ACTIVITY

4c (i)

Activity Title:

Sand budgeting (i)

Focusing question

What is a sand budget and how is the budget kept in balance?

Resources required

- Fact sheet – Formation and function of sand dunes – page 155
- Three level reading questions – page 157

Prior Learning

2i Interrelationships – dune animals and plants

Method

1 The objective of this activity is conduct a literacy exercise investigating the concept of a sand budget and how this budget is kept in balance.

2 Discuss how sand dunes are formed and eroded (this process was also shown in the DVD/Video in the segment about the wave tank and in the PowerPoint presentation **4b Formation of dunes**). Explore how this is an example of a dynamic process.

3 Independently read the fact sheet **Formation and function of sand dunes**.

4 Complete the three level reading questions using the following as a guide:

- level one (literal) – the student reads the lines to work out what the writer says
- level two (interpretative) – the student reads between the lines and infers what the writer means
- level three (applied) – the student reads beyond the lines and relates the knowledge to other contexts.

Possible next steps

- 4c (ii) Sand budgeting – build on this literacy activity by exploring in more detail the concept of a sand budget and how this is maintained (as described by the cut and fill diagram).
- 4d Role of plants in dunes – an activity that builds on the knowledge gained during this and the previous activity and explores in more depth the role plants play on the dunes, particularly in terms of erosion prevention.

Activity Title:

Sand budgeting (i)

Environmental Education Aspect:

About the environment

Environmental Education Concept:

- Interdependence
- Sustainability

Curriculum Links:

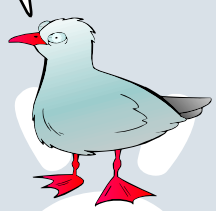
- Literacy

Suggested Curriculum Level:

Secondary

SUSTAINABILITY TIP!

Instead of photocopying one for each student, project a digital image of the fact sheet and save paper.



Formation and function of sand dunes

In its natural state, the coastal land area adjacent to the beach berm is generally characterised by sand dunes. To understand the development of these areas we need to look back in time. Between 17,000 and 7,000 years ago the melting ice caps caused sea levels to rise. Large amounts of sand moved onshore and alongside to build barrier spits and dune ridge sequences. This deposit, referred to as the Holocene barrier, generally ceased developing about 2,000 years ago when the transport of sand from the continental shelf ceased.

Coastal processes

Wind, waves, currents, tides and floods, collectively termed coastal processes, influence the distribution of sediments and thus the shape of the coastline. Along the Bay of Plenty coastline, tectonic warping or plate tectonic movements have also influenced the formation of coastal lands.

Wind, the primary source, generates waves which can cause direct changes to the coastline by:

- stirring up sand from the seabed
- creating currents
- eroding or building up beaches and dunes depending on the wave conditions.

The combination of waves and currents can move large volumes of sediment in various directions:

- onshore under the direct action of waves
- offshore by rip currents
- along shore by longshore currents.

Beach changes are cyclical in nature:

- storm waves move significant quantities of sand from the beach and dune to build offshore storm bars
- subsequent calm weather and offshore winds favour onshore movement of the sand to re-establish the beach
- onshore winds blow sand back into a dune system where it can be trapped by surface vegetation.

The short term fluctuations of the shoreline are often very large and may mask the long term accretion or recession.

Importance of offshore sandbars

We are only just beginning to understand the importance of offshore storm/sand bars to sand dunes. It seems sandbars that form along the coastline are important during storms to break waves offshore, reducing the wave energy impacting on beaches and dunes.

It seems these offshore bars are formed during the first high tide of a storm. Sand is removed from the dunes by backwash to help create the offshore sand/storm bars. Waves breaking on these bars spill about 50% of their energy each time they break, and sometimes two to three storm bars can form. (Work out the likely effect of two to three storm bars on storm waves running towards the shore, then check out the sea during the next storm!) These natural and relocatable wave dissipating devices can significantly reduce the impact of storm waves on a beach and dune system.

Less swash energy = reduced backwash

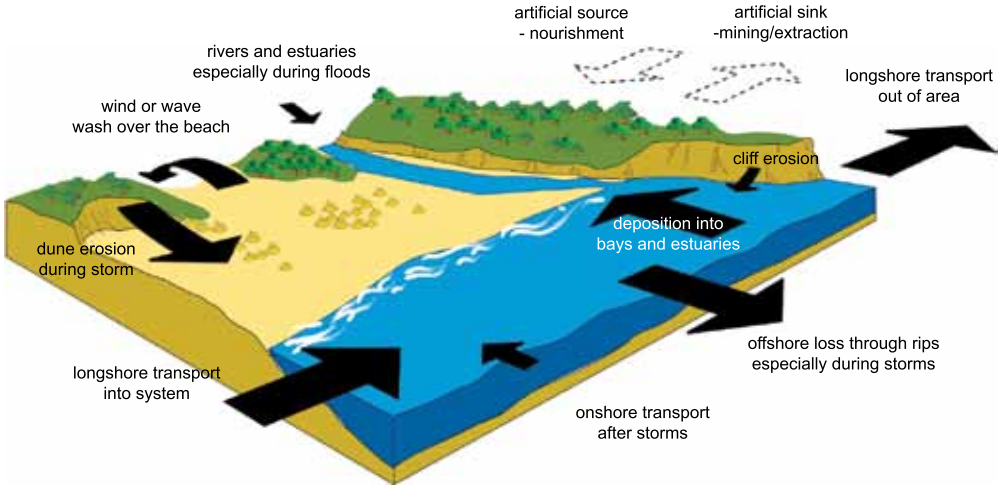
But this natural protection mechanism is only available on beaches with enough sand, and the best place to store sand is in a sand dune. But the sand dune needs to be wide enough to cope. Houses, roads and gardens must not limit the growth of the native dune plants whose function is to trap and hold sand between storms in this natural reservoir. The native dune plants are the only ones KNOWN to trap sand effectively enough after storms to keep the reservoir topped up. It's a continual cycle of sand movement. Can you think of a better way than this to protect sand dunes?

"The natural role of these frontal dunes acting as a reservoir of sand for rare but severe storms... and their enhancement needs to be adopted as a cornerstone of coastal management."

Prof. Terry Healy, Coastal Marine Group, University of Waikato. 1993

As there is little additional sand being fed to the coast, only a finite amount of sand is available to form beaches and dunes. Many west coast dunes and some along the Bay of Plenty coastline have been modified by wind action. This forms transgressive blowouts and parabolic dunes. This has been particularly prevalent around the New Zealand coast during the last 160 years, due to the destruction of natural dune vegetation during the colonial farming period.

Sand budget - showing sources and losses of sand for a beach



Transgressive and blowout dunes

Without the stabilising effect of vegetation, sand can be easily moved by the wind, resulting in wind erosion and sand drift. When a whole dune is moving by this action it is know as a transgressive dune system.

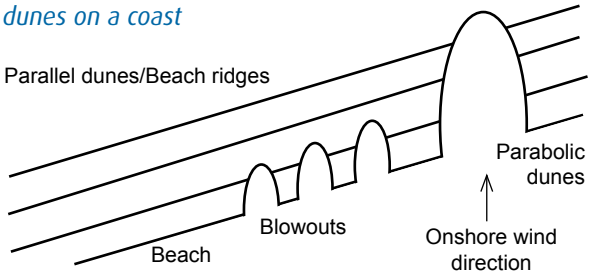
When this process affects only part of a dune it is called a "blowout". They are usually "U" shaped and aligned away from the direction of strong winds.

The wind blows through the gap in the dunes, sweeping sand from the beach and the dune in an inland direction. Consequently the blowout becomes deeper and wider, and can increase into a significant feature. A series of consecutive blowouts in an unstable foredune system often develop into parabolic dunes.

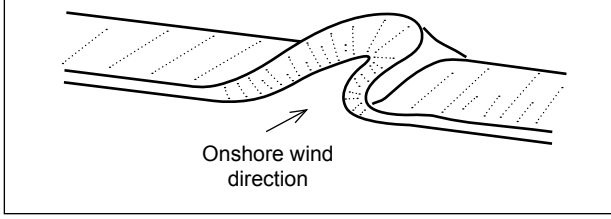
With the influence of prevailing winds, an advancing nose of loose sand can cause parabolic dunes (see diagram above). In this way the blowout develops into a parabolic or U-shaped dune.

Farming on coastal dunes and development pressures have resulted in dune systems being partially or completely modified. This restricts the amount of sand freely available to the beach system/buffer zone between land and sea. Using dunes for recreational purposes such as horse and bike riding have also impacted upon the dune vegetation and structure.

Blowouts and parabolic dunes interrupting parallel dunes on a coast



Parabolic dune



Te ngāunga ā Hine-moana

The biting and gnawing of Hine-moana the sea – forever biting the land

Find out more

If you want more information on Coast Care groups and programmes contact:

Coast Care Coordinator, Bay of Plenty Regional Council
Telephone: 0800 884 880
Facsimile: 0800 884 882
Email: coastcare@boprc.govt.nz
Website: www.boprc.govt.nz
Address: 5 Quay Street, PO Box 364, Whakatāne 3158

coastcare
Tiaki takutai

Bay of Plenty Regional Council in partnership with Tauranga City Council; Whakatāne, Western Bay of Plenty, and Ōpōtiki District Councils; and the Department of Conservation.

Three level reading questions

Formation and function of sand dunes

Level 1

Reading on the lines. Tick those statements from the text that are true and cross those that are not. Make sure you can give reasons for your answers.

❒ It is natural to have sand dunes on coastal land that is adjacent to the beach.

❒ Wind, waves, currents, tides and floods are all examples of coastal processes.

❒ Beach changes are cyclical in nature.

❒ Native dune plants are the only ones known to trap and hold sand effectively enough after storms, to keep the reservoir of sand in the dunes topped up.

❒ Farming and recreational uses such as bike riding and horse riding have no impact on dune vegetation and structure.

Level 2

Reading between the lines. Tick those statements that you think are true from what the text suggests. Find evidence in the text to support your answer.

❒ Where free from human intervention it seems that sand dunes will keep themselves in balance with sand being removed and replaced constantly with the onshore and offshore movement of sand.

Reason:

❒ Monitoring is required to determine long-term accretion or recession of dunes.

Reason:

❒ Whether blow-outs occur or not is affected by the presence or absence of vegetation on the dunes.

Reason:

Level 3

Reading beyond the lines. Tick those statements you agree with using what the author says and what you know. Be prepared to back up your argument with reasons.

❒ Sand dunes are like a budget – sand gets constantly deposited and removed. Nature keeps the budget in balance.

Reason:

❒ Parabolic dunes illustrate how vegetation can be an important aspect of maintaining sand dunes.

Reason:

ACTIVITY

4c (ii)

Activity Title:

Sand budgeting (ii)

Focusing question

What is a sand budget and how is the budget kept in balance?

Resources required

- The Cut and Fill Diagram – either on paper or projected electronically – page 155
- Fact sheet – Formation and function of sand dunes – page 149
- Large sheets of paper and coloured pens and/or student exercise books

Prior learning

2b Introduced dune plants and weeds

4a Importance of sand dunes

4b Dune formation

Method

1 The objective of this exercise is to explore the concept of a sand budget and how this budget is kept in balance.

2 Discuss how sand dunes are formed and eroded (this process was also shown in the DVD/Video in the segment about the wave tank and in the PowerPoint presentation **4b Formation of dunes**). Explore how this is an example of a dynamic process. Additional information on these processes is contained in the fact sheet **Formation and function of sand dunes**.

3 Explore the concept of a budget including deficits and profits and the idea of 'balancing the budget'. Use real life examples of pocket money budgets and bank balances to convey the concept. What are the consequences if the '+' column is higher than the '–' column and vice versa.

4 For levels 4 and higher, give students the fact sheet **Formation and function of sand dunes**. Using the information from the fact sheet create a sand budget. In the '+' column, record what processes add sand to the beach and in the '–' column record what processes erode sand from the beach. Create a list of factors that might cause the loss of too much sand from the beach creating a sand budget deficit. For levels 3 and below, conduct the same exercise, but as a class brainstorm.

Activity Title:

Sand budgeting (ii)

Environmental Education Aspect:

About the environment

Environmental Education Concept:

- Interdependence
- Sustainability

Curriculum Links:

- Social Science
- Science

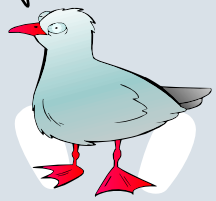
Suggested Curriculum Level:

Senior secondary

SUSTAINABILITY TIP!

Project a digital image of the fact sheet and save paper.

Use an electronically projected image of the Cut and Fill diagram and save paper.



5 For all students discuss:

- Can they remember going to the beach during or after a storm? What did they notice about the sea and the dunes?
- What happens to sand dunes during storms?
- What happens to sand dunes during calm weather?
- What are the factors that can result in a sand deficit on the beach?
- How can we work to keep the sand budget healthy?

Possible next steps

- 4d Role of plants in dunes – an activity that builds on the knowledge gained during this and the previous activity and explores in more depth the role plants play on the dunes, particularly in terms of erosion prevention.

Cut and Fill diagram