

GEOGRAPHY ESSAY

Climate		Textbook
1	"The climate of Tropical Equatorial region, Tropical Monsoon region and Temperate are similar". How far do you agree with this statement? Explain your answer.	Page 3-4
2	"Latitude is the most important factor that affects air temperature across the Earth's surface" How far do you agree with this statement? Use examples to support your answer.	Page 6-12
3	"The formation of rain occurs because of monsoons". How far do you agree with this statement? Use examples to support your answer.	Page 13-28
4	"Changes in climate is caused only by natural processes." How far do you agree with this statement? Explain your answer.	Page 29 -38
5	Anthropogenic factors are the main cause of climate change.' To what extent do you agree with this statement? Explain your answer.	Page 29 -38
6	"The changes in the Earth's orbit and tilt are the most significant natural causes of climate change." How far do you agree with this statement? Use examples to support your answer.	Page 31-33
7	"The direct impact of climate change is more devastating on human systems than the indirect impact." How far do you agree with this statement? Use examples to support your answers.	Page 39-62

8	"Terrestrial ecosystems experience the greatest change due to climate change." To what extent do you agree with this statement? Explain your answer.	Page 39-62
9	"The most effective adaptation strategies in building community resilience to climate change are those involving institutional approaches." How far do you agree with this statement? Use examples to support your answer.	Page 73-88
10	"Structural approaches in adaptation strategies are the most effective in building community resilience to climate change." How far do you agree with this statement? Use examples to support your answer.	Page 73-88
11	"Adaptation strategies involving structural approach is the most effective way to increase community's resilience to climate change." How far do you agree with this statement? Use examples to support your answer.	Page 73-88
12	"Mitigation strategies are more important than adaptation strategies in building community resilience towards climate change." To what extent do you consider this statement to be true? Explain your answer with the use of relevant examples.	Page 73-88
13	"Technological adaptation strategies such as high-tech farming are exceedingly successful in building community resilience to climate change." To what extent do you consider this statement to be true? Explain your answer with the use of relevant examples.	Page 73-88

Paper 1

Question 2: Cluster 2 – Tourism (15 marks)

Question 3: Cluster 3 – Climate (15 marks)

Candidates will be required to answer one 9-mark question testing AO3 in either Question 2 or Question 3

Paper 2

Question 2: Cluster 4 – Tectonics (15 marks)

Question 3: Cluster 5 – Singapore (20 marks)

Candidates will be required to answer one 9-mark question testing AO3 in either Question 2 or Question 3

Level Descriptors for 9-mark essay		
Level	Marks	Success criteria
3	7-9	• Breadth: Both sides of the discussion are considered and well-supported with a range of points. • Clarity: Points are supported with elaboration and relevant examples that show a comprehensive understanding of the issue. • Precision: Examples include specific details. • Relevance: Points are relevant to answering the question. Examples are relevant to illustrating points. • Logic: Points make sense together and support a well-reasoned conclusion / stand.
2	4-6	• Breadth: Only one side of the discussion is considered and well-supported with a range of points. • Clarity: Points <u>on only one side</u> are supported with elaboration and relevant examples that show a good understanding of the issue. • Precision: Examples include specific details. • Relevance: Points are relevant to answering the question. Examples are relevant to illustrating points. • Logic: Points make sense together and support a conclusion / stand.
1	1-3	• Breadth: Does not consider multiple perspectives. • Clarity: Arguments are unclear with limited description or may be listed. • Precision: No examples provided or examples are generic. • Relevance: Lack of relevant points. • Logic: Evaluation is simple, missing or unclear.
0	0	No creditworthy response.

“The climate of Tropical Equatorial region, Tropical Monsoon region and Temperate are similar”.

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

The statement that the climate of the Tropical Equatorial region, Tropical Monsoon region, and Temperate regions are similar is only partially accurate. While these climate types share some common features, such as high temperatures in the Tropical Equatorial and Tropical Monsoon regions, their overall climatic conditions are quite distinct. The Tropical Equatorial climate and Tropical Monsoon climate both experience high temperatures year-round, but differ significantly in their precipitation patterns. In contrast, the Cool Temperate climate stands apart due to its marked seasonal variations and moderate precipitation.

The Tropical Equatorial climate is characterized by consistently high temperatures, averaging around 27°C, with a very small annual temperature range of 2-3°C. This region receives exceptionally high annual rainfall, exceeding 2000mm, distributed evenly throughout the year. Examples include Brazil's Amazon Basin and Singapore. In comparison, the Tropical Monsoon climate also maintains high temperatures around 25°C and has a small annual temperature range of 3-4°C. However, it experiences a pronounced seasonal variation with distinct wet and dry seasons, leading to high annual precipitation of about 1500mm, as seen in India and Vietnam.

The Cool Temperate climate, by contrast, features four distinct seasons—spring, summer, autumn, and winter—resulting in a significant annual temperature range of about 21°C. Annual precipitation in this climate ranges from 300-900mm, distributed relatively evenly throughout the year. This climate is exemplified by regions like Canada's west coast and parts of France. The Cool Temperate climate's notable seasonal variation and moderate precipitation set it apart from the more stable temperatures and varying precipitation patterns of the Tropical Equatorial and Tropical Monsoon climates, illustrating the significant differences among these climate types.

“Latitude is the most important factor that affects air temperature across the Earth’s surface”

How far do you agree with this statement? Use examples to support your answer.

Latitude is a primary factor influencing air temperature across the Earth’s surface. At a global scale, latitude determines the angle at which solar radiation reaches the Earth’s surface, which significantly impacts temperature. Near the equator, the solar angle is high (close to 90°), resulting in direct and concentrated solar radiation over a smaller area, which causes consistently high temperatures. For instance, Singapore, located at 1°N latitude, experiences a mean annual temperature of about 29°C due to the direct overhead sunlight. Conversely, higher latitudes, such as Beijing at 40°N, receive sunlight at a more oblique angle, which spreads the solar energy over a larger area and leads to lower temperatures. Beijing’s mean annual temperature is around 12°C, demonstrating how latitude directly influences temperature by affecting solar radiation intensity.

Altitude is another critical factor that affects air temperature, particularly on a local scale. Higher altitudes generally result in cooler temperatures due to lower air pressure and decreased air density. Typically, for every 1000m increase in altitude, temperature decreases by about 6.5°C. For example, Genting Highlands in Malaysia, located approximately 1700 meters above sea level, experiences cooler temperatures averaging around 19°C compared to the surrounding lowland areas where temperatures average about 28°C. At higher altitudes, air is less dense as can be seen in Figure 12, which means air pressure is lower. This is because gravity pulls most of the air molecules towards the ground surface. This temperature difference arises because the thinner air at higher elevations has a reduced capacity to retain and radiate heat, leading to lower temperatures. This illustrates how altitude can significantly modify local temperature conditions, even within regions of similar latitude.

In addition to latitude and altitude, the nature of the surface also plays a crucial role in determining local temperatures. Different surfaces absorb and reflect solar radiation in varying amounts, affecting how much heat is retained or lost. Dark surfaces like asphalt and concrete absorb more solar radiation and subsequently emit more heat, leading to higher local temperatures. This is evident in urban areas where materials such as tarmac and glass create an "urban heat island" effect. For instance, in Singapore, the Central Business District (CBD) experiences higher nighttime temperatures, averaging up to 29.5°C, compared to rural areas like Lim Chu Kang, which average around 24°C. This localized temperature difference is due to the prevalence of heat-absorbing materials in the CBD, highlighting how surface characteristics can influence temperature on a smaller scale.

In conclusion, while latitude is a fundamental factor affecting air temperature by influencing the angle and intensity of solar radiation, it is not the sole determinant. Altitude also plays a significant role, particularly in regions with varying elevations. Furthermore, the nature of the surface impacts local temperatures by affecting heat absorption and radiation.

“The formation of rain occurs because of monsoons”.

How far do you agree with this statement? Use examples to support your answer.

The occurrence of the southwest monsoon brings heavy rain to the Indian sub-continent between June and September. During this period, it is summer in the northern hemisphere, which creates an area of low pressure as warm air rises. On the other hand, it is winter in the southern hemisphere, which creates an area of high pressure when cooled air sinks. Air moves from the southern hemisphere to the northern hemisphere as the southeast monsoon as it always flows from high to low pressure areas. When it crosses the equator, it is deflected to the right in the northern hemisphere due to the Coriolis effect. The formation of this southwest monsoon picks up moisture as it travels over the Indian Ocean and brings heavy rain to the Indian sub-continent. Similarly, the occurrence of the northeast monsoon brings heavy rain to Australia between October and February when it is winter in the northern hemisphere and summer in the southern hemisphere. As the northeast monsoon crosses the equator and forms the northwest monsoon due to the Coriolis effect, it picks up large amounts of moisture from the Indian Ocean and brings heavy rain to Australia.

However, there are other ways in which rain is formed, one of which is via convection. Convectional rain occurs when the earth's surface is heated intensely and the air around it expands and rises. As the air rises, its temperature begins to drop and eventually cools to dew point temperature where condensation occurs and cumulonimbus clouds are formed. When the water droplets in the clouds become large and heavy enough, they fall to the ground as rain, often accompanied by lightning and thunder. This lasts for a short time but brings intense rainfall over an area. Convectional rain is most dominant in the tropics, in countries such as Singapore and Brazil.

Relief rain is formed when warm moist air is forced to rise over physical barriers to wind such as landforms (e.g. mountain range). As the moist air rises up the landform on the windward side, air cools as it rises until dew-point temperature is reached and condensation occurs. As a result, clouds form and when the water droplets in the clouds become large and heavy enough, they fall as rain on the windward side. By the time the air reaches the leeward side, it is mostly dry and thus no rain occurs on the leeward side. One example of relief rain occurs in the Western Ghats, which is a mountain range that runs parallel to the western coast of the Indian peninsula.

In conclusion, while the occurrence of monsoons can bring about rainfall to the Indian sub-continent and Australia, it is not the only way rain forms. Convectional rain is dominant and occurs frequently in the tropics all year round, while relief rain forms along coastal areas or areas lined with huge landforms such as mountain ranges.

“Changes in climate is caused only by natural processes.”

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

Factors to consider in LDQ:

Given factors: Anthropogenic causes of climate change

- Burning fossil fuels
- Changing land use (due to agriculture, industry, urbanisation)

Alternate/other factors: Natural causes of climate change

- Changes in the earth's orbit / angle of tilt
- Sunspot occurrences
- Large scale volcanic eruptions

Example 1

Natural factors play a part in climate change. The sun emits varying amounts of solar radiation due to changes in its magnetic field. During periods of intense solar magnetic activity, the number of sunspots increases, resulting in higher solar radiation. The number of sunspots rises and falls with an approximate 11 year cycle. For example, in 2000, the most number of sunspots were observed due to higher solar activity, leading to an increase in global temperatures. When the number of sunspots reached its minimum in 2009, global temperatures were also temporarily lower than global temperatures in the past 20 years. However, natural factors have always been present and have not led to a drastic increase in global temperatures. Rather, it is anthropogenic factors that have resulted in an exponential increase in temperatures in the recent years. Therefore, natural factors have a smaller impact on global warming than anthropogenic factors.

Anthropogenic factors are the main cause of climate change as large scale human development has led to our massive need for space and the burning of fossil fuels, increasing temperatures all around the world. On the other hand, natural factors have always been taking place and have a smaller impact on temperatures in the recent years as compared to anthropogenic factors.

Anthropogenic factors are the main cause of global warming due to deforestation and burning of fossil fuels. Deforestation is the loss of forests due to the removal or clearance of trees in forested areas to make products such as paper and building materials. Forests absorb carbon dioxide through photosynthesis, taking in a significant amount of global greenhouse gas emissions. With deforestation, there are fewer trees and other plants to absorb carbon dioxide, leading to an increase in carbon dioxide levels in the atmosphere. Deforestation also exposes soil to sunlight, leading to carbon oxidation whereby carbon dioxide is produced. For example, between 2000 and 2010, 52000 square kilometres of forests are cleared every year, leading to an increase in carbon dioxide levels.

Also, more fossil fuels are burnt to meet the energy demands of agriculture, industry and an increasing urban population. When people live in urban areas, there will be a greater demand for energy for lighting of roads, buildings and the maintenance of other common facilities. This contributes to an increase in greenhouse gases by producing large amounts of carbon dioxide when burnt. For example, in 2010, global carbon dioxide emissions totalled 30.6 billion tonnes, which led to an increase in global temperatures. Therefore, anthropogenic factors are the main

cause of global warming due to the large amount of carbon dioxide emissions produced as well as the clearance of carbon stores like trees and soil.

In conclusion, natural factors are not the main cause of global warming as they have always been present and have not led to a massive increase in global temperatures. Anthropogenic factors are the main cause of global warming due to the massive amount of deforestation and burning of fossil fuels that have occurred over the recent decades, leading to an exponential increase in global temperatures.

Example 2

I agree that changes in climate is caused only by natural processes. Global warming refers to the long-term increase in the Earth's average temperatures. Recently, the earth has been warming at an unprecedented rate. In this essay, I will discuss two possible factors that could possibly lead to global warming: first, natural factor of changes in sunspot occurrences followed by man-made factors (anthropogenic factors).

Given factor: Natural factor (changes in sunspots)	
Content	One alternate factor is sunspot occurrences. Sunspots are cooler regions on the Sun's surface, caused by the Sun's natural activity cycle and changes in its magnetic field. An increase in magnetic activity leads to an increase in the number of sunspots. Sunspots are cooler regions on the sun's surface, but areas around the sunspot radiate more energy to compensate for the lower temperatures of the sunspot areas, which results in an overall higher solar output. The number of sunspots rises and falls every 11 years, which is known as the sunspot cycle.
Argument	Sunspots can cause global warming because of the number of sunspots present on the Sun's surface. At the highest point of the sunspot cycle, there will be higher number of sunspots appearing on the Sun. As such, the total amount of solar radiation given out by the Sun increases. As a result, the Earth receives more solar radiation, leading to higher temperatures on Earth.
Place-specific examples	The Maunder Minimum was a period around 1645 to 1715 during which sunspots were exceedingly rare. It was also called 'prolonged sunspot minimum'. During a 28-year period (1672–1699) within the minimum, observations revealed fewer than 50 sunspots (compared to the typical 40,000–50,000 sunspots seen over a similar timespan). The MM coincided with "The Little Ice Age", a period where the Northern Hemisphere cooled significantly. The UK experienced the "Great Frost" of 1708-1709, where temperatures dropped to as low as -15°C, leading to crop failure and famine, and hundreds of thousands of deaths across Europe.
Evaluation	However, it must be noted that sunspots may not be the main cause of global warming. During the period of 2000 to 2008, the number of sunspots was observed to decrease. However, the Earth's temperature still continued to increase. Hence, the role that sunspots play in the Earth's warming is limited.

Alternate factor: Anthropogenic factors	
Content	One anthropogenic factor is deforestation. Deforestation refers to the process where trees are felled to make products such as paper and building materials, or to make space for alternative land uses like mining and agriculture. Trees in forests absorb carbon dioxide (CO ₂) via photosynthesis, which makes them a 'carbon sink'. When trees are removed, the amount of CO ₂ (a GHG) that can be removed from the atmosphere decreases. When trees are removed, the soil is exposed to the sun, which causes an increase in carbon oxidation in the soil, which releases CO ₂ (a GHG). 'Slash and burn' methods where trees are burned instead of

	felled, will produce CO ₂ (a GHG). Use of machinery will also produce CO ₂ (a GHG).
Argument	Deforestation causes can cause global warming because it increases the concentration of GHG present in the atmosphere. In the greenhouse effect, shortwave radiation (energy) from the sun is absorbed by the Earth's surface, and the earth then re-emits longwave radiation (heat) into the atmosphere. However, a higher concentration of GHGs present due to deforestation traps more longwave radiation in the atmosphere, reducing the amount of longwave radiation lost to space. Thus, deforestation causes the earth's average surface temperature to steadily increase over time.
Place-specific examples	The Amazon Rainforest is responsible for removing 5% of global CO ₂ emissions. However, increasingly, it is being deforested by farmers to make more land for soy plantations. Due to slash and burn and logging, the region emitted 1.06 billion metric tons of CO ₂ into the atmosphere per year between 2010 and 2018. As such, the Amazon Rainforest region has begun to emit more carbon emissions than it can absorb. Its capability to function as a carbon sink is rapidly decreasing.
Evaluation	Deforestation is increasing at a rapid pace. The impacts of deforestation may be limited if governments put tight monitoring laws in place to protect forested areas. However, not all countries are able to do so, especially if they need the space for agricultural farming.

Conclusion

In conclusion, while both natural and human factors are capable of causing global warming, the recent global warming observed is likely due to human factors. Over the last 30 years, anthropogenic activities have produced more than 100 times more carbon dioxide than natural causes. While Earth's climate has changed throughout its history, the current warming is happening at a rate not seen in the past 10,000 years. Additionally, scientists that model the earth's climate conclude that the magnitude of warming experienced over the past 150 years is directly proportional to the rate of greenhouse gas emissions produced by humans. As such, due to the unprecedented scale and rate of global warming, it must be concluded that climate change is caused by human factors.

Anthropogenic factors are the main cause of climate change.'

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

The concentration of greenhouse gases in the atmosphere has increased mainly due to anthropogenic factors. Anthropogenic factors are factors caused by human activities such as deforestation, burning of fossil fuels and changing land use.

Deforestation means there will be fewer trees to absorb carbon dioxide. Since trees absorb billions of tonnes of carbon dioxide every year via photosynthesis, there will be less absorption of CO₂, leading to an increase in the concentration of CO₂ in the atmosphere. Furthermore, deforestation will also expose soils and soils contain a large amount of carbon accumulated through the decay of organic matter such as dead leaves and animals. Soils are now exposed to sunlight, increasing the temperature of soil and the rate of carbon oxidation. Thus, there will be more CO₂ released. These will inevitably cause more heat to be trapped, increasing the global air temperature and changing the climate.

Agricultural practices such as cultivating land, producing crops and raising livestock is the 3rd highest contributor of greenhouse gases. Crop cultivation releases key gases such as carbon dioxide, methane and nitrous oxide. The use of tractors will require fossil fuels to be burnt, thus releasing carbon dioxide. Cattle farming releases millions of tonnes of methane into the atmosphere annually, as gases are released from the digestive systems of cattle. Methane is produced when the stalks of wet rice plants rot in flooded fields during cultivation. In order to produce more food for the world's growing population, more nitrogen-based fertilisers are used and this releases nitrous oxide. Carbon dioxide, methane and nitrous oxide are greenhouse gases and increased concentrations of them would mean that more heat is trapped in the atmosphere, leading to an increase in global air temperature and changing the climate.

Industries including secondary industries such as manufacturing require the burning of fossil fuels that result in greenhouse gas emissions. Industrial activity is a major contributor of carbon dioxide through the burning of fossil fuels when creating energy for factory processes.

Other than agricultural practices and manufacturing industries, urbanisation will also lead to enhanced greenhouse effect. Urbanisation leads to an increase in concentration of various human activities that are necessary in urban places. Activities such as heating, cooling, cooking and lighting require a large amount of fossil fuels to be burnt in order for energy to be produced. All of them contribute to the amount of greenhouse gases in the atmosphere. Moreover, the high concentration of cars and buses, as well as the construction of infrastructure also contribute to the amount of greenhouse gases in the atmosphere. Thus, with higher concentration of greenhouse gases, more heat will be trapped in the atmosphere, which will lead to an increase in the global air temperature and changing the climate.

However, natural causes will also result in climate change. The sun emits varying amounts of solar radiation due to changes in its magnetic field. An increase in magnetic activity results in an increase in solar radiation. This solar activity cycle was discovered through the study of sunspots. Although the spots are cooler, there are more sunspots when solar activity is high. This is because the areas surrounding the sunspots radiate more energy, which compensates for the lower temperatures of the sunspot areas. Thus, when there is an increase in sunspots, there will be higher solar radiation, and the earth's temperature will increase, which is a form of climate change.

When a volcano erupts, large volumes of carbon dioxide, water vapour, sulfur dioxide, dust and ash are released into the atmosphere. Sulfur dioxide reacts with water to form Sulphur-based particles in the atmosphere. Together with dust and ash, these particles reflect solar energy back into space. This results in a cooling influence on regional and global temperatures. However, volcanic eruptions have few long-term effects on the earth's climate. This is because the temporary global cooling influence will cease once the volcanic dust and ash settle.

Over the last 30 years, anthropogenic activities have produced more than 100 times more carbon dioxide than natural causes. While Earth's climate has changed throughout its history, the current warming is happening at a rate not seen in the past 10,000 years. . As such, due to the unprecedented scale and rate of global warming, it must be concluded that climate change is caused by human factors.

“The changes in the Earth’s orbit and tilt are the most significant natural causes of climate change.”

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

Factors to consider in LDQ:

Given factor:

- Changes in sunspot occurrences

Alternate/other factors:

- Changes in Earth’s orbit and tilt
- Large scale volcanic eruptions

Introduction

I agree/disagree that the changes in the Earth’s orbit and tilt are the most significant natural causes of climate change.. Climate change refers change in the atmospheric conditions of the Earth over a long period of time, usually 30 years minimally. In geologic times, the Earth has been warming and cooling in a fluctuated manner. In this essay, I will discuss which of the two natural factors play a more significant role in climate change: first, changes in sunspot occurrences or 2nd, the changes in the Earth’s orbit and tilt.

Given factor: Changes in the Earth’s orbit and tilt	
Content	A natural cause of climate variability is due to the changes in Earth’s orbit (eccentricity) and angle of tilt (obliquity). There is evidence that the variations in the earth’s orbit shape and tilt would affect incoming radiation from the sun in three cycles, resulting in a long-term impact on climate variability.
Argument	When the Earth’s orbit is the most elliptic, the Earth receives more solar radiation, hence higher temperatures are experienced. On the other hand, when there is a change in the Earth’s tilt, temperature changes in both North and South Hemispheres. Greater tilt (24.5°) will result in warmer summers and cooler winter. The larger variation in temperature results in greater seasonal changes.
Place-specific examples	For example, over the last million years, it has varied between 22.1 and 24.5 degrees with respect to Earth’s orbital plane. Earth’s axis is currently tilted 23.4 degrees, or about half way between its extremes, and this angle is very slowly decreasing in a cycle that spans about 41,000 years.
Evaluation	However, it must be noted the changes are occurring over a long period cycle, between 40 000 – 100 000 years. Hence, the changes observed and felt are slower, though may be significant, hence other short-term factors may cause a greater, faster fluctuations of the Earth’s temperature.

Alternate factor: Changes in sunspot occurrences

Content	One alternate factor is sunspot occurrences. Sunspots are cooler regions on the Sun's surface, caused by the Sun's natural activity cycle and changes in its magnetic field. An increase in magnetic activity leads to an increase in the number of sunspots. The number of sunspots rises and falls every 11 years, which is known as the sunspot cycle.
Argument	Sunspots can cause global warming because of the number of sunspots present on the Sun's surface. At the highest point of the sunspot cycle, there will be higher number of sunspots appearing on the Sun. As such, the total amount of solar radiation given out by the Sun increases. As a result, the Earth receives more solar radiation, leading to higher temperatures on Earth.
Place-specific examples	The Maunder Minimum was a period around 1645 to 1715 during which sunspots were exceedingly rare. The MM coincided with "The Little Ice Age", a period where the Northern Hemisphere cooled significantly. The UK experienced the "Great Frost" of 1708-1709, where temperatures dropped to as low as -15°C.
Evaluation	However, it must be noted that sunspots may not be the main cause of global warming. During the period of 2000 to 2008, the number of sunspots was observed to decrease. However, the Earth's temperature still continued to increase. Hence, the role that sunspots play in the Earth's warming is limited.

Conclusion

In conclusion, changes in sunspot occurrences plays a more significant role in the short-term change in the Earth's climate as it occurs over 11 years, as the fluctuation is more rapid and significantly felt over a shorter period/cycle. However, over a long-term period, the change experienced in the Earth's climate is of a larger variation, where the changes in the durations for the various seasons are greater.

“The direct impact of climate change is more devastating on human systems than the indirect impact.”

How far do you agree with this statement? Use examples to support your answers.

Factors to consider in LDQ:

Given factor:

- R

Alternate/other factors:

- U

Introduction

I agree that direct impact of climate change is more devastating on human systems than the indirect impact. Impacts of climate change are interconnected and changes in the physical climate will affect natural systems. This in turn affects humans directly and indirectly. I will argue that direct/indirect impact of climate change is more devastating on the human systems across places on Earth.

Given factor: Direct impact (heat waves)	
Content	One of the direct impacts of climate change is heat waves. A heat wave can be defined as a period of excessively hot weather that is abnormal for the location and usually lasting for several days or longer. With climate change, temperatures are likely to increase further. Heat waves are projected to affect different parts of the world in the near future (year 2030) if there is not much being done for climate change.
Argument	Temperatures of heatwaves could be as high as over 40 degree Celsius and such high temperatures can cause adverse effects on humans as people may suffer from heat stroke, difficulties in breathing and in extreme cases, death. Heat waves have caused thousands of deaths worldwide. It has been found that almost one-third of all heat-related deaths are caused by global warming. Furthermore, the high temperatures from the heat wave can deplete the soil moisture necessary for crops to grow, leading to widespread crop failures. This can then affect food supply globally.
Place-specific examples	One example is the 2003 heat wave that hit Europe. It was estimated that around 70,000 people died from the heat wave which lasted for two weeks. Many crops such as wheat died, causing the price of bread to increase significantly. Food thus became less affordable for people. In 2019, two intense heat waves raged across Europe again, breaking many historical temperature records. Temperatures of 45 degree Celsius were recorded in France. It is therefore concluded that heatwaves of greater severity are occurring more frequently.
Evaluation	However, heat waves significantly affect the already dry and arid areas, making the areas even drier to experience a more severe and prolonged drought. Also, there is a significantly high number of populations in these dry and arid regions, especially in Africa which ultimately has a large-scale impact on the poorer regions as they may not be able to recover, given the

	food crisis that are already occurring in these regions. Heat waves will exacerbate the impact on the people living in the region. However, heat waves may not have a significant impact on cooler regions currently. But over a longer period of time and continuous increase in global temperature, these regions may also be adversely affected.
Alternate factor: Indirect impact (provisioning services)	
Content	Climate change results in physical changes to the environment that affects provisioning ecosystem services. This indirectly impacts humans as the environment's ability to provide resources for food production is affected. The two impacts in provisioning ecosystem services are fish production and agricultural yield.
Argument	As global temperatures generally increase, aquatic environments can be affected. Climate change causes ocean temperatures to increase and increase in acidity. Such changes to the aquatic environment can threaten the availability of aquatic life or affect the distribution of aquatic species as they look for cooler waters. This affects what fishermen can catch, and where they have to go to fish. Aquatic species may also die if they cannot cope with the sudden changes in the aquatic environment and this can affect fisheries negatively. Rising sea levels due to climate change can lead to salt water from the sea entering freshwater in rivers, which may threaten freshwater fisheries. This therefore indirectly impacts people who depend on the fisheries for their economic livelihoods. It also affects the food security of a place as fish supplies dwindle.
Place-specific examples	One example is Cambodia, where fish is a big part of the locals' diet, especially for people living near Tonle Sap, the largest lake in the country. With increasing temperatures and unpredictable rainfall, the water level in Tonle Sap has declined significantly, reducing fish habitats for fish and the availability of fishes. Hence, this threatens the economic livelihoods and food security of Cambodians.
Evaluation	However, the changes to the aquatic ecosystem can also bring some positive impact to the provisioning ecosystem services to certain places. Places located at higher latitudes may benefit by seeing an increase in fish species migrating polewards due to the cooler waters there. For example, in recent years, fishermen in Portugal have begun to catch new species, which were previously found in warmer regions. Hence, fisheries there will be able to catch a more diverse range of seafood.
Conclusion In conclusion, the impact is dependent on the places where the consequences are felt. It is also dependent on the level of development of the places from which the consequences are felt. For a developed country, provisioning ecosystem services may not have significant and devastating impact as countries are able to diversify their imports of food products from other countries. However, for a less developed countries, fish farming and agriculture may be their only forms of livelihood and sourcing for new supply of food resource poses a great challenge. Similarly	

for direct impact, developed countries are able to manage the impact by building infrastructures to provide shades and regulate the radiation and heat to grow crops, however, these infrastructures may be expensive for less developed countries to construct, leaving many of their crops to wilt and wither. Additionally, both direct and indirect impact has a multiplier effect, especially for developing nations and the disadvantaged communities living in these countries.

‘Terrestrial ecosystems experience the greatest change due to climate change.’

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

Factors to consider in LDQ

Given factor:

- Aquatic ecosystems

Alternate/other factors:

- Terrestrial ecosystems

Introduction

I agree/disagree that Terrestrial ecosystems experience the greatest change due to climate change. Earth’s atmospheric temperature has been increasing due to the emission of large amounts of greenhouse gases. Most of the excess heat trapped by these gases has been absorbed by the world’s oceans, causing their temperatures to increase. This has a devastating impact on both terrestrial and aquatic ecosystems.

Given factor: Terrestrial ecosystem

Content	As the atmosphere warms, terrestrial species will be forced to adapt. Those that can migrate will do so to find places with their preferred temperature. In general, this involves a shift towards the higher latitudes and altitudes where temperatures are cooler. The geographic distribution of species will also change, along with the mix and population densities of prey, predators and competitors in the ecosystems.
Argument	Terrestrial species may decline as they cannot find suitable habitats to migrate to. Mountain species prefer cold environments and might not have anywhere to go if the top of mountains are too warm for them. They also face competition with species from lower altitudes moving upwards. Hence, extinctions are predicted to occur at higher rates in mountainous areas than in other ecosystems. Others, such as plant species, might decline as they are unable to move and adapt fast enough. On the other hand, some species will flourish as they migrate to new, suitable habitats. As different species respond differently, new terrestrial communities can develop in new areas.
Place-specific examples	For example, in Australia, wallabies are migrating to higher altitudes. These Wallabies feed on herbfields in the mountains, threatening to reduce them to grassy lawns instead. In turn, other species that depend on these herbfields will be affected. The broad-toothed rats which also feed on these herbfields will face greater competition and are at high risk of extinction.
Evaluation	Climate change has high impact on terrestrial ecosystem because terrestrial ecosystems. The vast ecosystems include forests, grasslands, wetlands, deserts, and more, that rely on specific climatic conditions to maintain their biodiversity, structure, and ecological processes. Hence, its impact is high.

Alternate factor: Aquatic Ecosystem

Content	Climate change is causing the world's oceans to warm up, and the global ocean circulation to slow down. The slowing down of ocean circulation can disrupt marine food webs. Ocean circulation transports heat from the tropics to the poles and allows for the exchange of nutrients and oxygen between the surface and deep waters. However, as the sinking of water is reduced at the poles, warm surface waters mix less with cooler, deeper water.
Argument	With reduced mixing of deep and surface waters, aquatic organisms living near surface waters, especially phytoplanktons, would not get their supply of nutrients from the deep ocean. As phytoplanktons form the base of the food web, the species higher up in the food chain, such as fish and whales, will decrease due to a lack of food. The entire ecosystem will be affected. Similarly, the increase in ocean temperatures can have huge consequences on aquatic ecosystems. The warming oceans are expected to result in rapid changes in aquatic environments. Some species are not able to adapt and are therefore at risk of going extinct. As species are dependent on one another for food, a decline in one or more species may cause entire ecosystems to collapse.
Place-specific examples	For example, it has been found that phytoplankton levels in the North Atlantic have dropped by 10% since the 1800s. Also, the change in ocean's temperature and circulation have caused tropical fishes such as the parrotfish and rabbitfish to migrate to cooler waters of Japan and Australia.
Evaluation	Climate change has high impact on aquatic ecosystems, as it includes various ecosystems such as the oceans, rivers, lakes, wetlands, and estuaries, that are highly sensitive to changes in temperature and precipitation, which affect water quality, biodiversity, and ecological interactions.

Conclusion

In conclusion, terrestrial ecosystems are currently facing higher consequences for climate change due to the differential heating of the different surfaces of the Earth. Land heats up faster than ocean which results in a drastic increase in air temperature as compared to water surface temperature. With a higher increase temperature on land, the changes and shifts in composition, density and geographical locations of terrestrial species occurs more rapidly and at a larger scale as compared to aquatic species. However, over time, aquatic species will face similar changes and shifts, when global temperature continues to rise.

‘The impact of climate change is greater on the natural systems than human systems.’

To what extent do you consider this statement to be true? Explain your answer.

Factors to consider in LDQ:

Given factor: Natural systems

- Threats to coral reefs
- Disruption of marine food webs due to slowing down of ocean circulation
- Disruption to marine food webs due to changes in geographical distribution of aquatic species
- Threats to flora and fauna

Alternate/other factors: Impact on human ecosystems

- Direct impact on human systems
- Impact on provisioning ecosystem services

Possible Approach

Answer could describe the impact of climate change on natural systems (aquatic and/or terrestrial) with reference to examples. Answer would also describe how climate change affect human systems directly and/or indirectly with reference to examples. The evaluation could weigh the argument discussed using impact (short-term / long-term / irreversible) or interconnectedness – understanding that impact on natural systems also affect human systems indirectly (E.g. reduced catch for fishermen due to aquatic migration).

Relevant content

Impact of aquatic ecosystems

Threats to coral reefs

Point	Climate change threatens coral reefs
Explain	Warming oceans cause algae that live in coral reefs to leave them, turning the coral white. Without the algae, coral loses its major source of food and are more likely die due to exposure to diseases, breakage, and starvation.
Example	The Great Barrier Reef in Australia was severely affected in 2016 and 2017 by rising sea temperatures, up to two-thirds of corals died in the northern section of the reef.
Link	When coral die, millions of aquatic species like fish, seahorses and turtles lose their habitat and food source. Their population decline, further affecting other species that depend on them. The entire ecosystem will be affected.

OR

Disruption of marine food webs due to slowing down of ocean circulation

Point	Climate change may disrupt marine food webs
Explain	Ocean circulation transports heat from tropics to the poles and allow for exchange of nutrients between surface and deep waters.

	Due to rising ocean surface temperature, the surface water is becoming warmer and less dense thus slowing down the sinking of water at the pole, this slows down the ocean circulation. With reduced mixing of deep and surface waters, aquatic organisms living near surface waters, especially phytoplankton would not get their supply of nutrients from the deep ocean.
Example	It has been found that phytoplankton levels in the North Atlantic have dropped by 10% since the 1800s.
Link	As phytoplankton form the base of the food web, the species higher up in the food chain, such as fish and whales, will decrease due to a lack of food. The entire ecosystem will be affected.

OR

Disruption to marine food webs due to changes in geographical distribution of aquatic species

Point	Due to climate change, aquatic species migrate to areas where temperatures are more favourable.
Explain	Generally, aquatic species moving pole wards and into deeper, cooler waters due to rising ocean temperatures. Hence, it is expected that there will be a decrease biodiversity in the equatorial regions, with an increase in biodiversity in poleward regions.
Example	The North Sea experienced a 35% loss in Atlantic cod, haddock and herring as they migrated poleward and into deeper waters.
Link	In addition, the population densities of prey, predators and competitors in the ecosystem changes as existing food webs are disrupted and new aquatic communities develop.

OR

Impact on terrestrial ecosystems

Threats to flora and fauna

Point	Climate change threatens flora and fauna species
Explain	Generally, terrestrial species are migrating towards the higher altitudes and latitudes where temperatures are cooler.
Example	About 170 species of birds tracked in North America have expanded their range northwards by 50 km. Some places have seen species decline due to competition from the incoming species. In the Tundra, the migration of the red fox, which is typically found farther south, has caused competition for food and territory with the Arctic fox.
Link	As the geographical distribution of terrestrial species changes, the mix and population densities of prey, predators in the ecosystems also change. This alters the terrestrial ecosystems.

OR

Increase in extreme weather events such as droughts and excessive rainfall

Point	Climate change is also affecting terrestrial ecosystems by contributing to more frequent and severe droughts and rainfall.
Explain	A warmer atmospheric temperature drives more evaporation of water from the Earth, making some places drier and thus more prone to drought, while others becoming wetter and thus more prone to excessive rainfall.

	Droughts can cause plants to be more vulnerable to diseases and insect attacks. Some animal species could not adapt, as their habitats are destroyed and food supplies are reduced.
Example	Droughts in California, USA between 2012 and 2016 contributed to the death of 102 million forest trees due to the lack of water and spread of diseases. In Assam, India, unusually excessive rainfalls in 2020 resulted in floods where more than 200 wild animals were killed, including eight endangered rhinoceros.
Link	Habitats are damaged and threatening terrestrial ecosystems.

Impact on human systems

Direct impact on human systems

Point	With climate change, extreme weather events such as heat waves, droughts, floods, cyclones and wildfire are likely to occur more often and with greater severity.
Explain	Climate change leads to higher temperatures, therefore making heat waves more intense and more frequent. Heat waves could rise as high as over 40°C and cause adverse effects on humans as people may suffer from heat stroke, difficulties in breathing and in extreme cases, death. OR Warmer atmospheric temperatures due to climate change increases evaporation which reduces surface water and fries out soil and vegetation. In areas with dry climate, dry seasons may therefore get even drier, resulting in droughts. Lack of water can cause crop failure and people may be displaced when they are forced to move to seek water/food. OR Climate change leads to warmer oceans and more water vapour in the atmosphere which is believed to be a driving force for more intense tropical cyclones. Strong winds and heavy rainfall brought by tropical cyclones can result in loss of lives due to flooding, landslides and collapsed building.
Example	In 2003, a two-week heat wave hit Europe, resulting in an estimated 70000 deaths. In 2018 – 2019 drought in Afghanistan affected more than two-thirds of the country, over 10 million people suffer from crop failure and many were displaced. In 2020, tropical cyclones in Philippines resulted in massive destruction of properties and evacuation of nearly 1 million people.
Link	Impact of climate change can be very devastating on human systems causing deaths and displacement.

Impact on natural systems and hence provisioning ecosystem services

Indirect impact on human systems

Point	Due to climate change, increasing temperatures and unpredictable rainfall led to changes in natural systems which also affected provisioning ecosystem services such as food production.
Example	Increased temperatures and unpredictable rainfall led to water levels in Tonle Sap in Cambodia to decline significantly, reducing the availability of fishes.

Explain	This threatens the economic livelihood and food supply of the Cambodians as the provisioning ecosystems of Tonle Sap is disrupted. When food production fails, food prices may increase, resulting in greater possibility of malnutrition and starvation among the poorest in less developed countries such as Cambodia.
Link	When the Cambodian fishermen is forced to leave Tonle Sap and seek employment in other areas, his traditional way of life is affected and may result in lost cultures.

While the impact of climate change on natural systems is profound and often more immediate, it is crucial to understand that these impacts have significant and often indirect effects on human systems. The degradation of natural systems like not only disrupts provisioning ecosystem services but also affects the socio-economic conditions and cultural practices of human communities dependent on these ecosystems. The impacts can be short-term or long-term, and often irreversible, underscoring the complex relationship between natural and human systems and highlighting the need for integrated approaches to address climate change's multifaceted challenges.

"The most effective adaptation strategies in building community resilience to climate change are those involving institutional approaches."

How far do you agree with this statement? Use examples to support your answer.

Institutional approaches

Organise strategies on a national or regional scale, allowing for larger-scale measures which may otherwise be impossible if communities acted on their own due to lack of resources, expertise, or funding. At a national scale, Singapore has established organisations and agencies to coordinate climate action. The Ministry of Sustainability and the Environment (MSE) oversees how Singapore can be more climate-resilient and creates a national framework and roadmap for climate resilience. The Centre for Climate Research Singapore (CCRS) conducts research in climate science. This aims to develop understanding of the changing climate in Singapore, which is then used to support Singapore's resilience planning. However, institutional approaches may not be as effective as countries may have competing national priorities such as urgent development projects. They may not have the capacity to draw on national budget to finance adaptation projects.

Structural approaches

These are strategies that involve the construction of physical structures to ensure water and flood management. The Netherlands has been constructing polders since the 12th century. Polders are low-lying lands that are surrounded and protected by barriers called dykes. Excess water is then pumped out from the polder, protecting communities from river and coastal flooding due to sea level rise for centuries. However, building structures are costly for developing countries. Besides the massive manpower needed, construction of these structures may also involve eviction of informal communities, affecting their livelihood and homes.

Technological approaches

Technology can be used to produce food to help communities remain food secure despite the changing climatic conditions. 90% of Singapore's food is imported. Due to space constraints, less than 1% of our land is available. Hence innovative ways have to be adopted to produce more food locally in a more efficient manner. Through high-tech farming to produce high quality vegetables, eggs and fish efficiently, Singapore is able to increase its food security and hence community resilience. However, these strategies are costly, which may not be possible in countries with limited funding.

Social approaches

Raising awareness and educating communities on how to respond to climate change impacts are crucial. These allow communities to be aware of the warning signs of possible climatic hazards, and take appropriate steps to protect themselves, increasing community resilience. In Nepal, to cope with prolonged drought, communities are taught that they can plant more drought-resistant crops such as apples. However, some communities in Nepal prefer to stick to their traditional ways of adapting such as temporary migration, which is not sustainable. Hence lack of willingness to change behaviours limit the effectiveness of social approaches.

While institutional approaches may prove to be effective as they are larger in scale, they do have limitations as well. Hence there is no one approach is more effective than the other, as these adaptation strategies are place- and context- specific, and there is no one-size-fits-all. The effectiveness of each approach varies across places and may be limited by a country's resources and ability to commit. What is more definite is that these strategies cater more to developed

countries than less developed countries, increasing the possibility of effectiveness mainly in these richer nations.

“Adaptation strategies involving structural approach is the most effective way to increase community’s resilience to climate change.”

How far do you agree with this statement? Use examples to support your answer.

The effectiveness of structural approaches in building community resilience to climate change depends on various factors, including the specific context, the nature of the community, and the types of challenges posed by climate change. While structural approaches play a significant role in building community resilience, there are other approaches such as technological, social and institutional approaches that can also build community resilience to climate change.

Structural approaches involve implementing physical changes to the built environment and infrastructure to better withstand the impacts of climate change. Examples include building sea walls, elevating houses, constructing flood barriers, and improving drainage systems. These measures directly address the physical vulnerabilities of a community. Structural measures offer direct protection from climate-related hazards. They can reduce immediate risks and prevent or minimize damages from events such as floods, storms, and sea-level rise. Polder is a low-lying land that is surrounded and protected by barriers known as dykes. Excess water is pumped out from the polder and thus, it protects people, properties and environment from sea level rise and coastal floods. The Netherlands is one country that has been constructing polders since the 12th century and these have helped to protect communities from river and sea flooding. However, economically, it is costly to build structures such as polders which are strong enough to protect communities from flooding or sea level rise, especially for developing countries.

The structural approaches are effective in providing continuous protection over time, once implemented. These structures have long lasting impacts long-term, reducing the need for frequent reactive responses. Structural measures can offer relatively quick results, making them suitable for addressing urgent vulnerabilities. For example, water storage tanks in Singapore are effective in flood prevention, the Stamford Detention Tank in Singapore allows excess water to flow into the detention tank and be stored there temporarily. Being an island, low-lying areas in Singapore are vulnerable to floods caused by rising sea levels. These infrastructure to store excess storm water during periods of excessive rainfall to slow the water from rushing into the canals and drains. When sensors detect that water levels in drains have fallen, then the water in the detention tank will be released back into the drains. However, in the city of Jakarta, the construction of flood structures caused the eviction of informal communities.

However, there are limitations to the structural adaptation strategies. Building and maintaining structural solutions can be expensive. Many communities, especially those with limited resources, may struggle to afford these interventions. Structural measures require ongoing maintenance and adjustments. Without proper upkeep, these solutions can become ineffective over time or even contribute to new problems. Singapore has been using seawalls in East Coast Park to protect the coastline from sea level rise. However, seawalls may have to be monitored and enhanced regularly to protect communities from even higher flood levels as climate change worsens. This will add to the total cost of building such infrastructure. In Fiji, the sea walls are also costly to build even when local materials are used together with materials supplied by the government. It also requires a lot of manpower which adds to the cost of building the sea walls. Furthermore, the construction of these structures may involve the eviction of informal communities. In cities such as Jakarta, informal communities have been evicted or displaced to make room for the construction of flood prevention structures.

Hence, it is high ineffective for any country to rely only one approach. Apart from structural approaches, countries can adopt institutional approaches and technological approaches. For

instance, institutional approaches play a crucial role in shaping policies, regulations, and governance structures, which in turn influence a community's ability to adapt to climate change impacts. One way if when governments establish policies and governance frameworks that promote climate-resilient development. These policies can include zoning regulations, building codes, and land-use planning that take climate risks into account. Effective policies can encourage sustainable practices and discourage activities that exacerbate climate vulnerabilities.

In conclusion, the most effective adaptation approach to building community resilience often involves a combination of structural, technological, social and institutional approaches. Non-structural measures, such as education, community engagement, early warning systems, and adaptive governance, are equally important. These measures can enhance a community's capacity to respond, adapt, and recover from climate change.

‘Mitigation strategies are more important than adaptation strategies in building community resilience towards climate change.’

To what extent do you consider this statement to be true? Explain your answer with the use of relevant examples.

Given factor: Mitigation strategies

- International agreements
- Use of green energy and renewable energy sources
- Encouraging change in consumption patterns

Alternate/other factors: Adaptable strategies

- Structural approaches – seawalls, polders

Mitigation strategies refer to efforts that reduce greenhouse gas emissions and enhance carbon sinks to slow down climate change. An example of mitigation strategies is international agreements. The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty addressing climate change that is signed by 197 parties. The objective of the UNFCCC is to stabilise greenhouse gas emissions at a level that would prevent irreversible anthropogenic impacts and provide sufficient time for ecosystems to adapt naturally to climate change. As part of the UNFCCC, greater responsibilities are placed on developed, industrialised countries as they are considered the main source of past and current greenhouse gas emissions. Funds and technologies from developed countries are also directed to climate action in developing countries to help them develop renewable energy capabilities. In return, developed countries earn the opportunity to trade carbon credits to offset their carbon emissions so as to meet their emission targets. The UNFCCC also requires countries to regularly report on their climate change policies and greenhouse gas emissions. In 2015, members of the UNFCCC made significant progress as 191 parties signed the Paris Agreement, pledging to develop their own set of targets and measures. However, international agreements face institutional challenges. Many countries that are most-at-risk of climate change are often the lowest greenhouse gas emitters, while developed countries who are responsible for the bulk of emissions face the least risk as they often have the adaptive and mitigative capabilities to deal with climate change impacts. As a result, the commitment to act from different countries will vary. In addition, change in political leadership in countries may also affect a country's commitment to climate action. For instance, President Donald Trump announced in 2017 that USA will be withdrawing from the Paris Agreement as he believes that it will be detrimental to the manufacturing economy of his country.

Another mitigation strategy in building community resilience to climate change is to reduce greenhouse gas emission using clean energy sources. A type of clean energy source is solar energy. It is energy from the sun converted into thermal or electrical energy. It is the cleanest and most abundant renewable energy source available. Due to that, Singapore wants to increase its solar capacity to meet about 4% of Singapore's total electricity demand. However, the development and construction of this technology is expensive, and it depends heavily on government policies and financial support. Therefore, not all countries are moving to solar energy readily.

Adaptation strategies such as structural approaches involve implementing physical changes to the built environment and infrastructure to better withstand the impacts of climate change. Examples include building sea walls, elevating houses, constructing flood barriers, and improving drainage systems. These measures directly address the physical vulnerabilities of a community. Structural measures offer direct protection from climate-related hazards. They can reduce

immediate risks and prevent or minimize damages from events such as floods, storms, and sea-level rise. Polder is a low-lying land that is surrounded and protected by barriers known as dykes. Excess water is pumped out from the polder and thus, it protects people, properties and environment from sea level rise and coastal floods. The Netherlands is one country that has been constructing polders since the 12th century and these have helped to protect communities from river and sea flooding. However, economically, it is costly to build structures such as polders which are strong enough to protect communities from flooding or sea level rise, especially for developing countries

Despite the institutional challenges that undermine international agreements, mitigation strategies are still important as they slow down climate change, buying time to develop adaptive technologies. In addition, if greenhouse gas emissions are reduced, the effects of climate change will be lessened thereby reducing the scale at which adaptation strategies are implemented. As climate change is going to affect countries in varying degrees, it has resulted in a lack of commitment from some countries to act. Hence, it is inevitable for countries to face the eventual effects of climate change. Hence adaptation strategies will be the most pragmatic way to deal build community resilience towards climate change.

‘Technological adaptation strategies such as high-tech farming are exceedingly successful in building community resilience to climate change.’

To what extent do you consider this statement to be true? Explain your answer with the use of relevant examples.

An adaptation strategy in building community resilience to climate change is to involve technology in food production. With changing climatic conditions, such technology can increase food security and community resilience. One of such technologies is the use of high-tech fish farms. High-tech water tanks can monitor water quality and check if fishes have diseases. This enables swift action to be taken to prevent the spread of diseases. This is especially important in land-scarce Singapore. Singapore aims to increase local food supply to account for 30% of residents’ needs by 2030. Currently, 90% of Singapore’s food is imported. However, high tech farming in Singapore has its set of challenges. Shortage of labor, competition from lower-cost economies, and scarcity of spaces are big obstacles that the state needs to overcome. Demand for pricier locally grown food is also weak. Hence, technological adaptation strategies can be very costly and may not be possible in countries with limited funding.

Other structural approaches are effective in providing continuous protection over time, once implemented. These structures have long lasting impacts long-term, reducing the need for frequent reactive responses. Structural measures can offer relatively quick results, making them suitable for addressing urgent vulnerabilities. For example, water storage tanks in Singapore are effective in flood prevention, the Stamford Detention Tank in Singapore allows excess water to flow into the detention tank and be stored there temporarily. Being an island, low-lying areas in Singapore are vulnerable to floods caused by rising sea levels. These infrastructure to store excess storm water during periods of excessive rainfall to slow the water from rushing into the canals and drains. When sensors detect that water levels in drains have fallen, then the water in the detention tank will be released back into the drains. However, in the city of Jakarta, the construction of flood structures caused the eviction of informal communities.

In conclusion, both mitigation and adaptation strategies can be most effective when technological, economic, social, and institutional challenges can be overcome. However, countries may often have competing national priorities and may not have the capacity to draw on their national budget to finance these projects.