High waves at Rincón, Puerto Rico,

Chapter 10 Wave characteristics

Background

Waves are the main source of energy that causes beaches to change in size, shape and sediment type. They also move marine debris between the beach and offshore zone. Waves are generated by the wind blowing over water. Waves formed where the wind is blowing are often irregular and are called wind waves. As these waves move away from the area where the wind is blowing, they sort themselves out into groups with similar speeds and form a regular pattern known as swell.

Waves and climate change

Changing wind systems projected to occur with climate change will have the effect of altering the wave energy felt on coasts around the world. These changes have not yet been fully quantified. However, it is already known that there will likely be more extreme events resulting in coastal flooding as a result of sea level rise, storm surge, and ocean waves. In tropical areas affected by hurricanes/typhoons/cyclones, these are projected to become stronger and more intense. It is during such storms and extreme events that serious damage to the coast and beach occurs.

ACTIVITY 10.1 Measuring waves

What to measure→ The three main characteristics of waves are the height, the wavelength and the direction from which they approach. Figure 18 shows a diagram of a simple wave. Wave height is the vertical distance from the crest of the wave to the trough. Wave period is the time measured in seconds between two successive wave crests. Wave direction is the direction from which the waves approach.

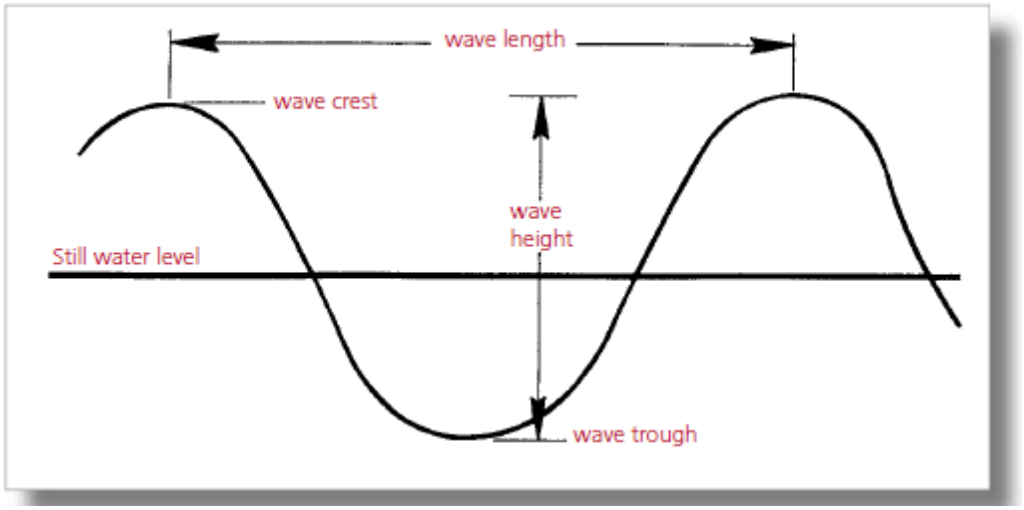

Figure 18 *Characteristics of a wave (adapted from US Army Corps of Engineers, 1981a).*

How to measure→ Wave height is measured by having an observer with a graduated staff or a ranging pole (pole with measured sections in red and white) walk out into the sea to just seaward of where the waves are breaking, and then to have the observer record where the wave crest and the following wave trough cut the staff; the difference between the two is the wave height. If no graduated staff or pole is available an improvised wave staff can be made with any long piece of wood or bamboo that may be lying on the beach. Alternatively, an estimate may be made of the wave height in whichever units the observer feels most comfortable with. Often it is best to have two observers independently estimate wave height and then to compare their results. The height of at least five separate waves should be estimated and the average taken.

Making a wave pole from a piece of bamboo found on the beach, Jamaica

Measuring wave height with a wave pole in Fiji

Wave period is the time in seconds for eleven wave crests to pass a fixed object, or if no such object exists, the time for eleven waves to break on the beach. Use a stopwatch if available or a wristwatch with a hand for measuring seconds. Start the timing when the first wave passes the object or breaks on the beach, and stop it on the eleventh. Divide the total number of seconds by ten to get the wave period.

Wave direction is the direction from which the waves approach and is measured in degrees. This can be measured with a compass, standing high up on the beach and sighting the

compass along the direction from which the waves are coming, which will be at right angles to the wave crests (see Figure 19).

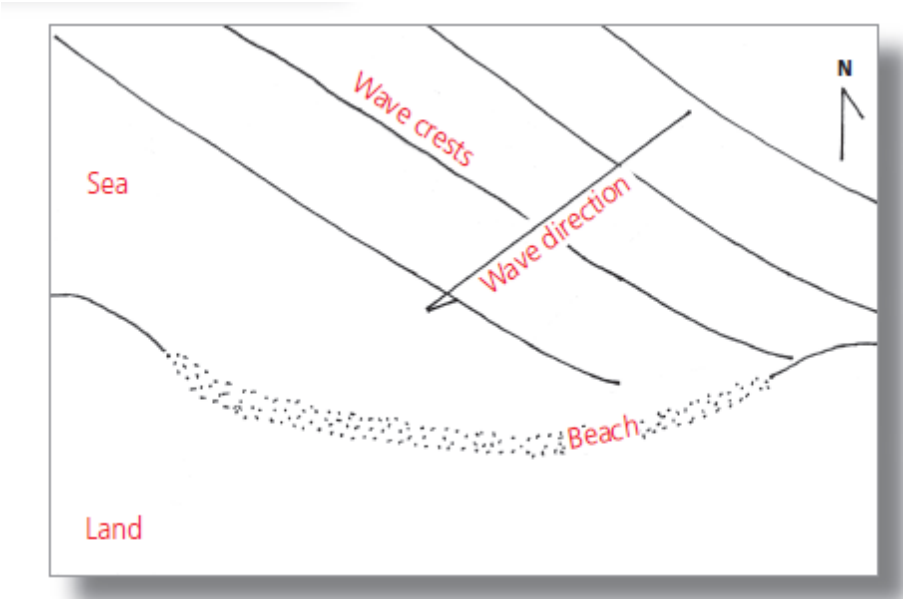

Figure 19 *Wave direction.*

When to measure→ This will depend on the time available and the nature of the monitoring activity. Waves change from day to day, so daily measurements are the most useful. However, if time is not available for daily measurements, weekly measurements or even twice-monthly measurements can still provide useful data.

What will the measurements show→ The measurements will show how the wave characteristics change over time. Depending on how often the data are collected, the measurements can be averaged over weeks or months and plotted on graphs. If beach width or marine debris is also being measured, it may be possible to correlate changes in the width of the beach or the amount of debris with the wave height. It may also be possible to pick out seasonal changes from the data such as the time of year when the waves are highest (see Figure 20).

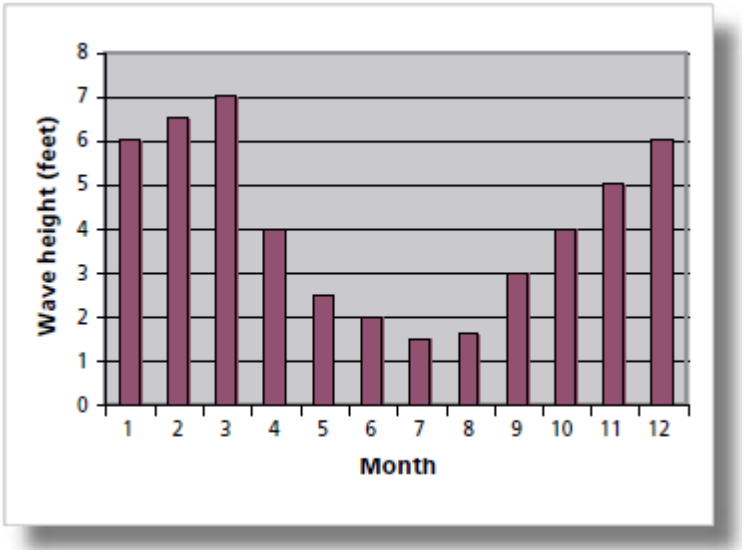

Figure 20 *Bar graph showing wave height variations over time*

Waves vary according to the time of year. The photo on the left shows calm conditions at Speightstown Jetty in Barbados in July, while the photo on the right shows the same site in high swell conditions in March.

ACTIVITY 10.2 Watching out for a tsunami

Tsunami warning sign, Rincón, Puerto Rico. (Translation: Danger zone, earthquake/tsunami. In case of an earthquake, move to a high place or move away from the coast.)

Learning about tsunamis→In the aftermath of the Indian Ocean tsunami that occurred on 26 December 2004, most people are now aware of these phenomena. Tsunamis are extremely high waves that are caused by earthquakes or huge undersea landslides. They are rare events. They occur most frequently in the Pacific Ocean where a tsunami warning system has been established. However, they have also been recorded in historic times in the Atlantic and Indian Oceans and in the Caribbean Sea where tsunami warning systems are being installed.

Recognising the warning signs→ During tsunamis, low-lying coastal areas, those below 6 m (20 ft) in height, may be flooded. However, because of the speed at which tsunami waves travel (800 km/hr or 500 mph) an earthquake off the Venezuelan coast might result in a tsunami reaching some Caribbean islands within minutes. However, in the Pacific Ocean, where distances are larger, an earthquake in Alaska might result in a tsunami reaching Hawaii and Japan several hours later. Knowing the warning signs could result in saving lives. One of the best warning signs is the earthquake itself, though it should be noted that not every earthquake generates a tsunami. A second warning sign is when the sea recedes – before the arrival of the tsunami wave(s), the sea recedes a considerable distance leaving a significant portion of the

seabed (which is usually covered by water) dry. If you are at the beach or near the shore, and you see either or both of these warning signs, run inland for higher ground and alert as many people as possible to do the same.

Discussion topics and beach activities

- Research the tsunamis that have affected their country within historic times (if any);
- Determine whether previous tsunamis caused damage or loss of life;
- discuss whether there has been a lot of coastal development in your country since the last tsunami;
- ask the students if they know the tsunami warning signs and ask them to find out if their parents are aware of these signs;
- use Google Earth (or a similar programme, see Chapter 4, Activity 4.3) to see an aerial photograph of your beach, and if the land behind the beach is low-lying, calculate how many houses and people might be in danger if the water extended 1 km inland.

Activity 10.3 Keeping a beach journal

What to measure→ Keeping an accurate and permanent record of major wave events, storms and other activities that affect your beach can provide useful information for beach managers and others wanting to help the beach become more resilient to climate change.

How to measure→ Visit the beach and take photos after a major weather event and keep a record of significant storms and major beach changes over a period of months or a year. Encourage the students to make the journal entries as detailed and accurate as possible. Drawings and photographs are useful additions to the journal. Sample entries are as follows:

- 24 October, 2009 heavy rains cut a deep channel 10 m wide at the southern end of the beach; by 15 November, 2009 the channel had filled up with sand.
- January 14, 2010, large sea swells more than 3 m high affected the beach for 2 days. No beach users or tourists could go swimming. A lot of sand disappeared and tree roots were exposed, one tree fell down.
- June 4, 2010, a tropical depression affected the island and for 2 days there were high winds, high waves and a lot of rain. Again a lot of sand disappeared and the lifeguard station had to be moved further inland.

When to measure→Observations and entries should be made after a major weather event such as a storm, a period of very high winds or heavy rainfall.

What the measurements will show→The observations and records can provide a permanent record of major weather events and how they affect the beach. This information can be entered in the Sandwatch Climate Change inventory (under preparation) and if your Sandwatch group has set up its own website (see Chapter 13) the journal entries can also be stored there.

You will be surprised how useful such information can be – for beach managers, for coastal engineers and even for persons wishing to develop coastal property. Such information is rarely recorded, so your group may be the first to do so at your beach. Such information also contributes to the growing inventory about climate change and how its impacts ecosystems locally and globally.