SIMULATION OF NITRATES POLLUTION IN AGRICULTURAL WATERSHED

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Introduction

- ✓Water Quality
- ✓ Pollutants (Point Source & Non Point Source)
- ✓ Nitrate Pollution
- ✓ Hydrological/Pollutant Transport Models
- ✓ Soil and Water Assessment Tool (SWAT)

Objectives

- Selection of watershed and NPS contaminant transport model
- Calibration, validation and sensitivity analysis of the model for runoff and nitrate flow in the river
- Analysis of the spatio-temporal characteristics of flow and contaminant transport

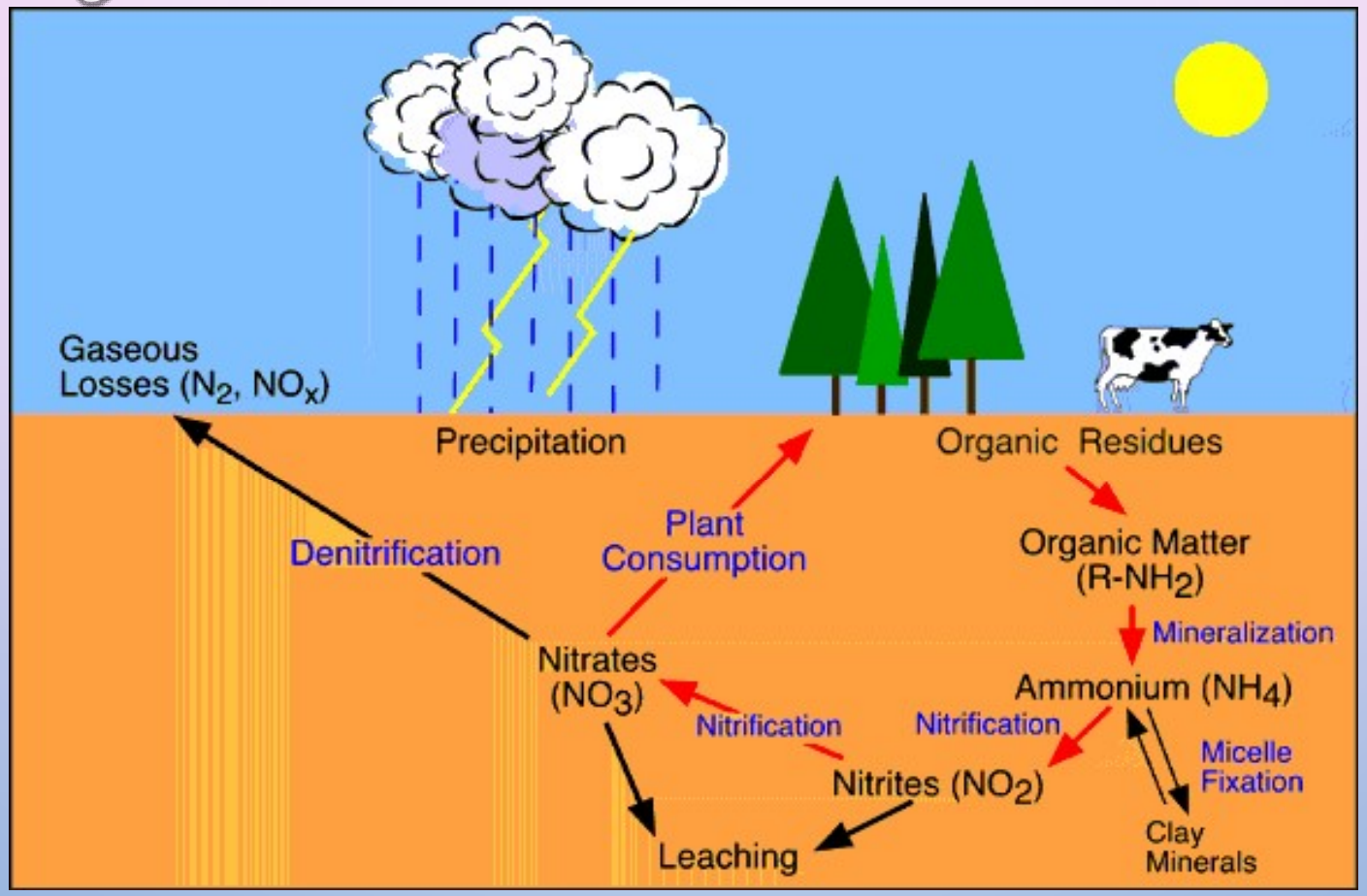

Figure 1. Nitrogen cycle

(Source: http://web.mit.edu/12.000/www/m2006/teams/nano06/research.html)

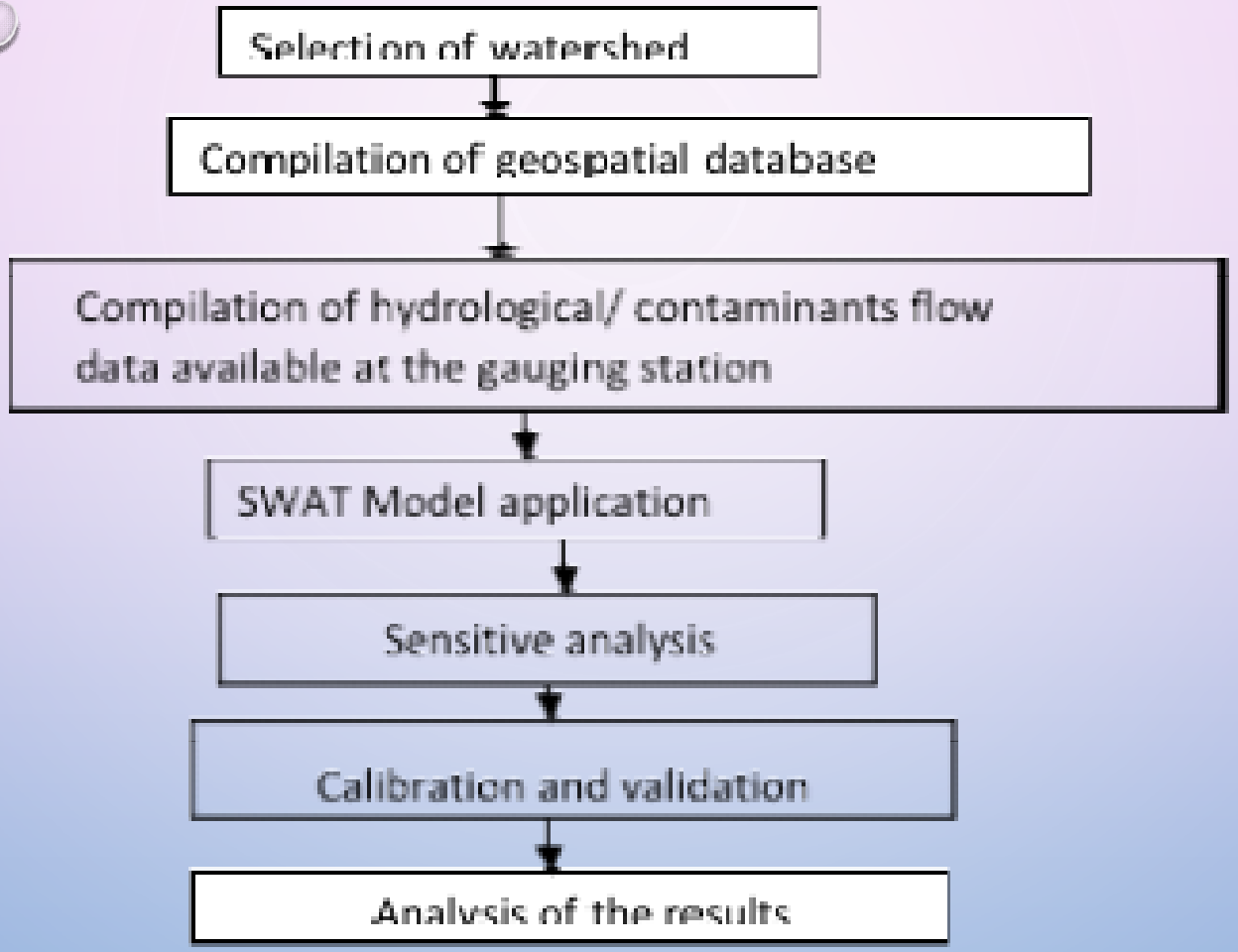

Figure 2. Methodology for the simulation of Nitrate concentration in the study watershed

Input Database

- DEM – SRTM -30M

  Source: https://earthexplorer.usgs.gov

- Soil Map & Land Use (LU)/Land Cover (LC) Map

  Source: http://swat.tamu.edu/software/links/india-dataset

- Daily Discharge and Contaminants Data at Gauge

  Source: CWC, Hyderabad

- Land Management Data

  Source: Joint Directorate of Agriculture, Krishna District, Andhra Pradesh

Study Area

- Munneru Watershed With Drainage Area of 9854 km^2
- The surface water quality station at the Keesara, Andhra Pradesh
- Records total of 41 parameters (Nitrates, Phosphates, Nitrites, Sediment Yield)
- Monthly data are available with Central Water Commission (CWC) Hyderabad office

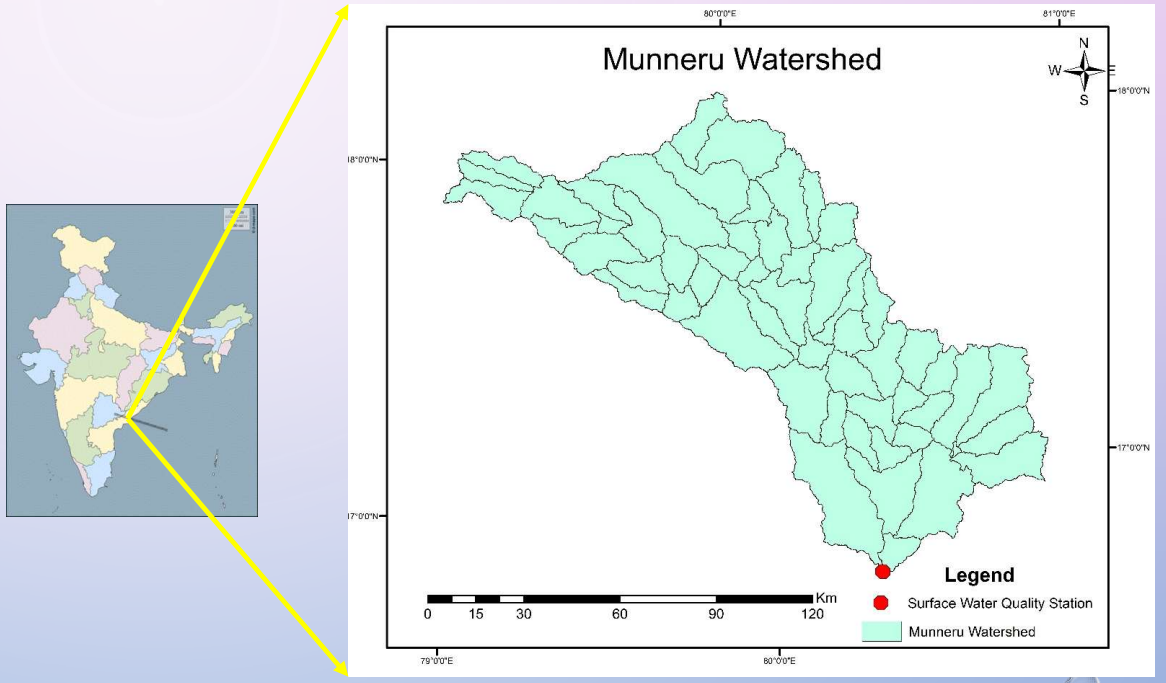

Figure 3. Location map of the Munneru Watershed

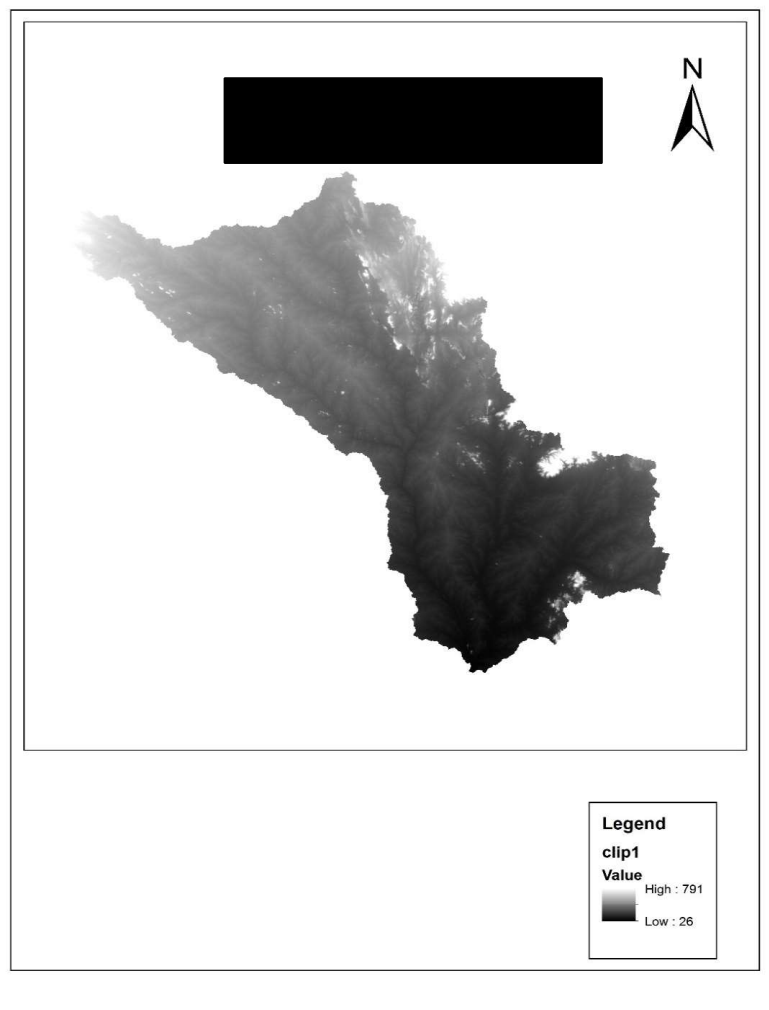

Figure 4. DEM of Watershed

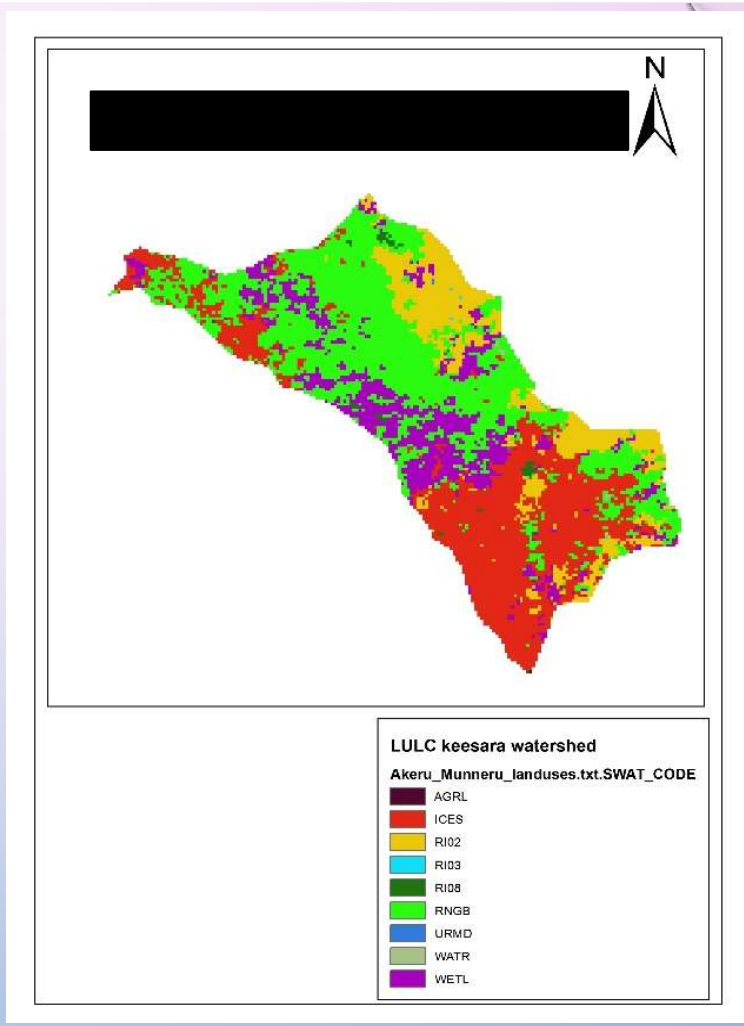

Figure 5. Land Use/Land Cover map

SWAT MODEL

SWAT (Soil Water Assessment Tool)

- Physically based continuous event river basin scale hydrological model
- It is the semi distributed parameter model and includes spatial heterogeneity

SWAT CUP – (Calibration and Uncertainty Program)

- Calibration: Model testing with known input and output to adjust or estimate factors
- Validation: Comparison of model results with an independent dataset (Without Further Adjustment)

- Two Types of Sensitivity Analysis

  Local - By changing values one at a time

  Global - By allowing all parameter values to change

- Sensitivity of one parameter often depends on the value of other related parameters
- The problem with one-at-a-time analysis is that the correct values of other parameters that are fixed are never known
- The disadvantage of the global sensitivity analysis is that it needs a large number of simulations

Land management

Different management operations need to be used

- Tillage
- Irrigate
- Plant growth
- Pesticide
- Harvest

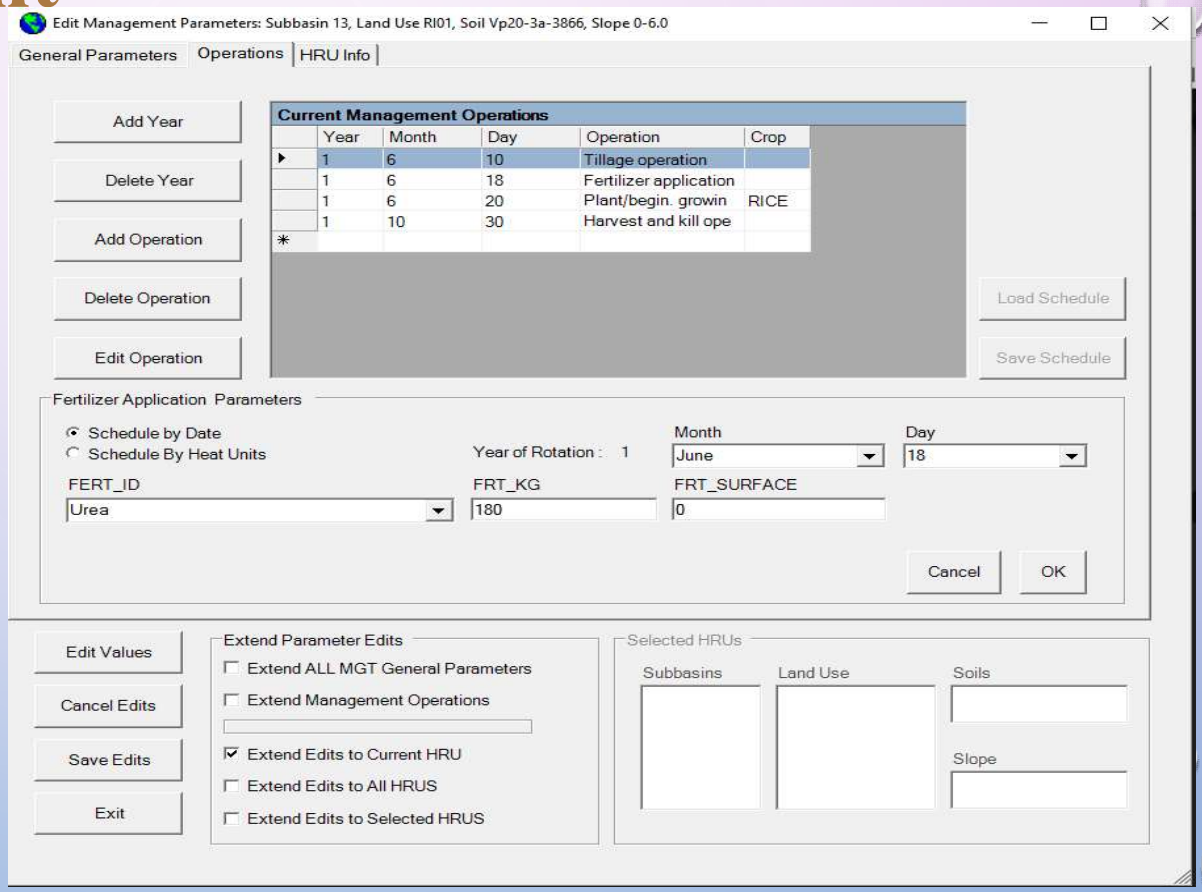

Figure 6. Land management tool

Evaluation of model prediction

Coefficient of Determination (R^2)

- ✓ Indicator of strength of relationship between the observed and simulated values
- ✓ It represents the percentage of variance in the measured data

Nash–Sutcliffe Efficiency

- ✓ It asses the predictive power of the hydrologic model
- ✓ It is a normalized statistic that determine the relative magnitude of residual variance compared to measured data variance
- ✓ NSE indicate how well the plot of observed versus simulated data fits the 1:1 line

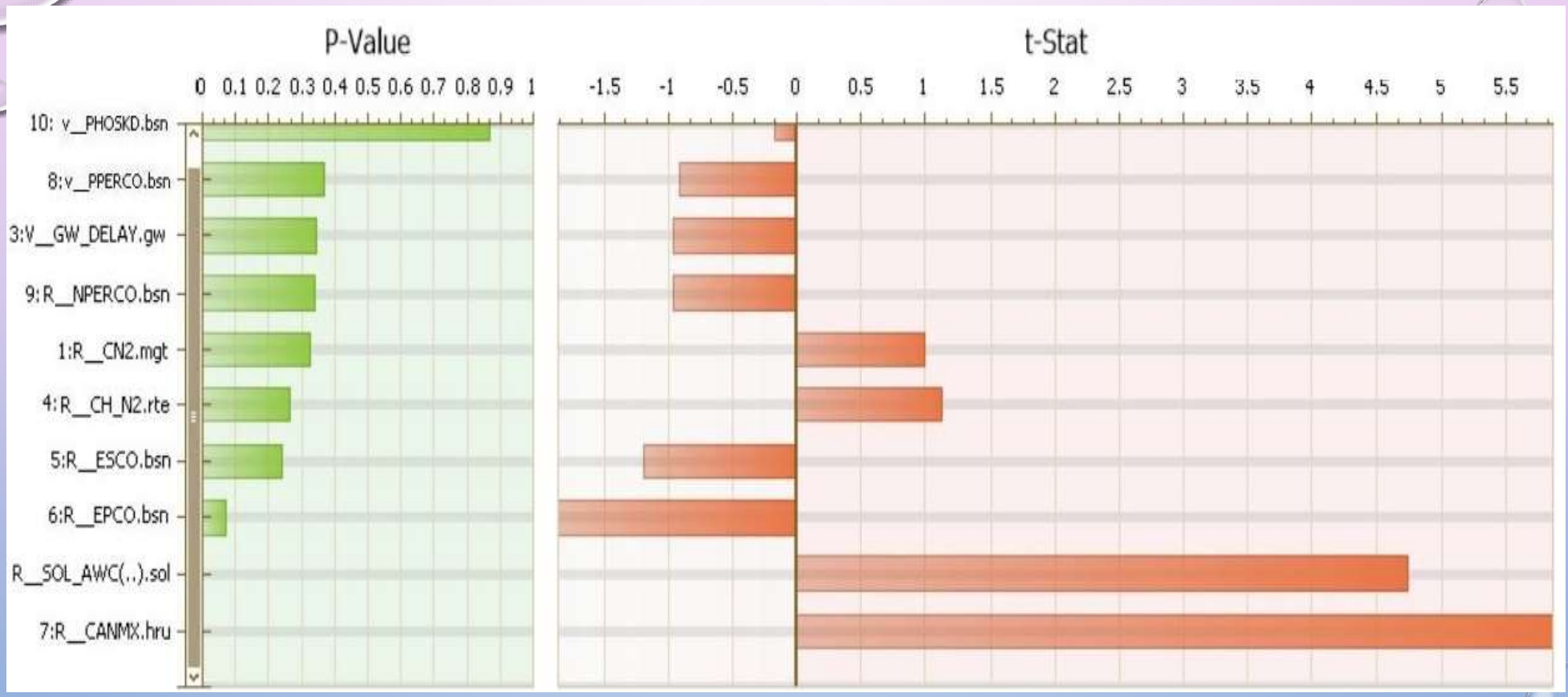

Figure 7. Global sensitivity analysis output t-stat and P- value

Table 1 Sensitive parameters rankings

Constituents	Variable name	Range	t-stat value	P value	Rank
Runoff	CANMX.hru	0-100.0	5.8	0	1
Runoff	SOL.AWC.sol	0.0-1.0	4.6	0	2
Runoff	EPCO.bsn	0.0-1.0	-2.0	0.08	3
Runoff	ESCO.bsn	0.0-1.0	-1.2	0.23	4
Runoff	CH_N2.rte	0.2-2.0	1.2	0.26	5
Runoff	CN2.mgt	0.01-1	1.0	0.33	6
Nitrate	NPERCO	100-200	-0.9	0.36	7
Runoff	GW_DELAY.bsn	0.0-0.3	-0.9	0.36	8

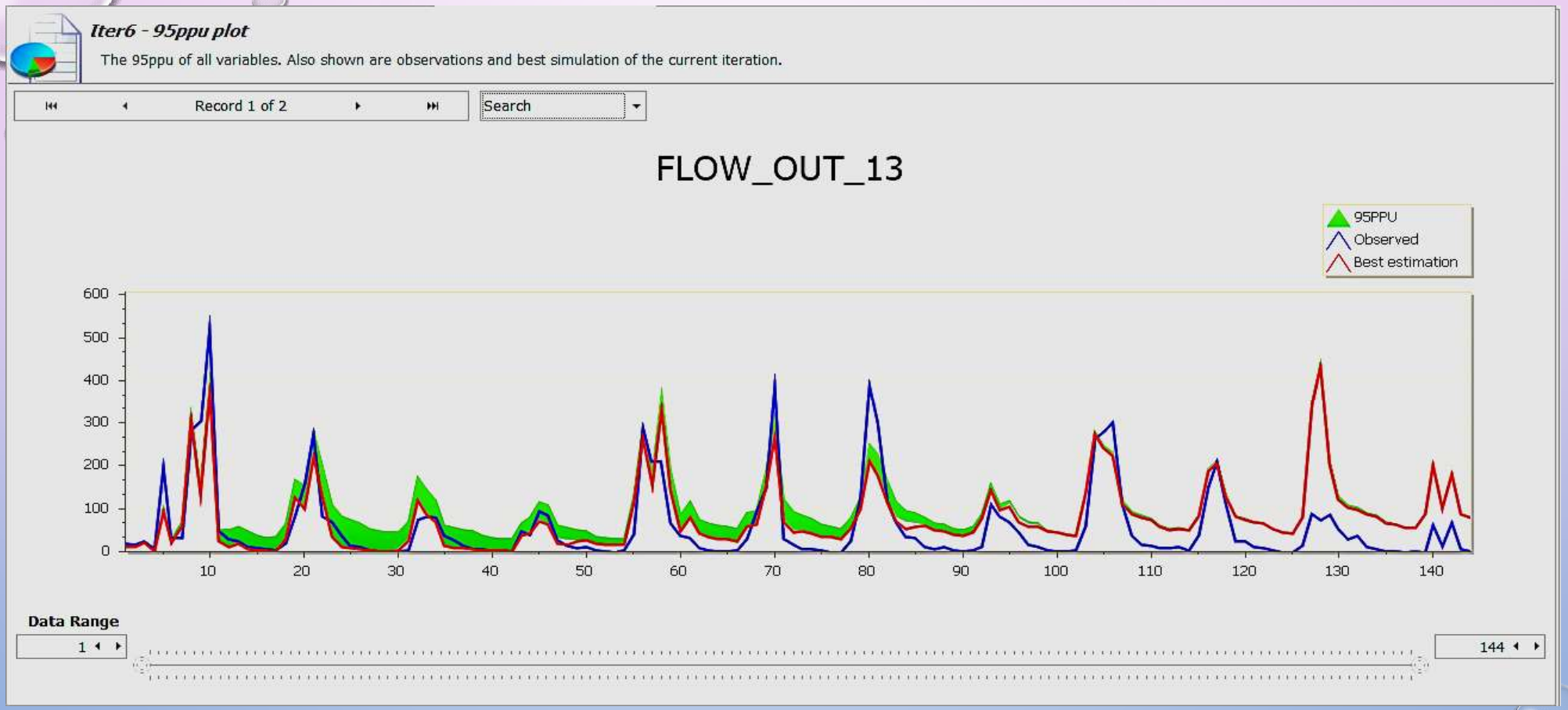

Figure 8: 95 Percentage Prediction Uncertainty plot for Out flow

Table 2 Mean Monthly Simulated and Observed Flows

Month	Observed(m^3/sec)	Simulated(m^3/sec)
January	17.15	13.23
February	9.53	6.65
March	8.66	6.54
April	4.46	2.50
may	2.36	1.69
June	15.80	22.33
July	7.58	10.26
August	**383.36**	**222.80**
September	264.22	325.26
October	249.47	311.97
November	91.13	130.12
December	39.76	45.58

Table 3 Mean Monthly Simulated and Observed Nitrates

Mean Monthly Nitrates	Observed	Simulated
January	0.21	0.14
February	0.11	0.17
March	**1.80**	**2.07**
April	0.55	1.19
May	0.03	0.03
June	0.05	0.04
July	0.10	0.09
August	**1.05**	**1.82**
September	**1.79**	**0.91**
October	0.63	0.86
November	**2.30**	**1.59**
December	1.27	0.86

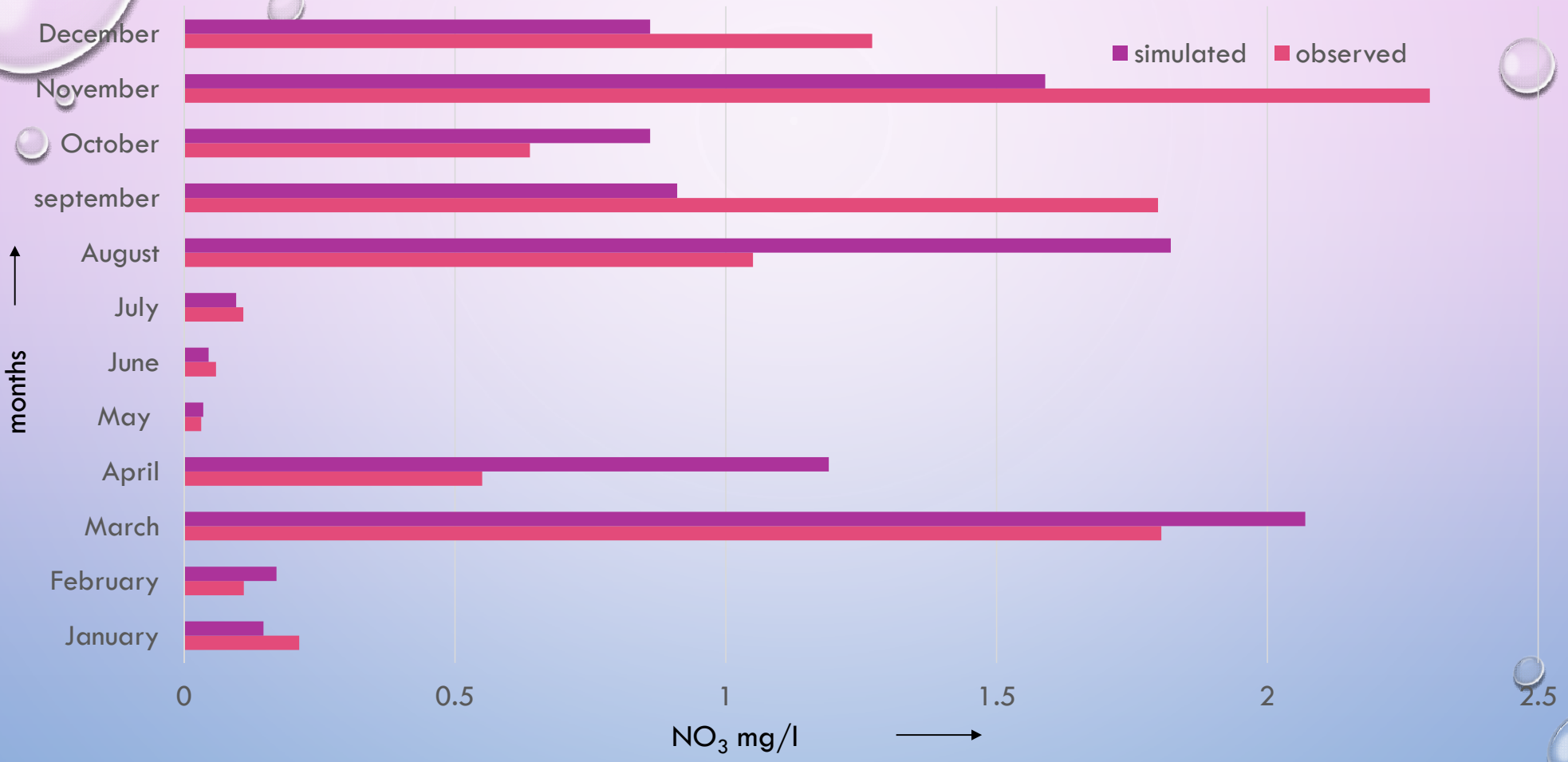

Figure 11 Mean Monthly Simulated and Observed Nitrates

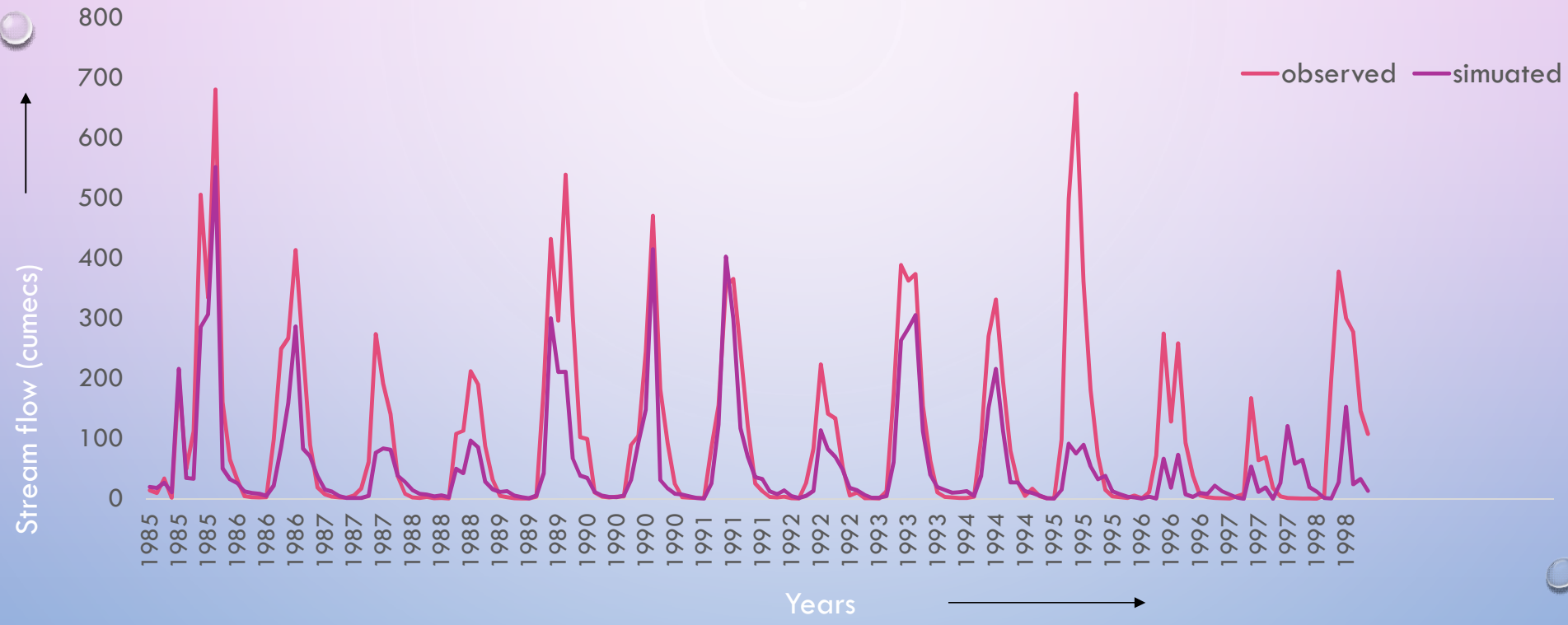

Figure 12: Annual observed and simulated stream flows

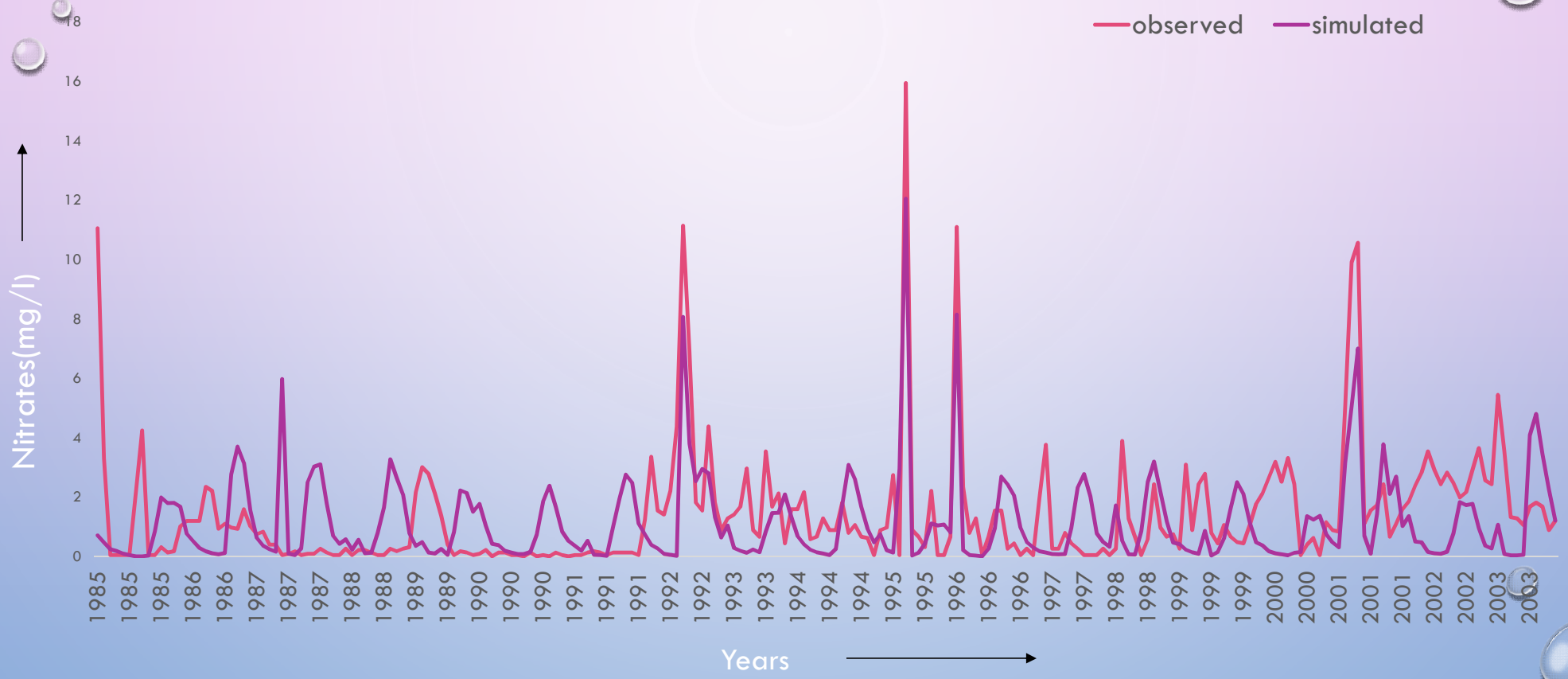

Figure 13: Annual observed and simulated Nitrates

Summary and Conclusions

- ✓ SWAT model calibration and validation is carried out for the runoff and Nitrates
- ✓ For runoff simulation, R^2 value obtained is 0.6 and the Nash-Sutcliffe efficiency obtained is 0.53 and for Nitrates, R^2 value is obtained is 0.35 and NSE is 0.33
- ✓ From the results, it is observed that the pollutants content (Nitrates) along with outflows are observed more during August and November
- ✓ Nitrate transport was occurred more during monsoon seasons and harvesting period

Further work

- Other contaminants in the outflow can be determined
- In the present work only SUFI-2 is used. Other optimization techniques can be studied.
- Finding out the critical areas for pollution in the watershed
- Developing best management practices

Acknowledgements

A. Mohan Reddy *Deputy Director and other officials in Central Water Commission (CWC), Hyderabad for providing the stream flow data and other quality measurements at Keesara gauge station, Munneru River, India.*

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Thank you

Seasons Greetings