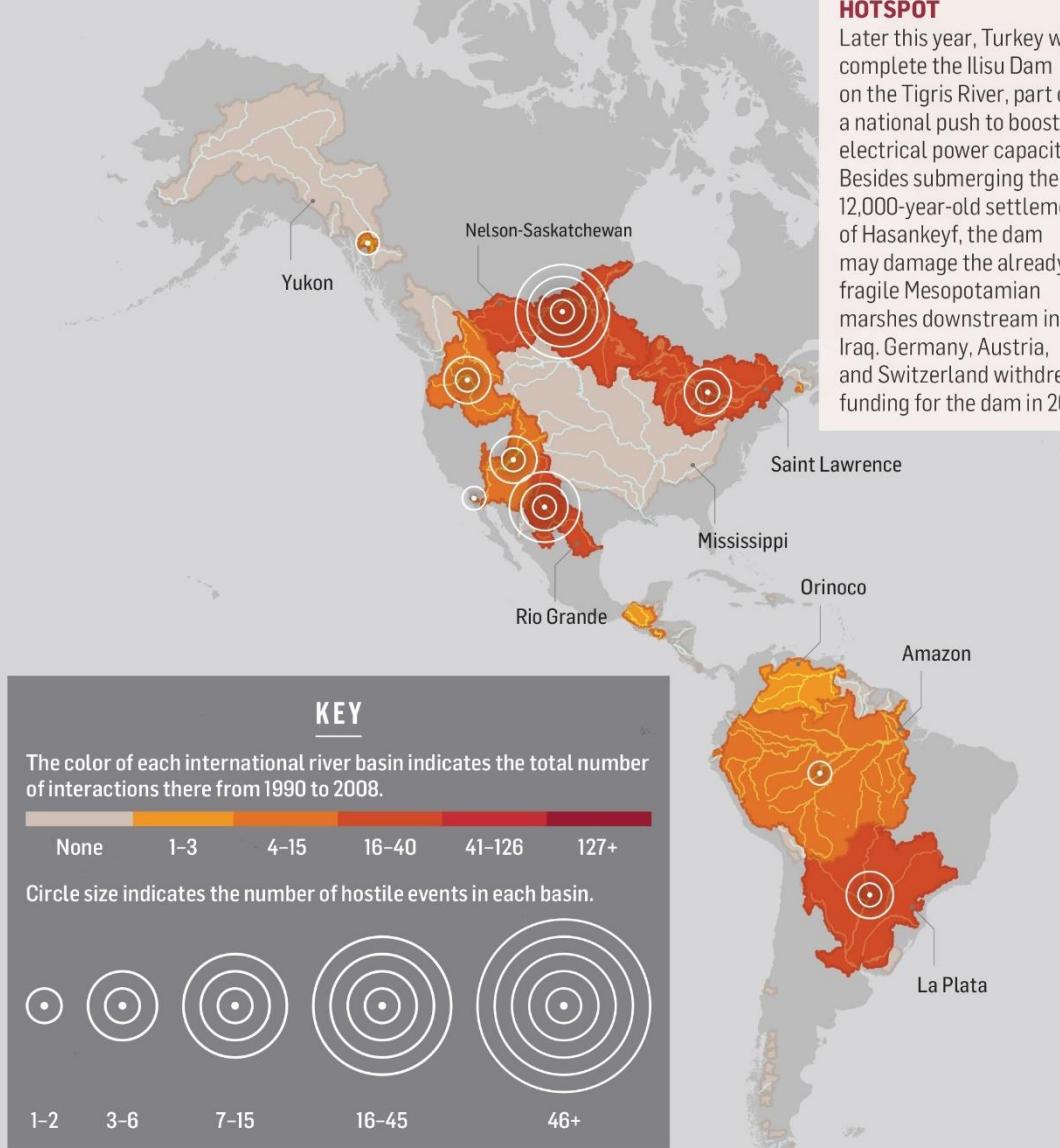


Next Gold Rush is Water and its emerging international conflicts?

R. Srinivasan
(r-Srinivasan@tamu.edu)

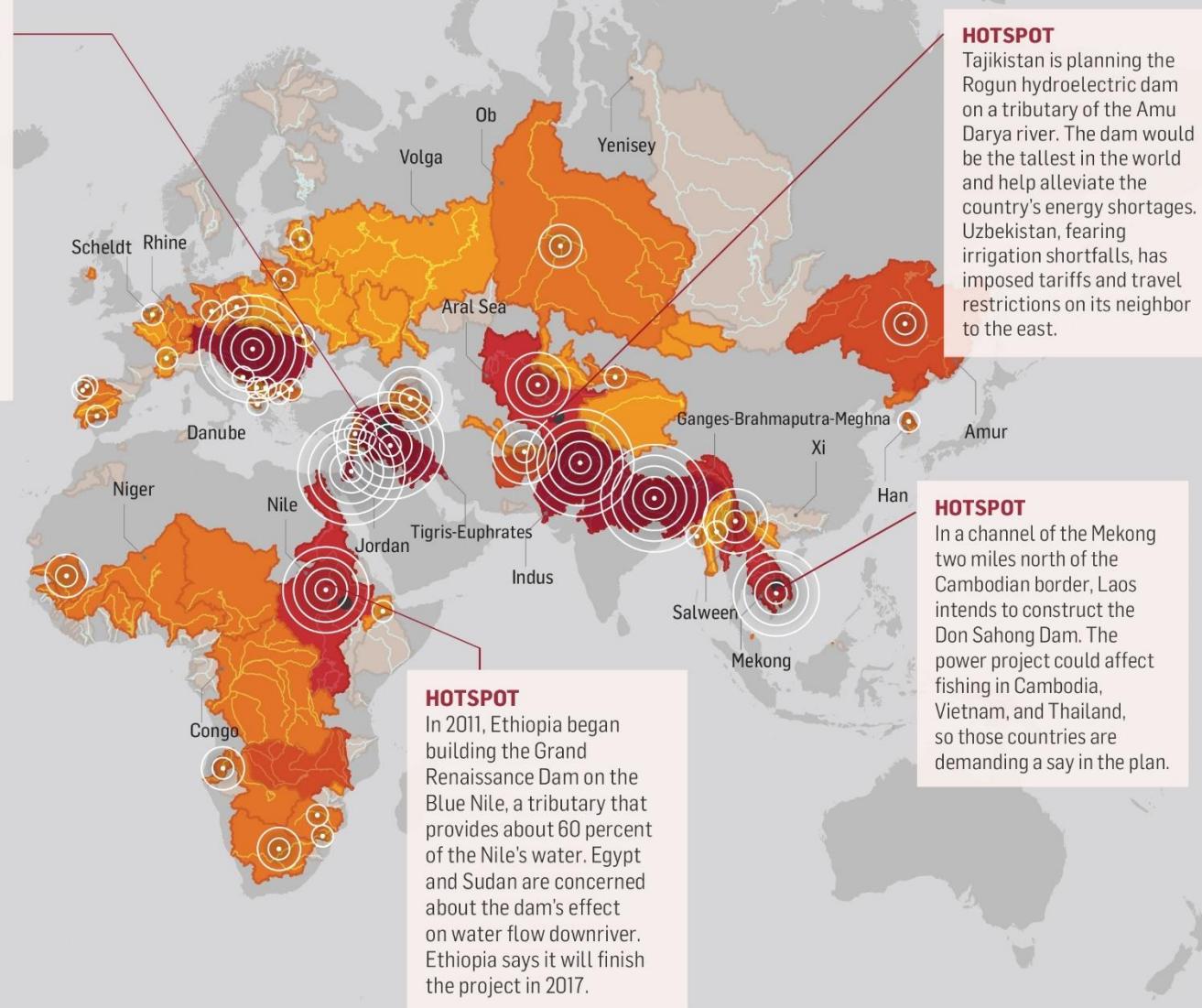
R. Srinivasan
Prasad Daggupati
Deepa Varma

Heat Map: Where is the highest water conflict in the world?



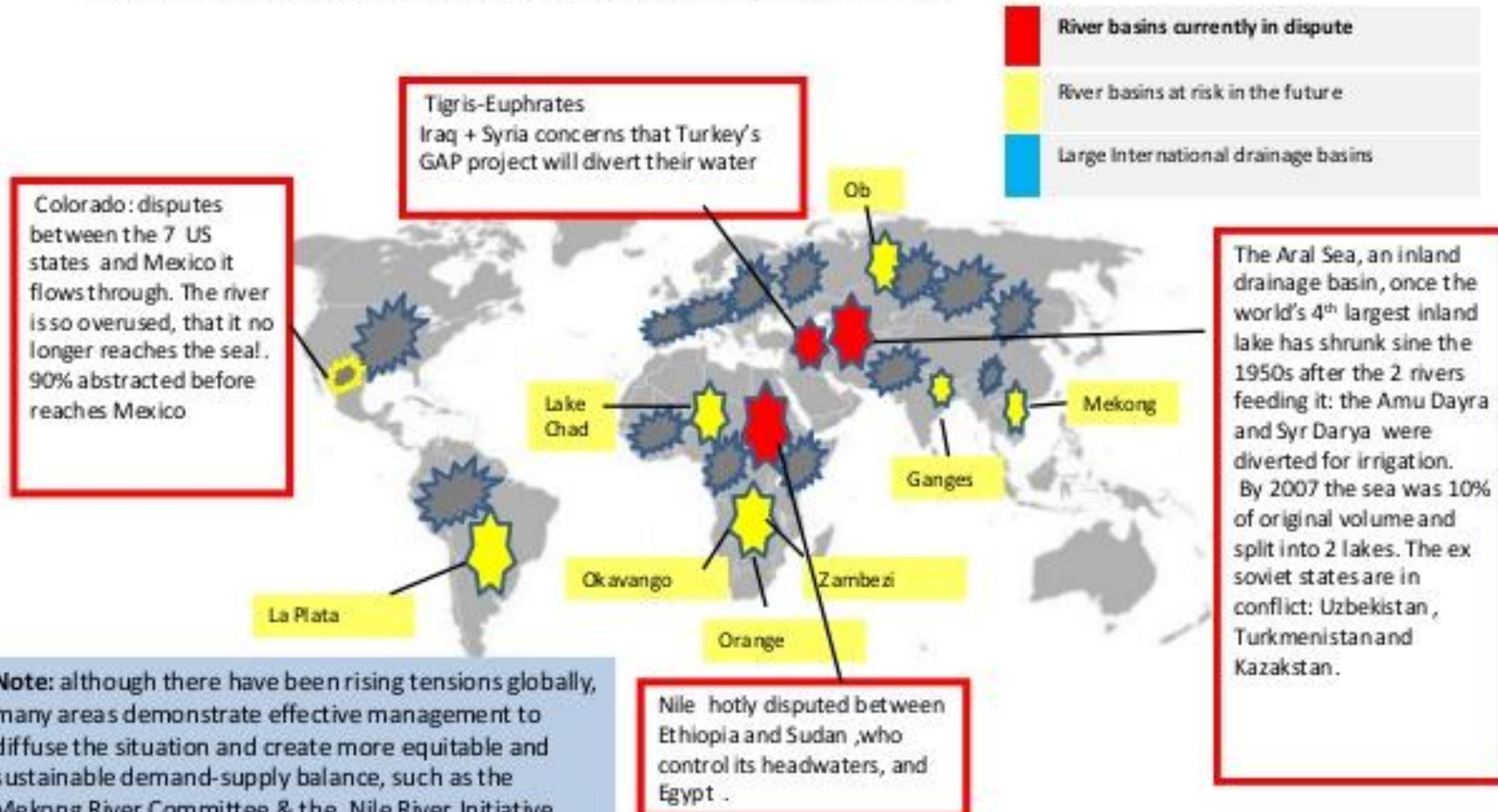
HOTSPOT

Later this year, Turkey will complete the Ilisu Dam on the Tigris River, part of a national push to boost electrical power capacity. Besides submerging the 12,000-year-old settlement of Hasankeyf, the dam may damage the already fragile Mesopotamian marshes downstream in Iraq. Germany, Austria, and Switzerland withdrew funding for the dam in 2009.

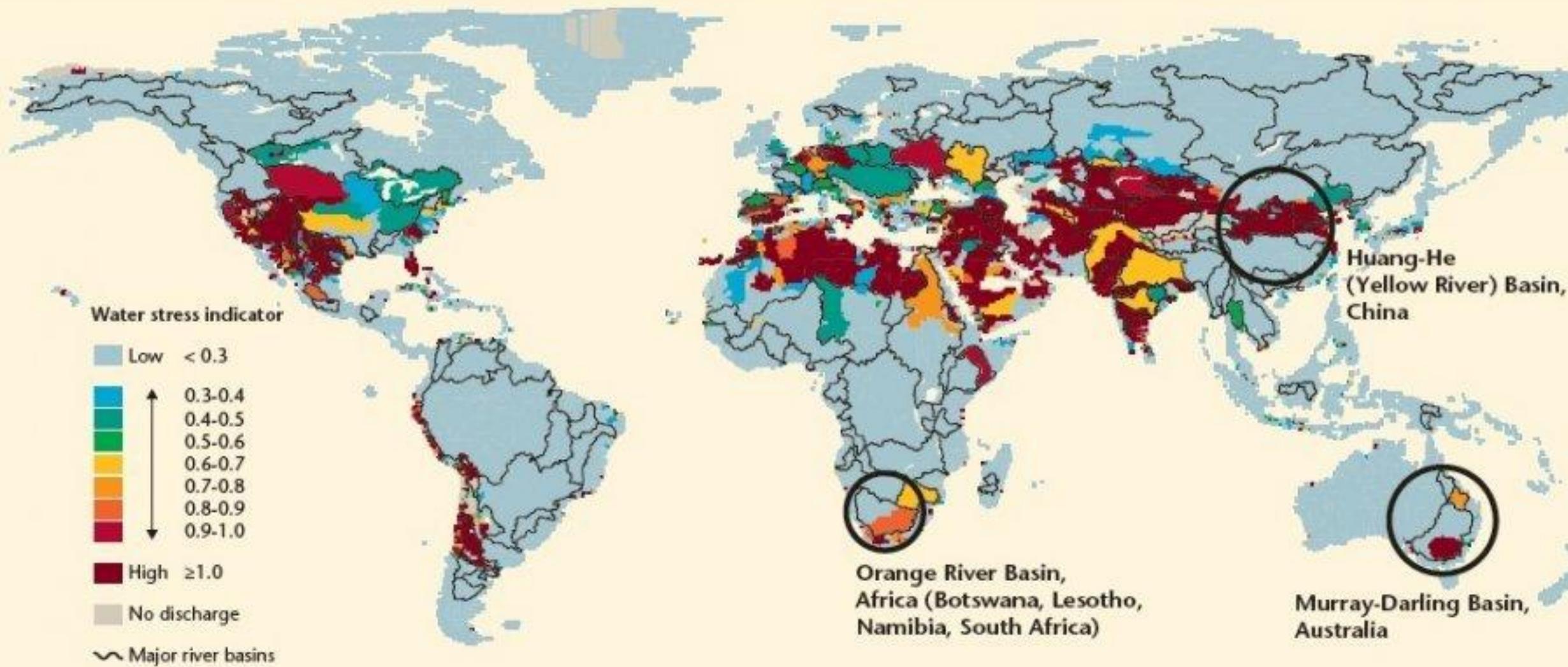


Present and potential water conflict hotspots

- As water supply decreases, tensions will increase as different players try to access common water supplies
- Many conflicts are transboundary in nature, either between states or countries



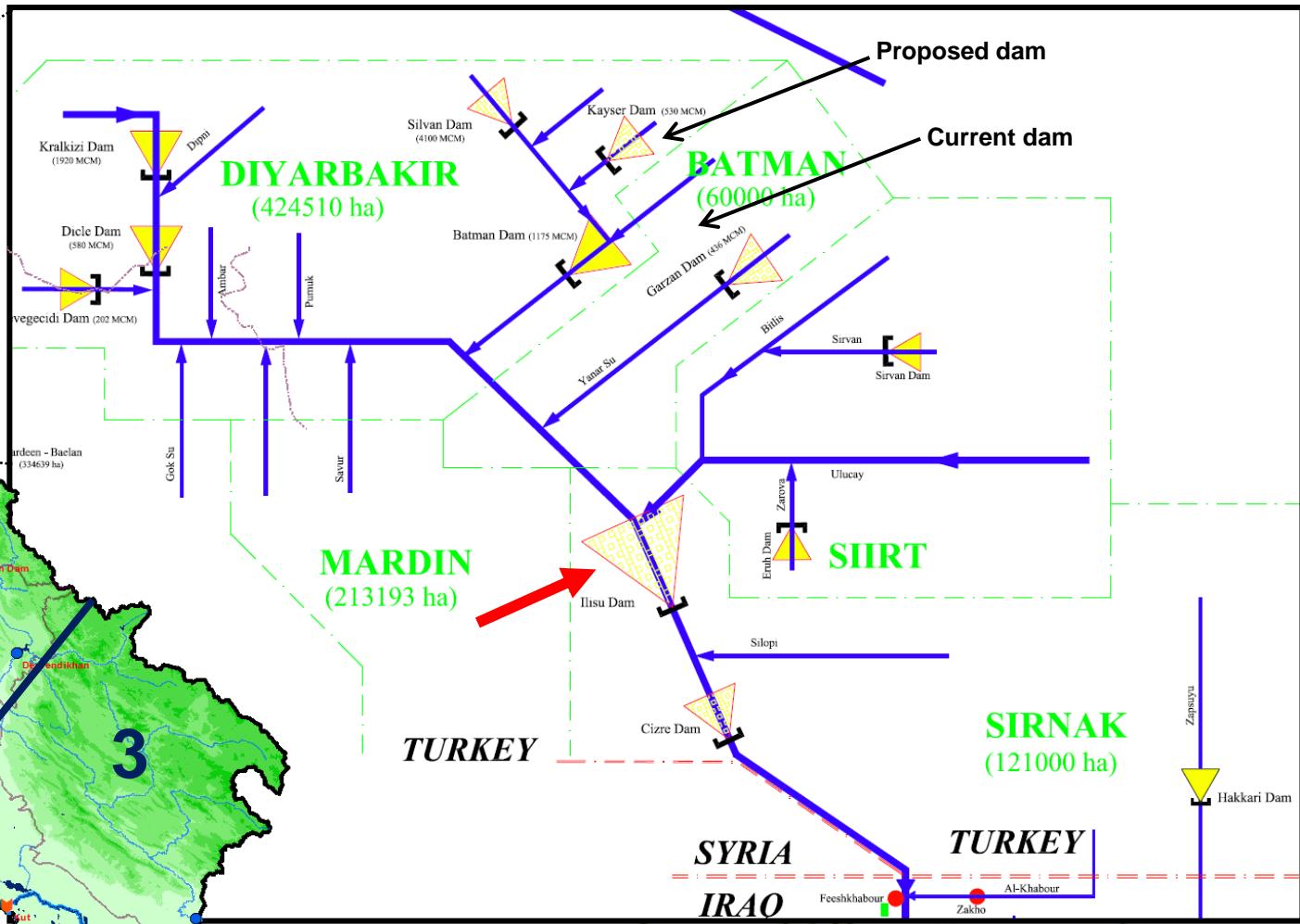
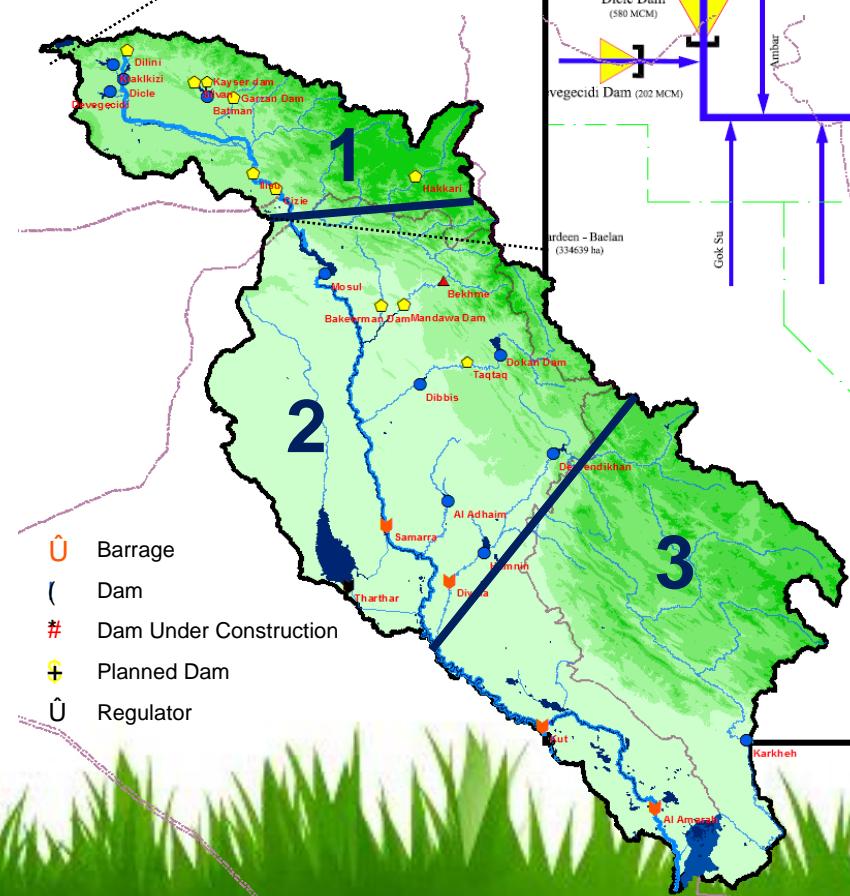
Map 6.3

Water stress level of major river basins, around 2002

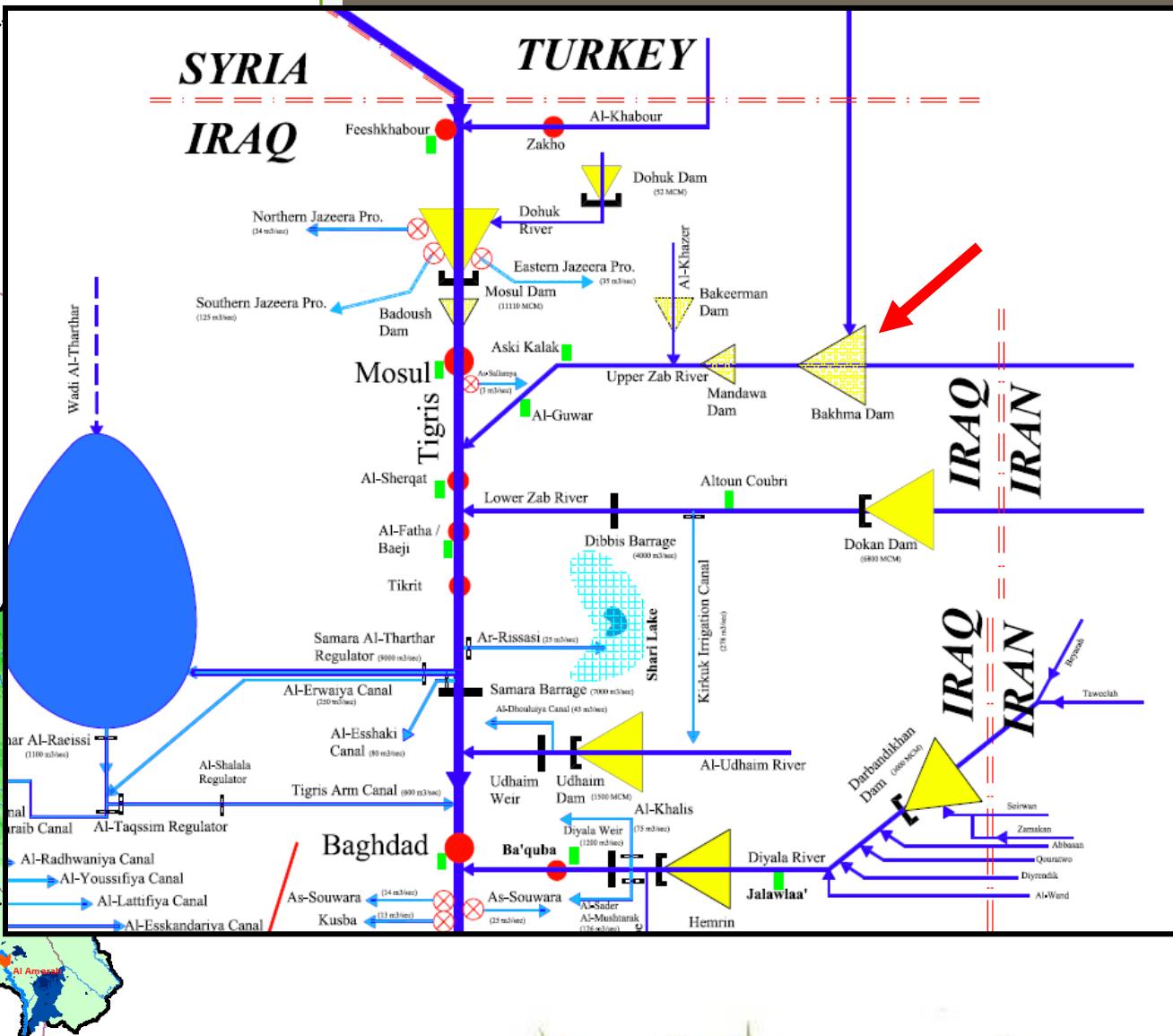
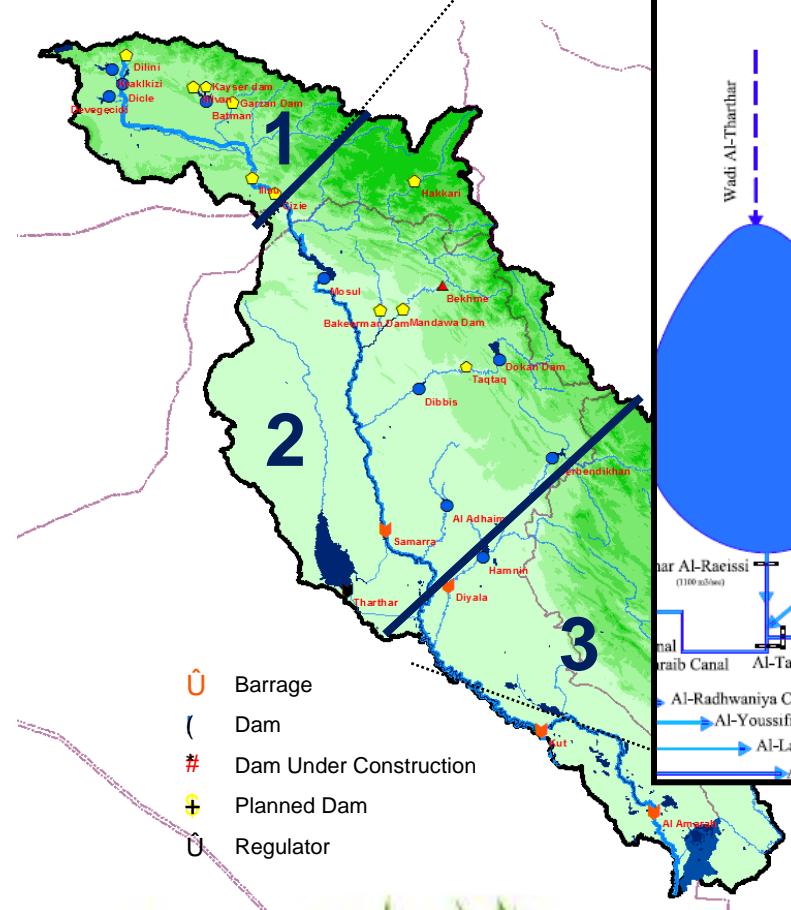
Source: Based on Smakhtin, Revenga, and Döll 2004.

Overview of Tigris river, tributaries and water structures feeding Hawizeh marsh

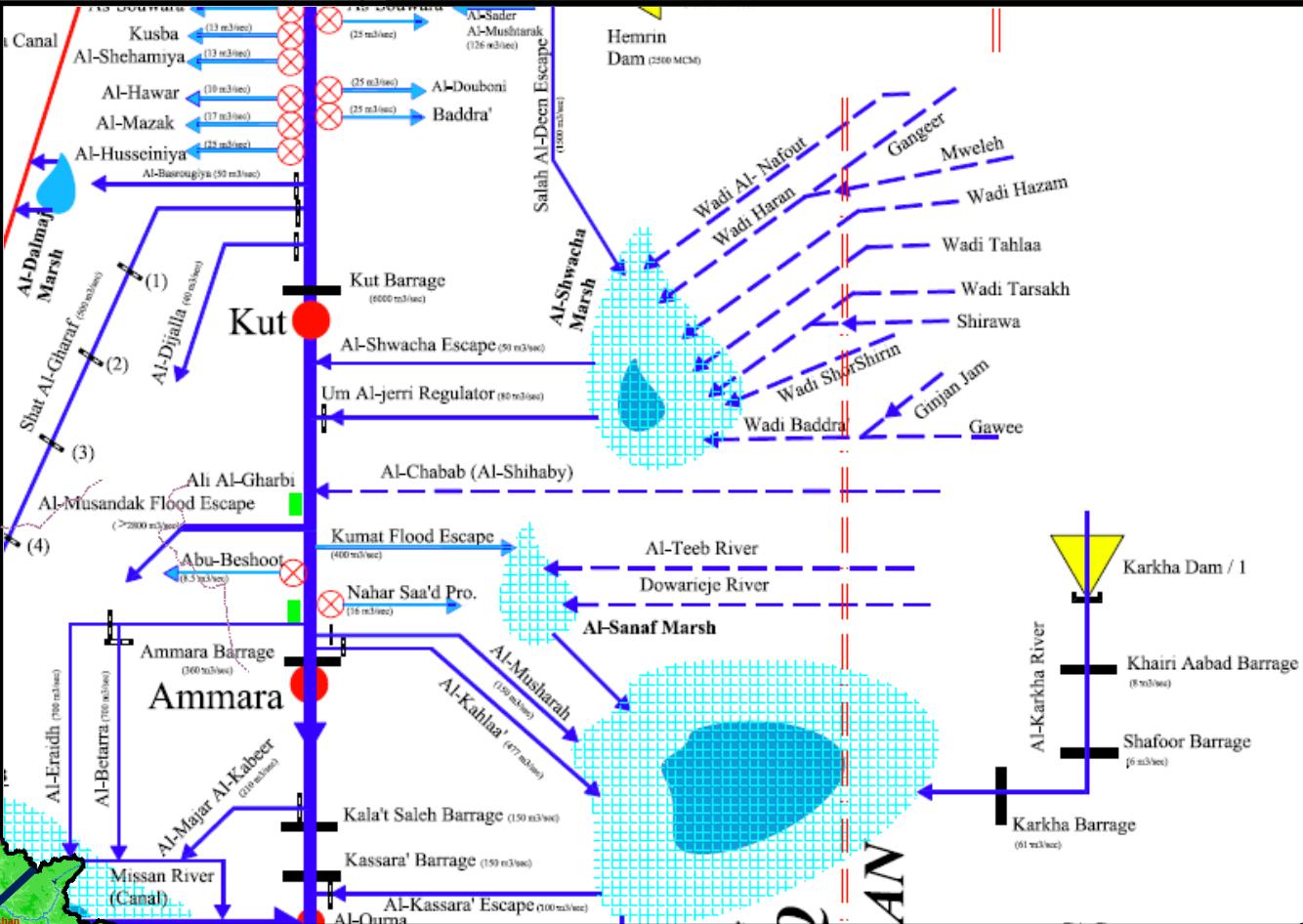
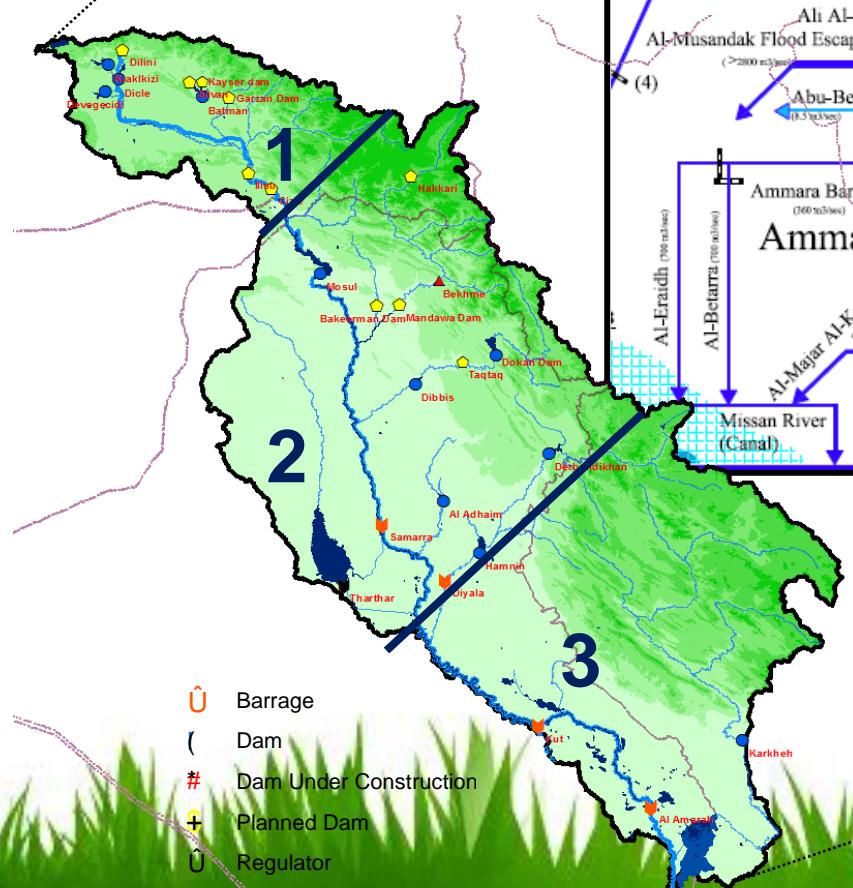
Upper Zone until Iraq border



Middle Zone until Bagdad



Lower Zone until Hawizeh Marsh

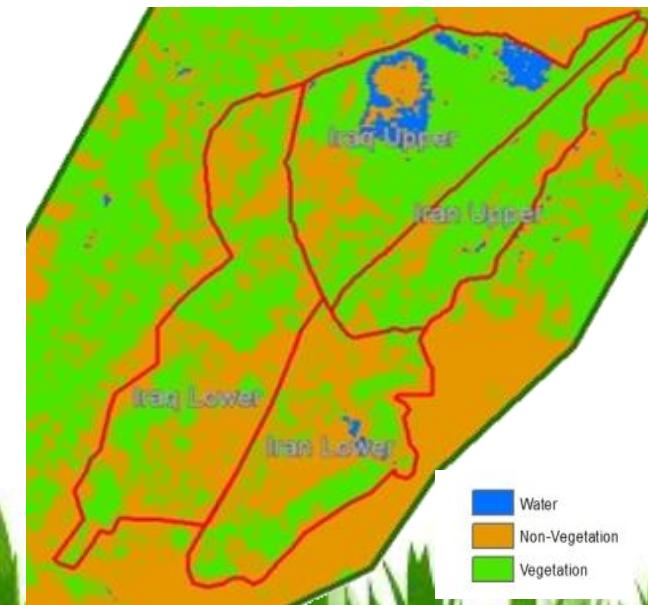
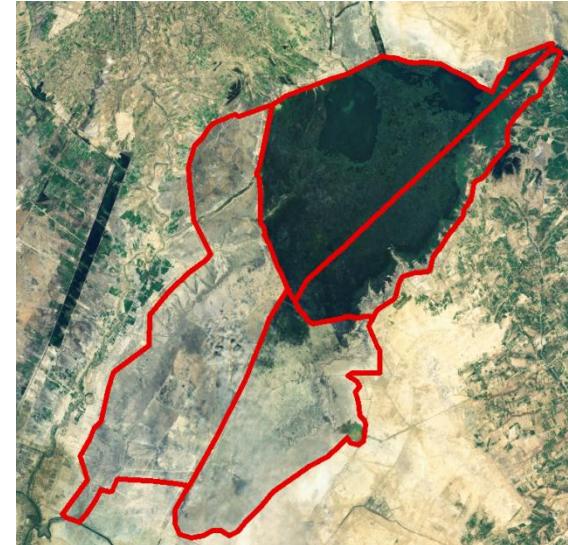


Spatio-temporal vegetation and water

- Marsh divided into 4 sections

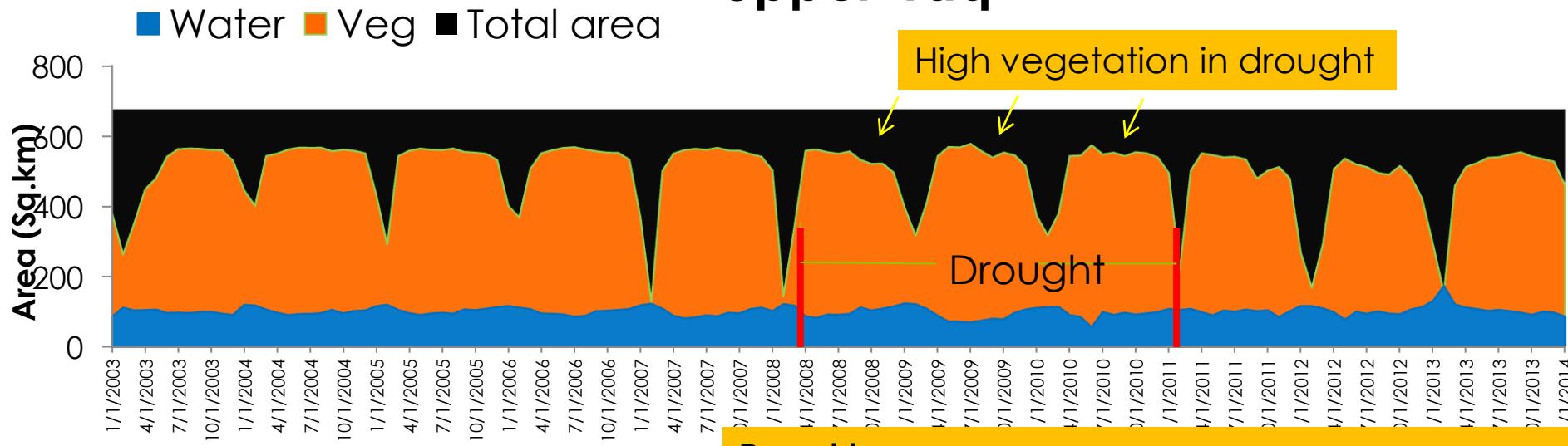
- Boundaries based on water and vegetation extent on aerial images and border of countries
- Upper Iraq: 676.25 sq.km (28% of total area)
- Lower Iraq: 783.31 sq.km (33% of total area)
- Upper Iran: 370.27 sq.km (15% of total area)
- Lower Iran: 519.18 sq.km (22% of total area)
- Total area: 2350 sq.km

- Biweekly Modis Terra 16-Day Vegetation Indices 250m (MOD13Q1) obtained and processed from 2003 to 2013
 - Vegetation indices used are NDVI and EVI
 - Vegetation was classified as water, vegetation and non-vegetation(bare)

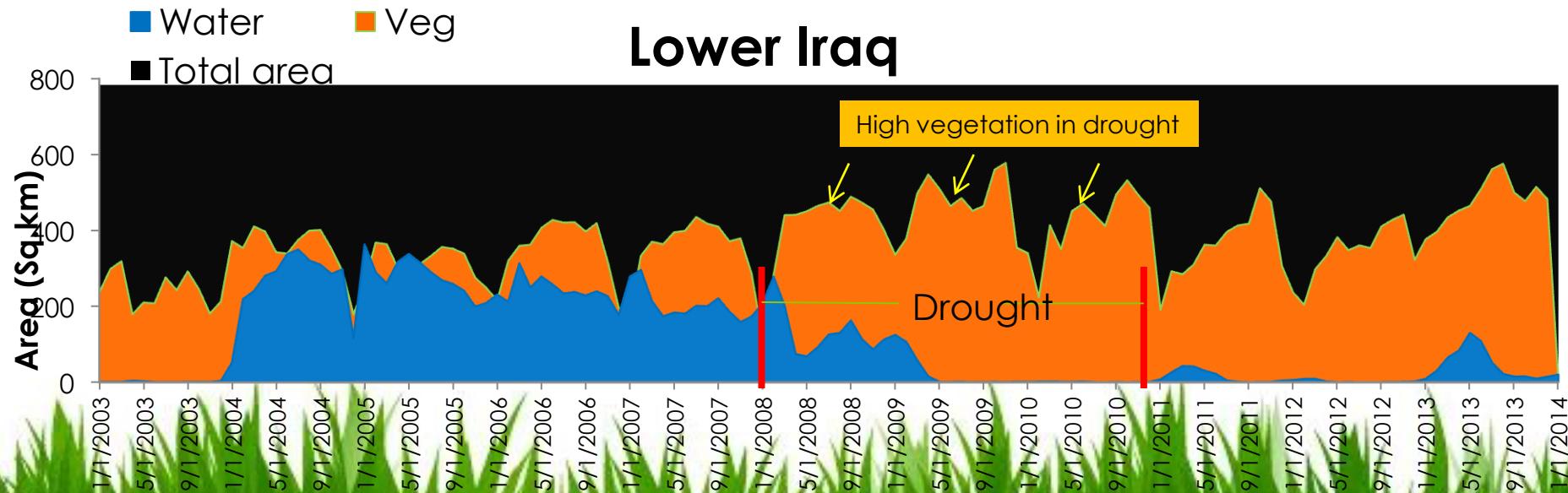


Temporal vegetation

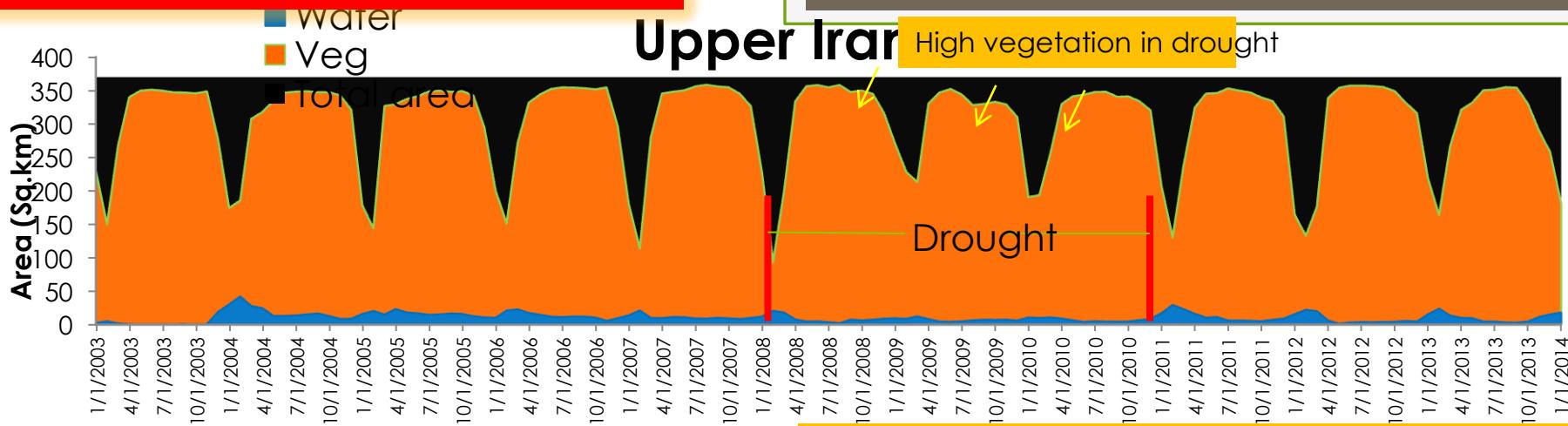
Upper Iraq



Lower Iraq



Karkheh dam completed in **2001**



Drought

Up iran: water and vegetation area remained same

Lw iran: water and vegetation area decreased



Completion of dyke

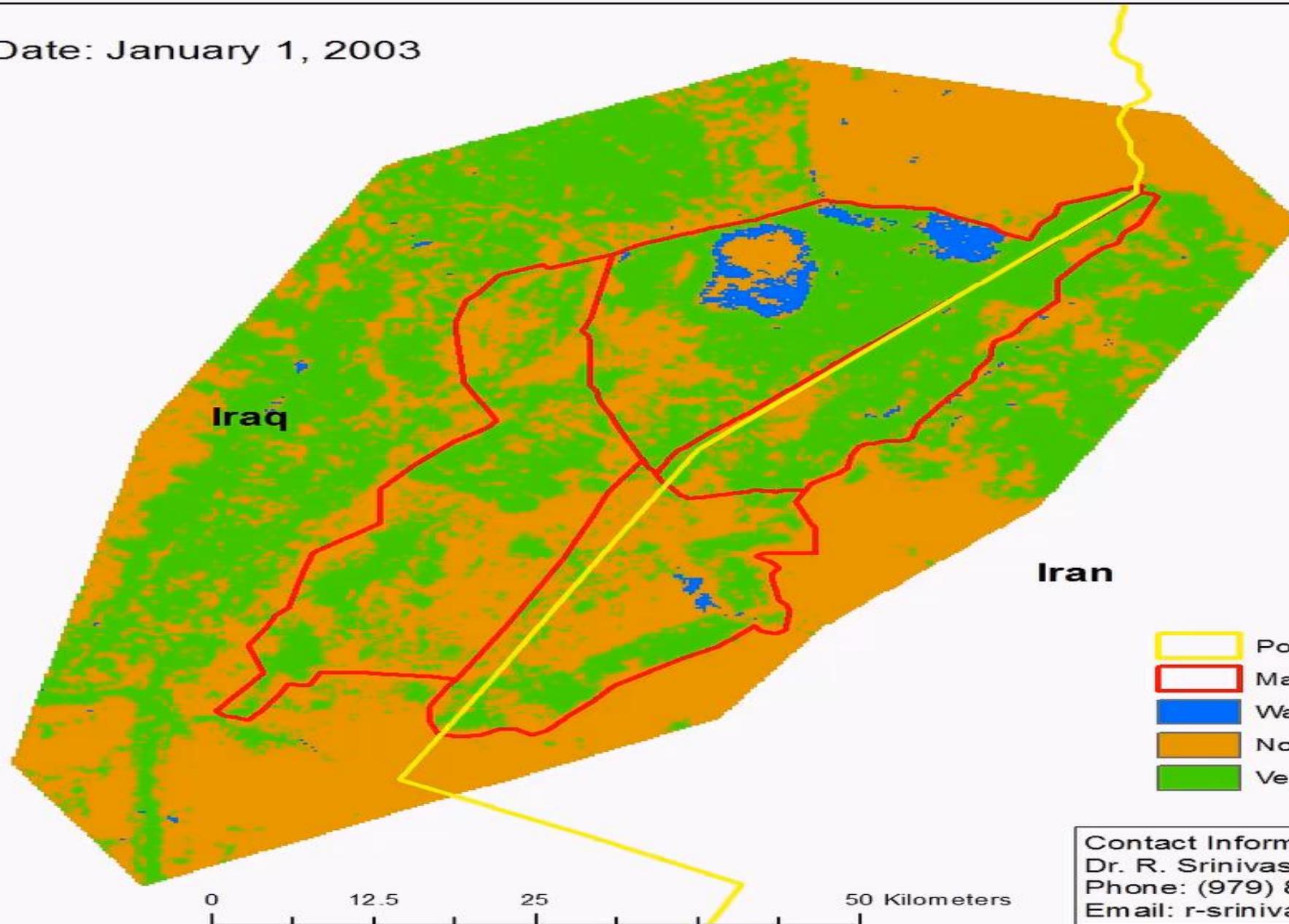
Drought

Shallow depth => evaporation



Image Date: January 1, 2003

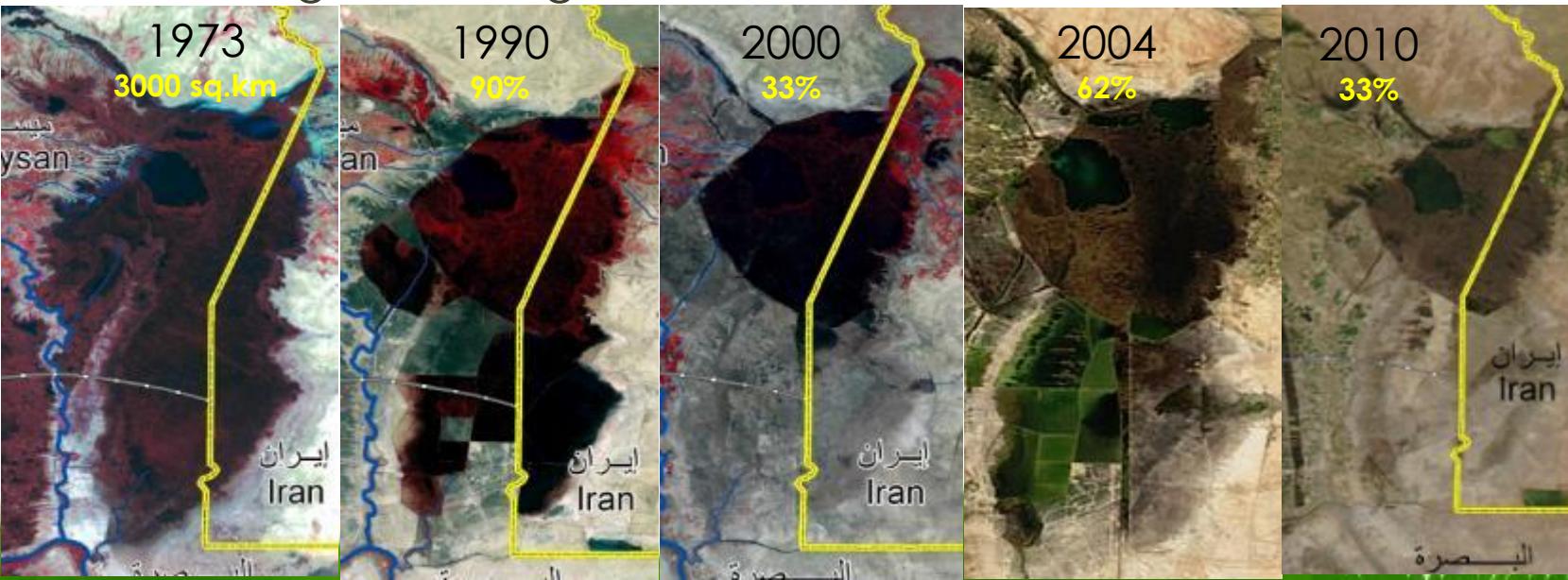
N



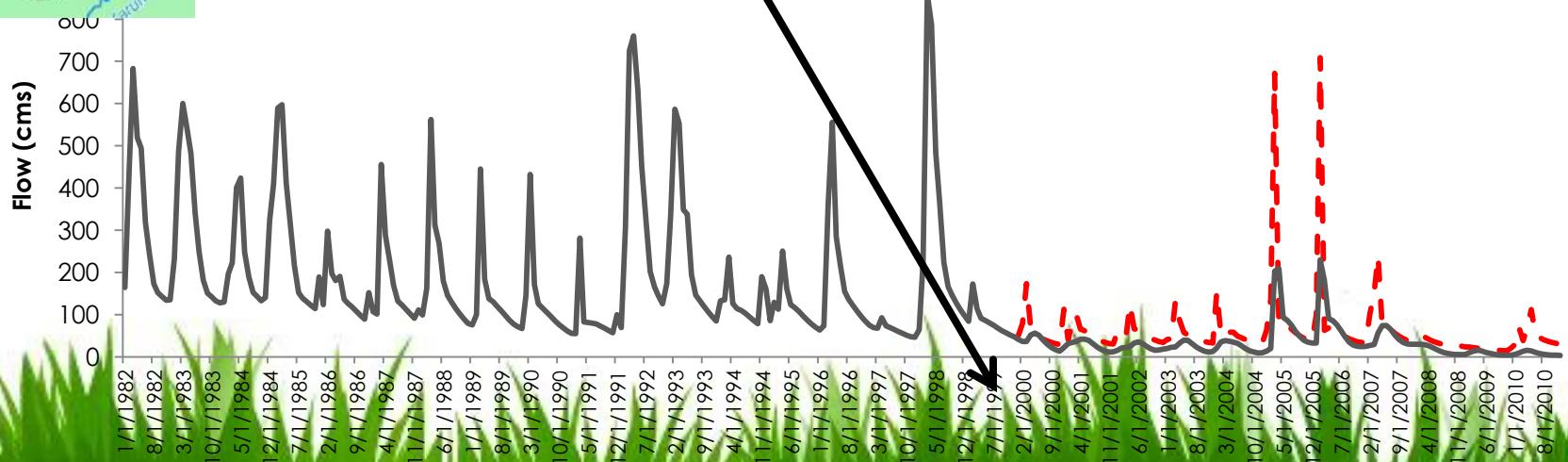
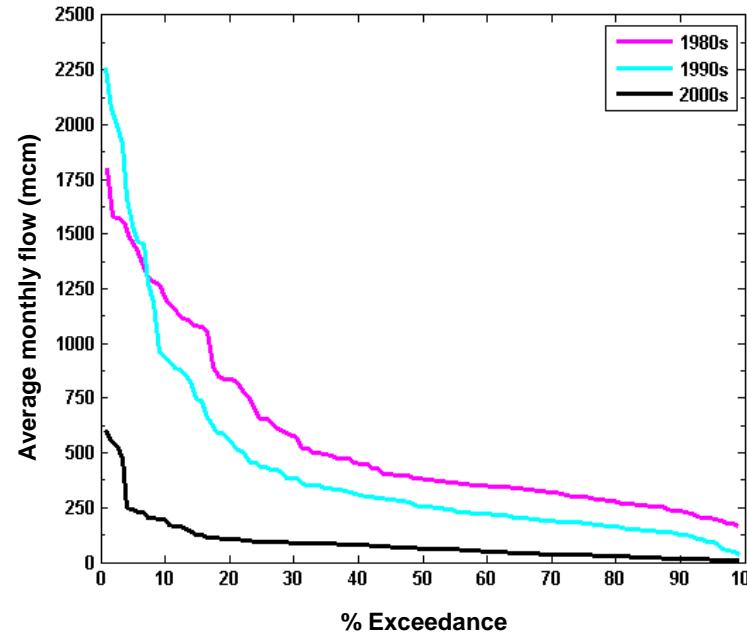
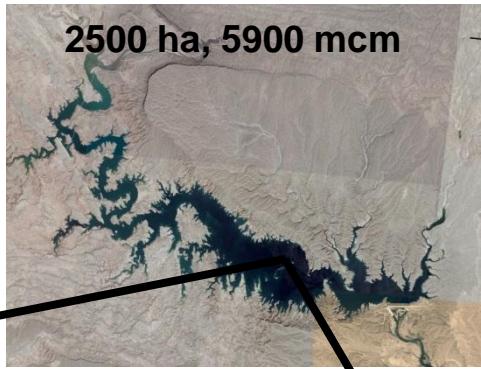
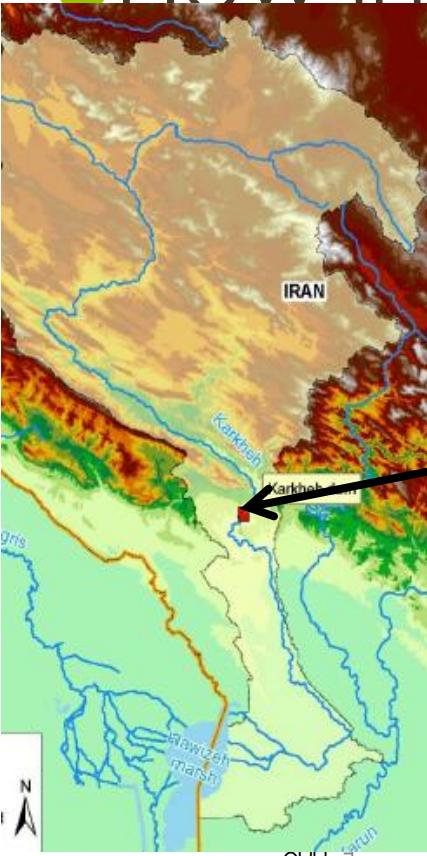
Contact Information:
Dr. R. Srinivasan
Phone: (979) 845-5069
Email: r-srinivasan@tamu.edu

Marsh History

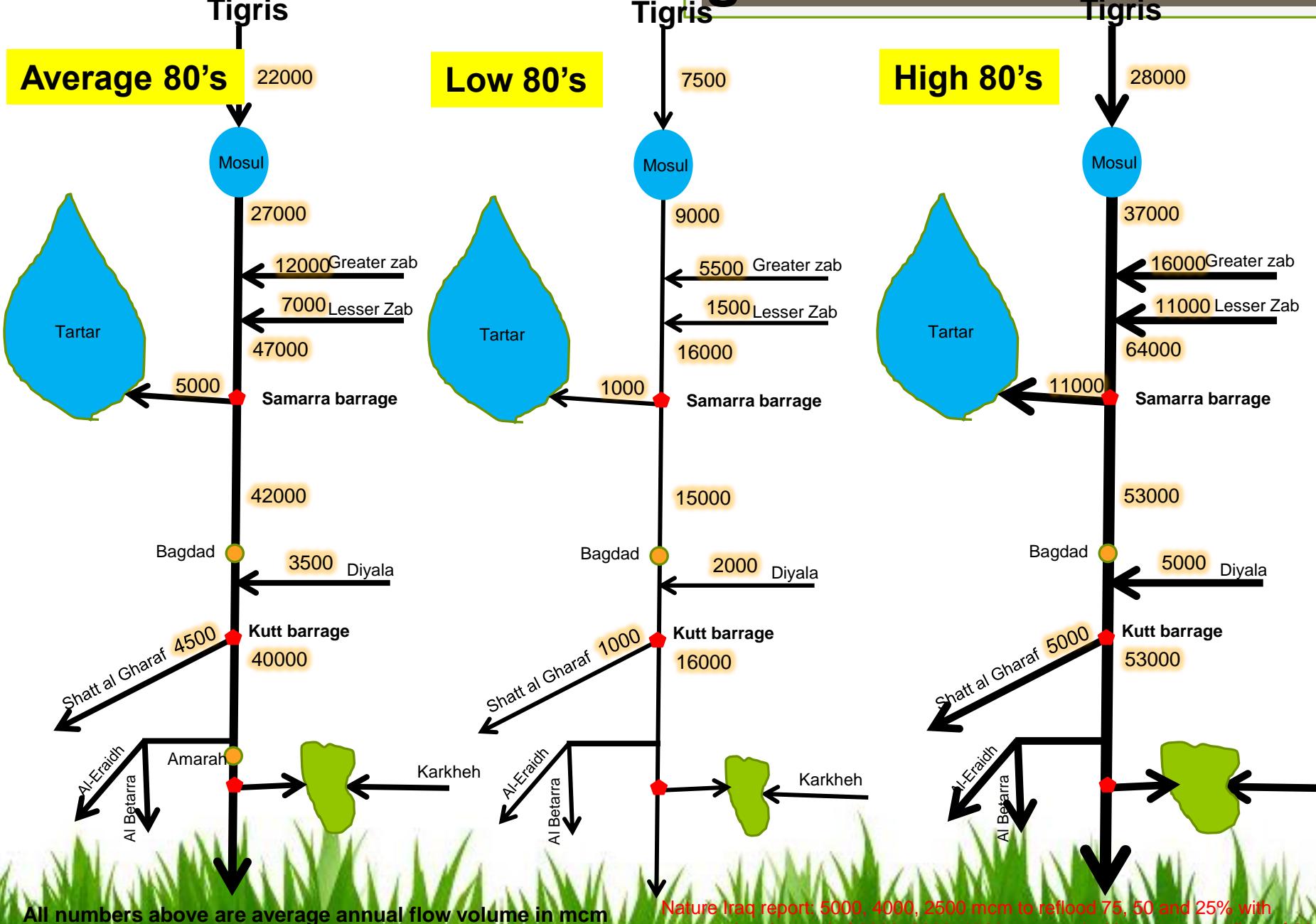
- The Hawizeh Marsh is a symbol of Iraq's rich natural and cultural history
- Marsh is fed majorly from Tigris and additional inputs from Karkheh(Iran)
- 1970's: Hawizeh area was in natural, undisturbed
 - not many dams on Tigris
- 1980's: Extensive work on drainage under Iraqi army
 - built dams on Tigris
- 1990's: Build more embankments inside marsh and burned vegetation
 - built dams on Tigris
- 2003 (freedom): Local people break embankments resulting in recovery of marsh and growth of vegetation
- 2004: recovered 62% of 1970's area
- 2009-2010: Drought resulting in reduction of area



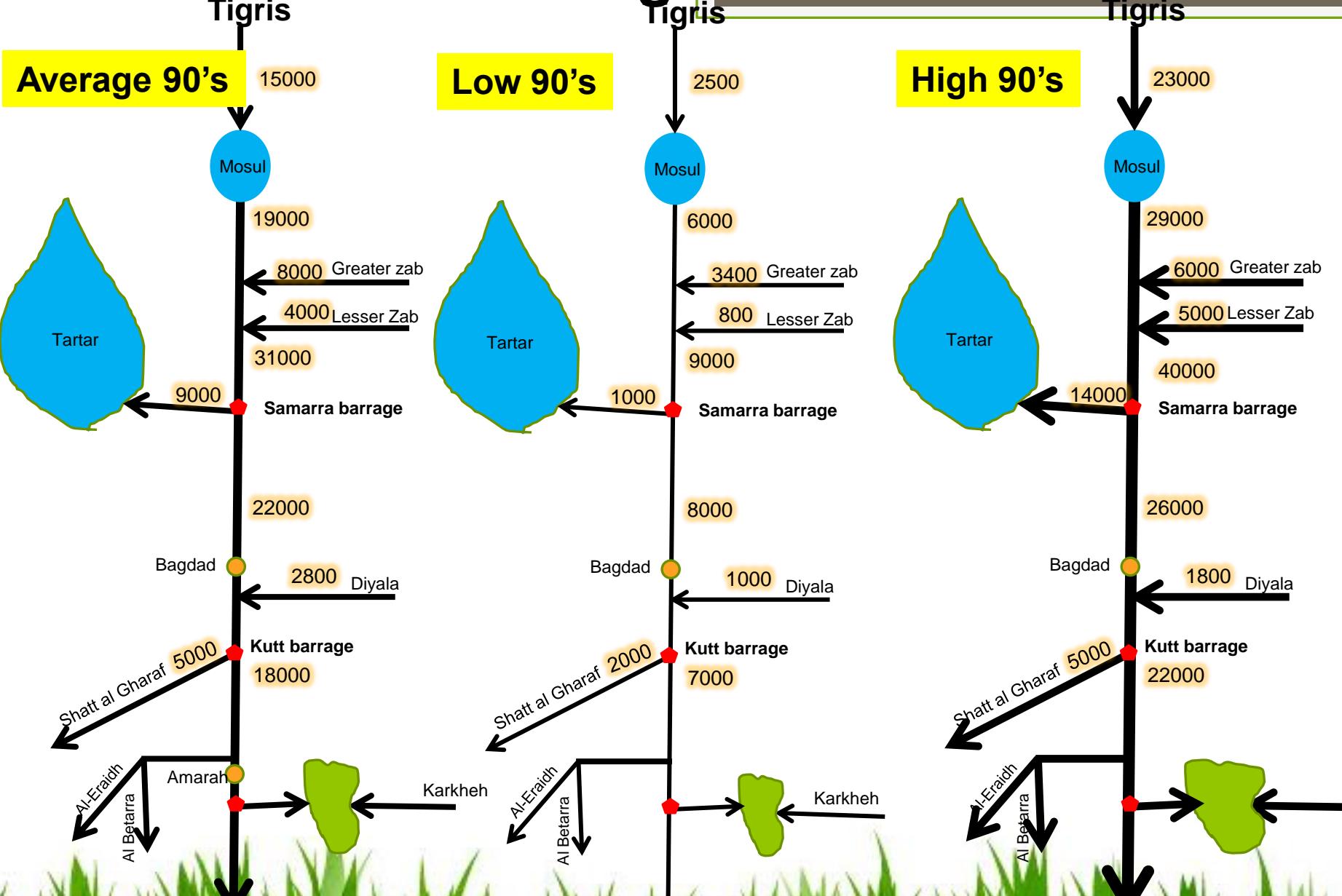
Flow into Hawizeh marsh from Karkheh



Annual Water budgets in 80's Kutt Barrage



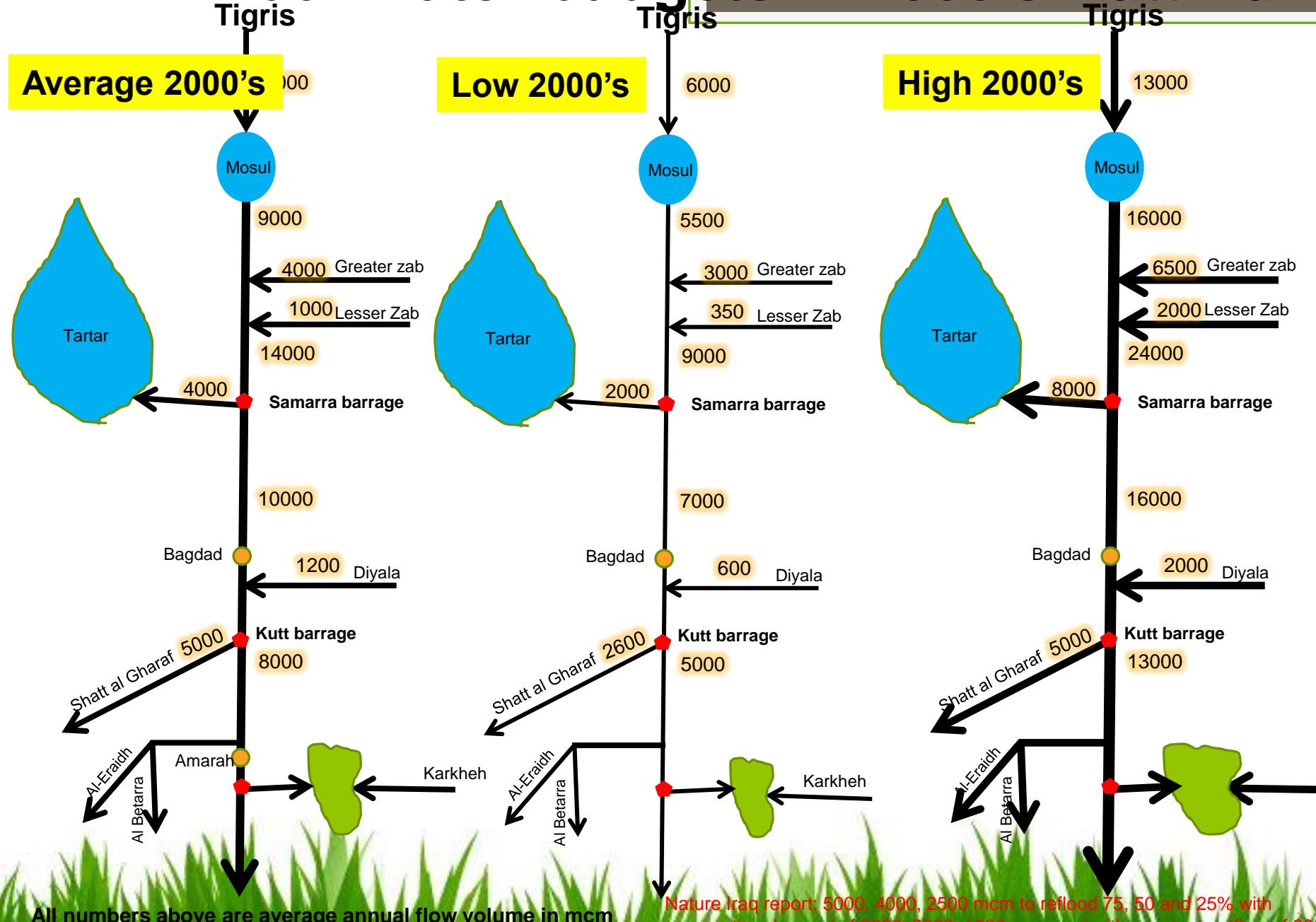
Annual Water budgets in 90's until Kutt Barrage



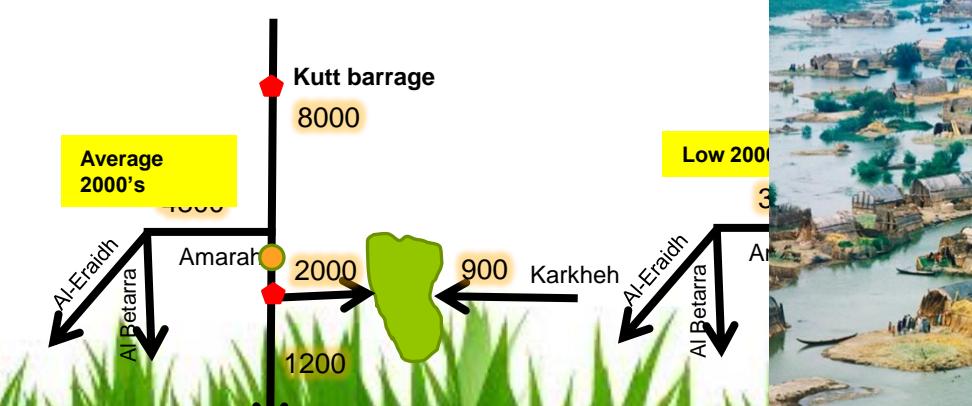
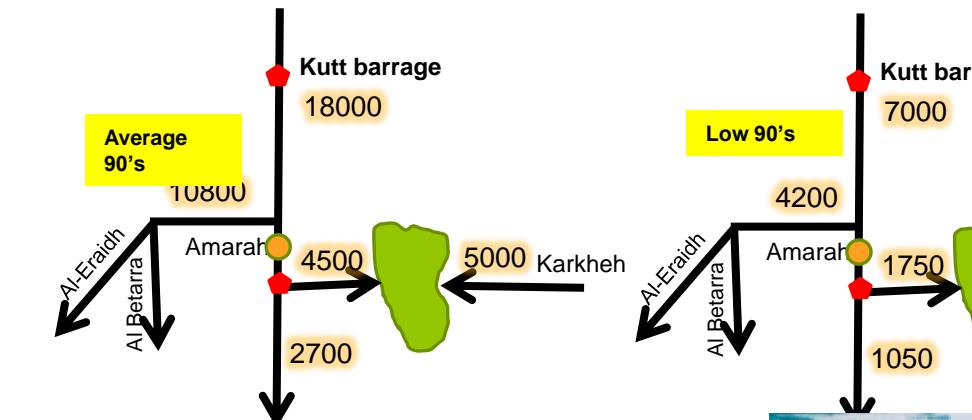
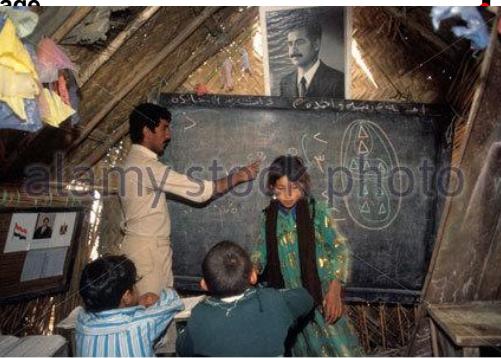
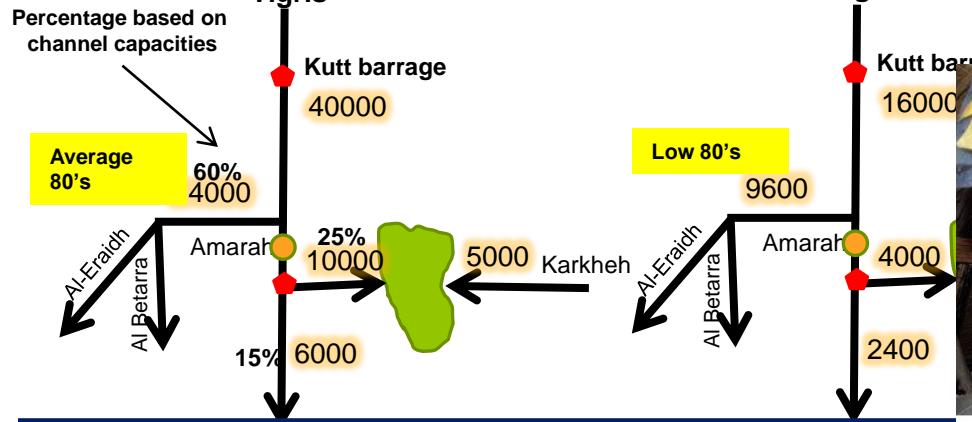
All numbers above are average annual flow volume in mcm

Nature Iraq report: 5000, 4000, 2500 mcm to reflush 75, 50 and 25% with evaporative demand of 3000, 2000, 1500 mcm and with constant outflow of 2000 mcm

Annual Water budgets in 2000's Kutt Barrage



Annual Water budgets below Kutt Barrage

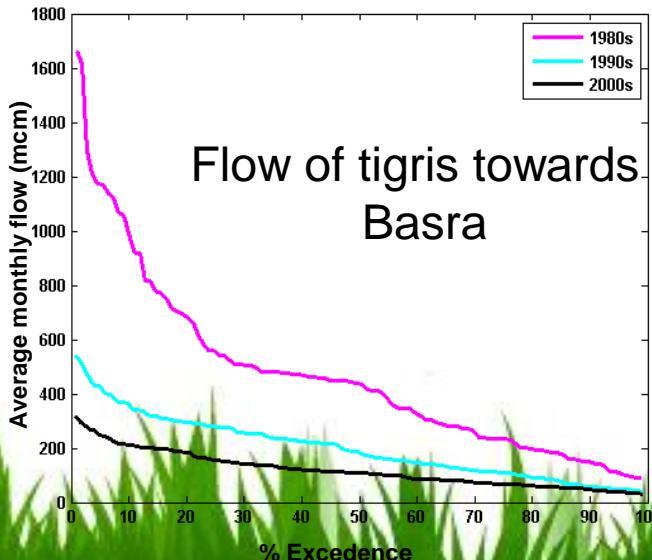
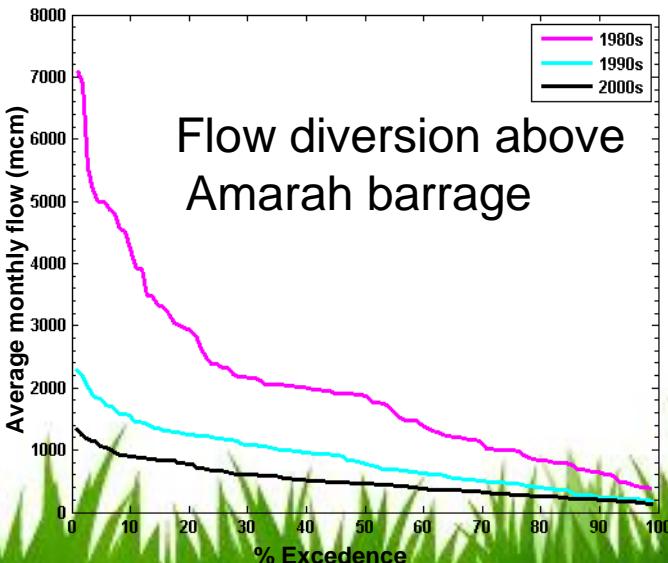
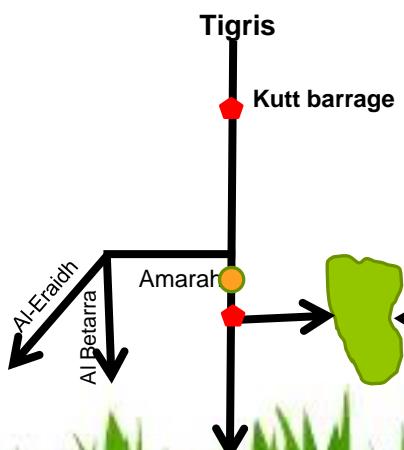
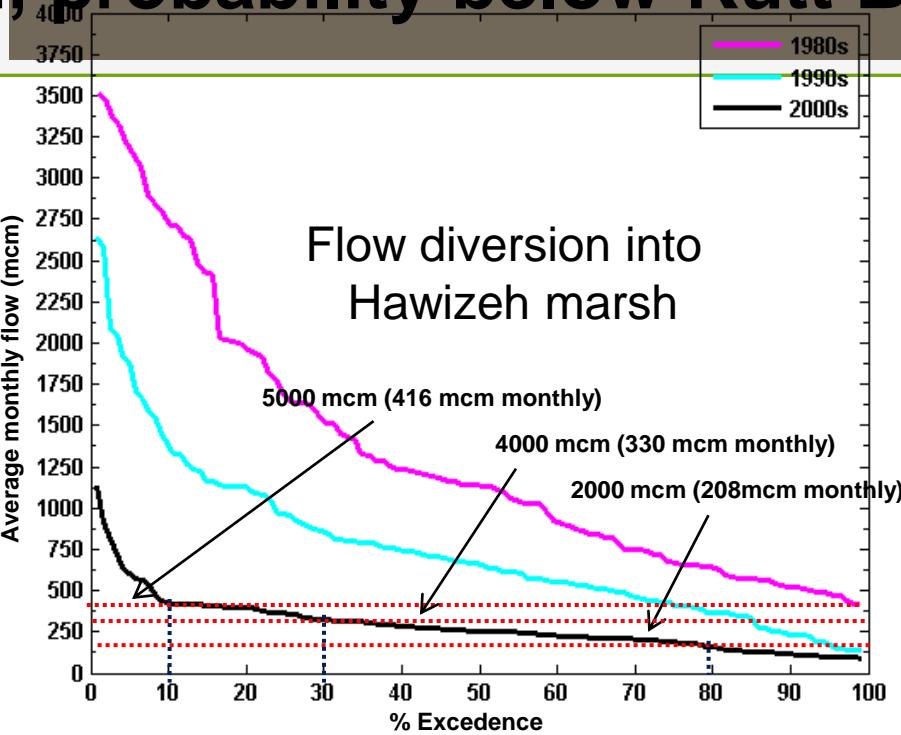
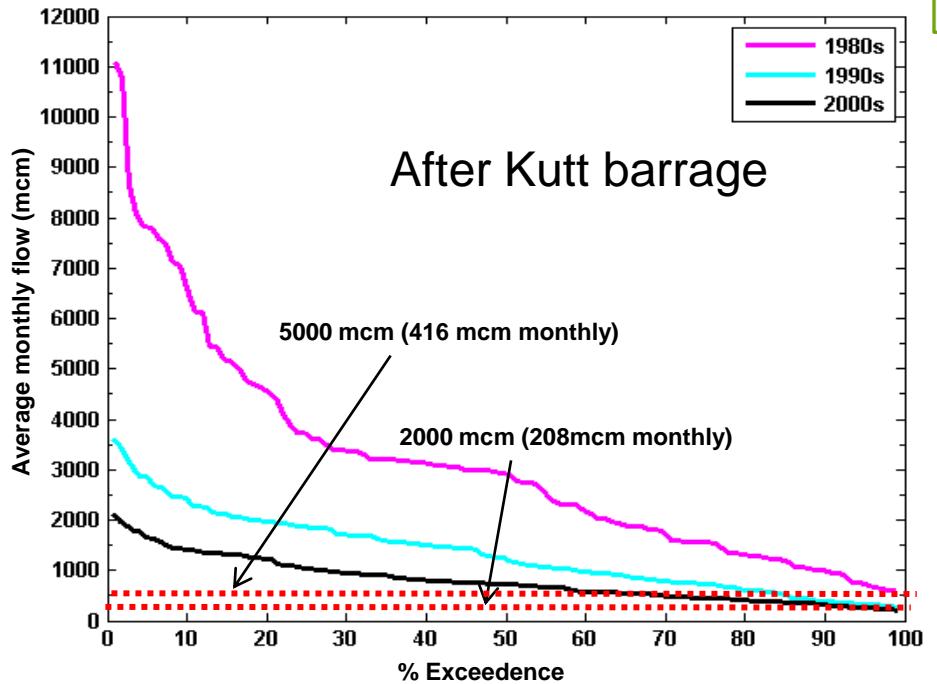


All numbers above are average annual flow volume in mcm

evaporative demand of 3000, 2000, 1500 mcm and with constant outflow of 2000 mcm

floods - 75, 50 and 25% water

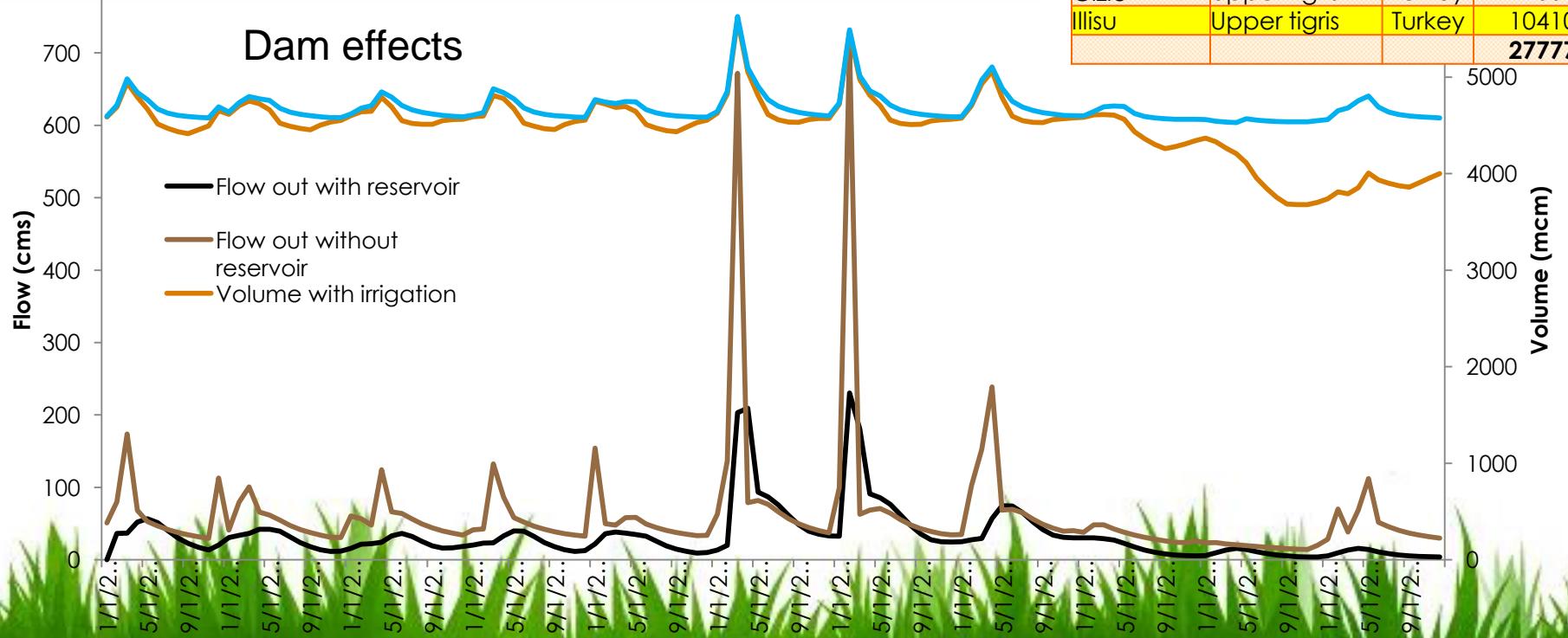
Flow intensity, duration, probability below Kutt Barrage



Dams

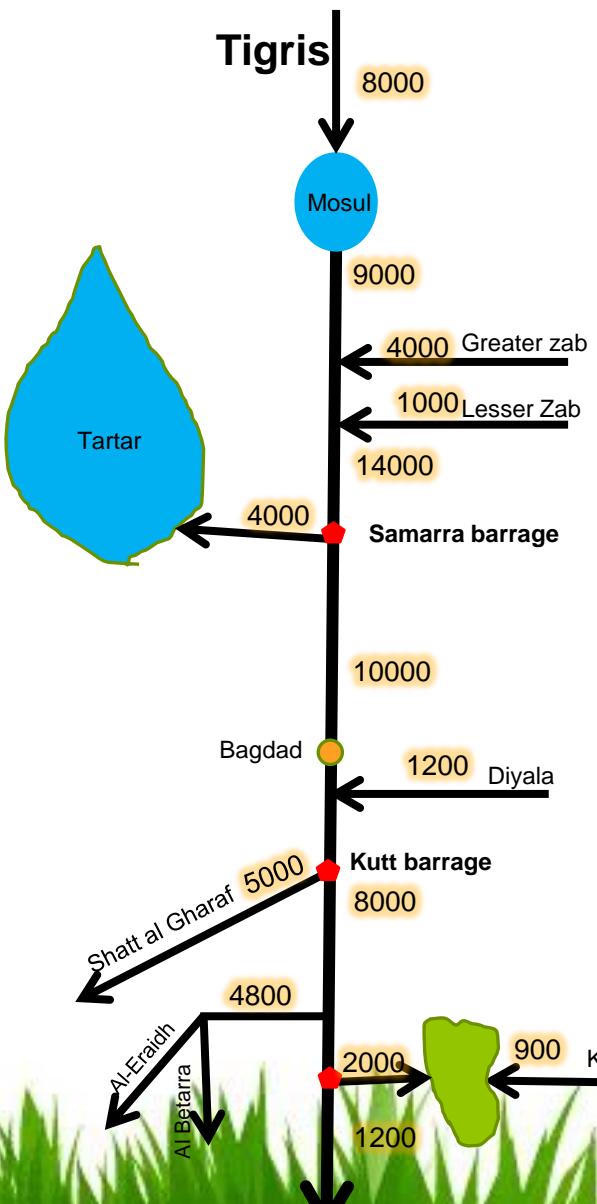
Current Dam	Volume (mcm)	Inflow (mcm)	Outflow (mcm)	% reduction	Evaporation (mcm)	evap/v ol
Batman	1100	1105	874	21%	50	5%
Dicile	580	674	659	2%	24	4%
Kralkize	1920	342	305	11%	54	3%
Mosul	11110	18799	17972	4%	416	4%
Dokan	6800	5799	4587	21%	309	5%
Dibbis	4000	4953	3932	21%	154	4%
Hemrin	2500	3318	2670	20%	78	3%
Derbinkhan	3000	3250	2866	12%	142	5%
Karkheh	5900	1978	1086	45%	40	1%
Tartar	11000	9000	-	-	2260	21%
Total	47910	49219	35519		3529	

Future Dams	River	Country	Volume
Taqataq	Lesser Zab	Iraq	2858
Bekhme	Greater zab	Iraq	8300
Bakeerman	Greater zab	Iraq	500
Mandava	Greater zab	Iraq	2000
Hakkari	Greater zab	Turkey	2000
Garzan	Trib upper tigris	Turkey	145
Kayser	Trib upper tigris	Turkey	1970
Dilini	Trib upper tigris	Turkey	200
Silvan	Trin upper tigris	Turkey	1175
Cizie	Upper tigris	Turkey	200
Illisu	Upper tigris	Turkey	10410
			27777

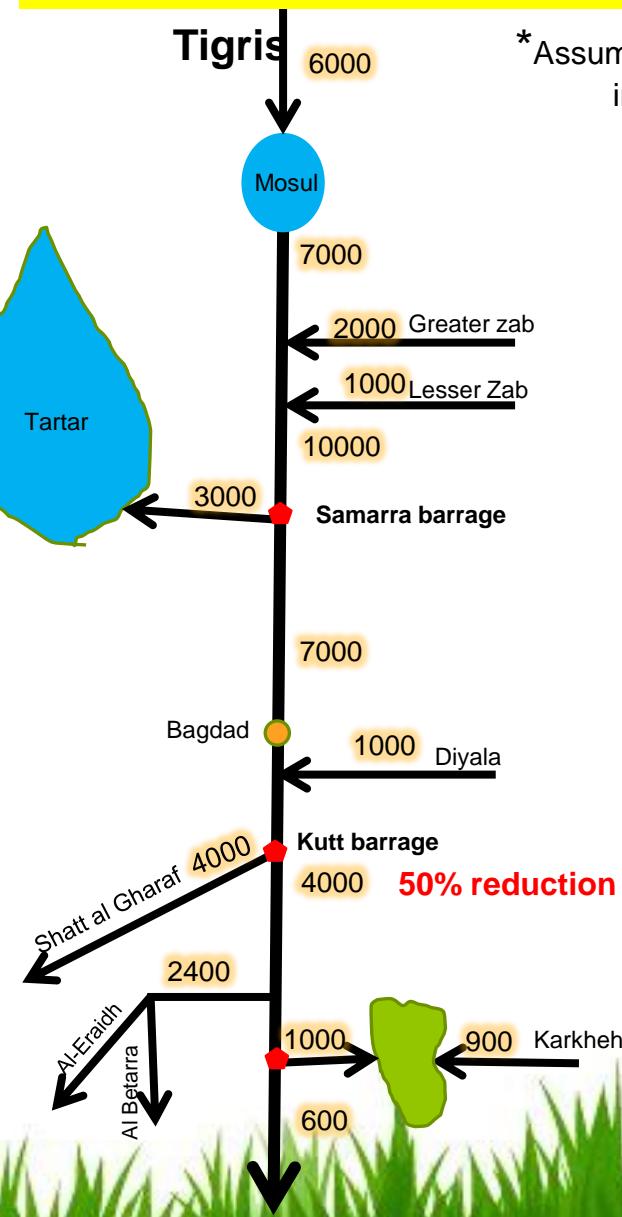


Current and Post Dams

Average 2000's - Current



Average 2000's – Post dams*



* Assumptions based on current dam sizes, inflow and outflow calculations

Conclusions

- Open source of knowledge about water is key to avoid conflicts
- Open source models and data availability publically is very important
- Mekong river basin is a good example
- The water conflicts are well known in other river basins such as Ganges, Nile, Amazonia, Danube, Colorado and other major rivers around the world.
- As SWAT modelers we could model these basins and publish the information in a peer review process to bring focus to the problem and contribute to the awareness to countries that have no or poor information.



Thank you

