Prediction of Summer Monsoon Rainfall over Bangladesh Using Climate Predictability Tool (CPT)

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Abstract

In this study, Prediction of summer monsoon rainfall over Bangladesh for the year 2021 is conducted using Climate Predictability Tool (CPT) based on SST as Predictor and observed rainfall as Predictand for the baseline period 1990-2020. The relatively strong correlation between observed and CPT-generated summer monsoon (JJAS) rainfall in Bangladesh from 1990 to 2020 is 0.7360. Maximum summer monsoon rainfall in Bangladesh is overestimated by CPT. There is a positive correlation between summer monsoon rainfall and SST in Bangladesh. The lowest RMSE of the estimate is 0.01 mm at Srimangal station forecasted maximum rainfall across Bangladesh while during the days of summer monsoon rainfall the highest RMSE of estimation is 1.00 at Faridpur station. Using SST of summer monsoon season, anticipated seasonal daily mean rainfall category and observed daily rainfall category are almost the same. Observed (7.77 mm/day) and forecasted (4.81 mm/day) JJAS mean rainfall at Rajshahi station in 2021 shows light rainfall. Also, in 2021, observed rainfall (26.93 mm/day) and forecasted rainfall (32.20 mm/day) of JJAS at Cox's Bazar station shows high rainfall. The research also shows that maximum summer monsoon rainfall is found in Sylhet and Srimangal stations in 1990-2020, but in 2021, this climatological pattern has altered and the highest summer monsoon rainfall is exhibited in Cox's Bazar station.

Key words: Monsoon Rainfall, CPT, Prediction, SST

1. Introduction

Bangladesh is predominantly an agricultural country where agriculture sector plays a vital role in accelerating the economic growth (Nadiruzzaman, 2019). The agriculture of Bangladesh largely depends on the amount and distribution of the summer monsoon rainfall, which comes during June-September. The monsoon season in Bangladesh is the most important rainy season, accounting for around 72 percent of the country's yearly rainfall (Ahasan et al, 2008). The main socio-economic sectors affected by such rainfall events are- agriculture, infrastructures, human health and social services etc. It is therefore, obvious, that an accurate and reliable prediction of the high impact rainfall events of summer monsoon poses to be an important and challenging task.

There are very limited facilities available in Bangladesh to predict the summer monsoon rainfall. Climate Predictability Tool (CPT) is one of the useful tools to predict the monsoon rainfall over Bangladesh. The CPT is a software package developed by the International Research Institute of the University of Colombia that is a powerful tool for efforts to forecast seasonal climate in tropical and sub-tropical areas around the world. It is currently being used in tropical and sub-tropical areas around the world (Mason, 2019)

Assessment of better prediction of seasonal rainfall by Climate Predictability Tool (CPT) using global sea surface temperature in Bangladesh is studied by Hossain et. al., 2019. In this study, the CPT is employed for predicting rainy seasonal rainfall over Rangpur, Dhaka, Barisal and Sylhet using SST of one month before rainy season and SST of starting one month of rainy season as predictor for comparing the prediction result of rainy seasonal rainfall. Das, 2015 is carried out a study on monsoon rainfall forecasting for different hydrological regions of Bangladesh using Climate Predictability Tool (CPT). In this study, three domains (Somali Jet, Bay of Bengal, and Arabian Sea) are considered to get the best fit domain. Rustiana et al (2017) studied on 'Rainfall Prediction of Cimanuk Watershed Regions with Canonical Correlation Analysis (CCA)'. In this paper, rainfall prediction in every 3 months on 2016 (after January) based on Climate Hazards group Infrared Precipitation with Stations (CHIRPS) data over West Java. In addition, Mannan et al., (2015) worked on Rainfall prediction over northeastern part of Bangladesh during monsoon season and Rahman et al (2015) worked on 'Seasonal forecasting of Bangladesh summer monsoon rainfall using simple multiple regression model'. Variability and trends of summer monsoon rainfall over Bangladesh is also studied by Ahasan et. al., 2010. Based on the above

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literatures, it is observed that there is no research work carry out for the prediction of summer monsoon rainfall on one specific domain, rather than many domains. The present study to predict the summer monsoon rainfall over Bangladesh has been carried out based on one specific domain.

The main objective of the study is the prediction of the summer monsoon rainfall (JJAS) over Bangladesh based on sea surface temperature (SST) using the Climate Predictability Tool (CPT). The secondary objective of the study is the comparison the predicted summer monsoon rainfall with that of rain gauge observed by Bangladesh Meteorological Department (BMD).

2. Data Used and Methodology

The Climate Predictability Tool (CPT), an IRI forecasting tool, is utilized to carry out the study. The data used to run the CPT and methodology followed to generate the predicted rainfall are described in the following section.

2.1 Data Used

This study is conducted using the CPT based on two secondary data sets: Sea surface temperature and Observed rainfall data. Observed rainfall is considered as predictand and sea surface temperature is considered as the predictor in CPT. These data sets are described below:

- ***Sea surface temperature data (SST)***

The version 2 of Climate Forecast System (CFS) models generated Sea Surface Temperature (SST) data (CFS2 SST) is downloaded from the website of the National Centers for Environmental Prediction (NCEP). The CFS2 SST data is available for four times per day (0000, 0600, 1200, and 1800 UTC) with 0.5° (approximately 56 km) horizontal resolution (Saha and Coauthors, 2014). This CFS2 SST data set is used as Predictor in CPT. This SST data is referred to as gridded data in this context.

- ***Observed Rainfall Data***

Observed rainfall (mm) data from 34 rain gauge stations of Bangladesh are collected from the archive of Bangladesh Meteorological Department (BMD). This observed rainfall data set is used as Predictand in CPT. After collecting rainfall raw data from the BMD, it converts into the CPT data format, which is then used to execute the CPT.

2.2 Methodology

In present study of prediction of monsoon rainfall in Bangladesh is conducted based on secondary data. Observed rainfall is considered as predictand and sea surface temperature is considered as the predictor. The baseline period is a climatological era (1990-2020), and the forecast year is 2021, according to the data.

2.2.1 Domain Selection

For rainfall prediction using CPT, it is necessary to select the domain: Predictor and Predictand. These two domains are discussed as under:

- ***Selection of SST domain as predictor***

It is vital to discover an appropriate goodness index in order to make better predictions and determine a more accurate performance. The measurement of the goodness index is dependent on the existence of a perfect domain. Furthermore, it has been noted that in Bangladesh, the SST rainfall forecast domains are not set every year, it's changeable. In appendix chapter show various kinds of domain like Bay of Bengal, Indian domain, Pacific domain and their goodness index are very much low which was negative and negative goodness is rejected. However, the supplied data contains just data on the position of Sea Surface Temperature (SST), with no data on the location of Surface Temperature. The given figure depicts that the location of Sea Surface Temperature (SST) has not only dropped on the sea, but it has also covered the land region. The location has been chosen in this manner in order to get a high Goodness Index score. It ranges from 0.0 to 1.0 and its higher values indicate better agreement. Co-ordinates of Goodness Index are shown in Table-1 and the best domain with maximum goodness index is shown in Fig. 1.

Table-1: Co-ordinates of Goodness Index.

Coordinate	Goodness Index (GI)
17N to -13S, 56W to 131E	0.103
7N to -39S, 47W to 112E	0.081
28N to -8S, 126W to 206E	0.087
17N to -20S, 52W to 102E	0.111
34N to -13S, 76W to 134E	0.104
31N to -7S, 95W to 229E	0.119

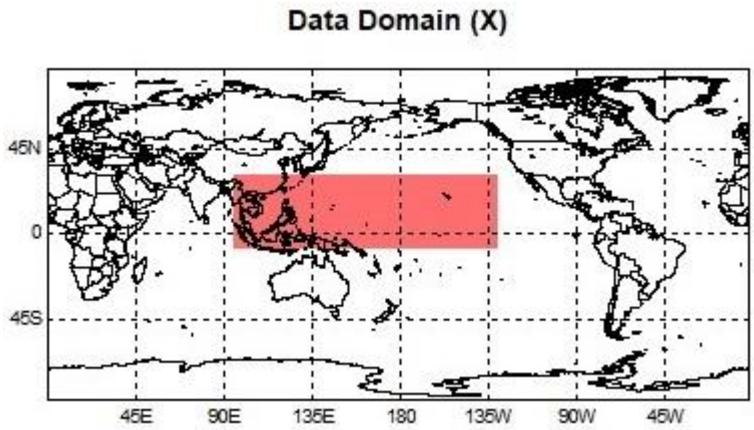

Figure 1: Maximum Goodness Index is 0.119.

- ***Selection of rainfall domain as Predictand***

There are 34 weather station's rainfall data about the 31year climatological period are included as predictands. Missing values are replaced by the long-term mean of each station. The maximum percentage of missing values per station and time step is set to 15%. The maximum percentage of missing values model data is set to 10%. Domain of predictands (20-27N and 88-93E) that was used in CPT is shown in Fig. 2.

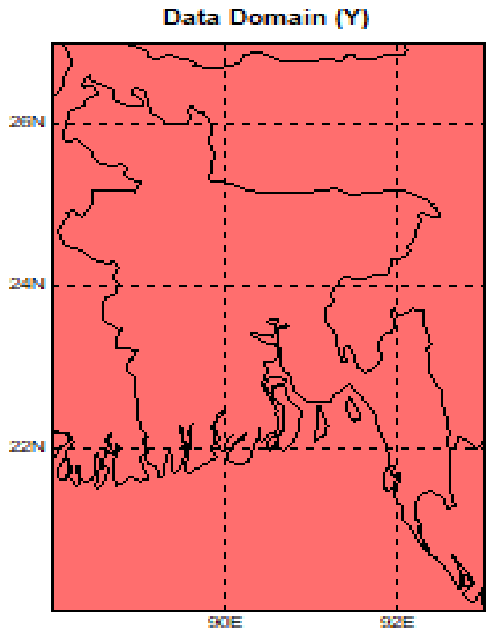

Figure 2: Domain of Predictands that was used in CPT.

Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Bias, Relative Operating Characteristic (ROC) statistical methods are used validate the CPT predicted rainfall.

Finally, the CPT is run using BMD observed rainfall data (1990-2020) of the summer monsoon (JJAS) as predictand, and gridded SST data as predictor. The value -999 is used to fill up the missing value. For long-range forecasting, the CCA (Canonical Correlation Analysis) statistical variable is employed (Hardoon & Shawe-Taylor, 2004), and the model is set up for CV (cross validation), after which the CPT is run and the output and analysis are obtained.

3. Results and Discussion

The CPT is run using SST (CFS2) as a predictor from 1990 to 2021 (consider as a X variable) and monthly summer monsoon (JJAS) rainfall (BMD) as predictand from 1990-2020 (consider as Y variable), which is generated rainfall forecast for JJAS of 2021. Better domain is selected for the study using best tele-connection between predictor and predictand. Tele-connection between predictor and predictand area is shown in Fig. 3. better canonical correlation is found 0.7360 in the first mode and temporal score was so much relatable.

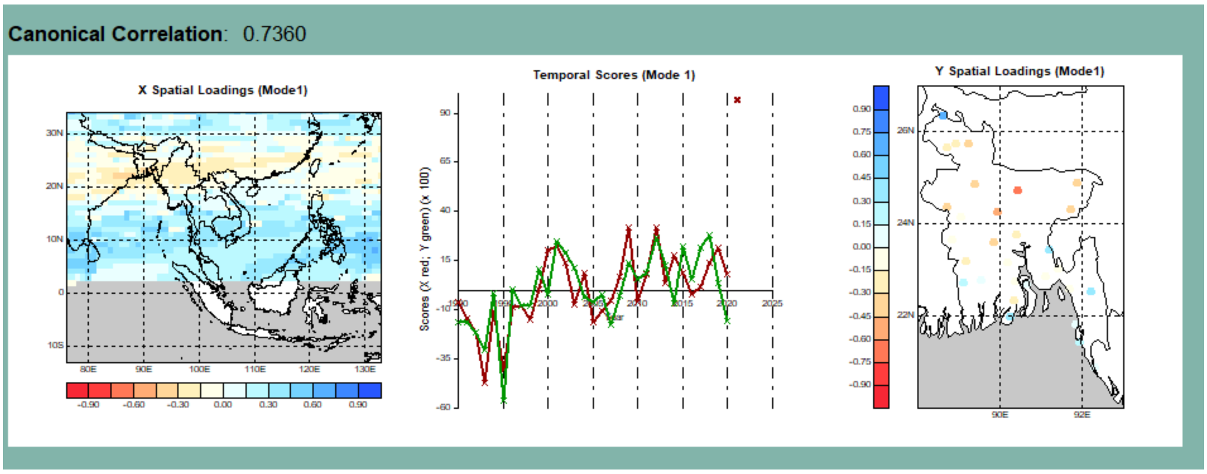

Figure 2: Tele-connection between predictor and predictand area.

3.1 Prediction of summer monsoon rainfall

In this study, prediction of summer monsoon rainfall for June, July, August, September (JJAS) over Bangladesh for the year 2021 is made using the sea surface temperature (SST) and BMD observed rainfall data for the baseline period during 1990-2020 using Climate Predictability Tool (CPT). The sea surface temperature (SST) and observed rainfall data for the base line period during 1990-2020 are incorporated in CPT and then calibrated the data. After calibrating the both datasets; CPT gives probable accumulated seasonal rainfall (JJAS) over Bangladesh for the predicted year 2021. The goodness index for the whole Bangladesh domain extending from 31˚N to -7˚S latitudes and 95˚E to 229˚W longitudes is 0.119.

The summer monsoon rainfall (JJAS) pattern of observation and forecast of Bangladesh are presented in Fig. 4. It is observed that the CPT predicted rainfall for the predicted year 2021 is more accurate at Dhaka, Sylhet, Comilla, Barishal, Mymensingh, Cox’s Bazar, Sitakunda, Patuakhali, Jashore, Chuadanga, Srimangal, Tangail stations. At the same time Rangpur, Rajshahi, Khulna, Chittagong, Teknaf, Khepupara, Rangamati stations are not matched with observed and forecasted rainfall patterns.

From the Fig. 4, it is clear that the position of peak point of observed rainfall is well matched with the that of forecasted rainfall as well as the position of bottom point of observed rainfall is also well matched with that of forecasted rainfall.

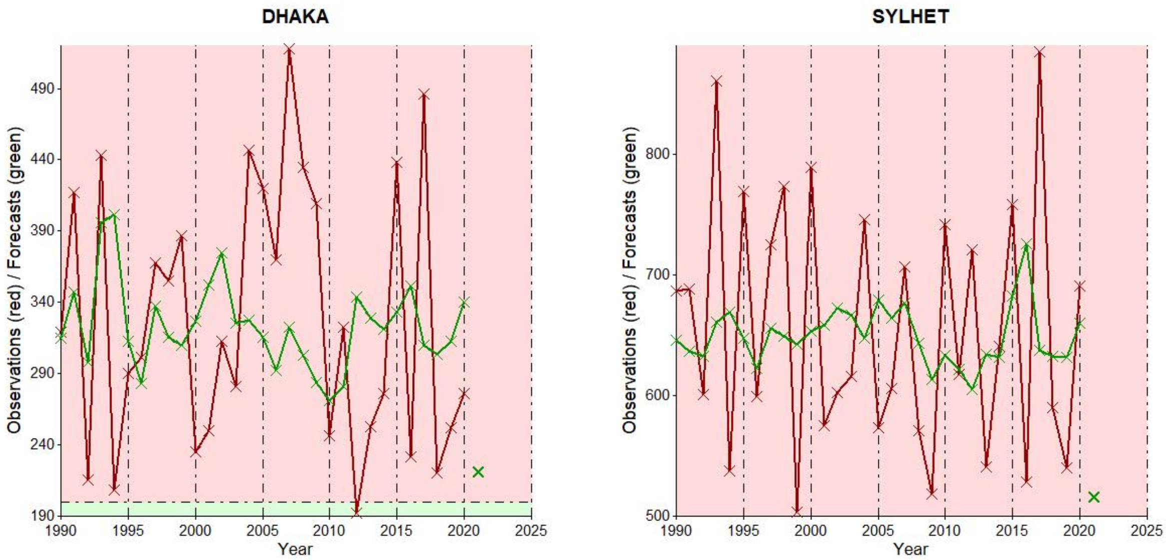

Figure 3 (a-b): Observation and Forecast Rainfall Pattern of Summer Monsoon (JJAS) over
a) Dhaka and b) Sylhet.

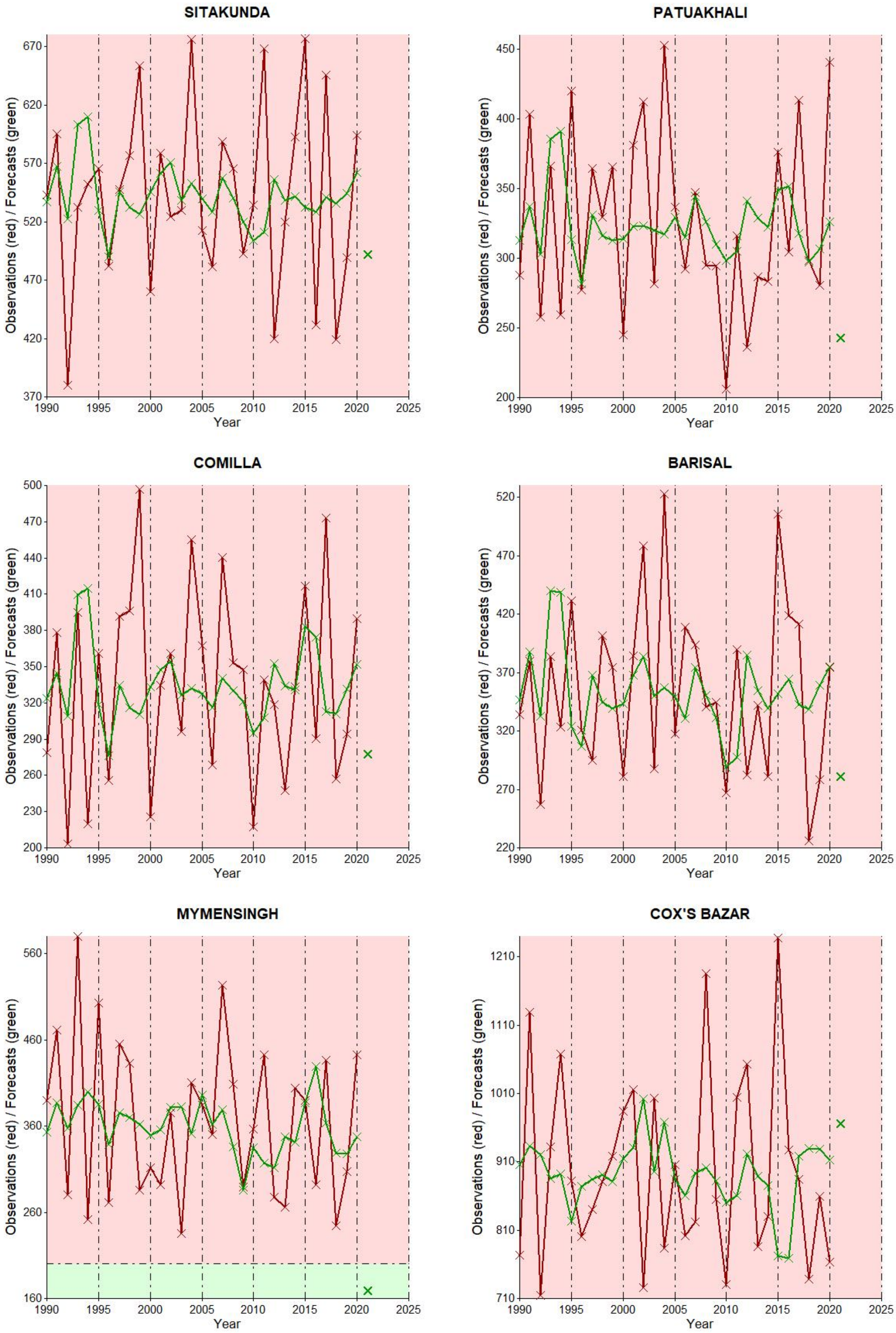

Figure 4 (c-h): Observation and Forecast Rainfall Pattern of Summer Monsoon (JJAS) over C) Sitakunda, d) Patuakhali, e) Comilla, f) Barishal, g) Mymensingh and h) Cox’s Bazar.

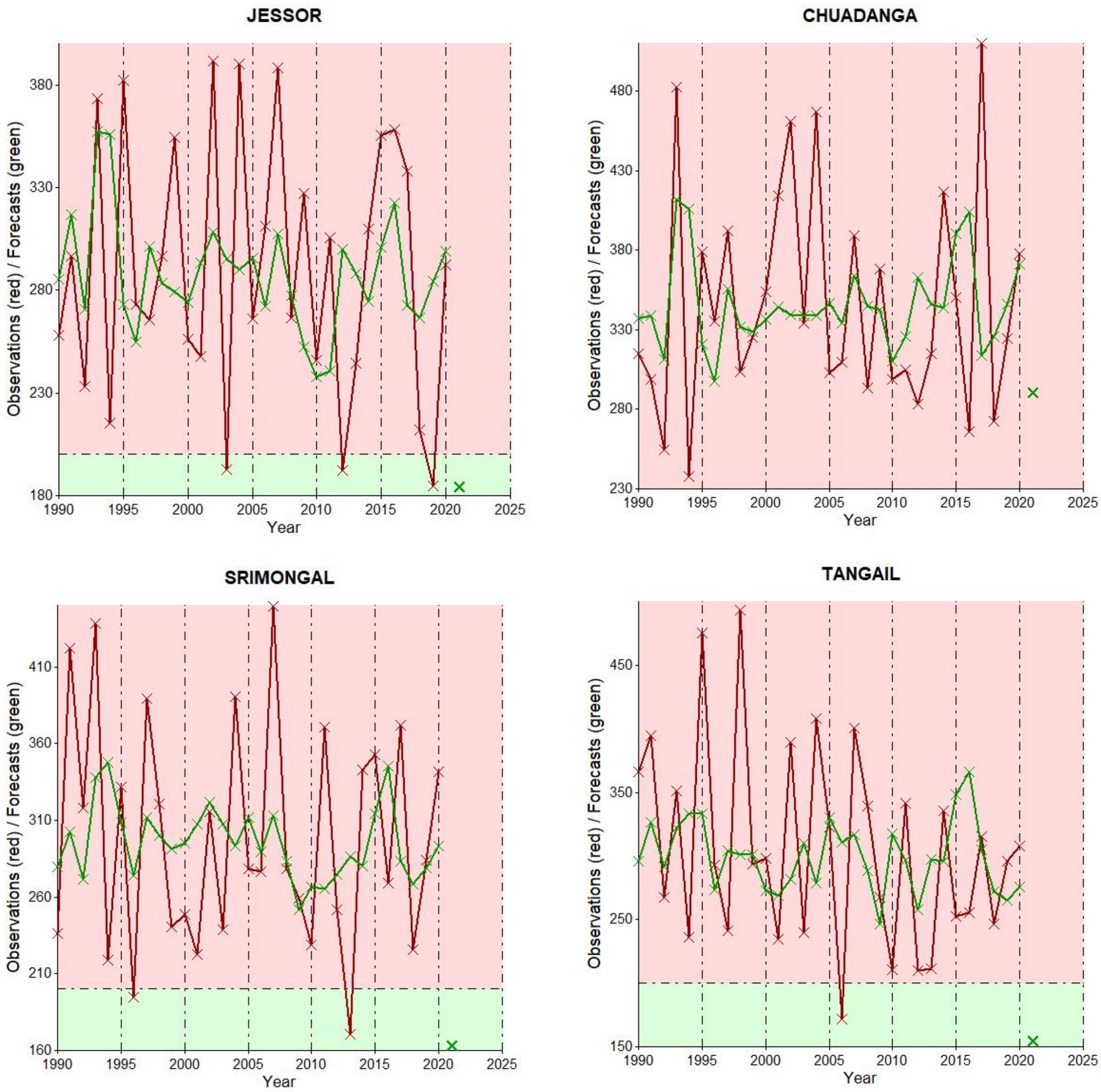

Figure 5 (i-l): Observation and Forecast Rainfall Pattern of Summer Monsoon (JJAS) over

i) Jassore, j) Chuadanga, k) Srimangal and l) Tangail.

3.2 Comparison of the predicted seasonal rainfall with that of BMD observed

Comparison of the CPT predicted summer monsoon (JJAS) rainfall of Bangladesh is made with that of BMD observed rainfall for the validation of CPT predicted rainfall. In this study, the CPT predicted summer monsoon rainfall of 2021 over the whole country of Bangladesh is classified into 5 categories and compare these in category wise in order to determine prediction validation accuracy.

I've classified the predicted summer monsoon rainfall of 2021 over the whole country of Bangladesh and compared it to the BMD rainfall category in order to determine prediction validation accuracy. The intensity of rainfall is classified according BMD classification is listed in Table-2.

Table-2: Classification of rainfall category in Bangladesh according to BMD.

Amount of rainfall intensity (mm/day)	Rainfall class used in Bangladesh	Categories
1-10	Light	Cat-I
11-22	Moderate	Cat-II
23-43	Moderate heavy	Cat-III
44-88	Heavy	Cat-IV
≥ 89	Very heavy	Cat-V

Comparing summer monsoon rainfall (JJAS) category between forecast rainfall and observed rainfall (mm/day) is presented in Table-3. According to the data in Table 6.10, although the anticipated rainfall at the different stations of Bangladesh indicates light, moderate, moderate heavy, heavy, very heavy rainfall, the observed rainfall at the BMD station indicates the same rainfall category.

The summer monsoon rainfall forecasts for Rajshahi, Rangpur, Saidpur, Faridpur, Chuadanga, Srimangal, and Dinajpur stations are in the light rainfall category, while the observed summer monsoon rainfall in Bangladesh has also been in the light rainfall category.

However, it is shown that the anticipated summer monsoon rainfall of 2021 in Dhaka, Sylhet, Feni, Satkhira, and Rangamati stations are in the moderate rainfall category, while the observed summer monsoon rainfall of Bangladesh in the same stations is also in the moderate rainfall category.

While anticipated summer monsoon rainfall for the other stations Mymensingh, Cox's Bazar, Rangamati, Kutubdia, Khepupara, Faridpur, Teknaf, Chittagong in Bangladesh was classified as heavy, observed summer monsoon rainfall was classified as heavy in all of these locations.

Table-3: Comparison of summer monsoon (JJAS) rainfall category between forecast rainfall and observed rainfall (mm/day).

Station	Forecast rainfall(mm/day)	Observed rainfall (mm/day)	Station	Forecast rainfall (mm/day)	Observed rainfall(mm/day)
Dhaka	14.69	18.1	Cox's Bazar	32.20	26.93
Sylhet	17.21	22.3	Teknaf	22.39	30.9
Rajshahi	4.81	7.77	Kutubdia	18.40	30.07
Rangpur	8.73	8.03	Khepupara	26.74	18.7
Comilla	9.25	14.63	Sitakunda	16.40	35.03
Khulna	9.22	15.27	M.Court	9.44	23.9
Barisal	9.37	11.33	Bhola	17.16	21.27
Mymensingh	5.64	14.3	Feni	12.81	20.6
Saidpur	9.40	8.17	Patuakhali	8.083	20.63
Chattogram	29.58	30.17	Madaripur	7.86	14.23
Jessor	6.15	12.27	Bogra	7.49	13.47
Faridpur	4.81	9.7	Dinajpur	5.37	9.63
Chuadanga	9.68	9.87	Ishwardi	8.08	14.33
Srimangal	5.43	7.6	Satkhira	16.96	13.4
Tangail	5.16	17.87	Rangamati	13.34	14.6

3.3 Skill Scores

Table-4 and Table-5 indicates the model accuracy according to different indices for different stations among these stations the mean absolute error (MAE) and the root-mean-square error (RMSE) values are calculated based on BMD 34 stations monthly observations. In the study seasonal rainfall especially summer monsoon rainfall June, July, August, September (JJAS) are analysed to calculate Mean absolute Error (MAE) and Root Mean Square Error (RMSE).

Table-4: MAE value of seasonal rainfall forecast over Bangladesh SST as a predictor.

Station	MAE	Station	MAE	Station	MAE
Dhaka	0.77	Saidpur	0.63	Jessor	0.77
Barisal	0.68	Tetulia	0.64	Madaripur	0.76
Rajshahi	0.76	Rangamati	0.67	Patuakhali	0.67
Rangpur	0.71	Satkhira	0.70	Feni	0.75
Chattogram	0.75	Ishwardi	0.75	Bhola	0.59
Khulna	0.76	Dinajpur	0.66	Khepupara	0.68
Mymensing	0.73	Bogra	0.74	kutubdia	0.75
Sylhet	0.64	Tangail	0.76	Teknaf	0.75
Comilla	0.68	Srimangal	0.96	Cox's bazar	0.81
Sitakunda	0.68	Faridpur	0.84	M.court	0.70

Table-5: RMSE of seasonal rainfall forecast over Bangladesh SST as a predictor.

Station	RMSE	Station	RMSE	Station	RMSE
Dhaka	0.87	Saidpur	0.90	Jessor	0.93
Barisal	0.83	Tetulia	0.84	Madaripur	0.95
Rajshahi	0.98	Rangamati	0.88	Patuakhali	0.67
Rangpur	0.98	Satkhira	0.83	Feni	0.97
Chattogram	0.93	Ishwardi	0.91	Bhola	0.74
Khulna	0.94	Dinajpur	0.84	Khepupara	0.87
Mymensing	0.85	Bogra	0.97	kutubdia	0.94
Sylhet	0.72	Tangail	0.93	Teknaf	0.93
Comilla	0.82	Srimangal	0.01	Cox's bazar	0.99
Sitakunda	0.88	Faridpur	1.00	M.court	0.91

From above table comparing different indices as well MAE and RMSE of rainfall event it is clear that CPT perform well expected at different stations over Bangladesh among these stations model perform best forecast over Srimangal station because RMSE value is the lowest over here and it's about 0.01. Beside these over Faridpur station RMSE value is 1.0 that indicates at this station CPT accuracy comparatively poor.

In Table-6 reveal bias value. Here maximum value comparatively very poor, which indicates the forecast values and observed values more accurate, the difference of observed seasonal rainfall value and predicted seasonal rainfall value are very little.

Table-6: Bias result of seasonal rainfall forecast over Bangladesh SST as a predictor.

Station	Bias	Station	Bias	Station	Bias
Dhaka	0.03	Saidpur	0.03	Jessor	0.04
Barisal	0.04	Tetulia	0.02	Madaripur	0.02
Rajshahi	0.03	Rangamati	0.05	Patuakhali	0.04
Rangpur	0.02	Satkhira	0.03	Feni	0.04
Chattogram	0.00	Ishwardi	0.03	Bhola	0.03
Khulna	0.04	Dinajpur	0.04	Khepupara	0.01
Mymensing	0.03	Bogra	0.02	kutubdia	0.01
Sylhet	0.01	Tangail	0.02	Teknaf	-0.01
Comilla	0.02	Srimangal	0.83	Cox's bazar	-0.01
Sitakunda	0.03	Faridpur	0.03	M.court	0.04

Table-7, Hit score rate range (40 to 70) % which express the forecast rainfall would be occurred. Here M.Court station's Hit rate is very lowest 42.59% and Teknaf station's Hit rate is comparatively high than other station which is 72.22%.

Table-7: Hit Score rate of seasonal rainfall forecast over Bangladesh SST as a predictor.

Station	Hit Score (%)	Station	Hit Score (%)	Station	Hit Score (%)
Dhaka	46.64%	Saidpur	51.57%	Jessor	42.08%
Barisal	54.11%	Tetulia	54.39%	Madaripur	53.49%
Rajshahi	51.27%%	Rangamati	58.68%	Patuakhali	52.99%
Rangpur	61.43%	Satkhira	54.61%	Feni	43.69%
Chattogram	55.29%	Ishwardi	49.84%	Bhola	59.46%
Khulna	49.42%	Dinajpur	47.67%	Khepupara	51.86%
Mymensing	45.21%	Bogra	45.25%	kutubdia	44.76%
Sylhet	55.83%	Tangail	50.95%	Teknaf	72.22%
Comilla	50.89%	Srimangal	52.24%	Cox's bazar	62.52%
Sitakunda	46.44%	Faridpur	48.43%	M.court	42.59%

From Table-7 of Hit Score (HS) rate, it's comparatively ensured that the predicted seasonal rainfall as much as closer to seasonal observed rainfall.

3.4 Forecast Verification

The probabilistic retroactive forecasts can be verified using a range of graphical techniques available from Climate predictability Tool (CPT). The forecasts for all locations / indices are pooled when calculating the results.

- ***Probabilistic map***

The greatest summer monsoon rainfall of June, July, August, September (JJAS) in Bangladesh in 2021 is shown on this map, which is above the average rainfall. By this map (Fig. 5) show that maximum weather stations in Bangladesh are considered above rainfall, few numbers of weather station in Bangladesh are respectively belong below range rainfall. Sylhet, Srimangal, Chittagong, Cox's bazar, Rangamati, Teknaf, Bhola, Barisal, Khulna, Rangpur, Rajshahi, Patuakhali, M.Court, Feni, Saidpur, Khepupara, Kutubdia, Sitakunda, Dinajpur weather stations are shown above range summer monsoon rainfall between June, July, August, September (JJAS),on the other side Dhaka, Mymensingh, Faridpur, Jessor. Ishwardi, Tangail, Chuadanga, Satkhira weather stations are considered normal to below range summer monsoon rainfall on June, July, August, September (JJAS).

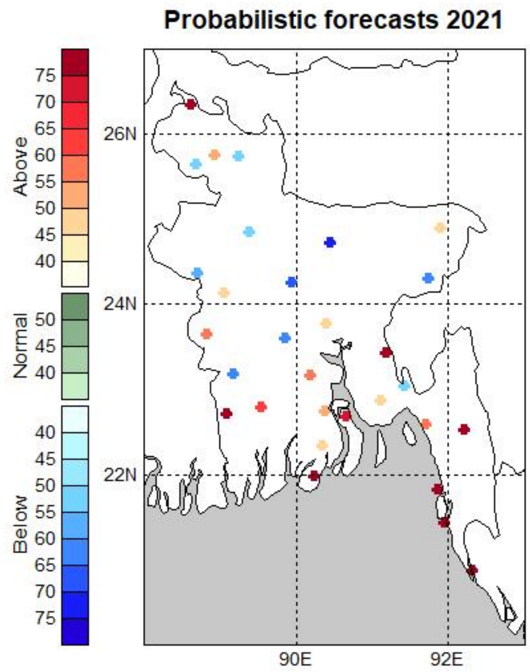

Figure 6: Probabilistic rainfall forecast for summer monsoon season of 2021 over Bangladesh

- ***Forecast probability***

Finally, CPT showed the forecast rainfall of 2021(Table-8). The forecast rainfall at Dhaka station is above 49% where below range is 41% and normal range is 10%, at Sylhet station above 47% where below range is 42% normal range is 11%, at Rajshahi station above 37% where below range is 59% normal range is 3%, at Rangpur station above 42% where below range is 53% normal range is 5%, at Comilla above 57% where below range is 38% normal range is 5%, at Khulna station above 62% where below range is 33% normal range is 5%, at Barisal station above 55% where below range is 39% normal range is 6%, at Barisal station above 55% where below range is 39% normal range is 6%, at Mymensingh station above 19% where below range is 71% normal range is 9% , at Saidpur station above 52% where below range is 46% normal range is 2%, at Chittagong station above 90% where below range is 5% normal range is 6%, at Barisal station above 80% where below range is 9% normal range is 11% , at Teknaf station above 81% where below range is 16% normal range is 3%, at Barisal station above 55% where below range is 39% normal range is 6%, at Kutubdia station above 77% where below range is 18% normal range is 5%, at Khepupara station above 59% where below range is 6% normal range is 3%, at Sitakunda station above 59% where below range is 38% normal range is3%, at M.Court station above 48% where below range is 44% normal range is 7%, at Bhola station above 71% where below range is 27% normal range is 2%, at Feni station above 45% where below range is51% normal range is 4%, at Patuakhali station above 47% where below range is 47% normal range is 6%, at Madaripur station above56% where below range is 40% normal range is 3%, at Jessor station above333% where below range is 63% normal range is 3%, at Barisal station above 55% where below range is 39% normal range is 6%, at Faridpur station above 30% where below range is 63% normal range is 3%, at Chuadanga station above 60% where below range is 35% normal range is 6%, at Srimangal station above 32% where below range is 65% normal range is 3%, at Tangail station above 26% where below range is 65% normal range is 3%, at Bogra station above 42% where below range is54% normal range is 3%, at Dinajpur station above 36% where below range is 54% normal range is 10%, at Ishwardi station above 48% where below range is 42% normal range is 10%, at Rangamati station above 87% where below range is 10% normal range is 3%.

Table-8: Forecast probability range (%) at different stations.

Station	Below	Normal	Above
Dhaka	41%	10%	49%
Sylhet	42%	11%	47%
Rajshahi	59%	3%	37%
Rangpur	53%	5%	42%
Comilla	38%	5%	57%
Khulna	33%	5%	62%
Barisal	39%	6%	55%
Mymensingh	71%	9%	19%
Saidpur	46%	2%	52%
Chattogram	5%	6%	90%
Cox’s Bazar	9%	11%	80%
Teknaf	16%	3%	81%
Kutubdia	18%	5%	77%
Khepupara	6%	3%	59%
Sitakunda	38%	3%	59%
M.Court	44%	7%	48%
Bhola	27%	2%	71%
Feni	51%	4%	45%
Patuakhali	47%	6%	47%
Madaripur	40%	3%	56%
Jessor	63%	3%	33%
Faridpur	63%	3%	30%
Chuadanga	35%	6%	60%
Srimangal	65%	3%	32%
Tangail	65%	9%	26%
Bogra	54%	3%	42%
Dinajpur	54%	10%	36%
Ishwardi	42%	10%	48%
Satkhira	16%	3%	81%
Rangamati	10%	3%	87%

4. Conclusion

On the basis of the results and discussion in the previous section, the conclusions of the study can be drawn as under:

The connection of summer monsoon rainfall (JJAS) between BMD observed and CPT-generated for the whole country of Bangladesh for the baseline period 1990-2020 is determined to be a strong correlation, with a coefficient of 0.7360.

The difference between the actual JJAS mean rainfall (7.77 mm/d) at Rajshahi station in 2021 and the CPT-generated forecast (4.81 mm/day) demonstrates that the difference between the observed rainfall and the anticipated rainfall is light categorial rainfall, which is statistically significant. On the other hand, the observed rainfall JJAS (26.93 mm/day) and forecast rainfall (32.20 mm/day) at the Cox's Bazar station in 2021 suggest that there would be substantial rainfall. Furthermore, the study reveals that the summer monsoon climate is changing. It is explained that the maximum summer monsoon rainfall is found in Sylhet and Srimangal stations between 1990 and 2020, but the predicted summer monsoon rainfall of 2021 reveals that this climatological pattern has changed and the maximum summer monsoon rainfall is shown at Cox's Bazar station, Rangamati.

Moreover, as a result, it can be said that CPT has shown certain abilities in the prediction of rainy season rainfall in a few chosen divisions in Bangladesh. Create a climate-prediction system to help mitigate the effects of natural disasters. To reduce the proportion of inaccuracy in the climate-prediction system.

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