AN OBJECTIVE TECHNIQUE FOR FORECASTING 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 Samrat 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:

$$f(X_1, X_2) \ldots \rightarrow Z_1 \rightarrow f(Z_1, Z_2) \rightarrow \text{Forecast}$$

where, $X_1 \ldots X_4$ 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
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. 1. Occurrence (%) of wind speed $\geq 20$
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.
Determine category number from Fig. 3 considering the Gopalpur pressure and Ratnagiri-Dahanu pressure difference.

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.

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References

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RELATIONSHIP BETWEEN SOIL TEMPERATURES AT VARIOUS DEPTHS

1. In order to study the behaviour of soil temperatures during different seasons, regression/correlation studies have been carried out on the weekly normal values of soil temperatures recorded at 12 stations having different soil types and spread all over India.

2. Data and method — The selected stations (Fig. 1) are as follows:

<table>
<thead>
<tr>
<th>Station</th>
<th>State</th>
<th>Soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhubaneswar</td>
<td>Orissa</td>
<td>Sandy loam fine, light coloured</td>
</tr>
<tr>
<td>Bikramganj</td>
<td>Bihar</td>
<td>Old alluvium</td>
</tr>
<tr>
<td>Dharwad</td>
<td>Karnataka</td>
<td>Black &amp; red soil</td>
</tr>
<tr>
<td>Gwalior</td>
<td>Madhya Pradesh</td>
<td>Alluvial soil</td>
</tr>
<tr>
<td>Hisar</td>
<td>Haryana</td>
<td>Sandy loam</td>
</tr>
<tr>
<td>Jodhpur</td>
<td>Rajasthan</td>
<td>Dune &amp; sandy plain</td>
</tr>
<tr>
<td>Nagpur</td>
<td>Maharashtra</td>
<td>Black soil</td>
</tr>
<tr>
<td>Paninagar</td>
<td>Uttar Pradesh</td>
<td>Haldy loam fine texture, brownish in colour</td>
</tr>
<tr>
<td>Pattambi</td>
<td>Tamil Nadu</td>
<td>Laterite, reddish colour</td>
</tr>
<tr>
<td>Pune</td>
<td>Maharashtra</td>
<td>Black cotton</td>
</tr>
<tr>
<td>Rajahmundry</td>
<td>Andhra Pradesh</td>
<td>Black clay</td>
</tr>
<tr>
<td>Solapur</td>
<td>Maharashtra</td>
<td>Medium coarse texture, blackish brown in colour</td>
</tr>
</tbody>
</table>

52 means of weekly normal values (based on data for 30 years, 1951-80) of soil temperatures at 5, 15 and 30 cm depths recorded at 0700 and 1400 IST have been used. The values of correlation coefficient have been computed for the three pairs of depths, viz., 5-15 cm (Layer L₁), 5-30 cm (Layer L₂), 15-30 cm (Layer L₃) and for all the stations separately by using the standard linear regression method. Surface layer data could not be used as the same was inadequate.