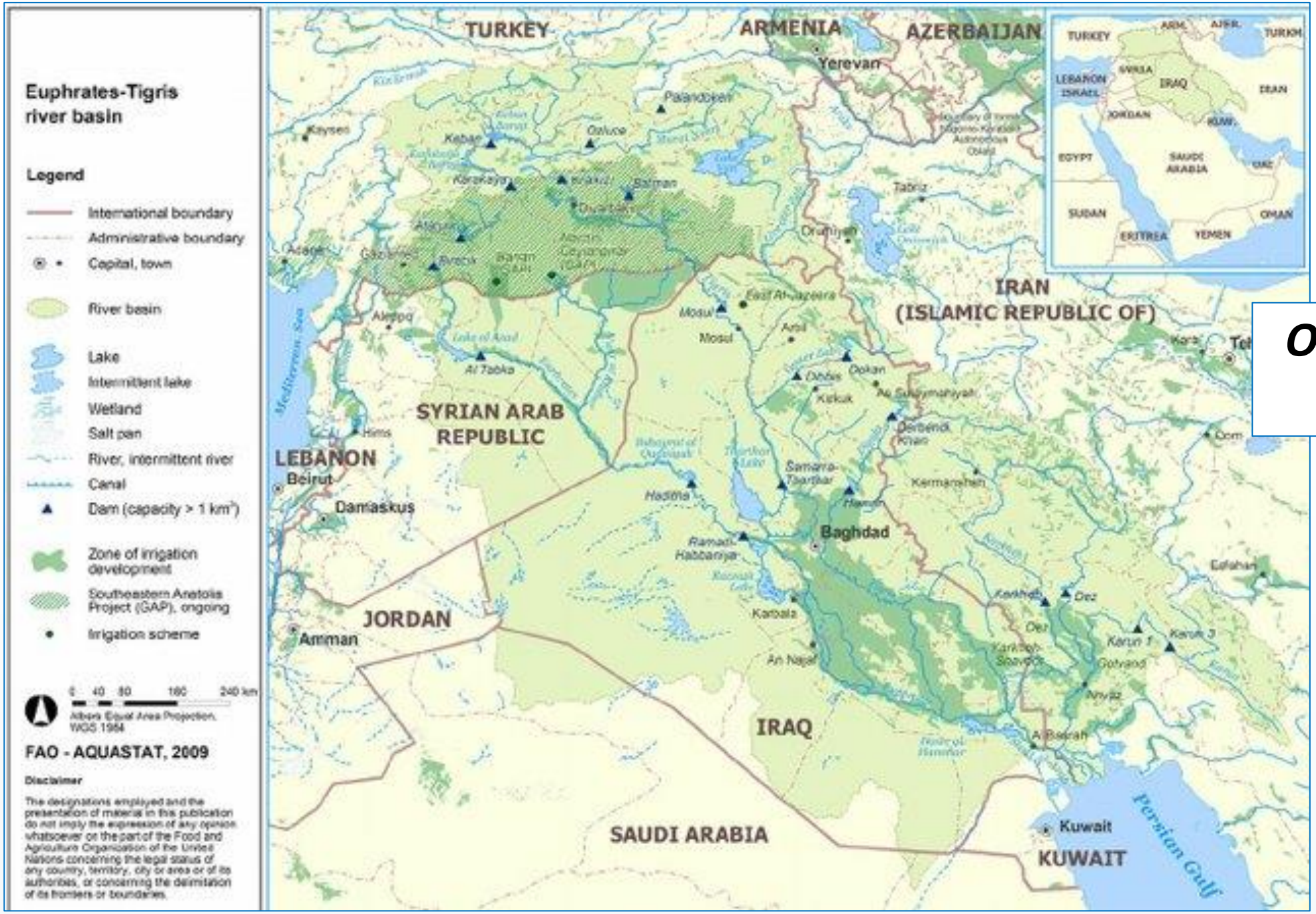
ANALYSIS OF WATER RESOURCES WITHIN IRAQ

Ron Passchier

Deltares

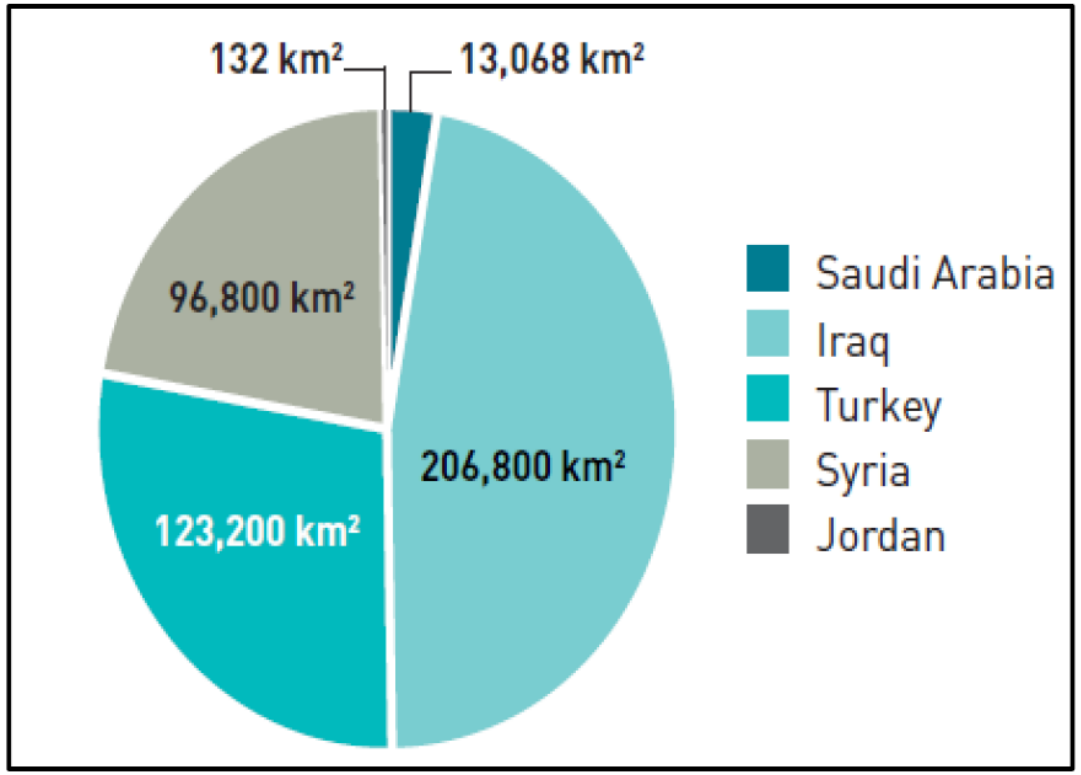
Excerpts from slides prepared for Water, Peace and Security tailor-made capacity development activities in Iraq. Please attribute authors when using materials.



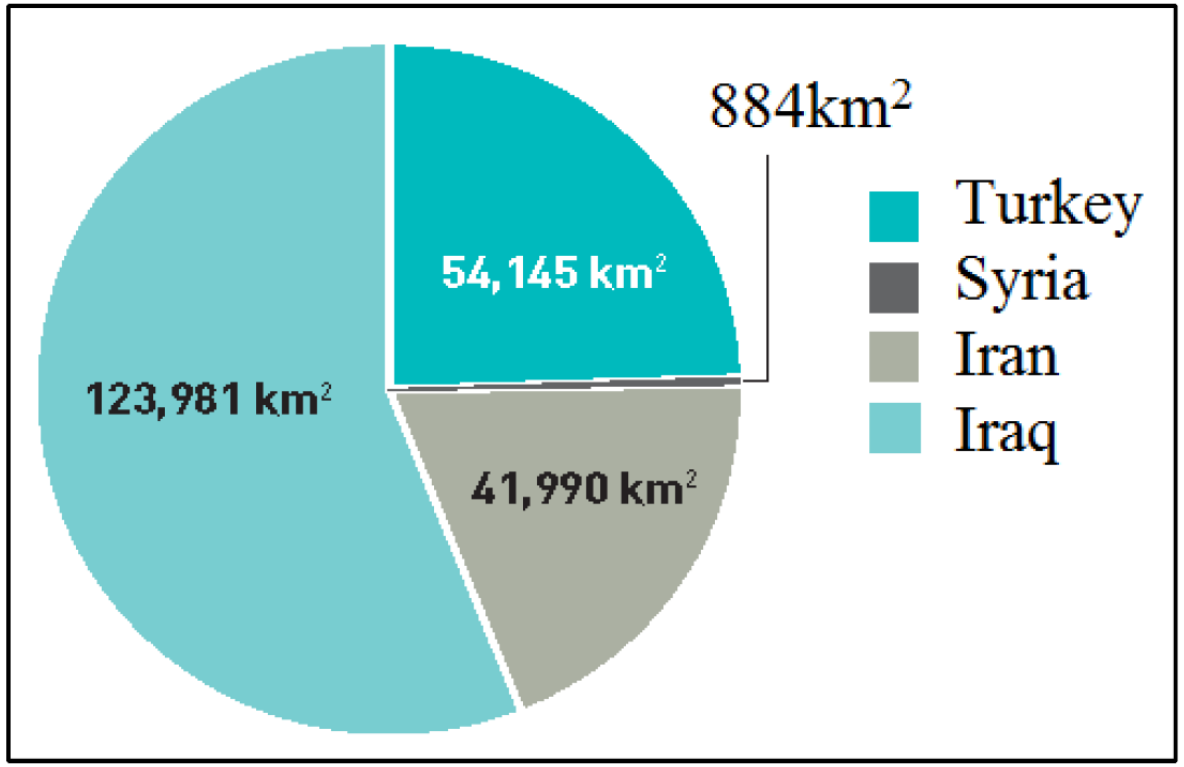
Overview of the basin

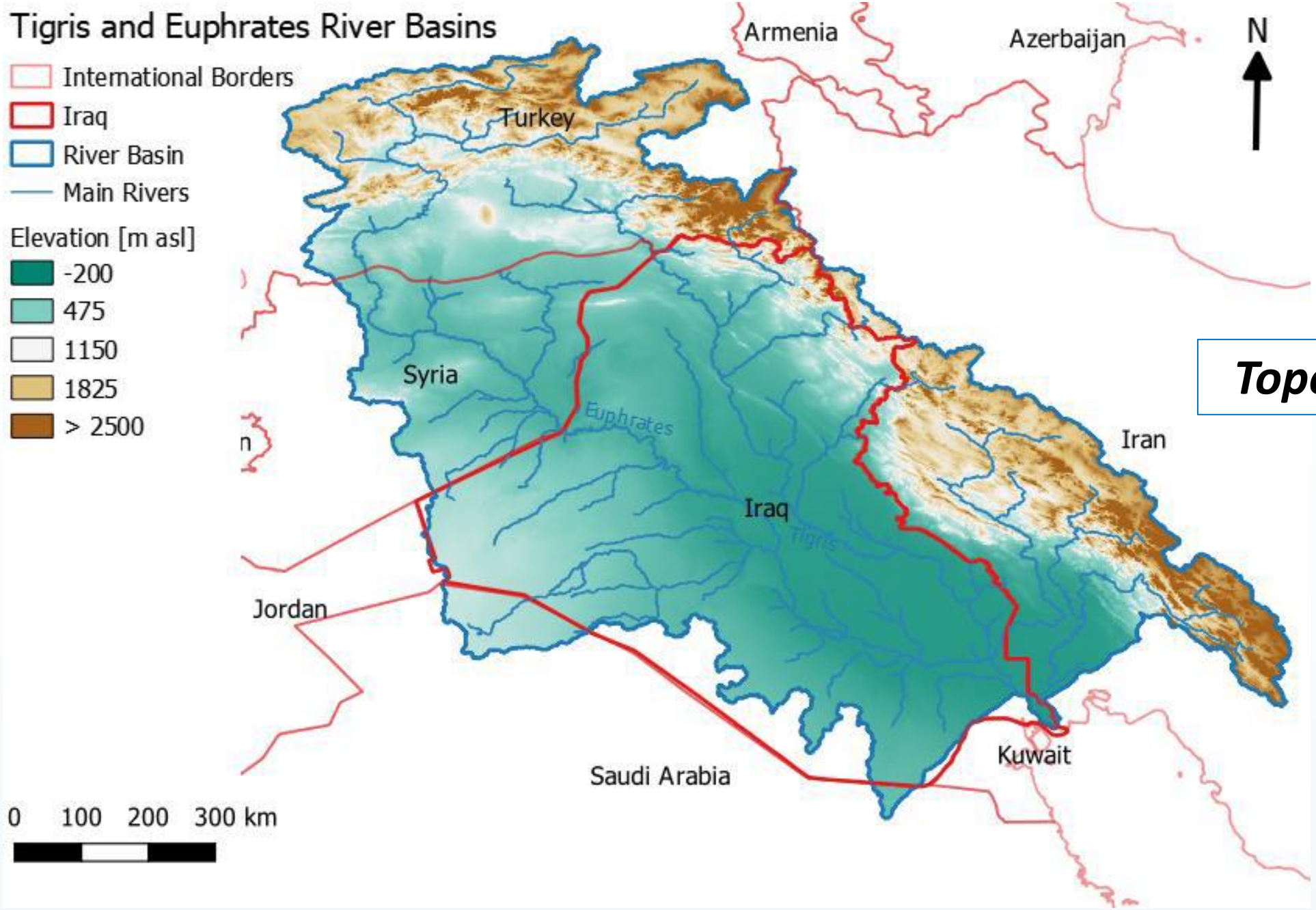
Distribution of catchment area

Euphrates

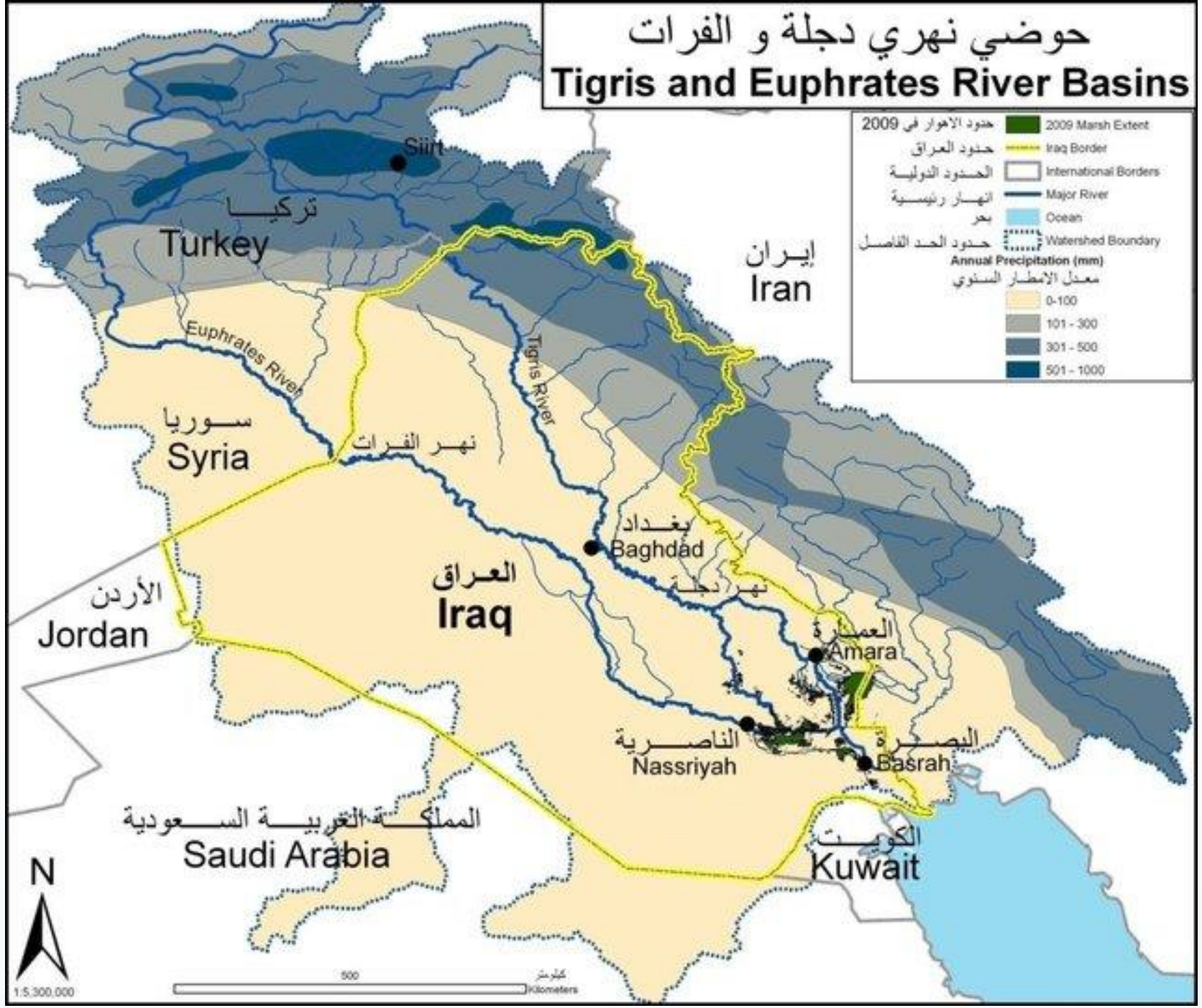


Tigris




Tigris and Euphrates River Basins
International Borders
Iraq
River Basin
Main Rivers
Elevation [m asl]
-200
475
1150
1825
> 2500
Armenia
Azerbaijan
N
Turkey
Syria
Euphrates
Iran
Iraq
Tigris
Jordan
Kuwait
Saudi Arabia
0 100 200 300 km

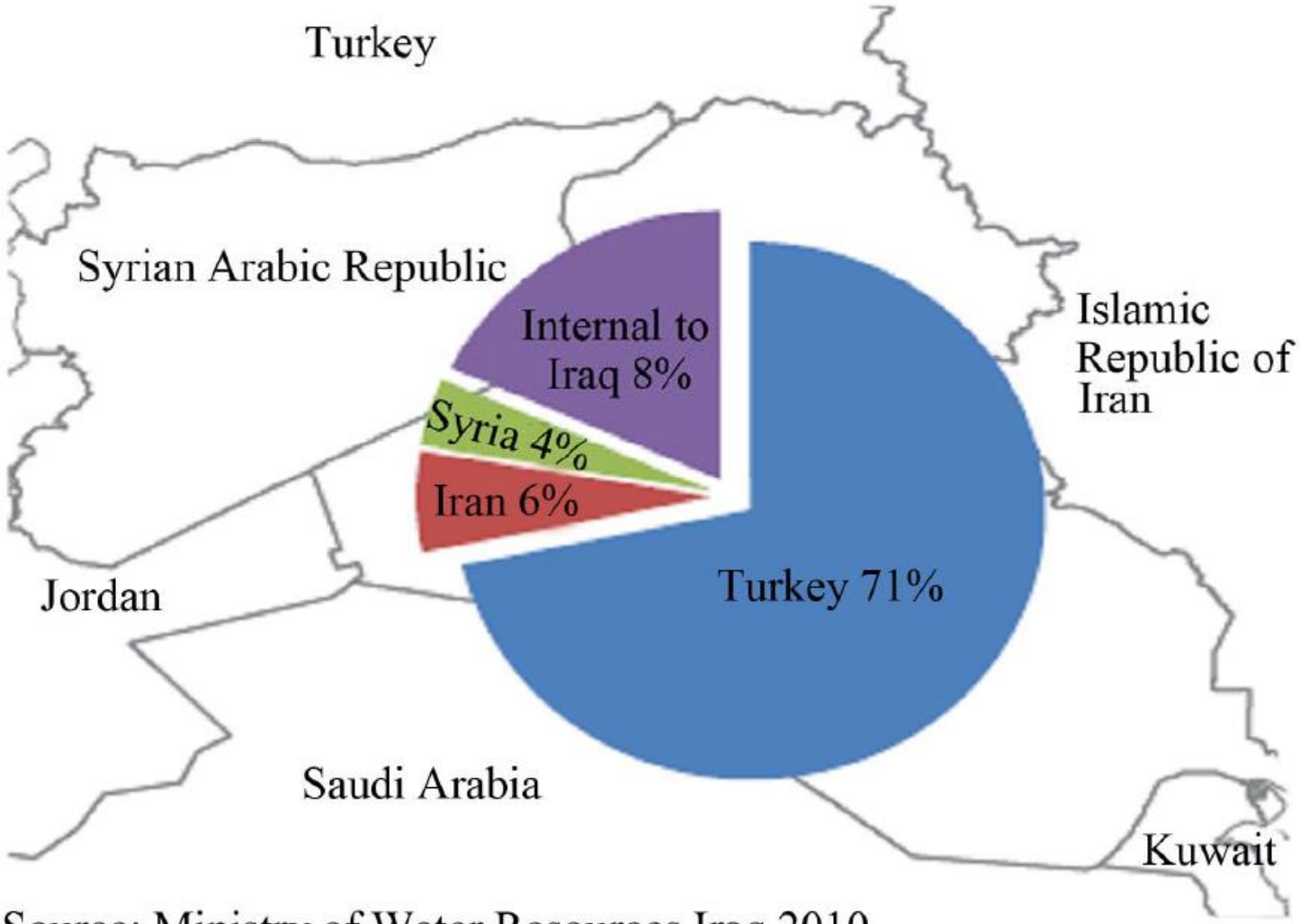
Topography



Overall rainfall pattern

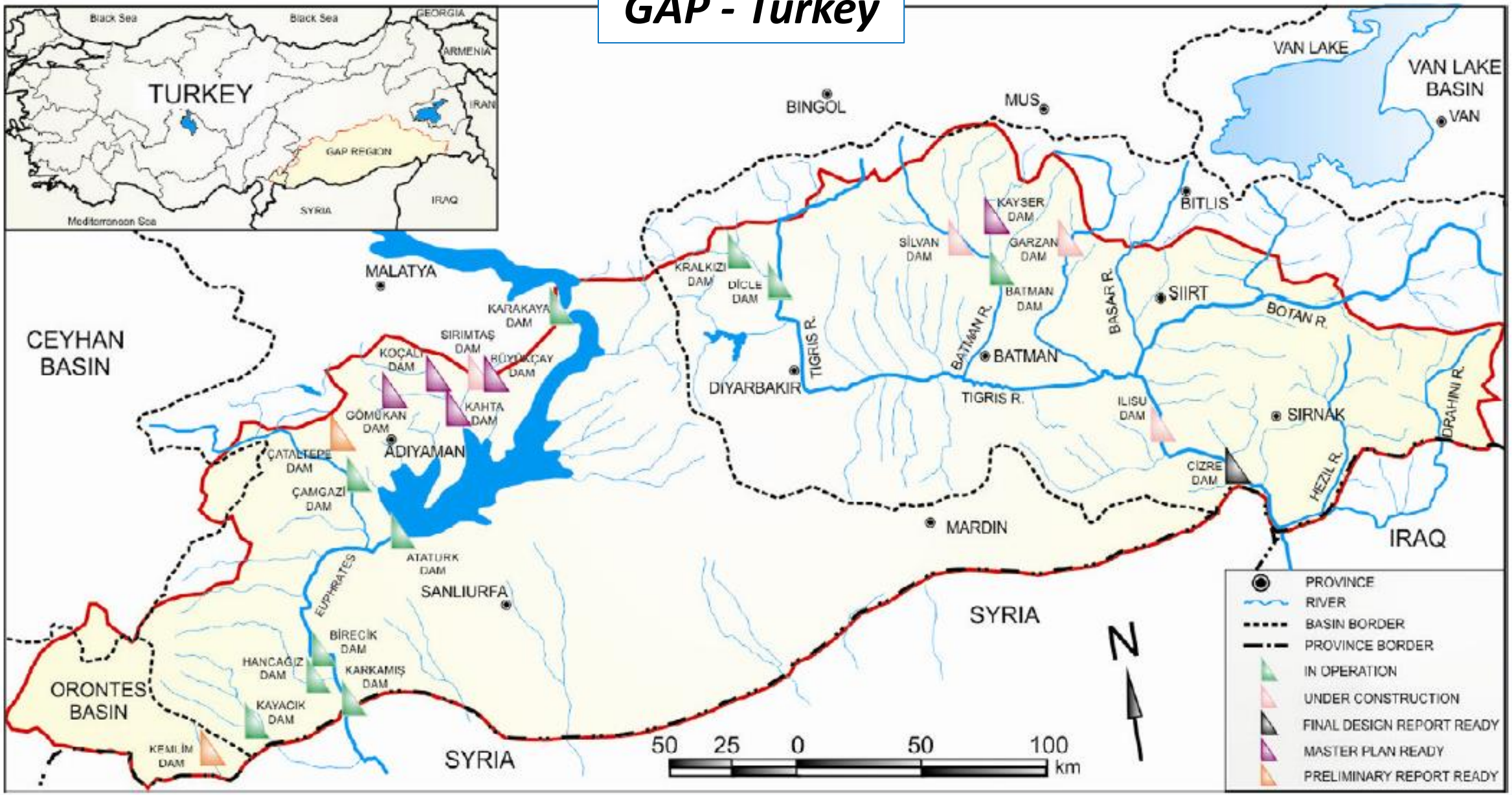
Salient features of Iraq Water Resources

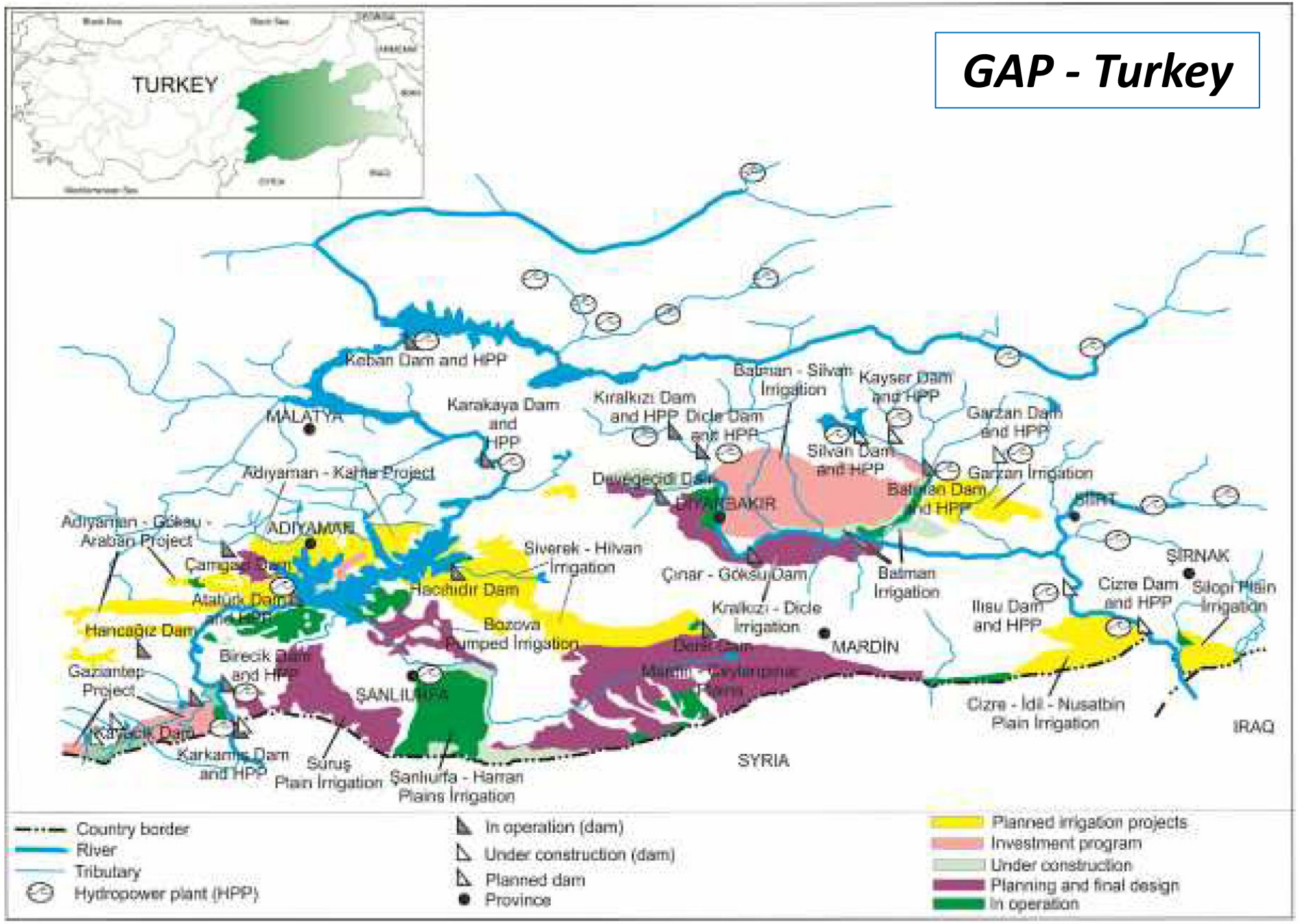
- Strong dominance by inflow from Turkey
- Second by Iran, but only to Tigris river
- Overall inflow has decreased tremendously
- Exact impact of GAP-Turkey is not clear
- Important link between rivers through Lake Tharthar



Source: Ministry of Water Resources Iraq 2010

GAP - Turkey


Black Sea
Black Sea
GEORGIA
ARMENIA
TURKEY
IRAN
GAP REGION
SYRIA
IRAQ
Mediterranean Sea
VAN LAKE
VAN LAKE BASIN
VAN
BINGOL
MUS
BITLIS
KAYSER DAM
SİLVAN DAM
GARZAN DAM
BATMAN DAM
KRALKIZI DAM
DİCLE DAM
MALATYA
KARAKAYA DAM
SIRIMTAŞ DAM
KOÇALI DAM
BÜYÜKÇAY DAM
KAHTA DAM
GÖMÜKAN DAM
ÇATALTEPE DAM
ÇAMGAZİ DAM
ADIYAMAN
ATATÜRK DAM
SANLIURFA
CEYHAN BASIN
ORONTES BASIN
BİRECİK DAM
HANCAĞIZ DAM
KARKAMIŞ DAM
KAYACIK DAM
KEMALİM DAM
EUPHRATES
TIGRIS R.
BATMAN R.
BASAR R.
BOTAN R.
DIYARBAKIR
BATMAN
SIIRT
TIGRIS R.
ILISU DAM
CİZRE DAM
SIRNAK
HEZIL R.
DRAHINI R.
MARDIN
IRAQ
SYRIA
SYRIA
N
50 25 0 50 100
km
PROVINCE
RIVER
BASIN BORDER
PROVINCE BORDER
IN OPERATION
UNDER CONSTRUCTION
FINAL DESIGN REPORT READY
MASTER PLAN READY
PRELIMINARY REPORT READY


GAP - Turkey
TURKEY
Keban Dam and HPP
MALATYA
Karakaya Dam and HPP
Kiralkızı Dam and HPP
Dicle Dam and HPP
Batman - Silvan İrrigation
Kayser Dam and HPP
Garzan Dam and HPP
Silvan Dam and HPP
Garzan İrrigation
Batman Dam and HPP
Adıyaman - Kahta Project
Adıyaman - Gölbaşı - Araban Project
ADIYAMAN
Çamgazi Dam
Atatürk Dam and HPP
Hancağız Dam
Gaziantep Project
Birecik Dam and HPP
Karkamış Dam and HPP
Süruç Plain İrrigation
ŞANLIURFA
Şanlıurfa - Harran Plains İrrigation
Siverek - Hilvan İrrigation
Hacıhıdır Dam
Bozova Pumped İrrigation
Çınar - Göksu Dam
Batman İrrigation
Kralkızı - Dicle İrrigation
MARDİN
Ilısu Dam and HPP
Cizre Dam and HPP
Silopi Plain İrrigation
ŞIRNAK
Cizre - İdil - Nusaybin Plain İrrigation
SYRIA
IRAQ
Country border
River
Tributary
Hydropower plant (HPP)
In operation (dam)
Under construction (dam)
Planned dam
Province
Planned irrigation projects
Investment program
Under construction
Planning and final design
In operation

Enormous development in irrigated agriculture in Turkey

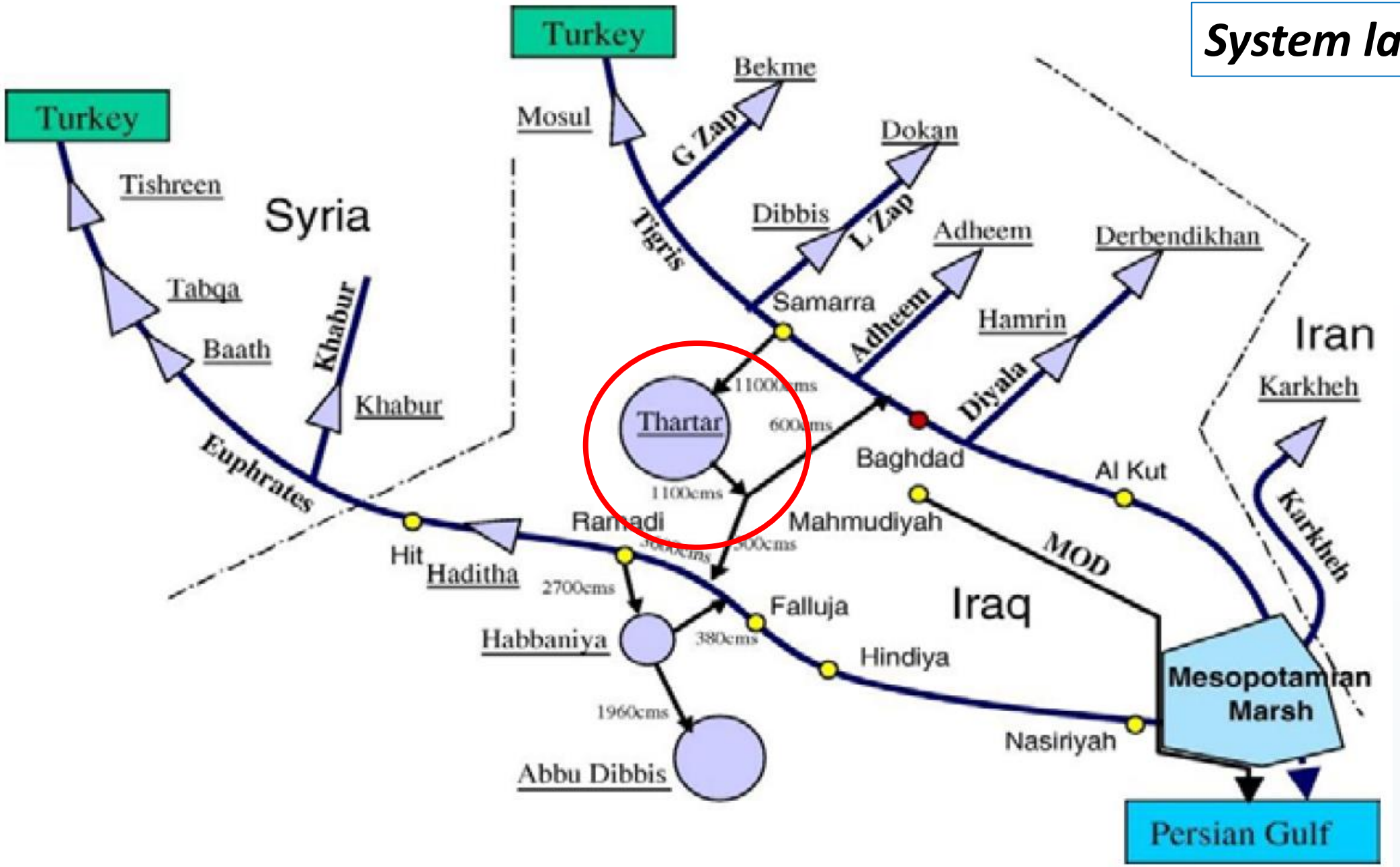
Table 1 General Features of the GAP Region [10]

Parameters	GAP region	Turkey	Ratio (%)
Total area (km^2)	75193	780000	9.7
Population (x 10^6)	7.82	74.7	10.5
Water budget (billion m^3)	52.9	186.1	28.4
Irrigable land (x 10^6 hectare)	1.82	8.5	21.4
Hydropower potential (TWh)	27.5	122	22.5

Intricate system with many dams and transfers

- Dams not only on the main rivers, but also on most of the Iranian tributaries
- Important diversion of Tigris to Lake Tharthar → storage for boosting of Euphrates and also Tigris in dry season

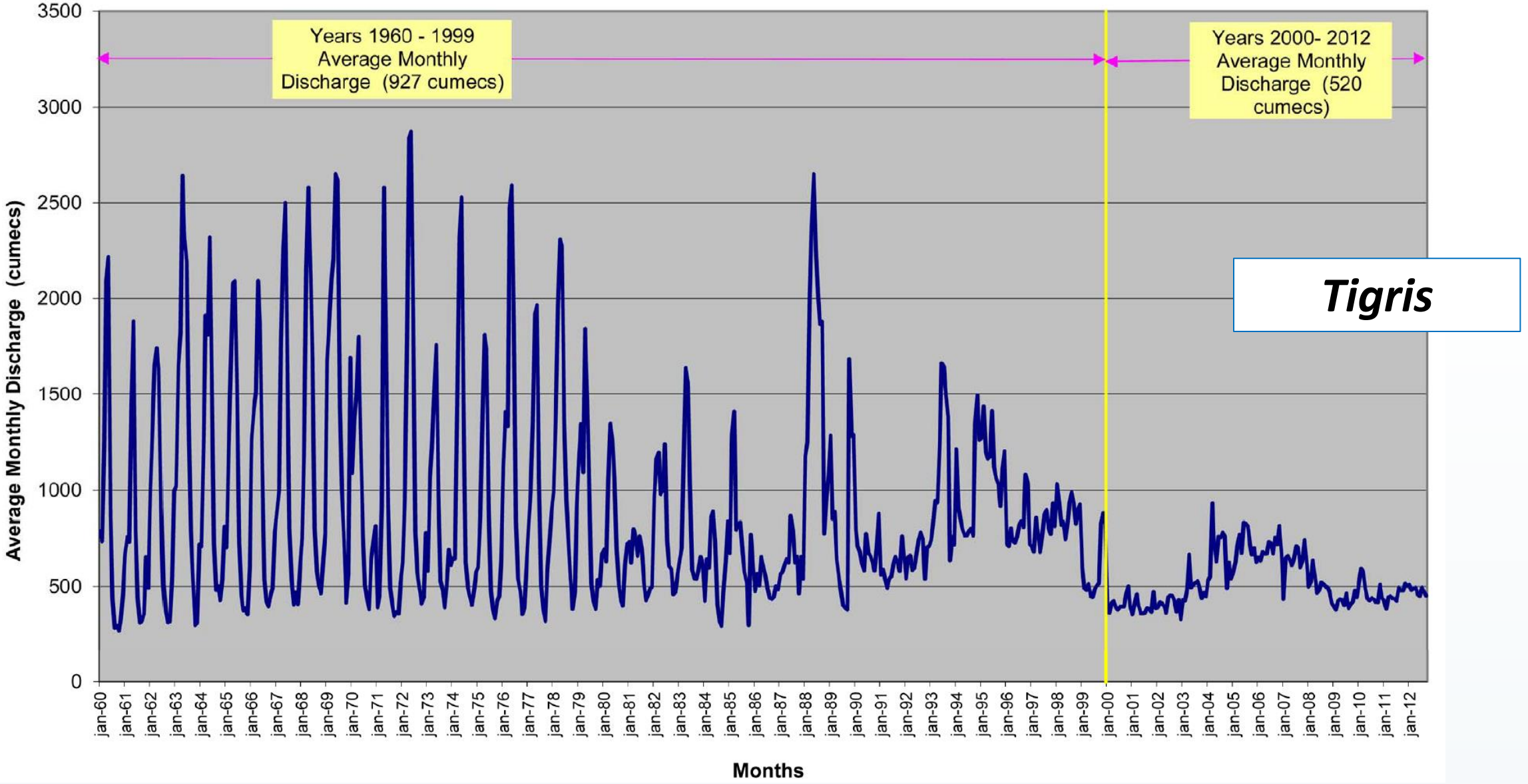
System layout

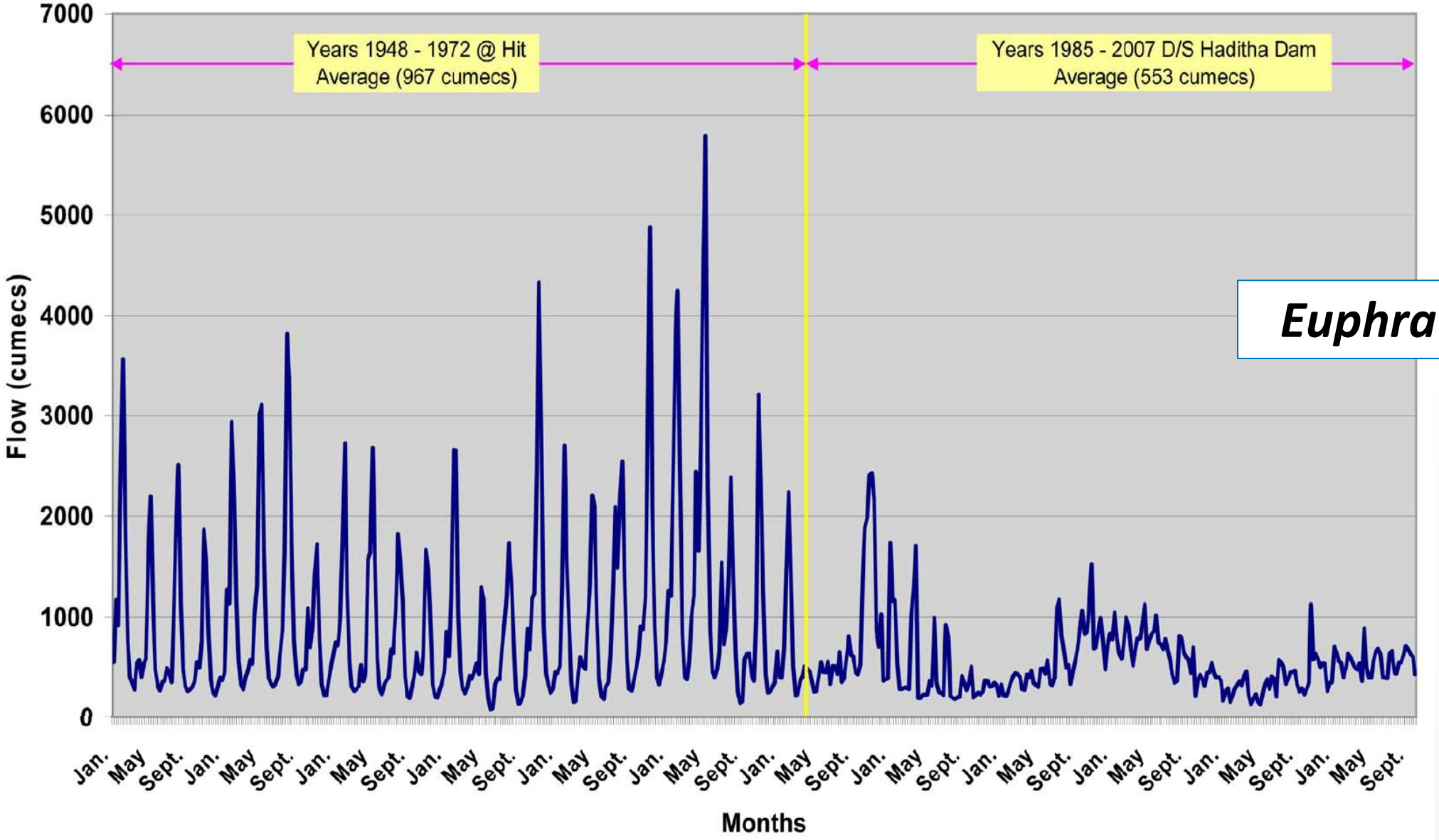


Alarming changes in river regimes

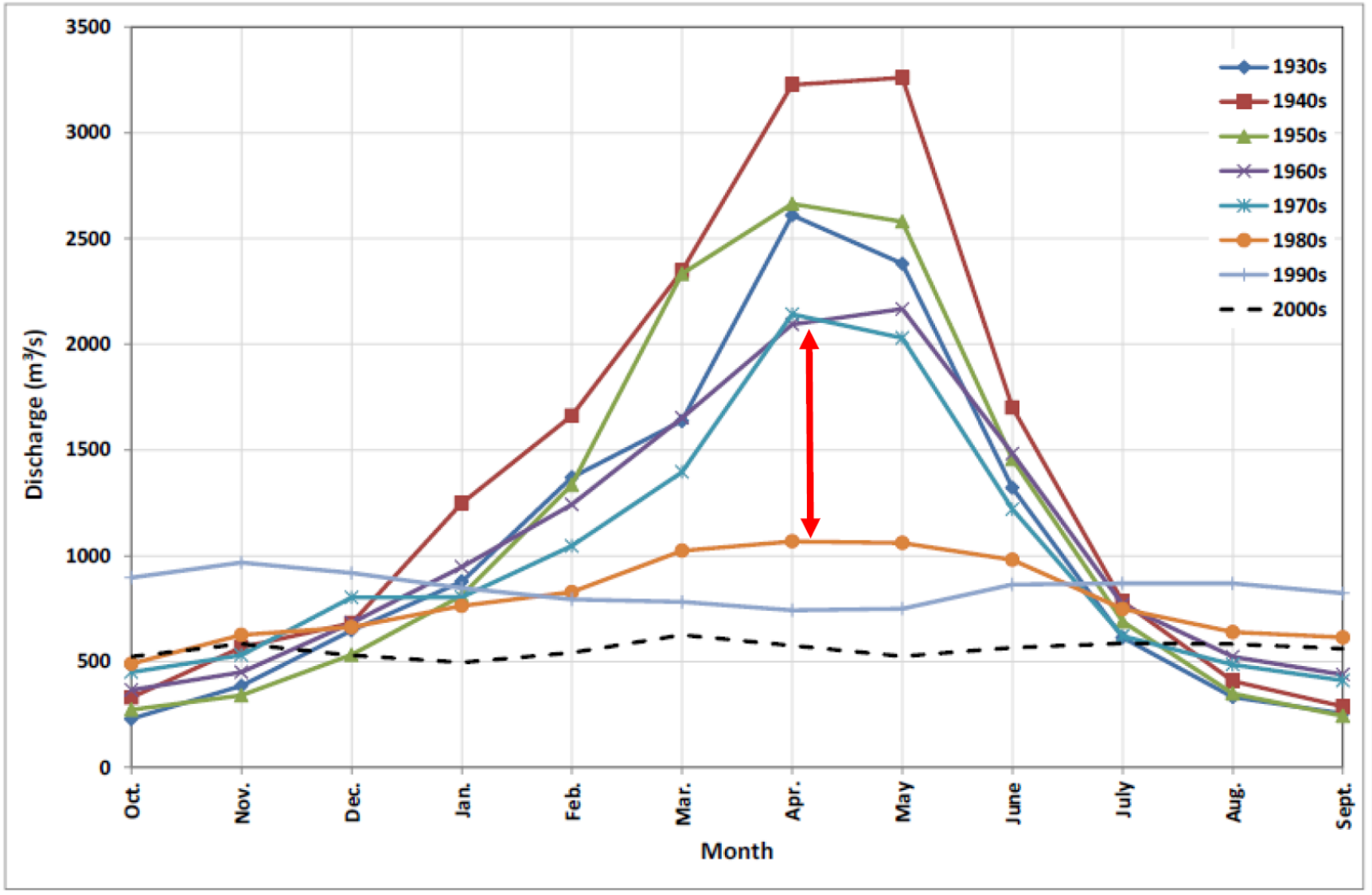
- Major changes in the seasonal pattern
- Lack of coordination of operation between reservoirs
- Increase of contamination by return flow of direct sewage outlets

- Mismatch between demand and supply
- Probably aggravated in the future by climate change

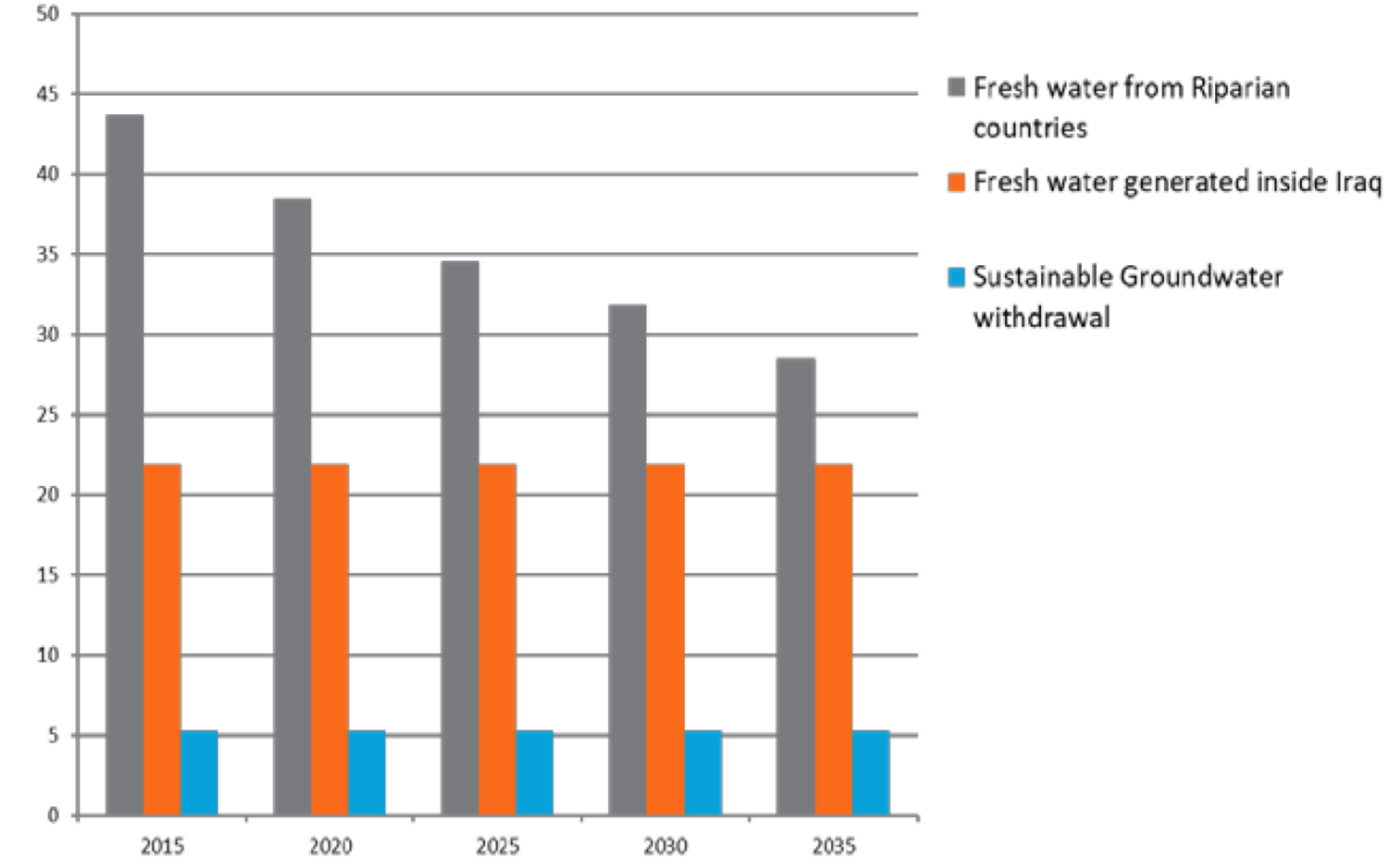

Years 1960 - 1999
Average Monthly
Discharge (927 cumecs)
Years 2000- 2012
Average Monthly
Discharge (520
cumecs)
Tigris
Average Monthly Discharge (cumecs)
Months
3500
3000
2500
2000
1500
1000
500
0
jan-60
jan-61
jan-62
jan-63
jan-64
jan-65
jan-66
jan-67
jan-68
jan-69
jan-70
jan-71
jan-72
jan-73
jan-74
jan-75
jan-76
jan-77
jan-78
jan-79
jan-80
jan-81
jan-82
jan-83
jan-84
jan-85
jan-86
jan-87
jan-88
jan-89
jan-90
jan-91
jan-92
jan-93
jan-94
jan-95
jan-96
jan-97
jan-98
jan-99
jan-00
jan-01
jan-02
jan-03
jan-04
jan-05
jan-06
jan-07
jan-08
jan-09
jan-10
jan-11
jan-12


Years 1948 - 1972 @ Hit
Average (967 cumecs)
Years 1985 - 2007 D/S Haditha Dam
Average (553 cumecs)
Euphrates
Flow (cumecs)
7000
6000
5000
4000
3000
2000
1000
0
Jan.
May
Sept.
Months

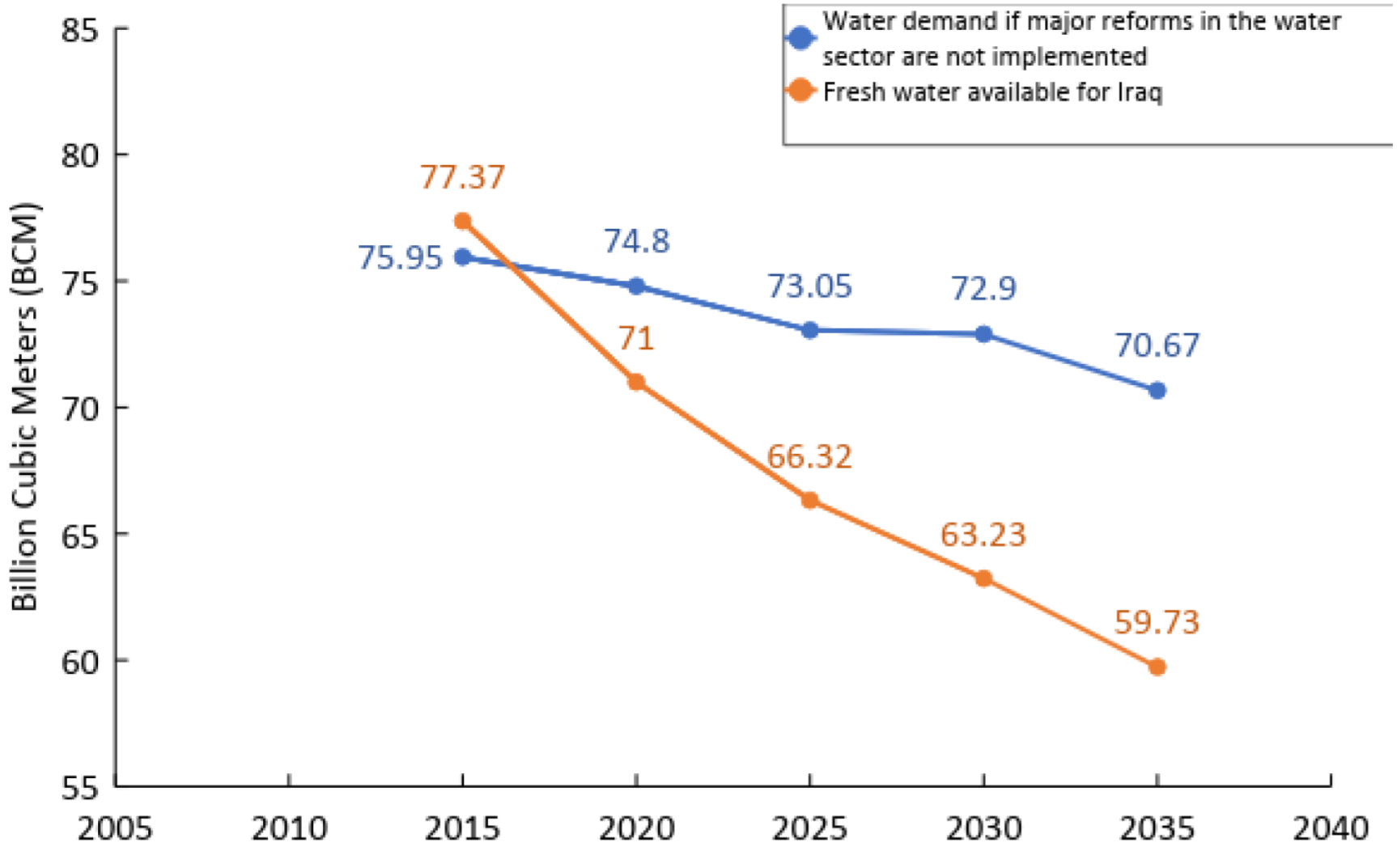
Tigris at Baghdad (1930 – 2013)



Expected water resources in Iraq (IraqEnergy, 2018)



Projection of water supply versus demand

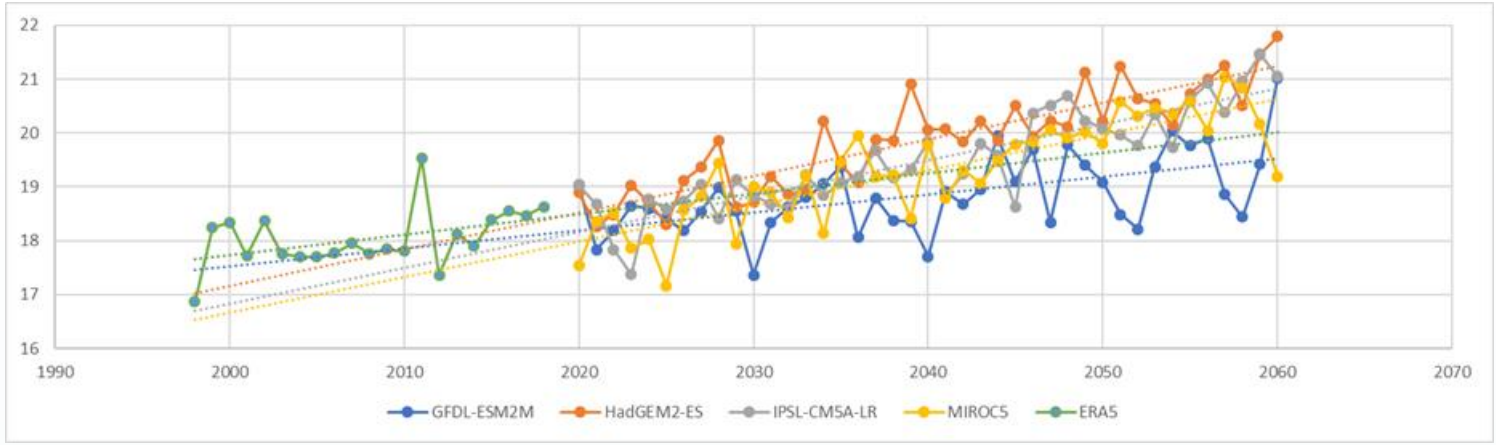


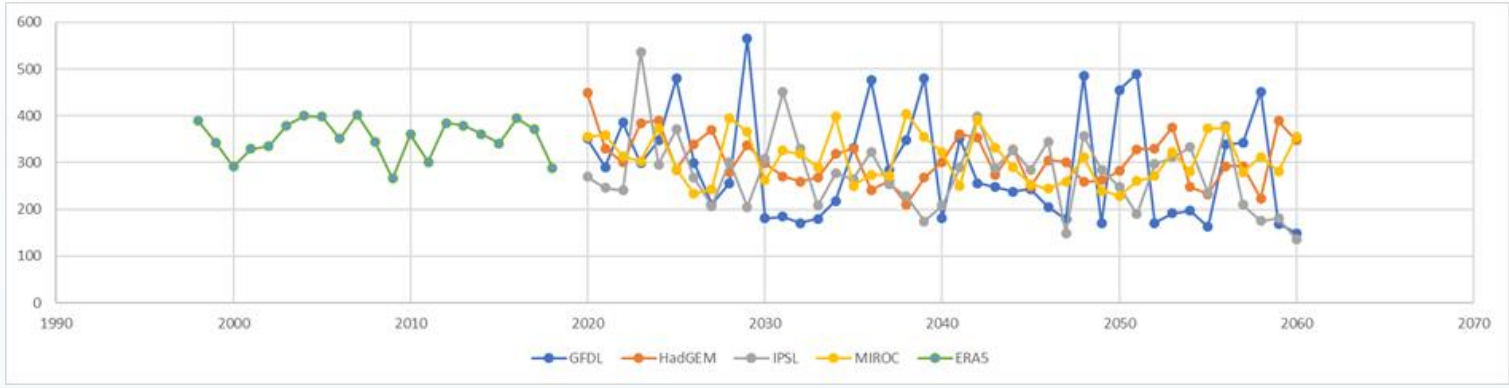
Impact of climate change

Based on two scenarios:

- GFDL-ESM2M
- HadGEM2-ES

In general increase in temperature and decrease in precipitation



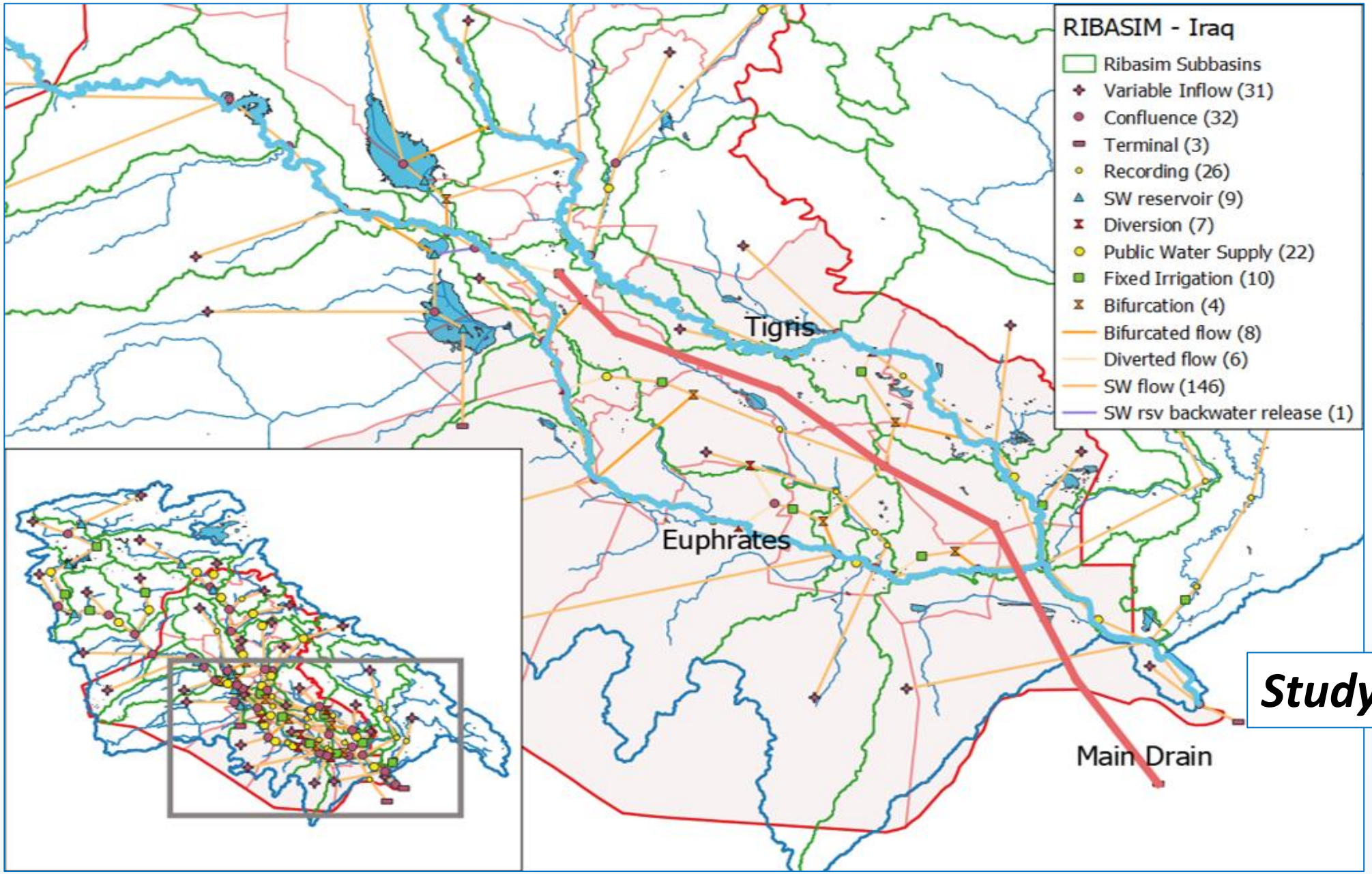


	2015	2020	2025	2030	2035
FRESH WATER FROM RIPARIAN COUNTRIES	**43.695**	**38.482**	**34.592**	**31.871**	**28.486**
EUPHRATES	18.396	16.683	14.137	12.383	9.999
TIGRIS	15.919	12.905	11.588	10.703	9.822
GREATER ZAB	3.378	3.377	3.375	3.316	3.294
LESSER ZAB	2.292	2.236	2.219	2.203	2.182
DIYALA	3.71	3.281	3.273	3.266	3.189
FRESH WATER GENERATED INSIDE IRAQ	**21.92**	**21.92**	**21.92**	**21.92**	**21.92**
EUPHRATES	1.123	1.123	1.123	1.123	1.123
TIGRIS	5.073	5.073	5.073	5.073	5.073
GREATER ZAB	7.462	7.462	7.462	7.462	7.462
LESSER ZAB	4.551	4.551	4.551	4.551	4.551
UDHAIM	0.956	0.956	0.956	0.956	0.956
DIYALA	1.788	1.788	1.788	1.788	1.788
THARTHAR	0.967	0.967	0.967	0.967	0.967
SUSTAINABLE GROUNDWATER WITHDRAWAL	**5.243**	**5.243**	**5.243**	**5.243**	**5.243**

Modelling of the Tigris – Euphrates system

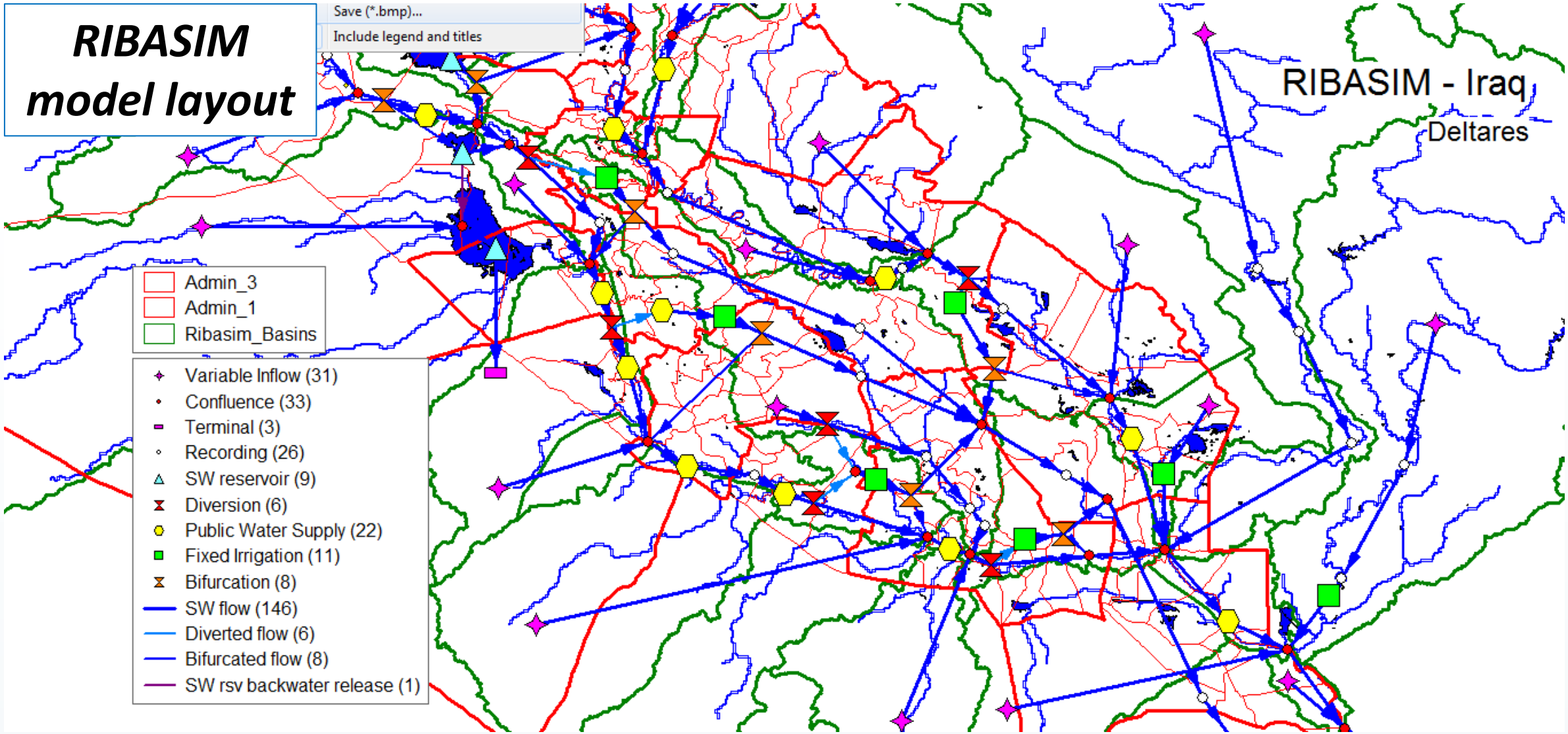
- Aimed at assessment of connection between water resources and migration in Southern Iraq (IOM)
- Implemented with RIBASIM water resources model
- Modelling mainly based on global data sets
- Global data not only hydrometeorology, but also e.g. population density, irrigated agriculture

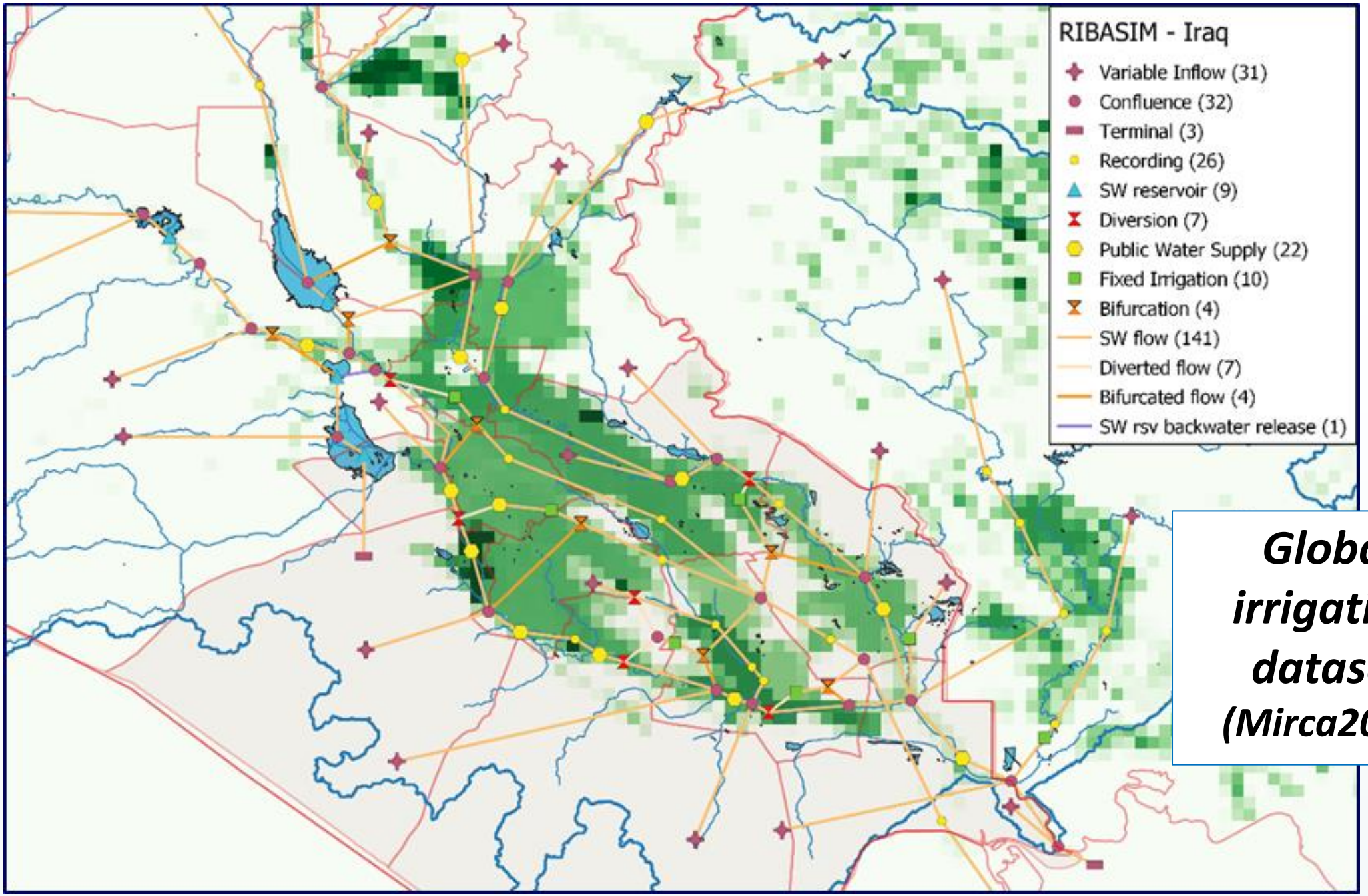
- Also included limited assessment of water quality (mainly salinity)



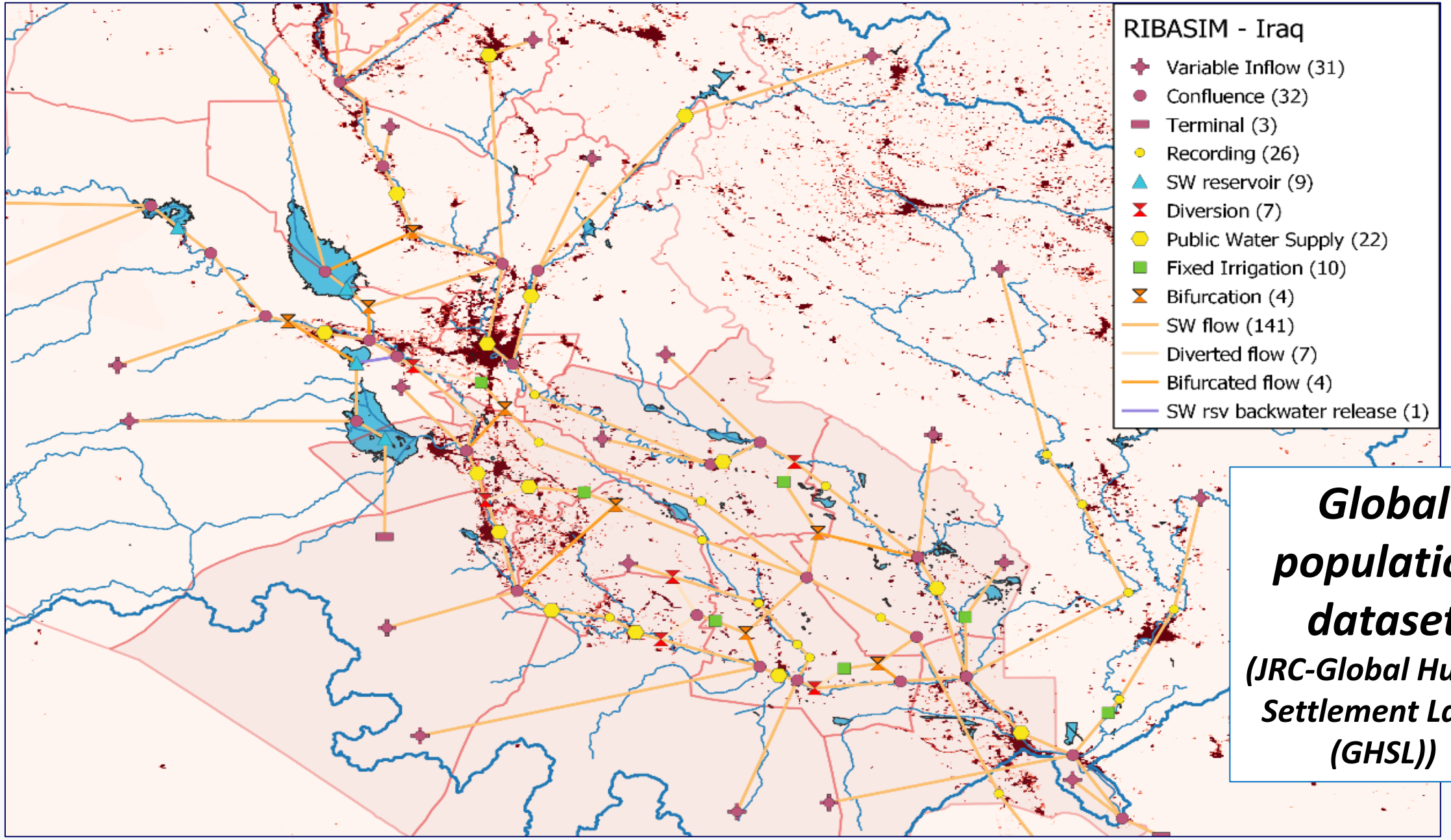
Study focus area

RIBASIM model layout



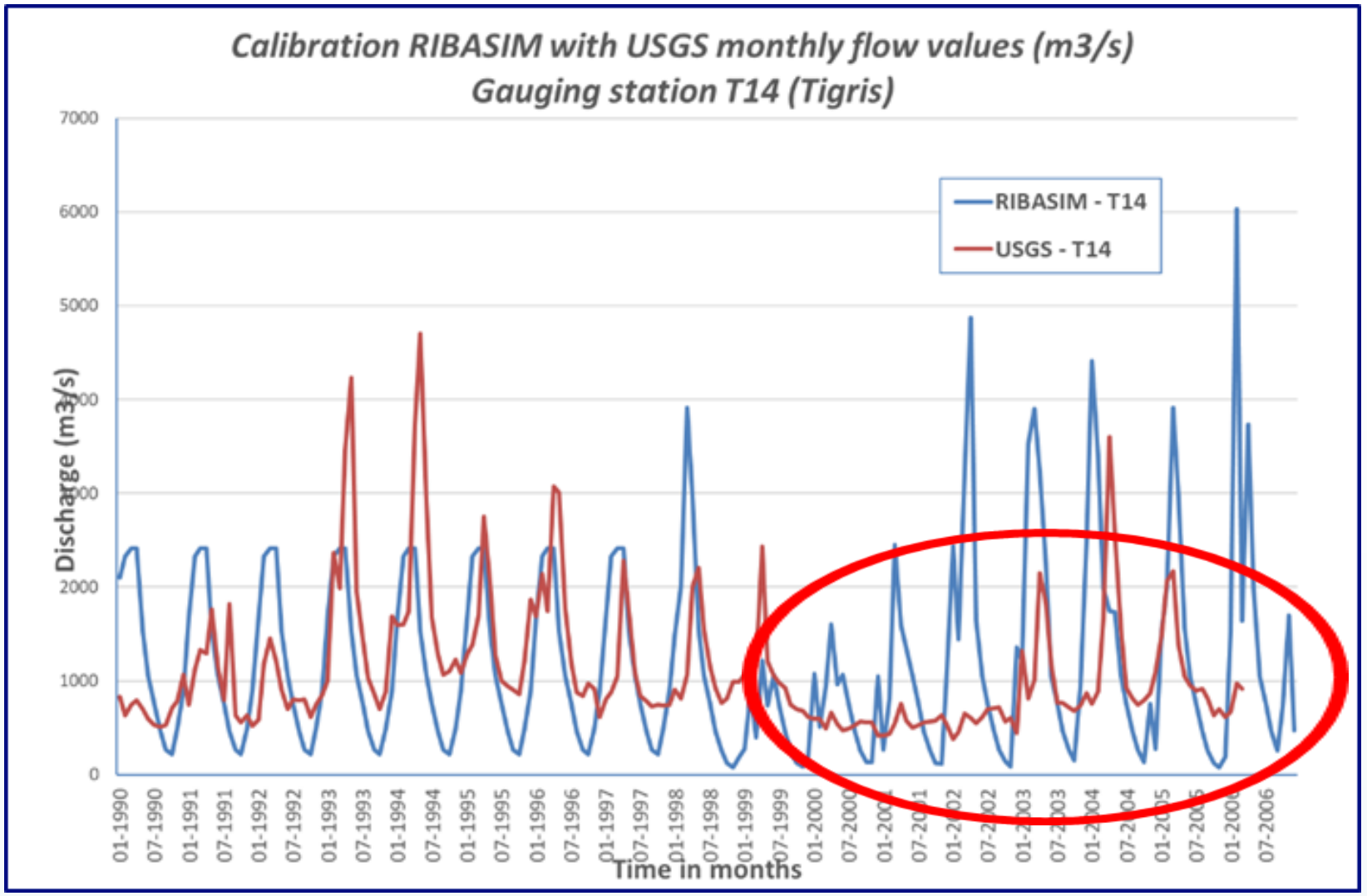


Global irrigation dataset (Mirca2000)

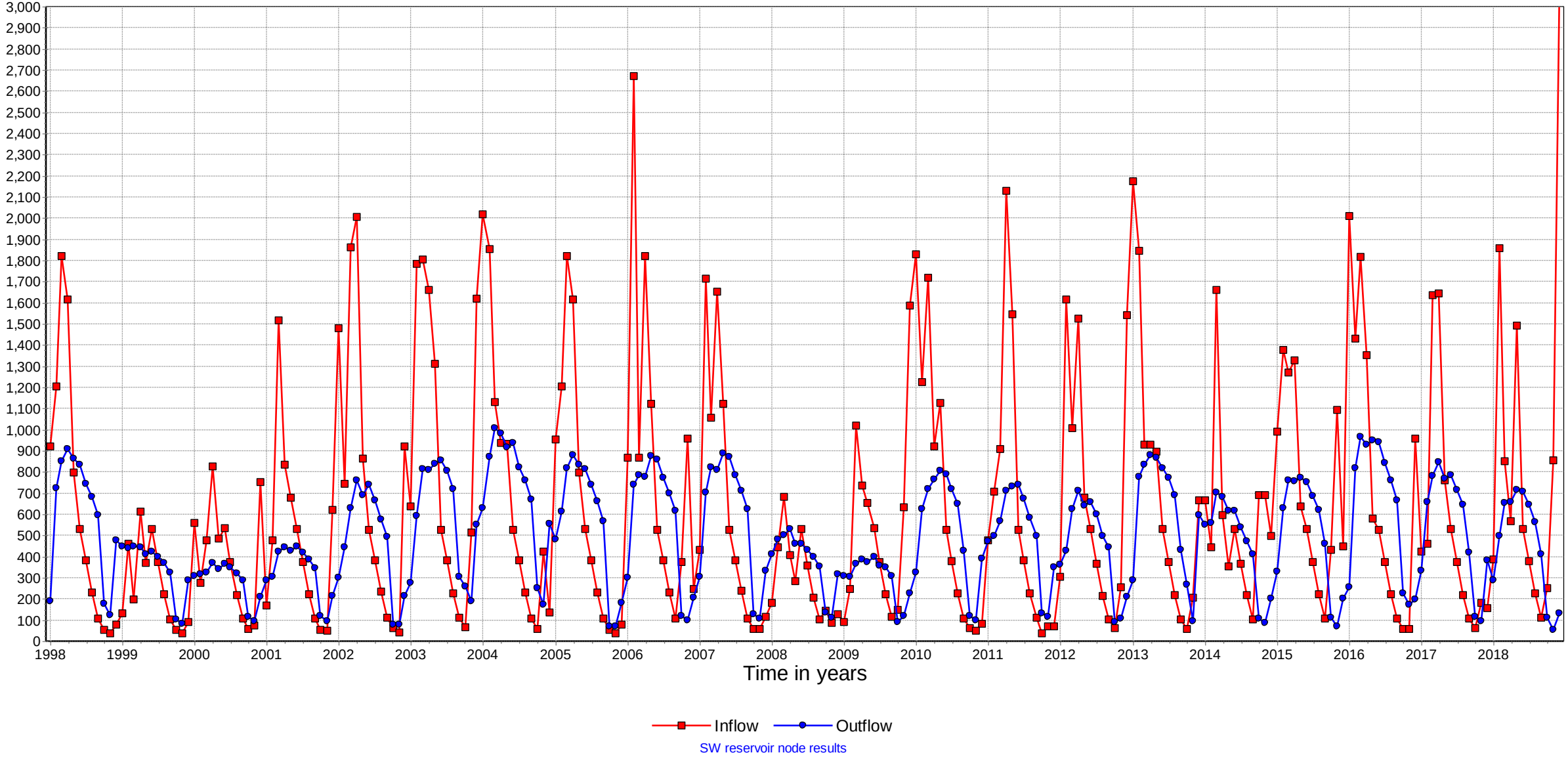


Global population dataset (JRC-Global Human Settlement Layer (GHSL))

Change in regime reflected in model output

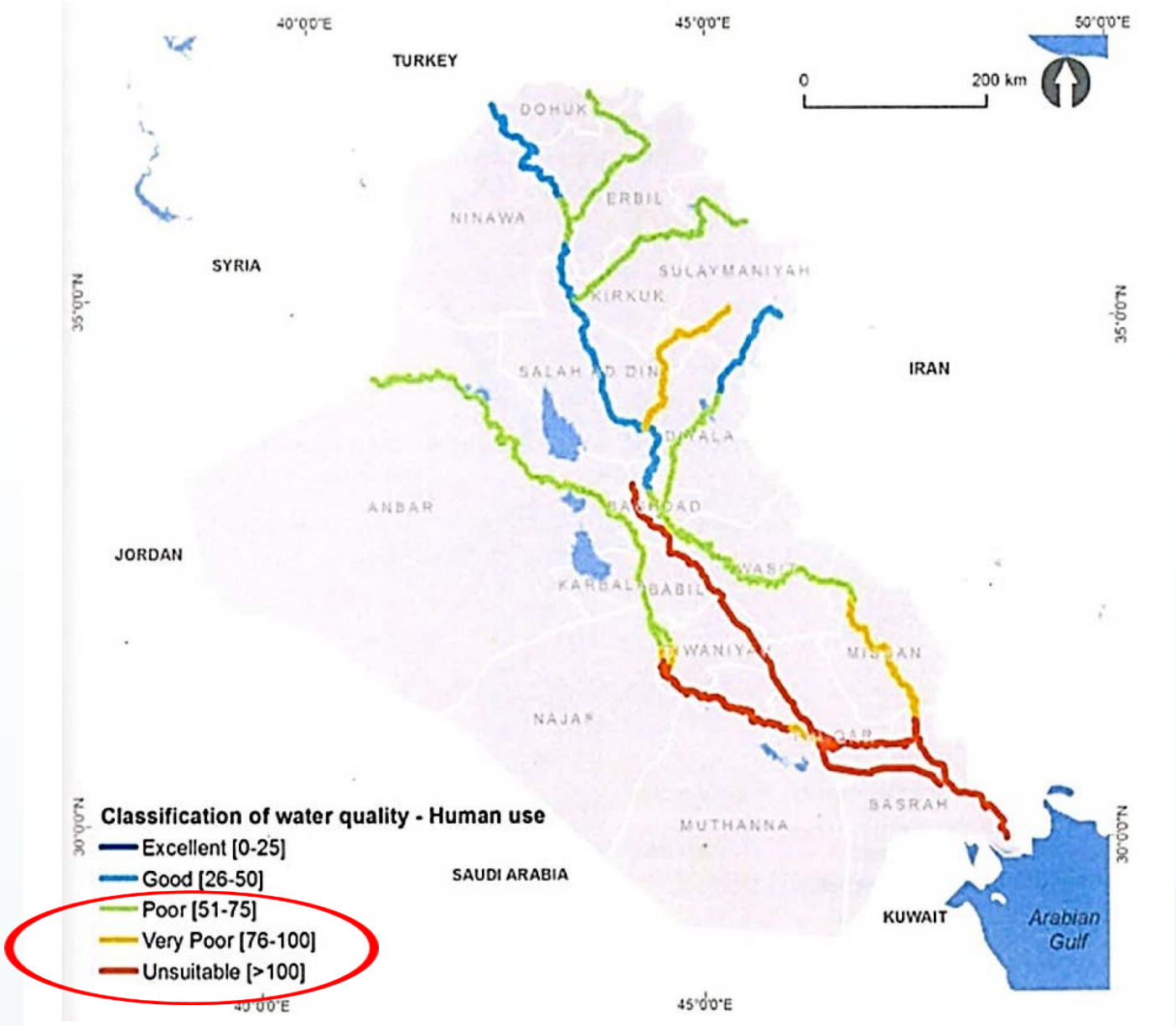


Inflow and outflow from Lake Tharthar - Basecase

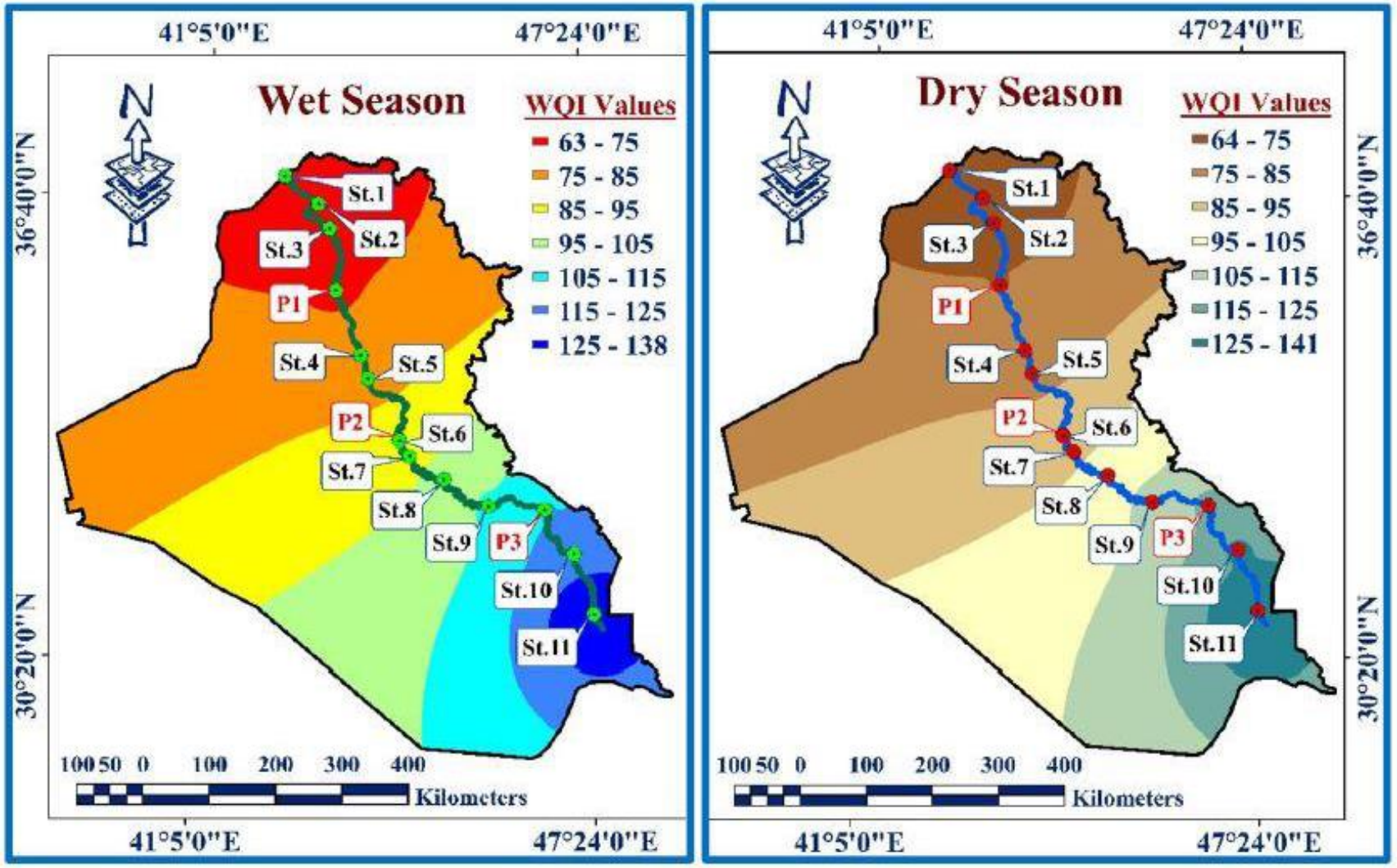


Water quality for human use

- On Tigris: poor to unsuitable downstream from Baghdad
- On Euphrates already poor over most of the length of the river



Water quality index along the Tigris river



Reasons for deterioration of water quality

- Al-Ansari et al (2018):
  - Discharge of wastewater to the rivers
  - Discharging solid waste to the rivers
  - The use of Al-Tharthar reservoir water to back up Euphrates and Tigris rivers basins shortages
  - Pollutions due to remnants of wars
  - Increase in water consumption due to high population growth rates.

Some conclusions and recommendations from the IWRM study

- Increasing the irrigation efficiency in Iraq would have a very positive impact on the water resources situation
- Lake Tharthar plays a dominant role in the water resources of both rivers and it is not possible to stop using the lake as intermediate storage unless other measures are taken to ensure the water supply to the various demand sectors
- It is necessary to study more in-depth the causes for the salinity in the two rivers
- For the salinity, optimization of the operation of Lake Tharthar may be beneficial