Edexcel AS and A level Geography

Topic Booklet for Area of Study 1: Dynamic Landscapes, Topic 1: Tectonic Processes and Hazards

Practical support to help you deliver this Edexcel specification

Topic 1: Tectonic Processes and Hazards offers students the opportunity to investigate and interpret the physical nature of tectonic processes and their impacts on an ever-changing planet. Students will learn about the history of theories, and develop an appreciation for the complex geography and geology of our planet. These important themes will be developed further in terms of coastal lithology and other subject areas later in the course, and an awareness of the basics will help students throughout.

This booklet is aimed at helping teachers to develop a clear path through the unit, and should allow you to adapt your resources and develop your teaching as you guide your students through the content. It aims to show that the content is manageable over the guided learning hours, although teachers will know the pace they need to get students ready for the exam.

The booklet is aimed at both the AS and A levels in Geography; the AS Assessment will be at the end of the first year, and the A level Assessment will be at the end of the second year.

Centres can adapt the guided learning hours to fit their own contexts and teaching styles. This topic guide has been produced as an example approach and is not intended to be prescriptive. It will indicate resources that you can use to support your teaching. These are only suggestions, and you are encouraged to use a wide range of resources to suit the needs of your students.

The advised teaching time for Topic 1: Tectonic Processes and Hazards is 18 guided learning hours. This requires some blending together of the detailed content. The guidance below includes suggestions about contextualisation or challenges that may be suitable for stronger students, as well as expected lesson outcomes for less able students. Please note that these are suggestions only and not specific syllabus requirements.

Each enquiry question/key idea is broken down into manageable sections, each beginning with a quick overview of the breadth of the enquiry question followed by a more detailed explanation of the key concepts and processes, examples of teaching strategies, guidance on integrating geographical skills, and a summary of the key terminology required. The structure is suggestive, not prescriptive.

Synoptic linkages and case study nesting

Our synoptic themes help students see ‘the bigger picture’ by encouraging them to make geographical links between topics and issues. To enable this, and to support exam preparations, we have continued to signpost ‘Players’ (P), ‘Attitudes and Actions’ (A) and ‘Futures and Uncertainties’ (F) throughout the specification content.

Synoptic links especially include topics such as glaciation and the hazards that exist between volcanic eruptions and glacial outbursts. Other links can include geological formations, coasts, raw materials, mining and farming, all of which are discussed in other areas of the course.

Introduction

Overview
Much of this topic has the potential to draw on material from the 2008 specification's World at Risk topic. More time will need to be spent on certain areas in terms of the physical nature and causes of events and a thorough understanding of the plates and their movements. Students should be aware that this content can appear in the synoptic paper and therefore it is useful to have a grounding in the potential causes and impacts in a range of locations.

EQ1: Why are some locations more at risk from tectonic hazards?

Teaching approach over 4 hours

Lesson 1 (1hr)	Global distribution of tectonic hazards.
Lesson 2 (1hr)	The theory of plate tectonics.
Lesson 3 (1hr)	Physical processes of plate tectonics.
Lesson 4 (1hr)	Physical processes explain the causes of tectonic hazards.

Lessons 1 and 2: The distribution and theories

Overview
For the start of this unit, teachers will need to get across the basics of the topic, including the history of the theories. This may be best approached via a timeline, while the distribution will need to be discussed and explained. Often students fail to fully appreciate the terminology here, which is key for examinations, and so all students, especially weaker ones, would do well to start a vocabulary book which will serve them well if tested regularly.
The key areas studied in these two lessons are the global distribution of tectonic hazards and the historic understanding of theoretical issues.

Key concepts and processes

All of the following should be understood in terms of their theoretical and physical elements, as well as the evidence for these and the historical context in which the theories were developed.

- Sea-floor spreading
- Continental drift
- Palaeomagnetism
- Plate boundary names and distribution

Students will also need to understand the physical processes of the earth, including:

- Slab pull, its impacts on subduction and its physical properties
- Mantle convection – how and why it occurs
- Subduction, and the fact that the subduction zone plays a large part in the creation of earthquakes and volcanoes

Internal earth structure – appreciate the different layers within the earth and their importance in terms of tectonic activity.

Guidance on teaching

Tectonics is both a broad and intricate subject. As it helps to underpin a lot of the geological concepts within the course, students at both A and AS level need to understand it clearly and well.

For the development of theory, less able students would benefit from the simple timeline shown below.

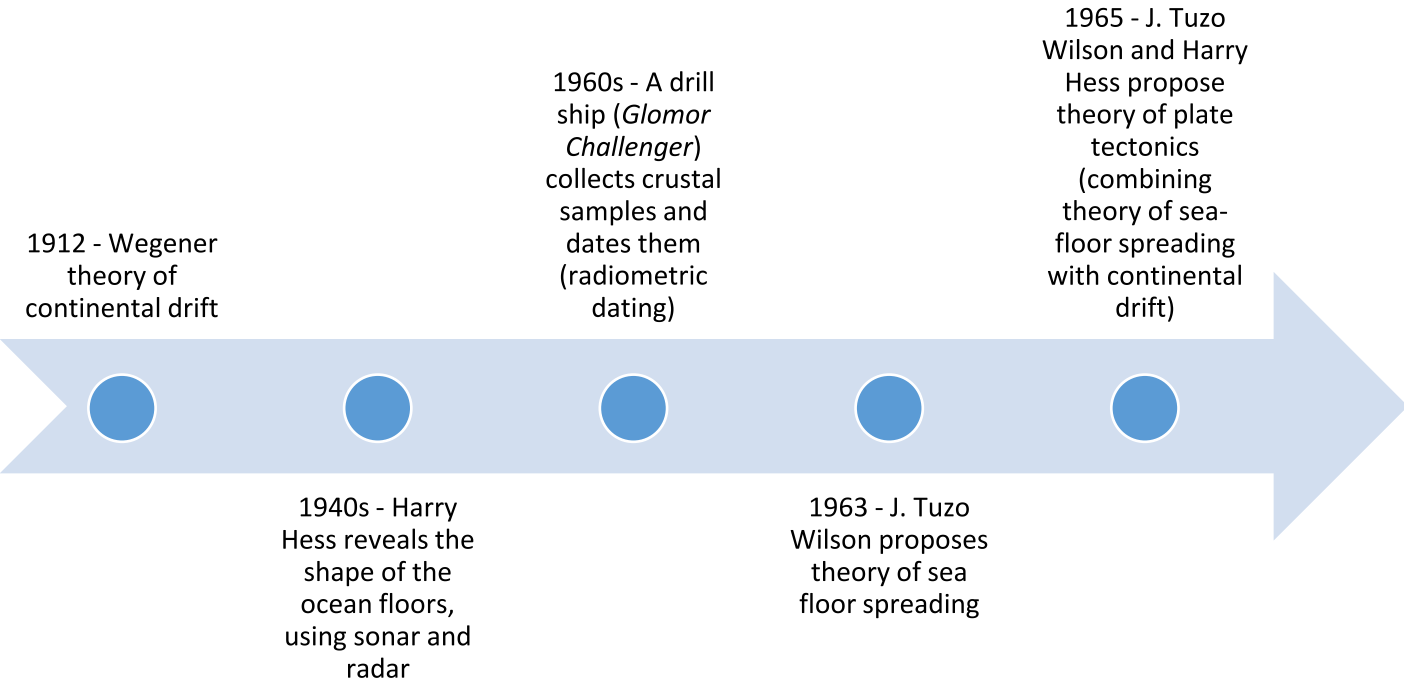

Figure 1: Tectonic timeline

Stronger students may wish to explore further, and there are many books and videos available for this (resources are listed below).

The differing evidence can be discussed and evaluated in groups, and students may wish to come up with their own theories as to how and why the earth's plates move as they do. (For a good interactive slideshow, see: timeline of discovery tracing the development of the theory of plate tectonics http://slideplayer.com/slide/7619133/)

Understanding of plate movements is often weak in less able students, and past exams have shown that some students lack a clear appreciation as to why plates move and the physical processes taking place. It is important that students know not only the movements but the names of all these plates, and good examples can be found in case studies. The more obvious ones can be used from the previous specification, including California (San Andreas), the Philippines (Philippine Fault Zone) and the Himalayan faults, while more able students may wish to look at more complex faults such as the Iberian fault or the Haiti fault line (Enriquilla-Plantain Garden Fault). Understanding the complexities of fault lines can be achieved via activities such as presentations, posters and spider diagrams, which will help students to appreciate the processes and the order in which they occur. Often boundaries do not follow the set patterns laid out in books. Both the Haitian and the Iberian fault lines are good examples, as they exhibit complexities that stronger students can investigate. The Haitian fault is a transform fault that is an offshoot of a subduction boundary, while the Iberian plate has many movements at different speeds. A useful resource with more information can be found at: http://geographyfieldwork.com/BarcelonaEarthquake1.htm

The earth is put under different pressures as the mantle pushes and pulls it in different directions. The San Andreas fault can exhibit similar issues to those described above but with less complexity; students can consider the impacts of such stresses and also possible links to features such as mining and water through basement capture and stream cut-off evident in many areas of the Owens Valley in California.

Lessons 3 and 4: Physical Processes

Overview

The key ideas of these lessons will be the physical processes within the earth and how they create hazards around the world. Now that students have an understanding of the history and reasons why plates move, teachers can build on this by getting students to think about how the processes cause events at different plate boundaries. For less able students, a table on these might be helpful, while a clear understanding of magma viscosity, heat and silica content is important in the appreciation of the chemical make-up of magma – not only the reasons for this but also why it influences different landforms.

Within these lessons, block diagrams can be used to show the movement of plates and the way this can create a variety of hazards as well as landforms. Examples of these can be found here: (http://christchurchquakes.weebly.com/plates-boundaries-and-faults.html)

Plate movement can often determine the extent of hazard. Stronger students may be able to determine these hazards, while weaker ones may need help via case-study analysis. Students could look at the variety of plates and consider the level of risk in each one. Synoptically, it is worthwhile for stronger students to consider the importance of coastal populations and their proximity to tectonic hazards, which was brought so vividly to life with the Indian Ocean tsunami of 2004 and the Tohoku tsunami of 2011.

Key concepts and processes

- The processes that determine magnitude and frequency.
- The physical different physical compositions of magma and their impact on lava movement and explosivity.

- The importance of the Benioff Zone in determining the outcome of an earthquake.
- The reasons for and differences between S and P waves and the hazards they create.
- The formation of tsunamis and the importance of prediction
    - the consideration of time – travel maps of the tsunami and the importance of prediction and warning in reducing the impact of such events.

Guidance on teaching

The importance of the geology of the area can be studied in terms of Haiti and Christchurch, which clearly show issues with liquefaction and the heightened impacts this can have. A slinky© is often a good way for students to appreciate the movement of the three wave types, while examples from YouTube and other videos can be helpful in terms of the importance of depth and focal point of an earthquake (*Anatomy of an earthquake* by Professor Iain Stewart, NERCscience, can be found on YouTube).

The impact of these events can be explored via student research into case studies (some useful links are offered below) where landslides and avalanches, liquefaction and the generation of a tsunami have occurred (Nepal 2015 – landslides and avalanches; El Salvador 2001 – earthquake; Christchurch 2010/11 – liquefaction; Japan 2011 – tsunami).

For volcanoes, studies in magma behaviour and the impact of eruptions can be taken from many different examples, including Eyjafjallajökull for tephra and ash fall, Pinatubo 1991 and Monserrat 1995–7 for pyroclastic flows, Lake Nyos 1986 for gas eruptions, as well as Eldfell 1973 and Mount Kilauea for lava flows.

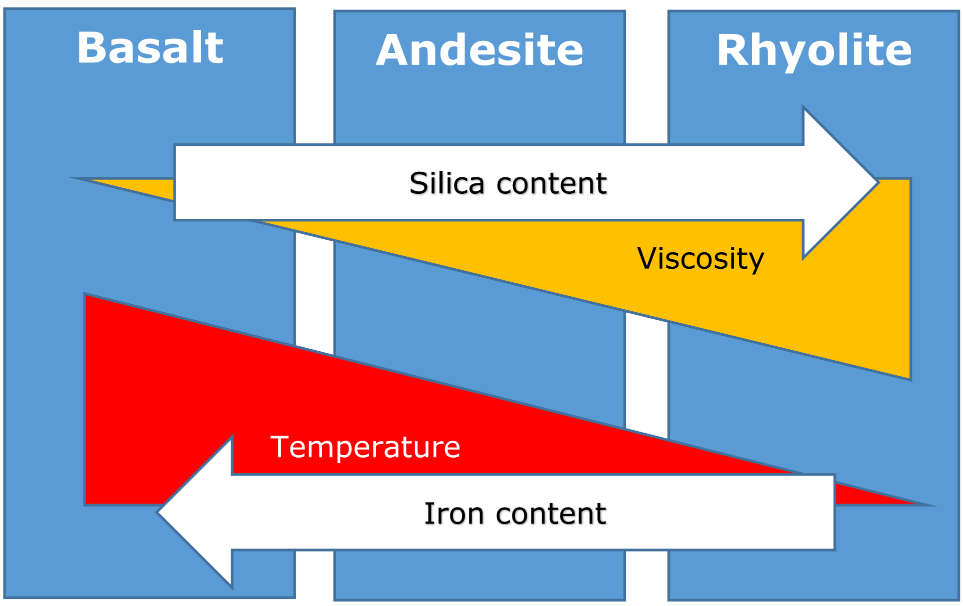

Figure 2: Physical properties of magma (J. Foster)

The three magma types			
Volcanic rock type	**BASALT**	**ANDESITE**	**RHYOLITE**
Description	Black to dark grey	Medium to dark grey	Light coloured
Volume of earth's surface	80%	10%	10%
Silica content	45–55%	55–65%	65–75%
Temp	1000–1200	800–1000	600–900
Viscosity	Low (consistency of melting ice cream)	Intermediate	High (consistency of toothpaste)
Gas escape from magma	Easy	Intermediate	Difficult
Eruptive style	Peaceful	Intermediate	Explosive

Figure 3: The three magma types

Students need to understand how tsunami generation is caused and the actual wave generated. This can be achieved by teachers explaining the process by which water column displacement occurs (the physics of a tsunami can be found here: http://wcatwc.arh.noaa.gov/?page=tsunami_science and more information including the tsunami warning system map can be found at: http://www.earthsci.org/education/teacher/basicgeol/tsumami/tsunami.html)

Hazards come in many forms, and stronger students can make links between glaciers and volcanic eruptions by studying the Icelandic glacier Vatnajökull, which has several volcanoes beneath it. The glacial outbursts of the past are well documented and include Grímsvötn, where major flooding occurred in 1996. (Some great links are below.) These jökulhlaup can be devastating and many interesting Icelandic case studies can be reviewed and compared.

Key vocabulary for EQ1

Key words	Definition
Basalt	Fine-grained, igneous rock, underlying more of the earth's surface than any other rock type, especially ocean basins. Associated mainly with constructive plate boundaries.
Andesite	Typically found in lava flows produced by stratovolcanoes. Generally formed after an oceanic plate melts during its descent into the subduction zone.
Rhyolite	Formed from granitic magma in continental or continent-margin volcanic eruptions where granitic magma reaches the surface. Rhyolite is rarely produced at oceanic eruptions.
Benioff Zone	A dipping flat zone where earthquakes are produced by the interaction of a downgoing oceanic crustal plate with a continental plate.

Subduction zone	The place where two lithospheric plates come together, one riding over the other. Most volcanoes on land occur parallel to and inland from the boundary between the two plates.
Crustal fracturing	Occurs when the earth's crust causes rock to break and fracture under stress and strain caused by seismic stresses.

Resources

http://slideplayer.com/slide/9374873/ Interesting slides of earth development and resources (APES: Chapter 8 Earth Systems & Resources).
http://www.physicalgeography.net/ PhysicalGeography.net has a lot of further information.
http://pubs.usgs.gov/gip/dynamic/historical.html – USGS historic perspective of tectonics.
http://www.nerc.ac.uk/press/releases/2014/25-earthquake/ – 'Anatomy of an Earthquake'.
https://volcanoes.usgs.gov/vhp/gas.html – USGS: Volcanic gases can be harmful to health, vegetation and infrastructure.
http://geology.com/ – Website for all things geological; great for pictures and definitions as well as further research for teachers and students.
http://www.flashcardmachine.com/geologycrustal-deformation.html – Flash cards for vocabulary.
http://www.physicalgeography.net/fundamentals/10l.html – Crustal deformation processes.
http://www.wdcgc.spri.cam.ac.uk/news/jokulhlaup/ – The 1996 Iceland jökulhlaup (World Centre for Glaciology Cambridge).
http://hvo.wr.usgs.gov/volcanowatch/archive/1996/96_10_11.html – USGS: Iceland's subglacial eruption.

EQ2: Why do some tectonic hazards develop into disasters?

Teaching approach over 4 hours

Lesson 5 (1hr)	The processes of disasters.
Lesson 6 (1hr)	The social and economic impacts of tectonic hazards.
Lesson 7 (1hr)	Tectonic hazard profiles.
Lesson 8 (1hr)	Development and governance and its effects on impacts.

Lessons 5 and 6

Overview

These lessons aim to look at key idea 1.4 and how a disaster occurrence can be explained through the relationship between hazards, vulnerability and resilience.

This enquiry question begins to look at why some hazards turn into disasters. It is important that students first realise what the processes for this are, then they can build on this in terms of impacts. There are many case studies that can be used here to help students determine why some hazards become disasters and some do not. Less able students who have already begun to build up case studies of disasters for comparative purposes may find it useful to continue doing this when looking at the PAR (pressure and release) model.

More able students may wish to consider the implications of physical processes of hazards as well as the type of hazards, and how one can affect the other. To help them understand the relationships between hazard vulnerability and resilience, students can draw on knowledge gained from EQ1 as well as other areas of the specification, such as globalisation and the growth of cities with high population densities in the developing world, which can both increase hazard risk and decrease resilience.

Key concepts and processes

Students need to understand:

- the difference between a natural hazard and a natural disaster, including definitions of both. The Emergency Database of Disasters (EM-DAT) provides an objective basis for vulnerability assessment and rational decision-making in disaster situations.
- the importance of the ‘Disaster Risk Equation’ in determining a disaster.
- the importance of the Pressure and Release model in determining hazard vs. disaster. This model looks at the physical and human factors within a disaster and can help in determining the importance of each by separating them into specific issues.
- the variety of magnitude scales for tectonic hazards, including Mercalli, Moment Magnitude Scale (MMS), Richter Scale and Volcanic Explosivity Index.
    - The MMS was developed when it was seen that the other two tended to underestimate the size of large earthquakes. The MMS, or M_w as it is sometimes known, is clearly linked to the physical size of an earthquake, since the seismic moment is a measure of the size of an earthquake based on the area of fault rupture, the average amount of movement, and the force that was required to overcome the friction holding the rocks together.
- the concept of threshold and resilience.
    - This idea reviews a community’s capacity to cope with a disaster. It is hard to measure as it consists of many factors, and since threshold varies between communities, so too does their ability to cope with specific hazards for a variety of reasons such as lack of preparation, perception of hazard etc.

Guidance on teaching

Some of the information from the previous specification can be used here, including the risk equation and definitions of hazards which will be important. Key comparative case studies might include the Haiti 2010 vs. Christchurch 2010/11 earthquakes, as these are excellent for appreciating the two countries' resilience and capacity to cope. This could be done by research or via presentations by students, or stronger students could hold a debate to help differentiate the reasons why the two hazards had such varied outcomes.

Though these two case studies offer distinct differences, it might be worth introducing another example where the differences are blurred, to help students appreciate that wealth and governance are not always the key to success. These could include the 2008 Sichuan earthquake and the 2010 Eyjafjallajökull vs. 1995 Monserrat volcanic eruption, or indeed the more recent Ontake 2014 eruption.

The important aspect of this type of case study is for students to be able to identify key factors that produced such vastly different outcomes. For weaker students, being able to understand and distinguish root causes, dynamic pressures and unsafe conditions will help them to appreciate what makes a hazard escalate into a disaster.

Since vulnerability has many facets, students will need to be aware of the reasons why some people or groups of people are more vulnerable to hazards than others. These could be put into broad categories:

- gender
- age
- proximity to hazard and isolation and accessibility
- inequality of access to education
- income opportunities
- population density and the degree of urbanisation
- environmental degradation
- housing.

More able students could research these categories or discuss them in pairs with reference to their case studies. This could also act as a stepping stone into the hazard profiles.

Lessons 7 and 8

Overview

Key ideas 1.5 and 1.6 are developed here, giving students an opportunity to look at hazard profiles and how they are a key way for countries to help build resilience to hazards. They can be researched using diagrams from the previous specification (GE04), or drawn by the students through research or instruction.

What students have learnt in lessons considering both magnitude and resilience will now help them to appreciate the importance of disaster management and good governance, as seen through resilience. More able students may begin to form links about this early on, and they can consider the wider links to development and infrastructure which can be exemplified using a variety of case studies.

Often the human aspects can be overlooked here, and it is worth getting 'large datasets' of HDI figures or other measures of development for students to contrast and begin to appreciate the reasons behind the impacts of these events and why some are dealt with better than others.

More able students may wish to compare disasters such as similar-sized earthquakes or volcanoes and review their causes and impacts. They can consider the importance of other factors that might have led to similar disasters having contrasting results, such as the Kashmir and Sichuan earthquakes of 2005 and 2008.

Key concepts and processes

Students need to understand:

- the factors that make up hazard profiles.
- the reasons why some hazards are more disastrous than others, such as time of day, time of year, planning, modification and adaptation techniques employed.
- correlation techniques to help analyse links between the human factors that can shape a situation and the physical processes in creating a disaster.

Guidance on teaching

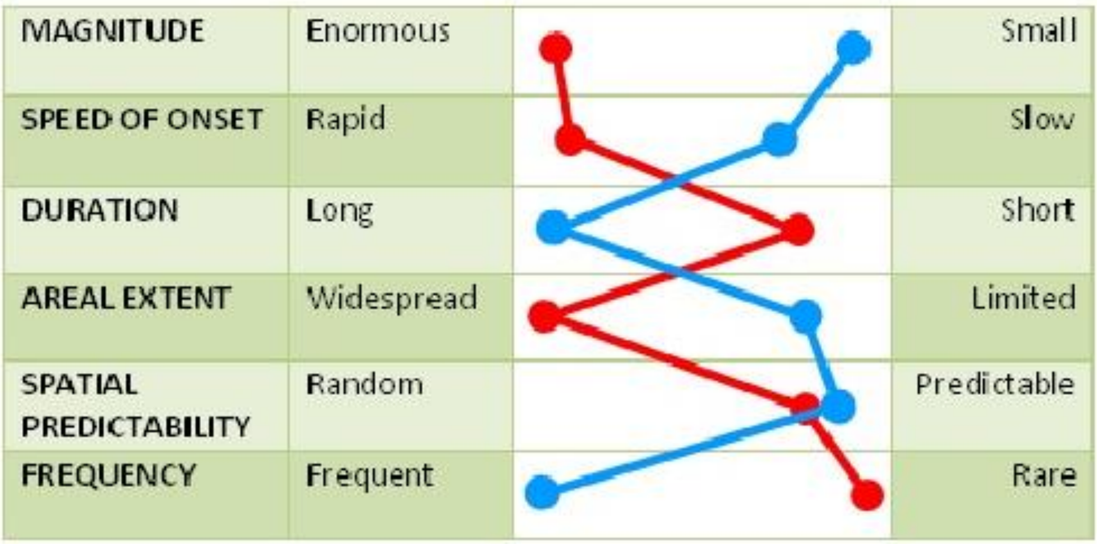

Figure 4: Example (Edexcel), showing hazard profiles for Boxing Day tsunami 2004 (red) and Kilauea continuous eruption 1983 (blue)

These two lessons can be combined in several ways and stronger students may well come up with conclusions based on research material presented to them, for instance the information from:

- HDI (http://hdr.undp.org/sites/default/files/ranking.pdf – HDI ranking by country, 2014)
  http://hdr.undp.org/sites/default/files/hdr_2015_statistical_annex.pdf – HDI datasets from the Human Development Report 2015
- EM-DAT information on several events via comparison – http://www.emdat.be/database
- International census data – http://www.census.gov/population/international/data/

These datasets will allow students to explore different areas, and there are many others that could be used, including the corruption index (http://www.transparency.org/research/cpi/overview). Students can use correlation techniques to analyse links between magnitude of events, deaths and damage. This can be achieved through group work where students use techniques such as Spearman's Rank to work out whether correlations exist. Climatic and other data can help students make a good overall judgement on the why an event unfolded into a disaster and to some extent deliver a verdict on some communities' capacity to cope.

Governance is an important aspect of a country's resilience, and again it is important to develop students' understanding of this. The teacher may wish to use activities such as a role-play exercise where students are put in charge of rich countries and poor countries and asked to develop their plans and preparation techniques using the income they have. Students then evaluate the importance of each method.

The importance of governance was brought into the limelight with the Tohoku earthquake in 2011 which caused the Japanese tsunami. Japan's energy policies, investment and ageing population led to failings in its planning for such an event, while the 2010/11 Christchurch earthquakes showed that good management worked, but slow insurance payouts could have led to more problems for the country.

Key vocabulary for EQ2

Key words	Definition
Mega-disaster	An extreme disaster which can impact globally.
Resilience	The capacity to overcome or recover from a setback or hazard.
Mitigation	Reducing the impact of a problem.
Hazard profile	A method to help in preparing for a hazard using several key elements such as speed of onset and areal extent.
Speed of onset	The time between an event occurring and it being felt, e.g. an earthquake can be instantaneous, while a tsunami wave may take some time to arrive.
Areal extent	The area over which damage occurs or a hazard is felt.
Spatial predictability	The extent to which the location of a hazard can be known in advance; this is generally easy for a volcano but less so along fault lines.
PAR model	A model developed by Blaikie et al. (1994). It depicts a disaster as a product of physical exposure and socio-economic pressure.
Threshold	In this context, the level of resilience a community has before it is overwhelmed by a disaster.
Focal depth	The depth of an earthquake, the point within the earth where an earthquake rupture starts.

Resources

http://www.geo.mtu.edu/UPSeis/intensity.html – How Are Earthquake Magnitudes Measured?
http://www.census.gov/population/international/data/idb/informationGateway.php – US Bureau of Census Data.
https://www.cia.gov/library/publications/the-world-factbook/ – World fact book by the CIA, great for country data and overview of individual nations.
https://www2.usgs.gov/natural_hazards/ – USGS natural hazards.
http://earthquake.usgs.gov/regional/nca/1989/ – USGS data on Loma Prieta Earthquake, 1989.
http://pubs.usgs.gov/gip/volc/text.html – *The Nature of Volcanoes*, R. Tilling.
https://www.geog.leeds.ac.uk/outreach/resources-for-teachers/ Leeds University resources for teachers.

EQ3: How successful is the management of tectonic hazards and disasters?

Teaching approach over approximately 6 hours

Lesson 9 (1hr)	Trends in tectonic disasters.
Lesson 10 (1hr)	The concept of a multiple-hazard zone.
Lesson 11 (1hr)	Prediction and forecasting; management.
Lesson 12 (1hr)	Use of Park's Model to compare the response curve of hazard events.
Lesson 13 (1hr)	Strategies to modify the event.
Lesson 14 (1hr)	Strategies to modify loss.

Lesson 9: Trends in tectonic disasters

Overview

This lesson looks at Key idea 1.7. This area allows more able students to review several case studies and the trends that go with them. Though earthquakes and volcanic events are not increasing, it would appear that the impacts are getting worse. For less able students the affirmation of this point is really important, while more able students may be able to find evidence to support it on websites such as EM-DAT. However, there are complex ideas surrounding this that both teachers and students must consider. It is important to note that information about tectonic activity and hazards is less reliable the further we go back in time, and factors such as increased population growth, social media and development need to be considered before making a judgement.

For more able students there is ample opportunity to use trend diagrams from websites such as EM-DAT. These can be highlighted for less able students. These concepts may need further explanation through discussion and annotation of graphs or comparative methods to help students visualise the issues.

Key concepts and processes

Students need to understand that:

- tectonic disaster trends since 1960 have changed in a variety of ways:
    - number of deaths
    - number of people affected
    - level of economic damage.
- research into these offers the potential for inaccuracies:
    - students should be able to interpret these trends and assess the reliability of the data they are using.

Guidance on teaching

Much of this lesson may be built on the previous lesson, and the two may even be combined as a study of hazard profiles and how countries at different levels of development cope with tectonic hazards. Good case studies can be used to explain these points, and some add a layer of complexity for stronger students, who should be encouraged to pursue:

- Indian Ocean tsunami and Tohuko earthquake and subsequent tsunami
- Haiti 2010 and Christchurch 2010/11
- Bam 2003 and Kashmir 2008.

These case studies allow for key points associated with number of deaths, number of people affected and level of economic damage. Students should consider the impacts of level of development and preparation in the extent of the disaster, however more able students should be able to appreciate that the relative costs of these disasters are often felt more by the less developed countries, and links to debt and aid could be brought in here.

Students should be encouraged to understand that the scale of a disaster is not simply down to the level of development but rather a complex variety of issues a country faces, and that at times countries do not cope as well as expected. For instance, Tohuko could be considered a success when compared to the death tolls elsewhere, but the failure to improve the height of the tsunami walls and consider the potential issues associated with the Fukushima nuclear power station made the event far costlier than it needed to have been.

More able students might point out that tectonic impacts can be made worse when an area is suffering from other hazards. Teachers should encourage this, and it is a good point with which to finish the lesson, with a possibility of research into areas that suffer from more than one hazard and the implications this has for the country.

Lesson 10: A multiple-hazard zone

Overview

Lesson 10 focuses on Key ideas 1.7b and 1.7c and is built on the content of the previous lesson. Information on hazard hotspots and multiple-hazard zones can be carried across from the previous specification. Examples include the Philippines, and California and Japan are among others that can be found in the World Bank's 'Natural Disaster Hotspots: a Global Risk Analysis' (https://openknowledge.worldbank.org/handle/10986/7376).

In this section, students will need to have a working knowledge of several types of hazards and why and where they occur. Students will look at the effects of multiple hazards on both the impacts and the resilience of the population affected. The detail needs to be only in reference to their case studies and the areas of the world where they appear.

More able and less able
Less able students may wish to consider a case study such as the 2004 Asian tsunami, Eyjafjallajökull 2010 eruption or 2011 Japanese tsunami, while more able students may wish to compare two (the Asian and Japanese tsunamis, for instance). There are many good sites and books to read in this area, some of which are listed below. It might be best for less able students to consider just one of these in greater detail, looking at the impacts and reasons why it could be considered a mega-disaster (one that has global significance).

Key concepts and processes

Students need to understand:
- the links between social and economic impacts in multiple-hazard-prone areas.
- how tropical storms, drought and flooding can impact on tectonic hazards and increasing recovery times, the number of people affected and the provision of aid and financial impact on a country.
- that tsunamis can have a devastating effect on long-term recovery, due to impacts on the environment and a country's development in terms of trade and globalisation.

Guidance on teaching

Students could be split into groups with several maps of selected distributions of natural events as well as an atlas and blank map. They can then begin to identify areas that could potentially suffer more than one hazard and areas that are prone to more than two. The key areas of the world and the areas with high population centres can be looked at, and students can then gather the information they need to improve their understanding of the problems caused by the large number of natural events in areas like the Philippines or California.

More able students could then try to piece together the reasons why some countries cope better with these events, and the wider synoptic links to globalisation, energy and water in terms of the impacts these disasters can have. Less able students could review one study and research the wider impacts it had on a global scale, as well as the impacts that the other hazards had.

Lessons 11–14: Management and coping with hazards

Overview
These lessons cover Key ideas 1.8 and 1.9 and look in detail at the theoretical frameworks designed for prediction and response as well as different aspects of the Hazard Management Cycle. Understanding this cycle is important for students in the development of their knowledge and appreciation of specific communities' resilience to a disaster. The UNISDR is a useful site for this and is highlighted below.

These areas are specifically aimed at the human responses to tectonic hazards and any secondary events; they can be differentiated by case study and by the challenges that each country faces.

Key concepts and processes

Students need to understand:

- the importance of prediction and forecasting and the accuracy of these. This can be difficult and often depends on the location and type of tectonic hazard.
- the Hazard Management Cycle and the stages within it:
  - response (a re-active measure of how a country or community reacts to events)
  - recovery (another re-active post-event measure in terms of the time it takes for recovery and action plans to be put in place)
  - mitigation (pro-active strategies put in place before an event occurs to prevent a hazard from occurring)
  - preparedness (another pro-active method to help increase resilience to a disaster).
- the use of Park's Model to compare the response curve of hazard events for areas at different levels of development:
  - the importance of Park's Model as a way of developing an understanding of the way countries and communities affected by hazards are impacted over the full cycle of disaster and recovery.
  - how to determine and interpret different Park's curves and develop reasoning as to why these may differ for different countries.
- the key strategies to modify vulnerability, including hi-tech monitoring, prediction, education, community preparedness and adaptation.
- strategies used to modify loss, including emergency aid (both short and long term), insurance and the role of insurers and NGOs in helping to reduce the loss from events.

Guidance on teaching

Students should review their case studies for this area and try to see the reasons why some countries had high death tolls while others did not. Haiti and Christchurch offer an excellent insight into the vast differences between a prepared and a non-prepared country. However, the lines are often less clear and students can be pushed by looking at similar events and seeing how some cannot be dealt with very well even when plans are in place – Eyjafjallajökull is an example of this – or *ad hoc* management such as the Eldfell 1973 or Tohuku earthquake; there are several events students can choose from to highlight the impacts and how planning helped or hindered the events.

When a disaster strikes, the initial search and rescue phase is followed by relief and rehabilitation, which may include international help. It is important for students to recognise that hospitals are often badly hit by earthquakes, as in Haiti and the San Fernando 1971 earthquake, where 50 of the 64 deaths were due to hospital collapse, and four hospitals suffered structural failure leading to a reduction in the area's capacity to cope. The 1994 Northridge earthquake saw eight hospitals evacuated and four were later demolished, while in Kobe in 1995, 13 were either partially or completely destroyed. Often in many less developed countries, an insufficient number of doctors leads to many deaths that could have been avoided with good preparation. More able students can investigate the importance of this within the management cycle and how it can impact on recovery times.

Park's Model can be drawn and annotated in terms of the times and problems incurred and the reasons why it can take so long to get back to normal conditions.

A great article (https://www.newsecuritybeat.org/2014/02/bouncing-forward-resilience-important-definition/) offers a good discussion point about not just bouncing back from a disaster but the need to 'bounce forward'. This might help students to appreciate that learning from past events is a key way in determining knowledge of future ones. It could also provoke ideas on the nature of recovery (Stage 5: Park's Model) and the need to reduce vulnerability and increase strategies to modify future vulnerability and prevent further events becoming disasters.

There is an array of coping mechanisms that students should be aware of, and these can be built into specific case studies:

- community management
- insurance
- role of NGOs
- aid (emergency, short and long term)
- education
- monitoring techniques (Montserrat, Christchurch and California are good examples).

There is a variety of case studies where students can look at specific examples, although this is not a requirement for more able students, they can use this for evaluation purposes or for assessing the importance of the techniques used, such as California's disaster preparedness day held yearly (http://www.caloes.ca.gov/ICESite/Pages/California-Day-of-Preparedness.aspx)

Community management can be reviewed here, while Aid for Haiti offers excellent knowledge bases, usefully put together here: https://www.theguardian.com/news/datablog/2010/jan/14/haiti-quake-aid-pledges-country-donations It might be useful to consider how this aid was eventually spent (more datasheets are linked here and further information can be found from this).

Monitoring techniques of Montserrat can be looked at via an information sheet from the University of Reading which looks at some of the hi-tech methods being employed:
https://www.reading.ac.uk/web/FILES/RED_Case_studies_Volcanic_monitoring_AS3.pdf
Also, the BGS website (http://www.bgs.ac.uk/discoveringGeology/hazards/volcanoes/montserrat/home.html) explains how they are looking at different monitoring techniques such as continuous seismic monitoring at Montserrat Volcano Observatory, which uses a state-of-the-art system; deformation monitoring, which involves a range of techniques to detect movement of the ground on or around the volcano. Environmental monitoring involves assessing the gas and ash released from a volcano and their effects on the environment, and vulcanological monitoring, which includes making detailed observations of the growing lava dome and studying the chemistry of the lava to check for changes.

California has the California Integrated Seismic Network (CISN) which students can study by visiting http://www.cisn.org/ This has an array of information suitable for further development.

These last lessons can bring together much of what is covered in the course, and stronger students can look at the synopticity and the links to development and the role of aid in superpower status, which will be discussed in future units.

Key vocabulary for EQ3

Key words	Definition
Community adaptation	Cooperation within communities to change people's way of life so as to reduce tectonic hazard impacts.
Community preparedness	Cooperation within communities to get ready for tectonic events. This can take a variety of forms.
Multiple-hazard zone	An area which suffers from two or more hazards.
Hydro-meteorological Hazard	A hazard relating to weather or weather patterns such as tropical storms, floods and droughts.
Retrofitting	Adding something to a building after it was built to help it withstand tectonic events.

Resources

https://www.wbdg.org/resources/seismic_design.php – Seismic design of buildings, good for teachers and stronger students.
http://www.whatstheplanstan.govt.nz/earthquake – What's the plan Stan? – New Zealand children's website.
http://serc.carleton.edu/integrate/workshops/risk_resilience/case/82120.html – Earthquake Preparedness in Christchurch, New Zealand.
http://www.csun.edu/emergency/training – California Emergency Preparedness Training.
http://content.time.com/time/world/article/0,8599,2058390,00.html – *Time Magazine* article – 'How Japan Became a Leader in Disaster Preparation'.
https://www.unisdr.org/files/32918_drrintheun2013.pdf – 'Disaster Risk Reduction in the United Nations' – large report suitable for teachers.
https://www.unisdr.org/we/inform/terminology – Terminology.
http://www.preventionweb.net/files/21008_21008torqaiddiagrammaticframeworkfo.pdf – A Diagrammatic Framework for Disaster Risk Management.
https://emergency.unhcr.org/entry/51487/search-and-rescue-response-and-coordination-natural-disasters – UNHCR handbook.
https://www.old.health.gov.il/emergency/docs/IsraelEarthquake.ppt – some information on hospitals during earthquakes from Professor of Emergency Medicine Director, Disaster Medical Services UC Irvine School of Medicine.
http://reliefweb.int/ – excellent up-to-the-minute information on a variety of disasters and relief efforts.