Role of Forecasting in Calamities

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Abstract- India has experienced a lot of natural calamities since last decade. Accuacy of forecasting and selection of forecasting technique becomes relevant for predicting the occurance of calamity and inventory of resuce equipments and other arragements to be needed post calamity. The calamities experienced in form of natural disasters such as earthquakes, cyclones, landslides, floods, draughts, wildfires, tsunamis and pandemics such as covid-19.The paper discusses on cyclones, their categorisation based on severity, and higlights the significance of choosing the most appropriate forecasting technique to predict the cyclone based on its severity.

Keywords– Forecasting, Calamity, Accuracy, Cyclone

1. INTRODUCTION

The prediction of calamities more accurately becomes significant with the increasing number of incidents of natural disasters and pandemics. The frequent occurance of calmaties such as floods, wildfire, and particularly in form of cyclones leads to devastation to residences near to coastal ares, ecological systems and infrastructures [1]. The most fatal cyclone that hit South Asia was Bhola that took more than 300,000 lives and caused 2.4 billion dollars loss in 1970. Other devastating tropical cyclone of south east Asia was Nargis that caused 140,000 causalities and damaging more than 10 billion dollars infrastructure in 2008 [2]. Accuracy of forecasting generally depends on availability of correctness of historical data of the calamities. The correct prediction of wind speed of cyclone is the most significant variable of interest. As the wind load that can by the sustained by infrastructures is computed as square of the wind speed[3].

The type of forecasting which uses historical data to predict the natural calamities and pandemics is referred as quanitative forecasting. There are many scenarios where the data is not available such as cases of some pendamics than the qualitaive forecasting techniques are used. Qualitative techniques are based on expert opinions, judgements and markst surveys. Warning timing and reach during cyclones or other calamities are anlysed through qualitative forecasting[4]. There are a lot of predicting techniques are available, but the expertise requires to select the most appropriate technique for a particular problem.

With the avaialbility of advance prediction techniques based on Machine Learning like LSTM, and presence of other powerful and effective time series forecasting models like ARIMA, and other available time series forecating methods such as Exponential Smoothing, Moving Average techniques, it becomes quite diffiicult for anticipation of calamity particularly cyclones severity correctly [5]. The prediction of wind speed expected to hit coastal areas accurately based on selecting appropriate forecasting technique.

2. METHODOLOGY

In this paper a dataset of past cyclones gathered between 2019-2024. The cyclones are arranged on basis of time occurance and wind speed is analysed and predicted using different forecasting techniques. The cyclones are generally categorised based on severity. Till today the most severe and destructive cyclone was Bhola that occurred in South East Asia,. Cyclones geneally occured in coastal areas. In India the maximum cyclones hit during 2019 to 2024 in the states of Odhisa, followed by West Bengal, Gujarat, Andhra Pradesh, Tamil Nadu, Assam and Madhya Pradesh [6,7]. The below figure shows the cyclones that hit India since last decade.

The Figure 2 shows the damages incurred in in billion dollare due to cyclones occurred in India between 2019-2024. It has found that cyclone Amphan was most destructive and led to damages of 13000 US million dollars.

The cyclones are compared on the basis of magnitude of wind speed (Figure 3). It has been found that cyclone Amphan occurred in 2020 had the maximum wind speed of 260 Km/h among the cyclones experienced in India in last six years.

Cyclones not only caused damages to property, infrastructures, ecosystem but also cause human

casualties. The cyclones that hit India in last six years cause more than 600 fatalities. Figure 4 shows the fatalitied due to cyclones. Tauktae cyclone brought about170 deaths, Amphan cyclone led to 128 deaths while the Fani cyclone caused 89 fatalities.

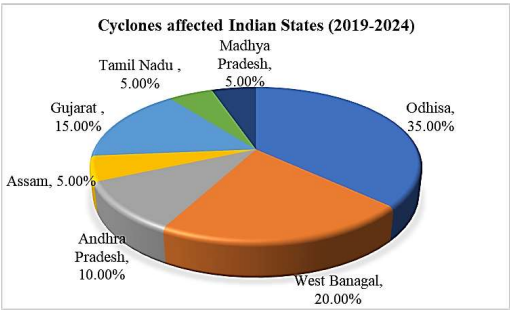

Figure 1: Cyclones affected Indian States

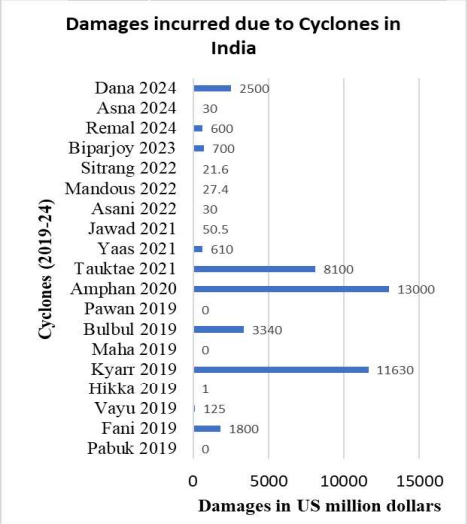

Figure 2: Damages incurred due to Cyclones

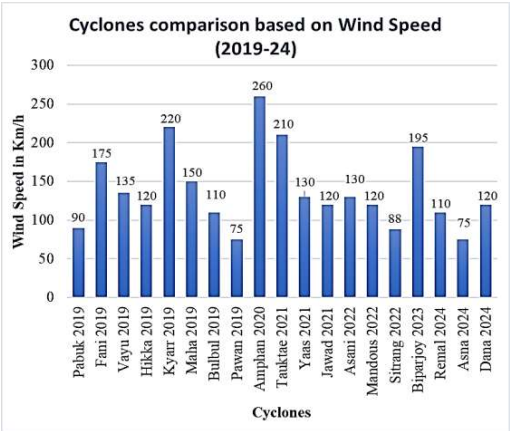

Figure 3: Comparison of Cyclones on Wind Speed

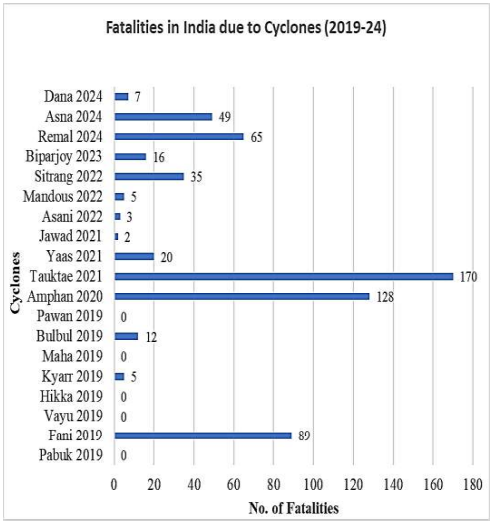

Figure 4: Number of Fatalities due to Cyclones

The Figure 5 depicts the categorisation of cyclone based on its severity.

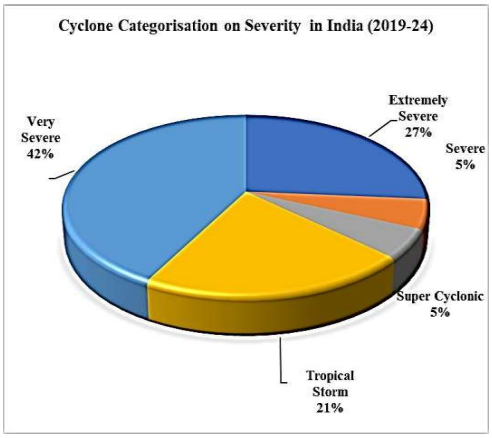

Figure 5: Categorisation of Cyclones on Severity

3. TIME SERIES FORECASTING

The quantitative forecasting rely on past historical data. The data which varies with respect to time is reffered as time series. The timeseries forecasting methods are simple average, naïve, moving average, weighted moving average, exponential smoothing, double exponential smoothing, linear trend methods, ARIMA.

Simple averaging method which simply averages past periods demand is one of the most quick and easy method of prediction. The naïve method where no expertise is needed just to predict the forecast values exactly equal to last period of actual demand or values of interest. Weighted averaging method simply assign weights in decreasing order from latest to earliest actual demand data. Exponential smooting

method assigns weight exponentially to the actual data. In double exponentially two paremerts are used one smoothing constant and other trend constant.
ARIMA method is combination of autocorrelation and the moving average. The previous works highlighted the relevance of application of time series models in real world forecasting problems [8]-[10].

4. LSTM

Long-Short Term Memory (LSTM) method is also applicabe in time series forecasting. It works on the recurrent type neural network. For applying LSTM for prediction cyclones or other time series problem, collection of historical data is required. Then normalizing the data, followed by modeling it in Python. The model for the gathered data then is trained and tested. After that it can be applied to time series forecasting problem. In previous works time LSTM has been used for wind prediction and other forecasting problems.[11], [12].

5. RESULTS AND DISCUSSIONS

The forecasting techniques used for predicting cyclone wind speed are Exponential Smoothing, Three period Moving Average, Three period Weighted Moving Average and LSTM. The forecasting techniques comparison is shown in Figure 6.

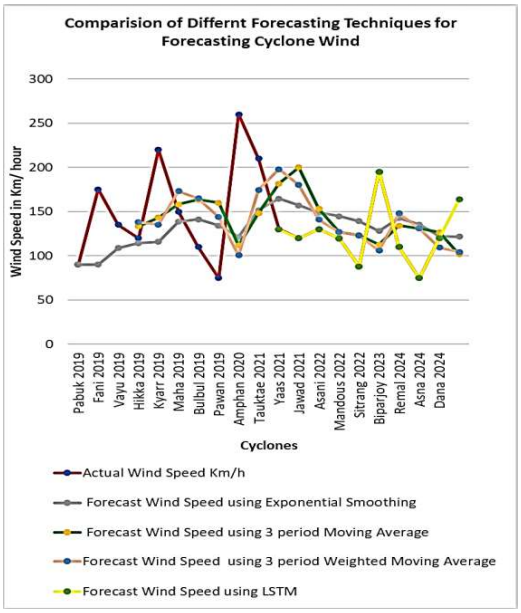

Figure 6: Comparision of Forecasting Techniques for predicting Cyclone Wind Speed

The Figure 6 shows that the LSTM approach almost overlaps the actual wind speed curve. The figure also shows the curves generated with moving average, exponential smoothing and weighted moving averages but shows deviation from actual wind speed of cyclones.

Table 1: Comparison of Accuracy of Forecasting Techniques

Types of Errors	Exponential Smoothing	Three period Moving Avearge	Three period Weighted Moving Average	LSTM
Error	8.01	283.81	-3.81	0.09
MSE	58.44	288.39	63.60	0.21
MAD	47.15	252.28	45.50	0.08

The accuracy of forecasting techniques chosen to predict cyclones wind speed are comparedon the basis of Error, Mean Absolute Deviation (MAD) and Mean Square Error (MSE). The results of it are presented in the Table 1.

CONCLUSIONS

The paper higlights the significance of forecasting during calamities, especially in case of cyclones to estimate their severity (in terms of wind speed), expected damages to infrastructure, casualties and ecosystem, for getting prepared for such natural disasters in advance. In this work, data is gathered for cyclones hitting India during past six years, categorising on severity, fatalities, damages and model it using Exponential Smoothing, Moving and Weighted Moving Averages Time Series Models and more complex forecasting approach LSTM separately. On comparing the forecasting results for these approaches on Error, MAD and MSE, it has been found that LSTM approach outperformed the other approaches. Therefore, for predicting the cyclones severity (wind speed) LSTM approach is recommended. In future, the LSTM approach can also be applied to forecast other types of calamities.

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