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HL

8.1.9 Rapid human population growth has increased stress on the Earth's systems

1.2 Systems
1.3 Sustainability

The increased stress on Earth's systems from rapid human population growth is related to biocapacity disparity and to the crossing of social foundation and planetary boundaries in the doughnut economy model (Topic 1, Sections 1.3.19 and 1.3.20).

The drivers of population growth include changes in fertility, mortality and migration. The global human population reached 8 billion in 2022 and the UN predicts that it will level out by 2100 at between 10 and 11 billion (see Figure 8.8 on page 723). However, the population may not rise that high since fertility decreases as education and level of wealth increase. Decreased fertility rate may also occur due to other improvements brought about, in part, by the UN SDGs, e.g. better access to clean water and improvements in food production (because the need for replacement children to replace those expected to die decreases). Some organizations believe that peak global population may occur by 2060. For example, The Lancet[1] believes that peak population will occur around 2065 at 9.7 billion. Many people believe that most of the growth will take place in Africa (Table 8.9). In 1992, the UN produced a long-range world population projection, which stated that the high estimate was 23 billion, the medium estimate 11 billion and the low estimate just 5 billion! This is very different from current predictions and suggests that fertility would remain very high in LICs. As a result of falling fertility, the numbers predicted in current population projection models are much lower than they were in 1992. It is clear that the further into the future the projections are made, the less precise they become.

Table 8.9 UN 2019 World Population Prospects – median scenario.

	World population in 2000 (billions)	World population in 2050 (billions)	Growth (%)	% change/ year
Asia	3.74	5.29	+ 41	+ 0.7
Africa	0.81	2.49	+ 207	+ 2.3
Europe	0.73	0.71	– 3	– 0.1
South/Central America and Caribbean	0.52	0.76	+ 46	+ 0.8
North America	0.31	0.43	+ 39	+ 0.7
Oceania	0.03	0.06	+ 100	+ 1.4
World	6.14	9.74	+ 60	+ 0.9

Population growth, and the increase in the number of middle-income households, along with high-income households, is putting great pressure on many environmental systems (see Topic 1, Section 1.3.20). Rapid population growth places great stress on the Earth's systems. Increasing affluence intensifies these stresses. For example, there

[1]https://www.healthdata.org/news-events/newsroom/news-releases/lancet-world-population-likely-shrink-after-mid-century

is increased demand for freshwater and for meat and dairy products, which use more land than arable farming. Resources, such as fossil fuels, are used in great quantities. Forests are cut down for timber, fuel and to make way for farming. In addition, human activity pollutes many environments.

Biocapacity or biological capacity refers to the goods and services that an ecosystem (or the Earth) provides. It includes goods such as food, water and timber, as well as services such as climate-regulation and flood control. An increase in population leads to a decrease in biocapacity (Topic 1, Section 1.3.19).

8.1.10 Age–sex pyramids can be used to determine dependency ratios and population momentum

HL

1.2 Systems
1.3 Sustainability

The **dependency ratio** compares the number of dependents, i.e. non-workers, commonly those aged under 15 years and over 64 years, to the economically productive people, aged 15–64 years, in a population.

It is often shown as a formula: $$\frac{\text{Dependent population (\%)}}{\text{Workers (\%)}} \times 100\%$$

Or alternatively:

$$\frac{\text{Young people (\% aged 0–14 years) and Elderly (\% aged 65 years and over)}}{\text{Adults (\% aged 15–64 years)}} \times 100\%$$

The dependency ratio tends to be high in populations with either a very high or a very low fertility rate.

Activity

1. Visit the Population Pyramid website.
2. Use the interactive pyramid to work out :
   (a) the dependency ratio for Japan in 2100.
   (b) the dependency ratio for Japan in 2025.

Population momentum

Population momentum explains why a population will continue to grow even if the fertility rate declines. Population momentum occurs because it is not only the number of children per woman that determine population growth, but also the number of women of reproductive age.

Population momentum occurs if there is a significant bulge in the youthful population yet to enter their reproductive years. For example, during China's one-child policy (1980–2016), China's population continued to grow and is expected to peak in the 2030s, despite decades with a TFR below the replacement level of 2.1. At the start of the one-child policy, one-third of China's population was below the age of 15 years. Negative population momentum occurs when, despite a rise in the TRF, the number

of people in reproductive cohorts has shrunk, and so there are fewer people having children. Figure 8.13 shows the age–sex pyramid for Japan in 2021. For Japan (2021) there are relatively few women of reproductive age, so the population momentum is decreasing. In contrast, the age–sex pyramids for Swaziland (Figure 8.11b) show that population momentum will continue to occur for a few years there but will start to decline after 2025.

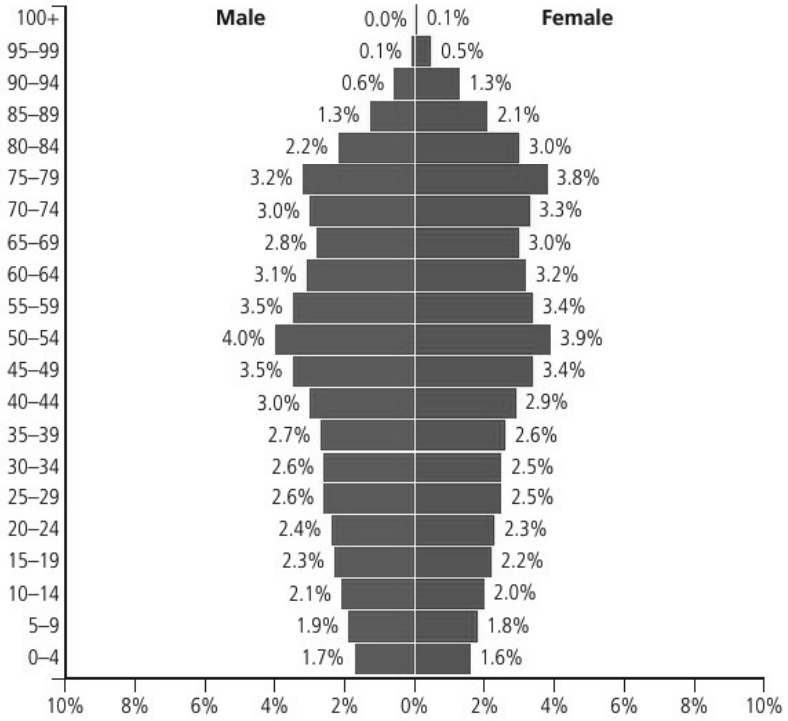


Figure 8.13 Age–sex pyramid for Japan, 2021, when the population was 121,960,407.

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8.1.11 Reasons for patterns and trends in population structure and growth

1.1 Perspectives
1.2 Systems
1.3 Sustainability

Different countries have contrasting patterns and trends in population structure and growth for historical, cultural, religious, economic, social and political reasons. For example, Ethiopia and the USA have very different patterns.

HL a Environmental law
HL b Environmental economics
HL c Environmental ethics

Example – Comparing Ethiopia and the USA

Ethiopia and the USA are countries at different stages of the DTM. Ethiopia is in stage 3, having a high CBR (30.5‰) and a low death rate (5.7‰) as shown in Table 8.10. The USA is in stage 4 of the DTM as its CBR and CDR are both quite low (CBR 12.28‰ and CDR 8.38‰). Ethiopia's population has grown from 38 million in 1983 to 113 million in 2023, despite over 1 million people dying in the famine of 1984. Ethiopia's population is predicted to reach 214 million in 2053. In contrast, the population of the USA rose from 233 million in 1983 to 337 million in 2023 and is projected to reach 377 million in 2053.

You need to study two countries in different stages of the DTM, and consider the reasons for patterns and trends in population structure and growth.

	Ethiopia	USA
Population (millions)	113	337
Population growth (%)	2.46	0.69
CBR (‰)	30.5	12.28
CDR (‰)	5.7	8.38
IMR (‰)	33.5	5.17
Life expectancy (years)	68	80
TFR	3.99	1.84
Population with access to contraceptives (%)	38	74
Urban population (%)	23	83
Age-structure (%)		
0–14 years	40	18
15–64 years	57	65
65 and over	3	17
GNP/head (US$)	2300	63,700
Population in employment (%)		
Agriculture/primary industries	72.7	1
Industry	7.4	20
Services	19.9	79

Table 8.10 Selected population data for Ethiopia and the USA.

There are many reasons for these differences. First, Ethiopia has a very youthful age-structure (Figure 8.14) as over 40% of the Ethiopian population is under 15 years of age and only about 3% is aged over 64 years. Such a youthful age-structure will help produce a high birth rate.

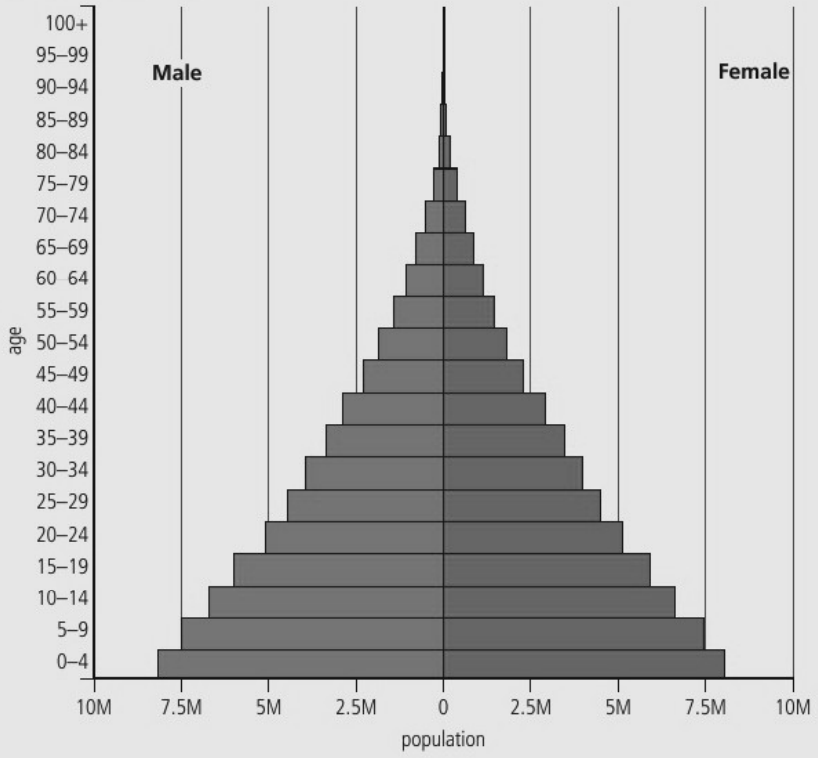


Figure 8.14 Age-sex pyramid for Ethiopia, 2023.

The TFR in Ethiopia is 3.99, which is more than double that the USA's rate of 1.84. In addition, over 70% of Ethiopians are employed in farming. Having children can be a benefit to farmers for the extra labour they provide. Ethiopia also has a relatively high IMR. Some families will decide to have more children to compensate for the high IMR. Most Ethiopians follow one of the three major religions – Ethiopian Orthodox (44%), Muslim (31%) and Protestant (23%). Most religions are in favour of large families (pro-natal), and many are anti-contraception. The contraceptive prevalence rate in Ethiopia is 38%.

In contrast, in the USA, only 14% of its population is under 15 years old, and there is a clear decline in the birth rate. This is shown in Figure 8.15 by the inward-sloping cohorts under the age of 34 years (with the exception of 0–4-year-olds). There are a greater number of elderly people in the USA compared to Ethiopia. In the USA, 17% of the population are aged over 64 years. Only around 1% of the workforce is employed in farming, so there is no need for children to work on farms. In addition, the IMR in the USA is low, so there is no need for compensatory births. In the USA, around 83% of people live in urban areas, compared with just 23% of Ethiopia's population. The main religions in the USA are Protestantism (46%) and Roman Catholic (21%), with 23% of the population not being affiliated to any religion. Contraceptive prevalence in the USA is 74% so is much higher than in Ethiopia. Thus in the USA, there is a smaller reproductive group and greater use of contraceptives (family planning).

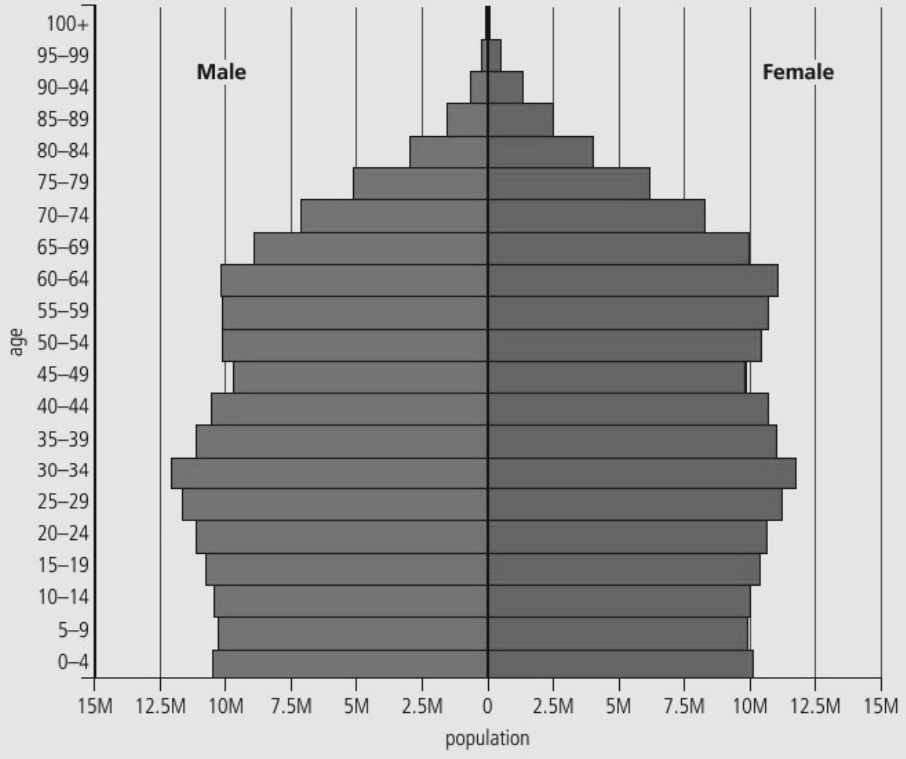


Figure 8.15 Age-sex pyramid for the USA, 2023.

Activity

The CIA World Factbook is an excellent source of data for all countries around the world.

1. Find out about levels of education in Ethiopia and USA and also about access to contraceptives. How might these affect population growth rates in both locations?
2. With a partner, go to the CIA World Factbook website and investigate two contrasting countries in terms of factors that affect population growth.
3. Compute the relative population growth for
   (a) Ethiopia from (i) 1983–2023 and (ii) 2023–53, and for
   (b) the USA from (i) 1983–2023 and (ii) 2023–53.
4. Suggest reasons why the birth rate and fertility rate are higher in Ethiopia than in the USA.

When studying countries in different stages of the DTM, you need to consider the patterns and trends from the past (at least 30 years or more ago), the present, and into the future (at least 30 years). You should also consider reasons (e.g., historical, cultural, religious, economic, social and political factors) for the countries selected.

8.1.12 Environmental issues are causing environmental migration

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Environmental migration may occur as a result of climate change and sudden onset events such as flooding, droughts, forest fires or intensified storms. However, it is also increasingly occurring as a result of slow onset events such as desertification, sea-level rises and saltwater inundation. An example that demonstrates the occurrence of migration due to an environmental issue is the emigration from Mozambique occurring due to repeated cyclones that have caused local devastation. Another example is the increased migration from Tuvalu to New Zealand due to the impacts of climate change on the islands. See examples below.

1.2 Systems
1.3 Sustainability
6.2 Climate change – causes and impacts

HL a Environmental law
HL c Environmental ethics

Example – Climate change and the impact on Tuvalu and Kiribati

Tuvalu is an island group and Kiribati is an atoll in the South Pacific ocean. Tuvalu and Kiribati are among the countries most at risk from global climate change despite not having contributed much to it. The land in Tuvalu has an average height less than 2 m above sea level. Sea levels are rising at a rate of about 3.9 mm per year around Tuvalu, which is approximately twice the global average, and have risen about 30 cm over the last century. Table 8.11 shows some of the main population characteristics of Tuvalu and Kiribati.

	Tuvalu	Kiribati
Population size	11,639	115,372
Growth rate (%)	0.81	1.02
GDP per person (US$)	4900	1900
Employment structure (%)	Agriculture and fishing 24.5 Industry 5.5 Services (incl. tourism) 70	Agriculture and fishing 23 Industry 7 Services (incl. tourism) 70

Table 8.11 Characteristics of Tuvalu and Kiribati (2023).

As global climate change increases, the number of climate change migrants will increase.

Both countries have limited access to New Zealand for migration, with just 75 spaces available each year. Applicants are selected by ballot (which costs US$ 150 for the first try and US$ 50 for every try thereafter). This, along with the cost of travel to New Zealand and the limited opportunities for low-skilled workers to migrate to Australia and New Zealand, limits the number of emigrants.

Kiribati has relatively low levels of emigration and a very small disparate population in Australia and New Zealand. The migrant population of Kiribati is about 4% of the population compared with 19% in Tuvalu (Figure 8.16).

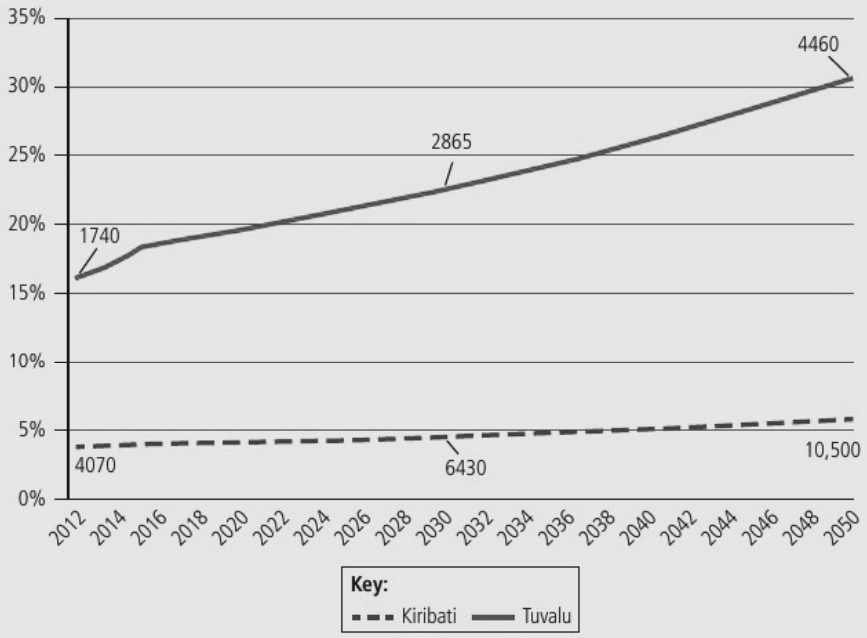


Figure 8.16 Projected migrant population as a percentage of resident population, 2012–50.

Migration strategies are important for dealing with climate change as rising sea levels, coastal flooding and seawater intrusion threaten lives and livelihoods. However, climate change is not the only factors influencing migration from these countries. Increasing population density and the limited amount of arable land are also putting a stress on the ability of the land to support the people. The human-carrying capacity of small islands is estimated to be 100 people/km^2. However, in Tuvalu the population is approximately 367/km^2 and in Kiribati the population is 251/km^2. Population pressure in Kiribati is increasing due to the limited availability of land, as more land is eroded, and saltwater intrusion affects water quality (Figure 8.17). Approximately 15% of Kiribati's population have left over the last decade.



Figure 8.17 Seawater seeps inland in Funafuti atoll, the capital of Tuvalu.

The problems being experienced in the Pacific Islands should act as a warning to the rest of the world – 70% of the world's major cities, including Kolkata, Shanghai, Bangkok and New York, lie within 1 km of the coast and global sea level rise could lead to a huge increase in environmental refugees. According to the Internal Displacement Monitoring Centre (IDMC) more than 250 million people were internally displaced between 2008 and 2019 due to climate disasters worldwide. In 2019, around 24 million people from 140 countries were displaced due to climate disasters.

Tropical cyclones are becoming stronger and more frequent. Other problems affecting the water supply in Kiribati include saltwater intrusion, storm surges and drought. Some 70% of households in Kiribati and Tuvalu, along with 35% of

i The 1951 Geneva Convention does not cover climate-induced migrants, only those affected by war. Thus, climate-vulnerable populations cannot easily migrate to overseas countries.

households in Nauru, wish to migrate due to global climate change, but only 25% can afford to do so. Between 2005 and 2015, 10% of Nauru's population and 15% of Tuvalu's population emigrated. By 2055, it is predicted that international migration from Kiribati will increase by 35% and from Tuvalu by 100%. To make migration easier, the UN has suggested that training people to become nurses, teachers and police will improve the chances of gaining employment.

Example – Repeated cyclones in Mozambique

In March 2019, Cyclone Idai devasted large parts of central Mozambique. Some 3 million people were affected and 200,000 people were displaced. Around 1 million ha of crops were destroyed. Idai was the second deadliest cyclone in the Southern Hemisphere. It may have killed more than 1000 people and caused damages that cost in excess of US$ 2 billion. It also produced a storm surge of over 4 m in height that completely or partially destroyed up to 80% of areas in Macomia, Mozambique.

Just five weeks later, Cyclone Kenneth hit northern Mozambique and affected a further 300,000 people. Over 30,000 homes and thousands of ha of crops were destroyed. A further 20,000 people were displaced. Cyclone Kenneth was classified as a Category 4 tropical cyclone. It struck at the peak of the harvest season, causing a potential 6-month period with limited food supplies.

This was the first time that two major tropical cyclones had hit Mozambique in the same year. The impacts were especially severe in the remote areas of central Mozambique and in the north of the country. Overall, between 5 and 10% of Mozambique's population was displaced. The majority were unable to return to their lands as the government believed the risk of future cyclones made it unsafe and uninhabitable.

By July 2019, the appeal for aid for Mozambique following Cyclone Idai had reached only 46% of its target and for Cyclone Kenneth only 20% of its target was reached. The 200,000 people displaced were forced to live in tents, while those able to return to their homes found that many of their possessions had been lost and their homes had been partially or totally destroyed.

SKILLS

Use secondary data to test a hypothesis about the relationship between a socio-economic indicator and a demographic factor using a suitable statistical tool

Using the data in Table 8.12, carry out a Spearman's rank correlation test to see whether there is a statistically significant relationship between gross national income (GNI) per person and CBR.

Country	GNI (US$)	CBR (per thousand)
Monaco	115,700	6.61
Austria	54,100	9.39
Kuwait	43,900	17.65
Poland	34,900	8.31
Argentina	21,500	15.38
Gabon	13,800	25.89
Ecuador	10,700	16.19
India	6600	16.53
Senegal	3500	30.84
Niger	1200	46.86

Table 8.12 GNI per person and CBR data for different countries.

There is a resource explaining the different statistical tests and when they are used on this page of your eBook.

Engagement

- In your class, assess and debate issues regarding population change in your local or regional area.
- Investigate the main migration routes that exist into and out of your home country, the threats to migrants using these routes and the solutions involved into making these routes safer (if necessary).
- With the help of your teacher, find out if there is a refugee/immigration centre in your home area and volunteer or raise funds for the centre.
- Find out if there are any local NGOs supporting seasonal or Indigenous communities and volunteer to help them.
- With your teacher, find out how you can help with the work of the United Nations High Commissioner for Refugees (UNHCR).

Exercise

Q1. **Investigate** rates of migration for a country of your choice.

(a) At a national level, do more people enter the country or leave it? Where are they mainly coming from and going to?

(b) At a local level, what type of settlements are migrants moving to and coming from?

Q2. **Describe** the global pattern of birth rates.

Q3. **Suggest** reasons for the high rates of migration to the USA and Saudi Arabia.

Q4. **Calculate** the doubling time of a population that has a natural increase of **(a)** 1% **(b)** 2% **(c)** 3%.

Q5. **Describe** the changes in the annual growth rate of the world's population, 1700-2100.

Q6. **(a)** **Define** the terms *pro-natalist* and *anti-natalist*.

(b) **State** one example of a country with a pro-natalist programme and one with an anti-natalist policy.

Q7. Describe the changes in Russia's population between 1990 and 2020, as shown in the age–sex pyramids in Figures 8.18a and 8.18b.

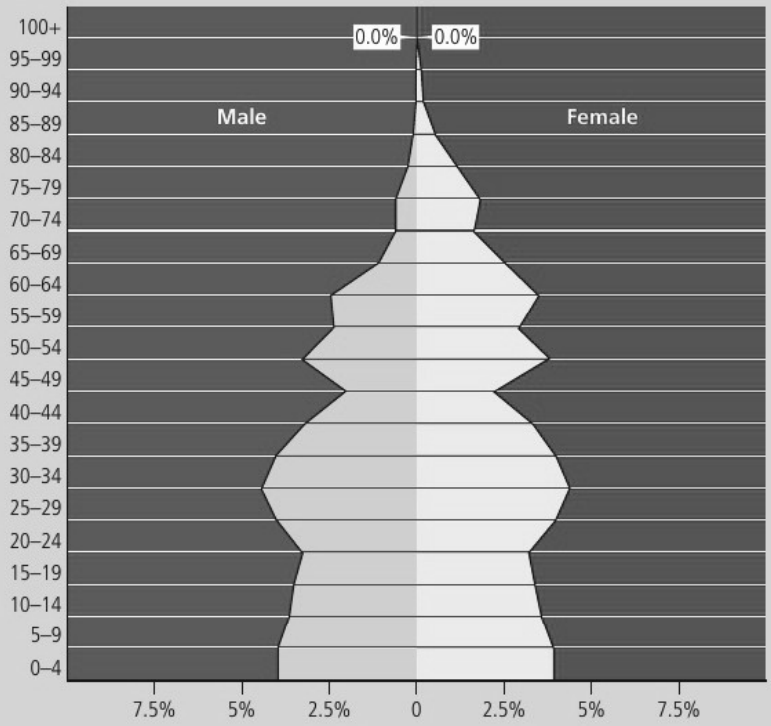


Figure 8.18a Russia's population in 1990 (largest population 147 million).

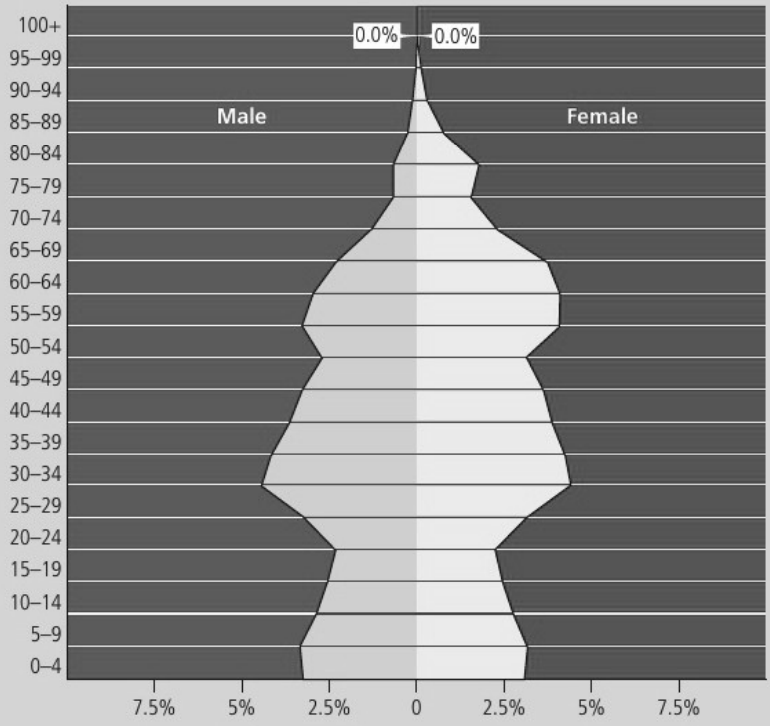


Figure 8.18b Russia's population in 2020 (143 million)

Q8. Describe the global pattern of death rates.

Q9. Describe the main characteristics of the world's age–sex pyramid in 1950 and the projected pyramid for 2100, as shown in Figure 8.19.

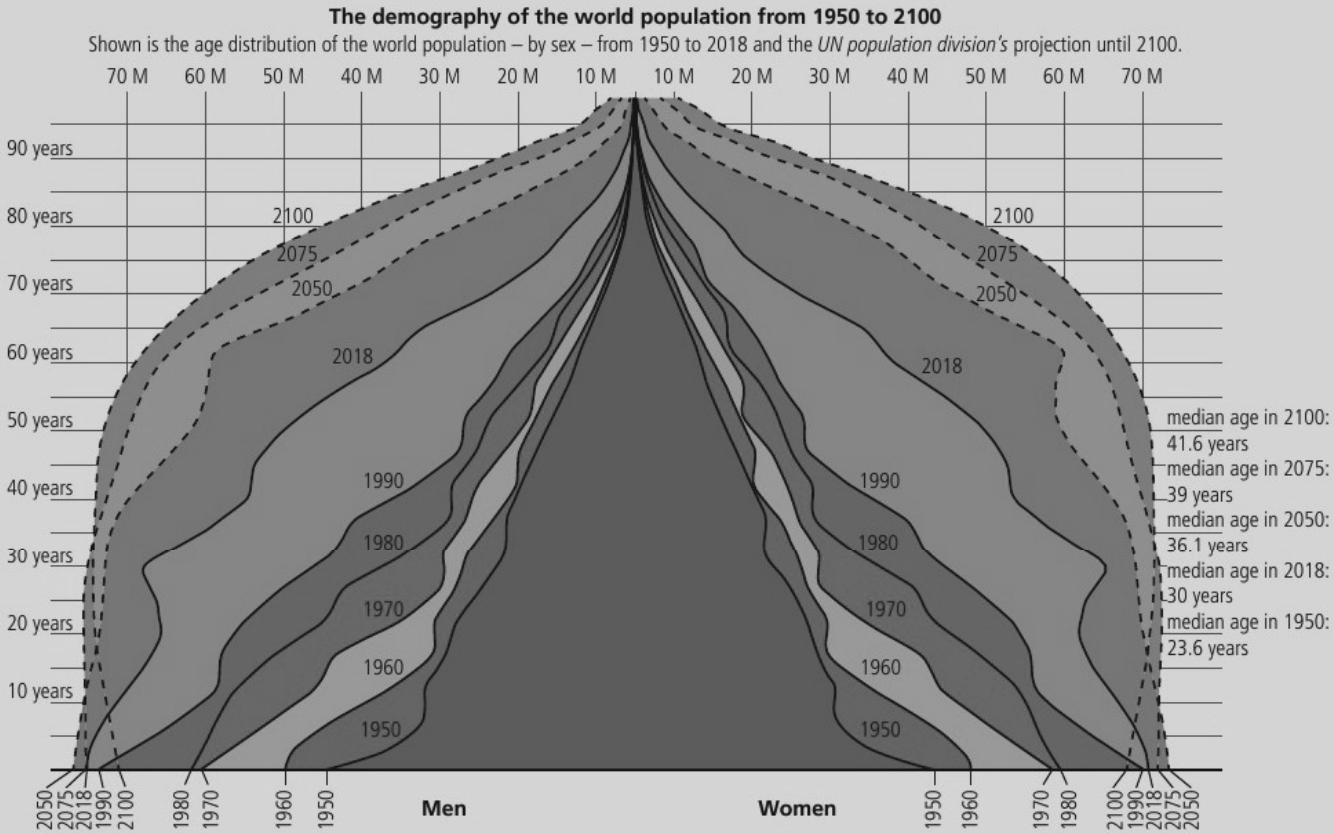


Figure 8.19 The global population pyramid: How global demography has changed and what we can expect for the 21st century - Our World in Data.

Q10. In which stage(s) of the DTM does exponential growth occur?

Describe what happens to the total population in stage 5 of the DTM.

Q11. Explain why population growth decreases in stage 5 of the DTM.