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WEAP model for the disaggregation of SDG 6.4.2 (Level of water stress) : Case of the Cap Matifou sub-basin (Algeria)

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Plan

1. Introduction and background
2. Presentation of the study area and data
3. Water demand vs Water resources
4. Hydrological calibration - Operational model calibration
5. Development of scenarios to calculate the water stress
6. Water stress level by sub-basin
7. Conclusion

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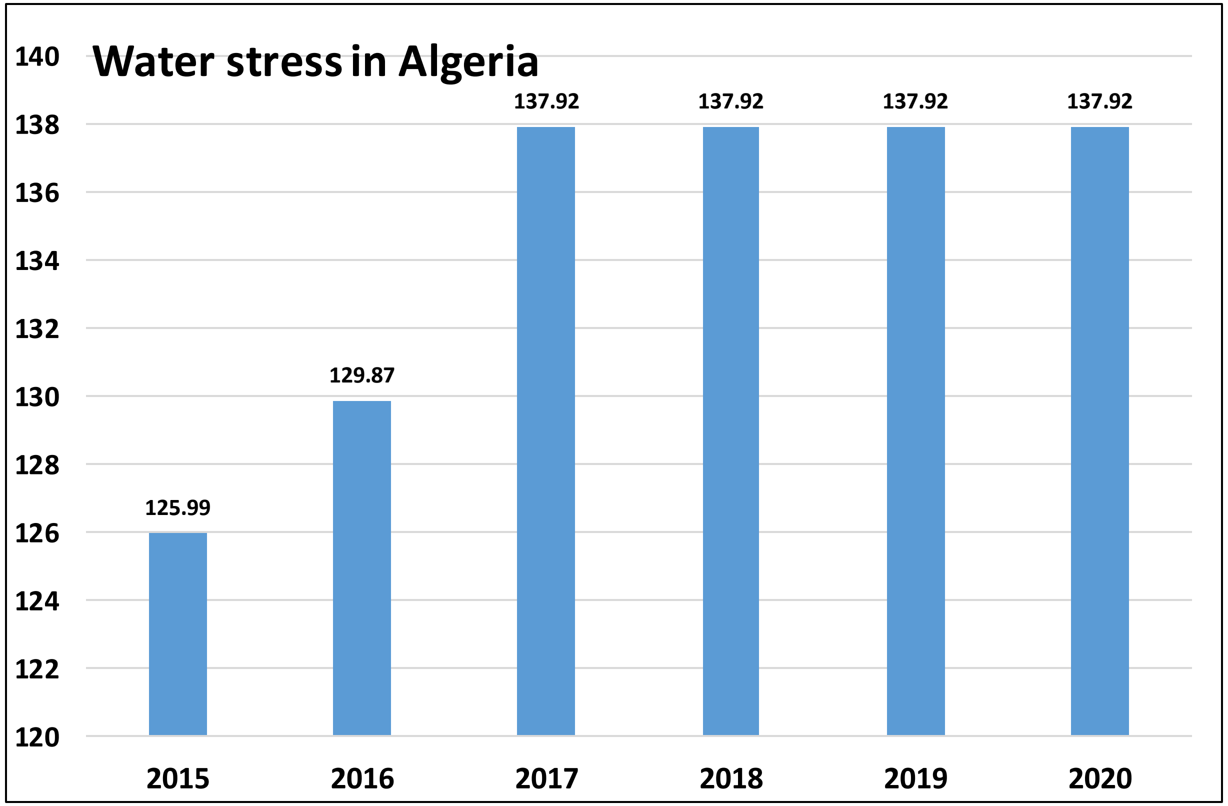
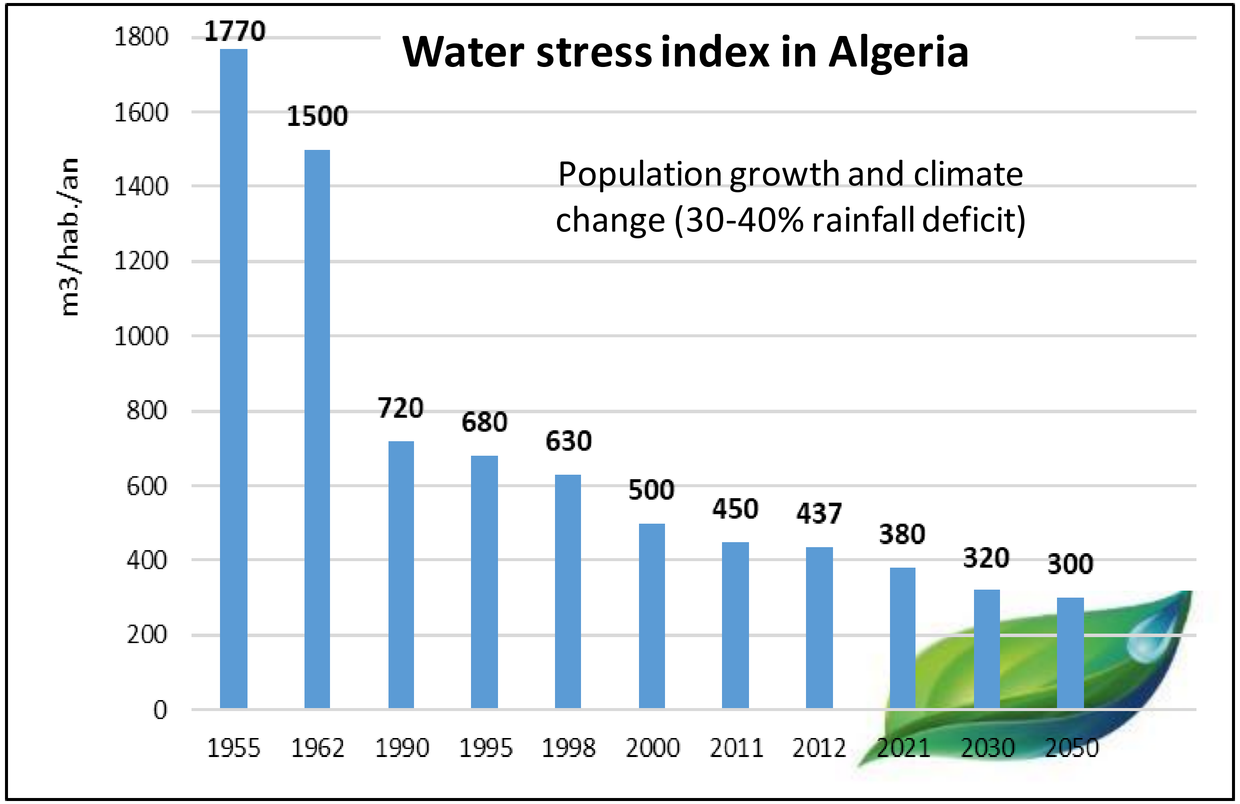
1. Introduction and background

- In Algeria, as in the whole NENA countries, water is becoming increasingly scarce with an average water endowment 380 m^3/capita/year in 2021 due to population growth, climate change and rainfall deficits. For every **1°C** increase in temperature, a decrease in surface runoff and an increase in ET is expected.

The **water stress has reached 138 % in 2020, but what's the situation at the sub-basin level ?**





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2. Presentation of the study area and data

- The Cap Matifou sub-basin (**795.7 km²**) is part of the Algerian coastal basin (02a) and is crossed by several wadis (Hamiz, Boudouaou, Keddara, Arrara ... etc.). The sub-catchment area covered and modeled with WEAP is **636.5 km²**

- Irrigation scheme of Hamiz: **2279 ha** irrigated in 2019, i.e. **20.5%** of the irrigable potential and about **15670** ha irrigated in PMH.

- A wetland (Lake Réghaïa) classified Ramsar since 2003, hence the environmental need.

- Spread between 4 wilayas, with over **1.5 million inhabitants**.

- Cap Matifou suffers from pollution, marine intrusion and overexploitation.

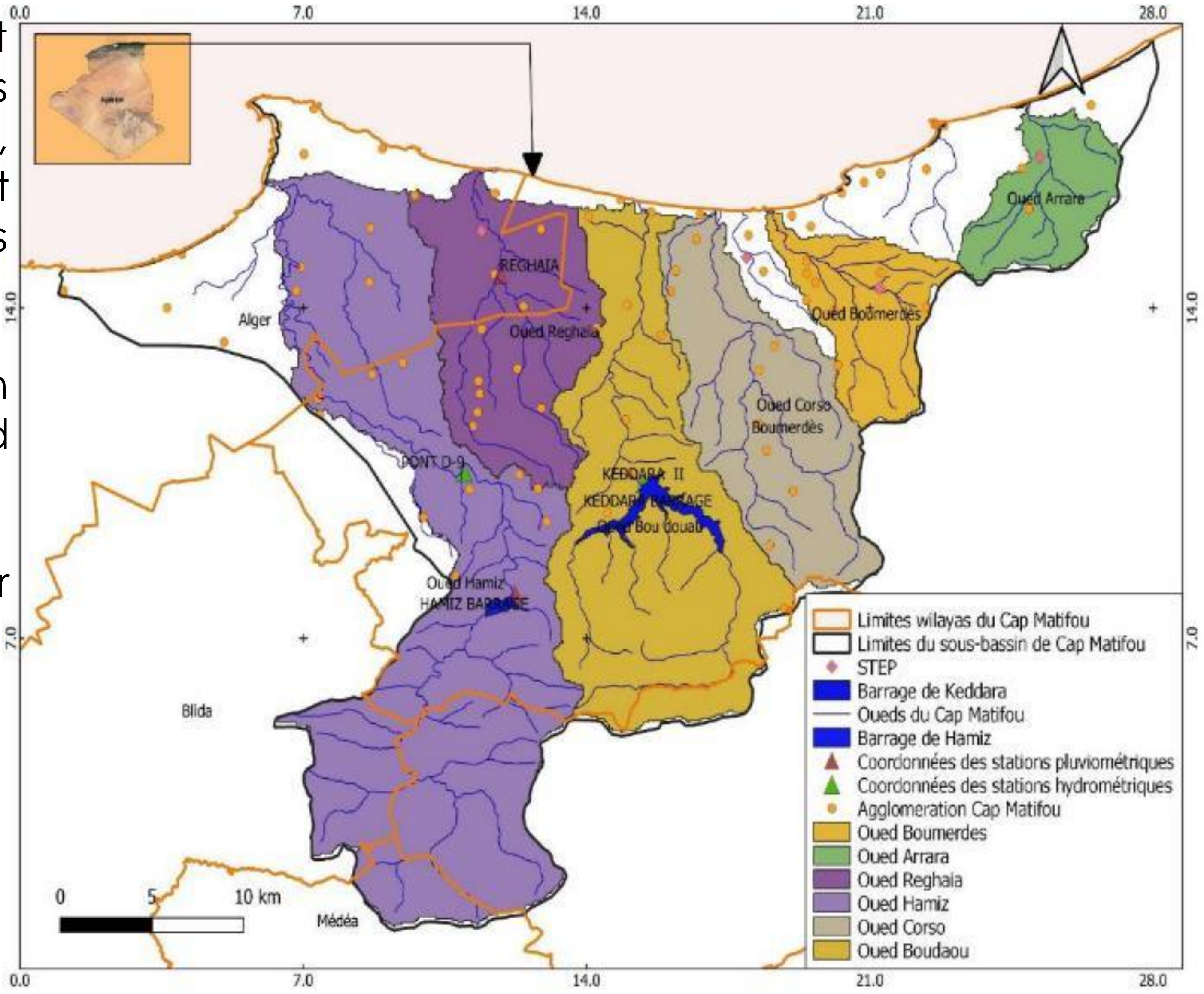

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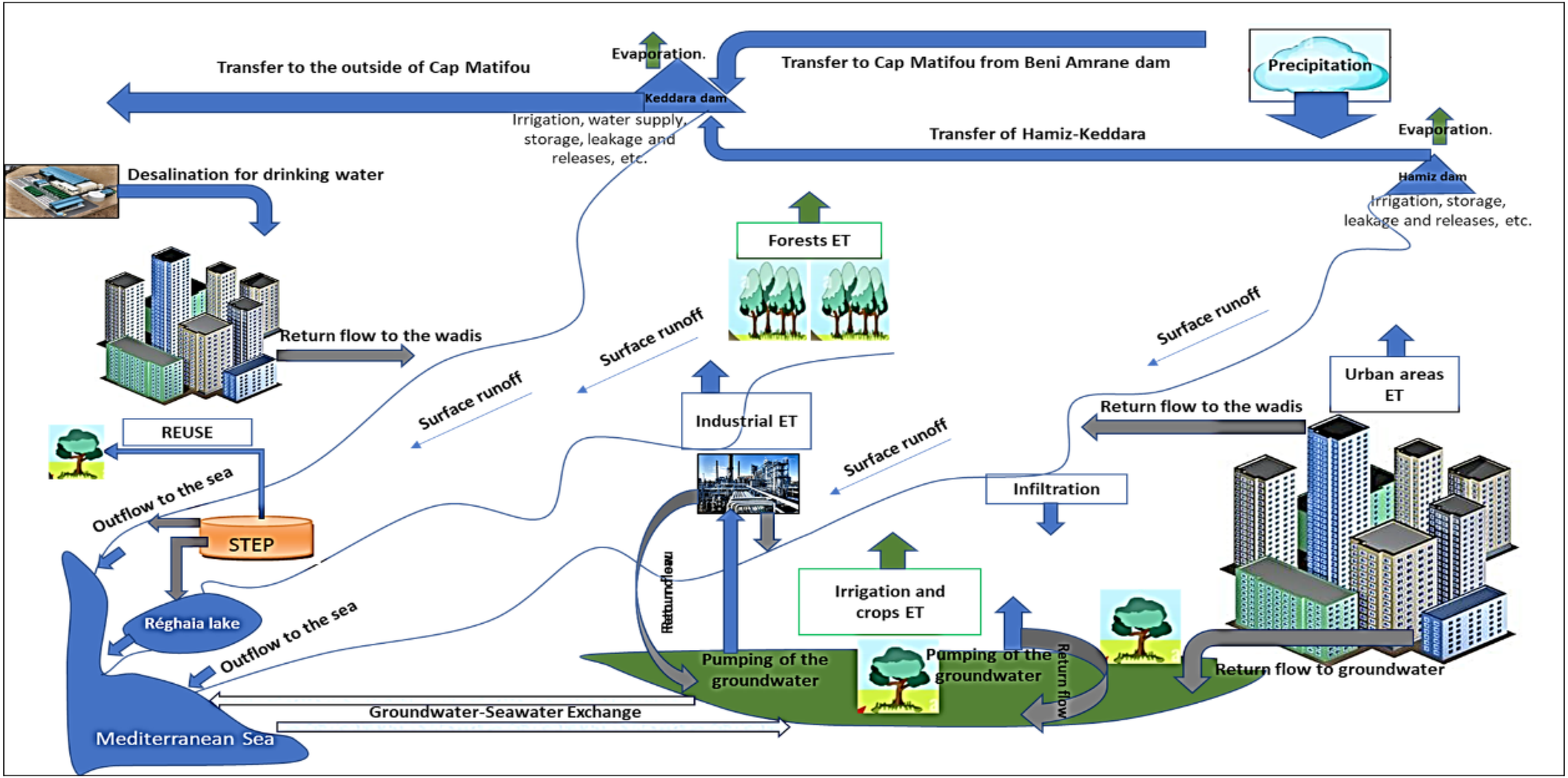
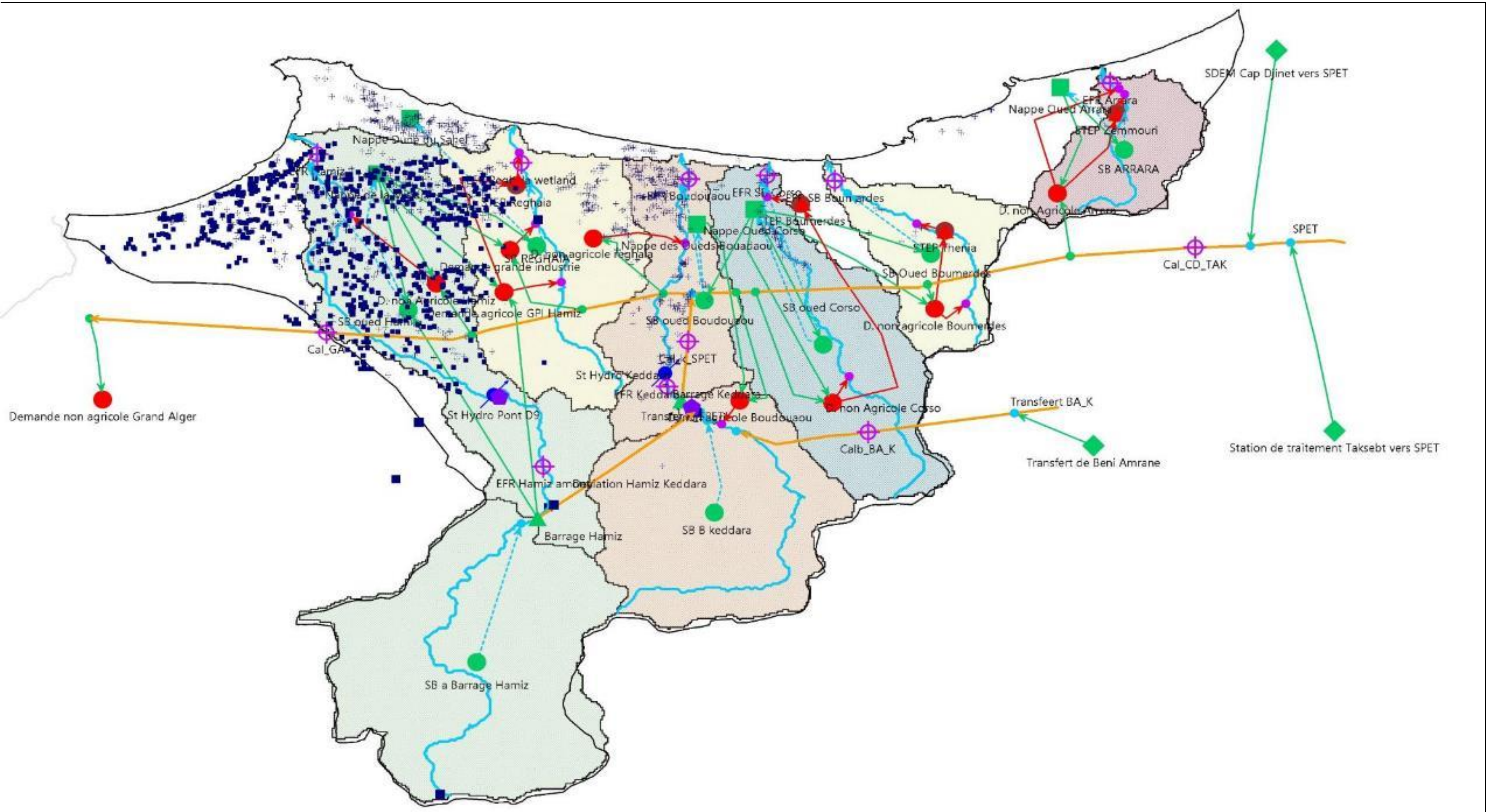
Diagram of the water flows in Cap Matifou and RIDA approach





SDEM Cap Djinet vers SPET
Nappe Oued Arrara
EFR Arrara
STEP Zemmouri
SB ARRARA
SPET
Cal_CD_TAK
STEP Thenia
SB Oued Boumerdes
D. non agricole Boumerdes
EFR SB Boumerdes
STEP Boumerdes
Nappe Oued Corso
SB oued Corso
D. non Agricole Corso
Transfeert BA_K
Calb_BA_K
Transfert de Beni Amrane
Station de traitement Taksebt vers SPET
SB B keddara
Barrage Hamiz
SB a Barrage Hamiz
St Hydro Pont D9
Demande non agricole Grand Alger
Cal_GA
Demande agricole GPI Hamiz
St REGHAIA
Nappe des Oueds Boudouaou
SB oued Boudouaou
Cal_K_SPET
St Hydro Keddara
Barrage Keddara
Nappe Dune du Sahel

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Model data sources :

- Data/information from water institutions (MRESH, AGIRE, ABH, ANRH, ONID, ANBT...etc.)

- Sectoral water planning studies: National Water Plan(PNE) (2007, 2010 and 2018), water resources master plan (PDARE), PMH inventory study (SOGREAH, 2009), sectoral project studies...etc.

- Remote sensing data when in situ measurements are not available.

- Processing of Rasters statistics from several products, in particular to determine the land use closest to both reality and water institution inventories.

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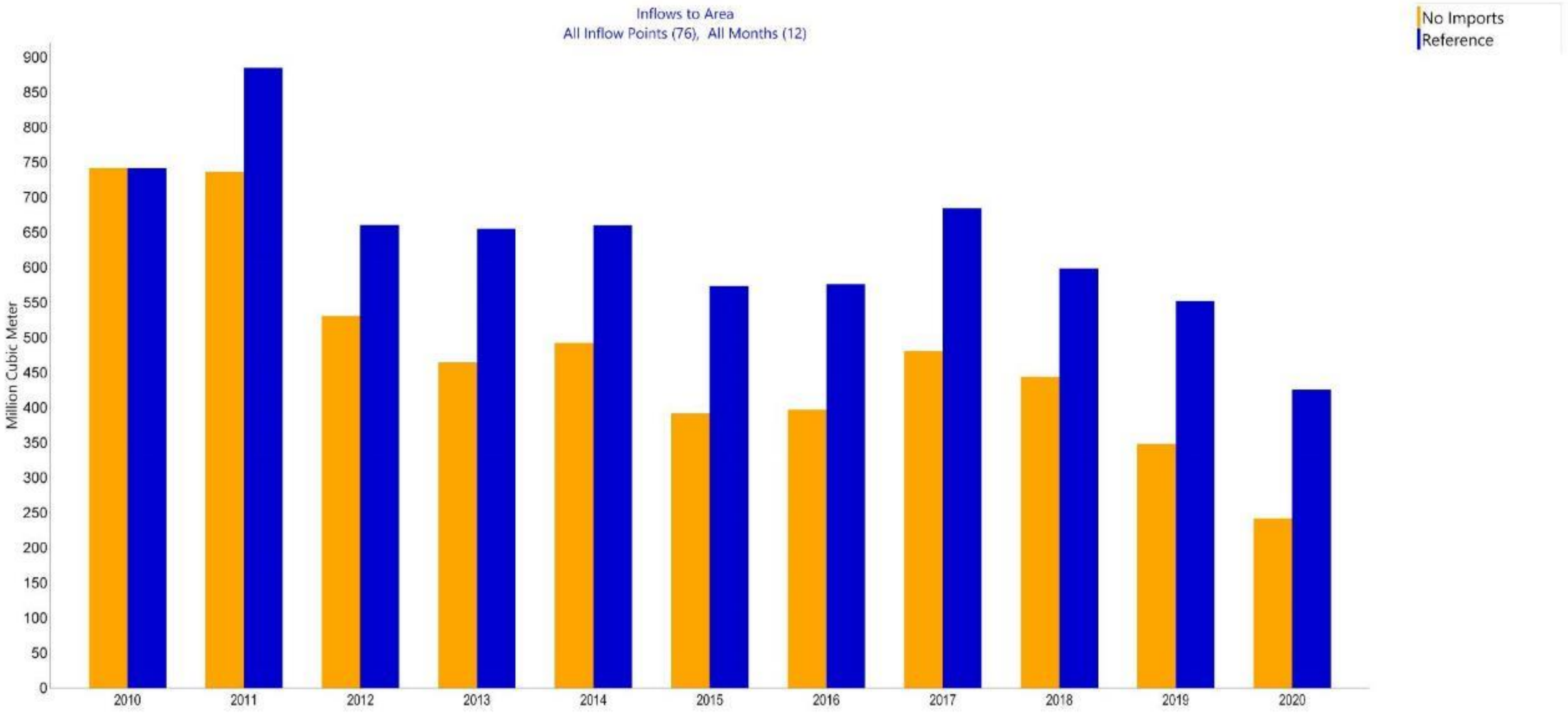
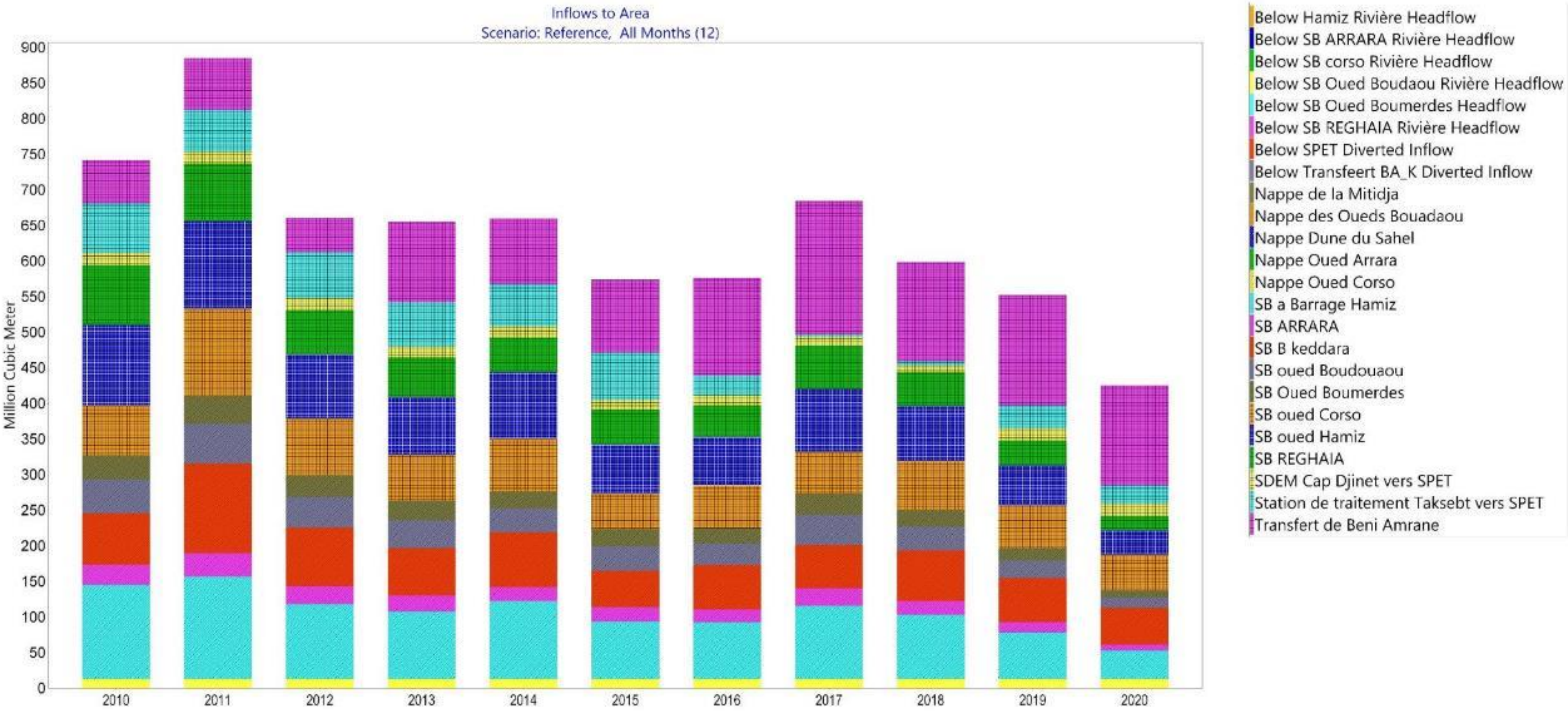
3. Water demand vs Water resources



3. Water demand vs Water resources



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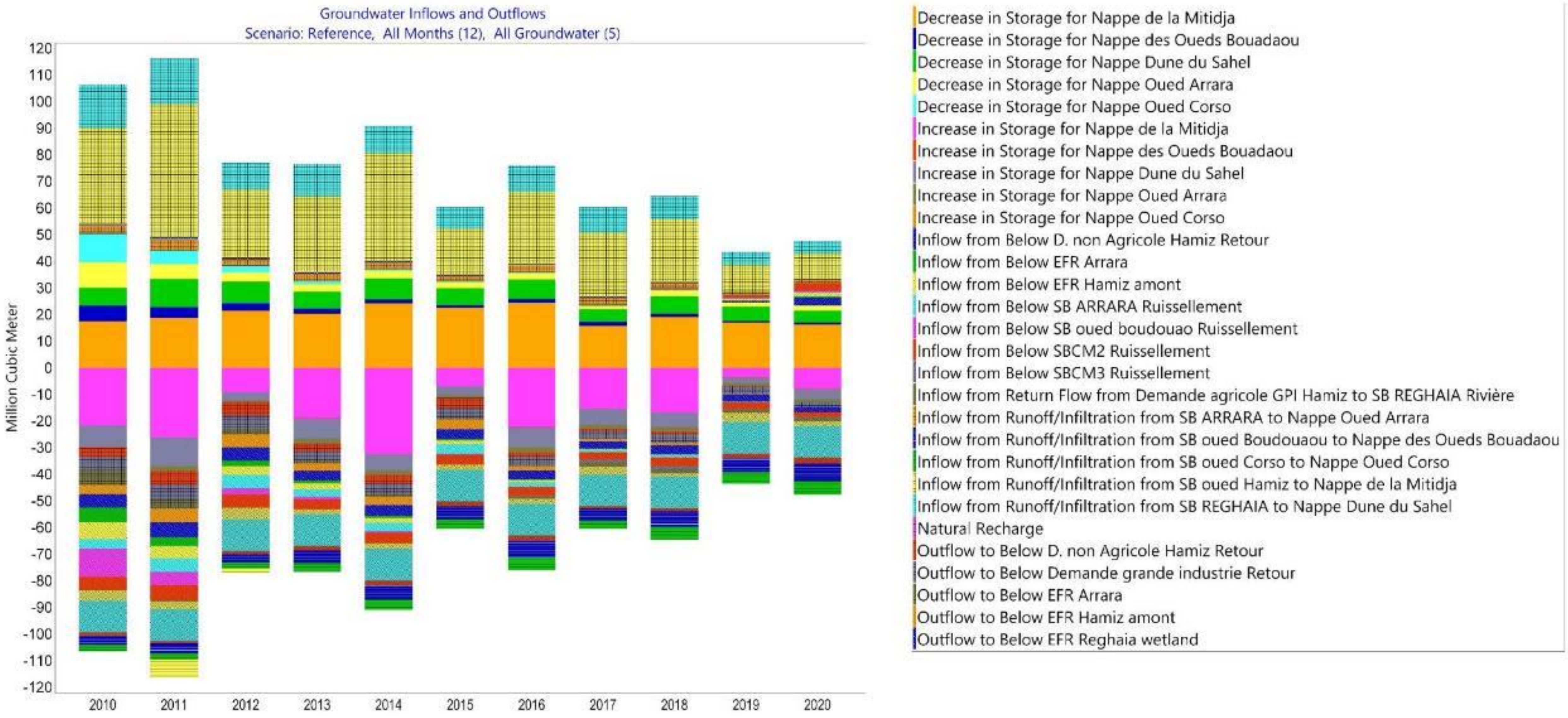
3. Water demand vs Water resources



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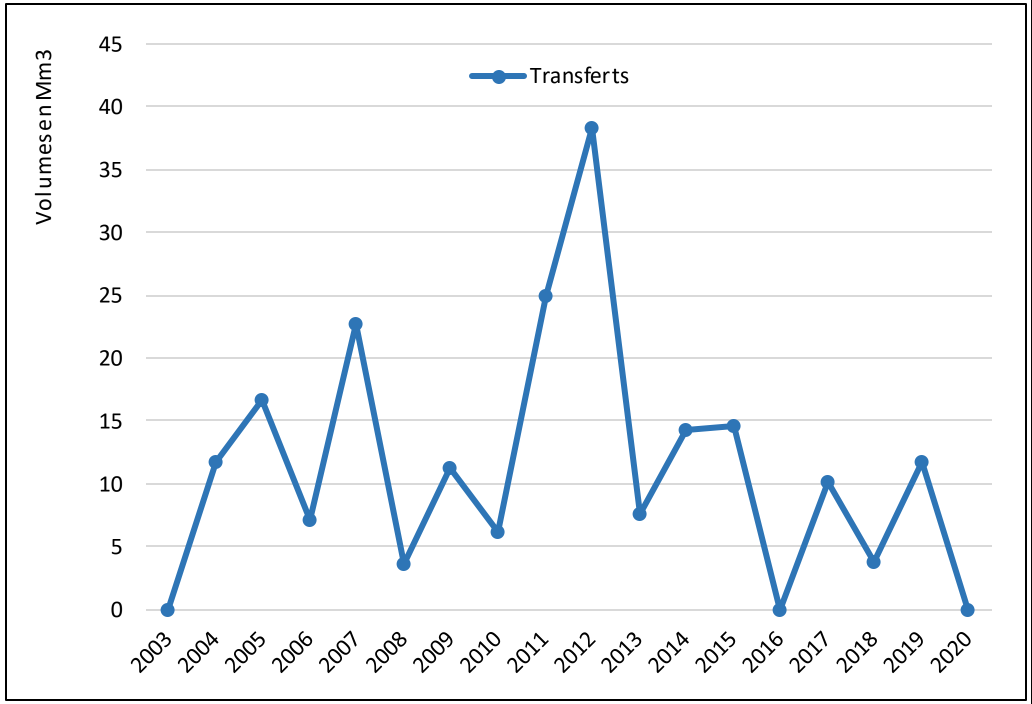
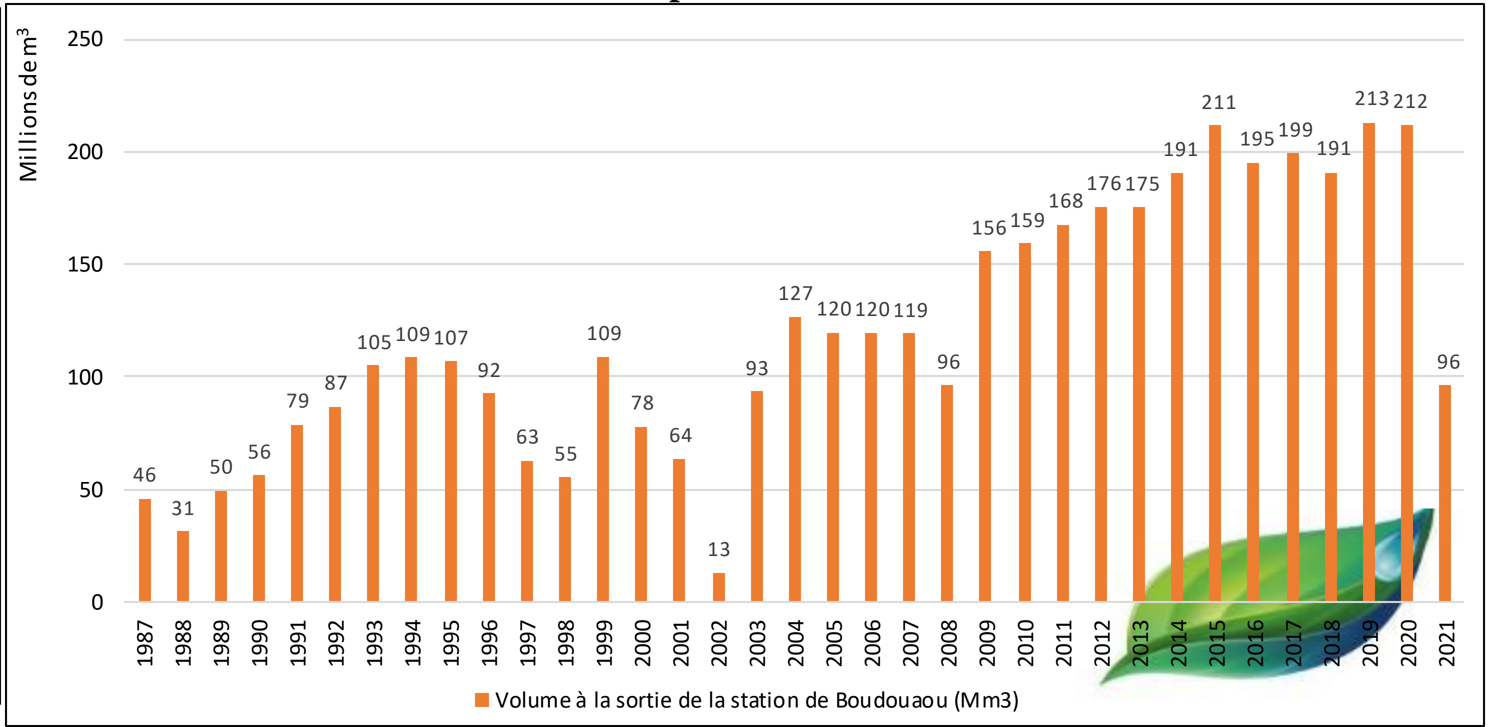
	OUED ARARA (40,12 Km^2) Recharge in Mm^3	OUEDI CORSO (3.7 Km^2) Recharge in Mm^3	OUEDI BOUDOUAOU (11,2 km^2) Recharge in Mm^3	MITIDJA ALLUVIAL PLAIN (214 km^2) Mitidja Recharge in Mm^3
Average annual groundwater recharge (Mm3) (ENERGOPROJEKT, 2009)	0.37	0.42	1.43	31.09
Annual average (2009 to 2022) (our calculations)	3,4	0.11	1,62	32,85

Water transfers to the Keddara dam (2004 to 2019)



Water production at the Boudouaou plant between 1987 and 2007. Between 2008 and 2021, volume of water produced from SPIK and SPET



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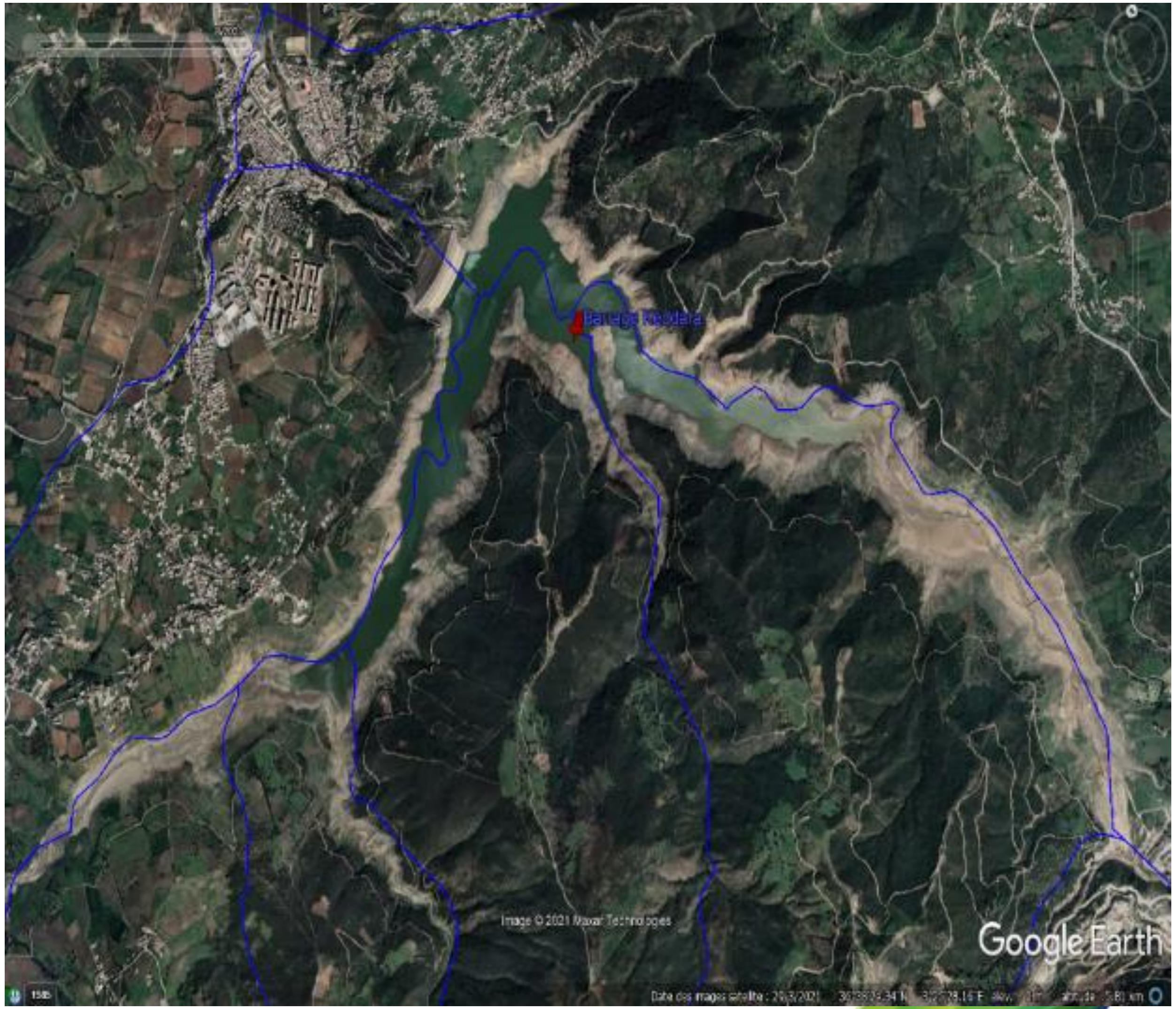

Drought impact on Keddara dam filling 28/02/2008 (left) and 29/03/2021 (right)

Source : photos de Google Earth du 05 août 2021.

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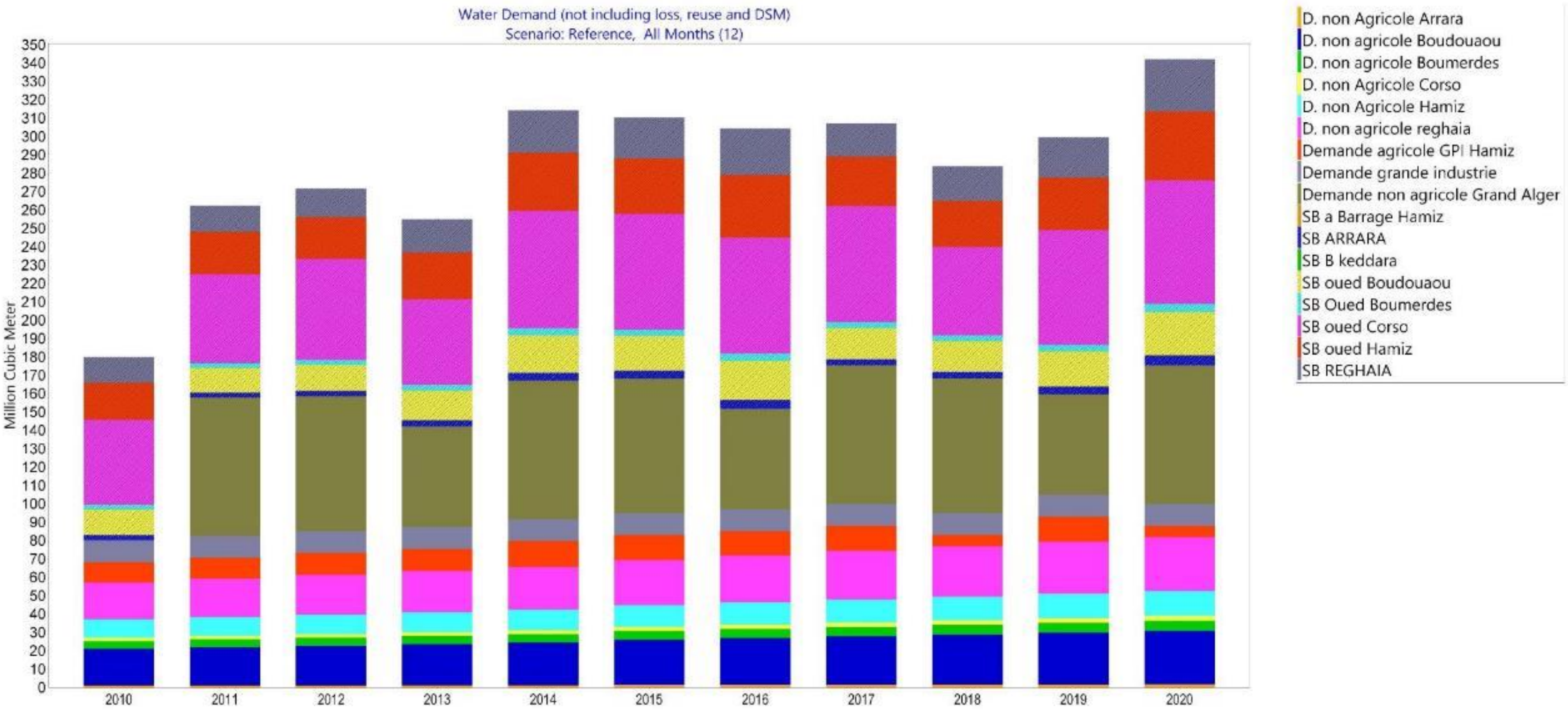
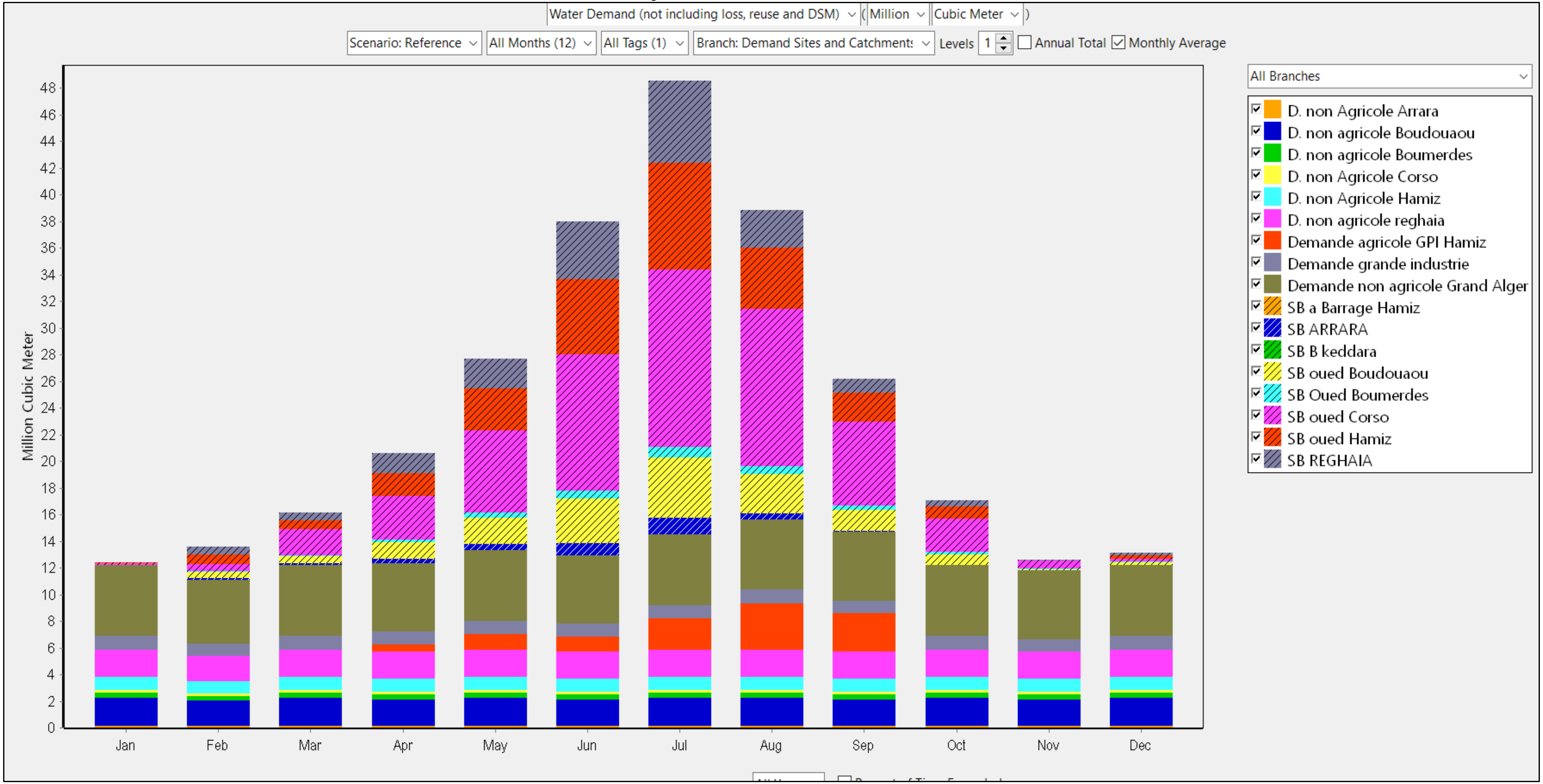
Water demand and use



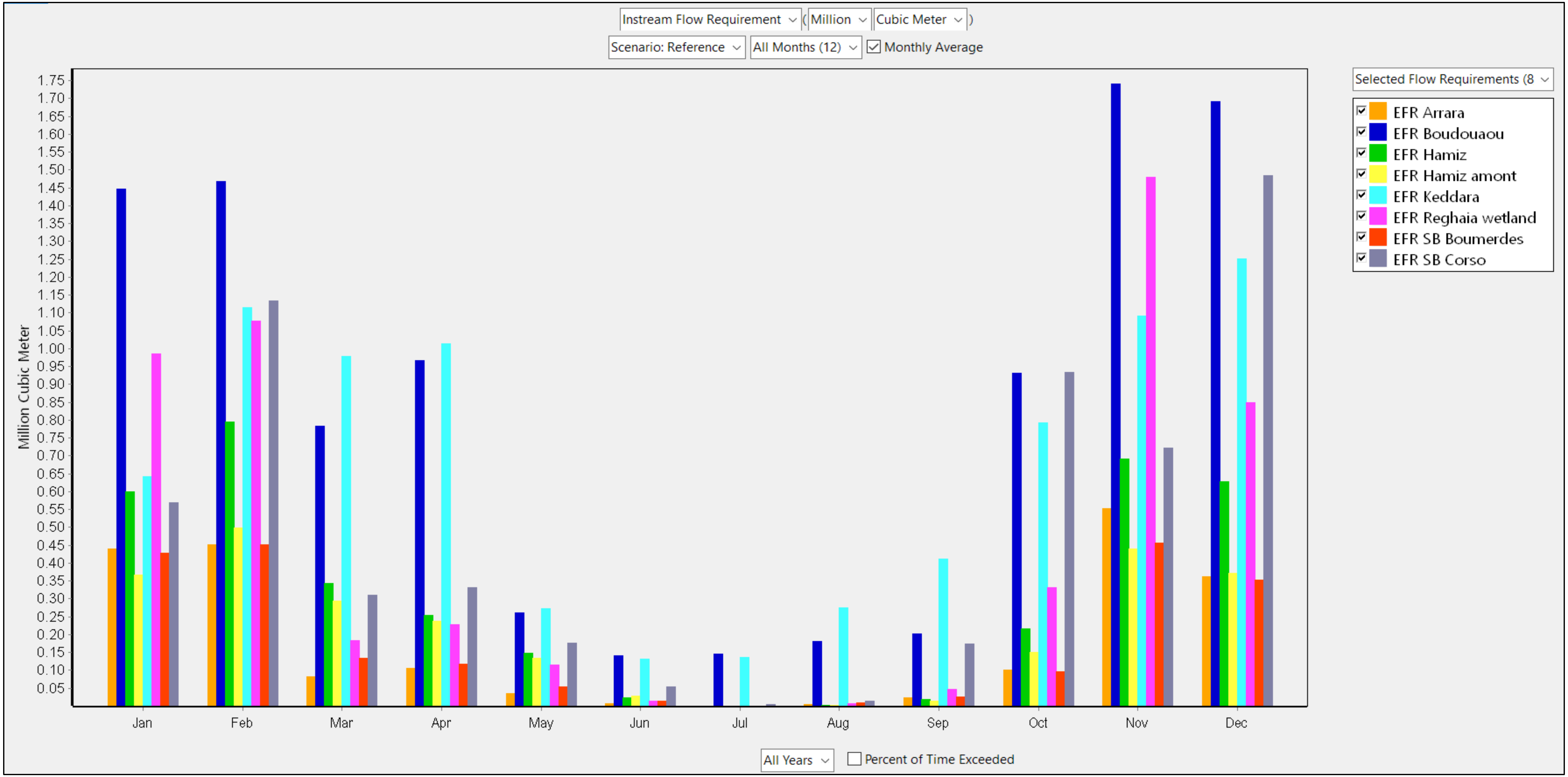
Water demand and use

Demand by month



Water demand and use

Environmental flows



Water uses

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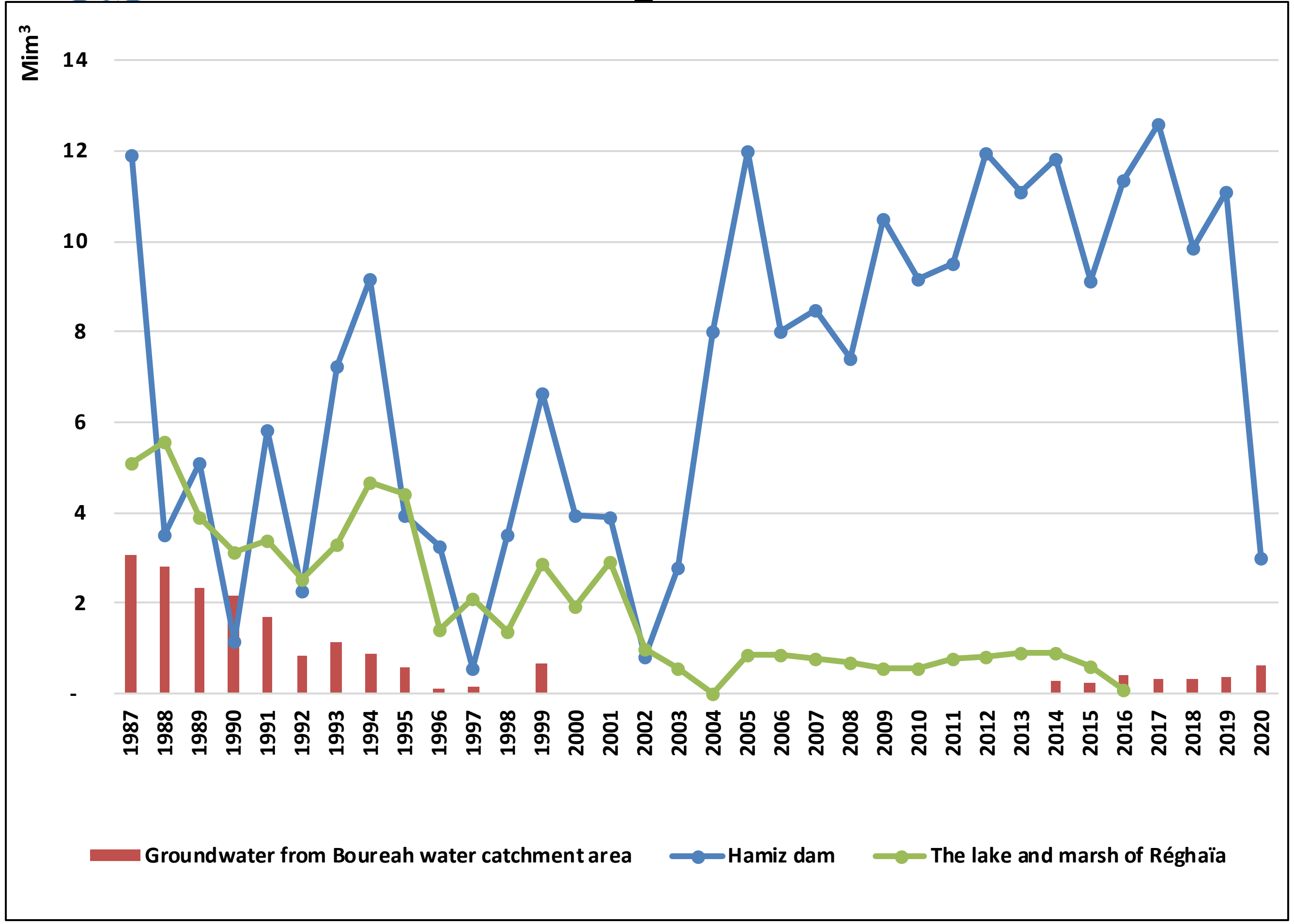
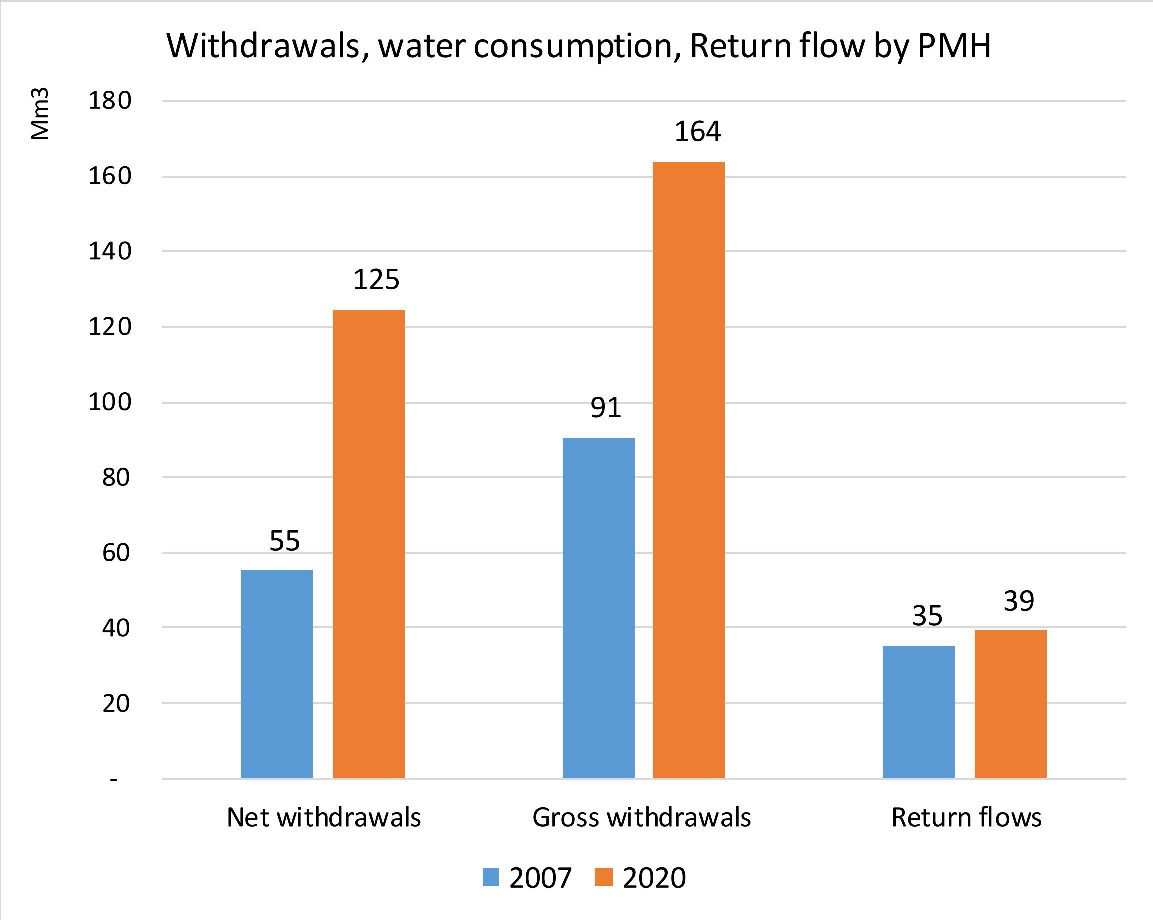
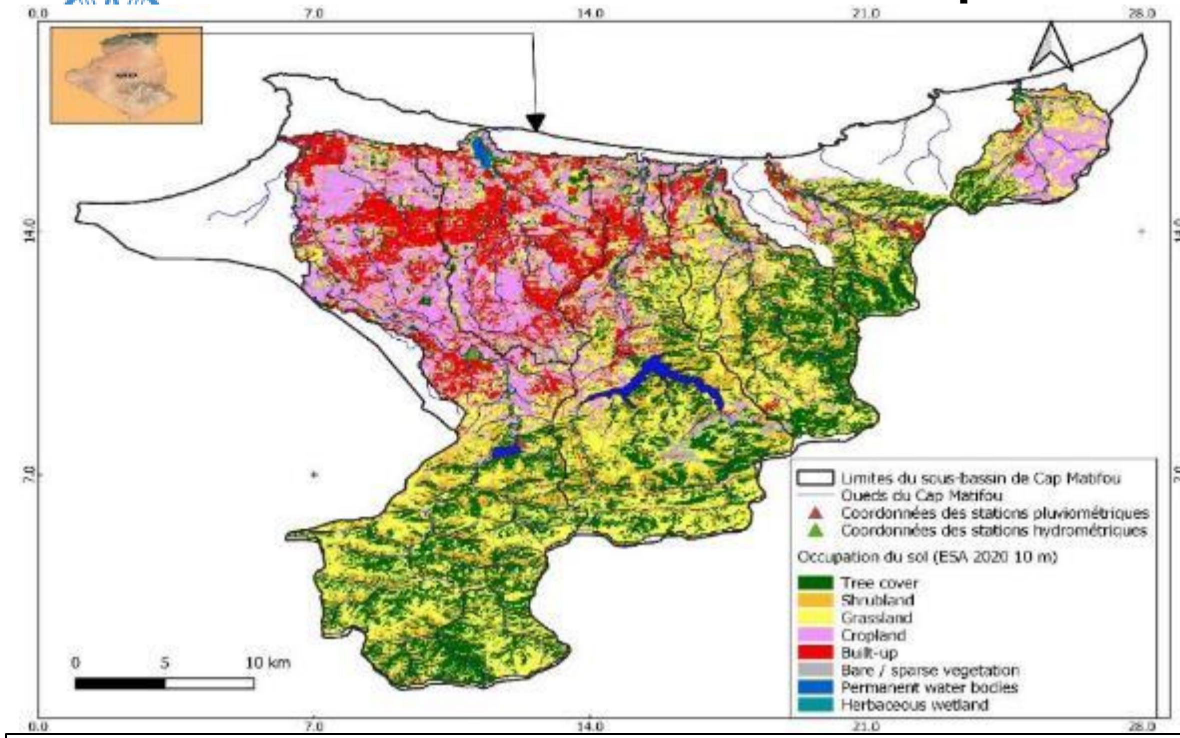
The irrigated scheme of Hamiz

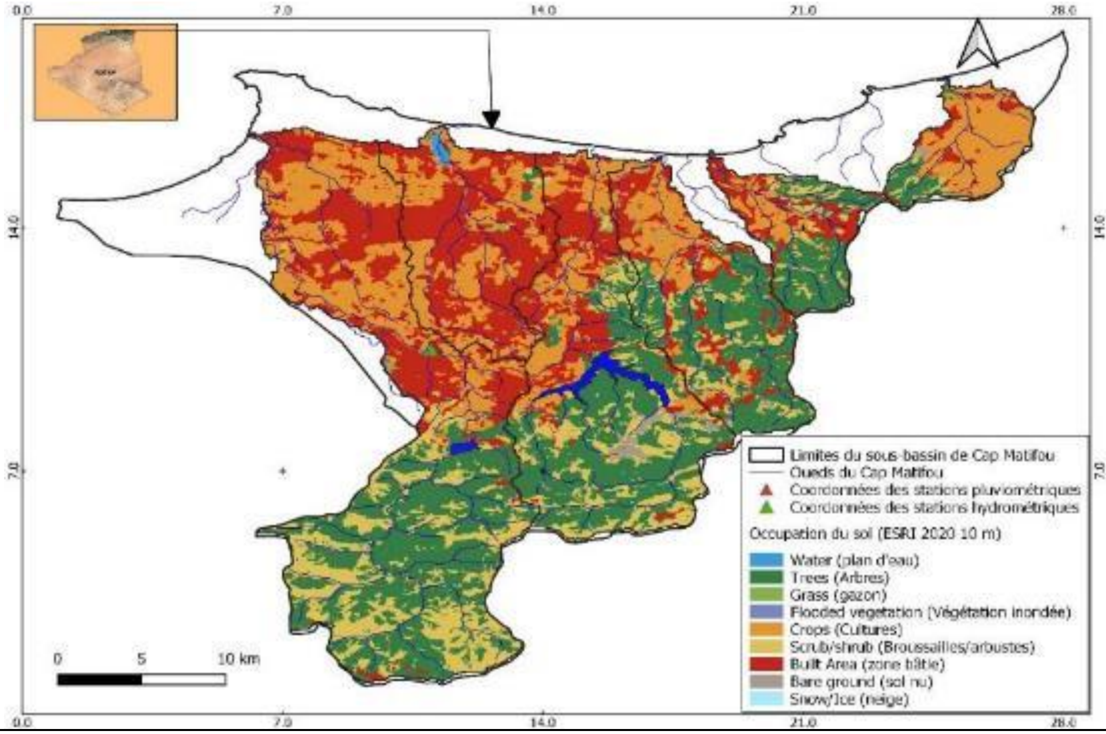


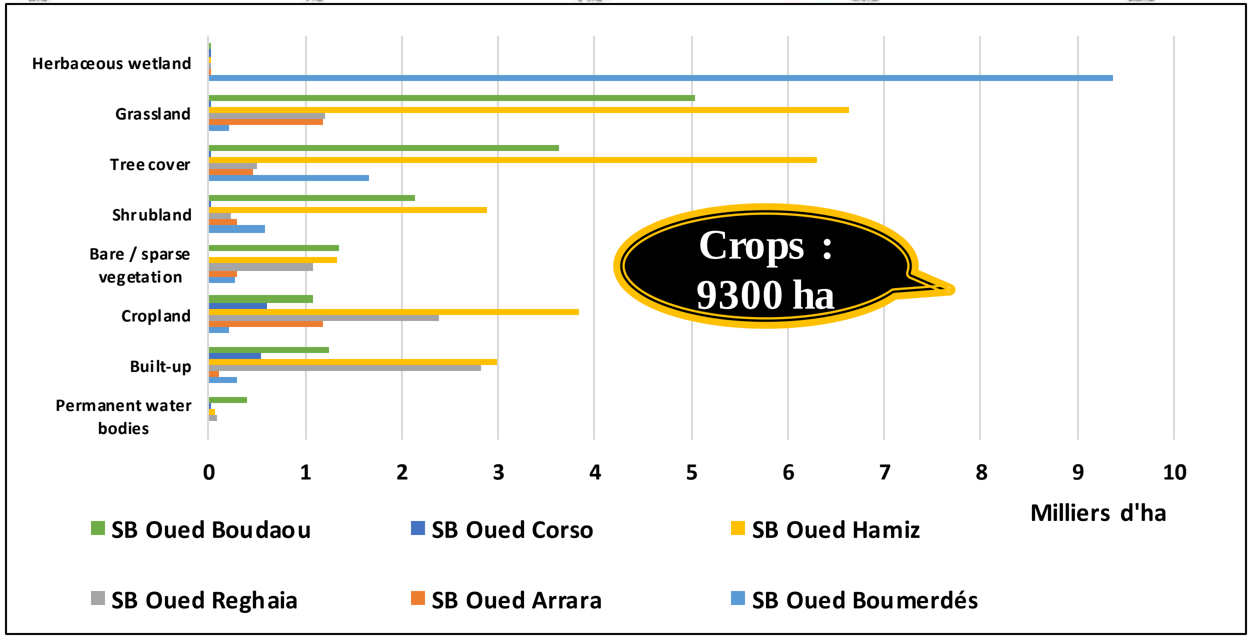
Individual irrigation

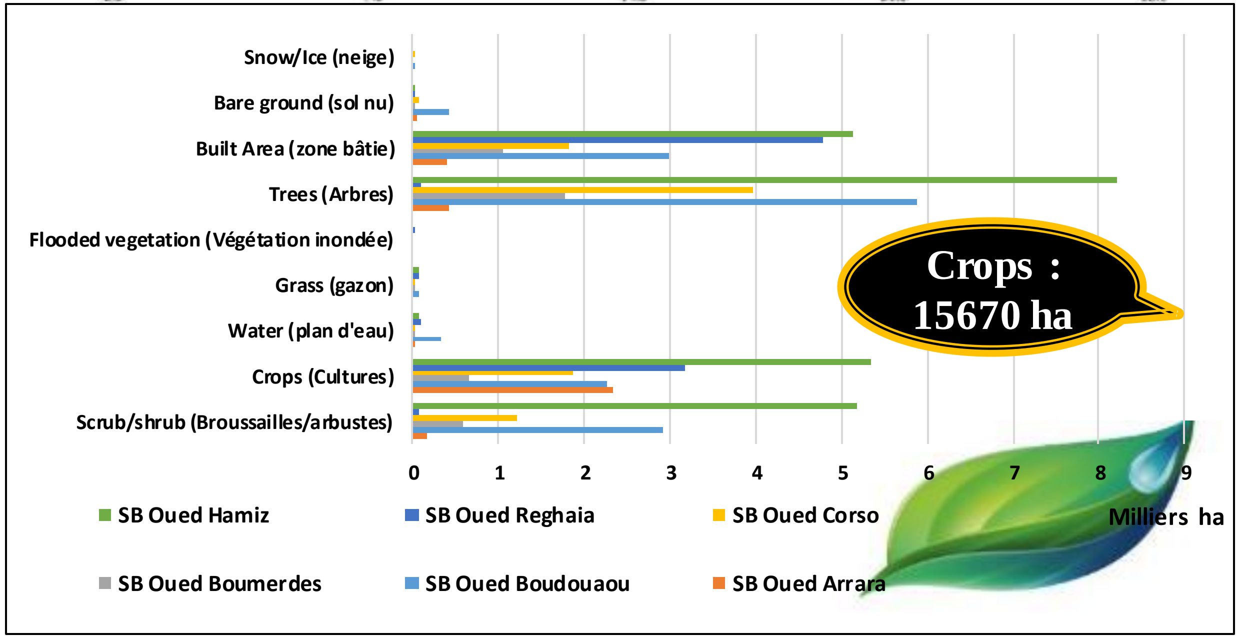


- # Land use and crops









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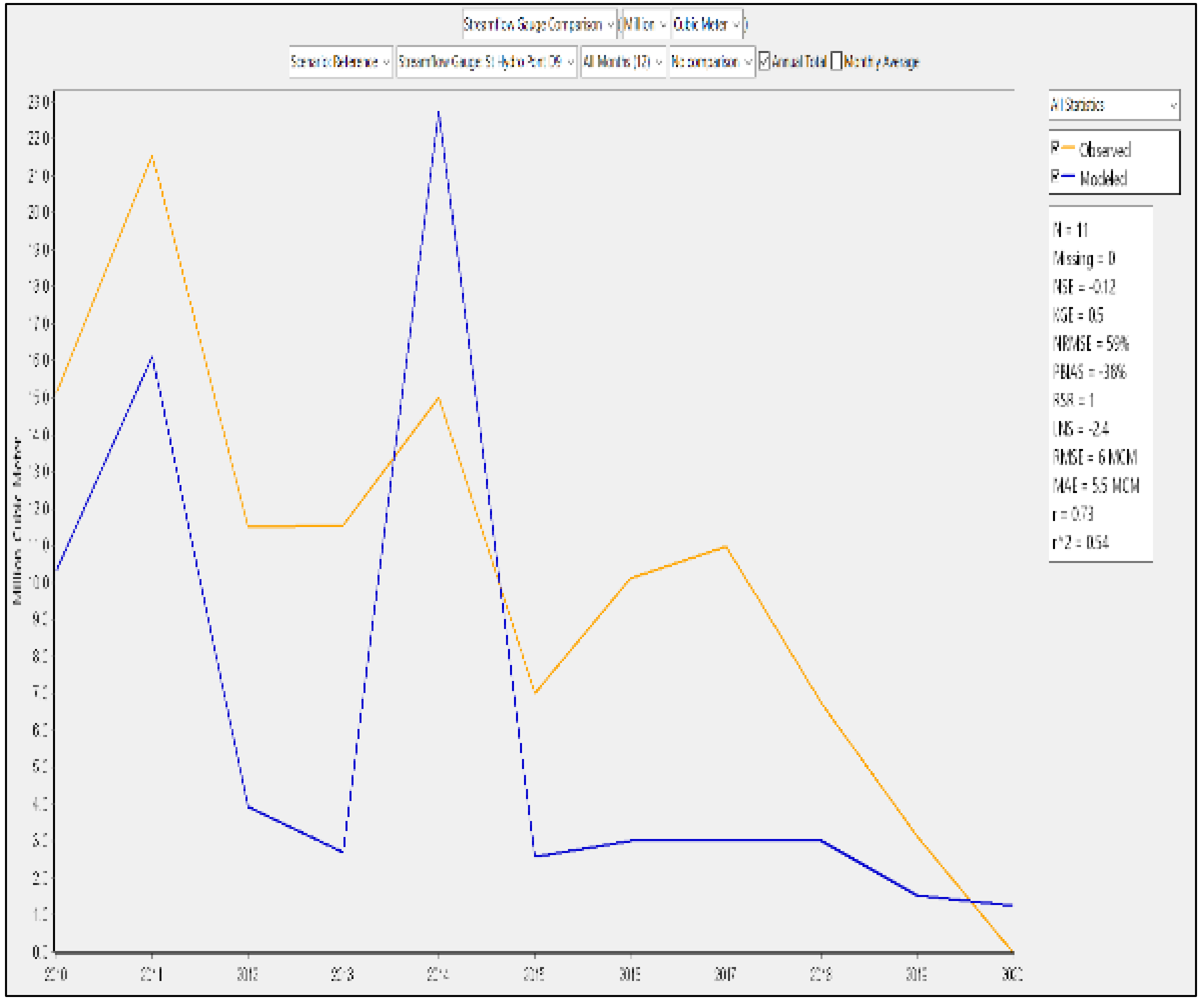
4. Hydrological calibration/Operational calibration

Gauging station : Keddara Dam

Gauging station : Pont D9 (Hamiz)



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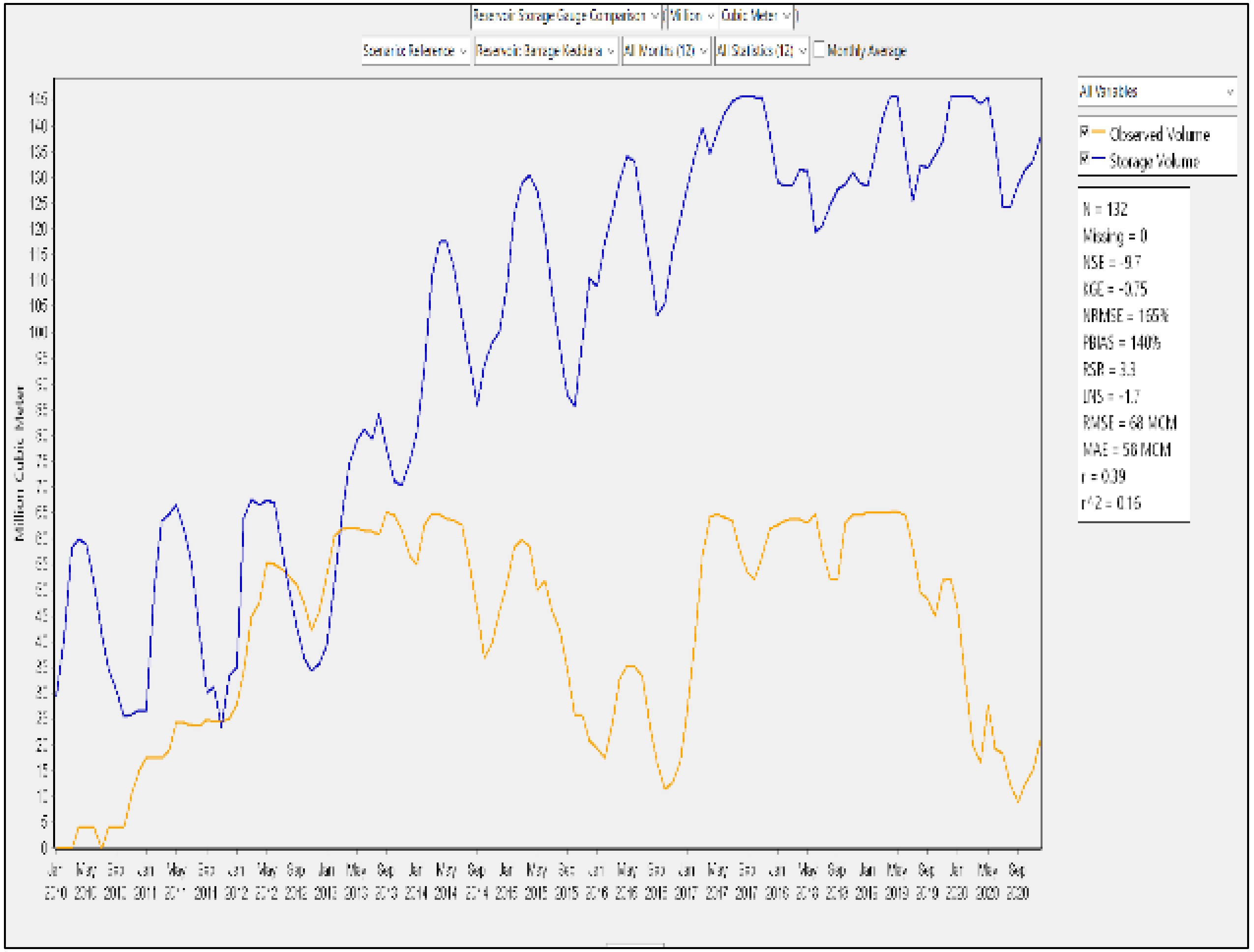
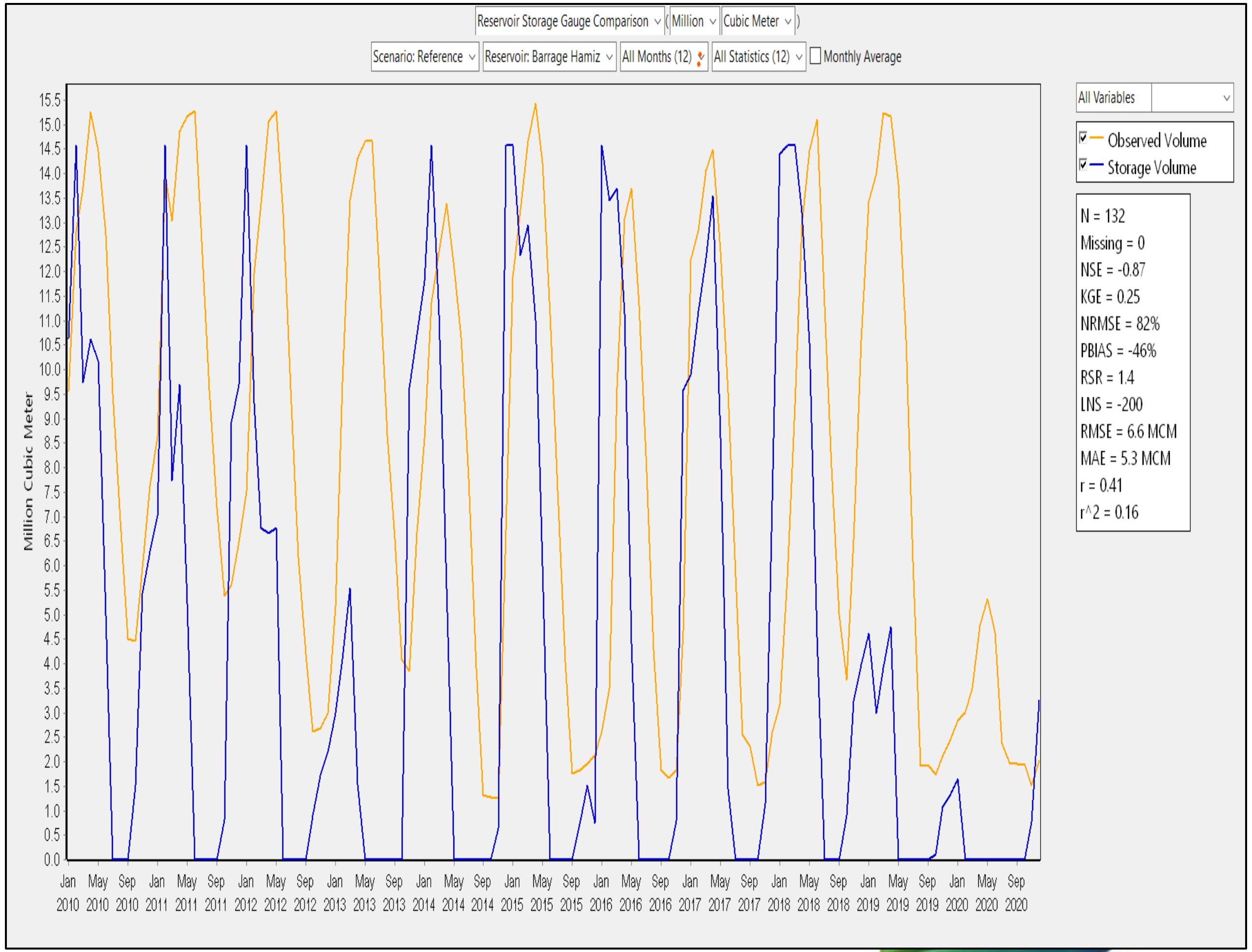
Kedarra dam



Hamiz dam



The main steps involved in calibrating the final model are as follows:

- Collect and organize water accounting data
- Complementary WA work has been done
- Complete the model data: remote sensing products
- Review and refine hydrological calibration: discrepancies were identified
- Update EFR values: from GFIS
- Compare historical water balance values with modeled values
- Make other necessary model adjustments: GW calibration and adjustments to cope with calculation gaps.

5. Development of scenarios to calculate the water stress :

Several scenarios are considered to calculate the water stress, in order to draw up a trend in water withdrawal and availability:

- **Population growth scenario: voluntarist and trend-based scenario**

- **Scenario with water transfers to the sub-basin (reference) and without transfers (no imports)**

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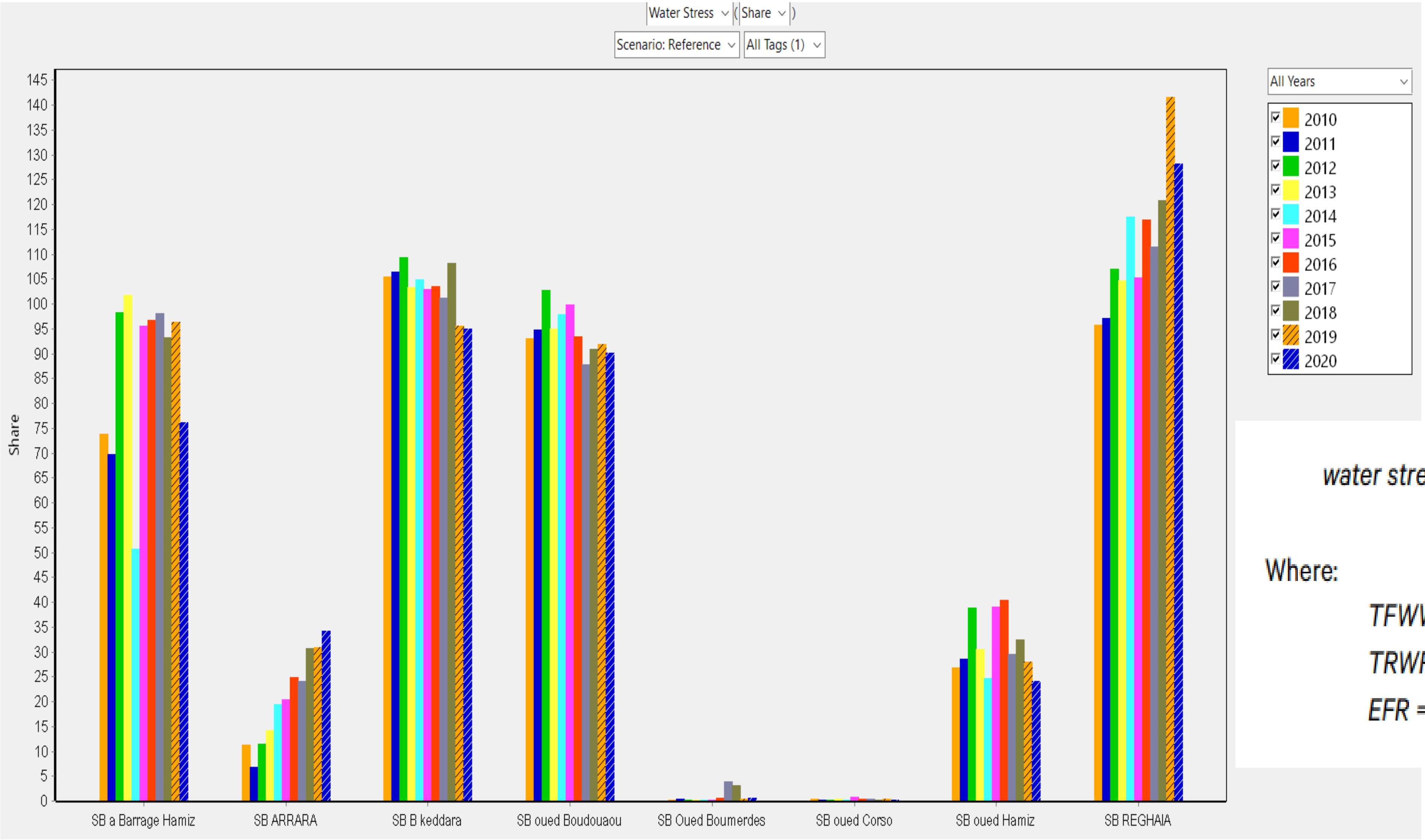
6. Water stress level by sub-basin : water stress plugin on WEAP

Reference period (2010-2020)



$$\text{water stress} = \frac{TFWW}{TRWR - EFR} \times 100\%$$

Where:

TFWW = Total freshwater withdrawals

TRWR = Total renewable freshwater resources

EFR = Environmental flow requirements

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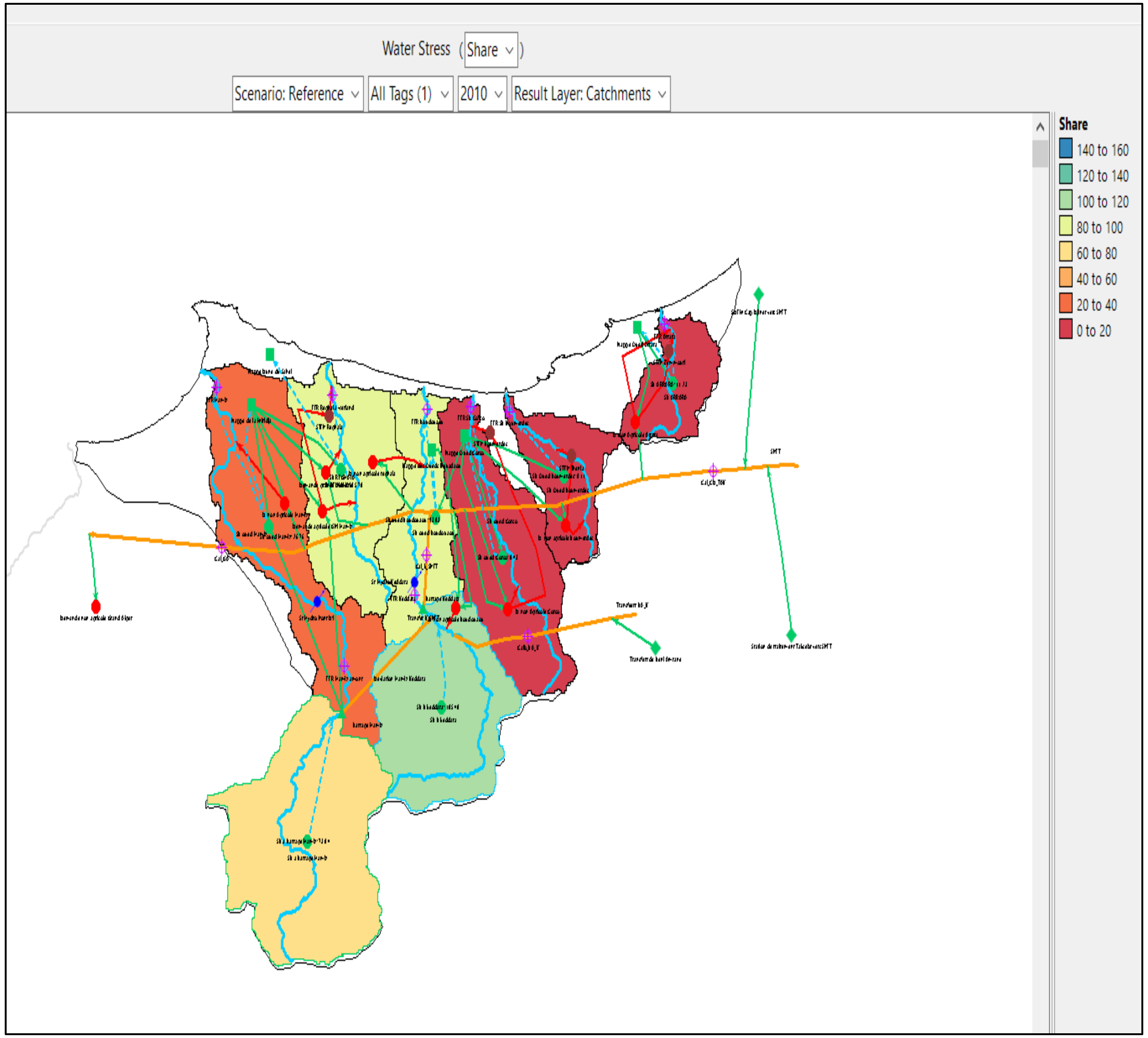
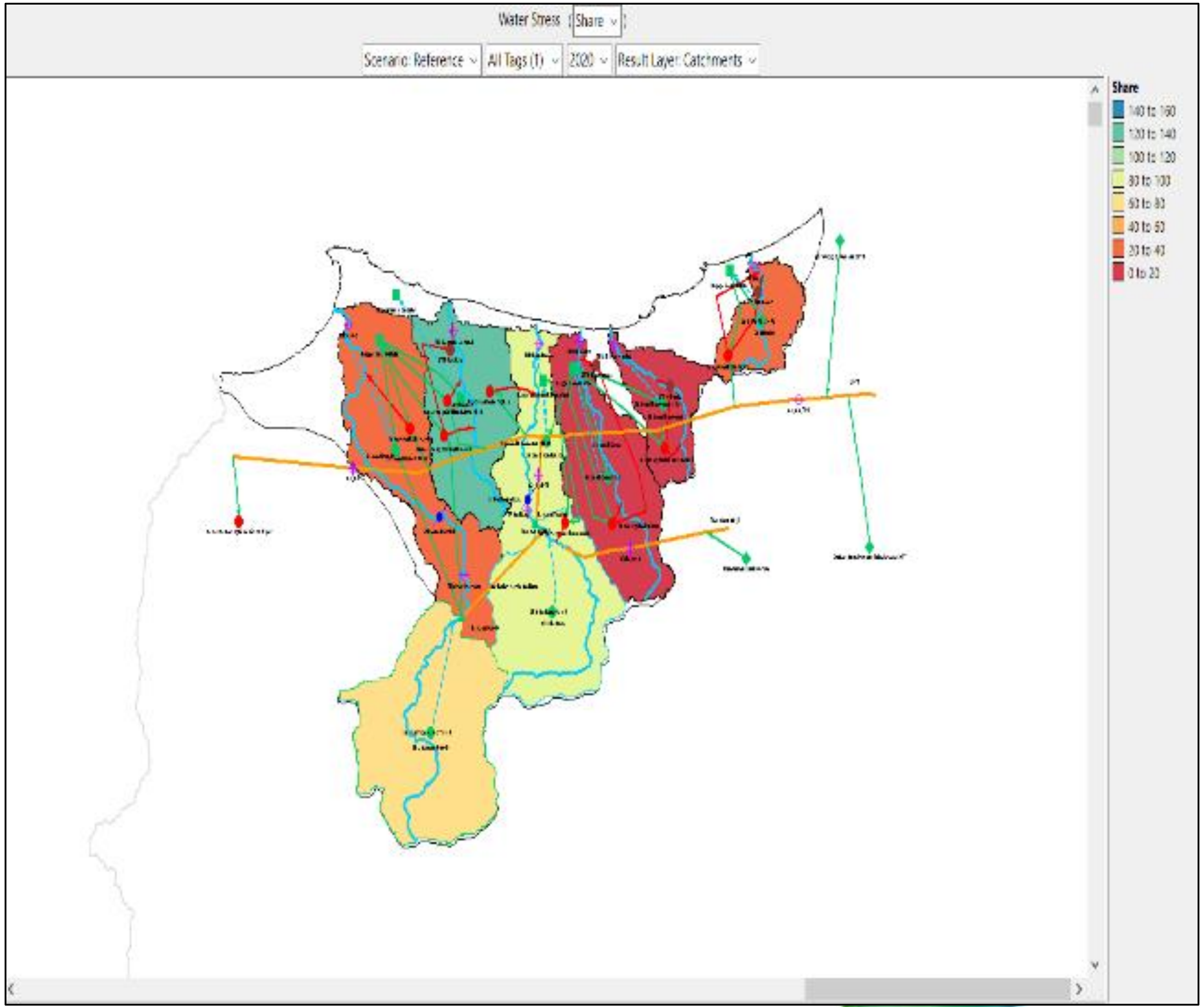
Spatial distribution of water stress by sub-basin





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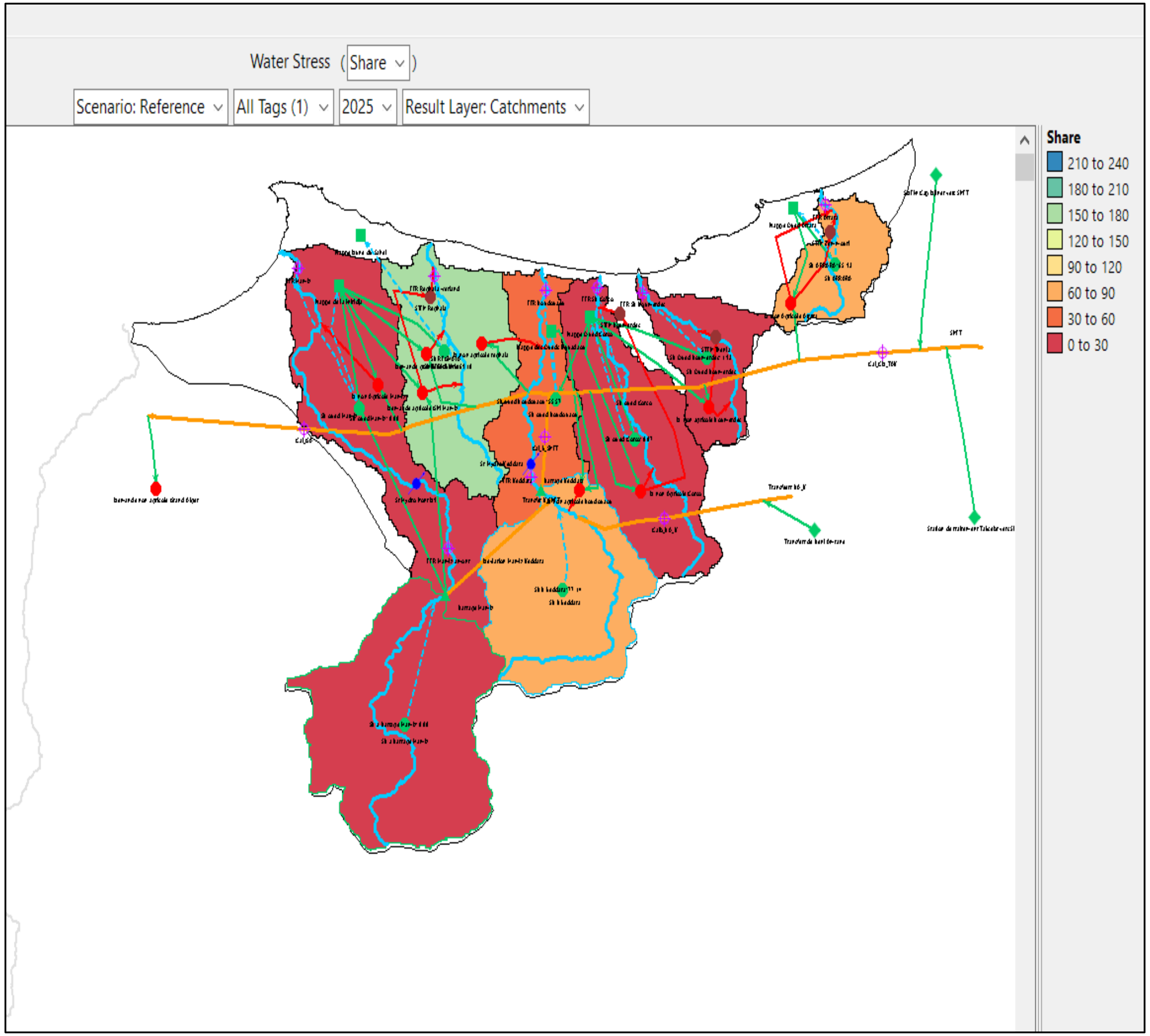
Trend population growth scenario WITH water transfers from outside (2010-2030

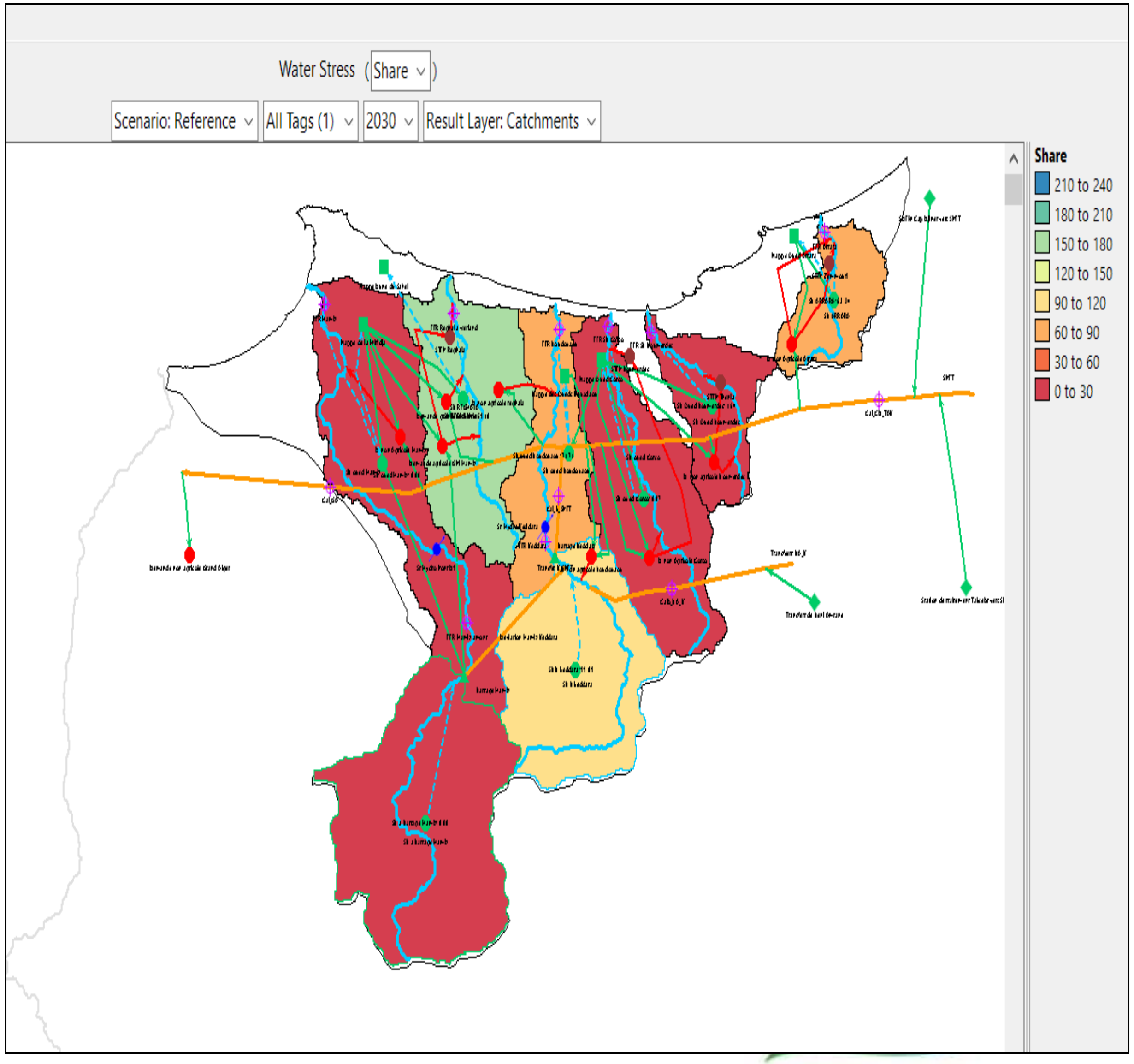
Water Stress (Share)

Scenario: Reference | All Tags (1) | All Catchments

Catchment	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	**Sum**
SB a Barrage Hamiz	73.84	69.67	98.36	101.75	50.69	95.64	96.70	98.07	93.26	96.28	76.10	85.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1 035.48
SB ARRARA	11.23	6.79	11.49	14.15	19.33	20.43	24.90	24.01	30.65	30.93	34.25	107.46	65.47	58.37	66.87	65.93	71.22	85.50	60.95	61.67	63.34	934.94
SB B keddara	105.40	106.48	109.29	103.27	104.79	102.93	103.55	101.25	108.21	95.51	95.03	113.24	95.66	53.18	84.00	77.14	100.19	134.26	129.84	126.00	99.89	2 149.11
SB oued Boudouaou	93.03	94.74	102.80	95.06	97.91	99.84	93.40	87.82	90.80	91.88	90.19	103.70	68.95	42.30	58.98	55.57	66.11	76.64	81.20	81.72	71.71	1 744.36
SB Oued Boumerdes	0.11	0.44	0.11	0.12	0.14	0.10	0.64	3.90	3.18	0.36	0.54	0.63	1.75	1.73	2.02	1.93	2.12	2.98	1.63	1.62	1.64	27.68
SB oued Corso	0.43	0.12	0.21	0.45	0.22	0.72	0.37	0.38	0.27	0.33	0.26	0.17	0.08	0.05	0.07	0.07	0.09	0.14	0.19	0.11	0.07	4.78
SB oued Hamiz	26.76	28.48	38.94	30.52	24.71	39.13	40.33	29.54	32.49	28.06	24.15	36.43	2.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	382.29
SB REGHAIA	95.78	97.11	107.01	104.77	117.52	105.25	116.99	111.56	120.85	141.56	128.10	200.02	174.36	169.17	169.22	169.18	169.18	169.18	169.22	169.18	169.18	2 974.38
Sum	406.58	403.82	468.20	450.10	415.31	464.03	476.89	456.54	479.70	484.90	448.61	646.78	408.99	324.79	381.17	369.82	408.92	468.71	443.04	440.30	405.83	9 253.03

Trend population growth scenario WITH water transfers from outside (2010-2030





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Trend population growth scenario WITHOUT transfers (2010-2030)

Water Stress (Share)

Scenario: No Imports | All Tags (1) | All Catchments | No comparison

Catchment	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	**Sum**
SB a Barrage Hamiz	73.84	69.86	98.81	101.97	51.16	96.91	98.08	99.96	98.56	96.54	70.43	82.25	10.52	6.55	7.76	6.66	8.27	7.94	7.68	8.75	13.55	1 116.06
SB ARRARA	11.23	15.86	27.54	25.42	34.29	38.92	36.55	31.85	41.04	60.51	52.26	22.62	5.95	7.52	8.48	9.88	9.86	11.22	8.43	10.73	14.32	484.47
SB B keddara	105.40	120.45	140.10	3 375.92	180.48	251.68	0.00	326.64	516.94	212.19	265.44	172.32	133.71	118.68	130.01	126.52	134.64	138.79	137.71	136.38	125.91	6 849.91
SB oued Boudouaou	93.03	81.88	84.62	65.04	76.96	88.97	71.81	77.64	104.72	109.97	105.45	68.13	46.18	61.67	53.62	57.78	51.79	51.02	46.19	50.05	60.12	1 506.62
SB Oued Boumerdes	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.21	128.21	128.21	128.21	128.21	128.21	128.21	128.21	128.21	128.21	128.21	1 410.37
SB oued Corso	0.43	0.08	0.14	0.44	0.19	0.85	0.41	0.49	0.35	0.28	0.28	0.15	0.08	0.05	0.08	0.07	0.09	0.15	0.22	0.11	0.07	5.02
SB oued Hamiz	26.76	30.62	44.39	40.96	29.61	52.91	53.10	43.24	55.51	57.67	58.91	58.01	5.96	3.41	4.00	3.59	3.70	3.80	4.29	4.24	4.97	589.65
SB REGHAIA	95.78	93.67	103.50	95.72	109.77	96.22	97.51	98.20	98.93	117.61	94.44	145.42	30.98	41.10	46.05	42.08	56.55	51.10	47.35	42.72	43.77	1 648.48
Sum	406.58	412.41	499.10	3 705.47	482.46	626.46	357.45	678.04	916.05	654.77	775.41	677.11	361.59	367.19	378.21	374.78	393.11	392.24	380.06	381.18	390.91	13 610.58

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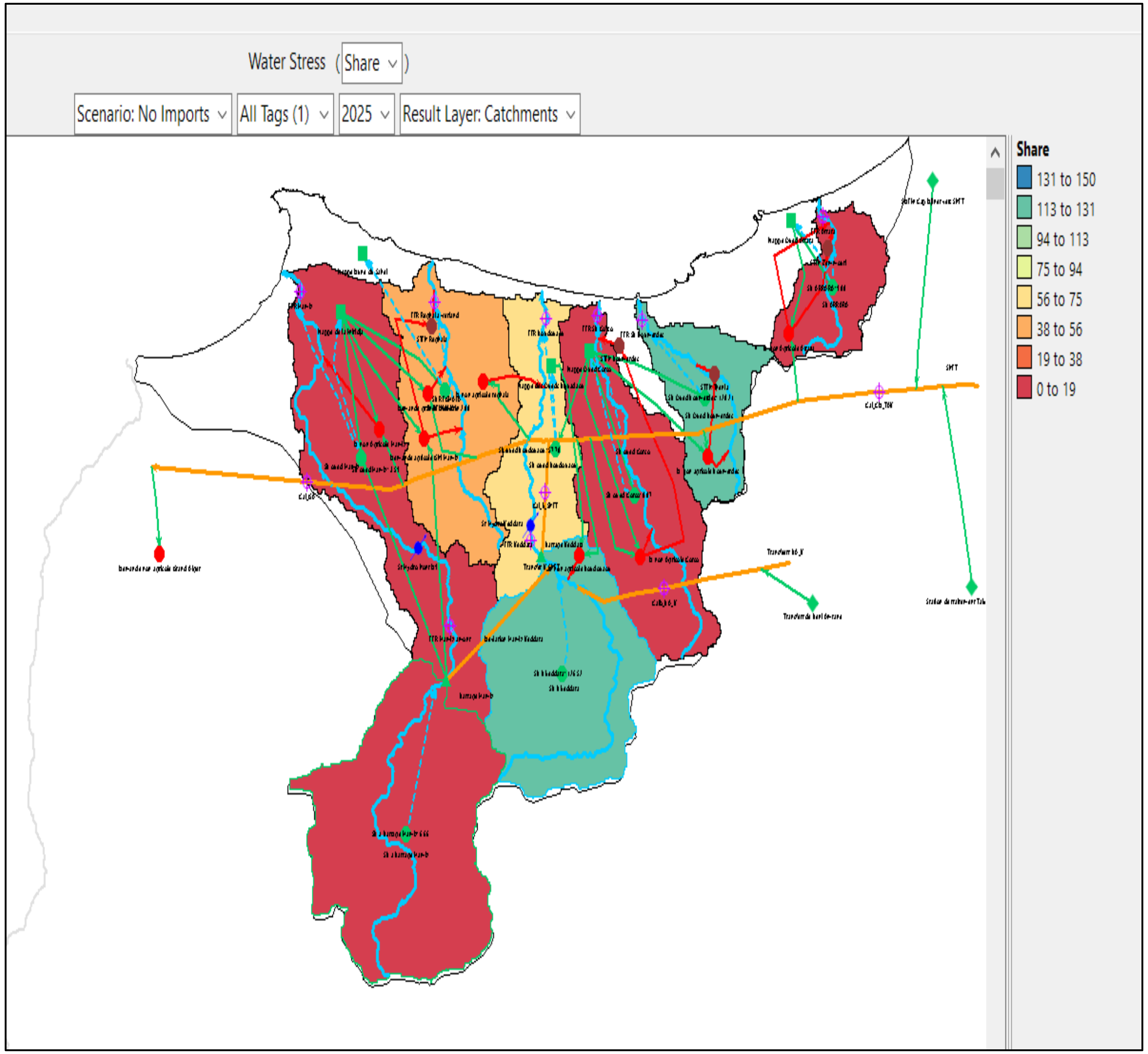
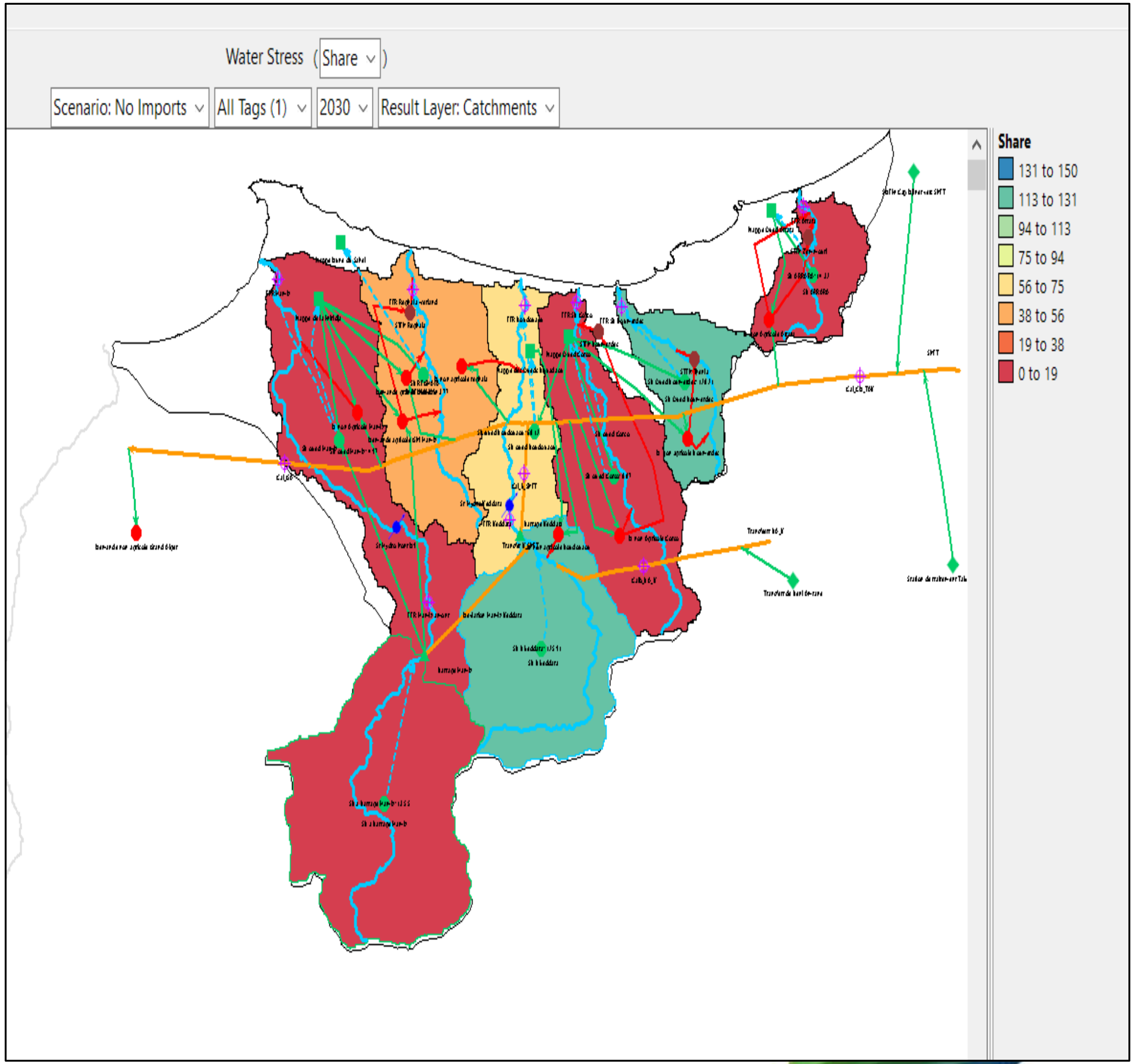
Trend population growth scenario WITHOUT transfers (2010-2030)





7.Conclusion

- Regardless of the uncertainties, the disaggregation model for SDG 6.4.2 has confirmed some of the findings of the water accounting work.
- Water stress rates are high for the reference scenario;
- Projections show stress increasing to alarming levels (+150%).
- Transfers have alleviated water stress in the sub-basins.
- The model can be further developed to include other scenarios (Climate change scenario and rainfall deficit, Water saving scenario, Increased supply scenario).
- The results of the model can be improved by enhancing data quality.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Thank you for your attention

Special thanks to: Brian Joyce (SEI), Doreen Salazar (SEI), and a team from several water institutions in Algeria.

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