Junior Rangers

Junior Ranger program

Lesson Plan

Tide times

Purpose

This activity aims to introduce students to tide charts and the affect of the sun and moon on tides.

The tidal changes that students living in coastal areas see everyday are the effect of gravitational forces occurring at a solar system scale. Studying tides can be a way of introducing students to Earth and Space Science just by looking out the window. For rangers managing sea country, looking after the estuarine environment makes up a significant portion of work in coastal communities. Student knowledge of coastal environments and how tides work is central to this lesson plan.

Links with the Australian curriculum

This activity is suitable for a broad range of year levels and may be used to demonstrate a range of learning outcomes.

Year 2 Science: Science as a Human Endeavour/Use and Influence of Science

People use science in their everyday lives, including when caring for their environment and living things.

Elaboration

1. Monitoring information about the environment and Earth's resources.
2. Learning how Aboriginal and Torres Strait Islander people use science to meet their needs, including food supply.

Year 5 Mathematics: Measurement and Geometry/Using units of measurement

Compare 12- and 24-hour time systems and convert between them.

Elaboration

Investigating the ways time was and is measured in different Aboriginal Country, such as using tidal change.

Year 5 Science: Science Understanding/Earth and space sciences

The Earth is part of a system of planets orbiting around a star (the sun).

Elaboration

Recognising the role of the sun as a provider of energy for the Earth.

Year 7 Science: Science Understanding/Earth and space sciences

Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the Earth, sun and moon.

Elaboration

Modelling the relative movements of the Earth, sun and moon and how natural phenomena occur, such as solar and lunar eclipses and phases of the moon.

Introduction

Torres Strait Islanders and coastal Aboriginal people have very close ties with the sea. Indigenous people living on the coast often refer to themselves as Saltwater people. Traditionally, and in contemporary society, Saltwater people's lives revolve around the sea and the tides.

Saltwater people often express their concepts of time based on natural processes, such as tides, seasonal winds and currents. Indigenous languages spoken by Saltwater people are rich in terminology relating to the sea. The Lardil people in the Gulf of Carpentaria have language words for the tidal rising and falling and for low tide and very low tide (Memmott 2005).

People who live on the coast often have an intimate understanding of the coastal processes, including the current condition of the tide and when the next spring tide can be expected. Indigenous people use cultural knowledge gained over generations of living on the coast in their everyday lives.

Background information

Tides have a significant impact on the lives of people living in coastal environments. Understanding the tides is critical to making full use of resources that may be available during a small window of time.

In some locations in northern Queensland the sea can disappear beyond the horizon at low tide. Such events make it important to know how to read a time chart, understand how tide cycles work and make accurate predictions based on this knowledge.

Tides are caused by the gravitational pull of the sun and moon. The position of these two bodies relative to the Earth affects tide height. However, the affects of gravity are constant, which means the tide cycle can be predicted well into the future.

Tide cycles are very predictable. For example, in locations where there are two high tides and two low tides every day (semi-diurnal) the tide that occurs on a full moon or new moon is called the spring tide. The spring tide always occurs around 03.00 am (low), 09.00 am (high), 15.00 pm (low) and 21.00 pm (high).

The area between the high tide mark and the low tide is known as the intertidal zone. The intertidal area is largest during spring tides. The intertidal zone is typically rich in food resources containing fish, molluscs and crustaceans. Coastal Aboriginal people have always made use of these resources by observing and understanding the tides.

The spring tide in the mid-afternoon is always very low. Coastal Aboriginal people knew this was a good time to harvest animals and plants growing on the exposed reef in the intertidal region. There is also a corresponding low tide at around 3.00 am with a bright moon that lights the beach at night (at this time crayfish can be found on the move and speared by the moonlight).

Storm surge

While tide cycles can be predicted into the future other natural forces can also influence tides. For example, air pressure can significantly affect tide heights. The low pressures found in the centre of cyclones lift seawater so that the tides are much higher than predicted. High pressure systems have the opposite affect and effectually push down on the sea surface. High winds can also cause water to pile up into a storm surge and inundate land well beyond the highest astronomical tide level. The website on storm tide monitoring shows differences between the predicted tide levels and actual tide levels recorded for several locations across Queensland ‹www.ehp.qld.gov.au/coastal/monitoring/storm-tides/index.php›.

Brainstorm

What do you know about the tides? As a class, brainstorm the term 'tides'. How often do they occur? What causes the tides to come and go? What is the influence of the sun and the moon?

Match up these terms with their definition	
Highest Astronomical Tide	
Lowest Astronomical Tide	
Spring tide	
Neap tide	
Flood tide	
Ebb tide	
Slack water	

Term definitions

- The incoming tide.
- Predicted highest tide level possible under normal conditions (e.g. no storm surge).
- Tide of increased range occurring bi-monthly due to the enhanced gravitational affect of the new moon and full moon.
- Predicted lowest tide level possible under normal conditions (e.g. no storm surge).
- The state when a tidal current has a speed of near zero; the change of tidal current from flood to ebb or ebb to flood.
- The outgoing tide.
- Tide of decreased range occurring bi-monthly due to counteracting gravitational affects of the first and last quarter moons.

Spring tides and neap tides

Tides are affected by the position of the sun and the moon. Because the moon is closer to the Earth than the sun, the moon exerts a greater influence (there is a tidal bulge that always reaches towards the moon). There is also a second bulge on the opposite side of the earth that extends outward because of centrifugal force. The centrifugal force on Earth exists because, contrary to common belief, the moon does not orbit around the Earth but rather the Earth and moon revolve around a common centre of gravity—which just happens to be a spot inside the diameter of the earth but not its centre. The centrifugal force is exerted on the second tidal bulge in the same way that a bullroarer tries to fly free of the string as it is swung around.

To add a little more complexity, there is also a tidal bulge that extends towards the sun (and a centrifugal bulge on the opposite side). When the sun and moon are in a straight line the tidal bulges overlap and the effect is notably pronounced. During a full moon the Earth's oceans bulge outwards towards both the sun and moon. When the moon and sun are at right angles (first and last quarters) the gravitational affects are largely counteracted, resulting in only a small difference between high and low tides. This is known as a neap tide (see Figure 1 next page).

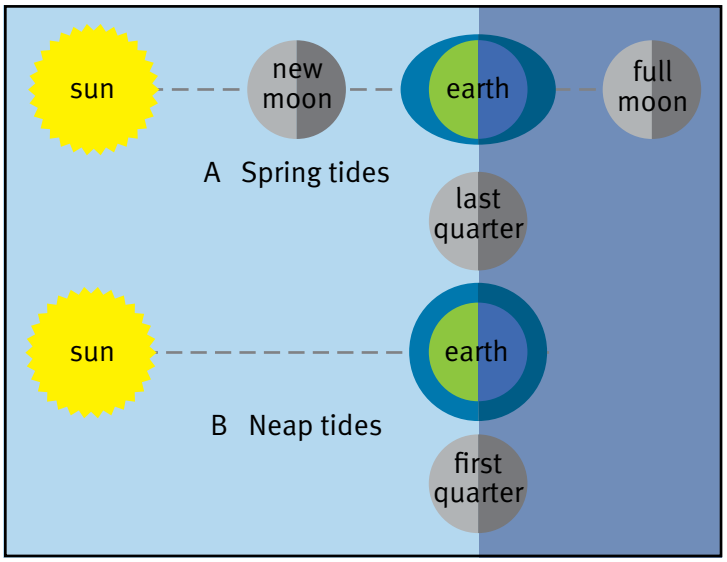

Figure 1. The position of the moon in relation to the sun will determine the extent of the tide. During the spring tides the moon and sun work in tandem.

Tide timetable

Tide heights are different from one location to the next because of differences in the shape of the land, surrounding land masses, reefs, prevailing winds and depth of water. These factors combine to make interesting tidal affects on western Cape York Peninsula and the Gulf of Carpentaria.

Many places around the world experience what is called a semi-diurnal tide sequence, meaning two tides cycles each day. A few places experience a diurnal tide, where there is only one tide cycle each day. There are even a few places that experience a mixed tide where the height of the two daily low tides vary significantly. Using the Bureau of Meteorology website, compare plotted tide heights from locations, such as Karumba and Mornington Island in the Gulf of Carpentaria, to tidal graphs in Cairns on the east coast. What do you notice? Which of these is diurnal, semi-diurnal and mixed?

Use a tide chart that calculates the tides for the year. Examine any four-week period from this chart and answer the following questions. How many high tides occur each day? What do you notice about the high tides? What do you notice about the height of the highest tide over a number of days? How often do very high tides occur daily, monthly and yearly (see highest tides in January and July)?

Students will notice there are generally two high tides each day, with one being slightly larger than the other. The highest tides occur every couple of weeks and coincide with the lunar month's full moon and new moon. King tides occur just twice a year, once in summer and once in winter. The winter king tide occurs on the full moon and the summer king tide during the new moon.

The Earth's orbit around the sun is not a perfect circle but is actually elliptical, therefore there are times when the Earth is slightly closer to the sun (January) and slightly further away (July). King tides occur in January and July when the Earth is either at its closest point (perihelion) or furthest point (aphelion). The affects of the sun's gravity are strongest in January and weakest in July.

Looking for patterns

Using the Bureau of Meteorology website ‹www.bom.gov.au/oceanography/tides/MAPS/qld.shtml›, find out the tide times for days of the full moon.

Look at tidal cycles for different locations on the east coast of Queensland during the full moon and note them in the below table. These locations are examples of typical semi-diurnal tide sequences with two daily tide cycles.

Time of low and high tides during full moon and new moon

	low	high	low	high
Cairns				
Townsville				
Gladstone				
Brisbane bar				

Round the minutes to the nearest hour. What do you notice about the times that the high and low tide occur? What pattern emerges? Based on the information from the table, what will be the approximate time of the high tide on the first full moon of the year 2050? (Answer: high tide 09.00 am and 21:00 pm; low tide 03.00 am and 15:00 pm).

If mooring your boat, what extra precautions would you need to take during the tides of the full moon and new moon?

Activity: Construct a beach profile

Students will take a field trip to the beach to profile a transect of the beach using ranging poles and plotting the results in their junior ranger field journals.

Arrange to arrive at the beach by mid-afternoon on the day of the full or new moon. By this stage students should be able to predict that there will be an ebb tide close to slack water. The winter king tide is a perfect time to conduct this activity.

It is important for students to observe tidal events using their new vocabulary. In the days and weeks leading up to the field trip have students observe the changes in the phase of the moon as a homework activity. Also have students predict when the next spring tide will occur.

Walk along the intertidal zone, making sure to note which food resources are present. Make note of interesting life forms, for example, various molluscs (snails and limpets), worms, fish and red algae (calcareous Crustose Coralline Algae make a great contribution to the amount of sand on the beach in tropical areas, though only after it passes through the guts of parrot fish).

What you will need

- ranging poles (marked bands 10 cm apart are useful)
- measuring tape
- protractor and an inclinometer (there are phone applications available if the specialist device is not available, otherwise use the alternative beach profile steps in the next section).

Procedure

- Draw a transect in the sand from the top of the beach to the shore line (as shown in Figure 2).
- Position the ranging poles at locations where there is a change in angle along the beach profile. If there are no obvious changes in profile then take measurements at regular distances, for example three metres. As long the poles remain parallel to each other, the angle between the bases of the two poles is the same as the top (see (i) and (ii) in Figure 2).
- Have students measure and record the angle from the top of one pole to the top of the next and the distance between them, marking the results in their junior ranger field journals. Students will need to scale the distances to best fit the grid in their journals, for example 1:100 (1 cm represents 1 m). The grid in the junior ranger field journal is 3 mm x 3mm.
- Without moving the second pole, move the first pole further along the transect and record the new angles and distances between them.
- Work your way down the beach until the entire transect is complete. Students should use the protractor and a ruler to graph the angles and distance in their journals.

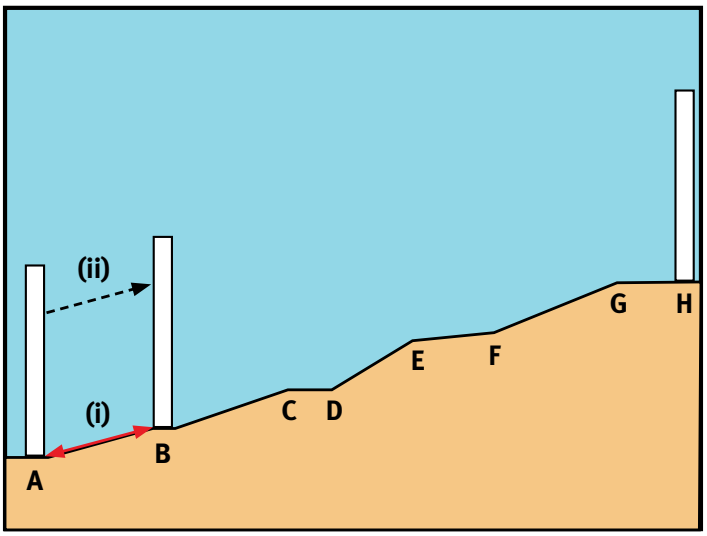

Figure 2. Beach profile

Alternative beach profile activity

If students do not have access to an inclinometer then it is possible to determine angles by measuring the distance in decimetres (tens of centimetres) that the horizon appears above or below an arbitrary mark on the ranging pole. Before heading out to the field prepare the ranging pole by drilling a sighting hole through the middle of the pole (broomsticks will suffice as poles if you cannot access poles). Using a thick black marker, delineate four decimetres (10 cm increments) above and below the hole on both poles.

Procedure

- Mark out the transect line from the top of the beach to the sea shore.
- Starting at the top of the beach profile, place both poles a set distance apart (for example, 3 m) along the transect (intervals can be any distance so long as they are consistent). The intervals will depend on the width of your field site, aim for 6–10 intervals.
- Students look through the eyehole towards the horizon and record the distance that the horizon appears above or below the eyehole on the second pole.
- Once this measurement has been made, take the first ranging pole and place it down slope of the second pole a distance of 3 m further along the transect line and repeat.
- Photograph the site and retain the profiles to compare with subsequent excursions.

Beaches profiles often change over the course of the year. For instance, seasonal changes in wind direction can change from a net gain of sand on the beach (accretion) to one where there is net loss of sand (erosion).

Extension activities

- Draw a sketch of the beach. Make note of interesting features including where the vegetation begins and ends, sand grain size, changes in slope, secondary dunes and strand lines.
- Make sand sculptures representing the food resources that Indigenous peoples would have accessed at the seashore.
- Draw a model in the sand showing the relative positions of the sun and moon to explain the current tidal cycle.
- Record your trip to the beach by taking photographs. Compile your information into a presentation and send this to a community school located far from the coast so they can learn about coastal activity in your area.
- If there are fish traps in your local area have elders and rangers explain how they work.
- Natural time units—ask an Elder about natural time units used by Traditional Owners to measure time. Read page two in the below article regarding the Kaiadilt language group from the Gulf of Carpentaria and the use of natural rhythms.

Reference

Memmott, P. '*Tangkic Orders of Time: an anthropological approach to time study*' (2005) in Scan Journal Vol 2 Number 2 September 2005 http://scan.net.au/scan/journal/display.php?journal_id=59

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