SWIM and Horizon 2020 Support Mechanism

Working for a Sustainable Mediterranean, Caring for our Future

SWIM-H2020 SM EFS-LB-1

State of water resources in the Nahr El-Kelb river basin up to 2040 and results of the application of demand management measures

Presented by:

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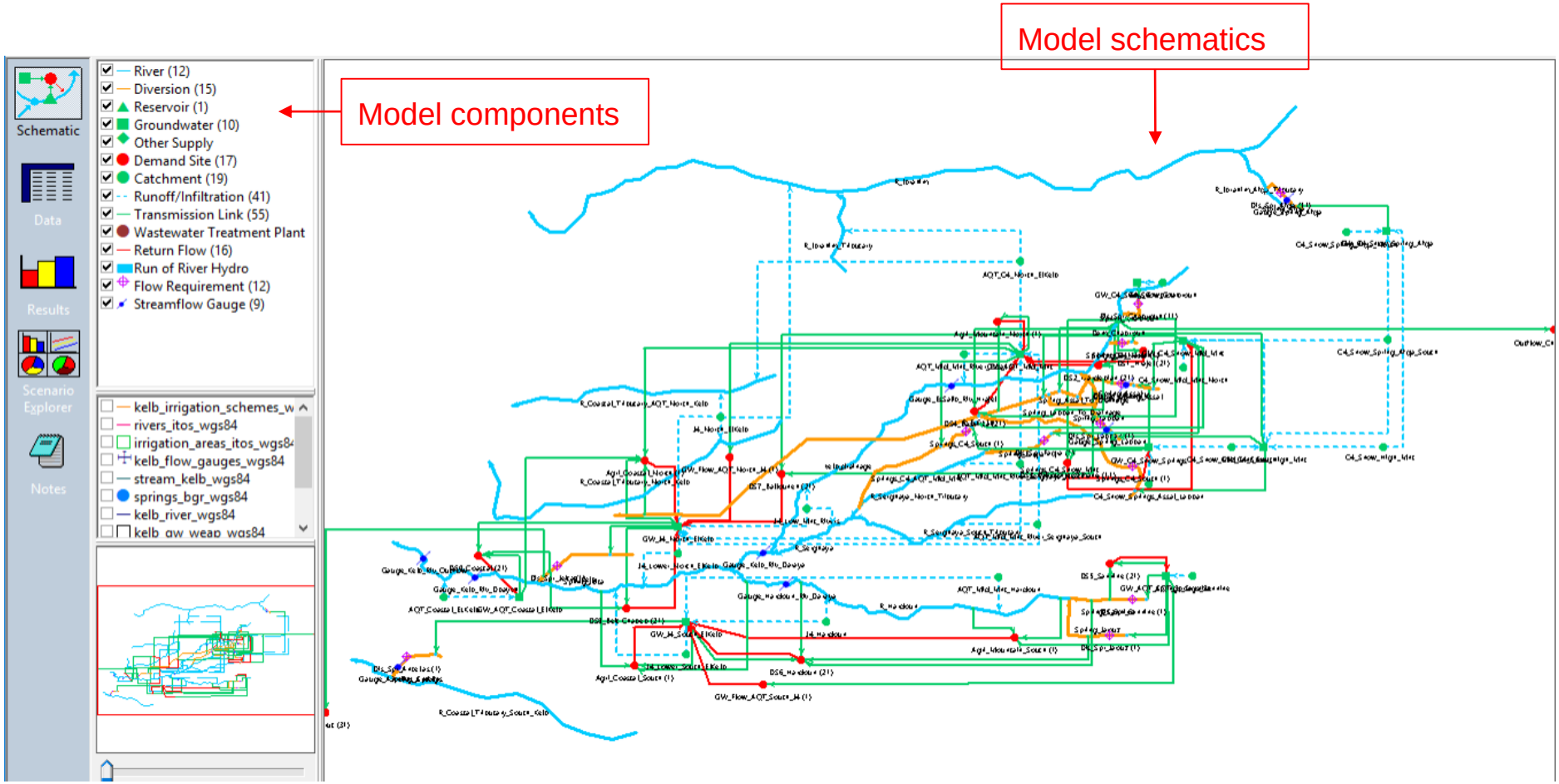
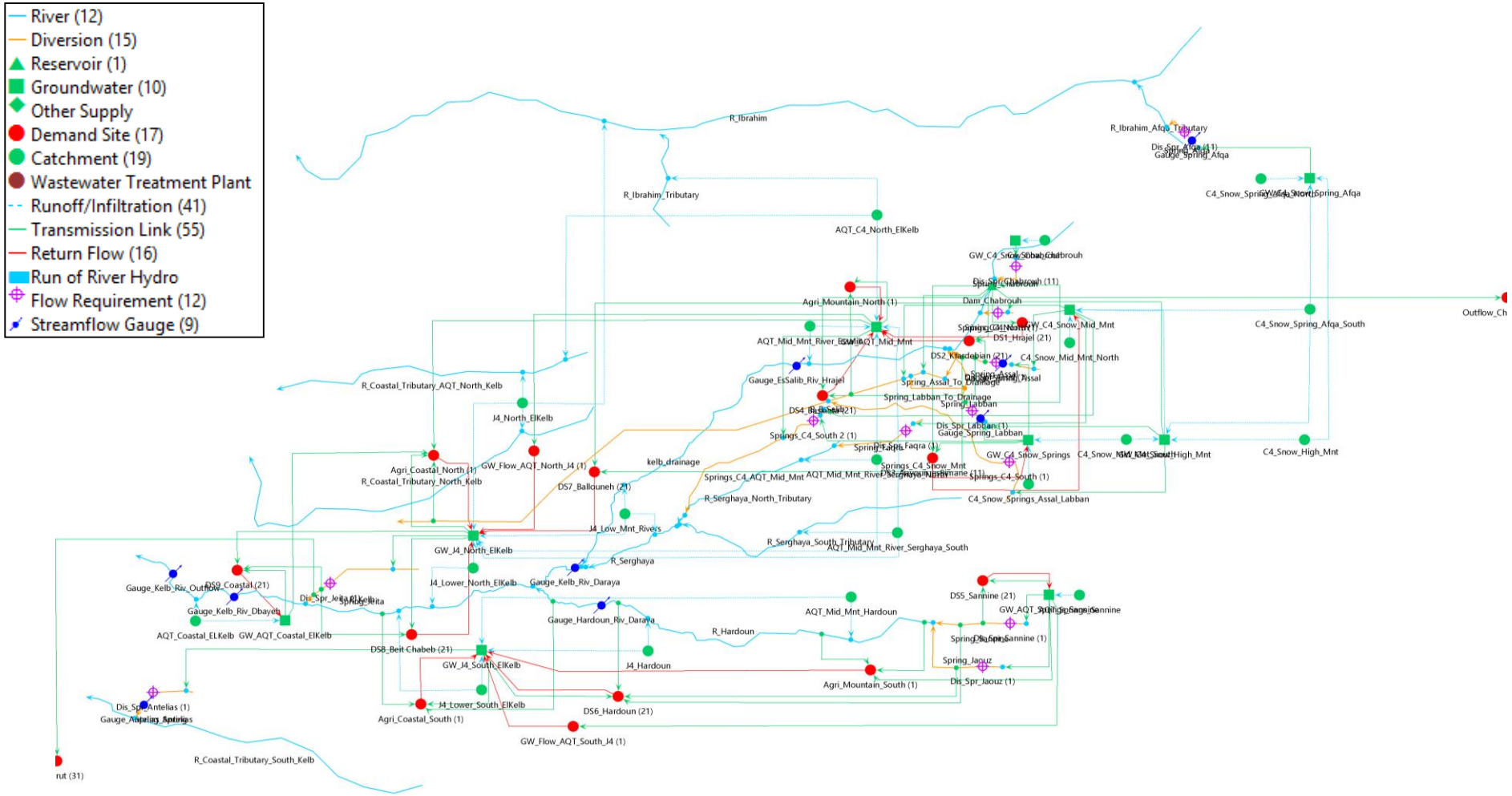
Consultation Workshop with stakeholders to define policy targets and a PoM in the Nahr El-Kelb

14th March 2019, Beirut, Lebanon

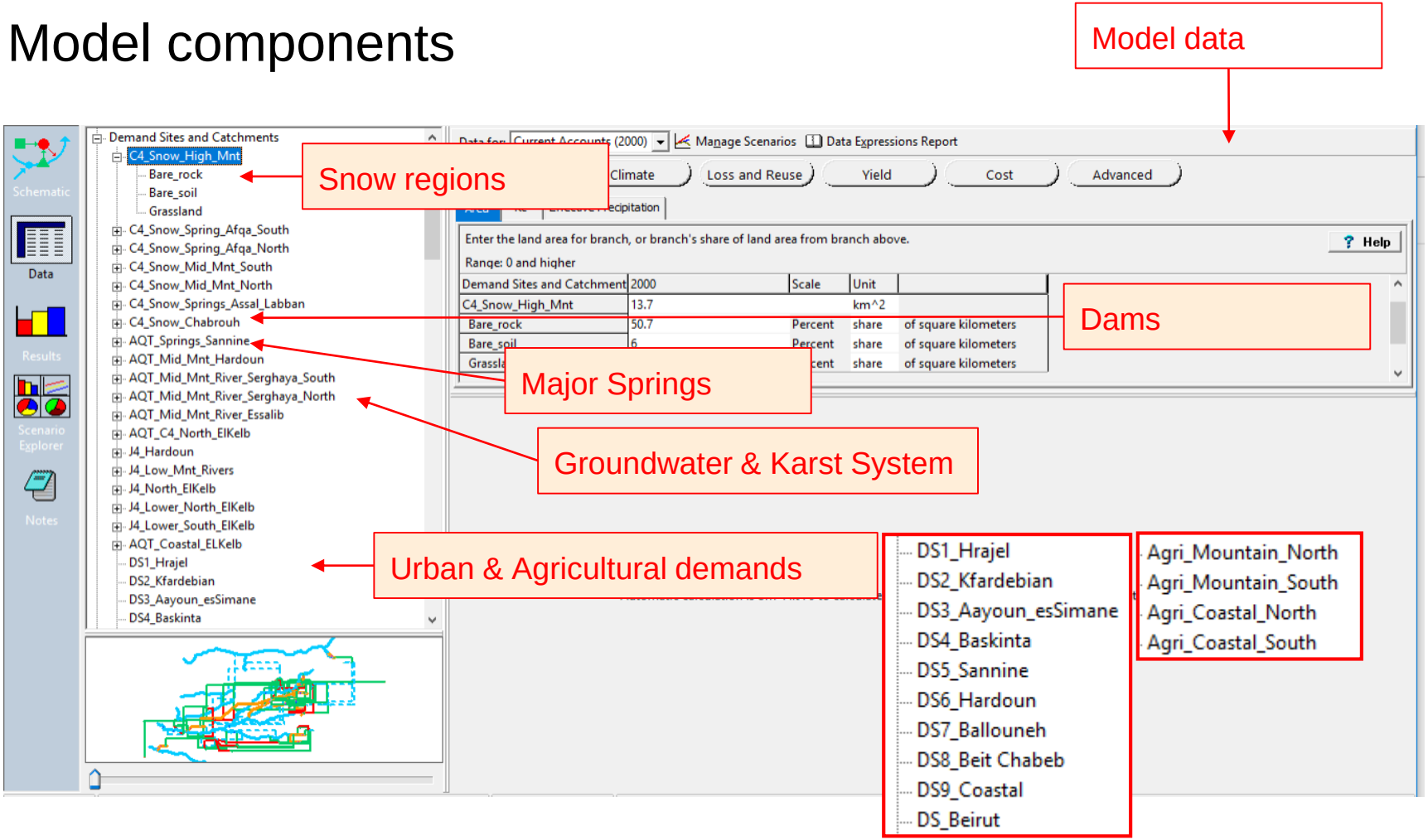
This Project is funded by the European Union

The WEAP Water Resources Mangement Model 2000-2040

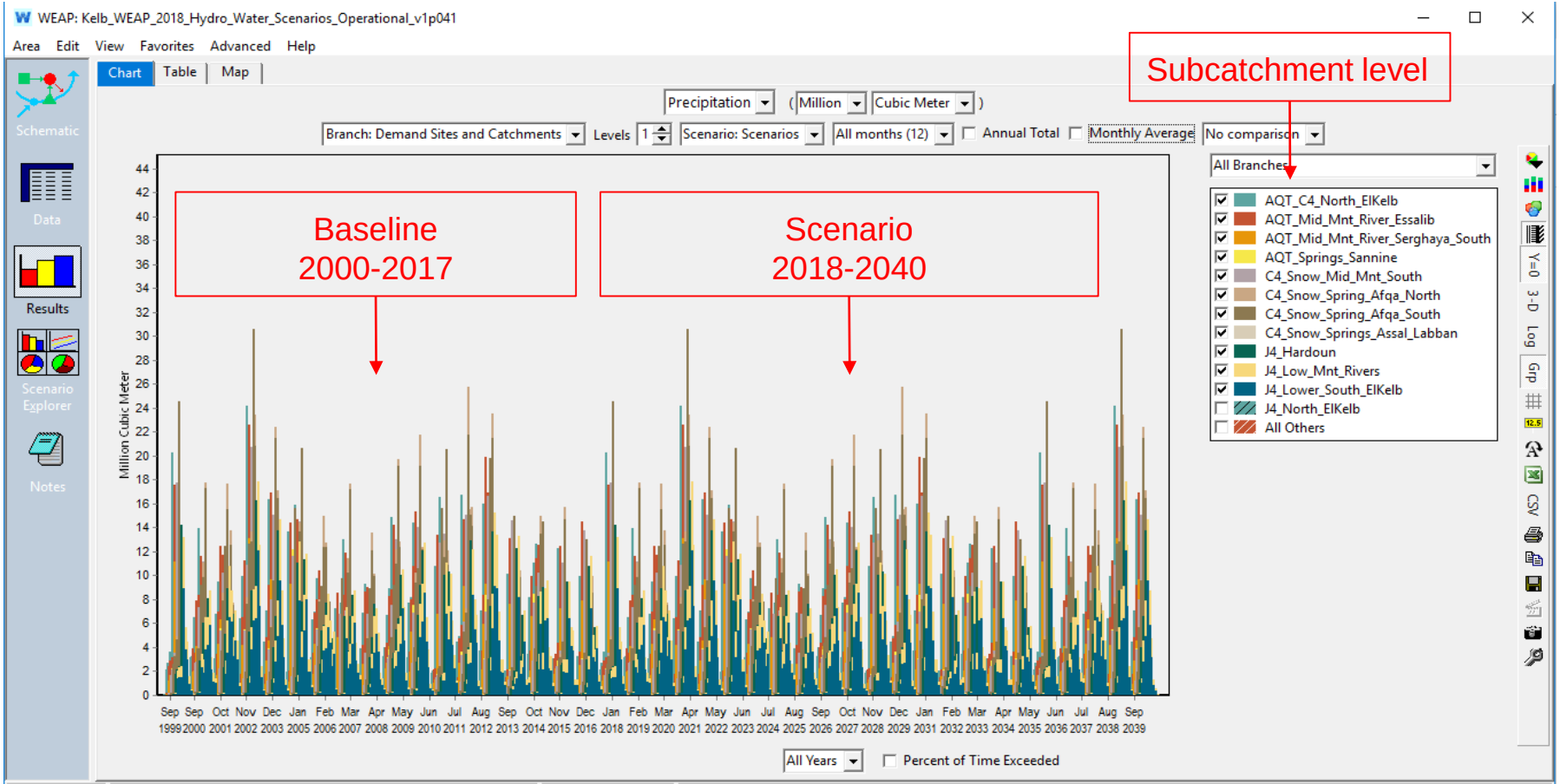



River (12)
Diversion (15)
Reservoir (1)
Groundwater (10)
Other Supply
Demand Site (17)
Catchment (19)
Wastewater Treatment Plant
Runoff/Infiltration (41)
Transmission Link (55)
Return Flow (16)
Run of River Hydro
Flow Requirement (12)
Streamflow Gauge (9)
R_Ibrahim
R_Ibrahim_Tributary
R_Ibrahim_Afqa_Tributary
AQT_C4_North_ElKelb
Agri_Mountain_North (1)
Dam_Chabrouh
C4_Snow_Spring_Afqa_South
Outflow_Ch
DS1_Hrajel (21)
DS2_Kfardebian (21)
C4_Snow_Mid_Mnt_North
Gauge_ElSalib_Riv_Hrajel
Spring_Assal_To_Drainage
Spring_Labban_To_Drainage
Spring_Labban
Springs_C4_South 2 (1)
Gauge_Spring_Labban
GW_C4_Snow_Springs
C4_Snow_High_Mnt
R_Coastal_Tributary_AQT_North_Kelb
J4_North_ElKelb
Agri_Coastal_North (1)
GW_Flow_AQT_North_J4 (1)
R_Coastal_Tributary_North_Kelb
DS7_Ballouneh (21)
kelb_drainage
Springs_C4_AQT_Mid_Mnt
R_Serghaya_North_Tributary
C4_Snow_Springs_Assal_Labban
J4_Low_Mnt_Rivers
GW_J4_North_ElKelb
R_Serghaya_South_Tributary
AQT_Mid_Mnt_River_Serghaya_South
R_Serghaya
DS9_Coastal (21)
Gauge_Kelb_Riv_Outflow
Gauge_Kelb_Riv_Dbayeh
AQT_Coastal_ELKelb
GW_AQT_Coastal_ElKelb
J4_Lower_North_ElKelb
Gauge_Kelb_Riv_Daraya
Gauge_Hardoun_Riv_Daraya
DS8_Beit_Chabeb (21)
GW_J4_South_ElKelb
J4_Hardoun
R_Hardoun
AQT_Mid_Mnt_Hardoun
DS5_Sannine (21)
Spring_Jaouz
Dis_Spr_Jaouz (1)
Agri_Mountain_South (1)
Dis_Spr_Antelias (1)
J4_Lower_South_ElKelb
Agri_Coastal_South (1)
DS6_Hardoun (21)
GW_Flow_AQT_South_J4 (1)
R_Coastal_Tributary_South_Kelb

Model components

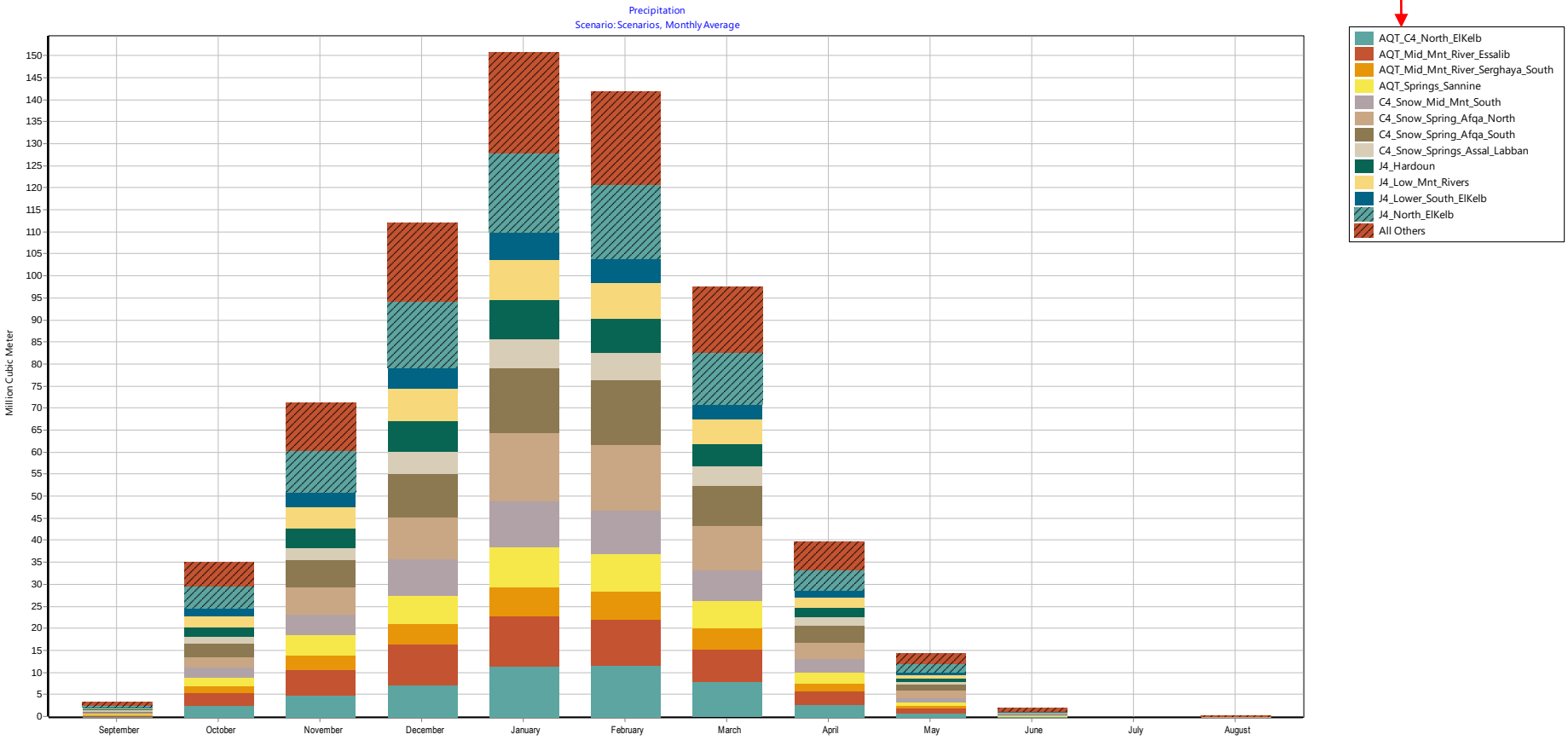


Climatology - precipitation

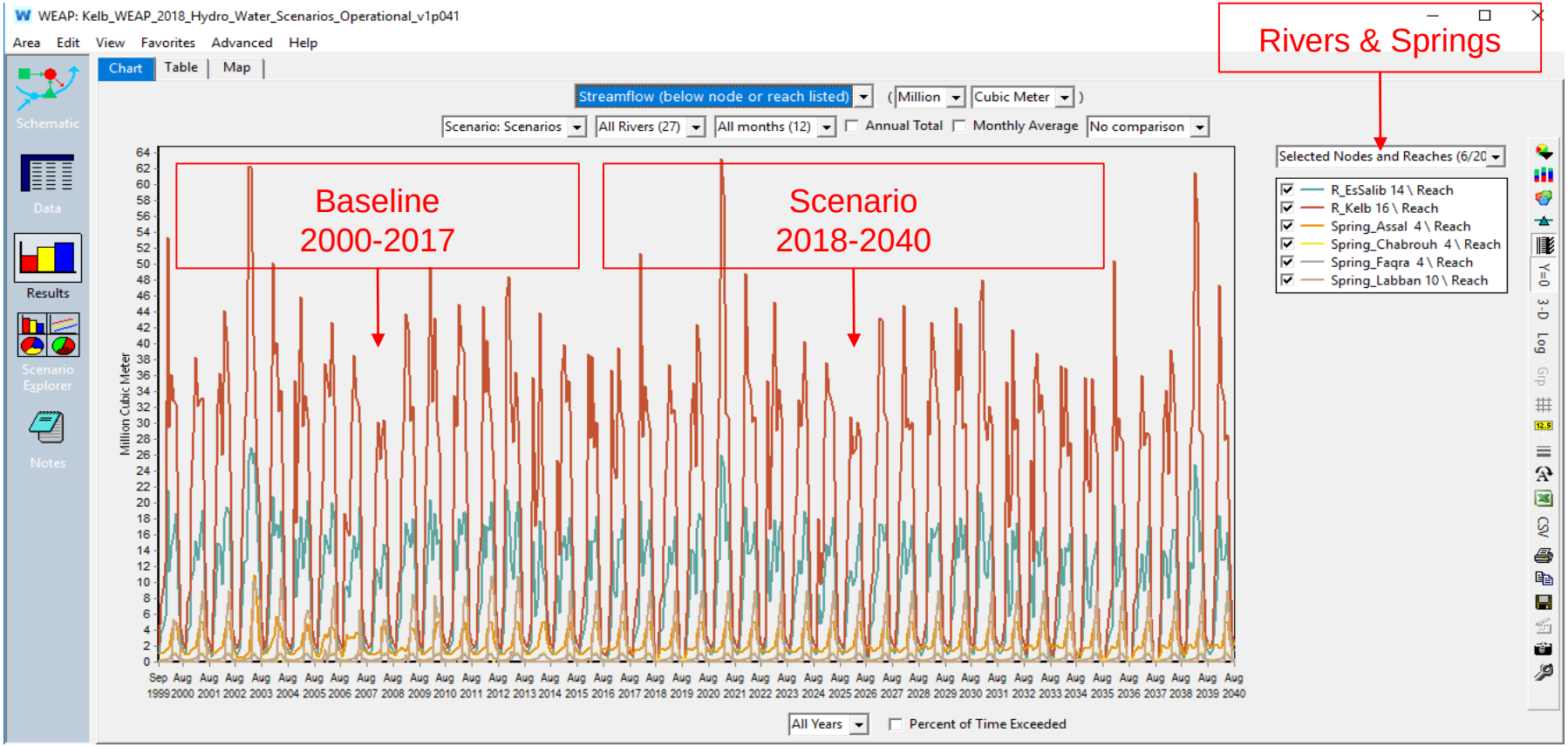


Climatology – precipitation, monthly average

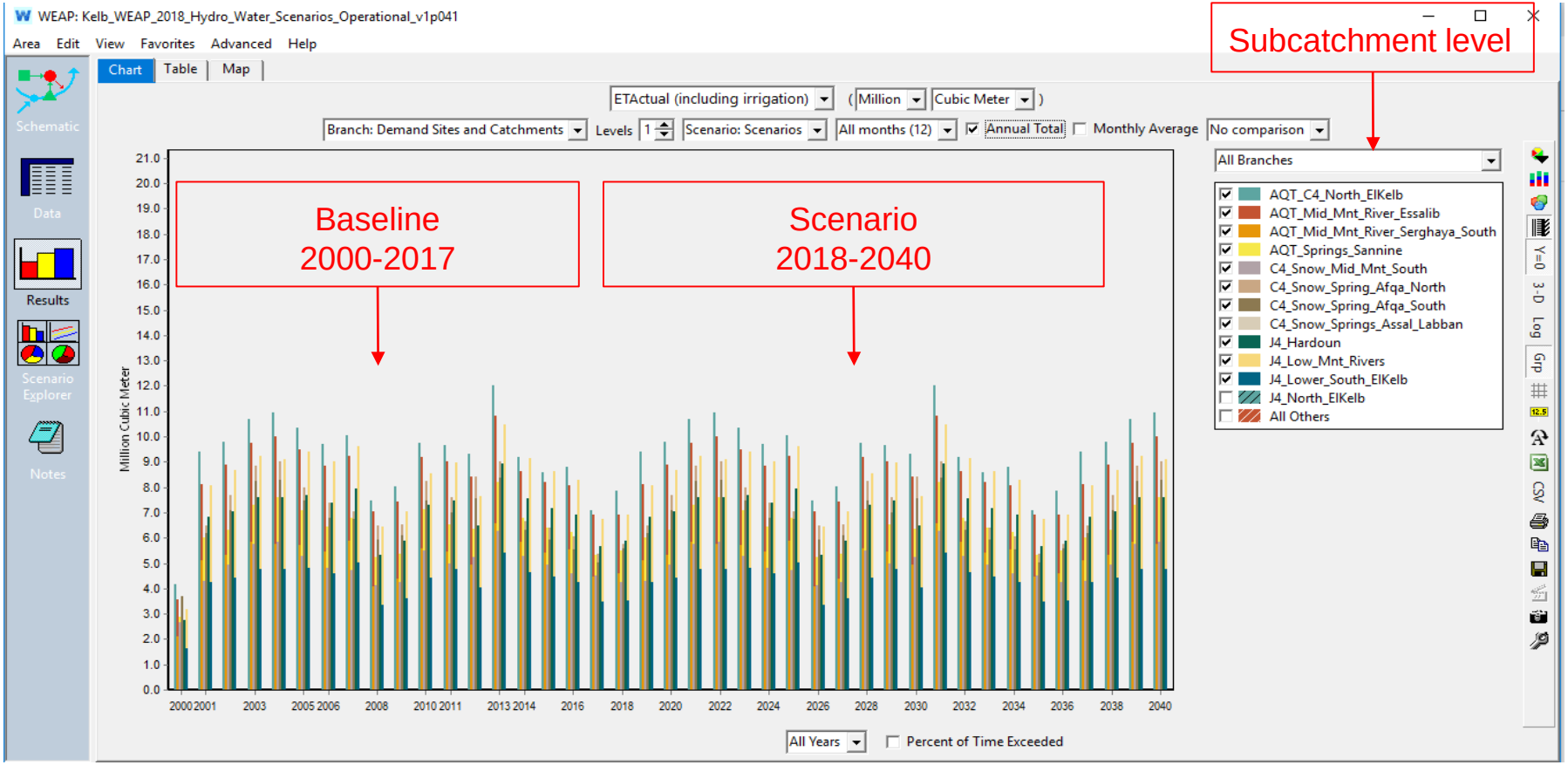
Subcatchment level



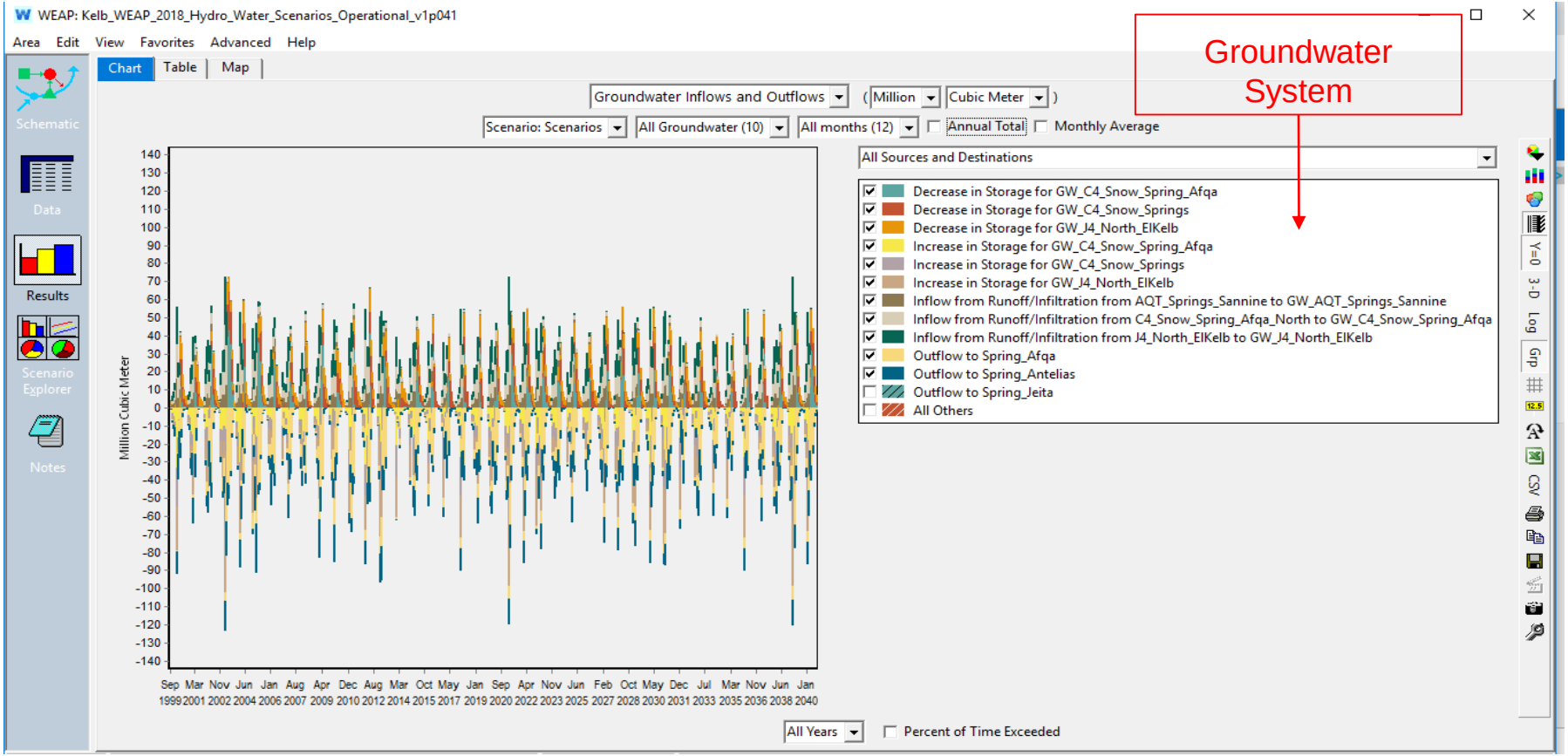
Hydrology - streamflow and spring discharge



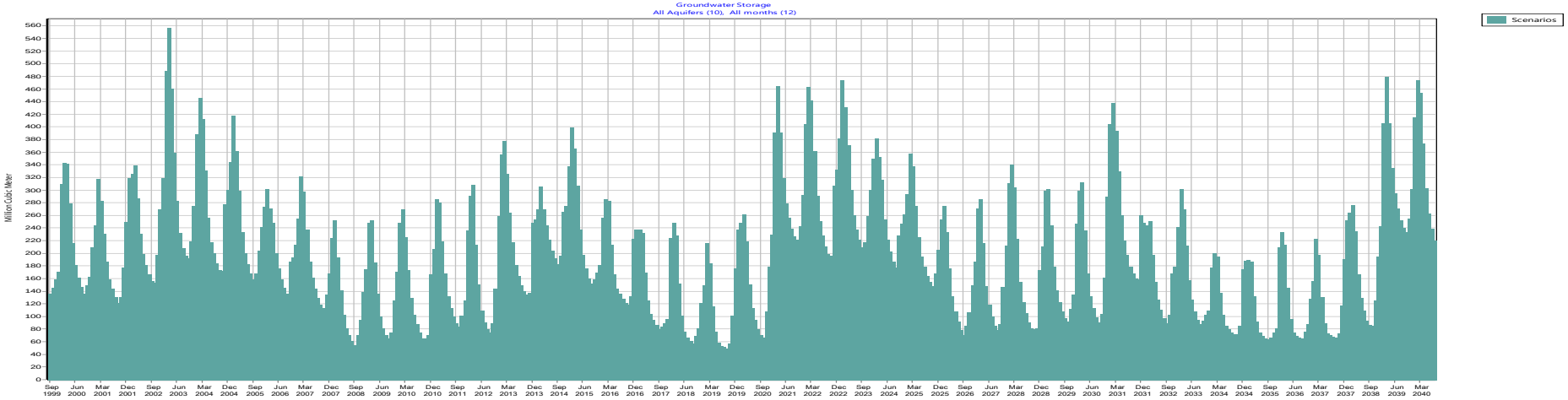
Hydrology - simulating evapotranspiration

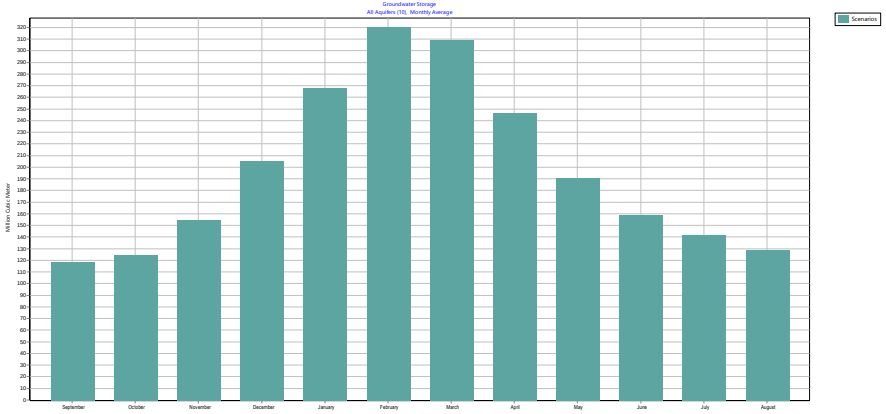


Hydrology - simulating groundwater system



Hydrology – groundwater storage

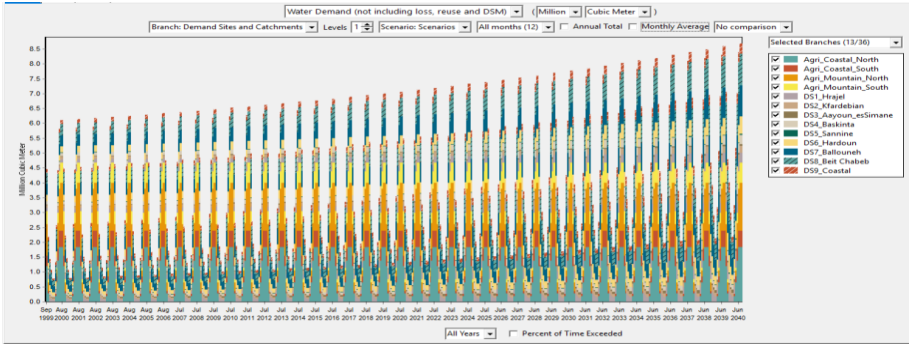


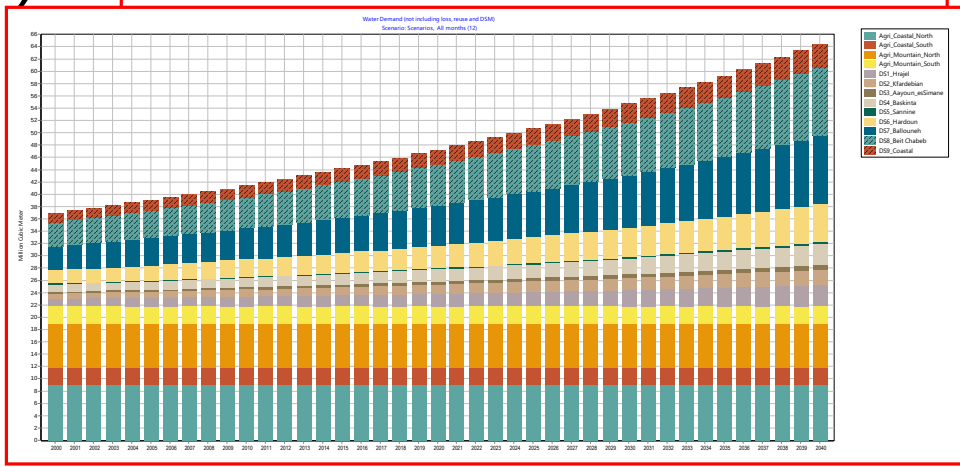


Water demand (urban, agriculture)

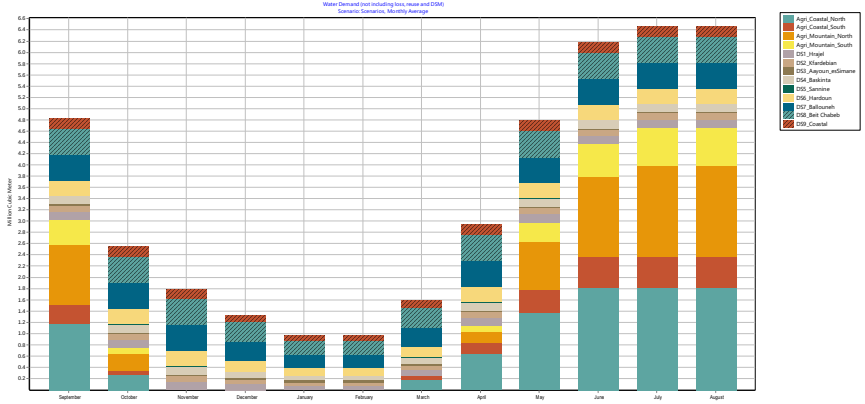
Total Annual (2018=46MCM ; 2040=64.4MCM

<u>Beirut</u> 114.6 MCM/yr is not included here

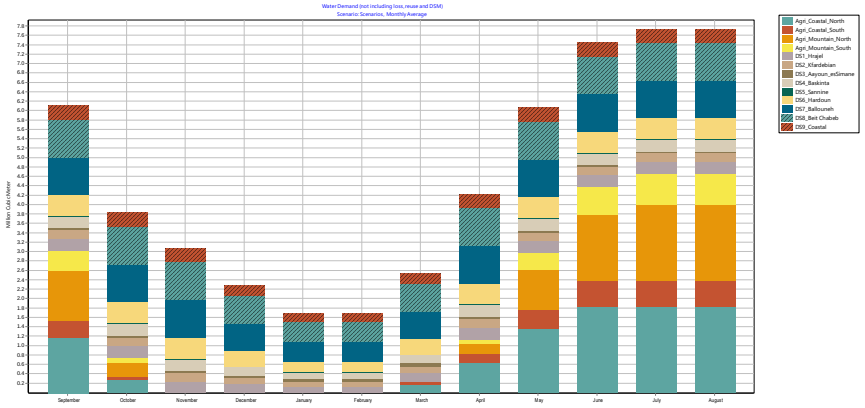




Monthly average 2000-2017



Monthly average 2018-2040

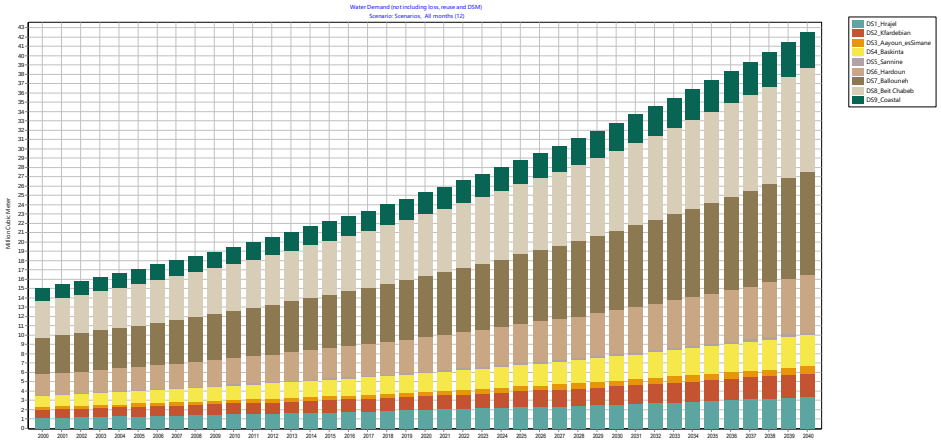


Urban water demand

Water use rate = 80 m3/cap

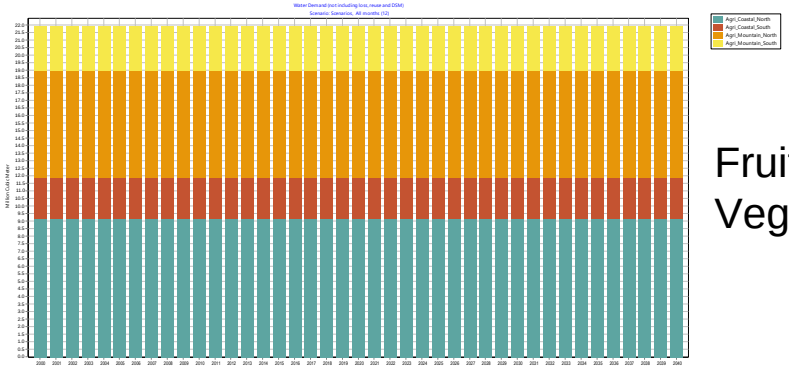
Urban netw. eff/. = 55%

Population increase = 2.2% per year



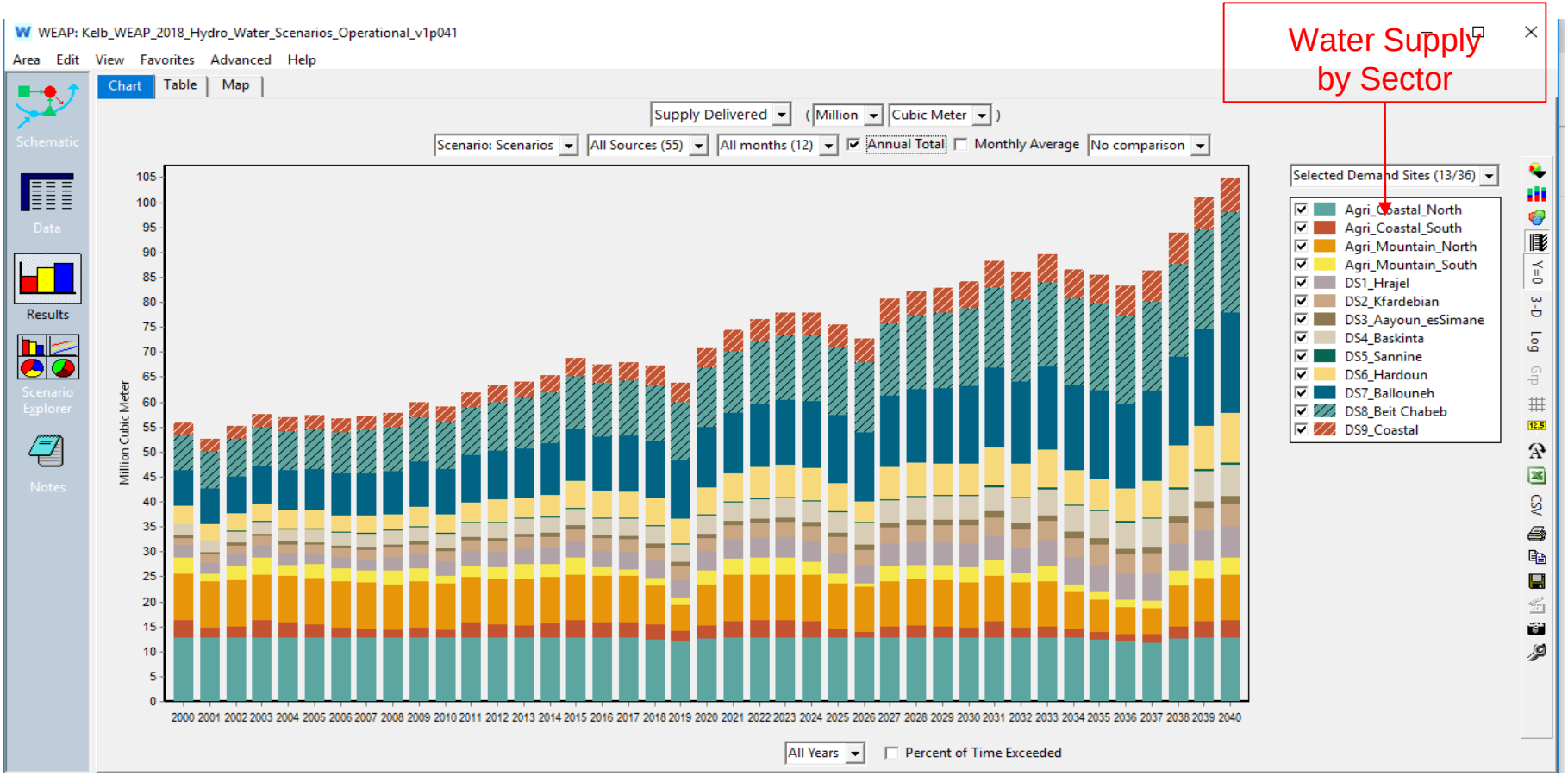
Year	Urban demand (mio m3/year)
2000	15.03
2005	17.11
2010	19.49
2015	22.20
2018	24.00
2030	32.78
2040	42.52

Agricultural water demand = 21.90 mio m3/year



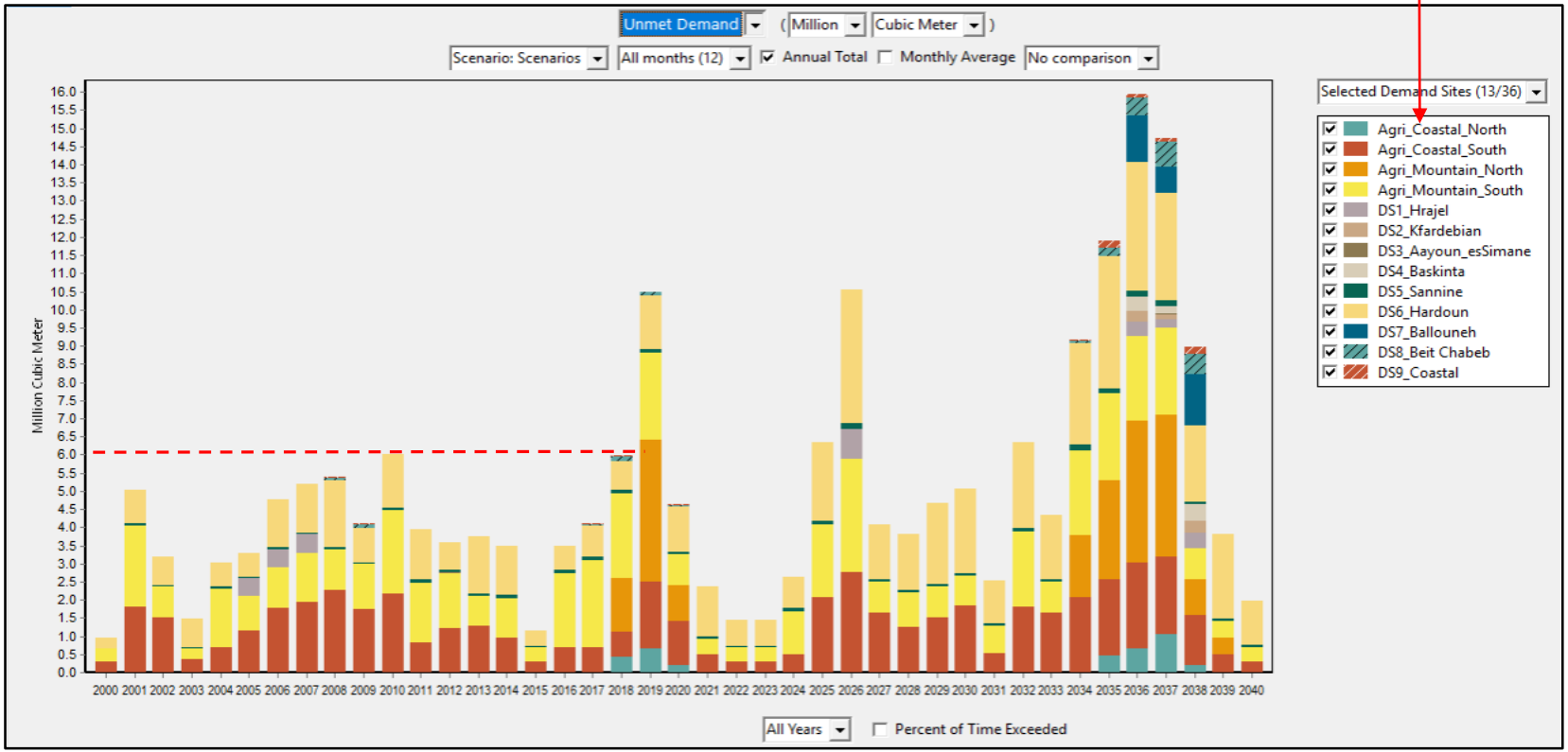
Fruit trees: 5,200 - 5,900 m3/ha/year; total area = 5,198 ha
Vegetables: 6,100 - 6,500 m3/ha/year; total area = 15,641 ha

Water resources management - water supply

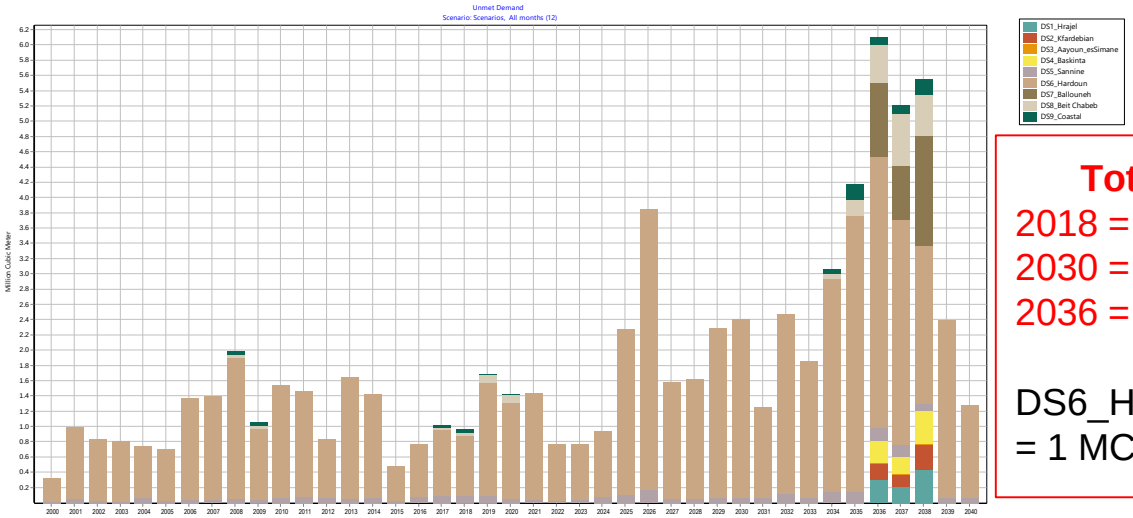


Unmet demand

Unmet Demands by Sector



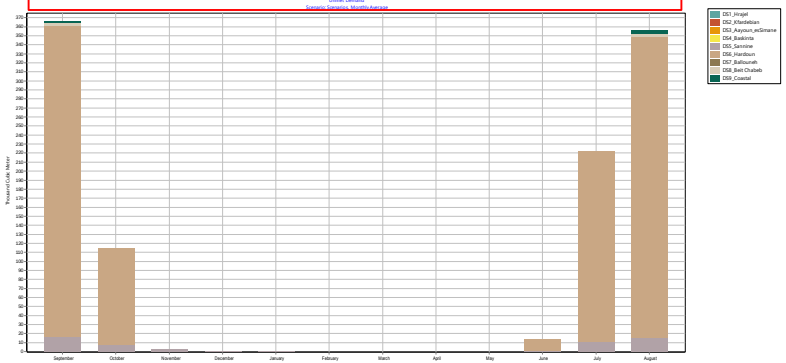
Unmet demand – urban sector (BaU scenario)



Total Annual
2018 = 0.96 MCM;
2030 = 2.4 MCM;
2036 = 6.1 MCM
[max]
DS6_Hardoun (avg. = 1 MCM → 2 MCM)

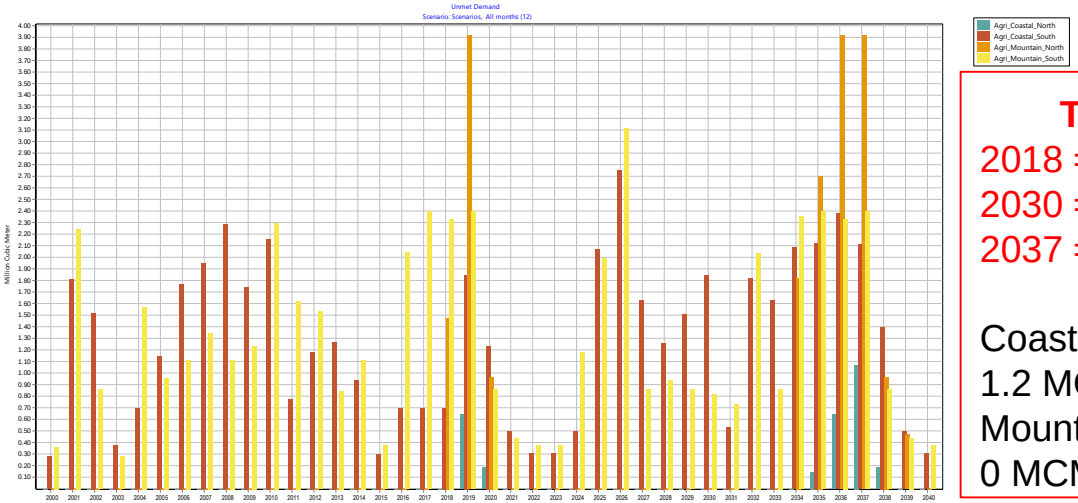
Month	% increase in 2018-2040
Sept	139 %
Oct	259 %
June	166 %
July	50 %
August	102 %
annually	*124%*

Monthly average 2000-2017



Monthly average 2018-2040

Unmet demand – agricultural sector (BaU scenario)



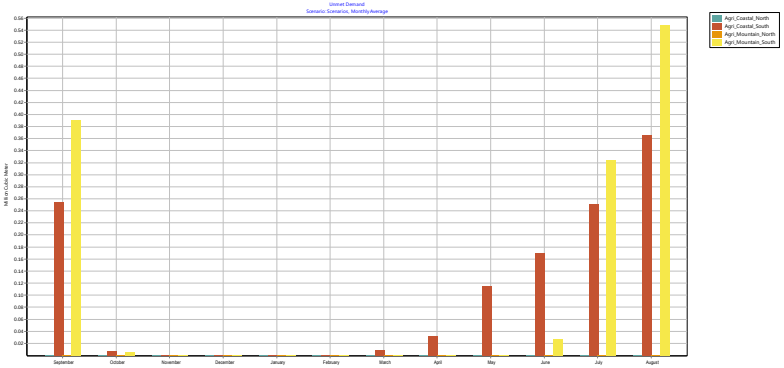
Total Annual

2018 = 4.5 MCM;
2030 = 2.7 MCM;
2037 = 9.5 MCM
[max]

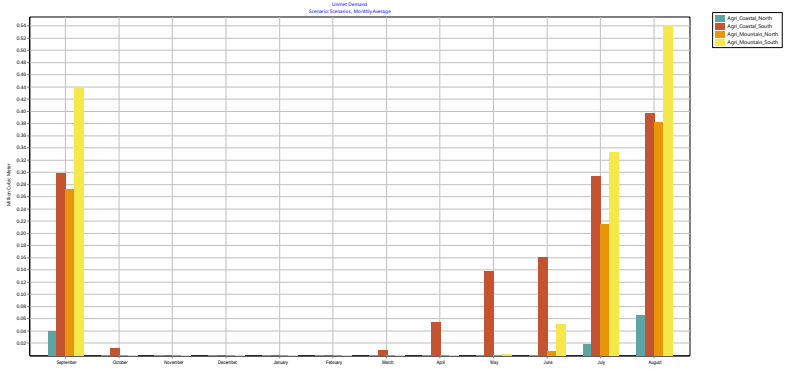
Coastal South (avg. = 1.2 MCM → 1.4 MCM)
Mountain North (avg. = 0 MCM → 0.9 MCM)

Month	% increase in 2018-2040
Sept	63 %
Oct	16 %
April	70 %
May	23 %
July	50 %
August	52 %
annually	*49 %*

Monthly average 2000-2017



Monthly average 2018-2040



Urban water saving scenarios (UrbSav)

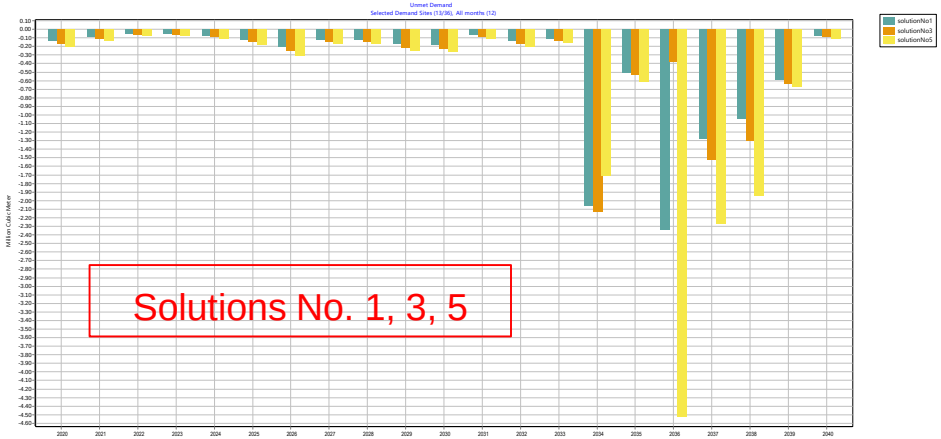
U1. Low water using fixtures and appliances (including hotels)

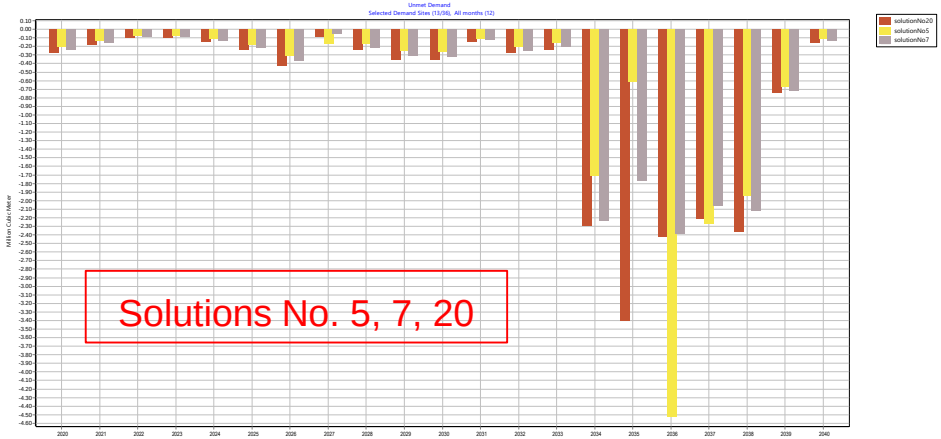
The measures have been applied in all the 9 urban demand nodes (187,849 inhabitants).
The measures have not been implemented in Beirut, since the target is to save water from the El-Kelb basin consumption so that more water could be available for Beirut

Solution No. #	Annual Equivalent Cost (AEC) per capita €	Water Saving per capita %	*Penetration (households adapting the measure)*				
			Dual flush toilet	*Shower-heads (1 item)*	*Low flow taps (2 items)*	*Efficient Washing Machine*	*Dish-washer*
1	2.8 €	5.10%		√			
3	7.5 €	6.73%		√	√		
5	10.8 €	7.60%	√	√			
7	15.5 €	9.23%	√	√	√		
20	43.3 €	10.63%	√	√	√	√	

Urban water saving scenarios (UrbSav)

Unmet Demand comparing UrbSav solutions to BAU





Reduction in unmet demand (water saving) when applying various UrbSav measures

All units in mio m3	**Total for 2020-2040**	**Mean Annual**	**Max potential**	**Min potential**	**Total AEC Cost (mio €)**	**€ / m3 of water saved**
Solution No.20	16.62	0.79	3.39	0.08	8.13	0.49
Solution No.5	14.09	0.67	4.52	0.06	2.03	0.14
Solution No.7	14.01	0.67	2.38	0.05	2.91	0.21
Solution No.1	9.39	0.45	2.33	0.04	0.53	0.06
Solution No.3	8.47	0.40	2.12	0.05	1.41	0.14

Urban water supply scenarios (UrbSav)

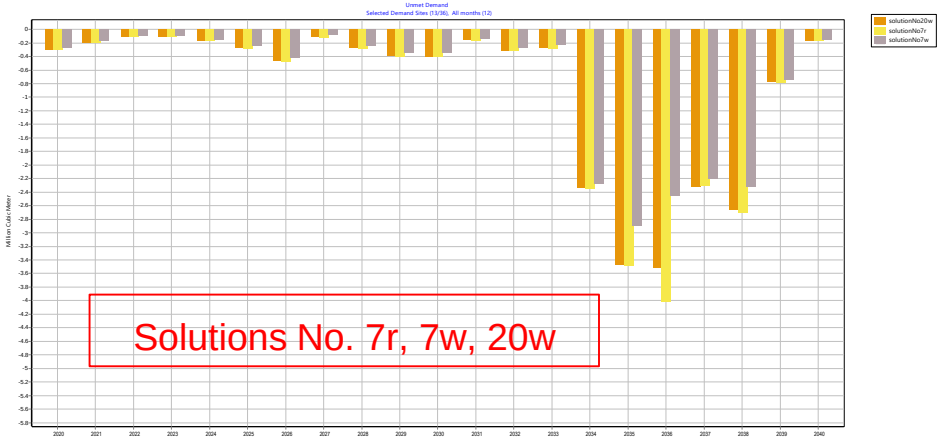
U2. Domestic greywater reuse (GWR) on-site; U3. Rainwater harvesting (RWH) on-site

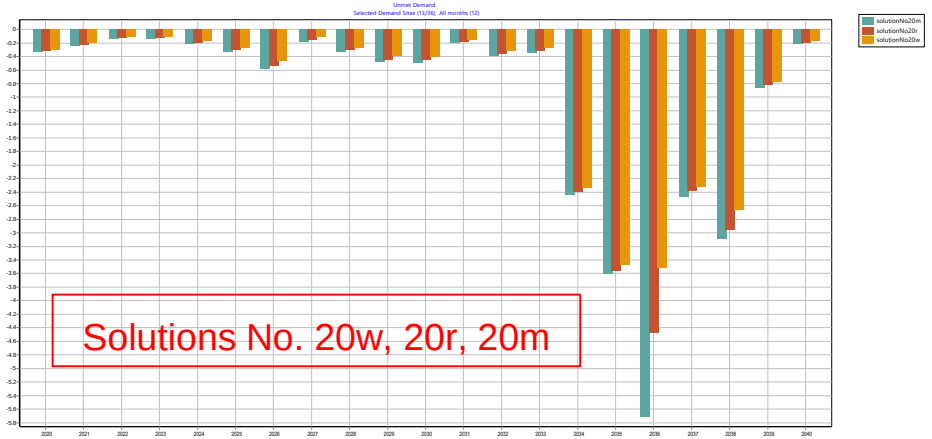
The measures have been applied in all the 9 urban demand nodes (187,849 inhabitants), and on top of the tier-1 water saving measures U1, i.e. in a “water efficient” house

Solution No. #	Annual Equivalent Cost (AEC) per capita €	Water Saving per capita %	*Penetration (households adapting the measure)*						
			Dual flush toilet	*Showerheads (1 item)*	*Low flow taps (2 items)*	*Efficient Washing Machine*	*Dishwasher*	*Rainwater Harvesting*	*Greywater Reuse*
7r	104.5 €	12.13%	√	√	√			√	
7w	140.0 €	10.38%	√	√	√				√
20r	132.3 €	13.53%	√	√	√	√		√	
20w	167.8 €	11.78%	√	√	√	√			√
20m	256.8 €	14.68%	√	√	√	√		√	√

Urban water supply scenarios (UrbSup)

Unmet Demand comparing UrbSup solutions to BAU





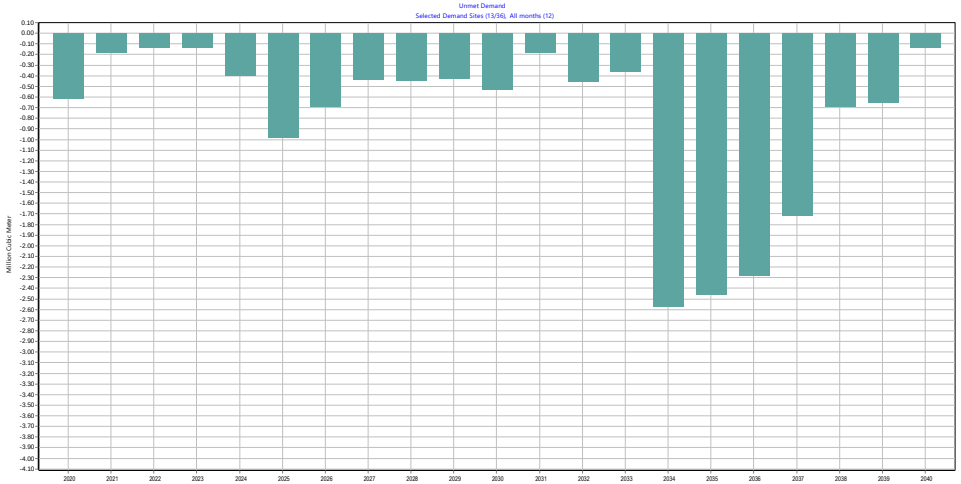
Reduction in unmet demand (water saving) when applying various UrbSup measures

All units in mio m3	**Total for 2020-2040**	**Mean Annual**	**Max potential**	**Min potential**	**Total AEC Cost (mio €)**	**€ / m3 of water saved**
Solution No.20m	22.59	1.08	5.71	0.12	48.24	2.14
Solution No.20r	20.66	0.98	4.47	0.11	24.85	1.20
Solution No.7r	19.30	0.92	4.01	0.10	19.63	1.02
Solution No.20w	18.61	0.89	3.50	0.10	31.52	1.69
Solution No.7w	15.99	0.76	2.89	0.07	26.30	1.64

Agricultural water saving scenarios (AgrSav)

A1. Increase conveyance efficiency (reduce leakage) and irrigation efficiency (change to drip irrigation)

The measures have been applied in all the 4 agricultural demand nodes
- Switch to 70% drip irrigation (**irrigation efficiency gains 7,5-12%;** new @ 84%)
- Reduced network losses by switching to 70% closed pipes (**conveyance efficiency gains 8-11%**; new @ 84.5%)

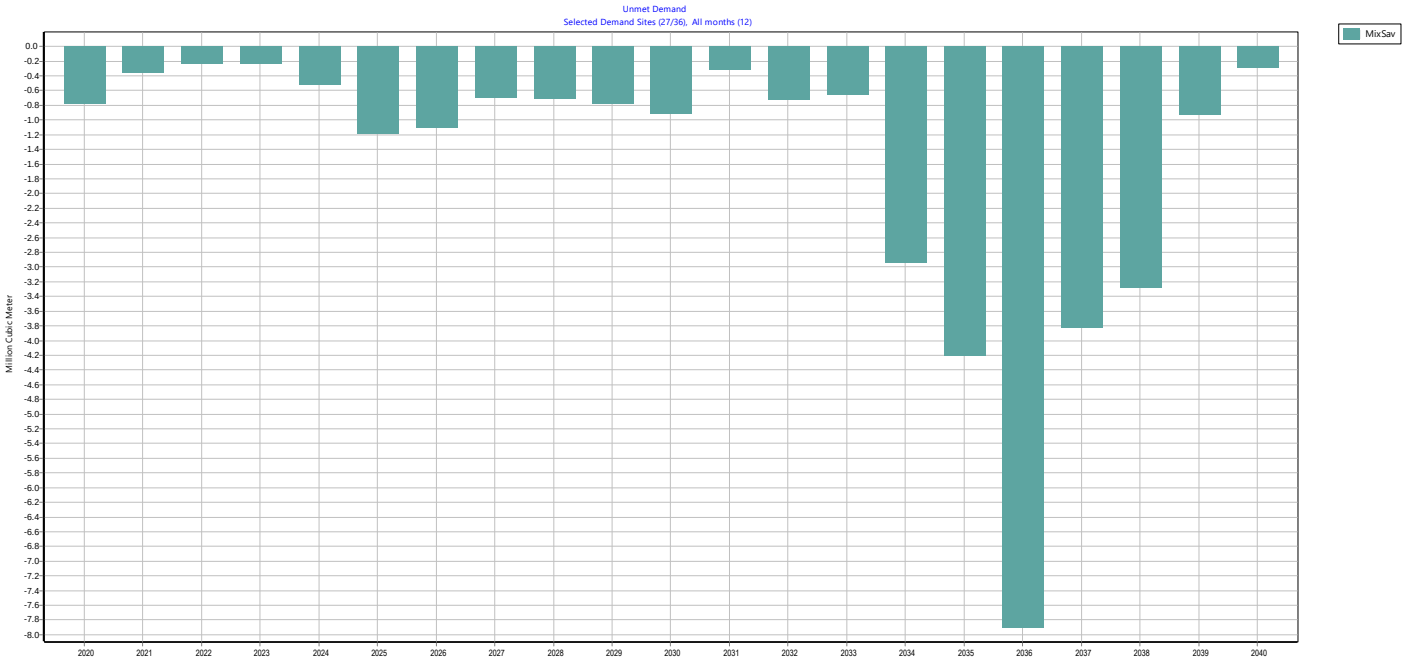


All units in mio m3

Total for 2020-2040	Mean Annual	Max potential	Min potential
16.37	0.78	2.57	0.13

Total AEC Cost (mio €)	€ / m3 of water saved
1,272,862 €	0.08

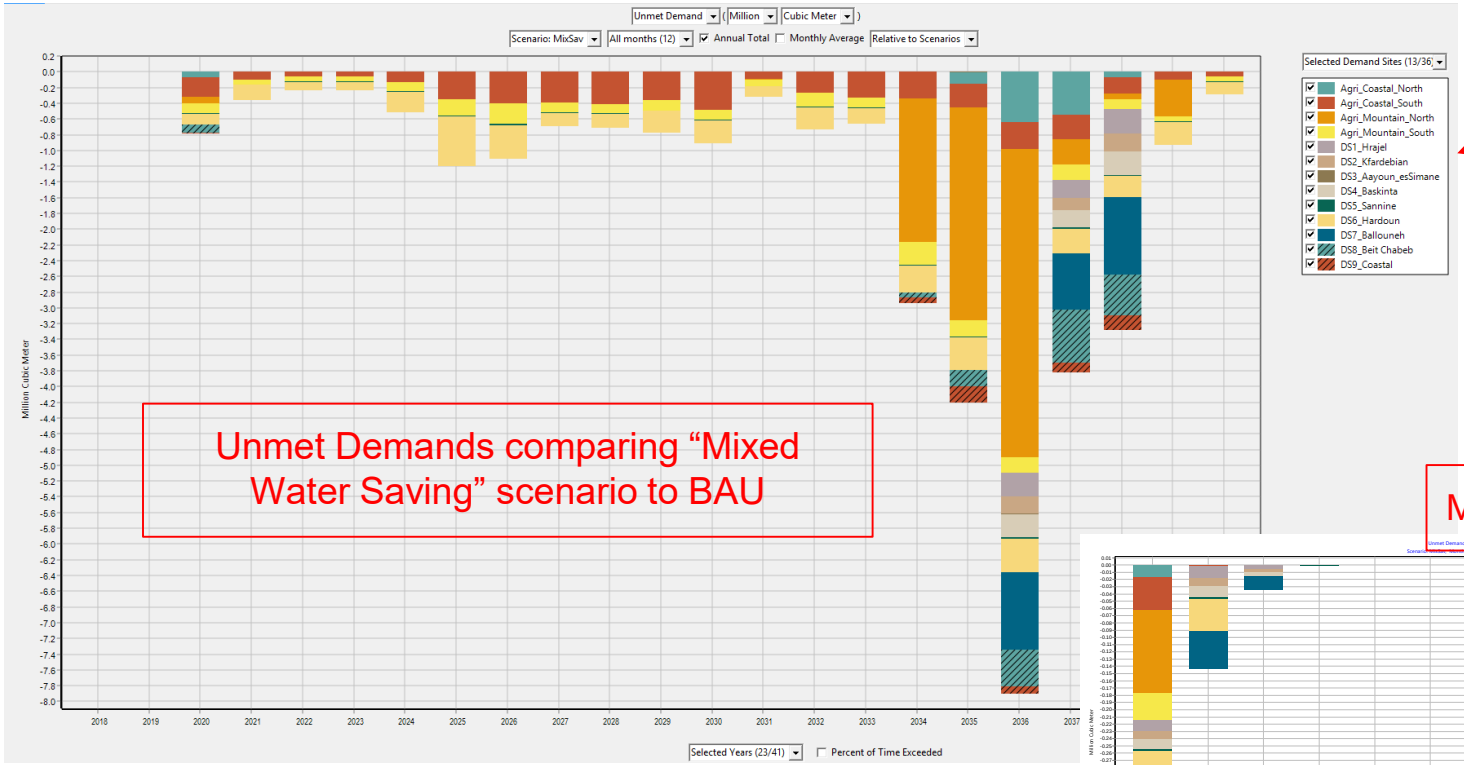
Mix water saving scenarios (UrbSav solution No.20 + AgrSav)



All units in mio m3

Total for 2020-2040	Mean Annual	Max potential	Min potential
32.37	1.54	7.89	0.22

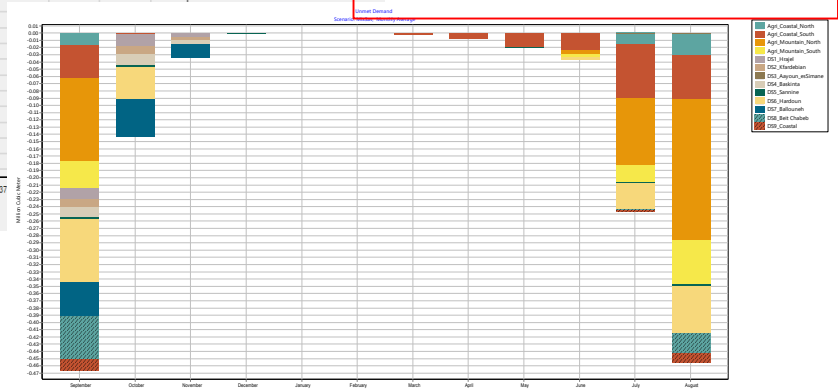
Mix water saving scenarios (UrbSav solution No.20 + AgrSav)



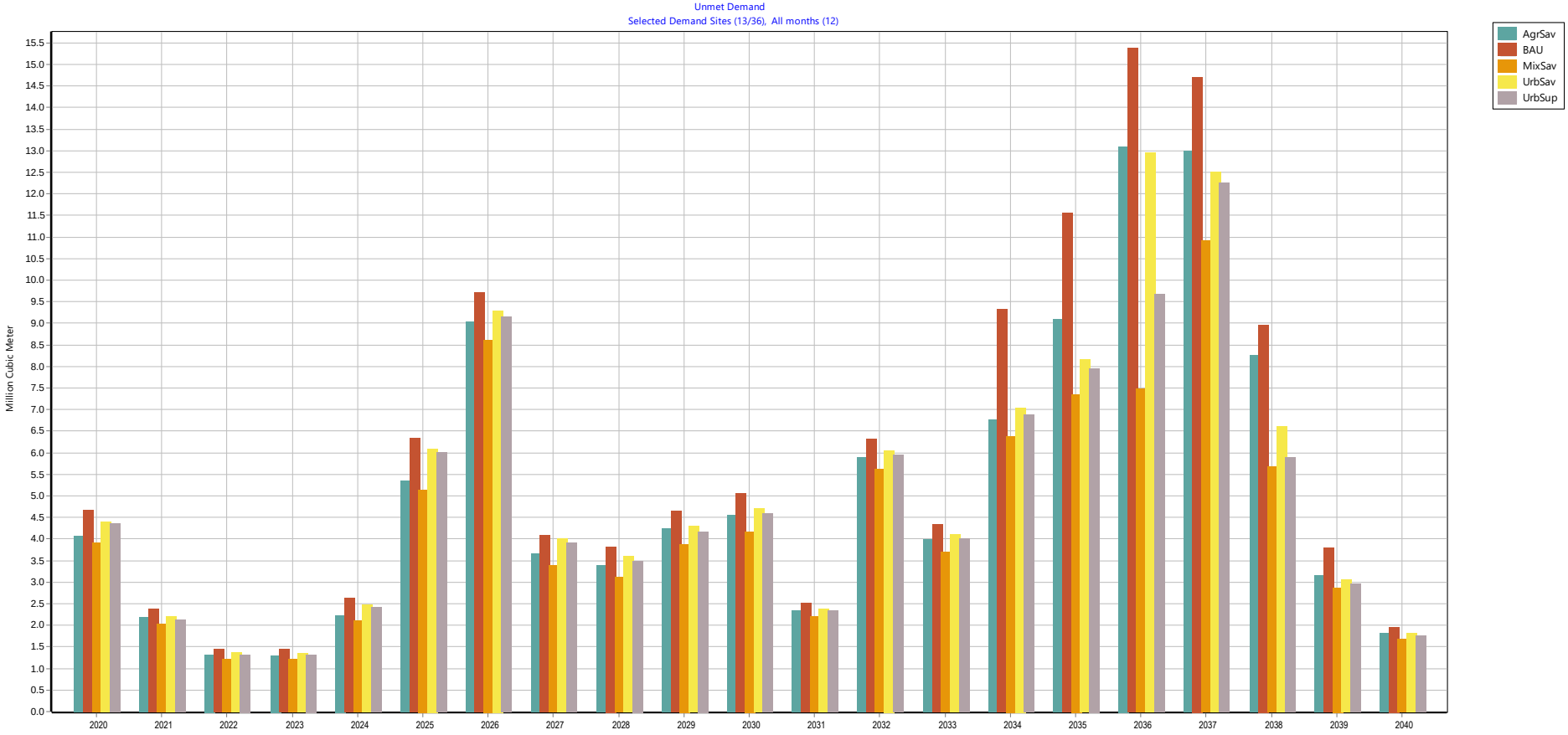
Unmet Demands by Sector

Unmet Demands comparing "Mixed Water Saving" scenario to BAU

Montly average 2020-2040



Unmet Demand 2020-2040 under different scenarios and the BaU

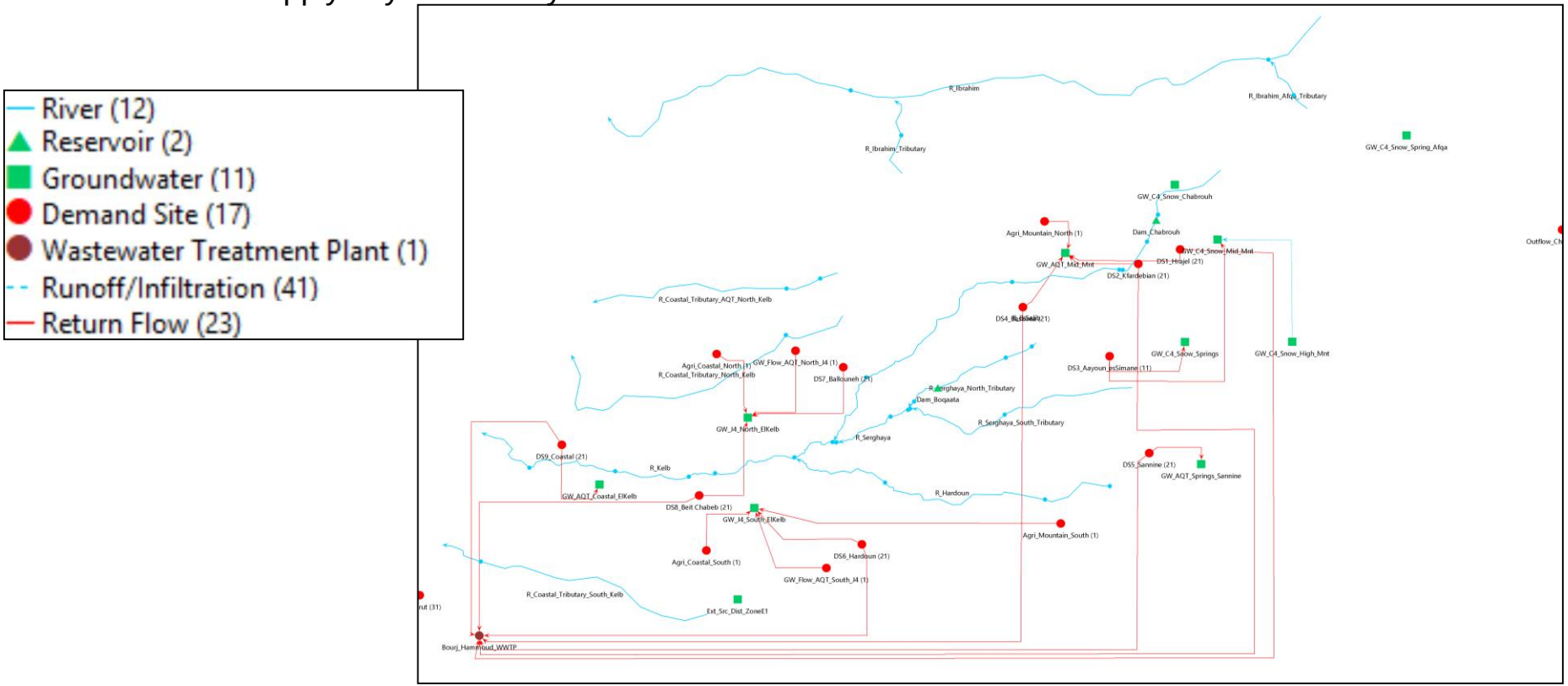


Implementation of the Bourj-Hamoud WWTP

<u>Assumptions</u>:

WWTP capacity: expected to serve 2.2 million PE ; 200 lt per capita ➔ Estimated capacity ~0.5million m3/day

Not connected to supply any demands yet

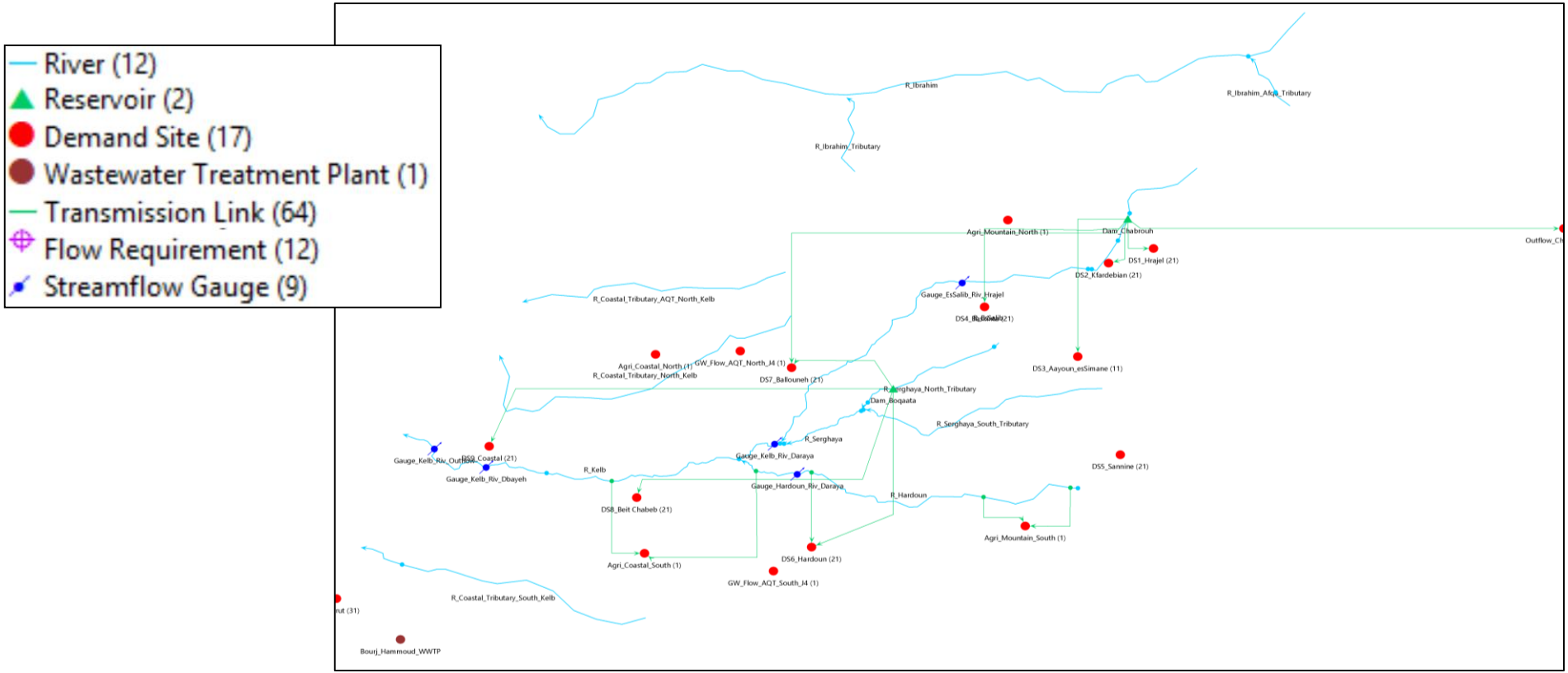
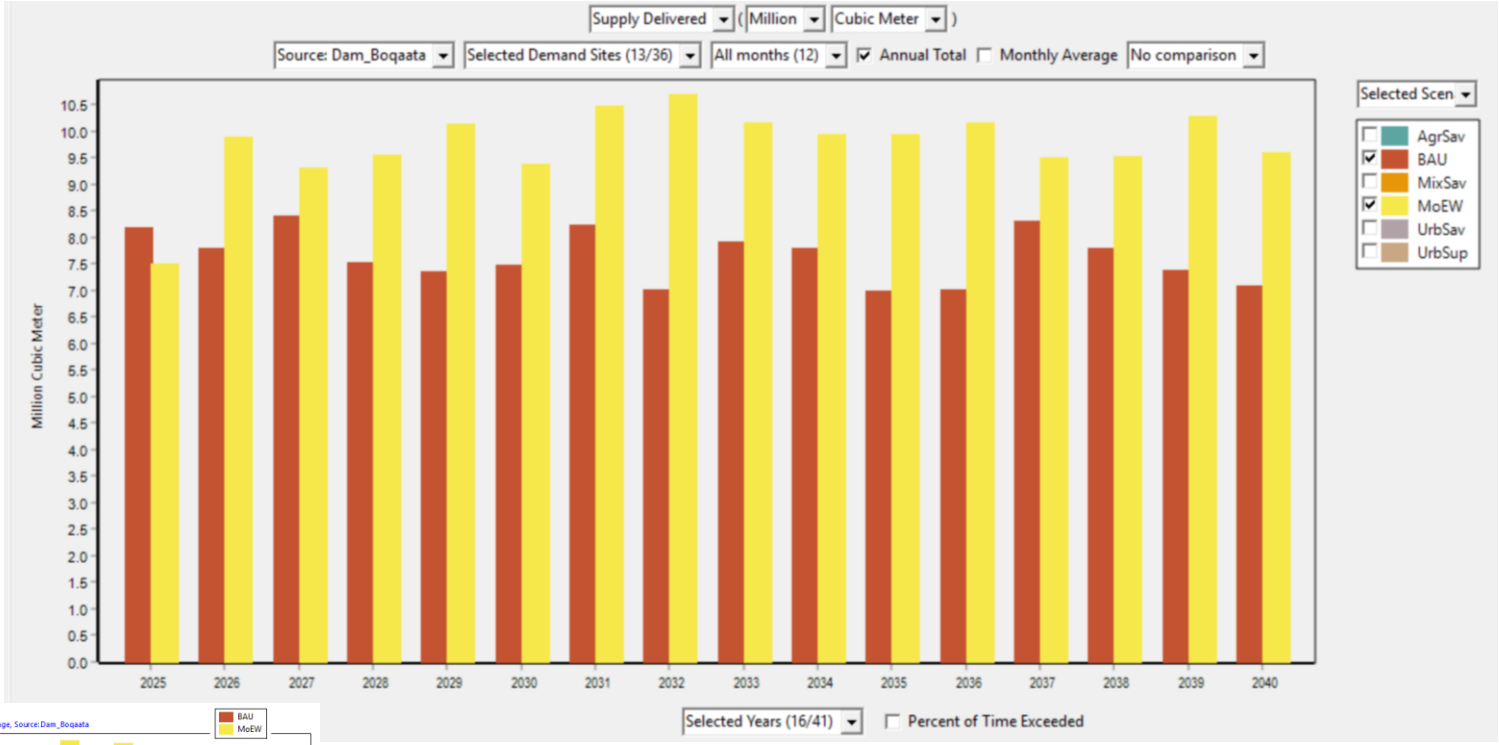
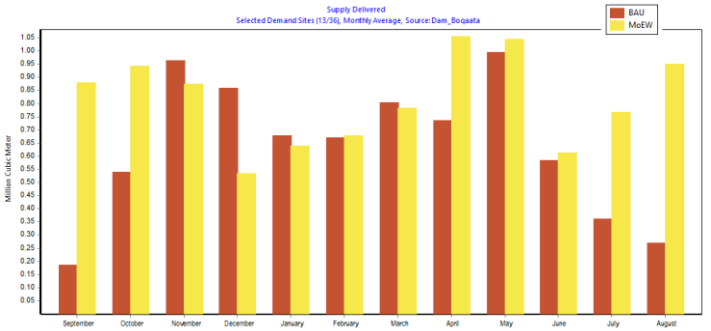


Implementation of the Boqaata Dam

<u>Assumptions</u>:

It is set to be operational in the model in 2025. Storage capacity 6 MCM.

Expected supply 5-10 MCM per year



Supply Delivered to all demand sites (agri + urban) from the Boqaate Dam (scenario MOEW)