Assessment of Ecosystem services with considering impact of Climate change on Godavari basin

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Contents of presentation

Introduction

- Hydrological simulation models are being used address an extensive array of water resources problems across the globe,including the effects of alternative best management practices (BMPs) and future climate change on stream-flow
- Global climate models (GCMs)/regional climate models (RCM's) downscaled data is used as input to hydrologic model to simulate the corresponding future flow regime in the catchment
- To drive a hydrological model, reliable information on climatological variables (e.g. temperature, precipitation, evapotranspiration, etc.) and their distribution in space and time are required.

Study area

Godavari Basin extends over an area of 3,12,812 km^2, which is nearly 9.5% of the total geographical area of the country.

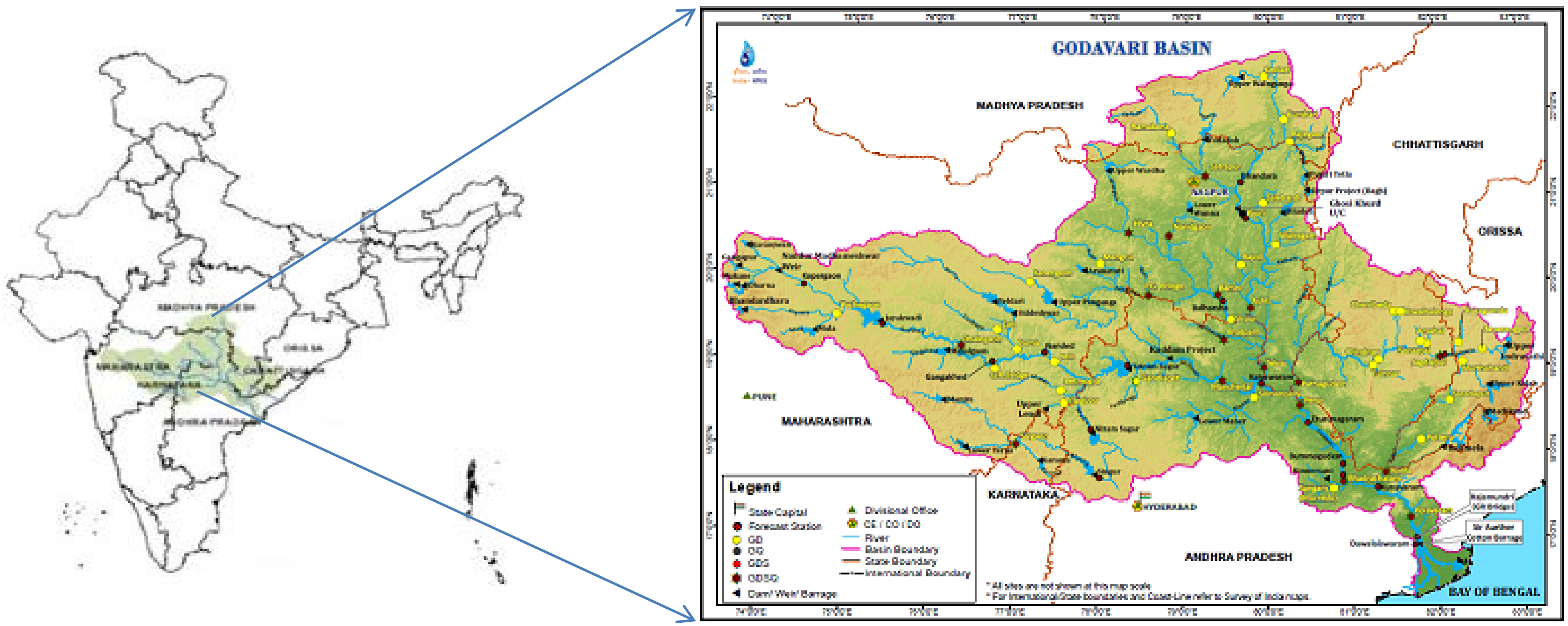

Figure 1: Godavari basin

- The Godavari, Perennial River of India is the Second largest river in India.
- It flows in the southern India and is considered to be one of the seven sacred rivers.
- The annual rainfall of Godavari basin varies from 3000 mm to 600 mm.
- The Godavari basin receives major part of its rainfall during the Southwest monsoon period. They contribute about 16% of the total annual rainfall in the Godavari basin

Motivation to take up this study

- The present status of the Godavari river basin, considering the drought and upcoming projects it is clear that the effects of all these will be on eco-system of the river and surrounding areas.
- A coupled atmospheric and hydrological modeling is necessary to understand the quality and quantity of flow in river
- This study we consider the effect of climate change on the river basin, concerning to the flow in the river using QSWAT and intern to study the effect on the ecosystem.

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Objectives

- Developing a Hydrological model for Godavari basin using QSWAT
- Calibrate and validation of stream flow using SWAT-CUP
- Prepare simulated climate change data for watershed-based hydrologic impact studies using the CMhyd (Climate Model data for hydrologic modelling) tool
- Use of downscaled (bias corrected) atmospheric parameters in hydrological model to predict future climate scenarios
- To support decisions towards sustainable water management in the Godavari basin, by quantitatively estimating the availability of water-related ecosystem services in the basin
- Use of the outputs from QSWAT, for mapping ecosystem services

Methodology

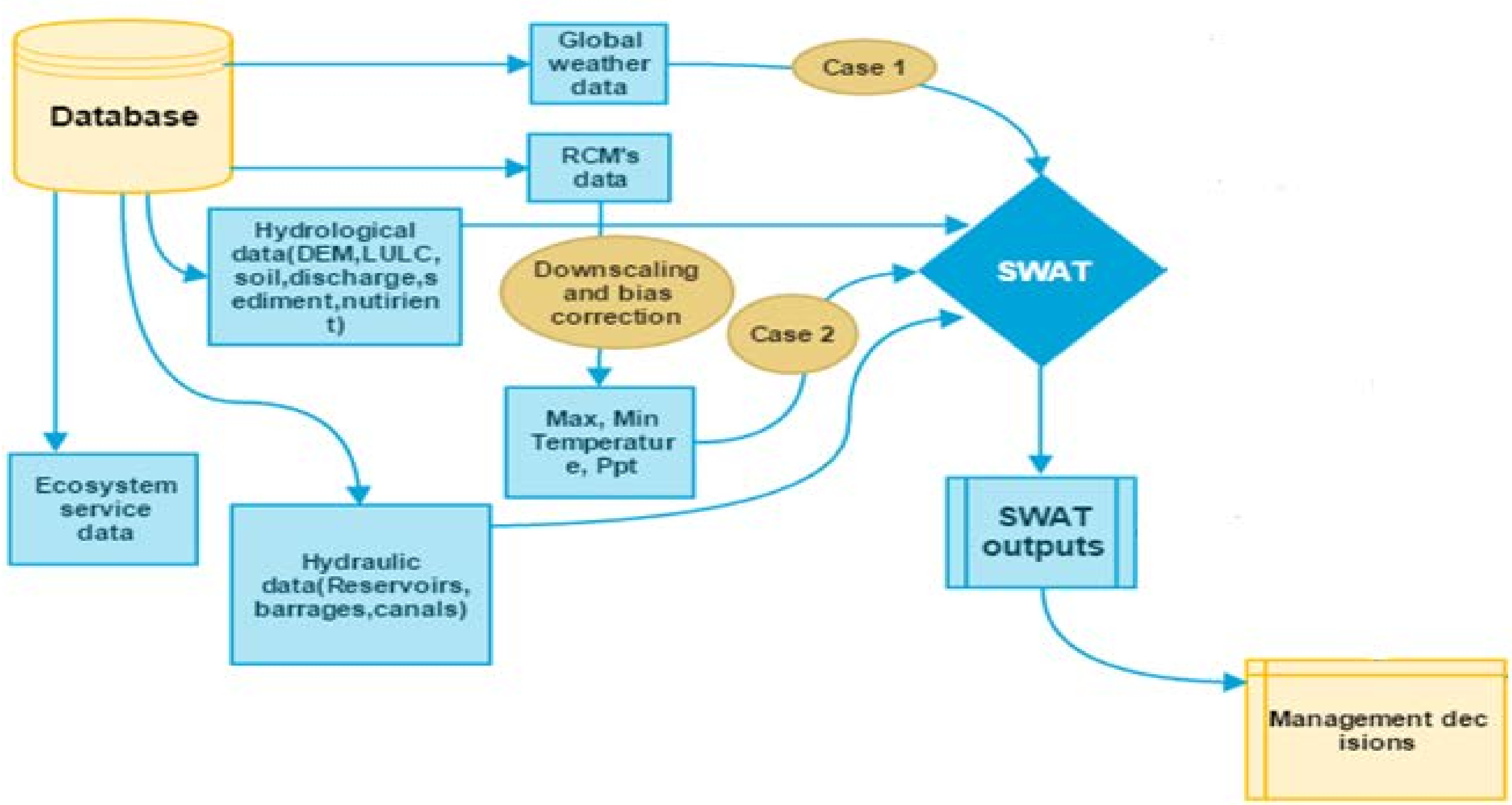

Figure 2: Overview of methodology

CMhyd(Climate Model data for hydrologic modeling)

- Prepare simulated climate change data for watershed-based hydrologic impact studies
- It Identifies biases between observed and simulated historical climate variables to parameterize a bias correction algorithm that is used to correct simulated historical climate data
- CORDEX achieve was considered for regional climate model
- CMIP5(South asia) climate projection data was used for entire godavari basin
- Pr ,tmax and tmin variables were considered for historical time period of 1995-2005, and future data(RCP85) for 2091-2100
- Observed data(Pr, Tmax and Tmin) used considering 279 weather stations falling in godavari basin

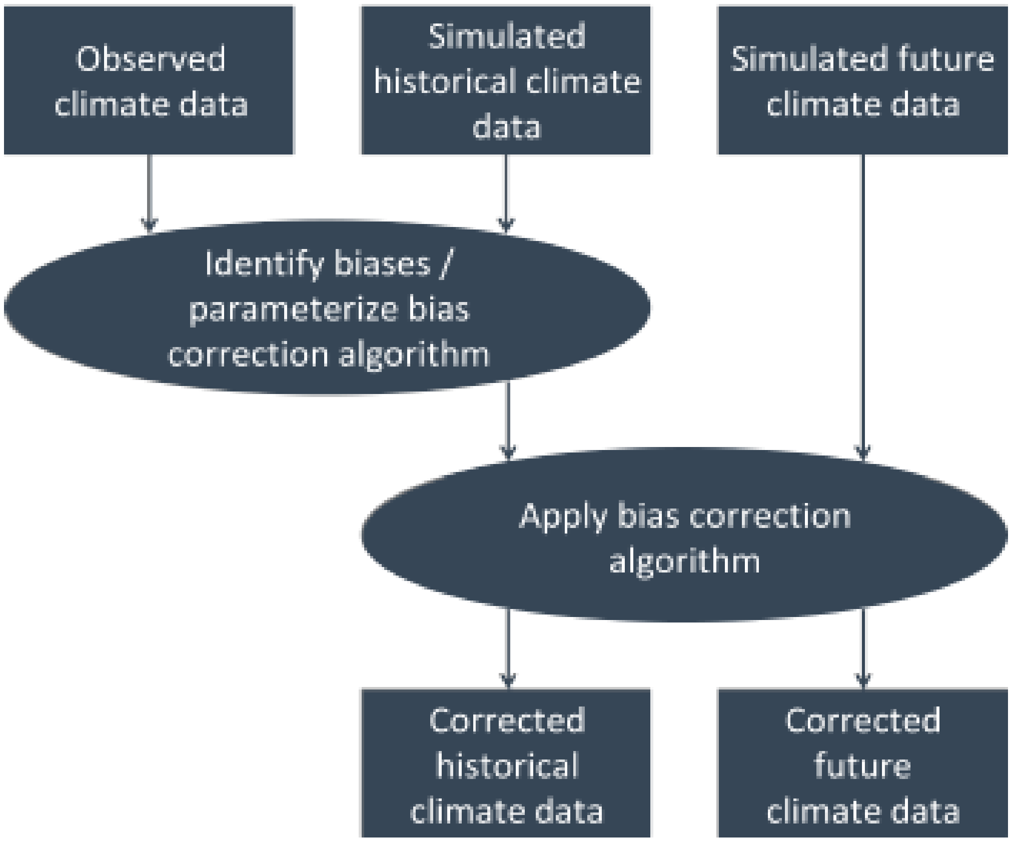

Figure 3: Bias correction framework
(Source: Cmhyd user manual)

Plots

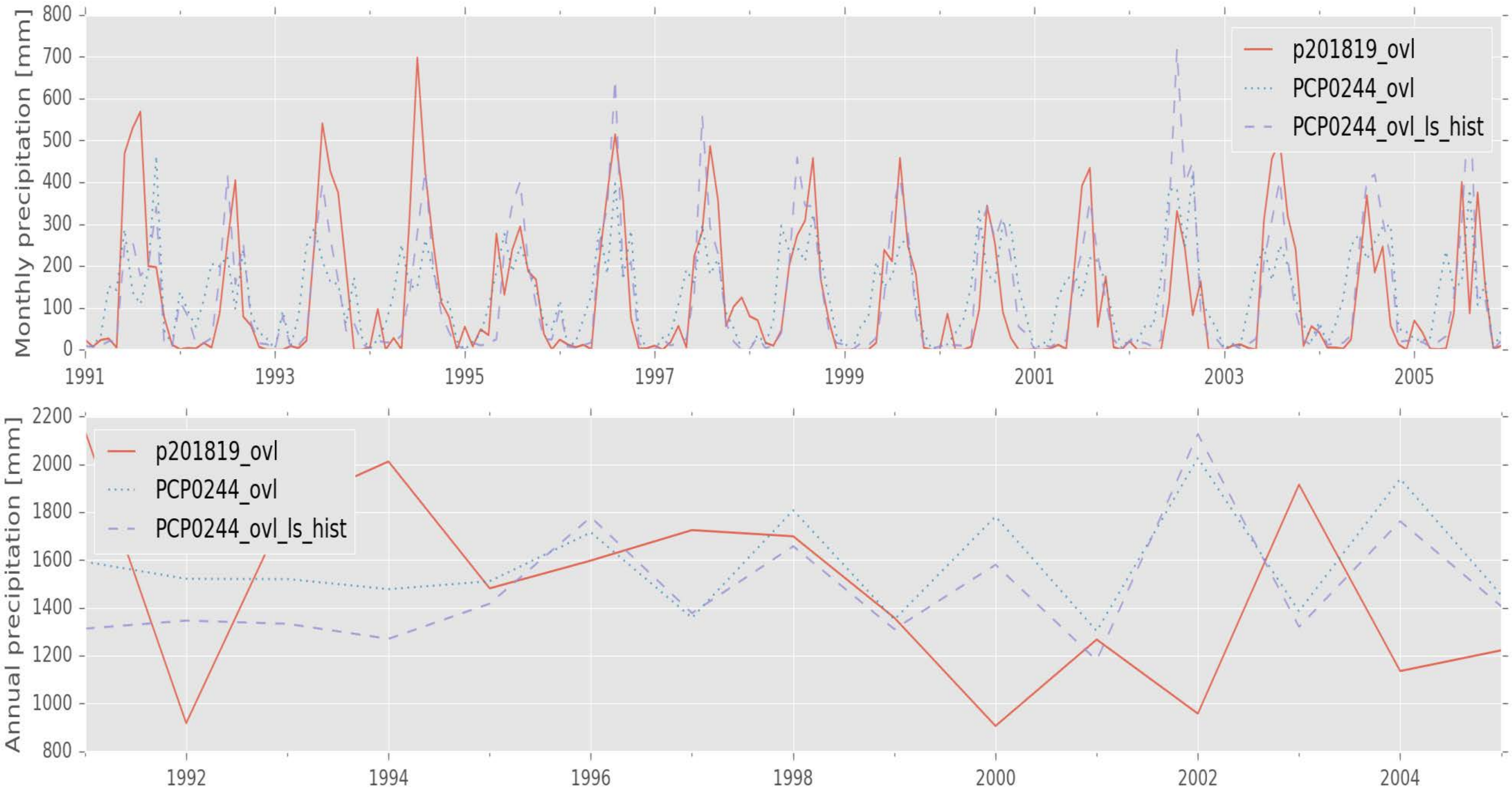

Figure 4: PCP time series for gauge station 244

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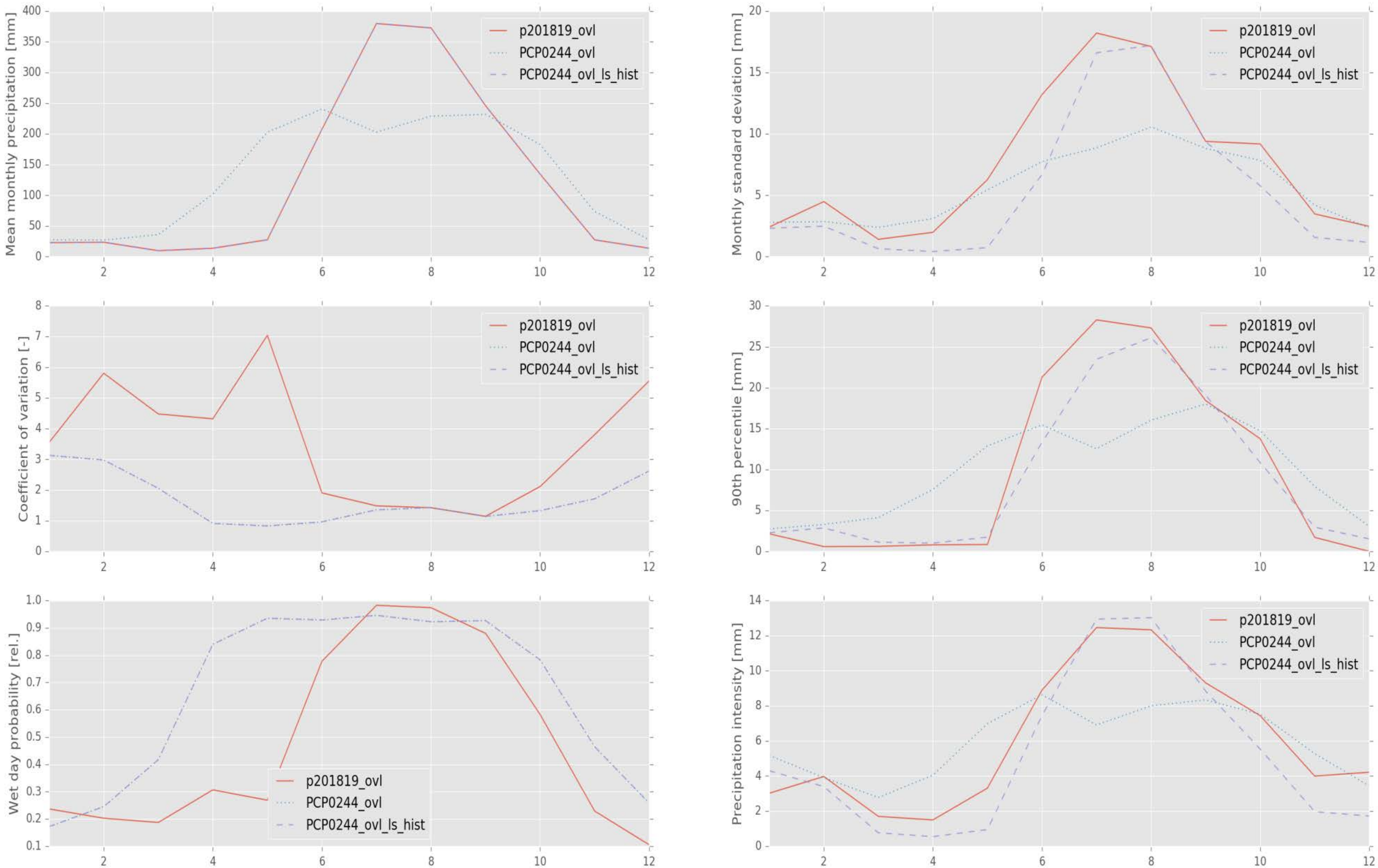

Figure 5: PCP monthly summary for gauge station 244

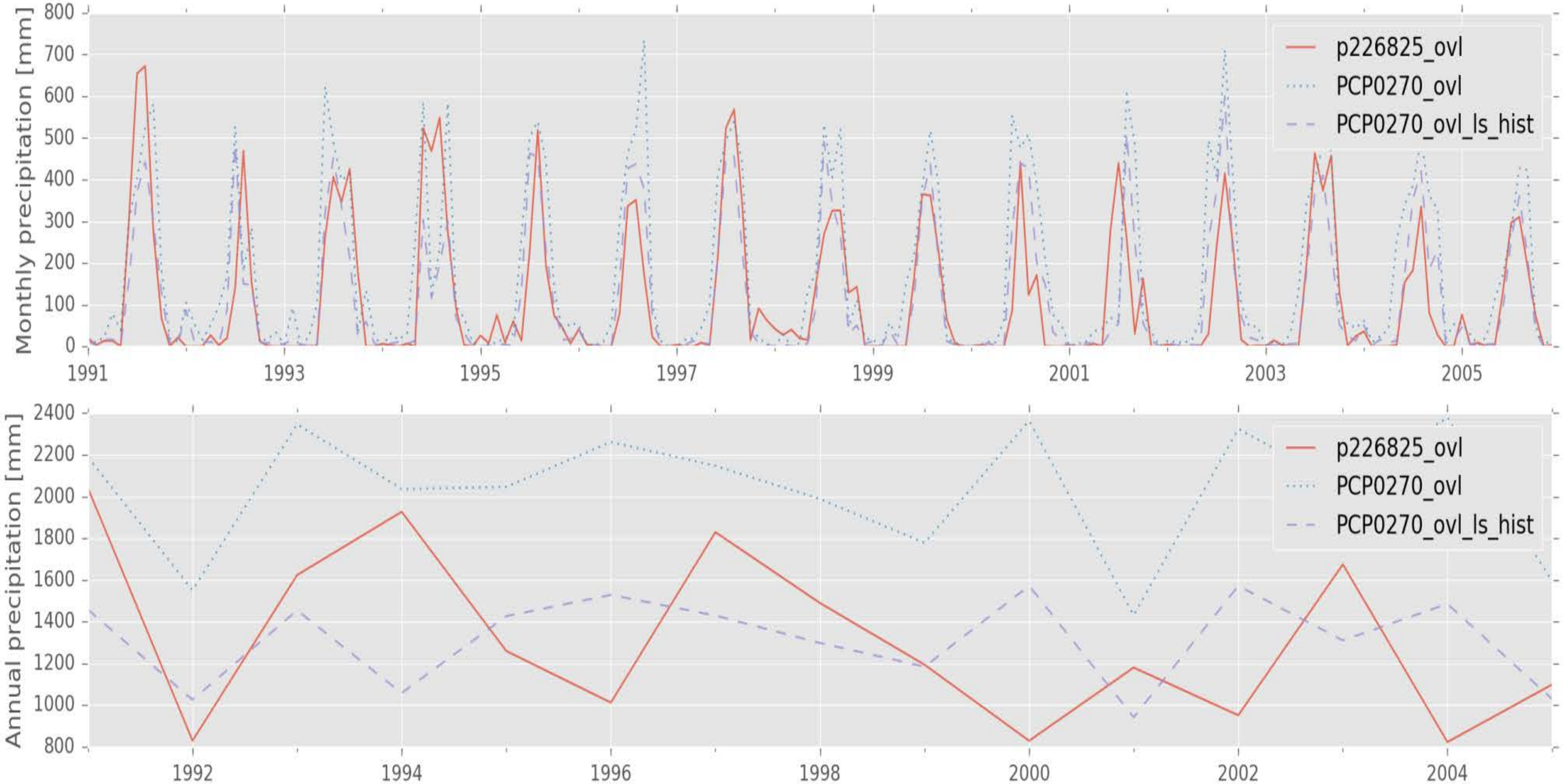

Figure 6: PCP time series for gauge station 270

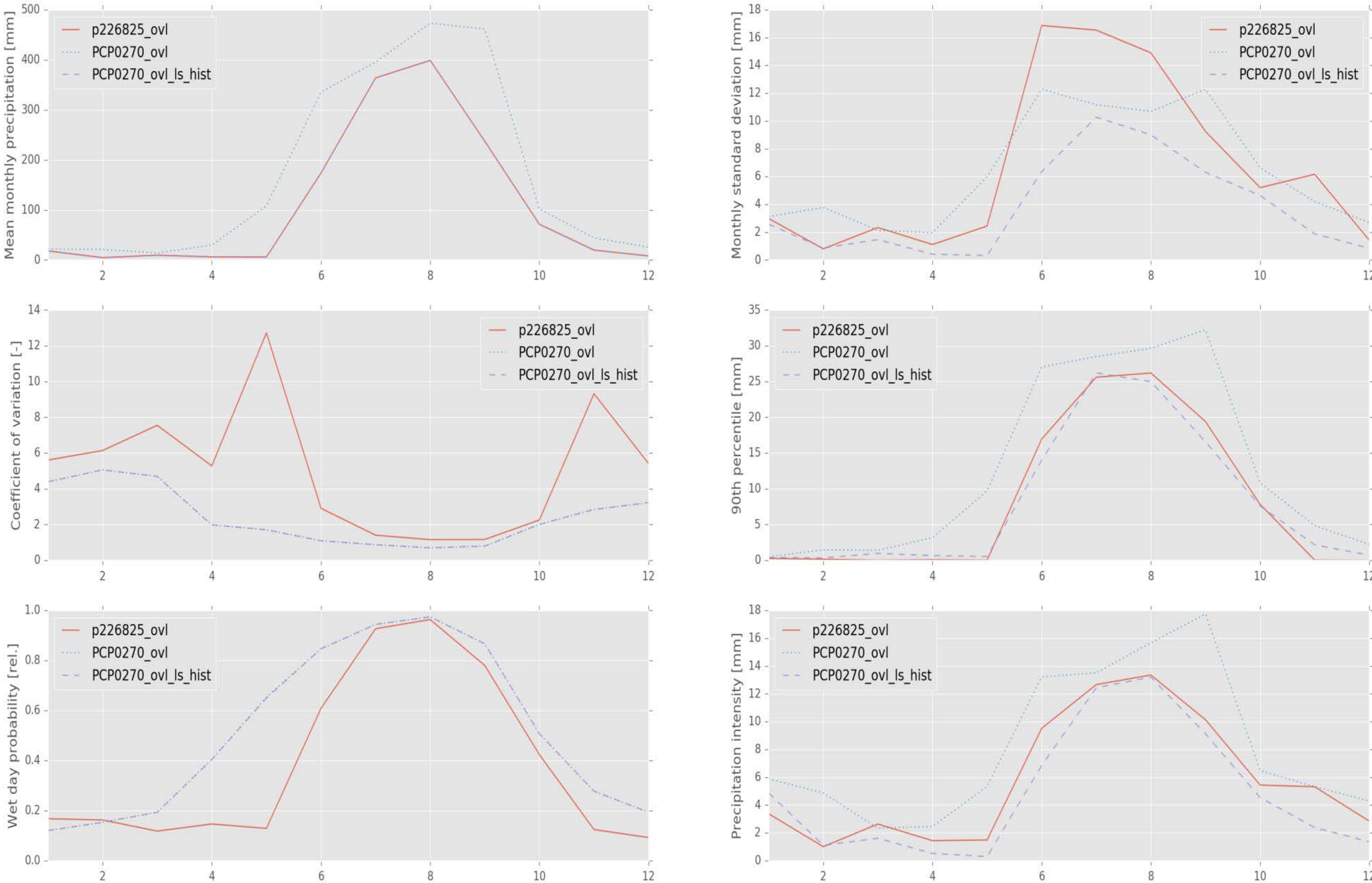

Figure 7: PCP monthly summary for gauge station 270

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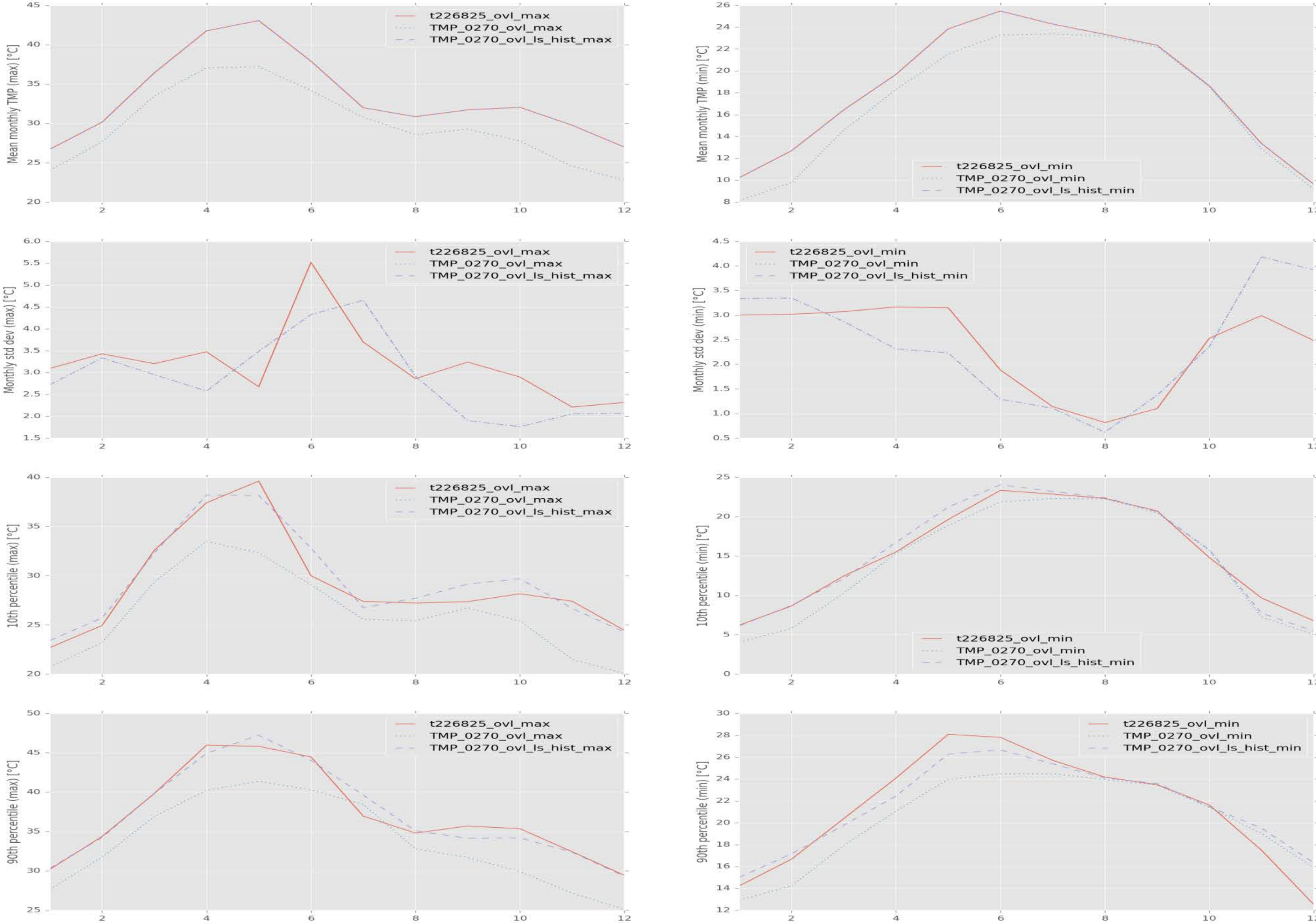

Figure 8: TMP monthly summary for gauge station 270

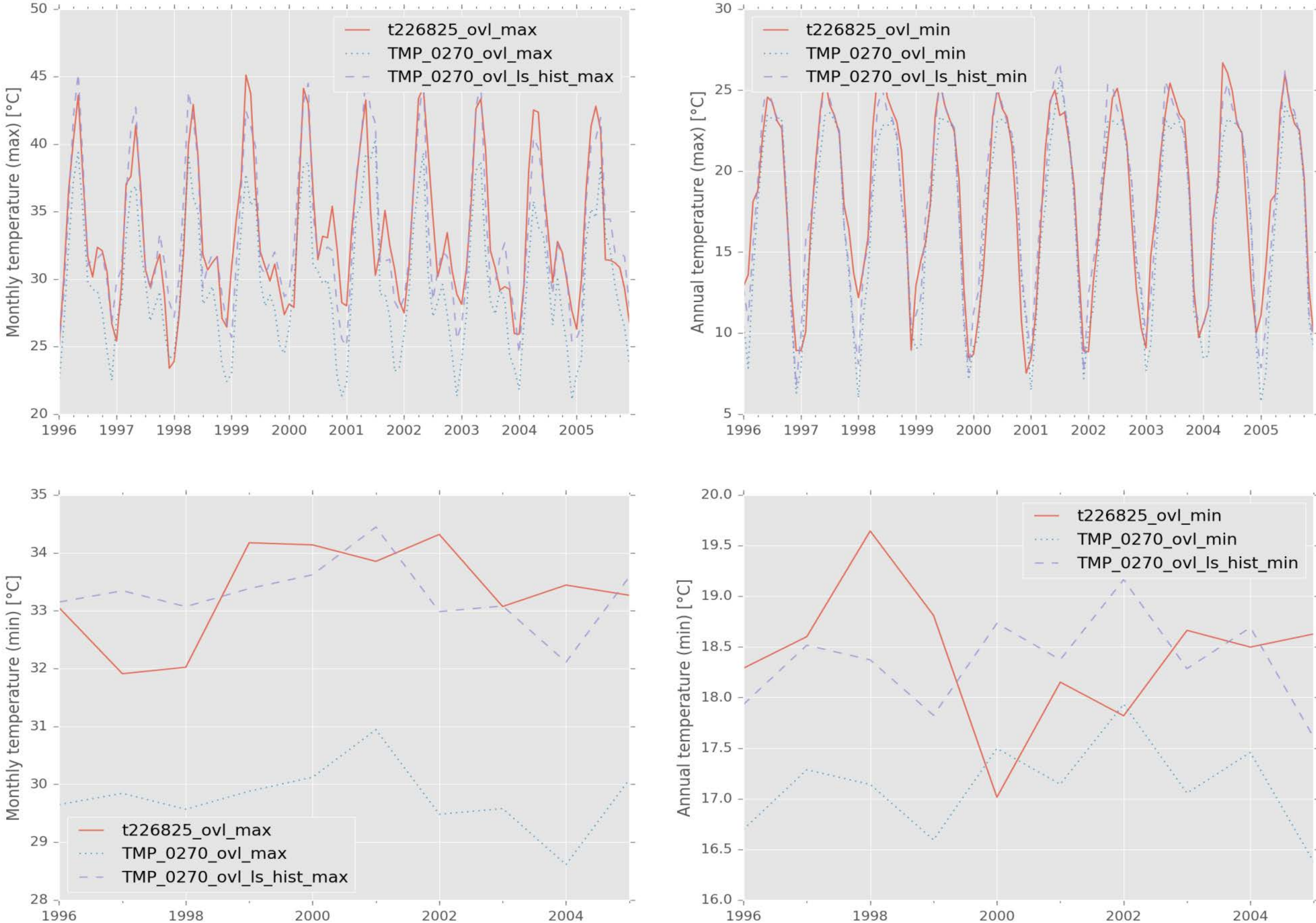

Figure 9: TMP time series for gauge station 270

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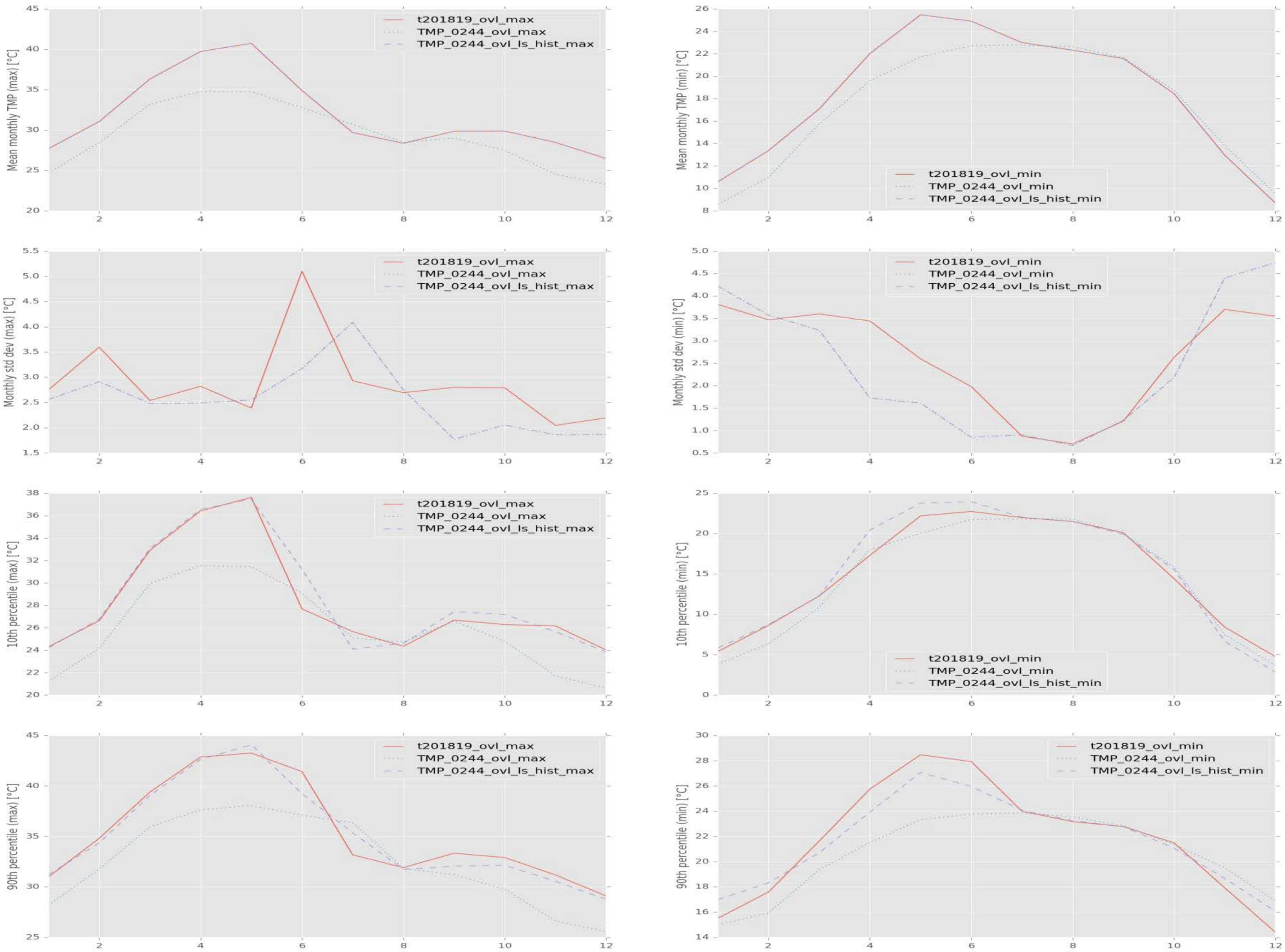

Figure 10 : TMP monthly summary for gauge station 244

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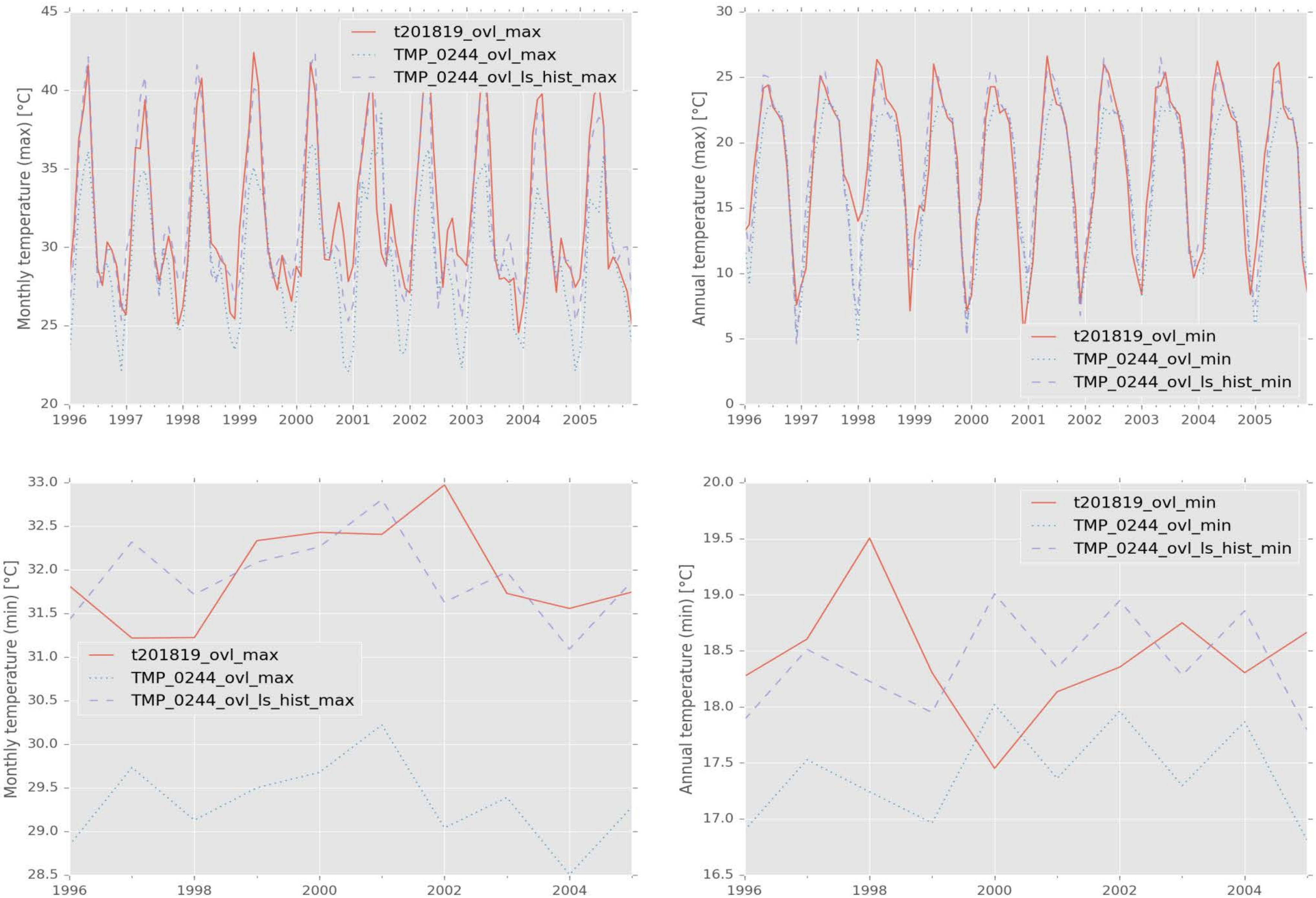

Figure 11: TMP time series for gauge station 244

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QSWAT – The QGIS interface for SWAT

- 120 sub-basins were formed in the entire Godavari basin
- The model was run from the period 1970 to 2014
- 5 years of warm period was considered
- For calibration of stream flow period of 1984-2004 was considered
- Validation was done for stream flow was from 2005-2014
- 5 parameters namely CN, GW_REVAP, REVAPMN, ESCO and EPCO was considered for optimization

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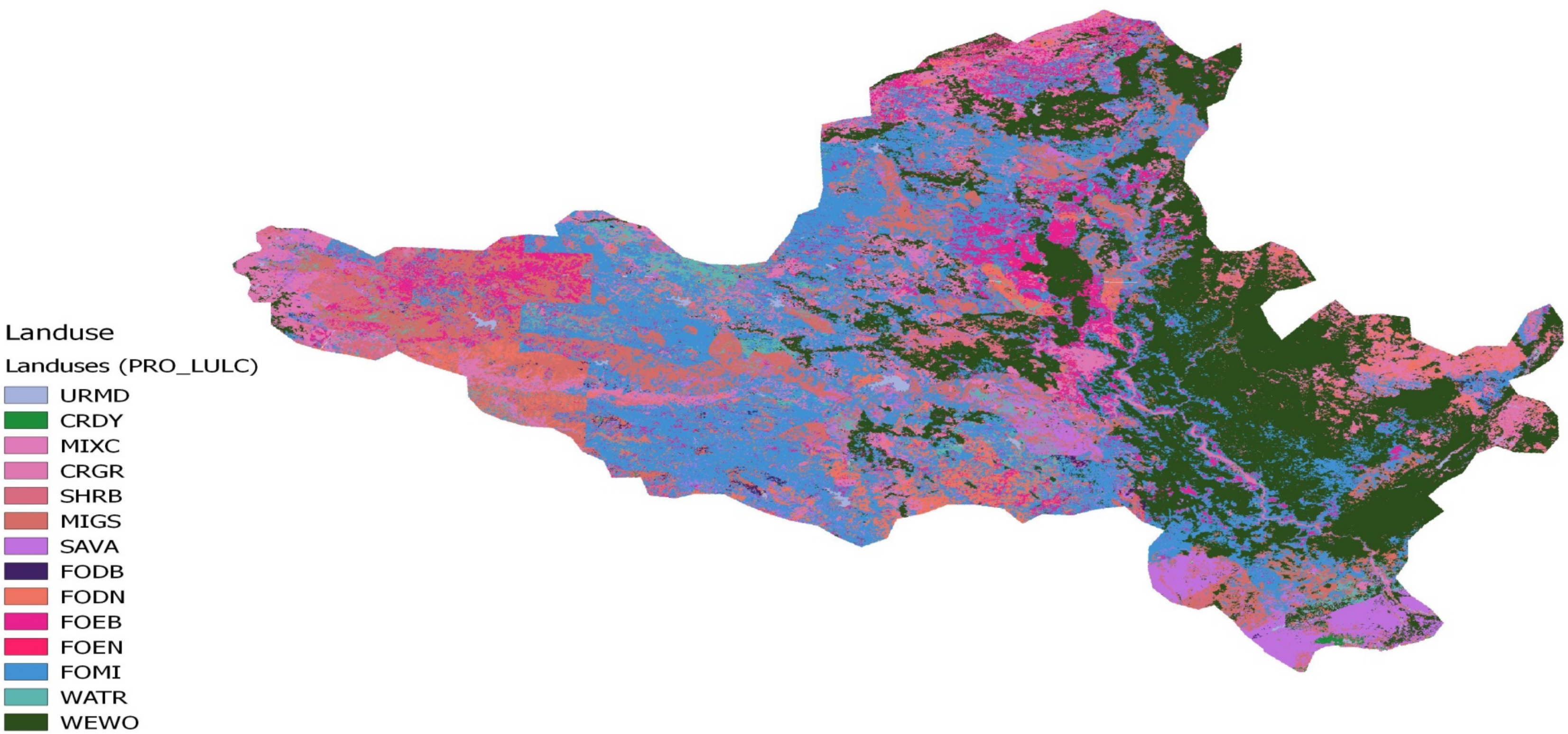
LULC map of godavari basin



Sub-basins

Watershed (subs1)
SWAT subbasin
discharge_data
Gandlapet
Mancherial
Somanpally
Cherla
Bhadrachalam
Koida
Polavaram

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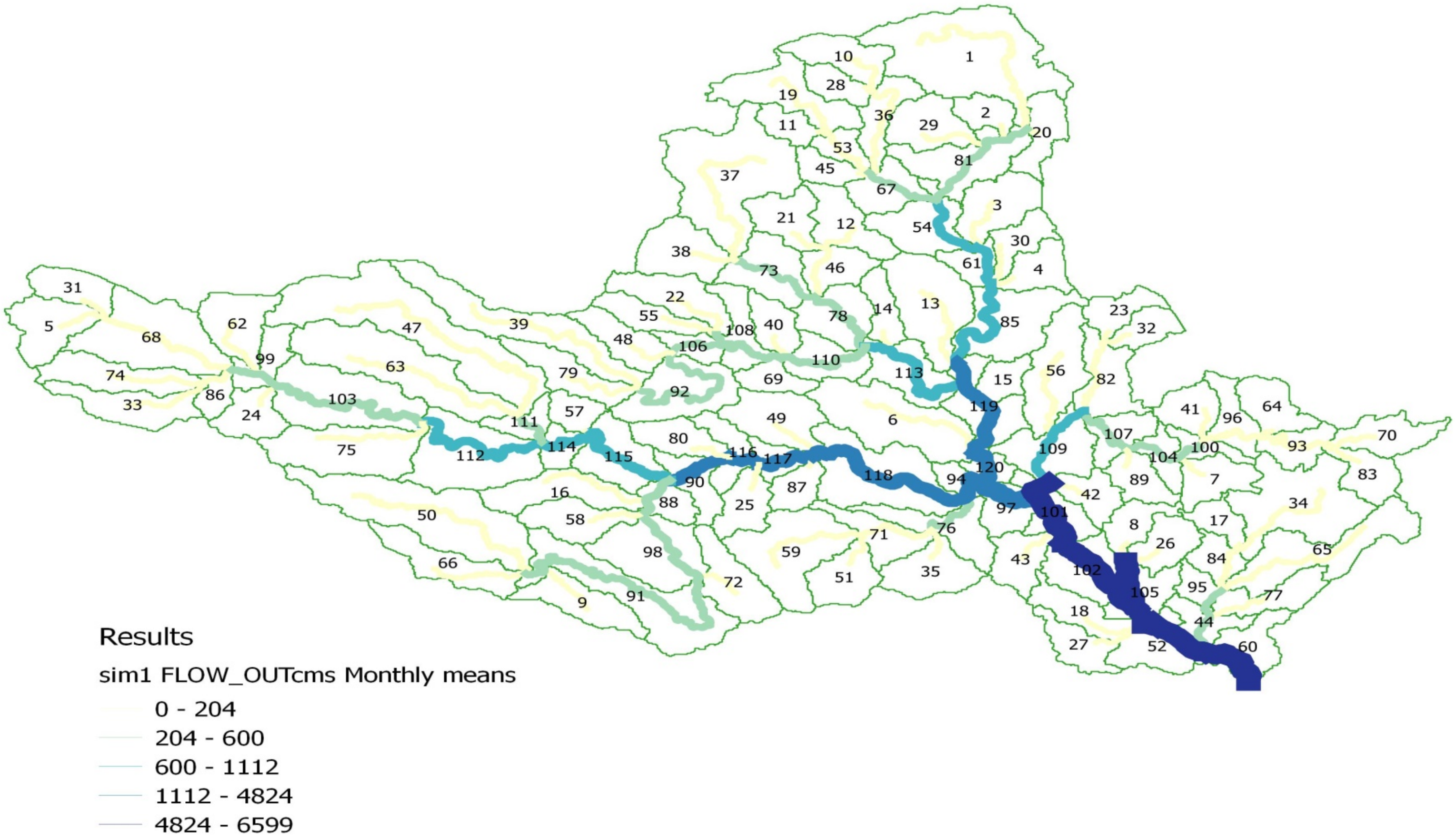
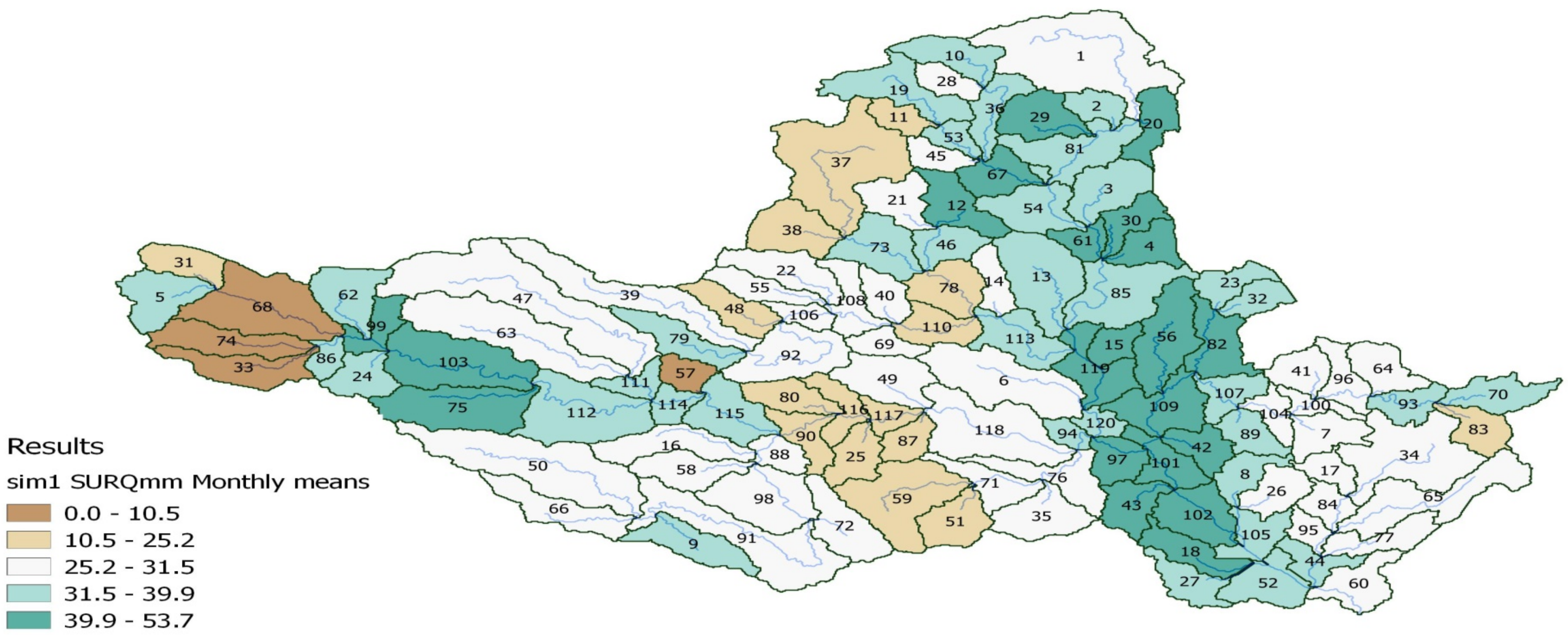
Flow in the river basin



Surface runoff obtained



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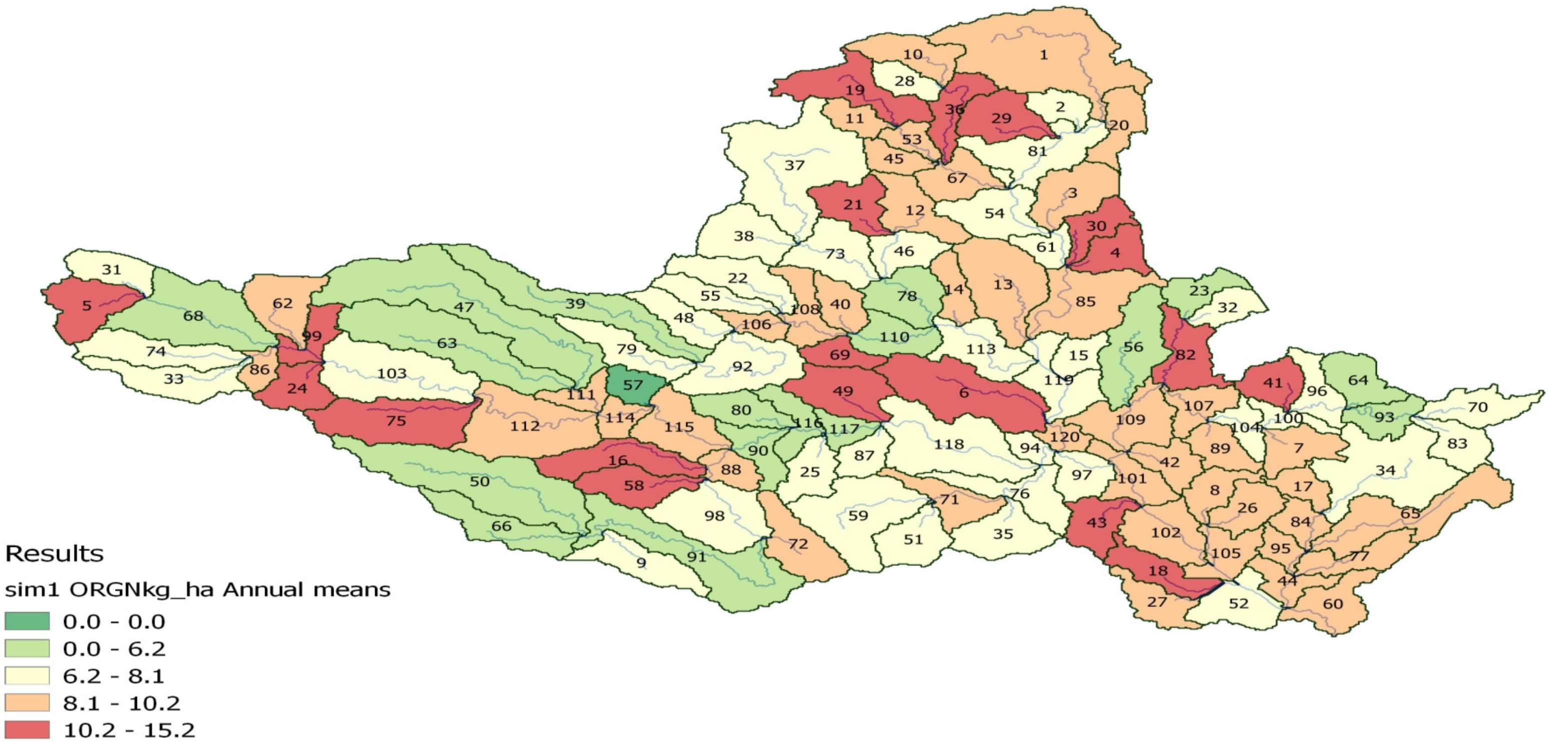
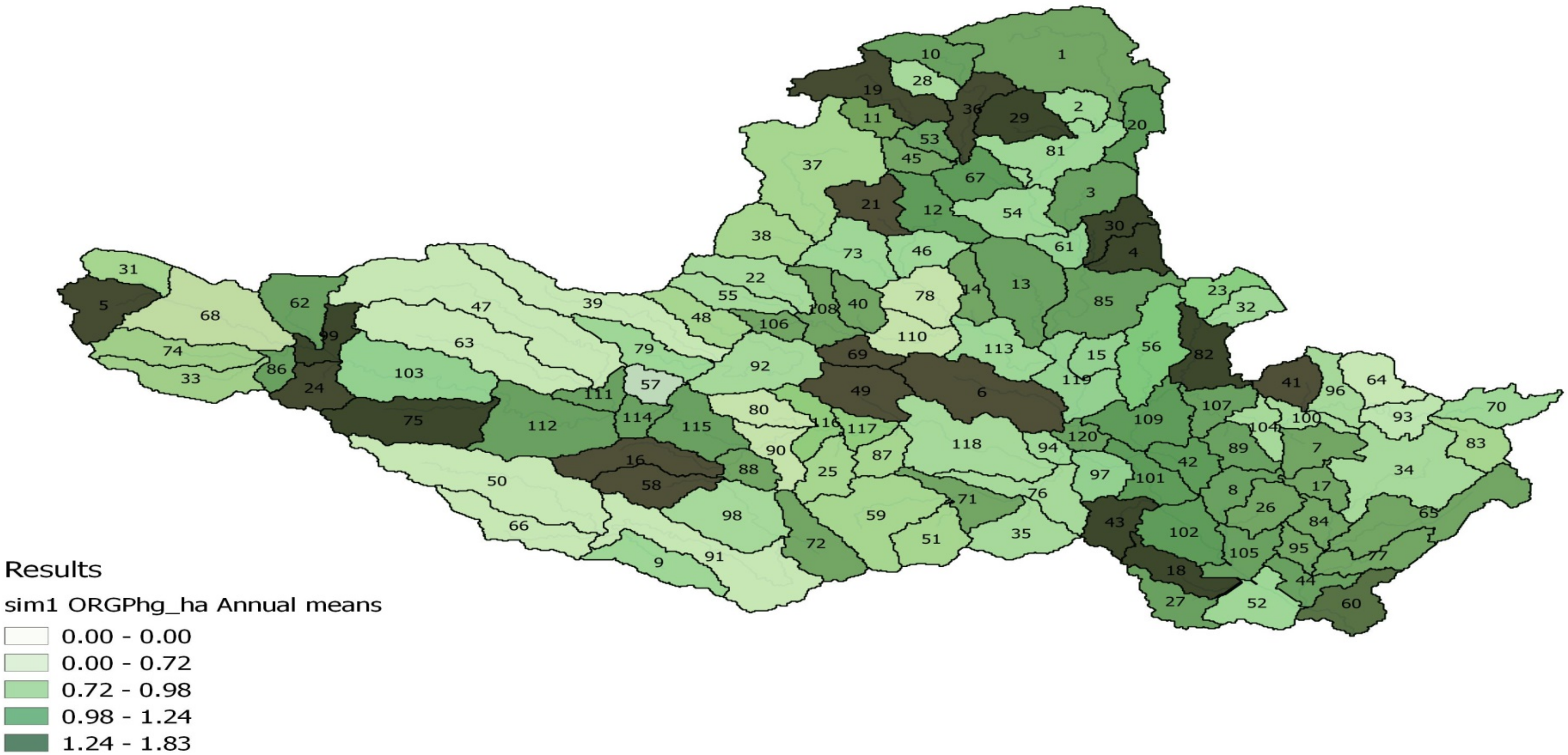
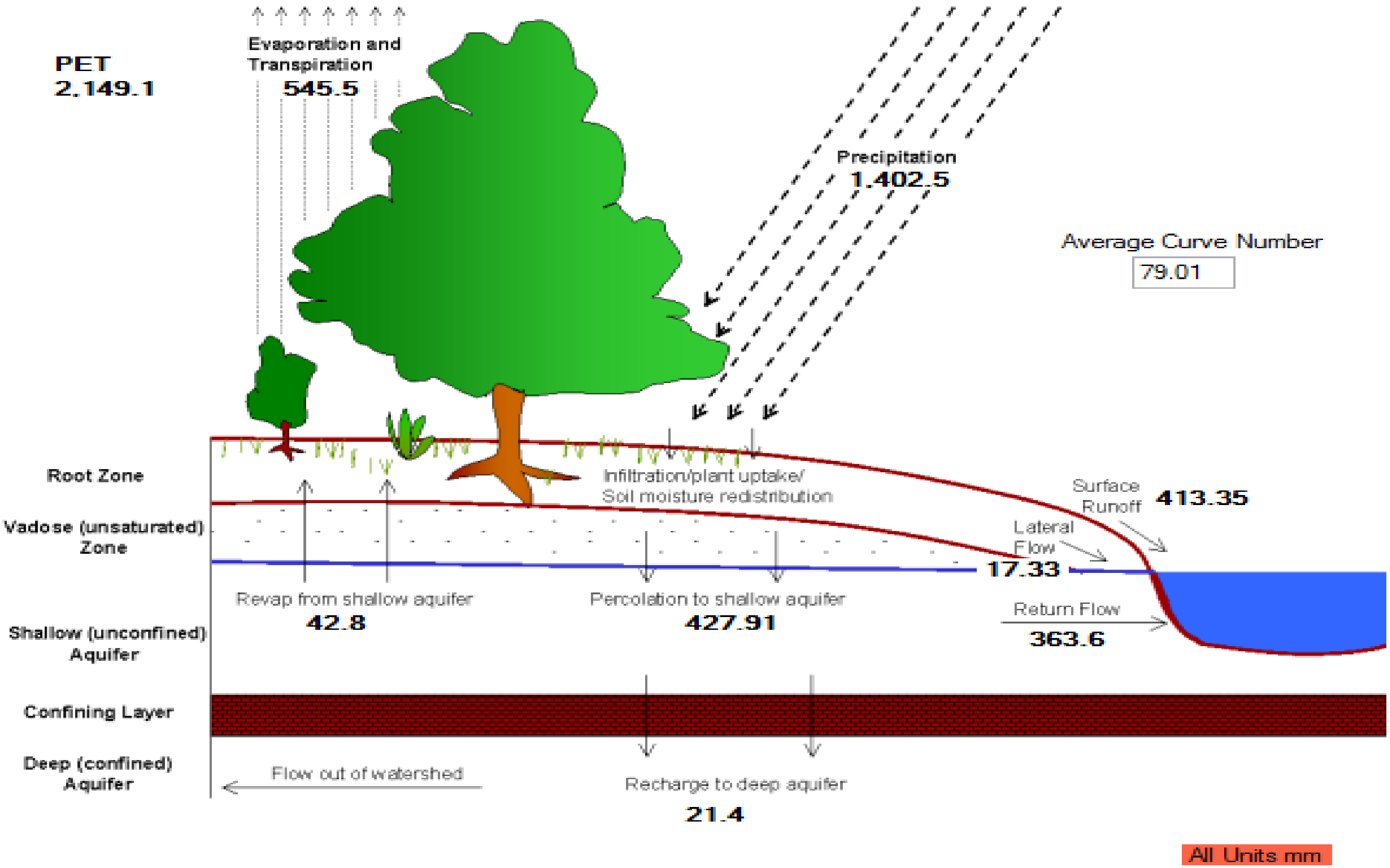
Organic N (kg/ha)



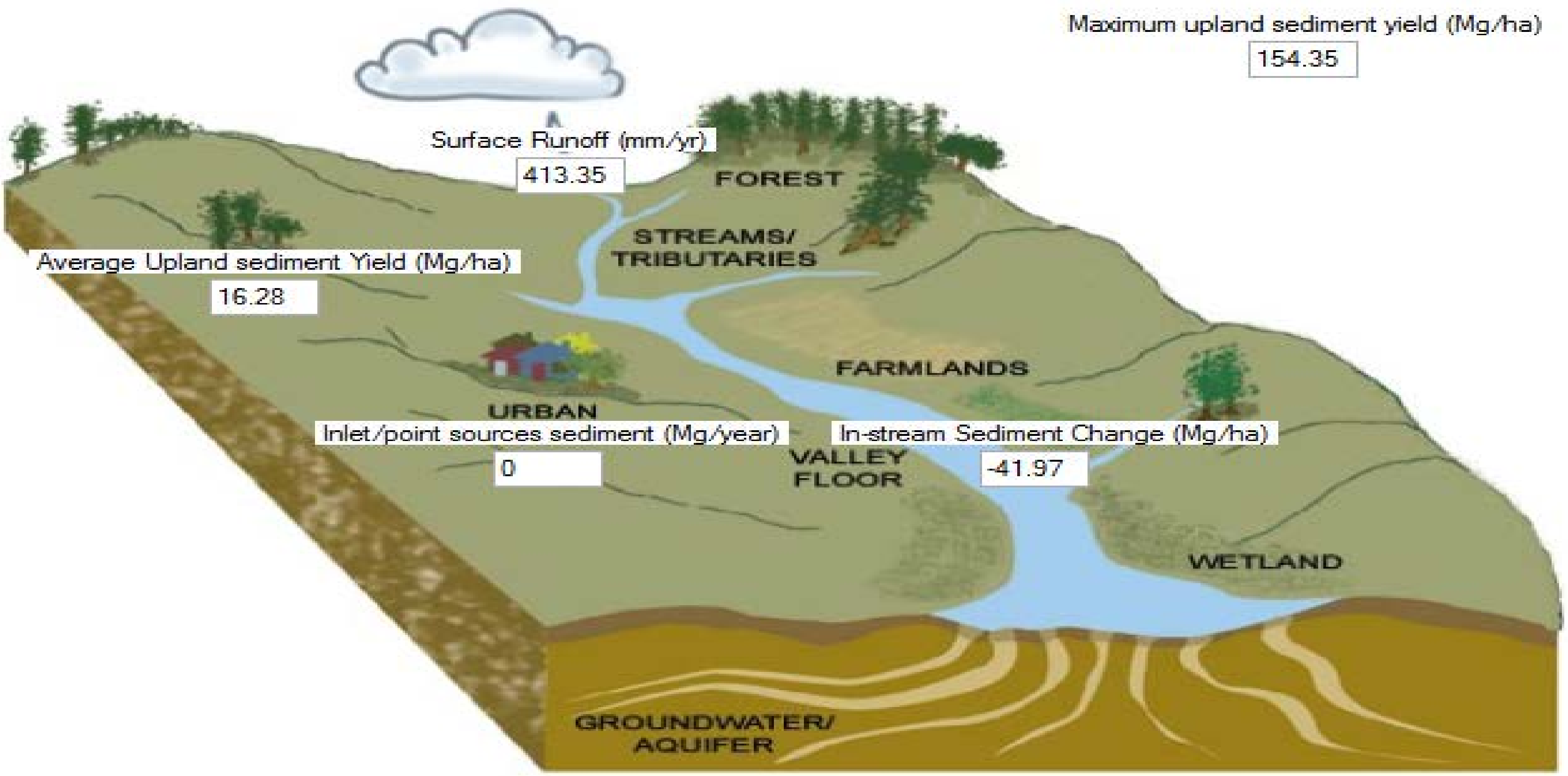
Organic P(kg/ha)



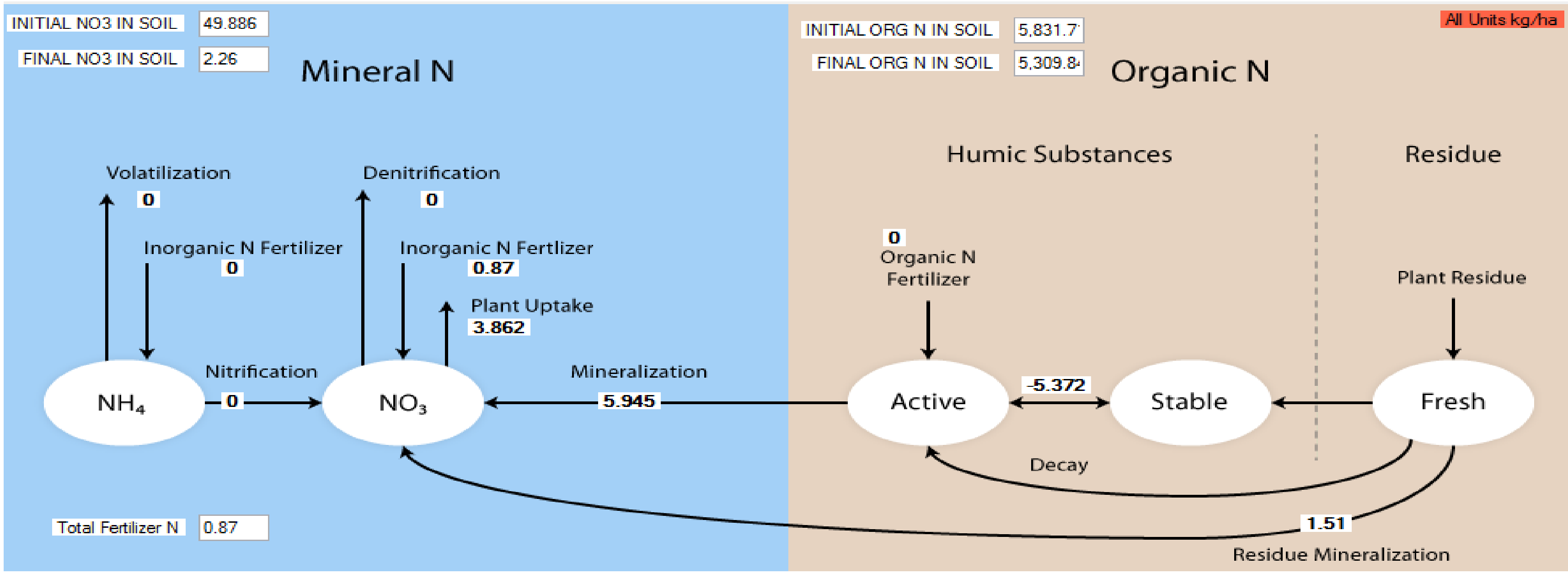
Hydrology of basin



Sediment loss

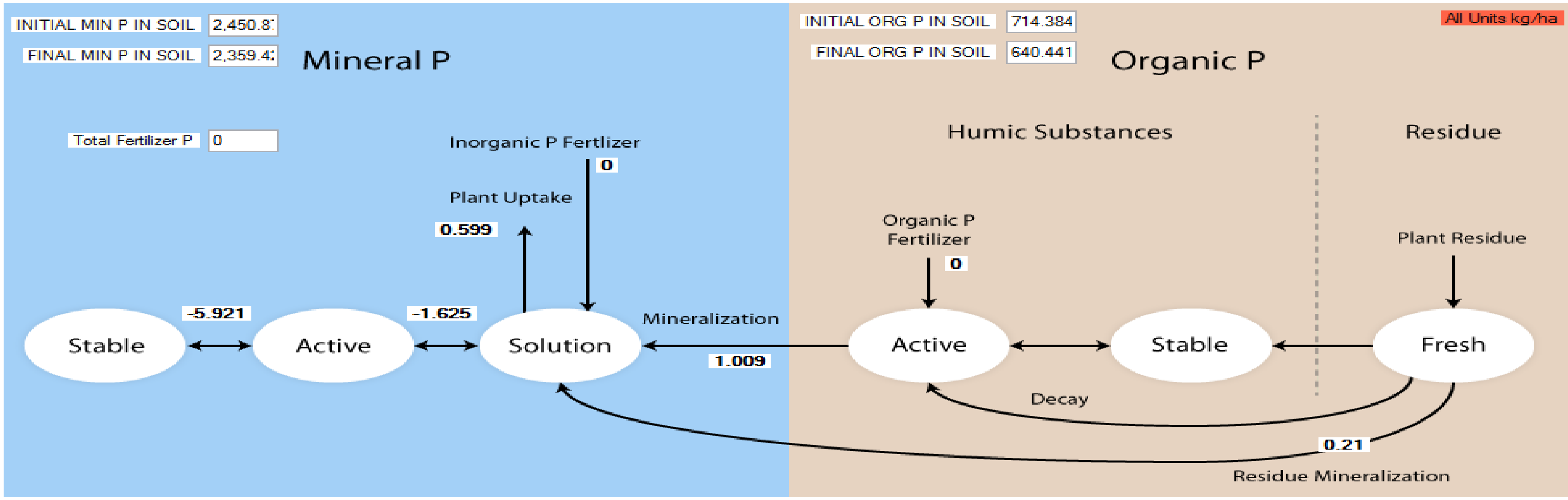


Nitrogen cycle



Nitrogen Losses	(Kg/ha)
Total N loss	12.71
Organic N	8.52
Nitrate surface runoff	0.021
Nitrate leached	4.06

Phosphorous cycle



Phosphorous Losses	(Kg/ha)
Total P loss	1.09
Organic P	1.03
Phosphorous surface runoff	0.058
Solubility ratio in runoff	0.053

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Mon	Rain (MM)	Snow Fall (MM)	SURF Q (MM)	LAT Q (MM)	Water Yield (MM)	ET (MM)	Sed. Yield (MM)	PET (MM)
1	13.08	0.00	0.50	1.34	10.53	17.91	0.01	145.46
2	7.34	0.00	0.41	0.99	3.74	15.71	0.03	174.16
3	8.84	0.00	0.51	0.90	2.72	67.41	0.01	243.32
4	5.62	0.00	0.04	0.71	1.75	24.06	0.00	281.71
5	11.71	0.00	0.58	0.60	1.84	10.38	0.00	329.45
6	203.96	0.00	39.05	0.57	26.86	55.84	0.81	213.07
7	391.73	0.00	135.78	1.18	134.11	87.62	5.36	127.74
8	380.60	0.00	137.47	2.14	206.00	79.65	5.89	102.21
9	235.35	0.00	67.15	2.60	187.38	80.02	2.81	125.14
10	103.81	0.00	25.91	2.55	135.85	57.06	1.13	143.39
11	32.66	0.00	5.42	2.04	70.48	31.49	0.19	130.61
12	7.87	0.00	0.59	1.70	34.34	18.18	0.03	131.26

Table 1: Average monthly basin values

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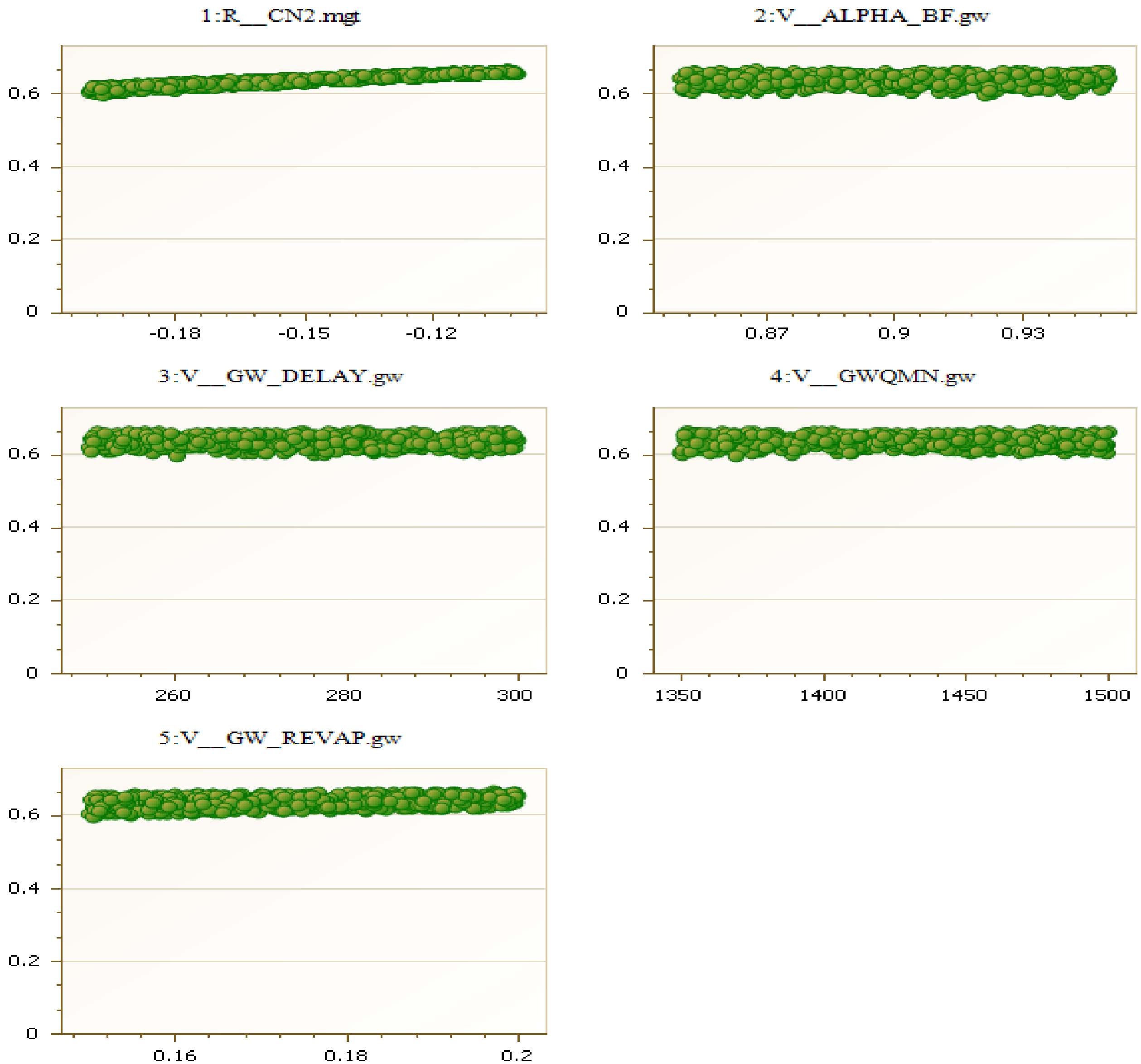
Parameter value v/s objective function



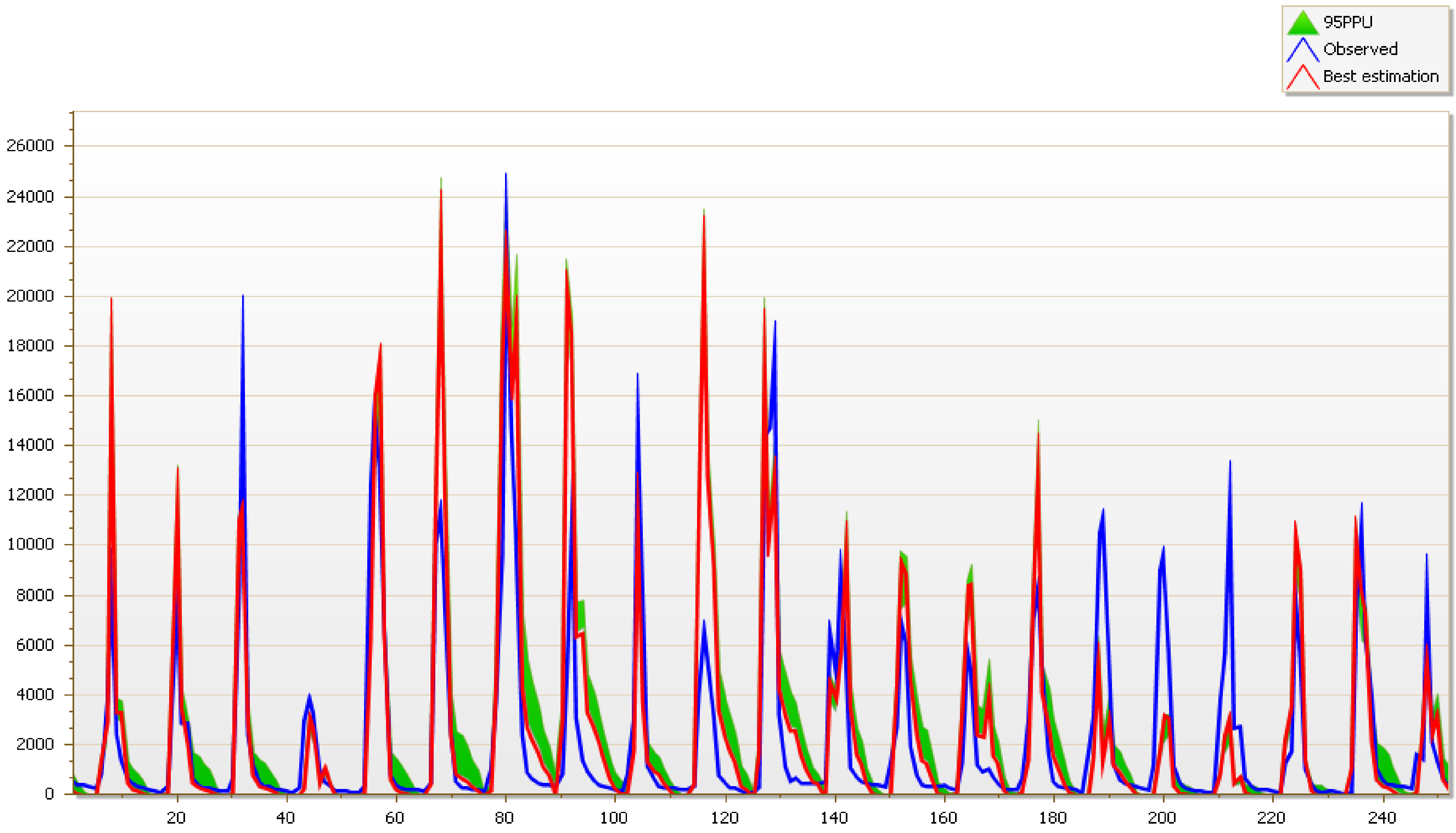
Summary of parameters

```
Goal_type= R2    No_sims= 500     Best_sim_no= 183     Best_goal = 6.646637e-001

Variable          p-factor  r-factor    R2       NS        bR2       MSE       SSQR     PBIAS     KGE       RSR     VOL_FR
---  Mean_sim(Mean_obs)       StdDev_sim(StdDev_obs)
FLOW_OUT_60          0.29      0.21      0.66     0.51      0.6467    8.4e+006  1.1e+006 59.7      0.70      0.70    0.87
2961.02(2589.23)             4948.23(4145.98)


---- Results for behavioral parameters ---
Behavioral threshold= 0.300000
Number of behavioral simulations = 500
```

FLOW_OUT_60



95PPU
Observed
Best estimation
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
20
40
60
80
100
120
140
160
180
200
220
240

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Conclusion

- QSWAT can be used to map the ecosystem component and visualize the output, the model predicted excessive runoff and water yield
- The model predicted streamflow/Precipitation ratio as 0.5, Surface Runoff/Total flow as 0.52, ET/ Precipitation as 0.39
- Flow calibrated shows a root mean square error of 0.66 and NS co-efficient of 0.56
- Total nitrogen losses are greater than 40% of applied N
- Nitrate losses in surface runoff is low
- Solubility ratio for nitrogen and phosphorus in runoff is low
- Further work is required to incorporate reservoir component and predict sediment loads
- Bias-corrected precipitation and temperature should be used to predict the future flow

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Thank You

Any questions?