

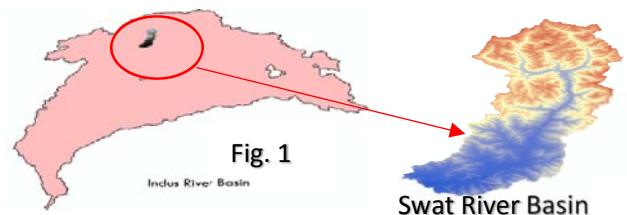
**ABSTRACT****SIMULATING HYDROLOGICAL RESPONSE OF SNOW AND GLACIER MELT AND ESTIMATING FLOOD PEAK DISCHARGE IN SWAT VALLEY RIVER BASIN****PAKISTAN METEOROLOGICAL DEPARTMENT, GUL MUHAMMAD****PWRI, ICHARM, ASSOCIATE PROFESSOR MOHAMED RASMY****PWRI, ICHARM, DOCTOR MORIMASA TSUDA****PWRI, ICHARM, PROFESSOR TOSHIO KOIKE****INTRODUCTION:**

Pakistan is a flood prone country and undergoes from flood of medium to high degree almost every year cause by summer monsoon concentrated high precipitation augmented by snow and glacier melt. 2010 flood was a record breaking flood which pushed nearly 2000 lives to death and affected more than 2 million people. In this research swat valley river basin which falls in the feet of Himalayan mountain range has been studied. It is snow fed and flood prone basin and starting tributaries Ushu and Utror and meet in Kalam. In summer season the snow melts and starts flooding in the lower reaches of the basin. Flooding not only affects Swat but also Charsadda, Nowshera and Peshawar districts, where Swat river meets Kabul river. A very few studies have conducted on this basin. (Mateeul Haq, 2008). Therefore this research has been carried out to strengthen the non-structural measures of flood early warning system. In the past hydrological model in which snow and glacier melt has been addressed, used for simulation of hydrological response for the flood forecasting and effective flood risk management in this basin. Therefore Integrated Flood Analysis System (IFAS) model with snowmelt function based on MODIS snow cover data has been used to model the hydrological response of the basin.

**STUDY AREA:**

Figure 1, shows Indus river system.

Inside the Indus river system is the study area i.e swat river basin as indicated by the red color circle. The right part of Figure shows DEM raster of the study area.



**MODEL AND DATA:** Public Works Research Institute Distributed Hydrological Model (PWRI-DHM) which is hydrological analysis model was used in this research. The model consists of a distributed hydrological model based on tank model and a routing model based on a kinematic wave hydraulic model.

**DATA:**

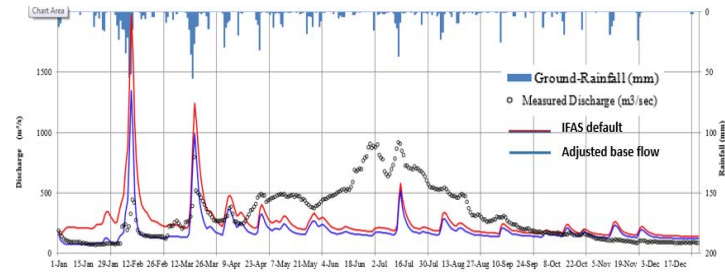
Table I: Data used for this study

Data	Period	Source
Digital Elevation Model 15 sec	-----	USGS (HydroSHEDS)
Daily Ground Rainfall, max and min	2005, June-Sep 2013	Pakistan Meteorological Department
Daily River Discharge	2005, June-Sep 2013	Water and Power Dev Authority, Pakistan
Daily Snow Cover (MOD10A1)	2005, June-Sep 2013	MODIS (NASA)

The daily rainfall data of four stations collected from Pakistan Meteorological Department of year 2005 & 2013 was used for this study. The daily river gauge data at chakadara location was taken from Water & Power Department Pakistan (Table 1). The snow cover data on daily basis has been downloaded from NASA.

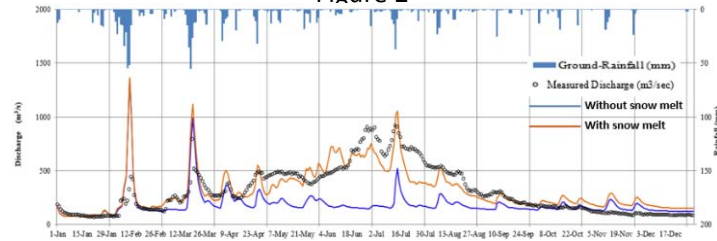
## RESULTS AND DISCUSSION:

In Figure 2, ground rainfall data of year 2005 was simulated by using IFAS model, as shown by red color hydrograph. Three issues were observed first the magnitude of first default simulated peak was much higher than observed, second base flow and peak discharge during summer monsoon period was not accounted by IFAS and third the base flow during winter season is a little bit high than observed one. By adjusting the value of initial water height on aquifer tank to 1.40 (default value=2.00), the problem of initial condition resolved. The MODIS snow cover data MOD10A1 was downloaded and used in IFAS Snow Runoff Mode, the model shows best result as shown by orange color hydrograph in Figure 3. For model validation the model was run for June to September 2013 ground rainfall data as shown in Figure 4. The model gives best result as peak duration and discharge are same, but base flow is well underestimated, then MODIS snow cover data MOD10A1 for target period was downloaded and run in IFAS snowmelt runoff mode. The model shows somewhat high base flow but still underestimated.



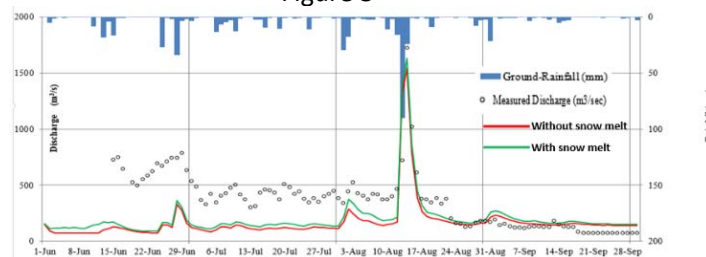
Hydrographs by simulating 2005 ground rainfall data

Figure 2



Hydrographs by simulating 2005 ground rainfall data with snowmelt

Figure 3



Hydrographs by simulating 2013 ground rainfall data with snowmelt

Figure 4

## Conclusion:

On the basis of the above partially carried out study the following conclusion has been given. Snowmelt contributed to Swat river runoff in simulating flood peak discharge. In case of result obtained from simulation under IFAS snow runoff model for year 2013, the low flow is still under estimation needs further investigation. However this study will further investigate the issues and develop effective flood early warning system.

**Summary:** In this research the hydrological response of Swat river basin has been studied. The ground rainfall data for year 2005 was simulated by using IFAS, the simulated results show low base flow then snow cover data of the target basin was imported by using IFAS snowmelt manager which shows good results. The model was validated for 2013 data but low flow is well under estimated which needs further investigation.

**References:** Mateeul Haq, 2008: "Snowmelt Runoff Investigation in River Swat Upper Basin Using Snowmelt Runoff Model, Remote Sensing and GIS Techniques".

Tsuda, M., Iwami, Y. Development and improvement of IFAS, 2016 proceedings of JSCE annual meeting (in Japanese).