Letters to the Editor

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AN OBJECTIVE TECHNIQUE FOR FORE-CASTING WIND SPEED OVER BOMBAY HIGH AREA

1. Bombay High Area (BHA) is the most important off-shore oil field of India and lies over the Arabian Sea about 100-150 km west of Bombay covering an area of about 15,000 sq km. Winds and waves are the two most important factors affecting the operational activities of the drilling rigs. Forecast of these parameters over the area is issued by Regional Meteorological Centre. Bombay on day-to-day basis.

Wind over sea area is also an indicator of expected wave height. According to Bhandari (1980). the sea and swell should not exceed 1.5 to 2.0 m for smooth operation and safe movement of the jack-up rigs. A wind speed of 20 kt is the corresponding critical limit to generate wave height of 1.6 to 2.4 m (Thiruvengadathan 1984 and Sivaramakrishnan 1984). An attempt has been made in the present study to evolve an objective method for forecasting the occurrences of wind speed of 20 kt or more after next 24 hours during the monsoon months.

2. Considering the fact that increase of pressure gradient over the west coast from south Gujarat to Goa coast and presence of low pressure systems over northwest Bay of Bengal have strengthening effect on the winds over the area. several variables have been tested both singly and in various combinations with respect to the occurrences of wind speed $\geq$ 20 kt. The following parameters have been found to produce the greatest skill and are, therefore. incorporated as predictors :

    (i) Bombay (Colaba) pressure.

    (ii) Gopalpur pressure.

    (iii) Goa-Surat pressure difference. and

    (iv) Ratnagiri-Dahanu pressure difference.

3. Initially the study was intended to cover the entire monsoon season but was later on restricted to the months of June to August only. as during primary analysis useful results could not be obtained for the month of September. This may be due to changing pressure pattern during the withdrawal phase of monsoon. The 0830 IST surface pressure data for the years 1986-1990 collected from the *Indian Daily Weather Reports* published by India Meteorological Department. Pune have been used in the study. The 0830 IST wind observations reported by the ONGC rig—*Sagar Samarat* have been taken as representative of winds over BHA. Data for the years 1985 and 1992 were utilized for testing the results of the study.

4. The method applied in the present study is the graphical regression method (WMO 1966) which involves relating the predictor variables to the cases of predictant (a wind speed of $\geq$ 20 kt or < 20 kt in this study). Various categories of the predictant are then arranged in ascending/descending order which act as derived variables. These derived variables are then used for the final forecast.

Symbolically. the procedure can be written as below :

$$\left.\begin{array}{l} f(X_1, X_2) ----- \overline{Z_1} \\ f(X_3, X_4) ----- \underline{Z_2} \end{array}\right] \rightarrow f(Z_1, Z_2) \longrightarrow \text{Forecast}$$

where. $X_1 ---- X_4$ are the predictor variables.

The frequency of occurrence of wind speed $\geq$ 20 kt observed with a lag of 24 hours from the predictors have been presented in Fig. 1. It is seen that the frequency of occurrence of wind speed $\geq$ 20 kt increases with decrease in pressure at Bombay/ Gopalpur and with increase in pressure difference between Goa and Surat/Ratnagiri and Dahanu. The figures on the top of the bars give the total number of cases.

Fig. 2 is prepared by considering Bombay pressure and Goa-Surat pressure difference as co-ordinates. The occurrences or non-occurrences of wind $\geq$ 20 kt over BHA after a lag of 24 hours have been stated against the variable ranges. The fractions denote the number of occurrences of wind speed $\geq$ 20 kt to the total number of
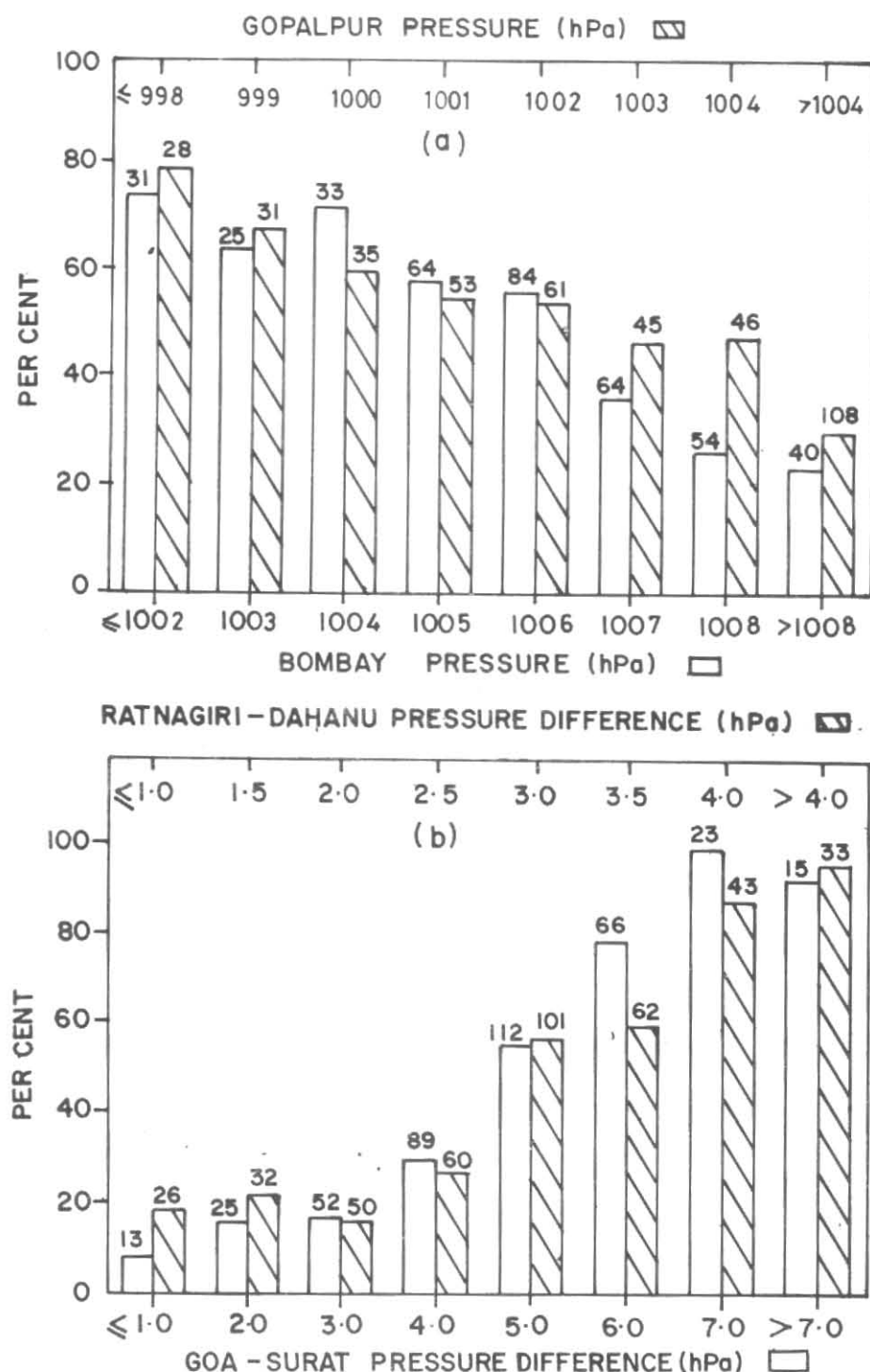
GOPALPUR PRESSURE (hPa)

Fig. 1. Occurrence (%) of wind speed ≥ 20

cases in the category. To make the diagram simpler, plotting of individual cases has been avoided and the fractions have been written at the centre of the interval square. The diagram is then divided into seven categories—I to VII—depending upon the per cent occurrences of wind speed of 20 kt or more. The per cent occurrences of such cases have been encircled in the respective categories. This has been considered as a new variable, say Z_1.

Fig. 3 has been prepared in a similar way considering Gopalpur pressure and Ratnagiri-Dahanu pressure difference as co-ordinates. The categories I to VII in this diagram define another derived variable, say Z_2.
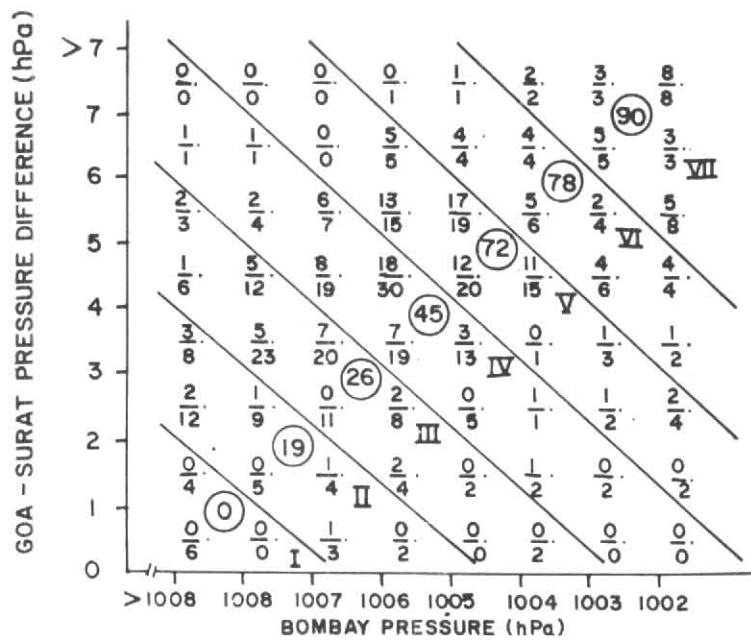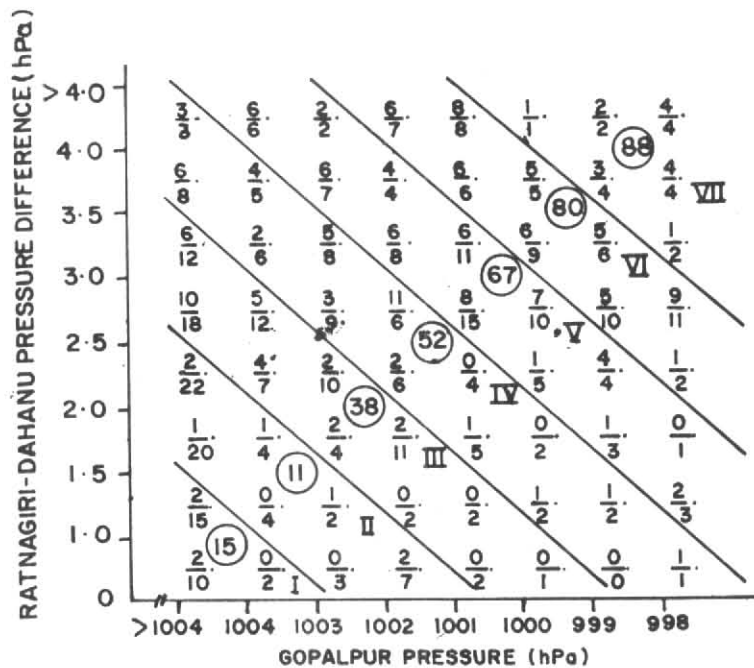
Fig. 2.

Fig. 3.

The derived variables Z_1 and Z_2 have been combined into a final diagram shown in Fig. 4. This diagram contains the combined information from all the four predictors. A solid line termed as 'forecast line' is drawn to separate the days of a wind speed forecast $\geq$ 20 kt. Any day above this line can be forecast to have wind speed of 20 kt or more after subsequent 24 hours.

5. The technique has been used to test the forecast of winds over BHA from June to August 1992. Out of 89 days (pressure values for 3 days were not available), the forecast has been found to be correct on 82 occasions. The combined results for the independent data of the years 1985 and 1992 are shown in Table 1. It is seen that the forecast has been found correct on 89 per cent of the occasions.

6. *Summary of method*

(i) Determine category number from Fig. 2 taking into consideration the Bombay pressure and Goa-Surat pressure difference.
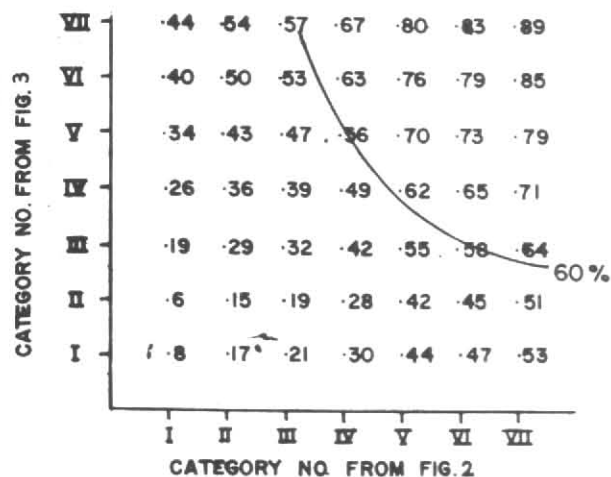
Fig. 4. Combination of categories from Figs. 2 and 3

(ii) Determine category number from Fig. 3 considering the Gopalpur pressure and Ratnagiri-Dahanu pressure difference.

(iii) Enter into Fig. 4 with the categories obtained from Figs. 2 and 3. If the point falls above the solid line, a forecast of wind speed 20 kt or more to occur over BHA during next 24 hours can be issued.

The method developed is a semi-objective graphical one. As the multiple correlation coefficient between the predictants and the predictor is 0.49 only, it would not be useful to develop a regression equation between them. However, the present technique gives good results and prediction of the wind speed over the Bombay High region can be made with good confidence.

TABLE 1

Contingency table of forecast *vs* observed occurrence of wind speed $\geq$ 20 kt

Observed	Forecast		
	Wind speed $\geq$ 20 kt	Wind speed $<$ 20 kt	Total
Wind speed $\geq$ 20 kt	55	5	60
Wind speed $<$ 20 kt	12	85	97
Total	67	90	157

Per cent correct : 89%.

7. The authors are grateful to Dr. S. Kumar, Dy. Director General of Meteorology, Regional Meteorological Centre, Bombay for his encouragement and useful suggestions.

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