Changing coastlines
Investigating how wave erosion, transportation and deposition can change the shapes of coastlines

Coastlines, with their cliffs, beaches, headlands and bays, are constantly changing shape. It is important to understand the processes because if you prevent erosion in one place this may lead to reduced deposition in another. There is usually a knock-on effect somewhere else when people try to control the shape of a coastline.
Set up a large tray with sand and water and fix it at a low angle, e.g. 5^0. Make a beach using the washed sand.

Coastal questions
- What happens when a piece of wood is used to make waves come in parallel to the shore-line?
- What happens when the waves come in at an angle to the shore-line?

Demonstrate these activities and discuss the results. Then **ask the pupils** these coastal questions:
- what happens when a marble is rolled at an angle up a sloping bed of sand?
- what happens when small sticks of wood are placed at right angles to the coastline at intervals as groynes and waves come in at an angle to the shoreline?
- what happens when cliffs are made along the coastline and a small block is placed on the top to represent a building?
- where would be the safest place to stand if you visited an area of crumbling cliffs like the one in the photo?
- what happens when small pebbles are placed at the base of the cliff to represent a coastal protection scheme?
- what happens if some of the coastline is cut away as though a river is entering the sea or the coastline changes direction?

Carry out these activities, either one by one, or after pupils have thought about all of them.

Wooden ‘groynes’ affecting longshore drift processes
Photo: Peter Kennett

Cliff collapse at Barmston, Yorkshire, UK
Photo: Peter Kennett

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The back up

Title: Changing coastlines

Subtitle: Investigating how wave erosion, transportation and deposition can change the shapes of coastlines

Topic: This activity can be used to study the processes of coastal erosion, transportation and deposition. It can also be used to investigate the problems these processes cause and the ways in which people try to solve those problems.

Age range of pupils: 8 - 18 years

Time needed to complete activity: 15 - 30 minutes

Pupil learning outcomes: Pupils can:
- appreciate that the coast is a zone where land and sea meet;
- see that when the waves hit a coastline, they often cause erosion;
- see that material is moved (transported) along the coast when the waves are at an angle to the coastline (groynes help to slow this movement);
- describe how land near the coast may be lost by wave erosion;
- see that cliffs are undercut by waves and buildings and other constructions (roads, fences) can be lost;
- explain how obstructions placed at the base of the cliff can protect it from the waves;
- describe how, if the wave current speeds slow at a river mouth or change of coastal direction, deposition occurs;

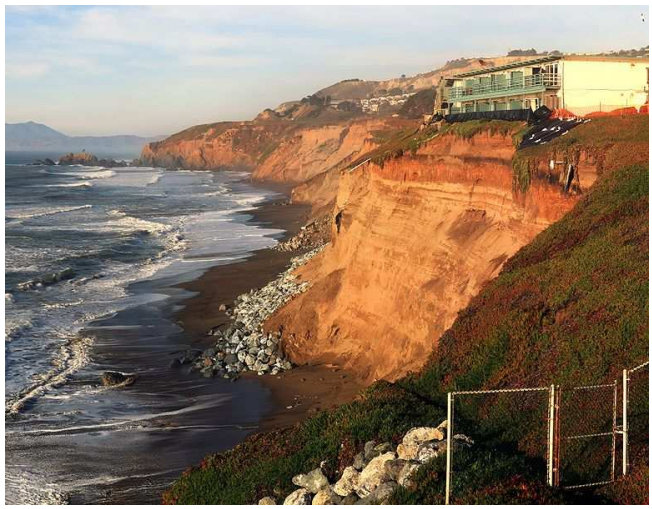
- appreciate that if people build coastal protection schemes, there will be consequences along the coastline.

Context:

- what happens when a piece of wood is used to make waves come in parallel to the shore-line?
  There is a little erosion at first and the waves transport material up and down the beach, but not along it. Deposition of the sand grains takes place only when the waves slow and stop.

  ***Note: Erosion** is the picking up of solid material, such as sand grains; **transportation** is the movement of that material, in this case by currents of water produced by waves; **deposition** is the laying down of the material in lower energy areas - also called **sedimentation**.*
- what happens when the waves come in at an angle to the shore-line?
  The waves pick up sand grains as the water flows at an angle to the beach. As the water runs back down the beach, at right-angles to the coastline, it takes some of the grains with it. These grains are then moved along at an angle again, by the next wave. Repetition of the process causes the sand grains to move along the coastline; a process known as longshore drift, ('drift' of sediment along the shore).
- what happens when a marble is rolled at an angle up a sloping bed of sand?
  The marble rolls straight back down the slope. This shows the longshore drift mechanism. Each wave that hits the beach at an angle carries sand up the beach at an angle, then drains straight back down, carrying sand with it. The sand is moved along the beach in a saw-tooth path.
- what happens when small sticks of wood are placed at right angles to the coastline at intervals as groynes and waves come in at an angle to the shoreline?
  These 'groynes' reduce the process of longshore drift which otherwise moves all the sand to one end of the beach. Instead sand accumulates on one side of the 'groyne' and is eroded from the other side.
- what happens when cliffs are made along the coastline and a small block is placed on the top to represent a building?
  The waves undercut the cliffs and cause cliff collapse with the loss of the building. This happens quickly with sand cliffs.
- where would be the safest place to stand if you visited an area of crumbling cliffs like the one in the photo?
  NOT on top of or beneath a crumbling cliff, (refer to photo of Cliff erosion sign). Probably the safest place is as far back from the cliff edge as possible, since the beach beneath the crumbling cliff could be subjected to a storm with big waves that would erode the cliff back even more.
- what happens when small pebbles are placed at the base of the cliff to represent a coastal protection scheme?
  Coastlines are often protected by placing large boulders of hard, resistant rock from somewhere else at the base of the cliffs (refer to photograph above); this is called rip-rap.
- what happens if some of the coastline is cut away as though a river is entering the sea or the coastline changes direction?
  As longshore drift proceeds along the coastline, sand grains are moved along. When the waves reach a point where the coastline disappears, either because of a river or change of direction, the speed of the waves slows down and deposition occurs. This results in the formation of a sand spit, (refer to photo on next page).

Cliff erosion sign at Grain, Kent, UK
Photo: Clem Rutter. Permission is granted to reproduce this photo under the terms of the GNU Free Documentation Licence.



Pacifica, California, USA.
On 17th December 2009, about 9m (30 feet) of cliff below this apartment building fell into the Pacific Ocean. Residents were given 20 minutes to evacuate the building.
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Farewell Spit, north of South Island, New Zealand
This photo is the original work of NASA and is in the public domain.

Following up the activity:
- Use a newspaper report/photo of dramatic cliff erosion. Ask what happened/caused this?
- Try using a sand/gravel mixture in the tray to see how the gravel can affect the results.
- Look at a map of the coastline nearest to your school – identify areas of erosion and deposition.
- Investigate methods of coastal protection.
- Consider how the tray would have to be altered in order to create bays and headlands.
- Using the map of the coastline nearest to your school, predict how the coastline may change shape in the future.

Underlying principles:
- Waves cause coastal erosion, transportation and deposition.
- If waves approach the coastline at an angle, they transport sediment along the coastline, (longshore drift).
- When the speed of waves slows down deposition of sediment occurs.
- Obstacles (groynes) placed along the coastline at right angles to it can slow down the process of longshore drift.
- Boulders placed at the foot of cliffs can slow down cliff erosion.

Thinking skill development:
- Investigating erosion, transportation and deposition involves construction.
- Using wooden sticks to slow longshore drift and boulders to slow cliff erosion involves cognitive conflict.
- Discussion and explanation of the investigation is metacognition.
- Applying the model used in the classroom to the real world involves bridging.

Resource list:
- large tray e.g. cat litter tray or Gratnell tray
- washed sand
- piece of wood (about 25cm x 12cm x 1cm)
- a few marbles
- wooden sticks (about 10cm x 1cm x 2mm)
- small pebbles, approx 1cm diameter or less
- water
- gravel (for extension)

Useful links:
www.happisburgh.org.uk – for the latest news; campaign; blog; press releases.

Source:
From an original idea by Earth Science Teachers' Association members. Adapted for use in the Earth Science Education Unit's workshop 'How the Earth works in your Classroom'.
www.earthscienceeducation.com

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