Real time flood forecasting in the Chenab basin in Pakistan

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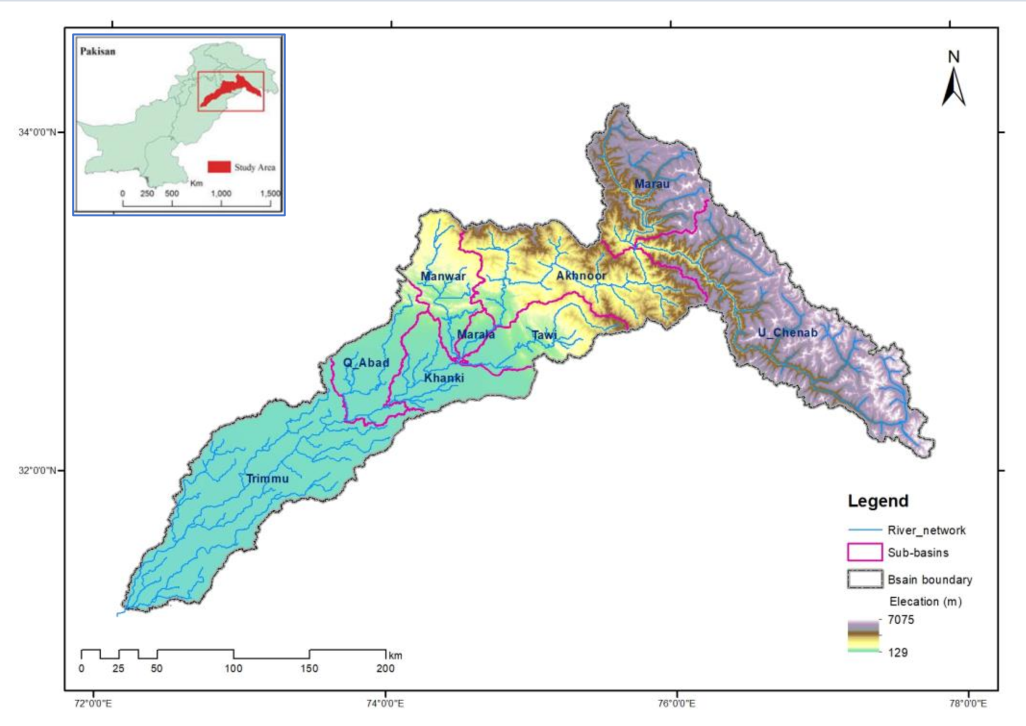
Introduction

The Chenab river a tributary of the Indus is extremely vulnerable to floods. It is a transboundary river with the upper catchments in India. In September 2014 the Jammu and Kashmir region received heavy rainfall which triggered floods and landslides in India and Pakistan. Considering the high vulnerability to flood disasters in the Chenab basin timely flood forecasts is necessary to save lives and livelihoods. Development of a well-calibrated, flood forecasting model based on real time rainfall is quite challenging, especially when in situ data is limited or unavailable such higher elevation mountainous area. However, the availability of real-time data from upper catchments is limited providing an opportunity for use of satellite data for flood prediction.

The system was developed using a precipitation-runoff model for basin catchments integrated with a hydrodynamic model for computing flood propagation along major rivers utilizing the freely available global satellite meteorological forcing.

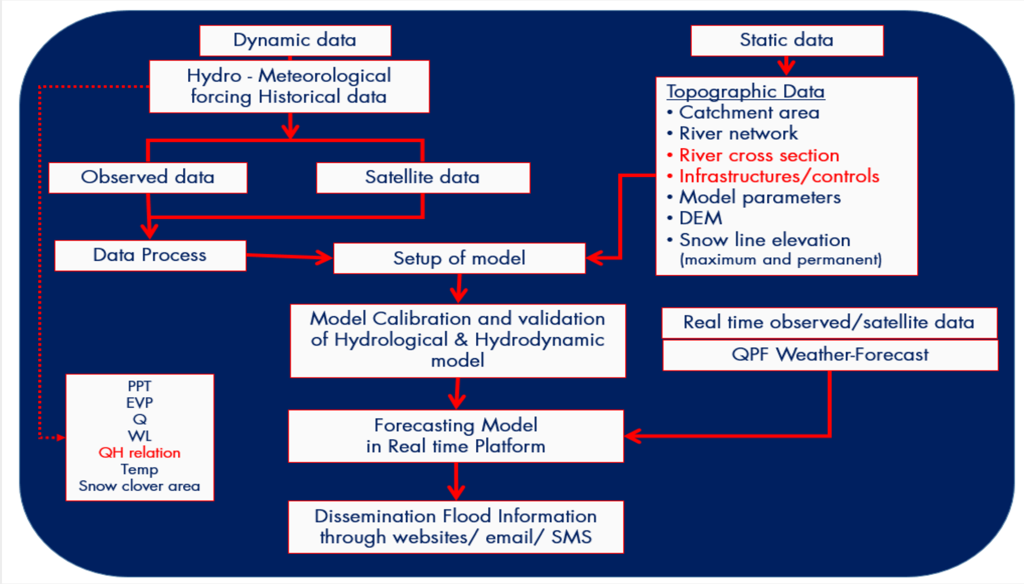
Study Area



Sub basin	Area (km²)
U_Chenab	10798
Tawi	2905
Akhnoor	6921
Marau	4818
Manwar	2845
Marala	453
Khanki	2916
Q_Abad	2786
Trimmu	10961

The model is setup in Chenab river basin up to the confluence of Chenab and Jhelum river. The Chenab River Basin is the major tributaries of Indus River Basin. This river is formed by the Chandra and Bhaga, which rises in Lahul. It flows through Himachal Pradesh and Kashmir and is known as Chandra-Bhaga or Chenab. It then traverses 330 km to Akhnoor, via Akhnoor it enters Pakistan. The Chenab river connect with Jhelum river at Trimmu. Its catchment area up to the Indo-Pakistan border is about 26,155 sq km and up to Trimmu is about 45,404 sq km and elevation ranges from 129 to 7075 masl. For this model, the Chenab basin is divided into 9 sub-basins.

Conceptual Model & Methodology



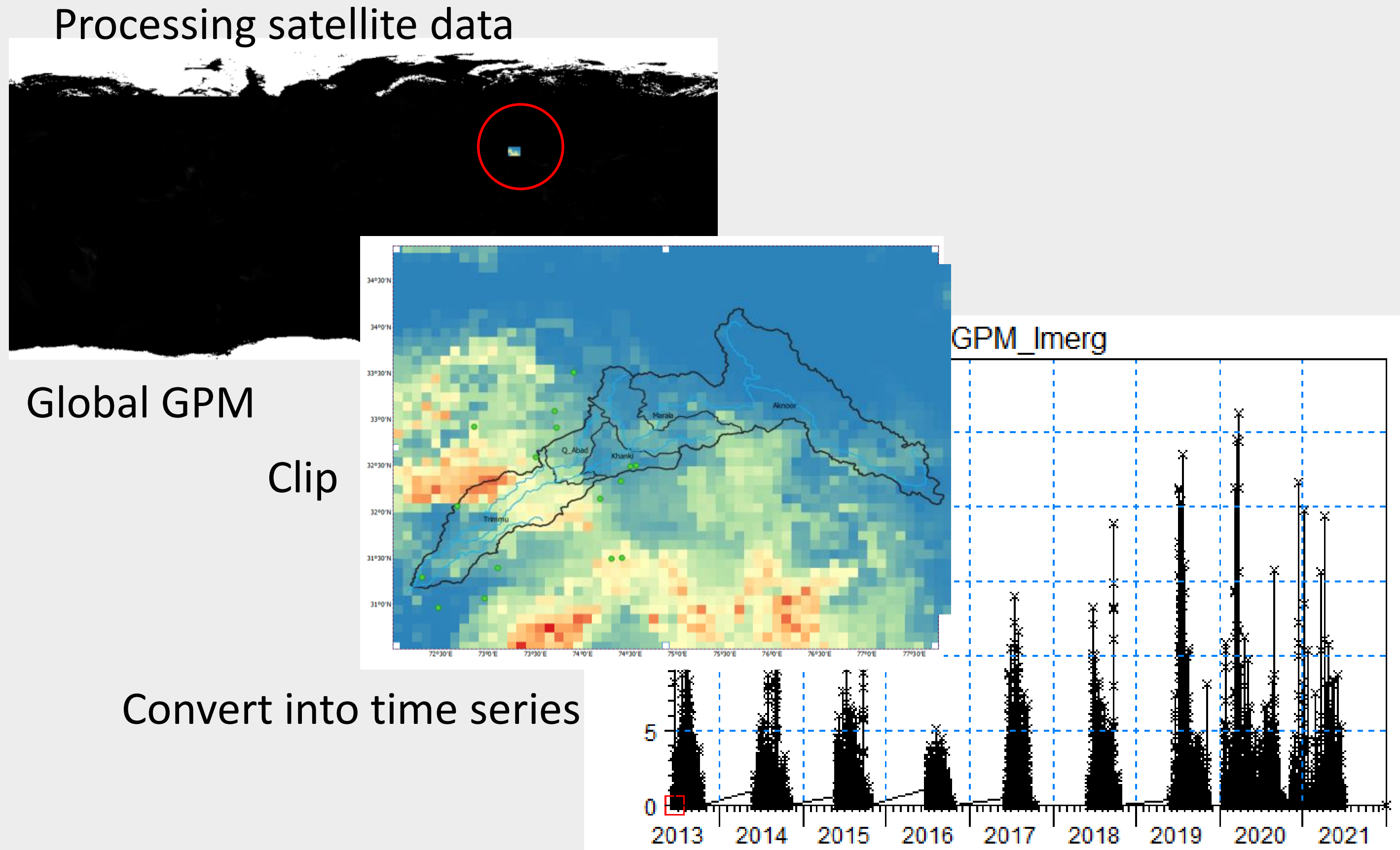
DHI MIKE platform is used to develop real time flood forecasting system with following models

- Hydrological model: NAM model
- Hydrodynamic model: HD model
- Data assimilation: Constant weightage function
- Operational : MIKE Operations

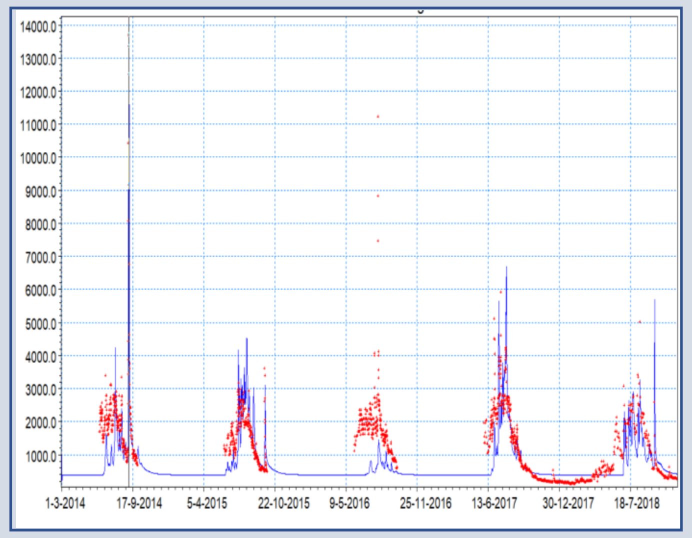
Data used

Datasets (used for model)	Temporal Resolution	Spatial Resolution
Global Precipitation Measurement (GPM – IMERG early)	1/2 hourly	0.1 ˚
ECMWF ERA Interim Evaporation & Temperature	Daily	0.125 ˚
Discharge (In-situ)	Event based	
Global Forecast System (GFS)	3 hourly	0.25 ˚
DEM (SRTM)	-	30 m

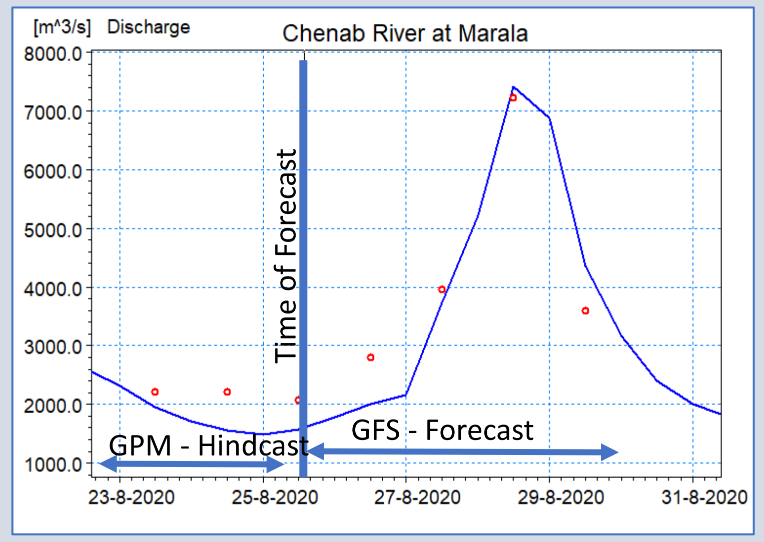
Processing satellite data



Result



Calibration



Event forecast

Parameter	Calibration Period	Monsoon 2020	Event (28 Aug 2020)	Unit
Correlation coefficient (R^2)	0.49	0.64	0.95	
Volume observed	-	27824294395	1638716843	M³
Volume modelled	32832000000	30347063337	1527983167	M³
Volume error	18.50	9.07	-6.76	%
Peak observed value	22500.00	7232.12	7232.12	m³/s
Peak modelled value	11600.00	7418.24	7418.24	m³/s
Peak error	53.70	2.57	2.57	%

- Model calibrated with combination of GPM & GFS rainfall data
- Model calibration period 2014 to 2018
- Mean weightage rainfall was recorded for 3hr accumulated recorded in Chenab basin is about 30 mm in 2017 & 2018 in Khanki sub-basin.
- Result of statistical analysis varies year to year due to uncertainty of satellite-based rainfall and QPF.

Conclusion and Limitation

- Satellite rainfall provides an opportunity in data sparse transboundary regions.
- Due to lack of real time insitu observation bias correction of satellite data is a challenge.
- This calibration is done only for the monsoon period (June to September) as discharge data is available only for the monsoon.
- The performance of the model is poor during the dry period which may be due to a numbers of infrastructure projects upstream for which no data is available.
- However, for a particular event the model performed well with a correlation coefficient of 0.9 and peak error of 2.57%.

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