Senior Secondary Liberal Studies
Learning and Teaching Exemplar
for NCS students (7)

Climate Change and Natural Disasters

Climate change and natural disasters

A. Basic information of the lessons

Topic | Climate change and natural disasters

Relevant modules, themes and issues for enquiry

Module 6: Energy Technology and the Environment;

☀ *Theme 1: The influences of energy technology*

- To what extent does the development of energy technology create or solve environmental problems?

- What are the implications of environmental change on the development of energy technology?

- How do energy problems affect international relationships, and the development of countries and societies?

☀ *Theme 2: Environment and sustainable development*

- How do the living styles of people and social development affect the environment and the use of energy?

- What responses could be made by different sectors of the society, governments and international organisations regarding the future of sustainable development?

Overall design rationale

☀ The lessons start from introducing the natural disasters in various regions, including Hong Kong and South Asian countries. Both the NCS and local Chinese students may learn about the consequences of climate change in the context of Hong Kong as well as other regions.

Students will be guided to identify and analyse the possible impacts caused by and possible reasons for global warming. Students will then discuss and suggest ways to counter global warming. With reference to various sources and their own knowledge, students would be guided to identify the controversies over the responsibility of reducing carbon emission among different countries.

The tasks in this teaching package enable students to acquire useful skills to deal with different types of sources and questions.

Guided writing tasks offer students the opportunities to learn to formulate their arguments logically.

Time required

☀ 4 lessons (40 minutes per lesson), approximately 160 minutes in total

Learning objectives

☀ *Knowledge:*

- To understand the current situation of global warming and its relationship with the occurrence of natural disasters worldwide
- To analyse the reasons for and impacts caused by global warming
- To explore various ways to counter global warming
- To evaluate the roles of different countries in alleviating the problem of global warming

☀ *Skills:*

- To interpret multimodal sources from multiple perspectives
- To apply relevant knowledge and concepts in discussing contemporary issues
- To make sound judgements by logical reasoning
- To express ideas in speaking and writing

☀ *Values and attitudes:*

- To understand the importance of environmental protection and sustainable development, and develop energy saving lifestyle
- To reflect upon one's roles and responsibilities in the society
- To foster positive attitudes towards balancing different views and comprehensive consideration

Basic Concepts for application

☀ climate change, resource depletion, energy technology, renewable energy, non-renewable energy, sustainable development, green lifestyle, global governance

Relevant learning experience at junior secondary levels

- Forms of energy, energy changes, generation of electricity and energy sources; the composition of air, balance of carbon dioxide and oxygen in nature; global warming, the greenhouse effect, etc.

- The interdependence of living things and their environment; choice and cost in the use of scarce resources; development in and interdependence between less developed and more developed countries, etc.
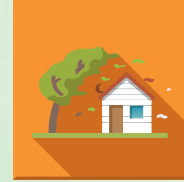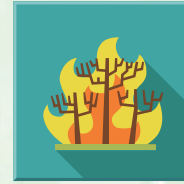
Catering the learning needs of NCS students

- The lesson will start from the natural disasters in Hong Kong as well as other regions outside Hong Kong.

- The use of audio-visual learning materials may arouse the interest of students in exploring the issues of climate change.

- The data file offers NCS students a variety of sources, including data, photos, comic and animation, to equip them with necessary skills in tackling different types of sources.

- Guiding questions are set after each source in the data file. The questions guide the students to process the data and generalise the implication step by step. Teachers may assess students' ability of identifying the key concepts and overall messages reflected in the source.

- **Micro-uniting:** there are several simple tasks to complete before an integrated task. This enables students to build up knowledge with the support of simple sequential tasks.

- **Reading strategies:** teachers are encouraged to guide less capable students to adopt some reading strategies for comprehending textual sources, which include: (1) highlighting of keywords, (2) chunking by punctuation, and (3) use of colour code.

- Teachers can choose to ask students to study the sources and answer the questions that followed as individual task or pair work, with reference to the learning mode and characteristics of the NCS students.

| Lesson | Learning and teaching strategies and flow |

Before class

Lesson preparation

☀ ● Ask students to study the photos and news reports about the natural disasters occurred in Hong Kong, South Asian countries and Canada. Answer the guiding questions. **(Appendix 1)**

● Ask students to read the relevant articles for more detailed information about the incidents if necessary.

1 **Focus:** **Current situation of global warming and its relationship with natural disasters**

☀ *Lead in (around 12 minutes)*

● Teachers go over **Appendix 1** with students, and facilitate their understanding of the severity and the human-caused nature of some natural disasters, aiming to enhance students' **awareness of environmental protection** and motivation.

● Guide students to read the statistics, and identify the trends of temperature in India and occurrence of major natural disasters, and the relationship between them. **(Appendix 2 – Sources A1 and A2)**

● Teachers can briefly introduce the data interpretation skills.

★ First, identify the trend. Then, cite the data, followed by data analysis.

★ Positive correlation is indicated by a positive value, and vice versa. Greater value reflects greater degree of correlation, and vice versa.

● Using the statistics of India may arouse students' curiosity to know more about the issues of climate change.

☀ *Individual task/ pair-work (around 18 minutes)*

● Guide students to read the sources with some reading strategies, and identify the impacts caused by climate change and the reasons for climate change. **(Appendix 2 – Source B)**

● Students are expected to pick an example of natural disasters, except wildfire mentioned earlier, to explain **how climate change may cause the occurrence of natural disasters**. **(Appendix 2 – Source C)**

● Ask students to report their answers, and help students clarify and elaborate their answers.

☀ *Round-up (around 10 minutes)*

- Ask students to draw a mind map to consolidate the concepts learnt in the lesson.

- Appreciate students' identification of other relevant keywords *(e.g. glacier melting, increase in sea water level, etc.)*.

- Help students clarify their understanding of key concepts.

- Teachers may offer hints with reference to students' learning ability.

☀ *Post-lesson assignment/ preparation before Lesson 2*

- Ask students to watch the animation and identify the features of climate change. **(Appendix 3)**

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2 | **Focus:** | **Possible impacts of global warming**

☀ *Lead in by questioning (around 5 minutes)*

- Teachers go over **Appendix 3** with students, and help them clarify and conceptualise their answer if necessary.

☀ *Individual task/ pair-work (around 25 minutes)*

- Ask students to read the sources, and identify the key messages reflected in the sources. **(Appendix 4 – Sources A and B)**

- Ask students to analyse the **impacts caused by global warming**, besides the occurrence of natural disasters (which has been discussed in Lesson 1), with reference to the sources provided. *Possible impacts include:*

  ★ *Social aspect: Homeless problem* **(Source A)**, *worsened public health (Source B), etc*.

  ★ *Economic aspect: Hindered economic development* **(Source A)**, *financial burden on public medical system* **(Source B)**, *etc*.

  ★ *Environmental aspect: Polluted water resources* **(Source A)**, *etc*.

- Ask students to report their answer, and help them clarify and elaborate their answer. Emphasis should be put on students' conceptualisation of impacts.

- Explain to students that the impacts of global warming on more developed countries (MDCs) differ from those in less developed countries (LDCs) **(Appendix 4 – Question 2).**

☀ *Round-up (around 10 minutes)*

● Ask students to draw a mind map to consolidate the concepts learnt in the lesson.

● Appreciate students' identification of other relevant keywords *(e.g. coral bleaching, irregular precipitation, etc.)*.

● Help students clarify their understanding of key concepts.

● Teachers may offer hints with reference to students' learning ability.

☀ *Post-lesson assignment/ preparation before Lesson 3*

● Ask students to study the comic, and interpret the message reflected in the comic. **(Appendix 5)**

● Teachers can briefly introduce the comic decoding skills in advance.

★ Cite the features shown in the comic, followed by the implication. Based on the comic features, summarise the overall message of the comic.

3 Focus: Possible impacts of global warming

☀ *Lead in by questioning (around 5 minutes)*

● Teachers go over **Appendix 5** with students, and help them derive the message reflected in the comic if needed.

☀ *Individual task/ pair-work (around 23 minutes)*

● Ask students to read the sources, and identify the key messages reflected in the source. **(Appendix 6 – Source A)**

● Ask students to analyse the **reasons for global warming** with reference to the sources provided. *Possible reasons include*:

★ *Social aspect: Pursuit of high quality of life* **(Source A)**, *development of urbanization, etc.*

★ *Economic aspect: Industrial production* **(Source A)**, *etc.*

★ *Political aspect: National direction "priority on economy over environment", etc.*

● Ask students to report their answers, and help them clarify and elaborate their answers. Emphasis should be put on students' conceptualisation of reasons.

☀ *Round-up (around 12 minutes)*

● Ask students to suggest **what governments can do to alleviate the problem of global warming** based on the reasons.

● Students are expected to suggest different types of methods which are commonly adopted by government (i.e. public education, provision of financial incentives, implementation of related policies, cooperation with other stakeholders, etc.), and be aware of their difference by nature.

● Help them clarify and elaborate their answers. Emphasis should be put on students' justification of their answers, i.e. the significance and effectiveness of implementing the suggested method.

☀ *Post-lesson assignment*

● Ask students to complete a writing task for consolidating the concepts and skills acquired in the lesson. **(Appendix 7)**

4 | **Focus:** | **Controversies over the responsibility of reducing carbon dioxide emission**

☀ *Lead in by questioning (around 8 minutes)*

● Ask students to study the statistics, and identify the relationship of the level of development of a country with carbon dioxide emission **(Appendix 8)**, and its relationship with carbon dioxide emission per capita **(Appendix 9)**.

● Teachers can facilitate students' revision of the data interpretation skills learnt before, if necessary.

★ First, identify the trend. Then, cite the data, followed by data analysis.

★ Identify "the most / least", "the greatest increase / decrease", etc.

● Help students consolidate the skills of categorising data, i.e. identifying the common features of the data in the same category (e.g. level of development – MDCs and LDCs) **(Appendix 8 – Questions 2 and 3; Appendix 9 – Questions 2 and 3)**, rather than analysing individual data items (e.g. China, the US, etc.) **(Appendix 8 – Question 1; Appendix 9 – Question 1).**

● With reference to the time constraint and students' learning progress, teachers may consider checking students' understanding of identifying features of MDCs / LDCs orally for **Appendix 9 – Questions 1 to 3.**

☀ *Individual task/ pair-work (around 20 minutes)*

- Ask students to go over **Appendix 8 – Source A1 and Appendix 9 – Source A2**, and identify the key message reflected in the sources provided. **(Appendix 9 – Question 4)**

- Ask students to identify the factors affecting the role of different countries tackling the global warming problem.

- Ask students to report their answers, and help them clarify and elaborate their answers. Emphasis should be put on students' conceptualisation of factors.

- Guide students to compare the **responsibility of reducing carbon dioxide emission among MDCs and LDCs**. Help them clarify and elaborate their answers. Emphasis should be put on students' justification of their answer under the common ground for comparison. **(Appendix 8 – Source A1; Appendix 9 – Source A2)**

☀ *Summary (around 12 minutes)*

- Teachers conclude that all countries should play their roles in tackling the global warming problem with reference to their responsibilities and resources available. The responsibility issue is controversial among countries which may hinder the effectiveness of international cooperation on global environmental issues.

☀ *Post-lesson assignment*

- Brief students about the post-lesson assignment for consolidation of learning in previous lessons. **(Appendix 10)**

- A framework, which includes guidelines and examples, can be provided for less capable students.

- Share students' work (both good and weak samples), and give constructive feedback to students.

Appendix 1: Pre-lesson task

Read the sources below, and then answer the questions:

Let's warm up!

SOURCE A

In September 2018, Hurricane Mangkhut swept across Hong Kong, and caused many damages.

SOURCE B

In August 2017, Heavy monsoon rains and intense flooding caused many damages and lives killed in Bangladesh, India and Nepal of South Asia.

SOURCE C

In May 2016, a wildfire swept through the southwest of Fort McMurray, Alberta, Canada.

Source:
- Source A: SCMP. (2018). Typhoon Mangkhut officially Hong Kong's most intense storm since records began. Retrieved September 19, 2018, from https://www. scmp.com/news/hong-kong/health-environment/ article/2164523/its-official-typhoon-mangkhut-was-most-intense
- Source B: REUTERS/Anuwar Hazarika
- Source C: REUTERS/Mark Blinch

1. What are the types of natural disasters shown in the above sources?

i. _____   ii. _____   iii. _____

2. What are the possible impacts these natural disasters may cause?

_____

_____

_____

_____

3. Do you think we could prevent these natural disasters from happening in the future? Why?

_____

_____

_____

_____

Appendix 2:

Read the sources below, and then answer the questions:

Let's go!

| | SOURCE A1 | Correlation matrix of temperature and major natural disasters in India from 1901 to 2013 |

	Annual Mean Temperature in °C	Drought	Earthquake	Flood	Landslide	Storm
Time Series (1901 – 2013)	0.677	0.227	0.347	0.722	0.503	0.669

Hint:

- Positive value indicates a positive correlation, and vice versa.
- Greater value reflects greater degree of correlation, and vice versa.

Source: Mishra, A. (2014). An Assessment of Climate Change – Natural Disaster Linkage in Indian Context. Journal of Geology & Geosciences, 3:167 doi:10.4172/2329-6755.1000167

Questions:

1. According to Source A1, what is the trend of the annual mean temperature in India from 1901 to 2013?

   The annual mean temperature in India was (increasing / decreasing)*

   from 1901 to 2013. According to Source A1, (   ) indicates a

   positive correlation between the annual mean temperature and the time series,

   which reflects that India became hotter in this period of time.

   * Delete the incorrect option

2. According to Source A1, what is the trend of the major natural disaster occurrence in India from 1901 to 2013?

   _____

   _____

   _____

   _____

Correlation between temperature and major natural disasters in India from 1901 to 2013

	Drought	Flood	Landslide	Storm
Annual Mean Temperature in °C	0.291	0.611	0.448	0.441

Hint:

- Positive value indicates a positive correlation, and vice versa.
- Greater value reflects greater degree of correlation, and vice versa.

Source: Mishra, A. (2014). An Assessment of Climate Change – Natural Disaster Linkage in Indian Context. Journal of Geology & Geosciences, 3:167 doi:10.4172/2329-6755.1000167

Questions:

3. According to Source A2, what is the relationship between the temperature and major natural disaster occurrence in India?

_____

_____

_____

Read the sources below, highlight the keywords, and then answer the questions:

SOURCE B:

On 1 May 2016, a wildfire began southwest of Fort McMurray, Alberta, Canada, and then swept through the community. More than 80 000 people were evacuated from their homes. The fire burned the forested area, and halted the oil sands production at facilities of Fort McMurray.

Professor Mike Flannigan from The University of Alberta pointed out that the human-caused climate change may have turned this fire into unfolding tragedy. Polluted ozone layer as well as occurrence of lightning may cause more frequent and intense wildfires. In addition, the extremely high temperature, very low humidity and low precipitation have extended the forest fire season in recent years. The wildfires have caused irreversible permafrost thaw, which is crucial for carbon retention. More methane released exacerbates the climate change. With such a vicious cycle, the greenhouse effect may worsen and run out of control.

Highlight the impacts caused by climate change in **green.**

Highlight the reasons for climate change in **yellow.**

Source: Integrated from the following references
- CBC/Radio-Canada. (2019). Alberta wildfires linked to climate change, scientist says. Retrieved June 23, 2020, from https://www.cbc.ca/news/canada/edmonton/alberta-wildfires-climate-change-1.5168355
- RT News. (2016). Alberta wildfires expected to burn for months, threaten oil sands mines. Retrieved June 23, 2020, from https://www.rt.com/news/342257-alberta-wildfires-months-oil/
- The Washington Post. (2016). The Fort McMurray fire's stunning pulse of carbon to the atmosphere. Retrieved June 23, 2020, from https://www.washingtonpost.com/news/energy-environment/wp/2016/05/20/the-fort-mcmurray-fires-stunning-pulse-of-carbon-to-the-atmosphere/

Questions:

4. **Source B** states that "the greenhouse effect may worsen and run out of control". Explain this statement with reference to **Source B**.

Source B mentioned that climate change causes (   )

and (   ), which intensify the occurrence of (   ).

Also, (   ) weather extends the

(   ). Worse still, the occurrence of wildfire results

in the melting of (   ) and release of (   ),

which in turn worsens the problem of climate change. Therefore, the

greenhouse effect is a (   ).

SOURCE C:

As mankind has produced increasing amounts of carbon dioxide and other greenhouse gases that may remain in the atmosphere for decades or even hundreds of years, we can expect to face a warmer climate. Global warming may melt glaciers and ice blocks, elevate global sea level, bleach coral reefs, and increase the frequency and intensity of typhoons.

Source: Liberal Studies Curriculum Resources Booklet Series – Energy Technology and the Environment, "Climate Change", p.28.

Questions:

5. How does climate change cause more occurrence of natural disasters? Explain your answer <u>with an example of natural disaster</u> **other than the one stated in Source B**.

_____

_____

_____

_____

_____

Round-up: Concept consolidation

Illustrate the relationship among the following concepts with a mind map.
Other relevant keywords are welcome. Use stick notes if you want to.

natural disaster / global warming / greenhouse gas emission / climate change

Appendix 3:

Watch the animation and answer the question:

> **Animation:** "Climate Kid" presented by Do The Green Thing and UNICEF
> **Date:** 4 March 2011
> **URL:** https://youtu.be/0l2GpCaNxLk
> **Duration:** 1 min 49 s

According to the **animation**, how would an ordinary kid "evolve" in order to adapt to climate change?

(Hint: Refer to the features of a "fully enhanced Climate Kid" (i.e. **1 min 23 s** in the animation), and analyse how the features could facilitate one's adaptation to climate change.)

The feature of climate change	← to adapt to	The feature of a "fully enhanced Climate Kid"
1.		
2.		
3.		

Appendix 4:

Read the sources below, highlight the keywords, and then answer the questions:

Hang in there!

SOURCE A:

In 2019, the decade ended with record heatwaves across the northern hemisphere, while Australia fought some of its worst wildfires in decades, which killed at least 25 people and destroyed more than 2 000 homes in the state of New South Wales alone.
In fact, the Earth's average surface temperature has risen about 9°C since late 19th century. The Intergovernmental Panel on Climate Change (IPCC) reported that the warming trend is caused by emission from human activities. Climate change increases the frequency and intensity of natural disasters in Hong Kong and other countries/regions around the world. The United States based non-governmental organisation (NGO) Climate Central estimated that 1.3 million Hongkongers could be hit by flooding every year in areas such as Tai Po, Sha Tin, and at the Hong Kong International Airport.

Source:
- SCMP. (2020). Watch your carbon footprint: Hong Kong's getting hotter, as climate change makes its presence felt. Retrieved June 24, 2020, from https://www.scmp.com/news/hong-kong/health-environment/article/3046358/watch-your-carbon-footprint-hong-kongs-getting

Summarise the key message reflected in **Source A**:

Climate change increases the _____ and _____ of natural disasters. People living in coastal cities and low-lying areas are vulnerable to the _____ problem.

SOURCE B:

In 2015, a heatwave killed nearly 2 500 people in India, when the temperature reached highs of 48°C. The worst-hit region was Andhra Pradesh in the south east. Scientists sounded the alarm about climate change that it may become an annual occurrence in India and Pakistan.

Source: RT News. (2018). Deadly heat waves to hit India, Pakistan every year because of climate change – UN report. Retrieved October 26, 2018, from https://www.rt.com/news/440664-india-pakistan-heat-wave-climate/

Summarise the key message reflected in **Source B**:

The scorching weather may lead to _____ diseases such as dengue fever and _____. It may exert great burden on the _____ _____ system.

Questions:

1. What are the impacts that global warming may bring about <u>besides the occurrence of natural disasters</u>?

Impact	Elaboration (Hint: Describe features of the global warming problem first.)	Citation of source
Example: < Social > **Worsened public health**	Global warming causes (extremely hot weather)	Source B
	➔ tropical diseases, e.g. dengue fever, heatwave	
	➔ threatens public health	
	➔ exerts burden on public medical system	
< Economic >	Global warming causes ( )	
	➔	
	➔	
	➔	
	➔	
<Environmental>	Global warming causes ( )	
	➔	
	➔	
	➔	
	➔	

2. Which countries suffer the most from the natural disasters? Why?

_____

_____

_____

_____

Round-up: Concept consolidation

Based on what you have learnt, conclude the short-term and long-term impacts of the global warming problem with a mind map. All relevant keywords are welcome. Use sticky notes if you want to.

You may refer to the following concepts.

> **biodiversity / balance of ecological system / water resources / agricultural & fishery revenue / famine / public health / tropical diseases / burden on medical system / prosperity of tourism / homeless problem**
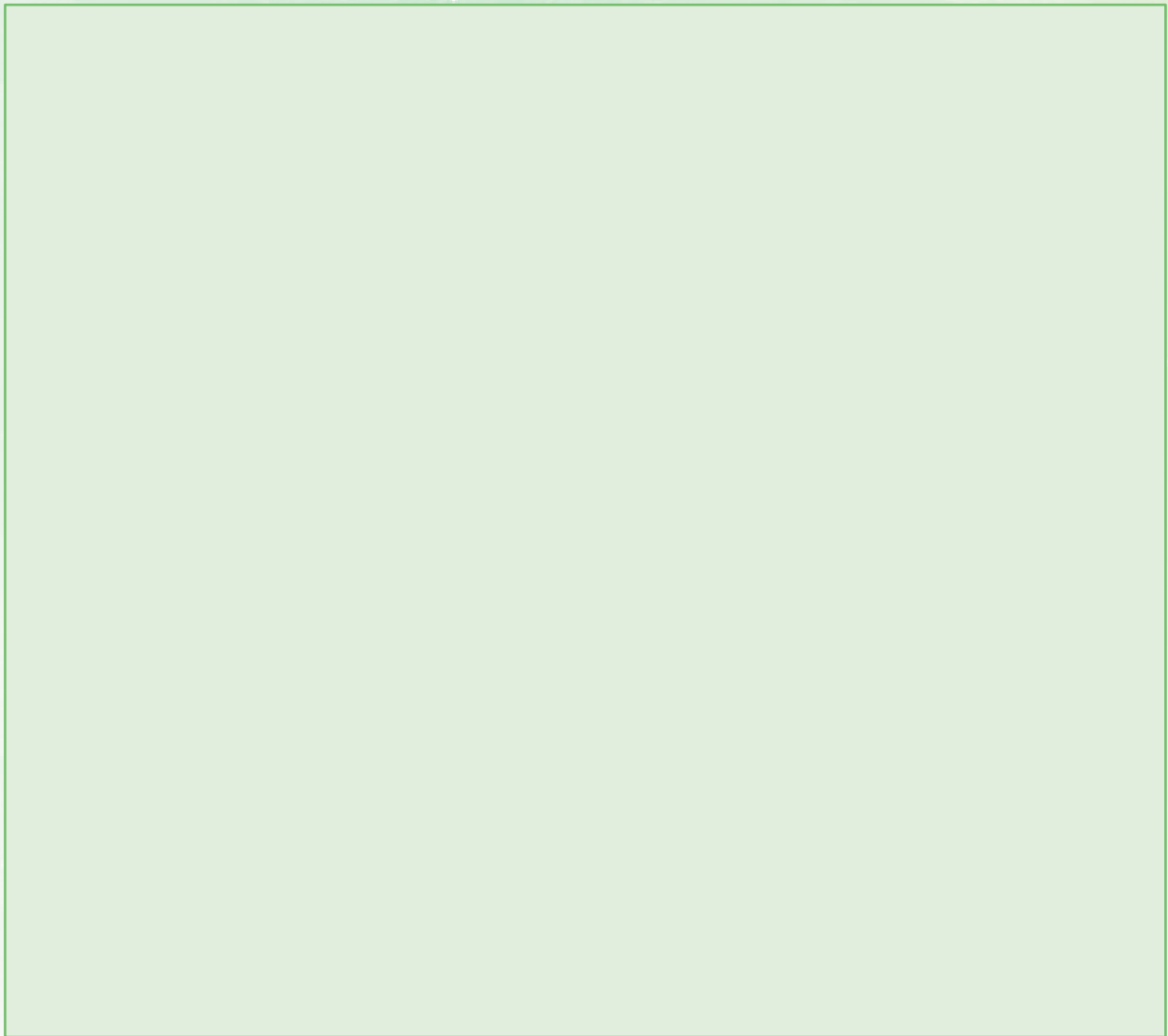
Read the following comic, and then complete the summary table:

SOURCE A:
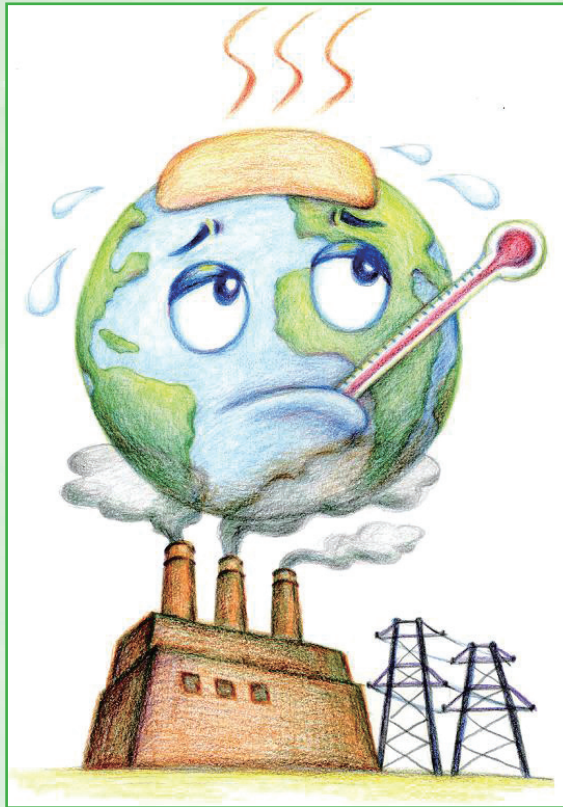
Source: Developed by the resource developer.

1. Interpret the message of the comic in **Source A**.

Feature shown in the comic	reflects that	Implication
1. (see the figure in the middle)		
2. (see the figure in the middle bottom)		
Therefore, the **overall message** of the comic is:		

Appendix 6:

Read the sources below, highlight the keywords, and then answer the questions:

It's almost there!

SOURCE A:

Under the Industrial Revolution and technological advances, people have been heavily relying on using fossil fuels to produce energy. Various economic and industrial activities aggravate greenhouse gas emission, resulting in more intensified greenhouse effect, and hence climate change.

Source: Australian Academy of Science. (2015). Are human activities causing climate change? Retrieved November 7, 2018, from https://www.science.org.au/learning/general-audience/science-booklets-0/science-climate-change/3-are-human-activities-causing

Summarise the key message reflected in **Source A**: *

☐ Less developed countries underwent Industrial Revolution, and were regarded as large CO_2 emitters.

☐ Increasing CO_2 emission in emerging countries originates from their accelerating industrial production.

☐ Increasing global CO_2 emission is attributed to the better quality of life worldwide.

*Tick the correct option

1. Based on Source A and your own knowledge, what are the reasons for global warming?

   (Hint: i. To elaborate your answer logically, mention the countries (i.e. MDCs or LDCs) which contribute for the problem of global warming where applicable.

   ii. Try to make use of more than one source where applicable.)

Reason	Elaboration (Hint: How is global warming aggravated?)	Citation of source
Example: **< Social >** **Pursuit of high quality of life**	Technological advances and economic development	Source A
	➔ people pursue high quality of life (QOL)	
	➔ use of electrical appliances and private cars	
	➔ more usage of fossil fuels for producing energy	
	➔ (increases emission /~~reduces absorption~~)* of CO_2	
	➔ aggravates the problem of global warming	
	➔	
	➔	
	➔	
	➔ (increases emission / reduces absorption)* of CO_2	
	➔ aggravates the problem of global warming	
	➔ (increases emission / reduces absorption)* of CO_2	
	➔ aggravates the problem of global warming	

* Delete the incorrect option

Round-up: Concept consolidation

With reference to the sources provided in Appendix 6 and your own knowledge, what can governments do to alleviate the problem of global warming?

(Hint: Refer to Appendix 6 Question 1 for the reasons. Suggest a method based on the reason.)

(1) For the Reason	(2) Suggestion	Effectiveness (Hint: (3)Explain concretely how the method can be carried out, and(4) how it can alleviate global warming.)
Example: (1) **For people's pursuit of high QOL**	(2)**Government can strengthen promotion and education about energy saving for the public**	(3) Promotion through mass media and organising territory-wide competitions
		➜ delivers the message of energy saving
		➜ (4)people learn good practice unconsciously
		➜ take the self-initiative to reduce energy use in daily life and thus carbon emission
		➜
		➜
		➜
		➜
		➜
		➜

Appendix 7:

What can governments do to alleviate the problem of global warming? Explain your answer with reference to the sources provided in Appendix 6.

(Hint: i. With reference to the example below, give one more suggestion.
Explain your answer.

    ii. Highlight different parts of your answer in different colours for self-checking.)

1st suggestion: (Example)

(1) **Based on a reason,**	(1) For *(people's pursuit of high quality of life),*
(2) **give a suggestion**	(2) government can *(strengthen promotion and education about energy saving for the public).*
(3) **Briefly explain the reason**	(3) To maintain high standard of living, people develop high consuming lifestyle, and contribute for high carbon emission through energy production.
(4) **Explain the suggestion in details**	(4) I suggest that government should *(strengthen public environmental education through mass media and organising large-scale competitions).*
(5) **Explain the effectiveness of the suggestion**	(5) With this method, *(the message of developing energy saving lifestyle could be delivered at the territory-wide level. People learn the good practice unconsciously, and take the self-initiative to reduce energy use in daily life, and thus carbon emission).*

2nd suggestion:

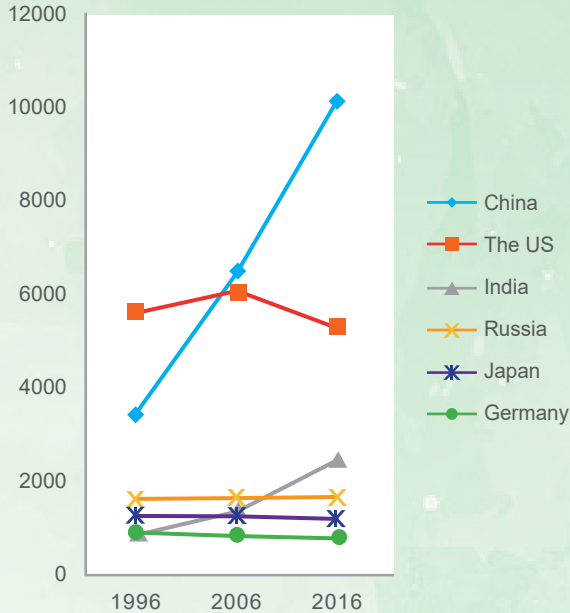|	
Based on a reason, give a suggestion	For ( ), government can ( ).
Briefly explain the reason	
Explain the suggestion in details	I suggest that government should ( ).
Explain the effectiveness of the suggestion	With this method, ( ).

Appendix 8:

Read the following statistics, and answer the questions:

SOURCE A1:

Annual carbon dioxide emission from 1996 to 2016 (in million tonnes)

	1996	2006	2016
China	3460.26	6523.95	10150.82
The US	5636.3	6051.5	5311.69
India	881.6	1406.46	2430.8
Russia	1581.38	1653.51	1634.71
Japan	1256.7	1287.1	1209.16
Germany	958.37	877.37	801.51
World	23603.84	30498.83	36182.59

Source: Our World in Data. (2016). Annual CO_2 emissions. Retrieved September 19, 2018, from https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions#annual-co2-emissions

Questions:

1. <u>In terms of individual countries</u>, what are the features of annual carbon dioxide emission from 1996 to 2016?

(Hint: Consider which countries contributed for the most / least annual CO_2, and which countries contributed for the greatest increase / decrease in CO_2 emission.)

The annual carbon dioxide emission of (   ) increased

the most from 1996 to 2016. It increased from (   ) in

1996 to (   ) in 2016. Its emission has exceeded

that of (   ), which ranked the first, since 2006.

2. <u>In terms of the countries' level of development</u>, what are the features of annual carbon dioxide emission from 1996 to 2016?

(Hint: Put the countries in **Source A1** into categories first, e.g. more developed countries and less developed countries.)

_____

_____

_____

_____

_____

_____

_____

3. Do you think there is any relationship between the carbon dioxide emission and the level of development of a country?

_____

_____

_____

_____

_____

_____

Appendix 9:

Read the following statistics, and then answer the questions:

SOURCE A2:
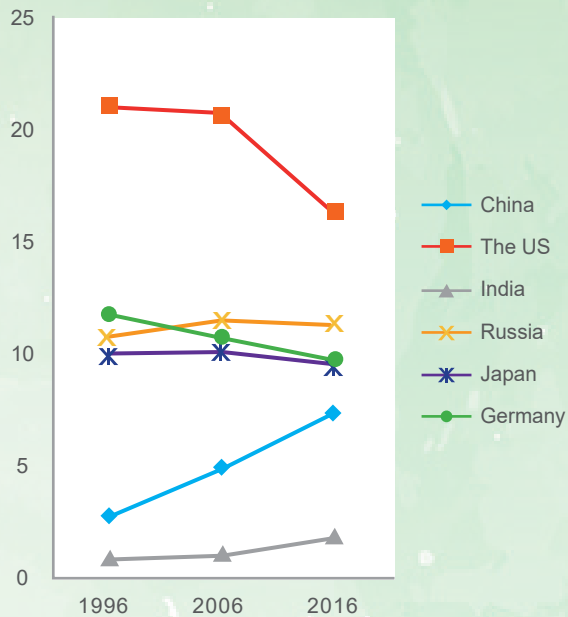
Annual carbon dioxide emission per capita from 1996 to 2016 (in tonnes)

	1996	2006	2016
China	2.77	4.91	7.36
The US	20.97	20.78	16.44
India	0.9	1.12	1.84
Russia	10.68	11.54	11.33
Japan	9.92	10.02	9.52
Germany	11.77	10.76	9.7
World	4.05	4.6	4.86

Source: Our World in Data. (2016). Per capita CO_2 emissions. Retrieved September 19, 2018, from https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions#per-capita-co2-emissions

For Q.1 to Q.3, teacher may consider checking students' understanding of identifying features of MDCs/LDCs orally, with reference to students' learning progress.

Questions:

1. <u>In terms of individual countries</u>, what are the features of annual carbon dioxide emission **per capita** from 1996 to 2016?

   (Hint: Consider which countries contributed for the most / least annual CO_2 <u>per capita</u>, and which countries contributed for the greatest increase / decrease in CO_2 emission <u>per capita</u>.)

   _____

   _____

   _____

   _____

2. <u>In terms of the countries' level of development</u>, what are the features of annual carbon dioxide emission **per capita** from 1996 to 2016?

(Hint: Put the countries in **Source A2** into categories first, e.g. more developed countries and less developed countries.)

_____

_____

_____

_____

3. Do you think there is any relationship between the carbon dioxide emission **per capita** and the level of development of a country?

Summarise the key message reflected in **Sources A1 and A2**: *

- From **Source A1**, (China / The US) has to bear greater responsibility of CO_2 emission reduction regarding the annual CO_2 emission in recent years. And, (China / The US) has to bear greater responsibility of CO_2 emission reduction regarding the **increase rate** of the annual CO_2 emission in recent years.

- From **Source A2**, (China / The US) has to bear greater responsibility of CO_2 emission reduction regarding the annual CO_2 emission **per capita** in recent years. And, (China / The US) has to bear greater responsibility of CO_2 emission reduction regarding the **increase rate** of the annual CO_2 emission **per capita** in recent years.

- Therefore, the responsibility issue of CO_2 emission reduction is _____ _____.

* Delete the incorrect option

5. What do you think are the factors affecting the role of different countries tackling the global warming problem?

Factors affecting the role of countries (i.e. the common ground for comparison)

Example: *Historical responsibility*

_____

_____

_____

_____

6. From **Source A1** [Appendix 8] and **Source A2** [Appendix 9], which countries, MDCs or LDCs, do you think have the greater responsibility of reducing carbon dioxide emission? Why?

(Hint: Pick one of the common grounds from **Question 5**, and answer the question.)

_____

_____

_____

_____

SOURCE A:

Burning of fossil fuels is one of the major sources of greenhouse gas emission. However, the high cost of developing clean energy, such as nuclear energy and wind power, makes it infeasible for LDCs. The Green Climate Fund (GCF) was established by the United Nations Framework Convention on Climate Change (UNFCCC) in 2010, with the goal of keeping average global temperature rise well below 2°C. It is the world's largest dedicated fund, which mobilises financial resources of MDC governments and private sectors in order to assist LDCs in adaptation and mitigation practices to counter climate change.

Source: Green Climate Fund. (n.d.). About GCF. Retrieved June 25, 2020, from https://www.greenclimate.fund/about

Some stated that "(1a)more developed countries should (2)help (1b)less developed countries to (3)alleviate global warming". Do you agree with this statement? Explain your answer with reference to **Source A** and your own knowledge.

(Hint: Pay attention to the key questioning words in the question, and highlight the corresponding parts in your answer (i.e. elaboration) in different colours. It serves the function of self-checking.)

Introduction:

To a (large / small)* extent, I agree with the statement.

_____

I would elaborate on my arguments from the perspectives of (

_____

_____).

* Delete the incorrect option

1st argument:

From the perspective of (_____) ,

_____

(According to [_____] / For example)* ,

_____

_____

This reflects that _____

_____

_____

* Delete the incorrect option

2nd argument:

From the perspective of (_____) ,

_____

(According to [_____] / For example)* ,

_____

This reflects that _____

_____

_____

* Delete the incorrect option

3rd argument:

From the perspective of (_____) ,

_____

(According to [_____] / For example)* ,

_____

This reflects that _____

_____

_____

* Delete the incorrect option

-- End of Appendix --

Guidelines for Teachers

Appendix 1: Pre-lesson task

Questions:

1. What are the types of natural disasters shown in the above sources?

   i. Hurricane   ii. Flooding   iii. Wildfire

2. What are the possible impacts these natural disasters may cause?

   Residents forced to leave home / Great burden on economic recovery / etc.

3. Do you think we could prevent these natural disasters from happening in the future? Why?

   It depends. Yes as some natural disasters were caused by human behaviours. E.g. dumping of cigarettes would cause wildfire, burning of fossil fuels would accelerate global warming and result in more frequent and intense typhoons, etc.

Appendix 2:

1. According to Source A1, what is the trend of the annual mean temperature in India from 1901 to 2013?

   The annual mean temperature in India was increasing from 1901 to 2013. According to Source A1, 0.677 indicates a positive correlation between the annual mean temperature and the time series, which reflects that India became hotter in this period of time.

2. According to Source A1, what is the trend of the major natural disaster occurrence in India from 1901 to 2013?

   The occurrence of major natural disasters in India was increasing from 1901 to 2013. According to Source A1, 0.277 – 0.722 indicate a positive correlation between natural disasters (e.g. drought, flooding, etc.) and the time series, which reflects that there were more natural disasters in this period of time.

3. According to Source A2, what is the relationship between the temperature and major natural disaster occurrence in India?

   The temperature in India is positively correlated with the occurrence of major natural disasters there. According to Source A2, 0.291 – 0.611 reflect that the weather in India got warmer and there were more major natural disasters occurred.

SOURCE B:

On 1 May 2016, a wildfire began southwest of Fort McMurray, Alberta, Canada, and then swept through the community. / More than 80 000 people were evacuated from their homes. / The fire burned the forested area, and halted the oil sands production at facilities of Fort McMurray.

Professor Mike Flannigan from The University of Alberta pointed out that the human-caused climate change may have turned this fire into unfolding tragedy. / Polluted ozone layer as well as occurrence of lightning may cause more frequent and intense wildfires./ In addition, the extremely high temperature, very low humidity and low precipitation have extended the forest fire season in recent years./ The wildfires have caused irreversible permafrost thaw, which is crucial for carbon retention. More methane released exacerbates the climate change. With such a vicious cycle, the greenhouse effect may worsen and run out of control.

Highlight the impacts caused by climate change in green.

Highlight the reasons for climate change in yellow.

4. **Source B** states that "the greenhouse effect may worsen and run out of control". Explain this statement with reference to **Source B**.

Source B mentioned that climate change causes polluted ozone layer and lightning, which intensify the occurrence of wildfires. Also, extremely hot and dry weather extends the fire season. Worse still, the occurrence of wildfire results in the melting of permafrost and release of methane, which in turn worsens the problem of climate change. Therefore, the greenhouse effect is a vicious cycle.
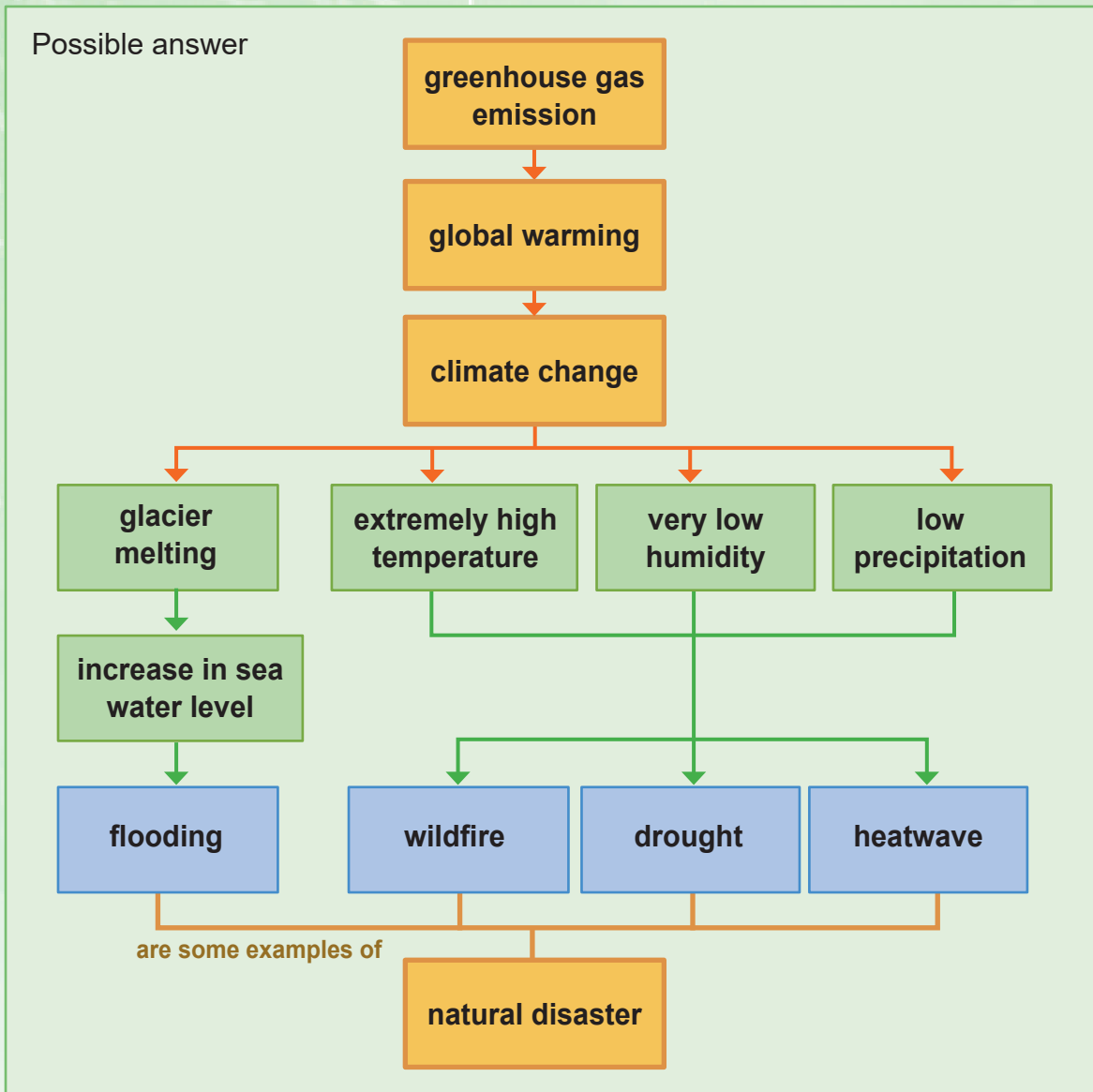
SOURCE C:

As mankind has produced increasing amounts of carbon dioxide and other greenhouse gases that may remain in the atmosphere for decades or even hundreds of years, we can expect to face a warmer climate. / Global warming may melt glaciers and ice blocks, elevate global sea level, bleach coral reefs, and increase the frequency and intensity of typhoons.

5. How does climate change cause more occurrence of natural disasters? Explain your answer with an example of natural disaster **other than the one stated in Source B**.

(Possible answer) As climate change intensifies, warmer sea water increases the sea water level. Coastal and low-lying areas are likely to be flooded, which would exert disastrous impacts on residents' living and the regional economy.

Round-up: Concept consolidation

Possible answer

```
                    greenhouse gas
                       emission
                          │
                          ▼
                    global warming
                          │
                          ▼
                    climate change
         ┌────────────┬────┴──────┬──────────────┐
         ▼            ▼           ▼              ▼
      glacier    extremely high  very low       low
      melting    temperature     humidity    precipitation
         │            └───────────┼──────────────┘
         ▼                        │
   increase in sea               │
    water level          ┌────────┼──────────┐
         │               ▼        ▼          ▼
         ▼            wildfire  drought    heatwave
      flooding          │        │          │
         │              └────────┼──────────┘
  are some examples of           │
                                 ▼
                          natural disaster
```

Appendix 3:

According to the **animation**, how would an ordinary kid "evolve" in order to adapt to climate change?

The feature of climate change	The feature of a "fully enhanced Climate Kid"
1. Excessive rainfall and occurrence of flooding	Able to swim
2. Prolonged sunshine	Equipped with head canopy
3. Occasional occurrence of cyclones	Equipped with dust lashes and wind riders

(or other reasonable answer as shown in the animation)

SOURCE A:

In 2019, the decade ended with record **heatwaves** across the northern hemisphere, **/** while Australia fought some of its worst **wildfires** in decades, which **killed** at least 25 **people** and **destroyed** more than 2 000 **homes** in the state of New South Wales alone. **/** In fact, the Earth's average surface temperature has risen about 9°C since late 19th century. **/** The Intergovernmental Panel on Climate Change (IPCC) reported that the warming trend is caused by emission from human activities. **/** Climate change increases the **frequency** and **intensity** of **natural disasters** in Hong Kong and other countries/regions around the world. **/** The United States based non-governmental organisation (NGO) Climate Central estimated that 1.3 million Hongkongers could be hit by **flooding** every year in areas such as Tai Po, Sha Tin, and at the Hong Kong International Airport.

Summarise the key message reflected in **Source A**:

Climate change increases the frequency and intensity of natural disasters. People living in coastal cities and low-lying areas are vulnerable to the flooding problem.

SOURCE B:

In 2015, a **heatwave killed** nearly 2 500 people in India, when the temperature reached highs of 48°C. **/** The worst-hit region was Andhra Pradesh in the south east. **/** Scientists sounded the alarm about climate change that it may become an annual occurrence in India and Pakistan.

Summarise the key message reflected in **Source B**:

The scorching weather may lead to tropical diseases such as dengue fever and heatwave. It may exert great burden on the public medical system.

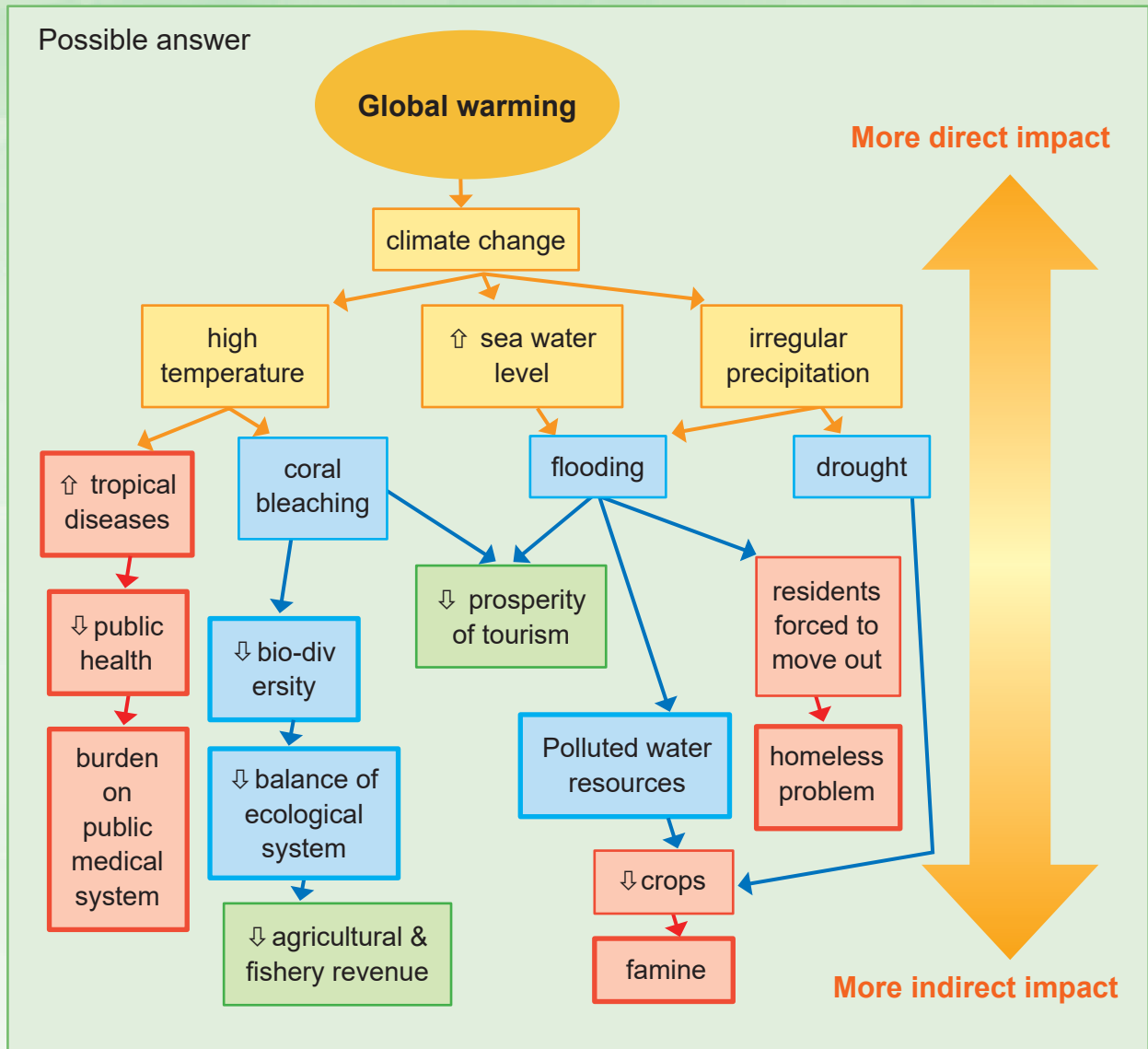1. What are the impacts that global warming may bring about <u>besides the occurrence of natural disasters</u>?

Impact	Elaboration	Citation of source
< Economic > **Hindered economic development**	Global warming causes shifted rainfall patterns	Source A or Source B
	➔ increased frequency and intensity of natural disasters	
	➔ e.g. heatwaves, wildfires, flooding	
	➔ causes loss of human lives and properties or financial burden on public medical system	
	➔ harms national economy	
<Environmental> **Polluted water resources**	Global warming causes warmer temperature increases sea water level	Source A
	➔ flooding in coastal cities and low-lying areas	
	➔ pollutes freshwater resources and destroys crops	
	➔ also, warmer ocean temperature	
	➔ enables growth of microorganism and bacteria	

2. Which countries suffer the most from the natural disasters? Why?

LDCs, in particular island countries suffer the most. These countries are geographically vulnerable to climate change and the subsequent consequences, e.g. flooding. Also, they are financially not able to recover from natural disasters or to counter global warming.

Round-up: Concept consolidation

Possible answer

```
                        Global warming
                              ↓
                        climate change
          ┌───────────────────┼───────────────────┐
    high temperature    ⇧ sea water level    irregular precipitation
```

More direct impact

⇧ tropical diseases — coral bleaching — flooding — drought

⇩ public health

⇩ bio-diversity

⇩ prosperity of tourism

residents forced to move out

burden on public medical system

⇩ balance of ecological system

Polluted water resources

homeless problem

⇩ agricultural & fishery revenue

⇩ crops

famine

More indirect impact

Appendix 5:

1. Interpret the message of the comic in **Source A**.

Feature shown in the comic	Implication
The Earth has a fever and looks ill.	The problem of global warming is intensifying.
The exhaust gas from the factories and power generation stations makes the Earth ill.	One of the major causes for global warming is people's heavy reliance on using fossil fuels

Therefore, the overall message of the comic is:

The global warming problem is intensifying, which is caused by people's heavy reliance on using fossil fuels.

Appendix 6:

Under the **Industrial Revolution** and **technological advances**, people have been **heavily relying on using fossil fuels** to produce energy. **/** Various **economic** and **industrial activities** aggravate greenhouse gas emission, resulting in more intensified greenhouse effect, and hence climate change.

Summarise the key message reflected in **Source A**: *

☑ Increasing CO_2 emission in emerging countries originates from their accelerating industrial production.

☑ Increasing global CO_2 emission is attributed to the better quality of life worldwide.

1. Based on Source A and your own knowledge, what are the reasons for global warming?

Reason	Elaboration	Citation of source
< Social > **Development of urbanisation**	Countries, especially LDCs, underwent urbanisation	/
	➜ more economic activities and consuming lifestyle	
	➜ increases CO_2 emission from electricity production	
	➜ also, deforestation for construction of buildings	
	➜ reduces absorption of CO_2	
	➜ aggravates the problem of global warming	
< Economic > **Industrial production**	All relying on fossil fuels since Industrial Revolution	Source A
	➜ LDCs benefit from coal-mining at low cost	
	➜ high CO_2 emission from mass production	
	➜ shifting production lines means emission from LDCs	
	➜ increases emission of CO_2	
	➜ aggravates the problem of global warming	

Round-up: Concept consolidation

With reference to the sources provided in Appendix 6 and your own knowledge, what can governments do to alleviate the problem of global warming?

[1] For the Reason	[2] Suggestion	Effectiveness
[1] For development of urbanisation	[2] Government can enhance the transportation infrastructure	[3] Develops intelligent transportation system
		➜ provides real-time information of traffic
		➜ [4] people may change to use other routes
		➜ CO_2 emission from idling vehicles during congestion could be reduced
[1] For industrial production	[2] Government can reward factories which adopt clean energy	[3] Allocates public expenditure for rewarding "green" factories
		➜ financial incentive reduces operational cost
		➜ [4] encourages use of clean energy
		➜ CO_2 emission during industrial activities could be reduced

Appendix 7:

What can governments do to alleviate the problem of global warming? Explain your answer with reference to the sources provided in Appendix 6.

2nd suggestion:

Based on a reason, give a suggestion	For development of urbanisation, government can enhance the transportation infrastructure.
Briefly explain the reason	Under urbanisation, deforestation for construction of infrastructure reduces CO_2 absorption. Greater population increases the travel demand, and CO_2 emission from vehicles.
Explain the suggestion in details	I suggest that government should develops intelligent transportation system for smooth traffic flow.
Explain the effectiveness of the suggestion	With this method, drivers are provided with real-time information of traffic flow, and may shift to use other less congested routes. CO_2 emission from idling vehicles during congestion could be reduced..

Appendix 8:

Questions:

1. In terms of individual countries, what are the features of annual carbon dioxide emission from 1996 to 2016?

   The annual carbon dioxide emission of China increased the most from 1996 to 2016. It increased from 3460.26 million tonnes in 1996 to 10150.82 million tonnes in 2016. Its emission has exceeded that of The United States, which ranked the first, since 2006.

2. In terms of the countries' level of development, what are the features of annual carbon dioxide emission from 1996 to 2016?

   The annual CO_2 emission of MDCs was decreasing, while that of LDCs was increasing. As a MDC, the annual CO_2 emission of the US decreased by 5.76%. As an LDC, the annual CO_2 emission of China increased by 193%. Besides, LDCs emitted more CO_2 than MDCs in 2016. From Source A1, LDCs (i.e. China, India and Russia) emitted 14216.33 million tonnes of CO_2, which were more than MDCs (i.e. the US, Japan and Germany) did (7322.36 million tonnes) in 2016.

3. Do you think there is any relationship between the carbon dioxide emission and the level of development of a country?

   Yes. In the past, CO_2 emission was positively correlated with the level of development of a country. That is, MDCs emitted more CO_2 than LDCs. Nowadays, CO_2 emission was negatively correlated with the level of development of a country. That is, LDCs emitted increasingly more than MDCs.

Questions:

[**Point-to-note for teachers**: For Questions 1 to 3, teacher may consider checking students' understanding of identifying features of MDCs/LDCs orally, with reference to students' learning progress.]

1. In terms of individual countries, what are the features of annual carbon dioxide emission per capita from 1996 to 2016?

   The US remained as the largest CO_2 emitter, and its annual CO_2 emission per capita decreased the most from 1996 to 2016. It decreased from 20.97 tonnes in 1996 to 16.44 tonnes in 2016, by 21.6%. Besides, the annual CO_2 emission per capita of China increased the most. It increased from 2.77 tonnes to 7.36 tonnes, by 166%.

2. In terms of the countries' level of development, what are the features of annual carbon dioxide emission per capita from 1996 to 2016?

   MDCs emitted constantly more CO_2 per capita than LDCs in general. From Source A2, MDCs (i.e. the US, Japan and Germany) emitted 35.66 – 42.66 tonnes of CO_2 per capita, which were more than LDCs (i.e. China, India and Russia) (14.35 – 20.53 tonnes). Besides, CO_2 emission per capita of LDCs was increasing, while that of MDCs was decreasing. As an LDC, annual CO_2 emission per capita of China increased by 182%. As a MDC, that of the US decreased by 21.6%.

3. Do you think there is any relationship between the carbon dioxide emission per capita and the level of development of a country?

   Yes. CO_2 emission per capita was positively correlated with the level of development of a country. That is, MDCs emitted more CO_2 per capita than LDCs. And there was a trend that CO_2 emission per capita of LDCs was increasing, while that of MDCs was decreasing.

4.

Summarise the key message reflected in **Sources A1 and A2**: *

● From Source A1, China has to bear greater responsibility of CO_2 emission reduction regarding the annual CO_2 emission in recent years. And, China has to bear greater responsibility of CO_2 emission reduction regarding the increase rate of the annual CO_2 emission in recent years.

● From Source A2, The US has to bear greater responsibility of CO_2 emission reduction regarding the annual CO_2 emission per capita in recent years. And, China has to bear greater responsibility of CO_2 emission reduction regarding the increase rate of the annual CO_2 emission per capita in recent years.

● Therefore, the responsibility issue of CO_2 emission reduction is controversial.

5. What do you think are the factors affecting the role of different countries tackling the global warming problem?

Factors affecting the role of countries (i.e. the common ground for comparison)

Calculation of carbon emission / Source of carbon emission / Financial capability

6. From Source A1 [Appendix 8] and Source A2 [Appendix 9], which countries, MDCs or LDCs, do you think have the greater responsibility of reducing carbon dioxide emission? Why?

(possible answer) In terms of historical responsibility, MDCs have greater responsibility

of reducing CO_2 emission than LDCs. According to Source B, "under the Industrial

Revolution and technological advances, heavy reliance on the use of fossil fuels

for economic activities results in high greenhouse gas emission". This reflects that

there have been great amount of CO_2 emitted from mass production in MDCs since

Industrial Revolution.

Appendix 10:

SOURCE A:

Burning of **fossil fuels** is one of the major sources of greenhouse gas emission. **/** However, the **high cost** of developing **clean energy**, such as nuclear energy and wind power, makes it infeasible for LDCs. **/** The **Green Climate Fund** (GCF) was established by the United Nations Framework Convention on Climate Change (UNFCCC) in 2010, with the goal of keeping average global temperature rise well below 2°C. **/** It is the world's largest dedicated fund, which mobilises financial resources of MDC governments and private sectors in order to **assist LDCs** in **adaptation** and **mitigation** practices to counter climate change.

Some stated that "[1a]more developed countries should [2]help [1b]less developed countries to [3]alleviate global warming". Do you agree with this statement? Explain your answer with reference to **Source A** and your own knowledge.

Introduction:

To a large extent, I agree with the statement. I would elaborate on my arguments from the perspectives of financial capability, historical responsibility and source of CO_2 emission.

1st argument:

From the perspective of financial capability, MDCs should provide LDCs with funds for developing clean energy at lower cost. According to Source A, "The high cost of developing clean energy, such as nuclear energy and wind power, makes it infeasible for LDCs." This reflects that [1a]**MDCs are more financially capable**, and can [2]**provide LDCs with green climate fund** so that [1b]**LDCs can afford** to [2]**install advanced power generators and other energy-saving equipment**, and [1b]**have less financial burden of heavy initial costs.** [3]**LDCs would be able to use clean energy and reduce carbon emission from power generation**.

2nd argument:

From the perspective of historical responsibility, MDCs should help LDCs to counter global warming for the cumulative CO_2 emission they caused. For example, under the Industrial Revolution and technological advances, heavy reliance on the use of fossil fuels for economic activities results in high greenhouse gas emission. This reflects that [1a]there have been great amount of CO_2 emitted from mass production in MDCs since Industrial Revolution. Thus, the severe condition of the global warming problem nowadays originates from MDCs, [1b]rather than LDCs. So that [2]MDCs are expected to shoulder more responsibility to offer LDCs capital or technology [3]to counter the problem more effectively.

3rd argument:

From the perspective of source of CO_2 emission, MDCs should help LDCs to counter global warming for them being the source of CO_2 emission. For example, under globalisation, Apple Company outsources the production and assembly processes of iPhones to mainland China and other LDCs. This reflects that [1a, b]the CO_2 emitted during production process was transferred from the US to China and other LDCs. [2]MDCs are expected to offer LDCs capital or technology to alleviate global warming [3]in order to compensate for their action of shifting the production and emission outside their countries. Overall amount of CO_2 emission could probably be limited.