Moana Explorers:
Stories of Change

Practical marine science activities for Yr 9/10 students in the Pacific.

OMI OCEAN MEDIA INSTITUTE

NEW ZEALAND MARINE STUDIES CENTRE University of Otago

UNIVERSITY of OTAGO Te Whare Wānanga o Otāgo NEW ZEALAND

THE CENTRE FOR SCIENCE COMMUNICATION Te Paepae Pūtaiao

Mālō e lelei!

We are thrilled to be partnering with the Tongan Ministry of Education on this exciting pilot project, led by researchers from the University of Otago's Centre for Science Communication, Department of Marine Science, the Division of Sciences, Pacific and Ocean Media Institute. This project is part of a research grant for the establishment of the *Moana Media Lab,* a virtual hub for Pacific science teachers to engage their students in science storytelling through the lens of culture. As a result of this grant, we have created this resource kit especially for Tongan secondary science teachers to test out and explore the science and story of climate change with their students.

We invite you to engage your students in the activities and experiments in this booklet and companion video through **a final single creative project** where students express what they have learned and how it relates to them personally. They can do this by creating a piece of artwork, a written story, poem or essay, or a video.

After the creative pieces are finished, we ask that you share them with us through photos and share your thoughts and feedback with us by conference call or email about how it went, what worked and didn't, and how we can make the resources more relevant and useful to you and other teachers.

We have also set up a Facebook Community called 'We Are Moana' at: https://www.facebook.com/WeAreMoana as an option for you and/or your students (with parent's permission) to connect with others and share stories, videos, photos, artwork and thoughts about Climate Change. You may also use the page for uploading outputs from this project, but that is purely optional and you are in no way obligated to do so.

By participating in this project and offering your thoughts and feedback, you agree to have your input counted as data in our research. Your identity and that of your students will remain private. If you decide not to take part, there will be no disadvantage to you. We do hope you will join us and thank you for participating!

If you have any questions at all, please feel free to email us at gianna.savoie@otago.ac.nz or losa.moataane@otago.ac.nz.

This project has been approved by University of Otago Human Ethics Committee.
Reference Number: D20/421, 11 Dec 2020.

Table of Contents

Introduction

Climate change, feliuliuaki‘o e ’ea, describes manmade change to the natural world mainly caused by increased greenhouse gases (e.g., CO_2) in the atmosphere. These greenhouse gases trap heat and warm the environment. These changes include global warming, sea level rise, and ocean acidification.

The size of the effects of these changes depends on where you are on the globe. For many island nations in the Pacific, climate change cannot be ignored as it is threatening traditional and future ways of life. When natural resources are limited, and environments are fragile, there can be large impacts on the social, economic, and cultural aspects of our daily lives. Educating Pacific students about the science of climate change and providing opportunities to investigate local impacts and explore possible solutions is key to future management of our natural resources.

Overview for Teachers:

When it comes to climate change, there is perhaps no group more central to the issue than Pacific youth. Positioned metaphorically -- and quite literally -- in the eye of the storm, they will bear the brunt of the impacts of rising and warming seas, severe weather and food security issues. They will have to learn to navigate these challenges with responsibility and resiliency.

Understanding the science of climate change and being able to communicate that science is therefore critically important at this age. Over the past 20 years, Tonga has seen a gradual shift towards science education that promotes the development of knowledge, skills, attitudes, and values required to engage with and use scientific evidence. This is a crucial start. Yet it is also important to recognise that though science offers utility and function, without a story that reflects personal and cultural connections, it can lack meaning and fail to engage. Never before has the voice of young Pacific Islanders been more relevant; these young people are a rising tide of their own, possessing the power to create solutions and to shape the future.

This resource supports secondary science students in the science of climate change. Students at Level 9/10 will explore their connections with the marine environment and investigate how our moana is changing over time. Three one-hour science lessons explore ocean science through hands-on investigations to be done in the classroom and on the seashore. The focus is on three key impacts of climate change on the ocean - a warming ocean, a rising ocean and a more acidic ocean.

This resource also engages secondary students in the story of climate change through a cultural lens and trans-media storytelling (artwork, writing, photography, music, performance) with the goal of igniting curiosity, excitement and an investment in science that will last a lifetime. As these young explorers share the narrative of climate change in ways that are meaningful and accessible to them, they will gain a deeper understanding of the issue and how it relates to them and their community and foster leadership skills to become confident change-makers. Although the focus is on science, the topic and activities will link to other curriculum areas including geography, English, and media studies. All the material required to carry out the activities are in the resource kit. Support information (including reference to web sites) is included on the supporting iPad. Additional marine science activities are included on the hard drive.

Links to the Science Syllabus & Prescription:

(For Secondary Schools in Tonga, Ministry of Education, 2018 Edition)

Strand 0: Scientific Skills

Level	Strand	Core Content	Activity Description & Link
Form 3 (Class 9)	9.0: Scientific Skills (pg 14)	Scientific Skills Dealing with data Laboratory Report	Activity 1, 2, 3
Form 4 (Class 10)	10.0: Scientific Skills (pg 14)	Scientific Investigation Scientific Report	Activity 3

Strand 1: Living World / Biology

Level	Strand	Core Content	Activity Description & Link
Form 3 (Class 9)	9.1: Living World (pg. 17, 30-31)	**Plants and Animals** • Structures and adaptations	Activity 3
Form 4 (Class 10)	10.1: Living World (pg 19, 32-33)	**Communities and Ecosystems** • Relationships in food chains and webs • Trophic levels • Nutrient (carbon and nitrogen cycles)	Activity 2,3

Strand 3: Material World

Level	Strand	Core content	Activity Description & Link
Form 4 (Class 10)	8.3 Material World (pg 24)	**Acids and Bases** • Testing the acidity of a solution	Activity 3

Strand 4: Planet Earth and Beyond

Level	Strand	Core content	Activity Description & Link
Form 3 (Class 9)	9.4: Planet Earth & Beyond (pg 26, 39)	**Climate** • Climate change and its impacts in their local community	Activity 1
		The Ocean • Causes impacts and adaptations to the changes in tides and sea levels	Activity 2
		Environmental Problems • The casues and effects of global warming, drought and pollution on the environment	Activity 1, 2, 3
Form 4 (Class 10)	10.4: Planet Earth & Beyond	**Earth System** • Greenhouse gases and their effects	Activity 1, 2, 3
	(pg 26, 40)	**Atmosphere** • Factors affecting Tonga's weather and the global climate • Ozone and how it relates to global warming • Climate change	Activity 1, 2, 3

Pre-Project Activity

Climate Change Mind Map: This activity will provide teachers with information about students' understanding of climate change at the start of the unit. Please photograph the map and send it to gianna.savoie@otago.ac.nz OR upload to Facebook group: https://www.facebook.com/WeAreMoana

Instructions for Teacher:

1) Teacher writes "Climate Change" on the board with a circle around it.
2) Students come up to the board and write a word that they associate with Climate Change.
3) It's okay if words are repeated. When words are repeated, just make a check mark or write the number of times the word was repeated next to it. Example: if 3 students write "storms," there will be a 3 next to that word, or √√√ next to it.
4) After all students have a chance to write their words, engage in a talanoa about why they chose those words and what they think about climate change. For example:
   - Is there something specific (an experience or story they have heard) that made them choose their word?
   - Can students identify patterns – repeated words or themes? What does that tell them?
   - Do they talk about climate change with their families?
5) Teacher photographs or copies the map (to compare with same exercise repeated at the end, and send to gianna.savoie@otago.ac.nz).

Optional Homework or In-class Assignment: Students choose 3 words from the board and make up a short story about climate change using them. The story can be true or fictional.

Lesson 1 – Heat Capacity of Water, Sand and Air

Introduction:
The air, the land, and the sea are all exposed to the sun for the same amount of time each day. Despite receiving the same amount of the sun's energy, the temperatures of these three substances are usually quite different from one another. Their temperatures may change a little, or a lot, between different times of the day or between different seasons. On some days, you may have noticed that the water is cold, the air above is warm, and the beach sand is scorching hot. During other times of the year, the sea may be warmer than the air and the land. At night, the land and air may be much colder than it was during the day, while the temperature of the ocean may not change at all. At higher latitudes (toward the Earth's poles), the coastline may stay relatively warm in winter. As you move inland, places at the same latitude may experience cold weather and snow. How do you explain these differences?

Objectives:
To investigate the ability of different substances to absorb, retain and release heat at different rates.

Materials:
- 3 black containers (tin cans covered with black paper)
- 3 polystyrene/corrugated cardboard lids (cut from food tray or cardboard box)
- 3 thermometers
- 1 flood lamp (with high watt bulb)
- 1 stopwatch (or use timer on cell phone)
- Sand and water

Method:
Teachers:
1. Fill one can with dry sand, the other with tap water, and leave the third one empty. Seal the lids firmly on each can.
2. Place the cans in the refrigerator at least one hour prior to running the experiment.

Students:
1. Remove the three cans from the fridge and place them somewhere warm (in the sun) (time 0).
2. Insert a thermometer in each lid and push down so the thermometer is in the middle of the water, air, or sand, but not resting on the bottom.

3. Record the temperature of each substance for time 0 (when the cans are placed in the sun). All substances should be a similar temperature at this time.
4. Start the stopwatch or note the time. Record the temperature on the thermometers every two minutes for the next twenty minutes using the *Heat Capacity Data Sheet* (page 11).
5. Record the temperature of the air, sand, and water next time you visit the beach and do some research to learn about seasonal differences in Tonga.

Results:

1. Create a graph of time vs. temperature for the three substances (water, air, sand).
2. Explain your results. How might the temperature of the water, air, and sand vary at the beach over 24 hours? Over a year?
3. Reflect on a recent trip to the beach; what time of day was it? What time of year? How did the temperatures of the air, sand and water compare? Which was the warmest? Which was the coolest?
4. What might happen to the temperature of the three substances if you placed the cans back in the fridge for 20 minutes at the end of the experiment?

Discussion:

1. Define the term ‘specific heat’.
2. Why do different substances have different heat capacities?
3. What impact does the heat capacity of water have on its ability to moderate our climate?

Lesson 1 – Heat Capacity of Water, Sand and Air – DATA SHEET

Group members: _____
School: _____
Date: _____

Time (min)	**Temperature** °C		
	Sand	**Air**	**Water**
0			
2			
4			
6			
8			
10			
12			
14			
16			
18			
20			

Observations: _____
_____
_____
_____

Which substance responded to the change in temperature first? _____

Which substance showed the biggest temperature change? _____

Which substance showed the least temperature change? _____

Specific heat is the quantity of heat required to raise the temperature of one gram of a substance by one Celsius degree.

Does it take more or less energy to raise the temperature of the water compared to the air? _____

Which has the higher specific heat, air or water? _____

Why do coastal areas have a narrower daily and seasonal temperature range than areas that are located further inland? _____
_____

How does the ocean reduce the impact of global warming?_____
_____

Additional Activities / Demonstrations:
If the class is large, or there is limited equipment, divide the class in smaller groups and have them work through the following activities to understand how the ocean is responding to the increase in atmospheric temperature due to climate change.

Lesson 1b – Water Absorption of Heat:
The ocean absorbs 80-90% of the heat produced by our warming world. Compare how a balloon filled with either air or water responds to a flame to better understand how water absorbs most of the heat produced by climate change.

Materials:
- 1 balloon filled with air, 1 balloon filled with water
- Heat source (flame from candle)

Methods: (see https://www.jpl.nasa.gov/edu/teach/activity/global-warming-demonstration/)
1. Place the flame under each balloon.
2. Record your observations and discuss how understanding the heat capacity of the ocean is important when investigating the effects of climate change.

_____
_____
_____
_____

Lesson 1c – Thermal Expansion of Water
Make a model demonstrating how water expands when heat energy is added. This thermal expansion of water explains about half of the measured global sea-level rise.

Materials:
- Clear bottle
- Lid with clear tube (labels like a ruler)

Methods: (see https://www.jpl.nasa.gov/edu/teach/activity/thermal-expansion-model/)
1. Fill the plastic bottle to the top with cold water. Screw on the lid with measured tube. The water level should be close to zero. Record the level in table below.
2. Place the bottle in the sunshine and leave for ~30 minutes.
3. After ~30 minutes, record the water level in table below.

Results:

	Time: 0 min	Time: 30 min
Water level (mm)		

Discussion:
How thermal expansion lead to sea level rise?_____
_____
_____

Communication Challenge 1 (optional)

<u>Climate Future Storyboard</u> (This can work as an individual or group assignment):

Based on the data collected, work in groups of 3 and use your imagination to make up a 3-Act story about your community in Tonga, 100 years in the future, using the storyboard template (PROVIDED).

- In the top 3 squares, illustrate a story about what it would be like if no action is taken on climate change.
- In the bottom 3 squares, tell a story about what it will be like if we do address climate change.
- Think about what Tonga might look like, what the weather is like, what the ocean is like, what are people eating, drinking, wearing? Why?

1) Draw an image in each square that represents a "scene" in the story.
2) In the lines below the picture, describe what is happening. Each scene should build on the one before it and link to the next.
3) Get creative and have fun!
4) Discuss your storyboard with the class.
*If possible, teachers, please photograph the storyboards and upload to Facebook https://www.facebook.com/WeAreMoana or report back to NZ team on how it went: gianna.savoie@otago.ac.nz

HOMEWORK:
Students interview (talanoa) family member(s) about climate change and report back the next day on how it went. They can come up with their own questions to start the conversation. Some sample questions they could ask:

- What do you think about when you hear Climate Change?
- Have you noticed changes in sea level since you were my age (if asking a parent or elder)?
- Have you noticed changes in weather over the years?
- Are they eating different foods now than they used to? What kinds? Why? If they fish, have they noticed changes in the type or quantity of fish they catch?
- Is there anything that worries you when it comes to climate change? What do you hope for?

Lesson 2 – Sea Level on the Seashore

Introduction:
Tides are caused by the moon's gravitational pull tugging on the ocean. As the Earth rotates, the direction of that pull changes, resulting in the sea level rising (high tide) and falling (low tide). Apart from the daily tidal cycle, the overall sea level has been increasing through time. As the Earth gets warmer, the ocean absorbs about 90% of that extra heat. Since water expands as it heats up, the sea level keeps getting higher. Increased temperatures also melt ice which, in turn, raise the sea level even more. The rate of sea level rise in Tonga is 6 millimetres per year, which is twice the global average. Most Tongans live along the coast where the effects of rising seas are most concerning. Why might that be?

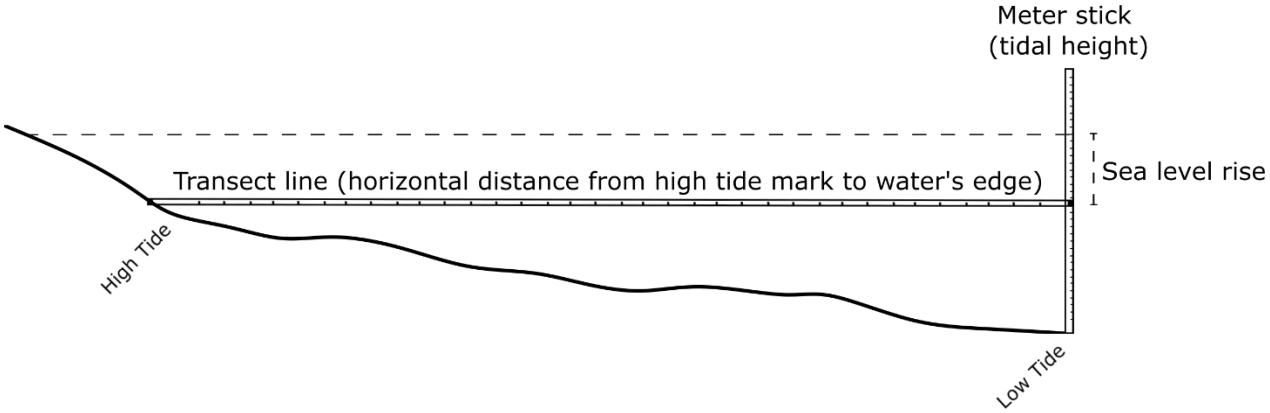
Objective:
To investigate how the sea level changes on the seashore within a day (tides) and across years (sea level rise).

Materials:
- Tide tables for Tonga
- 1 meter stick
- 30 m transect line
- 1 level

Method:
Preparing for the field trip:
1. Review the tide tables for Tonga and organise a seashore visit to coincide with the time of low tide (http://oceanportal.spc.int/portal/library/assets/2021.Tonga.Nukualofa.pdf).
2. Graph the tide height versus the time/date for 3 consecutive days (including the field trip date) and take note of the vertical height difference between high and low tide (http://www.tidetablechart.com/tides/region/Tonga).
3. Investigate how the tidal height changes over the year and what causes the change in tidal height.
4. Do some background research on sea level rise (e.g. watch the video https://www.youtube.com/watch?v=msnOHuPep9I).

At the seashore:
1. Look for evidence of the high tide line on the shore and described what you found (e.g. line of dried seaweed, woody debris, or shells.

2. Measure the distance to the water's edge using the transect line. Lift the line so it is level with the horizon, measure the height on the meter stick to get an estimate of the change in sea level from low to high tide.
3. Lift the transect line on the meter stick 60 mm to represent sea level rise over 10 years (6mm x 10 years = 60 mm). Extend the transect line so it is horizontal again. Where it meets the land will give you an idea of how far inland the water will extend in 10 years' time due to global warming.



In the classroom:

1. Investigate coastal flooding for Tonga that is predicted by 2100: https://earth.org/data_visualization/sea-level-rise-by-2100-tonga/
2. Use the following model https://coastal.climatecentral.org to make predictions of the impact of sea level rise on Tonga.

Results:

1. What is the vertical height difference between high and low tide?
2. Identify factors that modify the tidal height.
3. Illustrate the change in the water level on the shore, in 10 years.
4. Identify ways that the changing water level affects the shore.

Discussion:

1. Think about the impact of sea level rise on Tonga. What areas do you think will be affected by rising sea level?
2. How does the slope of the shoreline effect the horizontal distance between low and high tide?
3. Sea level has risen by about 6 mm per year, so use your pole and transect line to estimate where the high tide line will be in 5 years, 10 years, 30 years.

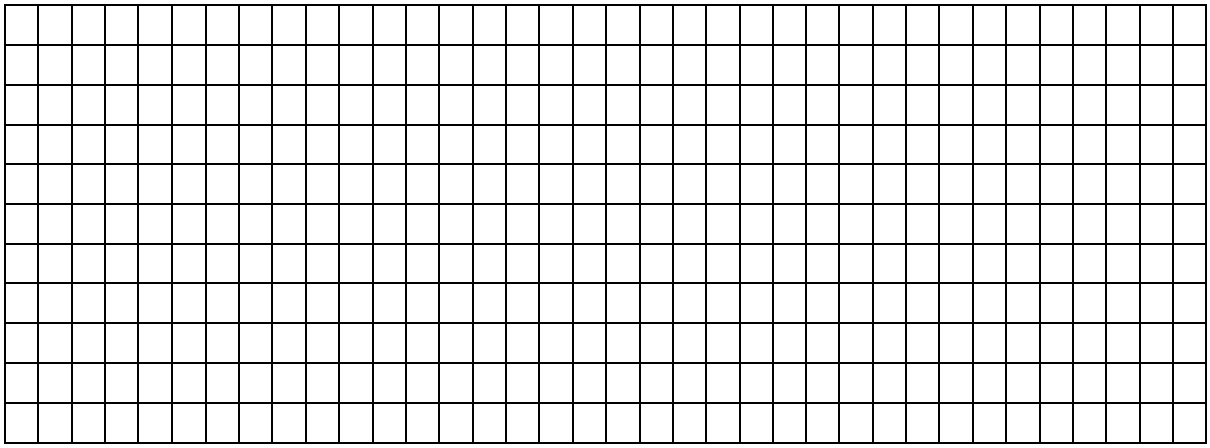
Lesson 2 – Sea level on the Seashore – Data Sheet

Group Members: _____

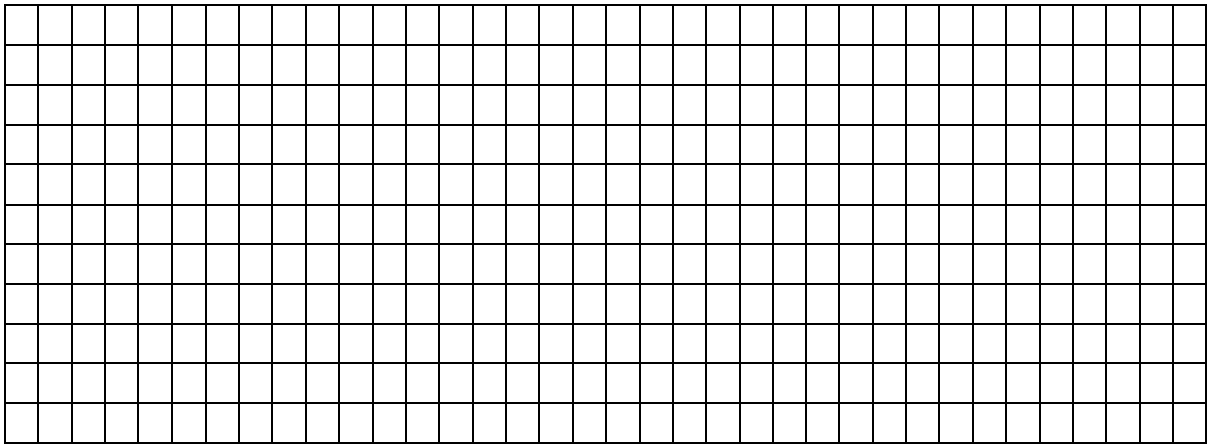
School: _____ **Date/Time:** _____

Location: _____

1. Graph of tidal height vs. time (remember to label your axes).



2. Draw a cross section of the seashore (step 2 in the methods for "at the seashore"). Label high tide level, low tide level, horizontal and vertical distance between high and low tide. Add dashed lines to illustrate the predicted tidal height in 5, 10, and 30 years.



Describe the impact of rising sea level on this shore: _____

_____

_____

Describe the impact of rising sea level on your village: _____

_____

_____

Lesson 2b – Modelling Sea Level Rise

This is an alternative activity in case a field trip to the seashore is not possible.

On Earth, ice can either be found sitting on top of the land or floating in the water. As global temperature increases, both ice trapped on land and ice in the water begin to melt, causing sea level to rise. However, the two types of ice contribute to sea level rise at different rates when they melt. What type of ice, land ice or sea ice, do you think contributes more to sea level rise when it melts? Why?

Objective:
To investigate what is causing sea level rise.

Materials:

- 1 block of plasticine / flat rock to represent Tonga (you may want to mould the plasticine to show the topography of the island.
- 1 block of plasticine / flat rock to represent Antarctica
- Tray with water (water should cover half way up the rock or plasticine)
- Ruler
- Ice

Methods: (https://www.jpl.nasa.gov/edu/teach/activity/whats-causing-sea-level-rise-land-ice-vs-sea-ice/)

1. Place the two blocks of plasticine/rock in a tray with water halfway up the plasticine / rock.
2. Measure the height of the water.
3. Put ice blocks on top of antarctica (you will need quite a few) and place the tray in the sunshine until the ice melts.
4. Repeat the experiment and put the ice blocks in the water.

Results:

	Time: zero	**Time: 30 min**
Water level (ice on land)		
Water level (ice in water)		

Discussion:

1. How did the melting ice affect the seawater level?
2. What is sea ice and where might we find it?
3. What is land ice? And were might we find it?
4. How did the location of the ice blocks (i.e., on land or in the water) affect the rate of sea level rise?

Communication Challenge 2 (optional)

Climate Change Investigator: A Picture Worth a Thousand Words
This project engages students in observing Climate Change in their everyday lives by gathering and interpreting visual evidence.

- Teacher shows 3 sample photos (provided in Appendix) and students guess the story behind it. There are no right or wrong answers and the students can guess at the "true" story behind the photo or make up a fictional story. The point is to interpret what they see.
- As assignment, working in groups, students go out and photograph 3-5 impacts of climate change (erosion, severe weather, flooding, drought . . . anything they consider evidence).
    - If they don't have a camera, they can sketch/write down/describe what they found.
- Students share with class and other students guess/imagine a story they are trying to tell through the image.
- Teachers report back to NZ team on how it went and/or via We are Moana Facebook group: https://www.facebook.com/WeAreMoana

Lesson 3 – Ocean Acidification and Seashore Snails

Introduction:
Climate change not only affects the sea level and temperature, but also the pH of the ocean. In a natural state, the concentration of CO_2 in the atmosphere and the ocean *equilibrate,* or become balanced. However, burning fossil fuels has rapidly increased the amount of CO_2 in the atmosphere, both changing the equilibrium between the CO_2 in the atmosphere and CO_2 in the ocean and decreasing the pH of the ocean. Ocean acidification (i.e., decreased ocean pH) makes it easier to dissolve shells. This means marine organisms will find it harder to make shells, or that they will need to use more energy to maintain their shells. This lesson will look at how increased CO_2 in the atmosphere changes the pH of seawater and how this can affect the animals in the oceans.

Objective:
To investigate the effect of temperature increase and pH decrease on the turn-over response of a marine snail.

Materials:
- 8 intertidal snails (4 snails per ice cream container, all approximately the same size)
- Seawater at 2 different pH's (from Activity 3a, Oceans of Tomorrow booklet)
- 2 ice cream containers per group (4-5 students/group)
- Stopwatch / timer
- pH meter
- Thermometer
- Paper straws

Methods:
1. Each group needs 8 snails and two ice cream containers.
2. Place seawater in one ice cream container and place 4 snails in the container.
3. Fill the other ice cream container with seawater, blows into the seawater for approximately 60 seconds (3 blows of 20 second duration) to lower the pH to 7.3 – 7.6. Measure the pH and blow again if needed.
4. Place 4 of the snails in the container with the reduced pH seawater.
5. Record the water temperature and the pH of both containers.
6. The snails should acclimate for approximately 15 minutes in the seawater treatments before continuing to step 8.
7. Turn over all the snails in each treatment and start the stopwatch. Turn the snails by only touching their shell. Touching the snail's operculum with your hand seems to affect their behaviour.

8. As soon as a snail has flipped its shell over, record the time. Remove the snail from the container.
9. Repeat step 9 with the remaining 3 animals in each treatment. Record results as you go into table provided.

Results:

1. Record the class results on data table.
2. Graph the class results on the graph.

Discussion:

1. Summarise your results. How do they compare to the combined class results?
2. What does this tell you about value of replication?
3. Why do you need to leave the animals to acclimate before the experiment?
4. Repeat the experiment under higher temperature conditions. How does the increased temperature affect the turn-over rate of the snails?

Extension:

Learn more about ocean acidification by working through the activities in the ***Ocean of Tomorrow*** resource booklet (enclosed in the Kit).

Lesson 3 – Ocean Acidification and Seashore Snails – Data Sheet

Group Members: _____
School: _____ **Date/Time:** _____
Location: _____

Record time to turn over and behaviours observed (e.g., time for antennae to appear, number of attempts to turn over, time for foot to reach over the edge of the shell for the first time).

Condition #1	Temperature: pH:	
	Behaviours observed	Turn-over time
Snail #1		
Snail #2		
Snail #3		
Snail #4		
Average turn-over time:		

Condition #2	Temperature: pH:	
	Behaviours observed	Turn-over time
Snail #1		
Snail #2		
Snail #3		
Snail #4		
Average turn-over time:		

Communication Challenge 3 (optional)

Ocean Acidification Infographic:
An infographic is a one-page graphic "story" that presents information quickly and clearly in a visual way. Simple images, icons, symbols and charts can be used to explain the data. Text is only used as labels or to briefly describe facts. The viewer follows the "story" of the science as it flows from image to image.

In this activity, students work in pairs to create an infographic to illustrate acidification (from land, to air, to sea) and its impact on Tongan marine animals, such as snails, clams, oysters, corals, starfish, sea urchins, etc. Students may focus on one species (even creating a character with a name) or on a community, such as a coral reef.

- On one sheet of paper, in simple images and words, illustrate:
  - What is ocean acidification?
  - How does it occur?
  - What could happen to marine animals as a result of acidification?
  - What is something humans can do that could reduce ocean acidification and could save these marine species?

Teachers, please photograph and send to gianna.savoie@otago.ac.nz
OR upload to Facebook group:
https://www.facebook.com/WeAreMoana

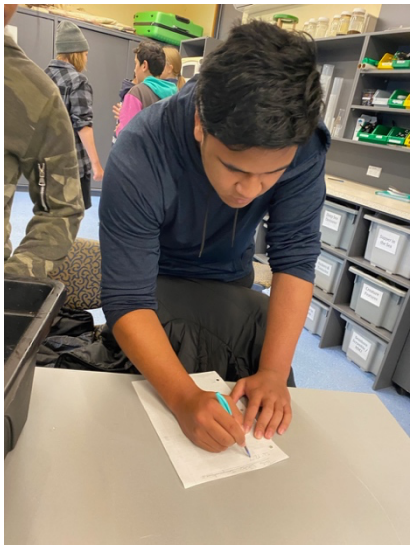
FINAL CREATIVE PROJECT:
Climate Changemakers

As the final project, students express what they have learned through a creative piece of their own that communicates a message about climate change. They may write a story or poem, create a piece of art, produce a video diary, song or performance, write a letter to a friend or relative, create a tapa cloth, etc. There is no wrong way to do this! The important thing is that it is a personal reflection. Teachers decide if the students work in groups or individually.

Some questions teachers can ask students to think about when creating their piece:

- Why is climate change important to you?
- What do you care about, worry about, hope for?
- How can you encourage others to be part of the solution?
- What is **your** message for the world?

When finished, students share their pieces with the class. Teachers, please photograph the final pieces and send to gianna.savoie@otago.ac.nz OR upload to Facebook group: https://www.facebook.com/WeAreMoana



Post-Project Activity

Climate Change Mind Map: Repeat this activity from day one with students to assess how their understanding has changed through the project. Please photograph the map and send it to gianna.savoie@otago.ac.nz OR you may upload to Facebook group: https://www.facebook.com/WeAreMoana

Instructions for Teacher:

1) Teacher writes "Climate Change" on the board with a circle around it.
2) Students write on a piece of paper a word that they associate with Climate Change
3) Students read their words, one by one, and teacher writes them around climate change circle. It's okay if words are repeated. When words are repeated by different students, teacher will make check marks or write the number of times the word was repeated next to it. Example: if three students say "storms," there will be a 3 next to that word, or √√√ next to it.
4) After all students have a chance to say their words, teacher engages them in a talanoa about why they chose those words and what they think about climate change. For example:
   - Is there something specific (an experience or story they have heard) that made them choose their word?
   - Can students identify patterns – repeated words or themes? What does that tell them?
   - Do they talk about climate change with their families?
5) Teacher photographs or copies the map

(to compare at the end and sends to gianna.savoie@otago.ac.nz)

Brief Post-Project Teacher Survey

We very much look forward to hearing your feedback on this project! Please feel free to share your thoughts with us by email at gianna.savoie@otago.ac.nz. Some things we are hoping to learn from you include:

- Did you find the Moana Explorer Lab useful to you work?
  - If so, what did you find most useful?
  - What did you find least useful?
- Did you come away with new ideas to engage your students in science/climate change?
- How likely are you to integrate the Moana Explorer techniques/ toolkit into your teaching?
- Would you recommend the toolkit to other teachers?
- Do you have ideas you would like to see integrated?
- Any other comments?

Communication Challenges Resources and Examples:

Facebook Page: https://www.facebook.com/WeAreMoana

We Are Moana is a Facebook Community where Pacific teachers and students can connect and share stories, videos, photos, artwork and thoughts about Climate Change. Many of the project outputs can be uploaded here, pending permission of parents and teachers.

Inspirational Videos: Pacific Youth Making Waves

Matagi Mālohi: Strong Winds -- Awesome, inspiring youth led Pacific Climate Warriors
"We are not drowning. We are fighting!"
https://350.org/matagimalohifilm/

Pacific Youth on Climate Frontlines (personal stories from Pacific climate activists; simple and could be something students could do on an iPad or phone)
https://www.youtube.com/watch?v=RYIjbHReHvM

Drowning Islands: The Sea Swallows Samoa (young woman telling story of how seal level rise will impact identity)
https://www.youtube.com/watch?v=X9PuPSl1_WE

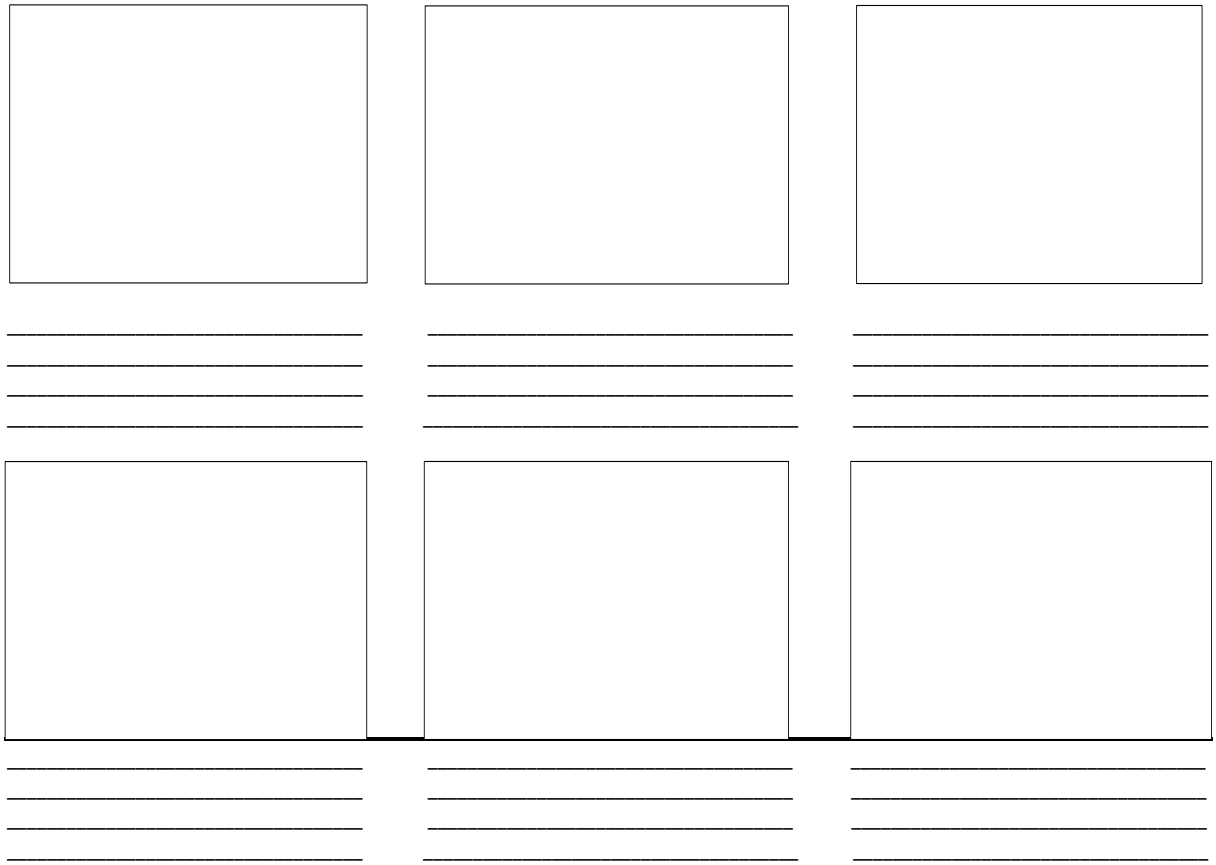
Communication Challenge Resources

Communication Challenge 1: Climate Future Storyboard

Storyboard Template (also on iPads)

STORYBOARD TEMPLATE: Project:_____

Name(s)_____ Date:_____



Communication Challenge 2: A Picture Worth a Thousand Words

Sample photos (also on iPads and feel free to choose your own examples as well):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Communication Challenge 3: Ocean Acidification Infographics (samples)

https://oceanacidification.noaa.gov/sites/oap-redesign/FKNMS_infographic.pdf?ver=2020-05-05-104419-683&timestamp=1588689915493

https://visual.ly/community/Infographics/environment/smokestacks-seashells

https://www.dfo-mpo.gc.ca/about-notre-sujet/publications/infographics-infographies/ocean-acidification-des-oceans-eng.html

Additional Information / Resources:

Scientific Skills

Science at Otago – video
https://www.youtube.com/watch?v=j2EuF-EFMeY

Activity 1 Sea Level Rise

Monthly sea levels for Tonga
http://www.bom.gov.au/ntc/IDO70053/IDO70053SLI.shtml

Infographic – sea level rise
https://climate.nasa.gov/climate_resources/125/infographic-sea-level-rise/

NASA – Lessons in sea level rise
https://www.jpl.nasa.gov/edu/teach/activity/the-science-of-earths-rising-seas/

NASA Measuring sea level with satellites
https://climatekids.nasa.gov/sea-level/