University of Utrecht

Morphodynamics of Wave-dominated Coasts
GEO4-4434
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Practical 1

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1 Exercise 1.1: Pre-processing

- *What is the duration of the signal in minutes?*

Using the *length()* function, we find that the dataset contains 14400 samples. At a sample frequency of 4 Hz, the duration of the signal is 3600 seconds or 60 minutes.

- *Compute the average water depth h_{mean} at the sensor.*

Using the *mean()* function, we find the average water depth during this period was 3.77 m. The time series of the depth can be seen in Figure (1.1).

- *Plot the evolution of h as a function of time. Plot also an horizontal line indicating the average water depth.*

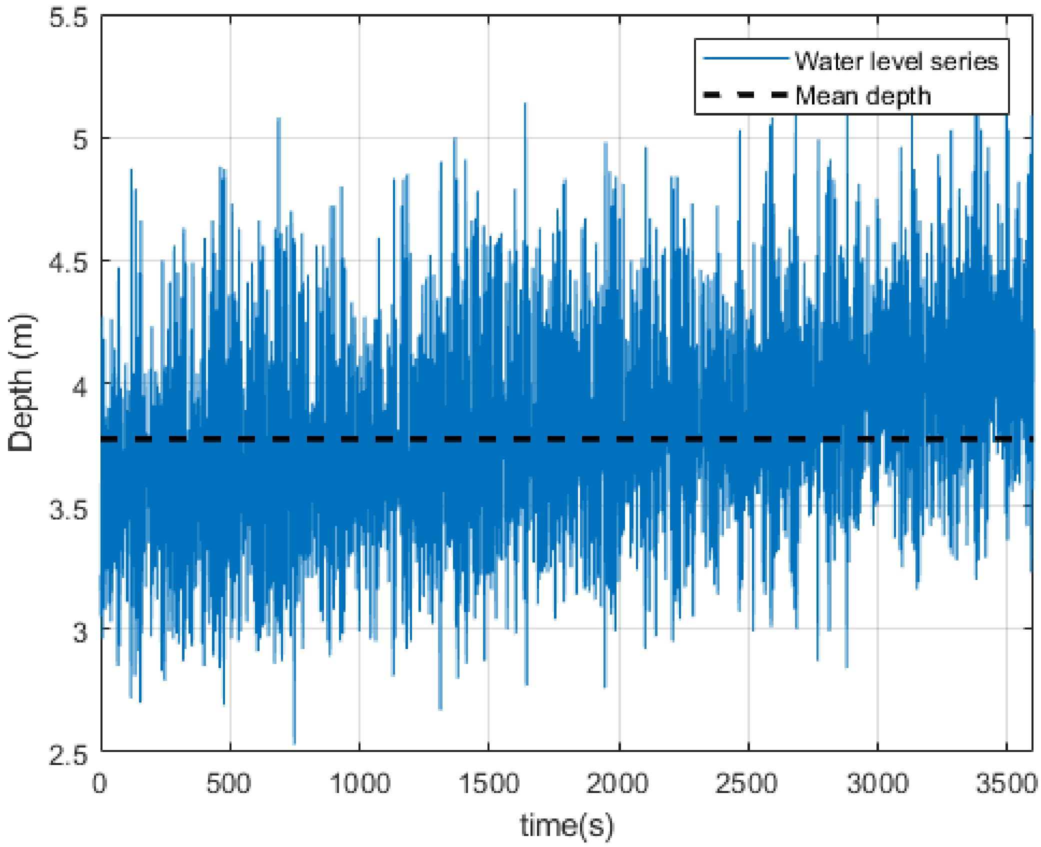

Figure 1.1: Time series of water depth at position P1. The average depth is shown by the dashed horizontal line.

- *It can be seen in the figure that the water level is increasing with time. Can you explain what is happening?*

The increase in the water level is most likely due to a tide. The measurements of this particular sample were taken during a flood or a rising tide.

- *In a new figure, compare the resulting time-series $h_{detrend}$ with h - h_{mean}.*

Here the *detrend()* function is used in order to remove the tidal signal. In Figure 1.2 the result of the detrended sample is compared with the original time series. In the time series of the h–h_{mean}, the linear increase of the wave signal is observed. This systematic shift in a wave signal, as mentioned before, can be a result of a tide at the observation point. In the detrended signal the linear trend is removed from the data. The mean frequency of the wave is now 0 and is not increasing along the time interval, hence reducing the overall variation. Even if trends are important, better interpretations of the signal can be made while the analysis can be mainly focused on the fluctuations in the signal once the trend is removed. When the detrended signal $h_{detrend}$ is subtracted from the $h - h_{mean}$, the trend line is produced, as shown in Figure 1.3. It can be observed that there is an increase of the water depth within one hour.

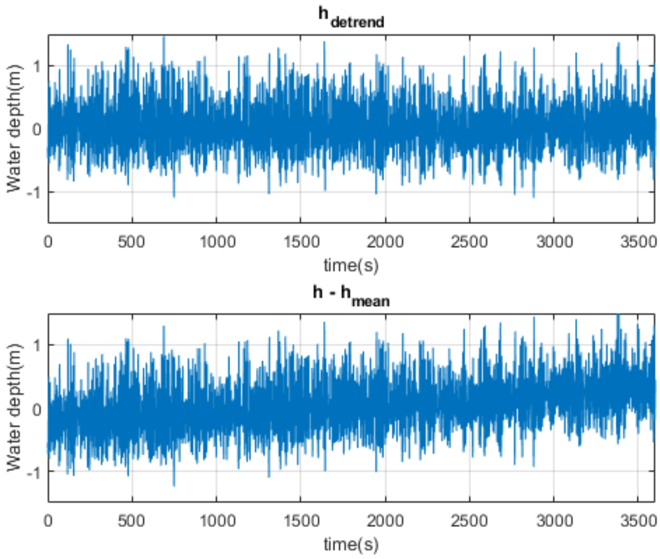

Figure 1.2: Time series of $h_{detrend}$(top) and $h - h_{mean}$(bottom). Water depth in meters.

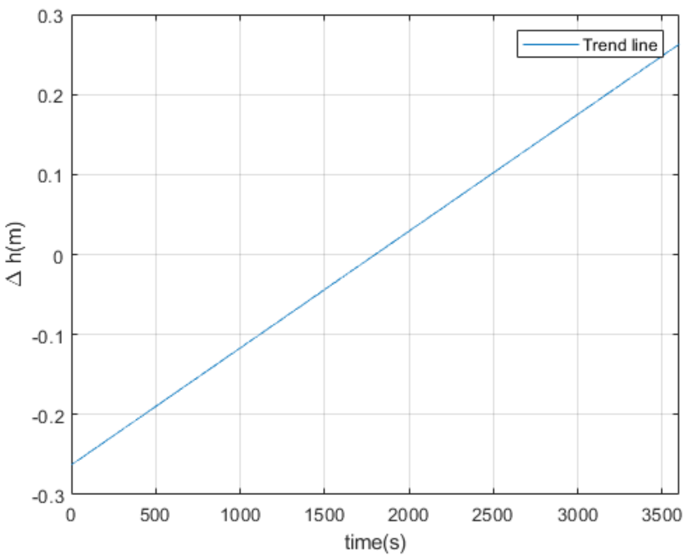

Figure 1.3: Trend line for depth series($h - h_{mean} - h_{detrend}$).

2 Exercise 1.2.1 Preliminary visualisations

- *Create a new figure which displays the time-series measurements in 6 sub-figures and choose appropriate axis limits.*

Figure 2.1 visualizes the time-series corresponding to the sensors P1, P3 and P6 for the low and high tide measurements. The low tide measurements are plotted in the first column and the high tide measurements in the second column. The y-axis is chosen to range from -2 to 2 meter for every subplot such that the wave characteristics at the different locations can be compared.

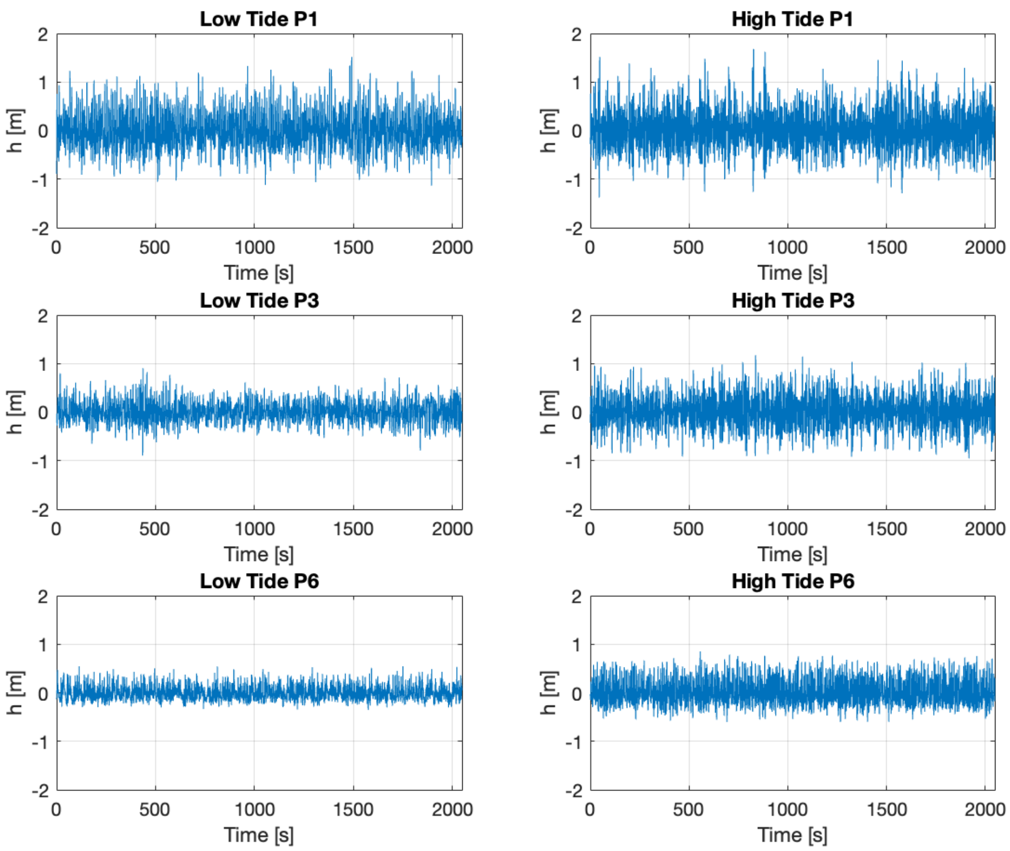

Figure 2.1: Subplots of the time-series corresponding to P1, P3 and P6 for the low (first column) and high (second column) tide measurements. The y-axis displays the sea surface elevation (m) and the x-axis the time (s).

- *Estimate visually the wave heights for these time-series.*

To visually estimate the wave height from the figure, an estimation of the height between a trough and a subsequent crest is made. Since the variability in the wave height in the time series is quite large, the average of three different wave heights at one location is taken in order to obtain a better estimation. Table 1 shows the estimations of the wave heights at the different locations for both the low and high tide measurements. First, it can be noted that the wave height decreases with the x-location of the sensors, i.e. it decreases from the location of P1 to P6 for both the low and high tide measurements. Secondly, the wave heights of the high tide measurements are higher than the low tide measurements at all sensor locations.

3 Exercise 1.2.2 Computation of wave statistics

3.1 Definition of new functions

Functions are made for the significant height and the root mean square and can be found in the attached Matlab files.

Tide	Location	Wave height [m]
Low	P1	2.17
Low	P3	1.40
Low	P6	0.80
High	P1	2.48
High	P3	1.83
High	P6	1.28

Table 1: Estimation of the wave height at the different sensor locations (P1, P3 and P6) for the low and high tide measurements.

3.2 Wave statistics at low tide

- *Plot of the mean, significant and root mean square wave heights together with a plot of the bed profile.*

Figure 3.1 shows a plot of the mean, significant and root mean square wave height as a function of the cross-shore position. Furthermore, the bottom plot shows graphically the bed profile together with the positions of the sensors. As mentioned before, the wave height changes as the cross-shore position increases. A difference of about 1 meter in the significant wave height between P1 and P6 can be observed. Furthermore, also the mean and root mean square wave height decreases for increasing cross-shore position. The mean wave height decreases from 0.9 m at P1 to 0.2 m at P6 and the root mean square wave height decreases from 1.1 m at P1 to 0.3 m at P6. The differences in bed height at the sensor positions are observed in the bottom plot, where it is seen that the sensor P1 is located at a lower bed height than the rest of the sensors, possibly explaining the decrease in wave height with cross shore position.

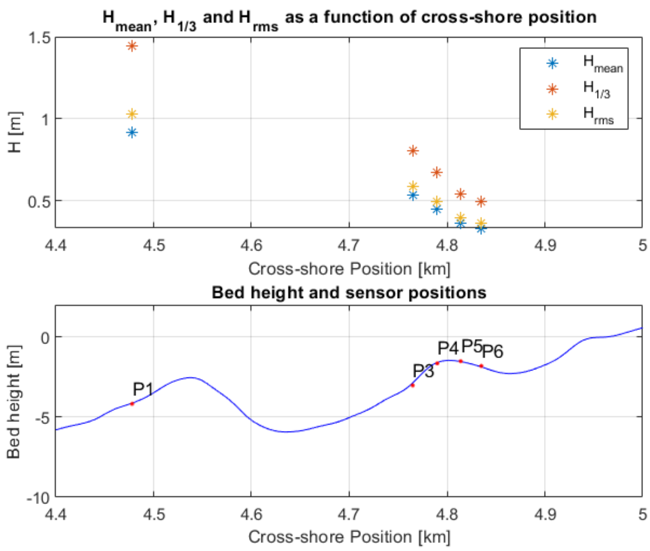

Figure 3.1: *Top*: Plot of the mean, significant and root mean square wave heights. *Bottom:* Plot of the bed profile.

- *Plot the significant wave height as a function of the mean root square wave height for the entire dataset.*

As can be observed in Figure 3.2, there is a good linear fit between the significant wave height and the mean square root wave height. It is shown that the linear fit closely follows the expected theoretical relation, given by $H_{1/3} = \sqrt{2}H_{rms}$. The values obtained for the linear fit using the *polyfit* function are 1.4239 for the slope and -0.0482 for the intercept. The theoretical relation holds a value for the slope of 1.4240 and an intercept of 0, so the linear fit is almost identical to what is expected from the theoretical relationship mentioned earlier.

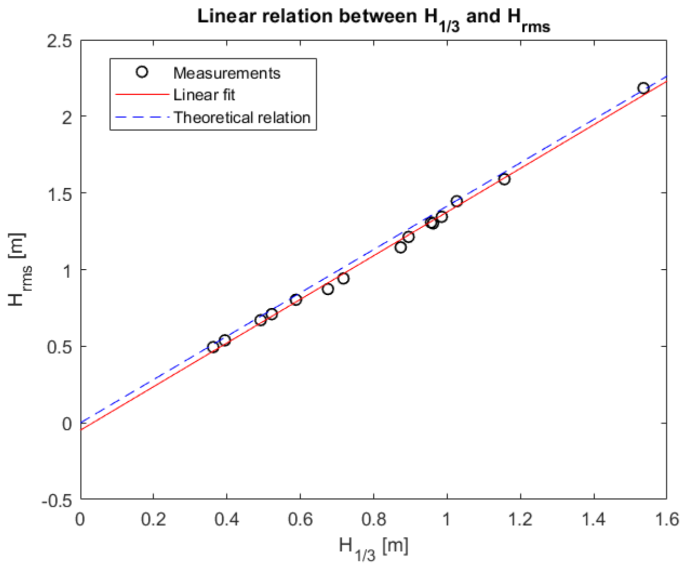

Figure 3.2: Linear fit relation between the significant wave height and the mean root square wave height, together with the measurement points and theoretical results.

- *Verify that* $H_m \approx 0.89 H_{rms}$.

The linear relation between the mean wave height and the root mean square wave heigth together with the theoretical relation and measurements is shown in Figure 3.3. It can be observed that the linear fit closely follows the theoretical relation and the measurement points. A slope of 0.8931 and an intercept of 0.0187 are obtained for the linear fit using the *polyfit* function. These values are very close to the theoretical values, which are 0.89 for the slope and 0 for the intercept, indicating that the linear fit is almost identical to the theoretical relation and hence $H_m \approx 0.89 H_{rms}$.

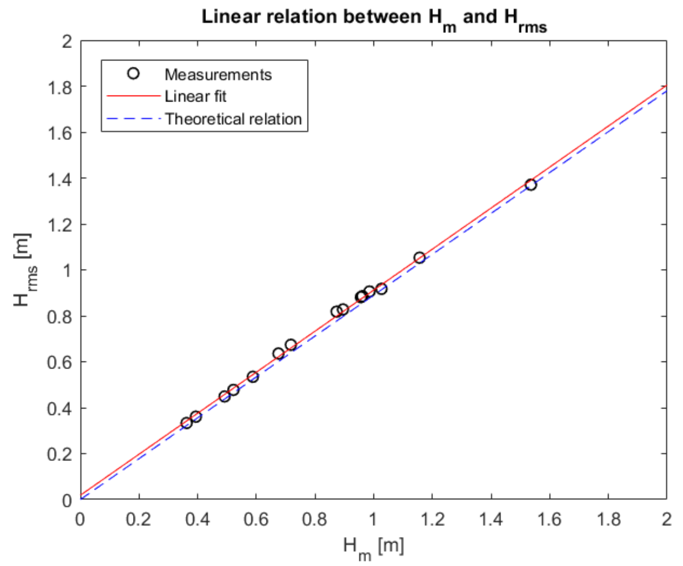

Figure 3.3: Linear fit relation between the mean wave height and the square root mean wave height, together with the measurement points and theoretical results.