Final Writing Assignment: Distance Learning Course in Hydrology: Basic Hydrologic Sciences for the Asian Region (2017)

The Work and Responsibilities of Flood Meteorological Office Jalpaiguri

Submitted by

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1 Introduction

Summer monsoon (or southwest monsoon) has a great impact on Indian economy as about 70% of Indian population lives in villages whose main source of income is agriculture. Agriculture is mainly depending on rainfall. But Indian summer monsoon is well known for its variability. For this variability droughts and floods are common in India.

Floods are among the most devastating natural weather hazards in India, causing deaths and property damage. As a result, prediction of floods in an accurate and timely fashion is one of the most important challenges in weather prediction.

In India for flood forecasting, India Meteorological Department(IMD) and Central Water Commission(CWC) are working together. IMD provides Quantitative Precipitation Forecast(QPF), intensity & spatial distribution of rainfall, heavy rainfall warning and other related inputs through its Flood Meteorological Offices(FMOs) to CWC and CWC issue the flood forecast based on these information.

Here we will discuss about different services provided by FMO Jalpaiguri and the future scope of improvement.

2 Different Units of FMO Jalpaiguri

Currently there are five major units are operational in FMO Jalpaiguri. The units are as follows:

2.1 FMO Unit

Flood Meteorological Offices Jalpaiguri(FMO Jalpaiguri) provides meteorological support to CWC, Lower Brahmaputra Division and other Central & State Government agencies for Upper-Teesta, Lower-Teesta, Jaldhaka, Torsa and Raidak sub-basin under Brahmaputra Basin.

2.2 Surface Observatory Unit

FMO Jalpaiguri maintaining a dawn to dusk observatory including all related works like observations, keeping of records, dissemination of observed data etc. During IOP days hourly special observations are also to be taken.

2.3 RS/RW Unit

Another important work performed here is Upper air observation. We are taking GPS based Radiosonde/Radiowind(RS/RW) observations daily at 0000 UTC. For upper air observations balloons are released with a radiosonde(RS) transmitter system, which transmits meteorological data i.e temperature, humidity and pressure at different levels.

2.4 GNSS Unit

Global Navigation Satellite System(GNSS) based Integrated Precipitable Water Vapor(IPWV) measurement system is also operational in FMO Jalpaiguri. There is a high correlation between water vapor and GNSS signal propagation delays. Calculating this signal propagation delays it gives almost the near real time estimation of IPWV.

2.5 ZIMC Unit

FMO Jalpaiguri is also working as a Zonal Instrument Maintenance Center(ZIMC) for the Sub-Himalayan West-Bengal region. Four surface observatories, twenty-seven part-time observatories and six Automatic Weather Stations(AWS) & thirteen Automatic Rain Gauge(ARG) are maintained from here.

3 Services Provided by FMO Unit

Depending on the location of basin the onset & withdrawal of S-W monsoon varies so the flood season. According to the CWC notification no 3/120/2013-FFM/2638-2717 dated 03.12.2013, the flood season for the basins under the jurisdiction of FMO Jalpaiguri is from 1st May to 31st October. The basin map is shown in Fig:1.

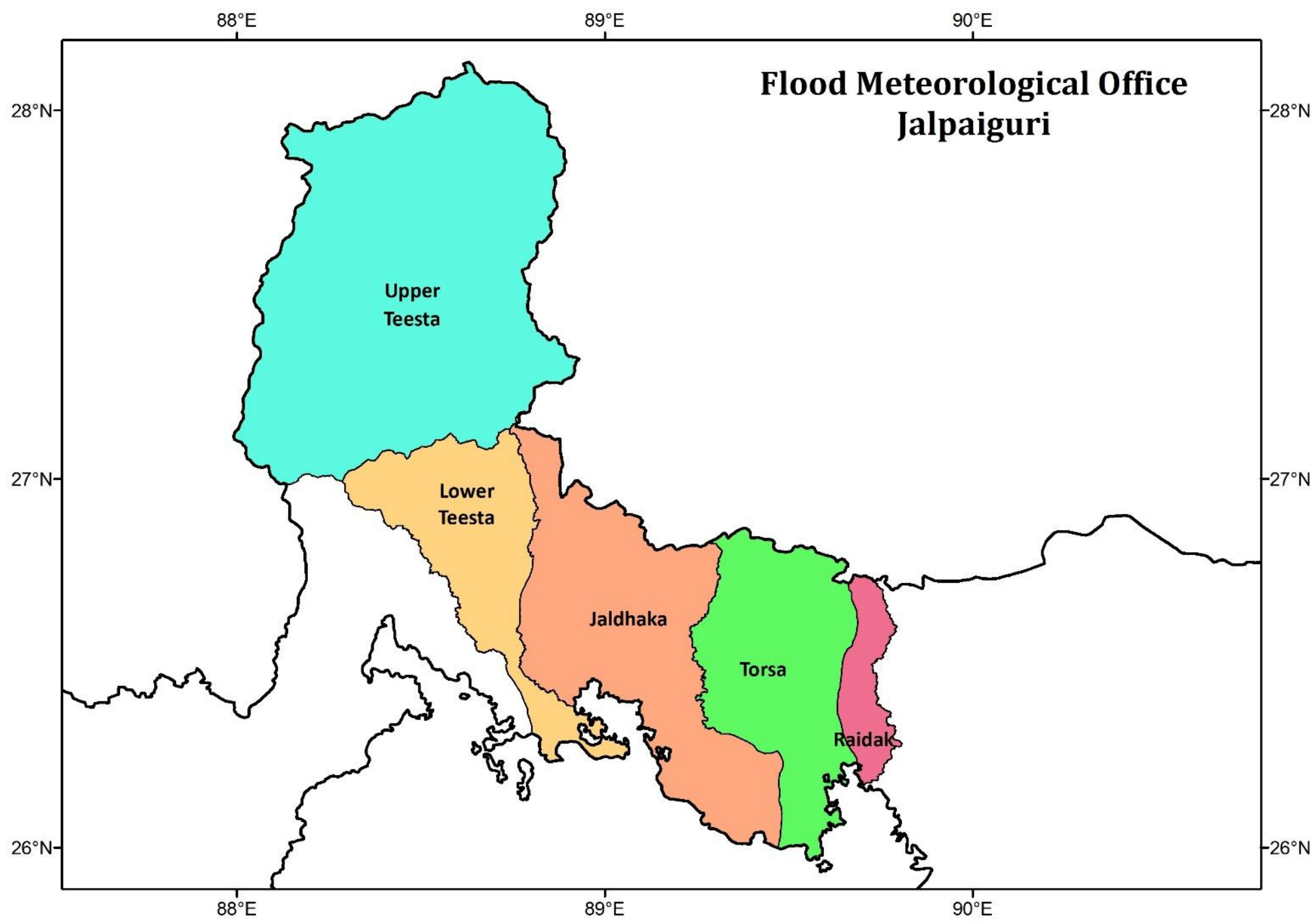

Figure 1: Basin Map of the Basins under FMO Jalpaiguri

The primary work of my office during the above mentioned period is as follows:

3.1 Quantitative Precipitation Forecast(QPF)[1] and Heavy Rainfall warming(HRW):

QPFs are prepared everyday by 0930 IST based on 00 UTC observation and 'Hydromet Bulletin' by 1230 IST with intensity & spatial distribution of rainfall, heavy rainfall warning and updated QPF (if necessary), based on 03 UTC observation. The forecast is issued for 3 days with daily outlook for subsequent 4 days. A modified Bulletin may be issued at 1730 IST based on 09 UTC observation if required. We usually issue the QPF depending upon the following factors:

1. **Synoptic Situations[1]**
   A knowledge of the synoptic situation causing the rainspell or rainstorm and the general climatological features of the region or river basin, is very useful in any Hydrometeorological analysis. From the all India weather inference we get the different synoptic conditions such as position and movement of low presser area, trough, western-disturbance etc.
2. **Synoptic Analogues Technique**
   Synoptic Analogues method is based on the philosophy that the weather behaves in such a way that the present initial conditions, if found to be similar to a past situation, will evolve in a similar manner. The synoptic analogue model is easy to implement and capable of quickly generating objective forecasts.
3. **NWP products**
   Different products from NWP models are also used to frame the sub-basin wise QPF. At present sub-basin wise rainfall product from 3 different NWP modes; WRF model for three days, MME model for five days and GFS model for seven days are available. Some useful websites are given bellow:
   Real time NWP model forecast and analysis: http://nwp.imd.gov.in/
   Sub-basin wise NWP mode rainfall products: http://hydro.imd.gov.in/hydrometweb/
4. **Satellite imageries/products[1,2]**
   We get the information about different atmospheric condition, cloud cover, cloud direction etc. form the geostationary satellite at high resolution in both time and space. This capability makes geostationary satellite data ideally suited for estimating and predicting heavy precipitation, especially during flash-flood events. Some useful websites are given bellow:
   Set. Met. products: http://satellite.imd.gov.in/insat.htm
   RAPID products: http://www.rapid.imd.gov.in/

The range of QPF refers to the amount of average rainfall expected over the basin in 24 hours. The QPFs are issued in the following ranges:

(i) 00 – No Rain	(ii) 0.1 – 10 mm	(iii) 11 – 25 mm
(iv) 26 – 25 mm	(v) 51 – 100 mm	(vi) > 100 mm

3.2 Collection of Rainfall Data[1]

In FMO Jalpaiguri, rainfall data is collected from two IMD surface and thirty FMO & other IMD part-time observatories. Rainfall data is received from these observatories recorded at 0830 IST daily. During the ‘Flood Alert’ period data is obtained at 3-hourly/6-hourly interval if necessary.

3.3 Calculation of Areal Average Precipitation(AAP)

Precipitation in a specific area expressed as an average depth of liquid water over the area is known as areal precipitation[3]. Several methods are commonly used for estimating areal average precipitation over a specific area such as (i) Arithmetic Mean Method, (ii) Thiessen Polygon Method, (iii) Isohyetal Method, (iv) Isopercental Method.

Here in FMO Jalpaiguri we generally use isohyetal method. The following steps are followed in isohyetal method.

1. Construct isohyets (rainfall contours): Isohytes is a smooth curve joining points of equal rainfall on the map.
2. Compute area between each pair of adjacent isohyets (A_i)
3. Compute average precipitation for each pair of adjacent isohyets (P_i)
4. Compute areal average using the following formula

$$\bar{P} = \frac{1}{A}\sum_{i=1}^{N} A_i P_i$$

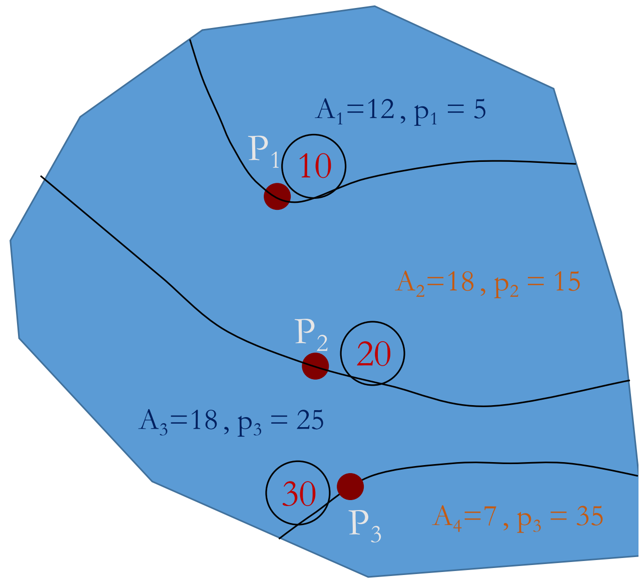

Figure 2: Rainfalls are in *mm*

Using the above formula, the AAP for the basin shown in Figure:2 is

$$\bar{P} = \frac{12X5 + 18X15 + 18X25 + 7X35}{55} \approx 18.64mm$$

3.4 Verification of QPF and HRW

QPF and HRW verification report is prepared weekly basis to test the quality of forecast. Also monthly and seasonal QPF verification report is prepared.

The QPF issued for different catchments is verified by computing Percentage Correct Forecast(PC), Heidke Skill Score(HSS) and Critical Success Index(CSI) using categorical method from the 6X6 Contingency table as given below:

Observed Rainfall (mm)	**Rainfall Forecast Range (mm)**						
	0	**0.1-10**	**11-25**	**26-50**	**51-100**	**>100**	**Total**
0	***a***	***b***	***c***	***d***	***e***	***f***	***A***
0.1-10	***g***	***h***	***i***	***j***	***k***	***l***	***B***
11-25	***m***	***n***	***o***	***p***	***q***	***r***	***C***
26-50	***s***	***t***	***u***	***v***	***w***	***x***	***D***
51-100	***y***	***z***	***aa***	***ab***	***ac***	***ad***	***E***
>100	***ae***	***af***	***ag***	***ah***	***ai***	***aj***	***F***
Total	***G***	***H***	***I***	***J***	***K***	***L***	***T***

$$PC = \frac{a+h+o+v+ac+aj}{T}\text{X100}$$

$$CSI = \frac{a}{A+G-a}, \frac{h}{B+H-h}, \frac{o}{C+I-o}, \frac{v}{D+J-v}, \frac{ac}{E+K-ac}, \frac{aj}{F+L-aj}$$ for all six categories of forecast.

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$$HSS = \frac{a+h+o+v+ac+aj-(AG+BH+CI+DJ+EK+FL)/T}{T-(AG+BH+CI+DJ+EK+FL)/T}$$

Probability of Detection(POD), False Alarm Rate(POD), Missing Rate(MR), Correct Non-Occurrence(C-NON), Critical Success Index(CSI/Threat Score), Bias for occurrence(BIAS), Percentage Correct(PC), True Skill Score(TSS), Heidke skill score(HSS) for each category is to be computed by reducing the above 6X6 contingency table into 2X2 contingency table for occurrence/nonoccurrence (YES/NO) Deterministic forecast as given below:

Observed	**Forecast**	
	Yes	**No**
Yes	***A***	***B***
No	***C***	***D***

$$POD = \frac{A}{A+B}$$

$$FAR = \frac{C}{A+C}$$

$$MR = \frac{B}{A+B}$$

$$C-NON = \frac{D}{C+D}$$

$$CSI = \frac{A}{A+B+C}$$

$$BIAS = \frac{A+C}{A+B}$$

$$PC = \text{Hit Rate X100} = \frac{A+D}{A+B+C+D}\text{X100}$$

$$TSS = \frac{A}{A+B} + \frac{D}{C+D} - 1$$

$$HSS = 2\left(\frac{AD-BC}{B^2+C^2+2AD+(B+C)(A+D)}\right)$$

For perfect forecast, POD=1, FAR=0, MR=0

The warning for heavy, very heavy and extremely heavy rainfall also is to be verified this 2X2 contingency table.

4 Future Scope of Improvement

The few areas where we need to improve in future for better Quantitative Precipitation Forecast and Heavy Rainfall warming are as follows:

1. Rainfall data may be collected from other organization's observatories (Agricultural universities, state irrigation department etc.) who maintain IMD standard for better coverage of data.
2. Though there are six AWS and thirteen ARG within the area of FMO Jalpaiguri, currently we are not using these data. AWS/ARG data may be used after the validation of data from these station.
3. Currently there is no Doppler Weather Radar coverage for the basins under FMO Jalpaiguri. So new DWR station may be established as there are a lot of thunderstorm activities and the area is also very prone to flash flood[2].

5 Summary

FMO Jalpaiguri have five major units; FMO, Surface Observatory, RS/RW, GNSS and ZIMC. Among these unit FMO unit is most important, it provides meteorological support such as QPF and HRW to CWC, Lower Brahmaputra Division and other Central & State Government agencies for Upper-Teesta, Lower-Teesta, Jaldhaka, Torsa and Raidak sub-basins.

References

1. https://www.meted.ucar.edu/hydro/basic_int/case_study/
2. https://www.meted.ucar.edu/hydro/basic_int/flash_flood/
3. https://www.meted.ucar.edu/hydro/basic_int/unit_hydrograph/