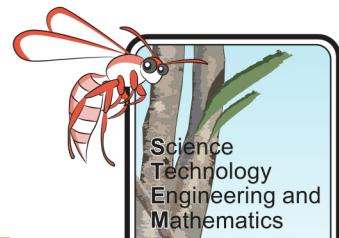


Sea Level Rise Mitigation – Teacher Resource



Intended Use of Resources

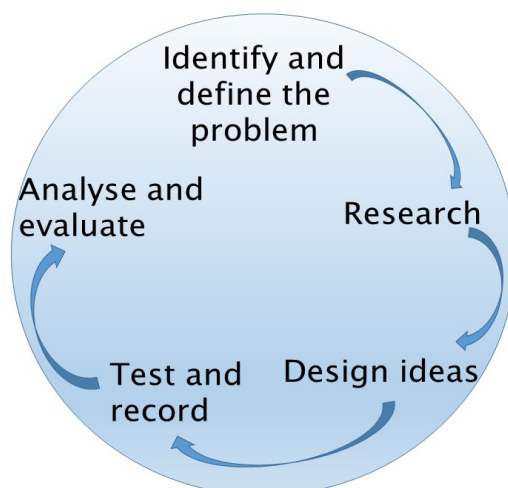
This project has been designed so that teachers from different STEM areas can pick and choose sections relevant to their subject area to work on. All activities in this package do not need to be completed to get value from the package – each activity can be completed as a stand-alone or can be approached, as a team, as a larger project. The package has potential to be extended into a much longer project to include curriculum points from different STEM subjects.

There are three **student workbooks - Open, Guided and Scaffolded**, that go alongside this resource; all have the same suggestions for activities, however, they have been written and edited to provide differentiated learning options to support good teaching practice. Teachers may pick and choose which versions they give which students, and may wish to edit them further to address their learning needs. Due to the differentiation of the workbooks, the **Open** activities will enable more syllabus links to be addressed, which is why each activity has its own syllabus links key. However, if you wish to give a truly open ended investigation then you could just give the students the challenge and background information section of the Student Booklet.

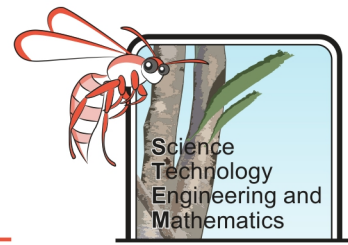
The Woodside Australian Science Project (WASP) STEM resources aim to be accessible and supportive for teachers and students, please contact us if you have questions, feedback, require assistance or would like to arrange an incursion or a professional development workshop - www.wasp.edu.au.

The Student Challenge

One of the consequences of climate change that is projected to impact a large number of people globally is sea level rise. The effects of which are already being felt by some in Australia. With the majority of the country's population living near the coast, it is imperative that there is forward planning to help reduce the impact of rising sea level on Australia's population. Your role is to analyse evidence, research the effects and impacts and investigate means of mitigation of sea level rise in Western Australia.



Sea Level Rise Mitigation – Teacher Resource



Background Information

It is now widely accepted amongst the scientific community and general population that the Earth's climate is changing. One major global concern relating to climate change is that sea levels are rising and will continue to rise. There are two main reasons for the sea level increase: rising global temperatures causing ice-caps and glaciers to melt, introducing more water into the oceans; and thermal expansion of the oceans due to increased temperatures. Preventing excessive sea level rise will require a global community effort. Although, even with the best intentions and efforts, the sea level will continue to rise for some time. With the vast majority of Australia's population living close to the coast, it is imperative that planning be put in place to mitigate the effects of future sea level rises.

Human populations are not the only ones affected by sea level rise. Flora and fauna are also impacted particularly marine and estuarine plants and animals. Australia's coast supports animals and plants which are not found elsewhere in the world and it is important that any strategies put in place help to protect these species as well.

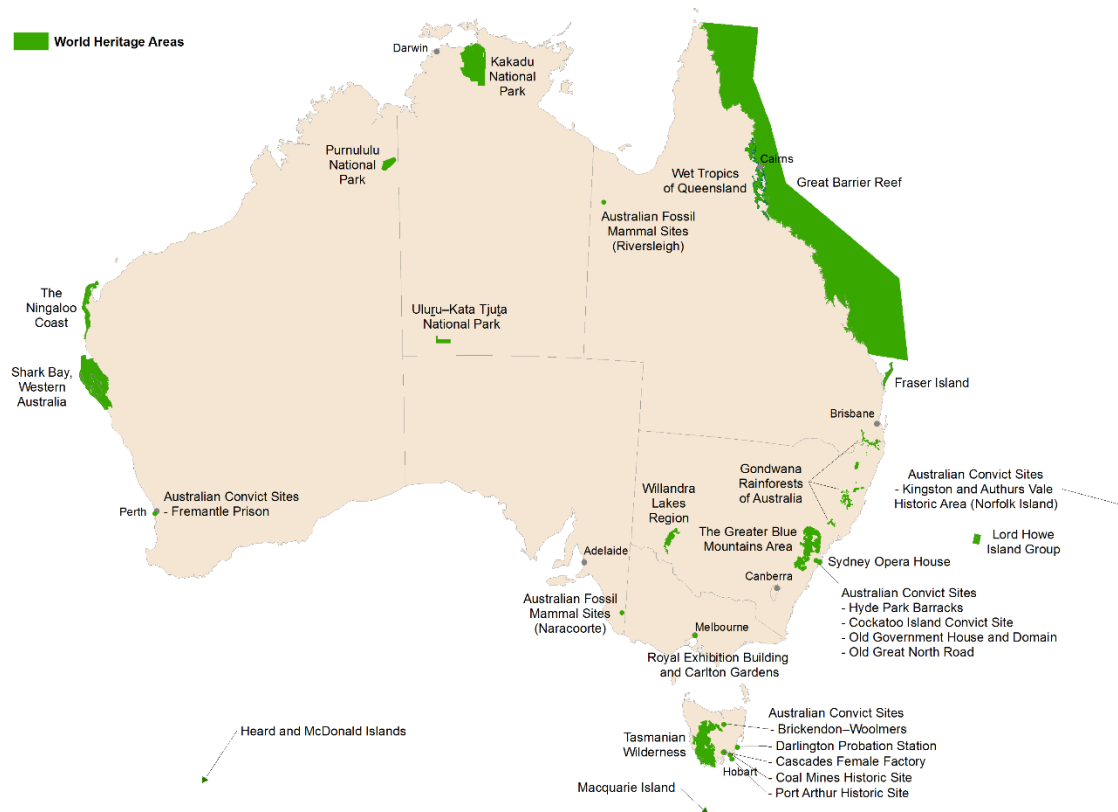
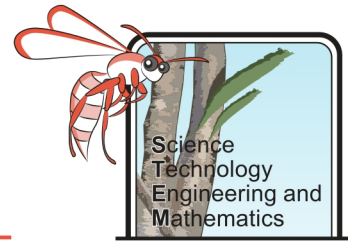


Figure 1. Australia's world heritage sites include Shark Bay and Ningaloo Reef in Western Australia, it is vital that these areas are protected. (State of the Environment, 2016)

Sea Level Rise Mitigation – Teacher Resource



Activities

This booklet contains extra information on each activity, including syllabus links the overall activity objective, suggestions for recommended equipment or alternative ways to run investigations as well as useful resources and website links*.

The syllabus links have been colour coded. These links to the Australian Curriculum are also relevant to the Western Australian Syllabus. – Please see the colour key below:

Covered in Scaffolded, Guided and Open Student Booklet

Covered in Guided and Open Student Booklet

Covered in Open Student Booklet

Italics – WA syllabus for DT and D and T

List of activities

[Background Research](#)

[Dissecting Data](#)

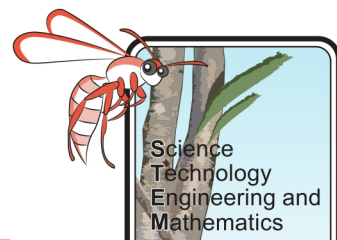
[Thermal Expansion Investigation](#)

[Investigating the Warming Ocean](#)

[Hard Engineering – Sea Walls](#)

**Please note that any reference websites provided were accessed in May 2019 therefore these addresses may have changed slightly. We would be grateful if you could let us know if these sites are no longer accessible.*

Sea Level Rise Mitigation – Teacher Resource



Background Research

Objective

Students will research causes and possible effects of sea level rise in Western Australia.

They will start to gain a general idea of different coastal engineering strategies.

The background questions should lead them to start thinking about further investigations they could do to find out more about evidence of sea level change, the causes and mitigation strategies. They are “teaser” questions about which students will be able to find out more through the other activities. Therefore, if you do not have time to complete all the activities you may wish to add to the background questions.

Students should find the two main reasons for sea level rise are thermal expansion of water as it heats up, and addition of water to the oceans through melting glaciers and ice caps.

The possible impacts of this could be loss of nesting areas for sea birds, plants and corals adapted to shallow waters may photosynthesise less effectively (due to depth of water).

Marine mammals, such as seals, may lose the beaches they used to rest and breed on.

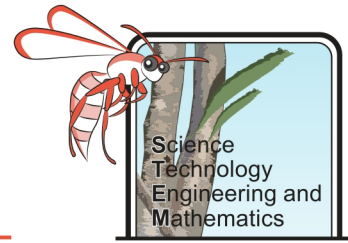
The impact on the housing market and infrastructure could be huge, with houses close to the coast and riverbanks devalued. Home owners in these locations may also find themselves having to spend lots of money on mitigation. Roads and railway lines may have to be moved or raised to prevent flooding and damage.

Governments will need to start making decisions about land usage and planning permission.

They may start rezoning areas, creating a buffer close to rivers and coasts. Funding may be required for engineered mitigation in critical zones.

	Australian Syllabus Links
Science	<p>ACSSU189 Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere.</p> <p>ACSHE191 Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community.</p> <p>ACSHE192 Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries.</p> <p>ACSHE194 People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people’s lives, including generating new career opportunities.</p>
Design and Technology	<p>ACTDEK040 Social, ethical and sustainability considerations that impact on designed solutions, complexity of design, and production processes involved</p> <p>ACTDEK041 Impact of emerging technologies on design decisions, and/ or economic, environmental and social sustainability.</p>

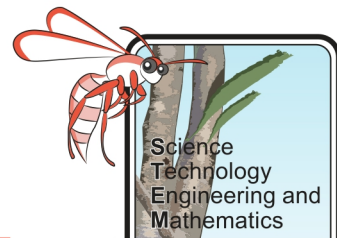
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Useful resources and websites:

- Short video from ABC education on sea level rise:
<http://education.abc.net.au/home#!/media/2266123/climate-change-and-the-rising-sea-level>
- Coastal engineering techniques information from the BBC:
http://www.bbc.co.uk/schools/gcsebitesize/geography/coasts/coastal_management_rev2.shtml
- Causes and effects of sea level rise:
<https://www.science.org.au/curious/earth-environment/too-deep-climate-change-and-rising-sea-level>
- Detailed website written at a good level for Year 10 students covering causes and effects of sea level rise:
<http://ocean.si.edu/sea-level-rise>

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Dissecting Data

Objective

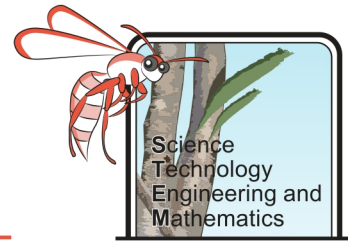
Students will analyse historical tidal data for evidence of sea level change in Western Australia.

When students download data from the tide gauges (as recommended in their booklets) you may find some locations have much more data than others. Therefore, you may wish students to use the same location. *Note: Fremantle has a lot of historical data.*

Natural factors which will change the tide are lunar cycles and seasonal changes, tides are generally higher in winter and when there is a full moon. El Niño and La Nina can have major influences on tides and sea level. Storm surges will also lead to higher sea levels.

Australian Syllabus Links	
Science	<p>ACSSU189 Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere.</p> <p>ACSHE191 Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community.</p> <p>ACSHE194 People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities.</p> <p>AC SIS203 Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies</p> <p>AC SIS204 Use knowledge of scientific concepts to draw conclusions that are consistent with evidence</p> <p>AC SIS205 Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of data.</p>
Mathematics	<p>ACMSP248 Determine quartiles and interquartile range.</p> <p>ACMSP249 Construct and interpret box plots and use them to compare data sets.</p> <p>ACMSP251 Use scatter plots to investigate and comment on relationships between two numerical variables.</p> <p>ACMSP253 Evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data.</p>

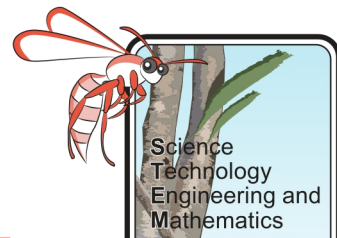
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Useful websites and resources:

- Bureau of Meteorology tide gauge metadata:
<http://www.bom.gov.au/oceanography/projects/ntc/monthly/index.shtml#wa>
- BBC bitesize revision notes and test questions on statistics:
<https://www.bbc.co.uk/education/topics/zcfrtc>
- BOM interactive chart of past El Nino and La Nina events:
<http://www.bom.gov.au/climate/influences/timeline/>

Sea Level Rise Mitigation – Teacher Resource



Thermal Expansion Investigation

Objective

Students will determine the relationship between temperature and volume of water. Then relate this to climate change as a cause for current sea level rise.

Students should already be aware that the oceans are warming and will continue to warm with increased global temperatures. They should also have an understanding that heating causes expansion, from Year 7 Science. This experiment encourages them to collect data and consider the impact of a warming atmosphere on the oceans.

The narrower the measuring cylinder the better as this will make it easier to observe volume change.

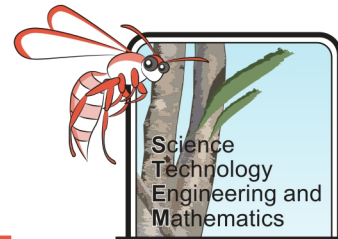
There are lots of versions of this experiment available online, where the water is being heated instead of cooled to take measurements, there are, however, dangers with this method so we have recommended taking measurements as the water cools.

Students may also use a straw in a conical flask and measure how far water travels up the straw. This would require more complex calculations, converting the lengths of straw into a volume, but it could be a good way to stretch more able students.

Further investigations could include using salt water.

	Australian Syllabus links
Science	<p>ACSSU189 Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere.</p> <p>ACSIS198 Formulate questions or hypotheses that can be investigated scientifically.</p> <p>ACSIS199 Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods.</p> <p>ACSIS200 Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately.</p> <p>ACSIS203 Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies.</p> <p>ACSIS204 Use knowledge of scientific concepts to draw conclusions that are consistent with evidence.</p> <p>ACSIS205 Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of data.</p>

Sea Level Rise Mitigation – Teacher Resource

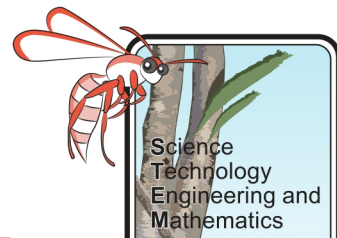


Australian Syllabus links	
Design and Technology	<p>WATPPS64 Apply design thinking, creativity, enterprise skills and innovation to develop, modify and communicate design ideas of increasing sophistication.</p> <p>WATPPS66 Select, justify and safely implement and test appropriate technologies and processes, to make solutions</p> <p>WATPP68 Work independently, and collaboratively to manage projects, using digital technology and an iterative and collaborative approach. Consider time, cost, risk, safety, production processes, sustainability and legal responsibilities.</p>
Mathematics	<p>ACMSP251 Use scatter plots to investigate and comment on relationships between two numerical variables</p>

Useful websites and resources:

- Further information, resources and activities on rising sea levels, causes and effects are available on the Earth Science Western Australia website:
<http://www.earthsciencewa.com.au/course/view.php?id=16>

Sea Level Rise Mitigation – Teacher Resource



Investigating the Warming Ocean

Objective

Students will investigate what happens to oceanic temperatures as atmospheric temperatures rise. Then investigate what happens to oceanic temperatures if atmospheric temperatures stabilise.

If you do not have heat lamps you could simply take containers outside on a sunny day to observe the air and water temperatures. Once temperatures reach a set number (you may need to choose a value lower than 30°C depending on the weather) students could use books to shade the container to try and keep the air temperature constant.

You could also try this investigation on a very large scale, using the air conditioning in a room to keep the temperature at a warm constant and then looking at the change in temperature in water bowls/a paddling pool.

Students can relate the difference in air temperature to observations they will have made when jumping into swimming pools/the sea on a hot day. They will probably have noticed that after a week of hot weather the pool will be much warmer than only after one day of hot weather, as the water takes much longer to heat. They may also have noticed that the ocean is often at its warmest in autumn as it has had the whole summer to heat and it is yet to cool down, as it stores the heat for a long time. Very able students may look into specific heat capacity and investigate this phenomenon further.

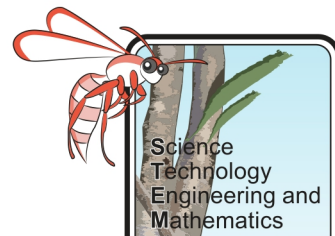
If the containers get very warm they might start to steam up making it difficult to take readings.

Data loggers will provide more accurate temperature readings as they will not be affected by refraction.

It is important that the containers are given a gentle shake frequently to encourage an even temperature throughout the water.

	Australian Syllabus links
Science	<p>ACSSU189 Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere.</p> <p>ACSI198 Formulate questions or hypotheses that can be investigated scientifically.</p> <p>ACSI199 Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods.</p> <p>ACSI200 Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately.</p> <p>ACSI203 Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies.</p>

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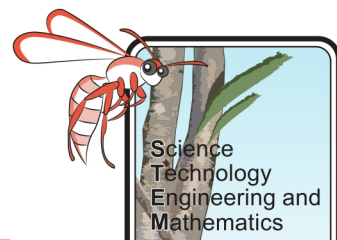


Australian Syllabus links	
Science	<p>AC SIS204 Use knowledge of scientific concepts to draw conclusions that are consistent with evidence.</p> <p>AC SIS205 Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of data.</p> <p>AC SHE194 People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities.</p>
Design and Technology	<p>WATPPS64 Apply design thinking, creativity, enterprise skills and innovation to develop, modify and communicate design ideas of increasing sophistication.</p> <p>WATPPS66 Select, justify and safely implement and test appropriate technologies and processes, to make solutions</p> <p>WATPP68 Work independently, and collaboratively to manage projects, using digital technology and an iterative and collaborative approach. Consider time, cost, risk, safety, production processes, sustainability and legal responsibilities.</p>
Mathematics	<p>AC MSP251 Use scatter plots to investigate and comment on relationships between two numerical variables</p>

Useful websites and resources:

- Basic article explaining what would happen if we stopped emitting greenhouse gases today:
<http://www.iflscience.com/environment/what-would-happen-climate-if-we-stopped-emitting-greenhouse-gases-today/>
- Higher level scientific article with information on sea level rise predictions:
<https://www.science.org.au/curious/earth-environment/too-deep-climate-change-and-rising-sea-level>

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Hard Engineering – Sea Walls

Objective

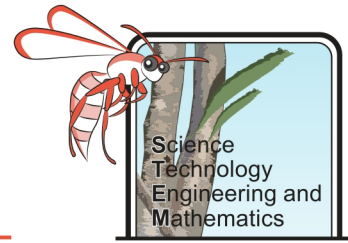
Students will investigate different types of sea walls and discuss the pros and cons of each. It is widely accepted that soft engineering techniques (zonal planning etc.) are the most effective, economic, environmentally friendly and easily maintained of the possible mitigation strategies for coastal erosion. However, in areas where there are pre-existing buildings and population pressures there is a need for hard engineering techniques to be put in place.

Sea walls can be expensive to build and maintain and will only slow the impacts of sea level rises down, not prevent the rise. For example, in Seabird, WA, where storm surges have already lead to damages to the sea wall. Sea walls can also change ecosystems and natural habitats drastically, by removing the gentle sloping beach with a hard wall. This can make it difficult for organisms which live in shallow waters and rock pools to survive.

This activity can be completed in a few hours or has the potential to be much longer if students investigate case studies, economics and spend more time on their designs. They may even like to go to a location, if possible, to take photos and measurements to gain more information.

	Australian Syllabus links
Science	ACSHE192 Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries.
Technologies	ACTDEK040 Social, ethical and sustainability considerations that impact on designed solutions, complexity of design, and production processes involved. ACTDEK041 Impact of emerging technologies on design decisions, and/ or economic, environmental and social sustainability. ACTDEK046 The combination of a range of characteristic and properties of materials, systems, components, tools and equipment to create designed solutions. WATPPS61 Identify the needs of the client/ stakeholder to determine the basis for a solution. WATPPS64 Apply design thinking, creativity, enterprise skills and innovation to develop, modify and communicate design ideas of increasing sophistication. WATPPS66 Select, justify and safely implement and test appropriate technologies and processes, to make solutions. WATPP68 Work independently, and collaboratively to manage projects, using digital technology and an iterative and collaborative approach. Consider time, cost, risk, safety, production processes, sustainability and legal responsibilities.

Sea Level Rise Mitigation – Teacher Resource



Useful websites and resources:

- Short Catalyst video explaining some environmental impacts of sea walls and how they can be overcome:
<http://www.abc.net.au/catalyst/stories/2936248.htm>
- ABC video clip explaining sediment drift and human impacts on beaches:
<http://education.abc.net.au/home#!/media/1481409/disappearing-acts-changing-shorelines>