



How do sand dunes form?

Time needed for activity Activities vary from 1 hour to 10 minutes

Location Outdoors or indoors

Context

These activities are intended to explain the process of sand dune formation in a number of different ways. Natural Resources Wales' purpose is to pursue sustainable management of natural resources in all of its work. This means looking after air, land, water, wildlife, plants and soil to improve Wales' well-being, and provide a better future for everyone.

Background

Offshore sand is transported by currents caused by both waves and tides, so long as the currents are strong enough to move the sediment. Under certain conditions, typically when waves are calmer, sand is moved toward the beach and deposited, building up the beach. The process of longshore drift (the term used to define the movement of sediments and particles along a coast's shore) also plays a part in transporting sand from elsewhere along the coastline. Rivers can also bring sand to the coast from inland, and erosion of nearby cliffs and larger particles already in situ, add to the sand supply. Dunes tend to form in places with a wide sandy beach at low tide, as this provides a source of sand to feed the dunes.

Curriculum for Wales

Humanities

- **What matters** - Enquiry, exploration and investigation inspire curiosity about the world, its past, present and future.
- **What matters** - Our natural world is diverse and dynamic, influenced by processes and human actions.

Health and Well-being

- **What matters** - Developing physical health and well-being has lifelong benefits.

Science and Technology

- **What matters** - Being curious and searching for answers is essential to understanding and predicting phenomena.



Objectives

Learners will be able to:

- understand the processes that lead to the formation of sand dunes
- use some of the correct technical vocabulary used to explain the processes involved in sand dune formation

Resources and equipment

- Information note - Marvellous marram
- Resource cards - Set A - Sand dune super species

Introduction

Sand is a loose granular substance made up fragments of rock, pebbles, gravel, soil or shell that have been ground down by the sea. Weathering processes such as wind, rain and freeze/thaw cycles erode hard rock cliffs, resulting in loose rocks which eventually become sand. Sand is hard and insoluble and blankets the beaches, sand dunes and many riverbeds and deserts of the world. Although not all deserts and riverbeds are sandy as some can be rocky or consist of ice. The material, colour and size of grains will be dependent on the substance and location from where they have originated.

What to do

The main task is for learners to understand what needs to happen for a sand dune to form. There are a number of ways suggested on how to do this depending on your location and the abilities of your learners.

Choose from the list below.

Introduction

1. Begin the session by asking your learners 'What is sand? How does it form? Where can it be found? How does sand feel? What is it used for? Discuss their thoughts and fill in any gaps in their knowledge.
2. Have your learners ever been to a sand dune? If so ask them to describe them. Can they identify any typical sand dune characteristics?
3. Discuss with your learners how they think sand dunes form.
4. Can they explain their thoughts by drawing a diagram?



Activity 1

How does sand move inland to form a sand dune?

Time needed for activity 30 minutes

Location A flat and spacious outdoor area

Context

This activity introduces the three processes that determine if, and how, an individual grain will be transported by the wind.

Background

Sand will not be moved until the wind reaches a velocity fast enough to move the particles of sand. To move, large sand particles requires a higher wind velocity than smaller particles. If there is a dip in wind velocity, deposition will occur. Deposition is when particles of sand are dropped onto the beach.

Resources and equipment

- Safe space to run/roll
- Quoits, traffic cones, or similar
- Measuring tape

What to do

1. Explain to your learners the transport of sand by the wind is known as aeolian transport and there are three aeolian processes that determine if, and how, an individual grain will be transported by the wind. These are:

- Saltation
- Traction
- Suspension

Saltation

When wind blows from the sea to the land, the sand grains will be blown inland. When the wind blows over the sand, lift and drag forces are generated, disturbing sand particles. Single grains take to the air, reaching heights of up to 6 metres. The force of gravity causes them to fall back down. As the grain of sand lands, if it has enough energy, it dislodges other grains which are forced to bounce up in the air by the transfer of energy, causing a chain reaction. This is the most common way that sand is moved by the wind.

2. To demonstrate this concept ask your learners to imagine that they are each a grain of sand, moving through this process.
3. Divide them into groups of 6 and ask them to arrange themselves in 3 lines of 1, 2 and 3 learners respectively with roughly one metre distance between each line.



4. Explain that you are going to give them instruction on the movement of the sand grains and that they need to act it out.
 - Line 1 – The first learner is the first grain of sand that sets off the process. The prevailing wind blows inland and disturbs and dislodges the grain of sand. The grain of sand takes to the air and moves one meter to the middle of Line 2.
 - Line 2 consists of two grains of sand. Grain one has moved to the middle of these two grains and taps these two grains on the shoulder, mobilising them. After the count of three, the three grains in Line 2 move one meter and slot into line 3.
 - Line 3 consists of three grains of sand. As the prevailing wind continues to blow, the incoming grains of sand mobilise the stagnant sand by patting them on the shoulder. After the count of three, the 6 grains in Line 3 jump one meter and create a new line - Line 4.
 - The pattern continues. If time allows, your learners could form larger groups, or even try to co-ordinate this as a whole group.

Traction

Large or dense particles of sand are too heavy to be picked up and carried by the wind, so instead they are rolled along the ground, colliding with other grains. Once sand begins to move through this process it picks up momentum and won't stop until it collides with an object. Through this process not only are sand particles moved but by moving and colliding against other particles, they can erode into smaller sand particles, which can be mobilised by the process of saltation or suspension.

- To demonstrate this concept, ask your learners to visualise that they are all individual grains of sand. Instruct them to lie in parallel lines on the ground (providing it is safe and appropriate to do so). The number of rows and learners in each line will depend on the size of the group.
- Learners in the first row need to roll along the ground (gently) until they touch another learner in the next row, who can then start rolling as the learners in the previous line gradually come to a stop. Repeat until all the rows have moved.

Suspension

This process involves fine, light sand being moved by the wind, high in the air. Suspension does not feature in the formation of sand dunes although it does influence the shape of sand dunes. Deposition occurs when wind velocity reduces such as in the wind shadow of a dune or embryo dune. It is this process which gives dunes their characteristic shape. What ideas do your learners have to demonstrate the concept?



Activity 2

On your marks, get set, dune! Sand dune formation - the essential components

Time needed for activity 30 minutes

Location A flat and spacious outdoor area

Context

This activity is run in the form of 'tag' and explains to learners what essential components a sand dune needs in order to start developing.

Resources and equipment

- Safe space to run
- **Resource cards - On your marks, get set, dune!**
- 5 containers such as buckets
- A quoit, traffic cone or rock to denote an obstacle on the beach - at least three.

What to do

1. Prior to the activity, spread the containers over your chosen area (ideally a flat area with no trip hazards). Fill each container with one set of resource cards, for example 'wind'. Ensure you have enough cards in each bucket for each group member to collect one of each. Place the 'obstacles' somewhere suitable within the running space. In the first round have a number of obstacles but then reduce them in the next round.
2. To set the scene, discuss with your learners what essential components a sand dune needs to form.
 - **A supply of sand (resource card)** - for a sand dune to form and develop, a significant quantity of mobile sand must be available.
 - **Room to grow (resource card)** - a dune will need space to grow in both width and height.
 - **Range of the shoreline (resource card)** - there must be an area with a large tidal range (a decent distance of beach between high and low tides) so that when the tide subsides, a large area of dry sand is exposed to the wind, allowing time for it to be transported.
 - **Wind (resource card)** - strong onshore winds (wind blowing from the sea to the land) to transport sand particles up the beach.
 - **Humidity (resource card)** - wet sand particles are more difficult for the wind to pick up, as wet sand tends to clump together. However wet sand also facilitates plant growth, roots then stabilise the sand into remaining in one place which can then serve to facilitate dune growth.
 - **An obstacle (a quoit or traffic cone)** - an obstacle for the dune to form against. For example, a stone, piece of driftwood, or litter.



3. Explain to your learners that sand dunes commonly begin as piles of sand above the normal maximum reach of waves. As sand is blown across the shore (represented by the area you are using), it continues until it meets with an obstruction on the ground. For instance, seaweed, a pebble, or human refuse (fishing nets or discarded bottles). These obstructions can lower the wind velocity and cause sand grains to deposit and accumulate. Sand grains accrue in the wind 'shadow' of the object (a sheltered place, downwind of the obstacle, where the wind doesn't reach). In time, the side facing the wind forms a crest and an embryo dune is born.
4. Ask your learners to imagine that a strong onshore wind is blowing, so the grains of sand have been mobilised and are moving around the area.
5. Explain to your learners that they are going to play a game where they will each act as a grain of sand, aiming to play their part in creating a sand dune.
6. To create an embryo dune each grain of sand will need to 'blow' around the designated area and collect one of each of the essential component cards. If they successfully collect one of each of the essential component cards, the grains of sand should stand touching the object used to denote an obstacle on the beach.
7. Start your learners off on an initial round of the game. Sound a whistle or make a noise or call stop loudly when you want the round to end.
8. After playing the game for a couple of rounds, bearing in mind the 6 different components required for sand dunes to form, can your learners think of any issues that may hinder sand dunes from forming. Can they break these down into natural and human influences? For example, lack of space because of buildings and infrastructure being built directly behind beaches, a reduction in available sand or not enough room to grow.
9. Play the game again but reduce the range of the shoreline (make the playing space smaller). Ask your learners to discuss what difference this has on the creation of their sand dune?
10. Reduce the number of cards in the buckets so that not everybody has access to each card, therefore they will never all be able to start the process of making a sand dune.



Activity 3

Sand dune formation yoga

Time needed for activity 10 minutes

Location Outdoors or indoors

Context

This activity offers an active and memorable introduction to sand dune formation through yoga and can be run as either an introduction or a plenary activity.

Resources and equipment

- An open, flat space

What to do

1. Explain to your learners that they need to imagine that they are grains of sand and that they are going to work together to act out the formation of a sand dune.
2. Ask your group to stand facing you. Your learners should spread out at least 2 arm lengths away from each other.
3. Begin by describing the different parts of the sand dune creation cycle and the physical actions they have to act out to represent each part (see below). By repeating the actions a few times everyone learns the sequence and it can then be performed in silent synchronisation which has a lovely calming effect on the liveliest of groups.

Actions

Sand formation

- “Standing tall, put your arms up straight in the air reaching as tall as you can”.
- “Wiggle your fingers and slowly bring your hands down to the ground, just as rain does when it falls from the sky”.
- “The wind is blowing, bring your hands to your collar bone, exhale and open your arms out to your side”.
- “Cross your arms so you have a hand on each shoulder. It’s freezing cold, you are piece of rock breaking down into smaller particles due to weathering processes such as wind, rain and freeze/thaw”.
- “You crumble to the ground – crouch down as low as you can”.

Bashed by the sea

- “You are washed out to sea, where you are mixed with shells. Standing up tall and straight, stretch out your arms either side of your body and make wave movements side-to-side and back and forth to show the gentle wave motions of the sea”.
- “You are bashed, rolled and broken by the force of the waves and tides – make your movements bigger and more defined”.
- “You become smaller and smaller, until eventually you have become a small grain of sand – stand still, head bowed”.



Wind moves sand by suspension and saltation

- “An onshore wind is blowing; you are moved inland by the processes of suspension and saltation. Stand with your feet apart”.
- “Bend your knees and place your hands on the floor between your feet. Inhale, then exhale as you jump forwards”.
- “Crouch to the floor”.

An obstacle traps the sand

- “You come to rest against a piece of driftwood on the beach. Sit on your heels, slowly bring your forehead down to the ground in front of your knees with your hands resting on your feet”.
- “Take a few deep breaths”.

An embryo dune is born

- “More sand grains trap around the piece of driftwood, a small ridge of sand begins to form, you have become an embryo dune. Place your hands and knees on the ground”.
- “Arch your back and tuck your chin into your chest”.

Plants begin to grow

- “Plant seeds and spores carried by the wind land on you, a lone marram grass plant germinates and grows on you, helping to trap, bind and stabilise the sand blown from the beach”.
- “Sit on your bottom with your head up, back straight and cross your legs”.

Sand layers build forming a dune ridge

- “The dune grows both in terms of height and width and survives winter storms. More plants grow and their long, strong roots dig deep, stabilising the ground. On your hands-and-knees, bend your elbows, rest your forearms on the ground, with your palms flat”.
- “Lift up your knees to straighten your legs and look forward”.

Secondary dunes form

- “These dunes are usually the largest within the dune system and can reach heights of 10 to 20 metres. The increased nutrients from plants decaying helps to stabilise the ground and sandy soil begins to develop. Stand on one leg”.
- “Reach the other leg out behind you”.

Disturbance creates bare ground

- “A family decides to picnic on you. Their trampling and activity flattens some of the dune ridge and remobilises the sand. Lie on your tummy”.
- “Place your palms flat next to your shoulders”.
- “Press into hands”.
- “Lift head and shoulders”.

A free grain of sand, an offshore wind blows you out to sea and the process begins again.



Activity 4

How do sand dunes form?

Time needed for activity 1 hour if in an indoor setting, or longer if outside

Location Outdoors or indoors

Context

This activity can be used as a consolidation activity after any of the previous activities to ensure that learners understand the steps or processes that take place when a dune system forms.

Resources and equipment

- [Resource cards - Sand dune formation](#)
- [Information note - Coastal sand dunes in Wales](#)
- [Sand dune formation - A3 Diagram for use with Set A Resource cards](#)
- [Sand dune formation - A3 Diagram for use with Set B Resource cards](#)

What to do

Choose the appropriate set of [Resource cards - Sand dune formation](#), with set B providing more challenge.

1. Ask your learners to play 'Spot the difference' between Set A image 3 and 5, or Set B image 4 and 7, (depending on which you are using) so that they can begin to grasp that sand dunes change. You could use other combinations of images.
2. Discuss the observed differences. What has led to the differences in the images they have looked at?
3. Explain that sand dunes are part of a coastal system, and are constantly changing and moving. They can be described as a dynamic system. Cut out the resource cards [Resource cards - Sand dune formation](#) and ask your learners to match up an image with a description. Check this is correct and then ask learners to put them in order of what happens first.
4. Discuss with your learners where a sand dune system starts and then ask them to place the images and descriptions in the relevant place on the diagram. Again the diagram for Set B will provide more challenge.
5. This activity could also be completed out in the field at a sand dune, where learners can identify real examples to go with the descriptions and take their own photographs.

Suggested key questions

- How does sand move inland to form a sand dune?
- What processes are at work on a beach that lead to sand dune formation?
- How are sand dunes formed?
- How and why does a dune system change as you move further away from the beach?
- What can damage the formation of a dune or lead to their destruction?



Adapting for different needs or abilities

More support

- Provide group or peer support
- Complete only activities 2, 3 and 4
- Activity 4 - Use Set A differentiated resources described above
- Complete Activity 2 in pairs

More challenge

- Define littoral drift, longshore drift, dynamic equilibrium and aeolian transport. Explain how the terms relate to the formation of sand dunes
- Activity 4 - use Set B differentiated resources described above
- Complete all activities

Follow up activity/extension

- Make a sand dune in a box. Can learners use their knowledge to get an artificial embryo dune to form?
- Investigate how plants survive and thrive in a sand dune.
- Design the ultimate sand dune plant survivor. What characteristics does a plant need to be able to flourish and grow on a sand dune?
- Explain what threatens the formation of a sand dune and is there anything that can be done to ensure nothing hampers this formation?
- Create a short film to show how sand dunes form. This could be done in a number of ways, encompassing a range of creative techniques, from using plasticine, drawing cartoons, creating models or recording a stop-motion animation.

Additional Information

- [Information note - coastal sand dunes in Wales](#)
- [Activity plan - Why are sand dunes important](#)
- [Resource cards - Why are sand dunes important](#)
- [Schools - Dynamic Dunescapes](#)

Learning in, learning about, and learning for the natural environment.

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