



National Council for Scientific Research



Water Accounting Plus (WA+) for Yarmouk Tributary Basin

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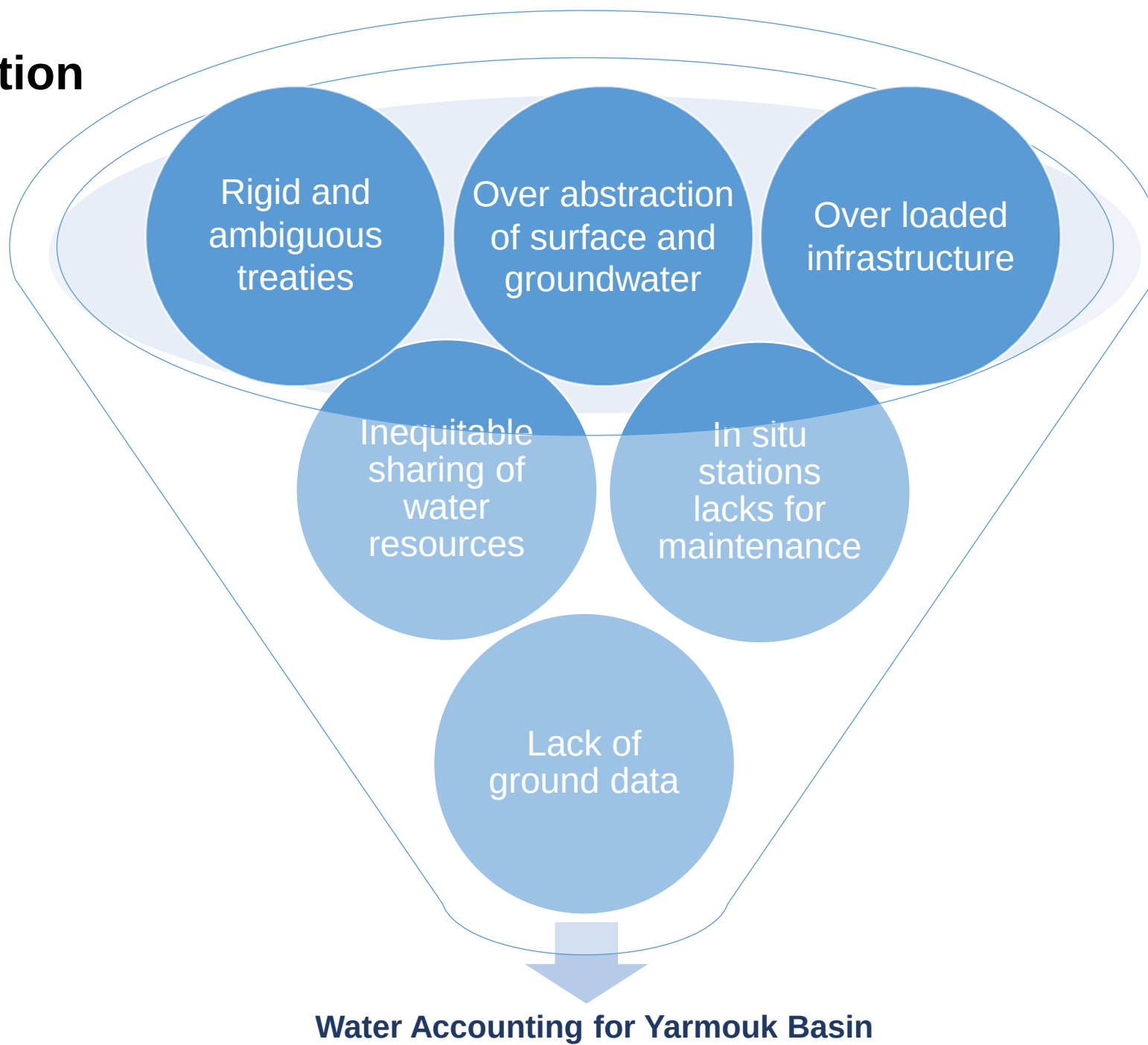


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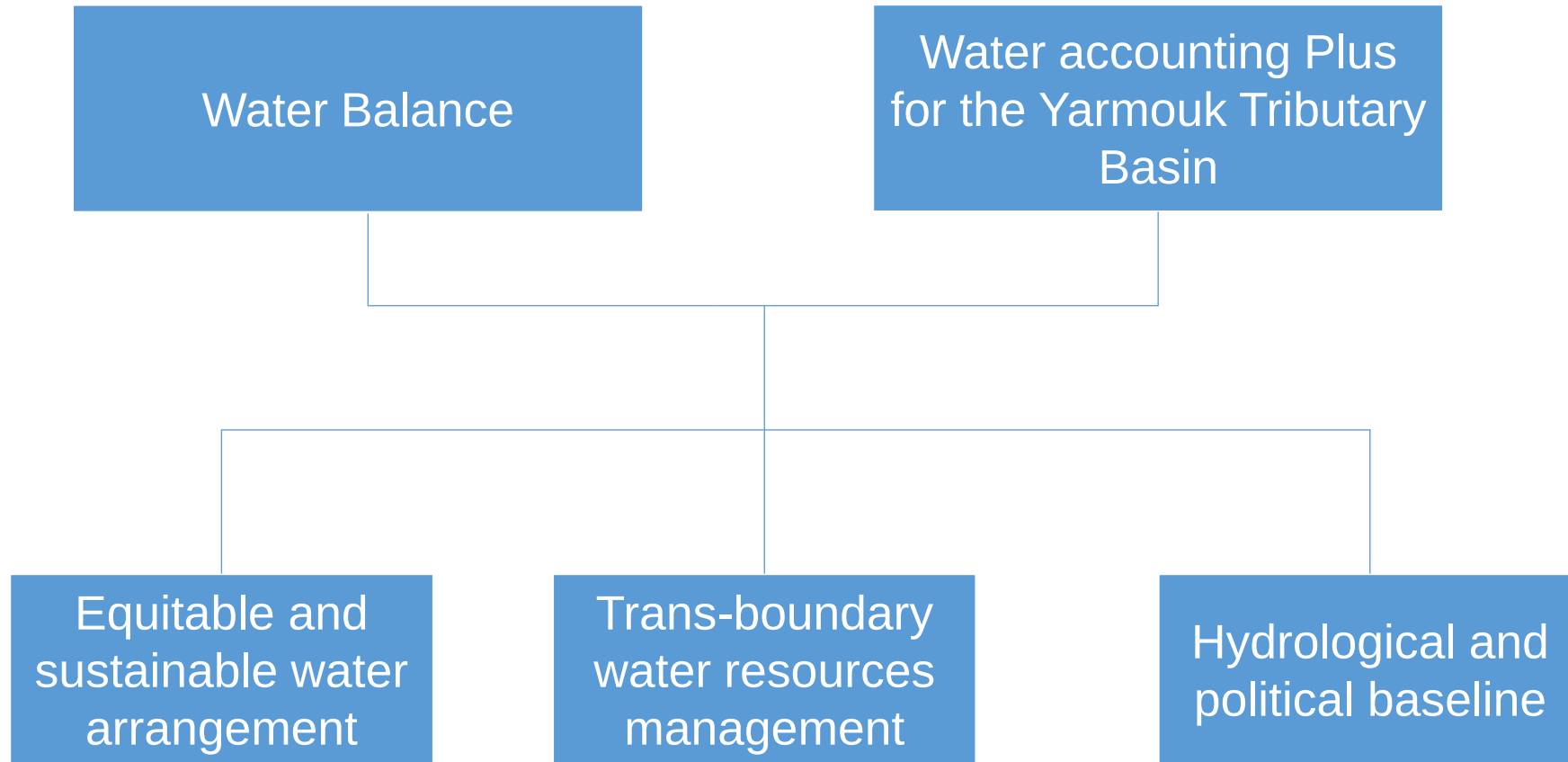


I. Introduction



I. Introduction (continue)

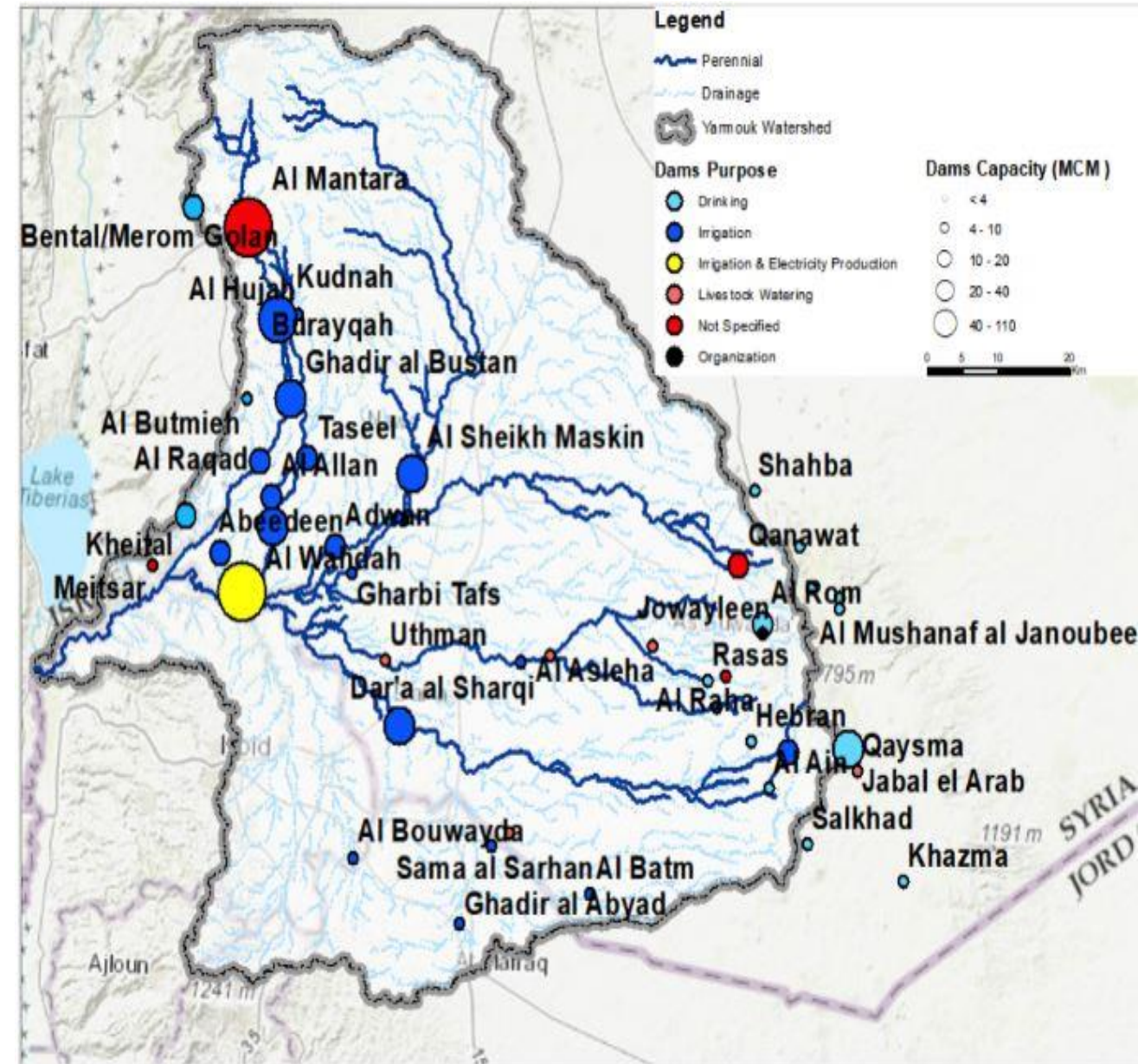
❖ Objective



II. Study Area Description

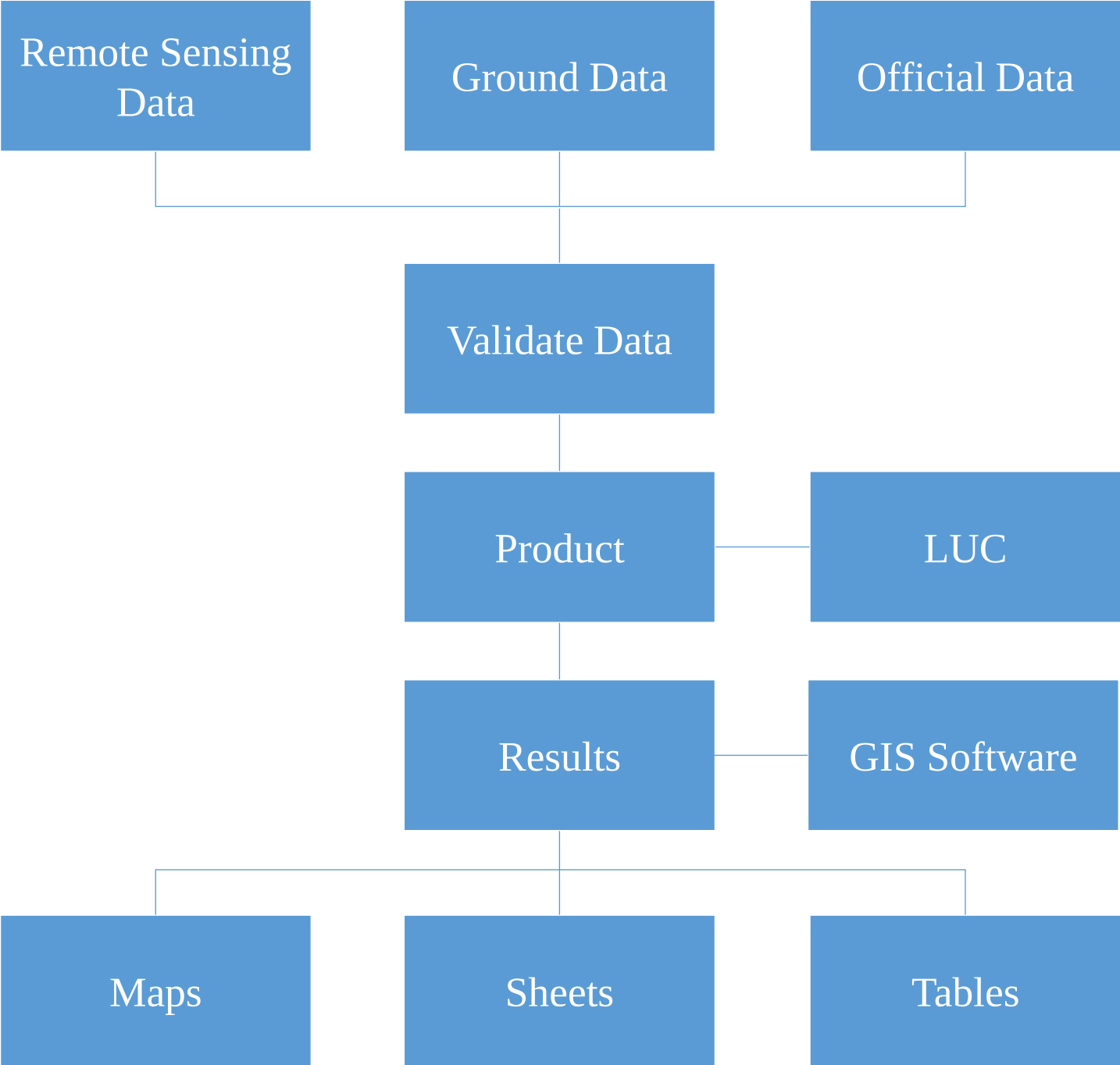
❖ Yarmouk Tributary Basin

- Catchment Area = 7,387 km²
- Syria (80%), Jordan (19.7%) and OSol (0.3%)
- 40 dams: 32 exist in Syria (206 MCM), 1 shared between Jordan and Syria (110 MCM), 4 built by Israel in the Occupied Golan (10 MCM) and 3 dams exist in Jordan (3.1 MCM)
- Two main aquifer:
 - Upper aquifer system mainly formed of Quaternary Basalts and it is found in the Syrian part and Golan height
 - Middle aquifer system mainly formed of Massive lime stones, marls and chalks, and located at north Jordan



Source: UEA (2018)

III. Methodology



III. Methodology (continue)

❖ Data obtained from remote sensing satellites

Precipitation	Actual Evapotranspiration	Reference, Crop and Incremental ET	Transpiration, Evaporation and Interception	Biomass Production	LUC
CHIRPS	WAPOR	WAPOR	WAPOR	WAPOR	ESRI base maps of GEOEYE (2011)
spatial resolution: 0.05°	Spatial Resolution: 100 m	Spatial Resolution: 20Km	Spatial Resolution: 100 m	Spatial Resolution: 100 m	Spatial resolution: 50 cm
	Penman-Equation derived by FAO	Based on the FAO 56 Penman-Monteith equation	Based on the FAO 56 Penman-Monteith equation		Based on Transpiration data to separate irrigated and rain-fed areas

$$\frac{0.404\Delta(Rn - G) + \gamma \frac{900}{T + 273} u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

$$ET_c = ET_0 \times K_c \times K_r$$

$$ET_{inc} = ET_c - ET_a$$

III. Methodology (continue)

❖ NDVI

Landsat7	SPOT5	Moderate Resolution Imaging Spectroradiometer MOD13-USGS
• Spatial Resolution: 30 m • Temporal resolution: 16-days decadal • 8 bands • Red and NIR bands	• Spatial Resolution: 5 m • Temporal resolution: decadal • Initial date: 2002	• Spatial Resolution: 250 m • Temporal resolution: 16-day decadal • Initial date: 2000

$$NDVI = \frac{Red - NIR}{Red + NIR}$$

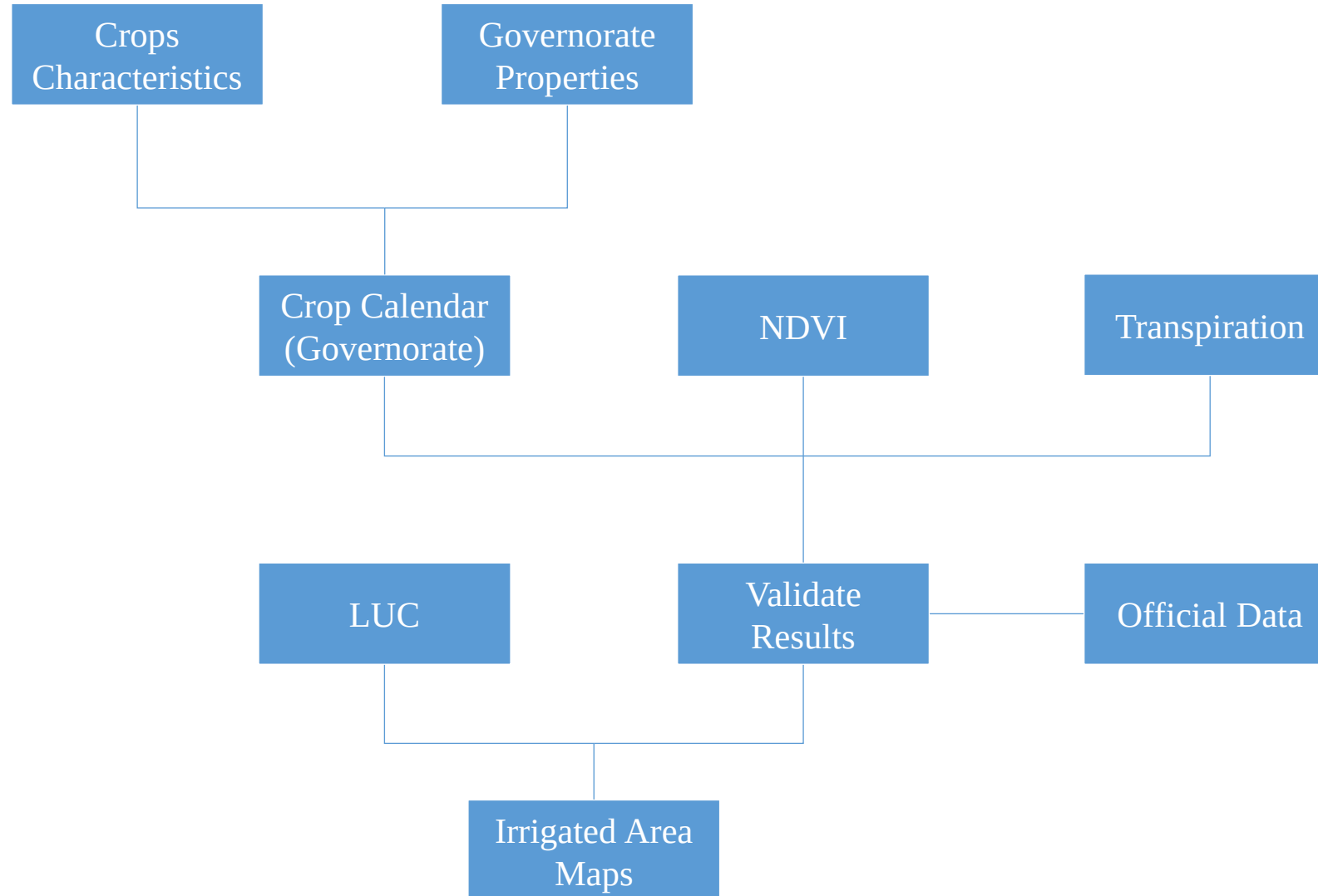
III. Methodology (continue)

❖ Separation of Irrigated and Rain-fed Areas

Governorate	Type of crop	Plantation date	Irrigation date	Harvest date
Dar'a	Wheat	November	January-March-April	May
	Vegetables	February	April-May-June	July
Quneitra	Protected Tomato	August	Sep-Oct	November
Suweida	Rain-fed Wheat and barley	November	—	May
Rif dimashq	Potato	February	April-May-June	July
Golan	Vegetables	February	April-May-June	July
Irbid	Vegetables	February	April-May-June	July

III. Methodology (continue)

❖ Separation of Irrigated and Rain-fed Areas



IV. Results

❖ Precipitation

- Annual precipitation 365 mm/year (2009)
- The eastern cities in the basin such as Al Sweida and Al Bouwayda in the southern ones receive the lowest rainfall rates

❖ Actual Evapotranspiration

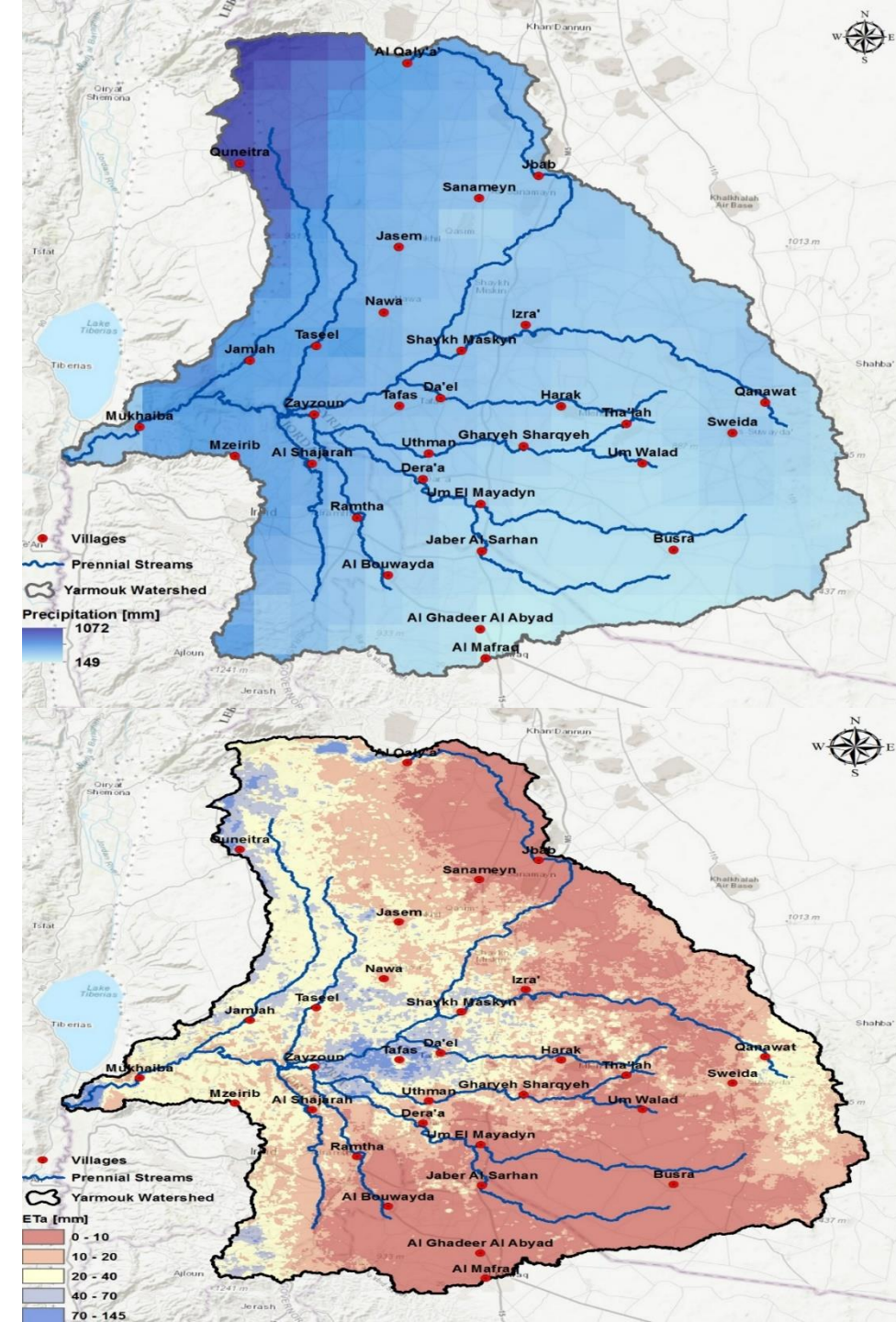
- Computed from WAPOR in 2009
- Most of the evapotranspiration occurs at the west of Dera'a, Quneitra, Golan, and a small part of Irbid that reflects the presence of irrigated and rain-fed crops

❖ Landscape and Utilized Evapotranspiration

- landscape ET that originates from precipitation and it is considered the total evapotranspiration during the winter season
- Utilized ET originates from surface and groundwater withdrawal, and it occurs mainly during the months where we have shortage as the difference between precipitation and the total actual evapotranspiration

❖ Transpiration

- April, May and June accounted for the highest transpiration rates which reflects the production period for most of the trees and wheat
- The highest transpiration accumulated on the west of Deraa, and near Golan and Quneitra where we have the most irrigated cultivation.



IV. Results (continue)

❖ Biomass Production

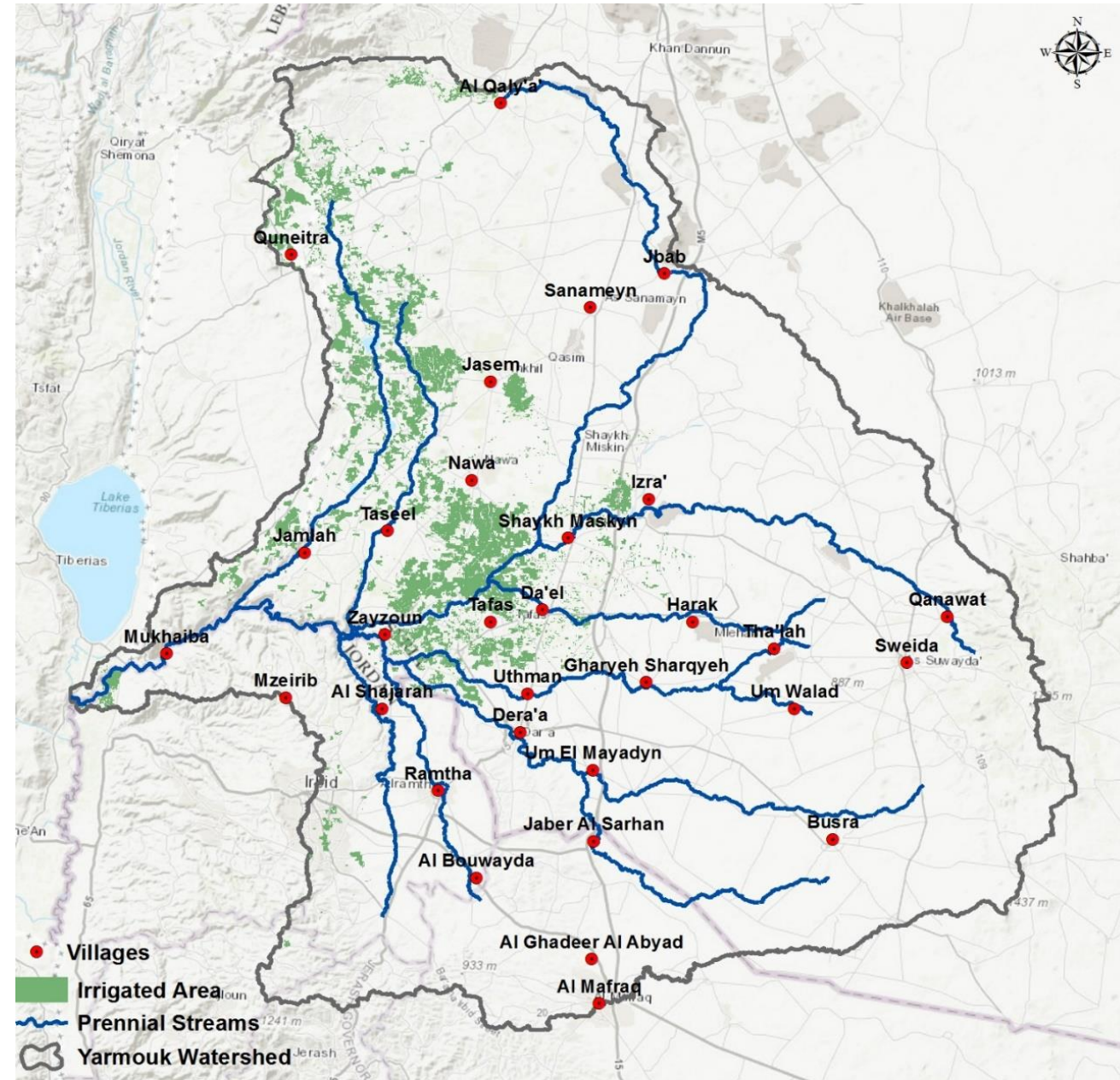
- Rain-fed crop's biomass was calculated for the winter period, by which it is the only period where crops and trees receive water for production
- Irrigated crop's biomass was calculated for both seasons, they receive water all over the year either from rain or from withdrawals
- Rain-fed crop's production within the Yarmouk basin is double that for irrigated crop's, this due to the large areas of rain-fed crops in comparison to the limited irrigated areas.

Type	CLASS	Biomass (Kg/ha)
Rain-fed	Fruit Trees	29,645,452.80
	Olive	70,800,868.80
	Vine	16,476,638.40
	Crop	201,815,193.60
Irrigated	Fruit Trees	5,301,633.60
	Vine	4,749,624
	Olive	11,594,714.40
	Crop	103,516,588.80

IV. Results (continue)

❖ Irrigated/Rain-fed Area

- The irrigated area is found to be in the western and northwestern parts of the Yarmouk basin, mainly located in Dera'a, Quneitra, Rifdimashq and Golan
- Main irrigated crops:
Irrigated wheat, protected tomato and potato
- Total irrigated area of 38114 Ha for crops, 3427.7 Ha for Olives, 1279.8 Ha for fruit trees and 964.7 Ha for vines.



IV. Results (continue)

❖ Irrigation Requirements

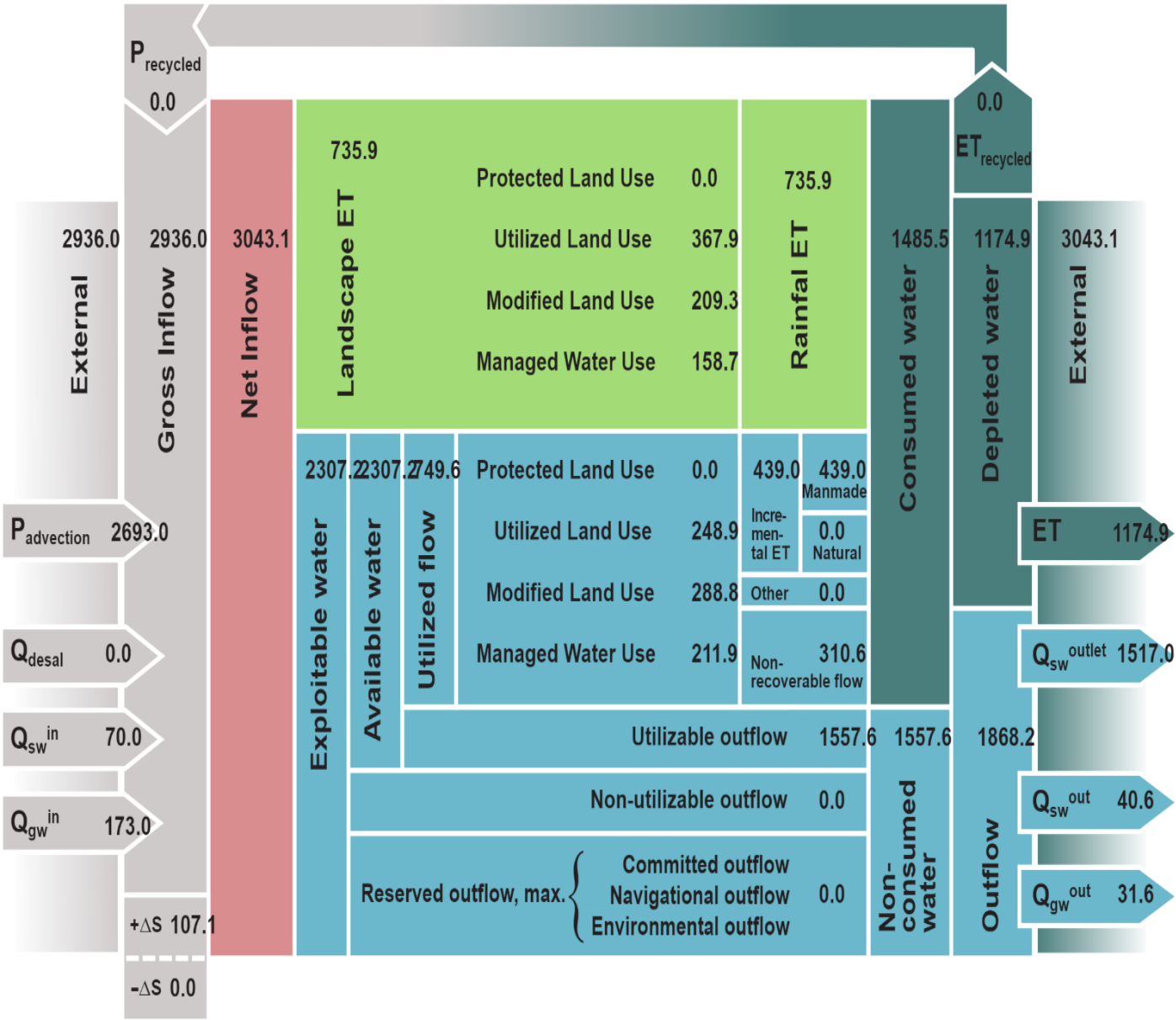
- The irrigation requirement for Yarmouk which is 439 MCM/Year is greater than the withdrawals from dams and legal wells
- Presence of many illegal wells where most of the groundwater is abstracted from

Tributary	Irrigation area (ha)	Irrigation volume (Mm3)	Volume used for irr from dams (MCM)	Wells Volume interval (MCM)	Flow volume (MCM)
Main Outlet	1390.85	11.0	13.49	-	37.5
Shalala	627.54	4.9		-	1.6
Zeidi	746.92	5.9	4.71	0-31.6	21.5
Thahab	2936.89	23.2	0.33	0-24.9	3.8
Hareer	23231.5	183.2	4.35	0-105.2	25.9
Allan	10147.42	80.0	7.42	0-8.5	12.3
Raqqed	16603.57	130.9	5.47	0-15.4	35.2

IV. Results (continue)



- It provides an overview on all water resources within the Yarmouk basin in 2009.
- Landscape ET accounts for 26.67% of the inflow while the exploitable water forms 73.3% of the net inflow → Problem of the over exploitation from surface and groundwater.
- Most of the rainfall was depleted over the bare lands, water bodies and forests.
- More than the half of the exploitable water shown to be non-consumed water, 34.7% is utilized within the basin and 65.3% is transferred out.

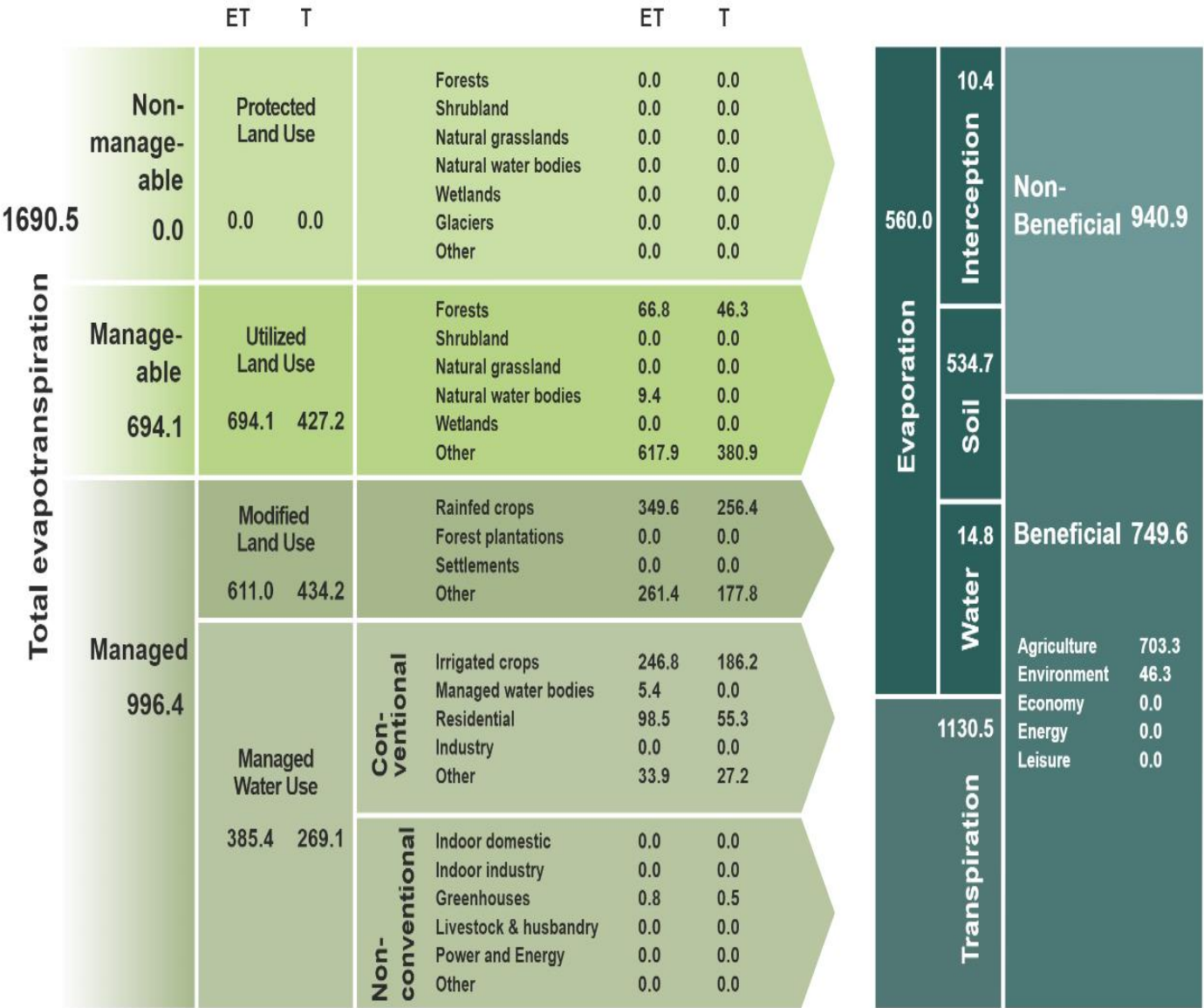


IV. Results (continue)

- It gives an overview on the water consumption for each land use class within the Yarmouk basin and shows whether water is depleted in a beneficial or non-beneficial way.
- 694.1 MCM is depleted within the Utilized Land Use which indicated that a large amount of water is being evapo_transpired through bare lands this depletion has no benefit on either agriculture nor environment.
- Evaporation and Interception were assumed to be non-beneficial, whereas Transpiration was considered beneficial except for grasses in bare lands, urban zones and the floating grasses over the water bodies.
- 56% of the water is depleted in a Non-beneficial way and only 44% of it depleted beneficial

Sheet 2: Evapotranspiration (MCM/Year)

Period: 2009-2010
Basin: Yarmouk Basin



IV. Results (continue)

- This sheet shows water consumption by rain-fed/irrigated crops and other plantings.
- Though the irrigated area is less than that of the rain-fed ones but the consumptive water by irrigated crops (201.62 MCM/Year) is greater than that by rain-fed crops (75.22 MCM/Year).
- The yield for rain-fed crops is greater than that for irrigated crops, this would seen very logical for a reason that the rain-fed area is much greater than the irrigated

Crop												Agricultural water consumption	276.84
Cereals	Non-cereals				Fruit & vegetables			Oil-seeds	Feed crops	Beverage crops	Other crops		
35.68	-	-	-	-	-	13.83	-	25.71	-	-	-	ET rainfed	75.22
	Root / tuber crops	Leguminous crops	Sugar crops	Merged	Vegetables & melons	Fruits & nuts	Merged						
61.89	-	-	-	-	-	5.18	-	5.65	-	-	-	ET from rainfall irrigated	72.72
103.00	-	-	-	-	-	12.80	-	13.10	-	-	-	Incremental ET irrigated	128.90
164.89	-	-	-	-	-	17.98	-	18.75	-	-	-	Total ET irrigated	201.62

Crop													
	Cereals	Non-cereals				Fruit & vegetables			Oil-seeds	Feed crops	Beverage crops	Other crops	
Land product-ivity	159838	-	-	-	-	-	36529	-	56074	-	-	-	Yield rainfed
	-	-	-	-	-	-	-	-	-	-	-	-	Yield from rainfall
	-	-	-	-	-	-	-	-	-	-	-	-	Incremental yield
	81985	-	-	-	-	-	7961	-	9183	-	-	-	Total yield
		Root / tuber crops	Leguminous crops	Sugar crops	Merged	Vegetables & melons	Fruits & nuts	Merged					
Water product-ivity	375.29	-	-	-	-	-	83.91	-	147.92	-	-	-	WP rainfed
	-	-	-	-	-	-	-	-	-	-	-	-	WP from rainfall
	-	-	-	-	-	-	-	-	-	-	-	-	Incremental WP
	16.43	-	-	-	-	-	0.99	-	1.68	-	-	-	Total WP

V. Conclusion

