

Edexcel A Geography GCSE

Topic 6B - Water Resource Management Detailed Notes

This work by [PMT Education](https://www.pmt.education) is licensed under [CC BY-NC-ND 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)



Resources across the Globe

There are many resources that humans **need to live** or use to enhance their living. A resource is a product that is **valuable** to living. Essential global resources can be split into three groups: **food, water and energy**.

There are many different types of resources:

1. **Abiotic** - Inorganic (non-living) materials from the earth, such as minerals, the air, water, etc.
2. **Biotic** - Living, organic materials such as plants, animals and fossil fuels.
3. **Renewable** - There is an infinite supply of this resource. This may be because:
 - a. Using this resource doesn't take away from the origin, for example using sunlight doesn't use up the Sun.
 - b. More of a resource can be grown, such as plants or crops
 - c. A resource cannot be destroyed, only reused as part of a cycle. This is the case for water, which cannot be lost from the planet.
4. **Non-Renewable** - There is a limited supply of this resource. Once consumed, this energy source cannot be re-used.

We need resources to be able to **live**, for example water, energy sources, food and metals. However, some humans **over-exploit** resources which could endanger the supply of resources in the **future**. There are many ways that we **exploit our environment**:

- **Fishing** - Fish are a good source of **nutrients and minerals** in our diet. However, the demand for fish has increased the size of fishing vessels in the UK and around the world. **Overfishing** will reduce the population of fish available in the future; if we consume too many fish now, some species may die out or become **endangered**. In addition, large fishing vessels and trawlers scrape nets across the bottom of the sea, which **damages precious environments** like coral reefs. Finally, in some parts of the world, particular fish are hunted for cuisine. **Whales and sharks** are overfished in Asia, since delicacies like shark fin soup are in high demand. **Shark finning** is banned in most countries, but fishermen continue to throw finless sharks back into the ocean.



Fishing Boat, Source: In Cornwall

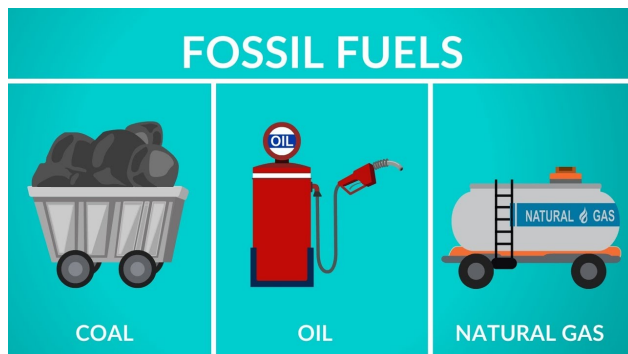


Full Trawler Nets, Source: Fewox

- **Fossil Fuels** - Energy resources have been **essential** for development: for heat, cooking, electricity, lighting, machinery, etc. However, the **demand for electricity** has come at a cost. Much of our **fossil fuel** supplies have been consumed to generate electricity and heat. Since fossil fuels are produced from dead animals and plants, under pressure for millions of years,



we cannot make more coal, oil and gas. Therefore, fossil fuels are a **non-renewable** source with a reducing supply available. In addition, when burned, fossil fuels release carbon dioxide and sulfur dioxide which lead to **climate change** and **acid rain**. These are global problems that will affect the supply of other resources; for example, acidic rain will damage crop growth, leading to **food shortages**.



Three types of Fossil Fuels, Source: Youtube



Coal-Powered Station, Source: Phys.Org

- **Deforestation** - **36 football fields** of trees are felled and destroyed each minute. Many countries have damaged or decreasing forests, since many clear the land for:
 - **Farming** and Cattle Rearing
 - **Houses and Industrial Plants**

To clear the forests or rainforests, trees are felled and any vegetation is burned (**slash and burn**). This releases large amounts of **carbon dioxide** and disrupts the **nutrients cycle**, which over time will leave the soil starved of minerals and prone to soil erosion. In addition, the loss of rare rainforests will **endanger many species** of plants and animals. These unstudied species could lead to **new medicines** and cures to illnesses, but could be lost through deforestation before we discover the cures!



A partly demolished rainforest, Source: Save Rainforest

- **Intensive Farming** - As the population increases, so does the **demand for food**. Farming can damage the environment:
 - **Pesticides and weed-killers** can be used to reduce damage to the crops. However, the impacts of chemicals running into the **water cycle** is unknown.
 - Planting crops without breaks - called **fallow periods** - will strip the soil of nutrients and moisture. Over time, this can lead to **soil erosion** and **desertification**.



Pesticides being spread across the fields, Source: Financial Express



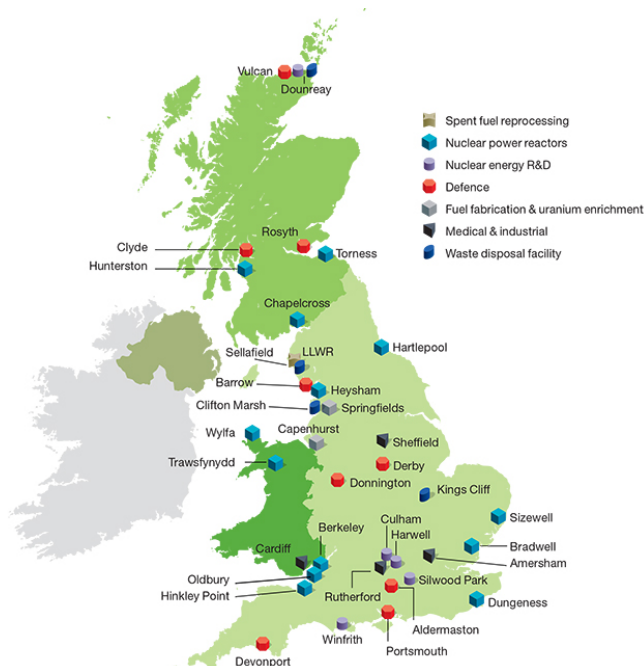
UK Resources

Across the UK, there are **many resources** that we use and conserve. Let's take a look at **four** resources: water reservoirs, nuclear energy power stations, woodlands and farmlands.

Reservoir stocks in England and Wales



Map 1 - Reservoirs, Sources of Clean Water



Map 2 - Nuclear Power Stations

The UK experiences **little water scarcity**, due to its **temperate (rainy) climate**. Reservoirs are found in regions of **high latitude**, as shown in Map 1, so many are found in the mountain ranges of the Pennines and Snowdonia. There are also a cluster of reservoirs in South-East England, due to London's **large population**. The largest reservoir in the UK is Kielder Reservoir, and there are hopes to connect reservoirs across the country through **transfer schemes**.

Nuclear power stations are relatively spread out across England, Wales and Scotland (see Map 2). Nuclear power stations are found **along to coast** for two reasons:

- To distance radiation from **major cities** and settlements, since radiation over time is dangerous to humans.
- In the event of an **emergency**, seawater may be used to cool down the reactor to avoid meltdown.

Energy production is not localised in the UK; electricity generated at remote coastlines in the UK can be transported across the country using **pylons and underground cables**, as part of the **National Grid**.

In Map 3, there is a **spread of farmland** across the UK, but the type of farming depends on the location. This is because **weather** conditions change depending on the **relief** of the land and **soil type** will affect the type of crops able to grow.

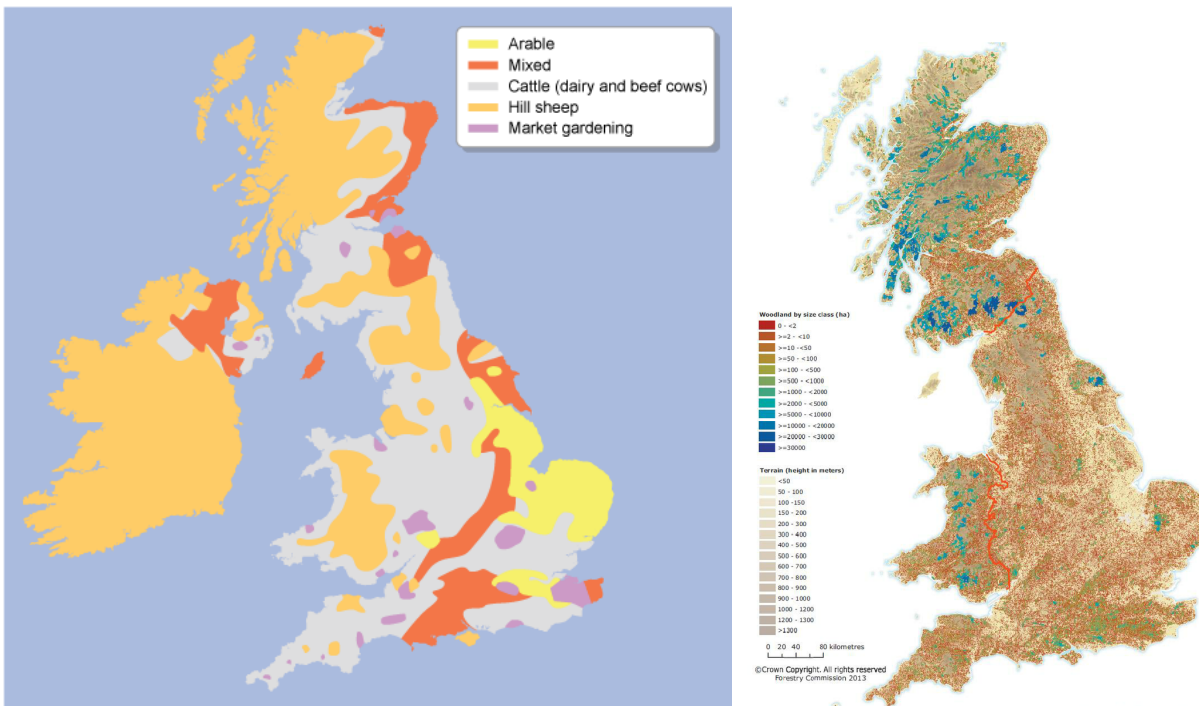
Along the west coast, rain and wind from the Atlantic tend to be concentrated here, since rain clouds cannot pass over the Pennines (**relief rainfall**). Due to the large amount of rainfall, wind and



mountainous landscape, most farmers choose to rear sheep and cattle. Most crop growing occurs along the east coast; here, conditions are more **sheltered** and the land has a **flatter gradient**.


However, overall the UK has **limited greenfield land** for agriculture. In addition, imported foods such as vegetables and fruits offer a wide variety at cheaper prices. This is leading to a reduction of crop (arable) farming and an increase in **food imports**.

Finally, Map 4 shows the **spread of woodland** across Britain. The largest density of woodland can be found in Scotland, especially along the west coast where the land is **less mountainous**. Scotland has a **large timber production** industry, so some of its woodlands are artificially growing and regularly felled.



Water Distribution

Water is important for human life, as it is essential for humans to survive to drink clean water daily. We also use water in **business** and **food production**. For example, these everyday items consume vast amounts of water to produce:

		
Cars require 76,000 litres of water	Jeans require 8,000 litres of water	A barrel of beer requires an additional 6000 litres of water

This water is used in **cooling** materials down, to produce **electricity** and to wash away (to **dilute**) any waste products.

Alternatively, **food production** requires a large amount of water to keep crops well **irrigated**. This can be increased by planting crops in **unsuitable environments**. Some examples of water consumption in food includes:

		
To produce 1kg of beef requires 15,500 litres of water	To produce 1kg of olives requires 4,400 litres of water	To produce 1kg of chocolate requires 24,000 litres of water

To measure water distribution, we measure the **water surplus and deficit** for each country.

- **Water Surplus** - The supply of water **exceeds the demand** for water
- **Water Deficit** - The supply of water is **less than the demand** for water
- **Water Stress** - There could be a large enough volume of water to meet demand, but not enough clean, good quality water is available or the water is inaccessible.



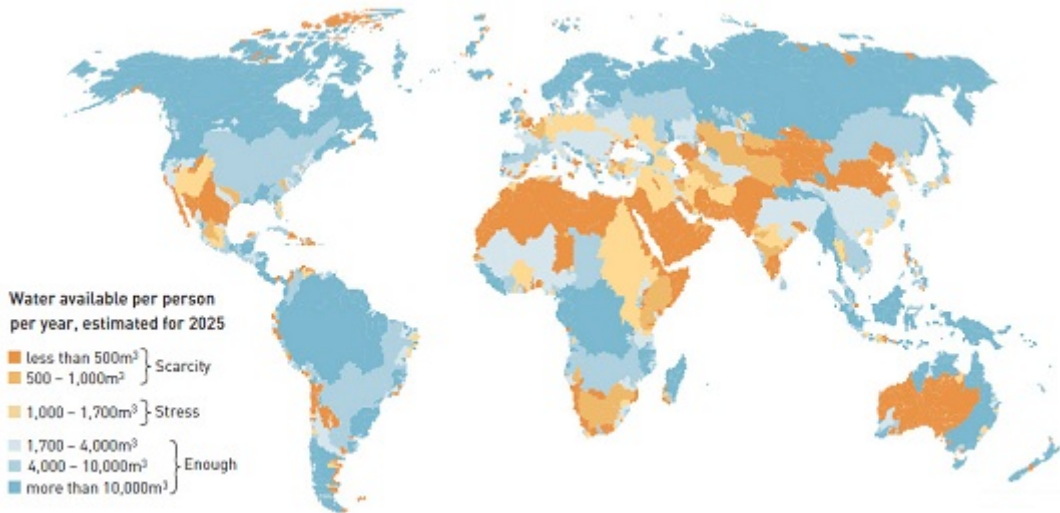
Global Water Resources

The amount of **water available** depends largely on a country's **climate**; countries at the Equator receive less rainfall per year than countries at the Tropics.

Looking at the map below, can you name three countries with:

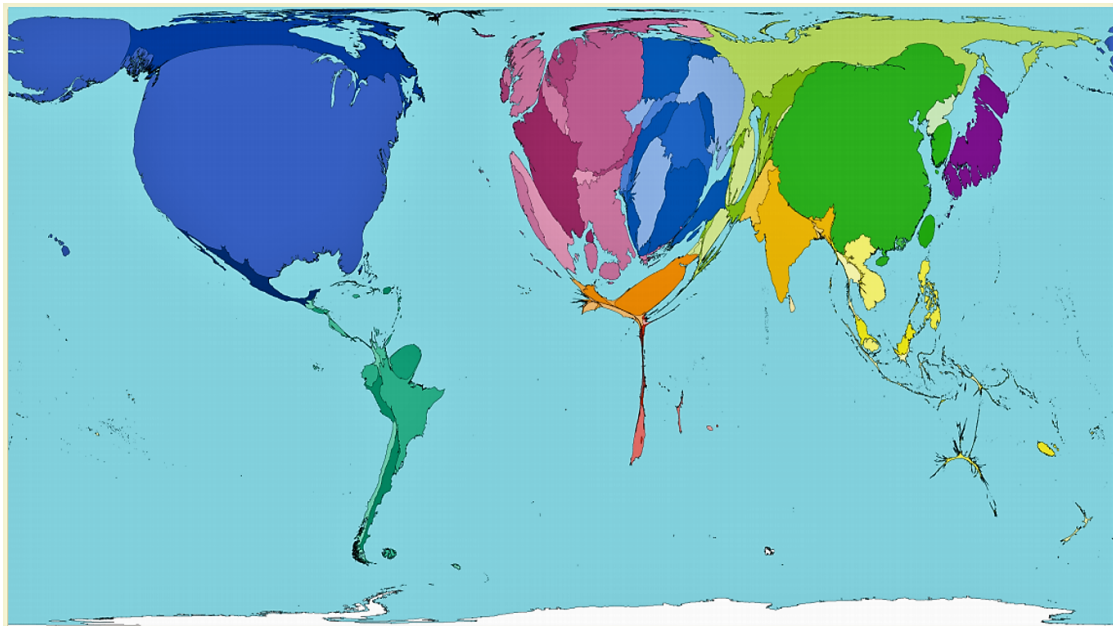
a) Freshwater available

b) Water scarcity



Map of freshwater availability. Source: Freshwater Watch

However, countries with the largest freshwater availability may suffer from water scarcity. This is due to the large demand on water by a population, for various reasons: domestic, industrial or agricultural.



Map of Water Consumption, where the area of a country represents the amount of water consumed. Source: SSWM



Comparing these two graphs to the country's **level of development**, you might see that the newly industrialised countries have the highest levels of water stress. **Newly industrialised countries** with extremely high levels of water stress include: India, Saudi Arabia and Iran.

MEDCs (such as the UK and Canada) have medium levels of water stress as they have a **high demand** for water for consumable goods, but the **efficiency** of their industries has also improved. Increased efficiency will reduce the amount of water used in industries and businesses, as well as reducing the amount of water wasted by households. On the other hand, **LEDs** (such as Zambia and Kenya) have **smaller scale industries** and tend to **conserve water**, using only what they need to use.

In addition, some families may not be able to afford freshwater, even if it is available. **Purifying water** can be an **expensive** process. These three processes add to the cost of water:

1. **Treatment and Purification** - to remove dirt, bacteria and harmful ions.
2. **Sewage Treatment** - Sewage must be kept separate from clean water, to reduce the risk of water-borne diseases.
3. **Desalination** - To remove salt from water requires a large amount of electricity, which costs a large amount of water. This is important for countries with large coastlines, who may not have a large amount of clean water but have a vast quantity of seawater.

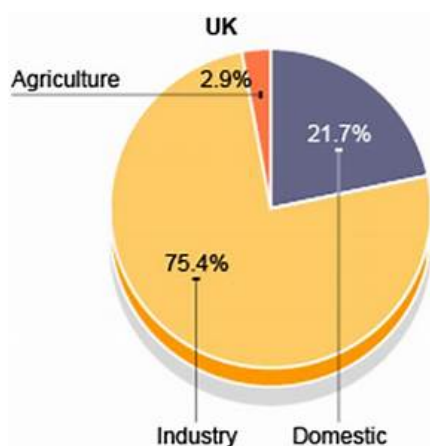
Without treating the water, families may be prone to **water-borne diseases**, such as diarrhoea, which decrease **life expectancy** and largely impact the development of a country.

Proportions of Water Usage:

Different countries consume different amounts of water, as well as for **different purposes**. The type of water usage can be split into three groups:

- **Domestic Use** - Using clean water in the home for drinking, cooking and washing.
- **Industrial Use** - Using water for industrial purposes, such as producing a product or generating electricity.
- **Agricultural Use** - Using water during farming for irrigation of crops, keeping cattle hydrated or cleaning produce.

We shall look at three countries at different **levels of development**. Each country uses different proportions of water for domestic, industry and agriculture.



The UK - Developed Country:

Largest Proportion - Industry

Why?

Developed countries tend to have growing **quaternary industries**, which demand electricity! Generating **electricity** requires water for cooling and to produce steam to turn turbines.

Source: BBC



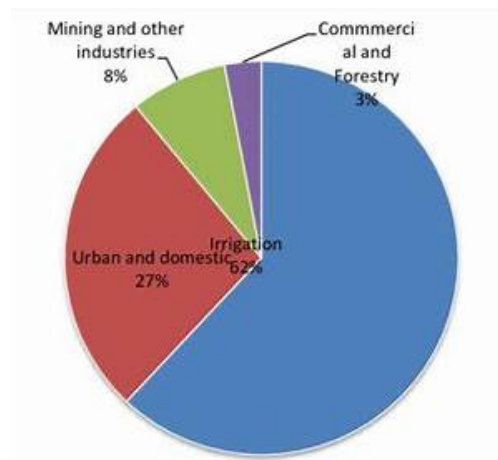
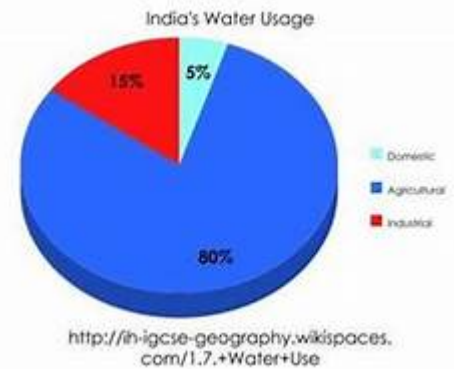
India - Newly Developed Country:

Largest Proportion - Agriculture

Why?

India has the **2nd largest population** in the world, which means the government requires large quantities of food to feed the population. It is cheaper to **produce food** than import, keeping the country's costs down whilst India continues to develop.

Source: Quora



South Africa - Developing Country:

Largest Proportion - Primary Industries

Why?

Developing countries produce **raw materials** - ingredients, minerals and timber - that can be sold to other countries for manufacturing. However, because raw materials earn small **profits**, the country cannot afford to develop and improve secondary industry. Often, primary industries consume large amounts of clean water.

Source: Research Gate

Water Security

Water security means to have a **clean, reliable** source of water that meets **demand** throughout the year. Therefore countries will suffer from water insecurity if:

- Their water source is **contaminated** or **polluted**
- Locals cannot **clean/purify** the water before drinking it
- The volume of water varies over the year due to **drought**, lack of rain or the water **freezes**

It is very important for a community to have a reliable, clean water source for their **health and wellbeing**, as well as for the **local economy**. Water insecurity can lead to **water stress**, when the volume of clean water falls below **1700m³ per person** per year.



Source: Liberals Backward Thinking

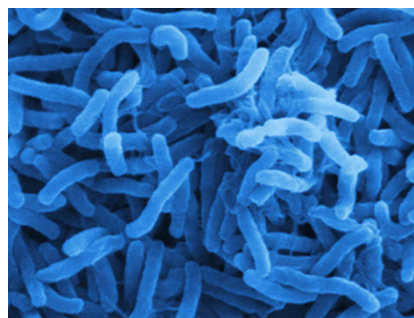
The amount of clean water across the world is **decreasing**, whilst the consumption of water is greatly **increasing**. This is because the **world's population** is increasing massively. Also, some water sources are becoming **polluted** by industries. In addition, **climate change** is reducing the



amount of rainfall in hot climates and also increasing the frequency of weather hazards, which can damage clean water supplies and increase water insecurity.

Impacts of Water Insecurity

- **Water-borne diseases**, such as Cholera and Typhoid, occur when pollution (especially unsanitary pollution such as **sewage**) contaminates a water source used for drinking. Symptoms of water-borne diseases include:
 - Diarrhea
 - Vomiting
 - Dehydration
 - Stomach Cramps



Source: NPR.org

In addition, contaminated water can become a breeding ground for **parasites**, such as mosquitoes (who carry **Malaria**) and worms. Water-borne disease can be **fatal**, resulting in **829,000** deaths around the world in 2016.

- Water shortages can impact **food and agriculture**, as crops need to be **irrigated** and cattle kept hydrated. **Droughts** can have a direct consequence in causing **crop failures** and reduces the yield produced, which in turn increases food insecurity in the world. In addition, other **industries** require a constant supply of water too. Businesses that require water may move to another country, causing **job losses**, if there isn't enough water available in a region.



Source: Food Collapse

- **Conflict** can occur over water supplies. This happens when the supply cannot meet the demand for a region. In the world today, there are **many disputes** over water sources between different states or between different countries. For example:
 - **The Nile** is the source of conflict between Egypt and Ethiopia, since Ethiopia plans to build a **dam** upstream to reduce water insecurity in Ethiopia. Despite being the source of the river, Ethiopia has quite a **dry climate** and so has limited fresh water supplies, because most of the freshwater flows downstream to Egypt. However, the dam could starve Egypt of water further downstream. Egypt is especially worried about losing water since its **population** is increasing rapidly. This has caused **conflict** between the two countries!
 - In 2000, violent protests in **Bolivia** resulted in nine people being killed. This was caused by a **private company** taking control of the country's water supplies, which could be seen as a threat against water security (locals would need to pay to access water).





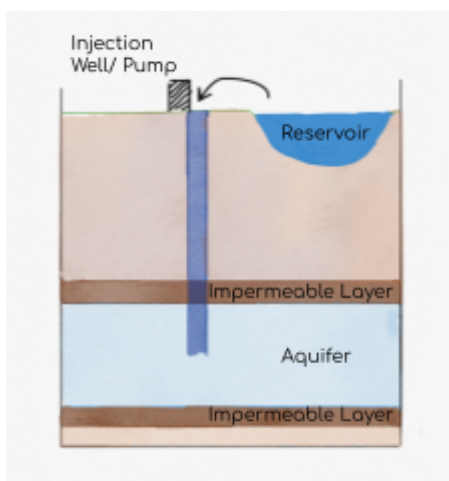
Source: Nato Council

For further examples of water conflicts, take a look at this map produced by [World Water](#). It lists all small and large scale conflicts in the history of humanity up until the present day.

Strategies to Increase Water Supplies in the World

It's not just the UK that is trying to **increase the supply** of clean water available. There are many countries who are trying to reduce their **water insecurity**, to improve their population's health or to improve their country's economic development.

Underground Storage



Source: PMT

Description: In countries where surface evaporation is high, water is pumped underground and stored in aquifers.

- 👍 Reduces water loss due to evaporation, which could supply extra houses

Dams and Reservoirs



Source: Basic Civil Engineering

Description: Naturally occurring valleys are dammed, so the river floods the valley and water is trapped till it is needed

- 👍 Dams control the river flow, and can reduce the risk of flooding downstream



- 👍 Works for infrequent rainfall, so water can be stored for times of no/little rainfall
- 👎 Expensive to construct and run constantly
- 👎 Are there any environmental problems with forcing water underground (tremors, similar to fracking)?

- 👍 Electricity can be generated using the dam, through hydroelectric power
- 👎 Some villages and towns must be flooded to create the reservoir, meaning locals lose their homes
- 👎 Reservoirs can lose water from its surface through evaporation. This makes them unsuitable for hot climates

Water Transfer Schemes

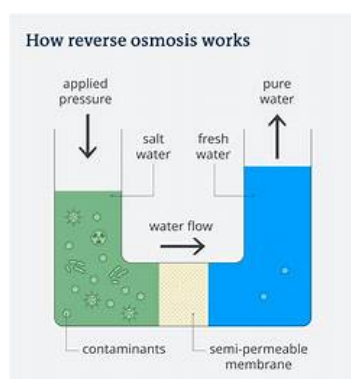


Source: Economist

Description: Water can be transported from areas of large supply to areas of large demand. This may be between states, or between countries where water is traded.

- 👍 Supplies large urban cities, where there isn't room to build large reservoirs
- 👍 For countries with surplus water supply, water trade can be very profitable (for example, [Lesotho](#))
- 👎 Very expensive to construct
- 👎 Risk of leakages, which would waste water and lose money. Because pipelines can be hundreds of kilometers long, it's difficult to find where the leak is

Desalination



Source: DW

Description: Salt water is converted into fresh water through reverse osmosis

- 👍 Increases the volume of freshwater available, especially in coastal areas where there are few lakes and freshwater stores
- 👍 New research uses [graphene](#) to make small scale desalination filters for households
- 👎 Desalination requires energy, which adds cost to cleaning water
- 👎 The waste brine is very concentrated, which could be hazardous when pumped back into the sea

Sustainable Water Supply

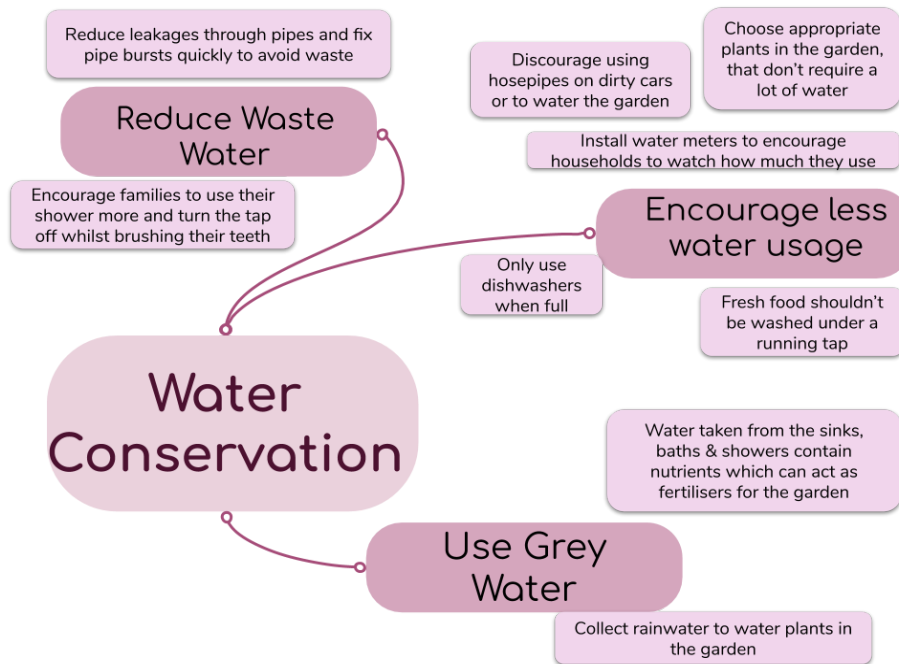
The strategies above all **increase the supply** of water for areas of **high demand**. These strategies tend to be used for major **cities**, where there is a high population and existing water supplies are



under high demand. But most strategies involve large **concrete constructions**, which releases **carbon dioxide** into the atmosphere, and any habitats or wildlife must migrate away from construction.

Therefore, some governments wish to look into more **sustainable** strategies. These schemes are also ideal for **smaller towns and villages**, who couldn't afford a reservoir or transfer scheme.

Water conservation can be an easy and cheap strategy to reduce the demand for clean water.



Other sustainable strategies include:

Groundwater Management

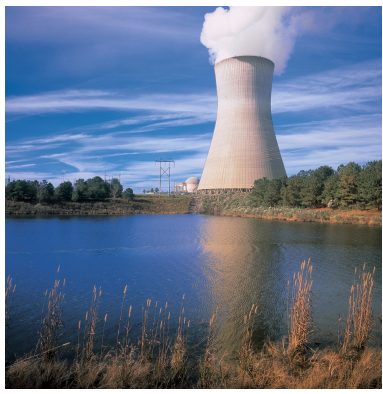


Source: water.ox.ac.uk

Description: Managing through laws the number of water pumps will reduce the risk of over extraction from aquifers

- 👍 Reduces the risk of water being consumed and not replaced naturally

Recycling



Source: Joshua Kleind

Description: Re-using domestic or industrial water, after treatment, in industrial cooling plants. Alternatively, sewage can be used in agriculture and farming

- 👍 Re-using water in industries can save



(known as recharge)

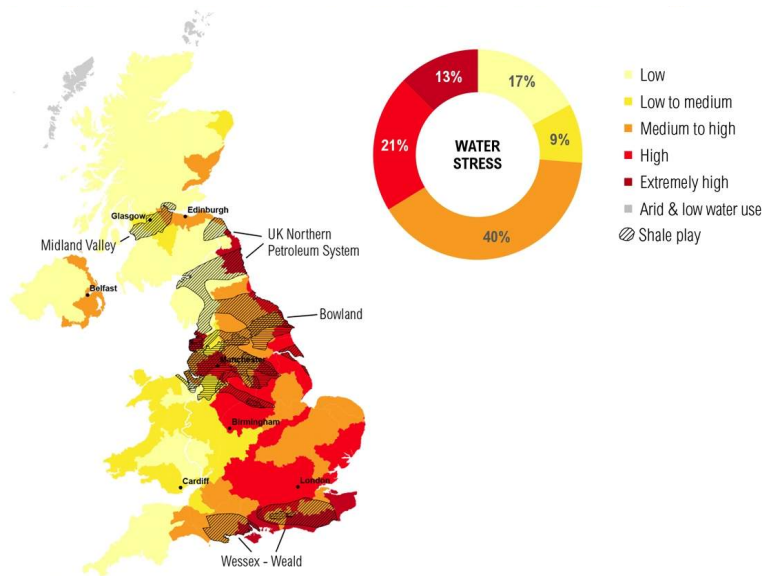
- 👍 Reduces the risk of contamination. The lower the water levels in aquifers, the higher the risk of salt or pollution contaminating it
- 👎 Some people ignore laws, and continue to extract water illegally
- 👎 If there are too few pumps, water could be sold at an unfair price, which would increase water inequality

many gallons of fresh water, that instead can be used for drinking

- 👍 Sewage in fish farming boosts algae, which feeds the fish, increasing the yield
- 👎 Some industries don't feel obliged to be sustainable. Also, treating the water increases its price

Water Provisions in the UK

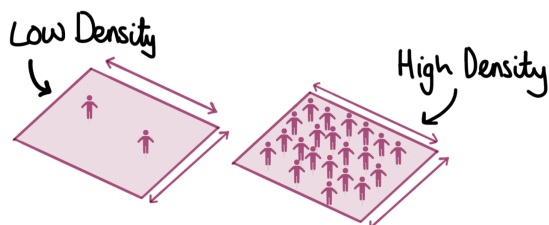
Most people would think that the UK has a good supply of water and shouldn't suffer from water stress, due to its **rainy maritime climate**. However, the rain does not fall on the entire UK evenly and factors such as the **growing population** and **water-intensive appliances** that we use in our house means that some areas do not have enough clean water. The map below shows the **water stress** for each region of Britain, where areas of **red** suffer from the greatest water stress.



www.wri.org/water-for-shale

WORLD RESOURCES INSTITUTE

There are several factors that affect the water stress for a region:



- **Population density** is a measure of how many people live per area of land. If a region has a low population density, the demand for water per area is low. This is the case for North England and much of Scotland, where the population is spread out across the rural land.

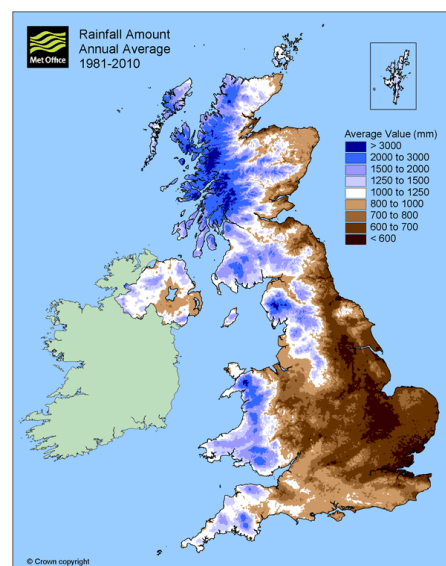


- The amount of **rain** that falls in the UK isn't the same everywhere. Instead, the **precipitation levels** are high in **Scotland** and along the **west of England** and low in **South-East England**.

This is because weather systems (such as depressions) travelling from the **Atlantic Ocean** tend to be heavy with **moisture**, and lose this moisture over the first hills the weather system hits. In this case, rain tends to fall across the **Pennines** and the **Scottish Highlands**.

Therefore, the regions that have the highest demand for water don't receive the most rainfall!

- 21%** of the UK's water supply is **wasted** through leaks in pipe systems and wastage in the households. This is improving with advancing **technology**, such as dye for your drains or low-risk radiation. But because pipes are **underground**, it can be difficult to pinpoint the crack in a pipe and can continue leaking without anyone realising.



Water Management in the UK

There are several ways that the UK government and water companies are trying to reduce water stress:

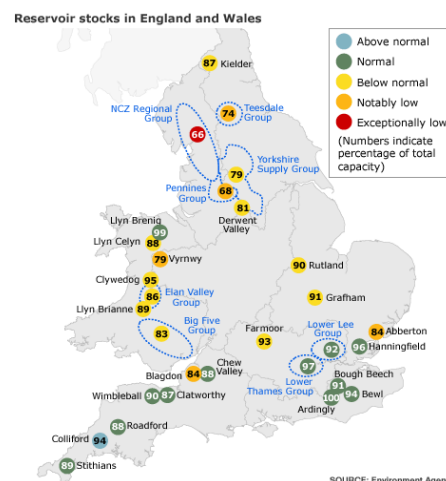
- Increasing the amount of clean water available in areas of low rainfall,
 - e.g. *Water Transfer Schemes, Reservoirs*
- Reducing waste and improving the water efficiency of households
 - e.g. *Increased Use of Grey Water, Government Campaigns*
- Monitoring and protecting clean water supplies from pollution
 - e.g. *Measuring water quality of rivers and reservoirs, Detecting Industrial Leakages into Water Supplies*

Water Transfer Schemes and Reservoirs



There are many **reservoirs** built across the UK. They are spread out to try to supply any nearby **cities** and reduce any **water inequality**.

The largest reservoir in the UK, **Kielder Water**, can hold up to **200 billion gallons** of water. The aim of a reservoir is to hold water after periods of high rainfall, so the water can be used in periods of low rainfall.

Many countries use **water transfer schemes** to connect water reservoirs in rural regions and transport water to a major city,



where the supply of clean water is limited. However, in the UK, this has faced **opposition** and any schemes originally planned haven't begun.

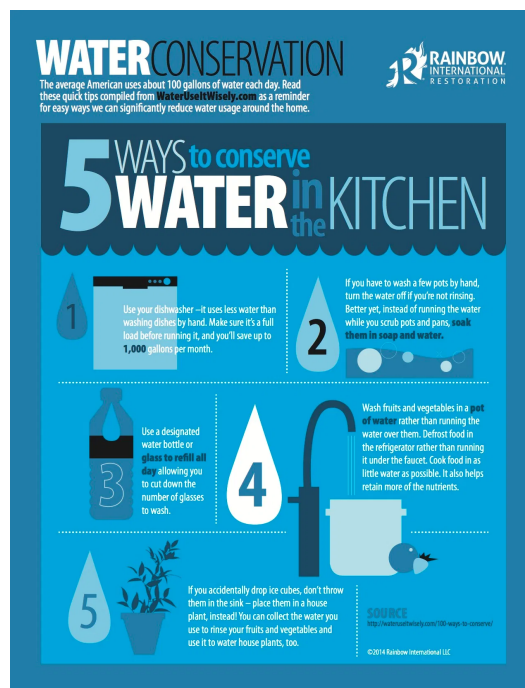
 Advantages	 Disadvantages
<ul style="list-style-type: none"> - Surplus water in the North of England could be used to supply London or Birmingham, rather than going to waste - Rural regions have more space for reservoirs than urban cities, so it would be cheaper to use land further away and pipe the water back to the city 	<ul style="list-style-type: none"> - Water transfer schemes are extremely expensive - Habitats and wildlife would be disrupted by the reservoir, as fish cannot migrate up the river if it has been dammed. Also, rural land would be built upon for the pipes, disrupting more UK wildlife. - Concrete used in engineering releases large amounts of carbon dioxide, which contributes to Climate Change.

Conserving Water

The UK Government has set up several **campaigns** over the last decade to try to reduce water **wastage** and limit household demand in the summer, when reservoirs are **at risk** of being emptied.

For example, from a young age UK school children are taught to **conserve water** in their lifestyle choices. This could be turning the tap off whilst you brush your teeth, or choosing to have a shower instead of a bath. These **marginal improvements** by each household add up for the entire UK population, making a difference to the demand of water.

Alternatively, **grey water** (water which isn't clean but hasn't got sewage in it - like shower water or washing up water) is becoming increasingly popular to reduce the demand for clean water. For example, some UK farms use grey water to **irrigate their crops**. Some households collect their own grey water using a water butt, to **water their gardens** instead of using a hose pipe.



Source: Our Greenish Life





Source: NY Times

Occasionally, during summers of **long drought** and **extremely low rainfall**, the government will ban the use of **hosepipes**. This is to reduce the unnecessary use of clean water, such as to fill up paddling pools or to clean cars. These measures are effective in conserving reservoirs' supplies and avoiding a **water deficit** in the UK.

Protecting Clean Water Supplies

The **Environmental Agency**, alongside water companies local to each region, **monitor** the UK's standard of water. It is important to protect waterways from pollution to protect the limited clean water supplies. The Environmental Agency will:



- **Regulate** water sports, stopping any sports in reservoirs to minimise rubbish in the water
- Monitoring rivers to reduce the risk of **pollution** being washed into a water supply
- **Filtering** and **purifying** water where necessary, such as adding chlorine or filtering out muds and sediments.

However, waste from **industries** can pollute a waterway. The biggest contributions to pollution in the UK are **disused mines** and **chemical fertilisers** used in farming.

