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Assessment of Hydrological Parameters of the Watershed using ArcSWAT

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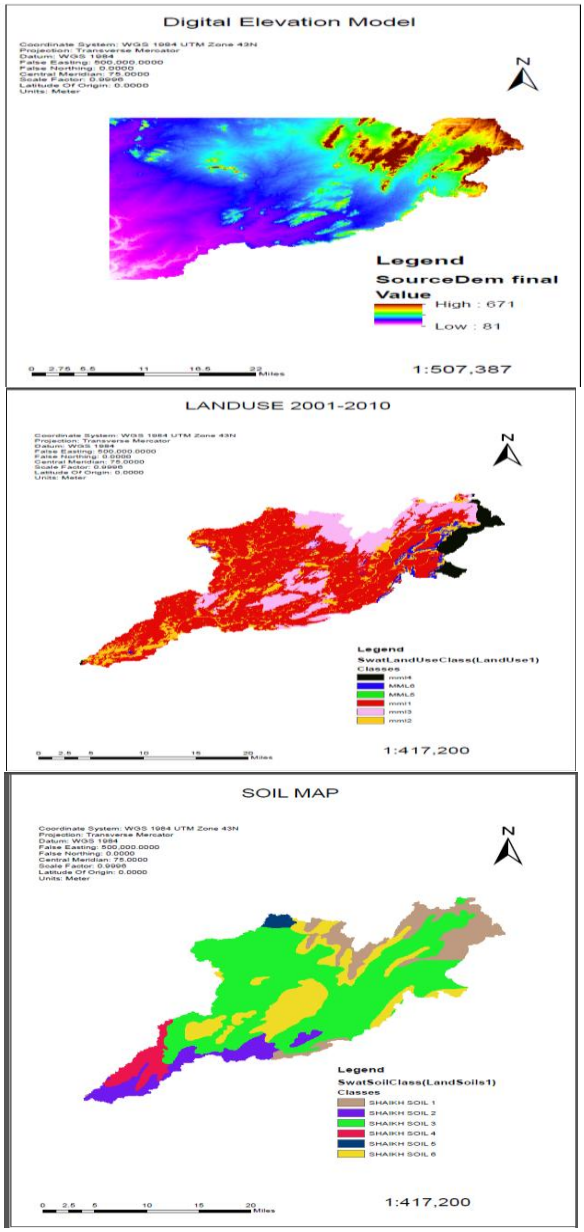
Abstract*: Climate change is an inevitable phenomenon that has lead the earth to evolve from an ice age to present era. Due to rise in temperature, rate of Evapotranspiration is increasing that leads to higher rate of maximum event. This raises the need to analyse the watersheds which shows considerable vulnerability towards climate change. SWAT model is chosen to simulate the analysis which is a semi-distributed hydrological model. The model run has been carried out for 35 years where model outputs are compared with the observed values of Evapotranspiration. Model is successfully validated for five years giving NSE as 0.89. Calibrated & Validated model shows that average values of Evapotranspiration & Surface Runoff in mm against 882mm of rainfall are 303mm & 285mm respectively. A Hathmati watershed of western India is taken to demonstrate the work.

***Keywords* : SWAT, Hathmati, Evapotranspiration, Surface Runoff**

I. INTRODUCTION

Hathmati (23°30′49″N 72°49′29″E) is one of the major tributary (left) of Sabarmati River (Western India). The spatial variation in the rainfall is highest for Hathmati basin amongst all sub-basins of Sabarmati basin. It lies in Bhiloda (Sabarkantha district) and rises from Gujarat Malwa Hills. After travelling a course of 98km it meets Sabarmati near village Ged. Total catchment area is 1574 sq.km. (157400 ha)[6]. Rainguage station is installed at Bhiloda where average annual rainfall is 864mm[6]. An earthen dam is situated near Himmatnagar. The co-efficient of variation of annual rainfall over the basin is rather high and ranges between 42-65% and average maximum and minimum temperature reaches about 38°C & 16°C[6].The data for the study includes various spatial data like DEM, LULC, Soil Map and several collateral data like weather files from raingauge stations are used for the study.

The data collected is incorporated in SWAT model with the interface of ArcGIS. ArcSWAT is a semi-distributed model that allows the data to vary spatially. The spatial maps are shown in figure-1.



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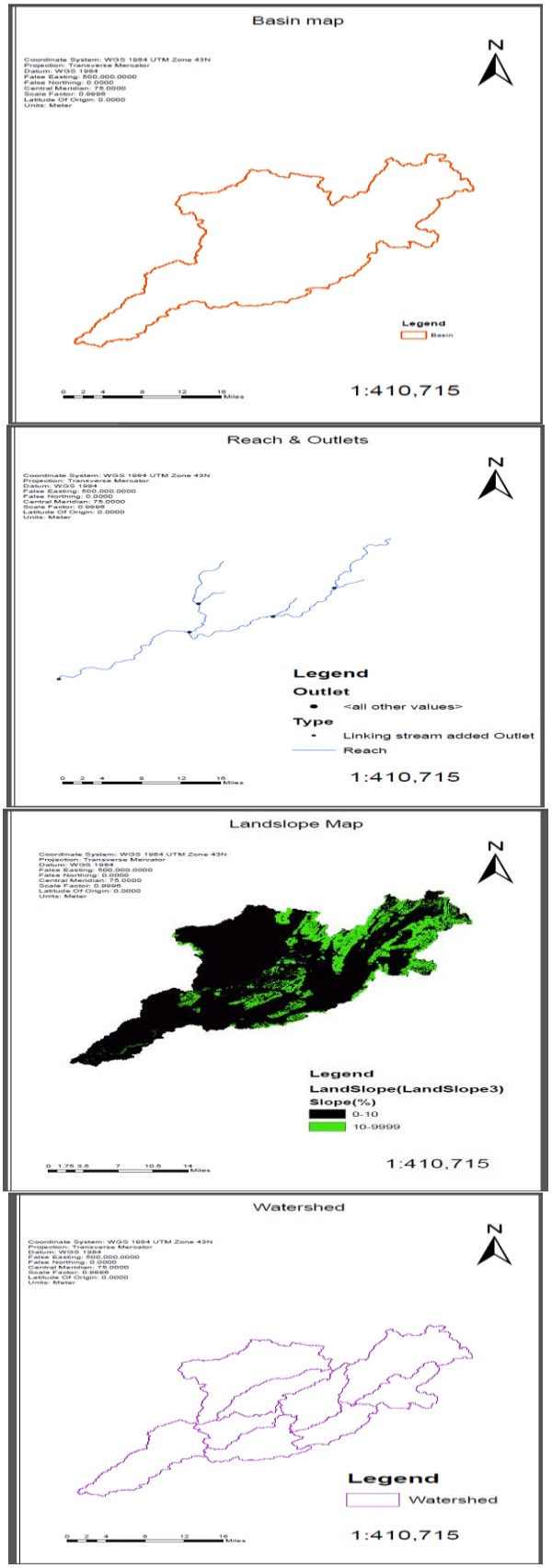


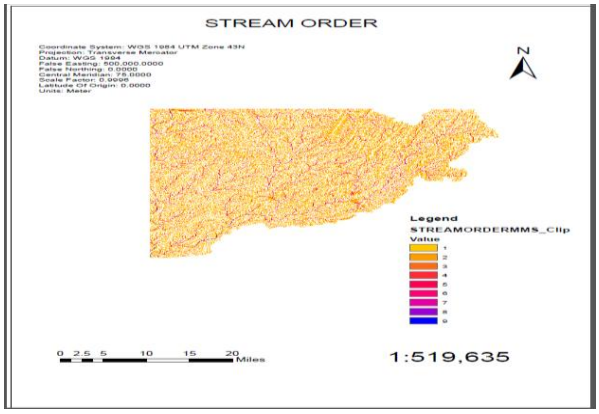


Figure 1 Spatial Maps

II. HYDROLOGICAL MODELLING

SWAT is chosen as the model for the study, as it is free, open source, actively supported by model developers, well documented, and has been tested around the world. It has a substantial and growing number of users in the developing world, as shown by the papers presented at its biennial conference. The SWAT interface was written as a plug-in for ArcGIS which is apparently the way most dynamic existing SWAT module.

ArcGIS version 10.2.2 interfaces with SWAT 2012 is used for the study and like any other semi-distributed hydrological model it acquires several spatial data in the form of maps and some temporal data like weather files. The model run takes four step to obtain the result as

1. Watershed delineation
2. Hydrological Response Units (HRU) formation
3. Weather files input
4. Model run (Simulation)

The model run is classified in three modules as;

1. Model setup
2. Model calibration (Sensitivity analysis)
3. Model validation

Model setup

The model is setup for simulation and results were obtained for the period of 1979 to 1990 (12 years). All the steps shown in pint 5.5 are successfully completed and the results are shown in figure 5.7. Default database were installed and the model gives Nash Sutcliffe efficiency of 0.66 between observed and modelled values of ET in mm.

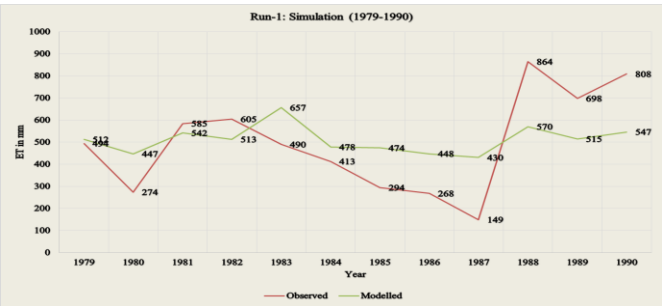


Figure 2 SWAT setup results

Model calibration

The model is calibrated by choosing parameters (Variables) affecting the value of ET (Considerably) for the period of 2000 to 2010 (10 years).

The parameters affecting the value of ET are calibrated as a part of sensitivity analysis and the results are obtained as shown in figure 4 giving average NSE as 0.89. The steps of sensitivity analysis are shown in figure 3.

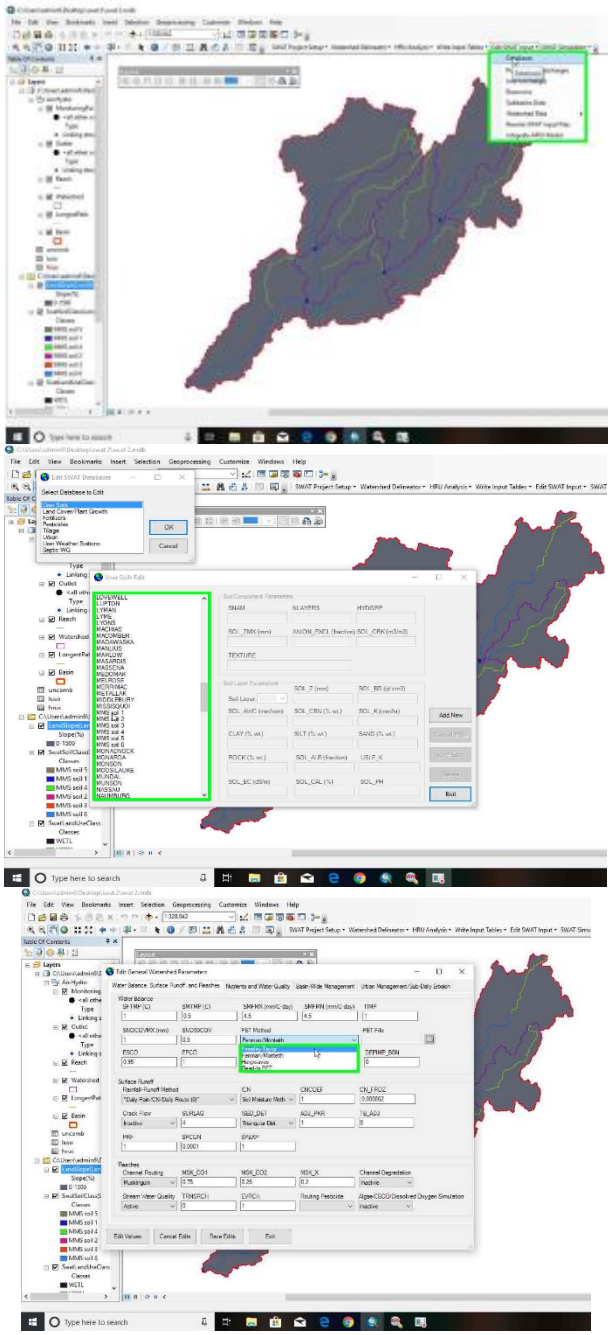
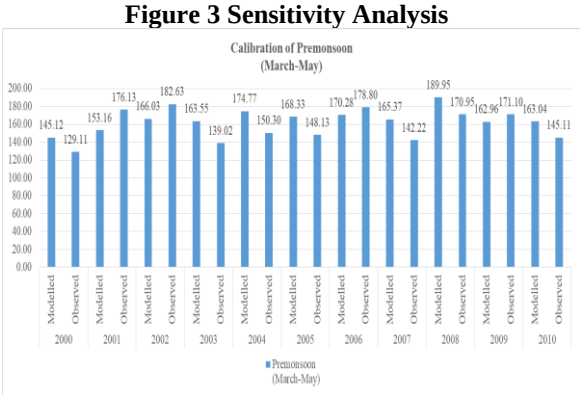
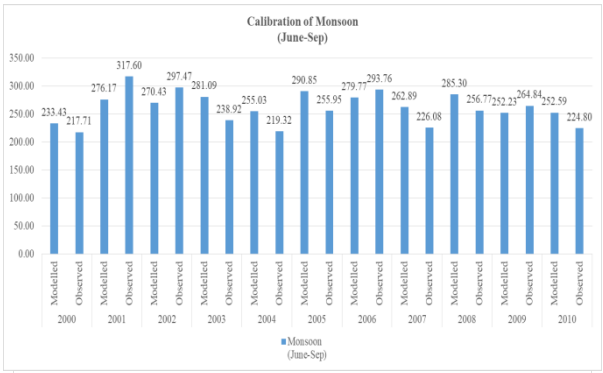
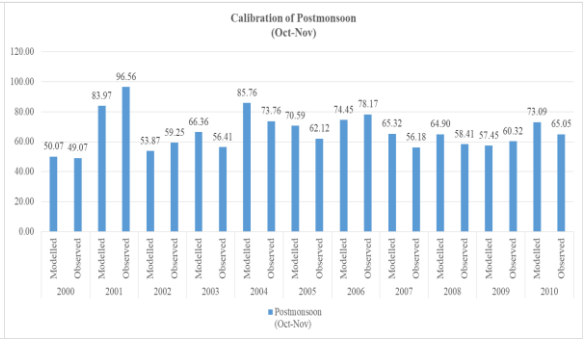
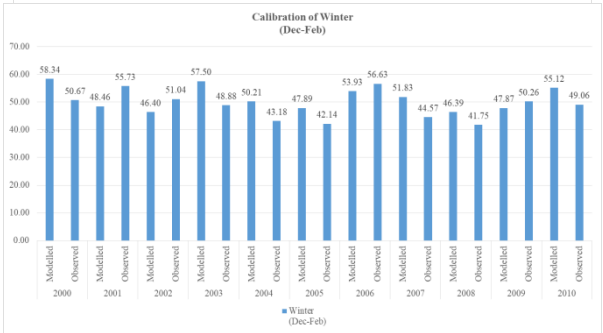


Figure 3 Sensitivity Analysis









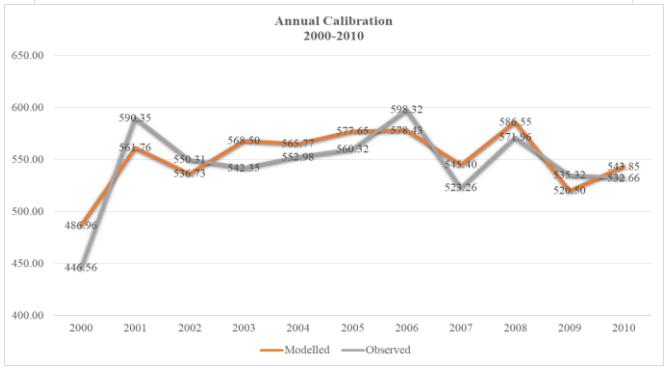


Figure 4 Calibration results

Model validation

The model is validated for next five years (2011-2014) and monthly values are show below giving NSE as good as 0.88. The monthly results are obtained to compare with the observed data, presented in the graphical format in figure 5.

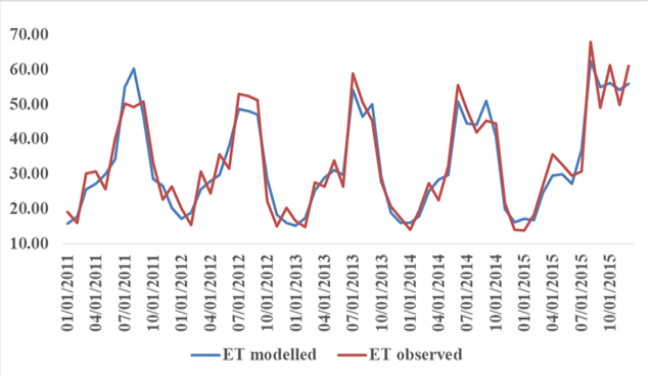


Figure 5 Validation results

III. RESULT AND DISCUSSION

After validation the model is made to run (simulate) for 36 years (1979-2015) for ET and PCP. Figure 6 gives the brief summary of Hydrological Modelling after calibration & validation of model giving annual average value of PCP, ET and SURQ in mm as 882, 303 & 285.

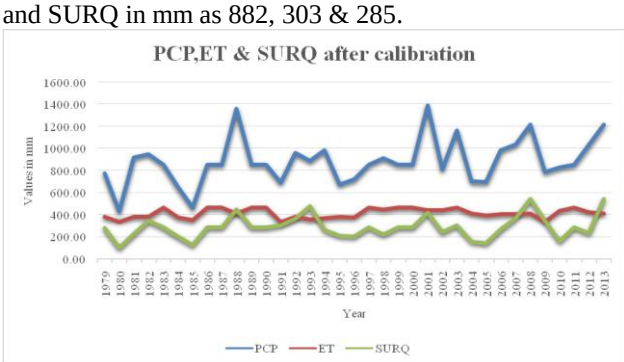


Figure 6 Final results

IV. CONCLUSION

After successfully completing the model run, the results are summarised as;

- Semi-distributed model SWAT is used to find ET.
- Model is calibrated/validated with observed values.
- Simulation over 36 years is generated to find variation in ET.
- SURQ contributes about 28-30% while ET losses are about 35%.
- NSE after calibration & validation is obtained around 0.89.
- Model shows the average value of rainfall, ET and SURQ in mm as 882, 303 & 285.

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