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1 (a) (i) Complete Table 1.1 by filling in points 3 and 4. [1]

Point	Level of Importance
1	Extremely important
2	Very important
3	Moderately important
4	Slightly important
5	Not important at all

(ii) Name the sampling method as described in Fig. 1.1. [1]

- Stratified Random Sampling

(iii) Identify **two** types of ecosystem services shown in Fig. 1.2. [2]

- Regulating services
- Cultural services

(iv) Using Fig. 1.2, describe the importance of the ecosystem services and problems as rated by the respondents. [3]

- **Regulating services**, such as **maintaining air quality** and **flood regulation**, were rated as highly important by most respondents, with over **80% considering them extremely or very important**. [1 mark] This indicates a **strong awareness of environmental sustainability** and the need for **climate resilience**. [1 additional mark]

- **Cultural services**, such as **outdoor recreation and aesthetic feel**, were also valued, with many respondents appreciating green spaces for their social and recreational benefits. [1 mark] This highlights the importance of parks in **promoting well-being**. [1 additional mark]

- Among the problems, **issues like litter and poor smell were noted by about 40% of respondents**, suggesting concerns over cleanliness and waste management in the neighbourhood. [1 mark]

(v) A bar graph could be used to present the data in Table 1.2. Describe another way of presenting the data. [2]

- A **pie chart** could be used to visually represent the proportion of each vegetation type preferred by residents. [1 mark]

- Each segment will correspond to a vegetation type preferred by residents, making it easy to compare preferences at a glance. [1 mark]

(b) (i) With reference to Fig. 1.3, explain how the planners have provided the residents with recreation opportunities. [3]

- The park includes **adventure play areas**, such as a **nest-shaped treehouse**, which provides children and families with spaces for outdoor activities and social interactions. [1 mark]
- The presence of **viewing decks and open woods** allows visitors to engage in nature appreciation and bird-watching, enhancing leisure opportunities. [1 mark]
- The **eco-link (land bridge)** improves accessibility between different sections of the park, encouraging walking and cycling as recreational activities. [1 mark]

(ii) With reference to Fig. 1.3 and your own knowledge, explain how planners of new neighbourhoods like Bidadari Park can reduce traffic hazards. [3]

- The presence of **eco-links and dedicated walking paths** ensures that pedestrians can move safely without crossing busy roads, reducing the risk of accidents. [1 mark]
- The planners can design **separate cycling lanes**, encouraging alternative modes of transport and minimising conflicts between cyclists, pedestrians, and vehicles. This reduces congestion and enhances road safety. [1 mark]
- Roads can be designed with **roundabouts, traffic-calming measures (e.g., speed bumps), and clear road signage** to regulate vehicle speed and improve safety for all road users. [1 mark]

(c) (i) Using Fig. 1.4, describe the differences between routes 1 and 2. [4]

- Route 1 is **4 km long**, while Route 2 is **9 km long**, making Route 2 more than twice as long as Route 1. [1 mark]
- Route 1 runs **70 m underground**, whereas Route 2 is shallower at **45 m underground**, which may affect construction feasibility and environmental impact. [1 mark]
- Route 1 has a **shorter travel time of 5 minutes** and a **lower cost of S$40.7 billion**, while Route 2 takes **11 minutes** and costs **S$42.7 billion**, making Route 1 more efficient and cost-effective. [1 mark]
- Route 1 passes directly under the **Central Catchment Nature Reserve**, which may have a **higher environmental impact**, whereas Route 2 takes a longer path around the reserve, reducing direct disturbance to the ecosystem. [1 mark]

(ii) With reference to Fig. 1.4 (Insert) and Table 1.3, evaluate the impacts of each route. [4]

Positive impact

- Route 1 is **shorter (4 km)** and takes only **5 minutes** to travel between stations, making it a more efficient option for commuters. [1 mark]
  Or
- Route 1 is **cheaper (S$40.7 billion)** compared to Route 2 (S$42.7 billion), reducing overall project costs and providing economic benefits. [1 mark]

- Route 2 has a low **impact on plants and animals** since it runs on the perimeters of the Central Catchment Nature Reserve, preserving biodiversity and minimising habitat destruction. [1 mark]
  Or
- Route 2 results in **lower water quality impact**, avoiding severe disruptions to underground water systems and maintaining better ecological balance. [1 mark]

Negative impact

- Since Route 1 **runs directly under the Central Catchment Nature Reserve**, it has a **very high impact on plants and animals**, both during construction and operation, which could lead to habitat destruction and species displacement. [1 mark]
  Or
- Route 1 **has a high impact on water quality**, possibly disrupting groundwater flows and increasing sedimentation in nearby water bodies. [1 mark]

- Route 2 is **longer (9 km)** and takes **11 minutes** to travel between stations, making it less convenient for daily commuters. [1 mark]

(d) Describe how the activities shown in Fig. 1.5 contribute to a sustainable urban neighbourhood. [2]

- Volunteers are **planting trees** in the park. This helps to **increase greenery in the area**, making the neighbourhood more pleasant and providing shade. [1 mark]

- People are picking up rubbish in the park using trash bags. This keeps the environment clean and **reduces pollution**, ensuring that public spaces remain usable for all residents. [1 mark]

2 (a) (i) Name the type of rainfall shown in Fig. 2.1. [1]

- Relief rain

(ii) Annotate Fig. 2.1 to show the processes taking place for this type of rainfall to occur. [3]

Annotations should include:

- Moist air from the sea is pushed inland and is forced to ascend when it encounters highland areas. [1 mark]
- As the air moves higher, the temperature drops, causing **water vapour to condense** into water droplets, forming clouds. [1 mark]
- The condensed water droplets grow heavier and fall as **relief rain** on the windward slope of the mountain. [1 mark]

(b) (i) Using Fig. 2.2, compare the pattern of average monthly temperatures for Uaupés and London. [3]

Differences:

- Uaupés experiences **consistently high temperatures** throughout the year, ranging between **25°C and 28°C**, while London has a **distinct seasonal temperature pattern**, with **higher temperatures in summer (June–August) and lower temperatures in winter (December–February)**. [1 mark]
- The **mean annual temperature in Uaupés at around 26.5°C** is significantly higher than London's **mean annual temperature of approximately 11°C**. [1 mark]
- London has a **larger annual temperature range of about 13°C**, with temperatures varying from **5°C in January to 18°C in July**. In contrast, Uaupés has a **much smaller annual temperature range of around 3°C**, fluctuating only between **25°C and 28°C**. [1 mark]

Similarity:

- Both Uaupés and London experience **warmest temperatures around mid-year**. Uaupés reaches approximately **27.5°C in April**, while London peaks at around **18°C in July**. [1 mark]

(ii) With reference to Fig. 2.2, explain how latitude causes differences in the average monthly temperature at places such as these. [3]

- Uaupés has consistently **high temperatures between 25°C and 28°C throughout the year,** which suggests that it has a low latitude within the tropics. [1 mark]
- At low latitudes, the Sun's rays strike the Earth at a **high angle**, meaning that solar energy is more **concentrated over a smaller surface area**. This

explains why Uaupés experiences **a high mean annual temperature and a small annual temperature range**. [1 mark]

- London is located at a **higher latitude**, where the Sun's rays strike the Earth at a **lower angle**, spreading energy over a **larger surface area**. This results in **lower overall temperatures (mean annual temperature ~11°C) and greater seasonal variation (5°C in January to 18°C in July)**. [1 mark]

(c) Using Figs. 2.3 and 2.4, describe the different impacts of the climatic events shown on rural areas. [3]

- Fig. 2.3 shows a drought-stricken landscape with dry, cracked soil and withered crops. **Lack of water leads to crop failure**, reducing food production and income for farmers. [1 mark]

- Prolonged drought can lead to **soil erosion and desertification**, making land less fertile and difficult to cultivate in the future. [1 mark]

- Fig. 2.4 shows a flooded rural area where people and livestock are wading through water. **Flooding can destroy homes and force people to evacuate**, leading to temporary or permanent displacement. [1 mark]

- The image in Fig. 2.4 shows cattle moving through floodwaters, indicating that **flooding can drown livestock and damage farm structures**, leading to economic losses for rural communities. [1 mark]

(d) (i) Using Fig. 2.5, describe the distribution of the areas at high risk. [3]

- Areas at **high risk** are mainly found in **tropical regions**, particularly around the **Equator**. This includes north-eastern and central parts of **South America, Central Africa, and Southeast Asia**. [1 mark]

- Many **coastal areas and island nations** show high vulnerability, such as parts of **Southeast Asia and the Pacific Islands**, where rising sea levels and extreme weather events are major threats. [1 mark]

- Some regions in the **southern United States, southern Europe, and northern India** also face high risk, likely due to increasing extreme weather events such as droughts and heatwaves. [1 mark]

(ii) Explain how water and flood management strategies can mitigate a community's resilience to climate change. [3]

- **Constructing levees, flood barriers, and sea walls** help protect coastal and low-lying areas from rising sea levels and storm surges, reducing destruction to homes and infrastructure. [1 mark]

- **Sustainable urban drainage systems** such as permeable pavements and retention ponds, help absorb excess rainfall, reducing flood risks in cities. [1 mark]

- Implementing **rainwater harvesting, desalination, and efficient irrigation** methods reduces water scarcity, ensuring that communities have access to water even during prolonged droughts. [1 mark]

(e) 'Changing land use contributes more to climate change than burning fossil fuels.'

How far do you agree with this statement? Explain your answer. [6]

Changing land use plays a significant role in climate change by reducing natural carbon sinks and increasing greenhouse gas (GHG) emissions. **Deforestation for agriculture, urban development, and infrastructure expansion removes forests that act as carbon sinks, releasing stored carbon back into the atmosphere.** The Amazon Rainforest, for instance, has lost **over 17% of its forest cover in the past 50 years**, with deforestation releasing approximately **1.5 billion tonnes of CO_2 annually**. Additionally, **Indonesia and Malaysia**, two of the world's largest palm oil producers, have cleared vast areas of peatland forests, emitting **up to 900 million tonnes of CO_2 per year**. Such large-scale deforestation weakens the Earth's ability to absorb carbon emissions, accelerating global warming.

Despite the impact of land-use change, **burning fossil fuels remains the primary contributor to climate change**, responsible for **over 75% of global greenhouse gas emissions**. **The combustion of coal, oil, and natural gas for electricity, transport, and industry releases vast amounts of CO_2.** In **2022, China emitted 11.4 billion tonnes of CO_2**, making it the world's largest carbon emitter, followed by **the United States (5 billion tonnes) and India (2.9 billion tonnes)**. These emissions intensify the greenhouse effect, trapping heat and leading to rising global temperatures, **which have increased by approximately 1.1°C since the late 19th century**. Unlike deforestation, **fossil fuel combustion continuously adds GHGs to the atmosphere, overwhelming the natural processes that regulate carbon levels.**

While both land-use change and fossil fuel combustion contribute to climate change, **fossil fuel burning has a more substantial and immediate impact** due to its **scale, continuous emissions, and long-term effect on global temperatures**. Land-use change worsens the problem by reducing carbon sinks, but its contribution is secondary compared to the constant and large-scale emissions from fossil fuel use. **Thus, I agree with the statement to a small extent, as fossil fuel combustion remains the dominant driver of climate change.**

3 (a) Describe the distribution of major volcanic hotspots. [3]

- Major volcanic hotspots are **mainly located along plate boundaries**, particularly **convergent and divergent plate boundaries**. [1 mark]

- They are **concentrated along the Pacific Ring of Fire**, which surrounds the Pacific Ocean and includes countries such as **Japan, Indonesia, and the west coast of the Americas**. [1 mark]

- Some hotspots, however, are **found away from plate boundaries**, such as those in **Hawaii and Iceland**, which are formed due to mantle plumes. [1 mark]

(b) State two factors measured by the Volcanic Explosivity Index (VEI). [2]

- Volume of tephra ejected
- Eruption column height

(c) (i) Describe the trends shown in Fig. 3.2. [3]

- **Most volcanic eruptions resulted in fewer than 2,000 deaths**, with majority of data points on the graph show low numbers of fatalities. [1 mark]

- There were **anomalies** with significantly high death tolls, such as the eruption of **Mount Pelée** in 1902 caused around 28,000 deaths, and the **Nevado del Ruiz** eruption in 1985 resulted in more than 22,000 deaths. [1 mark]

- The **frequency of high-fatality eruptions has decreased over time** where after 1985, there were no major eruptions with extremely high death tolls. [1 mark]

(ii) Describe how the impacts of volcanic eruptions spread well beyond the region in which they occur. [2]

- **Ash clouds from eruptions can disrupt global air travel** as large amounts of volcanic ash into the atmosphere can result in the cancellation of flights across large regions. [1 mark]

- **Volcanic gases can contribute to global climate change** as large eruptions release sulfur dioxide, which forms aerosols that reflect sunlight, leading to temporary cooling of global temperatures. [1 mark]

(d) (i) Using Fig. 3.3, name the three features X, Y and Z. [3]

- X: Focus
- Y: Fault/ Faultline
- Z: Seismic waves

(ii) Explain how an earthquake is formed at a transform plate boundary. [3]

- At a transform plate boundary, two tectonic plates **slide past each other**, exerting **friction**. [1 mark]
- As the plates try to move, friction causes **stress and pressure to accumulate** at the fault line. [1 mark]
- When the **stress exceeds the frictional force**, the plates **slip suddenly**, releasing stored energy in the form of **seismic waves**, resulting in an earthquake. [1 mark]

(e) With reference to Fig. 3.4, describe the impacts of the earthquake. [3]

- The earthquake caused **severe cracks and destruction of roads, affecting accessibility** by making transportation difficult and dangerous. This can disrupt emergency response and daily commuting. [1 mark]
- The image shows **fire and smoke**, likely due to broken gas pipelines or electrical failures caused by the earthquake. Fires can spread quickly and **cause further destruction to buildings and homes**. [1 mark]
- The **presence of broken pipes** in the image suggests **damage to underground water or sewage systems**. This can lead to **water shortages, contamination, and health hazards** for the affected population. [1 mark]

(f) 'The most important factor influencing disaster risk management of earthquakes is the quality of building design and construction.'

To what extent do you agree with this statement? Explain your answer. [6]

The quality of building design and construction plays a crucial role in reducing the damage caused by earthquakes. Earthquake-resistant buildings are designed to **withstand strong ground shaking, preventing collapse and reducing casualties**. Engineering techniques such as **base isolation, shock absorbers, and flexible building materials** help to minimize structural damage. For example, Japan enforces strict building codes that require skyscrapers to be constructed with shock-resistant foundations, which significantly reduced casualties during the **2011 Tōhoku earthquake**. Without proper building standards, poorly constructed structures may collapse, trapping people under debris and increasing fatalities. Therefore, ensuring high-quality construction is a fundamental aspect of disaster risk management.

Early warning systems also play a significant role in reducing the impact of earthquakes. These systems **detect seismic activity and send alerts to residents before the shaking begins**, giving them valuable seconds or minutes to take protective action. For example, **Japan's Earthquake Early Warning (EEW) system provides alerts through mobile phones and public broadcasts**, allowing people to seek shelter and halt transportation services. This has helped to prevent accidents and minimize panic. In countries without early warning systems, earthquakes often result in higher casualties as people are caught off guard. Therefore, an effective early warning system is essential for disaster risk management, complementing the role of strong building infrastructure.

Another key factor in earthquake risk management is **community preparedness and education**. When residents are trained in emergency procedures, they are **more likely to respond effectively during an earthquake, reducing casualties and injuries**. Countries like Chile and the United States conduct regular earthquake drills in schools and workplaces to familiarize people with evacuation routes and safety protocols. Furthermore, emergency kits and designated shelter areas ensure that survivors have access to necessary supplies after an earthquake. Without proper preparedness, even well-constructed buildings may not be enough to prevent loss of life, as individuals may not know how to respond in a crisis. Hence, education and preparedness play a vital role in managing earthquake risks.

Although multiple factors contribute to disaster risk management, the quality of building design and construction is one of the most significant because it **directly determines the extent of physical damage and casualties during an earthquake**. However, it must be complemented by early warning systems and community preparedness to maximize disaster resilience. Thus, while building design is crucial, a **comprehensive approach that includes multiple strategies is necessary for effective earthquake risk management.**