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Modelling Rainfall-runoff Process for Sub Catchment of Narmada River Basin at Hoshangabad Using Semi Distributed Model HBV

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ABSTRACT

In this study, the light version of Hydrologiska Byrans Vattenbalansavdelning hydrological model (HBV), has been used to synthesize river discharge and daily flow series for twelve years in the sub catchments of the Narmada river basin at Hoshangabad. The plain area of Narmada river basin at Hoshangabad is used for this study,with a drainage area of 10594 km^2 and co-ordinates lies between 22°46'Nand 77°43'E. The model was run using twelve years data. Parametrization of parameters were obtained after warming, calibration and validating the results. There after the sensitivity analysis was done and acceptable range for each parameter was obtained. The Coefficient of Determination of observed and simulated discharge at the Hoshangabad was found to be 0.84. In Narmada River Basin at Hoshangabad hydrological modeling using the HBV model, MAXBAS is the most sensitive parameter. The sensitive parameters from high to low along with their slopes values are Maxbas: 0.23, Alpha: 0.018, Fc: 0.012, K1:0.010, Beta: 0.008, K2: 0.005, Perc: 0.001 and Lp 0.001. The study shows that light version of the HBV model can be used to model the runoff of the sub catchment of the Narmada river basin at Hoshangabad.

Key words *: HBV light model, Sensitive parameter, Parametrization, Narmada River, M.P.*

Introduction

Hydrology is that the main governing backbone of every kind of water movement. Hydrological models square measure vital tools for water resource coming up with and management and in assessing the consequences of climate and land use modification on the hydrological cycles and runoff regimes abstract hydrological models square measure wide accustomed simulate the land section of hydrological cycles since they will capture the dominant structure dynamics while remaining ungenerous and computationally economical while requiring computer file that square measure typically without delay out there and comparatively easy and straight forward to use. an effort has been created to use HBV model to get the discharge from the narmada geographical region set at Hoshangabad in m.p.,having catchment area of 10594 sq. kilometers. The model consists of many parameters out of that the foremost sensitive 9 parameters are tag and valid.

The following square measure the parameters and clarification however they're employed in the model.

1. FC (Field capacity): This represents the utmost soil wet storage (mm.) and features a vary from a hundred millimetre-1100 mm. It influences the overall

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volume of runoff. At low soil wet level, most of the precipitation is unbroken at intervals the unsaturated zone. If FC is simply too high the soil water level will increase throughout the spring flood.

2. LP: this is often the limit for potential evaporation. And its values vary from one.0 or but zero.9. it's a soil wet price on top of that evapotranspiration reaches its potential price, the disk parameter is often not tag however is adjusted if needed.

3. Beta: it's the exponent within the equation for the discharge from the soil water zone. the worth of Beta ranges from zero.25-3. Beta as FC conjointly influences the overall price and is tag by perceptive the time of year discharge.

4. Perc: this is often the Percolation capability of the higher response box . The water from higher reservoir percolates down in step with the parameter Perc. The unit is in millimetre per day. The vary of Perc is from 1-12 millimetre per day. This parameter influences the form of the hydrograph however not the amount. the bottom flow is additionally adjusted with Perc. an occasional Perc price can end in low base flow.

5. Alfa:It could be a live of the non-linearity, usually within the order of one. The vary of Alfa is from zero.1 to 1.1.when the discharge peaks square measure simulated Alfa is adjusted. Alfa is mostly not tag and is employed to suit the upper peaks into the hydrograph. the upper Alfa, the upper the peaks and faster recession.

6. K2:-It could be a recession constant for the lower response box. As Mount Godwin Austen enlarged an excessive amount of runoff was created.

7. K1:-It is that the recession constant for the higher response box

8. Maxbas:-It could be a transformation operate. The generated runoff of 1 time step is distributed on the subsequent days exploitation one free parameter, Maxbas, that determines then base in associate equal triangular coefficient operate.

9. Cet:-It could be a potential evaporation correction issue. it's associate ex gratia parameter needs extra information to use i.e. Mean temperature (T_Mean).

Materials and Methodology

Study area:-The Narmada basin, hemmed between Vindhya and Satpura ranges, extends over an area of 98,796 km^2 (38,145.3 sq mi) and lies between east longitudes 72 degrees 32' to 81 degrees 45' and north latitudes 21 degrees 20' to 23 degrees 45' lying on the northern extremity of the Deccan plateau. The Upper plain area of Narmada river basin at Hoshangabad sub catchment is used for this study, which is having drainage area of 10594 square kilometer and co-ordinates lies between 22°46'N and 77°43'E. The length of the stream beneath this structure is eighty two km.

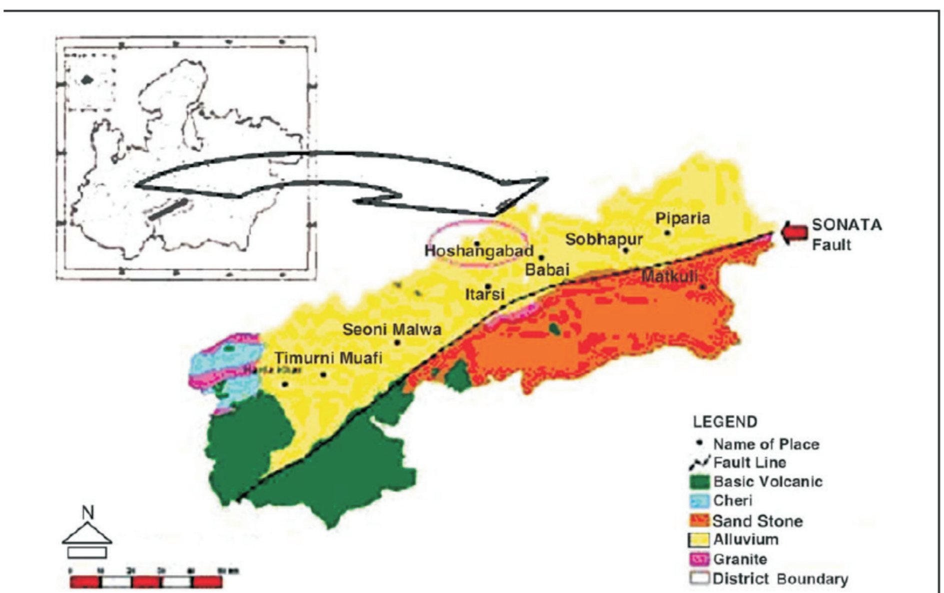

Fig. 1. Location of Hoshangabad sub catchment

Methodology

This study involves characteristics most sensitive Response routine parameter in associate agricultural watershed using HBV model. The analysis can be carried out in 5 main stages that are:

Warming of the model this can be the primary stage, during this stage the model are going to be run with the assumed parameters and information.

Standardization of the modeling this stage model standardization is that the method of adjustment of the model parameters and forcing inside the margins of the uncertainties.

ParameterizationI s that the method of deciding and process the parameters necessary for a entire or relevant specification of a model or geometric object.

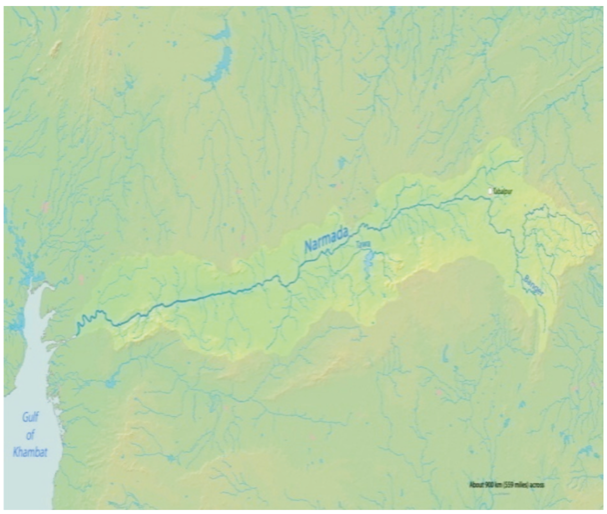

Fig. 2. Narmada river basin

Sensitivity analysis may be a technique by which we can measure the variation of that specific parameter with the respect to change in their value.

Validation to check's the effectiveness of the model's illustration of the real system.

Objective function

R^2

There are so many objective functions in this model. Among them R^2 is selected for this study because of its good relationship between observed and simulated values.

In statistics the coefficient of determination is denoted by R^2 and it represents the correlation between observed and simulated values.

$$R^2 = 1 - \frac{\sum_{i=1}^{n}\left[Q_{obs,i} - Q_{prd,i}\right]^2}{\sum_{i=1}^{n}\left[Q_{obs,i} - \bar{Q}_{obs,i}\right]^2}$$

Where $Q_{abs,i}$ is known as observed flow and $Q_{pred,i}$ can be said as predicted flow and n is the number of steps in the simulation period considered.

Results and Discussion

The study space was NARMADA geographic area. The Hoshangabad sub structure was hand-picked because the principal and presentation basin. the beginning time for computation was set to 01

Table 1. Parameter used in model and their Initialization and calibration value

S. No.	Parameters	Initialization Values	Calibrated value	Allowable range
01	Fc	100	608	500-700
02	Lp	0.1	0.334	0.2-0.4
03	Beta	0.25	1.584	1.25-1.75
04	Alpha	0.1	0.593	0.57-0.65
05	Perc	1	7.27	6-9
06	K1	0.01	0.0387	0.02-0.05
07	K2	0.02	0.099	0.08-0.12
08	MAXBASE	1	3.164	1-5
09	Cet	0.1	0.341	0.2-0.8
10	Pcalt	10	10	10
11	Tcalt	0.6	0.6	0.6
12	TT	0	0	0
13	CF MAX	0.5	0.5	0.5
14	SP	1	1	1
15	SFCF	0.5	0.5	0.5
16	CFR	0.05	0.05	0.05
17	CWR	0.1	0.1	0.1

Gregorian calendar month 2006. Warming the Model The model heat up was done by running the model for a amount of 3 years of amount from 2006 to 2008 then discharge was computed for the full amount of 01 Gregorian calendar month 2009 to thirty one Gregorian calendar month 2017.

Sensitivity analysis

Sensitivity analysis for Coefficient of determination (R^2)

The sensitivity analysis for all the nine sensitive parameters was done and is shown in Figure 4.13 to Figure 4.21. From these figures we can see the range in which these parameters are sensitive. Since the model parameters did not have a uniform increase or decrease for the sensitivity analysis, they are shown here as individual graphs. The trend lines in these graphs show the range in which these parameters are sensitive and have their influence upon the model. The slope of the graphs explains the most sensitive parameter and sensitive parameters of high and low along with their slopes values are shown in below figure:

Discussion

The HBV model was used with success to model discharge for the study space. Each standardization and validation results show a sturdy relationship between the simulated and discovered discharge from the study space. The results from the model standardization and validation square measure shown in on top of Fig. Best results (with best R2=0.83) were earned throughout the validation amount than the standardization amount for basin. These R2 values 0.83 throughout the validation amount. MAXBAS is usually influences the narmada geographic area at hoshangabad. There were four sorts of routine parameter utilized in HBV lightweight model. they're following:-

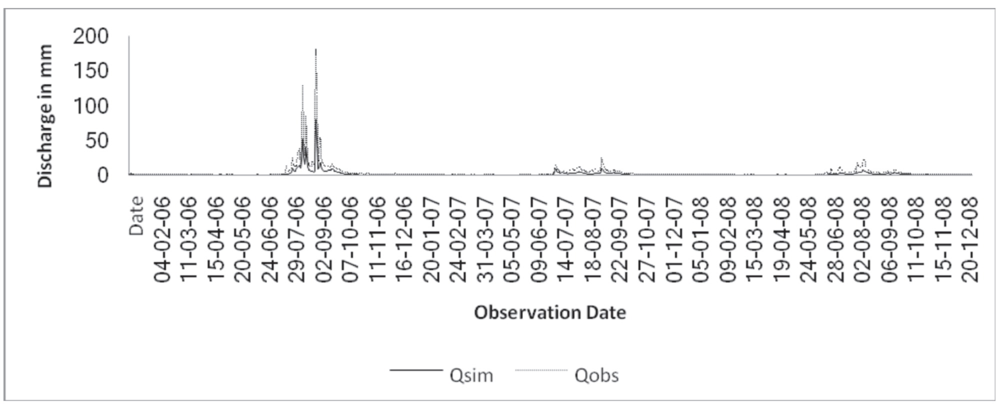

Fig. 3. Relationship between observed and simulated discharge by calibrated parameters for 2006-2008

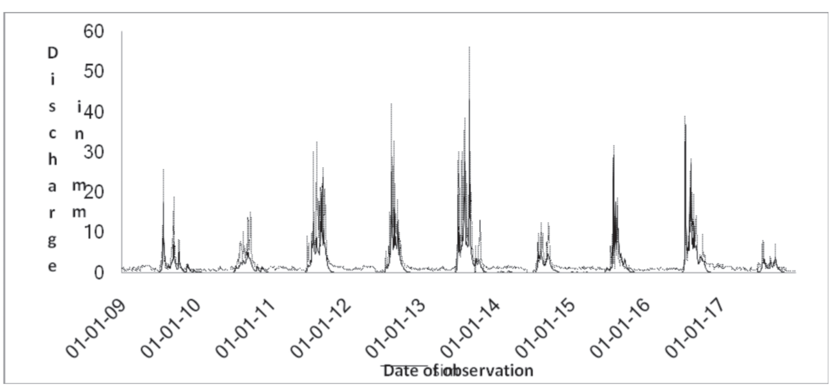

Fig. 4. Relationship between Observed and Simulated Discharge for model period of 2009-2017

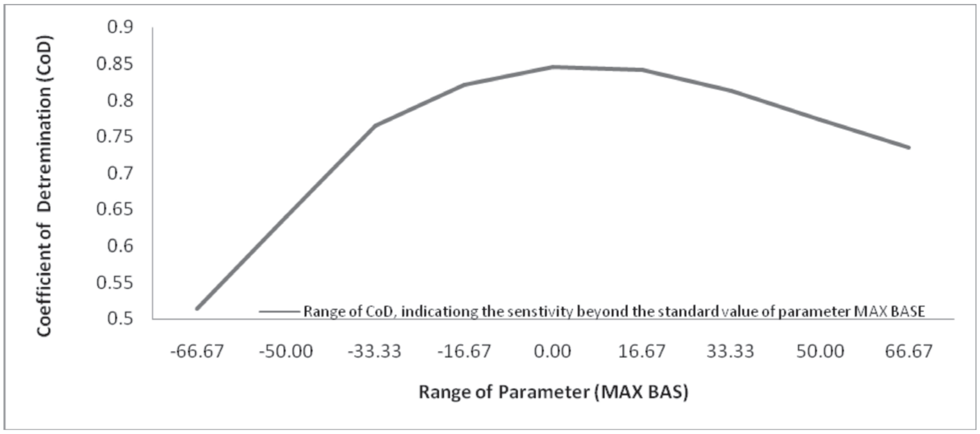

Fig. 5. Sensitivity analysis for MAXBAS values

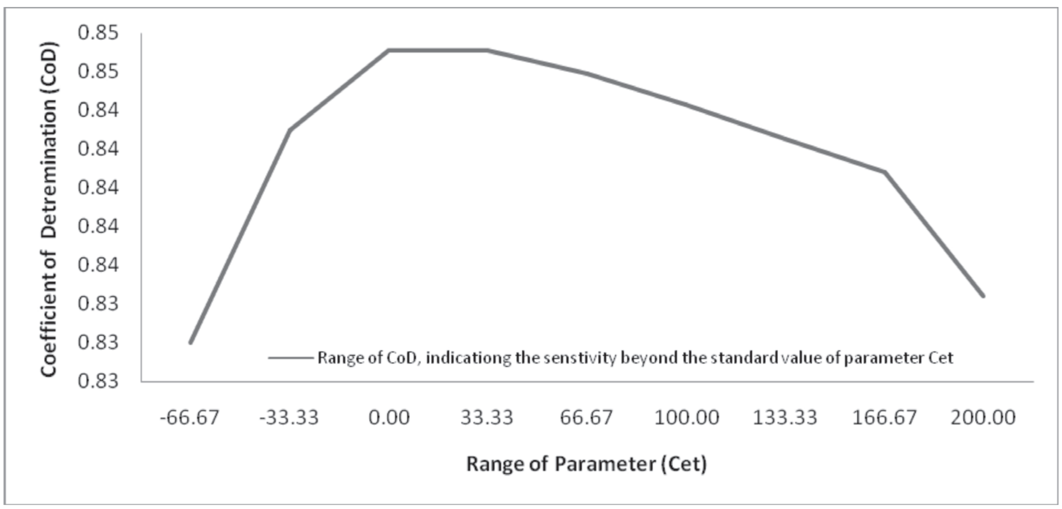

Fig. 6. Sensitivity analysis for Cet values

1. Snow parameter
2. Soil parameter
3. Response parameter
4. Routing parameter

The structure failed to have snow thus, snow parameters had not needed during this study. In soil parameters among Fc, LP and Beta FC was most sensitive with slope price zero.012 followed by Beta with slope price zero.008 and LP with slope zero.001. In Response parameters among K1, K2, Alpha and Perc ALPHAwas most sensitive with slope price zero.018 followed by K1 with slope price zero.1, Dapsang with slope price zero.005, and Perc with slope price zero.001. Maxbashad the foremost sensitivity with slope price zero.23. Parameter Cet had least sensitivity towards the discharge.

Conclusion

This study evaluated the consequences of varied parameter scale alternatives within the HBV model simulation. Comparison of hydrological simulation mistreatment average parameter values from short temporal standardisation and mistreatment manual improvement was conjointly conducted. we are able to acquire the subsequent conclusions: 1. The structure failed to have snow thus, snow parameters had not needed during this study 2. In soil parameters among Fc, LP and Beta FC was most sensitive with slope price zero.012 followed by Beta with slope price zero.008 and LP with slope zero.001 3. In Response parameters among K1, K2, Alpha and Perc ALPHA was most sensitive with slope price zero.018 followed by K1 with slope price zero.1, Dapsang with slope price zero.005, and Perc with slope price zero.001. 4. Maxbas had the foremost sensitivity with slope price zero.23

5. Parameter Cet had least sensitivity.

Simulation solely replicate the model sensitivity to alter in land and prediction will solely be as correct because the model structure and also the knowledge quality but a crucial consistency within the model results. The HBV model is originally a conceptually lumped model. tho' an excellent deal of effort has been invested with in accounting for abstraction variability of precipitation and temperature within the ''distributed'' HBV model, it still falls short in its ability to account for full abstraction variability because of its abstract and lumped in nature. HBV simulations square measure additional sensitive to changes.

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