



NATIONAL SENIOR CERTIFICATE EXAMINATION  
MAY 2022

**LIFE SCIENCES: PAPER II**

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**SOURCE MATERIAL BOOKLET FOR  
QUESTIONS 1, 2 AND 3**

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## SECTION A

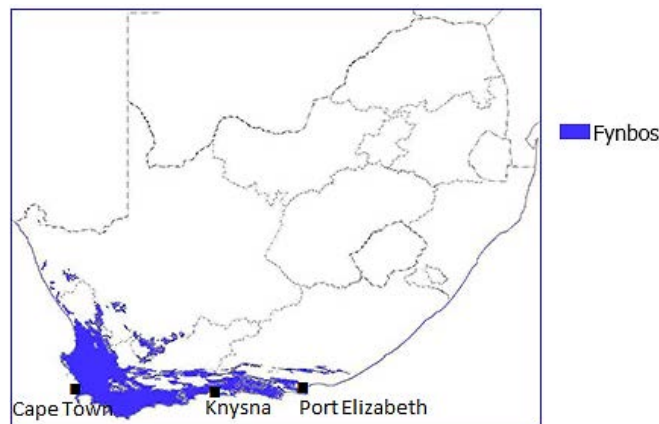
### QUESTION 1

Read the information below. Use this information as well as your own knowledge to answer Question 1 in the question paper.

Wildfires are part of the natural ecosystem, and many biomes are naturally susceptible to fires. Those ecosystems that were exposed to fire during their evolution often contain species that are adapted to fire, and often require fire to complete key stages in their life cycle.

The fynbos is one such biome. It mainly occurs in the Western Cape as shown in Figure 1.1.

**Figure 1.1 – Map showing distribution of fynbos in South Africa**



[Adapted: <<https://www.lh3.googleusercontent.com>>]

The fynbos biome is characterised by its richness in plant species (8 700 species), many of which are endemic. There are a higher number of different species occurring in this area than in the tropical rainforests of the Amazon. The fynbos biome is made up mostly of small plants with fine leaves. Many species of *Protea* occur in the fynbos. Most of this region has cool wet winters and hot dry summers, during which fires often break out. Drought is relatively common in many areas.

This biome faces various threats. A large percentage of the biome has been destroyed by farming and urbanisation. Another problem is that large areas have also been invaded by alien invasive species. Around Knysna, there are plantations of exotic trees such as gum trees and pine trees that supply wood and paper. These plants have spread into neighbouring areas of fynbos.

**Figure 1.2 – Healthy fynbos (left) vs fynbos invaded by alien plants (right)**



Pine trees  
invading fynbos  
outside Knysna

[Adapted: <<https://www.buffalo.edu>> / <<https://www.cms.groupeditors.com>>]

**Ecological benefits of fire in the fynbos**

Fynbos plants are dependent on fires roughly every five years for regeneration. After a fire, many plant species can regrow from their roots, while some regenerate from seeds in the ground after the fire. By burning the plants, nutrients are also recycled back into the soil. Many species store their seeds in fire-safe cones for release after a fire. For example, the conebush retains cones on the plant for up to 10 years. Only when a fire destroys the plant does the cone open and release the seeds so that they are available for germination.

**Problems caused by fire in the fynbos**

Without fire over long periods (greater than 10 years), increasing quantities of vegetation accumulate. This means that there are now huge quantities of vegetation to burn when a fire does occur, resulting in a very hot and destructive fire.

Another problem is the misuse of fire. Fynbos must burn, but fires in the wrong season (such as in spring, instead of late summer) or too frequently (so that plants do not have time to make seeds) eliminate species. Two major factors influence the occurrence of future fires in fynbos – **climate change** and **poor fire management**.

**Example of devastating SA fire in 2017**

Over four days in June 2017 wildfires had a devastating impact on the Knysna and Plettenberg Bay areas. The Knysna Fires incident will be recorded as one of the most destructive wildfire incidents in South Africa's history as the fire destroyed over 500 homes, farms and timber plantations. Around 22 000 hectares of land was burnt, seven lives were lost, and many communities were traumatised.

The following events increased the severity of the fire in 2017:

- The presence of large quantities of alien vegetation, a severe drought, low humidity, high temperatures and a cold front with extreme winds contributed to the severity of the wildfires. This also allowed the fires to spread very easily. Poor land management practices and the expansion of cities and farms into the fynbos also played a role.
- The excess vegetation resulted in an extremely hot fire (temperatures are speculated to have reached 2 000 °C). Many of the seeds stored in the soil were destroyed. Climate change has been implicated in the extreme drought in the area and these droughts and high temperatures are expected to become more common.
- The replacement of natural fynbos vegetation with pine plantations in the southern Cape, and the subsequent invasion of surrounding land by invasive pine trees, significantly increased the severity of the wildfires as they provided more fuel to burn. It is estimated that pine trees have invaded more than 90% of the fynbos vegetation around Knysna. Additional invasions by Australian *Acacia* and *Eucalyptus* species cover a further 29% and 14% respectively.

The Department of Forestry used to carry out regular burning in the 1970s and 1980s to reduce the amount of dry, dead or alien vegetation. This was stopped in the late 1980s. Instead, fires were completely prevented in order to protect forestry plantations and new residential developments. Knysna's human population grew by over 70% over the past 20 years, from 43 000 people in 1998 to 74 000 people in 2018.

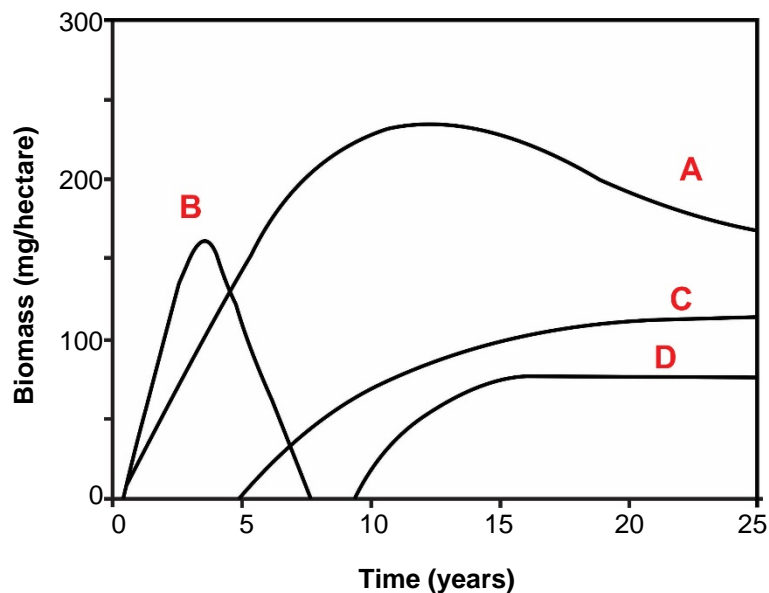
It took a few weeks for the first signs of new life to appear in the burnt area. Since 2017, the species found growing in the area have been recorded. A few of the species are recorded in Figure 1.5 on the opposite page.

**Figure 1.3 – Burnt area around Knysna**



[Adapted: <<https://www.safeforestryonline.co.za>>]




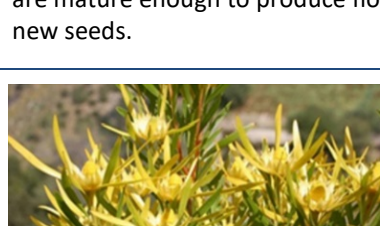

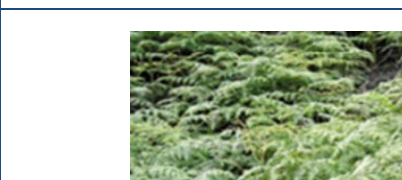


**Figure 1.4 – Graph showing biomass of species occurring in an area destroyed by fire**



[Adapted: <<https://www.global-safety-culture.com>>]



**Figure 1.5 – Plant species recorded growing in the burnt areas around Knysna since 2017**

	<p><b>Gonna bush</b> (<i>Passerina corymbosa</i>) produces many seeds. It is a relatively quick-growing but short-lived</p>		<p><b>Blushing bride plant</b> (<i>Serruria florida</i>) is highly dependent on fires. The parent plants die in a fire and the seeds survive to form the next</p>
<p>plant. Fire kills the plant. Seeds germinate very quickly after the fire, often in poor soil.</p>		<p>generation. Seeds only germinate slowly after fire has occurred. Seedlings require two years before they are mature enough to produce flowers and new seeds.</p>	
	<p><b>The coast metalasia</b> (<i>Metalasia muricata</i>) is able to grow in poor, sandy soils. It is short lived – dying after 2–3 years.</p>		<p><b>Conebush</b> (<i>Leucadendron eucalyptifolium</i>) is a relatively slow-growing, long-lived plant. The seeds are stored in woody cones on the</p>
	<p><b>Wild rosemary</b> (<i>Eriocephalus africanus</i>) has a well-developed root system that can penetrate the soil to a depth of 6 m. This makes the plant resistant to drought.</p>	<p>plant for many years. After a fire, the seeds are released from the cones, and germinate quickly with the first rains.</p>	
			<p><b>The green protea</b> (<i>Protea coronata</i>) is a fast-growing but short-lived plant.</p>
<p>The <b>bracken fern</b> (<i>Pteridium aquilinum</i>) grows very quickly after fires and remains growing in an area for many years. It is sometimes outcompeted in some areas after a few years by slower-growing plants like conebrushes.</p>			<p><b>Bobartia</b> (<i>Bobartia aphylla</i>) grows in exposed areas with poor soil. It grows quickly – flowering and producing seed after only a month. It is particularly abundant after fires.</p>

[Adapted: <<https://www.researchgate.com>> / <<https://www.scli.org.za>> / <<https://www.pza.sanbi.org>>]

[Adapted: Coetsee, C & Wigley, B. J. 2013. *Virgilia divaricata* may facilitate Forest Expansion in the Afrotropical Forests of the Southern Cape, South Africa. *Koedoe* 55(1)]

[Adapted: Kraaij, T. et al. 2018. An Assessment of Climate, Weather, and Fuel Factors Influencing a Large, Destructive Wildfire in the Knysna Region, South Africa. *Fire Ecology*. <<https://www.doi.org>>]

[Adapted: Monitoring for Sustainable Indigenous Forest Management in the Garden Route National Park. 2014. <<https://www.sanparks.org>>]

[Adapted: Stellenbosch University website. <<https://www.sun.ac.za>>]

[Adapted: <<https://www.gardenrail.wordpress.com>> / <<https://www.gardenrouterebuild.co.za>>]

[Adapted: <<https://www.pza.sanbi.org/vegetation/fynbos-biome>>]

## QUESTION 2

Read the information below. Use this information as well as your own knowledge to answer Question 2 in the question paper.

### Pilanesberg National Park – Operation Genesis

The Pilanesberg National Park is located north of Rustenburg in North West (province) in South Africa. The Pilanesberg is named for chief Pilane of the Kgafêla people and was proclaimed a reserve in 1979.

**Figure 2.1 – Map showing position of Pilanesberg Game Reserve**



[Adapted: <<https://www.travelcities.net>>]

Prior to its proclamation as a reserve in 1979, the Pilanesberg National Park was mostly overgrazed farmland with very little indigenous game. The area also had large numbers of alien invasive species. The area was deliberately and carefully redesigned as a national park. The people who originally lived in the Pilanesberg were not forcibly removed as had been the case in the establishment of other game reserves. Rather, their consent was sought, and they were promised that the establishment of the national park would be to their economic advantage.

A 110-kilometre Big Game fence was erected around the reserve. It was then decided to re-introduce the species that had occurred in the area historically. A decision was made to have a mass transfer of animals into the area, instead of a gradual restocking. So began Operation Genesis – the largest transfer of animals in the world at that time.

More than 6 000 animals of various species were moved into quarantine enclosures to acclimatise before being released. Major predators were introduced into the ecosystem in the early 1990s and have adapted well to the environment.



In terms of vegetation, the Pilanesberg is significant because it contains two separate biomes – the Arid Savanna and the Moist Savanna Biome. This means that there is also a wide variety of landscapes and habitats for both plants and animals.

The establishment of this national park was unique in a number of other respects as well. Provision was made for trophy hunting in order to raise funds for the reserve as well as environmental education. However, trophy hunting can only take place if there are excess animals to shoot. The park boasts healthy populations of lion and leopard, as well as other large mammals such as black and white rhino, elephant and buffalo. A wide variety of rare and common species coexist with endemic species such as the brown hyena, cheetah, sable antelope, as well as giraffe, zebra, hippo and crocodile. Over 300 bird species have been recorded. Such is the success of Pilanesberg National Park that today it boasts the highest concentration of rhinos per square kilometre in Africa.

**Figure 2.2 – Lion: a day-hunting predator (left) and brown hyena: night-hunting scavenger (right)**



[Adapted: <<https://www.wikipedia.com>>]



[Adapted: <<https://www.animalia.us-east-1.linodeobjects.com>>]

At considerable expense, the land was restocked with game, the traces of human settlement were removed, and tourism infrastructure was developed. This was the largest and most expensive game-stocking and land rehabilitation project ever undertaken in any African game reserve at the time.

**Figure 2.3 – A view of the Pilanesberg Game Reserve**



[<<https://www.getaway.co.za>>]

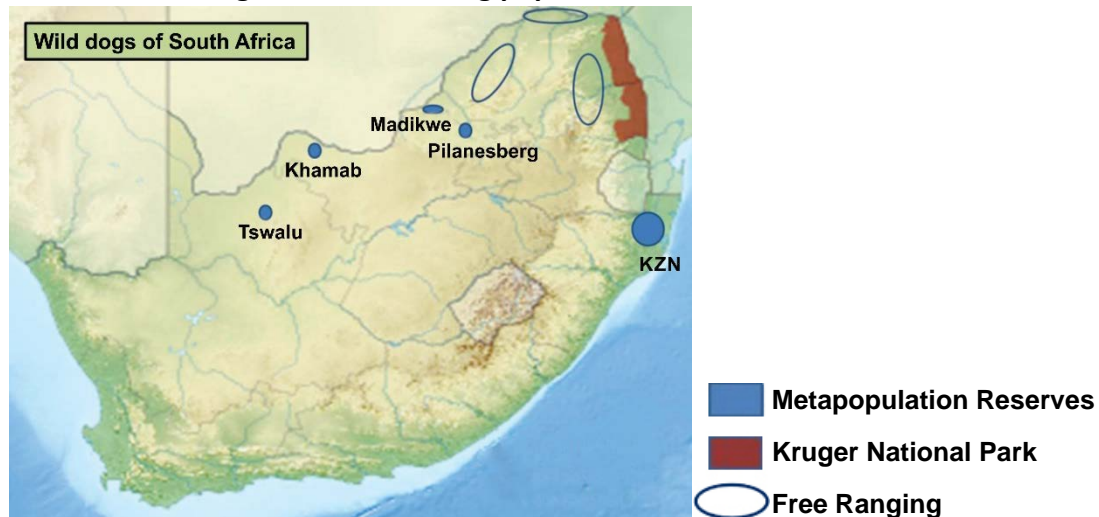
### **Wild dog populations in Africa**

A group of African Wild Dogs were released into the park in 1999. Wild dogs used to be found over most of Sub-Saharan Africa. Today their range is much smaller and very few self-sustaining populations remain. There were once over 300 000 wild dogs in 34 countries but today we are left with around 5 000 in 6 countries.

Wild dogs were mostly confined to a single population in the Kruger National Park. About 20 years ago, this population declined alarmingly. Studies have shown that for a population to be genetically healthy there needs to be a minimum of nine packs in an area. Each pack needs to have at least five individuals in order to cooperate in looking after the young and to assist with hunting.

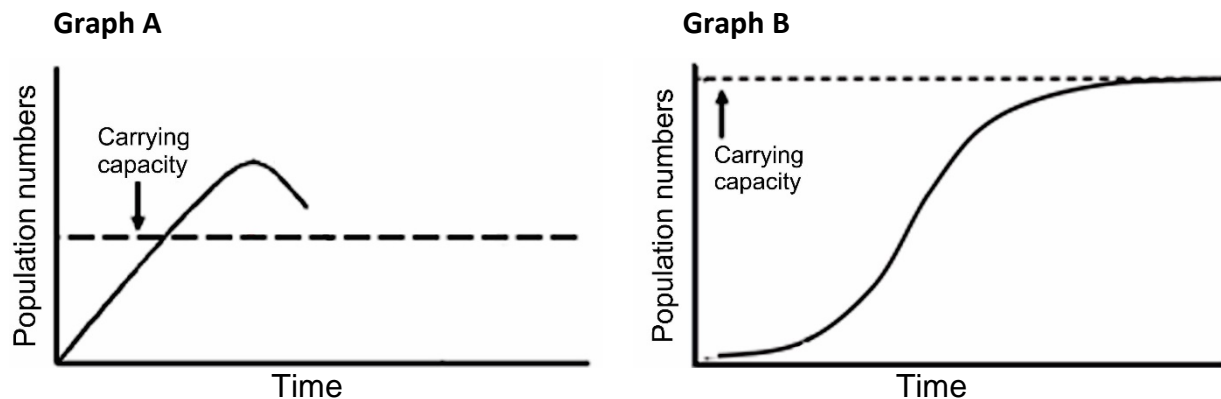
Young wild dogs, usually of the same sex, leave the pack and go in search of other small groups of wild dogs of the opposite sex from an unrelated pack. These groups will then form a new pack.

**Figure 2.4 – Wild dog populations of South Africa**



[Adapted: <<https://www.wildlifeact.com>>]

**Figure 2.5 – Graphs showing growth of wildebeest (Graph A) and buffalo (Graph B) populations in the Pilanesberg National Park**



[Adapted: <<https://www.encrypted-tnb0.gstatic.com>>]

[Adapted: <<https://www.researchgate.net>>]

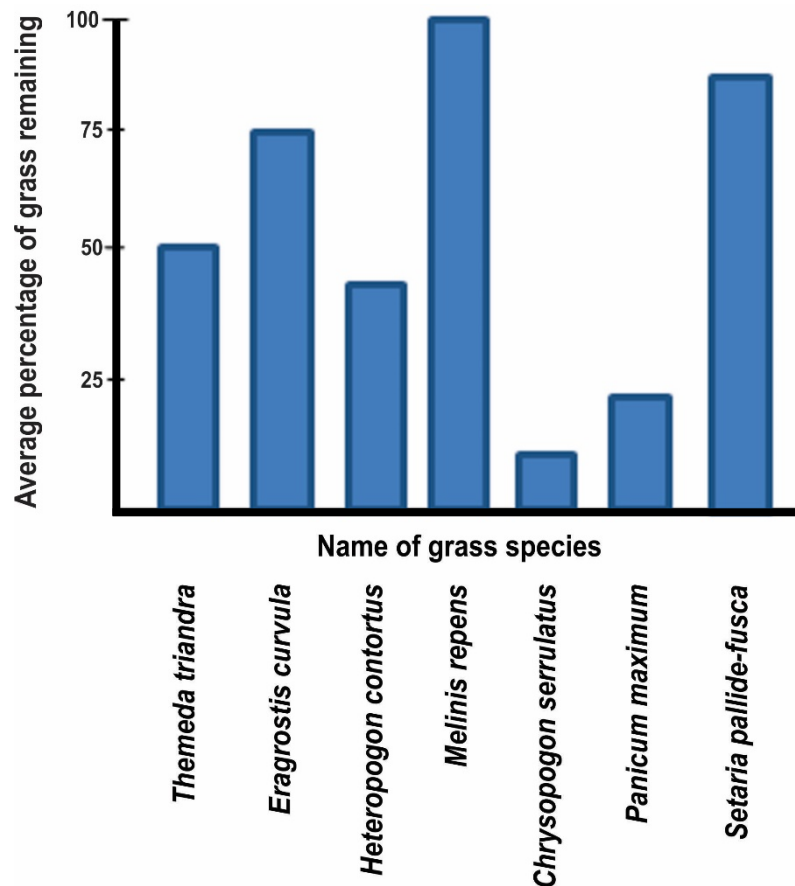
### **Sable antelope**

One of the animals that were found to be difficult to breed was the sable antelope. Sixty-seven sable antelope were released in 1979 and the population had only grown to approximately 70 animals by 1989. The sable population had increased to 327 animals by 1999. The earlier lack of population growth was probably due to below-average rainfall and lack of the grass species required for their diet. These grass species occupy similar niches.

In order to test this, 10 sable antelope were placed in an enclosed field containing equal quantities of seven different species of grasses. The antelope were left to graze and the average percentage biomass of each species of grass remaining was assessed. The results are shown in Figure 2.6 on the next page.



**Figure 2.6 – Graph showing percentage biomass of grass plants of seven species remaining after grazing by sable antelope**



[Adapted: Carruthers, J., 2008. Wilding the farm or farming the wild. *Transactions of the Royal Society of South Africa* 63(2): 160–181] [Adapted: Carruthers, J. 2011. Pilanesberg National Park, Northwest Province, South Africa: Uniting economic development with ecological design – A history, 1960s to 1984. *Koedoe* 53(1)] [Adapted: Manson, A. & Mbenga, B., 2009. *African Historical Review* 41(2): 85–115]

[Adapted: Magome, H. et al. 2008. Forage selection of sable antelope in Pilanesberg Game Reserve, South Africa. *South African Journal of Wildlife Research* 38(1): 35–41]

[Adapted: *A wild dog success story – managing the metapopulation in South Africa*. 2014  
<<https://www.wildlifeact.com>>]

[Adapted: <<http://www.gilbertguerin.com>> / <<https://www.nature-reserve.co.za>>]

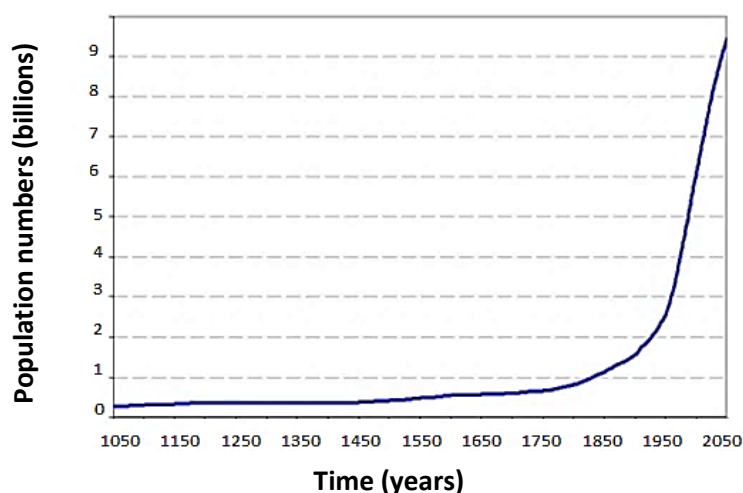
**SECTION B****QUESTION 3**

Read the information below. Use this information as well as your own knowledge to answer Question 3 in the question paper.

**SOURCE A Population growth**

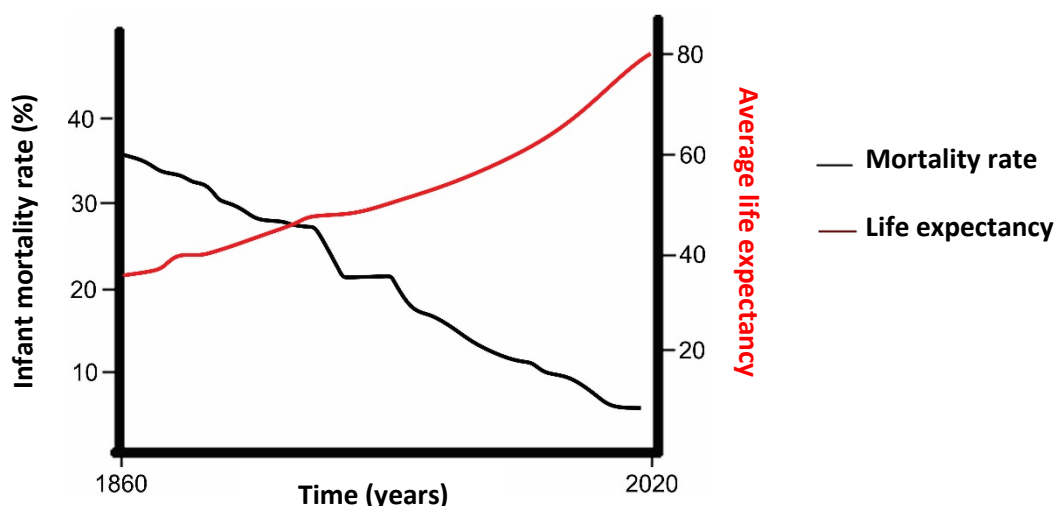
Overpopulation occurs when populations of a living species exceed their environments' carrying capacity. Many scientists predict that we have already reached the limits to growth and that our world population is on its way to growing beyond the carrying capacity of the Earth. **Human population control** is the practice of artificially altering the rate of growth of a human population.

**Graph showing human population change between 1050 and 2050**



[Adapted: <<https://www.uosm2018.files>>]

**Graph showing worldwide average life expectancy and infant mortality rate between 1860 and 2020**



This year, more than twice as many people will be born as will die. Humanity's numbers will swell by something like 80 million, pandemic or no pandemic. The optimum population of Earth – enough to guarantee the minimal physical ingredients of a decent life to everyone – is 1,5 to 2 billion people – rather than the 7 billion who are alive today or the 9 billion expected in 2050.

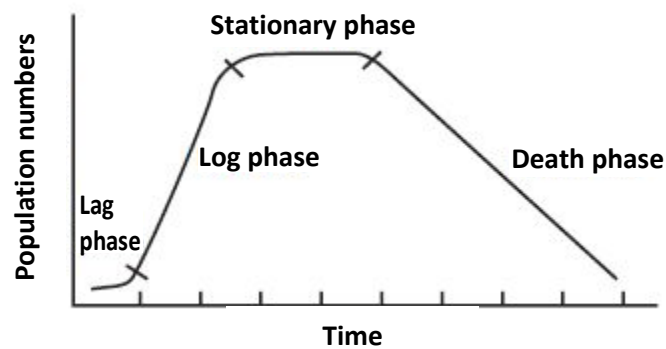
[Adapted: <<https://www.princeton.edu>> / <<https://www.royalsociety.org>>]

[Adapted: The Covid-19 pandemic has reignited questions about population size. 2020. New Scientist 3308]

## Cut world population and redistribute resources, expert urges

Paul Ehrlich, professor of Population Studies at Stanford University in California states that 'If population growth is not curbed, there would be only one other solution, namely the "death rate solution" in which the death rate is raised through war, famine or pestilence.'

### Graph showing human population numbers changing due to the 'death rate solution'



[Adapted: <<https://onlinesciencenotes.com>>]

'How many people the Earth can support depends on lifestyles. We have to humanely and as rapidly as possible move to population shrinkage.'

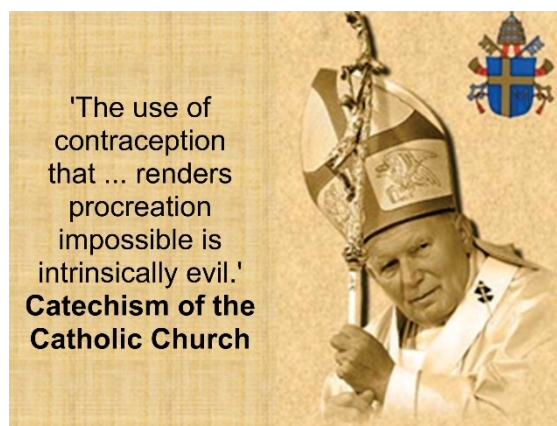
[Adapted: <<https://www.royalsociety.org>>]

**SOURCE B      Too many people?**

We know what works to limit population growth without resorting to force. It is what the world has been doing for the past half century, assisting the economic development of those, mainly poorer, countries with high population growth, broadening access to education, especially for girls and women, and ensuring access to contraception and abortion.



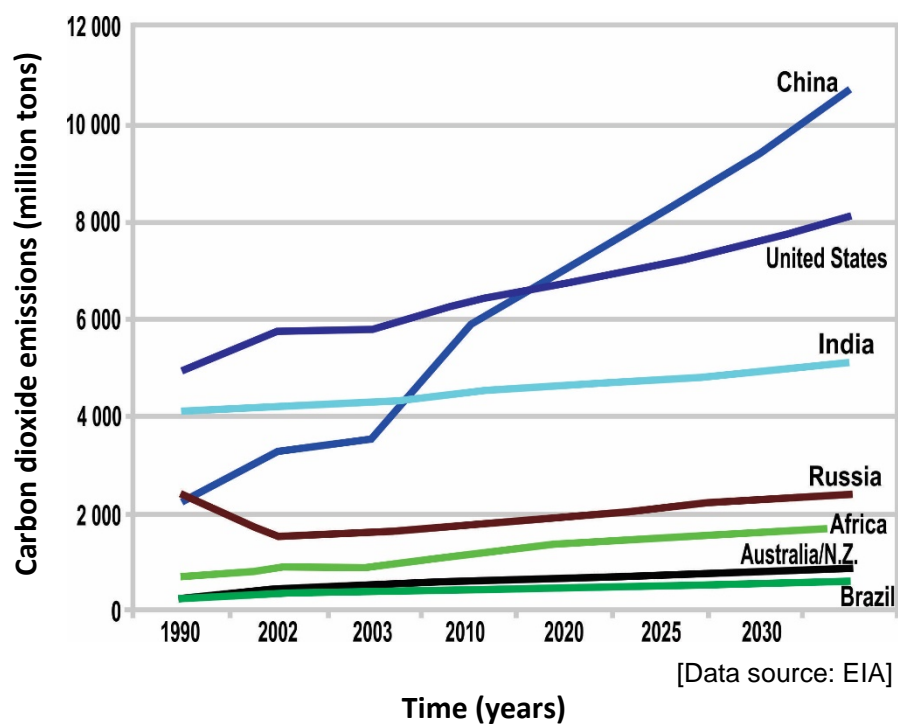
## Contraception methods



[<<https://www.bbc.com>> / <<https://www.studentpost.org>>  
 [<<https://catholicregister.org>> / <<https://www.slideplayer.com>>]

[Adapted: The Covid-19 pandemic has reignited questions about population size. 2020. *New Scientist* 3308]



**The population debate: are there too many people on the planet?****World carbon dioxide emissions by country, 1990–2030**



[<<https://www.post.healthline.com>> / <<https://www.pbs.twimg.com>>]

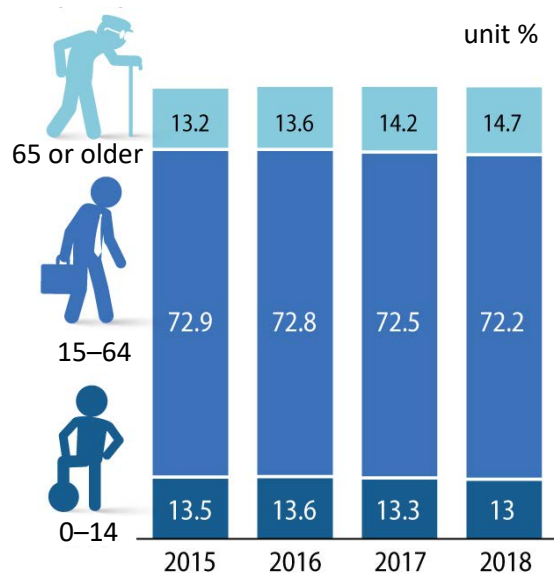
[<<https://www.biologicaldiversity.org>> /

<<https://www.static.boredpanda.com>>][<<https://www.lh3.googleusercontent.com>>]

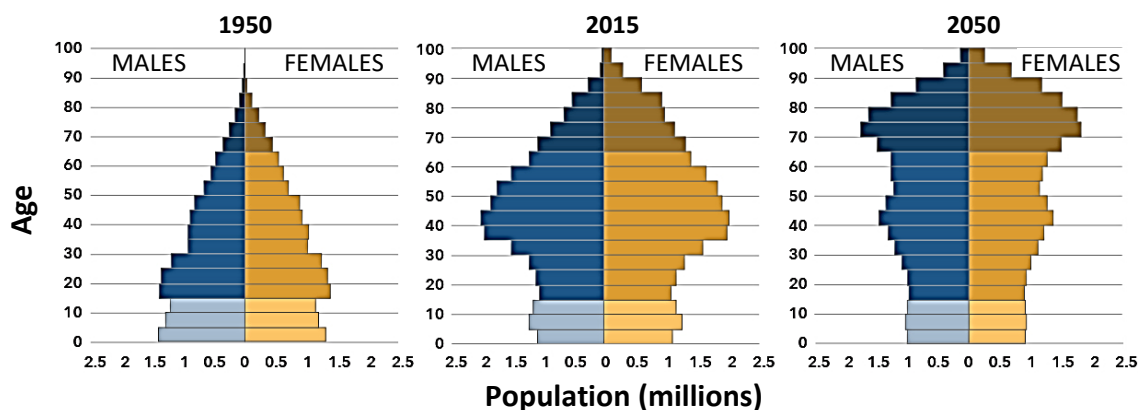
## SOURCE C Too few people?

From a high point of well over 2% a year in the late 1960s, the global rate of population growth has now fallen to a little over 1%. Fertility rates are at or close to the 'replacement rate' of 2,1 children per woman, the level that ensures a stable population. In some parts of the world, notably Japan, South Korea, Russia and some nations in eastern and southern Europe, fertility is below this rate, and populations are declining.

**Aging population in Korea**



[<<https://www.koreajoongangdaily.joins.com>>]

**Spain: A negative (shrinking) demographic**

[Source: <<https://www.graylinegroup.com>>]

With fewer people around in developed countries, economic growth, stable finances and society structure become harder to maintain. The solutions to these problems include higher taxes, less-generous welfare provision and later retirement. One alternative to deal with shrinking populations is to encourage immigration from other countries to increase the population.



**Anti-immigration protesters in the USA**



**Xenophobic mob violence in Alexandra, Johannesburg**

[<<https://www.theglobepost.com>> / <<https://www.static01.nyt.com>>]

[Adapted: The Covid-19 pandemic has reignited questions about population size. 2020. *New Scientist* 3308]

**Rwanda**

Environmental factors played a key role in the civil war and genocide in Rwanda in the 1990s. Rwanda is a small country whose population increased from 1 887 000 in 1948 to more than 7 500 000 in 1992. It is one of the most densely populated countries in Africa. As the population grew, the amount of available land for subsistence purposes decreased drastically, leaving many landless and unemployed. As a result, people were easily encouraged by political leaders to kill the second biggest ethnic group in Rwanda, the Tutsis. This was so that they could take possession of their land.

[Adapted: Moodley, V., Gahima, A. & Munien, S. 2010. Environmental causes and impacts of the genocide in Rwanda. <<https://www.accord.org.za>>]

## SOURCE D Sterilisation, incentives and human rights

Singapore promotes sterilisation to reduce population growth. Ninety percent of sterilisations are performed on females. As a result of this increased access to sterilisation and other family-planning services, Singapore's growth rate has fallen from 3,19 in 1957 to 0,765 – well below the replacement level of 1. The process requires consent from the person undergoing sterilisation before such treatment can take place; however, it allows the parents or spouse of persons with hereditary illnesses, intellectual or developmental disabilities, or health conditions such as mental illnesses or epilepsy to consent to sterilisation on their behalf.

[Adapted: <<https://www.pubmed.ncbi.nlm.nih.gov>>]

Some countries offer incentives like money or food to people who agree to sterilisation. There are many ethical objections to birth control programmes like these.

- **Coercion:** Using incentives to get people living in poverty to practise birth control amounts to coercion and violates the reproductive freedom of poor people.
- **Unfairness:** Incentive programmes are only likely to work on poor people – that's unfair.
- **Eugenics:** Incentive programmes that only work on poor people will tend to reduce certain classes and castes in society by causing them to have smaller families.
- **Human dignity:** Such programmes offend human dignity by treating children as a commodity – something that people can be paid to do without.
- **Abortion:** Such programmes might encourage people to abort fetuses in order to obtain the benefit of small-family policies if their birth control method fails.

Human rights are universal but also conditional. Women have the right to decide their number of children 'freely but responsibly'. 'Responsibly' means ensuring that the number of children born does not exceed the number that the parents can support. Governments could justify limiting an individual's reproductive freedom on the grounds that uncontrolled childbearing threatens the collective welfare of the population or of the environment.

**Reproductive rights** are legal rights and freedoms relating to reproduction and reproductive health. The World Health Organisation defines reproductive rights as follows:

Reproductive rights recognise the basic right of all couples and individuals to decide freely and responsibly the number, spacing and timing of their children and to have the information and means to do so. They also include the right of all to make decisions concerning reproduction free of discrimination, coercion, and violence. They include the right to receive education about contraception and sexually transmitted infections, and freedom from forced sterilisation, abortion, and contraception. Control over their own reproduction is a basic need and a basic right for all women.

[Adapted: United Nations Population Fund (UNFPA) and the World Health Organization (WHO)]

[Adapted: Cleland, J. & Mauldin, W. P. 1991. The promotion of family planning by financial payments.

The Case of Bangladesh. *Studies in Family Planning* 22:1–18.]

[Adapted: Dixon-Muelles, R. 1993. *Population Policy and Women's Rights: Transforming Reproductive Choice*. Westport, CT. Praeger.]



**SOURCE E                      Ecological footprint**

The idea of overconsumption is strongly tied to the idea of an ecological footprint. The term 'ecological footprint' refers to a mechanism for measuring human demand on the biosphere.

[Adapted: Russ, T. 2008. *Ecological footprint* in: Encyclopaedia of Earth. Eds. Cutler J. Cleveland. Washington, D.C.]

[Adapted: Environmental Information Coalition, National Council for Science and the Environment]  
[<<https://www.populationeducation.org>>]

**SOURCE F                      An example of the effects of overpopulation**

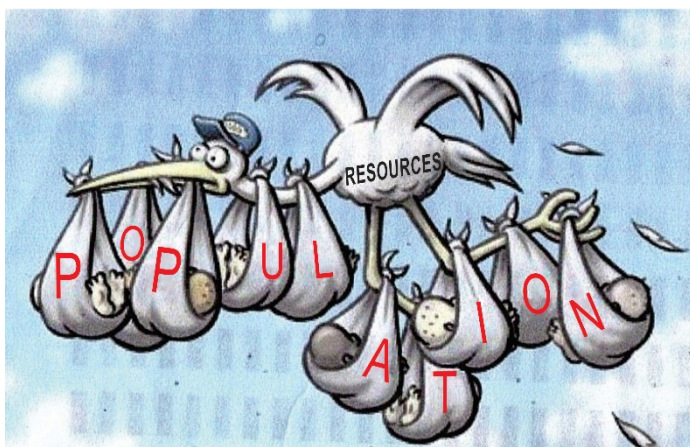
The Anasazi people were a group of Native American people who lived 1200 to 700 years ago. Deforestation, drought, warfare, overpopulation and environmental degradation combined to start the collapse of the Anasazi people in the 12<sup>th</sup> century in the USA.

After A.D. 900, a beneficial climate change took place, bringing predictable summer rains year after year. Crops grew in abundance. The population of Anasazi surged to about 100 000 people. Archaeologists estimate that the Anasazis cut down 215 000 trees from forests 48–64 km away to make the floors and roofs of their houses at Chaco Canyon.

In 1090 and again in 1130 severe droughts brought disaster to the Anasazi civilization. Depleted and eroded soils, deforested mountains, and over-hunted wildlife all contributed to widespread starvation. By 1170, the Anasazi had abandoned all their homes.

From the late 1200s until the 1500s, the Anasazi were continually at war with one another over control of farmlands and for access to wild-food resources. These were not just occasional raids, but brutal wars of extermination. Huge numbers of Anasazi starved to death or died in the violence.

[Adapted: Daniels, P. Bradshaw, M., Shaw, D. & Sidaway, J.  
*An Introduction to Human Geography Issues for the 21st Century Second edition*. Pearson Education]  
[<<https://www.crf-use.org>>]

**SOURCE G      Cartoons and quotes**

'Excessive growth may reduce output per worker, repress levels of living for the masses and engender strife.' – Confucius (Chinese philosopher) (551–479 BCE).

'Overpopulation in various countries has become a serious threat to the health of people and a grave obstacle to any attempt to organise peace on this planet.' – Albert Einstein (physicist) 1879–1955.

[<<https://www.i.pinimg.com>>]

[<<https://www.jonikcartoons.blogspot.com>>]