Geography A 'Level Summer Transition Work

You have **two** separate COMPULSORY tasks to complete for September, a Physical Geography set of work and a Human Geography one.

The complete work must be brought with you to your first lessons in September. You WILL have this work checked and some of it will be tested.

PHYSICAL GEOGRAPHY:

In Physical Geography you will begin with the topic '**Water and Carbon Cycles**'

You need to complete the reading on the attached PDF (named 'The Water Cycle') and complete the questions below:

1. Define what a system in in geography.
2. What are the interrelated parts of a system – provide definitions 5 elements.
3. Explain the difference between and open and a closed system. Provide examples to support your answer.
4. What is dynamic equilibrium in relation to natural systems? Provide an example to support your answer.
5. Explain in your own words what a feedback means in relation to natural systems.
6. Define what is meant by positive and negative feedback.
7. There are examples of positive and negative feedback in figures 1.3 and 1.4 on page 3. Research and provide a different example of each feedback.
8. Earth has 5 major subsystem. Research each one and create a fact file about it (biosphere, cryosphere, hydrosphere, atmosphere and lithosphere).
9. What does it mean when these systems' are referred to as being 'cascading'?
10. Using figure 1.5 describe the distribution of the water on planet Earth.
11. Describe the difference between terrestrial, atmospheric and cryospheric water.
12. What has happened to ocean pH in the last 250 years? Why has this happened?
13. Re-create the diagram on figure 1.6 – add more detail about the nature and location of the different cryospheric stores of water.
14. What is the difference between an ice sheet and an ice shelf?
15. How much are sea levels predicted to rise if both the Greenland and Antarctic ice sheets melt?
16. What is permafrost and how does it store water?
17. What are the characteristics of a wetland?
18. What is groundwater?
19. Why is groundwater decreasing globally? What impacts is this likely to have?
20. What is the difference between 'soil water' and 'biological water'?
21. Why is atmospheric water important for global climate?

Now read the article on the next page and complete the corresponding questions:

The Amazon Rainforest and Climate Feedback Loops

'We are perilously close to the point of no return': Climate Scientist on Amazon Rainforest's Future

Jonathan Watts for The Guardian - Thu 26 Jun 2025 12.00 BST

For more than three decades, Brazilian climate scientist Carlos Nobre has warned that deforestation of the Amazon could push this globally important ecosystem past the point of no return. Working first at Brazil's National Institute for Space Research and more recently at the University of São Paulo, he is a global authority on tropical forests and how they could be restored. In this interview, he explains the triple threat posed by the climate crisis, agribusiness and organised crime.

What is the importance of the Amazon?

As well as being incredibly beautiful, the world's biggest tropical rainforest is one of the pillars of the global climate system, home to more terrestrial biodiversity than anywhere else on the planet, a major influence on regional monsoon patterns and essential for agricultural production across much of South America.

You were the first scientist to warn that it could hit a tipping point. What does that mean?

It is a threshold beyond which the rainforest will undergo an irreversible transformation into a degraded savannah with sparse shrubby plant cover and low biodiversity. This change would have dire consequences for local people, regional weather patterns and the global climate.

At what level will the Amazon hit a tipping point?

We estimate that a tipping point could be reached if deforestation reaches 20-25% or global heating rises to 2.0-2.5C [above preindustrial levels].

What is the situation today?

It is very, very serious. Today, 18% of the Amazon has been cleared and the world has warmed by 1.5C and is on course to reach 2.0-2.5C by 2050.

How is this being felt now?

The rainforest suffered record droughts in 2023 and 2024, when many of the world's biggest rivers were below the lowest point on record. That was the fourth severe drought in two decades, four times more than would have been expected in an undisrupted climate.

Every year, the dry season is becoming longer and more arid. Forty-five years ago, the annual dry season in the southern Amazon used to last three to four months and even then there would be some rain. But today, it is four to five weeks longer and there is 20% less rain. If this trend continues, we will reach a point of no return in two or three decades. Once the dry season extends to six months, there is no way to avoid self-degradation. We are perilously close to a point of no return. In some areas, it may have already been passed. In southern Pará and northern Mato Grosso, the minimum rainfall is already less than 40mm per month during the dry season.

Aren't those the areas where the most forest has been cleared for cattle ranching and soy plantations?

Yes. Livestock grazing is a form of ecological pollution. The areas that have been most degraded by pastures are at, or very close to, a tipping point. That is all of the southern Amazon – more than 2m

sq km – from the Atlantic all the way to Bolivia, Colombia and Peru. Scientific studies show degraded pastures recycle only one-third or one-fourth as much water vapour as a forest during the dry season.

There is so much water in the Amazonian soil. Trees with deep roots bring it up and release it into the air, mostly through transpiration by the leaves. In this way, forests recycle 4-4.5 litres of water per square metre per day during the dry season. But degraded land, like pastures, recycles only 1-1.5 litres. That helps to explain why the dry seasons are growing one week longer every decade.

Why isn't an Amazonian savannah a good idea?

It would be less humid and more vulnerable to fire. The tropical forest generally has 20-30% more annual rainfall than tropical savannahs in Venezuela, Colombia, Bolivia and Brazil. The Amazon also has fewer lightning strikes because the clouds are lower than in the savannah. But the most important difference is the fact that a rainforest has a closed canopy so only 4% of solar radiation reaches the forest floor. This means there is always very little radiated energy for the evaporation of the water so the forest floor vegetation and soil are very wet. Historically, this means that lightning strikes only start very small fires that kill only one or two trees but do not spread. In evolutionary terms, this is one reason why there is so much biodiversity in the rainforest; it is resilient to fire. But once it starts to dry and degrade, it is easier to burn.

How would an Amazon tipping point affect the global climate?

The forest in the south-eastern Amazon has already become a carbon source. This is not just because of emissions from forest fires or deforestation. It is because tree mortality is increasing tremendously. If the Amazon hits a tipping point, our calculations show we are going to lose 50-70% of the forest. That would release between 200 and 250bn tonnes of carbon dioxide between 2050 and 2100, making it completely impossible to limit global warming to 1.5C.

Brazil is one of the world's biggest agricultural exporters. How would a tipping point affect global food security?

Almost 50% of the water vapour that comes into the region from the Atlantic through trade winds is exported back out of the Amazon on what we call "flying rivers". I was the first to calculate the huge volume of these flows: 200,000 cubic metres of water vapour per second. My former PhD student, Prof Marina Hirota, calculated that tropical forests and Indigenous territories account for more than 50% of the rainfall in the Paraná River basin in the far south of Brazil, which is a major food-growing area. These flying rivers also provide water for crops in the Cerrado, Mato Grosso, Mato Grosso do Sul, Goiás, Paraná, Santa Catarina, Rio Grande do Sul, Paraguay, Uruguay, and all that northern Argentina agricultural area. So if we lose the Amazon, we are going to reduce the rainfall there by more than 40%. Then you can forget agricultural production at today's levels. And that would also contribute to converting portions of the tropical savannah south of the Amazon into semi-arid vegetation.

What would be the consequences for nature and human health?

The devastation of the most biodiverse biome in the world would also affect hundreds of thousands of species and raise the risks of zoonotic diseases crossing the species barrier. For the first time since the Europeans came to the Americas, we are experiencing two epidemics: Oropouche fever, and Mayaro fever. In the future, the degradation of the Amazon forest will lead to more epidemics and even pandemics.

How can an Amazonian tipping point be prevented?

In 2019, [the American ecologist] Tom Lovejoy and I recommended nature-based solutions, such as large-scale forestry restoration, zero deforestation, the elimination of monocultures, and a new

bioeconomy based on social biodiversity. We argued that it is possible to build back a margin of safety through immediate and ambitious reforestation particularly in areas degraded by largely abandoned cattle ranches and croplands. This prompted a lot of research and new thinking.

Is the Brazilian government adopting these ideas?

Progress fluctuates depending on who is in power. In August 2003-July 2004, we had about 27,000 sq km of deforestation – a huge number. But the first Lula government, with Marina Silva as environment minister, brought the figure down and it reached 4,600 sq km by 2012. Later, during Bolsonaro's government, it went up to 14,000 sq km. And now, with Lula and Marina back, it is fortunately going down again and there are several beautiful new reforestation projects. This is progress, but not enough. Now I'm saying to Marina Silva, 'Let's get to Cop30 with the lowest deforestation in the Amazon ever, less than 4,000 sq km.' Who knows? But anyway, Brazil is working hard.

You have warned that criminal activity is a major new risk. Why?

Last year, we had a record-breaking number of forest fires in all biomes in tropical South America – from January to November 2024, the Amazon had more than 150,000. Studies by INPE (The Brazilian Space Agency) show something very, very serious is happening. More than 98% of the forest fires were man-made. They were not lightning strikes. This is very worrying. Because even when we are reducing deforestation, organised crime is making it worse. In my opinion, more than 50% of forest fires were arson.

All Amazonian countries are trying to reduce deforestation. That is wonderful, but then what to do to combat organised crime? They control a $280bn business – drug trafficking, wildlife trafficking, people trafficking, illegal logging, illegal gold mining, illegal land grabbing. It is all connected. And these gangs are at war with the governments. That's one of the main reasons I'm becoming concerned because I know reducing deforestation is doable, so is forestry restoration. But how to combat organised crime?

How have your feelings about this problem changed?

I am worried that we are not acting with sufficient urgency. Thirty-five years ago, I thought we had plenty of time to get to zero deforestation and to combat the climate problem. Back then, deforestation was 7% and global warming was a little bit above 0.5C. I was not pessimistic because I felt we could find solutions. At the Rio Earth Summit in 1992, many people were saying that the world should aim for zero emissions by the year 2000. Unfortunately, nobody moved. Emissions continued to rise and they hit another record high last year. We now face a climate emergency. I am very, very concerned.

Tipping points – in the Amazon, Antarctic, coral reefs and more – could cause fundamental parts of the Earth system to change dramatically, irreversibly and with devastating effects. In this series, we ask the experts about the latest science – and how it makes them feel. Tomorrow, Louise Sime talks about Antarctic tipping points.

Answer the following questions in detail. Each answer should be thoughtful and based on the reading you have completed in this article. You may wish to conduct some additional research to help you.

1. Explain how deforestation in the Amazon contributes to a positive climate feedback loop.
2. What is the role of moisture recycling in the Amazon, and how does its disruption affect local and global climate systems?
3. At what percentage of forest loss does the Amazon risk crossing a tipping point, and why is this significant?
4. How could the transformation of the Amazon into a savannah affect regional agriculture?

5. Why is the Amazon considered a carbon sink, and what happens when it turns into a carbon source?
6. Discuss how organized crime contributes to deforestation and what this reveals about the social dimensions of climate change.
7. What global implications could result from the Amazon tipping point being reached?
8. The article mentions efforts like reforestation and ending monoculture farming. How might these help prevent or reverse the feedback loop?
9. How do feedbacks in the Amazon compare to those in the Arctic (e.g., ice-albedo feedback)?
10. What actions can individuals and governments take to reduce the risk of crossing climate-tipping points like the one in the Amazon?

Chapter

1 Water and carbon cycles

The cycling of water has obvious and significant implications for the health and prosperity of society. The availability and quantity of water is vital to life on Earth and helps to tie together the Earth's lands, oceans and atmosphere into an integrated physical system. Added to this is the fact that water vapour is the most important greenhouse gas and is a major driving factor in determining climate. The global water cycle is driven by many complex processes and interactions at a variety of scales; these are often poorly understood and badly represented in model predictions.

Carbon is everywhere: in the oceans, in rocks and soils, in all forms of life and in our atmosphere. Without carbon, life would not exist as we know it. The well-being and functioning of our planet depends on carbon and how it cycles through the Earth's system. The carbon cycle plays a key role in regulating the Earth's global temperature and climate by controlling the amount of another greenhouse gas, carbon dioxide, in the atmosphere.

Both the water and carbon cycles (and other aspects of geography) can be studied by considering them as systems.

In this chapter you will study:

- systems frameworks and their application
- the water cycle
- the carbon cycle
- water, carbon, climate and life on Earth

1.1 Systems framework and their application

Key terms

Energy – The ability to do work. In physical geography, much of this energy ultimately comes from the Sun.

Flow/transfer – A form of linkage between one store/component and another that involves movement of energy or mass.

Input – The addition of matter and/or energy into a system.

Output – The results of the processes within a system.

Store/component – A part of the system where energy/mass is stored or transformed.

System – A set of interrelated components working together towards some kind of process.

Because the Earth is highly complex, geographers have attempted to simplify aspects of it so that relationships between components can be better understood. These simplifications are called models (for example, the water cycle or the demographic transition model). One type of model that is widely used, particularly in physical geography, is the system.

A system is an assemblage of interrelated parts that work together by way of some driving process. They are a series of stores or components that have flows or **connections** between them. There are three types of property:

- **elements:** things that make up the system of interest
- **attributes:** the perceived characteristics of the elements
- **relationships:** descriptions of how the various elements (and their attributes) work together to carry out some kind of process.

Most systems:

- have a structure that lies within a **boundary**.
- are generalisations of reality, removing incidental detail that obscures fundamental relationships.

- function by having **inputs** and **outputs** of material (**energy** and/or matter) that is processed within the components causing it to change in some way.
- involve the flow of material between components.

Systems can be classified as:

- **Isolated systems**: these have no interactions with anything outside the system boundary. There is no input or output of energy or matter. Many controlled laboratory experiments are this type of system and they are rare in nature.
- **Closed systems**: these have transfers of energy both into and beyond the system boundary but not transfer of matter (Figure 1.1).
- **Open systems**: these are where matter and energy can be transferred from the system across the boundary into the surrounding environment. Most ecosystems are examples of open systems (Figure 1.2).

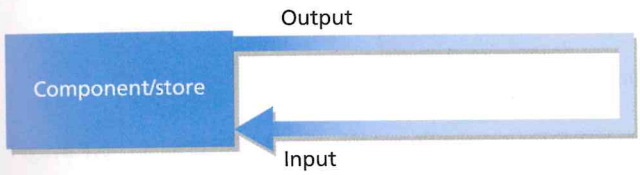


Figure 1.1 A closed system

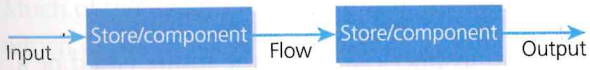


Figure 1.2 An open system (e.g. an ecosystem)

When there is a balance between the inputs and outputs then the system is said to be in a state of **dynamic equilibrium.** This means that the stores stay the same. If, however, one of the elements of the system changes, for example, one of the inputs increases without any corresponding change in the outputs, then the stores change and the equilibrium is upset. This is called feedback. There are two types of feedback:

- **positive feedback** where the effects of an action (for example, an increase in carbon dioxide) are amplified or multiplied by subsequent knock-on or secondary effects (Figure 1.3)
- **negative feedback** where the effects of an action (for example, the increased use of fossil fuels) are nullified by its subsequent knock-on effects (Figure 1.4).

The Earth can be studied using a systems approach; indeed the Earth as a whole could be considered a closed system. Energy comes into the system in the form of solar energy. This is balanced by radiant energy lost by the Earth. It could be related to the

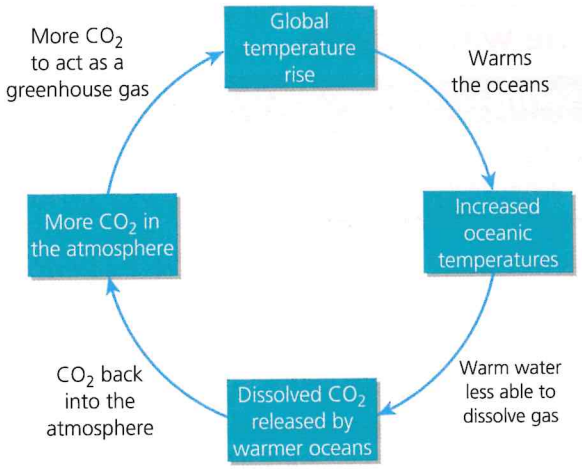


Figure 1.3 Example of positive feedback in a system

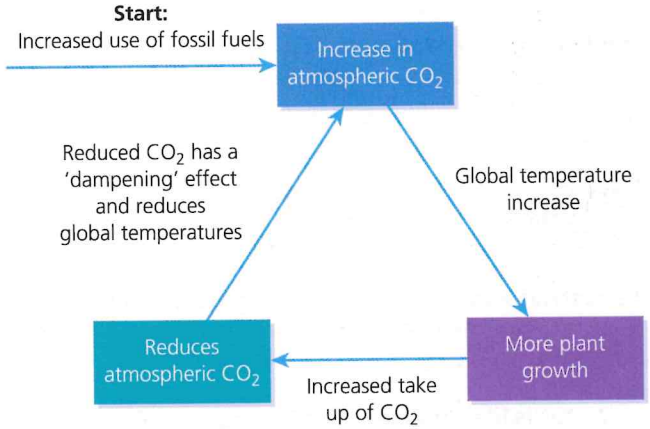


Figure 1.4 Example of negative feedback in a system

concept of 'spaceship Earth' which is a term usually expressing concern over the use of limited resources available on Earth and encouraging everyone on it to act as a harmonious crew working towards the greater good.

At the global level the Earth has four major subsystems, including the atmosphere, lithosphere, hydrosphere and biosphere. Each of these can be considered to be an open system that forms part of a chain: a **cascading system**.

Interlocking relationships among the atmosphere, lithosphere, hydrosphere and biosphere have a profound effect on the Earth's climate and climate change.

Review questions

1 Give two examples of:
   - physical geography systems
   - human geography systems.

2 For each example, consider the nature of any feedback that may apply to that system.

1.2 The water cycle

Key terms

Atmospheric water – Water found in the atmosphere; mainly water vapour with some liquid water (cloud and rain droplets) and ice crystals.

Cryospheric water – The water locked up on the Earth's surface as ice.

Discharge – The amount of water in a river flowing past a particular point expressed as m^3s^{-1} (cumecs).

Greenhouse gas – Any gaseous compound in the atmosphere that allows short wave ultraviolet radiation from the Sun to pass through the atmosphere, but then prevents outgoing terrestrial infrared radiation from escaping to space.

Hydrosphere – A discontinuous layer of water at or near the Earth's surface. It includes all liquid and frozen surface waters, groundwater held in soil and rock and atmospheric water vapour.

Oceanic water – The water contained in the Earth's oceans and seas but not including such inland seas as the Caspian Sea.

Terrestrial water – This consists of groundwater, soil moisture, lakes, wetlands and rivers.

'Water is life's matter, mother and medium.'

Albert Szent-Gyorgyi, 1937 Nobel Prize acceptance speech

The major stores of water

Water on or close to the Earth's surface is called the **hydrosphere**. Scientists have attempted many times to estimate the total amount of water in the hydrosphere. There is general agreement that it amounts to some 1.338×10^9 km^3. It is thought that approximately 97 per cent of this is **oceanic water** (Figure 1.5). Fresh water, which makes up the remaining 3 per cent, is locked up in land ice, glaciers and permafrost (**cryospheric water**), groundwater, lakes, soil, wetland, rivers, biomass (**terrestrial water**) and **atmospheric water**.

12,900 km^3 of water vapour are found in the atmosphere. This amounts to a global average of 26 kg/m^2 of water for each column of air on the surface of the Earth. There are large variations in this, however. Although atmospheric water only makes up 0.4 per cent of all water, it has a profound effect on our lives at present.

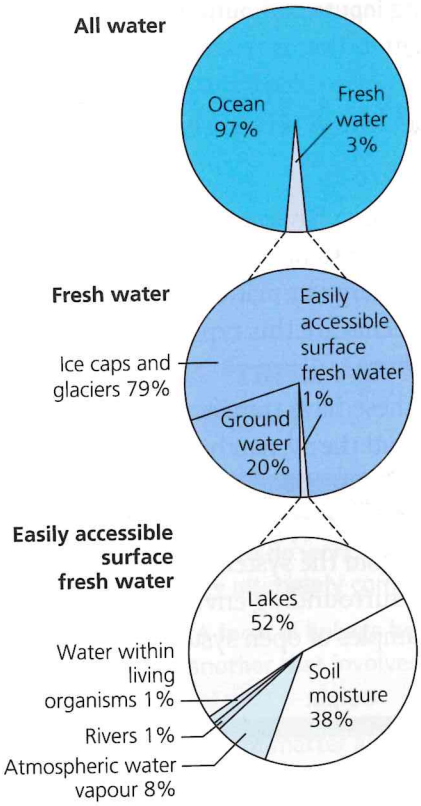


Figure 1.5 The distribution of the world's water

The amount of water in these stores is in a state of dynamic equilibrium with changes at a range of timescales from diurnal to geological. Changing amounts of atmospheric water in the future could be a major cause and/or important effect of climate change.

Oceanic water

The oceans dominate the amount of available water. The exact amount is unknown with figures varying from 1,320,000,000 to 1,370,000,000 km^3 with an average depth of 3,682 m. That difference is greater than the sum of all the rest of the water put together. They cover approximately 72 per cent of the planet's surface (3.6×10^8 km^2). They are customarily divided into several principal oceans and smaller seas. Although the ocean contains 97 per cent of the Earth's water, oceanographers have stated that only 5 per cent has been explored.

Oceanic water tastes salty because it contains dissolved salts. These salts allow it to stay as liquid water below 0°C. They are alkaline with an average pH of about 8.14. The pH has fallen from about 8.25 in the last 250 years and it seems destined to continue falling. This change in the pH is linked to the increase in atmospheric carbon and may have a profound influence on marine ecosystems.

The cryosphere

The cryosphere is those portions of the Earth's surface where water is in solid form. Figure 1.6 shows the five locations of cryospheric water.

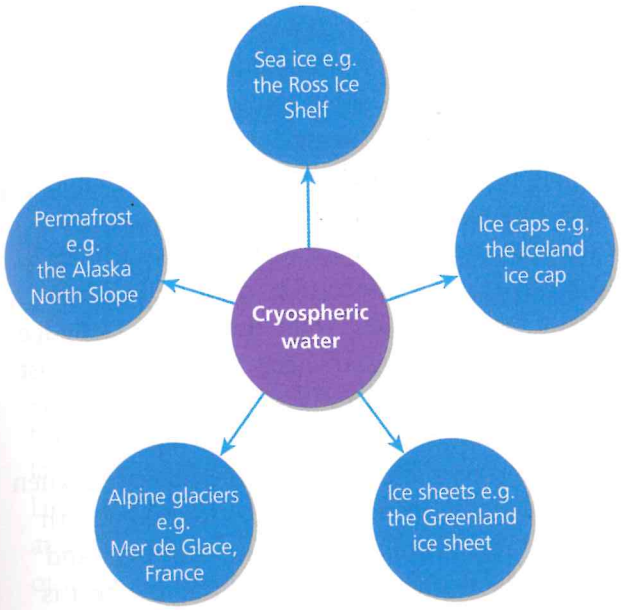


Figure 1.6 The locations of cryospheric water

Sea ice

Much of the Arctic Ocean is frozen; the amount of which grows in winter and shrinks in summer. The same is true of the waters surrounding Antarctica. Sea ice forms when water in the oceans is cooled to temperatures below freezing. Sea ice does not raise sea level when it melts, because it forms from ocean water. It is closely linked with our planet's climate, so scientists are concerned about its recent decline.

Figure 1.7 Chunks of broken sea ice in Yelverton Bay, Ellesmere Island, Canada

Ice shelves are platforms of ice that form where ice sheets and glaciers move out into the oceans. Ice shelves exist mostly in Antarctica and Greenland, as well as in the Arctic near Canada and Alaska. Icebergs are chunks of ice that break off glaciers and ice shelves and drift in the oceans. They raise sea level only when they first leave land and push into the water, but not when they melt in the water.

Ice sheets

An ice sheet is a mass of glacial land ice extending more than 50,000 km^2. The two major ice sheets on Earth today cover most of Greenland and Antarctica. During the last ice advance, ice sheets also covered much of North America, northern Europe and Argentina.

Figure 1.8 Mountains rising out of part of the Greenland ice sheet

Together, the Antarctic and Greenland ice sheets contain more than 99 per cent of the freshwater ice on Earth. The Antarctic Ice Sheet extends almost 14 million km^2, roughly the area of the United States and Mexico combined. It contains 30 million km^3 of ice. The Greenland Ice Sheet extends about 1.7 million km^2, covering most of the island of Greenland.

Ice sheets form in areas where snow that falls in winter does not melt entirely over the summer. Over thousands of years, the layers of snow pile up into thick masses of ice, growing thicker and denser as the weight of new snow and ice layers compresses the older layers. Ice sheets are constantly in motion, slowly flowing downhill under their own weight. Near the coast, most of the ice moves through relatively fast-moving outlets called ice streams. This type of glacier is significant in the Antarctic

where they can be up to 50 km wide, 2 km thick and hundreds of kilometres long. As long as an ice sheet accumulates the same mass of snow as it loses to the sea, it remains stable.

Ice sheets contain enormous quantities of frozen water. If the Greenland Ice Sheet melted, scientists estimate that sea level would rise about six metres. If the Antarctic Ice Sheet melted, sea level would rise by about 60 m.

Ice caps

Ice caps are thick layers of ice on land that are smaller than 50,000 km². They are usually found in mountainous areas. Ice caps tend to be dome-shaped and are centred over the highest point of an upland area. They flow outwards, covering almost everything in their path and becoming the major source for many glaciers.

Ice caps occur all over the world, from the polar regions to mountainous areas such as the Himalayas, the Rockies, the Andes and the Southern Alps of New Zealand. The Furtwangler Glacier on Kilimanjaro, at 60,000 m², is Africa's only remaining ice cap. It is melting rapidly and may soon disappear.

Figure 1.9 The Furtwangler ice cap. The last ice cap in Africa

Alpine glaciers

Alpine glaciers are thick masses of ice found in deep valleys or in upland hollows. Most valley glaciers are fed by ice from ice caps or smaller corrie glaciers. These glaciers are particularly important in the Himalayas where about 15,000 Himalayan glaciers form a unique reservoir which supports perennial rivers such as the Indus, Ganges and Brahmaputra which, in turn, are the lifeline of millions of people in South Asian countries (Pakistan, Nepal, Bhutan, India and Bangladesh).

Permafrost

Permafrost is defined as ground (soil or rock and included ice or organic material) that remains at or below 0°C for at least two consecutive years. The thickness of permafrost varies from less than one metre to more than 1,500 m. Most of the permafrost existing today formed during cold glacial periods and has persisted through warmer interglacial periods, including the Holocene (the last 10,000 years). Some relatively shallow permafrost (30 to 70 m) formed during the second part of the Holocene (the last 6,000 years) and some during the Little Ice Age (from 400 to 150 years ago). Subsea permafrost occurs at close to 0°C over large areas of the Arctic continental shelf, where it formed during the last glacial period on the exposed shelf landscapes when sea levels were lower. Permafrost is found beneath the ice-free regions of the Antarctic continent and also occurs beneath areas in which the ice sheet is frozen to its bed.

The permafrost has begun to melt as climate warms. This melting is releasing large amounts of carbon dioxide and methane, potentially affecting global climates.

Terrestrial water

Terrestrial water falls into four broad classes:

- surface water
- groundwater
- soil water
- biological water.

Surface water

Surface water is the free-flowing water of rivers as well as the water of ponds and lakes.

- **Rivers** act as both a store and a transfer of water; they are streams of water within a defined channel. They transfer water from the ground, from soils and from the atmosphere to a store. That store may be wetlands, lakes or the oceans. Rivers make up only a small percentage (0.0002 per cent) of all water, covering just 1,000,000 km² with a volume of 2,120 km³. One river alone, the Amazon in South America, is the largest river in the world by **discharge** of water, averaging a discharge of

about 209,000 m³/s, greater than the next seven largest independent rivers combined. It drains an area of about 7,050,000 km² and accounts for approximately one-fifth of the world's total river flow. The portion of the river's drainage basin in Brazil alone is larger than any other river's basin. The Amazon enters Brazil with only one-fifth of the flow it finally discharges into the Atlantic Ocean, yet already has a greater flow at this point than the discharge of any other river.

- **Lakes** are collections of fresh water found in hollows on the land surface. They are generally deemed a lake if they are greater than two hectares in area. Any standing body of water smaller than this is termed a pond.

  The majority of lakes on Earth are freshwater, and most lie in the Northern Hemisphere at higher latitudes. Canada has an estimated 31,752 lakes larger than 3 km² and an estimated total number of at least 2 million. Finland has 187,888 lakes 500 m² or larger, of which 56,000 are large (10,000 m²).

  The largest lake is the Caspian Sea at 78,200 km³. It is a remnant of an ancient ocean and is about 5.5 million years old. It is generally fresh water, though becomes more saline in the south where there are few rivers flowing into it. The deepest lake in the world is Lake Baikal in Siberia with a mean depth of 749 m and a deepest point at 1,637 m.

- **Wetlands:** The **Ramsar Convention** defines wetlands as 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing where there is a dominance by vegetation'.

  They are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season. Water saturation determines how the soil develops and the types of plant and animal communities living in and on the soil. Wetlands may support both aquatic and terrestrial species. The prolonged presence of water creates conditions that favour the growth of specially adapted plants and promotes the development of characteristic wetland soils.

  Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation and other factors, including human disturbance. They are found from the polar regions to the tropics and on every continent except Antarctica.

The Pantanal wetlands

The Pantanal of South America is often referred to as the world's largest freshwater wetland system. It extends through millions of hectares of central western Brazil, eastern Bolivia and eastern Paraguay (Figure 1.10).

It is a complex system of marshlands, flood plains, lagoons and interconnected drainage lines. It also provides economic benefits by being a huge area for water purification and groundwater discharge and recharge, climate stabilisation, water supply, flood abatement, and an extensive, transport system, among numerous other important functions.

Figure 1.10 The location of the Pantanal wetlands (shown in dark green)

Wetlands are the main ecosystem in the Arctic. These peatlands, rivers, lakes, and shallow bays cover nearly 60 per cent of the total surface area. Arctic wetlands store enormous amounts of greenhouse gases and are critical for global biodiversity.

Groundwater (lithosphere)

Groundwater is water that collects underground in the pore spaces of rock (Figure 1.11, page 8). Scientists have set a lower level for groundwater at a depth of 4,000 m but it is known that there are large quantities of water below that. A very deep borehole in the Kola Peninsula in Northern Russia found huge quantities of hot mineralised water at a depth of 13 km.

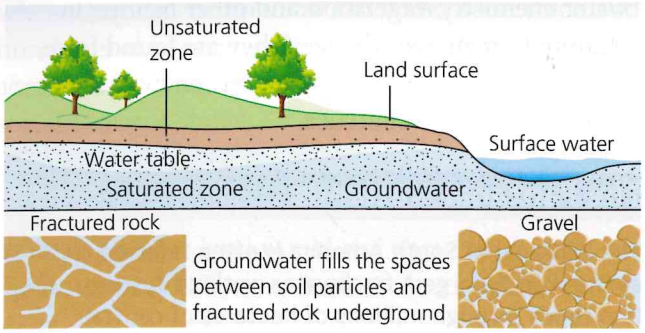


Figure 1.11 Groundwater

The depth at which soil pore spaces or fractures and voids in rock become completely **saturated** with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface. Natural discharge often occurs at springs and seeps, and can form oases or wetlands. The amount of groundwater is reducing rapidly due to extensive extraction for use in irrigating agricultural land in dry areas.

Soil water

Soil water is that which is held, together with air, in unsaturated upper weathered layers of the Earth. It is of fundamental importance to many hydrological, biological and biogeochemical processes. It affects weather and climate, **run-off** potential and flood control, soil erosion and slope failure, reservoir management, geotechnical engineering and water quality. Soil moisture is a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through **evaporation** and plant **transpiration**. As a result, soil moisture plays an important role in the development of weather patterns and the production of precipitation.

Biological water

Biological water constitutes the water stored in all the biomass. It varies widely around the globe depending on the vegetation cover and type. Areas of dense rainforest store much more water than deserts. The role of animals as a water store is minimal.

Trees take in water via their roots. This is either transported or stored in the trunk and branches of the tree. The water is lost by the process of transpiration through stomata in the leaves. This storage provides a reservoir of water that helps maintain some climatic environments. If the vegetation is destroyed, this store is lost to the atmosphere and the climate can become more desert-like. Many plants are adapted to store water in large quantities. Cacti are able to gather water via their extensive root system and then use it very slowly until the next rainstorm. The baobab tree stores water, but it is thought that this is to strengthen the structure of the tree rather than to be used in tree growth.

The atmosphere

Atmospheric water exists in three states. The most common atmospheric water exists as a gas: water vapour. This is clear, colourless and odourless and so we take its presence for granted. This atmospheric water vapour is important as it absorbs, reflects and scatters incoming solar radiation, keeping the atmosphere at a temperature that can maintain life. The amount of water vapour that can be held by air depends upon its temperature. Cold air cannot hold as much water vapour as warm air. This results in air over the poles being quite dry, whereas air over the tropics is very humid.

A small increase in water vapour will lead to an increase in atmospheric temperatures. This becomes positive feedback as a small increase in global temperature would lead to a rise in global water vapour levels, thus further enhancing the atmospheric warming.

Cloud is a visible mass of water droplets or ice crystals suspended in the atmosphere. Cloud formation is the result of air in the lower layers of Earth's atmosphere becoming saturated due to either or both of two processes: cooling of the air and an increase in water vapour. When the cloud droplets grow they can eventually fall as rain.

Factors driving the change in magnitude of water stores

Water exists on Earth in three forms: liquid water, solid ice and gaseous water vapour. Figure 1.12 shows the processes that occur as water changes from one state to another. Energy, in the form of latent heat, is either absorbed or released depending on the process. This is particularly important in atmospheric processes such as cloud or precipitation formation.

In Human Geography you will begin with the topic **'Contemporary Urban Environments'.**

The first section of the specification states for you to cover:

Urbanisation
Urbanisation and its importance in global affairs.
Global pattern of urbanisation since 1945.
Urbanisation: Characteristics, causes and effects (HIC/NEE/LIC differences)
Suburbanisation: Characteristics, causes and effects
Counterurbanisation: Characteristics, causes and effects
Urban resurgence: Characteristics, causes and effects
The emergence of megacities and world cities and their role in global and regional economies.
Economic, social, technological, political and demographic processes associated with urbanisation and urban growth.
Urban change: deindustrialisation, decentralisation, rise of service economy.

To provide an introduction to this you should complete all of the reading (pages 1-12 of the PDF document. You may want to do some extra research and reading on this topic, some additional articles and links are suggested below.

Use what you have learnt to answer the following questions on an online document which can be sent to your teacher ready for the first week.

1. What are the main characteristics of urban areas, and how do they differ from rural areas?
2. Explain the global patterns of urbanisation over the past 500 years.
3. What is suburbanisation, and what are its causes and effects?
4. What is counter-urbanisation, and why is it increasing?
5. How do megacities contribute to national and regional economies?
6. What are world cities, and how do they differ from megacities?
7. Discuss the social, economic, and technological impacts of urbanisation.
8. What are the advantages and disadvantages of urbanisation?

9. How does urbanisation differ between high-income countries (HICs) and low-income countries (LICs)?
10. Explain the concept of urban sprawl and its relationship with suburbanisation

Supporting articles

1. **Urban vs. Rural Characteristics**

- **Source:** *The Guardian* – No 10 climbs down over welfare bill

  https://www.theguardian.com/politics/2025/jun/27/no-10-climb-down-over-welfare-bill-move-win-rebels

  - While primarily about welfare policy, this article touches on urban-rural divides in public service access and economic disparities.

2. **Global Urbanization Trends**

- **Source:** *Oxford Economics* – The world's leading Sustainable Cities

  The world's leading Sustainable Cities: Built for long-term prosperity | Oxford Economics

  - Discusses how urbanization has accelerated, with cities now housing a third of the global population and driving economic growth, but also facing climate challenges 2.

3. **Suburbanisation: Causes & Effects**

- **Source:** *Slate* – The End of Sprawl

  https://slate.com/business/2025/06/suburban-sprawl-florida-arizona-construction-places-to-live.html

  - Examines how Sun Belt suburbs (e.g., Atlanta, Phoenix) are resisting further development due to infrastructure strain, signalling a shift away from sprawl 3.

4. **Counter-Urbanisation**

- **Source:** Number Analytics – The economics of counter urbanisation

  https://www.numberanalytics.com/blog/economics-counterurbanization

5. **Megacities & World Cities**

- **Source:** *Irish Star* – Tokyo: World's Biggest Megacity in 2025

  https://www.irishstar.com/news/us-news/tokyo-tops-global-city-populations-35250264

  - Details Tokyo's role as a megacity (37M people) and contrasts it with "world cities" like London, which focus on global influence rather than size 4.

6. **Impacts of Urbanisation**

- **Source:** *Forbes* – 8 Smart City Trends Reshaping Urban Life

https://www.forbes.com/sites/bernardmarr/2025/01/09/8-critical-smart-city-trends-reshaping-urban-life-in-2025/

  - Covers economic, social, and tech impacts, including AI-driven governance and climate-resilient infrastructure 7.

11. What are the main characteristics of urban areas, and how do they differ from rural areas? 1
    Urban areas are towns or cities with high population density, where most employment is not in agriculture. 2 In contrast, rural areas are small villages or hamlets with low population density, and agriculture is often the primary source of employment. 1 The two are mutually exclusive.

12. Explain the global patterns of urbanisation over the past 500 years. 3
    Urban populations remained relatively constant until post-1800, when urbanisation began to increase, especially in high-income countries. 3
    Rates of urbanisation grew rapidly in the mid-20th century, with 55% of the global population living in urban areas by 2016, up from 30% in 1950. 4
    Urban populations are expected to rise to 68% by 2050. 5

13. What is suburbanisation, and what are its causes and effects? 6
    Suburbanisation occurs when urban areas expand, absorbing nearby rural settlements into suburban areas. 6 It is often driven by wealthier people seeking better quality of life, larger homes, and more greenery. 7
    However, it can lead to inner-city deprivation, increased house prices in suburbs, and urban sprawl, which may require strategies like green belts to limit expansion. 8

14. What is counter-urbanisation, and why is it increasing? 9
    Counter-urbanisation is the process of people moving out of cities into rural areas, often due to dissatisfaction with urban life, such as overcrowding, pollution, and poor living conditions. 9 Modern advancements like improved transport links and technology make rural living more viable, allowing people to commute while enjoying cleaner air, more space, and better value housing. 10

15. How do megacities contribute to national and regional economies? 11
    Megacities, defined as urban areas with populations over 10 million, play a significant role in economic growth due to their large workforce and concentration of business investments. 11 They drive rapid economic development and often act as hubs for innovation and industry. 11
    However, they also face challenges like overpopulation and resource strain. 12

16. What are world cities, and how do they differ from megacities? 13
    World cities, such as London, New York, and Tokyo, are defined by their global political and economic influence rather than population size. 14
    They are hubs for banking, finance, and culture, with excellent transport links and significant roles in driving global economies. 15 Unlike megacities, their importance lies in their impact on world affairs. 14

17. Discuss the social, economic, and technological impacts of urbanisation.
    Urbanisation increases multiculturalism, improves access to jobs, education, and healthcare, and creates cultural hubs. 16 Economically, it shifts employment from primary to tertiary sectors, drives business growth, and boosts economic development. 17 Technologically, urban areas often become centres for innovation, such as Silicon Valley, and are the first to adopt new technologies like smart cities. 18

18. What are the advantages and disadvantages of urbanisation?
    Advantages include improved access to healthcare, education, and jobs, reducing mortality and fostering city development. 16 Disadvantages include unplanned housing, water pollution, exploitation of the poor, and social divides. 19 Overpopulation and lack of resources can lead to urban poverty and the emergence of squatter settlements. 20

19. How does urbanisation differ between high-income countries (HICs) and low-income countries (LICs)? 21
    In HICs, urbanisation is often planned, with better infrastructure and regulations, while LICs experience rapid and unmanageable urban growth. In HICs, suburban areas are well-developed with larger homes and green spaces, whereas LICs often have informal settlements or slums on the outskirts due to poverty and lack of affordable housing. 22

20. Explain the concept of urban sprawl and its relationship with suburbanisation. 23
    Urban sprawl refers to the expansion of urban areas into surrounding rural areas, often driven by suburbanisation. 23 As demand for suburban housing increases, rural settlements are absorbed into urban areas. 6 While suburbanisation offers better living conditions, it can lead to environmental degradation, loss of rural land, and increased infrastructure costs. Strategies like green belts aim to limit urban sprawl.

To provide an introduction to this you should complete all of the reading, following the links below. You may want to do some extra research and reading on this topic.

They cover the themes of rapid urbanisation and the 21st century challenges that the process creates:

Growing Pains, Mark Rowe – attached as PDF

https://21stcenturychallenges.org/urbanisation-2/

https://geographical.co.uk/culture/rapid-population-growth

https://www.theguardian.com/cities/2018/mar/21/people-pouring-dhaka-bursting-sewers-overpopulation-bangladesh

https://www.theguardian.com/cities/2018/mar/19/urban-explosion-kinshasa-el-alto-growth-mexico-city-bangalore-lagos

https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

https://www.theguardian.com/global-development/2014/jul/10/urban-population-growth-africa-asia-united-nations

Once complete, please use the information and write an answer to the following question:

What is urbanisation? Why is it an important global issue?

It is recommended that you write approximately 500-1000 words.

Please have this work ready to hand to your Human Geography teacher (Miss Heath) during your first lesson in September.

AQA Geography A-level

3.2.3: Contemporary Urban Environments

Detailed Notes

Urbanisation

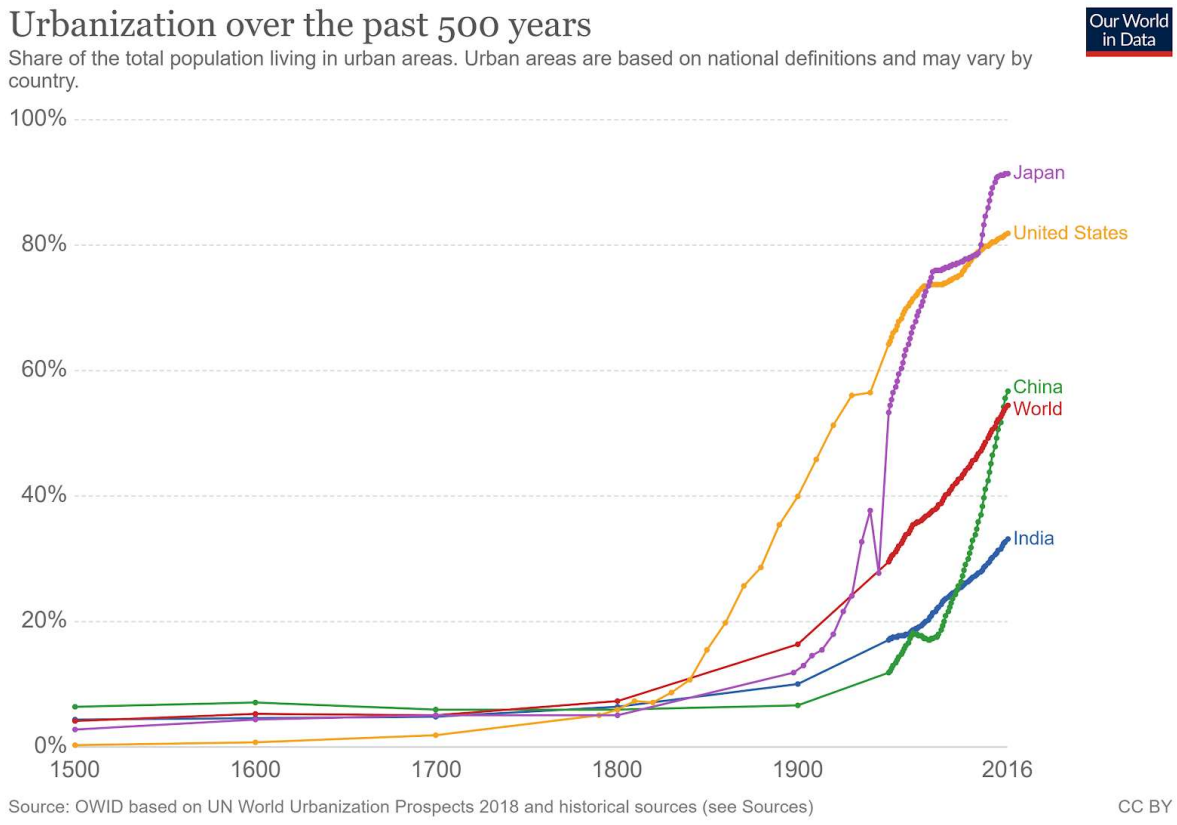
Urbanisation is defined as the **increase of the proportion of people moving to urban areas**.

There is no **standard definition** of a rural or urban area, therefore there may be some **ambiguity** as to what some areas should be defined as.

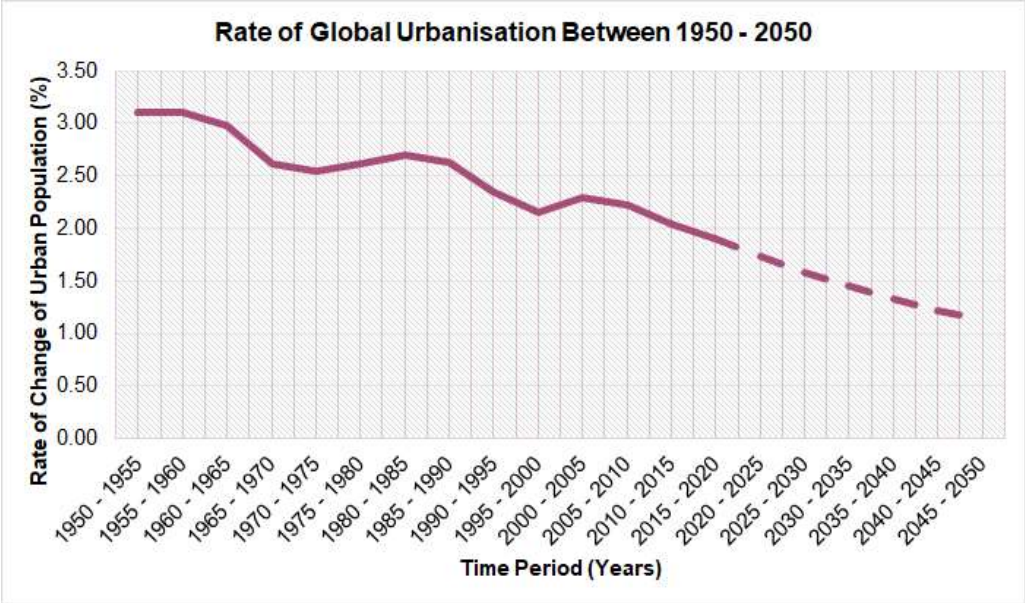
However in general, **urban** areas are **towns or cities** which have a **high population density** and the majority of the employment is **not in agriculture**. **Rural** areas are **small villages, hamlets and areas of land** with a **low population density**. If an area is not urban, it is rural (and vice versa - the two are mutually exclusive).

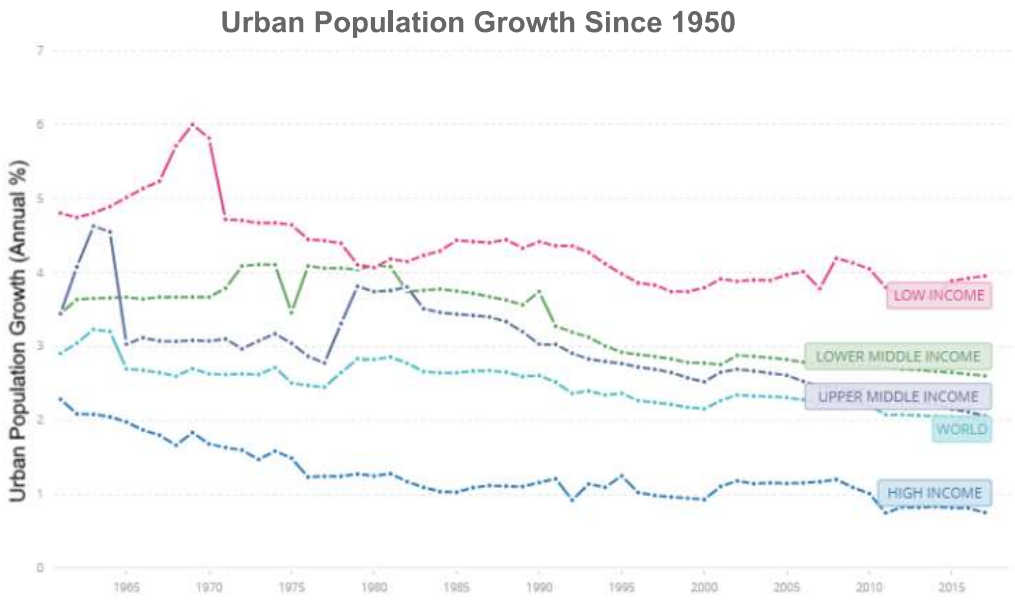
Global Patterns of Urbanisation

Urban populations have stayed **relatively constant** in the past 500 years until post-1800, where urban populations began to increase (especially in high income countries which were developing at a faster rate). Globally, urbanisation rates began to grow rapidly in the mid-20th century. The **amount of people moving to urban areas is increasing** globally.



The **rate of urbanisation** is **decreasing**, and the **rate of rural to urban migration is decreasing also**, meaning population growth in urban areas is **slowing**.

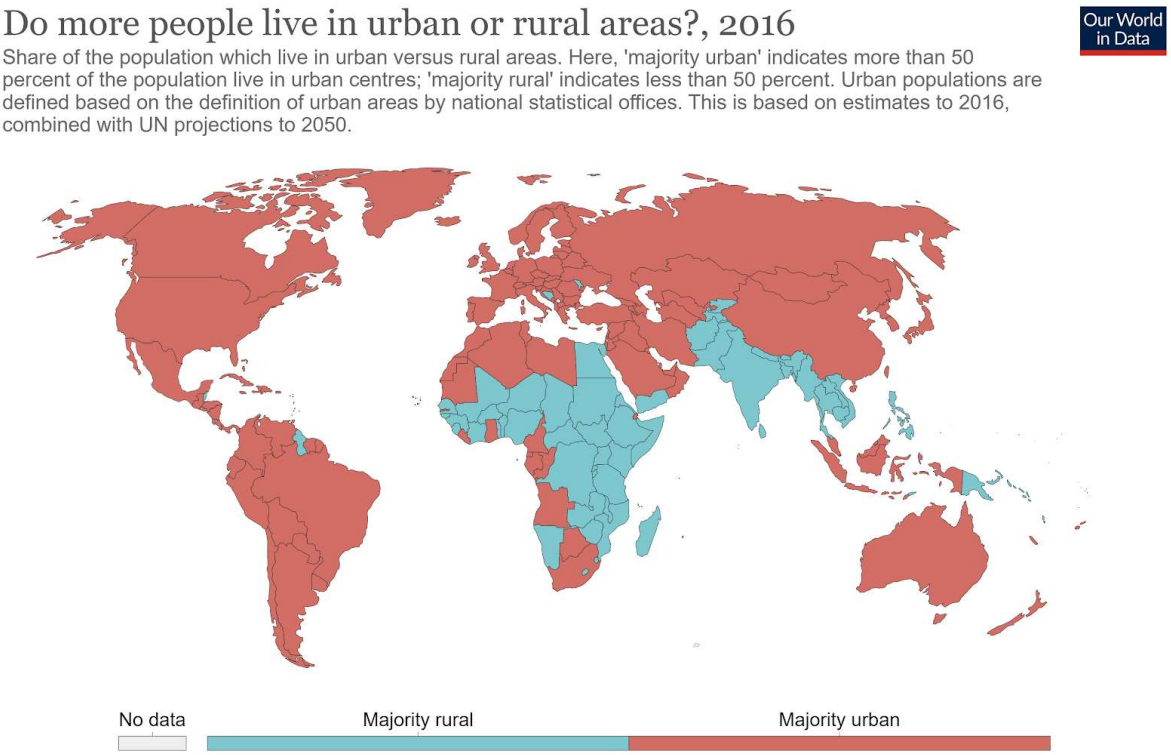




(Source: https://data.worldbank.org)

On a global scale, there are more people living in **urban** areas than **rural** areas.

- **55% of people live in urban areas** which is a 25% increase from 1950.
- Urban populations are expected to increase even more by 2050 to 68%.
- Since 1950, the world's **urban population** has increased from **750 million people to 4.2 billion.** More urbanisation statistics and information can be explored here (https://population.un.org/wup/)
- Usually, the proportion of those living in urban areas is higher in HICs than LICs.



Global urbanisation continues to increase; **suburban** areas are becoming more **urbanised**, and surrounding **rural** areas are becoming **suburbanised** (the process of an urban area spreading and becoming larger is known as **urban sprawl**). Urbanisation is increasing majorly due to high rates of **migration** from rural areas to urban areas.

Suburbanisation

Suburbanisation is where **urban areas grow** so that **rural settlements** such as villages become **absorbed into the urban areas** and engulfed by the city (becoming a suburban area i.e. an area close enough to the urban area to **commute**).

Suburbanisation usually occurs when **wealthier people** decide to move **away from the central city** into the suburbs in search of **a better quality of life**. The higher demand for this housing causes the **suburban area to grow** to meet demand.

(Source: https://garsidej.wordpress.com)

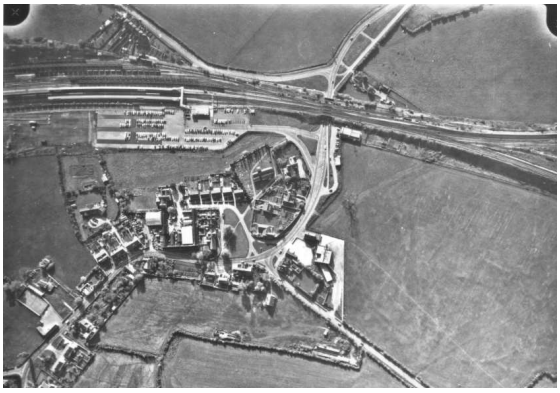
An example of an area going through **suburbanisation** is Stoke Gifford in South Gloucestershire. Located approximately 5 miles away from the city of Bristol, Stoke Gifford has urbanised in correlation with Bristol's **urban sprawl**.

The population has grown by **40%** from 2001-2011, and the area underwent **rapid urbanisation** in the 20th century, from a village to a suburban area. Are there any similar examples in your urban area?

1962

2018

1975



2018

(Source:stokegiffordhistory.wordpress.com//)

(Source: Google Earth)

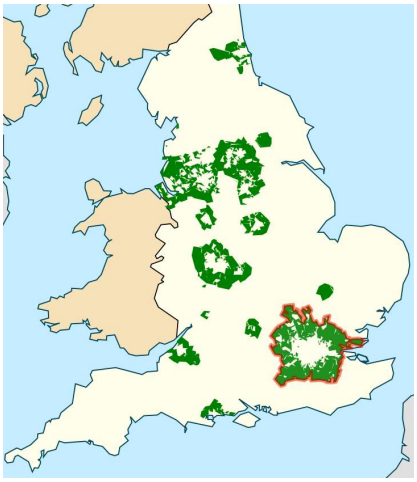
When urbanisation takes place, there is a **larger population to accommodate**, meaning the demand for **suburbs** (an area close to an urban area, but with more space, larger houses, more greenery like parks etc.) increases and the **suburban area expands**.

Issues with Suburbanisation

Suburbanisation's major **disadvantage** is that it can lead to **inner-city areas becoming deprived** and house prices within the suburbs increasing. In order to limit **urban sprawl**, strategies to limit **suburbanisation** can be put in place. An example of this is a **green belt**, which is an area around a city where building is **restricted** in order to preserve **rural areas**.

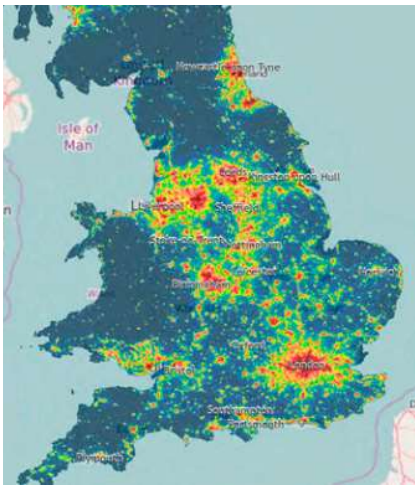
England's Green Belts

The Metropolitan green belt is outlined in red.
(Source: https://en.wikipedia.org/wiki/Metropolitan_Green_Belt)

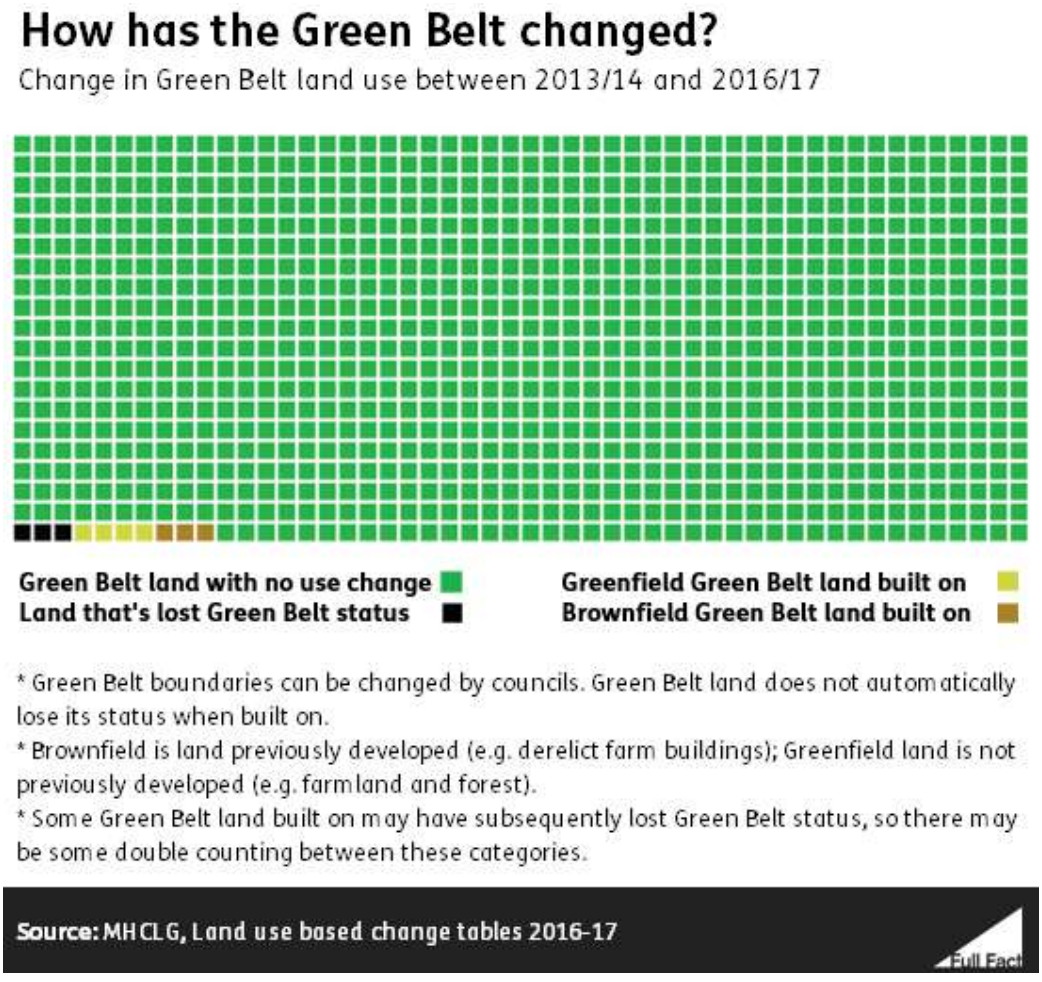


England's Cities

Shown by **light pollution levels**.
(Source: https://www.cpre.org.uk/)



However, green belts are **not always successful**; developers can work to remove green belt status in order to build on the land.



Counter-urbanisation

Counter-urbanisation is the process of people **moving out of cities** into rural areas. This process occurs as people seek for a **better quality of life** due to **urban quality of life being unsatisfactory**: i.e. overcrowding, pollution, poor quality of built environment and so on.

Modern **technological** and **socio-economic** advancements means there are **less drawbacks living in a rural area** than previously, e.g. transport links allow people to commute, meaning people are not missing out on work by living in a less urban area.

Key Term:	Urbanisation	Counter-Urbanisation
Explanation	The process of how a urban area grows as a process of increasing proportions of people living in urban areas. Urbanisation is the result of urban to rural migration	The opposite of urbanisation and is the process of the proportion of people living in rural areas increasing. It is a result or urban-rural migration
Push Factors	Famine, drought, poor healthcare, isolation	Pollution, large industrial areas, economic decline, overcrowding
Pull Factors	Oppurtunities, jobs, education, better healthcare, hope	Clean air, more space, countryside, better value housing
Advantages	Population more likely to gain skills and have access to better healthcare, reducing mortality. City develops over time, with more workers for infrastructure projects etc.	Forces inner-city urban areas to regenerate - or face collapse. Helps reduce overcrowding and housing shortages. E.g. commuter towns
Disadvantages	Increase in unplanned housing posing a great risk to the population during natural disasters. Water pollution increases and the poor are likely to be exploited. Large social divide in cities	Higher rural house prices, more traffic and congestion, less public transport use in villages. Conflict between existing elderly population and new residents
Examples	Mumbai	St Ives

Counter-urbanisation is **increasing**, but it does not **overtake urbanisation rates**, which is why urbanisation is overall still **increasing**. Between 1971 and 1991 the number of people living in the centre of UK cities **declined**. However, the population living in cities has **doubled since 2001**.

Urban Resurgence

Urban resurgence (also known as re-urbanisation) is the process of people moving **back into the city**, especially after the deterioration of the area.

(Source:https://www.thetimes.co.uk)

Urban resurgence usually occurs when schemes (created by councils and governments) are put in place that aim to **improve the quality of life in the city area**. These schemes encourage the city centre to economically grow and **regenerate.**

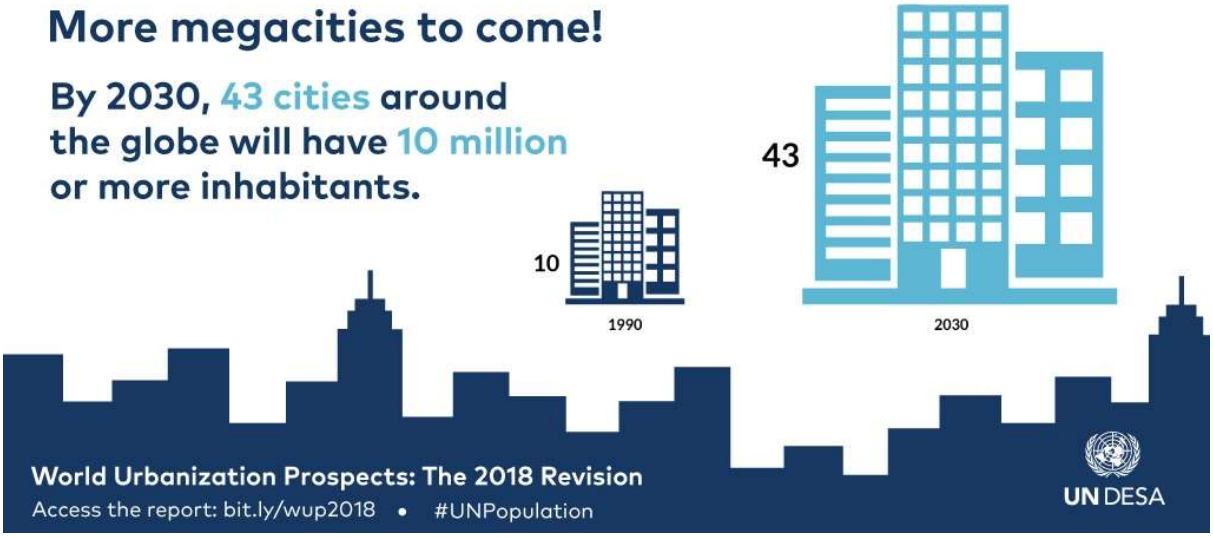
City centres are the location of **72% of all highly skilled jobs** and are 21% more productive than non-urban areas.

Urban resurgence can cause socioeconomic inequalities, as **gentrification** and **excess wealth** in the newly redeveloped areas mean that the **original population** can struggle to keep up with **higher prices** for housing and living.

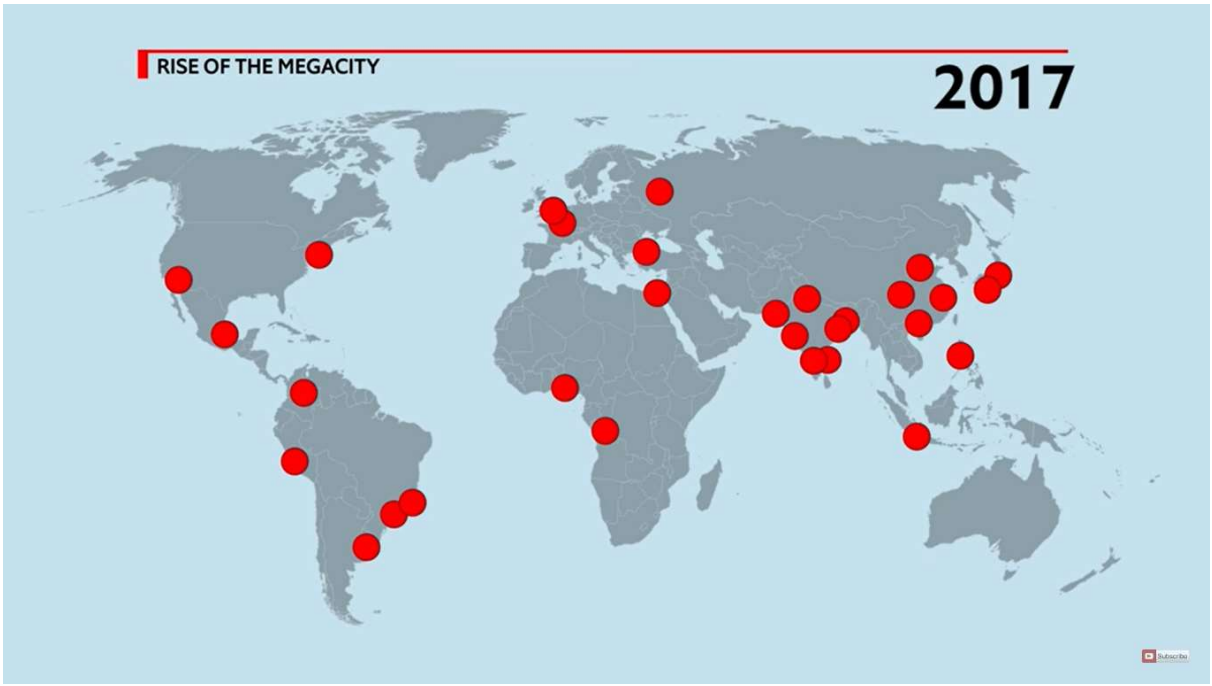
Megacities

Megacities are **urban areas with a very high population,** specifically a population of **over 10 million people** according to the **United Nations Department of Economic and Social Affairs (UNDESA)**.

The amount of megacities has been rising since urbanisation began; in the 1950s there were only 2 known megacities - **New York** and **Tokyo**. This number is rising quickly, and as of 2016 there were 31 megacities globally. The number of megacities is projected to increase along with urbanisation, and UNDESA project that **by 2030 there will be 43 megacities**.



More than two thirds of all megacities are concentrated within developing nations, and Asia accounts for over half of the world's megacities.



(Source: www.youtube.com/watch?v=JDS_BqDeZ4k)

Megacities have an integral role in contributing to national and regional economies, as the large workforce allows for **rapid economic growth** compared to the rest of the country. Also, business investments are usually concentrated within megacities, exemplifying growth.

World Cities

The growth in urbanisation has also led to the emergence of **world cities** globally (world cities are also referred to as **global cities**).

World cities are cities that have **significant political and economic influence** on a **global scale**. Unlike megacities, they are not defined by their **size** or **population**, but by their **importance** to world affairs. Examples of world cities include London, New York, and Tokyo.

These cities usually drive **global economies** and **business**, and are often hubs for banking and finance.

World cities are also characterised for their **rich culture** and **influence over social affairs** within the city and throughout the world. They are also **connected to the rest of the world** via excellent transport links, exemplifying their presence in the globalised world.

Tokyo (Source: www.japantimes.co.jp)

Dubai (Source: https://gulfnews.com)

Processes Associated with Urbanisation

Urbanisation causes cities to develop and change in different ways:

Social

- People from **different social and cultural backgrounds** migrate into the city, increasing multiculturalism and making cities more **diverse**.
- Urbanised areas develop into **cultural hubs**, hosting a multitude of **galleries, museums, theatres, shopping centres etc**. increasing quality of life for those living in the city.
- Urbanisation improves access to different **jobs**, **education**, **healthcare** services etc. due to larger investments within cities.
- Access to a **wide range of jobs** increases income, positively affecting quality of life.

Economic

- Urbanisation leads to a **shift in employment** from **primary sector** (e.g. agricultural industry) to **tertiary sector** (e.g. finance industry) jobs. This increase in **higher wage jobs** leads to **economic development** in urban areas.
- The **rural-urban migration** associated with urbanisation brings a **large population to urban areas**. This means more people are **working and contributing to the economy**, thus developing it. Consequently, the economy may **decline** in areas where people have migrated **away from** as there are less people contributing to the economy.
- **Urban growth** leads to the **development of a range of businesses and industries** that drive the economy.
- **Economic inequalities** may arise due to unsustainable urbanisation. Overpopulation and lack of resources can cause many of the population to struggle maintaining a satisfactory quality of life, especially when **the cost of living is higher**. An example of this is the emergence of urban squatter settlements, such as the Brazilian favelas or Dharavi in Mumbai.

Technological

- **Urban areas** often become **centres for technological advancement**, with many cities developing into technology capitals, such as Silicon Valley.
- New technology is often **introduced into cities first** as there is a **higher demand** for it, e.g. the development of 'Smart Cities'.

Political

- **Central political institutions** are almost always in the capital, making these urban areas the focus of political activities.
- Political movements are usually more prevalent in cities, for example how Extinction Rebellion often targets areas like London.

Demographic

- Cities host a lot of cultural diversity, making the demographic more **diverse**.
- The demographic in cities is usually predominantly **young adults**, as many move to urban areas for **education, better social life, and employment opportunities**.
- **Older people** tend to move away from cities into the suburbs in search of a better quality of life, also altering the demographic of urban areas.

Urban Change

Urban areas are **dynamic**, and many have **experienced changes** due to different processes acting within society. In the past half-century, many urban areas have experienced phenomena such as **deindustrialisation**, the rise of the **service economy**, and **decentralisation**, which have helped shape these environments.

Deindustrialisation

Deindustrialisation is the decline of industry within a country, usually measured by the **reduction of industry employment.** Deindustrialisation began in the **mid-20th century** in **developed countries**, though in recent decades the process is apparent in **developing countries**.

Deindustrialisation has happened on a mass scale in western society due to the struggle for industries to compete with **cheaper labour and manufacturing costs** in countries such as in China, Singapore and Taiwan).

(source: www.ft.com)

Characteristics of deindustrialised places

Economic restructuring on a large scale has ultimately left some people and places behind through **unemployment**. When the major source of employment for a community closes down and there is **insufficient support** to create new suitable employment opportunities by the government, masses of people are left without a source of income which directly **depletes quality of life**. This has caused increasing levels of **social deprivation**, worsening health, education, crime, access to services and the living environment. This is the case both in deindustrialised **urban** areas and **rural** settlements which were once dominated by primary and secondary economic activity such as **agriculture** and **manufacturing**.

This pattern of deindustrialisation was seen across many places in the UK in the **1980s** and **1990s**, particularly in the North and in Wales. Deindustrialised cities such as Blackburn and Stoke are categorised as 'low wage, high welfare cities', with places like Cardiff classed as 'low wage, low welfare.' The best achieving cities, such as London, Cambridge and Reading are classed as 'high wage, low welfare.' Cities with the highest percentage of low earners tend to be **19th century industrial** regions, whereas the high-earning cities are associated with employment **diversity** relating to the growth of tertiary and quaternary sectors.

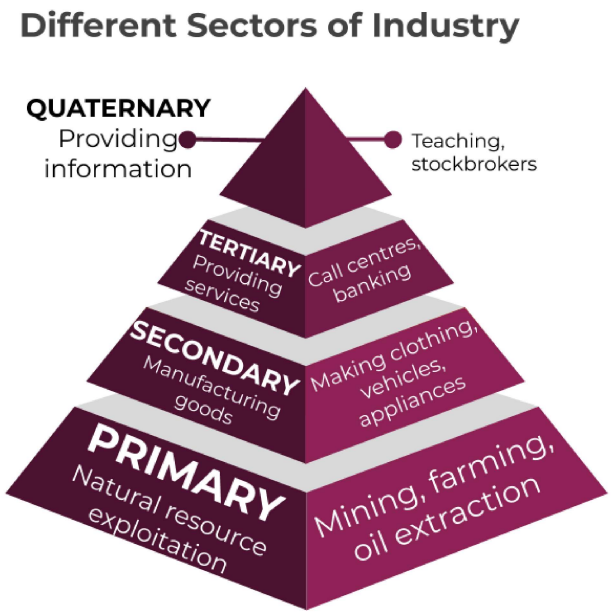
Rise of the Service Economy

A service economy is an economy where the **dominant source of economic growth** is through providing services, rather than goods.

Drivers of the tertiary sector expansion

- **Rising affluence -** services have grown to support the rising **disposable incomes** of individuals who have increased inclination to spend this on the service sector through leisure, entertainment and tourism.
- **Technological change -** technology has enabled industries to expand and relocate without the **barriers of geographical proximity** through transport and communication. **Transport** has expanded the extent of **labour pools** so skilled workers from further distances can have tertiary employment. Changing transport technologies have enabled retailing, offices and leisure industries to **disperse** beyond the city centre, across urban areas. Changing **communications** alter the distribution of the service economy, with **online** booking replacing travel agencies and hotels and conference centres becoming key functions for business life and tourism in most major cities.

Originally, the service sector grew to **support the manufacturing sector**. The **primary and secondary industries** needed the supporting commercial, financial and legal services to allow their **businesses to grow** successfully. Since then it has been the forefront of economic restructuring and is the **dominating sector** in the developed world (largely **concentrated** in urban areas). The rise of the service-based economy has been accompanied by the growth of professional, managerial, technical and creative employment of **highly educated** and **highly paid** persons.



Decentralisation

Decentralisation is the process of **urban developments away from the city centre**, such as large shopping centres or retail parks. Developments are **cheaper away from the city**, as land prices are usually cheaper than within the central business district. **Decentralisation** can cause issues as this drives customers **away from the city centre**, meaning there can be issues with **city centre degradation**.

In recent years there has been the announcement of **closures** of many common staple high street stores such as Marks and Spencer, New Look and House of Fraser. The financial failure of retailers impacts city centres, with **closed frontage altering the image** of the high street. Their replacement may not return the street to its former image, causing the **attractiveness** of the street to fall further and the loss of retail impacts **jobs**.

For example, the Metrocentre in Gateshead is a large shopping centre located a few miles from Newcastle's city centre. The Metrocentre has reduced city centre shopping.

Urban Regeneration in Britain

Following the socioeconomic and environmental effects of deindustrialisation and decentralisation, **urban regeneration** has become a priority for the British government. Since 1979, **urban regeneration policies** have been implemented nationwide to improve the conditions of cities.

1980s - 1998

Urban Development Corporations (UDCs)

UDCs created policies to ensure effective use of land, develop industry, provide social & housing facilities and overall enhance the quality of deteriorated areas. E.g. **The London Docklands Development Corporation** (1981-1998) built 24,000 new homes and created 85,000 jobs in the derelict and deprived London Docklands.

1981 - present

Enterprise Zones

Enterprise Zones are specific areas of land with **economic incentives**, such as **tax breaks** and **government support**, that aim to entice business to invest into an area that would benefit from business. Enterprise Zones still exist throughout the UK, with 24 new zones introduced in 2012, and another 18 zones announced in 2015.

1982 - present

Government Grants

The government created a number of grants that **entice private investors** to **develop and regenerate urban areas**. The Urban Development Grant and Urban Regeneration Grant, later merged into the City Grant (1988), allowed development plans to **bypass local authorities** completely, making developments easier to go ahead.

1992 - 2008

English Partnerships

English Partnerships was a **national regeneration agency** that aimed to develop derelict and underutilised areas. English Partnerships had certain powers to enable regeneration and development. E.g. the organisation could issue **Compulsory Purchase Orders**, which means land could be bought without the consent of the owner, therefore removing barriers to development.

1990s - present

New Initiatives

Several new **'bottom-up'** schemes have been employed in the UK, where the **local community** is encouraged to be a part of the regeneration process, and therefore benefit from it. City Challenge, the Single Regeneration Budget, and European Funding Programmes are all examples of where the social impacts of developments were considered alongside the economic impacts.

Urban Forms

A city's **urban form** refers to the physical characteristics of a city, such as its layout, size, and land-use.

The majority of urban areas are established in areas with **favourable resources**, such as access to water, food, fertile land and security. However, as society progressed, so did the form of urban areas. Urban forms **change over time** in **different ways** based on the **physical factors** of the area and **human influence**.

Physical Factors

- **Natural resources:** Areas rich in **natural resources** can encourage **development** in cities as resources can **support the population** and the **economy**. E.g. local access to **building materials** can support the construction of new buildings. **Coal and oil** can be used for **fuel** or can be **sold**, which promotes development and growth within the city.
- **Water:** Plentiful supplies of water are necessary for agriculture, sanitation, and health. Urban populations with poor water supplies will have to **adapt their land-use** to conserve or optimise water supplies, e.g. by building desalination plants (common in urban areas located in arid environments like Abu Dhabi). Water also acts as a **physical barrier to growth**, as it blocks **urban sprawl**, e.g. on a coastline.
- **Topography:** Areas with a flat topography are easier to build on, meaning **construction** can be more spaced out. Urban sprawl is difficult on **slopes**, especially at steeper, rougher areas, meaning building can be very **densely compacted** into one area that is suitable for building (e.g. the favelas in Rio).
- **Climate and Land-type:** Unstable soils, permafrost, or waterlogged ground surfaces can be **difficult and expensive** to build on, therefore limiting urban growth. Urban form is influenced in several ways, e.g. having to construct buildings on **stilts** in permafrost areas as the ground is impenetrable.

Human Factors

- **Wealth and development:** In richer countries, urban developments are usually **structurally safe** due to **building regulations**, and social/environmental effects are considered. In developing countries, urban growth can be **rapid** and urban sprawl can sometimes be **unmanageable**.Urban growth is severely limited by lack of **wealth**.
- **Planning:** Planned developments are considerate of **space**, **safety**, and **well-being**. E.g., open/green spaces are often incorporated into urban areas to make the area more visually appealing and nicer to be in. **Unplanned developments** can be **unsafe** and potentially overcrowded.
- **Patterns of growth:** Higher value land is usually in the **central business district (CBD)**, and land decreases in value away from it. **Wealthier businesses** occupy the CBD, whereas less wealthy businesses are located **further away**. Business parks and large shopping centres can be located away from the CBD as it is **cheaper**.
- **Economic activities:** Land-use is affected by the **economic activities** of an urban area, e.g. ports may be built for trade.
- **Past developments:** The original structure of a city may change how a city develops, such as limiting construction to protect **listed or important buildings**, or poor transport links as older **roads** may not be wide enough for parked cars and **two-way traffic**.

New Urban Landscapes

Land-use in many cities has developed and changed in recent decades to enhance the **social**, **environmental**, and **economic** aspects of city life. In **more developed countries especially**, planning and investments have allowed the emergence of **new urban landscapes**, for example:

Mixed-use developments

In older developments within city centres, **residential, commercial and industrial** areas were separated into **districts**, rather than **mixed** in one area. This means people have to travel **across cities** if they have multiple needs, e.g. leaving work for **lunch breaks**, commuting to/from work, eating out at a restaurant or going to a bar after shopping etc.

With **mixed-use developments**, different buildings with different uses are all in a **close proximity**, meaning people do not have to **travel around a city** if they want to visit different places.

Cultural and Heritage Quarters

Cultural/heritage quarters are large areas within an urban area that are recognised as having particular **cultural importance**, such as areas with cultural infrastructure or the presence of **historically important sites**. These areas can function as a leisure space, as well as an attraction for tourists.

Edge Cities

An area of business, shops and entertainment services on the outskirts of a city, usually by major transport links. Edge cities develop due to **cheaper land** being available outside of the typical central business district.

Fortress developments

Fortress developments, such as **gated communities**, are where areas are secured off from public access, and only certain people with **permission** are allowed to enter. There may be CCTV, security guards, and physical barriers like large gates to ensure people do not have access to these areas. Fortress developments are used in urban areas to provide a **safe space** for people.

The Post-Modern Western City

The concept of the post-modern western city is the idea that contemporary cities are changing their **industries, architectural style, and land use** in order to keep up with **socioeconomic changes** in society. The term 'western' is used as it is mainly western cities (in wealthier, high income countries) that are following this movement.

- Characterised by **unusual architecture** with strange styles, shapes and symbolism (e.g. the Gherkin in London). Emphasis on aesthetics.
- **Tertiary and quaternary** industries are the main sectors of the economy.
- **Fragmented urban forms** rather than things being concentrated in one area.
- A large amount of **socioeconomic inequality** exists, although more diverse.

Gentrification

Gentrification is the process of **housing improvement** on a **piecemeal** basis associated with low income groups being **displaced** and more **affluent** people moving in.
Gentrification is the consequence of economic and social change in central urban places. Wealthier individuals buy and **renovate** properties in more **run-down** areas, often in the inner city.

Reasons for gentrification:

- **The rent gap -** the **price** of a property has fallen below its **real value** due to a **lack of maintenance** and investment. Those who can afford this renovation make a profit from this.
- A changing **household composition** and demographic- young singles/couples see the **benefits of inner city living** and may be suited to the smaller, cheaper residences available.
- It is desirable to live in the inner city due to the proximity to employment opportunities **reducing commuting costs** and the accessibility to **central entertainment** and the diverse cultural opportunities of an urban centre.
- Sometimes these inner-city areas have a **reputation** of being the new 'hipster' neighbourhood with a **vibrant arts scene** and cultural and creative opportunities and freedom.
- They may be **encouraged locally** by the **council** and local decision makers who can see the benefits of improving the status, class and physical environment of an inner-city area.

The process of gentrification:

1. Lower-middle class incomes, including the creative class, migrate into cheap, outdated, **run-down inner city** places.
2. The pioneers **renovate** their homes, improving the environment.
3. The place gains a **fashionable** status, attracting more young professionals.
4. **Private sector** investors buy and renovate more of the housing.
5. Local government invests in the place as a '**growth pole**'.
6. **Wealthy** migrants and foreign investors move in.
7. House prices increase far beyond the average salary. Local people, especially lower income groups, are **priced out** of the housing market.

Benefits of gentrification	Costs of gentrification
• Rise in the general level of **prosperity** and increasing number and range of services and businesses • Increased **tax** revenue for local authority • Improved physical **environment**	• Low income groups, often those residing in this place previously, get **priced out** of the housing market • A threat to the **community** • **Tension** between new and old residents • Losses to lower order **local services**

Characteristics and Patterns in Contrasting Urban Areas

High income countries and **low income countries** have different **urban characteristics** due to **the different ways in which they develop** and the **different factors influencing development**.

Land-use patterns

There are some **similarities** in land-use between developed and developing urban areas, but also **many differences** caused by the **speed of urbanisation, wealth**, and **regulations**.

The majority of urban areas regardless of their levels of development have a **central business district (CBD)**. This is where **commercial, financial, and business activities are concentrated**. The CBD is usually the oldest part of the city, although new builds do often occur in the CBD. The age of buildings usually decreases **increasing distance from the city centre**, with the newest developments on the **edge of urban areas**.

Land-use in the **inner-city** differs between **high income countries** and **low income countries**. In LICs, high-cost residential areas are usually located within the inner city, such as luxury apartments and higher-class estates. In HICs, the high land price means developments are **densely compacted**, such as high rise flats, where rent is often cheaper, but quality of life is poorer. The inner-city is also where **industrial sites** are usually located, which are often near major transport links also (e.g. motorways).

Surrounding the inner city, sub-urban areas that are higher in value tend to reside in HICs. Effective planning means these areas often have **large open spaces**, and houses are usually **larger** and **more expensive**, especially within **commuting distance to the city**.

In LICs, areas on the **edges of cities** tend to have very **poor quality housing** that have been constructed with little or **no regulations**, such as **slums**. Houses closer to the city. may have been **improved over time**, making them sturdier and safer to live in. However, the **newest slums** often lack access to any **basic amenities** such as water and electricity, and can be **unsafe to live in**. A mixture of **rapid urbanisation** and **poverty** usually causes slums to arise, as there are **too many people migrating** to the city in comparison to how many **affordable homes** there are, causing extreme urban poverty.

Santa Marta, a favela (area of informal housing) in Rio.
(Source: /www.smithsonianmag.com/innovation/mapping-rios-favelas-180959816/)

Economic Inequality

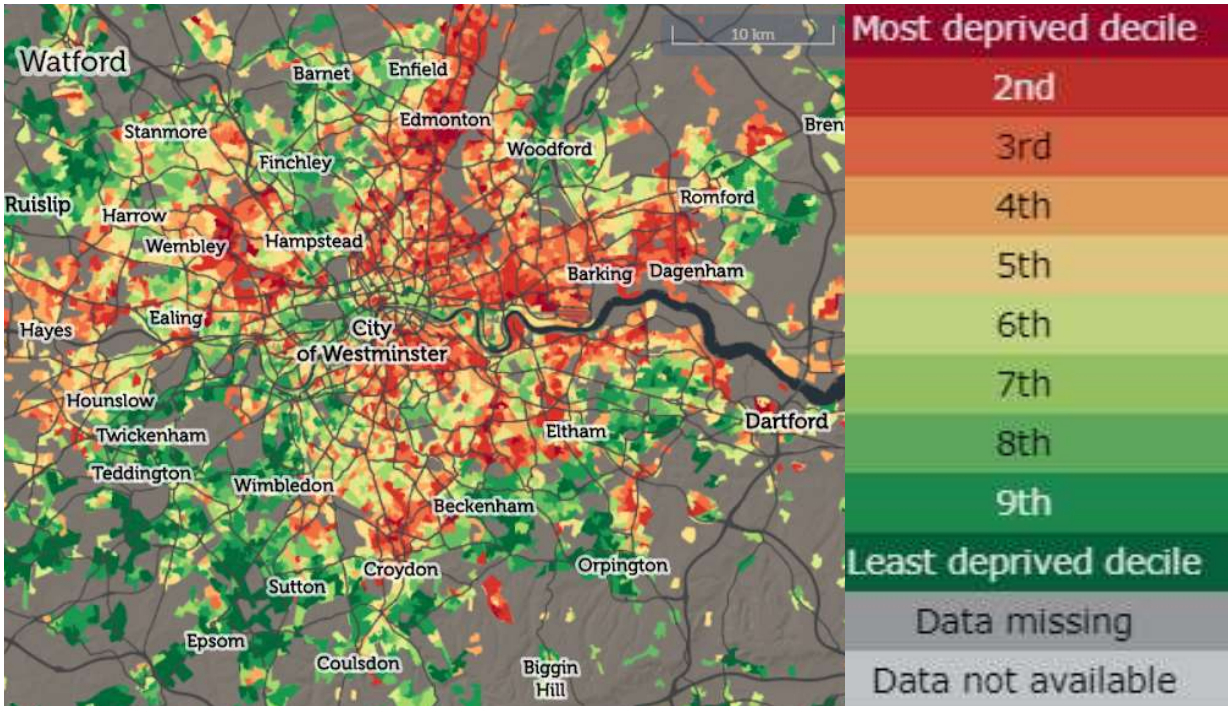
Economic groups are usually **spatially distributed within an urban area**. **Economic inequality** is present in different ways in contrasting urban areas, and can cause multiple problems.

As previously mentioned, in HICs, **expensive, larger** housing is located in the suburban area surrounding the city. This land-use pattern mirrors **economic patterns**; wealthier, less deprived populations usually live on the outskirts of the city in sub-urban areas, where the quality of life can be better than in cities. Affluence can be concentrated within the **centre of HIC cities** also, and house prices can be **very high** in these areas as land is so expensive.

There is a great deal of **poverty** within cities in developed countries, causing issues such as **deprivation** and **homelessness**. Rent is usually cheaper in the inner city than other areas of the city, but quality of life can be poor. High **population densities** and strained **public services**, low access to **green spaces**, and high **crime** and **unemployment** can be common within deprived areas such as residential tower blocks. With a high cost of living that usually comes with living in a city, many can struggle to cope, highlighting the **economic inequality** that exists within cities.

Post-industrialised cities also face **deprivation** and **unemployment** due to insufficient economic restructuring after industries closed down.

These trends can be seen in the map below, which shows a ranking of **deprivation** within London. Notice how in the centre and outskirts, there is less deprivation than in the inner city.

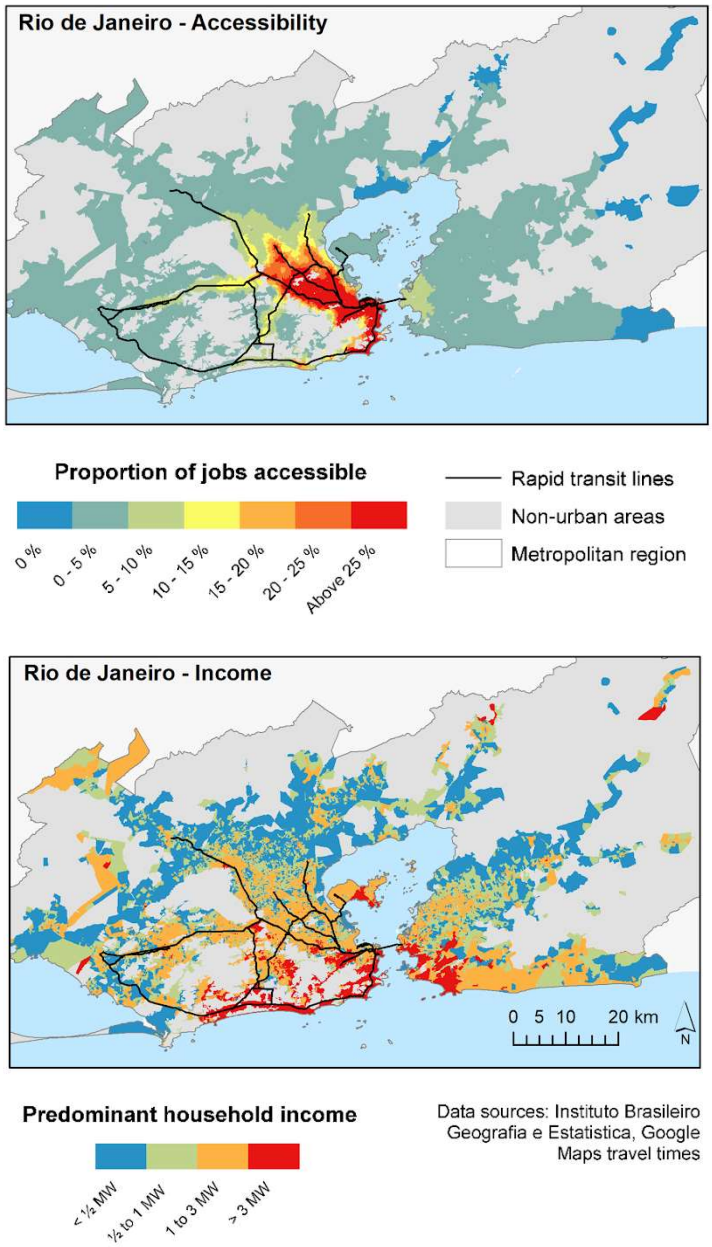


(Source: https://maps.cdrc.ac.uk/)

In lower income countries, economic inequality is usually **much more severe**, and it also follows **different spatial patterns**. This can be seen in Rio de Janeiro. The **wealthiest people live near the centre** along the coast (>3 MW = more than 3x the minimum wage), and the **poorest people live furthest away** from the city (<½ MW = less than half the minimum wage).

Many developing countries do not have the **wealth** or **resources** to support poorer populations like developed countries do. This can lead to **very severe poverty** in cities, like the development of 'slums' and informal dwellings. Many social issues can arise from this economic inequality, such as **the emergence of gangs** due to a lack of policing. **The Red Commando** is a gang associated with drug trafficking in Brazil. In some favelas, they operate without any police intervention.

Accessibility can be severely limited by **poor transport links**; if people cannot **travel** to find work, their income is limited by the smaller opportunities available. Studies have shown a very direct link between **accessibility and income**.



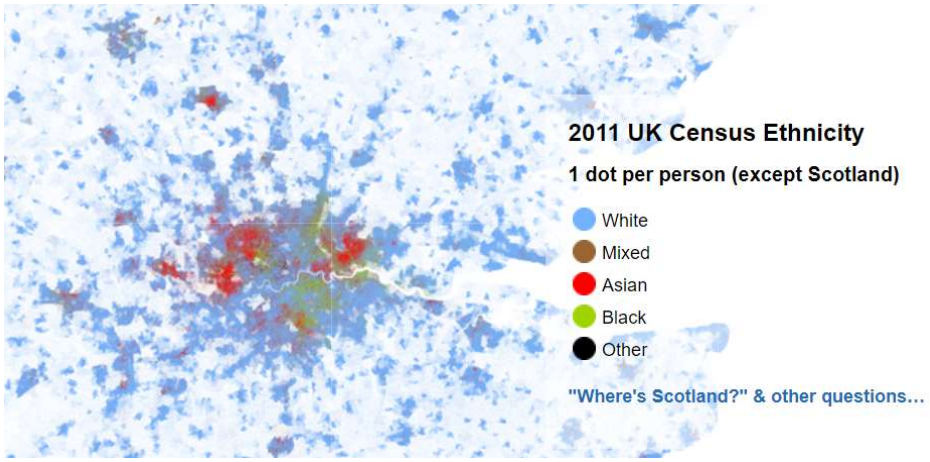
(Source:https://www.sciencedirect.com/science/article/pii/S0966692318304332)

Cultural Diversity & Social Segregation

International migration is a major driver in creating rich cultural diversity within cities. People migrate to cities seeking **better work opportunities**, **services**, and **quality of life**. Cultural diversity brings **many positives to a city**, such as increasing tolerance, allowing people to celebrate different cultures, and bringing tourism. However, it can also create issues, for example:

- People may not be **tolerant** towards different cultures, and some may experience prejudice behaviour or racism.
- Some cultures may feel **under-represented** within their area, and may not have access to **important aspects of their culture**, such as **food shops, places of worship** etc.
- There may not be **resources** available to improve quality of life for those with different cultures, such as providing information in **multiple languages** so that everyone can understand it.

Social segregation is where groups of people **live apart** from one another or from the larger population due to factors such as **wealth, ethnicity, religion or age**. Spatial segregation has occurred in many urban areas, often causing ethnic groups to be segregated and to live without **social cohesion**. Furthermore, **'gated communities'** also exist within urban areas, where (usually wealthier people) live in a secured, fenced-off community that only allows residents in, which also contributes to social segregation.



(Source:http://projects.andrewwhitby.com/uk-ethnicity-map/)

Social segregation can lead to many issues within urban areas:

- Areas can be under attack from **prejudice and racism**; certain areas can be stereotyped in derogatory ways based on who lives in that area
- People may feel **isolated** if they are not within the **demographic** of the majority who lives in that area
- Low paid migrant jobs, historically and currently, means migrants are limited with housing options and have to live in **cheaper, more deprived areas**. These areas are often **neglected by the government**, leading to high levels of crime, unemployment, and other social issues. This can exemplify the racial inequalities within society, as these socially segregated groups lack the **resources** that other people may have if they were to live in a less deprived area.

Strategies to Manage Urban Issues

Economic and social issues can be managed through **government** and **community** intervention. Approaches may differ between contrasting urban areas, especially between **low income countries** and **high income countries**.

- **City minimum wages -** in some cities such as London or New York City, the minimum wage is **higher** than in the **rest of the country** because the **cost of living** is very high in comparison to the rest of the country. Higher minimum wages work to **reduce economic inequality**, as people have more money for **food, rent, and utilities**. However, some countries do not have a **minimum wage** (40%+ of developing countries), and in others, the informal economy makes it difficult to **regulate** minimum wages.

- **Fair rent and housing policies** - Legislation can be put in place in cities to ensure people have access to **safe and affordable homes**, reducing the economic inequality existing within cities. There are laws in place to ensure that people pay a **fair price** for their rent, and city councils are constantly battling the demand for more homes.

  For example, the Mayor of London pledged that he will **"ensure an average of at least 17,000 more affordable homes per year in London [...] 60% of the affordable housing provision should be for social and affordable rent and 40% for intermediate rent or sale".** Social housing (e.g. owned by the council) is one way to ensure that more people have access to homes.

- **Recognising informal housing issues -** In **developing countries especially**, informal housing can exacerbate severe inequalities. In some countries, residents of squatter settlements are **evicted**, and their homes **demolished** as a way to limit the growth of informal residential areas. In order to **limit inequality and social issues**, these settlements can be **recognised by law** as actual residential areas, and therefore provide the tools and resources to make them **safe for people to live in**. This ensures access to **clean water, sanitation, transport and other essential needs** for all.

- **Encouraging multiculturalism** - Festivals such as Notting Hill Carnival can **encourage social cohesion** and allow people to celebrate different cultures.

(Source: https://www.visitlondon.com/things-to-do/event/9023471-notting-hill-carnival)

Urban Policies and Regeneration

- **Retraining** - a population with a **skills base** aligned to the needs of the primary/secondary industry needs to retrain to have the skills necessary to be successful in the **new services economy** (tertiary industry). This is a large undertaking when a large proportion of the population was brought up destined for a life of farming/mining etc, and now these opportunities are gone. However **diversifying skills** are essential for reducing the negative impacts of deindustrialisation by boosting employment opportunities.

- **Economic policies** - at a local level, governments can positively promote a place to carry out economic activity through favourable policies with regards to taxes etc. This is **boosterism**. At an international level, **FDI** can be used to revitalise a deindustrialised place, through stimulating tertiary growth and investment by foreign MNCs.

- **Environmental policies** - the government can set environmental **standards** that closing industries must abide by so to not leave unsightly derelict land strewn with toxic waste.

The Role of Government Policies

- By investing in **infrastructure**, such as high speed rails and airport developments, governments can maintain growth and improve **accessibility** to regenerate regions. It is often the role of national governments to facilitate **regeneration** projects in partnership with charities and developers.

- Government policies control the **rate** and **type** of **developments** allowed through planning laws, creating house building targets, considering housing affordability and gaining permissions. This affects economic regeneration of both rural and urban regions. Government actions may prioritise **national over local** needs and opinions which can delay regeneration projects and thus **worsen inequalities**.

- Government decisions about **international migration** and the **deregulation** of capital markets (e.g. allowing foreign investment in London real estate) significantly impact growth and direct/indirect investment. This can be done by the government, for instance, creating open door migration policies.

- Local governments compete to create **business environments** with designated areas for development to attract domestic and foreign **investors**. It is the actions of these local authorities that will determine the success of the regeneration projects.

- **Local interest groups** are vital in design-making and creating regeneration projects. However, there is often **conflict** between these groups as interests differ, some may wish to preserve urban landscapes whilst others seek to change It.

The European Social Fund (ESF) - this aims to tackle **poverty** and **social exclusion** by increasing employment and helping people to **access sustainable employment**, as well as investing in skills and improving the **diversity** of the workforce and investing young people with the skills required for the quaternary industry. To be successful it aims to reduce **poverty**, **increase skill levels** of the workforce and reduce the number of people with no or basic skills. It also wants to increase **youth** employment and attainment, whilst **reducing inequalities** in the labour market among women and other disadvantaged groups.

Re-urbanisation

Re-urbanisation is the large-scale, **government-backed** movement of people **into the city centre** as part of regeneration.

In the 21st century, there has been an expansion in the population of some central areas, alongside the development of **24-hour consumption of services** provided. Between 1971 and 1991 the number of people living in the centre of UK cities **declined**. However, the population living in cities has **doubled since 2001**. Central areas of cities are being **reclaimed for residential** uses and the services and service employment opportunities they provide are making them more attractive places to **live and work**. City centres are the location of 72% of all highly skilled jobs and are 21% more productive than non-urban areas.

Trends in re-urbanisation

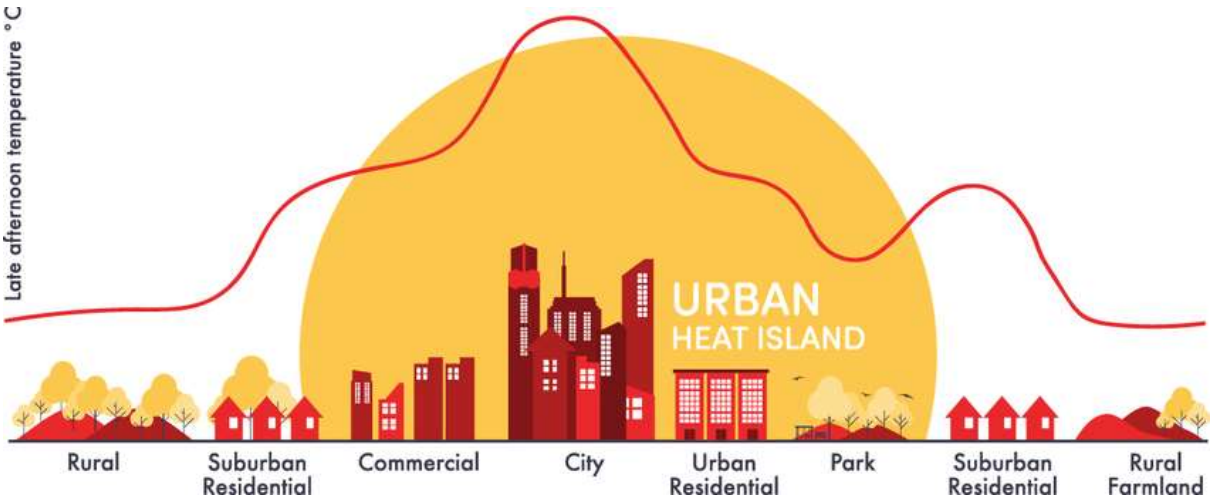
- There has been an increase in the construction of **centrally located residential areas**, composed of more flats and apartments which generally attracts a **new demographic** around the 'young professional'. Some of these have been the result of **relaxed development rights** which permit the conversion of commercial buildings and old industrial buildings to housing.
- There has been an increase in **studentification** with the expansion of city centre student accommodation and the rise of centrally-located new universities.
- Generally **rapid population increase** has driven re-urbanisation.
- The growth of **24-hour culture** and **central entertainment** districts has increased the attraction of the CBD.
- The growing effectiveness of **public transport** networks has made city centre living more viable.

Urban Climate

The characteristics of urban areas influence their climate, such as **temperature**, **precipitation**, and other weather events.

The Urban Heat Island Effect

The **Urban Heat Island Effect** is a phenomenon where the **characteristics of urban areas** and the activity within them cause the areas to **produce** and **retain** more heat than surrounding areas. Urban Heat Islands are particularly noticeable at **night** when the urban areas do not lose heat as quickly as surrounding rural areas.



(Source:Fuladlu, Kamyar & Riza, Müge & Ilkan, Mustafa. (2018).)

Urban Heat Islands develop due to different reasons:

1. Wasted heat from **urban activities**: urban areas host many activities that release heat, such as traffic, factories, homes and businesses, people and other activities. This wasted heat causes the average temperature in urban areas to be higher than surrounding areas.

2. Urban **materials**: urban surfaces and buildings **absorb and store more solar energy** (lower **albedo**) than other surfaces, such as grass. Tarmac, concrete and brick surfaces emit absorbed heat as **long wave radiation**, warming the surroundings (especially at night) which keeps average temperatures higher in urban areas.

3. Lack of **evapotranspiration**: heat energy is lost through evapotranspiration. Urban areas tend to have less vegetation, meaning less heat energy is lost via **transpiration**. Also, urban drainage systems reduce the amount of **surface water** in urban areas as rain is quickly transported elsewhere via drains etc., meaning there is less energy lost in evaporation. With reduced evapotranspiration, heat energy is stored within **urban areas**, keeping temperatures higher.

Weather in Urban Areas

The characteristics of urban areas **influence precipitation patterns**. Rainfall is seen to **increase** over urban areas in comparison to surrounding rural areas, and **intense rainfall** events (e.g. thunderstorms) are more frequent in urban areas. This pattern is thought to be due to several reasons:

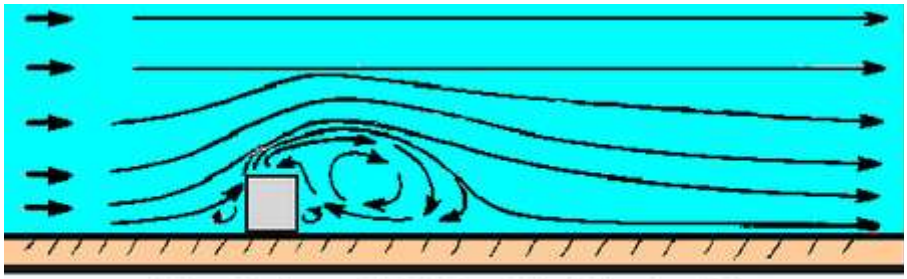
- Atmospheric instability caused by the **urban heat island effect** - warm, moist air rises above urban areas, then cools and condenses as rain. This causes cloud cover to be greater in cities.
- Altering wind patterns - airflow is obstructed by **tall buildings**, which reduces the ability for moist air to disperse.
- Aerosols and particulates - Particles in the air can cause water vapour to **condense** and form clouds. This also contributes to heightened cloud cover in cities, as well as higher incidences of **fog**.

As urban areas are **warmer**, incidences of **snow, frost and hail** are less frequent than in rural areas.

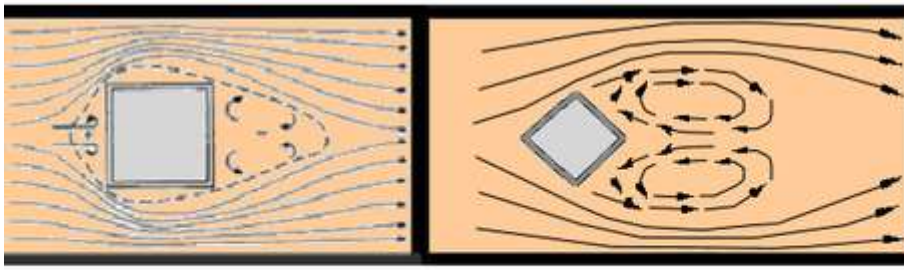
Wind

Wind patterns are **greatly altered** in urban areas due to **large buildings in urban areas**.

In general, wind speed is **lowered** in urban areas due to the presence of **many tall buildings** which cause friction and act as a barrier to wind. However, **turbulence** can occur around buildings due to **frictional drag**, forcing air to be deflected and swirl like a vortex.



Flow Pattern: Side View Wind Against Face



Flow Pattern: Top View Wind Against Face

Flow Pattern: Top View Wind Against Edge

(Source: www.islandnet.com/~see/weather/elements/citywind.htm)

Air Quality

Air quality is significantly poorer in urban areas due to **urban activities** creating **particulates** that stay suspended in the air. These particles come from different sources:

- **Vehicle exhausts** produce pollution such as carbon dioxide, carbon monoxide, nitrous oxides, volatile organic compounds and particulate matter.
- Industrial activities such as **coal burning factories** produce many particulates. Power plants are large contributors of sulfur dioxide, which produces acid rain.
- Construction work is more prevalent in cities. This can agitate **coarse particulates** such as fragments of cement or brick that can then become suspended in the air.

Photochemical smog

Photochemical smog is a particular type of air pollution caused when particulates react with **UV light** from the sun. Nitrous oxides and volatile organic carbons react with the sunlight to form **harmful secondary pollutants** such as **ozone** and peroxyacyl nitrates (PANs). Photochemical smog is more prevalent in **sunnier countries** with more UV light to fuel the reactions.

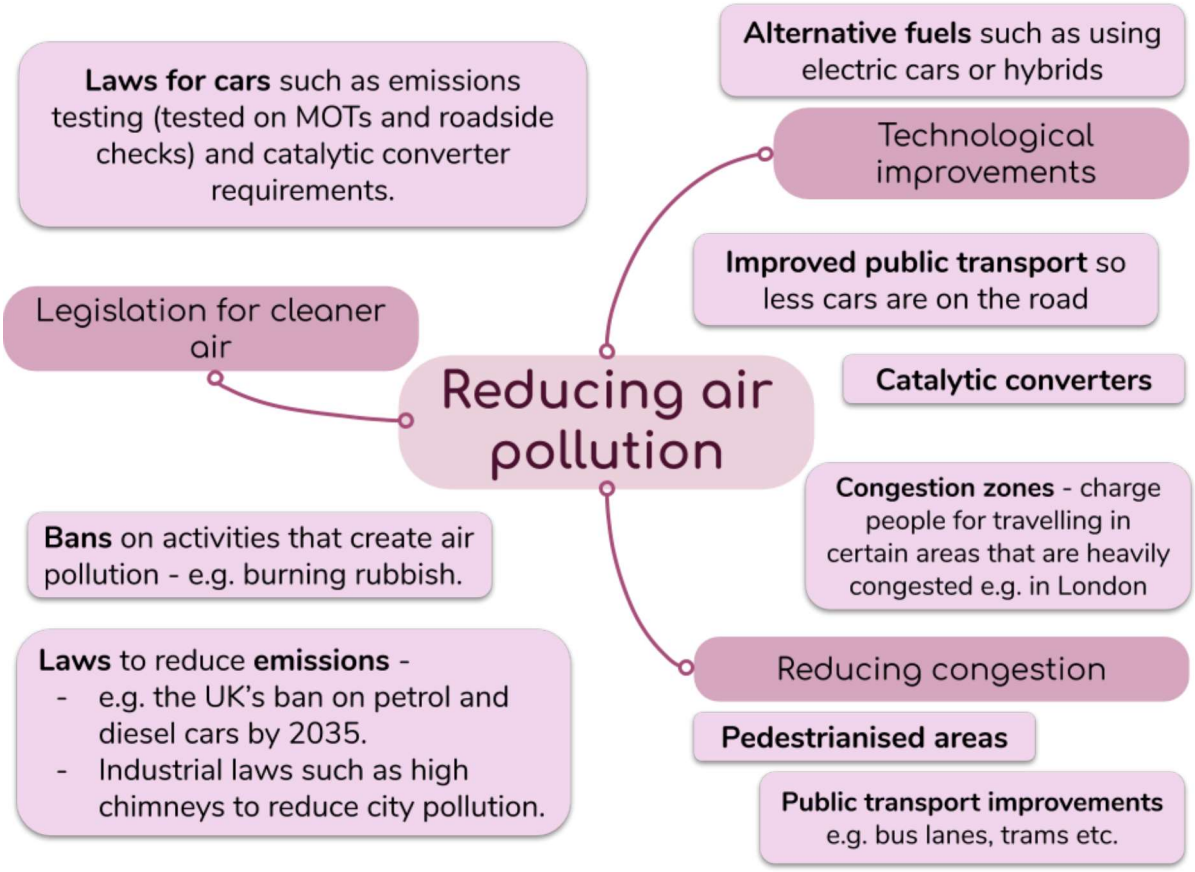
Photochemical smog stays at ground level due to a **temperature inversion**. Cool air is trapped below warmer air (the warm air acts as a lid) and causes the air to remain still and therefore the smog is trapped.

Photochemical smog is known to cause many respiratory disorders, such as asthma, as well as other illnesses.

(Source: https://www.popsci.com/smog-cloud-seeding-thailand/)

Policies to Reduce Air Pollution

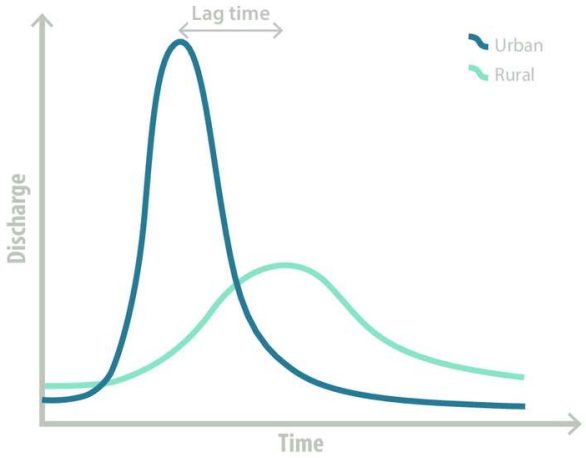
Due to the adverse health and environmental effects of air pollution, cities have worked to reduce air pollution through different strategies.



Urban Drainage

Urban areas have **different patterns of drainage** in comparison to rural areas.

- Due to the **impermeable surfaces** in an urban area (pavements, tarmac, buildings etc.) water cannot **infiltrate** into groundwater stores, meaning it can only flow as surface **runoff**.
- **Drainage structures** have been built in urban areas to **direct the water elsewhere**, such as rainwater downpipes and manmade watercourses on the side of roads to channel water into drains (a road camber).
- During high intensity rainfall, water is quickly transported into **rivers** in urban areas as the majority of water cannot be **stored** within the urban drainage basin, and instead flows **directly into the river**.
- This causes floods to have a short lag time and a high peak discharge.



Catchment Management in Urban Areas

Urban river catchments can be managed in order to **reduce issues associated with the urban water cycle** (flooding, riverbank erosion, contamination of groundwater, water shortages, water pollution etc.). However, many strategies may create **issues** if they are not properly implemented.

- **Dredging:** dredging is where sediments are **removed from the river channel** with machinery. It is used as a way of **reducing flooding** as it deepens the river channel so more water can flow into it.

  However, dredging can cause **water to flow more turbulently**, and can increase the speed of water flow. This can enhance the risk of flooding further downstream.
- **Dams and reservoirs:** Dams can be used to manipulate water flows and stores to reduce flooding, and reservoirs can be used as a water supply.

  Dam construction can cause a great deal of environmental damage e.g. large valleys can be flooded to make reservoirs, dams change how sediment is transported which can affect erosion etc. Settlements may also need to be **displaced** in order to make room for dams and reservoirs.
- **Flood defenses and water channel management:** Physically altering water courses through straightening channels, constructing flood walls, and creating drainage pipe systems can be an effective way to force water out of urban areas.

  These strategies may also worsen flooding downstream, as well as being expensive and **environmentally degrading**.

Dredging in the Hudson River. Source: EPA.

Sustainable Urban Drainage Systems (SUDS)

Sustainable urban drainage systems are systems that are designed to manage the flow of urban water sustainably. Rather than using **construction** and **environmentally unsustainable techniques**, SUDS use techniques that recreate **natural drainage systems**. This means water is allowed to flow gradually through the system before being removed, rather than removed as quickly as possible (which increases the risk of flooding).

Examples of SUDS include:

- Introducing **permeable surfaces**, such as grass verges
- Green roofs (vegetation on roofs of buildings) which increases transpiration
- Rainwater harvesting
- Ponds
- Swales (linear depressions, usually covered in grass, which slowly transport water away)

Urban Waste

Waste in urban areas needs to be **managed effectively** as **large amounts of waste** are created in a **relatively small area**. Sources of waste in urban areas include:

- **Industrial** - waste produced from construction, factories, power production, or manufacturing, e.g. metals, gases, chemicals, excess building material.
- **Commercial** - waste produced by businesses like restaurants or shops, e.g. paper, plastics, food, packaging.
- **Personal** - waste produced by humans in their homes - e.g. food waste, food packaging, discarded electronics/homeware.

Waste can be managed in different ways:

Unregulated I.e. dumping/fly tipping - waste is illegally dumped in places that are not **designated areas for waste disposal**. Unregulated waste dumping can be **significantly harmful to ecosystems** (disrupting wildlife, introducing toxic chemicals into habitats, leaving non-biodegradable materials in ecosystems etc.)
Recycling Reprocessing materials that can be used again, such as metals, cardboard, glass, and some plastics. Recycling reduces the need to **produce more materials** as well as reducing **waste going to landfill**, making it environmentally sustainable.
Incineration Burning waste rather than storing it. Incineration does reduce the amount of waste going to landfill, however burning requires fuel, and produces **gases** such as **greenhouse gases** as well as **toxic gases**, which are detrimental to the environment.
Recovery Using waste products as a replacement for **other products**, e.g. repurposing waste concrete into bricks for building. Recovery of waste reduces the amount of materials going to landfill which limits disruption to natural habitats.
Burial Dumping waste into areas designated for waste, e.g. landfill sites. Burial as a form of waste is unsustainable as it disrupts the natural environment, and many waste products take **a long time to break down**, meaning a lot of space is necessary. Furthermore, waste produces waste gases when it breaks down such as methane (a greenhouse gas).

Submergence

Dumping waste into **oceans**. This has many harmful environmental effects, such as disruption of marine life and the release of **harmful/toxic chemicals into the water supply**. Many countries still dump waste into the ocean despite it being illegal, such as China, which dumped 200.7 million cubic metres of waste into coastal waters in 2018.

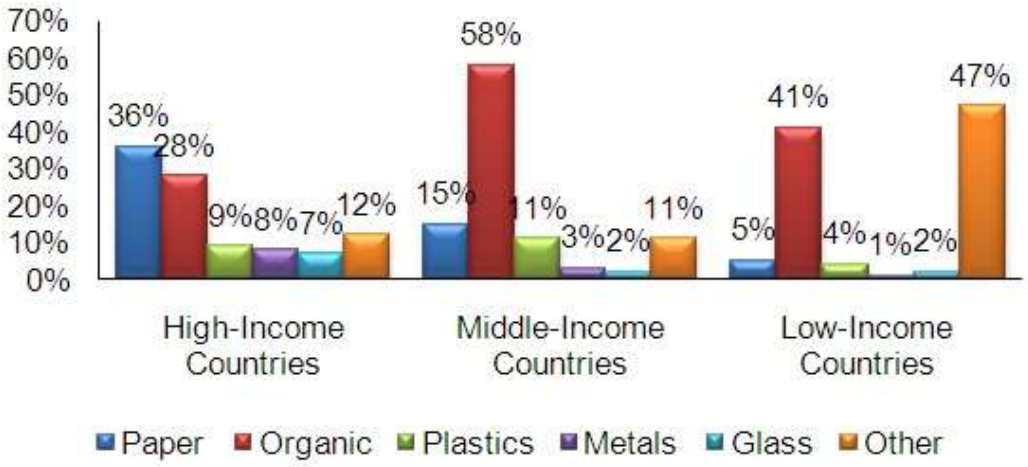
Trade

Selling waste to other countries so that **other countries can process** it. Trading waste can mean that waste is disposed of efficiently by systems that are designed to manage large amounts of waste, however if countries do not manage the waste effectively it can cause environmental issues. Also, waste must be **transported**, which requires energy.

Waste in Contrasting Urban Areas

Waste differs in countries with **different levels of development** and **different attitudes towards waste management**.

1. The **type of waste produced** differs between countries with varying levels of development. High-income countries produce less organic waste than middle-income and low-income countries, for example.

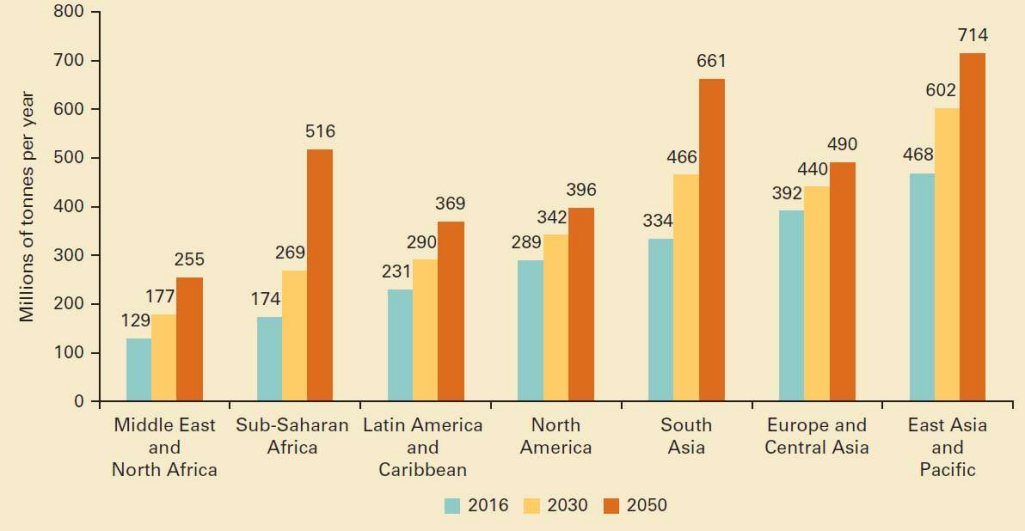


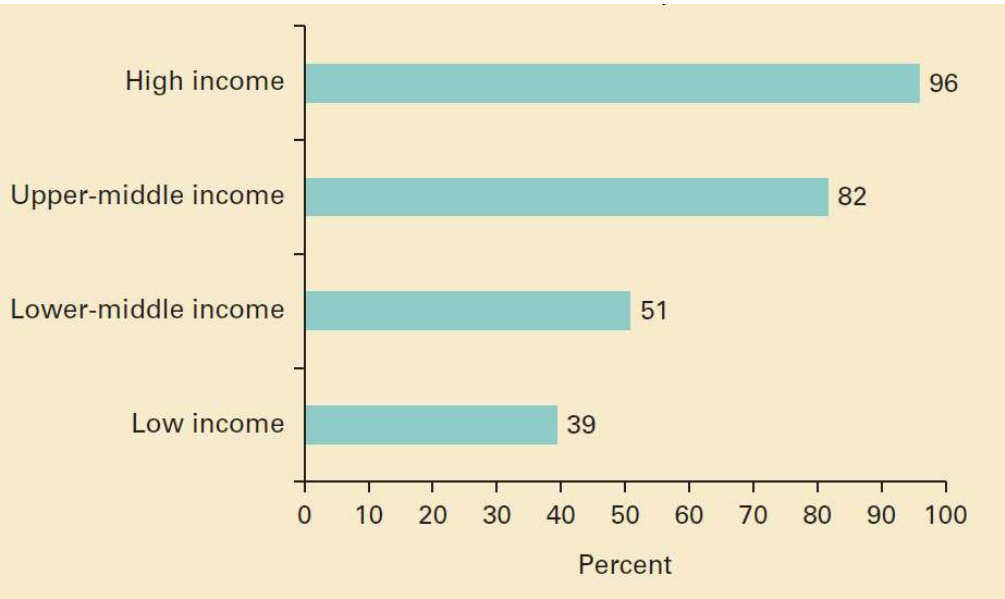
(Source: UNDESA, 2010).

2. Developed countries are increasingly developing into **consumerist** societies, where there is a **'throw-away'** culture. Waste is excessive, such as unnecessary packaging, which makes processing difficult and expensive.

Black plastic packaging cannot be recycled.
(Source: https://you.38degrees.org.uk/petitions/tesco-stop-using-black-plastic-packaging).

3. Developed countries usually produce more waste, but developed countries have better systems in place to **collect waste**. According to the World Bank, in low-income countries, over 90% of waste is burnt or dumped in unregulated areas.





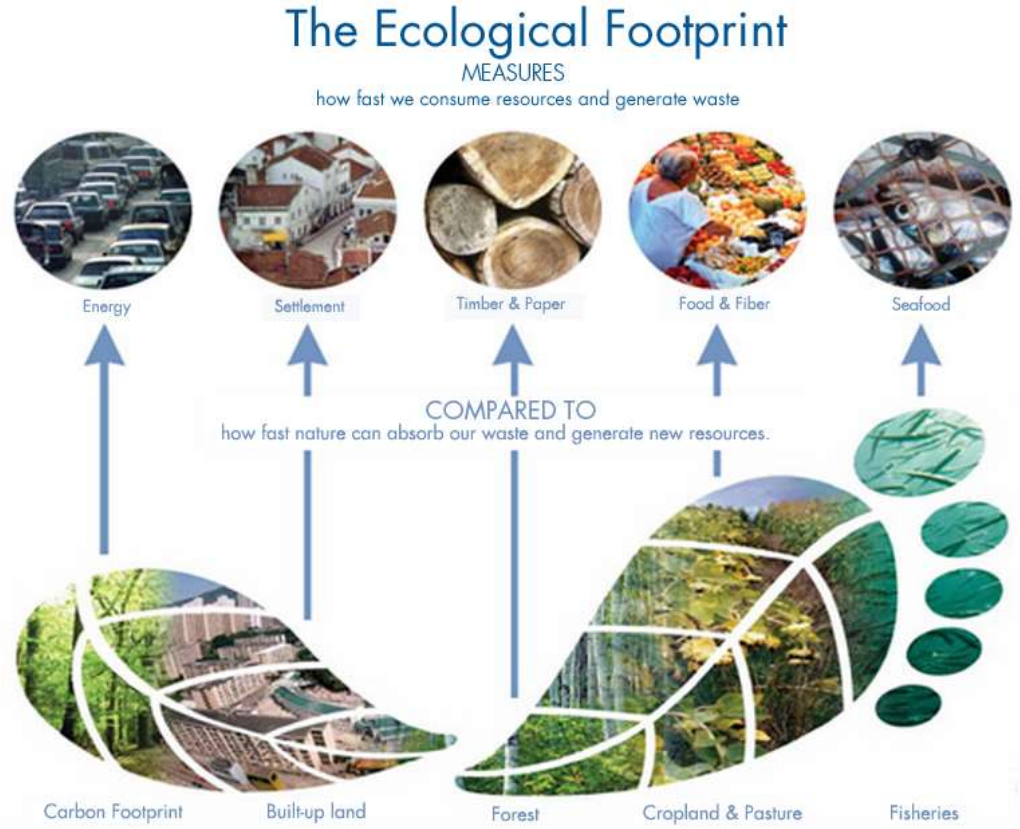
(Source: https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html)

Sustainable Urban Development

Urban areas have multiple effects on their environment over different scales. **Emissions** can cause **air pollution** locally - affecting health - but may also contribute to atmospheric CO_2 levels and **global warming**. Urban populations can produce **waste** that affects places locally (e.g. **littering**) but also all over the world (e.g. **plastic pollution in the oceans** affecting marine life everywhere). Therefore, it is important that urban areas are **sustainable in their practices**, and their negative effects on the world can be minimised.

The Ecological Footprint of Urban Areas

An ecological footprint is a measure of **how much we consume** in comparison to **how much the Earth can regenerate**. A larger footprint means consumption is large compared to the Earth's ability to deal with waste/make new resources.



(Source: https://www.footprintnetwork.org/our-work/ecological-footprint/)

Urban areas have a higher ecological footprint than rural areas due to different reasons, although this differs depending on the urban area:

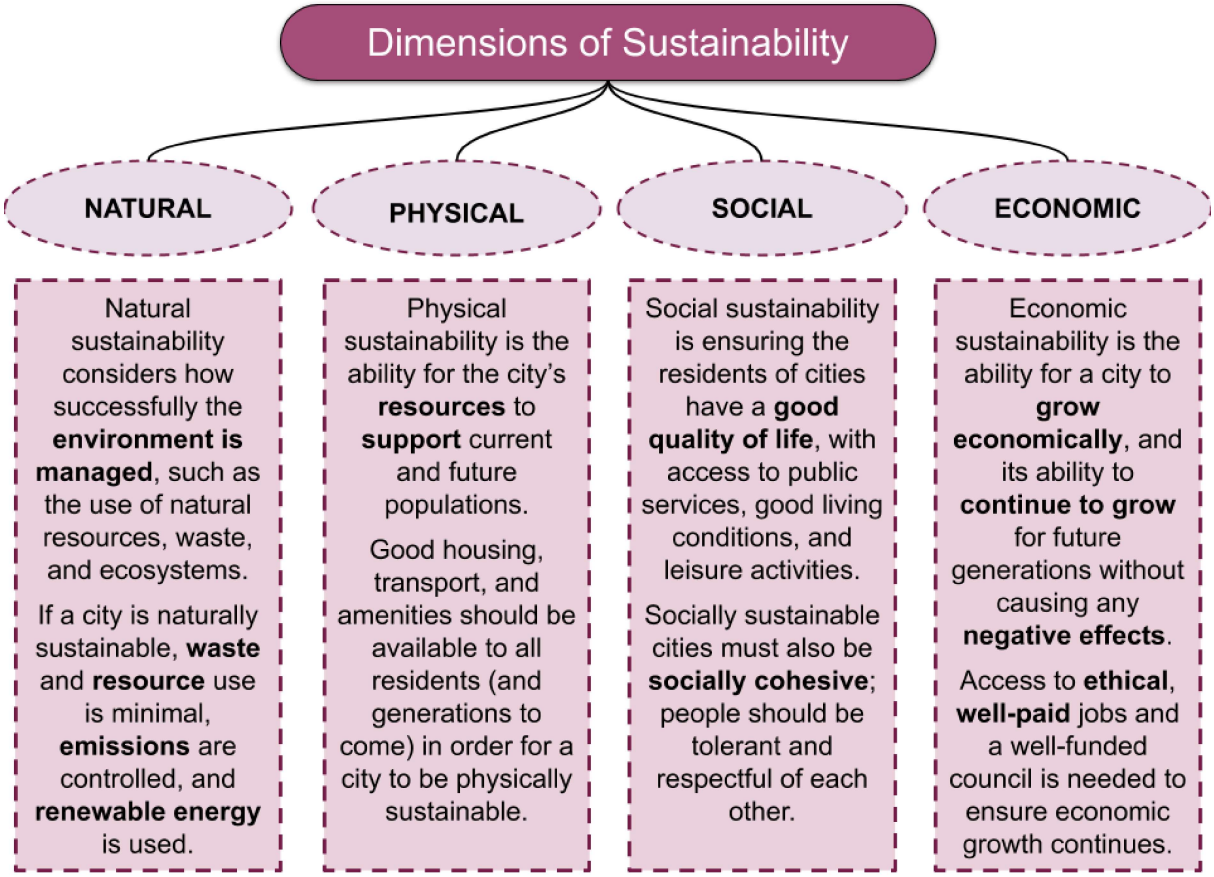
- **Transport** - the **large amount of cars** and other forms of transport means urban areas consume a great deal of **fossil fuels**, and emit a lot of waste gases. Some urban areas have policies to ensure **more efficient public transport**, which reduces the size of their ecological footprint.

- **Building materials** - urban areas need materials in order to grow, which come from natural resources. If an urban area is **larger** or is developing at a **fast rate**, more resources are needed, which is a larger strain on the Earth. Slow development can lower an ecological footprint as it allows time for the Earth to naturally produce more materials for development.

- **Needs of the population -** Larger populations consume **more things**, leading to more waste and a higher ecological footprint.

Dimensions of Sustainability

In order to be sustainable, the activities within cities need to support the **current population**, but not in a way that damages the ability for future generations to also be supported. Cities can be sustainable in different ways:



Overall, sustainability encompasses the concept of **liveability**. Liveability refers to how **able** a resident is to have a **good quality of life**. This encompasses all aspects of life, such as: job prospects, leisure activities, access to good public services like schools, healthcare, police, safety, sanitation, living conditions and environment. Sustainable cities must be liveable in the present and in the future.

Developing Contemporary Sustainable Cities

Opportunities	Challenges
The **importance** of living sustainably is now well-understood, meaning **investments** and **research** into sustainable cities are growing, and more people want to live sustainably.	**In LICs** especially, cities do not have enough money to invest in **expensive** sustainable ways of living, e.g. changing transport to be renewable, changing layouts of cities etc.
Investments into cities are more common than rural areas as they benefit more people.	**Fast urbanisation rates** makes it difficult to meet the needs of an ever-growing population.
Services can be implemented easily to many people as there is a high population density.	**Lifestyle habits** need to change - many do not want to change as they are comfortable.

Strategies to Develop Sustainable Cities

- Reducing waste - urban areas produce **huge amounts of waste**, which is unsustainable **environmentally, physically**, and **economically**. Waste can be reduced through implementing **effective recycling facilities,** encouraging **composting**, and introducing **farmers' markets** to reduce food packaging waste.

- Transport - one of the biggest issues in urban areas is the **number of vehicles**. The need for transport will never cease in cities as people need to travel for work, shopping, and leisure. Therefore, sustainable methods of transport need to be introduced.

  For example, **Zurich** has developed their public transport services to stop the reliance on cars, with bus and tram stops every **300 metres** in the city, and there are low fares, which is an incentive for people to use public transport.

- Green space - introducing green spaces into cities is a great way to improve the **environment of a city**, making it more sustainable. Green spaces such as green roofs or parks can reduce the effects of pollution or flooding, as well as making the area more attractive and pleasant for its residents. This improves the city's **physical and natural sustainability** as well as its **social sustainability**.

(Source: https://medium.com/@globechain/the-smart-way-to-build-sustainable-cities-607804f3c3f2)

- Efficiency of buildings - urban structures can be made more **efficient**, which enhances the sustainability of cities. Ways to improve the efficiency of buildings are constantly developing, and there are endless ways to do it.

  For example, buildings can be built to have south facing windows or have **efficient insulation** to reduce heating needs. Rainwater harvesting can be used for toilets, and using renewable energy such as building solar panels on the roof can **reduce the need for natural resources**. Smart meters can also be installed so people can monitor their usage, and this also gives an **incentive** to save money.