WWF

MARCH 2011

Guidelines for Monitoring Beach Profiles

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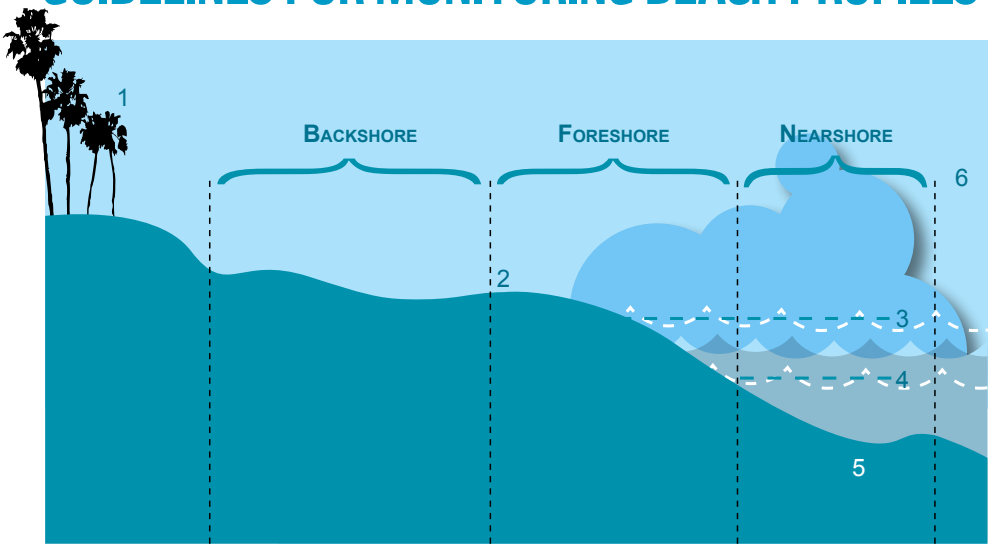
Cite as:

"Fish, M.R. 2011. *Guidelines for monitoring beach profiles.* WWF, San Jose, 16 pp."

GUIDELINES FOR MONITORING BEACH PROFILES



1. Foredune
2. Berm crest
3. High water mark
4. Low water mark
5. Offshore step
6. Offshore

Figure 1. *A typical beach profile*

Objective

The goal of these guidelines is to facilitate the measurement of beach profiles (Fig. 1), which can then be used to monitor changes in beach area and erosion and/or accretion patterns over time.

Methods

Beach profiles are measured from a fixed point at the back of the beach (the reference marker) towards the ocean. The profile is measured in segments, which can either be a fixed distance or can vary depending on the profile of the beach, i.e. each change in slope is the start of a new segment.

Step 1

Determine the coverage and frequency of your profiling points

The number of profiles used for monitoring your beach will depend primarily on your reason for monitoring and also on the number of beaches you want to monitor, the length of those beaches, and the resources in terms of time and personnel available to you. For example, if you want to measure seasonal changes at several beaches over a number of years, then you may want to measure a couple of profiles at each beach every three months. If your aim is to create a detailed model of one beach then you will need many profiles on one beach. After disturbance events such as hurricanes, rates of beach recovery could be measured with weekly profiling.

Step 2

Establish reference markers

Once the area to be profiled has been established, reference markers should be created. These are permanent reference points that mark the start of each profile and will be reused for all subsequent profiles. Use of reference markers ensures that profiles are taken at exactly the same point and are therefore comparable over time. Profiles are generally equally spaced along a beach, with additional markers at points of interest, such as particularly dynamic sections of beach.

Important points:

- Markers should be permanent objects (trees, buildings, walls etc.), or a permanent marker can be constructed, e.g. a long wooden stake securely fixed in place
- Mark and number each reference point using survey paint or a plastic/metal marker
- Record reference marker position using GPS or triangulation in case markers are lost. Triangulation involves taking compass bearings from the marker to three easily-observable, permanent structures, such as transmission towers, etc
- Measure the height of the mark above ground to use as a baseline
- It is best to start the profile from as far back as possible, e.g. behind the line of vegetation where it exists
- In general, you will need at least two people to measure a beach profile although it is possible to measure profiles alone using a tripod to stabilize the lower pole

Figure 2. *Using a tripod and pole to measure a beach profile.*

Step 3

Profiling

Method I
Emery Method

Equipment

- ☐ Paint or plastic/metal marker and nails
- ☐ Compass
- ☐ 2 x 1.5 m poles
- ☐ Spirit level or fishing weights and wire
- ☐ Measuring tape (1 x 30m)
- ☐ Line level
- ☐ String
- ☐ Data sheets
- ☐ Pencils
- ☐ Clipboard
- ☐ Camera

Preparation

Attach 'foot pads' to bottom of upright poles, e.g. wooden discs or similar, to stop the end of the pole sinking into the sand. Attach a small spirit level or fishing weight to poles to make sure they are held upright.

Field measurements

a. Locate first reference mark

b. Lay out the profile from the reference marker to the low-water mark using rope or a tape measure. Check the orientation of the profile, it should run perpendicular to the waterline up to the reference marker. Record the compass bearing of the profile

c. Measure the height from the top of the painted reference mark to the surface of the sand, to the nearest cm

d. Starting at the reference marker, stand one of the poles next to the reference marker, making sure the pole is vertical (use a small level or fishing weight on a line). The person holding the second pole should move it to the first change in slope (or fixed distance). Measure and record the distance between the first and second poles (z) (Fig. 3).

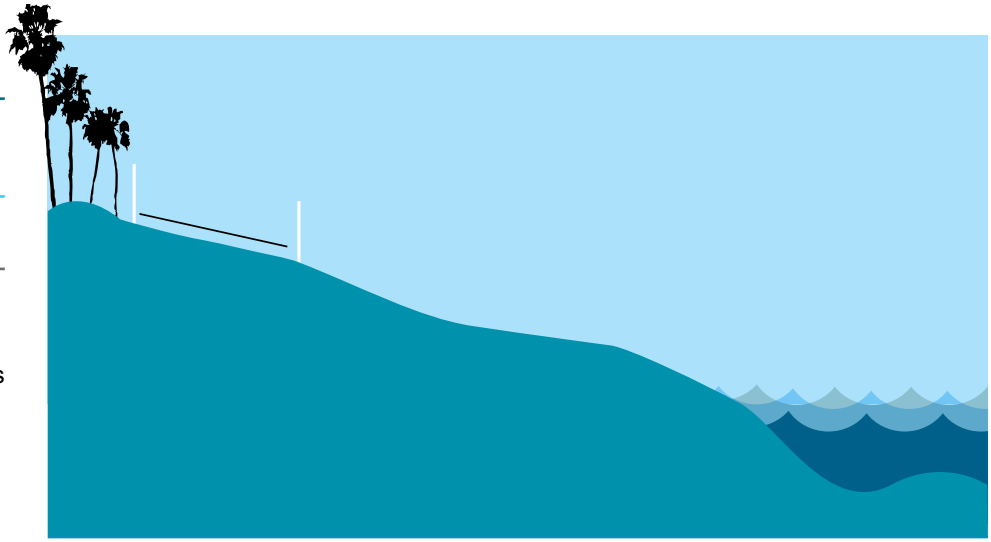


Figure 3. *The first segment*

e. Version 1. Run a piece of string between the upper and lower poles with a line level suspended from it making sure the string is over the top of the lower pole and is taut and level. Measure the distance from the top of the upper pole to where the string intersects it (y) (Fig. 4).

OR

f. Version 2. The observer kneels behind the upper pole and looks towards the horizon, moving until the top of the lower rod is in line with the horizon. Mark this eye level on the upper pole and measure the distance from eye level to the top of the pole (y) (Fig. 5).

g. For each section record any additional information that you may be interested in collecting, e.g. presence of vegetation, sand colour/ grain size etc.

h. Move down the beach profile so the upper pole is now where the lower pole was for the previous measurement (Fig. 7)

i. Continue until you reach the offshore step or low water mark

j. Take photos along profile

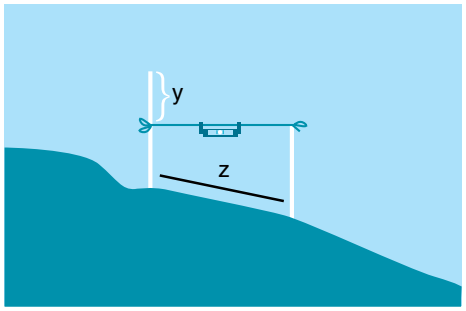


Figure 4. *Segment width (z) and change in elevation (y)*

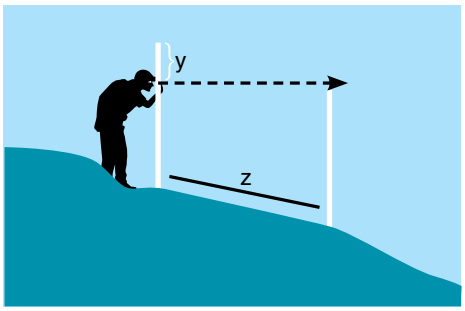


Figure 5. *Measuring the change in elevation (y)*

NB If the horizon is not visible or you are using tall poles, run a piece of string between the poles with a line level suspended from it. When the string is taut and level, record the distance from the top of each of pole to where the string intersects them (m and k). The difference between the numbers (y) is the change in elevation (Fig. 6)

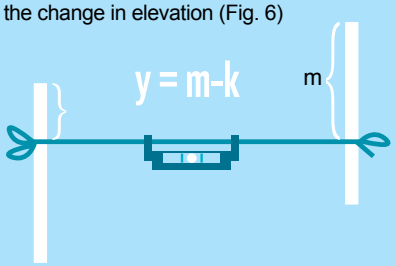


Figure 6. *Measuring the change in elevation (y) when you cannot see the horizon.*

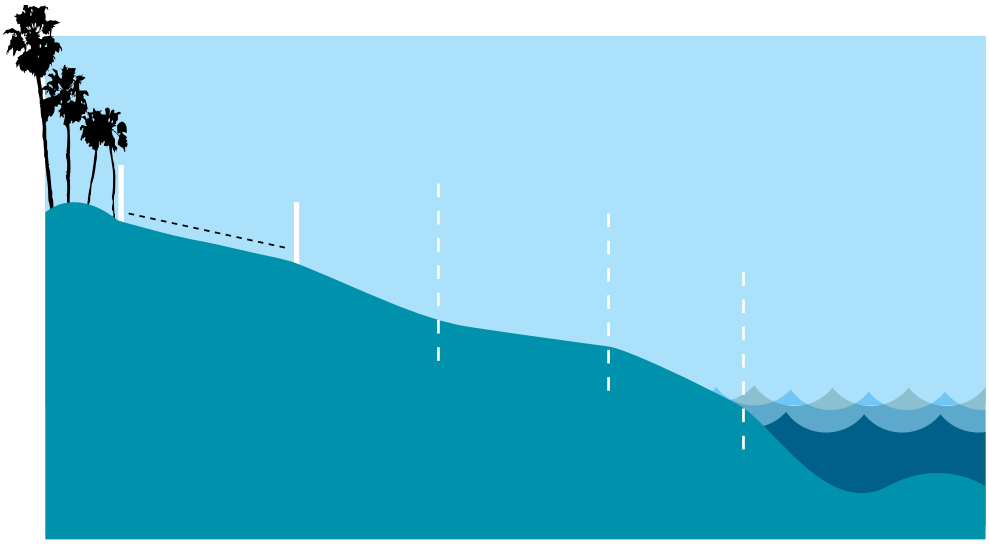


Figure 7. *Beach profile showing the division into segments based on change in slope*

Method 2
Abney Level Method

This method uses an Abney level and a pole to measure the distance and slope of each beach segment. Elevation can then be calculated to produce the beach profile.

Equipment

- ☐ paint or plastic/metal marker and nails
- ☐ compass
- ☐ Abney level
- ☐ pole (at least head height)
- ☐ masking tape
- ☐ tape measure
- ☐ data sheets
- ☐ pencils
- ☐ clipboard
- ☐ camera

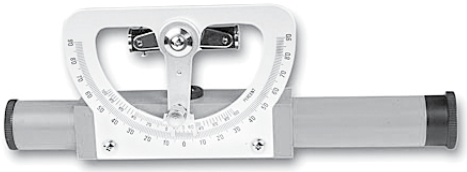


Figure 8. *An Abney level*

Preparation

Attach a wooden disc or similar to the base of the pole so that it does not sink into the sand. A level or fishing weight fixed to the side of the pole is useful to check that the pole is straight.

With the observer and upright pole both standing on a flat surface, measure and mark the observer's eye height on the pole with clearly visible paint or tape (Fig. 9).

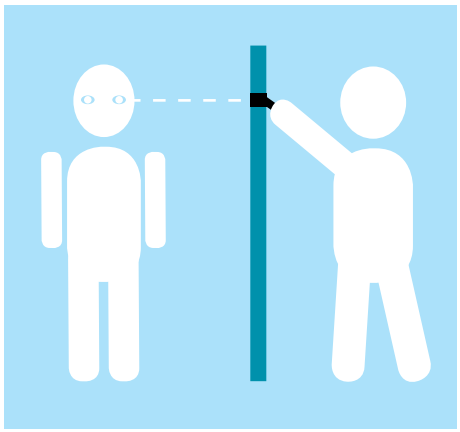


Figure 9. *Marking the observer's eye level on the pole*

Field measurements

a. Locate the first reference marker

b. Lay out the profile from the reference marker to the low water mark using rope or a tape measure. Check the orientation of the profile, it should run perpendicular to the waterline up to the reference marker. Record the compass bearing of the profile

c. Measure the height of the top of the reference mark to the surface of the sand to the nearest centimetre

d. Place pole at first break in slope, or at a fixed distance, making sure that the pole is straight and has not sunk into the sand

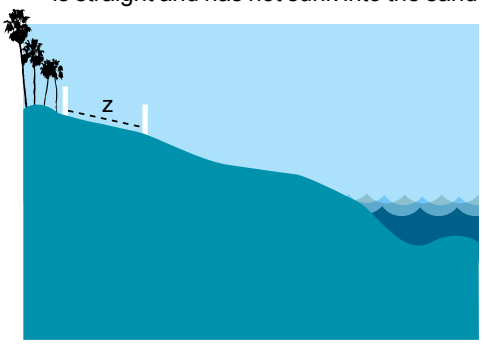


Figure10. *The first segment*

e. Record distance along the beach surface (z) from the reference marker to the pole (Fig. 10)

f. Observer – standing by the reference marker, use the Abney level to sight your eye-level mark on the pole (Fig. 11).

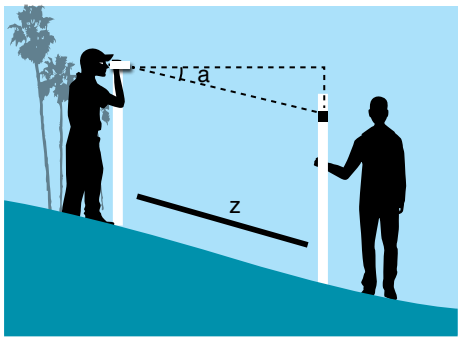


Figure11. *Measuring the angle of the slope (a)*

g. Line up the cross hair with your eye-level mark on the pole and while keeping these aligned adjust the level until the bubble is centred

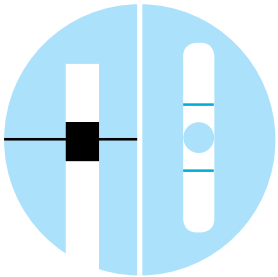


Figure12. *View through the Abney level towards the lower pole*

h. Record the slope degrees and minutes. Look at where the arrow (Y) intersects the degrees scale below it. Numbers to the left of 0 are negative and to the right are positive. If you are measuring from the back of the beach down towards the water, most of the measurements will be negative Here the arrow is halfway between 5 and 6, to the left of 0 so the slope would be - 5° (Fig. 13a).

i. Next look at the smaller lines to the side of the arrow. For negative slopes, look at the lines to the left of the arrow and for positive slopes the lines to the right of the arrow. Determine which of the lines most closely aligns with one of the degree lines below. This is the number of minutes. In the diagram this is 30 minutes (Fig. 13b), so the slope would be -5 degrees and 30 minutes

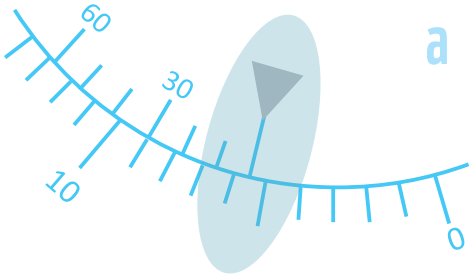
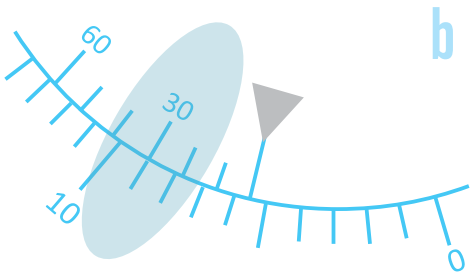


Figure 13. *The Abney level scale*



j. Record any additional information for this segment of the profile

k. For the next segment, the observer should move to the pole and then the pole should be moved to the next break in slope or fixed distance

l. Repeat until the end of the profile is reached at the offshore step or low water mark

m. Take photos of the profile

Step 4

Analysis

Cross-sectional profiles of the beach can easily be calculated from the beach profile data and profiles can be plotted with the horizontal distance on the x axis and elevation on the y axis (Fig. 14).

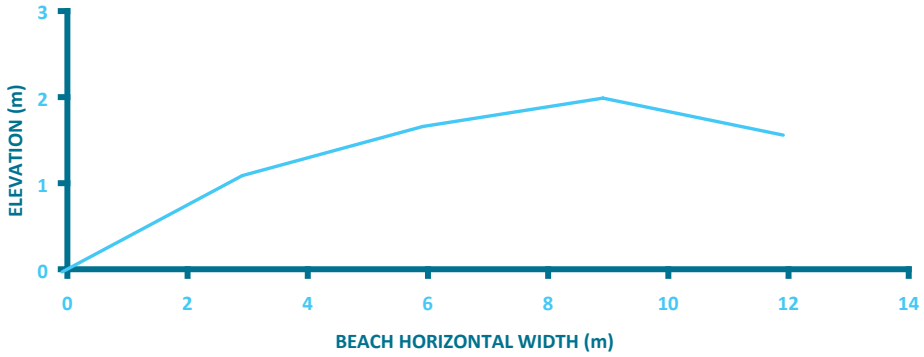


Figure 14. *A typical beach profile.*

EMERY METHOD

For each profile you have collected the beach width (z) and elevation (y) for each segment. To create the beach profile you will also need to calculate the horizontal distance (x).

- First step is to find (x) for each segment, which can be calculated using:

$$x = \sqrt{\left(z^2 - y^2\right)}$$

NB. If you are using Microsoft Office Excel the formula is: "=SQRT(POWER(z,2)-(POWER(y,2)" Insert cell for z and y, e.g. B2 and C2

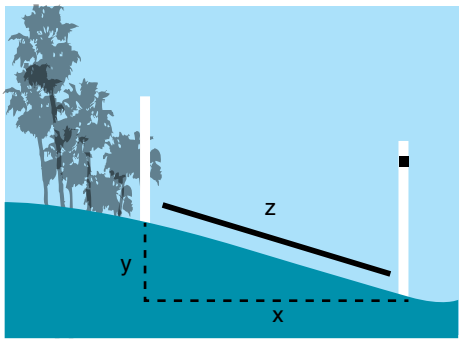


Figure 15. *Beach segment and measurements.*

- Using low-water level as 0, the widths of each segment can simply be added, taking into account any + or - signs, to give the total beach width. Do the same for beach elevation (Table 1) and then plot x and y to give you your beach profile.

Table 1. Example of data and calculations for a beach profile using the Emery method

Segment #	Segment width (z) (m)	Segment elevation (y) (m)	Horizontal width (x) (m)	Total horizontal width (x) (m)	Total elevation (y) (m)
1	17.9	1.09	17.87	28.74	1.78
2	2.9	0.29	2.89	10.88	0.69
3	8	0.40	7.99	7.99	0.4
Low water				0	0

ABNEY METHOD

To create a profile using the Abney level method measurements, you will need to calculate the total elevation and total beach width (Table 2).

Example highlighted in Table 2:

- First convert slope degrees and minutes to degrees:

$$3^{\circ}30' = 3 + (30/60) = 3.5^{\circ}$$

- If you are going to calculate beach elevation from the low water mark, but you measured the profile towards the water, you will need to reverse the + or - sign for the degrees

- Next calculate the elevation for each segment. Elevation (y) can be calculated as sin(slope angle)*segment width. In the example of Fig. 16, this would be:

$$y = \sin a \times z$$

NB If you are using Microsoft Office Excel, you will need to convert degrees to radians before you calculate elevation. To calculate the elevation in Excel:

$$y = SIN(RADIANS(3.5)) * 17.9$$

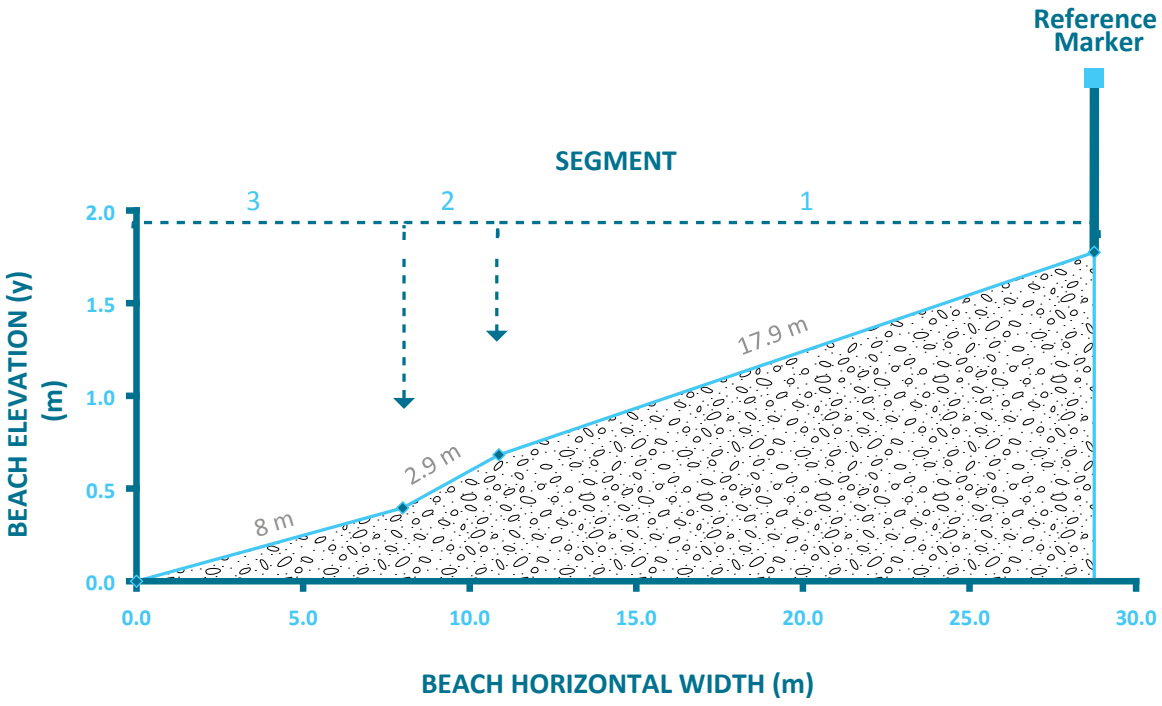
- Using the elevation at low-water level as 0, calculate the total elevation

- If you want to plot the beach profile (Fig. 15), you will need to calculate the horizontal width of the beach (x) using:

$$x = \sqrt{\left(z^2 - y^2\right)}$$

Table 2. Example of data and calculations for a beach profile using the Abney level method

Segment #	Slope (a) (degrees, minutes)	Slope (a) (degrees)	Slope from the ocean (a) (degrees)	Segment width (z) (m)	Segment elevation (y) (m)	Total elevation (y) (m)	Horizontal width (x) (m)	Total horizontal width (x) (m)
1	-3°30’	-3.50	3.50	17.9	1.09	1.77	17.87	28.74
2	-5°40’	-5.67	5.67	2.9	0.29	0.68	2.89	10.88
3	-2°50’	-2.83	2.83	8	0.40	0.40	7.99	7.99
Low water						0		0



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