DP IB Environmental Systems & Societies (ESS): HL

Your notes

4.2 Water Access, Use & Security

Contents

- Factors Affecting Water Availability
- Strategies for Increasing Water Supply
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Your notes

Factors Affecting Water Availability

- **Water security** is having access to sufficient amounts of **safe drinking water**
- Water security is essential for **sustainable societies**
  - Without adequate water, societies cannot continue to exist
  - Human well-being and health, agriculture and industries quickly begin to deteriorate when there is a lack of water
- Many different social, cultural, economic, political and geographical factors affect the availability of freshwater
  - These factors also affect **equitable access** to this freshwater (i.e. how **fairly** this water access is distributed between societies)

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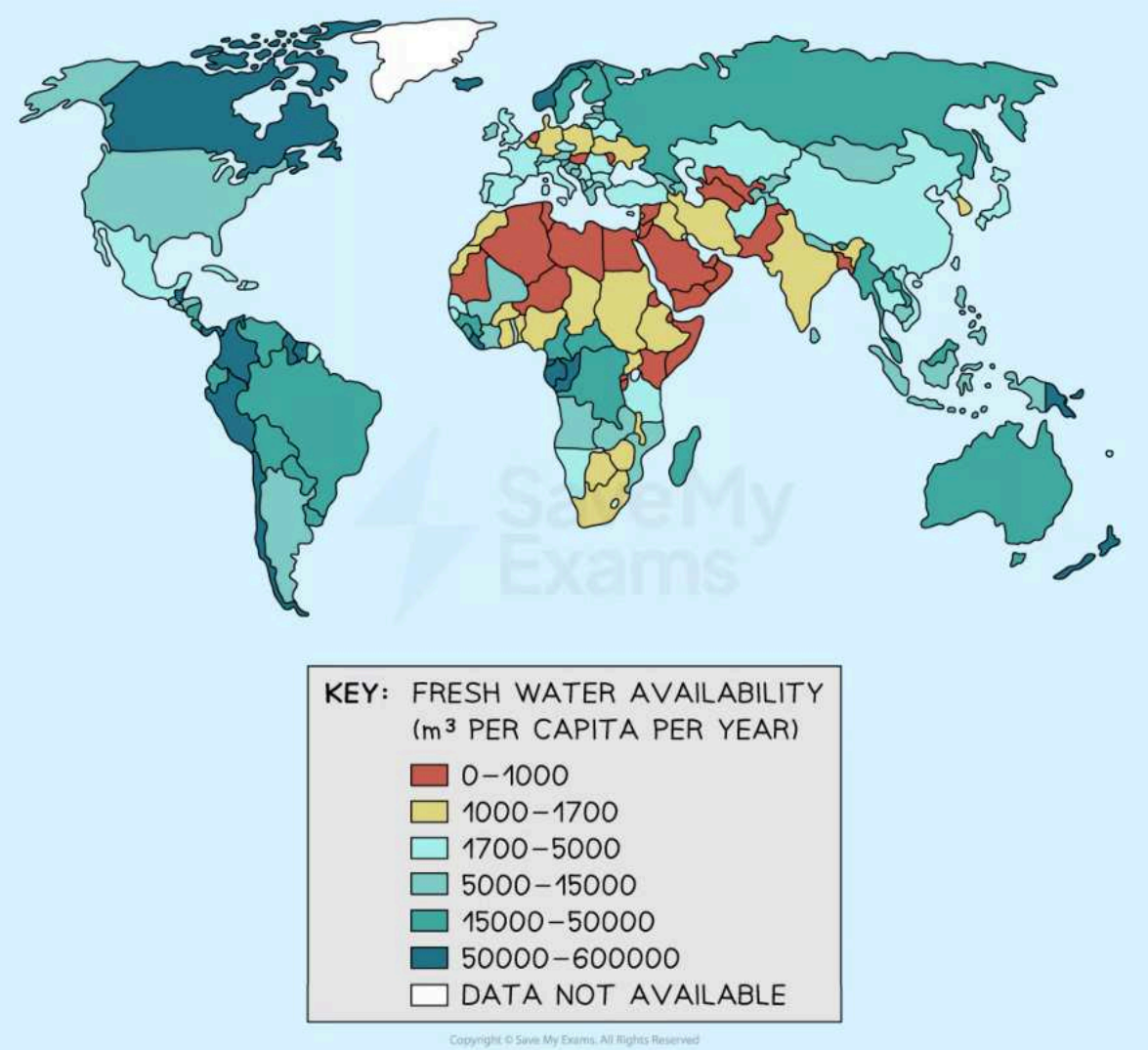

Access to an adequate supply of freshwater varies widely across the globe due to a number of factors

Social factors

- **Population growth**:
  - Larger populations increase water demand
    - For example, India's rapidly growing population is straining its water resources
- **Population density**:
  - Regions with higher population densities tend to experience greater pressure on water resources


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- Increased water demand for domestic, agricultural and industrial purposes can strain available supplies
- **Urbanisation**:
  - Cities require very large amounts of water
- **Living standards**:
  - Higher living standards often lead to higher water usage
    - For example, developed countries like the USA use more water per capita than developing countries

Cultural factors

- **Water conservation**:
  - Cultures that prioritise water conservation tend to manage their water supplies better
  - Some cultures may not prioritise water conservation, leading to wastage
    - For example, in parts of the USA, despite ongoing droughts, water usage remains high due to a lack of conservation efforts
- **Consumerism**:
  - High levels of consumerism often lead to increased water consumption
    - For example, in Western countries, the high demand for consumer goods results in significant water usage for manufacturing and food production
- **Traditional agriculture**:
  - Some traditional agricultural methods may use water inefficiently
- **Cultural attitudes towards water pollution**:
  - Attitudes towards pollution can affect water quality
  - In some regions, cultural indifference towards pollution has led to severe contamination of water bodies

Economic factors

- **Economic development**:
  - Industrial activities require significant water resources
  - Wealthier nations often have greater financial resources to invest in water infrastructure and management, which can result in better access to fresh water
  - In contrast, poorer countries may lack the means to develop and maintain robust water systems

- **Investment in infrastructure**:
  - The presence of well-developed water management systems, including reservoirs, dams, canals, and pipelines, can enhance water availability and distribution
  - Investing in water treatment facilities ensures a better supply of safe drinking water
- **Agricultural needs**:
  - Agriculture is a major water consumer
    - For example, in Egypt, a large portion of water from the Nile River is used for irrigation


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Political factors

- **Government policies**:
  - Policies and regulations affect water distribution and quality
    - For example, South Africa's National Water Act aims to ensure equitable water access and that the basic human needs of current and future generations are met
- **International agreements**:
  - Transboundary water management requires cooperation between countries
    - For example, the Nile Basin Initiative involves multiple countries working together to manage the Nile River's resources.
- **Conflict and stability**:
  - Political instability and conflicts can disrupt water supplies

Geographical factors

- **Geographic location**:
  - Some regions naturally contain abundant freshwater resources due to factors such as proximity to large rivers, lakes, or high rainfall
  - Others, like arid and semi-arid regions, naturally have limited water availability
- **Climate**:
  - Areas with high levels of precipitation, such as tropical rainforests or coastal regions, generally have better access to fresh water compared to arid or desert regions with low rainfall
- **Topography**:
  - Mountainous regions often have better access to fresh water

- This is due to higher precipitation rates and the presence of glaciers and snowpack that act as natural reservoirs
- Conversely, flat or low-lying areas may face challenges in water availability

Examiner Tips and Tricks

It's important to note that these factors are **interconnected** and can influence each other.

The combination of multiple factors often contributes to the wide variation in access to an adequate supply of freshwater across the globe.

Your notes

Your notes

Strategies for Increasing Water Supply

- Human societies undergoing **population growth** or **economic development** need to increase the supply of water or use it more efficiently
- Water is essential for:
  - Domestic use
  - Agriculture (drinking-water for livestock and irrigation-water for crops)
  - Industry

Strategies Used to Increase Fresh Water Supplies

Strategy	Description	Example
Constructing dams and reservoirs	Structures built to store water, regulate flow and prevent floods Helps store water during periods of high rainfall for use during dry seasons	The Hoover Dam in the USA creates Lake Mead, supplying water to several states and generating hydroelectric power
Rainwater Catchment Systems	Collecting and storing rainwater run-off from rooftops or other surfaces for domestic use Collected rainwater can be used for non-potable purposes like irrigation, toilet flushing and cleaning, reducing the strain on freshwater sources	In Chennai, India, rooftop rainwater harvesting helps tackle water scarcity It also mitigates stormwater run-off, reducing flooding and erosion
Desalination Plants	Removing salt and minerals from seawater to produce freshwater using methods like reverse osmosis	The Jebel Ali Desalination Plant in Dubai provides a significant portion of the city's water supply
Enhancement of Natural Wetlands	Improving wetlands to act as natural filters, removing pollutants and aiding groundwater recharge	The Everglades in Florida, USA, are being restored to enhance water flow and quality

Improving Irrigation Methods	Using efficient irrigation techniques like drip irrigation to reduce water wastage in agriculture	In Israel, the development and use of advanced drip irrigation technology has maximised water use efficiency
Water Recycling and Reuse	Treating wastewater for reuse in industrial processes or irrigation	Singapore's NEWater project treats and reuses wastewater, reducing reliance on imported water
Artificial Recharge of Aquifers	Increasing groundwater supplies by directing surface water into the ground to replenish aquifers Recharging aquifers helps prevent groundwater depletion and maintains a sustainable supply of water for wells and springs	In California, USA, managed aquifer recharge projects help counteract over-extraction of groundwater
Redistribution	Efficient water redistribution systems, such as canals and pipelines, transfer water from water-rich regions to areas experiencing scarcity Redistributing water resources can help balance supply and demand, particularly in densely populated or arid regions	The Central Arizona Project in the USA redistributes water from the Colorado River to arid regions of Arizona


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Using a combined approach

- Sustainable management of freshwater resources requires a **combination of strategies** to enhance water supplies
  - Dams, reservoirs, rainwater catchment systems, desalination plants and enhancement of natural wetlands are effective approaches to increase water availability
  - However, these measures can be **complemented** by water conservation practices, recycling and reuse, recharging of aquifers and sustainable agriculture
- By adopting a comprehensive and balanced approach, societies can ensure the sustainable use of freshwater resources

Examiner Tips and Tricks

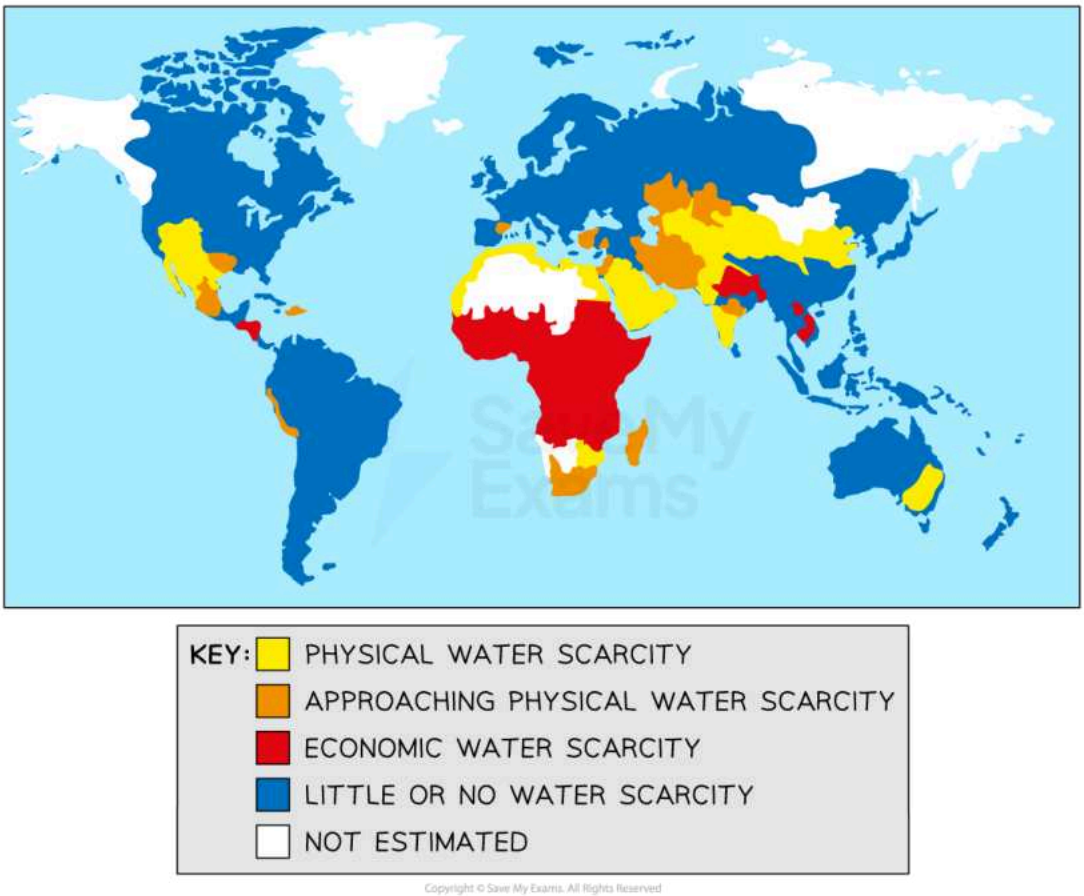
Make sure you understand the role of **wetland ecosystems**. They are not just valuable habitats for a huge variety of species—they are also crucial for human societies as they provide **essential services** like water purification and groundwater recharge.


Your notes

Your notes

Addressing Water Scarcity

- Water is **unevenly distributed** around the globe
- There are significant areas of **water surplus** and **water deficit**
- Around **450 million** people in **LICs** suffer from **severe** water **shortages**
- Around **1.2 billion** live in areas of **water scarcity**
- **Physical water scarcity** occurs where **demand** for water **outstrips supply**, often due to arid climate and low rainfall
- **Economic water scarcity** is where water is **available** but people **can't afford** it or the **infrastructure** is **inadequate**



Global pattern of water scarcity

Water conservation techniques


Your notes

Domestic Water Conservation Techniques

Technique	Description
Metering	Install water metres to monitor and control water usage accurately It helps households track their consumption
Rationing	Set limits on water usage per household This can involve implementing quotas or tariffs based on usage levels
Grey-water Recycling	Capture and treat greywater for reuse in non-potable applications like toilet flushing or outdoor irrigation
Low-flush Toilets	Install toilets with low-flow mechanisms to reduce water usage per flush
Rainwater Harvesting	Collect and store rainwater for tasks such as watering gardens or washing vehicles.

Industrial Water Conservation Techniques (Food Production Systems)

Technique	Description
Greenhouses	Use greenhouses equipped with large-scale rainwater harvesting systems to irrigate the crops grown inside)
Aquaponics Systems	Integrated aquaponics systems combine fish farming with hydroponic plant cultivation These closed-loop systems recycle water between fish tanks and plant beds, reducing overall water consumption
Drip Irrigation	Install agricultural drip irrigation systems to deliver water directly to the roots of crop plants, minimising evaporation and surface run-off

Drought-resistant Crops	Develop and cultivate crops that are resilient to drought conditions These crops require less water to grow and are suited for arid regions
Switching to Vegetarian Food Production	Transition to plant-based agriculture to reduce the significant water usage associated with livestock farming

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Case Study

Mitigation Strategies for Water Scarcity

Country Case Study: Australia

- Some parts of Australia face water scarcity challenges due to the arid climate and variable rainfall
- To address these issues, the country has implemented a range of innovative water management strategies, including:

1. **Water pricing mechanisms**
    - **Tiered water pricing**: Australia uses a tiered pricing structure where the cost of water increases with higher usage levels
        - This approach incentivises households and businesses to conserve water
    - **Water trading**: in regions like the Murray-Darling Basin, water trading allows users to buy and sell water allocations
        - This market-based approach helps allocate water more efficiently, especially during drought periods
2. **Desalination plants**
    - **Sydney Desalination Plant**: Sydney's only major source of non-rainfall dependent drinking water
        - This plant can supply up to 15% of Sydney's drinking water, providing a reliable water source during droughts
        - It uses reverse osmosis to remove salt and impurities from seawater, ensuring a continuous supply of fresh water
    - **Perth Desalination Plant**: one of the largest desalination plants in the Southern Hemisphere
        - It meets about half of Perth's water needs
        - This demonstrates the effectiveness of desalination in supplementing traditional water sources
3. **Water recycling programmes**

- **Purple pipe systems**: in some cities, recycled water is delivered through a separate "purple pipe" system for non-potable uses
  - This includes irrigation, industrial processes and toilet flushing
  - This reduces the demand on potable water supplies
- **Western Corridor Recycled Water Scheme**: this project in Queensland treats and purifies wastewater to a standard suitable for industrial use
  - In times of need, it can also supplement drinking water supplies

4. **Crop selection and rotation**
   - **Drought-resistant crops**: farmers are encouraged to grow crops like sorghum and millet
     - These require less water and are more resilient to dry conditions
     - Research institutions, such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), are developing new varieties of drought-tolerant crops
   - **Sustainable farming practices**: using crop rotation and conservation tillage helps maintain soil moisture and reduce water usage
     - For example, rotating legumes with cereals can improve soil fertility and reduce the amount of irrigation required
5. **Community awareness and education**
   - **Water conservation campaigns**: public awareness campaigns, such as "Target 155" in Victoria, encourage residents to limit their water use to 155 litres per person per day
     - These campaigns educate the public on water-saving techniques and the importance of water conservation
   - **School education programmes:** schools incorporate water conservation into their curricula, teaching students about sustainable water use and the importance of preserving this vital resource

- These strategies illustrate Australia's comprehensive approach to managing water scarcity through a combination of technological innovation, economic incentives and public education

Examiner Tips and Tricks

Although you do not need to learn this whole case study, you do need to be able to give a few named examples of how different countries or societies are using specific management strategies to address water scarcity.

Your notes

Freshwater Use (HL)

Your notes

Freshwater Planetary Boundary

- Freshwater use is considered a **planetary boundary**
  - This means there is a **limit** to how much water can be used **sustainably**
- Freshwater is essential for ecosystems, agriculture, and human consumption
  - However, **increasing demand** is putting significant stress on these resources
- If we exceed the freshwater planetary boundary, it could lead to **abrupt changes in the hydrological cycle**, such as:
  - Dried-up rivers and lakes
  - Depletion of groundwater reserves
  - Loss of biodiversity and freshwater ecosystems
- **Measuring the boundary**:
  - Scientists monitor freshwater use by comparing the **amount withdrawn** for human activities to the natural replenishment rate (e.g., rainfall and groundwater recharge)
- **Mitigation strategies** include:
  - Reducing water waste through **more efficient irrigation** and **industrial processes**
  - Recycling water in urban areas
  - Protecting natural water storage systems like wetlands and forests
  - Raising awareness and creating policies to manage water use sustainably

Local & Global Governance

- Local and global governance are critical to **managing water resources** and ensuring **sustainable freshwater use**
- **Local governance**:
  - In areas experiencing drought, local authorities can restrict water use to preserve supplies
    - For example, during droughts in the UK, local governments often ban garden watering and limit non-essential water use

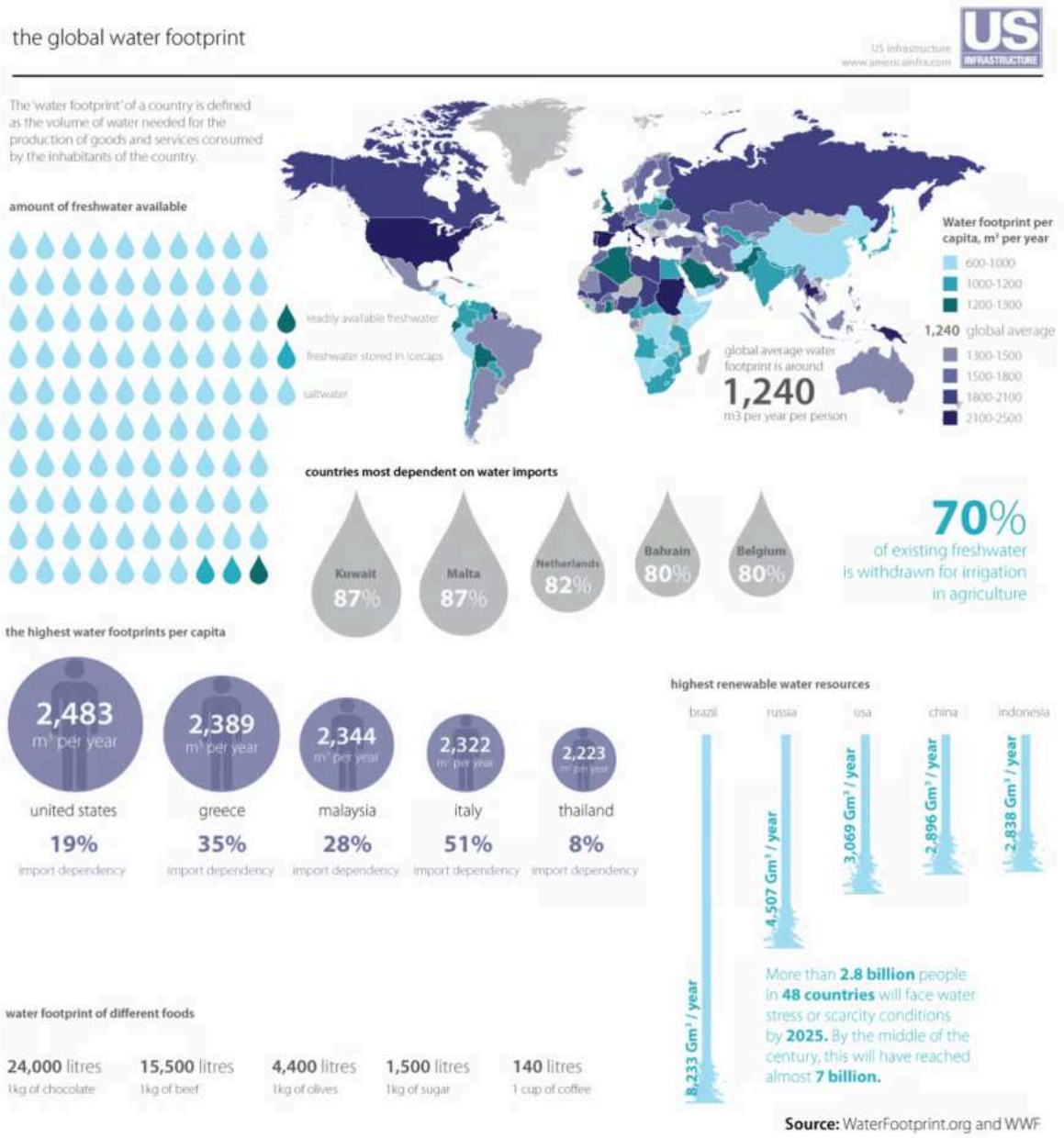
- Local water management also includes **building reservoirs** and encouraging **water conservation efforts** at the household level
- **Global governance**:
  - International cooperation is often necessary for water sources that cross national boundaries
  - Countries sharing rivers, lakes, or groundwater must collaborate to avoid overuse and conflict
  - For instance, six countries share the **Mekong River**, including China and Vietnam
    - Cooperation is essential to balance energy production, agriculture, and ecosystem protection along the river
  - Another example is the **Indus Water Treaty** between India and Pakistan
  - The treaty regulates the use of water from the Indus River system, a key resource for both countries


Your notes

Water Footprints

- A water footprint measures the **total amount of water used to produce goods and services**
  - This can provide important information about the sustainability of water use by different societies
- **Individual water footprints** measure how much water a person uses daily
- This includes:
  - **Direct use** (water for drinking and washing)
  - **Indirect use** (water needed to grow the food and manufacture the goods that the person consumes)
- **National water footprints** reflect the overall water consumption of a country
  - This includes domestic use and the water used for the manufacturing of all imported goods
- Water footprints can also apply to **industries** or **products**
- For example:
  - Growing crops like rice and cotton requires large amounts of water, leading to high water footprints
  - Over 15 000 litres of water is needed to produce 1 kilogram of beef, making meat production extremely **water-intensive**
- **Water footprint analysis** can inform sustainable decision-making
  - Governments can use this data to create water-saving policies
  - Consumers can reduce their water footprint by choosing products with **lower water demands**

Your notes



Infographic of water footprints around the world (by Tiffany Farrant, taken from Wikimedia Commons)

Citizen Science

- **Citizen science** involves ordinary (non-specialist) people participating in scientific research to gather data
  - This contributes to **monitoring** and **managing water resources**

- Citizen science projects often use standard protocols to ensure high-quality data
- Participants collect data on water quality, quantity, and other factors
  - For example, the **FreshWater Watch** project encourages citizen scientists around the world to monitor freshwater bodies for pollution and ecosystem health
  - Participants collect water samples and submit data
  - This helps scientists and governments manage water resources
- **Benefits** of citizen science:
  - Increases public awareness of water issues and encourages local stewardship
  - Provides large-scale data collection that scientists or governments may not have the resources to gather
  - Allows communities to monitor local water conditions and identify problems, such as pollution
- **Limitations** of citizen science:
  - Data accuracy can vary depending on training and experience of volunteers
  - Data collection is often limited to specific times and places, meaning it may not capture a complete picture of water issues


Your notes

Water Stress (HL)

Your notes

Water Stress

What is water stress?

- Water stress is a measure of water supply that considers not only the amount of available water but also the water's **quality**, **environmental flows**, and **accessibility**
  - **Environmental flows** refer to the amount of water needed in rivers, lakes, and wetlands to support **healthy ecosystems**
    - If over abstraction occurs (for irrigation or industry), ecosystems may suffer, leading to the degradation of habitats and loss of biodiversity
    - Healthy ecosystems, such as wetlands and rivers, need adequate water to maintain fish populations, provide clean water, and support other species
  - **Accessibility** refers to whether people can actually access clean, usable water, even if it exists in the local environment
    - Factors affecting accessibility include infrastructure, such as pipes and wells, the distance to water sources, and whether water is **affordable**
    - In some regions, water is abundant but not accessible due to a **lack of infrastructure** or **high costs**
    - In other regions, water may be available but not clean enough for human consumption
- Water stress differs from **water scarcity**
  - Water scarcity only considers the absolute shortage of water in a region
  - Even if a region has sufficient water, it may experience water **stress** if the water is **polluted** or **difficult to access**

Measuring water stress

- Water stress is defined as a situation where the available clean, accessible water supply is **less than 1 700 cubic metres per person per year**
  - This figure includes the water needed for:
    - Personal use
    - Other sectors, such as agriculture and industry

Causes of water stress

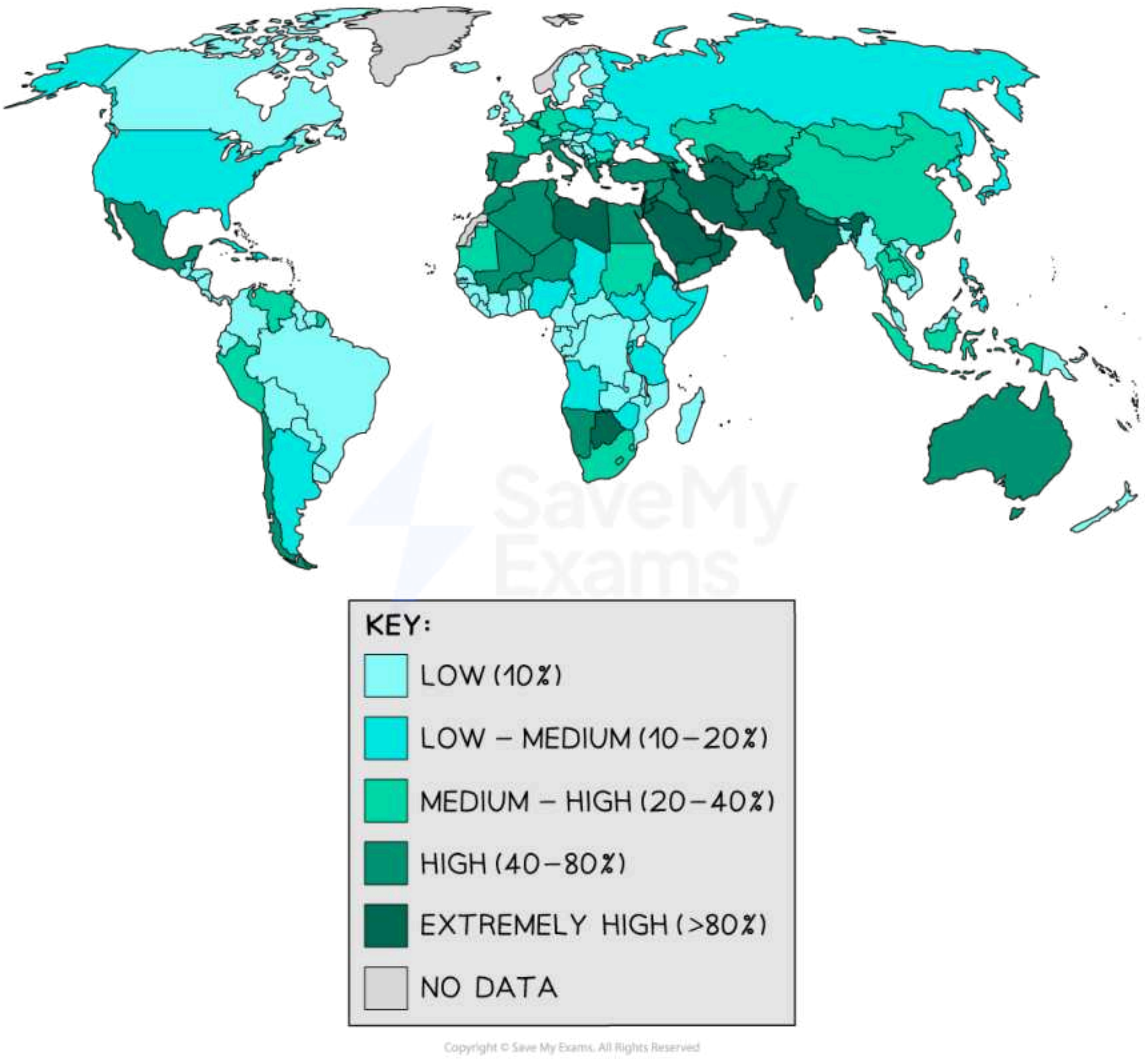
- **Industrialisation in emerging economies**:
  - As countries rapidly industrialise, the demand for water increases to support:
    - More factories
    - Greater energy production
    - Increasing urbanisation
  - For example, China has experienced water stress in its northern regions due to its rapid industrial growth
    - This is made worse due to limited freshwater sources in these areas
    - One major cause is that factories demand significant water for cooling and processes
    - This has led to competition with local agriculture and domestic use
- **Population pressure and over-abstraction in low-income countries**:
  - Population growth puts huge pressure on existing water supplies
    - Especially in countries with limited infrastructure to store and distribute water
  - For example, India faces water stress due to over-abstraction of groundwater in many regions
    - Especially in rural areas where agriculture depends heavily on underground water sources
    - The fast-growing population is making this problem worse


Your notes

Water stress and transboundary disputes

- When rivers, lakes, or other water sources cross regional or national boundaries, disputes can arise over access and control
  - For example, the **Nile River** flows through 11 countries
  - Disagreements, particularly between **Egypt** and **Ethiopia**, have intensified over Ethiopia's construction of the **Grand Ethiopian Renaissance Dam**
  - Egypt, which is highly dependent on the Nile for agriculture and drinking water, fears reduced flow downstream
- Political, historical, and environmental tensions often make these disputes even more complicated

Your notes



Water stress

Impacts of water stress

- **Agricultural impact**:
  - Water stress can reduce crop yields due to lack of sufficient irrigation water, leading to food insecurity
- **Economic impact**:
  - Water shortages can disrupt industries, particularly those requiring significant water inputs like energy, textiles, and food production

- **Health impact**:
  - Low water quality in stressed regions leads to diseases like cholera and dysentery due to lack of clean drinking water

Examiner Tips and Tricks

Remember the difference between water scarcity and water stress: water stress considers factors like quality, ecosystem effects and access, while scarcity is purely about quantity.

Your notes

Addressing Water Stress (HL)

Your notes

Industrial Level Strategies

- At an industrial level, various strategies can be used to **manage water stress**
  - These strategies ensure more sustainable water use and management
- **Large-scale infrastructure** and **technological solutions** are often used to address water stress
  - These solutions improving access to water for agriculture, industry, and communities
  - Each of these approaches has its specific applications, benefits, and challenges

Dams

- Dams are large structures built across rivers to block or slow water flow, creating reservoirs that store water for future use
- **Advantages:**
  - Store large volumes of water for long-term use in agriculture, irrigation, drinking, and industry
  - Water can be released in controlled amounts
  - Provide hydroelectric power and flood control
- **Limitations:**
  - Floods ecosystems upstream of dam
  - Can displace human communities
  - Disrupts natural river flow, affecting fish migration and sediment transport

Water transfer

- Water transfer involves moving water from areas with surplus supply to regions with shortages, typically through canals or pipelines
- It is often used to balance regional water availability for agriculture, urban consumption, or industrial use
- **Advantages:**
  - Provides water to regions suffering from water stress by transporting it from water-rich areas
  - Helps maintain water supplies for agriculture, industry, and households during dry periods

- **Limitations:**
  - High cost of infrastructure and maintenance
  - Potential disruption of ecosystems in both the source and receiving areas
  - Possible introduction of invasive species

Pipelines

- Pipelines are underground or above-ground pipes that transport water over long distances from water sources to areas where it's needed
- **Advantages:**
  - Provide a continuous supply of clean water without overland flow, reducing exposure to pollutants
  - Can transport water to remote or arid regions
- **Limitations:**
  - Capacity is fixed once installed, limiting flexibility for future demand
  - Underground pipelines are difficult to monitor and repair
    - Leaks result in high level of water waste
  - Surface pipelines disrupt transport and cause visual pollution

Water tankers

- Water tankers are large vehicles (e.g. ships or trucks) used to transport water over large distances
- **Advantages:**
  - Can deliver water quickly to areas in critical need or emergencies
  - Provide a temporary supply during droughts or natural disasters
  - Suitable for locations with limited water sources or infrastructure
- **Limitations:**
  - Expensive to operate over long distances
  - Transporting large volumes of water can have a high environmental impact due to the carbon footprint

Estuary storage with barrages

- Barrages are barriers built across estuaries to store freshwater in coastal areas
- Water is trapped during high tides and used during low tides or droughts


Your notes

- **Advantages:**
  - Provides water storage in coastal regions where natural freshwater sources may be scarce
  - Can also prevent seawater intrusion into freshwater systems, improving water quality for use
- **Limitations:**
  - Expensive to construct and maintain
  - Can have significant ecological impacts on estuarine ecosystems, affecting migrating fish and other marine species
  - Can alter tidal flows


Your notes

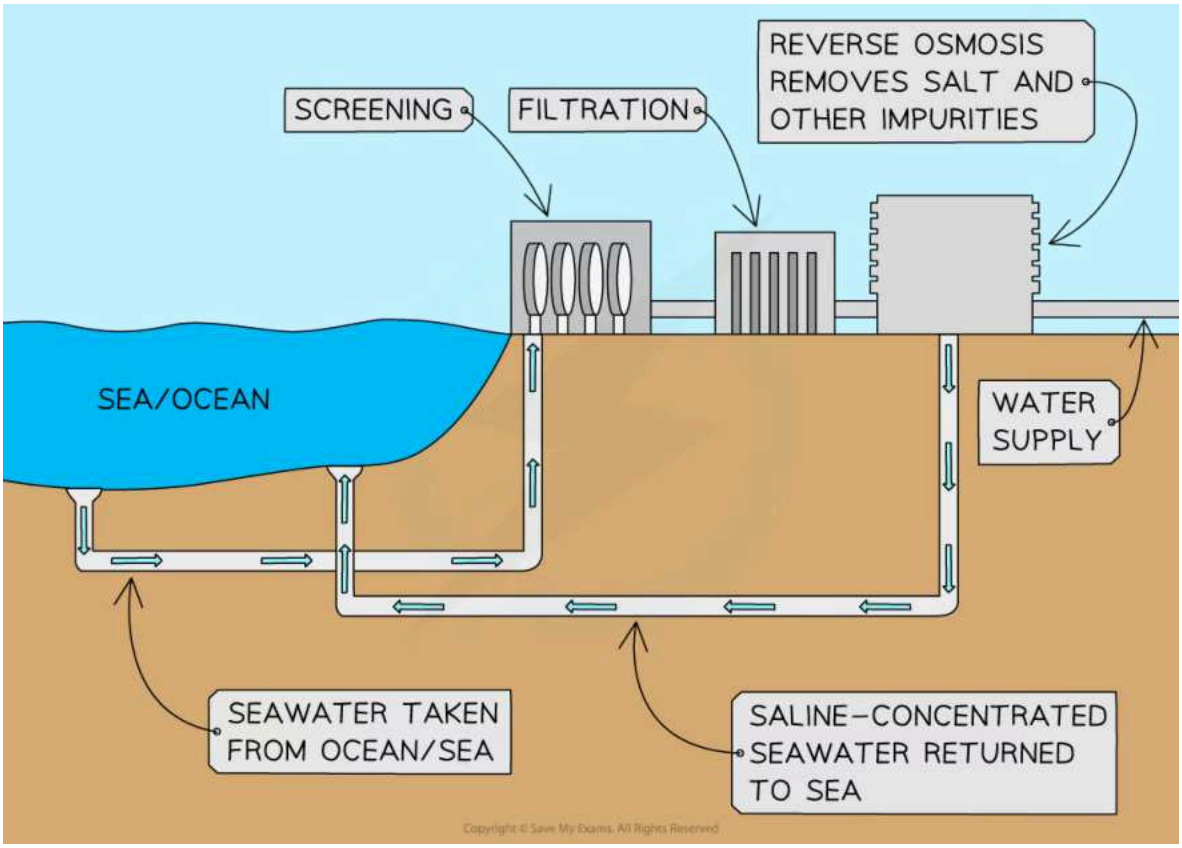
Rainmaking (cloud seeding)

- Cloud seeding is a form of weather modification that involves dispersing substances (like silver iodide) into clouds to encourage precipitation
- **Advantages:**
  - Can increase local rainfall in drought-prone areas, helping to replenish water supplies
  - Useful for boosting agricultural productivity in arid regions
- **Limitations:**
  - Expensive and requires favourable weather conditions to be effective
  - Long-term environmental impacts are not fully understood

Desalination

- Desalination is the process of removing salt from seawater to make it suitable for drinking or irrigation
- It is increasingly used in water-scarce regions, especially in coastal areas with access to seawater
- **Advantages:**
  - Provides a reliable source of freshwater in areas where natural freshwater resources are limited
  - Can supply large populations with drinking water, especially in arid regions
- **Limitations:**
  - High energy consumption and expensive to operate
  - Produces a concentrated brine byproduct that can harm marine environments when discharged

Your notes



Desalination process

Solar distillation

- Solar distillation uses solar energy to evaporate water, leaving behind impurities and salts, then condenses the vapour into clean water
- It is often used in small-scale applications
- **Advantages:**
  - Renewable energy source with low operational costs
  - Can provide clean drinking water in remote or arid locations
- **Limitations:**
  - Requires sunny conditions, so not reliable in all climates
  - Produces water at a slow rate, making it unsuitable for large-scale needs

Dew harvesting

- Dew harvesting involves capturing water vapour from the air, usually on cool surfaces, which then condenses into liquid water
- **Advantages:**
  - Provides a local, low-energy source of water in arid regions
  - Can be an effective water collection method in areas with low precipitation but high humidity
- **Limitations:**
  - Produces small amounts of water, making it unsuitable for large-scale needs
  - It requires specific environmental conditions (cool nights and high humidity)

Your notes

Aquifers

Aquifer storage and recovery (ASR)

- ASR is a process where surplus water is stored in underground aquifers during times of excess, such as during the rainy season, and retrieved during dry periods
- **Advantages:**
  - Reduces evaporation losses compared to surface storage (e.g. in reservoirs)
  - Can help manage water supply over long periods, including during droughts
- **Limitations:**
  - Requires careful management to avoid contamination of the stored water
  - Can lead to over-extraction and depletion of groundwater resources if not monitored

Artificial recharge of aquifers (AR)

- AR involves artificially increasing the amount of water that enters an aquifer, typically through the use of recharge wells or by directing surface water into recharge basins
- **Advantages:**
  - Helps restore depleted groundwater resources, which can be used during dry periods
  - Improves water security in areas that rely heavily on groundwater for agriculture and drinking water
- **Limitations:**
  - Potential contamination of aquifers if surface water is polluted
  - Requires significant infrastructure and ongoing monitoring to ensure effectiveness

Examiner Tips and Tricks

Know the differences between **ASR** and **AR**. ASR stores water for later use, while AR actively replenishes aquifers.

In an exam, you may be asked to provide examples of strategies suited to different environments (e.g., desalination for **coastal areas**, ASR for regions **prone to drought**).

Your notes

Environmental Impacts of Desalination

- Desalination provides a crucial solution to water stress, especially in arid regions
- However, it also has significant environmental impacts
  - The negative impacts of desalination can be reduced through **technology** and **careful management**, but they are not entirely preventable

Brine discharges

- Brine is the concentrated salty water left over after the desalination process
  - It is usually discharged back into the sea
- **Environmental impact:**
  - The concentrated brine can alter the salinity of coastal waters, harming marine ecosystems and reducing biodiversity
  - Brine can sink to the ocean floor, creating "dead zones" where oxygen levels are too low to support aquatic life
- **Mitigation:**
  - Dilution techniques can help disperse brine more evenly

Noise pollution

- Desalination plants generate significant amounts of noise during operation
  - Particularly from machinery like pumps and turbines
- **Environmental impact:**
  - Noise pollution can disturb nearby wildlife, especially marine animals that rely on sound for communication and navigation
  - The constant noise may also have an impact on people living close to desalination plants

- **Mitigation:**
  - Locating plants farther from sensitive habitats or residential areas can reduce noise pollution


Your notes

Air pollution and fossil fuel combustion

- Many desalination plants use fossil fuels to power them, resulting in emissions of air pollutants such as carbon dioxide
- **Environmental impact:**
  - Desalination contributes to air pollution and increases greenhouse gas emissions, worsening climate change
  - For example, desalination in the **UAE** is extremely energy-intensive, with plants relying heavily on fossil fuel combustion to power operations
- **Mitigation:**
  - Transitioning to renewable energy sources, like solar or wind power, can reduce air pollution and carbon emissions
    - However, high costs and energy demands make this difficult in many cases

Saline intrusion into aquifers

- Saline intrusion occurs when saltwater enters freshwater aquifers, often caused by over-extraction of groundwater
- **Environmental impact:**
  - Desalination plants that pump water from aquifers can worsen the problem, contaminating freshwater sources and making them unusable
  - Coastal areas are particularly vulnerable to saline intrusion, which can affect drinking water supplies
- **Mitigation:**
  - Careful monitoring of groundwater levels and limiting extraction rates can reduce the risk

Your notes

Water Equity Issues

Inequitable access to water and sanitation

- **Water equity** refers to the **fair distribution** of water resources, ensuring everyone has access to:
  - Safe, clean drinking water
  - Sanitation
- Inequitable access occurs when certain groups of people are denied this **basic human right**, which is essential for health and well-being
  - Lack of access to clean water can lead to severe health issues, including the spread of **waterborne diseases**
- Inequitable access to water **disproportionately impacts marginalised groups** such as:
  - Indigenous peoples
  - Low-income communities
  - Women

Human health impacts of inequitable water access

- Unsafe drinking water leads to widespread health issues, including waterborne diseases such as cholera, dysentery, and typhoid
  - **Diarrhoea**, often caused by contaminated water, is responsible for nearly 485,000 deaths annually
  - In children under five, unsafe water contributes significantly to **malnutrition** and **stunted growth**, affecting their development
- Poor sanitation leads to the spread of **infectious diseases**
  - Especially in overcrowded and impoverished areas

Negative impacts on sustainable development

- Inadequate water access **undermines sustainable development goals**, as clean water is essential for health, education, and economic growth
  - Access to clean water and sanitation is crucial for achieving Sustainable Development Goal 6 (**SDG 6**)

- This goal aims to ensure availability and sustainable management of water and sanitation for all people **by 2030**
- Communities without safe water and sanitation face difficulties in education, economic development, and quality of life
- Areas that lack clean water cannot develop industries, grow crops efficiently, or maintain healthy populations, making it **difficult to lift people out of poverty**


Your notes

Indigenous communities

- Limited access to safe water and sanitation:
  - Many Indigenous communities, especially in rural or remote areas, have limited or no access to clean water
    - In **Canada**, for example, **Indigenous reserves** face ongoing 'boil water advisories'
    - This means residents must boil their water before using it
    - Some of these advisories have lasted for **decades**
  - In Australia, Indigenous communities in rural areas often have less reliable access to safe drinking water than urban populations, affecting their health and quality of life

Low-income groups

- **Water affordability**:
  - For many low-income families, even if clean water is available, they may not be able to afford it
    - In the United States, rising water prices in cities like Detroit have caused water shut-offs, where families unable to pay water bills have had their water supply cut off
  - In developing countries, low-income communities may rely on unsafe water sources like rivers or shallow wells
    - This increases their exposure to diseases
- **Sanitation challenges**:
  - In urban slums, many people live without proper sanitation facilities, such as toilets or sewage systems
    - In Kenya, it is estimated that 60% of residents in informal settlements, such as **Kibera** in **Nairobi**, have no access to clean toilets, leading to open defecation and severe public health issues
  - Poor sanitation not only spreads disease but also increases the risk of water contamination, worsening the situation for those who are already vulnerable

Women

- **Women** and **girls** may be disproportionately affected by water inequity
  - Some may spend hours walking long distances to collect water
  - This can prevent them from attending school or engaging in paid work
  - This can significantly limit their **educational** and **economic opportunities**
  - Lack of access to sanitation may also affect school attendance for girls, who may miss school due to the lack of proper facilities during menstruation


Your notes