

19 Resource management

9.1 The global distribution of resources

On this spread you will find out about the uneven distribution of resources and their significance for human well-being

The significance of food, water and energy

Most people will agree that *quality of life* will depend on having enough food to eat, sufficient water for drinking, washing and sanitation, and enough energy for their daily lives. Quality of life is not the same as *standard of living*. Availability of resources such as food, water and energy is important for social and economic well-being.

What are resources?

A *resource* is a stock or supply of something that has a value or a purpose. The three most important resources are food, energy and water. Adequate supplies of these resources are essential for countries to develop.

These resources are unevenly distributed across the world. Most HICs have plentiful supplies and enjoy a high standard of living. But many of the world's poorer countries, such as those in sub-Saharan Africa, lack resources and struggle to improve quality of life for their people. As the world's population continues to grow, resource management will present many challenges.

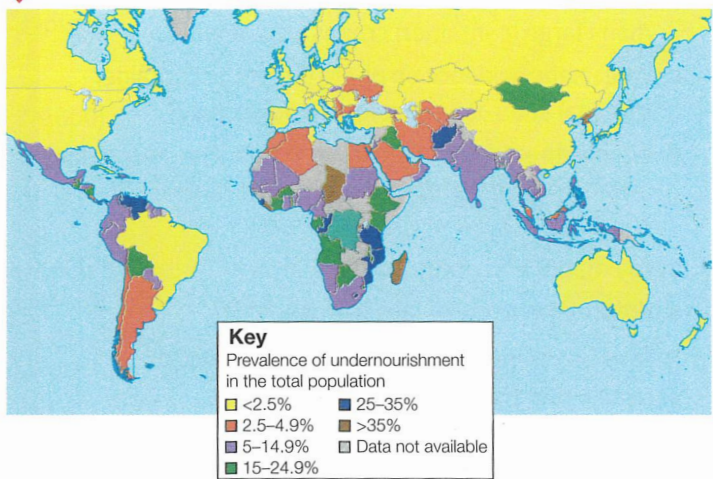
Food

The World Health Organization (WHO) suggests that we need 2000–2500 calories per day to be healthy. Over a billion people fall below this figure (map A). A further two billion have a poorly balanced diet lacking in minerals and vitamins, and so suffer **undernutrition** or *malnutrition*, resulting in a range of illnesses and diseases.

People need to be well fed to be productive at work and contribute to the economic development of their country. Obesity (being overweight) is an increasing problem.

China, India, the USA and Brazil produce the most food, yet there is still hunger in these countries. The countries with the highest daily calorie intake per head are Austria, the USA, Greece and Belgium.

A Areas where hunger was a problem in 2020



Country	GNI per head (US\$)	HDI ranking	Water per head (m³)
Canada	46370	16	80420
Australia	50050	8	210000
Saudi Arabia	55840	40	75
Burkina Faso	1970	182	710
Niger	1040	189	181

B Water supply data for countries at different levels of development

Water

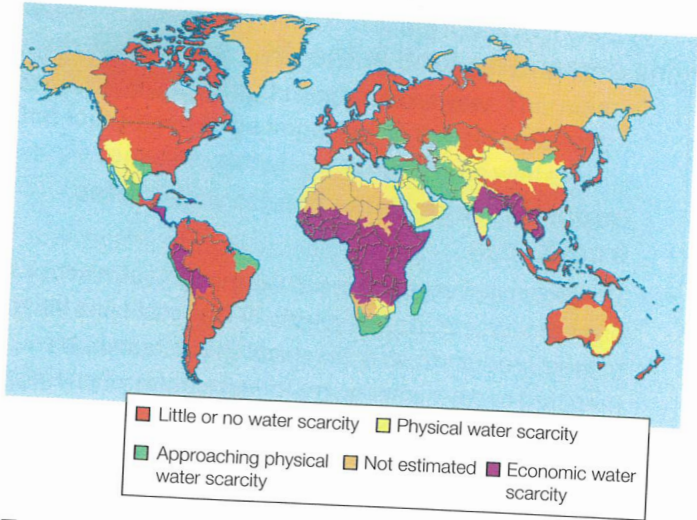
Water is not only essential for people and animals to drink, but is vital for crops and food supply and also as a source of power. As the world's population grows, more people are faced with a shortage of water.

The imbalance in supply is due mainly to variations in climate and rainfall. Rainwater needs to be captured in reservoirs or taken from rivers or underground aquifers. These are very expensive and require high levels of investment.

Many of the world's poorest countries have a water shortage (table B). The UN estimates that by 2025 there will be 50 countries facing water scarcity (map C).

There are significant differences in water use between HICs and LICs/NEEs (pie chart D).

C Projected areas of water scarcity by 2025



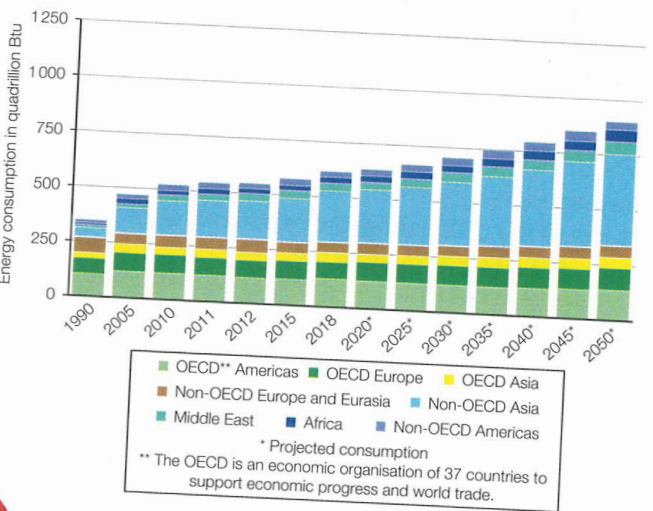
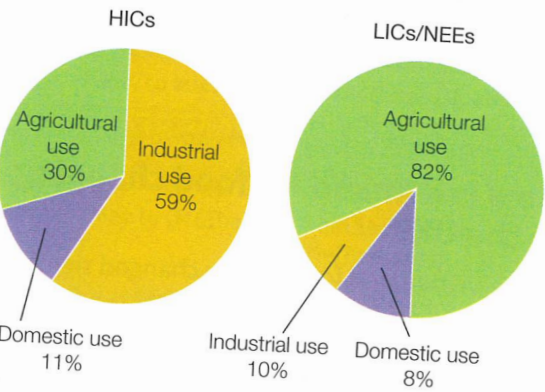
Energy

Think of the energy needed in your home and school for light and heat, and to power things like cookers, TVs and tablets. Energy is required for economic development. It powers factories and machinery and provides fuel for transport. In the past many countries could depend on their own energy resources. Today the situation is much more complex, with energy being traded worldwide.

Energy consumption is increasing as the world becomes more developed and demand increases (graph E). The world's richest countries use far more than poorer countries in Africa and the Middle East. The Middle East supplies much of the world's oil yet its own consumption is relatively small.

As NEEs become more industrialised, the demand for energy will increase and patterns of energy trading will change.

D How water use links to a country's income



E Global energy consumption by region, 1990–2050 (quadrillion British thermal units)

Activities

- Look at map A.
 - Which continent has the highest percentage of hungry people?
 - Within this continent, which countries suffer from the most extreme hunger?
 - Describe the parts of the world with the lowest levels of hunger.
- Look at map C.
 - What is the difference between 'physical' and 'economic' water scarcity?
 - Describe the distribution of the areas experiencing physical water scarcity.
- Describe the patterns of energy inequality (graph E).

Extension

Construct a table to identify the significance of food, water and energy to economic and social well-being.

Practice question

Describe the global inequality in the availability of food or water or energy. (4 marks)

Tips

- You should write about *one* only, from food, water or energy.
- In 'describing' inequality, focus on two or three major contrasts in the resource's availability.
- Refer to the appropriate map or graph and use facts and figures to support your answer.

9.2 Provision of food in the UK (1)

On this spread you will find out about the changing demand for food in the UK

How is demand for food changing in the UK?

In the UK demand for food has changed significantly in recent years as people seek greater variety, year-round availability and healthier options. This has resulted in a growing demand for:

- exotic high-value foods from abroad
- out-of-season produce to be available throughout the year
- wider availability of organic alternatives.

Growing demand for high-value food from LICs

In 2019, 12 per cent of the food eaten in the UK came from LICs in Latin America, Africa and Asia. Foreign travel and the growth of ethnic restaurants have changed the UK's eating habits, and many foods are imported into the country.

A growing proportion of imported food consists of high-value products. Even if the food is produced cheaply in the LICs, high storage and transport costs result in high prices in the shops. Some specialist products are expensive, such as vanilla from Madagascar and the spice saffron, which has to be hand-picked, from countries such as Iran (photo A). Despite the high prices in UK shops many farmers in LICs and NEEs earn little from growing these products.

With the UK leaving the EU it is likely that more food will be imported from LICs in Africa, such as Kenya. The UK already imports a quarter of Kenya's fresh produce exports, including beans and peas, and more than half of its tea exports. Many of these products are high-value imports.



A Price negotiations at a saffron flower market

Importing high-value foods: vegetables from Kenya

The growing of vegetables such as mangetout is Kenya's biggest source of income (photo B). The cost of air freight to keep produce fresh is very high. UK customers are prepared to pay higher prices for vegetables when they are not in season in the UK.



B Vegetables produced in Kenya

Kenyan farmers only earn a fraction of the price of the vegetables in a UK supermarket (table C). Two-thirds are casual labourers with no job security or benefits. They are paid very little.

Stage	Price per tonne (£)	% of final price
Producer	630	12
Exporter	290	6
Packaging	280	5
Air freight/handling	1040	20
Importer	620	12
Supermarket	2500	45
Total price	5360	100

C Price breakdown for one tonne of Kenyan mangetout

Skills

Draw a pie chart to show the breakdown of the price of imported mangetout.

All-year demand for seasonal food

In the past people in the UK only ate foods that were in season. Today there is a growing demand for seasonal foods to be available throughout the year. This means that foods need to be imported so that, for example, people can enjoy strawberries during the winter months (table E).

Foods that are out of season have to be imported, and are more expensive. Transportation is usually by air due to the perishable produce. This creates a considerable carbon footprint, emitting greenhouse gases into the atmosphere (see page 280).

Riverford Organic Farms, Devon

Riverford Organic Farms began as an organic food and dairy farm in rural Devon. It supplied local people with fresh boxes of food delivered weekly. The company now delivers boxes of vegetables around the UK from its regional farms in Devon, Yorkshire, Peterborough and Hampshire. These farms help Riverford to:

- reduce food miles
- support local farmers
- provide local employment
- build a strong link between grower and consumer.



D Riverford Organic Farms vegetable box

Activities

- 1 List the reasons why food demand in the UK has changed in recent years.
- 2 Why do some imported food products sell for a high price in the UK (photo B)?
- 3 How do UK shops supply seasonal food throughout the year (table E)?
- 4 a Define 'organic food'.
b Suggest why organic food has become popular in the UK.

Type of food	Available in UK	Months imported and main countries of origin
Parsnips	July to March	April to July (Spain)
Lettuce	June to November	December to May (Spain)
Tomatoes	May to October	October to June (Netherlands)
Runner beans	July to October	November to June (Kenya, Morocco)
Strawberries	May to November	October to April (Spain, Netherlands)
Spring onions	April to November	December to April (Mexico)

E Out-of-season foods imported to the UK

Increasing demand for organic produce

Organic produce is grown without the use of artificial chemicals, often used in fertilisers, pesticides and herbicides. Organic food has become increasingly popular in the UK, although higher labour costs often make it more expensive. Between 2018 and 2019 overall sales of organic produce increased in value by 4.5 per cent. Home deliveries saw the highest growth, rising by over 11 per cent.

Organic food production is often associated with buying local produce (page 281) and producing seasonal food.

Extension

It has been estimated that the UK would run out of food by 21st August in a particular year if the country relied on home-produced food. Research online to investigate why the UK is not self-sufficient in food.

Practice question

Explain why changing demand has affected food supply in the UK. (6 marks)

Tips

- You should 'explain' (give reasons) why changing demand has affected food supply.
- In your answer make clear links between changes in demand and food supply.
- Try to refer to some examples, facts and figures to support your answer.

19.3 Provision of food in the UK (2)

On this spread you will find out how local food sourcing reduces agriculture's carbon footprint and about the development of agribusiness

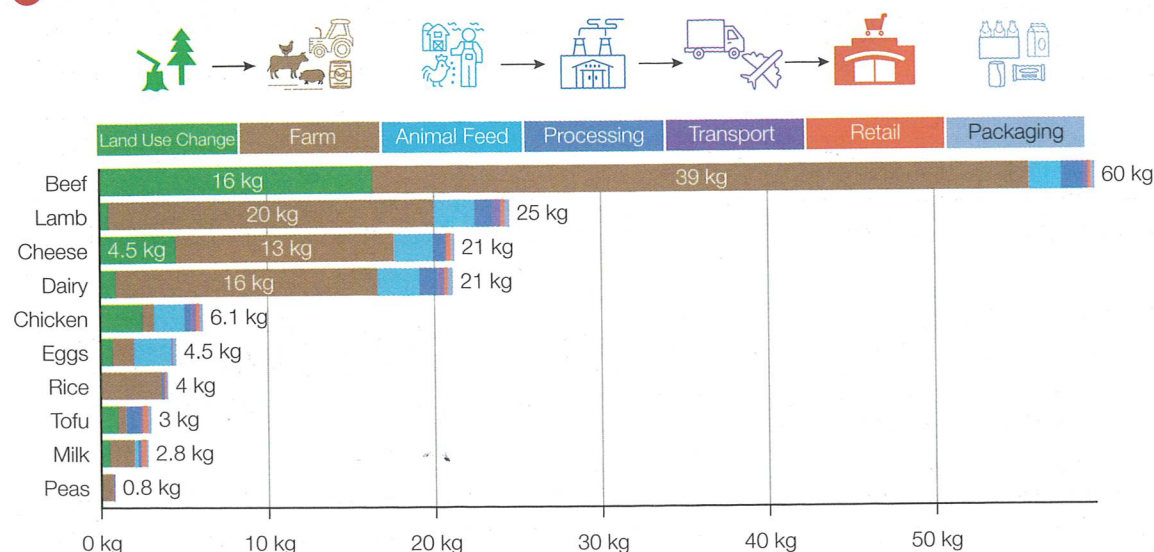
How does food demand affect the UK's carbon footprint?

Look at map **A**. It shows the distances travelled by selected foods imported to the UK – this is known as **food miles**. Not only is air transport expensive, but it also adds to the country's **carbon footprint**. This is the emission of greenhouse gases (including carbon dioxide and methane) that comes from the production, transportation, use and end-of-life of a product or service.

Agriculture contributes about 12 per cent of the UK's total greenhouse gas emissions. The contribution varies between different foods (graph **B**). Growing food in the UK generally reduces the carbon footprint, but there are exceptions. The carbon footprint of a tomato grown in the UK is three times more than for a tomato grown in Spain and imported! This is because UK tomatoes are often grown in heated greenhouses.



A Distances travelled by food imported to the UK



B Greenhouse gas emissions in the food supply chain

Local sourcing of food

In response to growing concerns about greenhouse gas emissions, there has been a move towards local sourcing of food in the UK. This can lead to a significant reduction in food miles and emissions. Supermarkets and small shops are increasingly selling and promoting locally produced foods, such as milk, meat, fruit and vegetables. Restaurants and cafés make use of locally sourced ingredients as an advertising strategy.

Farm shops and farmers' markets (photo **C**) sell directly from the farm to the public and help to support the rural economy. The food is fresh and 'in season' and may be produced organically. The carbon footprint is reduced by cutting down food miles, with less processing and packaging needed. Farmers can often sell 'imperfect' produce which some supermarkets refuse to sell, so there is less food waste.

Some farms provide opportunities to 'pick your own' (PYO) fruit and vegetables (photo **D**). This can reduce the farmer's costs of harvesting, processing, packaging and transportation, as well as reducing the carbon footprint.

Agribusiness

Agribusinesses are large commercial farms with high levels of investment, often part of a larger national or international business. These farms are often highly specialised, using modern technology, scientific research and chemicals to maximise production. Agribusinesses benefit from being large, enabling them to buy seeds and chemicals in bulk and use big and efficient machines.

ATB is a large agribusiness in Hertfordshire which provides services and the latest technologies to agriculture, construction, haulage, sport and biomass. The company farms over 2600 ha using new technologies and taking a sustainable approach to maximise food production (photo **E**).



C A farm shop



D The sign for a PYO farm



E Using modern technologies to maximise production

Activities

- 1 What is meant by 'local sourcing' of food?
- 2 How does local sourcing of food:
 - a reduce the farmer's costs?
 - b help to reduce the carbon footprint?
- 3 Describe how farm shops and 'pick your own' contribute towards local sourcing of food.
- 4 Draw a spider diagram to show the advantages of sourcing food locally. Use different colours to show the advantages to the farmer and the customer.

Extension

Using photo **E** and online research, investigate any potential conflict between the need to produce more food in the UK and the environmental impact of agribusiness.

Practice question

Describe the moves towards local sourcing of food in the UK. (4 marks)

Tips

- Write about more than one 'move' towards local sourcing of food.
- You are asked to 'describe' – you do not need to offer any reasons.
- You should aim to write about eight lines.

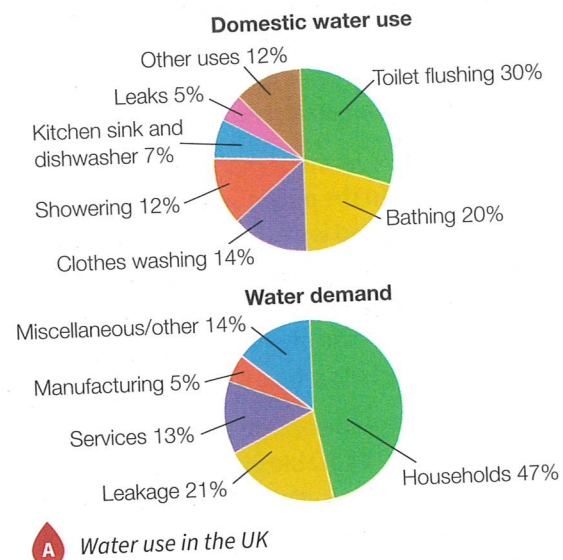
9.4 Provision of water in the UK (1)

On this spread you will find out about changes to the demand and supply of water in the UK

How is demand for water changing in the UK?

The UK is facing a future water supply problem. Demand for water is high and by 2034 it may exceed supply. In 2019 the average daily consumption of water in England was 143 litres per person. The pie charts (A) show how water in the UK is used. Climate change is likely to increase the problem, as rainfall patterns change and droughts become more frequent. Reasons for increasing water demand in the UK include:

- population increase, particularly in the south east of England
- greater use of domestic appliances such as washing machines
- increased demand for irrigation, both in fields and greenhouses
- increased use for leisure, such as watering golf courses
- rapid growth of house building.

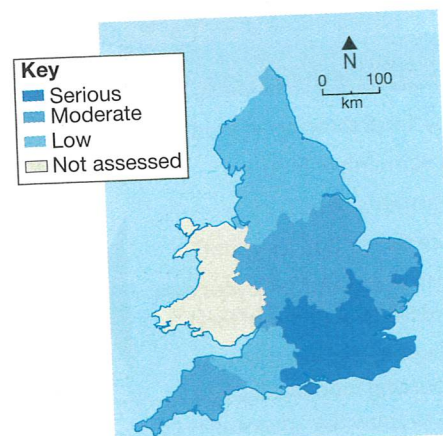
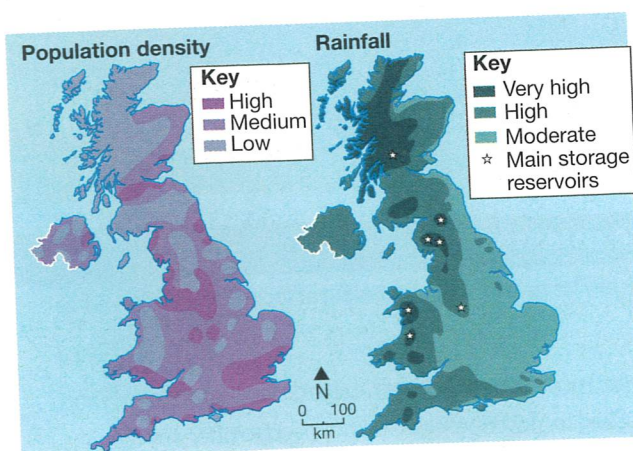


Matching supply and demand – areas of deficit and surplus

The main sources of water in the UK are rivers, reservoirs and groundwater aquifers. About one-third of tap water in England and Wales comes from aquifers. In the UK, 68 per cent of its water comes from surface stores. Matching supply and demand is a challenge as rain doesn't fall where it is most needed! (maps B and C)

- The north and west of the UK has a **water surplus** (supply exceeds demand). Here there is high rainfall, low rates of evaporation and plentiful sites for reservoir construction. Demand (population density) is relatively low.
- The south and east of the country has a **water deficit** (demand exceeds supply). This is the most densely populated part of the country, with the lowest rainfall.

Much of southern England experiences **water stress** (demand exceeds supply) (map C). Recent exceptional dry weather in East Anglia (2016–2019) has made the problem more acute.



Water transfer schemes

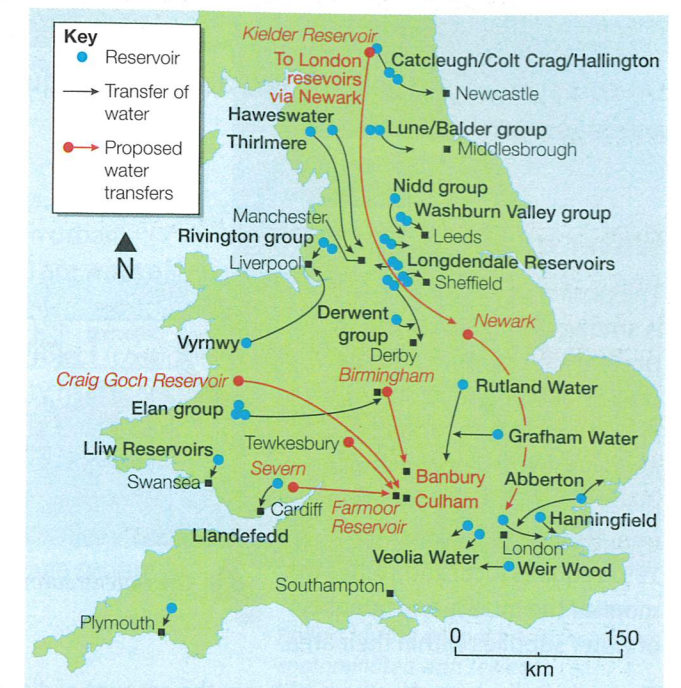
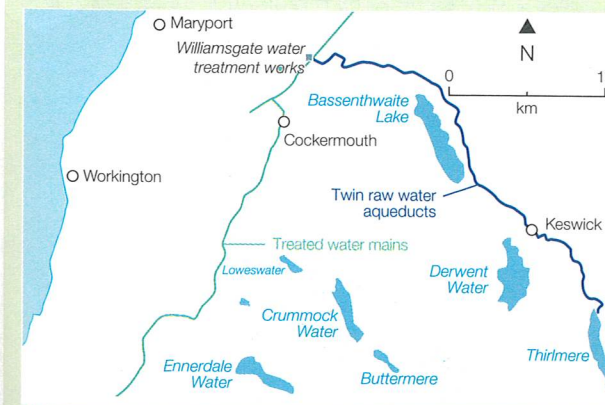
Water transfer schemes attempt to match supply and demand by moving water from areas with a water surplus to areas with a water deficit. Map D identifies water transfer schemes in England and Wales. One important scheme transfers water via the Rivers Tyne, Derwent, Wear and Tees as far south as Yorkshire. Despite a growing need to increase water transfer to meet demand, there is strong opposition for the following reasons:

- the enormous cost associated with constructing dams, tunnels and pipelines
- potential damage to ecosystems caused by the mixing of flora and fauna as water is transferred from one part of the country to another
- greenhouse gases produced when fossil fuels are used to generate the extra electricity needed to pump water over large distances.

The Thirlmere water transfer scheme

Since 1894 water has been transferred from Thirlmere in the Lake District to Manchester to support its industrial growth (map E). In recent years, due to population growth and climate change, West Cumbria has experienced problems with the quantity and quality of its water supplies. Historically, West Cumbria's main source of water was Ennerdale in the Lake District. However, the amount being extracted from the lake has caused environmental damage due to the lowering of the water level.

The Thirlmere scheme (2017–2022) will transfer water from Thirlmere, an area of surplus (2000 mm+ annual rainfall) to West Cumbria, an area likely to experience future water stress (< 1000 mm annual rainfall). Water will be transferred along two 30 km pipelines using gravity flow rather than pumps, to reduce the environmental impact.



Activities

- 1 What is the purpose of a water transfer scheme?
- 2 List three examples of water transfer schemes in the UK (map D).
- 3 Suggest why few transfer schemes have been implemented so far.
- 4 a Why is water being transferred from Thirlmere to West Cumbria?
b Outline the main features of the transfer scheme.

Practice question

Discuss the need for transfers to maintain water supplies in the UK. (6 marks)

Tips

- Focus on 'discussing' the different views on water transfer schemes.
- Use the correct geographical terminology, such as surplus, deficit and water stress.
- Refer to examples of water transfer schemes to support your answer.

Extension

Using online research, assess the likely impacts of climate change on matching water supply and demand in the UK.

9.5 Provision of water in the UK (2)

On this spread you will find out about water quality and pollution management in the UK

Water quality

The quality of tap water in the UK is among the highest in the world. Despite effective and efficient water treatment (diagram A), a report from the Environment Agency in 2020 reported that no rivers in the UK were pollution-free. The Water Industry Act 1991 requires local authorities to monitor the quality and quantity of water supplies within their area.

The main indicators of water quality are the amount of dissolved oxygen, acidity (pH), temperature, salinity, and nutrients such as nitrogen and phosphorus. Measurements are also made of toxicants such as insecticides, herbicides and metals. Scientists also measure turbidity – the number of suspended particles in the water (photo B).

Managing water pollution

What are the causes of water pollution?

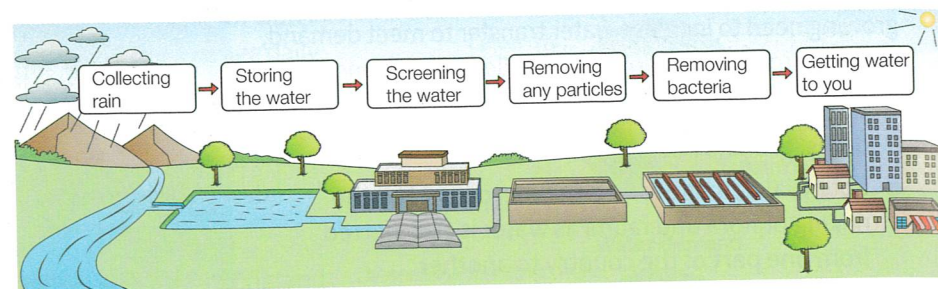
Diagram C shows the main causes of water pollution. Notice that these involve sources on land and at sea.

Agricultural pollution

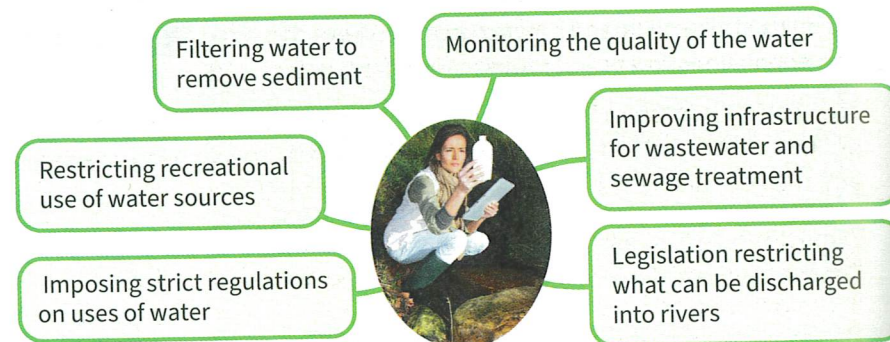
Organic matter such as **milk, food, crops, dirty water, silage effluent and slurry** is highly polluting to watercourses. The bacteria that are already present in water use organic matter to multiply and at the same time they remove oxygen from the water. Without oxygen the fish and small insect life in watercourses cannot survive. One litre of milk is as damaging to a river as 40 litres of raw sewage!

Since 2018 the government's 'Farming rules for water' require farmers to:

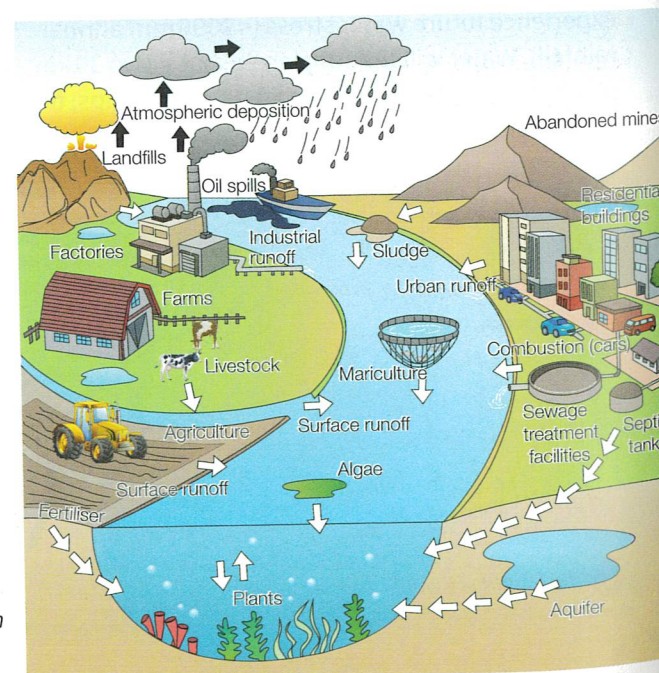
- restrict the amount of chemicals they use and not to apply them near rivers, springs or boreholes
- keep animals 50m away from sources of water
- plant and maintain vegetation breaks around fields to prevent runoff into streams



A The water treatment process



B How the Environment Agency manages water quality



C Sources of water pollution

- restrict ploughing to maintain soil structure and prevent soil erosion
- control the use of manure and use effective storage to avoid spills and water contamination.

Urban water pollution

Detergents from washing machines and runoff from houses, paved streets and roads are the main sources of water pollution in urban areas. Sustainable Drainage Systems (SuDS) (see page 206) are ways of reducing urban water pollution.

In 2010 Northern Ireland Water opened the Belfast Sewers Project (costing £160 million). Prior to the investment, water quality in the city had been affected by leaking sewers and overflows following periods of heavy rain. The sewer networks have been repaired and upgraded, increasing the city's ability to cope with storm water (photo D). A large drainage tunnel has been constructed to increase storm water capacity. The project has been successful in reducing the pollutant load from the sewage system into the River Lagan and its tributaries by 85 per cent.

Industrial pollution

When the last of the three collieries in the Taff Bargoed Valley in South Wales closed, the highly toxic mine water contaminated local water supplies (photo E). The Coal Authority built a treatment system with a pumping station which now treats up to 120 litres of mine water per second, preventing an estimated 72 tonnes of iron from entering the river every year.

The treatment system is part of the local community park. The large pollution-free wetlands are a valuable wildlife habitat for many species, and the river and lakes are used for fishing and canoeing.

Strict government legislation – Control of Pollution Act (1974) and Water Resources Act (1991) – aims to control water pollution from manufacturing and chemical industries. For example, under this act industries are not allowed to 'permit any poisonous, noxious or polluting matter or any solid waste matter' to enter rivers, aquifers or the sea.



D These children playing in floodwater in Belfast in 2012 did not know that it was contaminated with sewage



E Water pollution downstream of abandoned coal mines in South Wales

Activities

- 1 Look at diagram C.
 - a Give **three** sources of river pollution.
 - b Give **two** sources of groundwater (aquifer) pollution.
- 2
 - a How is water quality monitored by the Environment Agency (photo B)?
 - b How does the Environment Agency manage water quality and pollution?
- 3 Describe how the 'Farming rules for water' aim to reduce agricultural pollution.
- 4 What are the main features of the Belfast Sewers Project?
- 5 How is government legislation helping to reduce industrial pollution?

Extension

The principle 'the polluter pays' – those who produce pollution should bear the costs – underpins the regulation of pollution. Do you agree with this principle, and should it be applied in all cases of water pollution?

Practice question

Describe how water pollution is managed in the UK. (4 marks)

Tips

- In 'describing' how water pollution is managed, refer to at least **two** different sources of pollution, to give breadth in your answer.
- Try to include examples and some facts and figures to support your answer.
- Focus on *management* rather than *causes* of water pollution.

9.6 Provision of energy in the UK (1)

On this spread you will find out about the UK's changing energy mix and reduced reserves of fossil fuels

The UK's changing energy mix

In recent years there has been a surprising decline in energy consumption in the UK. Much of this is due to increased energy efficiency in our homes and workplaces, for example the use of low-energy appliances and insulation.

The UK's **energy mix** (the range and proportions of different energy sources) has changed significantly since the 1990s. As the pie charts (A) show, there has been a significant shift from a dependence on **fossil fuels**, primarily coal and gas, to the development of renewable energy sources, particularly wind.

In 2020 the UK set a new record for low carbon energy, with 47 per cent attributed to renewable sources and 15.1 per cent nuclear. Although 2020 was an unusually windy year, boosting wind energy production, the UK easily surpassed the government's target of 20 per cent renewables by 2020.

As graph B shows, the UK's renewable energy sector is dominated by wind, which in most quarters exceeded 50 per cent of total electricity generation. Due to the changeable weather conditions, the contribution of wind energy does tend to fluctuate much more than solar, hydro and bioenergy.

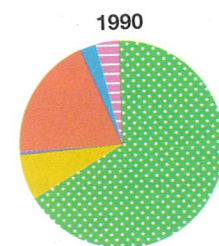
Recent trends in electricity generation

Today energy is mostly used to generate electricity which is flexible and clean at the point of use. Since the 1990s the UK's reliance on fossil fuels has declined as the importance of renewables has grown (graph C).

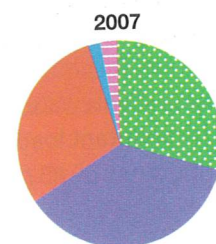
- In 2010 fossil fuel-generated electricity was ten times that generated by renewables.
- In 2019 the UK's wind farms, solar panels, biomass and hydro-electricity generated more electricity than from coal, oil and gas-fired power stations.
- By 2020 electricity generated by renewables had quadrupled, while that produced by fossil fuels had halved.
- In 2020 there were 68 days when the UK's electricity was made without using coal.

Recent developments in the UK's energy sector

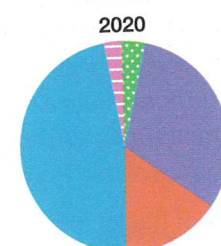
The shift from fossil fuels to renewables is largely due to the development of offshore wind farms. The world's largest offshore wind farm, Hornsea One, located in the North Sea off the Yorkshire coast (map D), was completed in 2021. Its 174 turbines produces enough electricity to power one million homes. Hornsea Two is due to be completed in 2022 and Hornsea Three in 2025. Hornsea Four is in the planning stage.



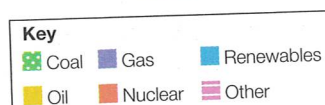
In 1990 almost three-quarters of UK energy came from coal and oil – 'fossil' or **non-renewable fuels**.



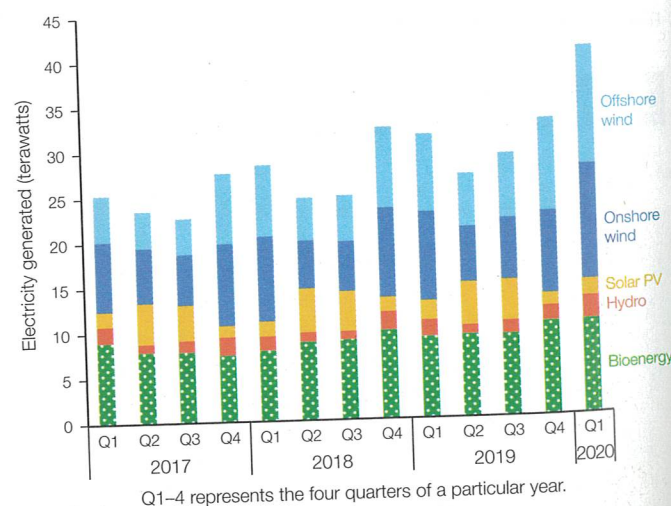
By 2007 there was an equal mix of coal, gas and nuclear – all non-renewable sources.



By 2020 renewable sources, such as wind and solar energy, had become more important (graph B).



A The UK's sources of energy, 1990–2020



B UK electricity generation using renewable sources, 2017–2020

Biomass is an important source of energy for electricity generation (graph B). The Drax power station in North Yorkshire has been converted from coal to biomass pellets (photo E). The newly converted power station began operating in March 2021. When fully operational, it will be able to generate up to 6 per cent of the UK's electricity needs – more renewable energy than any other single location.

By 2030 most of the UK's nuclear reactors will have closed, with a 35 per cent reduction in generating capacity. However, with the opening of Hinkley Point C in Somerset, which will produce 7 per cent of the UK's electricity demand, as well as the plans for Sizewell C in Suffolk and Bradwell B in Essex, nuclear power will remain a part of the UK's energy mix.

Reduced domestic sources of energy

The UK is no longer self-sufficient in energy. About 75 per cent of the UK's known oil and natural gas reserves have been exhausted and in 2019 the UK imported 35 per cent of its energy. The UK's **energy security** is affected as it becomes increasingly dependent on imported energy.

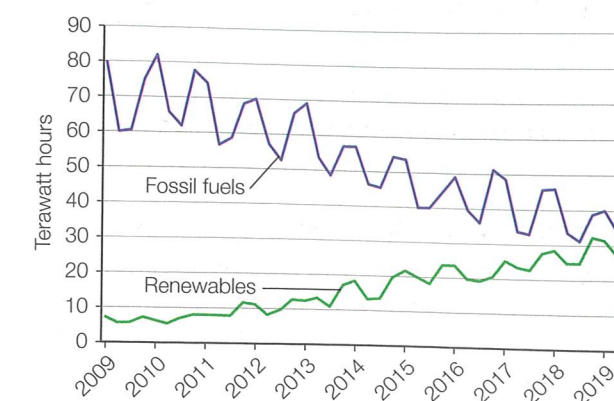
- Gas – two-thirds of the UK's gas reserves remain, enough to last about 50 years.
- Oil – production has declined by 5 per cent over ten years, though exploration continues.
- Coal – the last deep mine closed in 2015. Today there are just a few opencast mines operating, with only two years' supply.

Activities

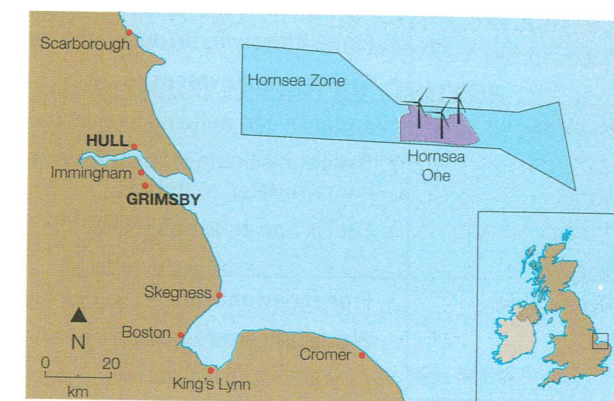
- 1 Look at the pie charts (A).
 - a What percentage of the UK's energy came from coal in 1990 and 2020?
 - b Which energy source saw the greatest increase between 1990 and 2020?
 - c Describe the UK's energy mix in 1990, 2007 and 2020.
- 2 Using graph B, describe the trends in electricity generated by renewable sources between 2017 and 2020.
- 3 Calculate the percentage change in the use of (a) fossil fuels, and (b) renewables between 2009 and 2019 (graph C).

Extension

'The UK should shut down its remaining domestic supplies of coal, gas and oil and focus entirely on renewables.' Do you agree with this statement? Justify your point of view.



C The changing use of fossil fuels and renewables in generating the UK's electricity



D The location of Hornsea One wind farm



E The Drax power station

Practice question

Suggest how the UK's energy mix will change by 2030. (4 marks)

Tips

- This question asks you to consider changes in the UK's energy mix to 2030.
- Demonstrate your understanding of the term 'energy mix'.
- The command word 'suggest' invites you to write about any reasonable (likely) changes in the energy mix.
- Focus on the trends to 2020 (pie charts A) and predict the likely future changes to 2030.

19.7 Provision of energy in the UK (2)

On this spread you will find out about the economic and environmental issues associated with energy exploitation in the UK

Exploiting new energy sources

The exploitation of new sources of energy in the UK will have economic and environmental consequences (table A). Sometimes the government is forced to change its policy due to public protests or on the advice of environmental organisations.

A Economic and environmental impacts of exploiting new sources of energy

Source of energy	Economic impacts	Environmental impacts
Fossil fuels	- Still large reserves in the country - Finite (they will run out eventually) - Creates employment	- Emissions of greenhouse gases - Coal mining causes landscape destruction - Danger of oil spillages
Nuclear	- Expensive to build nuclear plants - Decommissioning is expensive and involves contaminated materials - Fuel is non-renewable but can be recycled	- Radioactive waste expensive and controversial to dispose of - No greenhouse gases emitted - Warm, cooling water is released into coastal waters affecting ecosystems
Renewable	- Free renewable power source (e.g. wind, sun, tidal) - Electricity produced can be variable - Cost of installation is falling significantly	- Negative visual impact on landscape - Low levels of noise pollution with wind turbines

Economic and environmental issues with fossil fuels

Fracking

The UK has rich reserves of natural gas trapped deep underground in shale rocks. To extract the gas, high pressure liquids (containing water, sand and chemicals) are injected into the rock to fracture the shale and release the gas. This process is called *fracking*.

Despite being widely used elsewhere in the world, particularly in the USA, fracking has become a very controversial issue in the UK (photo B). Some people are concerned about:

- the possibility of earthquakes, caused by the fracturing of rocks
- pollution of underground water sources from contaminated liquids
- the high costs of extraction.

The Lancashire Fracking Controversy

There are significant reserves of natural gas trapped in the Bowland shale, a rock found deep underground in Lancashire. Test drilling in 2011 triggered a small earthquake which led to local protests about the safety of fracking. There were also concerns about the contribution to greenhouse gas emissions, and the noise and emissions from

heavy vehicles, required to transport water for the fracking process.

Following these and other protests, the UK government banned fracking in 2019. In 2021 the Climate Change Committee concluded that fracking must not continue in the UK until scientists had a better understanding of its full environmental impacts.



B An anti-fracking protest

A new coal mine for Cumbria?

In 2017 planning permission was granted for a new deep coal mine near Whitehaven in Cumbria. The £165 million mine was expected to extract 2.78 million tonnes of coal each year up to 2049, with 85 per cent exported to Europe. Those in favour of the mine argued that it would create more than 500 well-paid jobs at the mine and 2000 additional jobs in the supply chain. Despite the economic benefits the plan was highly controversial and led to large-scale protests. More than 80 groups wrote to the government opposing the plan.

Ahead of Glasgow hosting 'COP26' in 2021, the development of a new coal mine was felt by many people to be inappropriate. In May 2021 Cumbria County Council withdrew its planning permission, arguing that the new mine would break greenhouse emission reduction targets. Photo C shows part of the proposed site of the coal mine. In the background there are already many wind turbines generating clean electricity.



C The site of the proposed Cumbrian coal mine

Economic and environmental issues with carbon-neutral energy sources

Even if energy is produced by carbon-neutral nuclear and wind power, there are important economic and environmental factors to consider (table D).

D The economic and environmental impacts of nuclear and wind power developments

	Economic	Environmental
Nuclear	- Nuclear power plants are very expensive to build. In 2019 the new Hinkley Point C plant was estimated to cost £22–23 billion to build (see pages 54 and 287). - High costs for producing electricity. - Decommissioning old nuclear power plants is expensive. - Construction of new plants provides job opportunities and boosts the local economy.	- Produces fewer emissions than traditional sources such as coal. - The safe processing and storage of the highly toxic and radioactive waste is a big problem. - Warm wastewater can harm local ecosystems. - The risk of harmful radioactive leaks.
Wind farms	- High construction costs. - May have negative impacts on local economy by reducing visitor numbers. - Some wind farms attract visitors by becoming tourist attractions. - At Delabole wind farm in Cornwall, the UK's first commercial wind farm, local homeowners benefit from lower energy bills. The wind farm has also set up a Community Fund.	- Visual impact on the landscape. In the Lake District, concerns about falling visitor numbers have resulted in several plans being rejected. - Wind farms avoid harmful gas emissions and help reduce the carbon footprint. - Noise from wind turbines. - Construction of a wind farm and access roads can impact on the environment.

Activities

- List the economic advantages and environmental disadvantages of fracking being allowed in the UK (photo B).
- Explain why there was opposition to the proposed Cumbrian coal mine (photo C).
- Summarise the economic and environmental issues associated with nuclear power and wind farms (table D).

Extension

The Severn, Dee, Solway and Humber estuaries are all potential sites for tidal barrages. Using online research, consider the economic and environmental arguments that have so far prevented these sites being developed. Which of the four do you think is most likely to go ahead and why?

Practice question

Discuss whether economic advantages outweigh environmental disadvantages in developing new energy sources. (6 marks)

Tips

- Plan your answer by making a list of economic advantages and environmental disadvantages and consider the relative importance of each.
- Write about more than one type of energy source and refer to specific examples.
- Be prepared to discuss the issues, weighing up the advantages and disadvantages.
- In your conclusion, show that you have considered a variety of viewpoints.

1 Water management

1.1 Global water supply

On this spread you will find out that demand for water is rising globally but supply is not spread evenly

Water security/insecurity

Water security means having access to enough clean water to sustain well-being, good health and economic development. Regions that do not have access to sufficient safe water supplies experience **water insecurity**, also known as water scarcity.

Water insecurity may be caused by physical factors associated with supply, such as insufficient rainfall and saltwater entering natural underground reservoirs (aquifers). Human factors associated with demand, such as over-abstraction from aquifers (see page 308) and population increase, also contribute to water insecurity.

Map A is a United Nations map showing patterns of water scarcity (insecurity).

- Physical scarcity – these areas experience low rainfall (arid and semi-arid regions).
- Economic scarcity – these areas may physically possess water supplies but economic factors (such as the lack of infrastructure) prevent exploitation.

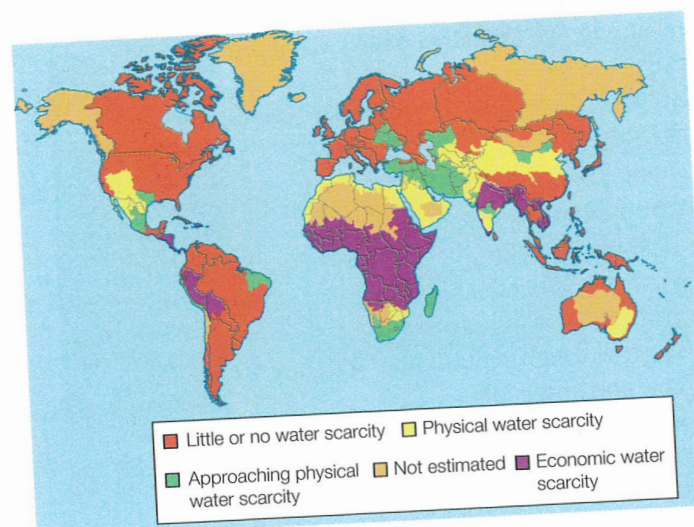
With the exception of Antarctica, water scarcity exists on every continent, but it is particularly severe and widespread in Africa. The UN estimates that about 1.2 billion of the world's population suffer from physical water scarcity; a further 1.5 billion suffering from economic scarcity.

Global patterns of water surplus and deficit

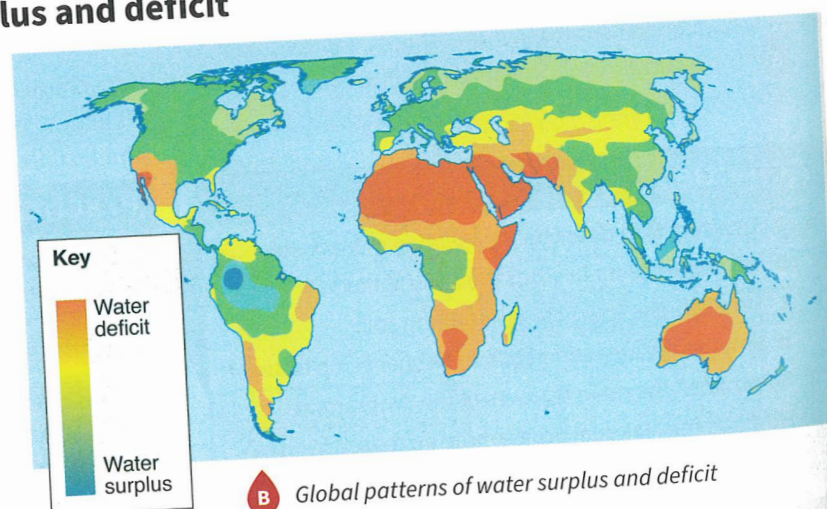
Map B shows global patterns of **water surplus** and **water deficit**. Regions with a water surplus have a plentiful supply of water with supply exceeding demand. These regions include North America, Europe and parts of Asia. Other regions have a water deficit, where demand exceeds supply and supplies are under pressure.

Regions with high rainfall usually have a water surplus. Areas with low rainfall, such as hot deserts, are more likely to have a water deficit.

Areas of high population density and high concentrations of industry have the highest demand for water. Without sufficient water supply these areas may experience a water deficit. Areas with low rainfall but a lower demand may have a water surplus.



A Global physical and economic water scarcity

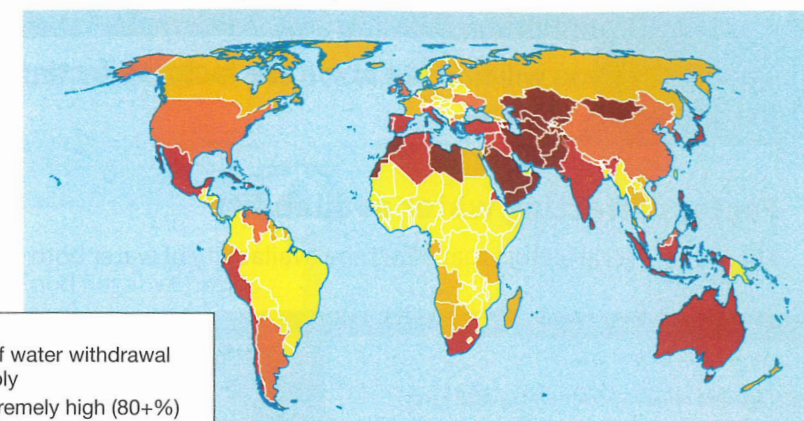


B Global patterns of water surplus and deficit

What is water stress?

Many countries face high **water stress** (map C). This means that more than 80 per cent of available water is used every year, leaving the threat of water scarcity.

Countries begin to experience water stress when less than 1700 m³ is available per person per year. Below 1000 m³, water stress may damage economic development – and human health and well-being. Regions with high water stress include several Caribbean islands, Bahrain, Cyprus, Malta and the Middle East.

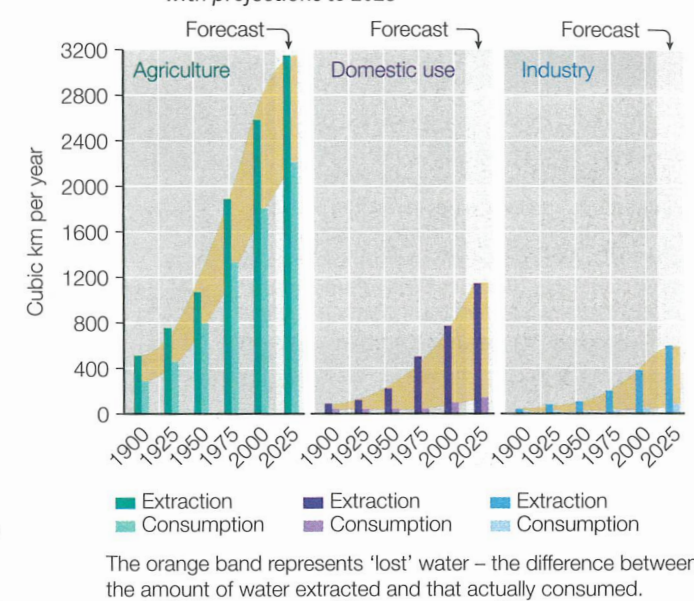


C Global water stress

Why is water consumption increasing?

Global water demand is expected to increase by 20–30 per cent by 2050. There are several reasons why water consumption is increasing.

- Economic development – increasing levels of development (particularly in heavily populated countries such as China and India) mean demand for water has increased. By 2030 the global economy may double in size, with India and China, comprising 40 per cent of the world's middle class, significantly increasing water demand.
- Population growth – between 1915 and 2015 the world's population increased from 1.8 billion to 7.3 billion. By 2050 it is expected to reach 9.3 billion. More people will increase the demand for water (graph D).
- Increased demand for food – demand for food is likely to increase by 70 per cent by 2050, the demand for water to irrigate crops and process food is likely to increase significantly (graph D).
- Increased urbanisation – as more people live in towns and cities, the demand for drinking, sanitation and industry will increase pressure on water supplies (graph D).



Activities

- What is meant by the term 'water security'?
- What is the difference between physical scarcity and economic scarcity?
- Using map A, describe the global pattern of water scarcity (insecurity).
- To what extent is Africa the continent which faces the greatest challenges associated with water security (maps A and B)?

Extension

Considering social, economic, political and environmental factors, suggest how global water insecurity can be reduced in the future.

Practice question

Explain why there is increasing global water insecurity. (4 marks)

Tips

- You should concentrate on writing about why global water insecurity is increasing, focusing on Africa.
- 'Explain' means giving reasons for an increase in global water insecurity, such as trends in water consumption (graph D).
- Refer to specific countries in your answer.

21.2 Factors affecting water availability

On this page you will find out about the factors affecting the availability of water

Factors affecting water availability

There are several factors that affect the availability of water both now and in the future.

A What affects the availability of water?

Climate

Regions with high and reliable patterns of rainfall rarely experience physical water scarcity. Water is usually plentiful and, once stored in reservoirs or trapped in underground aquifers, is more than sufficient to meet demands. Many of the world's tropical and temperate regions have surplus water supplies (see map B on page 306).

Geology

Percolation of water through permeable rocks forms huge underground reservoirs called aquifers. These are extremely important sources of water across the world. In arid parts of North Africa and the Middle East, 'fossil' aquifers exist, created several thousand years ago when the climate was wetter. Today, these aquifers are under threat from unsustainable demand, particularly from agriculture.

Pollution of supply

Increasing amounts of waste and the growing use of chemicals in farming have led to higher levels of pollution in rivers and aquifers. In some LICs and NEEs water sources are often used as open sewers leading to the spread of **waterborne diseases** (photo A).

Over-abstraction

Over-abstraction occurs when water is pumped out of the ground faster than it is replaced by rainfall (a process called *recharge*). As the *water table* (the upper level of underground water) falls, wells dry up and people no longer have access to water. Over-abstraction is unsustainable and often results from increased demand for irrigation (often associated with commercial agriculture) and industrial processing. Over-abstraction can also cause rivers to dry up as water tables fall.

Limited infrastructure

Limited infrastructure, such as pumping stations and pipes, may result in economic scarcity of water, particularly in LICs and NEEs. It is very expensive to establish an efficient and effective water supply system and also challenging to reduce water loss through leakages. In the UK almost a quarter of water is lost through leakages. According to the UN, underfunding of water infrastructure around the world is a major cause of water scarcity and insecurity.

Poverty

Many poorer communities in LICs and NEEs do not have access to safe water. UNICEF estimates that in 2019 2.2 billion people around the world did not have access to safe drinking water and 4.2 billion lacked adequately managed sanitation services. In poorer communities, inadequate infrastructure means that several households often have to share water supplies (photo B).

Extension

Suggest how pollution could be reduced in rivers, such as the one shown in photo A.

B Family using a shared public standpipe in Monjas Bajo, Cayambe, Ecuador

Activities

- 1 Construct a table to describe the factors affecting water supply.
- 2 Using photo A, suggest how water sources may become polluted due to the lack of infrastructure and poverty.

Practice question

Using photo B, describe how limited infrastructure and poverty can affect water availability. (4 marks)

Tips

- In your answer, focus on limited infrastructure and poverty only.
- Use the evidence in photo B to support your answer.

Bar graphs

On this page you will use a bar graph to show positive and negative trends in global projected water use

Skills

- Constructing a bar graph showing positive and negative trends
- Calculating range

What is the projected global use of water?

Over the next 30 years global demand for water is expected to increase. Currently, most of the world's fresh water is used in agriculture (69 per cent), industry (19 per cent) and domestic use (12 per cent). In LICs, where agriculture contributes more to the national economy, over 90 per cent of water use can be within this sector.

Whilst in the future the agricultural sector is expected to remain the largest user of water, demand is expected to rise at a much faster rate in the industrial and domestic sectors (table A). In agriculture, demand is expected to shrink slightly as water is used more efficiently (table A).

Water use	2030 (% change)	2050 (% change)
Domestic	+36.5	+65.1
Industry	+53.3	+119.8
Agriculture	-3.6	-6.9

A Predicted trends in water use to 2030 and 2050

Skills

- 1 For 2050, calculate the range in percentage change.
- 2 'For domestic consumption, the rate of increase is expected to more than double from 2030 to 2050.' True or false?
- 3 Use the data in table A to construct a bar graph showing the positive and negative trends.
 - a Draw a horizontal line (x-axis) in the centre of a sheet of graph paper. Label this line '0 per cent change'.
 - b On the left side, draw a vertical line (y-axis) extending above and below the x-axis to +120 per cent and -10 per cent. Write the numbers alongside the y-axis.
 - c Use the data in table A to draw three sets of adjacent (parallel) bars – one for 2030 and the other for 2050 – for each of domestic, industry and agriculture. Four bars will extend above the central x-axis (increases) and two below (decreases).
 - d Use colours or types of shading to distinguish between those water uses showing an increase and those showing a decrease.
 - e Write the names of each water use and give your graph a title.

Analysis

- 1 Suggest how water use in agriculture may become more efficient in the future.
- 2 Suggest why water use is expected to increase at a high rate in the domestic and industrial sectors.

Evaluation

- 1 Discuss the effectiveness of your bar chart in comparing percentage change in data.
- 2 Comment on the validity of table A in assessing global trends in water use.

Practice question

Suggest an alternative form of presentation for the data in table A. Give reasons for your choice. (3 marks)

1.3 Impacts of water insecurity

On this spread you will find out about the impacts of water insecurity

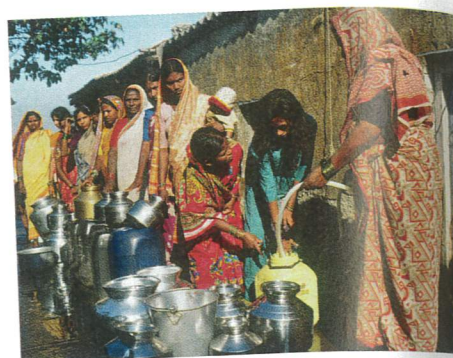
What is water insecurity?

Water insecurity occurs when a country can't supply enough safe water (commonly sourced from reservoirs, rivers or underground aquifers) to support the needs of its people in sustaining well-being, good health and economic development.

Waterborne diseases and water pollution

In countries where water supply infrastructure is limited, there may be little or no sanitation. There may be open sewers and high levels of pollution in rivers and other water sources. Contaminated drinking water can cause outbreaks of life-threatening diseases such as cholera and dysentery.

With a shortage of clean water, people may have to queue for a long time to obtain a supply from standpipes (photo A). This wastes time and reduces levels of productivity.



A Queuing for water at a standpipe

Water pollution: The River Ganges, India

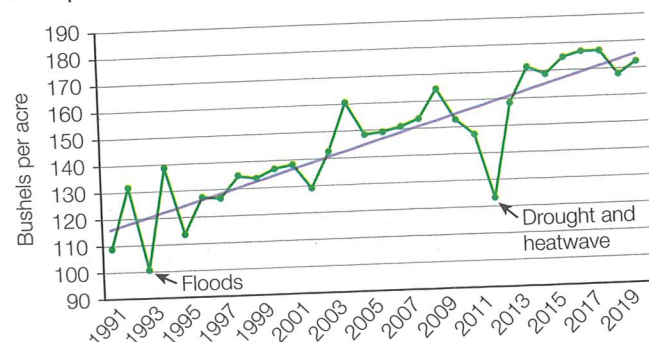
The River Ganga (Ganges) is 2520 km long and flows through northern India and Bangladesh. It is the most polluted river in the world, with both human and industrial waste.

- Over one billion litres of raw sewage enter the river each day from the cities, towns and villages along its banks.
- Hundreds of factories discharge 260 million litres of untreated wastewater into the river daily.
- The major polluting industry along the Ganges is the leather industry, because toxic chemicals leak into the river.
- Runoff from pesticides and fertilisers is another major source of pollution.

Pollution of the Ganges has become so serious that bathing in the river and drinking its water have become very dangerous.

Food production

Agriculture uses about 70 per cent of global water supply and suffers the most from water insecurity. Drier regions of the world with unreliable rainfall are most at risk. The USA supplies 30 per cent of the world's wheat, maize and rice. Droughts and floods are serious issues (graph B) and can have a global impact on food production and supply. Droughts can lead to crop failure, and floods can destroy crops or cause them to rot.



B Corn (maize) yields in the USA, 1991–2020

Water shortages in Egypt

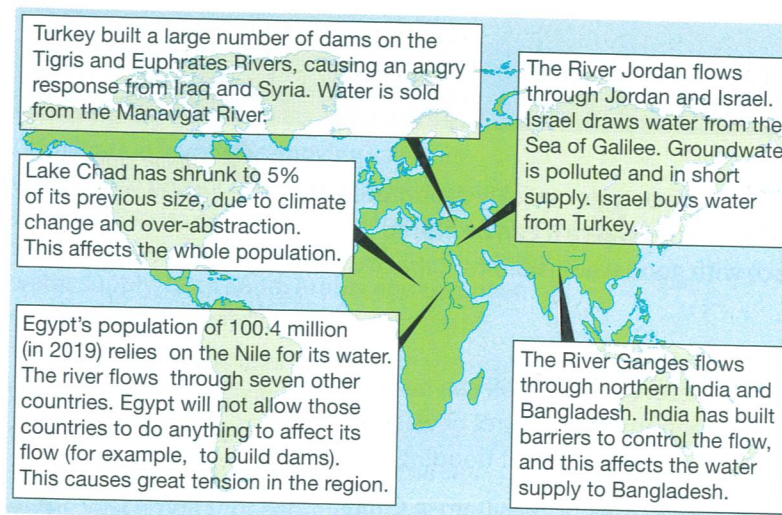
Shortage of water is affecting Egypt's food security. The River Nile is Egypt's primary source of water. Climate change and the demands of countries upstream are expected to reduce its flow by between 10 and 90 per cent by 2095. Although around 86 per cent of Egypt's water supply is used in agriculture, food production in southern Egypt is likely to decline by 30 per cent by 2050 as a result of climate change. Currently Egypt has to import about 40 per cent of its food and agricultural products.

Industrial output

Industry is the second largest consumer of water, accounting for about 19 per cent of global water withdrawals. It is predicted to be the fastest growing sector, increasing in demand by nearly 120 per cent by 2050. Growth in manufacturing and processing industries, particularly in NEEs, will account for much of this predicted future demand.

Water conflict

In the past, wars were fought over oil supplies – in the future, they may be fought over water. This is because water sources, such as rivers and groundwater aquifers, cross national and political borders. Many of the world's great rivers, such as the Nile and Danube, flow through several countries. Issues such as reservoir construction and pollution can impact on more than one country, and create conflict (map C).



C Some of the world's potential water conflict zones

Activities

- What is meant by water insecurity?
- Use graph B to describe the effects of extreme weather on corn yields in the USA.
- What is the evidence on map C that water insecurity can lead to conflict?

Practice question

Explain why water shortages (insecurity) can lead to a reduction in food production and an increase in the potential for conflict. (6 marks)

Tips

- Focus on the impacts of water insecurity (shortages) on food production and the potential for conflict only. You do not need to write about waterborne diseases and pollution or industrial output.
- Explain clearly the link between cause (water insecurity) and effect (reduction in food production and increased potential for conflict).
- You should aim to write about 12 lines.

Chinese industry

China has 20 per cent of the world's population but only 7 per cent of its fresh water. By 2030 Chinese industry is predicted to demand 32 per cent of the country's water resources. To meet China's overall water demands, supply will need to increase by 24 per cent by 2030. Water shortages cost China about US\$40 billion per year in lost crops, lower industrial production and stalled economic output. Some factories have closed temporarily due to water shortages. Coal mining and power stations, on which the country's economic growth depends, use about 20 per cent of China's water.

The Rogun Dam, Tajikistan

Several rivers flow from mountainous Tajikistan to Uzbekistan in the west. In 2014 the World Bank agreed to finance the Rogun Dam Project on the Vakhsh River. The construction of the dam started in 1976, but long delays meant that the power plant only began operating in 2018. Once fully operational, electricity generated by the dam will support industrial growth in Tajikistan.

The project is very controversial in neighbouring Uzbekistan, which suffers from a water deficit. Irrigated cotton is Uzbekistan's main export and there is concern about the impact of reduced water supplies on its economy.

Extension

Using graph B, consider to what extent water insecurity contributes to the rising cost of food and manufactured goods.

21.4 How can water supply be increased?

On this spread you will find out about different strategies used to increase water supply

The amount of water available is limited. To make more water available means finding new sources or moving it from areas of surplus to areas of deficit.

Diverting supplies and increasing storage

Water supplies can be artificially diverted and stored for use over longer periods. For example, in some parts of the world surface water evaporates rapidly and is lost. This water can be stored in deep reservoirs or in permeable rocks (aquifers) underground.

In Oklahoma, USA, rainfall is infrequent but heavy. Surface water quickly evaporates, so it is collected and diverted into underlying alluvial soils where it can be stored (diagram A). Alluvial soils are loose at the surface with good water-holding capacity.

Dams and reservoirs

Dams control water flow in rivers by storing water in reservoirs. Rainfall can be collected and stored and then released gradually during drier periods. The control of water flow enables it to be transported and used for irrigation. It helps to prevent flooding.

Dams range in size, from huge, multi-purpose dams, e.g. Three Gorges Dam in China, to earth or cement dams a few metres high in sub-Saharan Africa. Large dams are expensive to construct and maintain and can displace many people. Also, they may reduce the flow of water downstream. In hot, arid regions, reservoirs can lose a lot of water through evaporation.

Kielder Water, Northumberland

Kielder Water is the UK's largest reservoir in terms of its storage capacity (photo B). The dam, 1.2 km long and 50 m high, was built in the late 1970s at North Tyne Valley near Falstone. The valley is relatively narrow, reducing the cost of building. The 10 km-long reservoir took two years to fill.

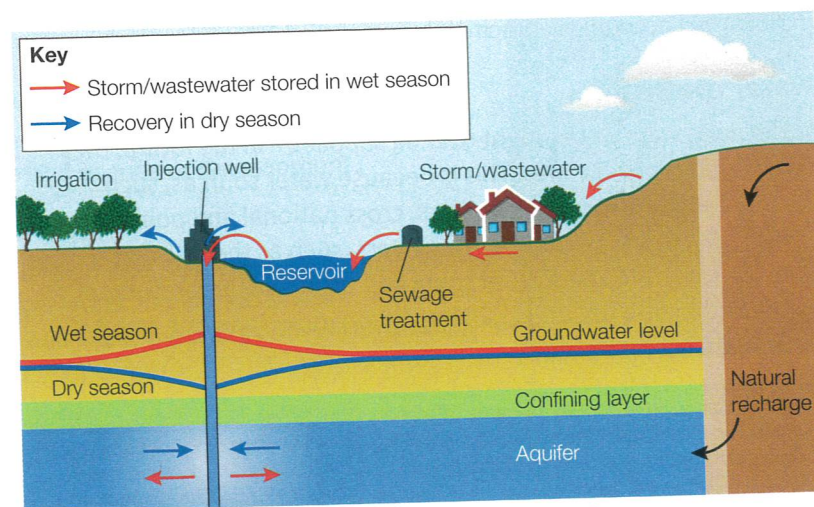
The reservoir regulates flow in the North Tyne, making up for water abstracted (taken) further downstream. Water is also used to generate electricity.



B Kielder Water

Water transfers

Water transfer schemes aim to redistribute water from areas of water surplus to areas of water deficit. They often use canals and pipelines. In the UK the Kielder transfer scheme carries water south to the Rivers Wear and Tees.

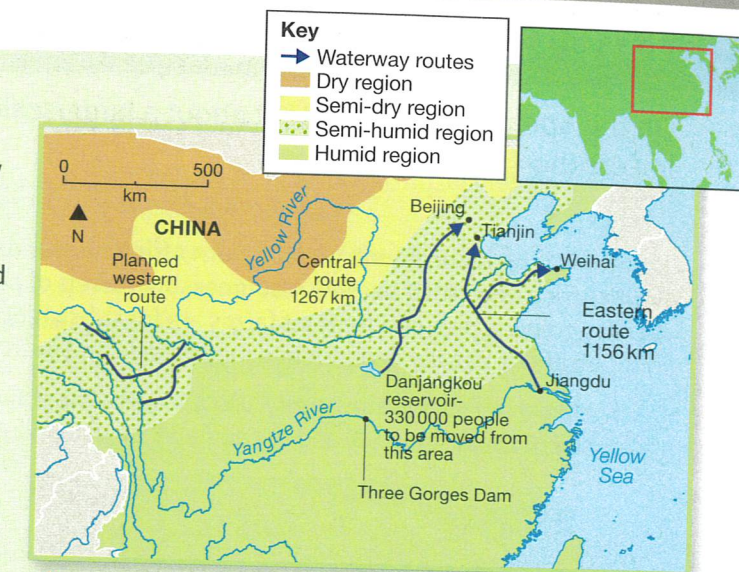


A Aquifer storage and recovery

China's south-north water transfer scheme

China is spending almost US\$80 billion to transfer water from the Yangtze River in the south to the Yellow River Basin in the arid north (map C). Water will be transferred through three canal systems. In 2013 the first water transfers took place in the eastern route and in the following year the central route was completed.

The western route, still at the planning stage, is very controversial, with concerns about social and environmental impacts. The project involves constructing several dams and hundreds of kilometres of tunnels through the Bayankala Mountains. This region is largely populated by minority Chinese groups. The entire scheme is expected to be completed by 2050.



C China's water transfer project

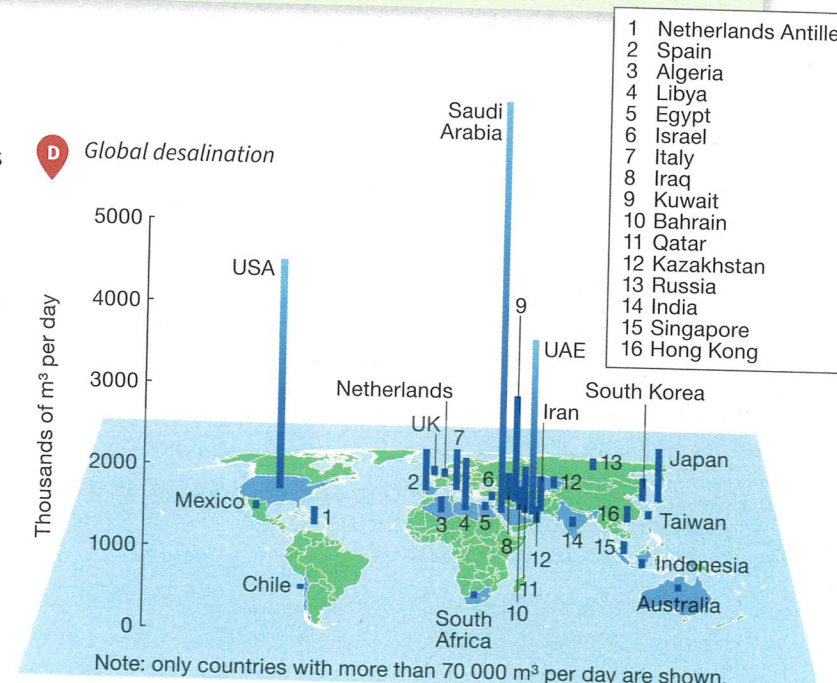
Desalination

Desalination involves removing salt from seawater to produce fresh water. This is very expensive so is used only where there are serious water shortages and few alternatives to increase water supply. Both Saudi Arabia and UAE have developed desalination plants (see map D).

There are several issues linked with the process of desalination, such as:

- environmental impacts on ecosystems when salt waste is dumped back into the sea
- the vast amount of energy required, adding to carbon emissions
- the high cost of transporting the desalinated water to inland areas.

Future technological improvements may reduce costs and make this process more economically viable for NEEs or even LICs.



Activities

- Using map C, explain why China is transferring water from the south to the north of the country.
 - What were the human impacts of constructing the Danjiangkou reservoir in the central route?
 - Suggest reasons why the western route is still at the planning stage.
- Describe the distribution of the countries where large amounts of water are desalinated (map D).

Extension

Consider the arguments in favour of and against the construction of the western route of China's south-north water transfer scheme. To what extent might the final decision be political?

Practice question

Explain how water transfers and desalination can increase water supply. (4 marks)

Tips

- In your answer, focus on water transfers and desalination only.
- Make clear connections explaining how water transfers and desalination can increase water supply.

21.6 Sustainable water supplies

On this spread you will find out about strategies for a sustainable water supply

What is a sustainable water supply?

Sustainable development is defined by the UN as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. Essentially, it is economic development that does not harm or deplete natural resources, such as water.

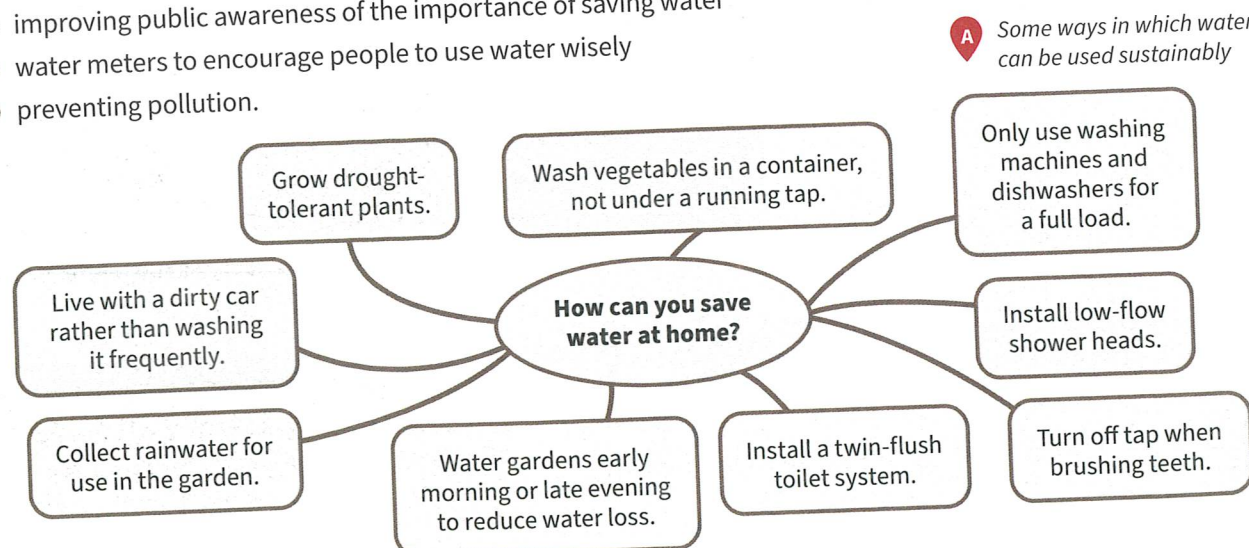
In 2015 the United Nations identified 17 Sustainable Development Goals (SDGs) to achieve a better and more sustainable future for all by 2030. SDG 6 'Clean water and sanitation' aims to ensure availability and sustainable management of water and sanitation for all.

Sustainable approaches to water supply focus on the careful management of water resources and the need to reduce waste and excessive demand.

Water conservation

Conserving water is about reducing waste and unnecessary use. Strategies can include:

- reducing leakages (25–30 per cent of global water supply is lost through leakage)
- monitoring illegal and unmetered connections
- water tariffs, with charges increasing sharply after a certain level of usage
- improving public awareness of the importance of saving water
- water meters to encourage people to use water wisely
- preventing pollution.

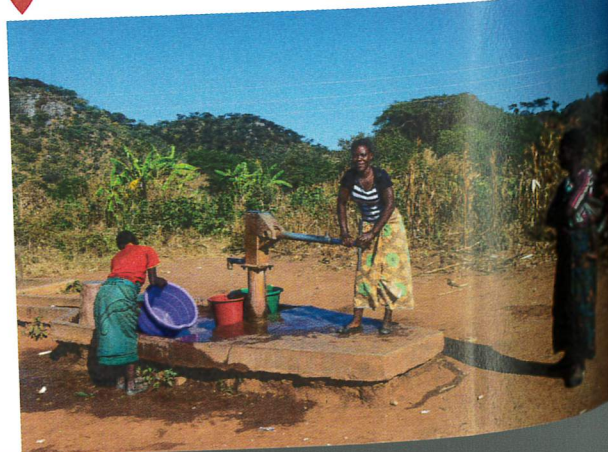


Groundwater management

Groundwater stored in underground aquifers has to be managed to maintain the quantity and quality of the water. To ensure supplies are sustainable, water abstraction (loss) must be balanced by recharge (gain). If groundwater levels fall, water can become contaminated, making expensive water treatment necessary.

In many LICs individual families or groups own wells, so effective community-based management is needed (photo B).

B Local women at a communal water well, Malawi



Recycling

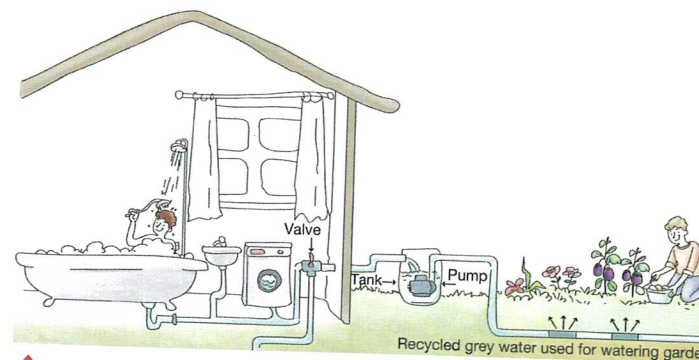
Water recycling involves re-using treated domestic or industrial wastewater for useful purposes like irrigation and industrial processes. For example:

- Large quantities of recycled water are used for cooling in electricity-generating and steel-making plants. In some Australian power stations recycled water replaces enough fresh water to fill an Olympic-sized swimming pool.
- In Kolkata, India, sewage water is re-used for fish farming and agriculture. Sewage is pumped into shallow lagoons where sunlight helps algae to photosynthesise. This oxygenates the water so that it can be re-used.
- Some nuclear power plants, like the Palo Verde nuclear generating station in Arizona, USA, use recycled water for cooling (photo C).

Using grey water

Grey water is taken from bathroom sinks, baths, showers and washing machines. It may contain traces of dirt, food, grease, hair and some cleaning products. If used within 24 hours it contains valuable fertiliser for plants. Water from toilets is considered to be 'black' water and cannot be used in the same way.

Grey water is mainly used for irrigation and watering gardens (diagram D). In Jordan 70 per cent of the water used for irrigation and gardens is grey water.



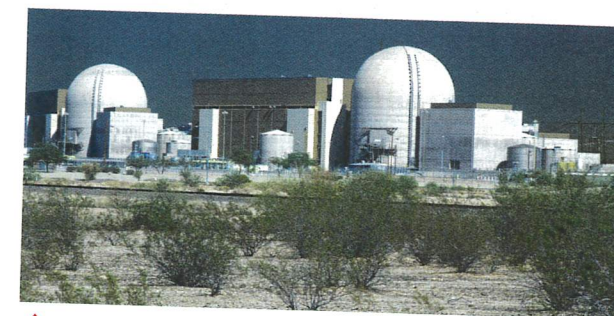
D Re-using grey water

Participatory Groundwater Management (PGM), India

In rural India, 50 per cent of water for irrigation and 85 per cent of drinking water is groundwater. Communities are encouraged to conserve water from their wells through the PGM scheme. Without careful management, the future of some rural communities is at risk. The PGM scheme involves:

- training local people to record rainfall and to monitor groundwater levels and water abstraction
- helping farmers to plan when and how much water to use for irrigation
- encouraging farmers to plant crops to fit in with annual periods when water is available.

Through PGM, rural communities have used scientific monitoring to balance water supply and demand using sustainable practices.



C Palo Verde nuclear generating station, Arizona, USA

Extension

To what extent is the UN on track to achieving 'availability and sustainable management of water and sanitation for all' by 2030?

Activities

- 1 What is meant by a sustainable water supply?
- 2 What is water conservation and why is it an attractive alternative to increasing water supply?
- 3 Using photo B, suggest why effective community-based management is necessary to ensure sustainable supplies of water.
- 4 What is water recycling and how does it differ from using grey water?

Practice question

To what extent is it possible to increase water supplies sustainably? (6 marks)

Tips

- Begin your answer by stating your point of view ('to what extent').
- Focus on the various sustainable strategies of increasing water supply. Try to write about at least two or three.
- Show a clear understanding of terms such as 'groundwater' and 'grey water'.

1.7 The Wakal River Basin Project

On this spread you will find out about a local scheme to manage water supplies in a more sustainable way

Rajasthan is a region in north west India (map A). It is the driest and poorest part of India, and largely covered by the Thar Desert (see pages 84–85). Summer temperatures can reach 53°C. Rainfall is less than 250 mm per year with 96 per cent between June and September. There is little surface water, as rain quickly soaks away or evaporates.

What are the issues with water supply?

Water management in the region has generally been poor. Over-use of water for irrigation has led to waterlogging and salinisation. Over-abstraction from unregulated pumps has resulted in falling water tables in aquifers and some wells have dried up. With access to wells controlled by households or villages, there has been little coordination of water management.

The Wakal River Basin Project

The Wakal River Basin is located in the south of Rajasthan. The United States Agency for International Development (USAID) has funded a project called the Global Water for Sustainability Program (2004–2014). This NGO (non-government organisation) has been working with local people in the Wakal River Basin to improve their water security and overcome the problems of water shortages. Local people needed to be actively involved in the decision-making process to make the water management successful.

The two main aims of the scheme are to:

- increase water supply and storage using appropriate local solutions
- raise awareness in local communities of the need for effective water management.

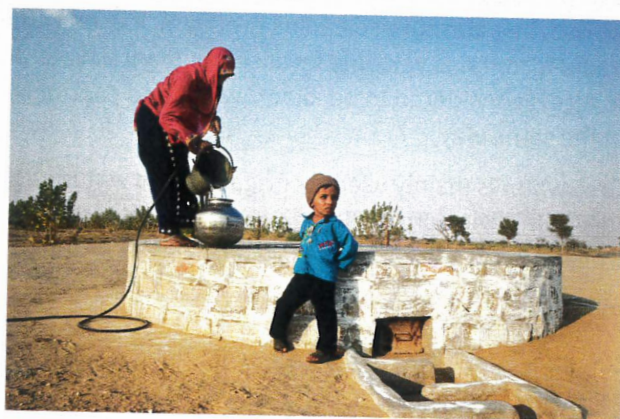
Increasing water supply

The project has encouraged greater use of rainwater harvesting techniques to collect and store water. This benefits villages and individual families. The methods used include the following:

- **Taankās** – underground storage systems about 3 m in diameter and 3–4 m deep (photo B). They collect surface water from roofs.
- **Johad** – small earth dams to capture rainwater (photo C and diagram D). These have helped to raise water tables by up to 6 m. Five rivers that used to dry up following the monsoon now flow throughout the year.
- **Pats** – irrigation channels that transfer water to the fields (diagram E).

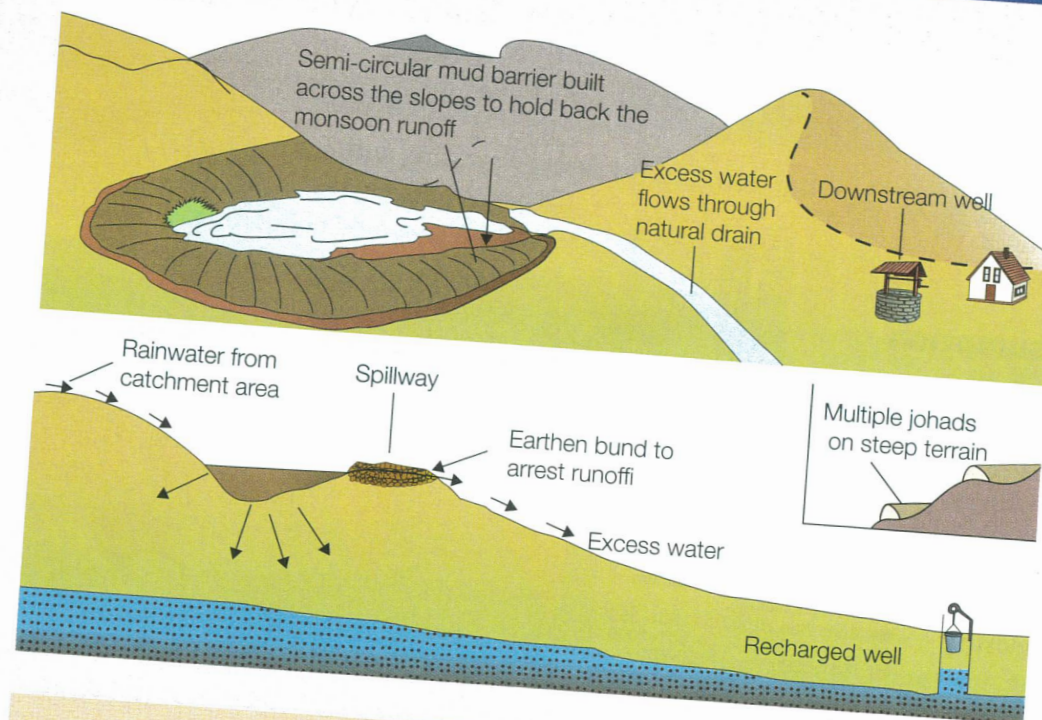
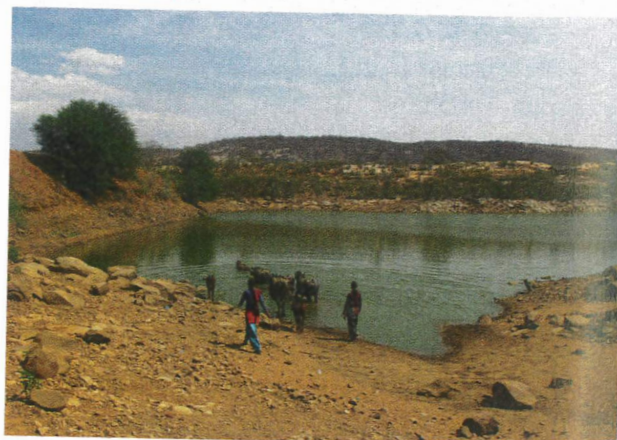


A Location map of Rajasthan



B Collecting water from a concrete taanka

C Taking cattle to the Mandalwas village johad

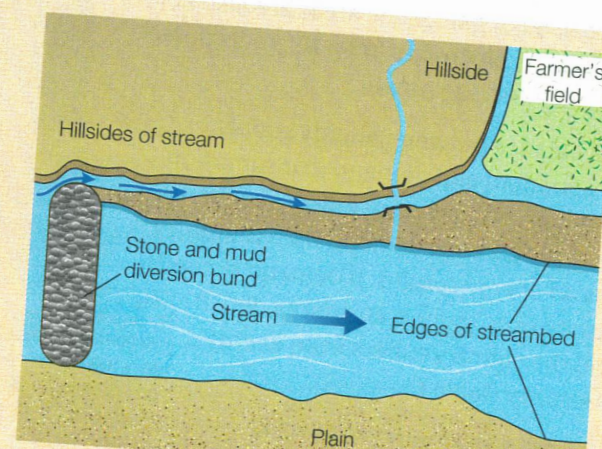


D Capturing rainwater using a johad

How does the pat system work?

In the *pat* system, a small dam called a bund diverts water from the stream towards the fields. Bunds are made of stones, and lined with leaves to make them waterproof.

Villagers take turns to irrigate their fields using water controlled in this way. The irrigation channels need regular maintenance to avoid them breaking or silting up. This is done by the villager whose turn it is to receive the water.



E The pat irrigation system

Activities

- 1 Explain why the state of Rajasthan needs a sustainable water supply.
- 2 Use photo B to describe and explain the main features of a taanka.
- 3 a Make a copy of diagram D.
b Explain how a johad increases sustainable water supply.
- 4 What is the pat system and how does it work (diagram E)?

Extension

Consider ways in which water loss and waste can be reduced in both HICs and LICs/NEEs.

Practice question

Using an example, explain how local schemes can increase sustainable water supplies in LICs/NEEs. (6 marks)

Tips

- Focus on an example (the Wakal River Basin Project) and include specific information about it.
- Explain clearly how this 'local scheme' has increased sustainable water supplies.
- Make sure that you demonstrate a clear understanding of the term 'sustainable'.