

SIMULATION OF SUB-DAILY RUNOFF FOR AN INDIAN WATERSHED USING ArcSWAT MODEL

***2012 INTERNATIONAL SWAT CONFERENCE
NEW DELHI, INDIA
JULY 16-20, 2012***

T. Reshma¹, K. venkata Reddy², Deva Pratap³



Introduction

- SWAT model is a hydro-dynamic and physically-based hydrologic model.
- Geographic Information System (GIS) provides the framework within which spatially-distributed data are collected and used to prepare model input files and to evaluate model results.

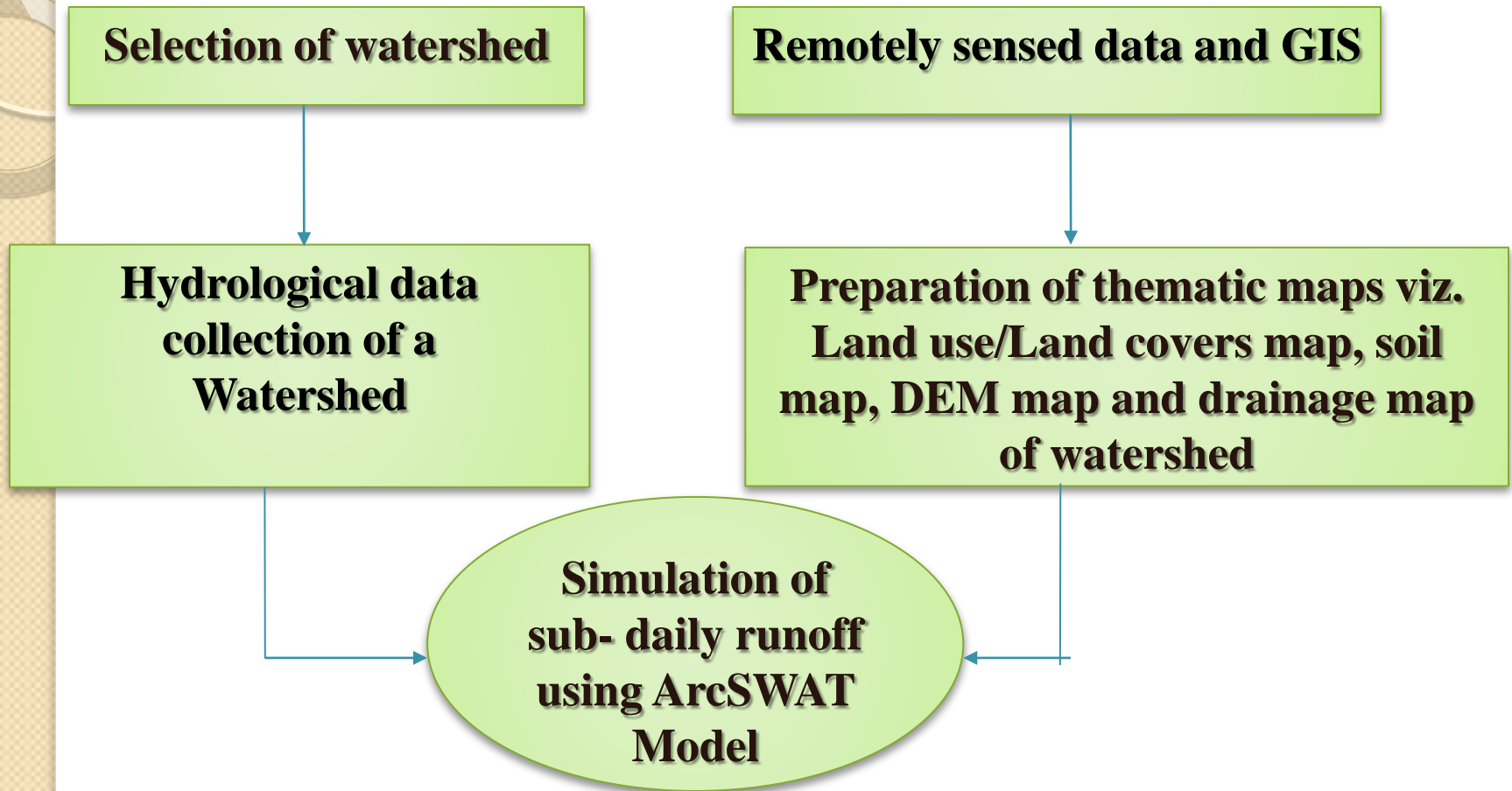
Literature Review

- Arnold et al. (1999) presented two methods of simulating excess rainfall on a large basin with multiple rain gages and compared the simulations.
- Simic et al. (2009) studied the application of SWAT in modeling of the rainfall runoff Process.
- Arnold et al. (2010) presented the development and testing of a sub-hourly rainfall–runoff model in SWAT.

Objectives

- The objective of the study is to simulate the sub-daily runoff using ArcSWAT model.
- Harsul watershed has been selected and relevant hydrological data has been collected.
- Remotely sensed data and GIS have been used to prepare the thematic maps of the watershed.

Methodology



Methodology Flowchart

Location map and Study area of the Harsul Watershed

- Harsul watershed is located in Nashik district, Maharashtra, India.
- The watershed has an area of 10.929 sq. km.
- It is situated between East Longitude of $73^{\circ} 25'$ and $73^{\circ} 29'$ and the North Latitudes of $20^{\circ} 04'$ and $20^{\circ} 08'$.



SWAT Model Description

- The model setup involves the following five steps:
 - Watershed delineation
 - HRU definition
 - Weather data definition
 - Edit SWAT input
 - Run SWAT.

Watershed Delineation

DEM Setup

F:\arcswat_harsuel\SWATHarsuel_12\RasterStore.mdb\

DEM projection setup

☐ Mask

☒ Burn In F:\arcswat_harsuel\SWATHarsuel_12\Raste

Stream Definition

☒ DEM-based

☐ Pre-defined streams and watersheds

DEM-based

Flow direction and accumulation

Area: (5 - 1046) 100 [Ha]

Number of cells: 400

Pre-defined

Watershed dataset:

Stream dataset:

Stream network

Create streams and outlets

Outlet and Inlet Definition

☐ Subbasin outlet

☐ Inlet of draining watershed

☐ Point source input

☐ Add point source to each subbasin Add by Table

Edit manually

Watershed Outlets(s) Selection and Definition

Whole watershed outlet(s)

Cancel selection

Delineate watershed

Calculation of Subbasin Parameters

☐ Reduced report output

☐ Skip stream geometry check

☐ Skip longest flow path calculation

Calculate subbasin parameters

Add or delete reservoir

Number of Outlets: 7

Number of Subbasins: 7


Exit Minimize

Menu for Automatic Delineation of Watershed in ArcSWAT model


Land Use/Soils/Slope Definition

Land Use Data | Soil Data | Slope

Land Use Grid

 no location

Choose Grid Field

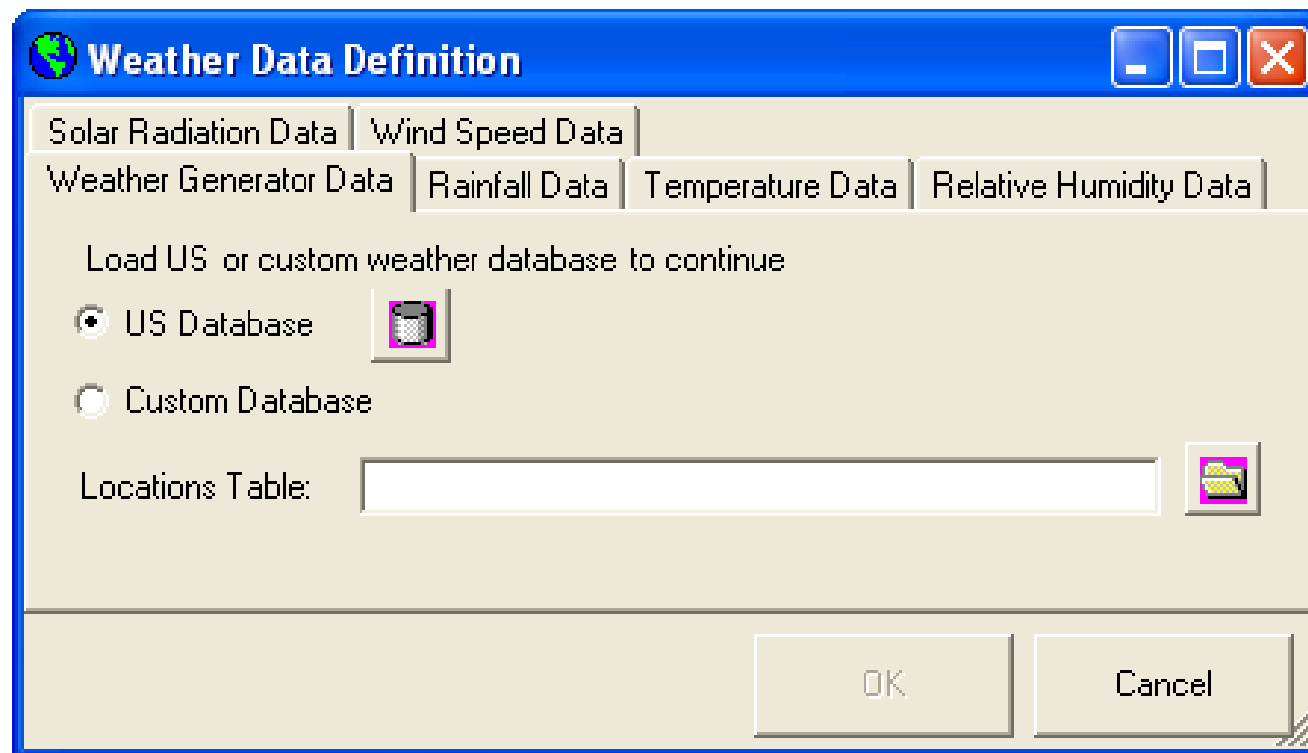


LookUp Table Table Grid Values ---> Land Cover Classes

SWAT Land Use Classification Table

☐ Create HRU Feature Class
☒ Create Overlay Report

Menu for Hydrologic Response Unit Analysis in ArcSWAT model



Menu for Weather Data Definition in ArcSWAT model

Setup and Run SWAT Model Simulation

Period of Simulation

Starting Date : Ending Date : ☐ Simulate Forecast Period

Rainfall Sub-Daily Timestep

Timestep: Minutes

Forecast Period

Starting Date : Number of Simulations:

Rainfall Distribution

☒ Skewed normal

☐ Mixed exponential

SWAT.exe Version

☒ 32-bit, debug ☐ 32-bit, release

☐ 64-bit, debug ☐ 64-bit, release

☐ Custom (swat2009User.exe)

Printout Settings

☒ Daily ☐ Yearly ☐ Print Vel./Depth Output ☒ Print Hourly Output

☐ Monthly NYSKIP : ☐ Print Pesticide Output ☐ Print Soil Storage

☐ Print Water Quality Output ☐ Print Log Flow ☐ Route Headwaters

☐ Print Binary Output ☐ Print Soil Nutrient ☒ Limit HRU Output

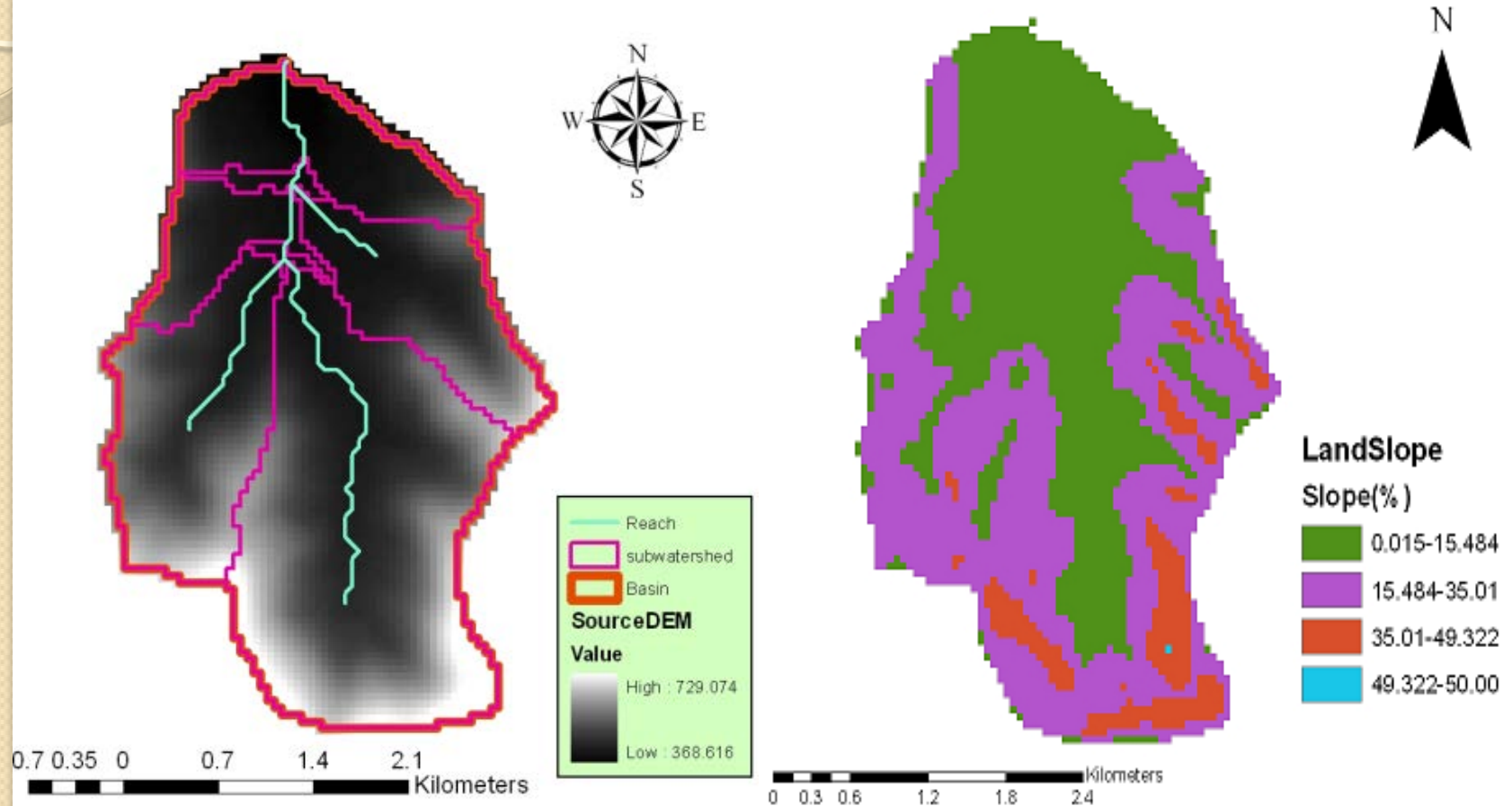
☐ Print MGT Output ☐ Print Snow Output

Deposition File:

Setup SWAT Run Run SWAT Cancel

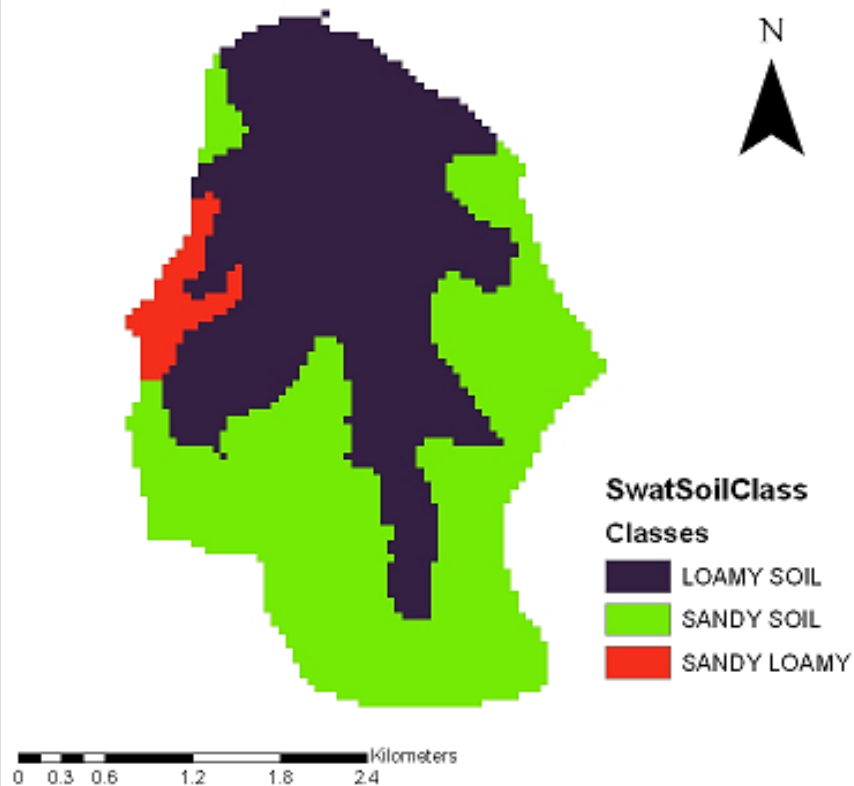
Menu for Setup and Run SWAT model simulation

SWAT Model Application

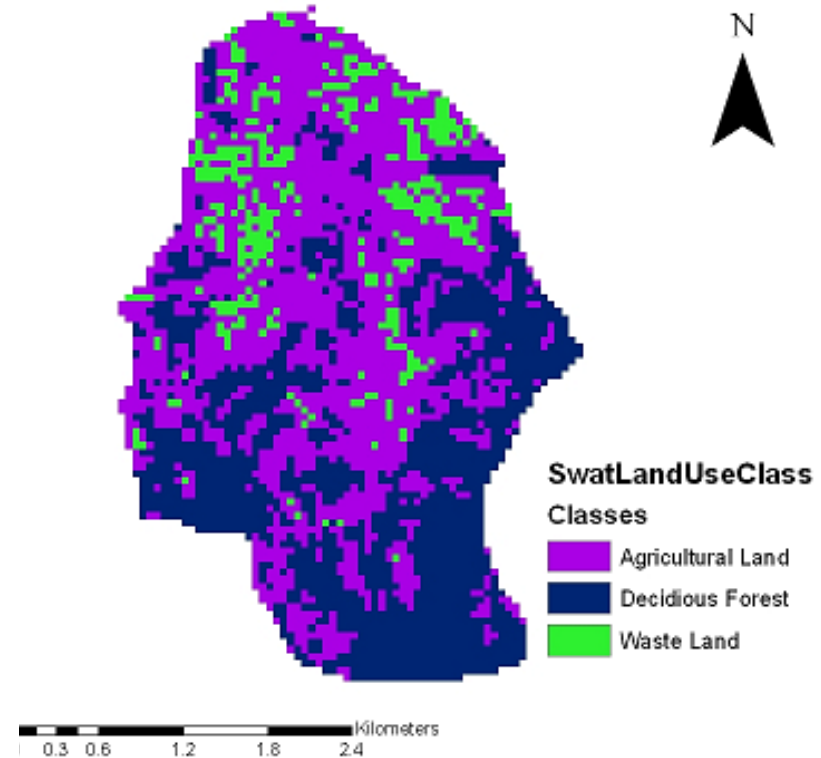


Automatically delineated sub-basins
Harsul watershed

Modified Slope map of
Harsul watershed

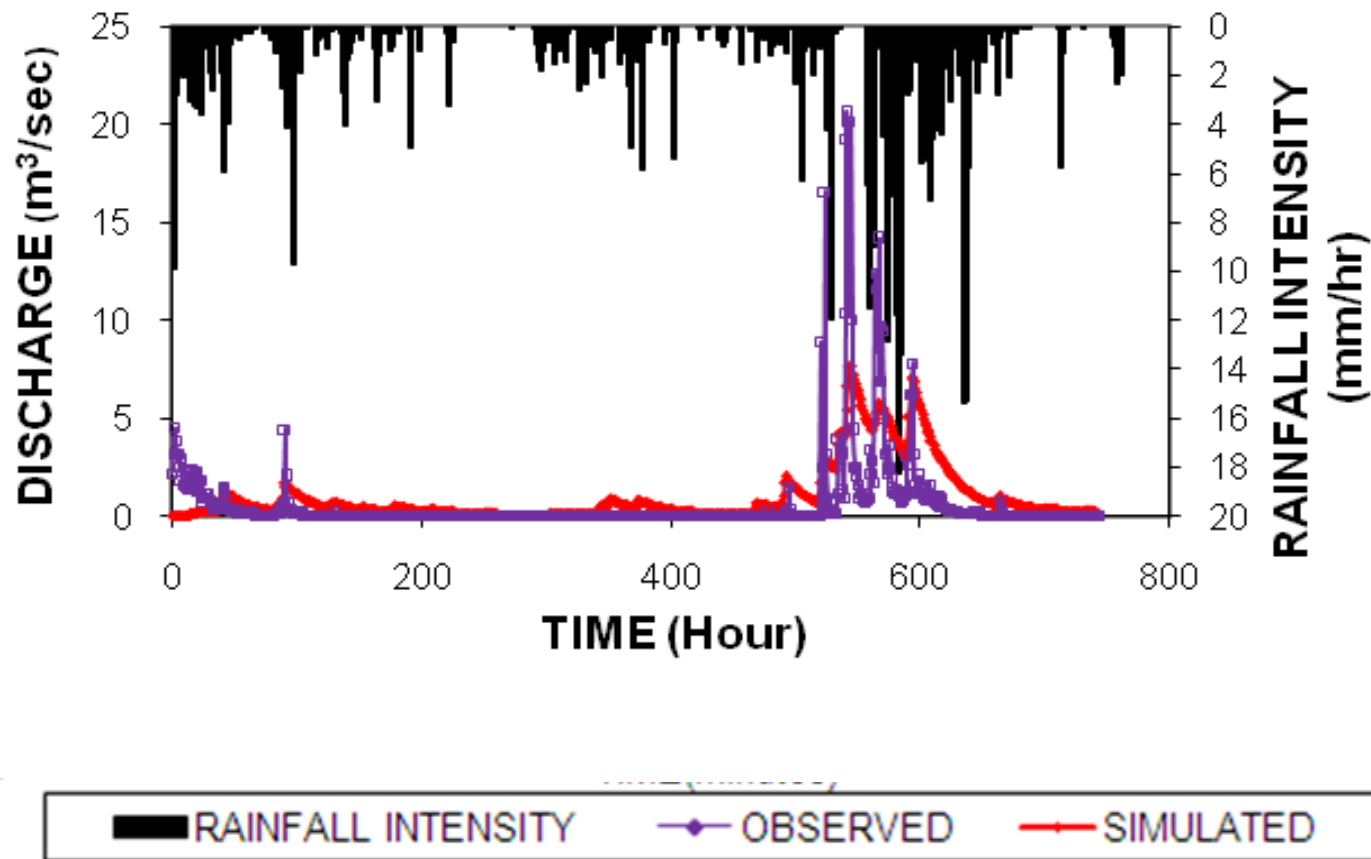


Modified Soil map of Harsul Watershed

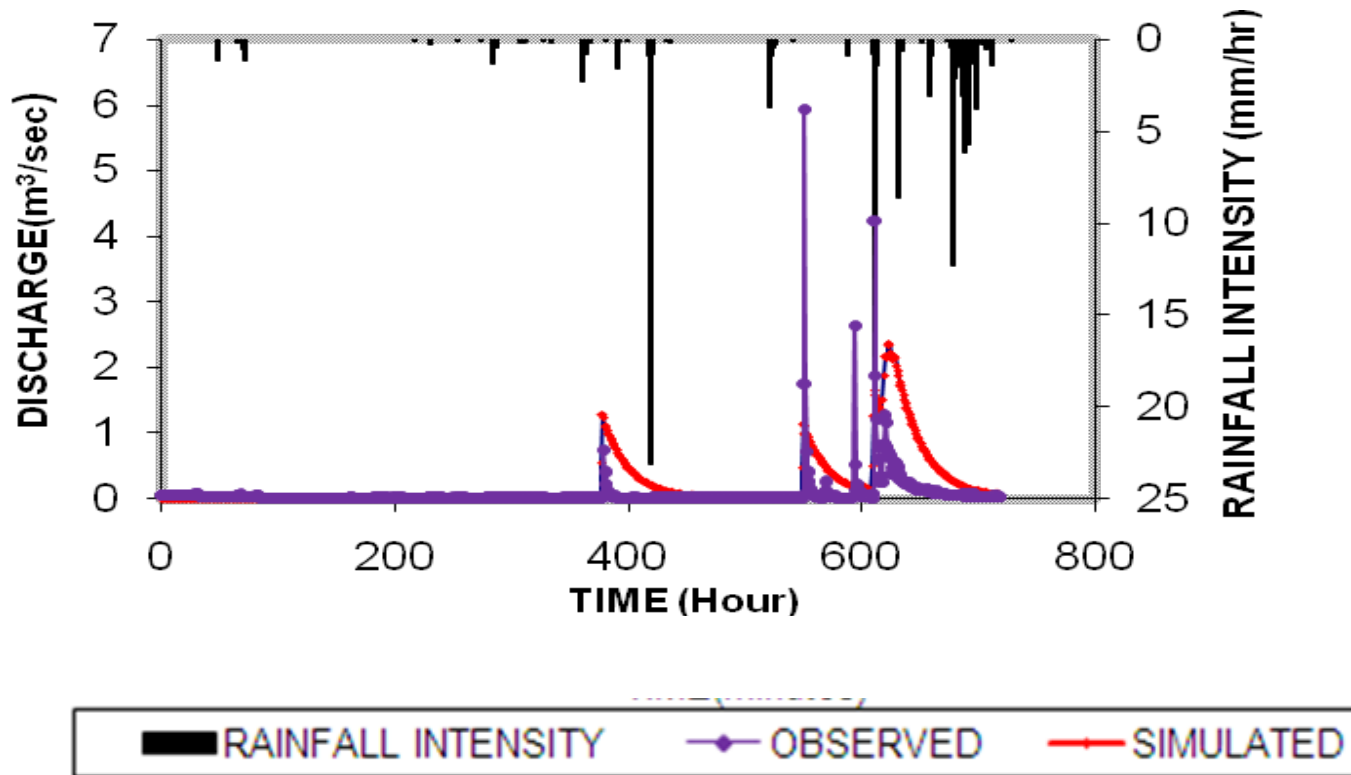


Modified LU/LC map of Harsul Watershed

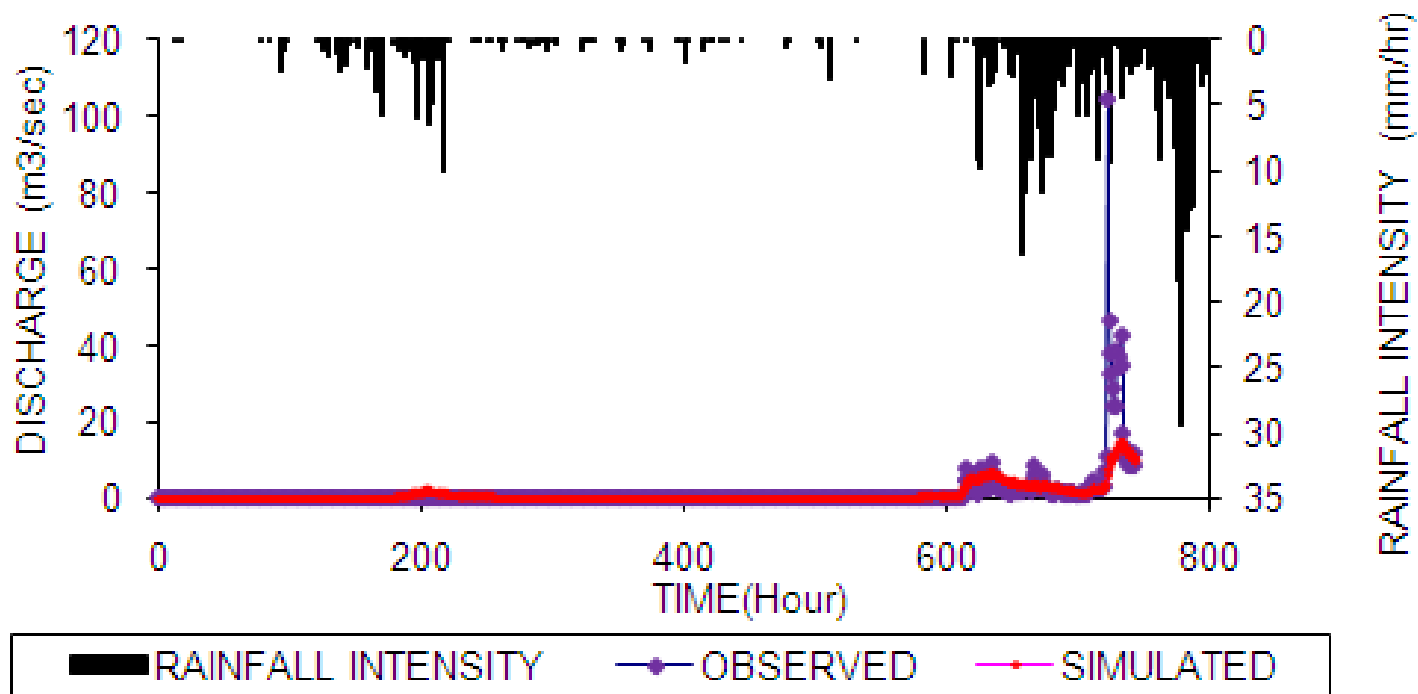
Results and Discussions



Simulated and Observed hydrographs for the Harsul watershed (July 1997)



Simulated and Observed hydrographs for the Harsul watershed
(September 1997)



Simulated and Observed hydrographs for the Harsul watershed
(August 1997)

Table 1. Simulation results for Harsul watershed

Rainfall months	Volume of runoff (mm)		Peak runoff (m ³ /sec)		Time to peak (Hour)	
	Observed	Simulated	Observed	Simulated	Observed	Simulated
July, 1997	307.76	242.21	104.784	12.9	723	730
August, 1997	143.24	247.36	4.437	1.67	91	91
September, 1997	16.71447	47.42	5.935	2.37	551	623

Conclusions

- The model has been applied for the three month's rainfall data.
- From the simulations, it is observed that, the model is able to simulate the volume of runoff and time to peak runoff. But large variations are observed in peak runoff.
- This may be because of inexactness in the values of parameters.
- It is also observed that sensitivity analysis has to be carried out to improve the simulation results.
- The methodology presented in this study is useful to simulate hourly runoff in Indian watersheds using ArcSWAT models.

References

- Arnold, J.G., R. Srinivasan, R. Jayakrishnan, and C. Santhi. 2005. Advances in the application of the SWAT model for water resources management. *Hydrological Processes*. 19, 749-762.
- Birhanu, B.Z., P.M. Ndomba, and F.W. Mtalo. 2007. Application of SWAT Model for Mountainous Catchment. *Catchment and Lake Research*.
- Bijan. D., R. Srinivasan, and G.S. Shimelis. 2008. Hydrological Modelling in the Lake Tana Basin, Ethiopia Using SWAT Model. *The Open Hydrology Journal*, 2, 49-62.
- Jeong. J., N. Kannan, J. Arnold, R. Glick, L. Gosselink, and R. Srinivasan. 2010. Development and Integration of Sub-hourly Rainfall–Runoff Modeling Capability Within a Watershed model. *Water Resour Manage*. Accepted: 6 May.
- Reshma T., K. Venkata Reddy and Deva Pratap. 2011. Simulation of runoff of a watershed using ArcSWAT model. In *Proc. International Conference on Spatial Technologies for Rural Development/Watershed Development*.
- Srinivasan, R., X. Zhang, and J. Arnold. 2010. SWAT ungauged: hydrological budget and crop yield predictions in the upper mississippi river basin. *American Society of Agricultural and Biological Engineers*. Vol. 53(5): 1533-1546.
- Venkata Reddy. K, Eldho. T. I, Rao. E.P. and Kulkarni, A.T. (2011), FEM-GIS based channel network model for runoff simulation in agricultural watersheds using remotely sensed data, *International Journal of River Basin Management*, 9(1), 17-30.



Thank u