Assessment of SWAT Potential Evapotranspiration Options and data-dependence for Estimating Actual Evapotranspiration and Streamflow

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« Modeling hydrology and diffuse pollution loads to assess surface water quality for a Tunisian agricultural catchment »

- The relation between agriculture and water quality is recognized since 1970's.

- This relation constitutes today an important goal in preserving water resources stored in dams. Risks of water contamination by nitrogen represents a main research field.

- Preserving water requires a better understanding of the processes governing the agricultural pressure and environmental impacts.

- The main objective of our study is to evaluate the impact of the real agriculture practices on the water quality at the catchment scale and to evaluate the fluxes of nitrogen going into the downstream dam using SWAT model.

Purpose of This study

❖ The accurate estimation of water loss by ET is very important for assessing water availability.

❖ SWAT model uses Potential Evapotrtanspiration (PET), soil proprieties and land use characteristic for estimating actual evapotranspiration.

❖ SWAT model offers the possibility of using several methods for computing the potential evapotranspiration methods including: (i) Penman-Montheith (PM), (ii) Hargreaves (H) and (iii) Priestly-Taylor (PT).

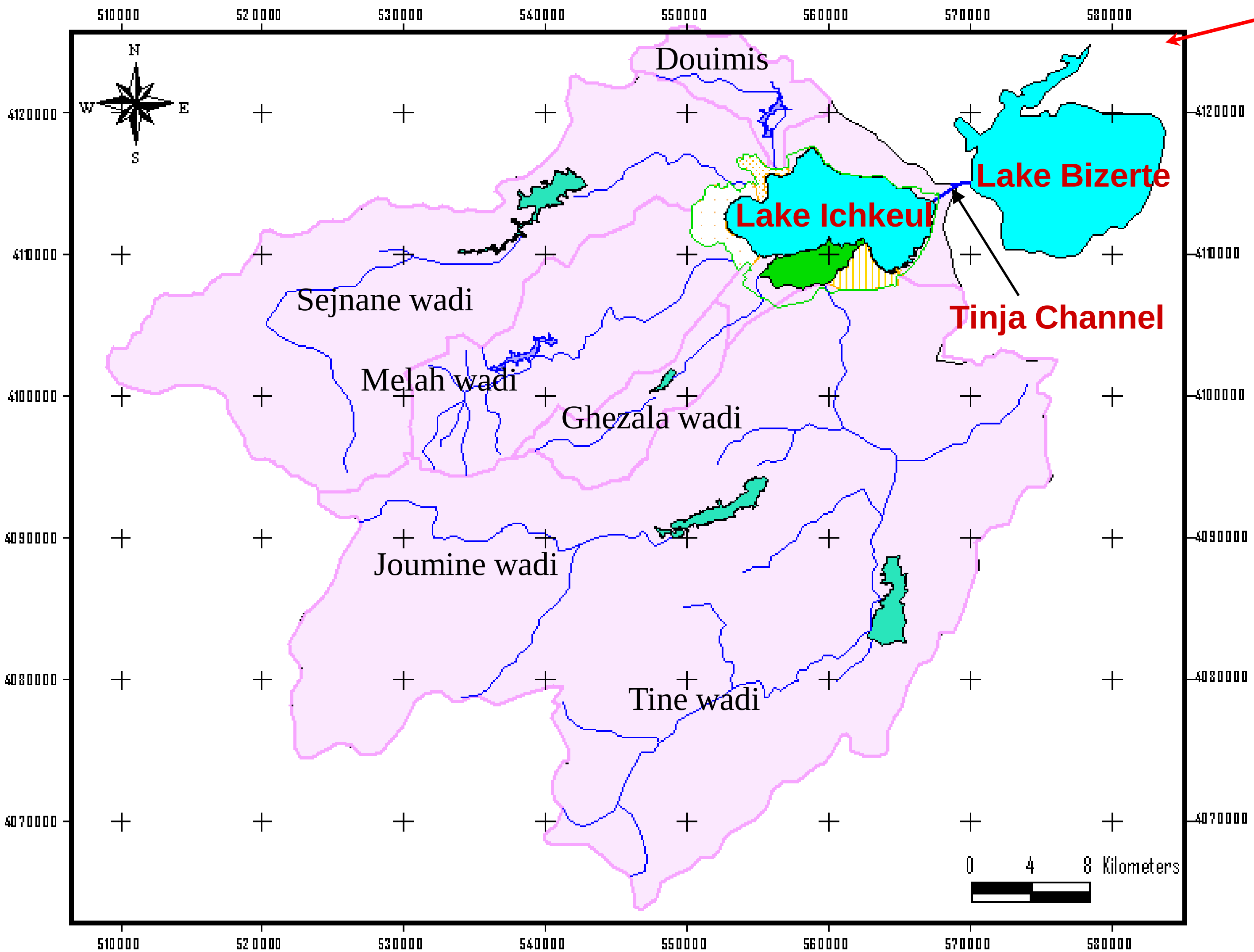
❖ The PM model that requires five daily climatic parameters: temperature, solar radiation, wind speed and vapour pressure.

❖ The first objective is to test the weather generator included in SWAT model for estimating missing climatic data and to evaluate the PM method for calculating PET with measured climatic data and with generated climatic data.

❖The second objective is to compare the use of the different ET models on daily and monthly PET, AET and Streamflow (Q) production

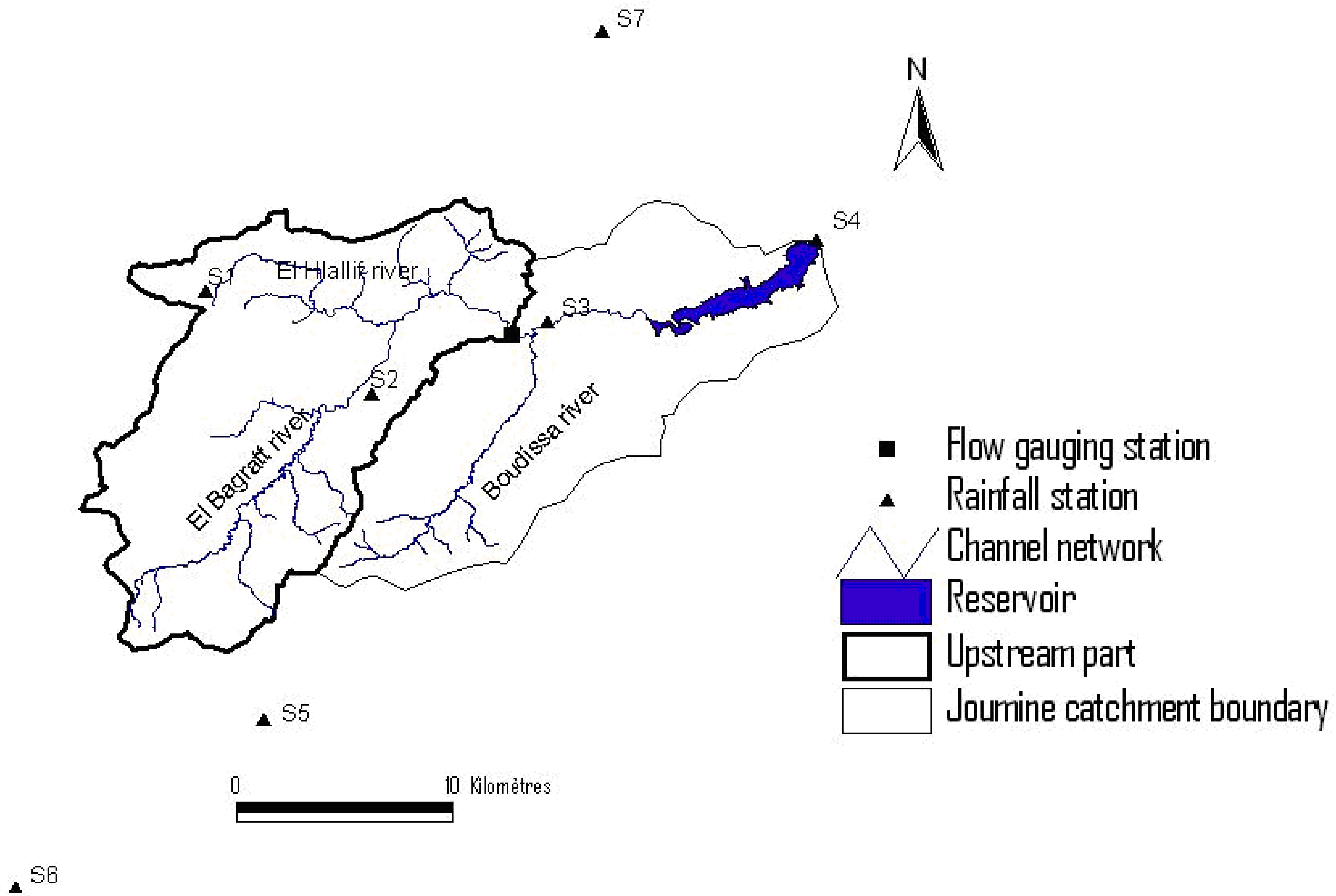
Study area Location

The Ichkeul National Park inscribed in the UNESCO world heritage wetland. It is in northern Tunisia, some 50 km north of the capital, Tunis.



It is linked by a narrow channel (Tinja channal) to the lagoon of bizerte with inturn has an outlet to the Mediterranean sea.

Watershed of Joumine Dam



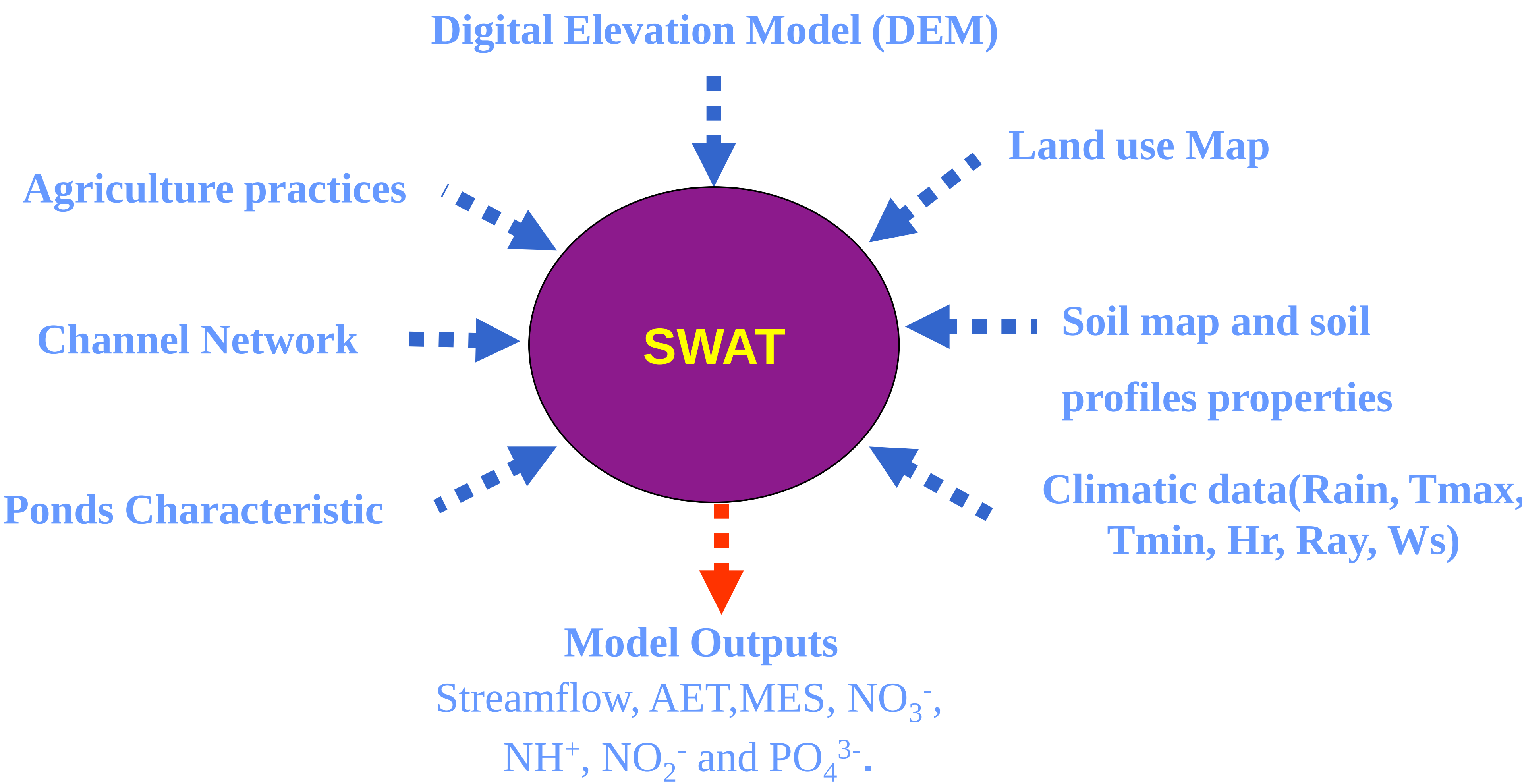
Intensification of agriculture

The dominant cultures are, OATS, WHEAT and SUNFLOWERS

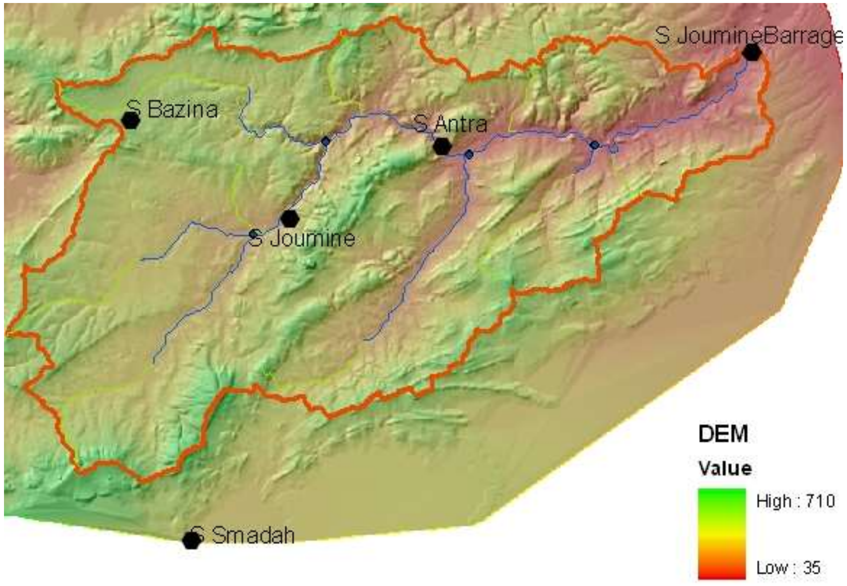
Water is for drinking and irrigation

Specific discharge (mm/year)	Precipitation (mm/year)	Evaporation (mm/year)
182	750	1629

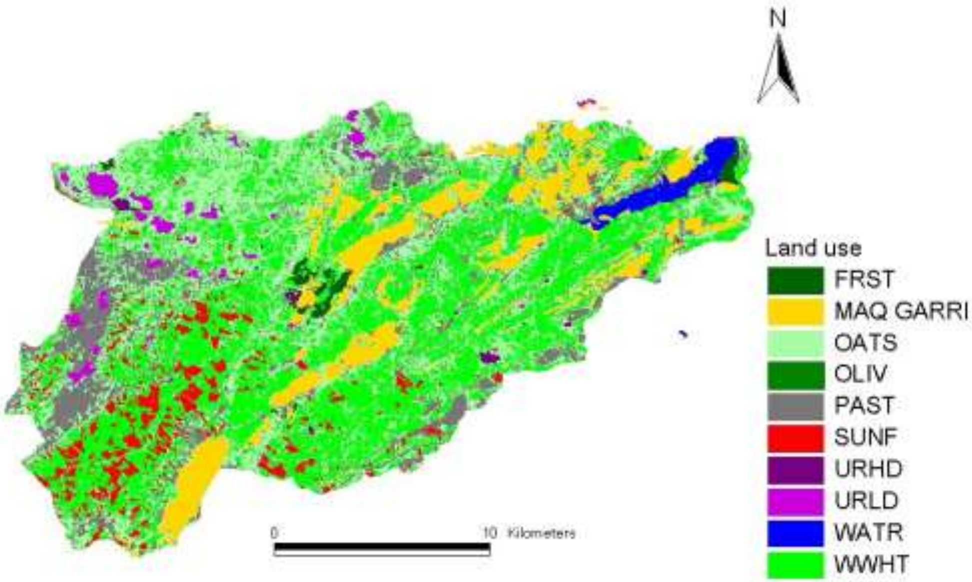
Model Inputs and Outputs data



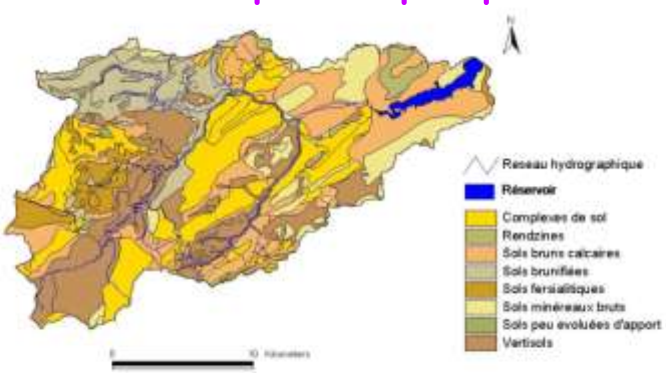
- Digital elevation model



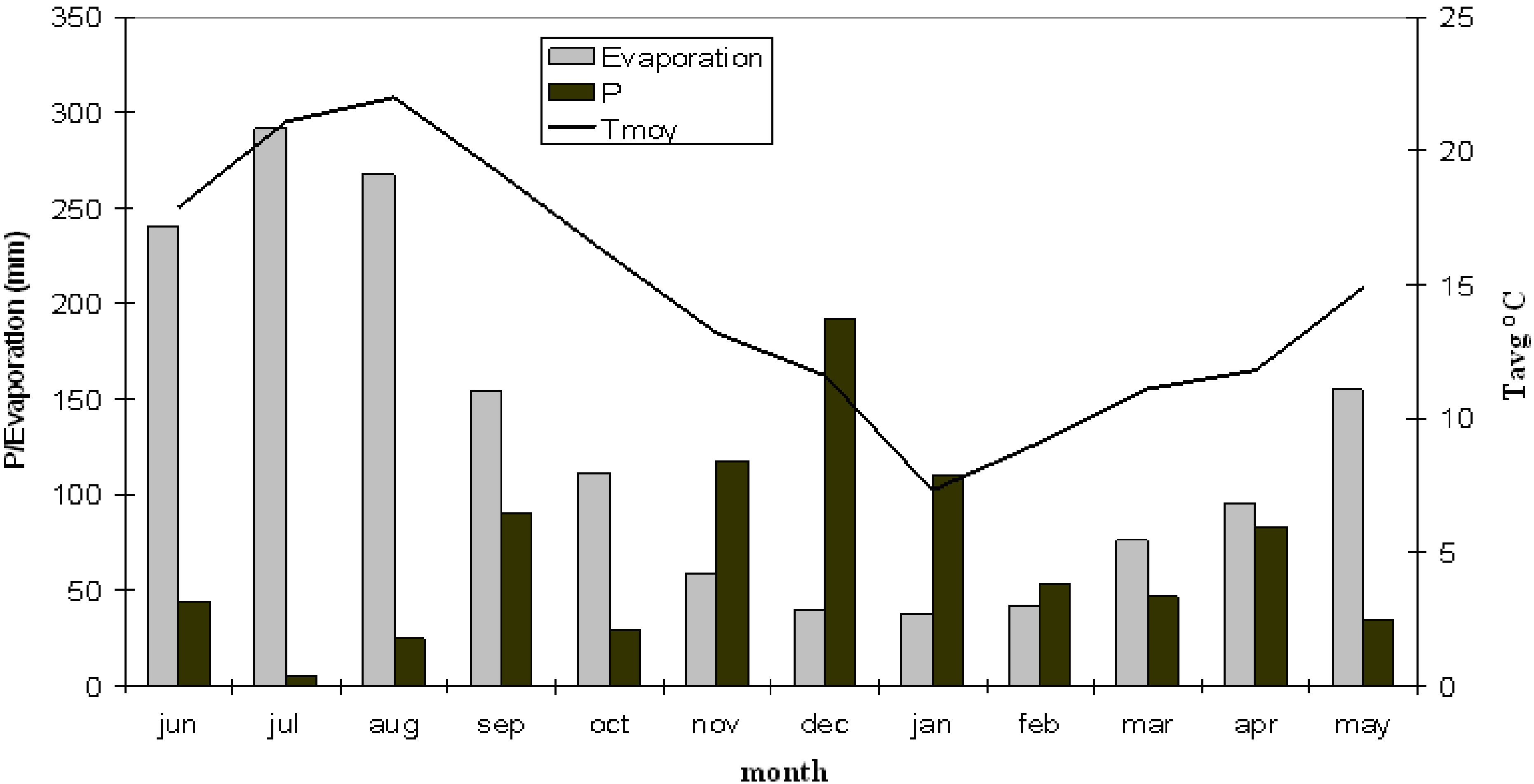
- Land use / cover map



- Soil map and properties profile



Average monthly precipitation, evaporation and temprature



Evaluation of Penman - Monteith method for calculating potential evapoatranspiration with measured climatic data and with those generated for SWAT-Predicted model actual evapotranspiration and Streamflow.

Results Comparison for daily model runs

Nash (EFF), coefficient of determination (R^2), for relationship between daily SWAT Predicted potential evpotraspiration (PET), actual evapotranspiration (ET) and stream flow (Q) using Penman-Monteith method for estimating potential evapotranspiration considering all weather data and missing data: -U=without wind speed, -R=without solar radiation, -T= without temperature.

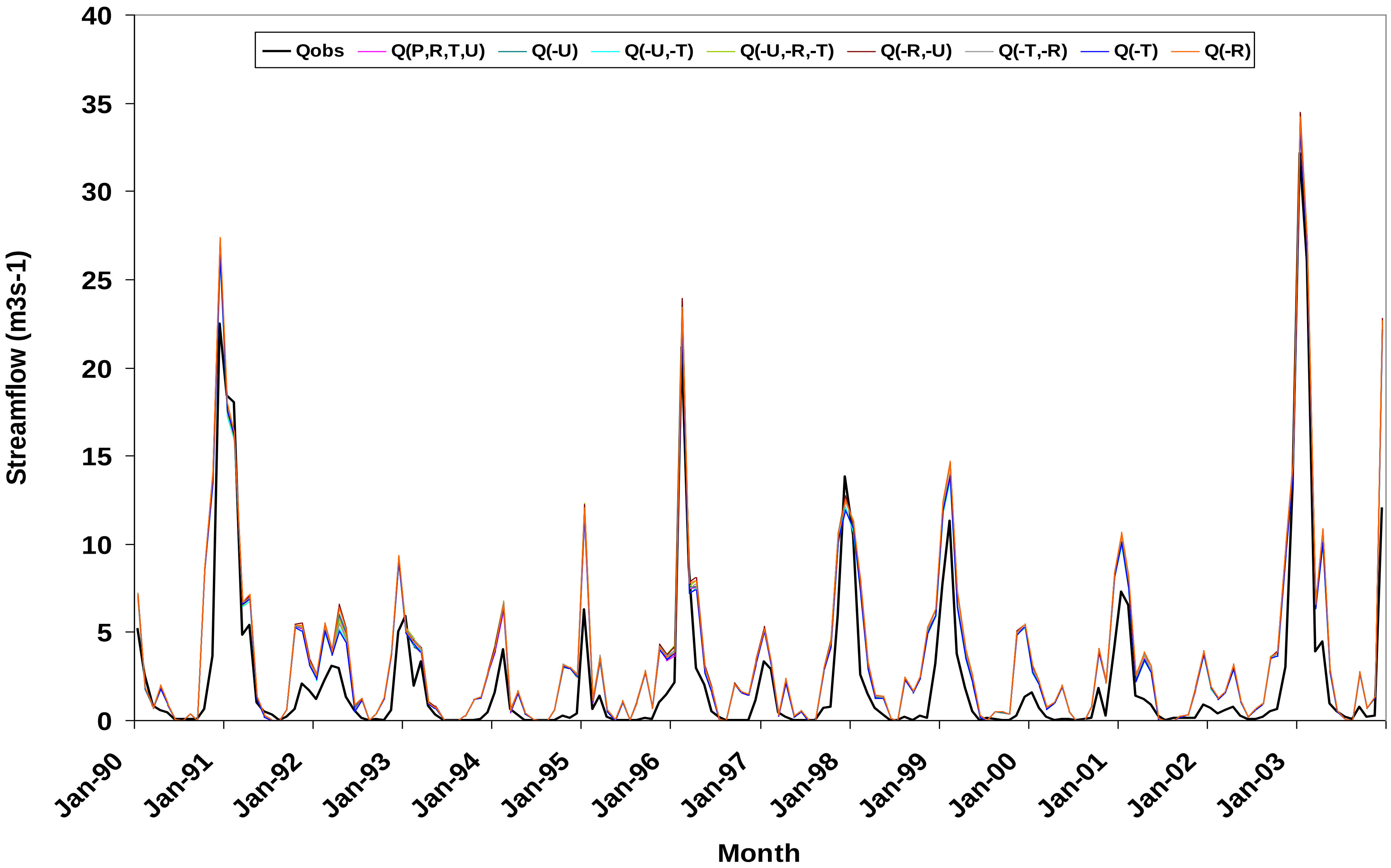
Used PET (measured climatic data) reference								
PET	**PET (P, R, T, U)**	**(-U)**	**(-U,-T)**	**(-U,-R,-T)**	**(-R,-U)**	**(-T,-R)**	**(-T)**	**(-R)**
Nash		**0.91**	**0.86**	**0.78**	**0.8**	**0.89**	**0.93**	**0.92**
R^2		**0.91**	**0.86**	**0.84**	**0.86**	**0.9**	**0.94**	**0.95**
Used ET (measured climatic data) reference								
ET	**ET (P,R,T, U)**	**(-U)**	**(-U,-T)**	**(-U,-R,-T)**	**(-R,-U)**	**(-T,-R)**	**(-T)**	**(-R)**
Nash		**0.92**	**0.78**	**0.65**	**0.99**	**0.73**	**0.85**	**0.84**
R^2		**0.92**	**0.8**	**0.7**	**0.57**	**0.77**	**0.87**	**0.86**
Used Q (measured climatic data) reference								
Q	**Q (P, R, T, U)**	**(-U)**	**(-U,-T)**	**(-U,-R,-T)**	**(-R,-U)**	**(-T,-R)**	**(-T)**	**(-R)**
Nash		**0.99**	**0.99**	**0.98**	**0.97**	**0.99**	**0.99**	**0.99**
R^2		**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**

Results Comparison for monthly model runs

Used PET (measured climatic data) reference								
PET	**PET (P, R, T, U)**	**(-U)**	**(-U,-T)**	**(-U,-R,-T)**	**(-R,-U)**	**(-T,-R)**	**(-T)**	**(-R)**
Nash		0.98	0.97	0.9	0.88	0.96	0.98	0.94
R^2		0.99	0.99	0.99	0.99	0.99	0.99	0.99
Used AET (measured climatic data) reference								
ET	**ET (P,R,T, U)**	**(-U)**	**(-U,-T)**	**(-U,-R,-T)**	**(-R,-U)**	**(-T,-R)**	**(-T)**	**(-R)**
Nash		0.99	0.93	0.93	0.97	0.94	0.94	0.98
R2		0.99	0.94	0.94	0.97	0.94	0.94	0.98
Used Q (measured climatic data) reference								
Q	**Q (P, R, T, U)**	**(-U)**	**(-U,-T)**	**(-U,-R,-T)**	**(-R,-U)**	**(-T,-R)**	**(-T)**	**(-R)**
Nash		0.99	0.99	0.99	0.99	0.99	0.99	0.99
R^2		0.99	0.99	0.99	0.99	0.99	0.99	0.99
Used observed streamflow reference								
Q	**Q (P, R, T, U)**	**(-U)**	**(-U,-T)**	**(-U,-R,-T)**	**(-R,-U)**	**(-T,-R)**	**(-T)**	**(-R)**
Nash	0.76**	0.757	0.77	0.74	0.72	0.74	0.77	0.73
R^2	0.88**	0.88	0.88	0.88	0.87	0.88	0.88	0.88

***indicated the comparison of simulated streamflow with measured data and those with generated data with observed streamflow.*

Comparison of the monthly observed streamflow with the simulated values based on measured as well as on generated weather data



SWAT - Predicting PET, ET and Streamflow using Penman - Monteith, Hargreaves and Priestly Taylor methods for estimating potential evapotranspiration

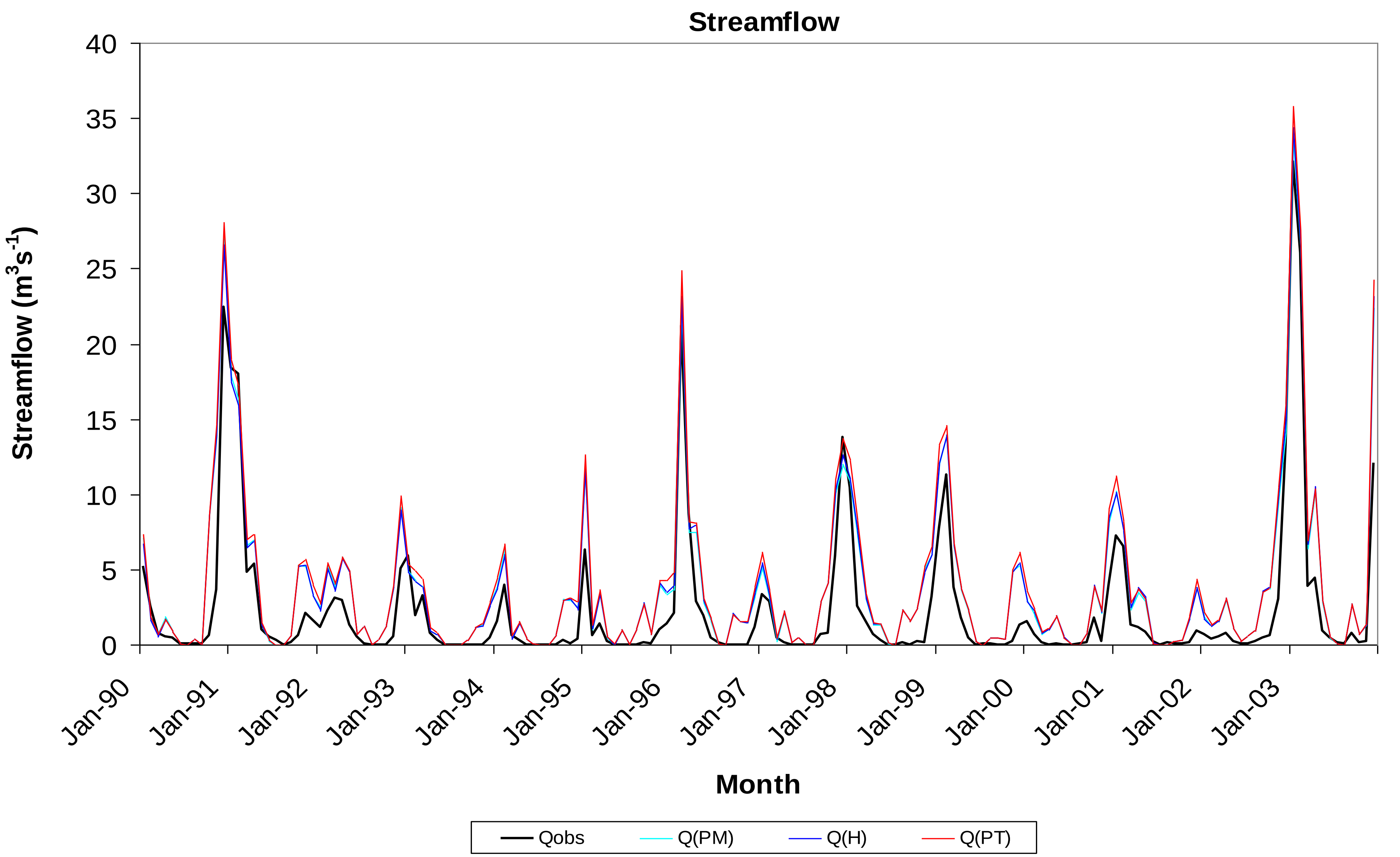
Results Comparison for daily model runs

Used Simulated Potential evpotranspiration (PM) reference			
	PET(PM)	PET (H)	PET(PT)
Nash		0.66	0.72
RMSE (mm)		1.5	1.37
R2		0.74	0.77
Used Simulated Actual evpotranspiration (PM) reference			
	ET (PM)	ET(H)	ET(PT)
Nash		0.64	0.64
RMSE (mm)		0.43	0.43
R2		0.7	0.7
Used Simulated Streamflow (PM) reference			
	Q(PM)	Q(H)	Q(PT)
Nash		0.99	0.99
RMSE (m^3s^{-1})		0.42	0.85
R2		0.99	0.99

Results Comparison for monthly model runs

Used Simulated Potential evpotranspiration (PM) reference			
	PET(PM)	**PET (H)**	**PET(PT)**
Nash		**0.82**	**0.86**
R2		**0.95**	**0.94**
Used Simulated Actual evpotranspiration (PM) reference			
	ET (PM)	**ET(H)**	**ET (PT)**
Nash		**0.97**	**0.92**
R2		**0.97**	**0.93**
Used Simulated Q(PM) reference			
	Q(PM)	**Q(H)**	**Q(PT)**
Nash		**0.99**	**0.99**
R2		**0.99**	**0.99**
Used observed Streamflow Qobs reference			
	Q(PM)	**Q(H)**	**Q(PT)**
Nash	**0.76**	**0.74**	**0.7**
R2	**0.88**	**0.88**	**0.88**

Comparison of the monthly observed streamflow with values simulated using PM, H and PT methods for estimating potential evapotranspiration



Sensitivity analysis (SA)

✓Latin Hypercube (LH)-One-factor-At time (OAT)

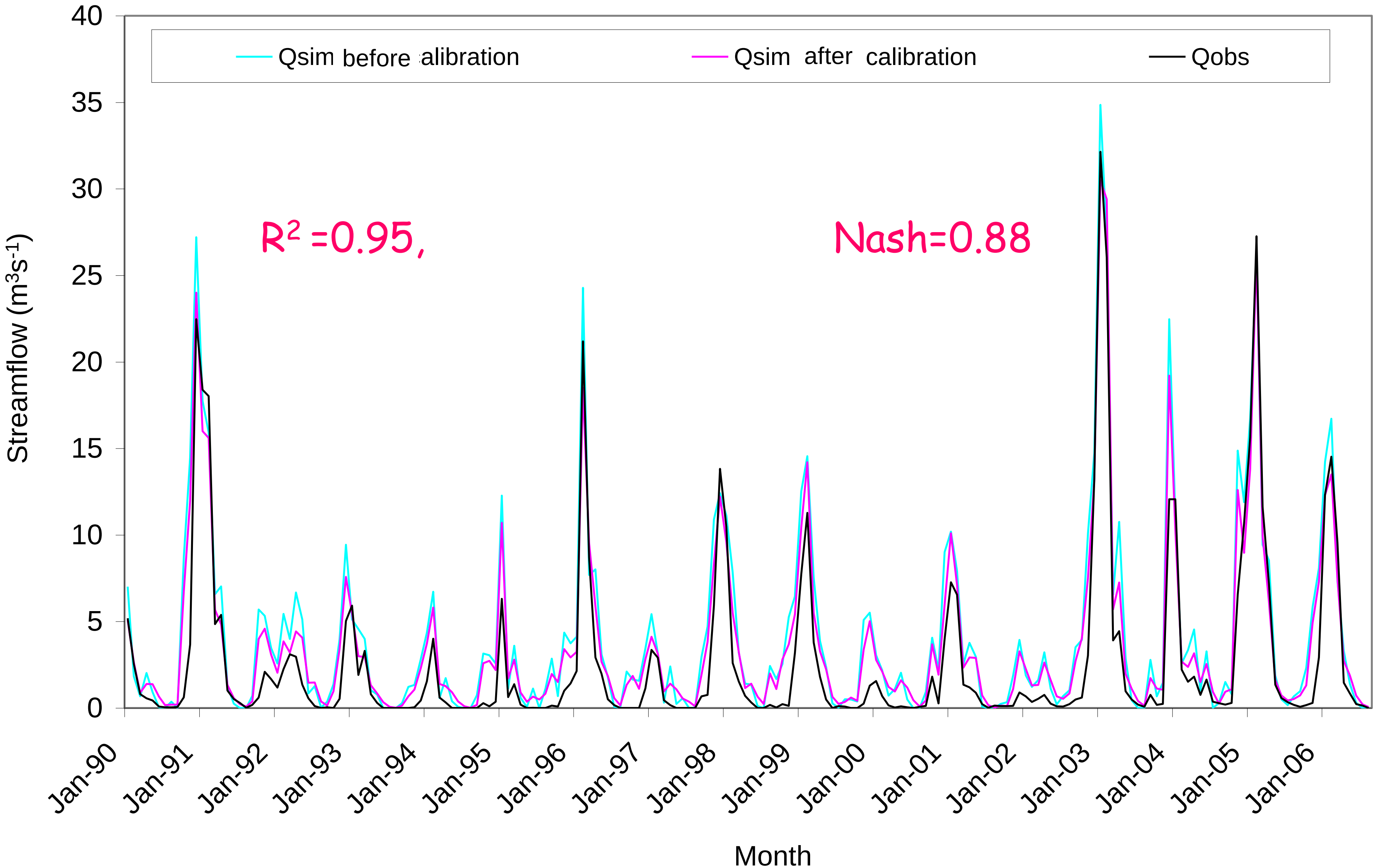
✓A parameters SA provides insights on which parameters contribute most the output variance.

✓The SA was performed for 16 parameters of hydrology that are related to streamflow (Q).

✓The parameters for calibration were selected by the SA results (the red parameters)

Paramètres	rang
Alpha_Bf	1
Cn2	2
Ch_K2	3
Ch_N2	4
Esco	5
Sol_Z	6
Sol_Awc	7
Slope	8
Sol_K	9
Rchrg_Dp	10
Surlag	11
Epco	12
Gwqmn	13
Gw_Delay	14
Gw_Revap	15
Revapmn	16

Results of autocalibration of SWAT model



❖ The results show that the generated data did reproduce acceptably well the computations of PET passed on the Penman-Monteith method.

❖ However, using generation procedures to replace missing climatic data had an impact on daily actual evpotranspiration simulations.

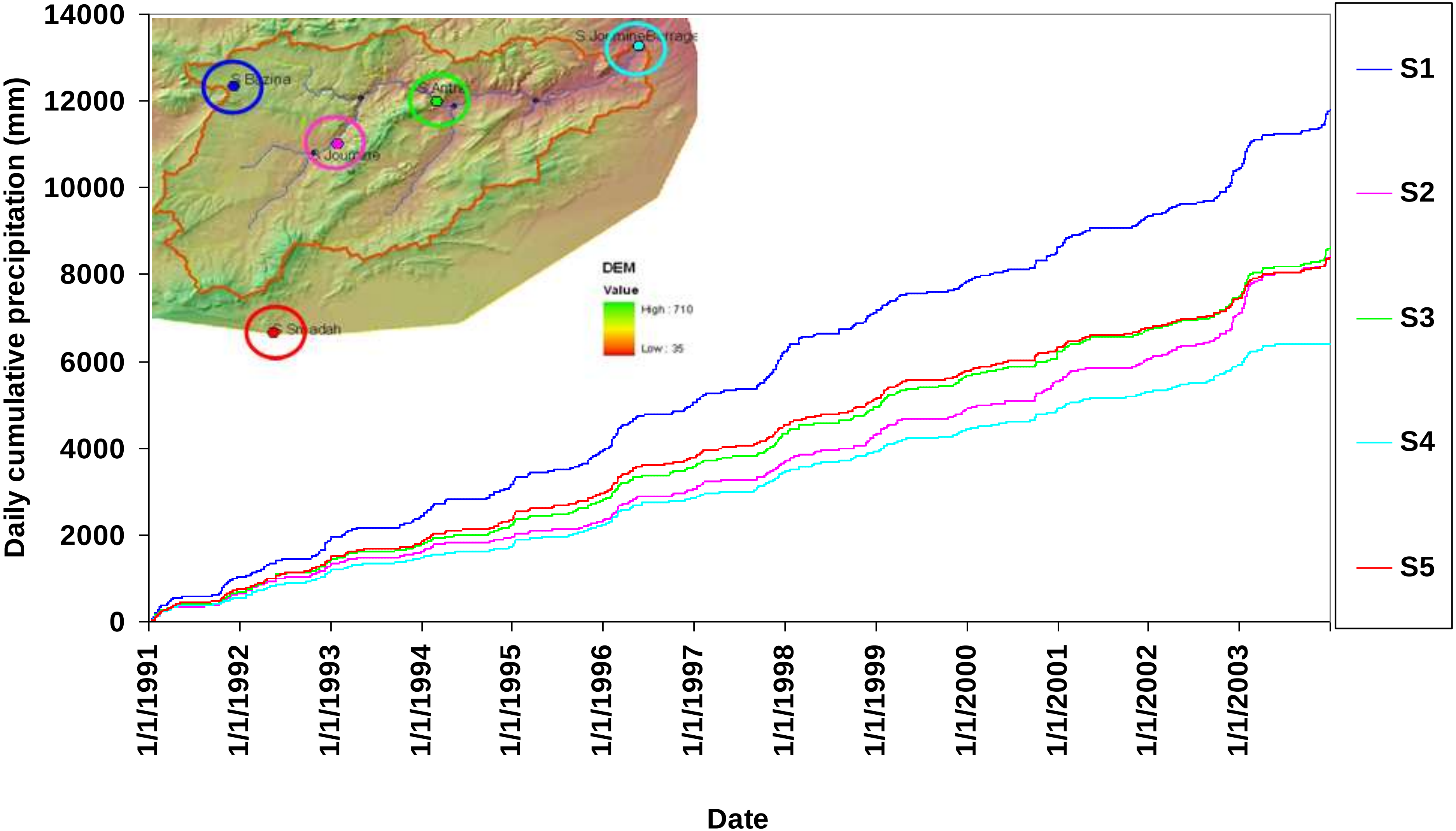
❖ Daily and monthly streamflow modeling results showed a good similarity between those computed based on generated data and those with measured data from a local climatic station.

❖ The advantage of generating climatic data based PET methods is to provide an option to estimate these variables when the weather stations do not have full dataset.

❖ The alternative ET methods (PM, H, PT) integrated in SWAT model for estimating PET showed a low influence in monthly streamflow and, actual evpotranspiration simulations.


Thank you for your attention

Daily Cumulative precipitation at 5 stations



❖ **In the winter, the oueds that drain its hillside basin bring down large amounts of fresh water and thus drown the marshes and increase the level of the water in Lake Ichkeul.**

❖ **In the summer, the water level drops as the oueds dry up and intense evaporation takes place, resulting in increased salinity. This drop in the water level sucks in salt water from the Bizerte Lake via Oued Tinja.**

❖ **It is this double seasonal alternation between a high water level with low salinity and a low water level with high salinity, that gives the Ichkeul ecosystems their originality.**