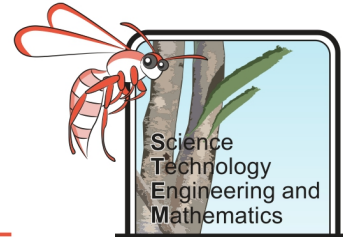# Sea Level Rise Mitigation – Student Booklet

The 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.
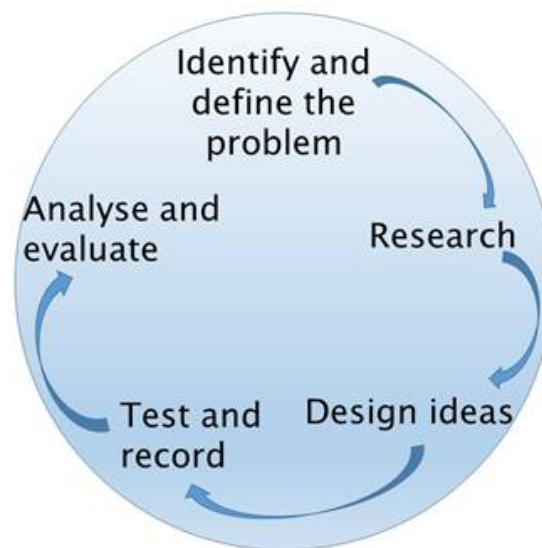
Background Information

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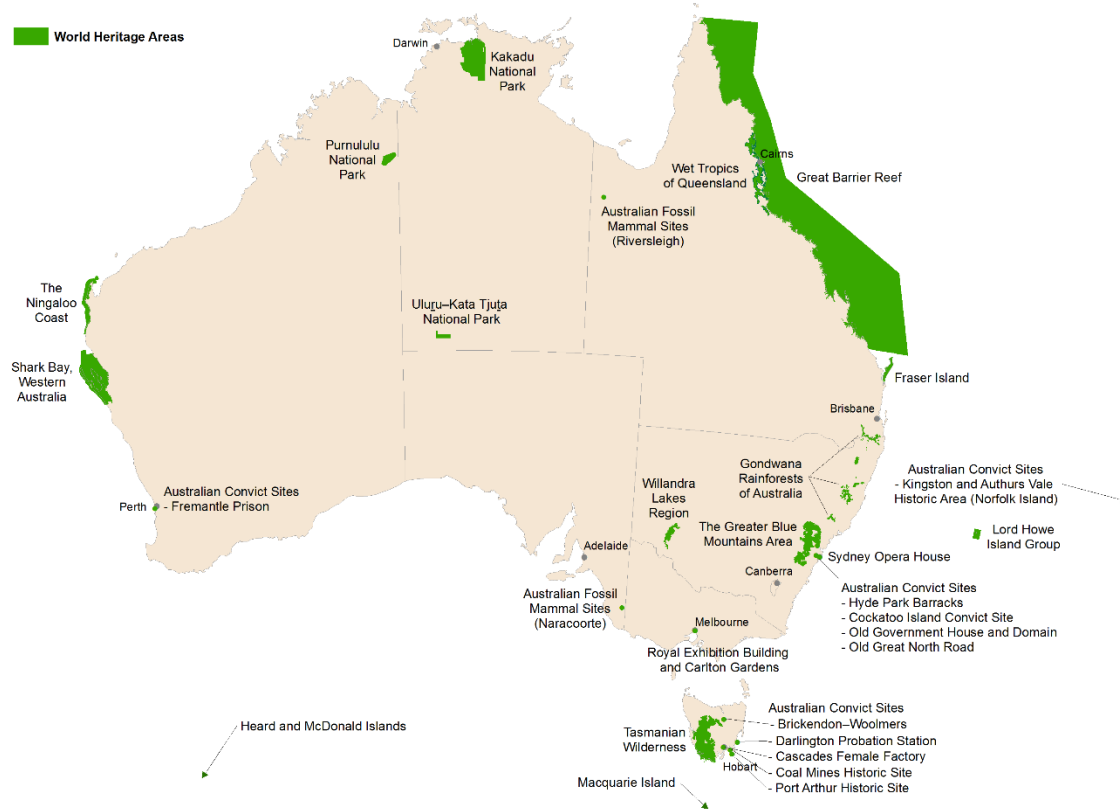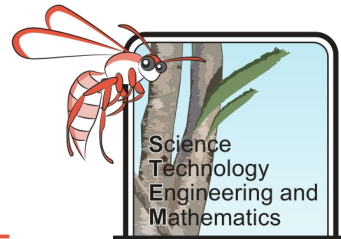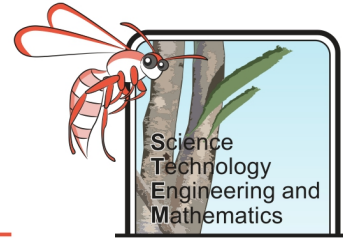
Figure 1. Australia's world heritage sites include Shark Bay and Ningaloo Reef in Western Australia, it is vital that these areas are protected. (State of the Environment, 2016)

Background Research

1. How rising global temperatures lead to sea level rise?

2. What is isostatic rebound? How can its effects make it difficult to determine sea level changes?

3. What are the different methods of attaining historical sea level records? How reliable are they?

4. What methods are used to measure sea level today?

5. Why have sea level measurements become more reliable with time?

6. How can vegetation lines be used as evidence of sea level change?

7. Use the interactive map at http://coastalrisk.com.au/# to explore the impacts of predicted sea level rises:
   - Choose your area (cities and areas at the base, scroll along if you can't see yours right away)
   - Accept the disclaimer
   - It will automatically come up with the predicted 2100 levels, zoom in and move the map around to explore where you live
   - Choose manual and move the bar from 0 to 10 metres to see what happens in different climate change scenarios

8. What effect might sea level rise have on biodiversity in Western Australia?

9. What effect could sea level rise have on low lying islands such as Rottnest, The Abrolhos and Garden Island?

10. What effect could sea level rise have on the tourism industry and explain why?

11. How could rising sea levels impact the people of Western Australia?

12. Outline examples of coastal erosion management strategies and explain how they work.
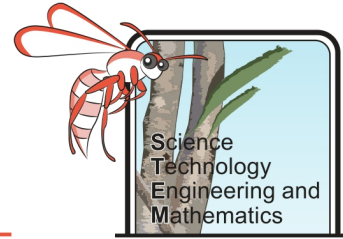
Dissecting Data

Objective

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

Method

1. Go to the Bureau of Meteorology website to find the tide gauge metadata and observed monthly statistics:
   http://www.bom.gov.au/oceanography/projects/ntc/monthly/
2. Select the tab for your state.
3. Select the data for your most local tide gauge or the tide gauge where you feel sea level change will have the largest impact (under Sea Level click 'Table and Plot').
4. Copy the data into Excel to make the sorting of data easier.
5. Produce visual representations of this data (consider stem and leaf diagrams and line graphs). Analyse what these representations are telling us about sea levels.
6. Calculate the mean maximum and minimum sea level for each month of the year for the last 30 years.
   **THE ENSO Effect**
7. What is ENSO and how does it impact Australia?
8. Use the BOM website to look at El Nino and La Nina patterns in the past:
   http://www.bom.gov.au/climate/influences/timeline/
   Can you see any correlation between the mean sea level over the past 30 years and the ENSO cycle? Use data to support your answer.
9. What other natural phenomena may have an impact on sea level, and how would it effect it?

Evaluation

1. How useful is using this data from the past 30 years in interpreting sea level rise?
2. What data would be more useful?
3. What are some of the difficulties faced in determining the rates of sea level rise?
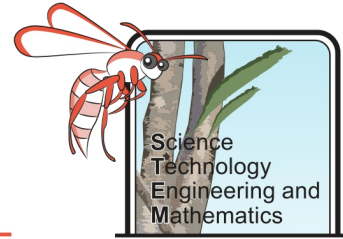
Thermal Expansion Investigation

Objective

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

Method

Write a hypothesis, equipment list and method for an investigation that will enable you to examine the relationship between temperature and volume of water. Show this to your teacher, for approval, before conducting the experiment.

Results and Analysis

1. Produce a table of results.
2. Plot your results as a scatter graph. Add a trend line and (if your line of best fit is straight) calculate the gradient of that line.
3. Add another column to your table to record the percentage increase in volume (from an initial or room temperature reading).
4. Plot a graph for these results.
5. Discuss your findings in regards to the relationship between temperature and volume of water, relating this to climate change.
6. The global average ocean temperature in the 20th Century was 12^0C (NOAA, 2018), it is predicted that the ocean temperature will rise at least 2 degrees in the next 30 years. Use your data to determine what the percentage increase in volume will be if there is an increase from 12^0C to 14^0C in ocean temperature. (show your working)

Evaluation

1. Were there any potential sources of error in your investigation?
2. How could you improve this investigation?
3. Outline any further investigations you could undertake to determine this relationship.
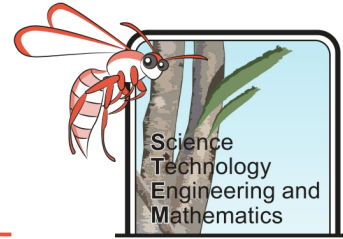
Investigating the Warming Ocean

As the atmosphere warms the oceans warm.

Objective

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

Method

Write a hypothesis, equipment list and method for an investigation that will enable you to examine the relationship between atmospheric and oceanic temperatures and to determine how oceanic temperatures respond to a stabilisation of atmospheric temperatures. Show this to your teacher, for approval, before conducting the experiment.

Results and Analysis

1. Produce a table of results.
2. Plot your results as a scatter graph. Add a trend line and (if your line of best fit is straight) calculate the gradient of that line.
3. Discuss your findings in regards to the relationship between atmospheric and oceanic temperatures, relating this to climate change.
4. If atmospheric temperatures stabilised what does your data suggest would happen to oceanic temperatures.

Evaluation

1. Were there any potential sources of error in your investigation?
2. How could you improve this investigation?
3. Outline any ideas you have to investigate the relationship between atmospheric and oceanic temperatures further.
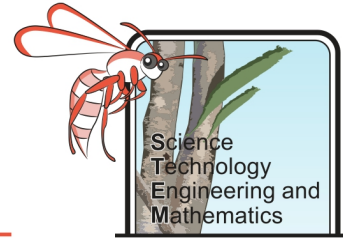
Hard Engineering – Sea Walls

Background

An engineered solution to help mitigate erosion caused by sea level rise are sea walls. Locations such as Seabird, WA already have seawalls in place to protect housing on the shore. There are many different types of sea walls, some are designed to prevent the sea reaching houses and infrastructure. Others are designed to stop sediment migration. There are other benefits of sea walls including, creating recreational areas for fishing and calmer waters for people to swim. However, sea walls can also have negative effects on the natural environment by changing the space and area in which marine animals live. The materials from which sea walls are built can make a big difference to the cost of the project, as well as impact upon the marine life.

Objective

To investigate different types of sea walls and discuss the pros and cons of each.

Research and Preparation

1. Research different types of sea walls.
2. Consider the pros and cons of different materials that may be used to build sea walls in terms of cost, need for maintenance, longevity and how environmentally friendly it is.

Test different models of sea walls to determine how useful they will be at preventing erosion.

Method

Write an, equipment list and method for an investigation that will enable you to examine the effectiveness of a range of sea wall types. Show this to your teacher, for approval, before conducting the experiment.

Results and Analysis

1. Present your results in a way that clearly demonstrates your outcomes.
2. Discuss the strengths and weaknesses of each of the models you tested. Which design would be the best to mitigate coastal erosion? Why?

Evaluation

1. Were there any potential sources of error in your investigation?
2. How could you improve this investigation?
3. Outline any ideas you have to investigate the effectiveness of sea walls further.
4. If you were a town planner how would you recommend that coastal areas mitigate coastal erosion?