

CORAL REEFS

Environmental Change and Management

Louise Swanson, Vice President GTANSW

Investigating change

Pre-lesson class questions

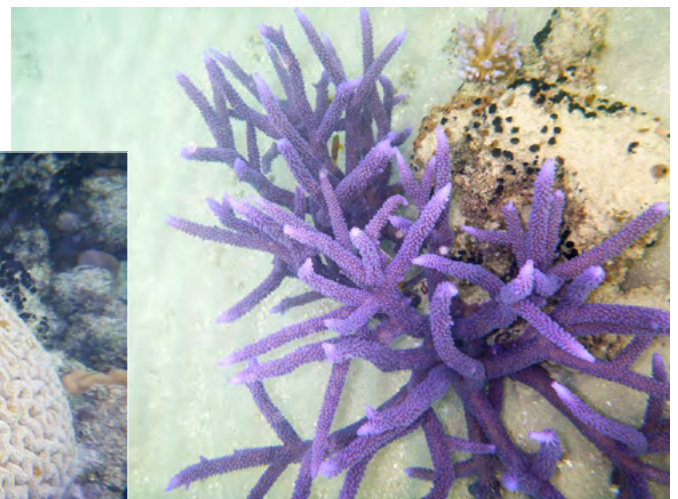
- What do you already know about types of environments and how they function?
- What are some local environments?
- What environments have you visited on your holidays?
- Are all types of environmental change negative?
- What do you already know about coral reefs?
- Have you ever visited any areas of coral reefs?
- What changes to coral reefs have you heard about in the news?

Examples of types of environments

- Coral reefs
- Coasts
- Deserts
- Grasslands
- Wetlands
- Mountains
- Polar lands
- Rainforests
- Rivers
- Tundra

Lesson activities

- Brainstorm features of the environment and processes that relate to the four spheres (lithosphere, hydrosphere, atmosphere and biosphere).
- Create a mind map of causes of environmental change.
- Create a digital portfolio on environmental change. Include three articles about environmental change at each of: local, regional and national/global scale. Write a one paragraph analysis on each article addressing:
 - What is the cause of the change?
 - What are the positive and negative impacts of the change?
 - How do these changes impact on how the environment functions?



Photographs: Louise Swanson

ENVIRONMENTAL CHANGE: CORAL REEFS



Overview – Coral reefs

In this investigative study you need to compare environmental change in Australia with at least one other country. Throughout the activities you will compare change to coral reefs in Australia with change in countries such as Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste. Explore [ArcGIS](https://www.arcgis.com/home/webmap/viewer.html?useExisting=1&layers=97071c96008d4ea6b0aabe4ed125661f) – location of coral reefs. <https://www.arcgis.com/home/webmap/viewer.html?useExisting=1&layers=97071c96008d4ea6b0aabe4ed125661f>

- With reference to ArcGIS, describe the location of coral reefs in: Australia, Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, Timor Leste

Glossary

Adaptation – when behaviour, structural form or biology of an organism change over many generations.

Coral bleaching – when microscopic algae in coral tissues are expelled when there are changes in water chemistry including changes to temperature, salinity and pH.

Coral spawning – when clouds of coral eggs and sperm are released in large quantities and float around. Eventually the egg and sperm meet and larvae settle on the old reef to grow.

Ocean acidification – the ongoing decrease in pH of oceans caused by absorbing CO₂.

Resilience – the ability to recover from a negative event.

Symbiosis – a very close relationship between two organisms

Upwelling – when cool nutrient-rich water is pushed to the ocean surface.

Zooplankton – very small animals that rely on water currents to move around

Biophysical processes

Climate and weather

Coral growth and functioning requires specific climatic and weather conditions. Average temperatures of around 26 degrees and clear water are essential for growth. If the temperature is too low the coral can't produce limestone, while if it is too high the coral will expel the zooxanthellae. Zooxanthellae are plant-like organisms that live in corals.

Corals can be damaged by extreme weather events. Heavy rainfall and floods can result in increased run-off and large amounts of sedimentation from mainland areas. These can suffocate corals and lead to algal blooms. During extreme events, wind and waves can break corals. Tropical cyclones can result in heavy rainfall (increased freshwater), increased river flow (sedimentation entering the ocean) and increased wind (coral breakage).

Symbiotic relationships

Symbiosis is a long term relationship between two organisms. There are three types of symbiotic relationship: mutualism (where both organisms benefit), commensalism (where one species benefits, but there is no benefit or harm to the other species), and parasitism (where one organism benefits to the detriment of the other). There are many examples of symbiosis on coral reefs.

Clownfish and anemones

The Sea Anemones have tentacles with stinging cells. These stinging cells kill many organisms and it is in this way the anemones get their food. Clownfish hide in amongst the tentacles of the Sea Anemone, but are not harmed by them. In this way the clownfish are protected from other predators. Occasionally the Clownfish will catch food for the Sea Anemone.

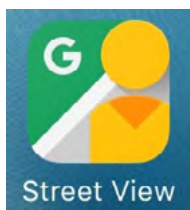
Corals and zooxanthallae

The relationship between the corals and the zooxanthallae is beneficial to both. Corals provide the zooxanthallae with an environment suitable for survival. It is moist and the coral's waste gives energy to the zooxanthallae. Through the process of photosynthesis the zooxanthallae produce compounds that the coral use for food.

Sharks and Remoras

Sharks sometimes get parasites which live on the external surface of the shark. Remoras are cleaner fish, and they attach themselves to the shark and kill the parasites. When the shark feeds the Remora are able to eat the scraps from the feed.

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Using Streetview to investigate coral diversity

Overview

Street View enables you to explore places with the full 360 degrees.

Click Explore, Choose a location, and click the Google Cardboard icon. You do really feel like you are part of the place. This could be valuable in helping students develop an appreciation of the places you are studying, and to get a better understanding of what those places are actually like.

How to...

Search for a location.

The location of the various options will show on the map. Select one of the options by scrolling down and clicking on your choice.

Students can maneuver around the reef. By scrolling to the right or left for a 360° view or by moving the forward or back arrows.

If students have access to a virtual reality headset they can click the headset icon to view it in a more immersive way.

Virtual reality lesson activity

Use Google Streetview to examine a range of sites around the Great Barrier Reef and Coral Triangle. Choose specific sites, eg, several locations around Lizard Island, or Kimbe Bay. Compare the two main virtual field sites.

Make judgements about the quality of the corals, the colours of the corals, etc.

Try to identify specific types of coral. You will need to refer to a coral identification site.

Compare the complexity and biodiversity of the two sites.

Find two secondary sources that support your findings.



Causes of change to coral reefs

Climate change

Reefs are highly vulnerable to climate change. Increasing temperatures can result in slowed growth, loss of hard corals, crumbling of reef structures and widespread bleaching. Climate change is associated with sea level rise, increased ocean temperatures, ocean acidification, increased occurrence of extreme weather events such as cyclones, and movement of species.

Population pressure

Increased population pressures on mainland North Queensland have resulted in increased levels of pollution and physical activities related to tourism on the reef area.

Tourism

The outstanding beauty of the reef attracts millions of tourists each year. The pressure placed on the reef as a result of tourism includes developments on the shoreline (and associated sewage, rubbish) increase boating activity (including oil spills, coral breakage as a result of boat propellers), and tourist activities (breaking corals while snorkelling, walking on reefs, accessing sensitive areas).

Agriculture (particularly sugar cane farming)

Agriculture, including sugar cane farming, has resulted in increased sediment and fertiliser run-off from cane farms. Sugar cane farmers apply fertilisers containing Nitrogen (N) and Phosphorous (P). Many put on extra fertiliser in case of heavy rain (so it is not all washed away). Of all fertilisers applied, only a third is absorbed by the crops. The rest is either evaporated, enters groundwater or runs off into nearby rivers or canals.

Land clearing and deforestation

Clearing of forests for farming, livestock and urban development increases runoff and the sediment it carries with it. Erosion has accelerated due to clearing of land (less tree to stabilise soil), including the erosion of river banks. Due to erosion the river can erode into paddocks. In Australia, there is believed to be four times more sediment reaching the coast than prior to European settlement, and in some places it is closer to 40 times. Indonesia is one of the world's highest deforesters, and is also home to some of the most diverse coral reefs in the world. Indonesia clears 1.1 million hectares of forest every year.

Fishing

Recreational and commercial fishing have had major impacts on the reef. Commercial prawn fishing accounts of a large proportion of Queensland's Fisheries output. Approximately 6 million kgs of prawns are harvested in a good year. Recreational fishing in the General Use

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zones of the Great Barrier Reef Marine Park (GBRMP) accounts for 75% of the fin fish taken from the reef each year. Commercial fishing includes fishing for crayfish, finfish, reef fish, barramundi and tuna.

Dredging

Dredging is removing sediment from the bottom of a river bed, harbour, etc and placing it elsewhere.



Coral bleaching

The changes in temperature and associated bleaching are resulting in a different mix of species on the reef. This will impact reefs in the long term.

Loss of species

Fish, whales, dolphins, sharks, rays and the many other organisms found in reefs rely on the complexity of the ecosystem for survival. Some fish rely on the colour of the corals for camouflage and the structure of the coral for hiding. Many organisms are unable to carry out normal functions and processes as a result of the increased ocean acidification associated with climate change. Shellfish are less able to create their shells due to increased pH. Slow growing corals will take 100-200 years to recover, meaning that the reef will not exist in the form that we have known it in the past.

Dispersal of spawn

Ocean warming impacts on the dispersal of coral spawn (eggs). Increased ocean temperatures result in a decline in the dispersal distance of coral spawn from the origin (parent coral) to the destination site. This change in dispersal patterns can impact on species' distribution, abundance or corals in particular areas and genetic diversity across reefs. Changes to dispersal patterns can also impact on the connectivity (interconnections) between different areas of the reef by limiting the areas of reef that particular coral species are located.

Poleward shift of species

Ocean warming can also result in a poleward shift of species from tropical zones to more temperate zones. Warmer waters are found further from the tropics and species are able to take advantage by increasing their range.

In Western Australia, a species of wrasse - cheorodon rebuscens has started to shift its range with displacement of recruits south of its usual habitat. There is evidence of high recruitment at the temperate edge and no recruitment at the tropical edge. The range shift provides limited expansion opportunities, reducing resilience of the species.

Irukandji are migrating further south on the Great Barrier Reef as a result of warmer waters and are also having longer seasons in other areas. There have been anecdotal reports of increases in reports of stinging and hospitalisations on islands within the Great Barrier Reef (e.g Fitzroy Island) and snorkellers are being strongly advised to wear stinger suits outside of usual peak Irukandji seasons. Irukandji and associated stings have also been reported on western side of the southern tip of Frazer Island where they haven't previously been found.

Symbiotic relationships

Following bleaching events or even natural disasters, corals can become overgrown with algae, making it difficult for coral recruits to settle and grow. The mix species on a reef can impact on how resilient that particular reefs is. The scale of the bleaching on GBR makes it unlikely that natural processes will have much of an impact on recovery in the short to medium term.



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Using twitter to investigate coral changes

Overview

Social media is a tool that students are very familiar with and use for a variety of personal and social purposes. If we can tap into students' enthusiasm for and ability to use social media we can easily harness it to enhance student learning. Recent coral bleaching events have been discussed widely on twitter by experts and organisations that study and work to protect coral reefs.

Who to follow...

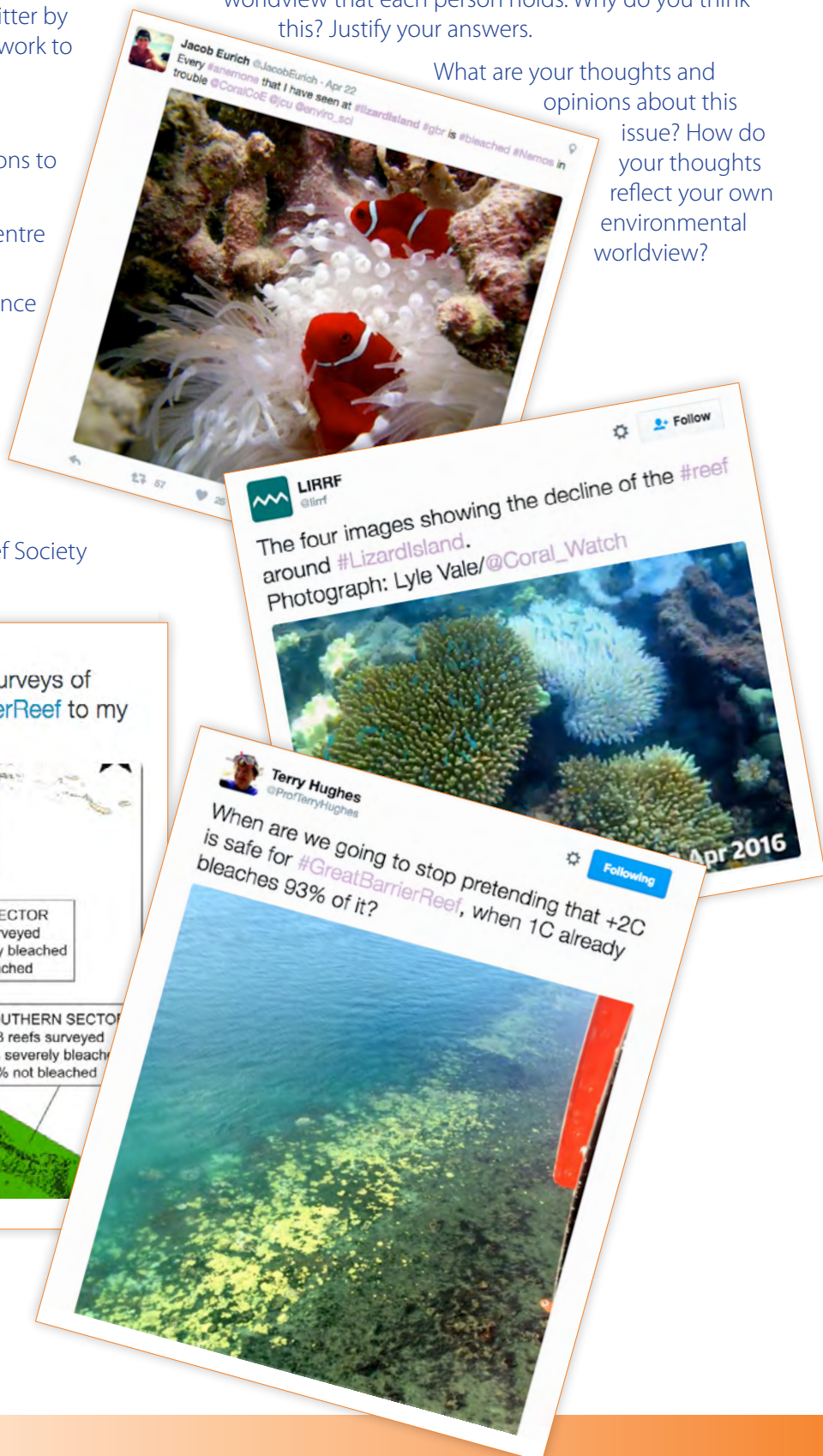
Some examples of experts and organisations to follow on twitter:

- @ProfTerryHughes – Director of ARC Centre of excellence
- @CoralCoE – The ARC Centre of Excellence for Coral Reef Studies
- @jpGattuso – CNRS Research Professor
- @AllisonPaley & @GraceEFrank – Research Assistant with Coral Ecophysiology Lab
- @jcu – James Cook University
- @AustCoralReefs – Australian Coral Reef Society

Twitter lesson activity

Investigate the differences in people's views about the causes of environmental issues such as coral bleaching and ocean acidification. Take screenshots of a range of different views about this issue. Refer to the information about environmental worldviews from previous lessons. Make an inference about the environmental worldview that each person holds. Why do you think this? Justify your answers.

What are your thoughts and opinions about this issue? How do your thoughts reflect your own environmental worldview?



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Investigating changes using GIS

In this activity you will use Reef GIS to investigate factors causing change in coral reef cover and health.

Visit Reef GIS

<http://reefgis.reefbase.org>

Before you begin the activity, explore the menus on the left hand side of the screen. You have three options: Maps, Layer and Legends.

Maps allows you to select from different map themes.

Layers allows to select the type of information that shows on your map.

Legends allows you to see the colours or symbols used on the map and a label to explain what they mean.

Some of the map themes you can choose from include: Location of coral reefs, Coral diseases, Coral bleaching and Sea Surface Temperatures, Reefs At Risk, Solomon's Post-disaster and Marine Protected Areas.

Begin by exploring the Location of Coral Reefs. Click the option from the Maps list.

You can view this information at a global scale or zoom in the look more closely at individual countries, by selecting the country name from the drop down list.

When you click on the Layers tab you are able to click the types (or layers) of information that you want to view. In this case, you can view reefs by type, geomorphology or depth. Each category of information is shaded in a different colour to help you see the information.

The Legend provides the colour and category of information shown by the colour, but you can also see this information in the Layers tab.

Comparative study: Australia and Indonesia, Malaysia or Papua New Guinea

Choose an issue/factor affecting coral reefs from the themes in the Maps section. Examine the data shown in the map. Write an information report including the following:

- Describe the issue/factor causing change in coral reef environments globally (comment on spatial distribution, scale, etc). Propose an explanation for the spatial patterns/trends you can see.
- Conduct secondary research to identify the causes of this change in Australia and at least one of the listed countries.
- For both Australia and one other country, describe the extent of the change shown in the Reef GIS map.

- Describe how Geographical Information Systems (like Reef GIS) might be used to analyse geographical information, make predictions and suggest management strategies.
- Reflect on the information you have gathered. Propose individual, community or government actions that could be taken to address the issue/factor affecting coral reefs.



Using Within to examine environmental change

Within is a virtual reality app that provides a range of educational programs, one of these is Valen's Reef, created by Conservation International: the Click Effect.

Open the Within app, select Valen's Reef.

This presentation follows a local fisherman explaining the pressures on him and his local reef.

A narrative is provided over the footage of the reef and the island. Students can maneuver around the scene to access 360° views. Students will feel immersed in the scene and the story.



Valen's reef lesson

Virtual reality lesson – Valen's Reef

Students view Valen's Reef, using the Within app. A couple of quick questions:

- What were some of the threats to coral reefs in Raja Ampat?
- What was the role of Conservation International?
- Assess whether the strategies being implemented are successful? What indicator suggest success?
- The narrator refers to continued "outside pressures". What is he referring to?
- What evidence is there throughout the experience of traditional worldviews or management structures/strategies?

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Change and management

Worldviews

Environmental worldviews are the viewpoints that people hold about how the world works and where people fit into the world. The worldview that someone holds will form the assumptions and values that guide an individual's actions towards the environment.

Egocentric: where people see themselves and their needs as the most important factor to consider.

Anthropocentric: acknowledges that humans have a variety of needs and wants that often must be placed above the desire to protect environments.

Stewardship: recognises that although humans need to make use of environments for survival and development, they have a responsibility

Biocentric: recognises the significant role that the Earth and its environments play in sustaining life, including human life. It strives to minimise the impact of human activities on environments and species.

Ecocentric: a worldview that places the preservation of environments above all other needs and wants.

The implications of different worldviews are that the competing demands for and uses of coral reefs result in varied and sometimes opposing management of the marine environment (coral reefs).

Management strategies

- Government Policy
- Legislation
- World Heritage Sites
- Marine Parks
- Zoning
- International agreements
- Government cooperation
- Traditional use
- Climate change strategies
- Low intensity fishing techniques
- Equipment restraints
- Artificial lagoons
- Reef restoration
- Species protection
- Ecotourism
- Yield constraints
- Education
- Research
- Species monitoring
- Taboos
- Reef and lagoon tenure.

Lesson activities

- Create a dot point summary about the cause of change to coral reefs.
- Develop a blog or use a twitter hashtag to compile evidence of coral bleaching globally.
- Groupwork: Coral bleaching. Investigate coral bleaching in a location other than Australia. Prepare a one minute lecture and interactive presentation to present to the class.
- Create a board game about coral bleaching.
- Write newspaper/magazine articles about the different ways that corals can be managed, and compile them into a class magazine to be published on the school website or Facebook page.
- Create a series of podcasts about coral reefs and their management. Conduct peer reviews of other groups' podcasts and provide feedback.
- Create an infographic using picktochart or a similar program. Your infographic should be on the topic of the causes and consequences of environmental change in coral reefs. It could include themes such as pollution, runoff, coral bleaching, the impact of land clearing, or coastal development.
- Identify your own worldview. Organise yourselves into groups with likeminded people, undertake research about Adani coal mine and establish your point of view about the development. Develop two opposing groups in the class, and hold a debate on: *The benefits of the Adani coal mine will outweigh the disadvantages.*



Using Storify to investigate management

Create a Storify that shows the progress of discussions, research, campaigns and decisions related to the management of a coral reef. Use the tweets and the links contained in them as a starting point for a geographical inquiry. This may help you to pose questions, planning an investigation, collecting secondary information. In doing so, consider:

- Have you represented a range of viewpoints?
- Is there evidence of reliable geographic or scientific research?
- Where can you take your inquiry from here?

Summarise the key points from your storify. This will provide the context for a geographical inquiry.