# Sample Unit: Earth and Environmental Science – Year 12

***Sample for implementation for Year 12 from Term 4, 2018***

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| **Unit title** | Module 7: Climate Science | | **Duration** | 30 hours |
| **Unit description** | **Content Focus**  A significant global concern of governments and non-government bodies relates to natural and scientific evidence of anthropogenic climate variation. The acidification and warming of oceans can affect marine life, and evidence indicates that rising sea levels could also have an impact on human communities in low-lying locations around the world.  Students examine the mechanisms and scientific evidence for climate variation. They distinguish between evidence of natural processes and scientific evidence of anthropogenic influences, both of which cause the Earth’s climate to change. Students are led to form evidence-based opinions on, and develop strategies to manage, the effects of climate variation in the future.  **Working Scientifically**  In this module, students focus on developing and evaluating questions and hypotheses, analysing primary and secondary data, and solving problems to communicate scientific understanding about climate science. Students should be provided with opportunities to engage with all Working Scientifically skills throughout the course.  This topic is ideally suited for students to access, interpret and analyse current scientific research so, wherever possible, access to current information from the internet provided by governments, universities and organisations is recommended. | | | |
| **Outcomes**  A student:   * develops and evaluates questions and hypotheses for scientific investigation EES11/12-1 * solves scientific problems using primary and secondary data, critical thinking skills and scientific processes EES11/12-6 * communicates scientific understanding using suitable language and terminology for a specific audience or purpose EES11/12-7 * analyses the natural processes and human influences on the Earth, including the scientific evidence for changes in climate EES12-14 | | | | |
| **Inquiry questions**   * How long does it take for the climate to change naturally and what causes these changes? * What scientific evidence is there of climate variations in the past? * Is there scientific evidence to show that human activity has led to a variation in the Earth’s climate since the Industrial Revolution? * Is there scientific evidence that demonstrates how humans could minimise and respond to the effects of increased global temperatures? | | | | |
| **Depth Study**  This unit does not include a Depth Study; however, these suggestions may provide the stimulus for student-initiated Depth Studies.  Conduct a field study to visit alternative energy production sites, eg wind, solar, biogas.  **OR**  Access a museum and/or science centre or exhibition, eg <http://www.powerhousemuseum.com/ecologic/the-exhibition/climate-change/>  **OR**  Contact a presenter from a university or council/government to present a workshop for the students to cover current technologies, research or local policy responses. | | **Formal assessment**  Research and Oral Presentation on Australia’s response to managing climate variation.  Students:   * produce summary factsheet(s) of their findings * deliver a speech accompanied by a digital presentation from the point of view of a climate action group or government minister * explain the options Australians have to minimise any human contribution to the greenhouse effect in their daily lives * evaluate scientific evidence for the usefulness of a range of mitigation and adaptation strategies. | | |

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| **Natural Processes of Variations in Climate** | | |
| **Inquiry question:** How long does it take for the climate to change naturally and what causes these changes? | | |
| **Content** | **Teaching, learning and assessment** | **Differentiation** |
| **Students:**   * use modelling to explain the causes of the natural greenhouse effect and examine the timescales in which changes occur (ACSES049, ACSES084) Critical and creative thinking icon  Information and communication technology capability icon Literacy icon Numeracy icon | * Students identify the range of greenhouse gases and their natural sources * Students design and conduct a practical investigation to model the effect of heat trapped in a ‘greenhouse’ situation * Students relate the observations from this model to the action of gases in the Earth’s atmosphere and explain how the natural greenhouse effect maintains a liveable temperature on Earth * Students discuss the use of models in Science to represent complex systems and allow us to make predictions * Students use a variety of resources to examine climate variation over geological time particularly focusing on the generally slow rate of change and natural variations from icehouse conditions to a greenhouse world * Working in groups, each group collates information to produce and share a factsheet on causes of natural variation in climate. | **Structured**  Students follow a practical procedure to model the effect of heat trapped in a ‘greenhouse’ situation. |
| **Students:**   * using secondary sources, assess the different causes of natural climate variation and the timescales in which changes occur, including: (ACSES104, ACSES105) Critical and creative thinking icon  Information and communication technology capability icon Numeracy icon * the plate tectonic supercycle * massive volcanic eruptions, the Deccan and Siberian Traps * changes in the Earth’s orbit around the Sun * changes in ocean currents and ocean circulation | * Students use data and information gathered from secondary research and assess the effects on climate variation on each of: * the plate tectonic supercycle * massive volcanic eruptions, the Deccan and Siberian Traps * changes in the Earth’s orbit around the Sun * changes in ocean currents and ocean circulation * Students determine the timescales and the range of variations that occurred with each process. |  |

| **Evidence for Climate Variation** | | |
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| **Inquiry question:** What scientific evidence is there of climate variations in the past? | | |
| **Content** | **Teaching, learning and assessment** | **Differentiation** |
| **Students:**   * describe and discuss ancient evidence of variations in global temperature, including but not limited to: (ACSES088, ACSES108) Literacy icon * pollen grains in sedimentary rocks * changes in rock types * fossils and microfossils * changing isotope ratios in rocks and deep sea sediments | * Students explain the use and significance of proxies in determining characteristics of previous climates * Students describe the evidence of climate variations that specific proxies can provide, including: * pollen grains in sedimentary rocks * changes in rock types * fossils and microfossils * changing isotope ratios in rocks and deep sea sediments |  |
| **Students:**   * identify and explain more recent evidence of climate variation, including but not limited to: (ACSES091, ACSES107, ACSES108) Critical and creative thinking icon  Information and communication technology capability icon Literacy icon Numeracy icon * ice cores containing gas bubbles and oxygen isotopes * dendrochronology * Aboriginal art sites showing now-extinct species and environments (ACSES107) Aboriginal and Torres Strait Islander histories and cultures icon * human instrumental records (ACSES087, ACSES107) * isotope ratios shown in stalagmites, stalactites and corals | * Students explain how a range of different techniques provide information concerning climate variation, such as: * ice cores containing gas bubbles and oxygen isotopes * dendrochronology * Aboriginal art sites (eg engravings or ochre depictions) showing now-extinct species and environments * human instrumental records * isotope ratios shown in stalagmites, stalactites and corals * Students explain how cross-referencing evidence obtained from different sources can provide stronger evidence on climate variation * Students read the publications about: * [Jawoyn ochre depiction of megafauna](http://www.abc.net.au/news/2010-05-31/megafauna-cave-painting-could-be-40000-years-old/847564) * [Burrup Peninsula rock engravings](http://www.abc.net.au/radionational/programs/backgroundbriefing/burrup-peninsula-rock-art-shows-extinct-megafauna/6561788) * Students explain the significance of this art in terms of the information about climate variation * Students outline the alleged scientific controversies surrounding the [Burrup Peninsula engravings](http://www.abc.net.au/radionational/programs/backgroundbriefing/burrup-peninsula-rock-art-shows-extinct-megafauna/6561788) and explain the potential impacts. | **Structured**  Students describe specific evidence that can be used to provide information concerning climate variation.  **Extension**  Students investigate whether the industrial complexes on the Burrup peninsula are affecting the rock engravings. |

| **Influence of Human Activities on Changes to Climate** | | |
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| **Inquiry question:** Is there scientific evidence to show that human activity has led to a variation in the Earth’s climate since the Industrial Revolution? | | |
| **Content** | **Teaching, learning and assessment** | **Differentiation** |
| **Students:**   * distinguish between the natural greenhouse effect and any anthropogenic greenhouse effects Critical and creative thinking icon  Information and communication technology capability icon | * Students describe the differences between the natural greenhouse effect and the enhanced (anthropogenic) greenhouse effect * Students explore the [Earth System Research Laboratory](https://www.esrl.noaa.gov/gmd/ccgg/trends/index.html) site and analyse the records of CO2 generated at Mauna Loa over various time periods to describe the variations recorded. They then compare global data with that recorded at Mauna Loa. * Students view the [Trends in atmospheric CO2](https://www.esrl.noaa.gov/gmd/ccgg/trends/history.html) video and describe the trends in CO2 concentrations shown since industrialisation and going back through 800 000 years. |  |
| **Students:**   * investigate any influence that human activities may have had on the environment since the Industrial Revolution, for example: Critical and creative thinking icon Ethical understanding icon  Information and communication technology capability icon Numeracy icon * increases in greenhouse gases (ACSES104) * ocean acidification (ACSES105) | * Students view a range of graphics and animations (suggested in the Resources section below) to note the rate of warming since the industrial revolution compared to the rate of warming since the last Ice Age * Students plan and conduct a practical investigation to examine the effect of the varying pH levels of sea water on sea shells (calcium carbonate) over time. | **Structured**  Students plan and conduct a practical investigation to examine the effect on the pH of water/sea water when CO2 is bubbled through it |
| **Students:**   * investigate flow-on effects of changes to climate, including but not limited to: (ACSES106, ACSES108) Sustainability icon Asia and Australia’s engagement with Asia icon Critical and creative thinking icon Ethical understanding icon  Information and communication technology capability icon Numeracy icon Civics and citizenship icon * changing weather patterns (ACSES049, ACSES050, ACSES052) * changes in glaciers, sea ice and ice sheets * changing range of species due to rising sea level | * Students plan and conduct a practical investigation to examine the different consequences of ice melt in sea ice and land ice * In groups students investigate and report on the consequences of climate variation on either: * weather patterns * changes in glaciers, sea ice and ice sheets * mountain snows, eg Himalayas * rising sea levels * biodiversity * Students formulate a comprehensive response to the inquiry question, citing a range of different types of evidence. | **Extension**  Students investigate whether changes in climate cause these effects or whether there is a correlation between them. |

| **Mitigation and Adaptation Strategies** | | |
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| **Inquiry question:** Is there scientific evidence that demonstrates how humans could minimise and respond to the effects of increased global temperatures? | | |
| **Content** | **Teaching, learning and assessment** | **Differentiation** |
| **Students:**   * investigate possible human-induced causes for the enhanced greenhouse effect, including:  Information and communication technology capability icon * the burning of fossil fuels for energy Asia and Australia’s engagement with Asia icon * land use and land cover change (ACSES092, ACSES093, ACSES094, ACSES105) | * Students analyse the data presented in ‘[What’s really warming the world?](https://www.bloomberg.com/graphics/2015-whats-warming-the-world/)’ to formulate an answer to this question * Students compare energy production and carbon emissions per ton of coal, gas and oil and outline the main uses of these fossil fuels in Australia. * Students use a variety of resources, explain the influences on the enhanced greenhouse effect of: * burning fossil fuels * bush/forest fires * land use and land cover change. |  |
| **Students:**   * investigate scientific evidence of ways in which humans may assist to minimise any human contribution to the greenhouse effect in their daily lives (ACSES098, ACSES108) Sustainability icon Critical and creative thinking icon  Information and communication technology capability icon Civics and citizenship icon | * Students calculate their [carbon footprint](http://www.epa.vic.gov.au/AGC/home.html) to determine the greatest components of their carbon usage * Students discuss ways of improving energy efficiency at home * Students compare carbon emissions from multiple individual cars vs public transport (buses/trains) for the same number of passengers. | **Extension**  Students consider the carbon footprint embedded in transported consumer goods and imported food. Discuss the implications of agricultural and commercial practices on increasing carbon footprints. |
| **Students:**   * evaluate scientific evidence for the usefulness of a range of mitigation and adaptation strategies, including but not limited to: (ACSES090, ACSES097, ACSES108) Asia and Australia’s engagement with Asia icon Sustainability icon Critical and creative thinking icon Ethical understanding icon  Information and communication technology capability icon Literacy icon * urban design * geo-engineering strategies * alternative energy sources * using or changing agricultural practices of a range of cultural groups, including those of Aboriginal and Torres Strait Islander peoples Aboriginal and Torres Strait Islander histories and cultures icon | * Students review the media publications ‘[Rethinking Indigenous Australia’s agricultural past](http://www.abc.net.au/radionational/programs/bushtelegraph/rethinking-indigenous-australias-agricultural-past/5452454)’, ‘[Fighting Fire with Fire](http://www.natureaustralia.org.au/our-work/climate/fire/)’ and ‘[The biggest estate on Earth](https://www.youtube.com/watch?v=zGO2GbLRWcQ)’ to gather information indicating ways in which Aboriginal agricultural practices reflect a clear understanding of the habits and requirements of living things * Students carry out research to form the basis of their assessment task; a research and oral presentation task on Australia’s response to managing climate change * Students: * produce summary factsheet(s) of their findings * deliver a speech accompanied by a digital presentation from the point of view of a climate action group or government minister * explain the options Australians have to minimise any human contribution to the greenhouse effect in their daily lives * evaluate scientific evidence for the usefulness of a range of mitigation and adaptation strategies. |  |

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| **Resources**  Armstrong, V (2009) Climate Change - Cool Ideas for a Hot Planet Book A and B, User Friendly Resources  **Greenhouse and climate variations:**  <https://sealevel.jpl.nasa.gov/files/archive/activities/ts1hiac1.pdf>  <http://www.starhop.com/library/pdf/studyguide/elementary/glojar-7.pdf>  <http://earthguide.ucsd.edu/virtualmuseum/climatechange1/02_1.shtml>  <http://www.indiana.edu/~geol105b/1425chap7.htm>  <http://www.ozcoasts.gov.au/indicators/greenhouse_effect.jsp>  <https://www.climatechangeinaustralia.gov.au/en/climate-campus/modelling-and-projections/climate-models/>  <http://nature.nps.gov/geology/nationalfossilday/climate_change_earth_history.cfm>  <http://www.victoria.ac.nz/antarctic/about/staff/pdf/pb-second-great-climate.pdf>  <https://www.ncdc.noaa.gov/paleo/ctl/cliscibeyond.html>  <http://www.eo.ucar.edu/basics/cc_3.html>  <https://www.bgs.ac.uk/discoveringGeology/climateChange/general/causes.html?src=topNav>  <http://www.euronet.nl/users/e_wesker/climate.html>  **Plate tectonic supercycle:**  <http://www.djburnette.com/projects/climate.html>  <https://www.ucar.edu/communications/gcip/m10histclimvar/m10pdfc1.pdf>  **Volcanic eruptions:**  <http://www.pbs.org/wgbh/nova/earth/permian-cause.html>  <https://www.geolsoc.org.uk/flood_basalts_1>  **Changes in Earth’s orbit:**  <http://www.indiana.edu/~geol105/images/gaia_chapter_4/milankovitch.htm>  <http://earthobservatory.nasa.gov/Features/Paleoclimatology_Evidence/>  **Ocean circulation:**  [http://www.pik-potsdam.de/~stefan/Lectures/ocean\_currents.html](http://www.pik-potsdam.de/~stefan/Publications/Book_chapters/rahmstorf_eqs_2006.pdf)  <http://nationalgeographic.org/media/ocean-currents-and-climate/>  **Evidence of climate variation:**  <https://www.youtube.com/watch?v=ytGgFXqJOI8> or  <https://www.youtube.com/watch?v=M9_c1tfOm-I> or  <https://www.youtube.com/watch?v=-qLvQ50Gz44>  <http://earthobservatory.nasa.gov/Features/Paleoclimatology/paleoclimatology_intro.php>  <https://www.bgs.ac.uk/discoveringGeology/climateChange/general/pastClimatesEvidence.html>  <https://www.ncdc.noaa.gov/paleo/proxies.html>  <http://www.bgs.ac.uk/discoveringGeology/climateChange/howToUseThePoster.html>  <https://www2.usgs.gov/climate_landuse/clu_rd/paleoclimate/proxies.asp>  <http://www.abc.net.au/news/2010-05-31/megafauna-cave-painting-could-be-40000-years-old/847564>  <http://www.abc.net.au/radionational/programs/backgroundbriefing/burrup-peninsula-rock-art-shows-extinct-megafauna/6561788>  <http://www.abc.net.au/catalyst/stories/3173004.htm>  <http://www.windows2universe.org/earth/climate/CDcourses_investigate_climate.html>  **Influence of human activities on changes to climate:**  McConchie, P 2013, *Fire and the story of burning country*, Cyclops Press, Avalon, NSW  Pascoe, B 2014 *Dark Emu: Black Seeds: agriculture or accident?* Magabala Books, Broome, WA  *Before the Flood.* film by Leonardo DiCaprio  <https://www.environment.gov.au/climate-change/climate-science/greenhouse-effect>  <http://www.nova.org.au/earth-environment/enhanced-greenhouse-effect>  <https://www.epa.gov/climate-change-science/causes-climate-change>  <https://www.esrl.noaa.gov/gmd/ccgg/trends/index.html>  <https://www.esrl.noaa.gov/gmd/ccgg/trends/history.html>  <http://www.ecowatch.com/leonardo-dicaprio-before-the-flood-2057070140.html>  <https://xkcd.com/1732/>  <https://www.climate-lab-book.ac.uk/2016/spiralling-global-temperatures/>  <http://climate.nasa.gov/climate_resources/28/>  <http://climate.nasa.gov/interactives/climate-time-machine>  <http://www.csiro.au/greenhouse-gases/>  <http://www.ozcoasts.gov.au/indicators/greenhouse_effect.jsp>  <http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F>  <http://ocean.si.edu/ocean-acidification>  <http://www.antarctica.gov.au/about-antarctica/environment/climate-change/ocean-acidification-and-the-southern-ocean>  <https://www3.epa.gov/climatechange/kids/index.html> <https://www.environment.gov.au/climate-change/climate-science/understanding-climate-change/indicators>  <http://climate.nasa.gov/evidence/>  <https://www.environment.gov.au/climate-change/climate-science/climate-change-future/sea-level>  <https://weather.com/science/environment/news/glaciers-then-and-now>  <http://earthobservatory.nasa.gov/IOTD/view.php?id=89257>  <https://nsidc.org/cryosphere/quickfacts/icesheets.html>  <https://www.nasa.gov/content/goddard/nasa-data-peers-into-greenlands-ice-sheet>  <https://www.nasa.gov/content/goddard/hidden-movements-of-greenland-ice-sheet-runoff-revealed>  <http://phys.org/news/2016-12-antarctic-ice-sheet-reveals-year.html>  <https://www.nasa.gov/mission_pages/icebridge/index.html>  <http://earthobservatory.nasa.gov/IOTD/view.php?id=89280>  <http://www.nova.org.au/earth-environment/climate-change-and-biodiversity>  <http://www.gbrmpa.gov.au/managing-the-reef/threats-to-the-reef/climate-change/what-does-this-mean-for-habitats/coastal-and-estuarine-habitats>  <http://www.ecowatch.com/rising-sea-levels-threaten-233-endangered-species-1881837633.html>  **Mitigation and adaptation strategies:**  <https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>  <http://climate.nasa.gov/causes/>  <http://www.climatecentral.org/news/world-passes-400-ppm-threshold-permanently-20738>  <http://nca2014.globalchange.gov/report/sectors/land-use-and-land-cover-change#intro-section-2>  <https://www2.usgs.gov/faq/node/5601>  <https://www.washingtonpost.com/news/energy-environment/wp/2016/07/12/the-ultimate-forest-fire-whatll-happen-when-the-amazon-burns/?utm_term=.16a3e8dc5bf6>  <http://www.epa.vic.gov.au/AGC/home.html>  <http://switchon.vic.gov.au/more-ways-to-save/visit-our-interactive-energy-efficient-house/Interactive-energy-efficient-house>  <http://www.climatecouncil.org.au/blaming-the-solution>  <http://www.sbs.com.au/topics/science/earth/article/2016/08/16/physicist-brian-cox-dropped-mic-one-nation-climate-denier>  <http://in.reuters.com/article/farming-climatechange-food-idINKBN12H18B>  <http://www.fao.org/resources/infographics/infographics-details/en/c/411348/>  <http://phys.org/news/2016-05-cities-combat-climate.html>  <http://www.geoengineering.ox.ac.uk/what-is-geoengineering/what-is-geoengineering/>  <http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/Browse_by_Topic/ClimateChangeold/responses/mitigation/carbon>  <https://arena.gov.au/about-renewable-energy/>  <https://www.cleanenergycouncil.org.au/policy-advocacy/reports/clean-energy-australia-report.html>  <https://www.climatecouncil.org.au/blaming-the-solution>  <http://video.nationalgeographic.com/video/food-by-the-numbers/141014-world-food-day-ngfood>  <http://www.abc.net.au/news/2016-10-19/environmental-concerns-cows-eating-seaweed/7946630>  <http://www.fao.org/in-action/micca/en/>  <http://www.fao.org/climate-smart-agriculture/resources/video-audio/video/en/>  <http://www.abc.net.au/radionational/programs/bushtelegraph/rethinking-indigenous-australias-agricultural-past/5452454>  <http://www.natureaustralia.org.au/our-work/climate/fire/>  <https://www.youtube.com/watch?v=zGO2GbLRWcQ> |

**Reflection and Evaluation**

**TEACHER: CLASS:**

**DATE UNIT COMMENCED: DATE UNIT CONCLUDED:**

* **Variations to program:** (List additional resources and outline alternative strategies used)
* **The most effective teaching/learning strategies and resources in this unit were:** (Please nominate 3 at least)
* **Less effective teaching strategies and resources for this unit were:** (Please nominate 2 at least)

**TEACHER’S SIGNATURE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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