Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Monday 12 June 2023

Afternoon (Time: 2 hours 15 minutes)

Paper reference **9GE0/03**

Geography

Advanced

Paper 3

You must have:
Resource Booklet (enclosed)
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any **calculations** must show all stages of **working out** and a **clear answer**.

Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- You are **advised** to spend the first **15 minutes** reading the Resource Booklet.
- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over

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Answer ALL questions. Write your answers in the spaces provided.

You must use the Resource Booklet provided and your own knowledge and understanding from across your course of study to answer the questions in this paper.

1 Explain **one** reason why global demand for energy is likely to rise.

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(Total for Question 1 = 4 marks)

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2 (a) Table 1 below shows the results of a 2019 survey of people's concerns about global climate change in 11 developed countries.

The following question was asked:

'Do you think that climate change is a major threat to your country?'

Country	Percentage (%) of people who agreed
Australia	59
Canada	67
Denmark	60
France	83
Germany	69
Japan	80
South Korea	81
Spain	83
Sweden	63
UK	71
USA	62

Table 1

(i) Calculate the mean percentage (%) of people who agreed that climate change is a major threat to their country.

Give your answer to one decimal place.

You must show your working.

(2)

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(ii) Calculate the interquartile range of the % of people who agreed that climate change is a major threat to their country.

You must show your working.

(2)

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(b) Explain why the data on Table 1 may not be a reliable guide to global opinions about the threat of climate change.

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(Total for Question 2 = 8 marks)

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3 Study Figure 1 and Figure 2 in Section A of the Resource Booklet.

Analyse the relationship between global population growth and land-use changes.

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(Total for Question 3 = 8 marks)

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4 Study Figure 3, Figure 4a and Figure 4b in Section A of the Resource Booklet.

Analyse the variations in European forest coverage.

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(Total for Question 4 = 8 marks)

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5 Study the resources in Section B of the Resource Booklet.

Evaluate the view that to be effective the mitigation of climate change requires many contrasting strategies.

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(Total for Question 5 = 18 marks)

You should have read the whole of the Resource Booklet, including Section C, before attempting this question.

6 Evaluate the view that the crisis of biodiversity loss is both more serious and more challenging to solve than climate change.

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(Total for Question 6 = 24 marks)

TOTAL FOR PAPER = 70 MARKS

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Geography

Advanced

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Resource Booklet

Do not return this Resource Booklet with the question paper.

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SECTION A

Population and land-use changes

10,000 years ago the global population is estimated to have been about 4 million. By 1700, the population had reached 600 million (see Figure 1).

Growth rate increased slowly after 1700 but accelerated in the 20th century. In the past 50 years the growth rate has generally fallen.

Today the global population is about 13 times larger than in 1700. However, during the same period, global Gross Domestic Product (GDP) grew from 643 billion (US$) to 120 trillion (US$). This astonishing growth has largely been a consequence of using fossil fuels.

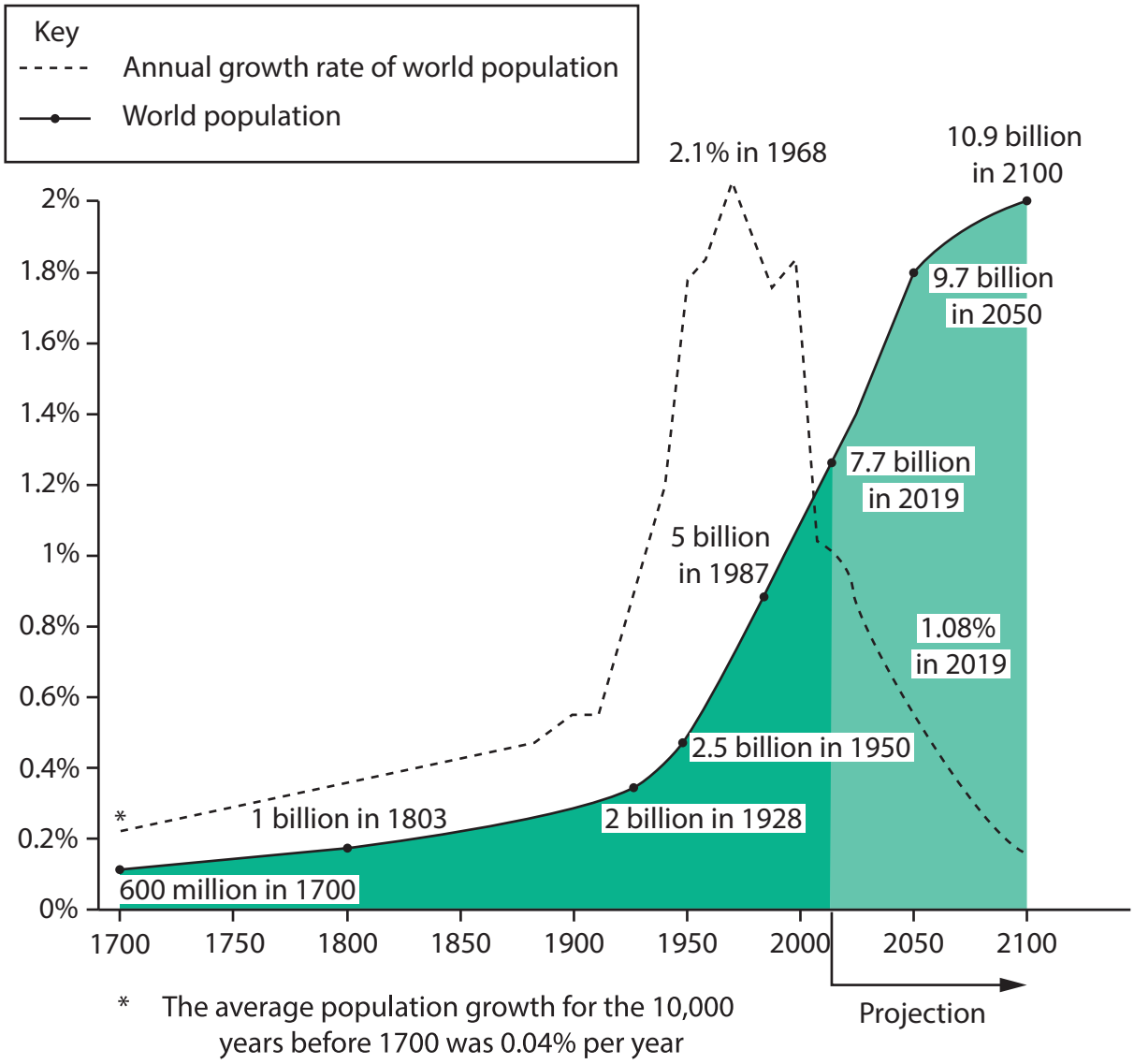

Figure 1

Past and projected global population growth, 1700-2100

Global land-use has changed. 10,000 years ago 10.6 billion hectares (ha), 71% of the Earth's land surface, was covered by forests, wild grassland and shrubland. The remaining 29% was made up of uninhabitable mountains, deserts and glaciers, much as it is today.

By 1700, 9% of the world's habitable land was farmed. Today that figure has risen to 46%, mostly grazing land for animals (see Figure 2).

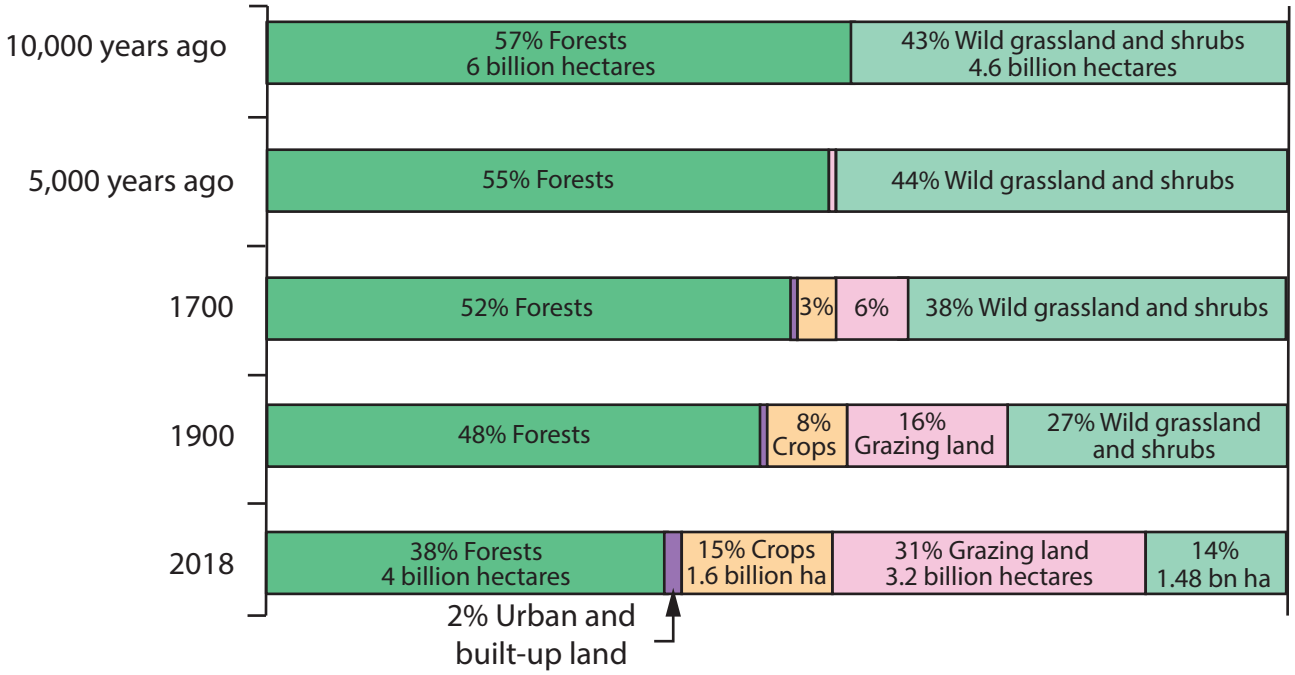

Figure 2

Changes in the land-use of habitable land in the past 10,000 years

More than half of Europe's forests have disappeared in the past 10,000 years. The main reasons are the demand for agricultural land and wood for fuel. As economies grow and diets change, forest area declines rapidly before recovering through afforestation in post-industrial economies.

The differences in modern Europe are partly explained by climate, geology, relief and population density but also by land management policies and practices.

For example, 60% of Iceland is glaciers and rocky desert. Most of the rest was forested when the original settlers arrived 1150 years ago. The settlers deforested it for both heating and construction and also grazed sheep, preventing forest regeneration. Colder climates in the past also changed some lowland areas into a treeless tundra, but recent global warming has increased the area that could be reforested.

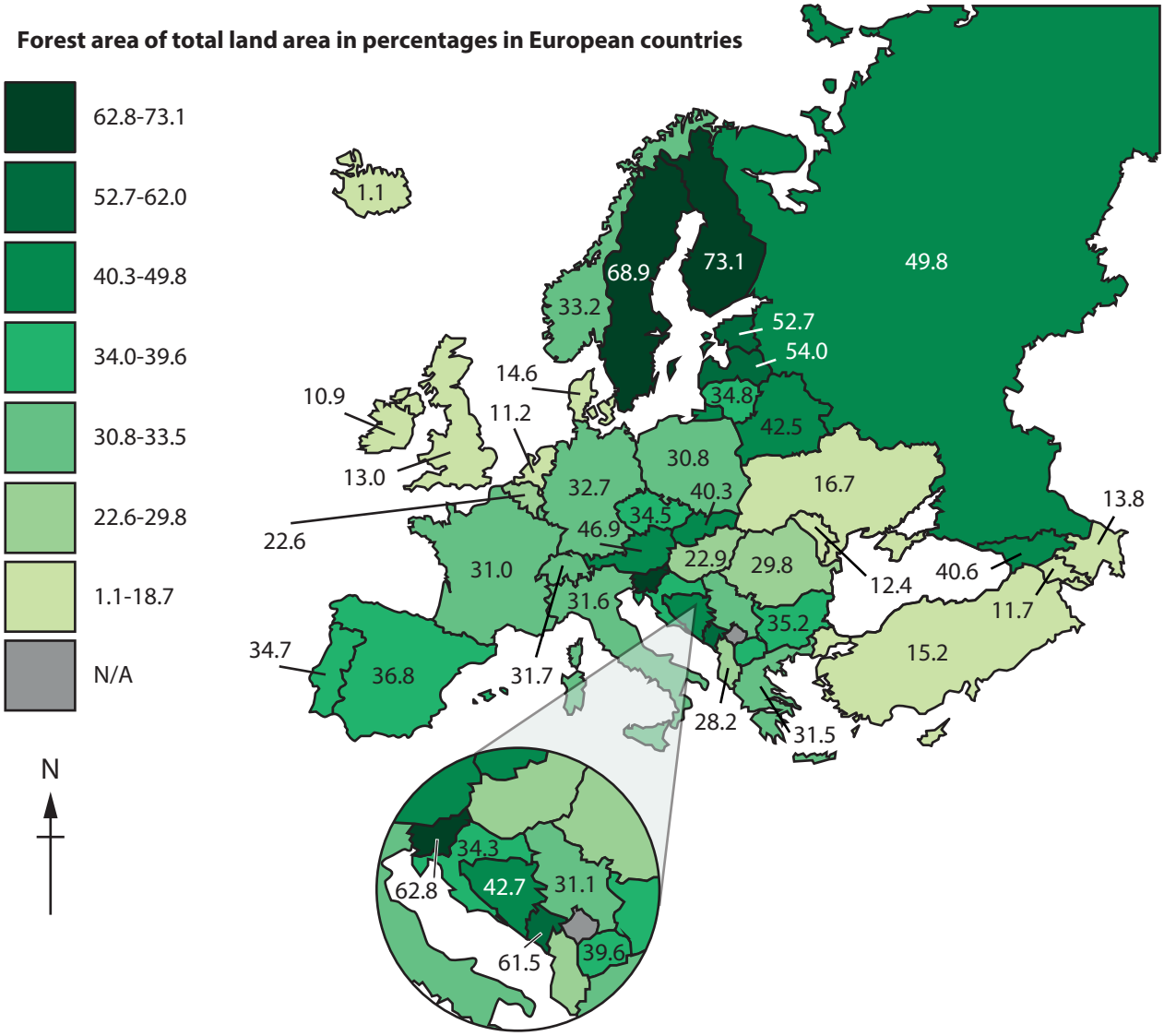

Figure 3

Forest area as a percentage (%) of total land area in European countries, 2018

Land management and social history also help to explain modern variations in forest cover**.** The geology, relief and climate of south-west Norway (Figure 4a) and north-west Scotland (Figure 4b) are very similar, but the landscapes are not.

Farms in Norway are normally much smaller than the typical farm estate in Scotland. Land-use in Norway's mountains is diverse, with farm income based on a mix of agriculture, grazing, forestry, hunting and fishing, fuel wood production and tourism.

Trees can grow in almost all of Scotland. However, on some of the large estates in the Highlands, landscapes have been deliberately transformed into open moorland, which limits tree growth. Incomes and employment are often based on the hunting of deer and the shooting of game birds such as grouse.

Figure 4a

The forested landscape of south-west Norway

Figure 4b

The deforested landscape of north-west Scotland

SECTION B

Mitigating climate change

CO_2 levels were at 415 parts per million (ppm) in 2022, significantly higher than the historic, pre-industrial levels of 280 ppm. This increase correlates with global temperature increases, especially over the past 70 years. There is no serious doubt that human beings are responsible for this enhanced greenhouse effect.

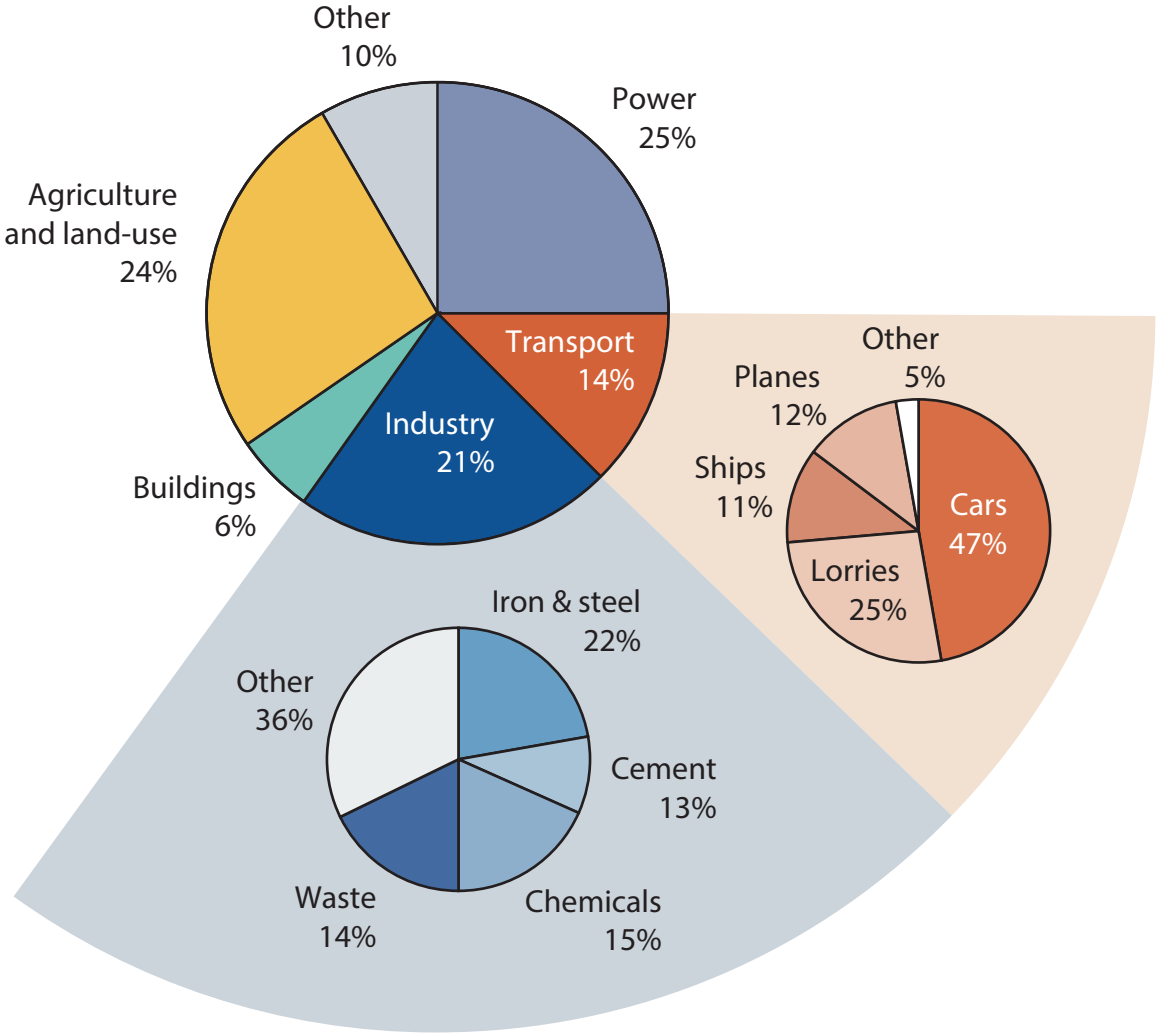

Figure 5

Global fossil fuel usage by sector, 2019

There are three main ways of mitigating climate change.

The first way is to reduce the emission of greenhouse gases created by the burning of fossil fuels.

To reduce the current dependence on fossil fuels, substitutes need to be found. There are several important challenges in achieving this.

- There is a global dependency on oil for transport, and the manufacture of plastics and fertiliser. Substitutes are not immediately available for many of its uses, for example as fuel for aircraft and shipping.
- Not all power sources are always available; for example solar and wind power. Fossil fuels and nuclear energy offer flexibility because they can be used at different rates at different times depending on demand.
- Many renewable sources have low power densities. This is a measure of the amount of power (watts) generated per square metre, (see Figure 6). Power densities for fossil fuels are often high, ranging from >10,000w/m^2 to 200w/m^2. For example, the USA provides for all its energy needs using just 0.5% of its land area. A complete switch to renewable energy would require about 50% of its land area.

Energy Source	Median Power Density watts/m^2	Issues
Nuclear Power	240	Worries about safety and storage costs of nuclear waste.
Solar Power	6.5	Very difficult to store and creates an unappealing landscape.
Wind Power	1.8	Also very difficult to store and creates an unappealing landscape.
Geothermal	1.0	Only economically profitable in a few locations such as Iceland.
Biofuels	0.8	Likely to lead to a net increase in emissions if forest is removed to make way for plantations.
Hydroelectric Power	0.2	May increase greenhouse gas emissions with drowned land creating methane.

Figure 6

Nuclear and renewable power densities

The second way of mitigating climate change is by developing technologies that extract greenhouse gases from the atmosphere.

This can be done through carbon capture and storage (CCS). Currently the cost of extracting a tonne of CO_2 is between \$100 and \$250. Almost any switch to renewable energy and therefore a reduction in CO_2 emissions is cheaper, but the technology is improving.

The third way of mitigating climate change is to reduce the amount of incoming energy from the sun with various methods of solar radiation management (SRM).

Both CCS and SRM are examples of artificial geo-engineering, the costs of which are disputed. These technologies have support and investment from many transnational corporations (TNCs) including fossil fuel TNCs. There are also significant concerns about the science behind some artificial geo-engineering, especially SRM.

Natural geo-engineering is promoting forest growth through reforestation and rewilding to achieve the same goal (see Figure 7).

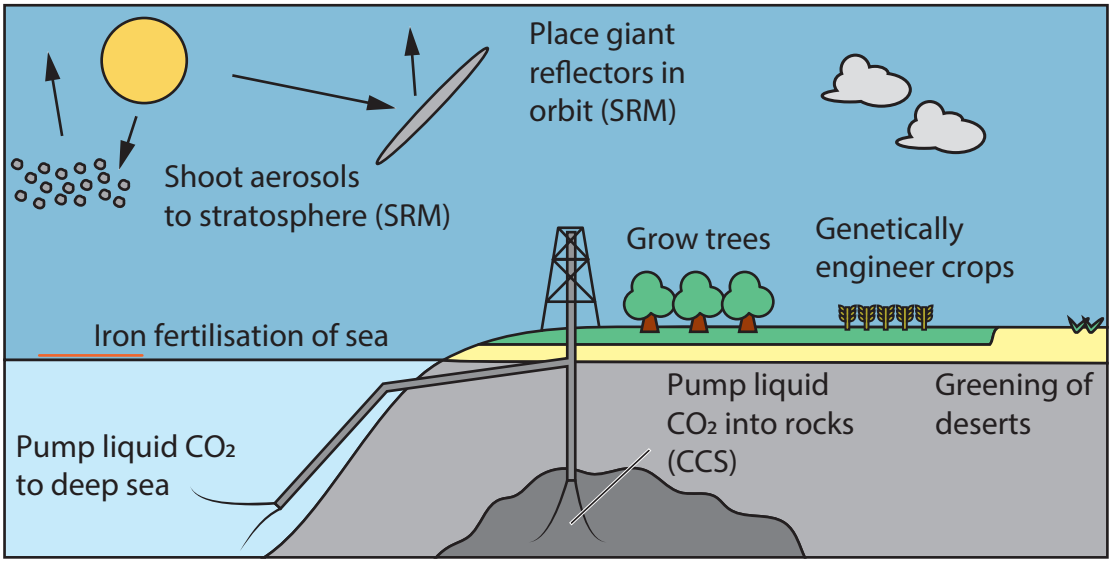

Figure 7

Artificial and natural geo-engineering plans to mitigate climate change

SECTION C

The sixth extinction

In 1993 American biologist E.O.Wilson suggested that humanity faces a sixth extinction event with an estimated 30,000 species disappearing every year. Previous extinctions include the fifth extinction event which wiped out most dinosaurs.

Estimates of the total number of species of animals and plants that live on the Earth range from 3 million to 100 million. An estimate from 2019 puts the figure at 8.7 million with 6.5 million on land and 2.2 million in the oceans.

Forests probably contain over 80% of land species. Tropical rainforests are especially rich reservoirs of global biodiversity with as many as 365 tree species in a single hectare and 1,200 different species of beetle on a single tree. Despite the efforts by conservationists, rainforests are still shrinking because of deforestation, mostly for agriculture.

The rate of biosphere change accelerated about 10,000 years ago when farming replaced hunting and gathering for food production. Extinction rates have accelerated in the last 100 years, and are currently said to be between 100 and 1000 times faster than at any other time in the history of the planet (see Figure 8).

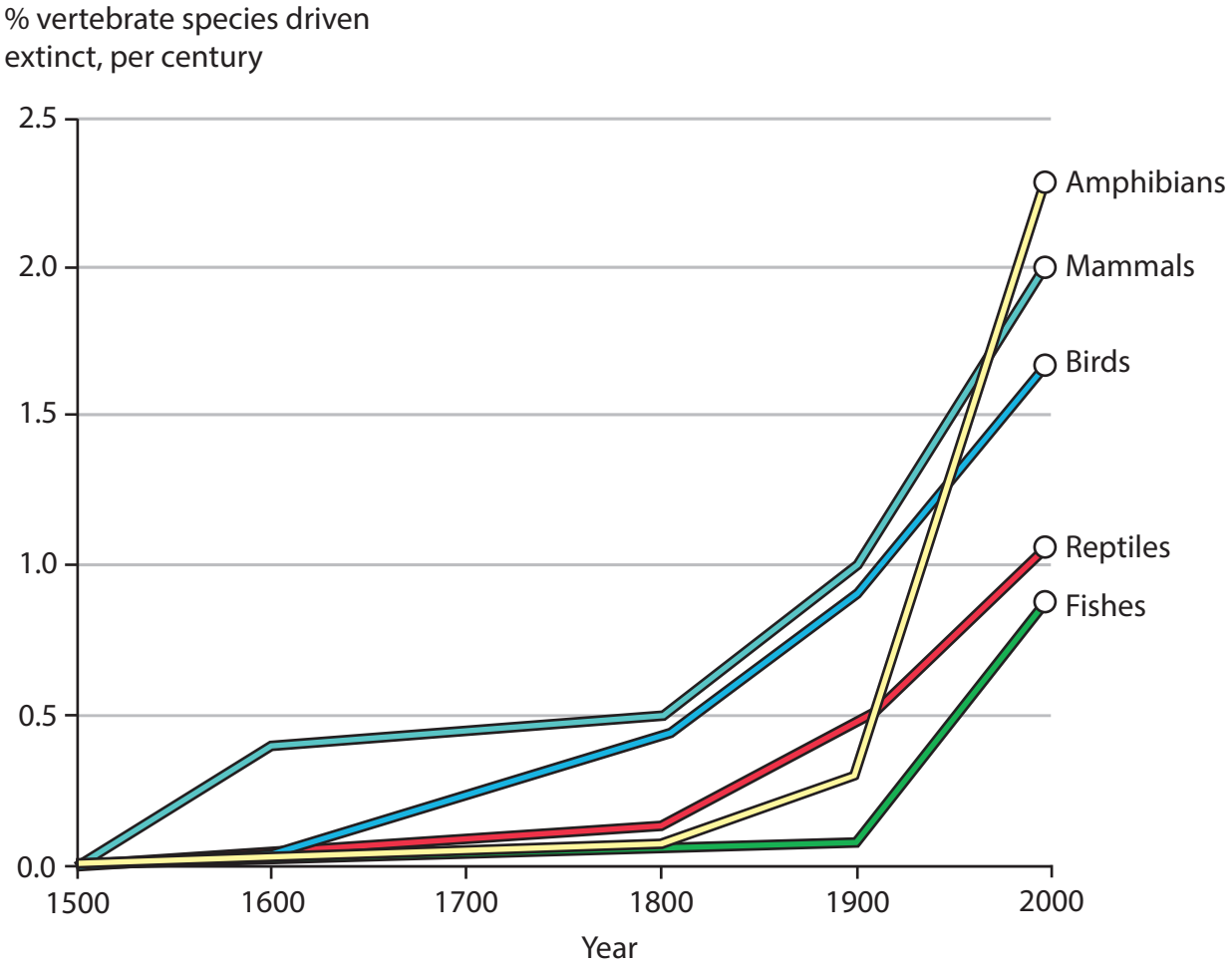

Figure 8

Species extinction rates 1500-2000

Climate change is a threat to biodiversity but there are other threats.

Many species are overhunted, overfished and overharvested for our food, clothing and medicines. Habitat destruction is an inevitable result of making space for agriculture and to extract fuels and other resources for human society. The habitats that are not completely destroyed are often polluted with toxic elements.

Natural geo-engineering relies on reforesting a large area of the planet, perhaps half of it. Supporters of this 'half-earth' project would restore forests (rewilding) to their pre-industrial levels. This could be achieved by changing from meat-eating diets to vegetarian and vegan alternatives (see Figure 9).

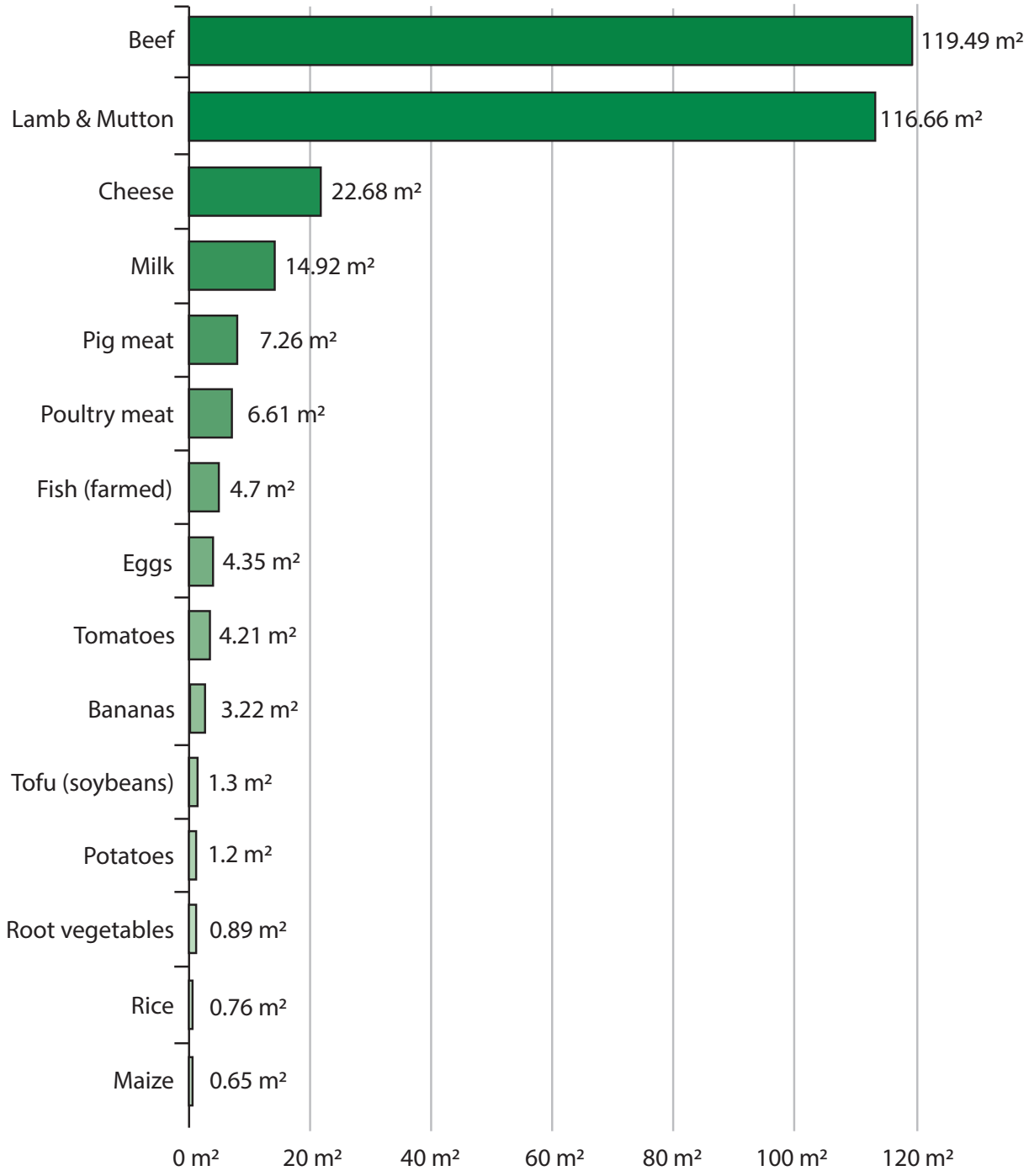

Figure 9

The land needed (in m²) to produce 1000 kilocalories of selected food products

Climate change and environmental challenges are increasingly political issues. It is obvious that without agreement at a global level, attempts to mitigate climate change and reduce the environmental impact of human actions are unlikely to be effective.

There are significant differences between countries and within countries over the supposed depth of the crisis and the need for action. Some political parties and their supporters are more concerned with climate change and environmental issues than others.

Country	Overall % of people who agreed	Left-wing people % who agreed	Right-wing people % who agreed
Australia	59	76	46
Canada	67	82	53
Denmark	60	71	53
France	83	86	76
Germany	69	75	58
Japan	80	86	79
South Korea	81	86	80
Spain	83	95	75
Sweden	63	69	55
UK	71	86	62
USA	62	89	40

Figure 10

The impact of political opinions on whether 'climate change is a major threat to your country'

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Acknowledgements

Pearson Education Ltd. gratefully acknowledges all the following sources used in the preparation of this paper:

Figure 1: https://ourworldindata.org/world-population-growth-past-future

Figure 2: https://ourworldindata.org/

Figure 3: https://data.worldbank.org/indicator

Figure 4a © Anton Petrus/Getty Images

Figure 4b © danm/Getty Images

Figure 5: https://www.brookings.edu/blog/brookings-now/2019/12/13/charts-of-the-week-tackling-climate-change/

Figure 8: CEballos et al. Sci. Adv. 2015;1:e1400253

Figure 9: https://ourworldindata.org/grapher/land-use-kcal-poore?