

DP IB Environmental Systems & Societies (ESS): SL

4.2 Water Access, Use & Security

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Factors Affecting Water Availability

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)

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
 - 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

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

Strategies for Increasing Water Supply

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	<p>Increasing groundwater supplies by directing surface water into the ground to replenish aquifers</p> <p>Recharging aquifers helps prevent groundwater depletion and maintains a sustainable supply of water for wells and springs</p>	In California, USA, managed aquifer recharge projects help counteract over-extraction of groundwater
Redistribution	<p>Efficient water redistribution systems, such as canals and pipelines, transfer water from water-rich regions to areas experiencing scarcity</p> <p>Redistributing water resources can help balance supply and demand, particularly in densely populated or arid regions</p>	The Central Arizona Project in the USA redistributes water from the Colorado River to arid regions of Arizona

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

Addressing Water Scarcity

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**

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Water conservation techniques

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



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