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Rainfall-Runoff Model for Parwati Basin using Arc-SWAT

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ABSTRACT: The present study examines one of the most widely used flood hydrograph modeling approach for gauged and un-gauged basins and efforts have been made to produce Surface Runoff with the help of Arc-SWAT Model, which is best for large catchment and based on the Geomorphological data, rainfall, soil, land use /land cover, and whether data. Under the suggested methodology five tributaries of Chambal basin were selected from the state of Madhya Pradesh and Rajasthan for study purpose. Arc-GIS 10.5 software was used for analysis purpose. SRTM Image popularly known as Digital Elevation Model (DEM) by using Arc GIS software was used as an input. Various land use, soil map, simulation data, basin map, monitoring point as output were derived from Arc-SWAT model. The complete data was derived through Arc-SWAT software and SWAT-CUP and various parameters were extracted. The result shows that monthly precipitation =1152.8 mm, Surface Runoff = 523.5 mm, Average curve number =86.85, coefficient of determination (R²) = 0.774. From this we can make relation between rainfall-runoff calibration and validation.

KEYWORDS: Calibration, Runoff-Rainfall Model, Arc-GIS, rainfall-runoff, gauged Catchment, SRTM, DEM (Digital Elevation Model), Arc-SWAT.

I. INTRODUCTION

Due to growing population expansion water contamination and extreme climate change, water availability is one of the most pressing challenges. To achieve sustainability, the current generation must pay attention to this issue all throughout the world [1]. SWAT was one of the first semi-distributed hydrological models to be developed, and it was designed to predict discharge from ungauged basin [2].Runoff may be depend on basin nature like slope, landuse and so many thing. The swat mainly works on equation of water balance [3]

$$SW_t = SW_0 + \sum (R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw}) \quad \text{Equation 1}$$

Where: SW_t is the final soil water content (mm);

SW₀ is the initial soil water content on day in (mm);

R_{day} is the amount of precipitation on day in (mm);

Q_{surf} is the amount of surface runoff on day in (mm);

E_a is the amount of evapotranspiration (ET) on day in (mm);

W_{seep} is the amount of water entering the vadose zone from the soil profile on day in (mm);

Q_{gw} is the amount of return flow on day in (mm).

The SWAT model was used to measure the water balance and estimate the surface runoff of the Parwati basin in this study. In comparison to other approaches the SWAT was created simulation at basin scale water and nutrients cycle in landscape whose dominate landuse is agriculture. It can also help in a assessing the environment efficiency of best management practices and alternative management policies. In the current study, Arc SWAT is utilized to estimate runoff in gauged watersheds for particular for output point.



II. STUDY AREA

This study area is the third largest right bank tributary of Chambal River flowing through Madhya Pradesh and Rajasthan. It map of the Parwati watershed originates from Vindhyanal ranges near Astha in Sehore district of Madhya Pradesh at an elevation of 609 m and joins river Chambal in Kota district of Rajasthan. The total length of river is 436 Km. The total catchment area of Parwati sub basin is 15,861 Sq. Km (11.07 % of catchment area of Chambal basin) out of which 10,860 Sq. Km falls in Madhya Pradesh and 5001 Sq. Km in Rajasthan. Initially for a length of 162 Km in Madhya Pradesh, the river traverses north-easterly course and in the balance 60 Km in north-westerly course. The river then forms common boundary between Madhya Pradesh and Rajasthan for next 50 Km before entering the Kota district of Rajasthan. It then traverses about 107 Km before joining the Chambal. Parwati river DEM is shown in figure 1.

Table 1: Basin characteristics of Parwati watershed

S.no.	Parameters	Properties or Value
1	Study Area	Mahalpur barrage Baran district, Rajasthan
2	Elevation of origin of Parwati River	270 meter above mean sea level (msl)
3	Geographical Location of study area	76°33'50" E longitude
		25°19'46" N latitude
4	The total distance	159 km
5	Origin of Parwati Watershed	Vindhya range of Madhya Pradesh
6	Nature of Parwati Watershed	gauged

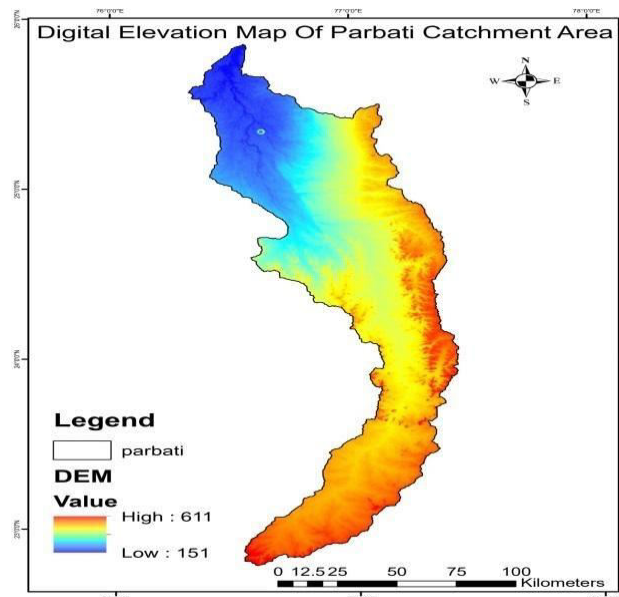


Figure 1 : DEM map of the Parwati watershed

III. METHODOLOGY

Digital Elevation model has been used and SWAT model simulation, the simulation time was provided, stream flow data was produced as monthly, and skewed normal Rainfall distribution was selected this all step are shown on Fig.2

Generation of database:-

Data has been classified from the above process. All data has been measured in S.I. Unit and derived simulated flow from Arc-SWAT model has been some Analysis data list:1) land use/land cover shown Fig.3 and table3. 2) Soil



Classification has been shown in Fig4 and table4 .3) Slope Classification Fig.5 and table5. Swat output shown in Fig.6.and relationship between simulation data and observed data is shown in graph.

FIG. 2: FLOW CHART OF METHODOLOGY USED

Table 2: Landuse classification

Sr. No.	Landuse classification	Landuse Code	% Wat Area
1.	WATER	WATR	1.09
2.	FOREST MIXED	FRST	21.88
3.	AGRICULTURAL LAND GENERIC	AGRL	73.40
4.	RESIDENTIAL HIGH DENSITY	URHD	3.59
5.	PASTURE	PAST	0.04

Hydrological and Metrological data: - In this study area, daily rainfall, temperature data is taken from IMD (Indian Meteorological Department) wind, relative humidity solar radiation data in SWAT file format were used. Daily discharge data is provided by Rajasthan water resource department.

Elevation data: - A digital elevation model (DEM) generated from the Shuttle Radar Topography Mission (SRTM) of 30-m resolution was used in this study and it is downloaded from USGS Earth Explorer.

Soil map: - A soil map is extracted from Geo Network-food and agriculture organization of the united nation site.

Land use/Land cover: - Land use is prepared by sentinel file which is downloaded from Earth explorer search in grid format. And this sentinel file extracts land use by ArcGIS tool SVM (support vector machine).

Table 3: Type of data collection (Data-set)

S.no	TYPE OF DATA collection	NAME OF DATA	PERIODS/ SOURCE
1	Spatially Data	• Digital Elevation Model	• SRTM DEM Data from Earth explore
		• Land use /Land Cover Map, Soil Classification Map	• Sentinel file exact by SVM and FAQ
2	Time Series Data; Weather Data Daily	• Maximum/Minimum Temperature	1979-2014IMD
		• Relative Humidity	1979-2014IMD
		• Wind Velocity	1979-2014, Power NASA
		• Solar Radiation	1979-2014, Power NASA
3	Hydrological Data	• Rain Fall (Observed)	1990-2008, IMD
		• Runoff (Observed Flow)	1997-2008, NWDA Data set



LANDUSE LANDCOVER MAP OF PARBATI RIVER BASIN

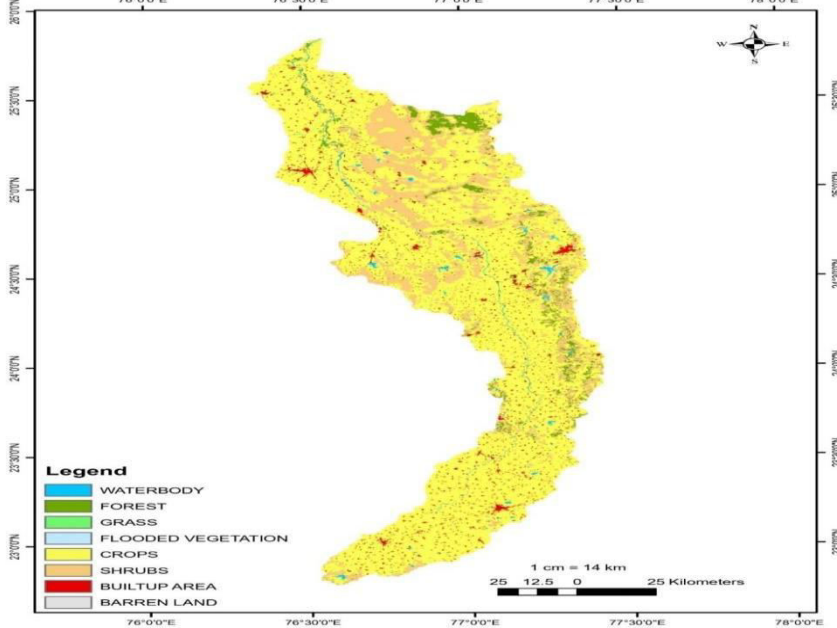


Figure 3: Land use classification of watershed

Table 4: Soil classification

Sr. No.	Soil classification	Area in (ha)	% Wat Area
1.	Be85-2a-3686	132844.1025	8.78
2.	Bv12-3b-3696	474.3060	0.03
3.	I-Bc-Lc-3714	183096.1781	12.10
4.	Vc43-3ab-3861	1196839.7177	79.09

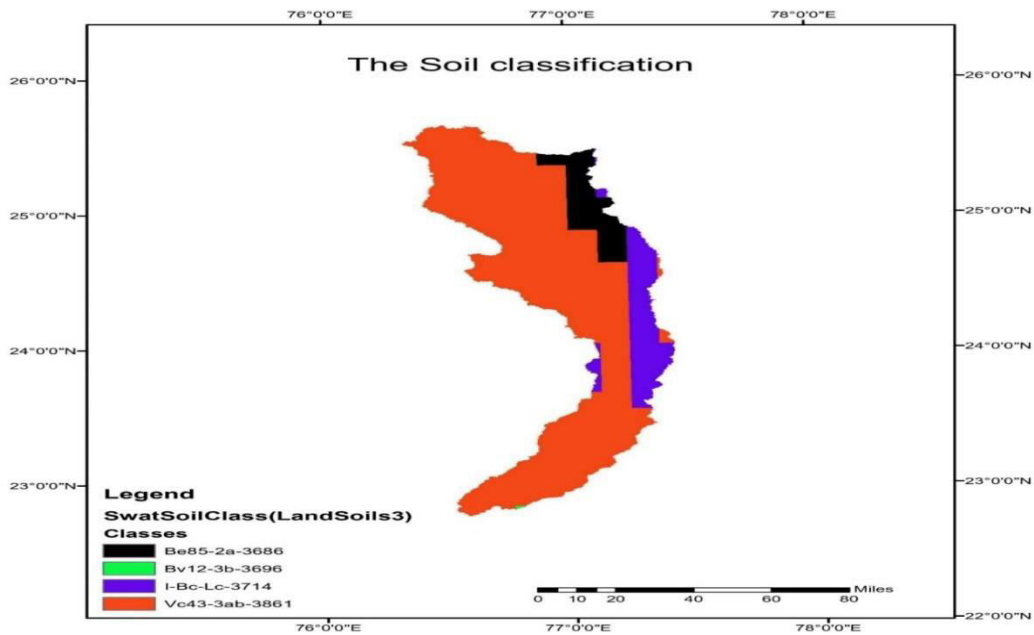


Figure 4: Soil classification of watershed Map



Table 5: Slope classification

Sr. No.	Slope classification	% Wat Area
1.	0-3	20.73
2.	15-9999	4.40
3.	3-15	74.87

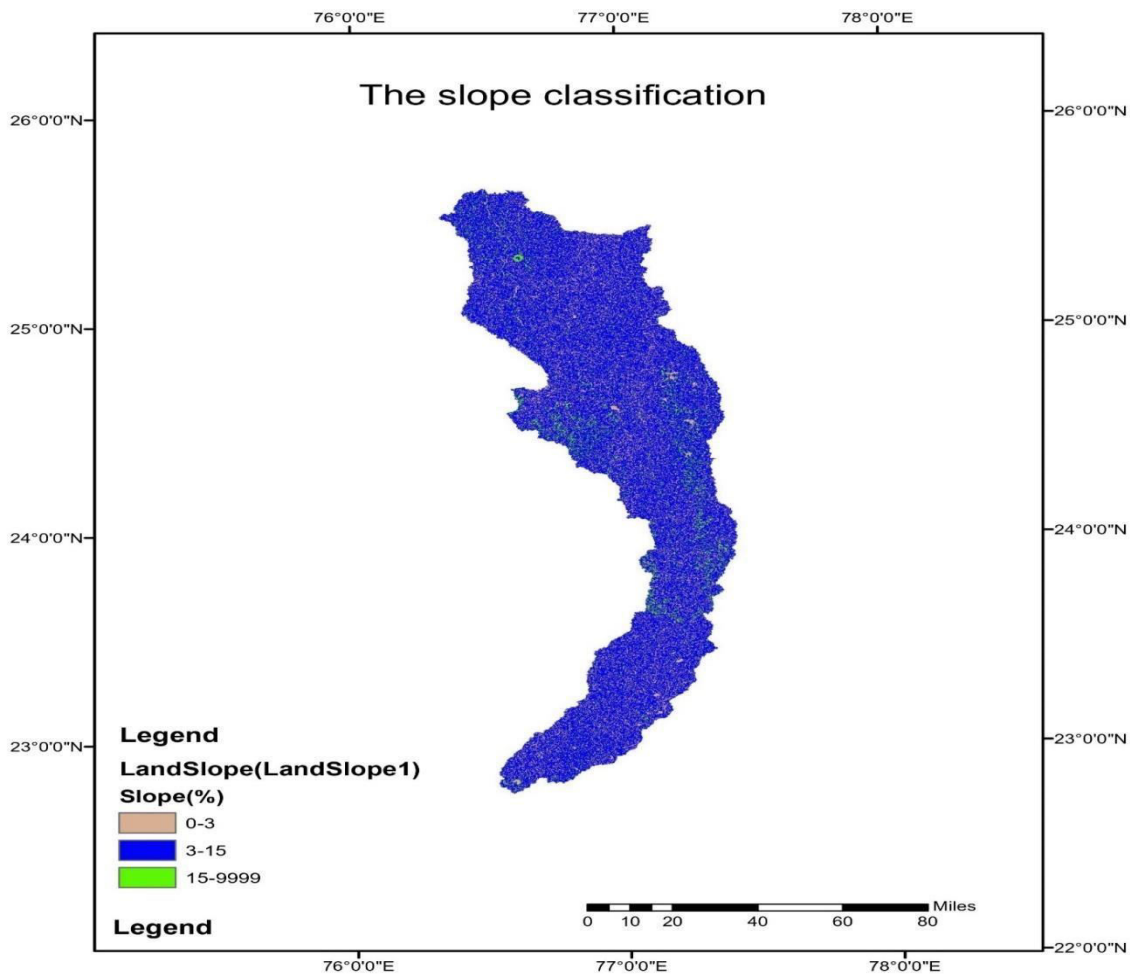


Figure 5: Slope classification of watershed

IV. EXPERIMENTAL RESULTS

The study shows that various parameters required for developing runoff-model through use/land cover map, which previously had 10 classes, was reclassified into Five classes, as indicated in fig. After reclassification, it was determined that croplands covered the maximum size, contributing for 89.39 % of total land cover, followed by pasture lands, which represented for 0.03percent. SWAT simulations were conducted on a monthly basis, with a 3-year simulation span running from January 1982 to July 2014. Monthly monsoon precipitation and surface runoff averaged 1152.8 mm and 523.5 mm, respectively, according to SWAT output, with an average curve number of 86.85.



According to the model's predictions the curve number is high, which means that the higher the curve number, the more surface runoff in the basin.

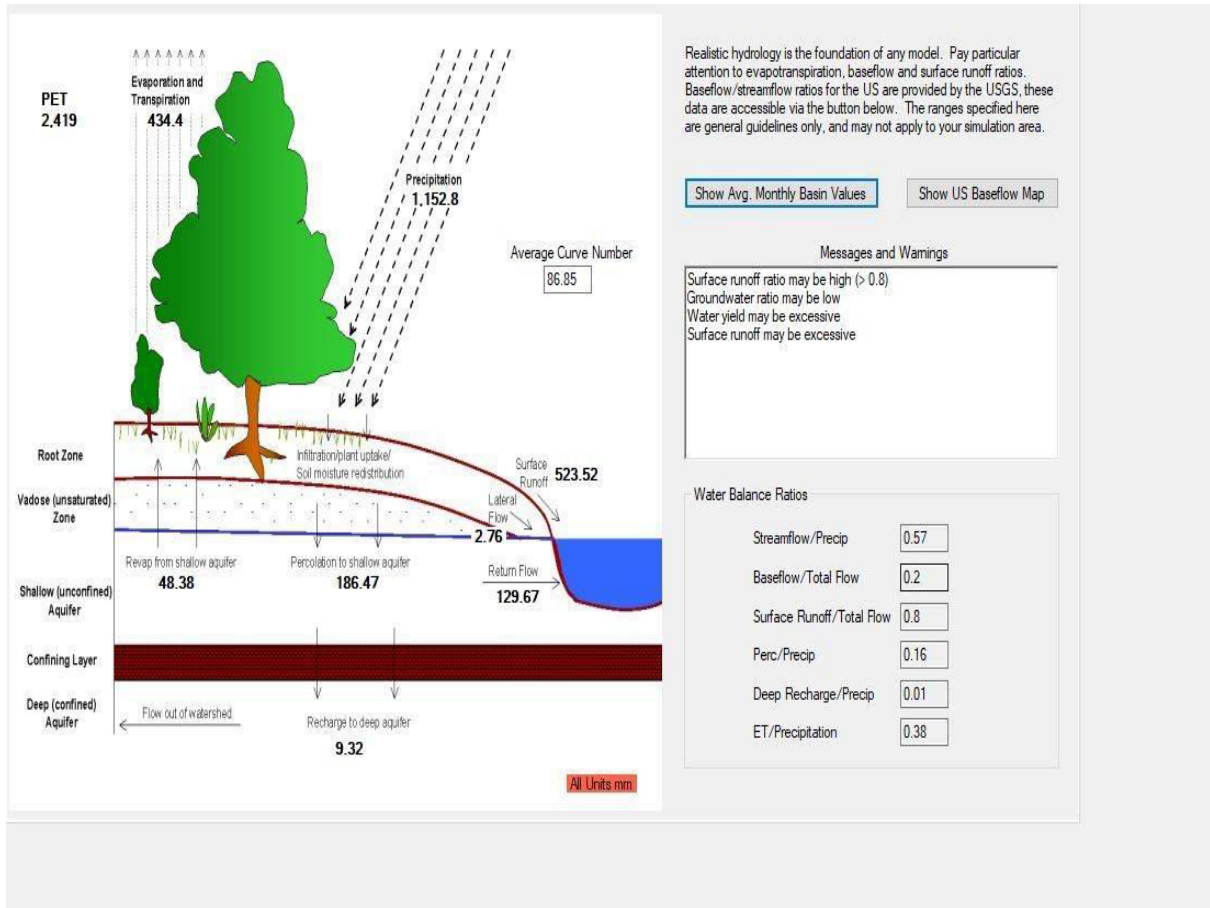
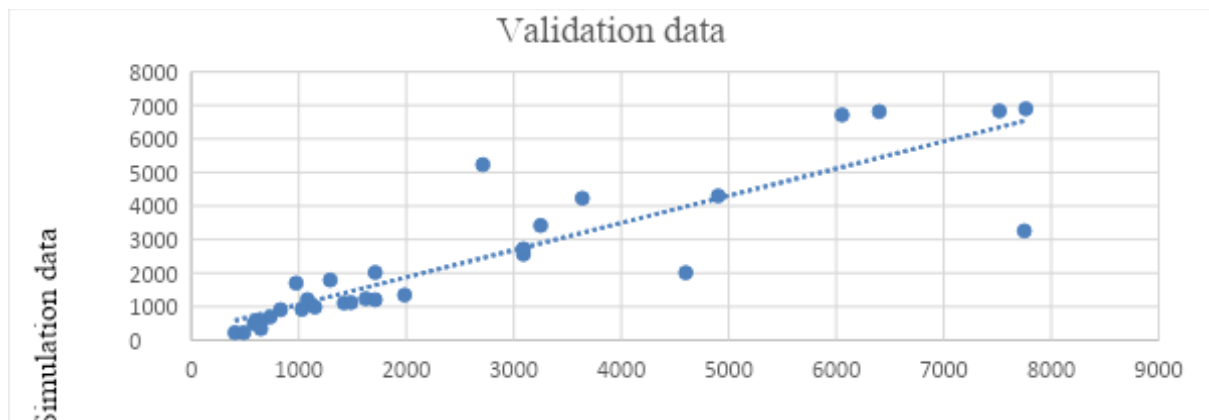


Figure 6: Swat output watershed

Table 6: AVERAGE MONTHLY BASIN VALUES

MONTH	RAIN (MM)	SURF Q (MM)
1	6.96	0.51
2	6.71	0.45
3	3.33	0.11
4	2.87	0.16
5	3.92	0.29
6	89.38	26.66
7	364.95	181.68
8	341.57	185.27
9	132.98	62.33
10	27.96	9.13
11	5.97	1.37
12	6.68	2.28



V. CONCLUSION

The study shows that based Swat Mode is found to be highly effective for developing Runoff-rainfall since the majority of the required Dem, landuse, soil, rainfall data based. The study indicates that all input parameters: Soil rainfall landuse weather set data is easy inserted and result is sufficient to analysis and also analysis b swat-cup $R^2= 0.7773$. The study shows that various parameters required for developing runoff-model through use/land cover map, which previously had 10 classes, was reclassified into Five classes, as indicated in fig. After reclassification, it was determined that croplands covered the maximum size, contributing for 89.39 % of total land cover, followed by pasture lands, which represented for 0.03percent. SWAT simulations were conducted on a monthly basis, with a 3-year simulation span running from January 1982 to July 2014. Monthly monsoon precipitation and surface runoff averaged 1152.8 mm and 523.5 mm, respectively, according to SWAT output, with an average curve number of 86.85. According to the model's predictions the curve number is high, which means that the higher the curve number, the more surface runoff in the basin.

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