**Year 12 Earth and Environmental Science**

## Duration

Ten weeks

## Description of unit

As energy on the Earth is changed from one form into another, it can result in events that can sometimes be classed as natural disasters, depending on their influence on human populations. Volcanic eruptions and earthquakes, which result from tectonic processes, and extreme weather events can result in hazards to human life, and also have impacts on natural ecosystems and climate. In turn, it is predicted by many scientists that human activities, including climate change, could contribute to the severity and frequency of some of these events. Humans have developed technologies which can somewhat predict the occurrence of these events, and others which aim to minimise their impacts once they occur.

## Inquiry questions

1. How and why do geological disasters occur?
2. How do natural disasters such as explosive volcanic eruptions, earthquakes and extreme weather events influence the biosphere and atmosphere?
3. What technologies enable prediction of natural disasters and minimisation of their effects on the biosphere?

## Working scientifically skills

In this module, students focus on developing and evaluating questions and hypotheses when designing and conducting investigations. They analyse qualitative and quantitative data about the evolving Earth. Students should be provided with opportunities to engage with all working scientifically skills throughout the course.

## Outcomes

A student:

* EES11/12-1 develops and evaluates questions and hypotheses for scientific investigation
* EES11/12-2 designs and evaluates investigations in order to obtain primary and secondary data and information
* EES11/12-3 conducts investigations to collect valid and reliable primary and secondary data and information
* EES11/12-4 selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media
* EES11/12-13 describes and evaluates the causes of the Earth’s hazards and the ways in which they affect, and are affected by, the Earth’s systems

| Content area | Teaching and learning | Evidence of learning |
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| **Background:**Introduction and prior knowledge of hazards and their effect on natural and built environments | **Diagnostic assessment:**The teacher engages students in a brainstorm for prior knowledge of different types of hazards (including tectonic and others) and their effects on natural and built environments. Some possible student misconceptions could be uncovered here, including use of certain terminologies such as “hazard” and “disaster”. The links to previous modules can be made clear (in particular Modules 2 and 3).**Video:**Watch Dante’s Peak (1997), Universal Studios. This provides a good stimulus to introduce the concept of volcanic eruptions as a tectonic disaster, and some of the associated hazards. Some discussion of accuracies of the portrayal of these could be useful. Different aspects of the inquiry questions can then be related to the film. Refer to [Controversial issues in schools policy](https://education.nsw.gov.au/policy-library/policies/controversial-issues-in-schools) for the use of audiovisual materials in schools. | * Students extrapolate relevant information from the video.
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| **Geological natural disasters – How and why do geological disasters occur?**Students:* using data, predict the zones along which earthquakes and both effusive and explosive volcanic eruptions are likely to occur and relate these to plate boundaries
* using secondary sources, investigate and model the changing depth of the focus of earthquakes at convergent and divergent boundaries
* using secondary sources, investigate and explain the hazards associated with earthquakes, including ground motion and tsunamis
* using secondary sources, investigate and explain the hazards associated with volcanoes, for example:
	+ ash eruptions and lava flows
	+ lahars and poisonous gas emissions
* account for the types of magma in each of the above types of volcanoes, and analyse how this affects the explosivity of their eruptions
* investigate the point at which a geological hazard becomes a disaster
 | **Practical investigations:*** Students design and conduct investigations to relate viscosity of fluids (e.g. water, oil, honey) to trapping of gases or pressure release to model explosive and effusive eruptions. They could make predictions about the outcome and relate their findings to the explosivity of eruptions at different tectonic settings, including the Cascade Mountains as described in Dante’s Peak.

[This resource provides some ideas around this type of investigation](https://www-tc.pbs.org/wgbh/nova/teachers/activities/pdf/3215_volcanoc.pdf)* Use a basic capillary viscometer to observe and record the time taken for liquids with varying viscosities to travel through the tube. Relate this concept to that of magma in different types of volcanoes at different plate boundaries.
* Model the different types of plate boundaries and the geological and tectonic features that exist (e.g. using Stop Motion, playdough 3D model, short film). They could test their model and determine the uses and limitations.

**Other activities:*** Engage students in mapping activities that relate tectonic events to plate boundaries. Data can be accessed from reliable government sources.

[Geoscience Australia](https://earthquakes.ga.gov.au/)* Access data to plot locations of earthquake foci along a known convergent plate boundary to predict the existence of a subduction zone. Draw a labelled model of the inferred subduction zone.
* Research and report on various types of hazards associated with earthquakes (including ground motion, soil liquefaction, building collapse, tsunamis) and explosive volcanoes (including pyroclastic flows, lahars, poisonous gas emissions). Students could be asked to assess the credibility of sources accessed. They could also make links to the occurrence of these in Dante’s Peak.
* Access real seismograph data to determine the magnitude and location of an earthquake and predict the likely hazards, given these factors.
* Produce graphs from data on the composition of volcanic material released in effusive and explosive eruptions. Students could be asked to hypothesise on whether the gases have resulted from certain tectonic settings.
* Use evidence from secondary sources to determine at what point in the movie the Dante’s Peak eruption would be classified as a disaster.
* Research and report on the evidence that exists for Aboriginal and Torres Strait Islander Peoples’ historical observations of large scale disasters such as volcanic eruptions, tsunamis, earthquakes and storm events.

[Article on Aboriginal legends revealing links to ancient events by BBC](https://www.bbc.com/news/world-australia-32701311) | * Students make links between real scientific processes and their portrayals in non-scientific media.
* Students make hypotheses, design and conduct a practical investigation to obtain primary data and analyse and communicate findings.
* Students construct models and assess the effectiveness, benefits and limitations.
* Students extract information and make inferences from a graph.
* Students show an understanding of scientific concepts using labelled scientific diagrams.
* Students assess the relevance, accuracy, reliability and validity of secondary source data.
* Students produce graphs from quantitative data extracted from secondary sources.
* Students appreciate and understand some of the Indigenous ways of knowing about the world.
* Students explain, in great detail, how and why earthquakes and volcanoes occur
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| **Impact of natural disasters on the biosphere – How do natural disasters such as explosive volcanic eruptions, earthquakes and extreme weather events influence the biosphere and atmosphere?**Students:* Use data from secondary sources to compare the eruptions that occur at explosive and effusive volcanoes in terms of the impact on the biosphere and atmosphere
* Analyse the effects of a major volcanic eruption on the atmosphere in terms of changing the climate (both warming and cooling)
* In a case study, investigate one eruption that has had a significant effect on the biosphere and atmosphere and assess its impact, including but not limited to Mount Pinatubo
* evaluate the causes and physical impact of climatic phenomena on a local ecosystem, including:
	+ hailstorms
	+ east coast lows
	+ droughts or floods
	+ bushfires
* investigate how human activities can contribute to the frequency and magnitude of some natural disasters, including:
	+ droughts or floods
	+ bushfires
	+ landslides
 | **Practical investigations:*** This can be conducted as an open-ended inquiry task. In the scene in Dante’s Peak where the boat quickly corrodes over the lake before Ruth jumps in the water with minor visible injuries likely? Formulate hypotheses and design and conduct an investigation into the effect of acidity (from volcanic activity) on human flesh (such as using pig skin) and on metals used in boats. Students could then communicate their findings in a scientific report.
* Students design and investigate whether human activities (e.g. urbanisation, land clearing, climate changes, and introduced species) influence the intensity or spread of bushfires by modelling in the laboratory. E.g. do leaves from introduced species burn with more intensity or spread easier than native ones?

**Other activities:*** Research evidence from secondary sources to describe examples where explosive eruptions have affected climate in the short and long term. Analyse graphical data on global temperature before and after large eruptions, such as Krakatoa or Pinatubo.
* Use Mt Pinatubo as an example case study and compare with a different eruption to asses impacts on biosphere and atmosphere. Create a table to compare all similarities and differences.
* Investigate safe levels of volcanic gas emissions for humans. Assess the scene from Dante’s Peak showing deceased animals from exposure to gas. Suggestion to research Lake Nyos, Cameroon as an example.
* Research and investigate the question: “What would happen if a tsunami hit Sydney?” Use secondary sources and make predictions about possible observations based on events that have occurred in the past.

[Article on impacts of a possible tsunami at Sydney by ABC](https://www.abc.net.au/news/2018-10-16/what-would-happen-if-a-tsunami-hit-sydney/10376680)* Present case studies on the cause and impacts of recent climatic phenomena such as Black Saturday bushfires, Newcastle/Wollongong storms/floods associated with ECL, Sydney hailstorms, and NSW droughts.

[Catalyst Report on “Extreme Weather”](http://www.abc.net.au/catalyst/stories/3796205.htm)* Investigate and report on Indigenous stories that involve past climatic phenomena.

[Indigenous weather knowledge](http://www.bom.gov.au/iwk/culture.shtml)[Traditional bushfire stories](https://www.fire.nsw.gov.au/gallery/files/pdf/publications/Traditional%20fire%20stories.pdf)* Assess the validity, reliability and accuracy of news reports and documentaries regarding how humans impact (e.g. climate change) on the frequency and magnitude of droughts or floods, bushfires and landslides.
* Investigate whether there has been an increased frequency of ECLs in more recent years as a possible consequence of climate change.
* Research the effects of droughts in Australia on the health of natural ecosystems. Assess the evidence for the contribution of human activities to this problem.
 | * Students make links between modules, in particular with ideas around climate change and in Module 7 and sustainability in Module 8.
* Students appreciate the impacts of natural disasters on the biosphere, including human populations and on natural ecosystems.
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| **Prediction and prevention of natural disasters – What technologies enable prediction of natural disasters and minimisation of their effects on the biosphere?**Students:* Use secondary sources to evaluate the effectiveness of technologies in predicting natural disasters, for example:
	+ volcanoes: three-dimensional imaging, seismic data, early-warning systems, ground-movement data, analysis of historical data
	+ earthquakes: ground movement detectors, anomalous animal behaviour, strain meters
	+ east coast lows: temperatures, pressure systems
* Investigate and evaluate the technologies used to minimise the effect of natural disasters associated with volcanoes and earthquakes, including building codes, disaster warning systems and education
* Using secondary sources, assess the accuracy of technologies used in meteorology to predict and prevent damage to life and infrastructure as a result of natural weather events
 | **Practical investigations:*** Design and construct a model seismometer or tiltmeter that could detect vibrations. Assess the effectiveness of the model, identifying benefits and limitations.

**Other activities:*** Research and report on each of the technologies used Dante’s Peak (such as seismometers, gravity meters, lasers, tiltmeters and COSPEC meter) and determine their use in predicting volcanic events.
* Research and report on technologies that could be used to help predict earthquakes and tsunamis (e.g. radon gas detectors, tsunami detection devices) and those used to mitigate the impacts of such events (e.g. seawalls, evacuation procedures, building codes).
* Design an early warning system, such as an evacuation plan for Dante’s Peak or similar and one that could be developed for communities in developing countries.
* Conduct a literature review into anomalous animal behaviour preceding earthquakes to determine whether animals can predict or warn about major oncoming earthquakes.

[Article on animals predicting earthquakes by Live Science](https://www.livescience.com/32156-can-animals-predict-earthquakes.html)* Use models and simulation tools to investigate changes in technology since WWII and assess the accuracy of these technologies such as Doppler radar and weather balloons in predicting and preventing damage to infrastructure.

‘[Tools Used in Meteorology](https://sciencing.com/tools-used-meteorology-22362.html)’* Research and report on practices used by Indigenous Peoples to mitigate problems associated with bush fires.
 | * Students can explain the benefits and limitations of different technologies used to enable prediction of natural disasters and minimisation of their effects on the biosphere.
* Students can conduct a critical literature review using scientific skills for a topic which is controversial in the scientific community (animal behaviours preceding earthquakes).
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## Reflection and evaluation