DP IB Geography: SL

Your notes

Water Scarcity & Water Quality

Contents

Water Scarcity

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Physical & Economic Water Scarcity

- Water scarcity is when the supply is below 1000m^3 a year per person
- There are two types of water scarcity:
  - **Physical water scarcity**
    - This affects about 20% of the world's population (1.2 billion)
  - **Economic water scarcity**
    - This affects about 25% of the world's population (1.6 billion)
- Physical water scarcity depends on a variety of factors, including:
  - Level of precipitation
  - Population growth
  - Water availability
  - Water demand
- Economic water scarcity is the result of:
  - Poor management of water resources
  - Lack of water infrastructure

Drought

- Drought is an extended period of dry weather that leads to extreme dryness:
  - **Absolute drought**
  - **Partial drought**
- Drought is caused by:
  - Changes in atmospheric circulation, such as a shift in the position of the **Inter-tropical Convergence Zone (ITCZ)** or **El Niño,** lead to:
    - A lack of precipitation as a result of short-term changes or longer-term trends
    - The lack of rainfall is often combined with high temperatures, which increases evaporation
- The severity of droughts depends on the length of the drought and the extent of the shortage

Impacts of drought


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- The impacts of droughts include:
  - Increase in animal mortality:
    - Over half a million **livestock** (cattle, goats) were affected by drought in Somalia in 2022
  - Increase in forest fires as the vegetation is dry and catches fire easily
  - Bans on hose pipes for watering gardens in higher-income countries
  - Potential for conflicts over water supply, particularly where countries share a river basin
  - Children in rural areas in low-income countries often miss out on school as they are responsible for collecting water (may have to walk miles to the nearest water source)
  - Lack of food due to:
    - Lower crop yields because the plants cannot be **irrigated**
    - Livestock deaths due to a lack of water
  - Damaged ecosystems and loss of habitats
  - Reduced economic development as water is not available for industry

Water Quantity & Water Quality

Water quantity and water quality

- Water quantity depends on several factors:
  - Rates of **rainfall**
  - **Groundwater** and river flows
  - **Transpiration**
  - **Evaporation**

Freshwater resources in the world

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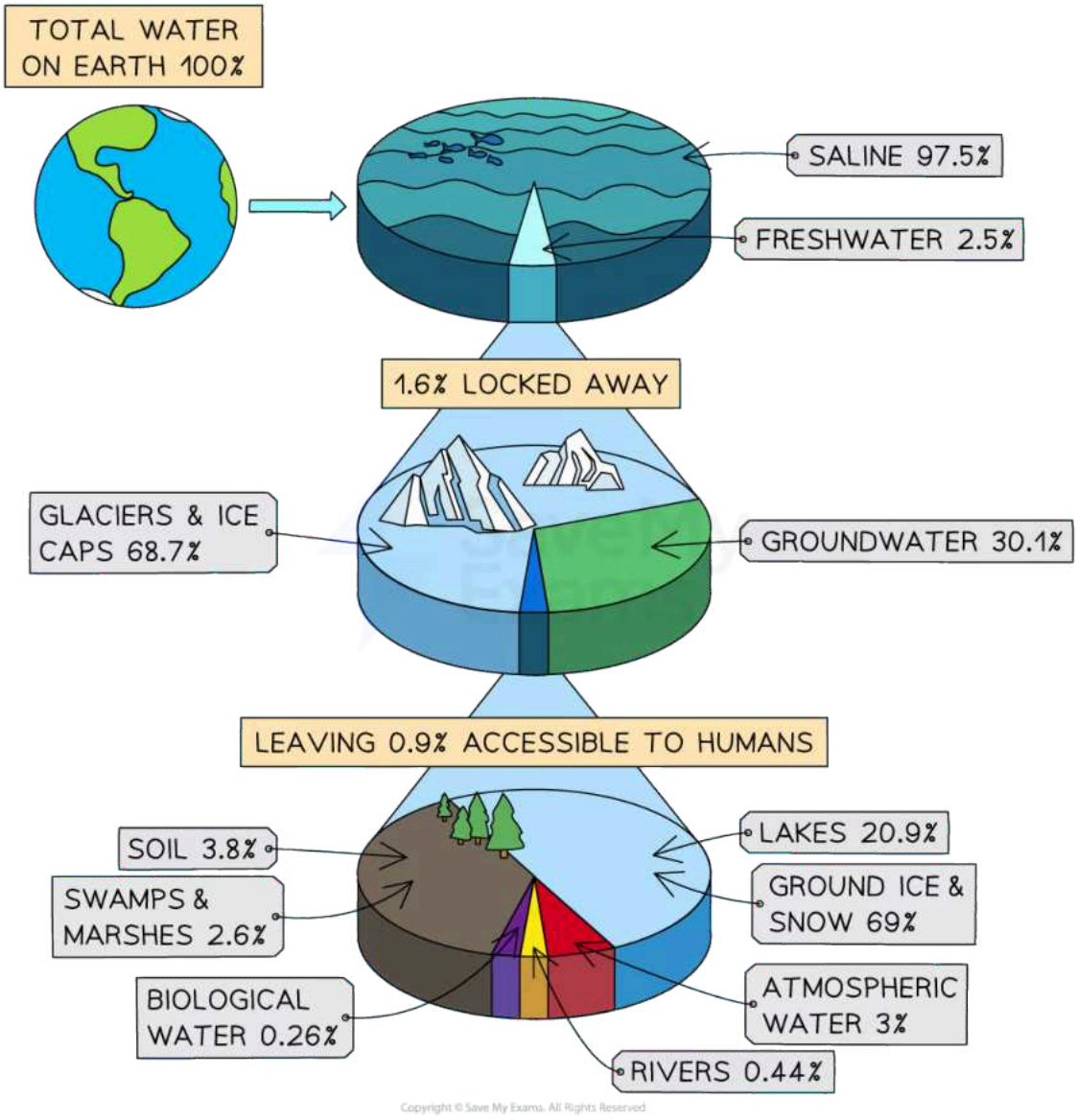

Freshwater resources in the world

- Globally, around 12,500 cubic kilometres of water are available for human use on an annual basis
- There are 6600 cubic metres per person per year available for individual human use
- If current trends continue, there will only be around 4800 cubic metres available per person in 2025
- The world's available freshwater supply is not distributed evenly around the globe:
  - 75% of annual rainfall occurs in areas containing less than two-thirds of the population

Map to show water stress

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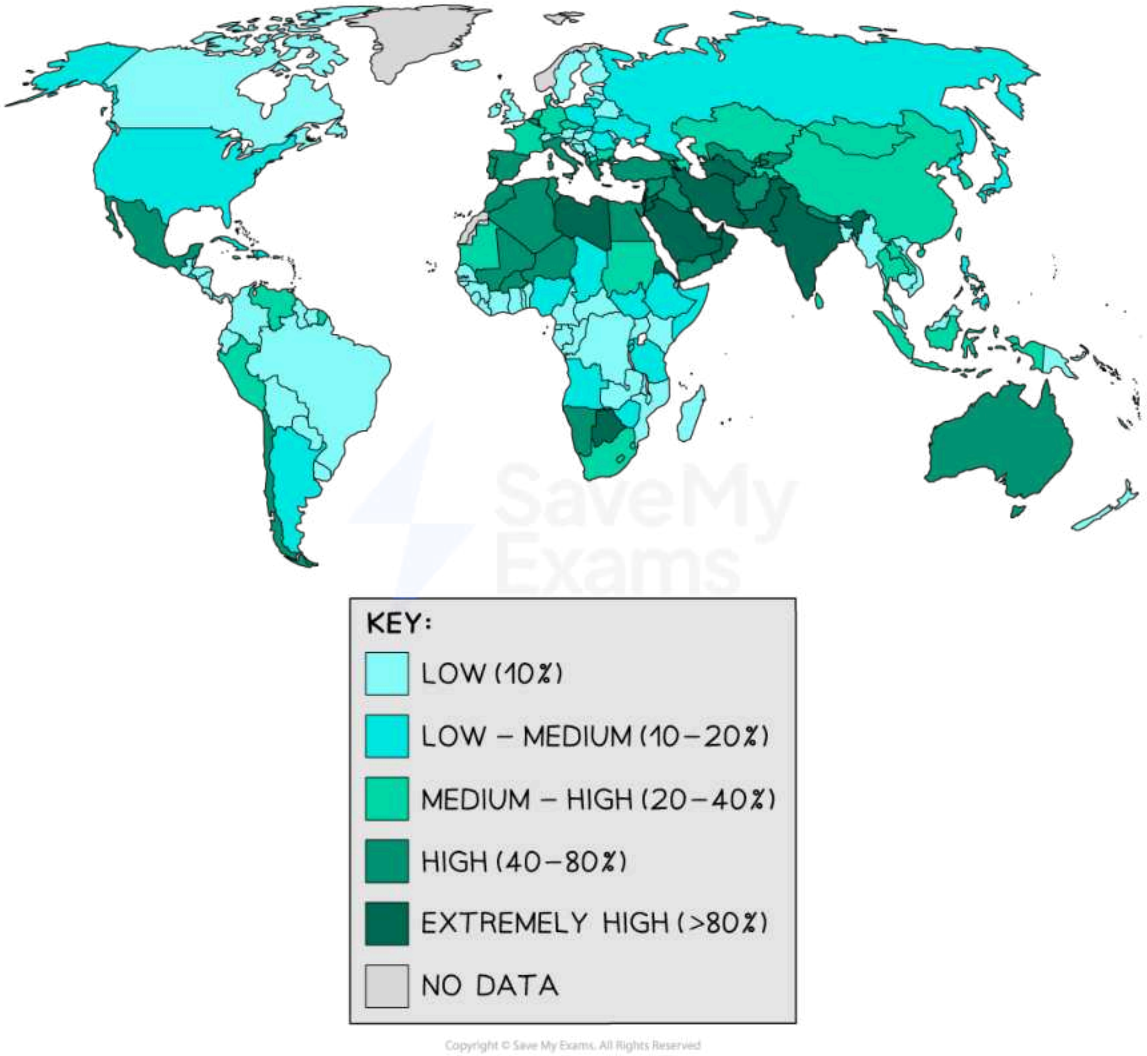
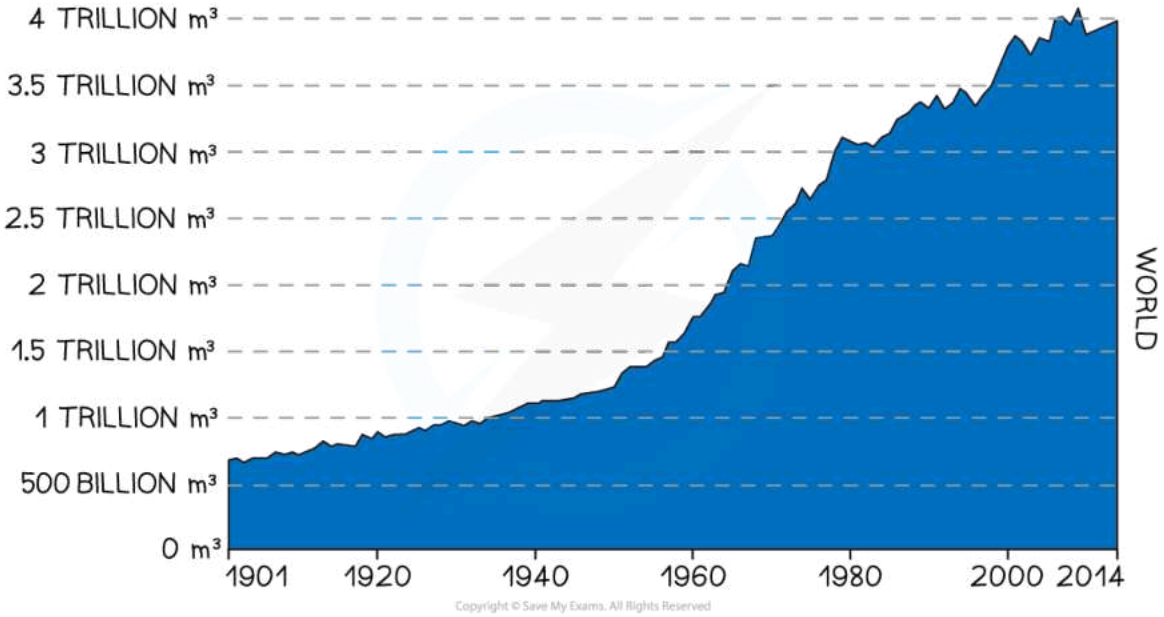


Water stress

- Water stress occurs when water supply is less than 1700 cubic metres per year
- Water stress can cause problems for food production and further economic development
- UNICEF claim that nearly four billion people will be affected by water stress in 2025

Water use



Graph to show increased demand for water

- The world's population has tripled since 1922
- This has increased the global demand for water

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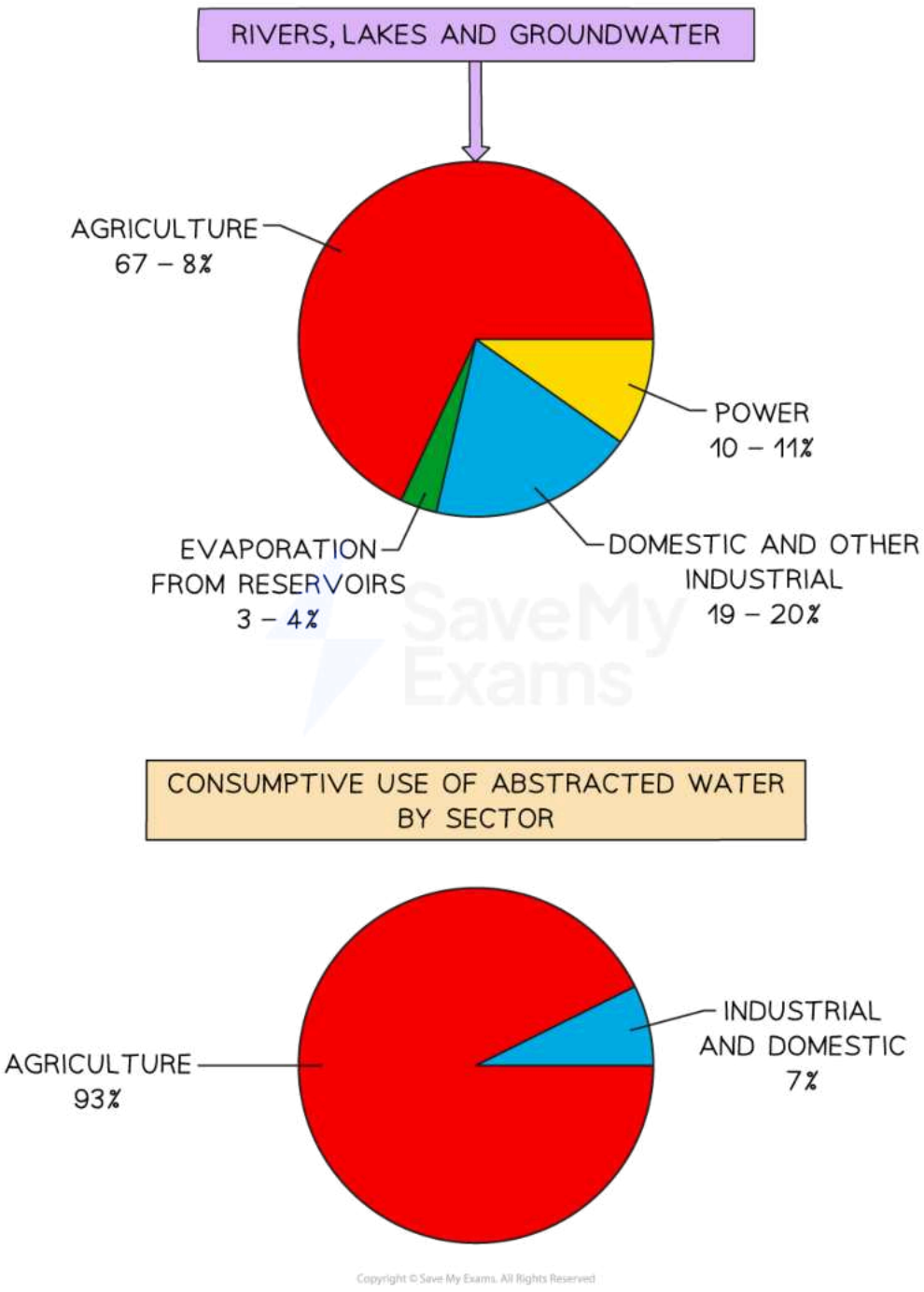

Water use by sector

- Globally, agriculture is the largest user of water

- Disputes over water scarcity may lead to more armed conflicts
- The World Health Organisation claim that 3.6 billion people do not have access to safely managed sanitation in their home
- Rural areas are the worst affected, 8 out of 10 people who continue to lack access to safe drinking water


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Water quality

- In 2022, at least **1.7 billion people** in the world drank water that had been contaminated with faeces
- Microbiologically contaminated water can transmit diseases such as **cholera**
- One million people are estimated to die each year from diarrhoea due to unsafe drinking water, sanitation and hand hygiene
- Water quality may be affected by:
  - Use of fertilisers and pesticides from agriculture
  - Sewage water
  - Industrial processes
- Access to safe water may be limited by availability, infrastructure and cost
- Urban areas have better access to clean water than rural areas
- The cost of water when connected to water mains is less expensive than when customers have to pay

Cost of bottled water

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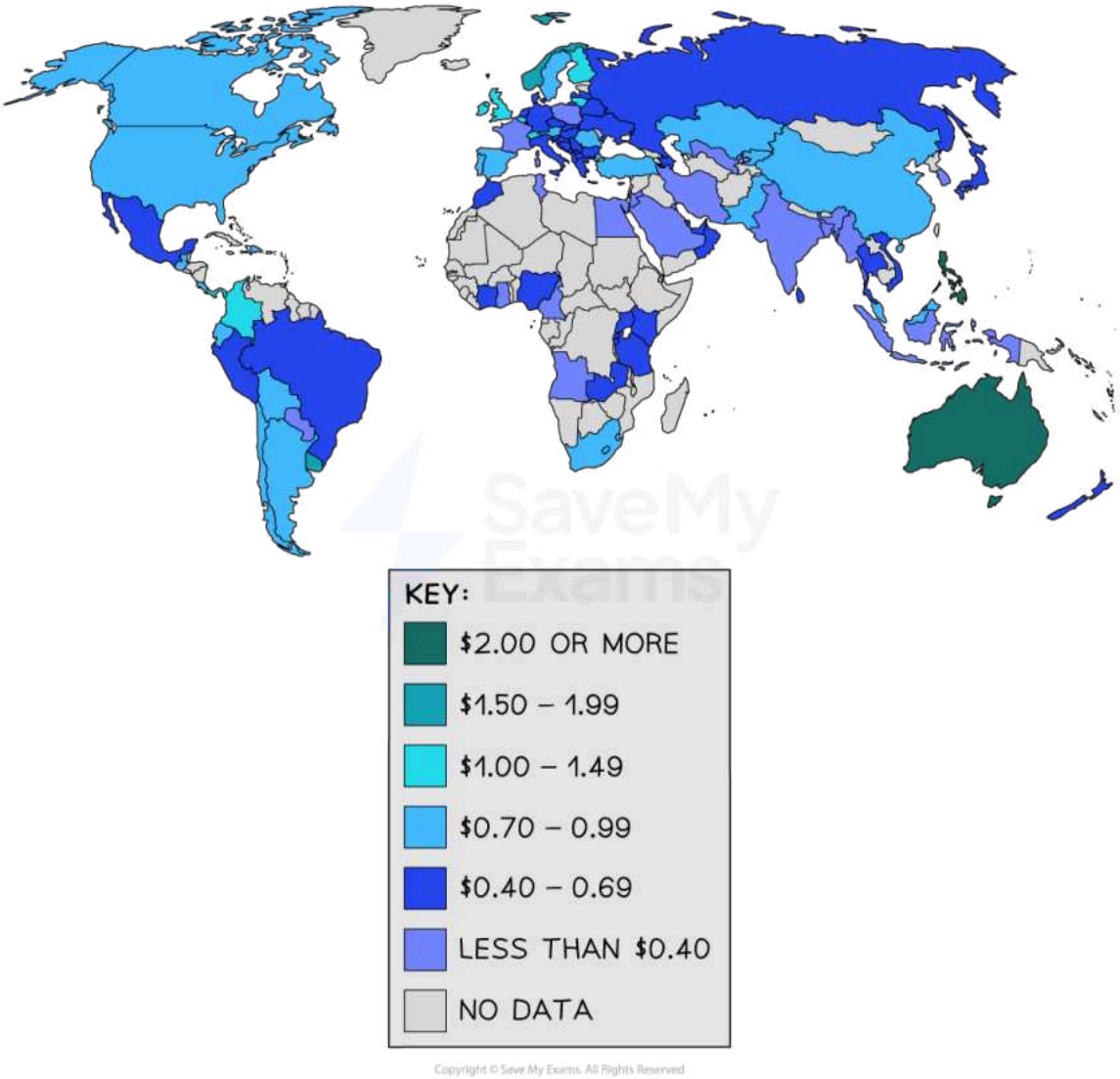

Cost of bottled water

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Agricultural Pollution & Water Quality

- Agriculture can impact on water quality in a number of ways
  - Wastewater from **silage** and **slurry**
  - Fertilizers, herbicides and pesticides
  - Soil erosion
- One of the main impacts of agriculture is eutrophication

Eutrophication

- Eutrophication is caused by an increase in the amount of nitrogen and phosphorus that is carried into streams and rivers from slurry and fertilizers
- This leads to nutrient enrichment

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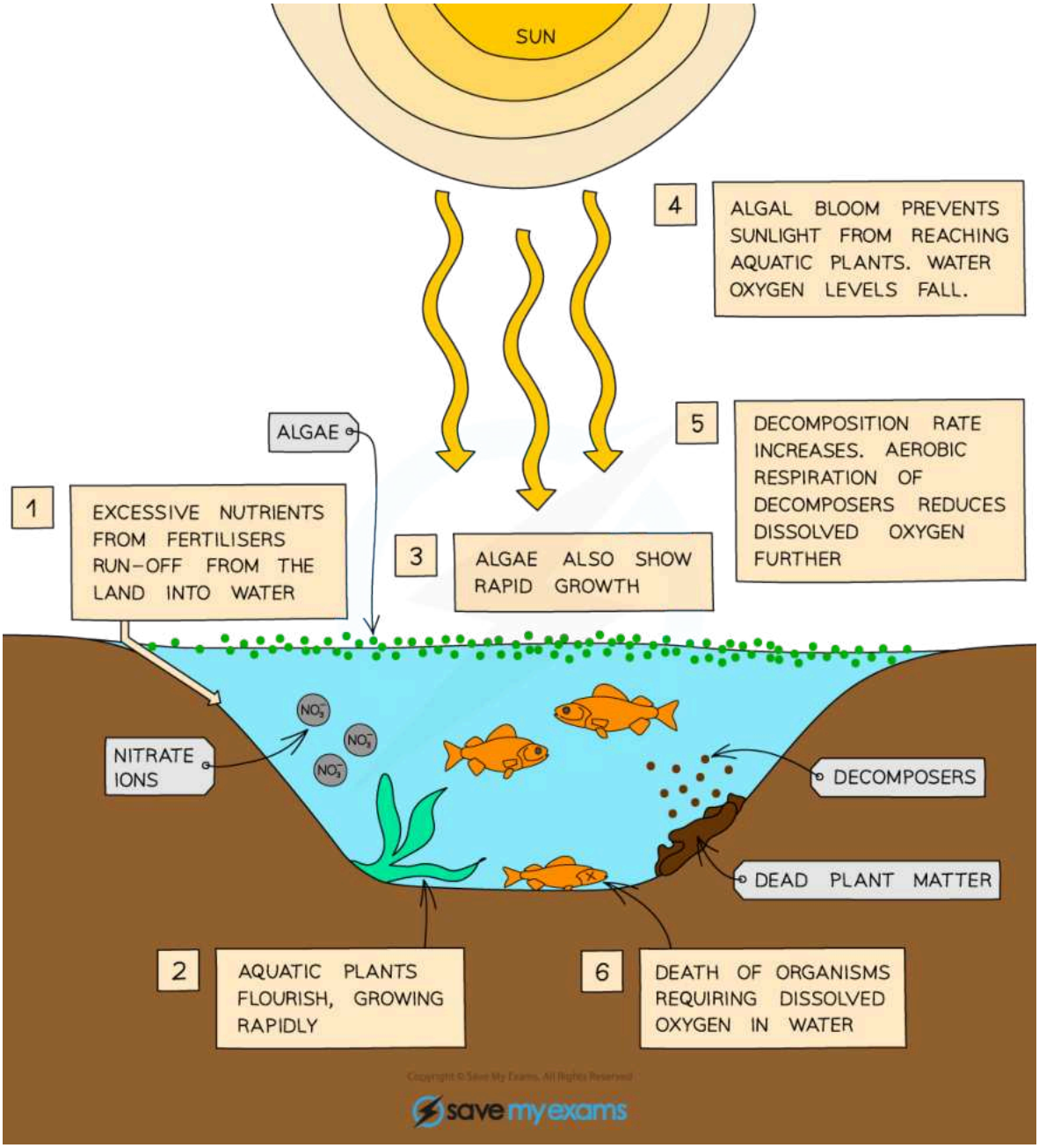

The process of eutrophication

- Algae blooms increase because of higher nutrient levels caused by eutrophication, which causes a **positive feedback loop**
  - Increased algae blooms lead to increased decomposition as light cannot reach aquatic plants


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- Which decreases oxygen levels
- This reduces consumers and further increases algae growth

- **Anoxia** can occur in the autumn season
- Dead zones occur near boundary points between river mouths and coastal zones
- There are three main reasons why eutrophication is a problem:
  - Nitrogen can cause excessive growth of algae
  - It can affect human health
  - A loss of fertiliser is an economic loss for agricultural production
- There are several ways of resolving eutrophication:
  - Use different types of fertilisers and detergents, which may alter human effects of pollution
  - Pump mud from eutrophic water
  - Remove nitrates and phosphates from water
- Reducing nitrate loss in the Northern Hemisphere:
  - Barley straw uses nitrogen in the process of decay
  - When soils are wet, avoid using nitrogen fertilisers
  - Avoid applying nitrogen fertilisers to fields next to streams or lakes
  - Avoid ploughing grass as it releases nitrogen
  - Avoid applying fertiliser if rain is forecast
    - Use barley straw to prevent the growth of algae

Irrigation & Water Quality

Irrigation

- **Irrigation** has been taking place since ancient times
- Water for irrigation can be taken from surface stores
- There are various types of irrigation including:
  - Total flooding, such as in rice fields
  - Sprinklers
  - Drip systems

Salinisation


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- Salinisation may occur due to an increase of salt in the soil left as the water evaporates
- Groundwater levels can be close to the surface
- **Capillary forces** can bring water to the surface and then evaporation occurs
- When evaporation occurs, soluble salts will be left behind
- These salts make the land toxic to many crops, so the land can no longer be used
  - Salinization in San Joaquin Valley, California, was projected to cost the state $1–1.5 billion

Impacts of irrigation

- In addition to salinization, there are various impacts of irrigation:
  - Loss of aquifer capacity
    - This is caused by diesel-run machinery, which abstracts water faster than the aquifer is recharged
  - In the state of Texas, irrigation has reduced the water table by 50 metres
  - Irrigation has reduced the world's **albedo** by 10% because dark green surfaces replace sandy surfaces
  - Evapotranspiration rates increase in the summer when surfaces have been irrigated
  - Hailstorms and tornadoes can increase over irrigated areas due to an increase in the moisture in the soil, which results in more evapotranspiration

Case Study: France

Stakeholders

- There are a number of stakeholders who may be affected by changes in water scarcity and quality, including:
  - Governments trying to achieve food security
  - Water companies that need to supply clean water to consumers
  - Farmers
  - Domestic consumers who rely on clean water supplies
  - HEP companies

- Environmental groups
- Industry


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Water scarcity and quality in France

- The OECD reported in 2020 that agriculture is responsible for 11% of total freshwater abstractions in France
  - In summer, this percentage increases significantly
- Agricultural pollutants are putting pressure on surface waters
- France is part of the European Union (EU) and so has to follow EU laws, which include
  - Three main directives which have frameworks and standards to try and reduce agricultural pollution
  - The **2006 Water and Aquatic Environment Act**
- Agriculture in France is now subject to three fees
  - A fee for the potential spread of agricultural pollution
  - A charge to distributors of fertilisers and pesticides
    - The higher the charge, the more toxic the product is
  - A fee for water pollution caused by livestock breeding
  - EU law also states that farmers in France must obtain water permits to abstract water for farming
  - The EU has banned some types of fertilisers which affect aquatic life
- Farmers in France suffer water shortages, which has affected agricultural production
  - In some areas, yields fell by as much as 50%
- In 2022, France's reservoirs were 80% below normal levels
- French authorities argued that giant irrigation reservoirs are necessary to support French farmers
- French farmers have been using precision farming, which is when farmers observe and manage their farms through the use of **Geographic Information Systems (GIS)**
  - Through precision farming, the farmers can reduce their water consumption and fertiliser and pesticide use on the farms
  - Precision farming also enables the farmer to help prevent the leaching of fertilisers and pesticides into the soil, which could 'run-off' into rivers

- Farmers have been using drip irrigation systems to administer the specific amount of water that is needed for good crop production


Your notes

Human Pressure on Water Resources

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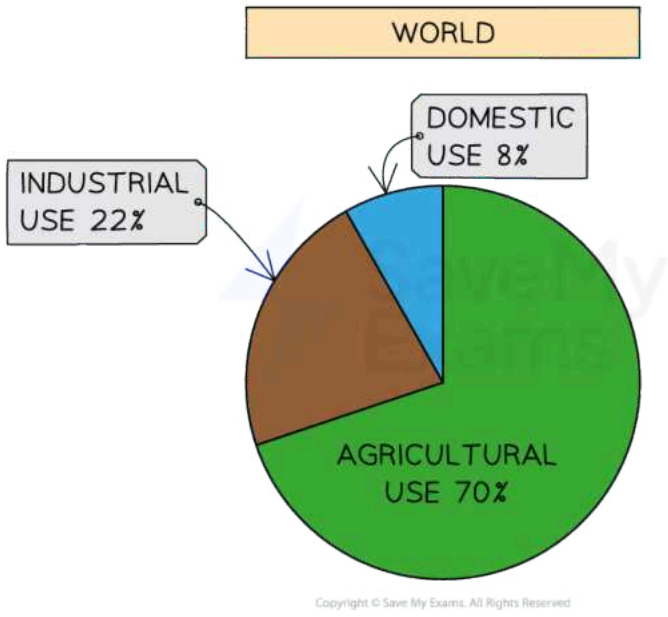
Impact of Population & Economic Growth on Water Quality

- The growth of the world population increases the demand for water
- Population growth is unevenly distributed and so the need for increased water supply is also uneven
- Urban areas experiencing a rapid increase in population usually experience the most water stress
- The quantity of water currently being used for all purposes is over 3700 cubic kilometres per year
- The growth of population leads to a greater demand for water for all uses:
  - Agriculture
  - Domestic
  - Industrial



Demand for water

- Agriculture is the largest user of water:
  - Consumes over two-thirds of water drawn from rivers and lakes

- Water for crop irrigation has increased by 70% since 1960
- Industry uses 22% of available water
- The domestic sector uses 8%
- These all impact on water quality and availability
- Many rivers have become polluted, which makes them unusable for human needs

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Sources of water pollution

- Rivers which are contaminated by industrial waste can cause algae blooms
  - This makes the water unsafe to be used by humans
  - The toxins produced by the algae can kill wild animals and livestock
- Many fish deaths are occurring because of the increase in temperatures in rivers
- Overuse of aquifers can result in reduced water supply
- There are many examples of water quality issues around the world
  - China's rapid economic growth has meant that over 70% of the country's rivers cannot be used for human consumption
  - Lead poisoning in Flint, USA, because of industrial pollutants in the river waters

Aral Sea

- The Aral Sea is an **endorheic** lake which is located in Asia
- The lake is **transboundary** because half lies in Uzbekistan and half in Kazakhstan
- Rivers enter the lake from **Amu Darya** and **Syr Darga**
- In 1997, the **Intergovernmental Panel on Climate Change** highlighted the Aral Sea as a case study for what happens when lakes are misused
- In 1960, the lake was the world's 4th largest inland water body

Use of water

- Large-scale **irrigation** systems were introduced in the 1930s
- Between 1960 and 1980, the area was known for the cotton industry
  - This required increased irrigation from the Amu Darya and Syr Darga rivers
- The population increased from 14.1 million in 1960 to 47 million in 2008

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- According to UNESCO, there are now 51 million people living in the Aral Sea basin
- By September 2011, the lake had separated into four parts and had shrunk in area by 85% and volume by 92%


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Impacts on the economy

- The fishing industry, which used to employ 40,000, collapsed
- Camel farming decreased because the grass that camels ate was too salty due to the wind blowing salt from the drying up lake
- Factories in the area which used the lake to transport their goods could no longer use the lake as a trade route, causing rising unemployment

Impacts on humans

- According to scientists, the Aral Sea could dry up in the next 20 years, which would affect drinking water supplies
- Due to highly toxic winds, there has been an increase in respiratory illnesses caused by dust from fertilizers being spread by wind

The Great Artesian Basin

- The **Great Artesian Basin (GAB)** is situated in central Australia
- One of the world's largest groundwater systems, which supports a variety of ecosystems and springs
- The basin is nearly 1.7 million square kilometres
- There has been little sustainable management of the basin
  - Leading to much wastage of water through evaporation and seepage
- Water wastage damages the environment through land and **water salinization**
- Agriculture has dominated groundwater extraction
- Water extraction for mining and oil projects has been increasing
- The Olympic Dam mining project has been extracting groundwater since 1983

Impacts on humans

- More than 180,000 people rely on the groundwater from the basin
- Over 120 towns are supported through the basin including both homes and businesses
- Aboriginal and Torres Strait Islander people have been using the basin for over 60,000 years

- In August 2018, the Australian government announced The Improving Great Artesian Basin Drought Resilience program worth up to $26.7 million


Your notes

Conflict Over Internationally Shared Water Resource

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Water Resources & Conflict

- Across the world, 17 countries face 'extremely high' levels of **water stress**
- Over 2 billion people live in countries with high water stress
- This can lead to conflict over water resources

Tigris Euphrates River conflict

- The Tigris Euphrates River conflict has been an ongoing issue since the 1960s
- The Euphrates river source can be found in Türkiye and flows through Northern Syria and Iraq
- Turkey, Iraq and Syria are all countries facing high water stress

Map of the Tigris and Euphrates rivers

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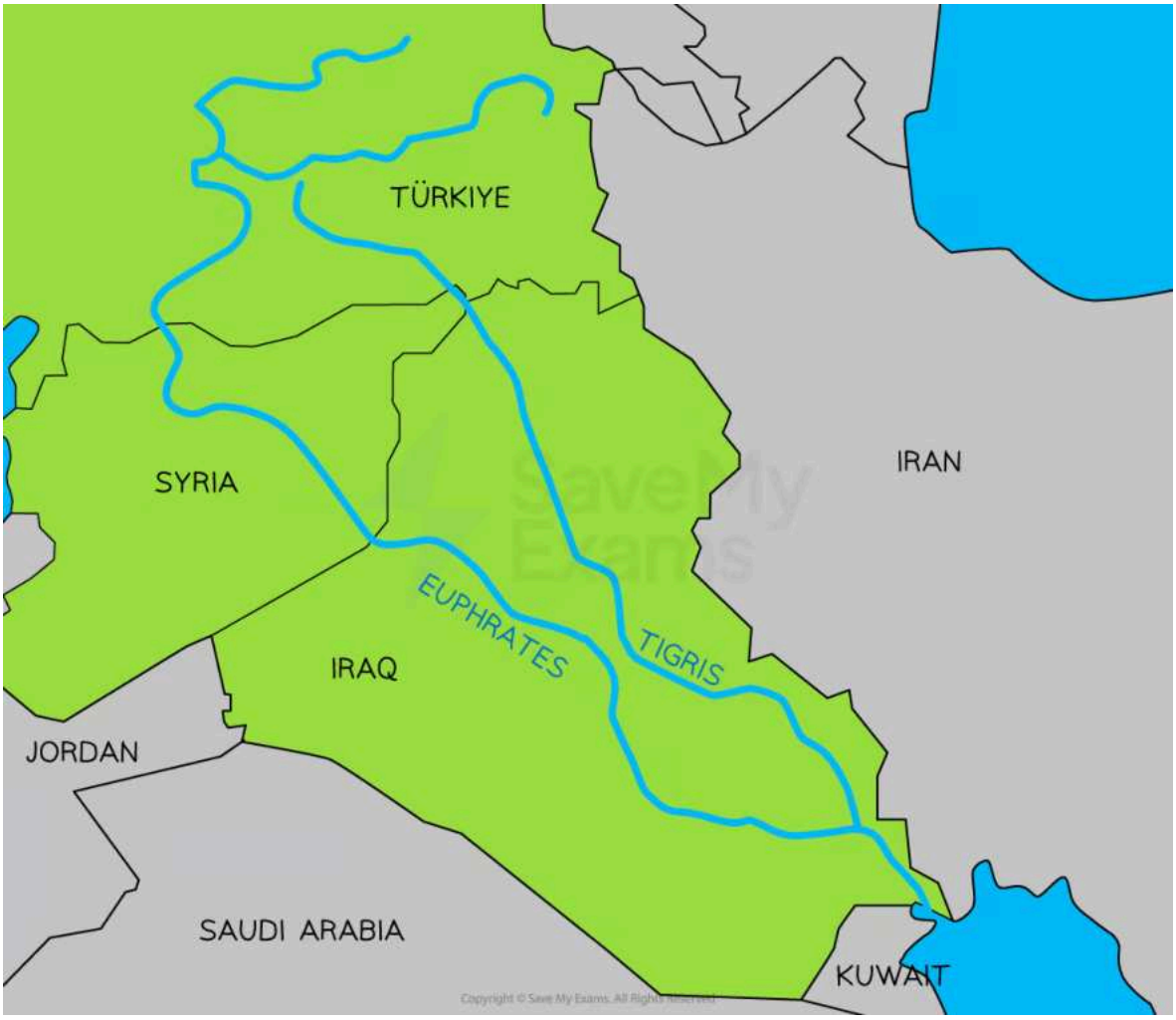

Map showing the Tigris and Euphrates rivers

- The Euphrates River is 2800 km long
- The Tigris River is the second largest river in Western Asia
- The Tigris River is surrounded by four countries:
  - Türkiye
  - Syria
  - Iraq
  - Iran
- The confluence of the two rivers is in the town of Al-Qurnah in the south-eastern area of Iraq

- Both rivers originate in Türkiye flowing south-east to the mouth of the rivers is the Persian Gulf
- It is estimated that over 60 million people rely on the Euphrates River
- In 1975, a potential armed conflict occurred between Syria and Türkiye over water usage


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Why is there a conflict?

- Türkiye relies heavily on energy imports, which has led them to focus on hydropower
- The creation of the **Llisu dam** on the Tigris River by Türkiye triggered geopolitical tensions with Iraq and Syria
  - Iraq and Syria unsuccessfully used international legal and diplomatic means to prevent construction of the dam
- Türkiye created the **Southeastern Anatolian Dam project (GAP)** and hydroelectric plants along both major rivers
- It is estimated that the dam projects constructed by Türkiye have reduced Iraq's water supply by 80% since 1975
- The Llisu dam is set to reduce the Tigris water flow into Iraq by 56%
- Between 2020–21 the region experienced its second-lowest rainfall season in 40 years
- Türkiye has withheld water along the Euphrates

How has climate change intensified the conflict?

- The river basin is one of the world's most vulnerable watersheds
- Temperatures in the region are increasing twice as fast as global averages
- Surface evaporation will place further pressure on the rivers and those that use them
- The Tigris had a reduced flow of 29% and the Euphrates 73% in 2021
- There is a possibility that the flows of the Euphrates and Tigris rivers will reduce by 30% and 60% respectively, by the end of the century
- Tishrin Dam will only be used for drinking water and not for agriculture in 2023 because Syria has also experienced below-average precipitation

Role of stakeholders in finding resolutions

- The Llisu dam was completed in May 2020 and since then Iraq has requested a minimum month-to-month flow from Türkiye
- The Iraqi government announced their intention to work on diplomacy with Syria and Türkiye as well as build a future dam to support their own water needs

- Government changes in Türkiye have meant that they have adopted an approach of 'zero problems' with neighbouring countries to reduce possible conflict
- Türkiye's water legislation policies have been changed to a more diplomatic style of inclusivity due to its proposal to join the European Union
- Syria has been adopting a **National Drought Strategy** to identify drought-prone areas and providing drought reports in both Arabic and English
- There are no official agreements between the countries that rely on the water basin


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Future possibilities

- A research paper produced by Cascades (an organisation looking at the impacts of climate change) outlines three scenarios in the Tigris Euphrates River basin
  - **'Turbulent transition'** where democratic and economic reforms are implemented to stop conflict in the area over water scarcity
  - **'Authoritarian autarchy'** where repressive regimes increase their power in the region
  - **'Precipitated progress'** where resources are used efficiently but not distributed equally