DP IB Environmental Systems & Societies (ESS): HL

Your notes

8.2 Urban Systems & Urban Planning

Contents

Urban Areas

Your notes

Understanding Urban Areas

What is an urban area?

- An urban area is a built-up environment with:
  - A **high population density**
  - A large concentration of buildings and man-made infrastructure
- Urban areas serve as centres for **residential**, **cultural**, **economic**, **trade** and **social activities**
- **Cities**, **towns** and **suburbs** are examples of urban areas
- Urban areas contrast with **rural areas**
  - Rural areas have:
    - **Lower population densities**
    - More dispersed settlements, often focused on agriculture and natural landscapes
  - For example, **London**, UK, is a large urban area with dense population, infrastructure and cultural hubs whereas the **Lake District** in the UK is a rural area with scattered villages and a focus on agriculture and tourism

Urban ecosystems

- **Urban ecosystems** are unique environments found within cities and towns
  - They occur where human activities interact with natural elements like plants, animals and climate
- These ecosystems have both **biotic components** (living organisms like plants, animals and humans) and **abiotic components** (non-living parts like soil, water, air and urban infrastructure).

Types of urban ecosystems

- **Residential gardens:**
  - Gardens found in **residential areas** are important urban ecosystems, providing habitats for plants, birds, insects and small mammals
  - These areas also help to improve **air quality** and reduce the effects of urban heat islands
- **Industrial sites:**
  - Industrial areas include factories, warehouses and other business operations


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- These areas may cause **pollution**, but some are now being redeveloped with **green spaces** to improve the environment

- **Inner-city derelict land:**
  - **Abandoned** or **derelict** land in cities can become important for wildlife and urban regeneration projects
  - These areas often develop **biodiversity** as nature reclaims the land
- **Green areas and open spaces:**
  - Urban **parks** and **green spaces** are essential ecosystems, offering habitats for animals, improving air quality and providing recreational space for people
- **Traffic corridors:**
  - Areas alongside **roads** and **railways** form their own ecosystems, with hardy plants and animals that can survive in polluted or disturbed environments
  - Urban planners can design **green corridors** along these routes to help connect different wildlife habitats within cities
- **Cemeteries:**
  - Cemeteries are often quiet, green spaces within urban areas that support a wide range of plant and animal life
  - They can act as **biodiversity hotspots**, with trees, grass and other vegetation supporting birds, insects and small mammals
- **Waste disposal areas:**
  - **Landfills** and **waste treatment plants** are part of urban ecosystems
  - Although they can cause pollution, they are also home to certain species of birds, insects and bacteria that thrive in waste environments
- **Forests, fields and water bodies:**
  - Some urban areas contain patches of **forests**, **fields**, **lakes** or **rivers**, which provide crucial habitats for wildlife and help with urban temperature regulation

Components of urban ecosystems

- **Biotic** components:
  - **Plants** (trees, shrubs, grass) found in parks, gardens and along streets
  - **Animals** such as birds, insects and mammals
  - **Humans**, whose activities like construction, gardening and commuting shape the ecosystem

- **Microorganisms**, including bacteria and fungi that break down waste and enrich soil

- **Abiotic** components:
  - **Soil**: essential for plant growth in urban parks and gardens
  - **Water**: found in rivers, lakes and urban infrastructure like water supply systems
  - **Air**: clean air is important for health but urban areas often face challenges with **air pollution**
  - **Climate**: urban areas often create a **microclimate**, with higher temperatures due to buildings and infrastructure
  - **Urban infrastructure**: buildings, roads, bridges and other structures are integral to urban ecosystems, affecting how people and nature interact

Examiner Tips and Tricks

Make sure you can clearly explain the differences between urban and rural areas in terms of population density, infrastructure, and ecosystem types.

Urban Systems

- An urban system is a network of interconnected elements that work together to support life in a city or town
- Urban systems involve:
  - Buildings
  - Transport
  - Power and energy supply
  - Water supply
  - Sewage systems
  - Plants and animals
  - Humans

Components of urban systems

Buildings and infrastructure

- Buildings form the core of an urban system, providing **residential**, **commercial** and **industrial spaces**

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- Infrastructure such as roads, bridges and utilities (electricity, water and waste) connects and supports the functioning of the urban area


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Transport

- Urban areas rely on transport systems like roads, railways and buses to move people and goods
- Efficient transport systems are essential to reduce **traffic congestion** and **air pollution**
  - For example, **London's Underground** is a major part of the city's urban transport system, helping to reduce road traffic

Power and energy

- Urban systems require **energy** to power homes, businesses and industries
  - This energy can come from **fossil fuels**, **nuclear power** or **renewable sources**
  - Ensuring a **reliable** and **sustainable** energy supply is vital for cities to function properly

Water and sewage

- Water supply systems provide clean water for drinking, washing and other daily needs
- Sewage systems remove and treat wastewater to prevent pollution and maintain hygiene

Microclimate

- Cities create their own **microclimates**
  - They often become warmer than surrounding rural areas (urban heat island effect)
  - This is due to the high concentration of human activities and infrastructure
- Urban planners consider **green spaces** and certain **building designs** and **materials** to manage urban microclimates

Humans, plants and animals

- Urban systems support **human populations**, as well as **urban wildlife** and plants in parks, gardens and green areas
  - These living (biotic) components of urban ecosystems provide recreational spaces and contribute to **air quality** and **biodiversity**

Other factors in urban systems

Urban waste and pollution

- Cities generate large amounts of **waste** and **pollution**, including solid waste, air pollution and water contamination

- Managing waste and reducing pollution is critical to maintaining urban efficiency and public health


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Urban efficiency

- Urban efficiency refers to how well a city uses its resources, including energy, water and transport systems
  - More efficient urban systems can reduce waste, cut down pollution and improve quality of life for residents

Urban sustainability

- Sustainability is about ensuring that urban systems can meet the needs of the present without harming future generations
  - Sustainable cities focus on reducing their environmental impact by using **renewable energy**, **reducing waste** and **promoting green spaces**
- Urban systems can operate with different types of resource management
  - They might follow either a **linear** or **circular metabolism** approach, which affects sustainability and waste management in cities
  - **Linear metabolism cities**:
    - These are cities that follow a 'take, use, dispose' approach
    - Resources (like energy and water) are used once and then discarded as waste
    - This leads to high levels of consumption and pollution
  - **Circular metabolism cities**:
    - These are cities that focus on **recycling**, **reusing**, and **reducing waste**
    - This approach aims to minimise resource use by creating a closed-loop system where outputs (like waste) are reused as inputs (e.g. recycling materials or generating energy from waste)

Urban resilience

- Resilience refers to a city's ability to recover from challenges like **natural disasters**, **climate change** or **economic crises**
  - Resilient urban systems have **strong infrastructure**, **emergency services** and **disaster preparedness plans**
  - For example, after **Hurricane Katrina** (2005), the city of **New Orleans**, USA, improved its flood defences and urban infrastructure to increase resilience against future disasters

Urban system flow diagram

- An **urban system** can be represented using a **systems flow diagram** by showing how resources (inputs) move through the city, are used, and generate outputs like waste and pollution

1. **Inputs**: the resources a city needs to function
    - Examples: **energy** (electricity, fuel), **water**, **food**, **goods** (materials for buildings and infrastructure), and **labour** (human workforce)
2. **Processes**: how the city uses these inputs in its daily operations
    - Examples: **buildings**, **transport systems**, **services** (healthcare, education), and **infrastructure** (roads, power plants, water supply)
3. **Outputs**: the results of urban processes, often in the form of waste
    - Examples: **solid domestic waste** (rubbish, recycling), **pollution** (air and water), and **sewage**
4. **Feedback**: information or actions that help the system improve in efficiency, sustainability, and resilience
    - Examples: **urban planning** decisions (like building more green spaces), implementing **renewable energy**, and **waste management** initiatives


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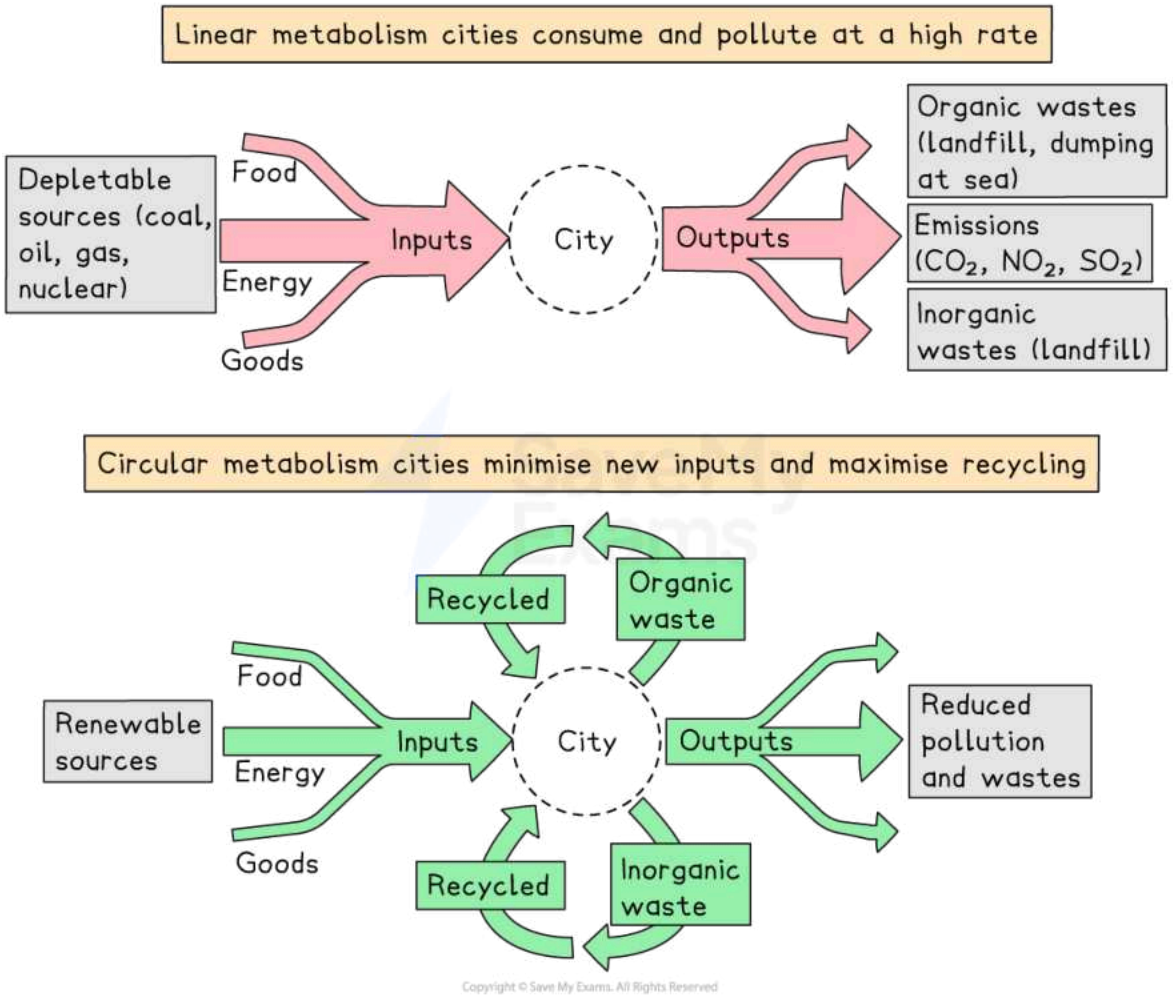

Cities of different types, as well as other urban systems such as towns or industrial sites, can be represented using system flow diagrams

Examiner Tips and Tricks

Urban areas work as systems, so be sure you can explain how the various parts of an urban system—like transport, energy, and waste—**interact** with each other. For example, as urban systems are **highly interconnected**, you could be asked to explain how improvements in one area (e.g. transport) can positively affect other areas (e.g. pollution).

Don't confuse terms like efficiency, sustainability, and resilience!

Urbanisation


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Urbanisation

What is urbanisation?

- Urbanisation is the process where a growing proportion of a country's population moves from **rural** areas (countryside) to **urban** areas (cities and towns)
  - This shift results in land becoming more **built-up**, with **infrastructure**, **housing**, and **industrialisation** dominating the urban landscape
  - As urbanisation occurs, cities:
    - **Expand**
    - Develop more **dense populations**
    - Experience more **continuous human activity**
- According to the World Bank, 56% (4.4 billion) of the world's population now live in towns and cities

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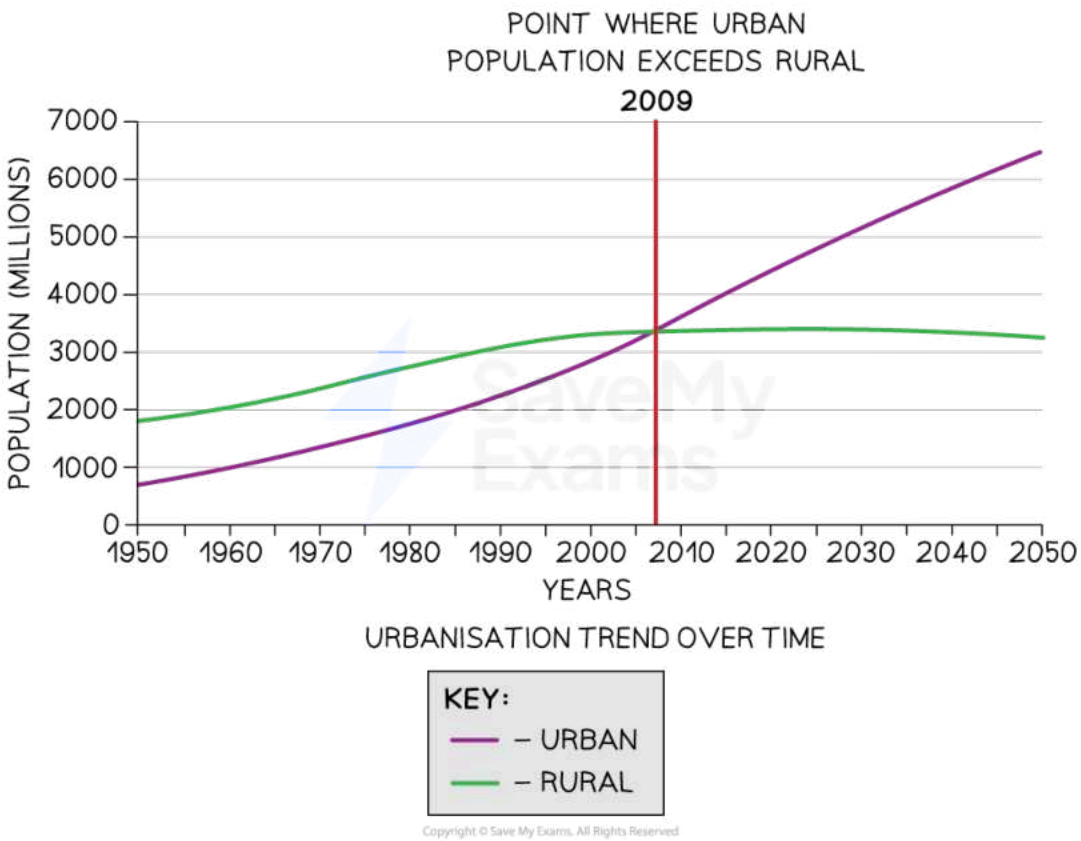

The trend shows that more people now live in towns and cities than in rural areas

Rural-urban migration

- Rural-urban migration is a major factor driving urbanisation
  - It is the movement of people from the countryside to cities in search of:
    - Better living conditions
    - Job opportunities
    - Safety
- This migration causes the urban population to grow, often at the expense of the rural population
  - For example, in **China**, rural-urban migration has led to massive city growth, with people moving from farming regions to cities like **Shenzhen** and **Beijing** in search of jobs in factories or offices
- Rural-urban migration is mostly **internal migration** (within a country)

Urbanisation pathway

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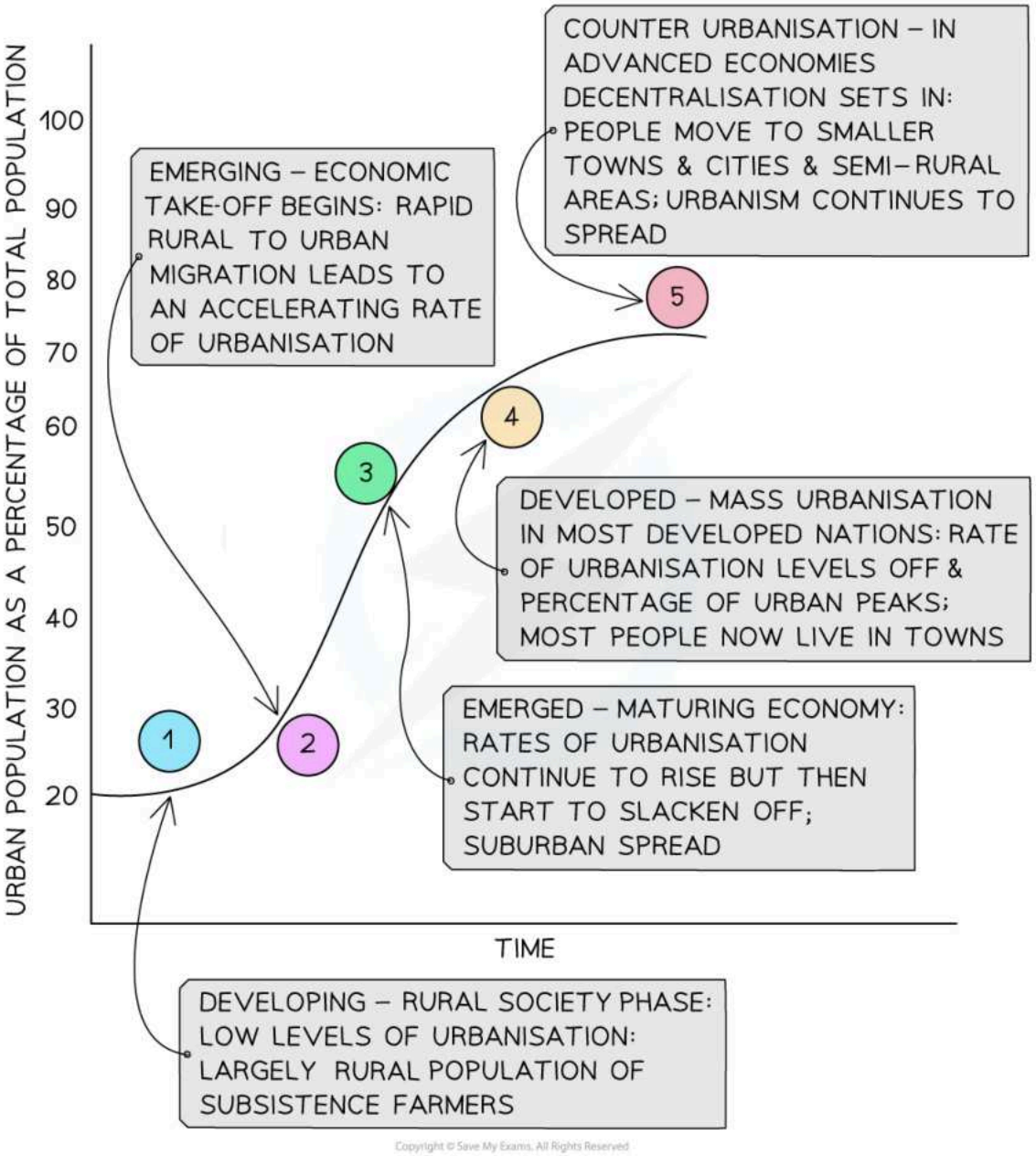
- Countries become more urban as they develop economically
- This transition from LICs to HICs can be shown as a **pathway over time**
- The pace through the stages slows and flattens or will decline as counter urbanisation gains speed



Urbanisation pathway showing the stages a country will pass through as economic development occurs

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Examiner Tips and Tricks

Don't confuse urbanisation level with urban growth. Developed countries such as the UK, Germany, USA, etc. have high levels of urbanisation but low growth rates. Their towns and cities are already in place. But emerging and developing countries such as China, India, and Nigeria have low levels of urbanisation but high growth rates; they are building their cities.

Push and pull factors of rural–urban migration

- **Push factors** are the reasons people **leave** rural areas
- These include:
  - **Poverty**: lack of jobs and low wages in rural areas
  - **Poor living conditions**: limited access to services like healthcare, education, and clean water
  - **Natural disasters**: droughts, floods, or other environmental challenges that make farming difficult
- **Pull factors** are the **attractions** of urban areas that draw people to move there
- These include:
  - **Job opportunities**: cities often offer more and better-paying jobs, especially in industries, services, and trade
  - **Improved living conditions**: access to better healthcare, education, and housing in cities
  - **Social and cultural opportunities**: cities provide more entertainment, cultural events, and lifestyle choices

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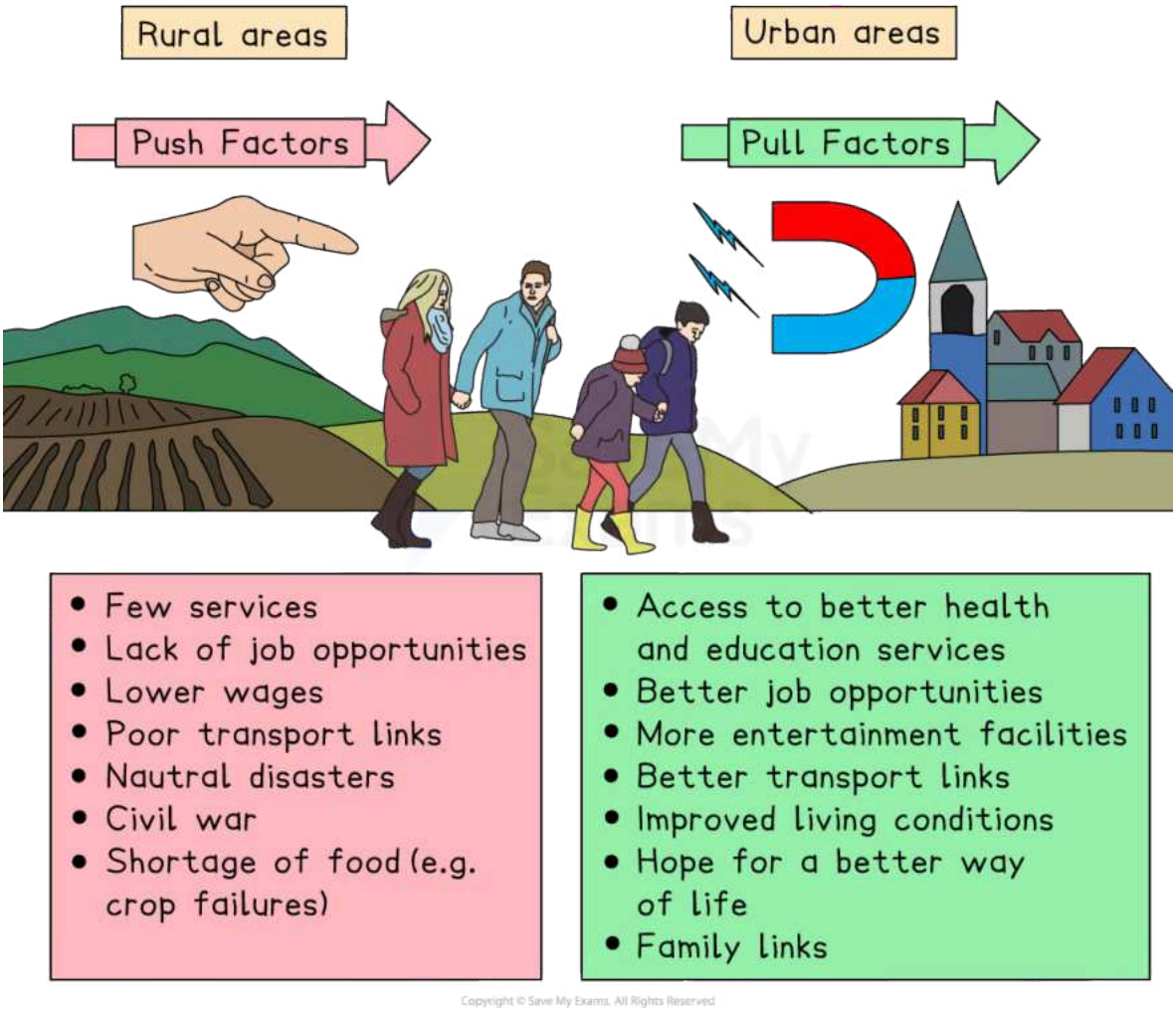

Push and pull factors of rural–urban migration

Forced and voluntary migration

- **Voluntary migration**:
  - When people **choose** to move to cities for better opportunities or living conditions
- **Forced migration**:
  - When people are **pushed** into cities due to circumstances like war, famine, or natural disasters
  - For example, refugees fleeing conflict in **Syria** and moving to urban areas in nearby countries such as **Turkey** and **Jordan**

Deurbanisation trends


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- **Deurbanisation** refers to the reverse process where people move out of cities and back to rural or suburban areas
- This can happen due to:
  - **Overcrowding**: cities becoming too congested, leading to higher costs of living and poorer living conditions
  - **Improved rural opportunities**: development in rural areas offering better services, jobs, and living conditions
  - **Technological changes**: with the rise of **remote working**, people can live in rural areas while working for urban companies

Urban Expansion

Your notes

Suburbanisation & Urban Sprawl

What is suburbanisation?

- Suburbanisation is the process where people move from the **dense central parts of cities** (urban areas) to the **less dense, peripheral areas** (suburbs)
  - It involves the expansion of cities into nearby rural or undeveloped areas, creating **lower-density residential areas**
  - People often move to the suburbs in search of **larger homes**, **green spaces**, and **better living conditions** away from the congested city centre

What is urban sprawl?

- **Urban sprawl** refers to the uncontrolled expansion of urban areas into surrounding rural land, creating spread-out developments
  - Urban sprawl is closely related to suburbanisation, as **lower-density housing** and commercial developments require more land, stretching the boundaries of the city
  - Sprawl often leads to **longer commutes**, **greater car dependency**, and increased demand for infrastructure such as roads and services

Causes of suburbanisation

1. **Desire for more space**:
   - People move to the suburbs for **larger homes** and **gardens**
   - Suburban areas often have more **green spaces** and parks than city centres
2. **Improved transport links**:
   - Advances in **public transport** and the widespread use of **cars** have made commuting from the suburbs to city centres easier
   - Suburban residents can travel to the city for work, shopping, and leisure
3. **Perception of better quality of life**:
   - Suburbs are often seen as **safer**, quieter, and better for **raising families** compared to crowded city centres
   - Suburban areas may offer better **schools** and **lower crime rates**

4. **Rising urban costs**:
    - High costs of housing and living expenses in city centres push people to move to the more affordable suburbs
5. **Traffic congestion and overcrowding in city centres**:
    - City centres are often very **busy** with people and **congested** with traffic, making commuting and living in the urban core more difficult


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Environmental Impacts of Urban Expansion

Loss of agricultural land and natural ecosystems

- **Loss of farmland**:
    - As cities expand, they often take over land previously used for **agriculture**
    - This reduces the amount of land available for growing food
    - For example, in **Beijing**, China, rapid urbanisation has consumed large areas of farmland, leading to concerns about **food security**
- **Deforestation**:
    - Urban expansion can lead to the **clearing of forests** to make way for housing, roads, and businesses
    - This destroys natural habitats and reduces biodiversity
        - For example, the growth of **São Paulo**, Brazil, has resulted in the destruction of parts of the **Amazon rainforest**
- **Loss of wetlands and ecosystems**:
    - Expanding urban areas often fill in **wetlands**, rivers, and lakes, reducing habitats for wildlife and affecting water systems
        - For example, in **Florida**, USA, urban sprawl has reduced the size of the **Everglades**, an important wetland ecosystem

Changes to water quality and river flows

- **Water pollution**:
    - Increased construction and industrial activities near cities can cause pollution to **rivers**, **lakes**, and **groundwater**
    - Chemicals from factories, waste from homes, and run-off from roads can contaminate water supplies


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    - For example, the **Ganges River** in India suffers from severe pollution due to urban growth and industrial waste from several major cities
- **Altered river flows**:
    - Expanding cities often build dams, divert rivers, or drain wetlands, which changes the natural flow of water
    - This can lead to **flooding** or **drought** in nearby areas
        - For example, in **Las Vegas**, USA, the city's rapid growth has strained the **Colorado River**, leading to water shortages and environmental issues

Air pollution

- **Increased traffic and industry**:
    - As cities grow, they generate more air pollution from **cars**, **trucks**, and **factories**
    - This increases levels of harmful gases like carbon dioxide and nitrogen oxides, contributing to **climate change** and health problems
        - For example, **Mexico City** is known for having high levels of **smog** and poor air quality due to urban expansion and traffic congestion
- **Heat islands**:
    - Urban expansion often creates **urban heat islands**
    - This is where cities become significantly warmer than surrounding rural areas
    - This happens because **buildings**, **roads**, and other urban surfaces absorb and retain more heat than natural landscapes like forests or grasslands
    - Air conditioners, vehicles, and industrial activities release additional heat into the environment

Loss of biodiversity

- **Habitat destruction**:
    - Urban expansion can destroy the natural habitats of plants and animals, leading to a reduction in **biodiversity**
    - This puts species at risk of extinction

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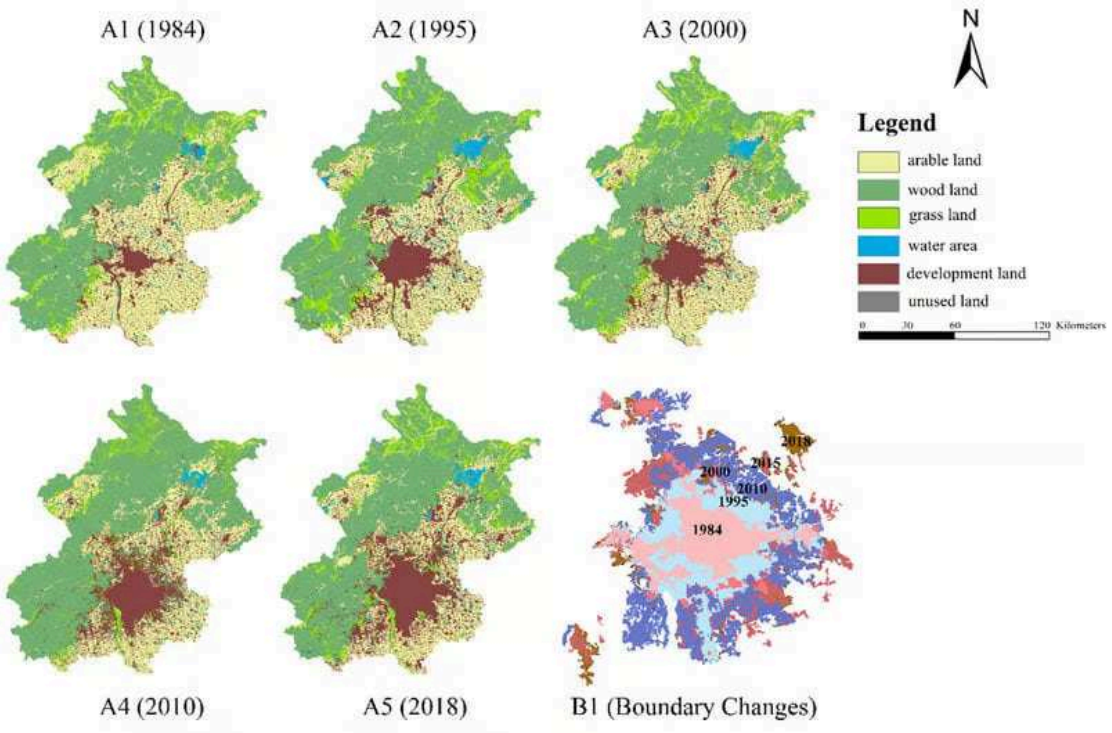

Map of urban expansion and land use change of Beijing (1984–2018). (A1–A5): Land use change of Beijing, 1984–2018. (B1): The process of urban expansion, 1984–2018. (Li, Yu et al., 2021)

Examiner Tips and Tricks

Always try to make connections between environmental impacts. For example, urban expansion can lead to deforestation, which contributes to air pollution and loss of biodiversity.


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Sustainable Urban Systems

Importance of urban planning

- **Urban planning** is the process of designing how land and buildings in a city are used to meet the needs of the population
  - It focuses on the best way to organise urban space to meet the **physical, environmental**, **commercial**, **industrial**, and **social needs** of all residents
- Effective urban planning ensures that cities grow in an organised and efficient way
  - This is to prevent issues like overcrowding, pollution, and inadequate infrastructure
- Modern urban planning aims to create **sustainable urban systems** that **balance** the **needs of the population** with **environmental protection**
  - In this context, sustainability means designing cities so they work well and fairly for people today, while also making sure they can meet the needs of future generations

Factors in sustainable urban planning

1. **Quality and affordable housing**:
   - Ensuring housing is available and affordable to **all income levels** is key for sustainable development
2. **Integrated public transport systems**:
   - A well-connected, reliable, and environmentally-friendly public transport system reduces the need for cars and lowers pollution
     - For example, **Copenhagen**, Denmark, has reduced car use by focusing on bicycle lanes and public transport
3. **Green spaces**:
   - Parks, forests, and other green areas improve air quality, provide recreational spaces, and contribute to the well-being of residents
     - For example, **Brasilia**, the capital of **Brazil**, was designed with a very large linear park running down its centre, promoting a balance between urban development and nature
4. **Security and safety**:
   - Creating safe neighbourhoods with reduced crime rates and effective emergency services

- Good lighting, surveillance, and safe public spaces contribute to a secure urban environment

5. **Education and employment**:
   - Providing access to schools, universities, and job opportunities is essential for sustainable cities
   - Urban systems must plan for education and employment to keep the population economically active
6. **Renewable energy and resources**:
   - Sustainable cities aim to use **renewable energy sources** like solar or wind power to reduce reliance on fossil fuels
     - For example, **San Francisco**, USA, has invested in **electric vehicle (EV) charging stations** to encourage the use of cleaner energy for transportation
7. **Reuse and recycling of waste**:
   - Sustainable cities focus on **reducing waste**, reusing materials, and promoting recycling to minimise environmental impact
     - For example, in **Singapore**, waste-to-energy plants help recycle waste while producing energy for the city
8. **Energy efficiency**:
   - Buildings in sustainable cities are designed to use energy efficiently, reducing waste and lowering energy costs
   - **Green buildings** incorporate insulation, solar panels, and other technologies to minimise energy consumption
9. **Water conservation**:
   - Cities must plan for efficient water use and ensure **water conservation** practices.
   - For example, **Dubai** uses **grey water** to irrigate its green spaces, conserving fresh water resources
10. **Community involvement**:
    - Successful urban planning involves the local community in decision-making processes
    - This ensures that the needs and ideas of residents are considered

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Examiner Tips and Tricks

Don't confuse urban planning goals: try to separate the social, economic, and environmental aspects of sustainability. For example, green spaces address environmental concerns, while

affordable housing tackles social issues.


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Ecological Urban Planning

What is ecological urban planning?

- Ecological urban planning treats the city as an ecosystem
  - This type of urban planning considers the interactions between living (biotic) and non-living (abiotic) components
  - It focuses on:
    - Creating balance between urban development and the natural environment
    - Ensuring cities are sustainable, resilient, and healthy for both humans and wildlife

Key components of ecological urban planning

Urban ecology

- Urban ecology integrates green spaces and natural habitats into city design
- This includes **parks, allotments, ponds, canals**, and other areas that provide habitats for wildlife and improve air quality

Urban farming

- Urban farming refers to growing food within cities
  - This is often done in unused or repurposed spaces
- This Includes activities like **beekeeping**, **horticulture**, **aquaculture**, and **city farms**
  - For example, **New York City** has community gardens and rooftop farms that supply fresh produce to local residents

Biophilic design

- Biophilic design brings nature into the built environment by incorporating natural elements into architecture
- This includes **living green walls**, **rooftop gardens**, **water features**, and the use of **natural light**
  - For example, the **Bosco Verticale** (meaning vertical forest) in **Milan**, Italy, is a complex of two residential skyscrapers covered in trees and plants, improving air quality and biodiversity

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The Bosco Verticale in Milan, Italy (Photo by Thomas Ledl)

Resilience planning

- Resilience planning focuses on designing cities to withstand and adapt to environmental challenges like climate change
- This may involve:
  - **Vertical farming** to produce food in limited urban spaces
  - Buildings on **stilts** to protect from flooding in **flood-prone areas**

- In flood-prone areas, such as the Netherlands, some homes are built to **float** on water, adjusting to rising and falling water levels
- Using natural elements like green roofs and permeable pavements to **manage stormwater** and **reduce flooding**


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Regenerative architecture

- Regenerative architecture aims to not only reduce environmental harm but actively improve the environment
  - **Building skins that clean the air**:
    - Some buildings are designed with special materials or coatings on their exterior walls (known as building skins)
    - These filter and remove pollutants (e.g. nitrogen oxides) from the air, improving air quality around the building
  - **Renewable energy sources**:
    - Many regenerative buildings use **solar panels**, **wind turbines**, or **bio-digesters** to generate more energy than they consume
    - They are then able to contribute clean energy back to the energy grid
  - **Bio-digesters**:
    - These systems use organic waste (like food or agricultural waste) to produce **biogas**
    - This can be used as a renewable energy source for heating or electricity
    - They also create natural fertiliser as a by-product
  - **Rainwater capture systems**:
    - Buildings can collect rainwater to be reused for non-drinking purposes, e.g. irrigation or flushing toilets
    - This reduces the demand on local water supplies

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Ecological Urban Planning

Key principles of ecological urban planning

1. Urban compactness

- Encourages the development of dense urban areas where **housing**, **jobs**, **schools**, and **services** are **close together**
- Reduces urban sprawl
- Minimises the need for long-distance travel
  - This encourages walking and cycling
- Compact designs often **reduce infrastructure costs**
  - This is because fewer roads and utilities need to be extended to distant areas

2. Mixed land use

- Combines **residential**, **commercial**, **industrial**, and **recreational** spaces within the **same neighbourhoods**
  - This reduces the need for long commutes by ensuring essential services are located nearby
- Increases economic opportunities by increasing foot traffic for local businesses
- Creates a more vibrant **community environment** by encouraging diverse activities in a single area

3. Social mix practices

- Aims to ensure neighbourhoods are **inclusive** of people from **different**:
  - Income groups
  - Backgrounds
  - Social classes
- Helps **reduce social segregation**
  - Leads to **greater social equality** in access to services and opportunities
- Ensures all residents have **equal access** to **green spaces**, **schools**, **healthcare**, and **transport**

Sustainable advantages of ecological urban planning

- **Reduced urban sprawl**:
  - Compact development limits spread of cities into rural and natural areas
    - Helps conserve forests, wetlands, and farmlands
    - These ecosystems are critical for biodiversity and carbon storage
  - Reduces the **environmental impact** and **economic cost** of creating new infrastructure
    - E.g. building roads and utilities in remote areas

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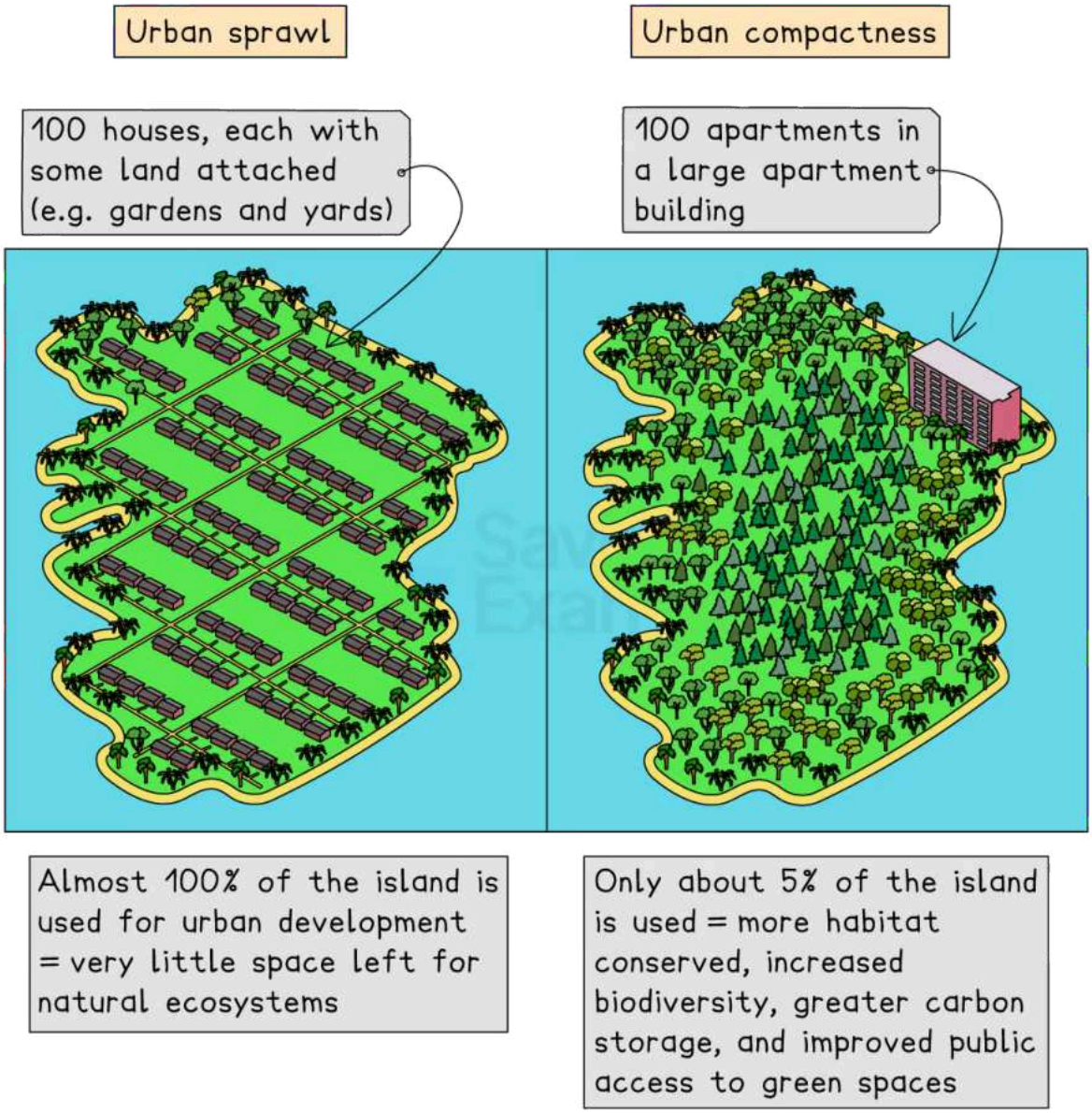

Urban compactness has numerous benefits for nature and urban residents


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- **Less car dependency**:
  - Compact urban areas enable people to use public transport, walk, or cycle instead of driving
    - This reduces greenhouse gas emissions and air pollution caused by vehicles
    - E.g. in Copenhagen (Denmark) over 60% of residents commute by bike, reducing traffic and emissions
- **Reduced energy consumption**:
  - Dense housing requires less energy for **heating** and **cooling** due to shared walls and smaller surface areas
  - **Walkable cities** lower the energy needed for transport
- **Improved public transport**:
  - High population density makes public transport systems **efficient** and **widely used**
  - **Reduces congestion**
  - Provides affordable travel options for all income levels
    - E.g. Curitiba (Brazil) has implemented a Bus Rapid Transit (BRT) system that efficiently serves a large population
- **Increased accessibility**:
  - Residents can easily access schools, healthcare, jobs, and recreational areas
  - Improves access for vulnerable populations e.g. the **elderly** and **disabled**
- **Social equality and environmental justice**:
  - Ecological urban planning ensures **all communities** have **access to green spaces**
  - This **prevents environmental injustices**
    - E.g. locating industrial zones or waste disposal sites near lower-income communities
    - This can often result in lower-income groups being **excluded** from green spaces
  - Improves **mental** and **physical health** by integrating parks and recreation areas into urban environments

Examiner Tips and Tricks

Make sure you are clear on what the key principles of compactness, mixed land use, and social mix mean. Ideally, ecological urban planning should support **environmental**, **social**, and **economic** sustainability, so make sure to consider all three of these factors and how they can link to each other.

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Urban Sustainability Models (HL)

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Urban Sustainability Models

Importance of urban sustainability

- Urban sustainability is essential for **addressing** the **challenges** created by:
  - **Rapid urbanisation**
  - **Resource depletion**
  - **Climate change**
- Sustainable cities aim to balance **environmental** health, **economic** resilience, and **social** well-being
- Frameworks such as the **circular economy model** and **doughnut economics model** can provide **practical solutions** for creating sustainable urban systems
- These models focus on:
  - **Reducing waste** and **conserving resources**
  - Promoting **equity** and **accessibility** for all residents
  - Ensuring that cities operate **within planetary boundaries** (environmental limits)

Circular economy model

Key principles of the circular economy

- **Minimising waste**:
  - Products and materials are reused, recycled, or repurposed, reducing landfill waste and pollution
- **Efficient resource use**:
  - Encourages design innovations that allow products to last longer, be repaired easily, or repurposed
- **Closing the loop**:
  - Urban systems are designed to reduce dependency on new (imported) raw materials

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Circular Economy Model

Examples of the circular economy in urban development

- **Amsterdam, Netherlands**:
  - Developed a "circular neighbourhood" called **Buiksloterham**
  - It is a pilot project for circular living
    - Buildings are constructed with recycled materials
    - Residents and businesses share resources, such as transport and tools, to reduce waste
- **San Francisco, USA**:
  - Implements a comprehensive **zero-waste strategy**, diverting around 80% of waste from landfills and incinerators through:
    - Mandatory composting and recycling
    - Circular programmes where construction waste is repurposed for new buildings

Doughnut economics model

Key principles of doughnut economics


Your notes

- **Social foundation**:
  - Focuses on meeting basic human needs, such as:
    - Housing
    - Healthcare
    - Education
    - Employment
- **Planetary boundaries**:
  - Limits urban development to stay within safe ecological thresholds, such as:
    - Reducing carbon emissions
    - Conserving water
    - Protecting biodiversity
- **Integrated sustainability**:
  - Balances social and environmental goals, creating cities that are both liveable and sustainable

Examples of doughnut economics in urban development

- **Amsterdam, Netherlands**:
  - Adopted the doughnut model as a blueprint for urban sustainability in 2020
    - Focuses on reducing emissions and energy use while ensuring affordable housing and transport
    - Expanded **green roof programmes** to insulate buildings, absorb rainfall, and promote biodiversity
    - Supported **urban farming projects** to reduce dependency on imported food
- **Brussels, Belgium**:
  - Uses the doughnut model to guide city planning, particularly in green infrastructure and social equity
    - Reduces emissions through **electric public transport** and **bicycle-friendly infrastructure**
    - Targets social inequality by increasing access to **affordable housing** and **public services**

Examiner Tips and Tricks

These two models are sometimes referred to as **alternative economic models**. Find more detail about these models, including some of their **strengths** and **limitations**, here!

Your notes

Green Architecture (HL)

Your notes

Green Architecture

What is green architecture?

- Green architecture focuses on designing and constructing buildings that:
  - Reduce environmental harm
  - Conserve materials and energy
  - Support sustainability
- It aims to:
  - Minimise negative effects on air, water, and soil
  - Protect the environment through sustainable construction methods
    - E.g. using **renewable**, **bio-based**, or **recycled** materials to lower environmental impact

Key features of green architecture

Use of sustainable materials

- **Bio-based materials**:
  - E.g. bamboo, hempcrete, straw bales
  - These materials are **renewable**, **biodegradable**, and require **less energy to produce**
- **Recycled materials**:
  - Reuses materials like glass, steel, and concrete from demolished buildings
  - Reduces waste and energy used for production of new materials

Energy efficiency

- **Passive design features**:
  - Natural ventilation, daylighting, and thermal insulation reduce energy demand
- **Renewable energy integration**:
  - Solar panels, wind turbines, or geothermal systems provide clean energy for buildings

Water conservation

- **Rainwater harvesting**:
  - Collects and stores rainwater for use in **irrigation** or **plumbing**
- **Greywater recycling**:
  - Reuses wastewater from sinks and showers for **non-drinking purposes**
    - E.g. can provide water for flushing toilets


Your notes

Circular construction

- **Reuses** and **recycles** materials during **demolition** and **renovation** projects
- Designs buildings that can be **disassembled**
  - This means the components can be easily reused elsewhere if needed

Techniques in green architecture

Bale construction

- Uses compressed straw bales as building blocks
- Advantages:
  - **Effective insulation** properties
  - **Affordable** material
  - **Renewable** material

Bottle and plastic construction

- Uses recycled plastic bottles or other waste plastic materials to create building blocks
- Advantages:
  - **Reduces plastic waste** and **environmental pollution**
  - Very **durable**
  - Provides **affordable** housing solutions

3D printed houses

- Uses 3D printing to construct homes from sustainable materials like bioplastics and recycled concrete
- Advantages:
  - **Reduces construction waste** and **labour costs**

- Highly **customisable**
- **Quick** construction process

Walls of a house being 3D printed (Shutterstock)

Arabic wind tower houses

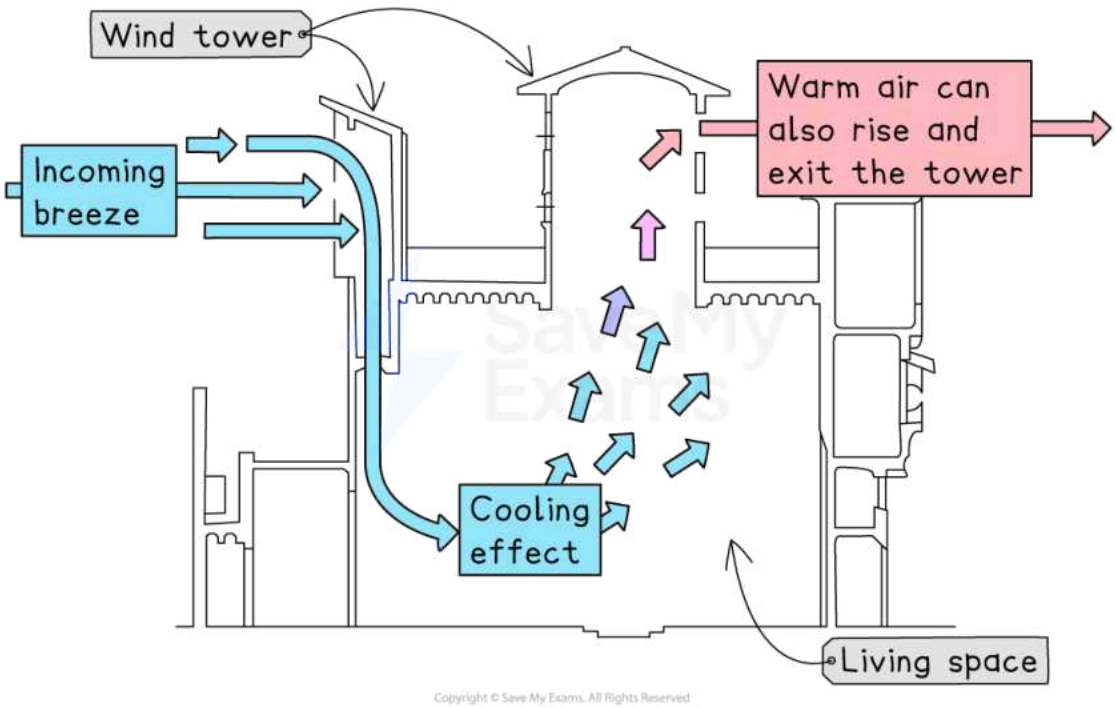
- Traditional Middle Eastern design using wind towers (known as barajeel) for cooling
  - They capture cool breezes and direct them into buildings
  - They are widely found in historic homes in the UAE, Oman, and Iran
- Advantages:
  - **Reduces need for air conditioning** in hot climates
  - Harnesses local climatic conditions for **energy efficiency** (lowers household energy consumption)

Your notes

Traditional wind tower (Shutterstock)

Your notes

Your notes



A traditional wind tower (barajeel) directs cool wind into the building, lowering the temperature of the interior

What is vernacular architecture?

- Green architecture and civil engineering often combines new and indigenous knowledge systems, and uses **vernacular architecture**
  - Vernacular architecture refers to buildings designed using **local materials**, resources, and **traditional knowledge** specific to a **region** or **community**
  - It reflects the cultural, environmental, and historical context of an area
  - Typically developed over generations, it **adapts to the local climate** and **needs** of the people
- Vernacular architecture is a **sustainable approach** to construction that prioritises **harmony with the local environment**

Characteristics of vernacular architecture

- **Use of local materials**:
  - Examples include **adobe** (clay and straw) in arid regions or **timber** in forested areas
- **Climate-responsive design**:

- Structures are built to suit local weather conditions
- E.g. thick walls for insulation in hot climates or sloped roofs for shedding snow in cold regions

- **Energy efficiency**:
  - Designs minimise reliance on external energy sources by utilising passive heating, cooling, and ventilation


Your notes

Examples of vernacular architecture

1. **Igloos (Arctic regions)**:
   - Made of ice blocks to insulate against extreme cold
2. **Thatched roof huts (tropical regions)**:
   - Provide natural cooling and water resistance using local grasses
3. **Barajeel (wind towers in the Middle East)**:
   - Capture and direct wind for natural ventilation in hot climates