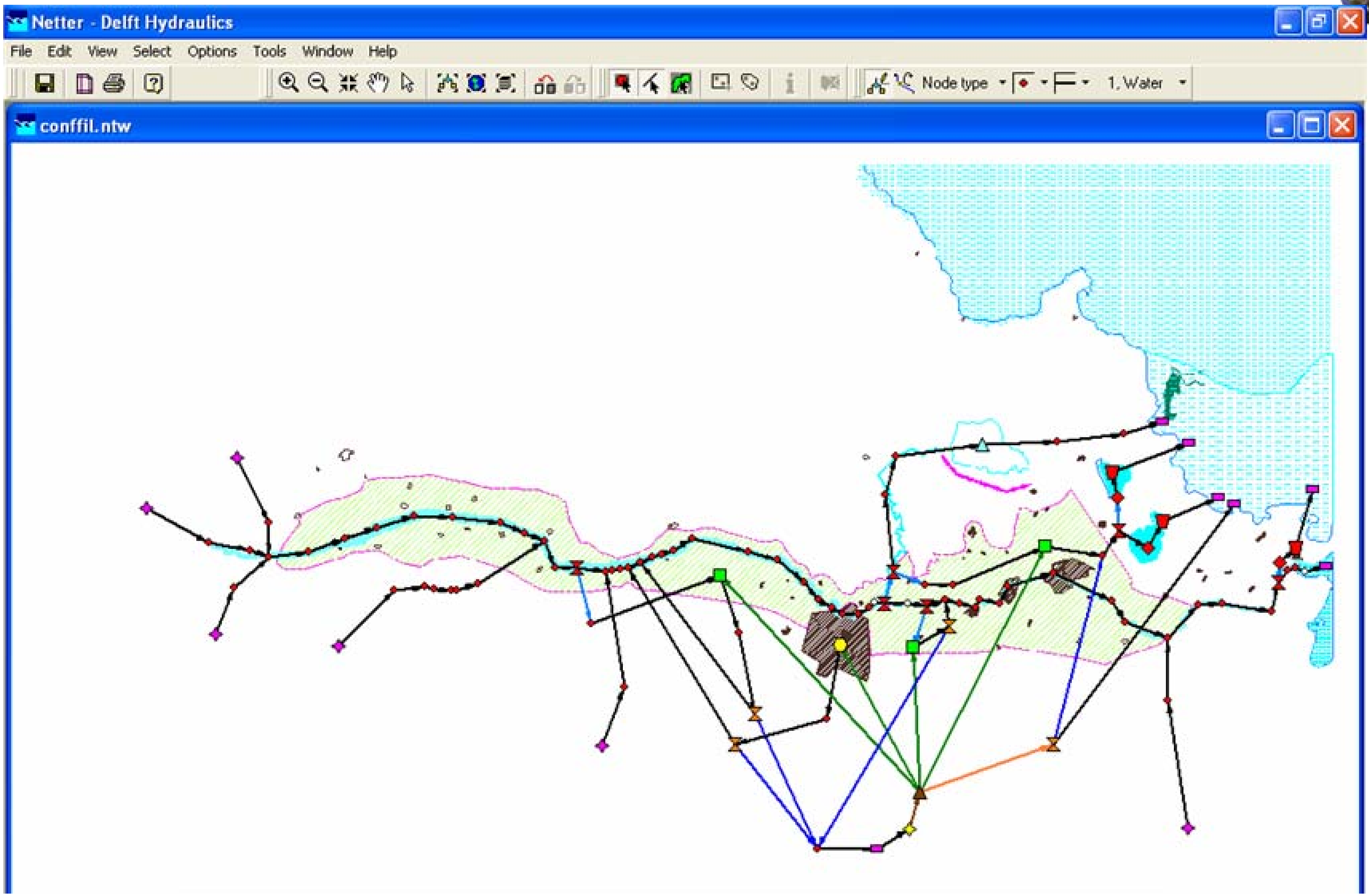
# The water courses and gauging stations



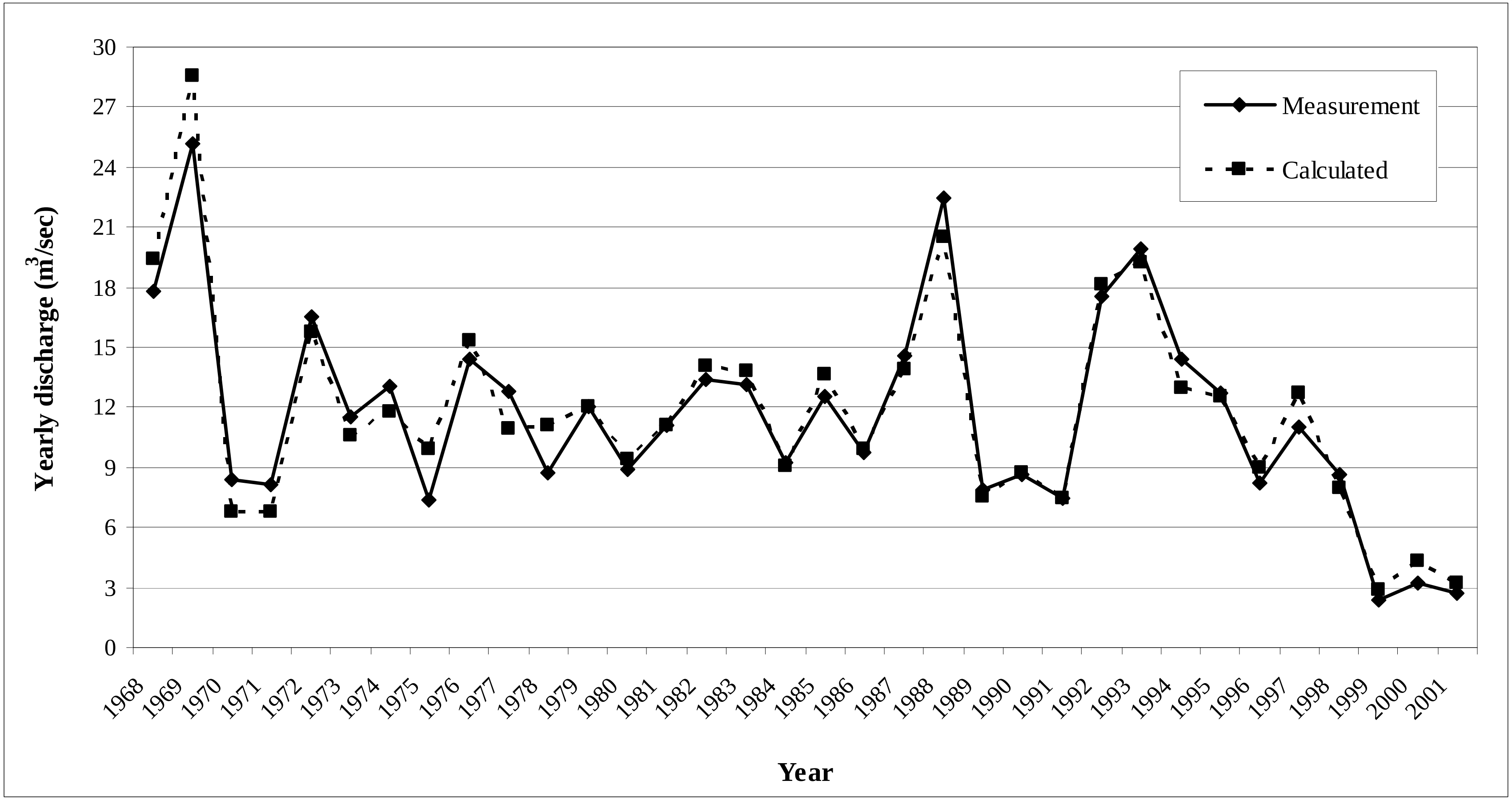
# Conceptual model of Ghadar Chai



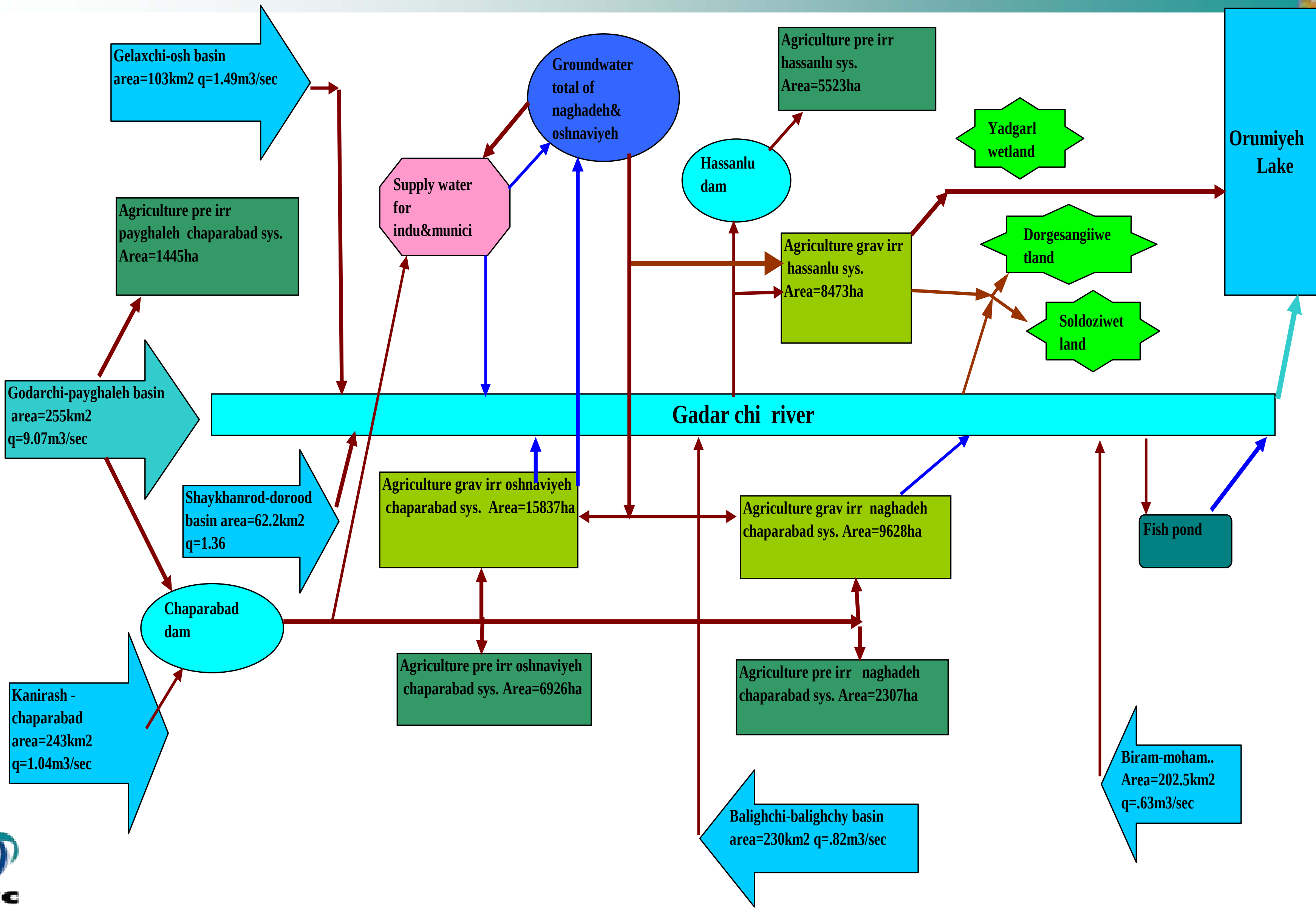
# Water network in Ribasim



# Long-term calibration of flow



# Future developments



# Scenarios

- Agriculture without efficiency increase
  - Priority 1: domestic and industrial supply
  - Priority 2: agriculture and fishponds with present efficiency
  - Priority 3: wetlands with present demand + streamflow
- Agriculture with efficiency increase
  - P1: domestic and industrial supply
  - P2: agriculture and fishponds with increased efficiency
  - P3: wetlands with increased demand + streamflow
- Environment without efficiency increase
  - P1: domestic and industrial supply
  - P2: wetlands with present demand + streamflow
  - P3: agriculture and fishponds with present efficiency
- Environment with efficiency increase
  - P1: domestic and industrial supply
  - P2: wetlands with increased demand + streamflow
  - P3: agriculture and fishponds with increased efficiency

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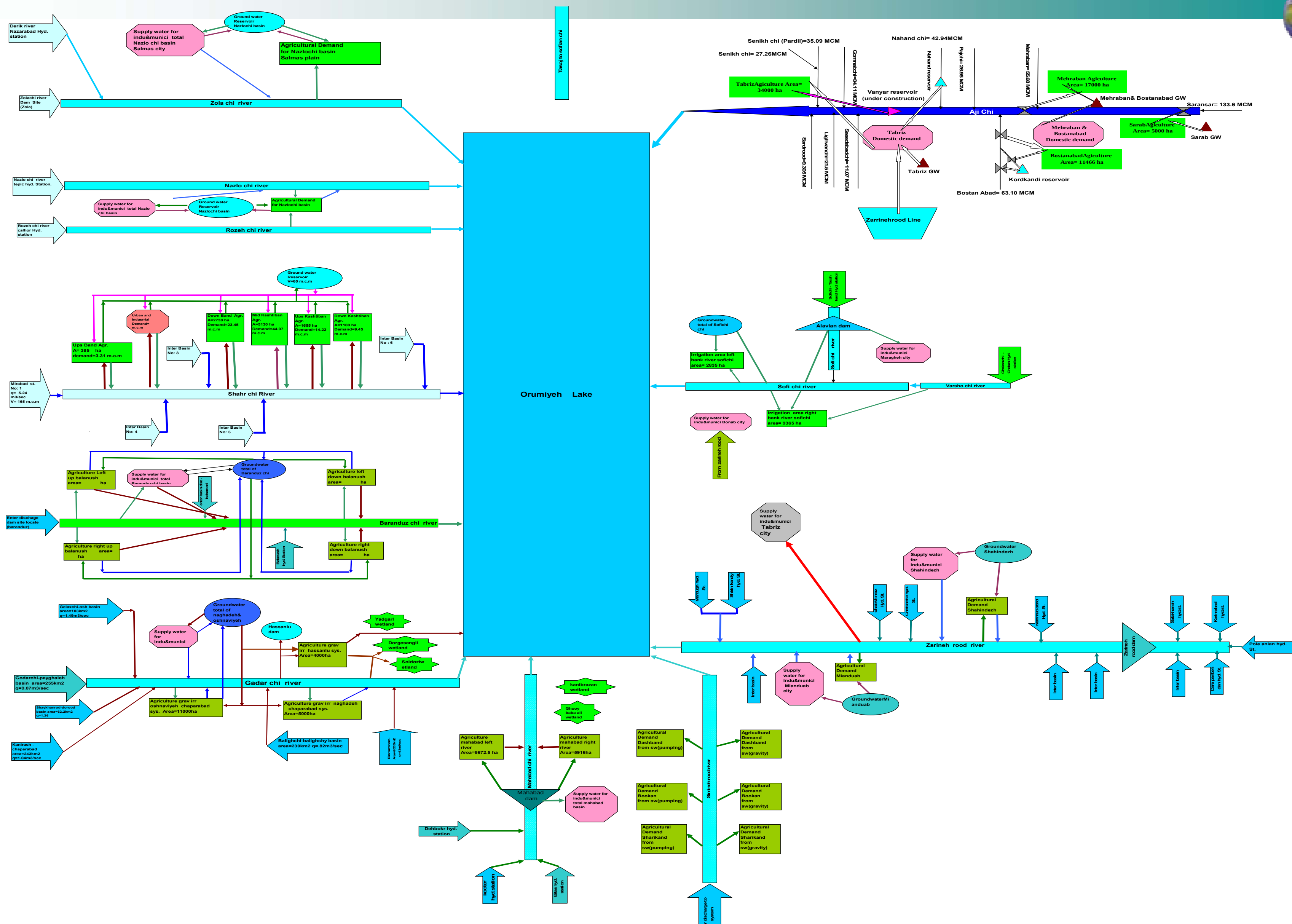
# Conceptual model of the Uromiyeh Basin



# Some results of scenario analysis

| Node index and name | Demand (Mcm) | Yearly average Deficit (Mcm) | Demand (m3/s) | Deficit (m3/s) | Success time steps number (-) | rate (%) | Success years number (-) | rate (%) | Number of successive failure years |
|---|---|---|---|---|---|---|---|---|---|
| Fir_Wa_Pay gha pre irr | 7.28 | 0.3 | 0.23 | 0.01 | 383 | 93.9 | 21 | 61.8 | 2 |
| Fir_Wa_Osh pre Irr | 34.92 | 9.03 | 1.11 | 0.29 | 310 | 76 | 9 | 26.5 | 4 |
| Fir_Wa_Nagh Pre Irr | 12.23 | 6.64 | 0.39 | 0.21 | 278 | 68.1 | 0 | 0 | 1 |
| Fir_Wa_ Osh grav irr | 138.16 | 18.47 | 4.38 | 0.59 | 342 | 83.8 | 12 | 35.3 | 4 |
| Fir_Wa_Hassanlo grav Irr | 73.23 | 3.26 | 2.32 | 0.1 | 380 | 93.1 | 18 | 52.9 | 3 |
| Fir_Wa_Hassanlu Pre Irr | 31.73 | 0.87 | 1.01 | 0.03 | 395 | 96.8 | 32 | 94.1 | 0 |
| Fir_Wa_Nagh_Grav Irr | 80.89 | 11.67 | 2.57 | 0.37 | 302 | 74 | 0 | 0 | 1 |
| Total | 378.44 | 50.24 | 12 | 1.59 | | | | | |

| Node index and name | Demand (Mcm) | Yearly average Deficit (Mcm) | Demand (m3/s) | Deficit (m3/s) | Success time steps number (-) | rate (%) | Success years number (-) | rate (%) | Number of successive failure years |
|---|---|---|---|---|---|---|---|---|---|
| Lfl_Wa_payghaleh | 15.78 | 2.86 | 0.5 | 0.09 | 324 | 79.7 | 8 | 23.5 | 4 |
| Lfl_Wa_Naghadeh | 15.78 | 1.87 | 0.5 | 0.06 | 344 | 84.3 | 13 | 38.2 | 4 |
| Lfl_Wa_yadgarlo wetland | 4.94 | 0.19 | 0.16 | 0.01 | 395 | 96.8 | 32 | 94.1 | 0 |
| Lfl_Wa_dogehsangi wetland | 3.34 | 0.03 | 0.11 | 0 | 403 | 98.8 | 32 | 94.1 | 0 |
| Lfl_wa_gerdeh&solduz wetland | 3.52 | 0.16 | 0.11 | 0.01 | 388 | 95.1 | 19 | 55.9 | 2 |
| Total | 43.35 | 5.12 | 1.37 | 0.16 | | | | | |

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# Total water availability results

| Scenario | Area of agricultural lands (ha) | Gravitational lands efficiency (%) | Under-pressure lands efficiency (%) | Agricultural water demand and shortage (MCM) | Drinking and industrial water demand and shortage (MCM) | Minimum stream flow water demand and shortage (MCM) | Wetlands water demand and shortage (MCM) | Inflow to Lake Uromiyeh(MCM) | Fishpond water demand and shortage (MCM) |
|---|---|---|---|---|---|---|---|---|---|
| **First scenario** | 50,000 | 32 | 64 | 378<br>50 | 40.4<br>0.53 | 31.56<br>4.73 | 11.81<br>0.38 | 90.44 | 35.43<br>3.66 |
| **Second scenario** | 50,000 | 32 | 64 | 378<br>56 | 40.4<br>0.53 | 31.56<br>1.8 | 11.81<br>0.01 | 92.5 | 35.43<br>3.26 |
| **Third scenario** | 50,000 | 50 | 64 | 312<br>17.8 | 40.4<br>0.3<br>0.02 | 31.56<br>1.32<br>0.46 | 11.81<br>0.01<br>0.0 | -<br>92<br>114.5 | 35.43<br>1.35<br>0.7 |
| **Fourth scenario** | 50,000 | 50 | 64 | 312<br>22.8 | 40.4<br>0.3<br>0.11 | 31.56<br>3.08<br>1.61 | 11.81<br>0.24<br>0.21 | 114.58<br>94<br>114 | 35.43<br>2.65<br>1.58 |

# Major conclusions of the project

- The recent water use is already more than the environmentally tolerable.
- Further development without efficiency improvement is killing Lake Uromiyeh.
- Even the planned efficiency improvement is not enough for balancing the population pressure (increasing agricultural production) and the need for energy production.

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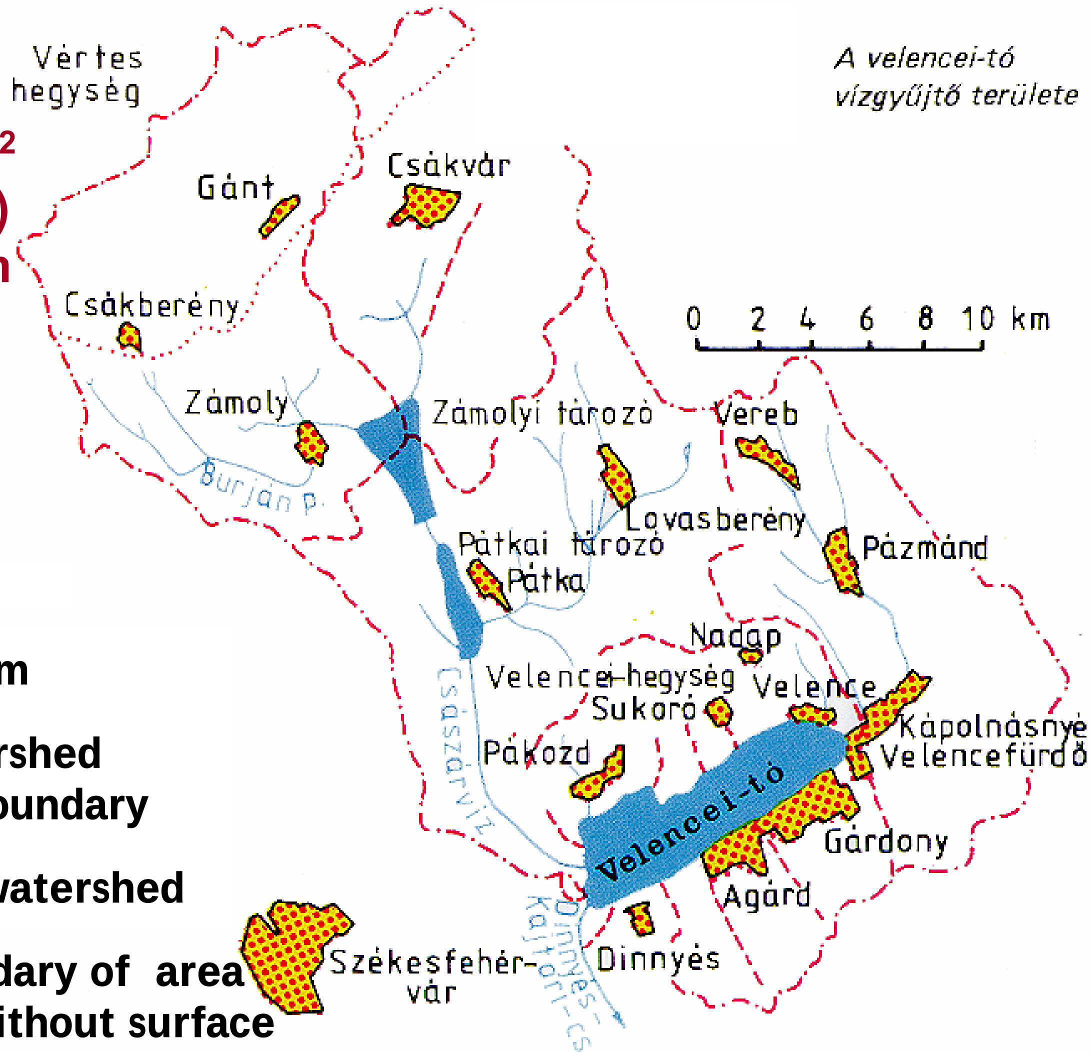
# The watershed of Lake Velence

- **Three parts:**
  - **Császár stream 383 km² (75 km² is inactive karst)**
  - **Vereb-Pázmándi stream 105 km²**
  - **Direct watershed of the lake 112 km²**
- **Total area is about 600 km²**



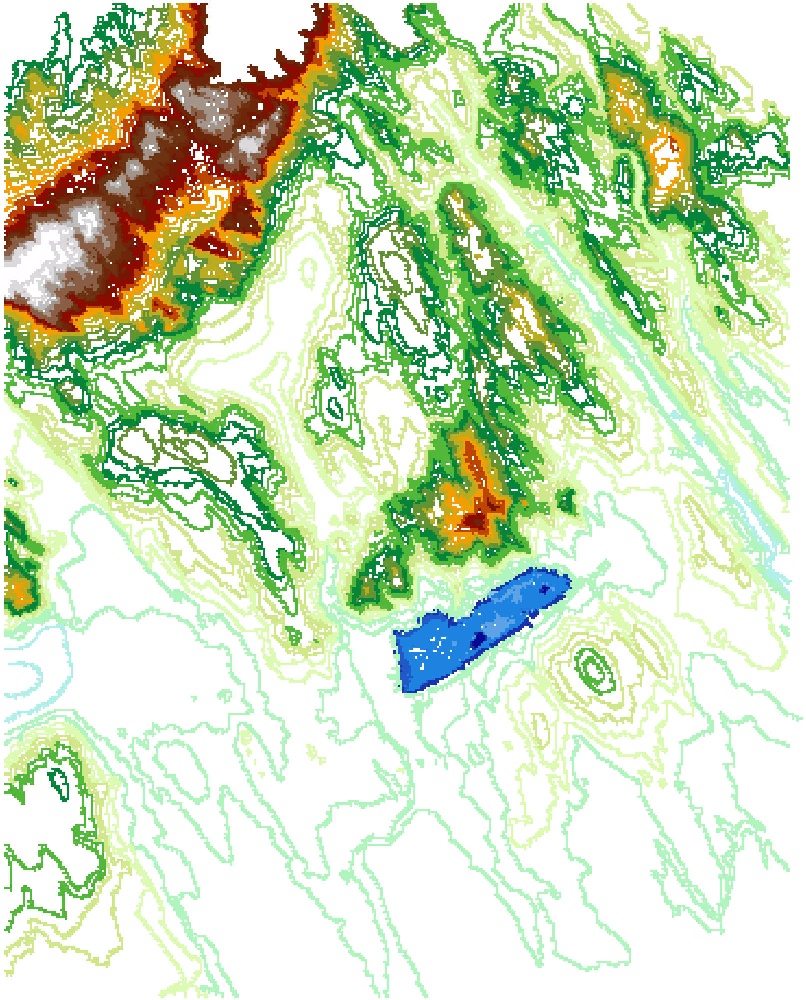

**Stream**

**Watershed boundary**

**Sub-watershed**

**Boundary of area without surface runoff**

# Topography



# Issues, questions (many more are possible)

- Strong human impact (intensive agriculture, tourism, discharge control, water outtake, waste water, etc.)
- Need for ‘precision water and environmental management’.
- What are the elements of the water budget of the lake?
- How much can the individual water users change their practice?
- How much can we improve on the water budget estimation by using spatial information?
- How can stakeholders be involved in the management of the whole watershed?

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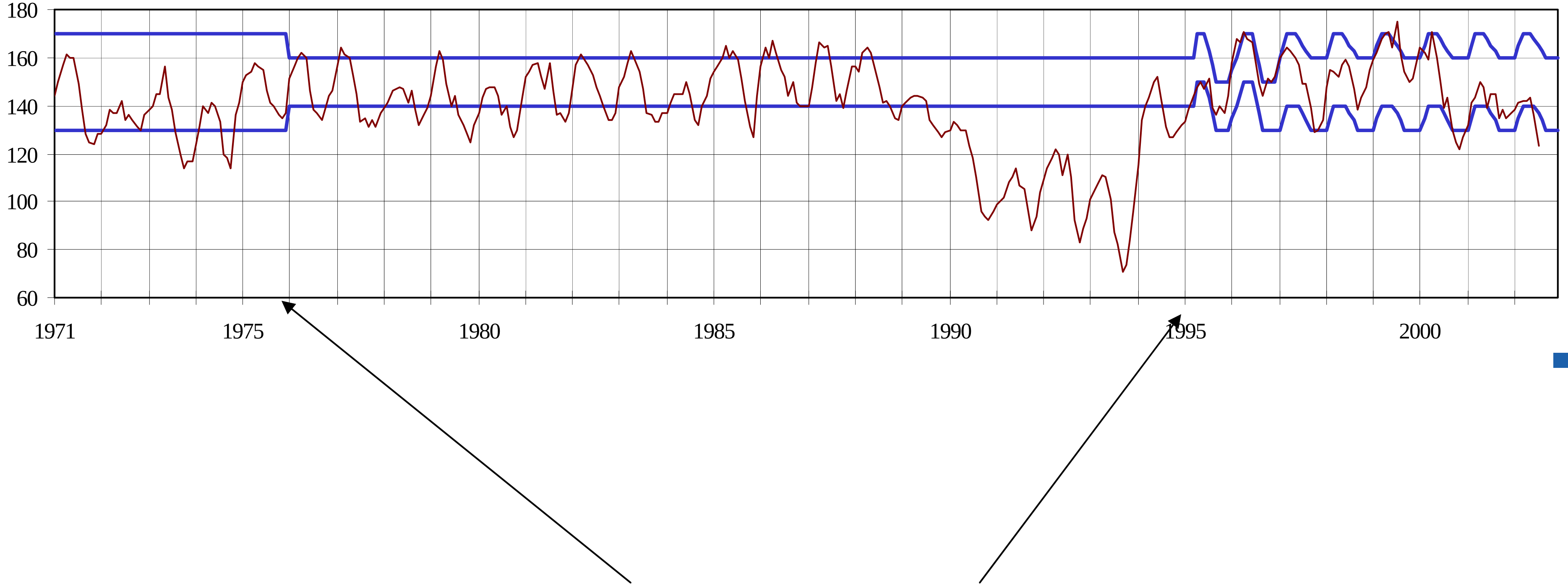
# Lake level fluctuations of Lake Velence (Hungary)




**Change of management methods**