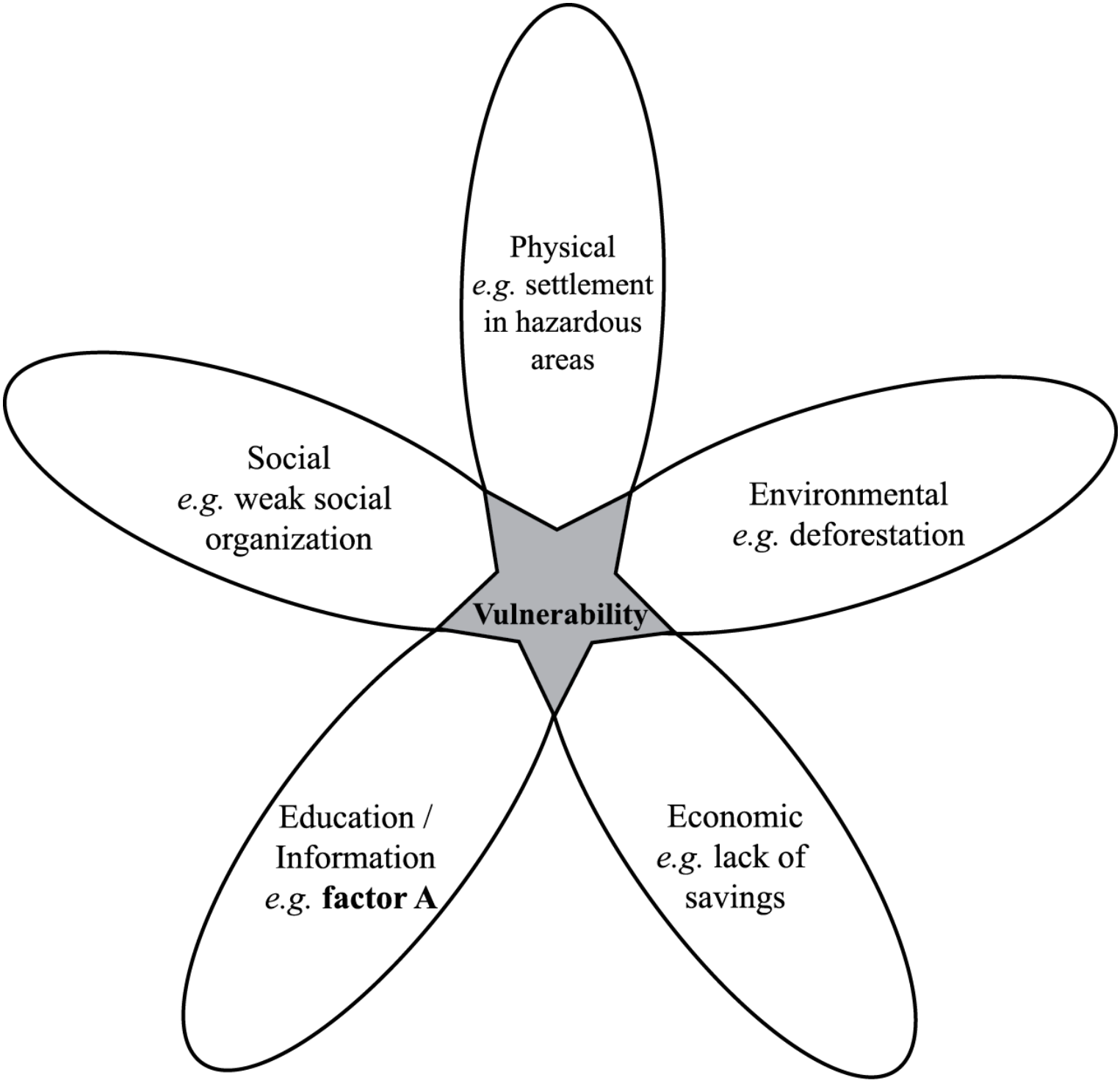
HL Paper 2

The diagram shows some of the factors affecting vulnerability to hazards.



[Source: Richard Rhoda and Tony Burton. *Mexico: A geographic perspective*, Sombrero books (2009)]

a. Suggest what factor A on the diagram might be. [1]

b. Explain how **two** of the other factors (other than factor A) shown on the diagram affect vulnerability to hazards. [2+2]

c. Analyse why communities may underestimate the probability of a hazard event occurring. [5]

d. For **one or more** hazards of your choice, examine how estimates are made for the probability and likely impact of a major hazard event. [10]

Markscheme

a. Factor A might be earthquake drills in schools, or presence/absence of early warning systems. Award 1 mark for any valid suggestion, which must be related to education/information.

b. Award 2 marks for each explanation, which must be related to the concept of vulnerability, and not, for instance, to the severity of the hazard itself.

c. Underestimating the probability of a hazard event occurring may stem from many causes including a community's misplaced optimism, having insufficient evidence available for a more accurate assessment, and an unrealistic belief that "it can't happen (again) here". Award 1 mark each for these or other valid statements, and a further 1 mark for each subsequent development of any point, up to the maximum of 5 marks.

d. There are many techniques used in risk assessment. They include the identification of trends and patterns, based on previous events. An example of the former would be working out the return intervals for major hurricanes; an example of the latter would be using gap theory to predict the location of the next major earthquake along a plate boundary. If the historical record is long enough, it is possible to calculate the probability of an event of any particular magnitude occurring with some degree of reliability. Assessing the likely impact of a major hazard event depends on the spatial analysis of the vulnerability of the population (lives and property). This may involve the use of GIS to identify areas where, for instance, housing types are less resilient to earthquakes, or where families cannot afford insurance against a specific hazard and have no financial reserves to recover quickly if a hazard event occurs.

   Depending on the hazard event examined, there are numerous possible approaches to this question, but answers considering both aspects of the question (probability and likely impact) in some detail are likely to be credited at bands E/F. It is not necessary for the two aspects to be treated in equal detail.

   A specific hazard event is a specific requirement of the question; it is expected in those answers achieving band D and above.

   Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]
d. [N/A]

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a. Describe **two** ways in which land-use planning (zoning) can reduce hazard risk for a **named** hazard type. [4]

b. Explain **three** reasons why people continue to reside in areas that are known to be affected by hazards. [6]

c. "Hazard events are predictable, disasters are not." Discuss this statement. [10]

Markscheme

a. The hazard type should be clearly stated otherwise award no more than ***[2 marks]*** for a generalized answer not directly related to a hazard.

In each case, award ***[1 mark]*** for identifying a land-use planning strategy, and ***[1 mark]*** for describing the nature of the risk.

For example:

- housing can be prohibited on low-lying areas ***[1 mark]*** which suffer inundation when hurricanes strike ***[1 mark]***
- emergency services can be located in areas of low earthquake risk ***[1 mark]*** for instance away from major fault zones ***[1 mark]***.

b. Award ***[1 mark]*** for each valid reason why people continue to occupy a site and ***[1 mark]*** for some explanation of why they tolerate the hazard risk.

Possible site reasons could include: fertile soils, mineral deposits, tourist potential, attachment to home, inertia, lack of funds to move/poverty.

Possible explanation of why risk is ignored/tolerated may include: some people know the risk (experts) but not others; perception of severity of hazard; belief that recurrence will not happen anytime soon; confidence in defences/personal resilience.

For instance:

- "Attractive landscapes are found in coastal areas ***[1 mark]***. People think the day-to-day benefit of living there outweighs the occasional risk of a storm surge ***[1 mark]***."
- A volcano may only explode every 500 years or so ***[1 mark]***. So people won't abandon their homes for such a very small chance ***[1 mark]***."
- "Many tourist jobs are found in coastal areas with a hurricane risk ***[1 mark]*** and people trust the warning systems work ***[1 mark]***."
- "People have a fatalistic attitude ***[1 mark]***, and remain in an area because of tradition/religious beliefs ***[1 mark]***."

There may be other approaches and these should be credited.

c. *Credit all content in line with the markbands. Credit unexpected approaches wherever relevant.*

Hazard events are the occurrence of a hazard, the effects of which change demographic, economic and/or environmental conditions. By contrast, disasters are the realization of major hazard events that cause widespread disruption to a community or regions that the affected community is unable to deal with adequately without outside help.

Some environmental hazard events are more predictable than others *eg* hurricanes and volcanoes. Others are less so *eg* earthquakes, tsunami and human-induced technological hazards. Earthquake prediction might suggest where, but not when,
and not the size of the event – so there are aspects of "predictable" to address that may be a feature of good answers.

Disasters are less predictable because the final intensity/magnitude of the hazard event, the resilience of defences and structures, and the extent of the area affected are unknown until after the event. The density of the population and wealth of the area affected are also contributory factors that mean the scale of disaster is not known until after the event when financial reckoning occurs.

For band D, candidates must comment on the predictability of hazards and disasters.

Band E should either provide greater detail about some range of hazard and disaster events, and the extent to which either are predictable, or offer some discussion of the concept of predictability, which has different dimensions (scale, cost, recovery).

At band F, expect both elements.

Examiners report

a. Many misunderstood the concept of land-use planning and there were some elaborate answers about building design. Floodplains were frequently used and although not part of the hazards option in the syllabus these were credited.

b. No problems found although a few found it hard to explain with sufficient depth why the people tolerated the risk.

c. This seemingly straightforward question proved a challenge. Most were able to discuss the predictability (or otherwise) of hazard events, but were often unable to consider that of disasters. There were many descriptive accounts of hazard events in LEDCs and MEDCs, which often did not relate to the question. A worrying number of candidates believe that earthquakes are predictable as to timing and strength.

a. (i) Describe what is meant by hazard risk. [4]

(ii) Describe what is meant by vulnerability to hazards.

b. Explain how building design and land-use planning can limit the potential damage from one **named** hazard type. [6]

c. “The faster the speed of onset, the greater the impact of the hazard event.” Discuss this statement, with reference to examples. [10]

Markscheme

a. (i) Risk is the probability of a hazard causing deaths, injuries, property and environmental damage ***[1 mark]***. Award ***[1 mark]*** for developing the idea by means of exemplification or identification of a factor that affects risk (location/magnitude/frequency/recurrence).

(ii) Vulnerability refers to the conditions (demographic, social, economic or environmental) that affect the susceptibility of people to a hazard ***[1 mark]***. Award ***[1 mark]*** for developing the idea by means of exemplification or identification of a vulnerable group in a population (elderly/poor/gender).

b. **Building design:** hurricane/flood surge protection may refer to large, raised shelters or individual house construction methods (metal shutters, thick concrete walls, secure roofs, stilts). Earthquake designs might include reinforced concrete foundation platforms, metal frames, shock absorbers, counterweights, safety glass, or in LEDCs light wooden frames, woven cane walls, light roofs, cement footings, concrete stilts in tsunami areas. In volcanic areas, buildings that have reinforced roofs to withstand the weight of ash or steep roofs to shed ash, or prefabricated sectioned homes that can be moved to avoid damage by lava flows.

Land-use planning: there are many possibilities, depending on the hazard type chosen, including prohibited development in areas with a known risk, evacuation routes, shelter access, buffers, mangroves, land-use zoning, building height restrictions.

Award ***[1 mark]*** for each idea, and additional marks for exemplification or extended explanation.

A simple list of factors without an explanation should not be awarded more than ***[3 marks]***.

If only building design or only land-use planning is addressed, award up to a maximum of ***[4 marks]***.

Accept answers that explain a number of designs in general or fewer detailed explanations.

c. Responses should examine at least two different, named hazard events with varying speeds of onset and discuss the relationship between the speed of onset and the impact of the hazard event. A balanced argument is required that takes into account hazard events with a rapid speed of onset, such as earthquakes, tsunamis or volcanic explosions, and those with slower onset, such as hurricanes or droughts which may have an equally large impact in the longer term.

Responses that do not make use of examples should not progress beyond band D.

Candidates might focus either on different hazard types (*eg* drought compared to earthquakes) or different events of the same hazard type (*eg* volcanic eruptions).

At band D responses are likely to be descriptive.

At band E expect a reasoned discussion between at least two different hazard events and an attempt at a conclusion.

At band F there should be a well balanced conclusion.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

a. Describe the global distribution of **either** volcanoes **or** earthquakes. [4]

b. Suggest **three** factors that might affect an individual's perception of the risk posed by tectonic hazards. [6]

c. "Hazard prediction is ineffective in reducing the impact of hazard events on people's lives and property." Discuss this statement, with reference to **two different** hazard types. [10]

Markscheme

a. *Award **[1]** for each of the following up to a maximum of **[4]***:

• concentrated around the Pacific rim/the "ring of fire"
• down the centre of the Atlantic Ocean
• the Caribbean archipelago
• East Africa rift valley
• Southern Europe/the Mediterranean
• Indonesian archipelago
• along plate margins
• any other valid distributional point (*eg* hotspots).

*For the award of full marks the candidate must go beyond a simple list of countries (maximum **[2]**).*

b. *In each case, award **[1]** for each valid factor, and **[1]** for further development*.

Possible factors include:

• awareness of the risk of hazards
• level of education
• frequency of occurrence of previous hazards
• government-sponsored awareness programs
• low magnitude of previous hazards
• length of stay in a hazard-prone area
• belief that they are protected against the hazard
• individual personality – risk taker/minimizer.

For example: The frequency of occurrence of previous hazards **[1]**. An area experiences frequent earthquakes so the population is very aware of the possible risk of damage by earthquakes **[1]**. Length of residence **[1]** – a person who has lived somewhere a long time may have experienced a rarer, high magnitude event and may have a greater perception of the level of risk **[1]**.

c. Candidates should describe differences of prediction of particular hazards and comment on their effectiveness. Some hazard events are more predictable than others, for example volcanic eruptions may be accurately predicted, but it is very difficult to predict earthquakes or droughts. The timing of a hazard event may be predicted, but it is often more difficult to predict their magnitude and areal extent. Measures taken to minimize the impact of hazards may be insufficient to prevent significant loss of lives and destruction of property. Technological hazards may not be predictable yet the impacts can be severe.

Good answers will compare the reliability of prediction for two different hazards and discuss their effectiveness. They might also discuss measures taken to reduce the risk of hazards, such as land-use zoning, building codes, development of protective infrastructure, evacuation plans, and awareness programs. They might discuss that these may be ineffective when the hazard is of a higher magnitude than planned for. Reference should be made to different
examples.

For band D, expect some description of hazard prediction and effectiveness for two different hazard types

For band E, expect <u>either</u> a more detailed explanation of the relationship between hazard event prediction and hazard impacts, <u>or</u> a structured discussion of the effectiveness of prediction.

For band F, expect both of these elements.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

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a. Referring to **either** earthquakes **or** volcanoes, briefly outline: [4]

(i) **one** scale used to measure the magnitude of the hazard event;

(ii) why some hazard events are categorized as disasters.

b. Referring to **either** earthquakes **or** volcanoes, briefly explain their occurrence: [6]

(i) at a destructive (convergent) plate margin;

(ii) in areas **other than** along a plate margin.

c. Discuss why some hazard events are easier to predict than others. [10]

Markscheme

a. (i)

- identifies a scale **[1]**
- provides detail of the scale **[1]**.

Example: (earthquakes) The Richter scale **[1]** gives values for magnitude on a logarithmic scale **[1]**.

Accept other valid details about the scale.

(ii)

- outside help is needed to deal with the disruption
- provides further detail or an example.

b. (i) Earthquakes:

- two plates move towards each other **[1]** and one is subducted/sinks due to density **[1]**
- this results in friction/tension that generates earthquakes **[1]** may give additional details *eg* deep focus events to a depth of 700 km **[1]**
- provides a clear diagram in support **[1]**.

Volcanoes:

- two plates move towards each other **[1]** and one is subducted/sinks due to density **[1]**
- this results in melting/partial melting to produce magma **[1]** may give additional details *eg* viscous lava resulting in explosive eruptions **[1]**
- provides a clear diagram in support **[1]**.

(ii) Earthquakes:

- transform/minor faults **[1]** run hundreds of kilometres perpendicular to plate boundaries **[1]** may give example **[1]**
- may occur at volcanic hotspots **[1]** due to thin plate/highly active plume **[1]** may give example **[1]**
- human-induced hazards *eg* reservoir construction **[1]**, mining or fracking **[1]** may give example **[1]**
- provides a clear diagram in support **[1]**.

Volcanoes:

- may occur at volcanic hotspots **[1]** due to thin plate/highly active plume **[1]** may give example **[1]**
- volcanoes at destructive boundaries may be some distance from actual margin due to the angle of subduction **[1]** may give details **[1]**
- provides a clear diagram in support **[1]**.

c. The most likely framework will be to explain, in turn, some combination of different types of hazard events: hurricanes, tectonic hazards, droughts and human-induced (technological) hazards. Two named types must be discussed in some depth for the award of full marks.

Credit should be given for the use of an alternative conceptual framework, for instance looking at the probability of high-impact/high-magnitude events as opposed to low-impact events with different recurrence intervals. Another approach is to look at spatial and temporal probabilities. We may predict where, but not when (San Andreas fault); or we may predict when, but not where (next year's hurricane season).

Good answers might critically discuss:

- the general predictability of hurricane activity but lack of ability to predict actual paths/intensities/landfall
- how our ability to predict in the short-term is actually improving/dynamic, *eg* analysis of earthquake "swarms" or GIS applied to detect magma chamber expansion
- the varying capabilities of countries at differing levels of development and their ability to predict/anticipate hazards
- unpredictability of human-induced hazards.

Only credit answers that refer to one or more of the four types of hazard included in the syllabus.

At band D, expect answers which describe some basic reasons for differences in our ability to predict where/when different hazards may strike.

At band E, expect <u>either</u> more detailed explanation of our varying ability to predict where/when different types of hazard will strike <u>or</u> some critical discussion of the statement

At band F, expect both.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

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a(i). Identify a scale used to measure the magnitude of **one** hazard type. [1]

a(ii). Describe the main features of the scale you identified in (a)(i). [3]

b. Explain the occurrence of hurricanes (tropical cyclones, typhoons) in a **named** area. [6]

c. "The economic impact of disasters is increasing while related deaths are decreasing." Discuss this statement, with reference to examples of disasters. [10]

Markscheme

a(i). Suitable magnitude scales would be the VEI or Richter.

Also accept intensity scales such as Mercalli or Saffir-Simpson scale.

a(ii).
- Statement of what is being measured (*eg* earthquake magnitude)
- May identify upper limit where one exists
- May identify critical boundaries (*eg* severe hurricane is 3+ on SS scale)
- Some idea of the differences between levels of the scale
- Provides example(s).

Three valid descriptive statements are needed for ***[3 marks]***.

b. Answers should name and locate a specific area ***[1 mark]*** and explain the reasons for the occurrence of the hurricane in that particular area ***[5 marks].*** The approach depends on the area chosen (could be a single town or wider region *eg* Caribbean). The formation of hurricanes (and thus their initial occurrence) is linked with a range of factors including water temperature and depth of warm water. Alternatively, their occurrence in coastal/inland areas can be explained with reference to hurricane development and tracks. Credit answers that claim increasing intensity/magnitude due to global warming.

c. A disaster is a major hazard event that causes widespread disruption to a community or region so that the affected community is unable to deal with adequately without outside help.

Answers should examine reasons for the increasing economic cost of disasters and the differences between rich and poor countries. However, the relative financial cost may be greater in poor countries. There may also be indirect losses such as from a decline in tourism and individual losses may be greater where there is no insurance cover.

The general trend has been for fewer deaths in disasters (reasons should be given) – but there are notable exceptions such as the Indian Ocean and Japanese tsunamis. The fact that more people are living in vulnerable areas could also be considered. Answers that describe hazard events that are not disasters (*ie* do not require outside assistance) should not move above band D.

For band D, examples must be used and impacts described. For bands E and F, some discussion of the statement should be offered (*eg* may see it as a generalization and dependent on a country's level of development, or recognizes some types of disaster *eg* mega-disasters/tsunamis can still bring many deaths).

Marks should be allocated according to the markbands.

Examiners report

a(i). Scale was correctly identified and features described but, as in question 7, there was an absence of three valid statements to gain the full 3 marks.

a(ii) Scale was correctly identified and features described but, as in question 7, there was an absence of three valid statements to gain the full 3 marks.

b. This was poorly answered; many candidates found it difficult to explain the occurrence of hurricanes, although they could identify locations, with most referring to the south-east USA.

c. This question elicited a wide range of responses, from the excellent, considered and detailed, to the "all I know about two contrasting case studies" approach which hardly addressed the question. Weaker answers concentrated on why death rates or economic damage had been high in their examples and did not enter into any discussion or attempt to differentiate between levels of development in countries. A few good candidates referred to the costs of preparation for disasters as well as damage and responses.

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a. Outline the methods used to describe the magnitude (strength) of **two** hazard types. [2+2]

b. Suggest **three** reasons why some people continue to live in places with a known hazard risk. [3x2]

c. "Economic factors and not physical factors determine the severity of the impacts of hurricanes (typhoons, cyclones)." Discuss this statement using examples. [10]

Markscheme

a. The most likely types selected will be earthquakes (Richter or Mercalli scale), volcanoes (VEI scale) and hurricanes/cyclones/typhoons (Saffir–Simpson scale). In each case allow 1 mark for naming the relevant scale and 1 mark for a brief description. Responses that refer to hazards not in the syllabus, such as tornadoes, but that outline the relevant scale, should be credited.

b. Award 1 mark for each reason stated (for example, soil quality, poverty, lack of knowledge, historical inertia) and 1 mark for an extended explanation or detail of the hazard risk.

c. A number of approaches are possible but most answers will refer to the contrasting effects of hurricanes on countries with contrasting levels of development. It is important that the answer refers to physical factors such as the strength of the hurricane, the size of the storm surge or the landscape of the area affected, as well as economic factors that may determine levels of preparation and protection, warning systems, evacuation, aid and recovery responses.

   The strongest answers that access bands E and F should focus on at least two hurricane events and balance the relative importance of these factors in assessing the severity of the impact in terms of loss of life, environmental damage and loss of property (economic cost).

   Answers that simply describe the impacts, or just describe physical and economic factors without discussing their relative importance, should not move above band D.

   Similarly, answers that do not refer to examples should not be able to access bands E and F.

   Marks should be allocated according to the markbands.

Examiners report

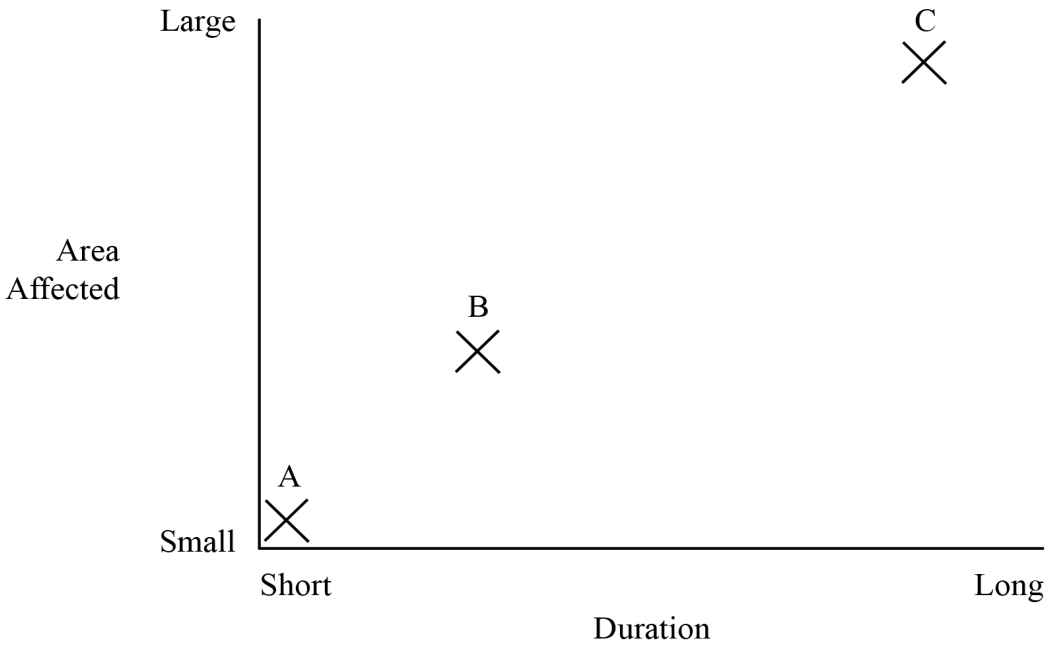
a. The most common scale chosen was the Richter scale, though few candidates at standard level were able to describe how it relates to earthquake strength. Many candidates who chose hurricanes were unable to refer to the Saffir–Simpson scale and simply referred to wind speeds.

b. Generally well done with a wide range of reasons, though weaker responses failed to refer to the actual risk that faced the inhabitants.

c. Responses were much stronger on economic factors than physical factors, with a surprising number of answers failing to mention that the consequences might depend on the category of the hurricane, its speed of movement, height of the storm surge and the type of coastline at landfall. Equally, the term "severity" was often interpreted in a very narrow sense with candidates apparently not realizing that such terms include a perceptual component (what is severe to one person is not to another).

   There were however many excellent case studies included at both levels.

The diagram shows three natural hazards (A, B, C), their duration and the size of the area they affect.



a. Identify **two** of the hazards shown and explain your choice. [2+2]

b. Analyse the global distribution of **one** of the hazards you identified in part (a). [6]

c. Using examples, evaluate the success of adjustment and response strategies for a named hazard type. [10]

Markscheme

a. A – earthquake – quakes last for seconds/minutes and affect a small area.

B – accept: either volcano – lasts for days to months; ash can affect a wide area or hurricane/typhoon/cyclone – lasts for days – affects a wide area.

C – drought – lasts for months/years – affects a very large area.

Accept any other valid examples and explanations.

The selection of a hazard not specifically named in the syllabus is likely to be self-limiting and requires no special action on the part of the examiner.

Allow 1+1 marks for identification of the hazards and 1+1 marks for justifications.

b. The chosen hazard should be clearly stated. A global scale must be used in the analysis. Award 2 marks for the description of the global pattern of the hazard and 4 marks for the explanation of the distribution, with reasons for any variations in the pattern.

c. The named hazard should be clearly stated. Relevant adjustment strategies may include modifying the hazard or changing the loss potential through building design, warning systems or land-use planning. In addition, adjustments to the loss may be included in terms of spreading losses, planning for loss or simply bearing the loss. Not all of these need be included in a good answer. Response strategies could include short-term rescue, shelter and aid, medium-term restoration of infrastructure and long-term reconstruction and rehabilitation.

The strongest answers will refer to examples of strategies used before and after actual hazard events. Answers that do not use examples or that simply describe relevant strategies should not move above band D. To access bands E and F, at least one adjustment and one response strategy should be evaluated.

Marks should be allocated according to the markbands.

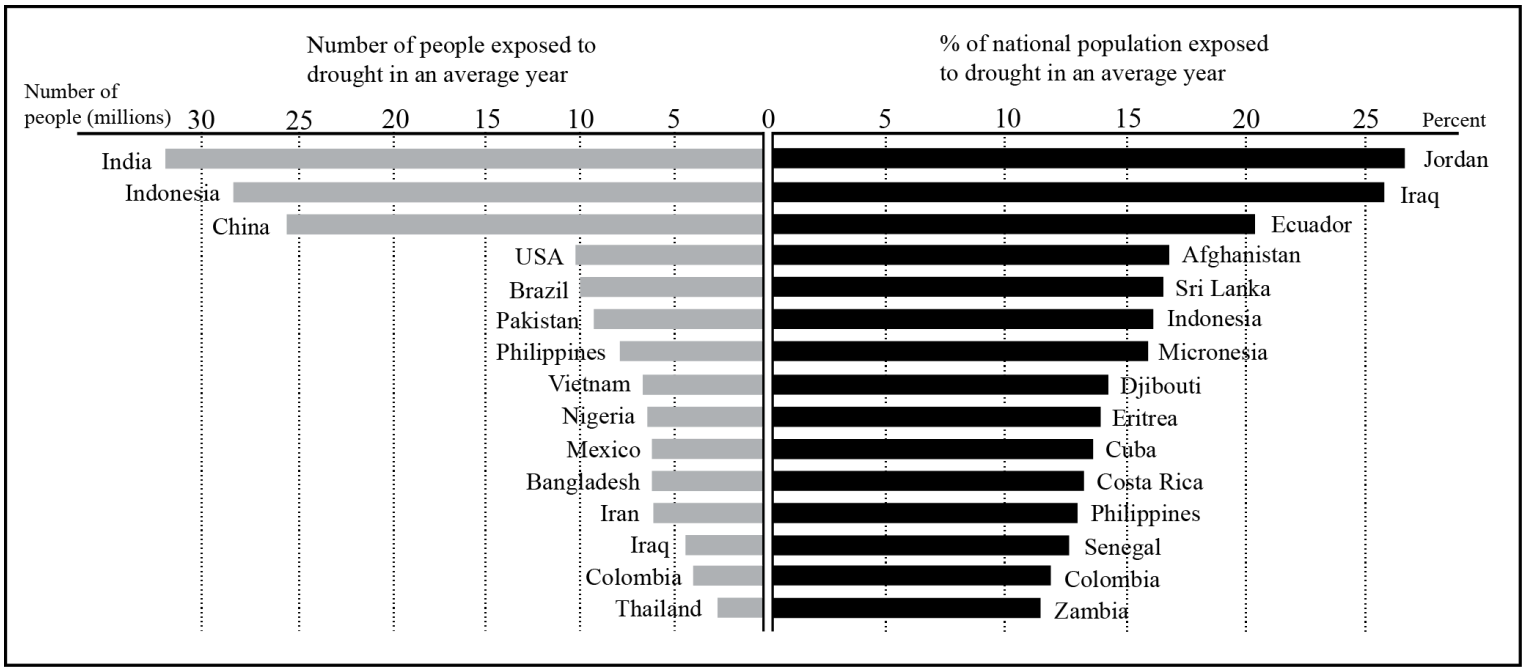
Examiners report

a. This was usually well done.

b. At both levels, very few offered a good description of the actual global distribution.

c. Responses tended to focus on only limited aspects of the question, and concentrate, for example, only on short-term strategies, ignoring longer-term ones. At standard level, responses frequently described strategies without evaluating their success. Detail was often missing, for example, "build earthquake-resistant buildings" was often stated as a strategy but without any detail as to how this could be achieved. Many candidates still believe that with current technology, earthquakes can be predicted and populations evacuated before they occur.

The graph shows the number of people, and the percentage of the total population, exposed to drought in different countries in an average year.



[Source: *Reducing Disaster Risk* – UNDP/BCPR, UNEP/GRID-Geneva]

a. Briefly describe any **two** distinct patterns shown by the data on the graph. [2+2]

b. Explain the reasons for the occurrence and severity of a specific drought event that you have studied. [6]

c. Referring to examples, examine why the geographic impacts of disasters vary in space and time. [10]

Markscheme

a. For each pattern, award 2 marks for its brief description, including quantification.

The graph reveals several patterns. The number of people exposed to drought in an average year tends to be higher in more populous countries such as India, Indonesia and China. The countries where the highest percentages of national population are exposed to drought in any given year tend to be relatively small in both population and in area, though Indonesia is a clear exception. Any two distinct valid patterns should be credited.

b. Award 1 mark for the identification of when and where a specific drought event occurred and a further 1 mark for a description of its severity. The remaining 4 marks should be reserved for the explanation of why the event occurred and for its severity. For 4 marks both must be explained, though it is not necessary for both to be explained in equal detail.

   Responses that do not focus on a specific drought event may not be awarded more than 3 marks.

c. There are many factors explaining why the impacts of disasters vary in space and time, and candidates are expected to include a variety of ideas in their answers.

   The impacts of disasters depend on the type of hazard event leading to the disaster. For example, a drought has very different impacts, in both time and space, to a volcanic eruption. The impacts of disasters are not only determined by the characteristics of the hazard event, but also by the characteristics of the population and economic activity in the area concerned. The vulnerability of the population varies spatially, and with time. Impacts will be reduced if well-rehearsed response plans work effectively. Conversely, impacts may be increased if the first signs of an upcoming disaster are ignored. For a disaster of any given magnitude, it is often argued that more lives may be lost, but that the value of property damage will be less, in economically less developed nations than in more developed nations.

   Other valid ideas should also be credited.

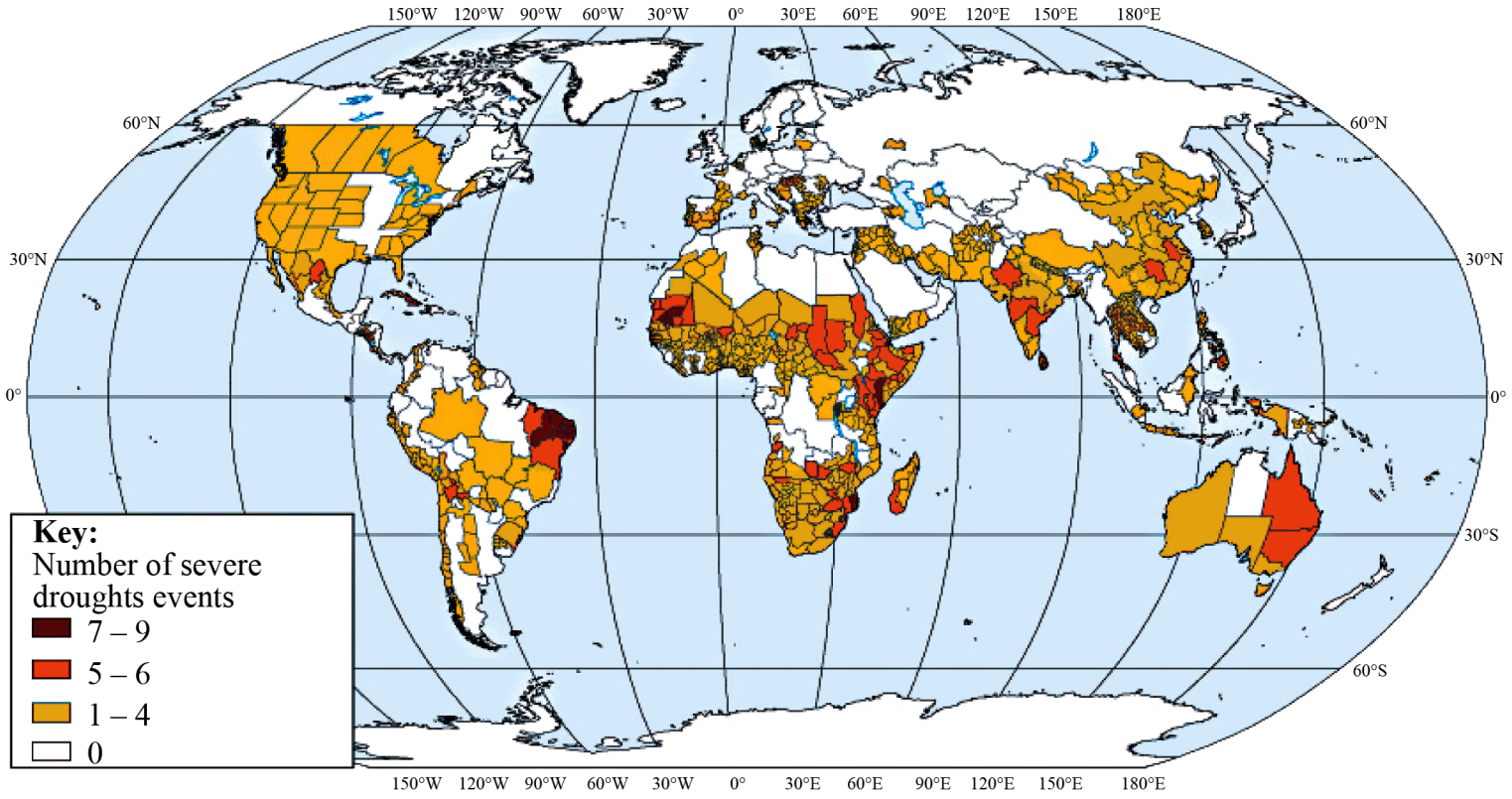
   It is not necessary for variations in space and time to be treated equally. Answers examining both aspects of the question in some detail are likely to be credited at bands E/F. Examples are a specific requirement of the question and are required to access band D and above.

   Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

The map shows the world distribution of severe drought events from 1974 to 2004.



[Source: http://www.preventionweb.net/files/10600_Figure226.jpg; ©UNEP/GRID]

a. Describe the distribution of areas in the northern hemisphere that have been affected by **five or more** severe drought events from 1974 to 2004. [4]

b. Analyse **three** ways in which communities can reduce the impact of drought. [2+2+

c. "Hazard preparedness is more important than hazard prediction." Discuss this statement with reference to any **one** hazard other than drought. [10]

Markscheme

a. Award 1 mark for each valid statement, either about general distribution (for example, most of the affected areas are between the equator and 30°N) or based on the naming of specific regions, for example, East Africa, or countries. No credit should be given for references to locations in the southern hemisphere.

b. Possible answers might include: early prediction through satellite remote sensing that detects changes in vegetation growth; the adoption of water conservation legislation in cities; cloud seeding; desalination; prevention of vegetation loss through overgrazing or soil erosion; water conservation techniques such as cisterns or tanks; catching run-off to raise water tables in wells using check dams and soil bunds; animal herd diversification; crop diversification migration; dry farming methods; government and international food aid; and disaster relief programmes. A variety of scales is acceptable.

Award 1 mark for a description of the method used, and 1 mark for development either by example or elaboration.

c. It is expected that most answers will refer to earthquakes or volcanoes, or to hurricanes or their associated hazards.

Answers that focus on a single, related hazard, such as a tsunami or storm surge, are equally acceptable. Discussion of human-induced hazards is also valid.

Answers should examine the effectiveness of methods of prediction of the chosen hazard and balance this with the success of methods used to prepare populations and property for the impact of a hazard event. In order to reach markbands E and F answers should present a discussion rather than just a list of prediction and preparation methods and reach a conclusion. It should not be possible to reach markbands E and F without reference to actual hazard events.

Marks should be allocated according to the markbands.

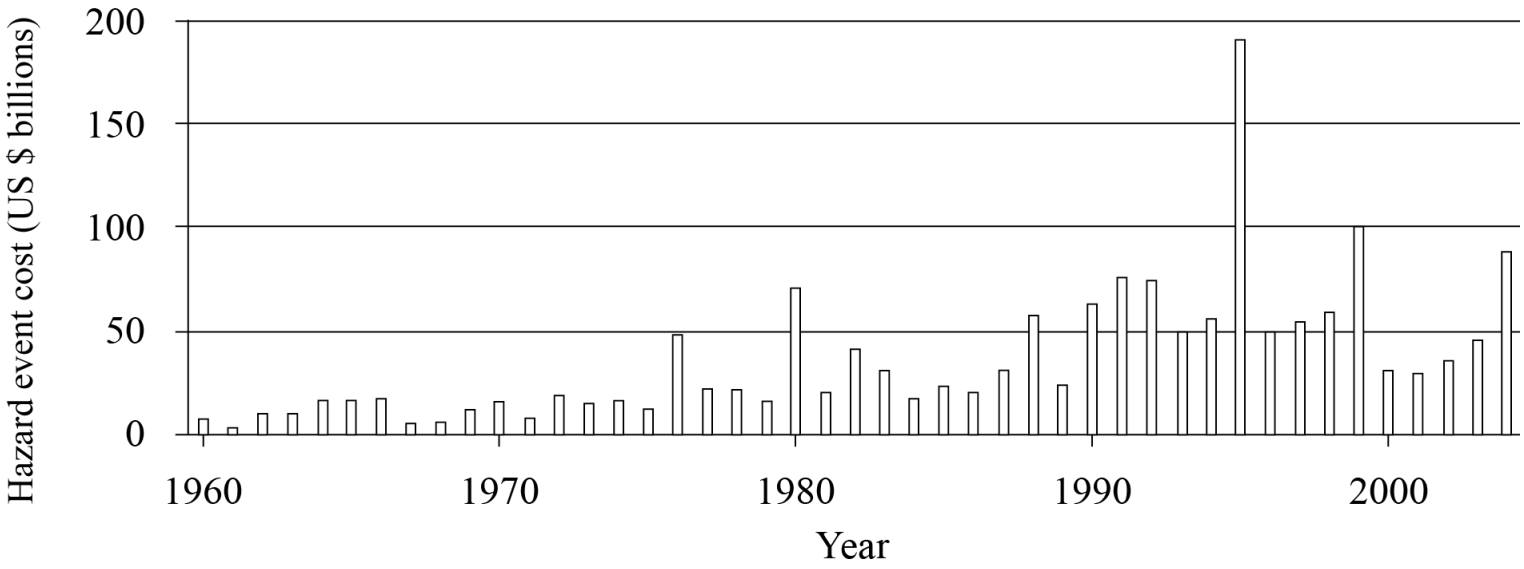
Examiners report

a. [N/A]

b. Some of the suggestions were long-term options that were not well related to reducing drought impact.

c. Responses tended to try to force rehearsed case studies into the question, irrespective of their real relevance. Some candidates discussed more than one type of hazard, in which case the strongest type was credited and the others ignored. In almost all cases, hazard prediction was less well understood than hazard preparedness.

The graph shows the cost of hazard events worldwide in US dollars from 1960 to 2004.



[Source: NASA Earth Observatory, http://earthobservatory.nasa.gov/Features/RisingCost/]

a. Describe the changes shown in the graph. [4]

b. Explain the reasons for the changes shown in the graph. [6]

c. Examine the different types of responses that occurred during **and** after a named disaster. (Do **not** refer to technological hazards in your answer.) [10]

Markscheme

a. Award [1 mark] for each valid statement supported by evidence from the graph including dates and costs. Possible answers include:

- a general upward trend in the cost of hazard events (e.g. no events costing over $25 billion before 1975, many events costing over $50 billion after 1988)
- but not a simple rise – there are fluctuations
- identification of major anomalies/cost events (Kobe, Indian Ocean tsunami)
- fall in 2000s compared with 1990s
- there may be other creditable points.

b. Answers could refer to:

- people have more possessions and more valuable possessions over time
- the increasing value of property and infrastructure over time
- more people are living in hazard prone areas.

Award [1 mark] for each valid reason; some development of each reason is expected for [2 marks]. Accept other valid reasons but they must include a clear explanation.

Answers that refer to an increase in the number or intensity of hazard events over time must give valid supporting evidence.

c. The disaster must be dated and located. How the event resulted in a disaster should be explained. The answer should refer to specific short-term

("during" as well as possibly before or immediate aftermath), medium-term and long-term responses ("after") related to the actual hazard event.

Short-term responses might include: search and rescue, emergency medical assistance, provision of security, emergency shelter, food and water and the clearing of debris resulting from the hazard event. Medium-term responses might include: destruction of damaged buildings, restoration of services such as communications, health care, transport and retailing, the return of displaced persons and rehabilitation programmes. Long-term responses may include: reconstruction, planning for future hazard events in terms of emergency response systems, the introduction of measures to mitigate future impact on people and property, awareness education and hazard training, the development of warning systems and evacuation strategies where relevant.

There may be alternate approaches – such as an examination of the efforts made by different agencies (NGOs, governments, etc.) – and these should be credited. Answers that simply describe local responses to a hazard event, as opposed to a disaster requiring outside assistance should not move above band D. Answers that examine a range of responses may be credited at bands E and F. Responses that examine a disaster outside the scope of the syllabus (e.g. floods) should be marked on their merits.

Marks should be allocated according to the markbands.

Examiners report

a. The description of changes was generally done well, although weaker responses did not use the data on the graph.

b. Many simply referred to an increase in hazards due to climate change without any evidence, though most were able to relate increased affluence to

rising costs. Surprisingly few referred to increased population living in hazard-prone areas.

c. A number of candidates concentrated on pre-disaster preparations, and whilst relevant to a certain extent, it meant that "during" and "after" were

neglected. Some only concentrated on what was not done, for example in Cyclone Nargis, or moralizing about Hurricane Katrina rather than

examining the facts. Some saw it as an excuse to write all they knew about a hazard event, with little reference to the question. A number used

Chernobyl, oil rig or oil tanker disasters despite the instruction against this.

Stronger responses demonstrated good planning and setting out of the pattern of responses along with time frames and set up some good structure in logical sequence.

---

a. (i) Describe what is meant by the term "drought". [4]

(ii) Outline **one climatic** reason for the occurrence of **one named** drought.

b. Referring to **either** earthquakes **or** volcanoes, explain **three** reasons why fewer deaths are caused by these hazards than in the past. [6]

c. Using located examples, examine why the intensity of hurricanes varies over time. [10]

Markscheme

a. (i)

Lower than expected/average rainfall **[1]**

Plus a development **[1]** such as:

- for an extended period of time
- or may distinguish between meteorological/agricultural/hydrological drought.

(ii)

*Award **[1]** for detail of why low rainfall occurs, and a further **[1]** for appropriate named location*.

Possible reasons: anticyclone / air mass movements; ENSO/El Niño/La Niña cycles; jet stream movements; North Atlantic Oscillation; climate change.

For example: California **[1]**, ENSO cycles **[1]**.
El Niño **[1]** has caused droughts in East Africa/Ethiopia **[1]**.

b. *In each case, award **[1]** for a basic reason why fewer lives are being lost to natural hazards than in the past and **[1]** for some further development*

using applied knowledge of earthquake or volcanic hazards.

For example:

- improved monitoring / short-term prediction **[1]** and may develop / provide examples **[1]**
- education / drills **[1]** and may develop / provide examples **[1]**
- greater knowledge of plate boundaries and where risks are present **[1]** and may develop / provide examples **[1]**
- land-use zoning **[1]** and may develop / provide examples **[1]**
- community preparedness *eg* emergency kits **[1]** and may develop / provide examples **[1]**.

For example: People in Iceland are aware of the dangers of volcanoes **[1]**, keep emergency supplies in their houses **[1]**.

c. Possible arguments include:

- during the passage of a hurricane, wind speed varies over time
- different hurricanes follow different tracks / make landfall in different areas
- variable hurricane strengths within a single season, perhaps linked to latitude, temperature and depth of water
- climate change could bring long-term increase in temperature of atmosphere and ocean.

Good answers are likely to conceptualize “intensity” in varying ways (different events or different phases of the same event), or may adopt different time scales as part of their answer (hurricane strength varies within a single season but there could be a long-term increase in intensity linked with climate change). Credit answers that look at spatial variations as well as temporal variations.

At band D responses are likely to describe some reasons for the differences in the strength of different hurricanes over time.

At band E, expect <u>either</u> more detail / range of reasons with located examples, for the varying intensity of different located hurricanes <u>or</u> some discussion of what “over time” means (eg seasonal or long term)

At band F, expect both.

Marks should be allocated according to the markbands.

Examiners report

a. (i)

There was often a poor understanding of the term drought, many simply stating a lack of rain.

(ii)

Many referred to a specific drought – *e.g*. Ethiopia 2015 and some were able to relate it to climatic factors, such as El Niño. However, named droughts were sometimes vague, as were the climatic reasons for the drought.

b. There were some very good responses and this was generally well answered. Weaker candidates gave basic reasons and these were not sufficiently developed for full marks. There was some misconception among candidates regarding the effectiveness of earthquake prediction.

c. This question posed some difficulties. Many candidates were unable to understand why intensity varied over time; this could be temporal or spatial; seasonal or long term (global warming). There was limited understanding of the processes involved in hurricane development. Some considered the example of a particular storm, showing how it varied in intensity as it passed over warmer seas and declined over land; others related changes to seasonal variations and climate change. Some confused intensity with varied impacts of hurricanes.

---

a. Outline **two** factors that can influence the vulnerability of a community to the impacts of a tectonic hazard event. [4]

b.i. Briefly explain the occurrence of **either** volcanoes **or** earthquakes at constructive plate margins. [3]

b.ii. Briefly explain the occurrence of **either** volcanoes **or** earthquakes at destructive plate margins. [3]

c. Examine the effectiveness of short- and long-term responses to **one** recent disaster caused by a hurricane (tropical cyclone/typhoon). [10]

Markscheme

a. *Award **[1]** for each factor and **[1]** for further development relating to vulnerability of a community to a tectonic hazard event.*

For example, a high degree of poverty **[1]** means that people cannot afford to build earthquake-resistant housing that does not collapse **[1]**.

Other possible factors include:

- lack of insurance
- elderly population
- a level of corruption
- time of day
- preparedness
- geographical location.

b.i. *Award up to **[3]** for any of the following points:*

Volcanoes

- are formed when two plates diverge as magma wells up to fill the gap **[1]**
- example of constructive plate margin, such as mid-Atlantic Ridge **[1]**
- usually begins as submarine volcano, but may later become island **[1]**.

Earthquakes

- are formed when two plates diverge as a result of friction and movement **[1]**
- the plate movement is explained, *eg* convection currents **[1]**
- example of plate margin, such as mid-Atlantic Ridge **[1]**.

Credit other valid points and/or the use of suitable annotated diagrams.

b.ii. *Award up to **[3]** for any of the following points:*

Volcanoes

- explanation of two plates converging **[1]**
- one plate sinks / is subducted **[1]**
- are formed due to melting, producing magma **[1]**

- differences in plate density causing subduction, causing magma to rise **[1]**
- additional detail, *eg* explosive eruptions around the margins of the Pacific plate **[1]**.

Earthquakes

- explanation of two plates converging, *eg* convection currents **[1]**
- subduction of denser oceanic plate **[1]**
- are formed due to friction between the plates **[1]**
- further detail, *eg* deep-focus **[1]**
- additional locational detail, eg around the margins of the Pacific plate **[1]**.

Credit other valid points and/or the use of suitable annotated diagrams.

c. *Responses considered should be both short-term and long-term.*

Short-term responses might include search and rescue, providing essential medical care, emergency food and water supplies, combating the threat of disease, establishing essential communications and alerting outside relief agencies.

Long-term responses continue for several months or years after the disaster, and might include rebuilding destroyed housing and infrastructure, re-establishing the local economy, undertaking protective measures and educating the local community in case of a future disaster, land-use zoning, establishing early-warning systems, planning evacuation routes.

Good responses will examine a range of different types of response to a recent named hurricane disaster, and consider their effectiveness in different timescales.

At band D, expect a descriptive account of different types of response to a hurricane disaster.

At band E, expect either a more detailed account of a range of short- and long-term responses, or some explicit examination of their relative effectiveness.

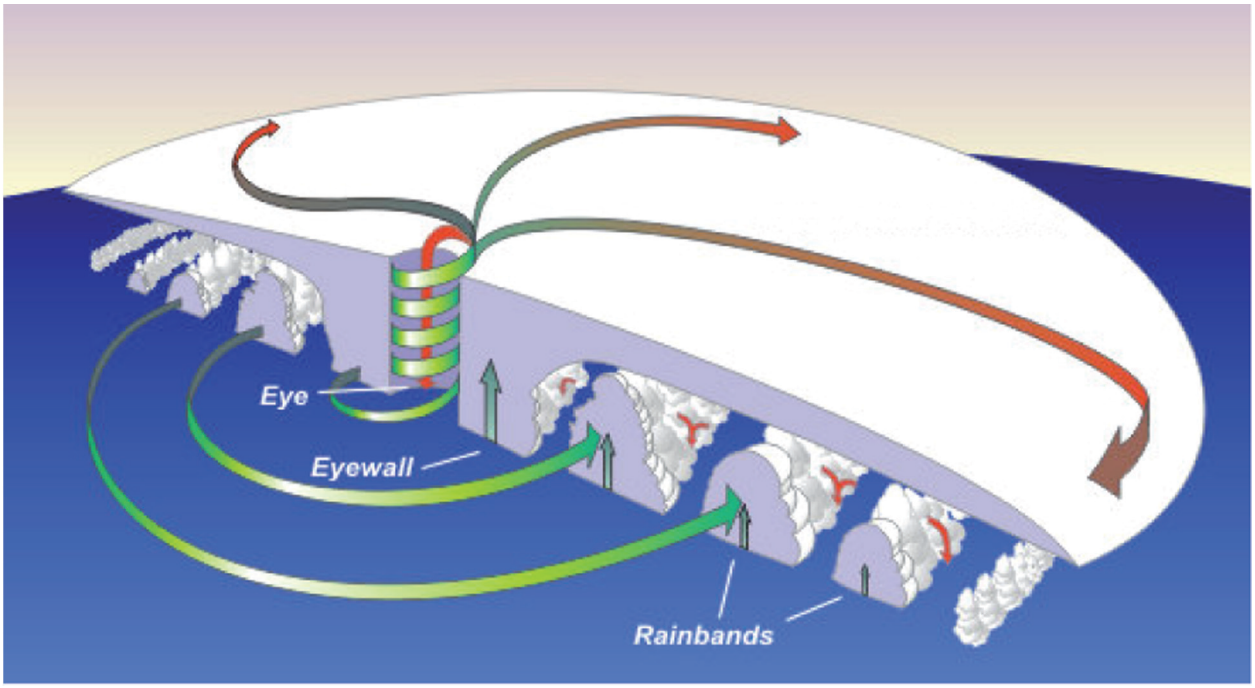
At band F, expect both.

Marks should be allocated according to the Paper 2 HL and SL markbands.

Examiners report

a. [N/A]
b.i. [N/A]
b.ii. [N/A]
c. [N/A]

The diagram shows the structure of a typical hurricane (typhoon, tropical cyclone) in the northern hemisphere.



[Source: http://library.thinkquest.org/03oct/00758/en/disaster/hurricane/structure.jpg]

a. Describe the atmospheric conditions in the eye and the eyewall of a typical hurricane. [2+2]

b. Explain the conditions needed for the occurrence of a hurricane hazard event. [6]

c. "Rich countries experience hazard events while poor countries experience disasters." Discuss this statement with reference to **one** named hazard type. [10]

Markscheme

a. In the eye the air is shown to be descending/warming [1 mark]. This results in calm weather and clear skies [1 mark].

In the eyewall the air is rising, rotating around the eye / cooling [1 mark]. This results in strong winds and heavy rain [1 mark].

Accept other plausible answers such as references to the release of latent heat in the eyewall causing rapid uplift / atmospheric pressure variations.

b. Valid conditions might include:

- warm ocean temperatures of 26/27° C provide the energy for the hurricane due to high rates of evaporation that trap latent heat which is released when condensation occurs during uplift
- suitable distance from the equator – allows the Coriolis force to operate giving rotation to the storm
- a stable atmosphere with no wind shear – the lack of variable wind speed with altitude allows vertical development of the storm to occur
- allow other valid conditions such as warm water depth of 50 m
- concentrated/vulnerable population in areas where the hazard is likely to strike e.g. coastal areas / removal of mangrove etc.

Answers should consider at least two conditions in detail or more in less detail to gain full marks. There should be some acknowledgement of the human dimension of the hazard event for maximum marks.

c. Answers should distinguish between a hazard (a threat that may cause loss of life or damage to property and the environment) and a disaster (resulting from a major hazard event and causing significant disruption, losses to life, property and ecosystems that the affected community is unable to deal with adequately without outside help).

Answers depend upon the type of hazard chosen but should refer to only one hazard type. It is expected that answers will discuss the ways in which rich countries are able to introduce measures that mitigate the effects of a hazard event thus reducing its impacts while poor countries are less able to do this and remain more vulnerable to the impacts of hazard events. It is expected that examples of hazard events from rich countries

and poor countries would be included to illustrate this. Good answers may suggest that rich countries are also vulnerable to disasters dependent on the intensity and location of the hazard event.

Answers that refer to multiple hazards should only be credited for the best of these. Answers that simply describe hazard events in poor countries and rich countries should not move above band D. To reach bands E and F a balanced discussion is expected.

Marks should be allocated according to the markbands.

Examiners report

a. Atmospheric conditions were not well understood but relative conditions between eye and eyewall were fine. Too many answers referred only to the weather experienced in the eye and eyewall rather than the atmospheric conditions, for example, few mentioned descending air in the eye and the rapid upward spiralling of air in the eyewall.

b. There was a good understanding of natural conditions necessary for formation of a hurricane but many missed the “hazard event” part of the question, and did not include any reference to human factors.

c. Weaker candidates focused on the case study and not the evaluation of the strategies. A significant error was the inability to distinguish between a hazard and a disaster, with weaker candidates merely comparing an event in an LEDC with an MEDC. Some referred to more than one hazard type. Stronger responses showed good differentiation between the impacts on rich/poor nations though many persist with the idea that evacuation before an earthquake is possible in rich countries. The use of some well-chosen examples were deconstructed with sound evaluation.

---

ai. Define *hazard risk*. [2]

aii. Define *hazard probability*. [2]

b. Explain **three** factors that affect the way that people perceive hazards. [2+2+

c. Examine the impact of a recent human-induced (technological) hazard event. [10]

Markscheme

ai. Hazard risk is the probability (accept “potential threat”) of a hazard event causing harmful consequences [1 mark]. Award a further 1 mark for development of this in terms of threats to life/property, injury, possessions, building structures, infrastructure.

aii. Hazard probability is the likelihood of a hazard event actually occurring [1 mark]. Award a further 1 mark for development of this in terms of the magnitude of an event and the frequency of its occurrence (the greater the magnitude, the less frequent the occurrence), or for reference to seasonal hazard occurrence, such as hurricanes.

b. Factors could include past experience of hazard events, level of education, age, gender, social status, access to information systems, level of technology, wealth, level of economic development, government awareness programs, religion (hazards as acts of God), personality. Award 1 mark for identifying a valid factor, with a further 1 mark for explaining how it affects hazard perception.

c. The hazard event should be identified and located. A description of the nature of the hazard event should be stated. The impact of the hazard on people, the environment, infrastructure and economy (as relevant) should be examined, though not necessarily all in the same depth. References to responses to the hazard should also be credited according to the markbands. Answers that do not relate to explosion or escape of hazardous material should not be credited beyond band C.

Marks should be allocated according to the markbands.

Examiners report

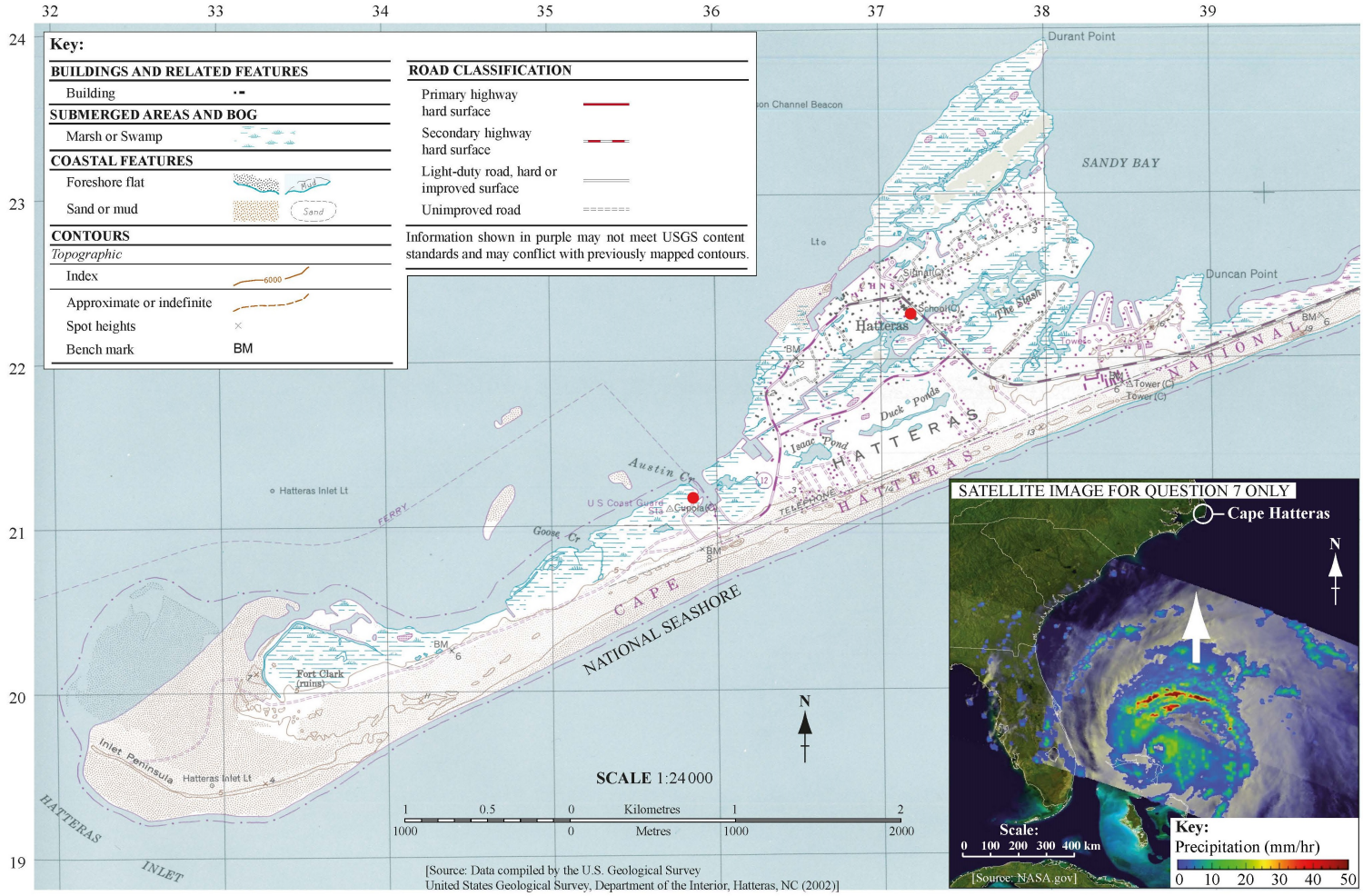
ai. Some candidates did not do well on this question.

aii. Some candidates did not do well on this question.

b. Most candidates had relevant suggestions for this question.

c. Weaker candidates, apparently unfamiliar with the word "perceive" wrote only about why people continue to live in hazardous areas. One of the most common choices of human-induced (technological) hazard event was the Fukushima Daiichi nuclear power station disaster (2011), though this was an inappropriate choice, given that it was caused by an earthquake and the resulting tsunami. Some credit was given in cases where candidates argued that human responses to the events had exacerbated the disaster. Wiser choices of example were the Deepwater Horizon oil spill (2010) or the Prestige oil spill in Spain (2002). Credit was given for the much older (and therefore not strictly "recent") Chernobyl disaster (1986) and the Union Carbide Bhopal toxic leak (1984).

The map shows the Cape Hatteras area of the east coast of the USA. The satellite image shows Hurricane Irene (2011), a few days before it reached Cape Hatteras.



a. (i) State the height in metres of the highest point west of gridline 35. [4]

(ii) State the four-figure grid reference for the square in which this point is located.

(iii) State the shortest distance by road, in kilometres, between the school and the ferry at Cupola.

b. **Using map evidence only,** explain why the inhabitants of this area were particularly vulnerable to the impacts of Hurricane Irene. [6]

c. "The level of economic development is **not** the main factor affecting the impact of a tectonic hazard event on a community." Discuss this statement, with reference to **either** earthquakes **or** volcanoes. [10]

Markscheme

a. (i) 11 metres (allow 7 metres)

(ii) 3419 (3320 for height of 7 metres in part (i))

(iii) Award the full ***[2 marks]*** to answers in the range 2.6 to 2.8 km.

Award ***[1 mark]*** to answers in the range 2.4 to 2.5 km or 2.9 to 3.0 km.

b. Explanations based on the map include:

- low relief (must state actual heights)
- limited evacuation possibilities by road – one road to the east and possible congestion
- limited evacuation possibilities by sea – only one ferry shown

- presence of a school – particularly vulnerable age group
- lack of protection from the south as hurricane approaches – though coast dunes appear higher than inland areas
- flatness and large areas of marsh increase the flood risk from heavy rainfall and potential flooding on evacuation routes
- exposure to the ocean and flat relief – means little friction therefore very high potential wind speeds
- situated directly in path of the hurricane track (as photograph on map shows).

Award ***[1 mark]*** for each explanation based on the map, and another ***[1 mark]*** for any further development (as indicated above).

The full ***[6 marks]*** can be awarded for six explanations without further development, or three explanations with development, or any combination thereof.

c. Answers should refer to examples of only one tectonic hazard type (earthquakes or volcanoes). Discussions should balance hazard events where the level of economic development proved to be a main factor affecting the impact, with other hazard events where this is not the case. In addition to economic development, factors such as population density, intensity of the hazard, time of day, awareness, prediction and warnings, ability to evacuate, preparedness, landscape, geology, and proximity to the hazard source could be taken into account. It is acceptable to argue that many/some of these may relate indirectly to levels of economic development.

If the response only looks at the factor of economic development it should not be credited above band D.

At band E candidates should provide some balance between economic and other factors and begin to show some attempt at evaluation.

At band F there should be a well balanced evaluation/conclusion.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

---

c. Explain **three** conditions necessary for the formation of tropical hurricanes. [6]

d. "Poorer communities are more vulnerable to the impacts of hazard events than richer communities." Discuss this statement. [10]

Markscheme

c. *Award **[1]** for each relevant point and **[1]** for further development*.

Conditions include:

• formation over warm tropical oceans / sea temperatures at least 26°C / significant depth of warm water in order to provide energy and moisture
• sufficient distance from the equator for the Coriolis force to be significant
• convergence of warm, moist air towards a centre of low pressure
• rapid uplift of air causes condensation and the formation of clouds/rain
• release of energy (latent heat) due to condensation results in further rapid uplift
• cooler air descends in the eye of the hurricane; as it descends the air warms and no clouds develop.

For example, the Coriolis force must be sufficiently strong **[1]** to impart rotation of the air, so hurricanes rarely form close to the equator **[1]**.

d. The vulnerability of a community to hazard events is affected by the demographic, social and economic characteristics of the population. Examples might be given at a variety of scales, from both rural and urban populations. Poorer communities are often more vulnerable because they often live in hazardprone areas, they lack education and awareness, and are unable to afford measures that might be taken to reduce the impact of hazards.

Richer communities are more able to plan and prepare for hazard events, have greater awareness and are better able to respond to the effects of a

hazard. Technological hazards may affect rich and poor communities alike, but poorer

people may live closer to the source of the hazard (as in Bhopal).

Good answers will discuss the vulnerability of poorer communities to hazards and the inability to respond to their effects, and will discuss the vulnerability of poorer and richer communities in different areas. Another approach is to discuss the scale of the hazard event, recognizing that all communities can be equally vulnerable, *eg* tsunamis. Another approach is to discuss temporal aspects of the hazard event, such as a poor community's long-term vulnerability to diseases after the hazard event.

Accept both countries and communities.

For band D, expect some description of the vulnerability of poorer communities and/or richer communities to hazard events.

For band E, expect either a more structured and detailed explanation of the vulnerability of poorer and richer communities, or a discussion that reflects critically on diverse communities, hazards of different scales, different types of vulnerability.

For band F, expect both of these elements.

Marks should be allocated according to the markbands.

Examiners report

c. [N/A]
d. [N/A]

---

a. (i) Define the term *disaster*. [5]

(ii) Outline **two** long-term actions a community can take to reduce the economic impact of hurricanes.

b. Explain the causes of **one named** human-induced hazard event. [5]

c. Examine the reasons why people continue to live in areas that have been affected by severe drought hazard events. [10]

Markscheme

a. (i) A major hazard event that needs outside help.

(ii) In each case award **[1]** for a basic way to reduce economic losses and **[1]** for some development (using knowledge of hurricanes, economics, planning, governance *etc*) or the applied use of an example, such as measures introduced after a named hurricane.

- Strengthen buildings **[1]** and may have details of structures or where this was done **[1]**.
- Purchase insurance **[1]** and may explain how policies operate to reduce costs for individuals **[1]**.
- Land-use planning **[1]** and may give details of areas to be avoided *eg* low lying land with flood risk **[1]**.
- Improved warning systems **[1]**, may suggest details, or describes a place where this was done **[1]**.

b. Award **[1]** for correctly identifying a named human-induced (human error) hazard event such as the 2010 major industrial waste spill in Hungary, the

Chernobyl nuclear power incident, the Gulf of Mexico oil spill (does not need to state year).

Award up to **[4]** for the explanation, for example:

- human error in design/operation identified **[1]** and may provide further explanation of this **[1]**
- provides specific details of the hazardous material provided *eg* names gas, radioactive isotopes **[1]**
- provides detail of how physical processes *eg* ocean currents, wind, led to a larger area or particular areas being affected **[1]** and may give examples of areas **[1]**
- shows why the event constituted a hazard risk to humans *eg* oil affected populated areas of Florida **[1]**
- credit other valid explanatory material (on the cause of the event/why it constitutes a hazard).

"High tech" problems triggered by a natural hazard *eg* Fukushima 2011 can be awarded up to **[3]** only.

c. Drought should ideally be understood as below average/expected/normal precipitation (and not simply arid environments). The answer should ideally be related to the global distribution of actual drought, including named areas (may consider irregularities of mid-latitude air mass movements; cyclic shifts; El Niño and La Niña).

Answers that deal with naturally arid regions (that are not necessarily subject to drought, such as normal summers in the Mediterranean) can reach band E (but not band F) if the discussion of human behaviour or adaptation is good.

Reasons might include:

- lack of knowledge including serious secondary risks (wildfires)
- lack of economic options/poverty/inertia/fatalism
- political issues *eg* refugees forced into drought-stricken areas
- too trusting of insurance/governance
- resilient/adaptive behaviour *eg* water storage, deep wells, crop diversification, temporary migration *etc*.

Good answers may examine in a structured way how reasons may vary according to the type of geographical area (level of development, scale, physical location *eg* continentality, geopolitics *eg* conflict zones). Another approach might be to examine the timescale over which drought events have occurred or knowledge of their recurrence intervals.

For band D, expect some description of a drought and/or some reasons why people do not relocate from hazardous areas in general.

At band E, expect either more detailed explanation of reasons why people remain in drought-prone areas or a structured examination of different kinds of area/context for drought.

At band F expect both of these elements.

Marks should be allocated according to the markbands.

Examiners report

a. (i) Definitions had to refer to the need for outside help to gain the mark.

(ii) When referring to the long-term actions, each point needed to be further developed to gain the additional mark. For example, candidates mentioned land-use planning but answers were generalized without development.

b. The question refers to a human-induced hazard event, such as Chernobyl or a major oil spill. Note that Fukushima is a problem triggered by a natural hazard and is not really relevant. Many described the event and discussed the impacts rather than examining the causes.

c. This was generally well answered. The best candidates used comparative case studies from, for example, Australia and a Sahel country.

---

a. Describe the difference between a hazard and a disaster. [2+2]

b. Explain why some sections of a community are more vulnerable to hazards than others. [6]

c. Compare the effectiveness of the methods used to predict the occurrence of **two** different natural hazard types. [10]

Markscheme

a. A hazard constitutes a threat to people, property and/or the environment [1 mark]. It can be natural or human in origin [1 mark].

A disaster results from a hazard event that has major impacts on people, economic and/or environmental impacts [1 mark] and which the area or country cannot deal with unless there is outside aid [1 mark].

b. Award up to 3 marks for each section of a community whose vulnerability is well explained or for a single factor which is well explained.

Vulnerable sections could include: different age categories, income groups, people with disabilities, location, gender, and ethnicity. (Do not accept MEDC/LEDC differences.) Not all of these are needed for 6 marks.

6 marks may also be awarded for a brief explanation of six valid factors. Factors might include: knowledge of the hazard, education level, warning systems, insurance, communications, population density, income level, building types and construction codes.

c. Answers depend on the hazard types chosen.

The two hazard types should be clearly identified and must be natural hazards. (It is expected that these will be chosen from volcanic hazards, earthquakes, hurricanes or drought, but other natural hazard types such as tsunamis may be credited.) Answers should clearly outline the methods used to try to predict the named hazard types and make comparisons as to their reliability in forecasting hazard events.

Responses that compare the effectiveness of methods used to predict one of the hazard types should be credited, but comparisons between the methods used for different types of hazard should form the bulk of the argument to essentially determine which hazard is the more predictable.

To access bands E and F, answers should effectively compare the methods used.

Marks should be allocated according to the markbands.

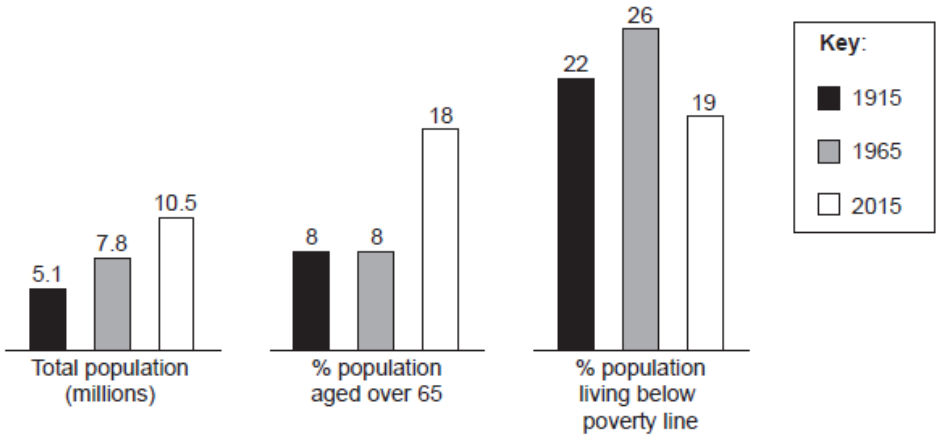
Examiners report

a. Candidates either knew the IB definitions of hazards and disasters or they did not – this differentiated those who scored 2, 3 or 4 out of 4.

b. There were some excellent answers which identified parts of the community (aged, young, women, infirm, poor, disabled) and explained why they are at increased risk. However, too many went for the MEDC/LEDC contrast and did not appreciate the scale involved in the question.

c. Answers frequently examined the methods used to predict their chosen hazards rather than evaluating their effectiveness. The two most frequent natural hazards chosen were hurricanes and earthquakes, which lend themselves to a very good contrast. However, answers needed to compare the effectiveness of the methods to predict to access the higher bands (E and F).

The diagram shows changes in population and vulnerability for a city at risk of multiple natural hazards, between 1915 and 2015.



[Source: International Baccalaureate Organization, 2015]

a. Using data from the diagram, describe **three** trends shown. [4]

b. Suggest how a community's vulnerability to hazards is affected by: [6]

(i) the demographic characteristics of its population;

(ii) the socio-economic characteristics of its population.

c. Using examples, contrast the strategies adopted to minimize the risk from future droughts and hurricanes. [10]

Markscheme

a. *Award **[1]** for each valid statement, up to **[3]**.*

Possibilities could include:

- total population increases **[1]**
- over-65s no change 1915–65 then rise in 2015/after 1965 **[1]**
- poverty % rises then falls **[1]**.

*Award **[1]** for each valid point up to a maximum of **[3]**. The final **[1]** is reserved for some quantification.*

b. (i) *Responses may use own knowledge or may refer to the diagram.*

*In each case, award **[1]** for each basic link between a valid population factor and some aspect of vulnerability/risk (such as preparedness, resilience, response) and up to **[2]** for further development using applied knowledge of a hazard, an example, or data from the diagram.*

Possibilities could include:

- more people means greater numbers are at risk **[1]** may give example of a place **[1]**
- more migrants who speak a different language and do not understand warnings **[1]**
- older people may have greater knowledge of dangers and are better prepared **[1]**.

For example: Vulnerability increases if more elderly people are in a place at risk of flooding who might be unable to move quickly **[1]**, this might be the case for a coastal town in Florida **[1]** with large numbers of elderly there who also may struggle to hear warnings **[1]**.

(ii) *Responses may use own knowledge or may refer to the diagram.*

*In each case, award **[1]** for each basic link between a valid population factor and some aspect of vulnerability/risk (such as preparedness, resilience, response) and up to **[2]** for further development using applied knowledge of a hazard, an example, or data from the diagram.*

Possibilities could include:

- high levels of poverty may mean more people living in hazard-prone areas **[1]**
- poorer people/areas have lower quality housing that is vulnerable to hazard events **[1]**
- lower income groups may not be able to afford insurance so are more vulnerable **[1]**
- high levels of affluence means more valuable possessions at risk **[1]**
- people with less formal education may have less knowledge of risks **[1]**.

For example: Low income groups cannot afford insurance and so are vulnerable **[1]**, and also may not have a television so do not get the warnings in time **[1]**. The poor were badly affected when Hurricane Katrina struck New Orleans **[1]**.

c. There are multiple aspects of adjustment and response, including building construction, land-use planning, insurance, education and community

capability-building, planning for rescue and rehabilitation.

Answers may also highlight the possibility of climate change, making hurricanes and droughts more frequent/less predictable, and thus management strategies would need to plan for the future.

Good answers may highlight and comment on the clear contrasts that emerge from the analysis, and the way these relate to the varying nature of the risk (hurricanes are sudden onset, powerful, destructive events and this ought to be factored into the way buildings are constructed; whereas droughts are slow onset, pervasive periods of water shortage and this may require better governance in relation to water management/food storage).

Answers that do not deal with predicted/future risk, but instead contrast the emergency/reconstruction response to events that have occurred already should be judged on their merits and might reach band D.

At band D, expect a basic description of strategies used for the two hazards (do not expect balance).

At band E, expect <u>either</u> greater, well-exemplified detail of the varied strategies and/or risks, <u>or</u> some critical evaluation of the contrasting character of the responses/risks.

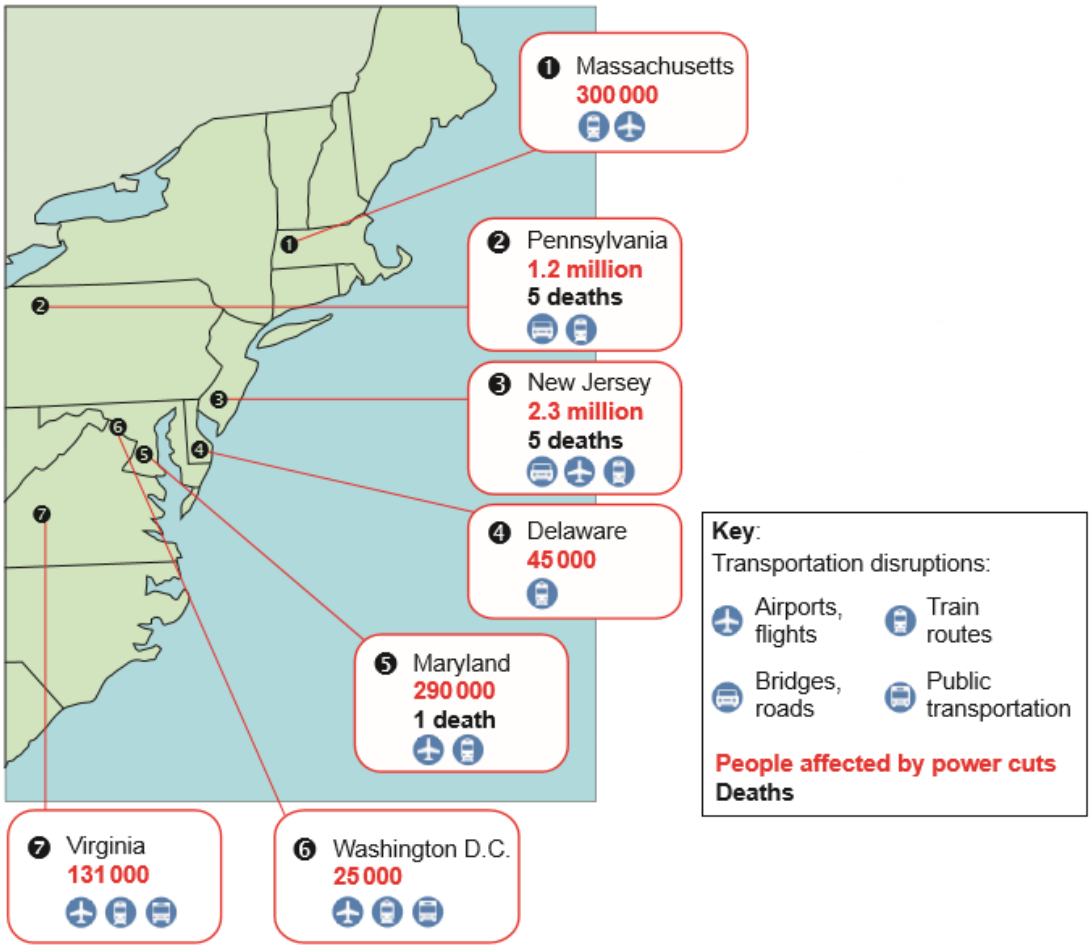
At band F expect both.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

The map shows the impacts of Hurricane Sandy on selected states in the Eastern United States in 2012.



[Source: © International Baccalaureate Organization 2016]

a. (i) Using map evidence, determine which state was worst affected and outline why. [6]

(ii) Using map evidence, determine which state was least affected and outline why.

(iii) Suggest how land-use planning (zoning) could help reduce vulnerability to hurricanes in this area.

b. Suggest why the distinction between a hazard event and a disaster is not always completely clear. [4]

c. Referring to **two or more** types of hazard, examine why the highest magnitude hazard events are not necessarily the most harmful. [10]

Markscheme

a. (i)

New Jersey **[1]**, and identifies two of the following: highest deaths, most people affected by power outages, three types of travel disruption **[1]**.

(ii)

Delaware **[1]**, and further justification **[1]**, for example, no deaths, least transport disruption **[1]**.
or
Washington **[1]**, and further justification **[1]**, for example, no deaths, fewest power cuts **[1]**.

(iii)

*Award **[1]** for each action. A single action can gain **[2]** if the idea is developed/exemplified*.

Possible actions include:

- housing restrictions in low-lying/coastal areas mean fewer people/properties will be at risk **[1]**
- other land uses, *eg* golf courses, parks **[1]**.

b. A hazard event is the realization of a threat to human life/property, resulting in harm/damage **[1]**.

A disaster is a major hazard event that causes widespread disruption to a community or region, and the affected community is unable to deal with it adequately without outside help **[1]**.

*Award the remaining **[2]** for an attempt to address the distinction:*

- What is meant by "outside" help is not clear – this has national / international dimension for instance.
- What is meant by "widespread disruption" may not be clear *eg* how many deaths/how much damage.

Credit other valid points that relate to the distinction.

c. The most likely framework will be to compare two or more events in very different contexts. Two named types must be discussed in some depth for the award of full marks.

Good answers are likely to conceptualize "harmful" in varying ways (injuries, deaths, property damage *etc*).

A good discussion should consider a range of arguments, such as:

- population vulnerability, density and distribution, and events in unpopulated areas
- socio-economic context (level of development and resilience/vulnerability/adaptation costs)
- timing of events (night-time or daytime)
- trajectory of hurricanes.

At band D answers are likely to describe some basic reasons for differences in the impacts of one or two hazards (eg knows that hurricane or tectonic events are likely to bring higher mortality in less developed countries).

At band E, expect either more detail / a range of reasons for the varying impacts that two or more hazards will have or some discussion of what constitutes harmful (contrasts mortality and property losses for instance).

At band F, expect both.

Marks should be allocated according to the markbands.

Examiners report

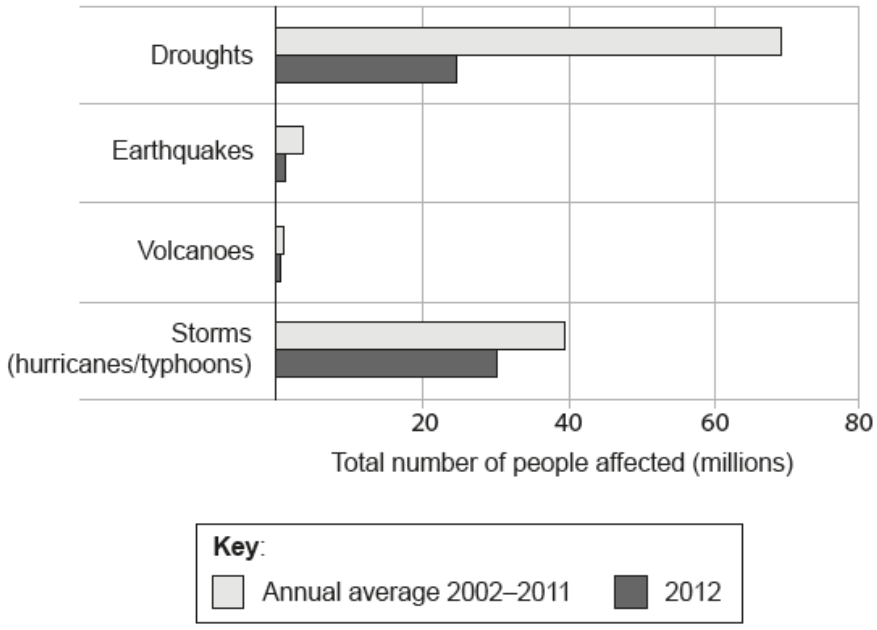
a. (i/ii) Most candidates correctly identified the state (Delaware and Washington were both acceptable) with supporting data.

(iii) Land-use planning (zoning) was frequently misunderstood.

b. Most candidates understood the difference between a hazard event and a disaster, but relatively few could suggest why the distinction is unclear.

c. This was generally well answered, showing a good understanding of hazard events and their contrasting impacts. Answers were focused with good reference to examples, such as Japan and Haiti. Weaker candidates gave descriptive answers.

The diagram shows the total number of people affected by different types of hazard event between 2002 and 2012.



[Source: © International Baccalaureate Organization 2015]

a. Identify which hazard: [2]

(i) affected the least number of people in 2012;

(ii) affected the greatest number of people between 2002 and 2012.

b. Suggest **two** reasons why the number of people affected by storms in 2012 is lower than in previous years. [4]

c. Explain what is meant by the: [4]

(i) rehabilitation response to a hazard event;

(ii) reconstruction response to a hazard event.

d. Examine why some areas of the world have a high hazard risk for **either** earthquakes **or** volcanoes [10]

Markscheme

a. (i) Volcanoes

(ii) Droughts

b. In each case award **[1]** for a basic explanation of why the 2012 figure is smaller and **[1]** for some development (using knowledge of the hazard) or the applied use of an example, such as a large named hazard event occurring in 2002–2012.

- There may have been fewer hurricanes in 2012 **[1]** – may suggest reasons *eg* ENSO **[1]**.
- There is natural variation in the strength of large hurricane events **[1]** and may link to higher return period idea (or similar) or may quote known case study data for 2002–2012 period, or may use Saffir–Simpson scale **[1]**.
- Not all tracks reach populated areas **[1]** and may give details or knows case studies of “near misses” in 2012 **[1]**.
- Credit suggestions of climatic variability or ENSO cycles **[1]** linked to critical temperature of 26°C **[1]**.
- Prediction and monitoring **[1]** – allows for evacuation and therefore fewer affected **[1]**.
- Other valid suggestions.

c. (i) Award **[1]** for definition and **[1]** for further development or exemplification.

For example: Rehabilitation describes treatment or help for people who have been harmed in some way **[1]**. It involves different types of help (*eg* counselling alongside surgery) **[1]** or after the Haiti earthquake 300 000 people needed help/rehabilitation **[1]**.

(ii) Award **[1]** for definition and **[1]** for further development or exemplification.

For example: Reconstruction describes the replacement of buildings damaged by a hazard event **[1]** (allow rebuilding of a country's economy). It involves different types of work (*eg* repair work or new building) **[1]**, or the reconstruction cost after Hurricane Katrina was US$81bn) **[1]**.

d. Hazard risk distribution comprises both the spatial distribution of earthquakes/volcanoes and population patterns and characteristics.

The physical explanation should include key factors such as tectonic margins, processes (subduction), possibly types of margin, and/or hotspots. Human factors may include coastal distributions of population, vulnerable megacities, income levels and property risks (the examination may compare the pattern of property risk in high-income countries with the pattern of mortality risk in low-income countries), adaptation measures.

If a candidate considers both earthquakes and volcanoes, only credit the first.

Good answers are likely to provide a structured examination of different human aspects of hazard risk (people/property) and may also distinguish between different physical aspects of the hazard risk (primary/secondary hazards). Another approach might be to use the concept of scale (*eg* examines how risk vary at both a macro-scale/continental scale and also at a micro-scale, such as along specific fault lines).

For band D, expect some description of plate margins and/or the existence of countries/populations at different levels of economic development.

At band E, expect either more detailed explanation of why margin movements bring risk(s) to different locations or a structured examination of the human risks for different areas.

At band F expect both of these elements.

Marks should be allocated according to the markbands.

Examiners report

a. The vast majority had no problem with this.

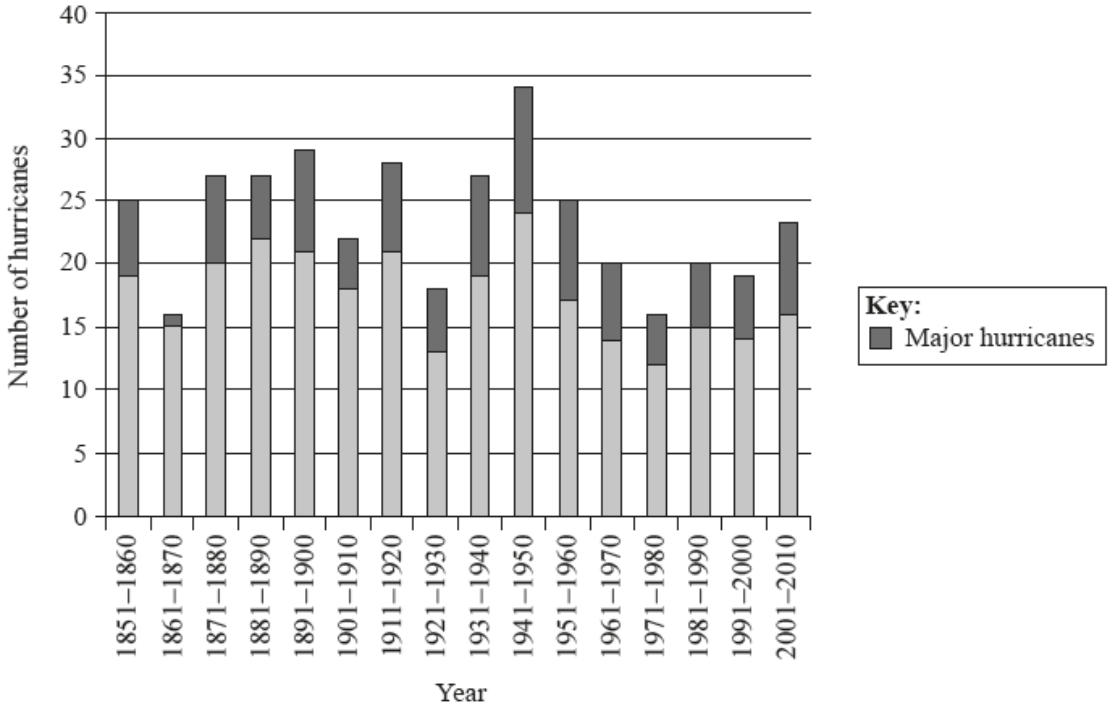
b. This posed few problems. Few, however, realized that the 2002–2012 figure was an average and that events such as Hurricane Katrina could have skewed the results. Most referred to improved prediction and increased preparedness.

c. Most could explain the difference between the two terms, often with examples and case studies. There was some confusion over the terms.

Reconstruction was stronger than rehabilitation.

d. A few candidates referred to both earthquakes and volcanoes, and if both are used only the first one mentioned was credited. The large majority chose earthquakes. To access the higher markbands, explanation should refer to both physical factors, such as tectonic margins, and human factors such as population distribution and contrasting levels of economic development. The physical factors were not detailed enough to show knowledge and understanding and the human factors were generalized and descriptive.

The chart shows the total number of hurricanes that struck a country per decade from 1851 to 2010.



[Source: adapted from NOAA, www.nhc.noaa.gov]

a. Describe the trends shown on the graph. [4]

b. (i) Outline the essential characteristics of drought. [6]

(ii) Explain the cause(s) of **one named** drought event.

c. "The level of economic development is the most important factor that influences the vulnerability of a population to environmental hazard risks." [10]

Discuss this statement.

Markscheme

a. Award ***[1 mark]*** for each of the following trends, and exceptions to/clarifications of the trends identified:

- general trend is up to 1941–51, then down to 1991–2001
- or may see a rise to 1891–1900, then general decline to 2010 but with some marked exceptions
- recent upturn 2001–2010, or since 1971–80 (with exceptions)
- rising trend is interrupted by anomalies at 1861–70, or 1901–10, 1921–30
- may view lows at 1921–30 (18) and highs at 1941–50 (34) as interrupting a trend of some sort
- after 1941–50 there were fewer than 25 hurricanes
- 1941–50 showed a sharp rise in the number of hurricanes ***[1 mark]***
- a fluctuating trend
- other valid comments that identify a trend, or exceptions/anomalies to that trend.

b. (i) Award ***[1 mark]*** for a valid definition of drought, and an additional ***[1 mark]*** for development. For example:

Lower rainfall than the long-term average ***[1 mark]*** for a prolonged period of time ***[1 mark]***

OR

With resulting impacts on the environment or human activity as a result of water shortages ***[1 mark]***.

(ii) Award ***[1 mark]*** for the timing (accept some margin of error) and general location of one drought event *eg* 2008–09 in Australia. Award up to ***[3 marks]*** for the explanation that follows.

For instance, credit any of the following ideas, if applied in a valid context:

- El Niño event ***[1 mark]*** when Pacific trade wind reversal ***[1 mark]*** increased air pressure in Australia 2008 ***[1 mark]*** bringing dry, subsiding air ***[1 mark]***
- La Niña event [1 mark] when Pacific trade wind strengthening ***[1 mark]*** resulted in colder eastern Pacific Ocean and high pressure ***[1 mark]*** leading to drought in Texas in 2011 ***[1 mark]***
- Excessive use of water by humans ***[1 mark]***. Over-extraction of groundwater, or over-irrigation ***[1 mark]*** resulted in water shortages ***[1 mark]*** and drought in Australia in 2010 ***[1 mark]***.

Credit other valid examples and approaches.

c. *Credit all content in line with the markbands. Credit unexpected approaches wherever relevant.*

Most responses will support the statement but high-scoring answers must present an argument to support their viewpoint that also examines other factors. Answers could refer to factors such as investment in warning systems, public education/awareness, effective lines of communication, preparedness and quality of emergency response, insurance, building codes, ability to coordinate the above. These are usually better developed in richer societies. Very good answers may refer to the fact that even in richer countries, some sections of the population are more vulnerable than others (may use case study of New Orleans, for example).

Other factors not related to economic development could include population density, knowledge of the area, culture, the magnitude of the hazard and the type of area (*eg* coastal) that the population inhabits.

For band D candidates must describe how economic development affects vulnerability with reference to at least one hazard type.

Band E should either provide much greater detail of a range of hazard risks that are related to economic development or discuss the concept of vulnerability in relation to at least one additional factor, such as population distribution.

At band F, expect both elements.

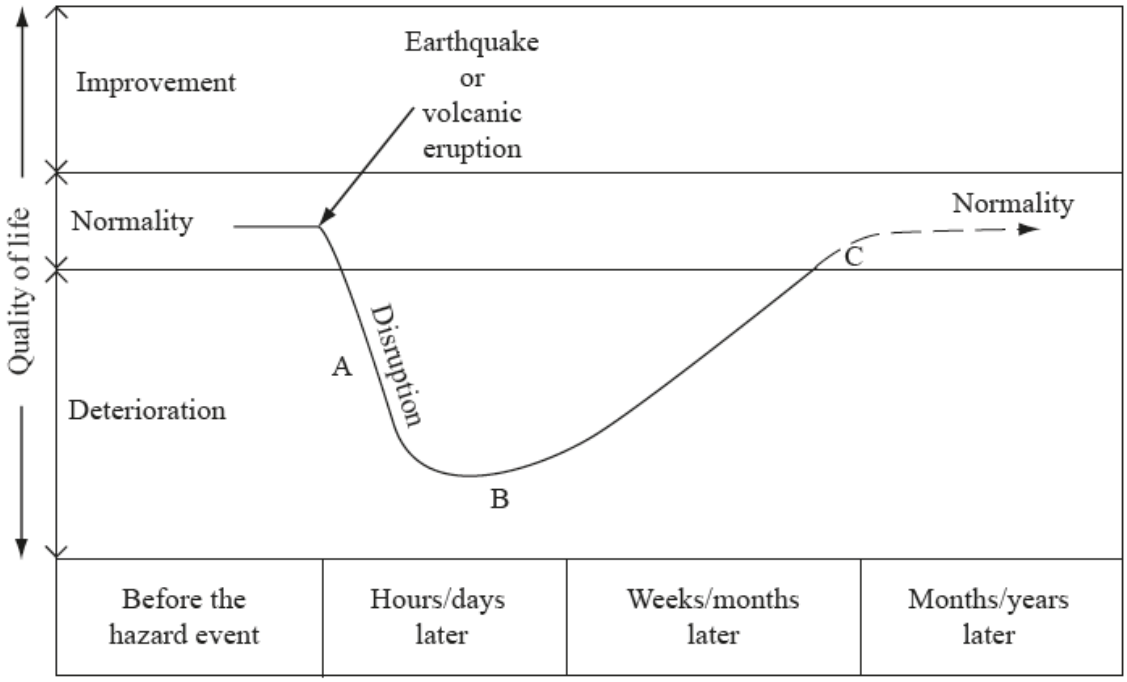
Examiners report

a. There were some very good responses showing the numerous trends on the graph. However, some identified patterns rather than trends.

b. Drought was generally misunderstood, with many simply stating that it was a period of low rainfall. Causes seemed to be for arid regions rather than for specific drought events. There were, however, some good answers referring to recent drought in Australia and its physical and human causes.

c. This was done well with some comprehensive responses including good contrasting case studies. Weaknesses included not applying the answer to a range of hazards or writing at length about other factors.

The diagram shows how an earthquake or volcanic eruption impacts on a population's quality of life.



[Source: adapted from V Bishop, (2001), *Hazards and Responses*, page 11]

a. With reference to **either** earthquakes **or** volcanic eruptions, describe **two** ways in which people's quality of life deteriorates at point A on the diagram. [4]

b. With reference to **either** an earthquake **or** a volcanic eruption, distinguish between the types of response to the hazard event that occur at point B and point C on the diagram. [6]

c. "Improved building design is the most effective way for people to reduce their vulnerability to hazards." Discuss this statement. [10]

Markscheme

a. Award ***[1 mark]*** for each impact on people (*eg* their home lost) and ***[1 mark]*** for how this affects quality of life (*eg* have to sleep in the open), or some detail of how the hazard led to this (ground shaking, liquefaction, volcanic ash).

Accept other valid statements.

b. B represents short-term response such as:

- emergency search and rescue of collapsed buildings
- the provision of emergency aid/food/shelter
- the arrival of specialist personnel (external agencies)
- evacuation in case of aftershocks/further eruptions
- other valid short-term suggestions.

C represents longer term organized response, such as:

- reconstruction (possibly with improved design or land zoning)
- wreckage clearance
- salvage operations
- care and rehabilitation (physical/mental)
- other valid long-term suggestions.

Award ***[1 mark]*** for each appropriate response that is outlined and ***[1 mark]*** for any further development of that point (may use examples, or qualify statements in other ways).

Award up to ***[4 marks]*** for either B or C; balance is not expected. Maximum ***[3 marks]*** if ideas do not relate to earthquake or volcano.

c. Improvements in building design could include modifications such as steel reinforcement, base isolators, movable hydraulic joints, strategies to reduce building shaking, shatter proof glass, deep foundations. Low cost designs include wooden buildings that shake in an earthquake, low density buildings, buildings on stilts, reinforced roofs *etc*. Similar improvements in building design/modification could be discussed with reference to volcanoes, hurricanes and other hazards.

A detailed description of building design is not required, although there should be a sound understanding of its importance.

Discussion should include other ways to reduce vulnerability including land-use zoning, early-warning systems, hard engineering structures such as sea walls, soft engineering structures such as mangrove swamps and belts of trees, response and awareness training, evacuation planning, emergency shelters, investment in emergency services, improved monitoring and prediction of natural hazards, insurance schemes.

At band D, responses are likely to be descriptive and might only cover building design or other simple ways of reducing vulnerability.

At band E, responses should either consider more ways in greater depth or offer some more explicit evaluation *eg*, a combination of ways is needed.

At band F, expect both.

Marks should be allocated according to the markbands.

Examiners report

a. Many candidates could describe an impact of an earthquake or volcanic eruption, such as destruction of homes, but did not then go on to describe how this affects the quality of life.

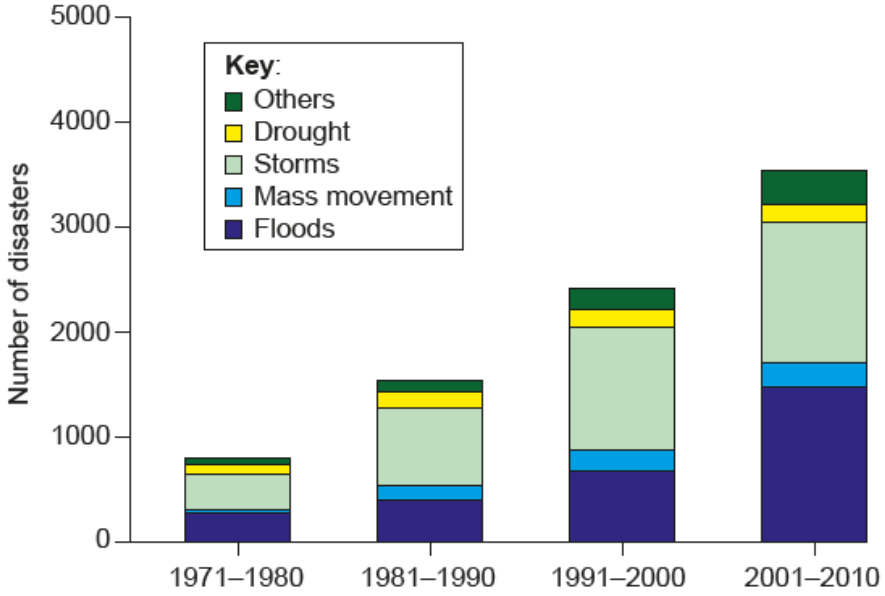
b. This was a straightforward question. However, many candidates did not clearly distinguish between points B and C, or interpret the diagram correctly to show the differences between short- and long-term responses. Where points B and C were distinguished there were some very clearly developed answers.

c. Stronger candidates had few problems with this question and were able to discuss the statement explicitly with good knowledge of building design and modifications and other ways of reducing vulnerability. Weaker responses mentioned building design, but with no detail or development, and focused on general ways to reduce vulnerability. A few did not include anything on building design at all.

Diagram A shows the number of reported disasters by decade by hazard type, globally. Diagram B shows economic losses by hazard type, globally.

Diagram A

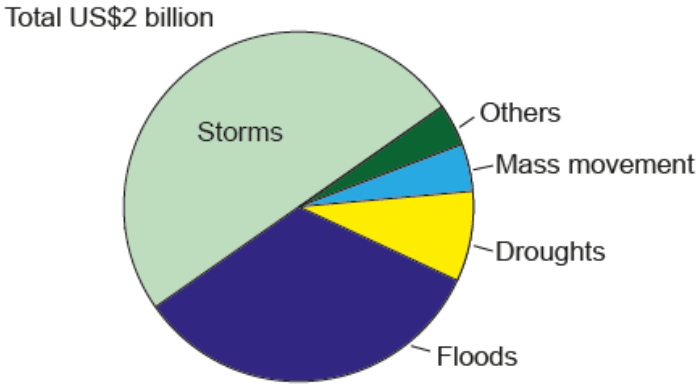
Number of reported disasters by decade by hazard type globally (1971–2010)



[Source: From Atlas of Mortality and Economic Losses from Weather Climate and Water Extremes (http://library.wmo.int/pmb_ged/wmo_1123_en.pdf), ©2014 World Meteorological Organization.]

Diagram B

Economic losses by hazard type, globally (1971–2010)



[Source: From Atlas of Mortality and Economic Losses from Weather Climate and Water Extremes (http://library.wmo.int/pmb_ged/wmo_1123_en.pdf), ©2014 World Meteorological Organization.]

a. (i) Describe the change in the total number of reported disasters between 1971 and 2010. [4]

(ii) State the type of natural hazard that has **not** increased in frequency since 1981.

(iii) Estimate the total economic losses due to storms and floods between 1971 and 2010.

b. Explain **three** reasons why communities may underestimate the probability of a major hazard event occurring in the area in which they live. [6]

c. Discuss the view that human vulnerability to natural hazards (excluding river flooding) is greater in urban areas than in rural areas. [10]

Markscheme

a. (i) The total number of disasters increased **[1]** from about 750 to about 3500 **[1]**.

[2 marks]

(ii) drought **[1]**

[1 mark]

(iii) US$1.65 billion (accept 1.6–1.75) **[1]**

[1 mark]

b. *In each case, award **[1]** for a valid reason and **[1]** for further development.*

For example, lack of data about previous events **[1]** may mean that it is impossible to predict the likely return interval of the hazard **[1]**.

Other reasons could include:

- lack of awareness
- lack of information from governments
- lack of education
- low impact of previous hazard events
- delayed impact of a long-term event, such as drought
- fatalistic attitude.

[6 marks]

c. Rapid urbanization and the concentration of large numbers of people in large urban areas is a feature of many poorer countries. Often, these are major ports occupying low-lying land at or near to sea level. Hurricanes can cause storm surges with major impacts for urban areas. Large unplanned, poorly built shanty towns develop in vulnerable areas, such as steep hillsides or low-lying ground, making them vulnerable to landslides in tectonically active areas or during hurricanes (saturated ground). Poor urban migrants are likely to be unaware of their vulnerability to hazards and lack access to information about what to do in the event of a disaster.

On the other hand, rural areas can be hard to reach after a hazard event/disaster and so mortality may be much higher. Poverty and lack of education in rural areas may also contribute to a high death toll. Some rural areas may be especially prone to certain hazard events, *eg* areas along plate boundaries, fold mountains, Pacific islands in typhoon belt.

Good answers may discuss dimensions other than rural/urban, such as the level of development as the main influence on vulnerability. They may also discuss how the magnitude/frequency of events may be higher in either rural or urban areas (*eg* many large cities are on coastal margins where hurricane/typhoon strikes are more likely than in inland rural areas; distribution of coastal cities also corresponds with plate margins).

At band D, expect some description of people's vulnerability to hazards in different rural/urban places.

At band E, expect <u>either</u> a more detailed explanation of how hazard/hazard vulnerability varies between rural and urban places <u>or</u> some explicit discussion of the statement (eg may argue that many other factors affect vulnerability, and these must be considered too, or may conclude on relative importance of vulnerability in urban areas compared to rural).

At band F, expect both.

Marks should be allocated according to the markbands.

[10 marks]

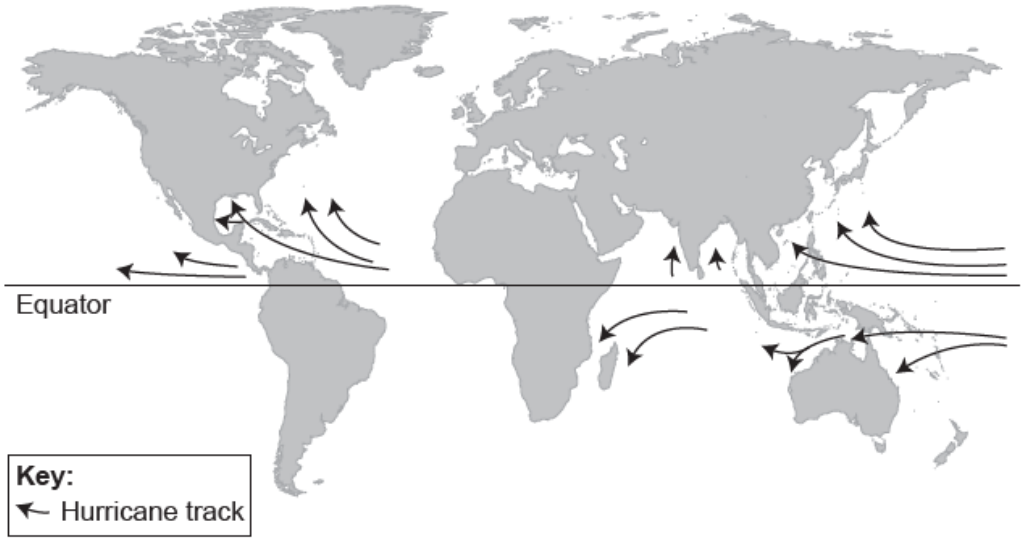
Examiners report

a.

b.

c.

The map shows the global pattern of hurricane (tropical cyclone, typhoon) tracks.



[Source: National Hurricane Centre / NOAA]

a. Describe the distribution **and** tracks of hurricanes (tropical cyclones, typhoons) affecting **mainland Asia**. [4]

b. Briefly explain **two** geographical consequences of a recent human-induced (technological) hazard. [6]

c. Using **one or more** recent examples, discuss the relative importance of short-term and long-term responses to hazard events and/or disasters. [10]

Markscheme

a. *Award **[1]** for each point, to a maximum of **[2]** in each case.*

Distribution:

- Most of southern mainland Asia experiences hurricanes
- Eastern section has hurricanes which are formed a long way away
- East coast affected but not at higher latitudes
- In the western Pacific Ocean / Bay of Bengal / Arabian Sea.

Tracks:

- Longer tracks move westwards and curve away from the Equator
- Shorter tracks move north and are straighter.

[4 marks]

b. *Award **[1]** for each consequence and up to **[2]** for further development/exemplification.*

For example: The Deepwater Horizon oil spill in the Gulf of Mexico in 2010 had a devastating environmental impact on marine life and food chains in the Gulf **[1]**, including death of dolphins, bluefin tuna and bird life **[1]**. The loss of marine life severely impacted local fish catches **[1]**.

Other consequences (depending on the hazard event) might include:

- destruction of buildings
- loss of farmland due to contamination
- loss of incomes
- social effects such as injuries, loss of life, and health issues.

[6 marks]

c. Short-term responses take place over a few hours, days and weeks, and might involve: search and rescue; provision of essential medical care; provision of emergency food and water supplies; combating the threat of disease; establishing communications to the outside world; alerting relief agencies.

Long-term responses go on for months and years after a disaster, and might include: provision of long-term shelter, rebuilding destroyed houses, schools, hospitals *etc*, re-establishing communications; re-establishing the local economy; undertaking protective measures and educating the local community in case of a future disaster; establishing monitoring stations to warn/help predict of a future hazard.

Good candidates may conclude that short-term responses may be more important, to reduce the immediate threats to loss of life and re-establishing the local economy, whereas long-term responses are important in a different way (long-term development) and more problematic, involving continued aid, re-structuring and investment into the area, which may not be forthcoming, especially in poorer countries. Good candidates may also discuss the importance of making adaptation integral to the long-term strategy in order to build resilience.

At band D, responses are likely to be descriptive accounts of some short-term and long-term responses.

At band E, expect either a more detailed explanation of the importance of short-term and long-term responses for a named disaster, or some explicit discussion of their relative importance (perhaps in relation to different goals or objectives).

At band F, expect both.

Marks should be allocated according to the markbands.

[10 marks]

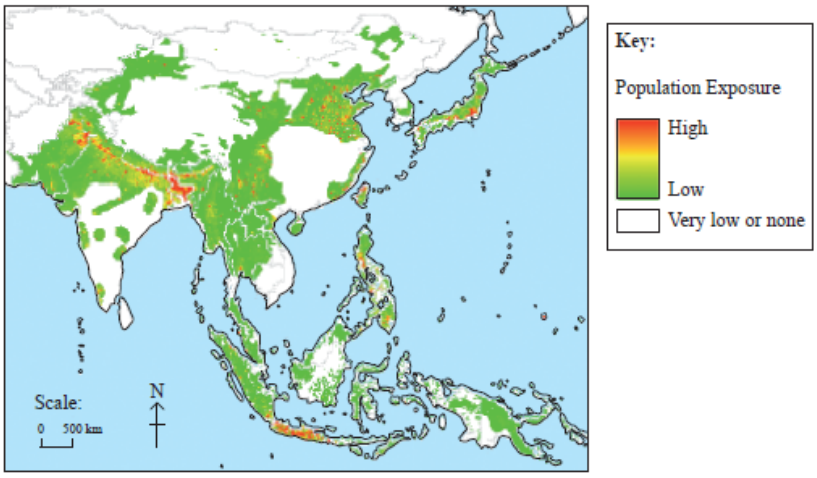
Examiners report

a.

b.

c.

The map shows the population exposed to tectonic hazards in south and east Asia.



[Source: OCHA Regional Office for Asia-Pacific, NGI Report 2007, 1600–1]

a. Describe the pattern of high population exposure to tectonic hazards shown on the map. [4]

b. Suggest **three** reasons why communities often underestimate the probability of a tectonic hazard event occurring in their locality. [6]

c. Examine the ways in which vulnerability to **either** earthquake **or** volcanic hazards can be reduced. [10]

Markscheme

a.
- Areas of high exposure are linear
- They lie along some plate boundaries
- These include the Himalaya region, the Philippines, Japan and Indonesia
- NE China has non-linear/scattered areas of high exposure
- Some anomalous high areas *eg* some islands
- High exposure coincides with high population density areas.

Four valid statements are needed for ***[4 marks]***. Up to ***[1 mark]*** for a list of place names.

b. Valid reasons could include lack of information and awareness of the hazard, poor education and ignorance of the risk resulting in lack of preparedness, poor information systems such as TV and radio, a long period since the last hazard occurrence, level of economic development, hazards as acts of God or fate, threat of the hazard compared with other concerns such as jobs, security, money, food availability, politics, civil unrest.

Award ***[1 mark]*** per reason identified and ***[1 mark]*** for some further detail of why this leads to underestimation of probability.

c. Vulnerability refers to the susceptibility of a community to a hazard or the impact of a hazard event. It is a function of demographic and socio-economic factors and of a community's preparedness/ability to deal with a hazard event when it happens.

Answer depends on the hazard chosen – a range of ideas can be covered, including larger-scale community/national government strategies, including relocation, as well as personal/individual actions (such as insurance). These include prediction and warning methods, hazard resistant engineering, preparedness, land use planning, modifying the event.

At band D, at least two ways should be described in some depth. At bands E and F, a clear understanding of vulnerability should be displayed (*eg* contrasting/varied ways are examined to highlight both property and social vulnerability).

Marks should be allocated according to the markbands.

Examiners report

a. Mostly accurate but very few scored the full 4 marks for this part as four valid statements were not made. Too many just listed countries (maximum 1 mark) and others could not name a country shown. Identification of patterns seemed to be a concept unfamiliar to many.

b. This was quite well answered, but some candidates wrote about hurricanes as a tectonic process, or wrote about how the hazard was dealt with.

c. This question elicited some excellent answers, with a discussion of a wide range of strategies. Weaker candidates were unable to show an understanding of the concept of vulnerability, and gave descriptive answers.

Optional Theme D — Hazards and disasters – risk assessment and response

7. The map shows the track of Hurricane Charley in August 2004 and changes in the intensity of the storm. Dates are also shown.

[Source: adapted from CIMSS image at http://tropic.ssec.wise.edu]

a. Describe the changes shown from 12 August to 14 August in: [4]

(i) storm intensity;

(ii) storm direction.

b. Explain **two** factors that affect the formation and development of hurricanes. [6]

c. Using examples, examine the demographic **and** socio-economic factors that affect the vulnerability of a community to hazard events. [10]

Markscheme

a. (i) Increases from category 1 to category 4 ***[1 mark]*** and provides dates or locations for this ***[1 mark]***.

(ii) Moves towards north-west then moves towards north-east/swings left then right/moves clockwise ***[1 mark]*** and provides dates or locations for this ***[1 mark]***.

b. Award ***[2 marks]*** for a description of each factor and ***[1 mark]*** for the explanation.

Answers could include:

- temperature of ocean ***[1 mark]***, (26□°C–27□°C) ***[1 mark]***, water depth (at least 60m) to allow evaporation for the energy of hurricanes ***[1 mark]***
- distance from the equator/latitude ***[1 mark]***, between approximately 5°–30° of the equator ***[1 mark]*** as coriolis force ***[1 mark]*** is sufficient away from the equator to generate spin ***[1 mark]***
- movement of hurricanes away from tropical oceans ***[1 mark]*** as they move over colder ocean areas and/or land masses ***[1 mark]*** they decline because of loss of energy ***[1 mark]***
- other possible factors include wind shear, wind speeds, converging winds, development of an equatorial wave.

c. Responses should show an understanding of the term vulnerability and include a range of demographic factors (these may include population density, migration, gender, age) and socio-economic factors (these may include education level, wealth, awareness, experience, the level of development, technology, insurance). Many hazard events are socially selective *eg*, Hurricane Katrina in New Orleans (2005) had a disproportionate impact on poorer communities than on richer communities.

To access band D, demographic and/or socio-economic factors should be described and an example named.

To access band E either a good examination of vulnerability should also be provided or a wider range of demographic and socio-economic factors for recognizable location(s) examined.

At band F, expect both.

Marks should be allocated according to the markbands.

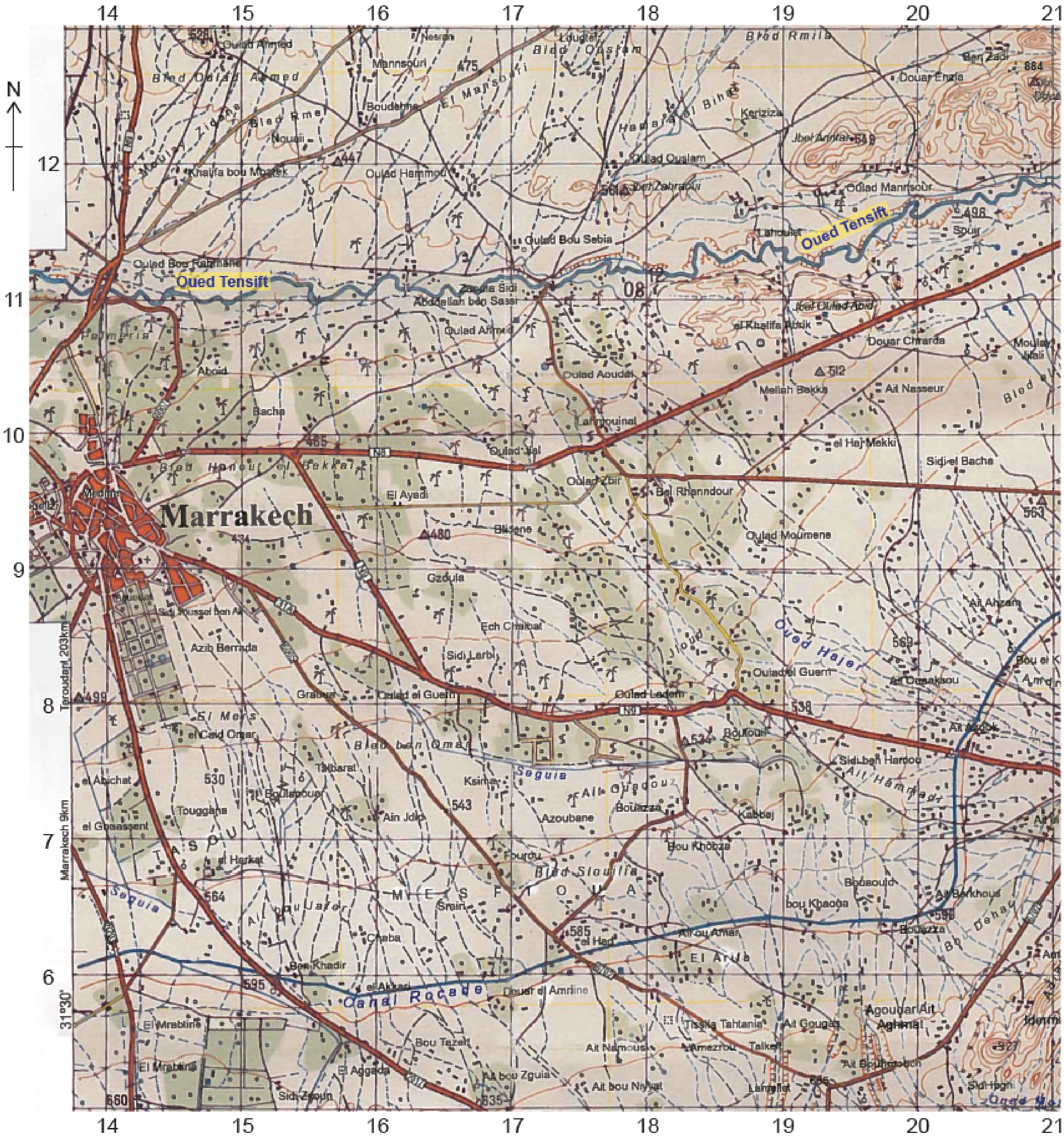
Examiners report

a. This question was generally well answered. Candidates were able to use map evidence to describe storm intensity and direction.

b. The formation and development of hurricanes was generally well understood, and most candidates gained about four marks, but often failed to elaborate sufficiently to gain the top marks. They were not able to identify two distinct factors or were unable to explain how the factors worked and were interlinked. Some candidates spent too much time on pressure and winds, and missed the obvious factors of sea temperature and distance from equator. The Coriolis effect was not clearly understood.

c. The term vulnerability was often not clearly understood or emphasized. Unfortunately, most responses focused on only socio-economic factors and failed to include demographic factors. There was a rather wide-ranging misinterpretation of the term demographic, which many took to mean geographic location. There were some good contrasting case studies.

The map shows Marrakech and the surrounding area. The scale of the map is 1:160 000 and the contour interval is 40 metres.


N
Marrakech
Oued Tensift
Oued Tensift
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Canal Rocade
Seguia
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Oulad Ahmed
Mannsouri
Boudehra
Nouaii
Khalifa bou Mbarek
Oulad Hammou
Oulad Bou Rahmane
Oulad Oulam
Oulad Bou Sebia
Keriziza
Douar Enzla
Ben Zadi
Oulad Mannsour
Lahoulat
Bled Rmila
Bled Oulad Ahmed
Abdallah ben Sassi
Oulad Ahmed
Oulad Aoudal
Aboid
Bacha
Oulad Val
El Ayadi
Oulad Zbir
Bel Rhenndour
Mellah Bakka
Ait Nasseur
Douar Chrarda
el Haj Mekki
Sidi el Bacha
Oulad Moumene
Gzoula
Ech Chabat
Sidi Larbi
Azib Berrada
Oulad el Guern
Oulad Ladem
Oulad el Guern
Ait Ouaaksou
Ait Ahzam
el Caid Omar
el Abichat
Tougghana
Boulaboua
Ain Jdid
Ksima
Azoubane
Bouazza
Kabbaj
Bou Khobza
Sidi ben Harooo
Ait Hammadi
Fourou
Srain
Chaba
Ben Khadir
el Akkari
Douar el Amriine
el Had
Ait ou Amar
El Arifa
bou Khaoua
Bousouid
Ait Barkhous
Bouazza
Agoudar Ait Aghmat
Ait Gougas
Tissila Tahtania
Ait Namous
Talkert
Bou Tazert
El Aggada
Ait bou Zguia
Ait bou Niyat
Sidi Zeroun
El Mrabtine
Ait Bouhmoch
Sidi Hagni
Idurmi
Taroudant 203km
Marrakech 9km
31°30'
14
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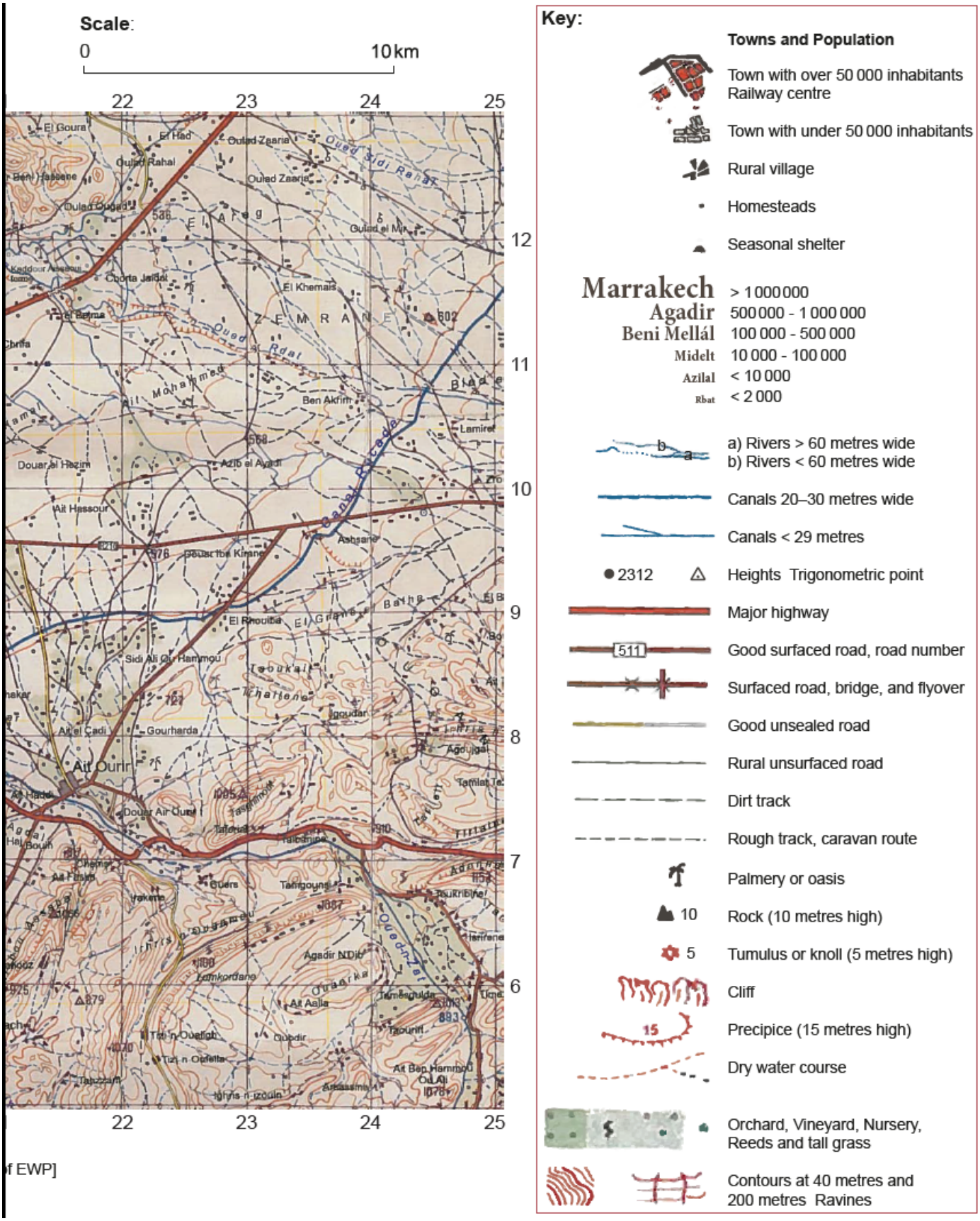

[Source: Marrakech topographical map. Reproduced with permission of EWP]

Marrakech is located in a semi-arid agricultural area, with an average rainfall of 281 mm/year, mainly falling between October and May. The area is prone to droughts, which have become more frequent in recent years.

a.i. State the height in metres of the highest point north of the Oued Tensift river. [1]

a.ii. State the four-figure grid reference for this point. [1]

a.iii. Briefly describe the distribution of fruit farming areas shown on the map. [2]

b.i. Explain **two** possible human impacts that could occur as a result of a long-term drought in the area shown on the map. [4]

b.ii. Suggest **one** short-term strategy that the local community could use to help overcome the problem of drought in the area shown on the map. [2]

c. Examine the reasons why people continue to live in areas affected by frequent earthquake or volcanic activity. [10]

Markscheme

a.i. 884 (metres) **[1]**

a.ii. 2012 **[1]**

*If an incorrect height is identified, but the GR is correct for that height, award **[1]**.*

a.iii. *Award **[1]** for any of the following points, up to a maximum of **[2]**:*

- mainly located in the west **[1]**
- mainly close to Marrakech **[1]**
- south of the Oued Tensift river **[1]**
- located on lowland areas **[1]**
- mainly below 500 metres **[1]**.

b.i. *Award **[1]** for each possible human impact, and **[1]** for explanation.*

Relevant human impacts will reflect that the term “drought” implies a lack of water, not high temperatures.

Possibilities in this area include:

- irrigation systems are under strain **[1]** due to drying up of seasonal rivers/decreased river flow **[1]**
- decline in yield of food/income **[1]** leads to out-migration from affected areas **[1]** to Marrakech
- possible famine leading to increased death rates.

b.ii. *Award **[1]** for the strategy and a further **[1]** for development.*

Possible strategies include:

- reducing water consumption by people in Marrakech, lowering the demand for water
- adopting “dry farming” techniques, ensuring that crops are more resilient to the impact of drought.

Do not credit long term infrastructure projects, eg reservoir construction.

c. *Allow answers that consider both earthquake and volcanic activity.*

Possible reasons might include:

- lack of knowledge/awareness of previous tectonic activity
- benefits of continuing to reside in the area outweigh possible impacts, for example fertile soils/tourism in volcanic areas
- lack of economic options: poverty/inertia/fatalism
- good preparation for possible impacts of hazard event, such as earthquake-resilient buildings
- planning and early-warning systems give sense of security
- insurance against damage caused by tectonic activity.

Good answers may examine in a structured way how reasons may vary according to the type of geographical area (level of development; proximity to areas of tectonic activity); the frequency and magnitude of past events, and the decisions made by individuals and communities.

For band D, expect some description of some reasons why people continue to live in areas prone to volcanic or earthquake activity.

For band E, expect either a more detailed explanation of why people choose to remain in a particular area prone to earthquakes/volcanoes, or a structured examination of different kinds of hazards (eg at different levels of economic/social development).

For band F, expect both.

Marks should be allocated according to the Paper 2 HL and SL markbands.

Examiners report

a.i. [N/A]
a.ii. [N/A]
a.iii. [N/A]
b.i. [N/A]
b.ii. [N/A]
c. [N/A]