DATA COLLECTION AND ANALYSES.

This chapter confines to the field programmes, method of data collection and analyses undertaken in connection with the present investigation. A brief description of the locations of field programmes and the reasons for the selection of these locations are given. Since two types of wave recording systems were used, a comparison of their relative performance was carried out and the results presented in this chapter.

3.1. Field Programmes

3.1.1. Location

The field programmes in connection with the proposed work were carried out at two different locations along the Kerala coast, viz. Trivandrum and Alleppey (Fig. 3.1.). These locations were particularly selected for this investigation because they present a wide range of field parameters, which help the evaluation of the prediction models for their applicability along the entire Kerala Coast.

The differences in shallow water wave climate between the two locations are discussed by Baba et al. (1983a, b and 1987). Trivandrum is a high energy coast
Fig. 3.1 Location Map with Wave Recording Stations
compared to Alleppey. Significant wave heights of the fair-
season (November-April) and rough season (May-October) for
the year 1982 are reproduced from Baba et al. (1987) in
Fig. 3.2. During the rough season, the significant wave
heights ($H_s$) exceed 2.0 m at Trivandrum and 0.9 m at
Aleppey for 50% of time. During fair weather $H_s$ exceed 1.0
m at Trivandrum and 0.6 m at Alleppey for 50% of time. The
maximum nearshore wave heights reported during the period
1980-85 are 6m and 3.8 m respectively at Trivandrum and
Aleppey (Baba, 1985).

While the coastline has approximately NW-SE orientation
at Trivandrum, it has NNW-SSE trends at Alleppey (Fig. 3.1).
Both the coastlines are more or less straight. Trivandrum
is characterised by a steep inshore shelf gradient, while
Aleppey is fronted by wide, and flat inshore profiles
(Fig. 3.3). From a depth of 20 m offshore, though the
slopes of both the profiles remain the same, the shelf at
the same offshore distances is considerably deeper at
Trivandrum than Aleppey.

The shelf sediment characteristics vary much at these
two locations. Studies by Hashimi et al. (1981) have shown
that the shelf sediments are having mean sizes of 346 $\mu$ and
31 $\mu$ respectively at Trivandrum and Aleppey. During the
course of this study, size-characteristics of inshore
sediments were further studied, which are discussed later.
Fig. 3.2 Percentage Exceedance of Wave Height
(after Baba et al, 1987)
Fig. 3.3 Shallow Water Bottom Profiles
Data on coastal currents is scanty for this coast. Current measurements off Cochin by Premchand (1987) indicate that the coastal currents are generally sluggish; hence currents may not play any significant role in the wave transformation off this coast.

3.1.2. Wave Recording

The wave measurement essentially involved the synchronised deep water and nearshore wave recording using wave recorders.

3.1.2.1. Deep water recording

For the measurement of deep water waves, a Datawell Waverider buoy was used. The description of the waverider system and details of its mooring are available in Nayak and Anand (1981). The sites of operation of the buoy at the two locations are indicated in Fig. 3.1. The buoy was operated off Trivandrum at depths of 60m during October 23-24, 1983 and 48m during May 19 -June 12, 1984. The buoy was operated off Alleppey at a depth of 30m during May 14-15,1984. The offshore depth covered at Alleppey was limited to 30m because of the greater width of the shelf there and the consequent logistic problems associated with the coverage of the distance. During all the operations, the WAREP receiver of the buoy was kept at shore and continuous wave recording was carried out, except during night hours, when the
recording was in the programme mode for half an hour durations at intervals of 1 h or 3 h. Deep water wave directions were measured using a Brunton Compass during attended operation of the buoy. During the unattended operation the ship observations of IDWR and the coastal observations were depended upon for wave directions.

3.1.2.2. Nearshore wave measurement

Nearshore waves at both the locations were measured using a pressure recorder. The description of the equipment and the mode of installation are given in Baba et al. (1983a). The sites of nearshore wave recording are shown in Fig. 3.1. Both the sites of measurement had a depth of 5.5m and the transducers of the system were at a depth of 3m from Mean Water Level (MWL). The wave recordings were carried out for 30 minutes duration at intervals of 3 h during the period of operation of the waverider buoy. Directions of nearshore waves were measured at least twice daily using a Brunton Compass at the measurement sites.

3.1.2.3. Synchronised recording at the same site

For a comparative study of the performance of the two systems, the pressure recorder and the waverider were operated simultaneously at the same site off Alleppey. This is achieved by deploying the waverider buoy at the nearshore wave recording site adjacent to the pressure recorder.
Simultaneous wave recordings were carried out in both the systems for a duration of two and half hours.

3.1.3. Bathymetric surveys

Accurate and updated bathymetric charts, especially for the inshore, were an essential requirement of the investigation. Detailed bathymetric charts of the inshore zones of the present study area had been prepared in Centre for Earth Science Studies based on the surveys carried out during 1981-82 (Baba et al., 1983b). These charts were updated with some more soundings during the course of the present field programmes. The 'Skipper' echosounder was used for the soundings. The position fixing was carried using a 'miniranger', which gives distances of offshore points from shore reference stations, at Trivandrum and theodolites at Alleppey.

3.2. Analyses

3.2.1. Analyses of Wave Records

The following analyses were carried out on the wave records collected.

3.2.1.1 Tucker-Draper method

Analyses of wave records were carried out using the Tucker-Draper Method as given in Silvester (1974) for the
deep water as well as nearshore wave records. Since the nearshore records were collected using the pressure recorder which has a pressure transducer, attenuation corrections had to be applied to the height parameters $H_1$ and $H_2$ derived from this analysis. The method of pressure attenuation correction followed is discussed in Section 3.3. The significant wave height ($H_s$) and zero-crossing period ($T_z$) derived from this analysis were used for the study of transformation of wave height and verification of models.

3.2.1.2. Wave-by-wave method

The wave-by-wave zero-up-crossing method of analysis was carried out on the records, which were used for the comparison of the performance of buoy and pressure recorder. The $H_s$ and $T_z$ derived from this study were used for the comparisons.

3.2.1.3. Spectral analyses

The spectral analyses of wave records was carried out using the FFT method. The stability and accuracy of spectral estimates depend on many parameters such as record length, sampling interval, number of points etc. (Goda, 1974; Harris, 1974; Baba et al., 1986; etc). The digitisation and analysis were carried out, keeping the optimum conditions (Baba et al., 1986) given below in view, in order to get best and reliable results. Except for the few
records used for the study in Section 3.3., all waverider and pressure records were digitized at intervals of 0.5 s and 0.6 s respectively and the total number of data points were 2048 for each record. Since the chart paper speed could not be maintained uniform for both the types of records, the digitization intervals varied slightly in view of the convenience in the digitisation, which had to be carried out manually. The slight difference in the digitisation interval may not affect the comparability of the spectra (Baba et al., 1986). The digitisation interval was kept uniform at 1 s for both the types of records used in Section 3.3. and the number of data points were 1024.

The computer programme (Hameed, 1985, unpublished) used for the computation of spectra and spectral parameters has provision for correcting the pressure recorder data for pressure attenuation, which is again discussed in Section 3.3.

3.2.2. Analysis of Sediment Samples

Sediment samples collected from the inshore regions (5-15 m depth) of the locations of study during 1980-81 were used for the size-gradient analysis. The samples were chemically dispersed using sodium hexametaphosphate solution as per standard procedures and separated into sand fraction and fine fraction (clay and silt). Mechanical sieving was
carried out for sand fractions and pipette analysis for fine fractions. The results are presented in Table 3.1.

3.3. Comparison of Performance of Waverider and Pressure Recorder

3.3.1. Need for the Comparison

In the present investigation since data derived from two different systems were to be used for comparison and verification of the models, a comparison of the relative performance of the two systems was carried out first. The data collected as in subsection 3.1.2.3. were used for this study.

The major uncertainty in the use of pressure recorder data is related to the pressure attenuation correction required for the wave height. The pressure attenuation correction formula,

$$H = H' \frac{\cosh(2\pi d/L)}{\cosh\left[\frac{2\pi d}{L}(1-z/d)\right]}$$ (3.1)

where $H$ and $H'$ are the corrected and uncorrected waveheights respectively, $z$ and $d$ are the transducer and station depth respectively), consists of an instrument factor $K_n$ which has been assigned values ranging from 1.1 to 1.5 by various researchers (Homma et al., 1966, Cizlak and Kowalzki, 1969;
Table 3.1  Average Size Characteristics of Nearshore Sediments (depth : 5-15 m)

<table>
<thead>
<tr>
<th>Location</th>
<th>Median</th>
<th>D_{90}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trivandrum</td>
<td>0.203</td>
<td>0.368</td>
</tr>
<tr>
<td>Alleppey</td>
<td>0.029</td>
<td>0.088</td>
</tr>
</tbody>
</table>
Dattatri, 1973; etc). Bergan et al. (1968) found from their laboratory tests that the spectral wave heights were well predicted without the empirical factor $K_n$ for a pressure record.

To obtain the surface spectrum from the pressure spectrum, Black (1978) proposed the following relationship

$$S(f) = S'(f) \frac{\cosh^2 \frac{2\pi d}{L}}{\cosh^2 \frac{2\pi d}{L} (z+d)}$$

(3.2)

where $S'(f)$ and $S(f)$ are the uncorrected and corrected pressure spectrum respectively. In the absence of a standard procedure for pressure attenuation correction, a comparison of the performances of the two systems used in the present investigation was felt very important.

3.3.2. Comparison of Wave Heights

The wave records collected from both the systems during the simultaneous operation were subjected to the Tucker-Draper, wave-by-wave and spectral methods of analyses. The height parameters $H_1$ and $H_2$ derived from Tucker-Draper method and $H_5$ from wave-by-wave method for the pressure recorder were further corrected for pressure attenuation using equation (3.1) without instrument factor (i.e. $K_n = 1$) and with $K_n = 1.25$, as proposed by Dattatri (1973). In Fig. 3.4 the $H_1$ and $H_2$ values for the wave rider records
Fig. 3.4 Comparison of Wave Heights

- Instrument factor = 1.25, ○ - No attenuation correction
- ♦ - No instrument factor
are plotted against the corresponding values for pressure recorder without attenuation correction, and with attenuation correction using $K_n = 1.0$ (i.e. no instrument factor) and $K_n = 1.25$. It is seen that there is good correlation between the wave rider and pressure recorder heights when the attenuation correction is applied to the latter without any instrument factor.

3.3.3. Comparison of Period Parameters

The plot of wave period parameters $T_z$ and $T_c$ of the pressure recorder against waverider is given in Fig. 3.5. The period parameters obtained from the pressure recorder are always higher than the corresponding ones for waverider. This is due to the differences in the response characteristics of the two systems. The pressure recorder used has 100% response only for periods above 5 s and the response is 95% for periods between 3 and 5 s (Baba et al., 1986). In the case of waverider the 100% response starts from a period of 3 s. Hence very short period components get filtered in the pressure record resulting in a shift of the period parameters towards higher period side.

3.3.4. Comparison of Wave Spectra

Spectral analyses were carried out for the wave records from the two systems. Pressure attenuation corrections using equation (3.2) were provided for the pressure recorder.
Fig. 3.5 Comparison of Period Parameters
spectra. Table 3.2 and Fig. 3.6 give a comparison of spectral parameters and spectra respectively from the records of both the systems. The spectra of wave records from the two systems compare well. In Table 3.2, the two values in sequence against given for each parameter are for 1205 and 1235 respectively. The spectral moments from both the systems nearly tally. The significant wave heights and the spectral peakedness parameter $Q_p$ are also comparable. Like the other period parameters ($T_z$ and $T_c$) the spectral peak period $T_p$ of pressure recorder is higher than waverider when no smoothening of the spectral lines is done. However, when smoothening of spectral lines into spectral bands of frequency 0.0078 (which is used for plotting the spectrum in Fig. 3.6) is done, the peak periods are comparable as is seen in Table 3.2. The average periods are also comparable. Thus the results show that the periods derived from spectral analysis are more comparable.

3.3.5. Summary of Results of Comparison

Wave heights from pressure recorder corrected for pressure attenuation using equation (3.1) without any instrument factor gives good comparison with waverider heights and Hence the pressure recorder heights so derived can be used along with waverider data for study of wave transformation and for verification of models. The spectra derived from pressure recorder after corrections using
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Waverider</th>
<th>Pressure Recorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m_0$</td>
<td>0.042</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>0.035</td>
<td>0.039</td>
</tr>
<tr>
<td>$m_1$</td>
<td>0.006</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>0.005</td>
<td>0.005</td>
</tr>
<tr>
<td>$m_2$</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>$H_s(m)$</td>
<td>0.82</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td>0.79</td>
</tr>
<tr>
<td>$\bar{T}_s(s)$</td>
<td>7.0</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td>6.9</td>
<td>7.4</td>
</tr>
<tr>
<td>$T_p(s)$</td>
<td>16.0</td>
<td>16.0</td>
</tr>
<tr>
<td></td>
<td>14.0</td>
<td>16.0</td>
</tr>
<tr>
<td>$Q_p$</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>1.7</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Fig. 3.6 Comparison of Spectra
equation (3.2) compare reasonably well with waverider spectra and hence both can be used together for study of spectral transformation. While wave period parameters from Tucker-Draper analysis are always higher for the pressure recorder, the spectral analysis gives comparable values.