Paper 2 Physical Options

UNIT 3 Hazardous environments

Recommended Prior Knowledge As is the case for all the Advanced Geography options completion of the core modules is expected. This option builds on knowledge gained in the compulsory core Units 2 Atmosphere and weather and 3 Rocks and weathering.

Context This option is focused and dependent upon an understanding of the physical/human interface of the subject, i.e. the relationship and interaction between the physical events and the human response to those events.

Outline Three major groups of hazards should be studied. In section 3.2 the activity and resultant landforms has been separated from the hazardous nature of the activity. Exemplar material is essential to an understanding of the ways in which the impacts of these hazards vary according to location and scale of the impact. Therefore the final unit which focuses upon a case study may already have been covered as the rest of the syllabus for this option is covered. Examination questions may focus on a specific hazard or require knowledge of a range of hazards.

Content	Objectives and suggested teaching activities	Online resources	Other resources
	General introduction to hazards **Definitions of terms** Hazard and disaster. **Relationship between the physical event and human population** Where the two overlap - that is the hazard/disaster. Usefully shown by means of a Venn diagram, see Fig. 1 opposite. **Classification of hazards** **Tectonic or crustal** Volcanic activity and earthquakes (3.1); **geomorphological**: a range of mass movements, landslides, mudflows and avalanches (3.2); **atmospheric**: tropical storms and tornadoes (3.2); should include coastal and river flooding. **Factors which influence the impact of hazards** such as: economic (e.g. level of development); social (e.g. ethnic groups, education); physical (e.g. magnitude and frequency);	www.geography@btinternet.co.uk has excellent links to volcanoes.	Introductory chapters in Skinner, Ross and Bishop. Bishop p.5, Venn diagram, Fig. 1 Nagle p.329, classification table. Waugh p.31 Bishop pp.10-11

	political (e.g. aid, international relations); psychological (e.g. perception of risk). **Location** Start with a world map showing relationship between hazards and population distribution and densities. Annotate, highlight multi-hazardous zones. Discuss level of economic development and likely variations in impact and response. **November 2003 Q. 6(a)** tectonic hazards Encourage students to keep **diaries** of hazardous events as they occur throughout their course. Newspaper cuttings, television/radio news; current internet sources. They should record date, time, magnitude, location, cause, impact, scale of response- short term/longer term; local, national, global. Introduce idea of increasing frequency of hazardous events and numbers affected. Reasons: Global warming? Population increase? Relationship between magnitude and frequency; recurrence intervals. **Prediction** Precaution, protection, prevention, preparedness, costs, benefits, aid, insurance, perception – acceptance - deterministic view where the environment is in control, adaptation, dominance i.e. 'technological fix' - the opposite of acceptance, so human control of the environment by engineering and technology. Discussion of this philosophical issue may generate interest and further enquiry. Management strategies which involve technological fix, acceptance and /or adaptation. Discussion would include assessment of costs and benefits of strategies chosen. Forecasting and prediction of hazards, e.g. weather/tropical storms. Differences in response due to variations in levels of wealth, economic and technological development.	http://www.guardian.co.uk Newspapers are an excellent resource. The US Geological Survey has excellent sites. www.Vulcan.wr.usgs.gov Volcano World www.adpc.ait.ac.th www.volcanoes.com	Bishop p.17 Bishop p.7, pp.10-11 Bishop Chapter 2 covers these points in general and the book provides a structural framework and useful terminology for the study of hazards. Digby (GC) p.9 good on determinism versus 'technological fix'. Bishop p.23 Bishop Chapter 2 Quoted in Bishop p.18

	Differentiate between prediction and forecast. **Forecast** 'is a relatively imprecise statement of time place and nature of the expected event' (Bishop, p.23). **Prediction** 'is a relatively precise statement of time place and ideally the nature and size of the event i.e. a precise forecast' (Bishop, p.23). **Human response to hazards** Introduction to basic ideas of risk and vulnerability. **Risk** exposure of people to a hazardous event. **Vulnerability** 'ability of a person or group to anticipate, cope with and recover from the impact of a natural hazard' (Blaikie et al. 1994). It may be that these ideas are best conveyed through case study material, rather than as general principles. This is a matter of individual choice and resources. However the ideas form the guidelines which can be followed in each of the units of this option.		. Cook, Hordern et al. pp.336-343.
3.1 Hazardous environments resulting from crustal (tectonic) movement	**Activity related to tectonic plates** **Definition/description** i.e. lithospheric plates **Global distribution** Relate to plate boundaries - global distribution of tectonic plates. Definition of a tectonic plate; activity related specifically to plate margins. Add reminder about relationship to population distribution. Not random, linear, coastal.	**November 2003** **Q. 6(a)**	Good diagram of model of plate tectonics, Bishop p.37 Maps Bishop p.37 types of plate boundary; p.38 earthquake location; p.60 active volcanoes; p.16 hazard zones. Witherick p.12 clear map. Waugh p.15 Guinness and Nagle p.94-95 Nagle p.9 Witherick p.12 Waugh p.16-21, excellent block diagrams, ideal visual aids for understanding.

	Types of plate margin Convergent/destructive; divergent/constructive; conservative/passive. **Causes of plate movement** Convection currents relate to direction of movement - slab pull at the destructive margins and slab push at the mid-oceanic ridges. Relation between crustal creation (divergent margin) and crustal destruction (convergent margin). Rates of movement. Clear well annotated diagrams are ideal here - ones that can be reproduced easily in response to examination questions which frequently demand this skill. **Activity associated with tectonic movements** **Volcanic activity** Relationship between plate margin and type of activity. **Destructive margins** Explosive activity, pyroclastic flows/nuées ardentes, ash fallout, acid viscous lava flows. **Resultant landforms** Dome volcanoes – high, steep-sided, narrow cones. **Constructive margins** Less explosive activity - fluid, basic, basalt lava flows, fire fountaining, lava bombs e.g. Iceland. Resultant landforms: shield cones – low, gently-sloping, wide cones. **Conservative margins** Little vertical displacement, largely horizontal movement, produces earthquakes. Link to next section on earthquakes. Emphasise hazardous nature of the activity: pyroclastic flows, lava flows and bombs, fire fountaining and lahars. Location especially 'Pacific Ring of Fire'. **Hot spots** e.g. Pacific plate. These are 'plumes' of molten material from the mantle which are ejected on the surface far from a plate boundary. They tend to produce isolated activity and can occur on continents as well.	Use key words for search engine. e.g. *Montserrat Volcanic observatory* **June 2005 Fig. 3 Q. 6** Useful diagram of a typical volcanic cone. **June 2008 Q. 5(a)** Excellent map of Ring of Fire**, (b)** products. . **June 2006 Q. 6 Fig. 3** map based on the Mt St Helens blast.	Bishop pp.36-39 Ross pp. 36-7 Causes - good diagram includes 'hot spots'. Geofile 554 Sept 2006 Plate boundaries Himalayas and Pacific USA Geofile 526 Hot spots in Plate tectonics Evolution of a theory **June 2008 Fig. 3** Good map of a destructive margin. Nagle pp.14-15 Good on landforms and type of eruption Waugh p.24 Very good on lava. Bishop p.68 Bishop pp.68-9 Bishop pp.65-6 Good detail on lava flows, pyroclastic flows. Ross pp.29-30 very good on ash fallout. Ross pp.30-1 for products of activity. Guinness and Nagle p.104 excellent series of diagrams of pyroclastic flows. Guinness and Nagle AS p.103, excellent diagram of the Hawaiian hot spots.

	Secondary activity **Lahars -** mudflows. Link to 3.2. A lahar is a type of mass movement. Best example is Nevado del Ruiz in Colombia, 1985. **Climate change** as the addition of dust to the atmosphere results in temporary cooling, e.g. Mt Pinatubo. **June 2002 Q. 6(b)** Nature and causes of tectonic hazards **June 2003 Q. 6(b)** Well annotated diagrams can be used to answer questions which require description. **Prediction -** monitoring indications of imminent activity such as harmonic tremors, bulges in the cone, geochemical changes, gravitational changes, temperature changes, satellite monitoring. **Reduction -** control, hazard mapping, building structures. **Human response to volcanic activity** Case studies best exemplify this section. Highlight the physical causes and nature of the activity. The example should be closely tied to the relevant plate boundaries so that the causes and nature of the eruption are clearly known and understood. The links can be made to the impact on the population. Two case studies which contrast the type of activity and level of economic development of the country would be ideal. **Earthquakes** Definition of terms: focus, epicentre, seismic waves.	**June 2005 Q. 6(a)** **Fig. 3** Mt Pinatubo eruption map.	Guinness and Nagle AS p.106 Nevado del Ruiz includes map. Ross pp.33-4 Guinness and Nagle p.395 excellent section on the effect of a pyroclastic flow on global temperatures, Mt Pinatubo. Ross pp.37-9 Bishop pp.74-80 very comprehensive Skinner pp.29-30 Ross pp.39-41 Bishop pp.71-80 Geofile 536 Jan 2007 Physical Disaster Warning systems All the textbooks have case studies e.g. Waugh Mt Pinatubo pp. 30-32; Bishop Mont Pelee pp.67-8 and Pinatubo pp.81-2; Ross Pinatubo pp.34-5 and Montserrat, 1995 pp.42-5 Skinner pp.27-8 Congo, 2002

	Measurement of earthquakes: Richter (magnitude) and Mercalli (intensity) scales. Seismograph (instrument) seismogram (print out of magnitude of seismic waves). **Causes** Link to conservative plate boundaries, fault lines. Appreciate that the effects extend beyond the immediate plate boundary. Ground movement, landslides. Other physical factors may compound the impact: geological conditions; liquefaction. **November 2002 Q. 5(a)** Nature and causes of earthquakes. **Management of the hazard** **Prediction** Seismic gap theory. Monitoring of earthquake zones - use of instruments. Hazard mapping; community preparedness, e.g. Earthquake Awareness Day in Japan; hard engineering: earthquake proof building structures are an example of technological fix. **Human Response to earthquakes** **Two contrasting case studies**. Earthquakes of similar magnitude, one in an LEDC and one in an MEDC. Good examples: Iran 2003 and California 2003. Kobe 1995 is an excellent example of an earthquake which had a huge impact on a country seemingly prepared. Provides many issues for discussion and is well documented. Examples should relate to the particular plate boundary and contain factual detail. Issues of the causes, hazardous nature and impact of the event should be at the core of the study. Scale is a useful framework: area affected; long and short term impacts.	**June 2002 Q.6(b)** www.earthquakes.bgs.ac.uk Use Key words of location of an earthquake to locate factual information on the internet. In the case of a recent event CNN and the BBC are useful sources of up-to-date information. www.curriculum-press.co.uk Geo Factsheet September 2002 Number 133 Earthquakes: Why do some places suffer more than others?	**Nov 2005 Q. 6(a)** Richter and Mercalli scales, excellent teaching resource and **(b)** on measurement cause and effect. Bishop p.42, good diagram. Nagle p.19 Skinner pp.16-7 Ross pp.10-11, measurement. Ross p.12 and Guinness and Nagle p.336 Mercalli scale Bishop p.44 Waugh pp.9-10 Ross pp.12-14 Bishop pp.44-46 Bishop p.46 Nagle p.21 Guinness and Nagle p.336 Ross p.14 **Nov 2006 Q. 6** distribution and hazardous nature. Ross pp.20-24; Nagle pp.20-1 Both texts have good diagrams on earthquake proof buildings. Bishop pp.47-51 Very good diagram of instrumentation p.49. Skinner pp.23-4, good on Japan. **Some case study material is attached.** Ross pp.16-20 Kobe pp.24-27 Guinness and Nagle AS pp.100-102 Nagle pp.22-3 Japan Loma Prieta, California, 1989 Bishop pp.27-8; 45; 51; 52-4; Kobe pp.55-8 Gujarat 2001.

	Awareness of secondary events e.g. mass movements: landslides and mudflows. Link with 3.2 mass movements. These activities can compound the hazard. **November 2002 Q. 5(b)** **Tsunamis** Definition - popularly known as tidal waves, but not linked to tides. Causes and formation, link to earthquakes. Nature of hazardous activity associated with tsunamis. A short case study e.g. Papua New Guinea 1998 is the best documented example. Indian Ocean ('the Asian Tsunami') Dec 2004		Skinner pp.20-1 Waugh pp.52-3 Geofile 513 Jan 2006 The Asian Tsunami Geo Factsheet 179 Tsunamis - rare but devastating Geo Factsheet 194 Tsunami + 1 – An Analysis of the Response
3.2 Hazardous environments resulting from mass movements	**Slope processes** Revision of theoretical work covered in Paper 1 Physical Core Unit 3.3. Focus for this unit should be on hazardous nature of the activity, especially management. This section may be short because foundations were laid in the AS course and case study material has been covered already. . **Causes of mass movements** 1.**Physical** Idea of downslope movement of material under the influence of gravity. Relationship between internal strength of, and external stress on, weathered material on a slope. **2. Human** mismanagement. **Nature and speed of the movement** Classification of processes: flows, slides and heaves. Speed of flows; mixed lithology - rotational slip. **Landslides and mudflows** **June 2003 Q. 6(a)**	www.marauder.miller.sv **June 2002 Q. 5(a)** asks about the causes of mass movement.	Skinner pp.88-91 Nagle pp.24-5 Ross pp.31-2 Waugh pp.46-9 Waugh pp.52-3, natural causes.

	Lahars link to previous section - volcanic activity. Link to river flooding. **Avalanches** will be new material. Nature of avalanches: slab-dry and snow-wet. Causes: conditions for avalanche formation. Precaution, prevention, control. Avalanches as hazards: human responses. **Case studies** will illustrate the above main points: Vaiont Dam, Italy; Aberfan, South Wales 1966; Holbeck Hall, Scarborough, UK. **Note** This section may appear short. This is for two reasons. 1. The theoretical side of the section on processes may have been covered in the AS Physical Core, Rocks and weathering 3.3 and 3.4 (to some extent). 2. The case study material may also be linked closely to section 3.4 in this syllabus, the sustainable management of a hazardous environment resulting from mass movement.	www.csac.org **June 2007 Q. 5(c)** www.curriculum-press.co.uk Geo Factsheet Number 143 Avalanches January 2003 Geofile online September 2002 Number 435 Avalanche Management www.nhc.noaa.gov www.regolith.com	Nagle pp.48-52 Good on theory Bishop pp.123-5 Ross pp.46-48 Waugh pp.54-5 Excellent section on human mismanagement. Guinness and Nagle AS p.110 excellent diagrams of types of mass movement. Skinner pp.80-1 Holbeck Hall, UK. Bishop pp.129-30 Ross pp.50-52 Waugh pp.52-53 Bishop pp.129-132 Waugh pp.124-7, good case studies. Nagle p.52; p.130 excellent classification and diagrams. Alps 1999 in Bishop pp.133-4; Waugh pp.124-7 Italy 1998 in Nagle p.54 and Waugh p.49 UK landslides in Nagle p.55 Hong Kong 1992 in Ross pp.48-50
3.3 Hazard resulting from atmospheric disturbances	**Tropical storms (cyclones)** **Definition** **Classification** Hurricanes, cyclones and typhoons. **Location** Map to show global location and areas most at risk. **June 2002 Q. 6(a)** **June 2003 Q. 5 (a)** **Formation** Conditions for formation. Understanding of processes of instability, adiabatic changes of temperature, release of latent heat. Link to AS Unit Atmosphere and weather 2.1 and 2.2.	**June 2007 Q. 6(a)** Map of Cyclone Eline, useful teaching resource.	Maps of location Skinner p.39; Bishop p.97; Nagle p.170; Ross p.56; Guinness and Nagle p.421 Ross p.57; Skinner p.38; Bishop pp.95-7; Nagle pp.170-1; Warburton

	Weather conditions High winds, heavy rainfall and storm surges may result in flooding and landslides. Link to hazardous nature of the physical event. The weather elements and the way in which they are hazardous are important. **June 2008 Q. 5(b)** Cross section of a tropical storm - fully labelled and annotated. **November 2002 Q. 6(a)** **Magnitude and frequency** these hazards have considerable potential to damage life and property. Location may be an important factor - e.g. barrier islands of the eastern seaboard of the USA. **Prediction** Arguably tropical storms and tornadoes are the most predictable of all these physical events. Forecasting technology, seasonal pattern of the storms. However it is notoriously difficult to guarantee track and speed of movement. Reminder about distinction between forecasting and prediction. **Precaution** Evacuation, protection: coastal and river defences against flooding, drills, land use planning/zoning. Insurance, perception of the risk. **Two contrasting case studies** one in an MEDC, one in an LEDC. Hurricane Isabel Autumn 2003 - eastern seaboard of the USA. (Other well documented ones are Gilbert and Andrew) and Hurricane Mitch 1998 – Central America. The causes and secondary effects, e.g. storm surges, high winds, coastal flooding should be highlighted as these are specifically mentioned in the syllabus. The impact of the storm and the response to the event should be emphasised. Population densities, perception of the risk and contrasting levels of empowerment to control the environment, can be highlighted in the contrasting choices.	www.curriculum-press.co.uk Geo Factsheet Number 162 Hurricanes: A Predictable Hazard? www.bbc.co.uk ideal web site www.chaseday.com/tornadoes.htm Good images.	pp.156-163, very good on impact. Geofile 516 April 2006 Hurricane Katrina Geofile 530 Sept 2006 Hurricanes Rita and Katrina and the after effects Geofile 500 Sept 2005 Hurricane season in the Caribbean Skinner p.40; Bishop pp.99-100; Ross pp.57-8 Skinner p.40; Digby, p.18 Skinner p.43;Ross p.59 Money pp.39-43 Skinner p.44 **June 2008 Q. 5** **Nov 2006 Q. 5** Cyclones Bishop pp.17-21; Ross pp.60-1,62; Guinness and Nagle p.423; Waugh p.238; 'Orissa' Warburton pp.165-6 Hurricanes 'Mitch' Bishop pp.103-4; Waugh p.238; Skinner pp.41-2. Digby (GC) pp.16-17 'Andrew' Warburton pp.163-5

	Recent examples: Cyclone Nargis, Irrawaddy delta, Burma May 2008. Useful because of the political implication of the rescue and management of the aftermath. **November 2003 Q. 5(b)** **Tornadoes** **Definition** A tornado is a short-lived, violently rotating, narrow, funnel-like column of cloud that reaches the ground from a cumulo-nimbus cloud. It is associated with intense low pressure conditions. **Formation** **Measurement of magnitude** Fujita Tornado scale **Case study** to demonstrate hazardous nature. **November 2003 Q. 5(a)** formation of tropical storms and tornadoes	www.spc.noaa.gov/faq/tornado Has frequently asked questions. www.zetnet.co.uk/iogs/torro www.solar.ifa.hawaii-edu/tropical/tropical.html www.wmo.ch	Bishop pp.105-6, very good detail maps and diagrams Fujita scale - Ross pp.60-2; Warburton pp.166-8 Ross p.61-2; Warburton Oklahoma 1999, p.167-8, p.169 Geo Factsheet Jan 2006 192 Tornadoes
3.4 Sustainable management in hazardous environments	Case studies incorporated at each stage will fulfil the requirements for this section of work. Therefore a separate section may not be needed. **General guidance on case studies** 1. Knowledge of the cause and nature of the event and its location is fundamental. In the case of tectonic hazards, the nature and location of the plate boundary is essential. 2. The information should be focused under side headings. 3. Annotated maps and diagrams which are reproducible in examination conditions are ideal. 4. Factors that influence the impact of the hazard - physical, economic, social, political. Discussion and awareness of causes and factors that influence magnitude and response are important, e.g. nature of the underlying material in an earthquake can magnify the event. Political tensions may potentially influence availability of aid, e.g. Iran 2003.		

	5. Time scale i.e. short term and long term view of factors and impacts should be considered. Link made between the physical event and the human response. Case studies which contrast an MEDC with an LEDC provides useful material for discussion of human response to the physical event. Evaluation of the impact in terms of magnitude and timing of the physical event, preparedness, precautionary measures, prevention and control measures need consideration. e.g. hard engineering schemes. More sustainable precautionary measures, impact on the landscape/environment. Reality of accurate prediction in the future. Importance of technological fix. Management of the hazard after the event and preparation for the next hazardous event, e.g. Montserrat 1995 or impact of Mt Pinatubo on global climate. **Multiple Hazard Zones** could provide a useful vehicle for this section, e.g. California, Iceland, New Zealand. Local examples are always preferable, if applicable. Candidates are expected to cover a range of hazards and be able to appreciate the human responses and management strategies, as well as the impact of the physical event itself, e.g. timing, location and scale of the event. Kobe 1995 would be a useful example. China 2008, 7.2 on the Richter scale, was interesting because of primary and secondary impacts. Candidates should be aware of long term effects not always obvious at the time. These include psychological trauma; loss of family members, possessions and livelihoods; economic effects. **June 2002 Q. 5(b)** **June 2003 Q. 5(b)** **November 2003 Q. 5(b)** and **Q. 6(b)** **June 2008 Q. 6(b)**	www.curriculum-press.co.uk Geo Factsheet September 2002 Number 137 West Sussex: A multiple hazard zone?	See attached case study of the Bam earthquake, Iran, December 2003. Ross pp. 42-5 Good case study and questions on Montserrat. Ross pp.34-5 Guinness and Nagle p.395 Skinner has a chapter on multi-hazard urban environments - Los Angeles, USA, and Mexico City.

	These questions focus on the prediction and management of hazards/hazardous environments. Case studies of contrasting environments and levels of economic development serve to illustrate answers very well.		