DP IB Geography: SL

Your notes

Urban Environmental & Social Stresses

Contents

Urban Microclimates

Your notes

Urban Microclimate Modification

- Cities create their own **microclimate domes**
- This means that they have unique:
  - Temperature ranges
  - Wind patterns
  - Clouds and precipitation rates
  - Pollution
- Urban microclimates vary according to urban areas' size, shape and location
- There are several causes, some of which include:
  - Changes to **land surfaces:** concrete, brick and tarmac
  - Cities have **fewer trees** than surrounding rural areas
    - Trees shade the ground, preventing heat from the sun from being absorbed
  - **Dark** rooftops and dark pavement absorb more solar radiation
  - **Tall** buildings reflect and absorb sunlight
  - **Cars** engines and factory exhaust produce heat
  - **Fewer plants** in urban settings mean that less evapo-transpiration occurs (a process that cools the air)
  - **Poor** building **insulation** means the release of heat at night
- Within these microclimate domes, there are two levels:
  - **Urban canopy** - processes act in the spaces between buildings below roof level
  - **Urban boundary** - processes acting above roof level and extends downwind as a plume into the surrounding rural areas
- Patterns of precipitation and air quality are extended to immediate areas via the prevailing winds

A diagram of the microclimate dome

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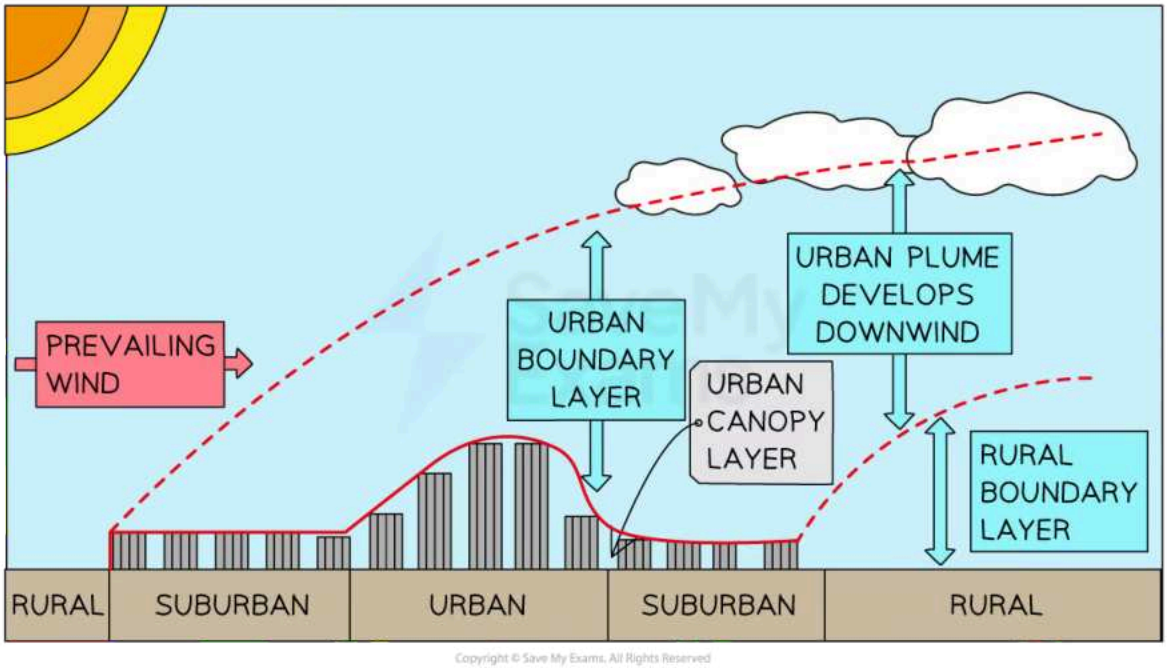

A microclimate dome

- Urban climates have the following **characteristics**:
  - Lower relative humidity
  - 2–3 weeks fewer frosts
    - Greater diurnal temperature range: higher max and min temperatures as compared to rural areas
  - Pollution levels are higher
    - Fog and photochemical smog are likely
  - 5–10% more cloud
    - 5–15% more precipitation
    - Increased thunderstorms
  - Lower wind speeds, with the exception of the tunnelling effect
    - Varying pressure gradients

Urban Heat Island Effect

- The air in urban areas can be 2 - 5°C warmer than nearby rural areas

- This is known as the **urban heat island (UHI)** effect
- The UHI is most noticeable when there is little wind
- The highest temperatures are found in densely built-up areas and industrial areas, where activities generate more heat
- **Temperature sinks** (where temperatures fall) are found above green spaces and water - e.g. parks and lakes
- **Temperature plateaus** (where temperatures remain the same) occur in areas with the same land use - e.g. industrial areas
- **Temperature cliffs** (where temperatures increase) occur when temperatures change rapidly from one land use to another - e.g. suburban housing to high-rise inner city buildings

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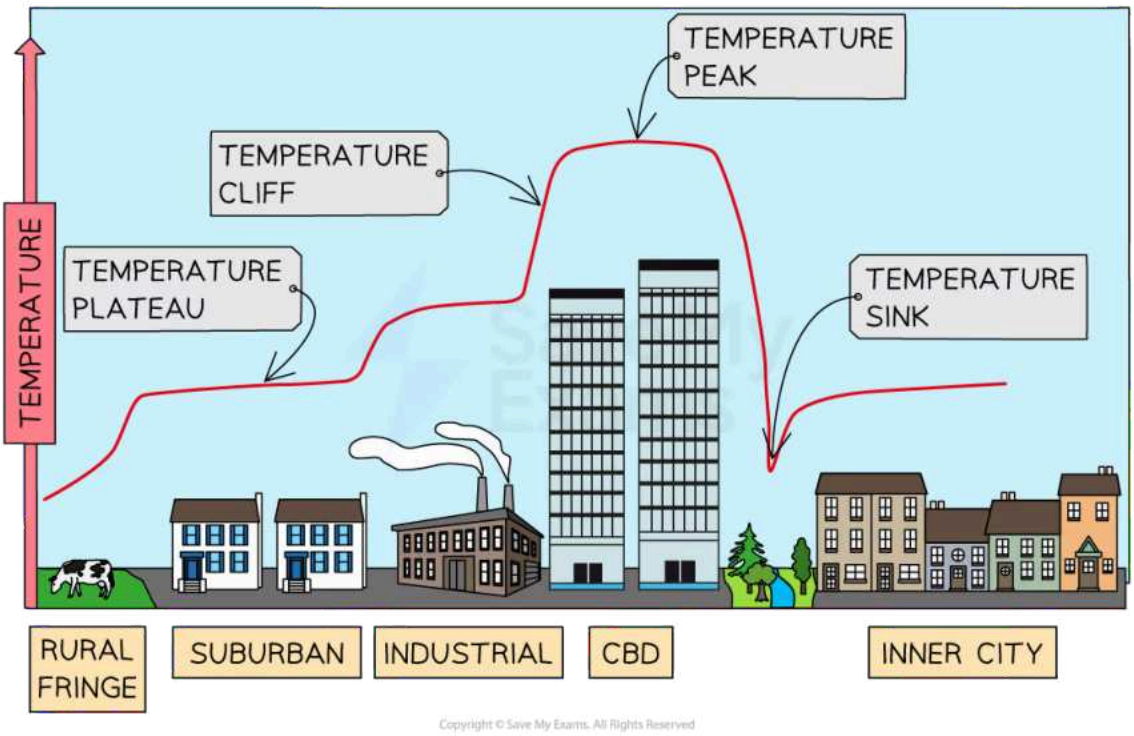
Illustration of the urban heat island effect



Urban heat island effect

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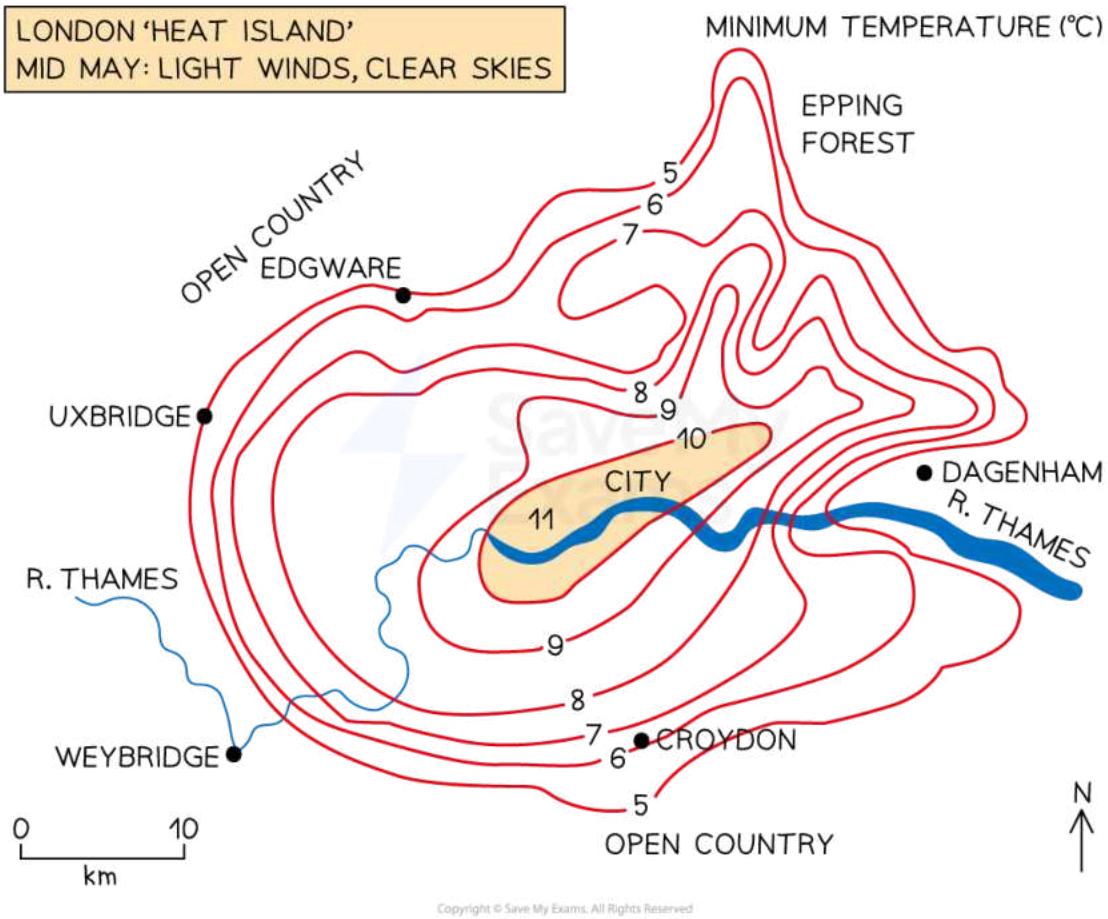

London's urban heat island – note how the isotherms curve around open areas such as Epping Forest, indicating large areas of reduced temperature. Central London shows a greater concentration of heat due to high density land use

Causes of the urban heat island effect

- The main causes of the UHI effect are:
  - **Air pollution:** pollution from cars, industry, etc. increases cloud cover and produces a pollution dome. Both of these trap outgoing heat and reflect it to the surface
  - **Heat from human activities:** air conditioning units, heating homes and offices, etc.—all release heat into the surrounding area
  - **Absorption of heat by urban surfaces**: urban surfaces have a low **albedo**. Tall buildings reflect and absorb sunlight

- **Less evapotranspiration:** removal of green spaces and trees reduces the cooling effect of evapotranspiration


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Diurnal and seasonal temperatures

- There is a larger range between daytime and night-time temperatures (**diurnal** range), compared to rural differences
- In urban areas, daytime temperatures are approximately 0.6°C warmer and night-time temperatures can be up to 4°C warmer
- Rural areas do not store as much energy and release heat quicker than urban areas
- Average urban summertime temperatures can be as much as 5°C warmer in mid-latitude cities, with average winter temperatures of 2°C warmer
- Temperatures can increase during periods of anticyclonic weather (high pressures)
  - These produce clear skies and low winds
  - Which allow greater **insolation** to reach urban surfaces
  - The low winds prevent warm air from being dispersed

Urban Microclimate Management

Strategies to reduce the urban heat island (UHI) effect

- Strategies are aimed at reducing the causes of the UHI effect, which are:
  - Air pollution
  - Heat from human activities
  - Absorption of heat
  - Removal of green spaces

Reduction of air pollution

- Reducing emissions by introducing clean air zones and congestion charges

Modifications to buildings and planning

- Changes to building design, such as using reflective materials, can reduce the absorption of heat
- Adding gardens to rooftops increases the amount of vegetation as well as decreasing heat absorption
- Making buildings more energy efficient to reduce the loss of heat

Increasing green spaces

- Parks, gardens and vegetation increase evapotranspiration, which has a cooling effect
- The increased vegetation cover also improves air quality

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Air Pollution Patterns & Management

Air pollution patterns

- The amount of **particulates** in urban areas is greater than in rural regions
- Sources include:
  - Vehicle exhausts
  - Burning wood, coal, cigarettes, rubbish, etc. releases fine and coarse particulates
  - Construction, mining and quarrying
  - Plants and moulds generate coarse particulates such as pollen and mould spores
- Poor urban air quality has several effects, including:
  - Respiratory problems such as asthma
  - Increasing haze through increased emissions of sulphur dioxides and nitrous oxides
  - An increase in carbon dioxide, adding to the enhanced greenhouse effect and global warming
  - Increased particulates in the atmosphere attack building **facades**
  - **Photochemical oxidants** cause eye irritations and headaches

Smog

- Smog happens when smoke particulates, **sulphur oxides**, **hydrocarbons**, etc. mix with fog
  - The London smogs of the 1940s were caused by the sinking of cold air trapping air, pollutants in a pollution dome
  - Today smog is more likely due to **photochemical** reasons:
    - Sunlight reacts with the chemical pollutants in the atmosphere
    - UV light causes them to break down into secondary, harmful chemicals to form photochemical fog
  - Photochemical fog is a major problem in large cities like Los Angeles, Mexico City, Beijing, etc.

- Smog is more common in warm, sunnier cities, as these places tend to suffer from **temperature inversion** fog (a layer of warm air is trapped below dense, cooler air)
  - This keeps the pollutants at the surface level


Your notes

Air pollution management

- Rapidly developing countries have some of the highest rates of air pollution and reducing urban air pollution globally, is a challenge
- Strategies include:
  - **Technical innovations**
  - **Vehicle restrictions**
  - **Government legislation**

Technical innovations

- **Filters**
  - Fitted to industrial gas and particulate exhausts, filters carbon out of the gases released during industrial processes
  - **Catalytic converters** fitted to vehicle exhausts remove harmful pollutants before being released
- **Photo-catalytic materials (smog-eating material)**
  - Façades are retrofitted to the front of old buildings or new buildings are constructed with **photocatalytic concrete**
  - Special tiles are coated with **titanium dioxide**, which is a pigment that acts as a **catalyst** and is also used in sunscreen
    - When UV rays hit the tiles, a reaction occurs, converting mono-nitrogen oxides (smog-producing substances) into less harmful calcium nitrate and water
- **Self-cleaning concrete (Tiocem)**
  - This is **photocatalytic concrete** that has titanium dioxide mixed in
  - When sunlight strikes a building, nitric and nitrogen oxides will be able to break down
- **Greening the urban area**
  - Improve air quality by planting trees and vegetation
  - Vertical gardens: around concrete columns and on the sides of buildings
  - Roof gardens

- Urban agriculture using open and derelict spaces
- **Air purification towers**
  - Dutch designed "Smog Free Tower", which is an air purifying tower that sucks in pollution and expels clean air
  - The first tower was installed in Rotterdam and cleans 3.5 million cubic metres of air per day
- **Self-driving cars**
  - Studies have estimated that self-driving vehicles could improve fuel efficiency by 15-40%, which would reduce local emissions of pollutants as well as global greenhouse gases
- **Hydrogen fuel additives**
  - Additives improve fuel combustion and reduce emissions in existing vehicles
  - UK-developed **'ezero1' technology**, feeds small amounts of hydrogen into the vehicle's air intake, creating a more efficient burn
- **Alternative fuels**
  - **Electric vehicles**
  - **LPG**
    - Dual fuel or bi-fuel vehicles that can switch between LPG and petrol
  - **Synthetic "gas to liquid" (GTL)**
    - Reduced nitrogen oxide (NOx) emissions of 5-37% and particulate matter (PM) emissions of 10-38%.
  - Natural gas can also be converted into **dimethyl ether (DME)** as another alternative to diesel
    - Reduces NOx emissions by around 25%, and PM emissions are virtually eliminated

Vehicle restrictions

- **Congestion charge**
  - Charges for using vehicles in certain places at certain times (e.g. London's congestion charge)
  - This reduces pollution through a reduction in road traffic (London's emissions dropped 15% in its first year)
  - However, it can increase fringe/outer zone traffic and emissions as people try and avoid the charge by using alternative routes
- **Selective bans**
  - Certain days and times are designated as no travel times for vehicles


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- **Pedestrianisation**
  - Vehicles are restricted from entering certain places at certain times
  - This reduces emissions by reducing road traffic
- **Park and ride**
  - Local authorities provide buses at the urban periphery, and they charge a flat rate for all-day parking and transportation from the parking area to the urban centre
- **Improvements to public transport**
  - Improved bus services make accessing areas cheaper, faster and more efficient
  - Trams and light railway services run on lines that avoid congestion
- **Car sharing/pooling**
  - Many urban centres have designated lanes for cars with two or more people in them
  - This keeps the flow of traffic moving and reduces journey times and emissions


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Government legislation

- Legislation can be local or global
- However, according to the UN,

> One in three countries in the world lack any legally mandated standards for outdoor air quality - UNEP 2021

- Laws aim to reduce pollution by limiting emissions from industry, private and public facilities and vehicles
- **Industries** are are regulated under **Integrated Pollution Prevention and Control (IPPC),** set up under the Pollution Prevention and Control Act of 1999
  - Factories are not allowed to emit 'dark' smoke under the Clean Air Act of 1993, except in unavoidable circumstances (e.g. starting up)
  - The amount of dirt and dust emitted is also strictly monitored/controlled
  - Chimneys must have up-to date modern filters/scrubbers fitted
- The Air Quality Standards Regulations of 2010 in the UK regulate significant air pollutants

- Laws set air quality standards such as:
  - **UK Clean Air Acts** of 1956 and 1968 reduced domestic pollution through the introduction of smoke free zones
  - Industrial pollution was reduced by introducing tall chimneys, thereby dispersing pollutants higher into the atmosphere
  - The introduction of the MOT emissions test by the Road Vehicles Regulations means all vehicles have to pass an emissions test to be allowed on UK roads
  - In Scotland, roadside emissions tests are carried out and fines issued if the vehicle fails
  - Local authorities in the UK can issue fines to people leaving their engines running unnecessarily


Your notes

Case Study: New Delhi

- In 2023, New Delhi was identified as the most polluted capital city in the world
- During 2022, schools and colleges were closed for several days at a time due to the levels of pollution
- In November 2023, the air pollution level was 100 times the World Health Organisation's healthy limit

Causes of pollution in New Delhi

- Over 19% of the pollution is the result of the over 3,000 industries in the area
- New Delhi is inland so there is often little wind to move the pollution away
- The areas around New Delhi are agricultural and crop burning in winter adds to the pollution levels
  - The use of diesel-powered irrigation pumps also contributes to emissions from agriculture
- There are 11 coal-fired power stations in the area surrounding New Delhi
  - In 2023, all but one of the power stations exceeded the allowed emission levels
- Many residents still use wood and biofuel for heating and cooking
- Between 1988 and 2020, the number of cars in New Delhi increased by 3.1 million
- Burning of waste and landfill fires
  - In April 2022, the Bhalswa landfill site caught fire and burned for twenty days
- Methane emissions from the landfill sites
  - Since 2020, there have been 37 major methane leaks from the Ghazipur landfill site

Impacts of pollution in New Delhi

- A study by Greenpeace and IQAir estimated that 54,000 **premature deaths** in New Delhi were caused by air polllution
- Doctors during times of high pollution report increased numbers of patients with:
  - Breathing problems
  - Irritated eyes and throats
  - Asthma
  - Lung cancer
- The University of Chicago energy policy institute estimates that life expectancy in New Delhi is reduced by 11.9 years due to air pollution
- Schools and colleges are frequently closed during winter due to air pollution levels
- It is estimated that 50% of children in New Delhi have irreversible lung damage


Your notes

Traffic Congestion

Your notes

Traffic Congestion Patterns & Trends

- Many urban areas grow faster than the local government can improve and extend the area's infrastructure
- This leads to challenges such as **traffic congestion**

What is traffic congestion?

- Traffic congestion is when:
  - **Traffic flow** is significantly reduced
  - There is a **reduction** in vehicle **speed**
  - The number of vehicles is increased
- The view of what constitutes traffic congestion varies from place to place
- Traffic congestion affects both **people** and the **environment**
- The extent of traffic congestion depends on several factors, including:
  - **Size of the urban area**
  - **Urban planning**
  - **Population density**
  - **Transport infrastructure**
  - **Population density**
- These factors affect the amount of traffic and its flow through the urban area

Patterns of traffic congestion

Peak hour congestion

- Cities all experience peak-hour congestion
- This is increased traffic during morning and evening **rush hours**
- It occurs when most people are travelling to and from work

Events

- Urban areas often experience traffic surges when there are events such as concerts or sporting competitions
- The amount of traffic is unpredictable and can cause significant congestion

Seasonal variation

- The patterns of traffic change during public holidays, school holidays or seasonal events
- This can lead to both increases and decreases in traffic

Bottlenecks

- These are locations in urban areas where congestion regularly occurs, such as at particular junctions in the traffic infrastructure

Trends of traffic congestion

Urban expansion

- As cities expand, they will experience all of the following, which will increase the amount of traffic on the roads:
  - Growth of industries and businesses
  - Population increase
  - Increased size of the urban area

Increased wealth

- Increased wealth means that more people can afford cars
- Fewer people are using public transport

Traffic Congestion Impacts

- There are several impacts of traffic congestion including:
  - Increased pollution
  - Longer journey times
  - Unpredictable journey times
  - Slower speeds
  - Increased stopping and starting

Increased pollution


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- More traffic and starting and stopping leads to **higher emissions** in urban areas
- Congestion in London is estimated to increase emissions by 15%, in Berlin it is estimated to be an 11% increase in emissions
  - Imperial College London's research estimates that pollution caused the **premature deaths** of 4000 London residents in 2019
- In Delhi, India, 67% of pollution is from traffic and it is estimated to lead to 5000 premature deaths a year


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Longer and more unpredictable journey times

- The slower traffic impacts the economy
  - In London it is estimated that traffic congestion costs the economy £5.1bn a year
- Research shows that in 2021, the average driver in London spent 148 hours sitting in traffic

Case Study: Rio de Janeiro

- Rio de Janeiro has a population of 6.7 million (2020)
- The population of the greater metropolitan area is estimated at 13.5 million
- The **mountainous landscape** surrounding the city increases the issues with traffic because:
  - A large volume of traffic is forced into only a few roads
- Air pollution causes approximately 5000 premature deaths a year

Causes of traffic congestion in Rio de Janeiro

- **Car ownership** in Brazil has increased by over 25% between 2012 and 2022
- The average journey during rush hour takes 50% longer than at other times
- Buses are the main form of transport but there are a number of issues with the bus system, including:
  - There are too few buses for the number of passengers
  - Safety fears, particularly at night
  - Lack of air conditioning
- **Bottlenecks,** such as the ones at either end of the Rio Niteroi Bridge, are common
  - The bridge is 14km long and saves an 80km journey
  - Cars often breakdown on the bridge, leading to longer journey times

Traffic management in Rio de Janeiro


Your notes

- There have been several attempts to manage traffic congestion in Rio de Janeiro including:
  - Yellow Line Expressway
  - Rio Niteroi Bridge
  - Metro Rio
  - Trams
  - Bike Rio
- All the management schemes aim to reduce the amount of traffic on the roads
- The schemes include both public and private strategies

Yellow Line Expressway

- The expressway connects Barra da Tijuca to the North Zone and the international airport
- The cost of the road building was so high that it is now a **toll road**
- Every day, 70 000 vehicles use it
  - This is 13 000 more than it was built for, which has led to congestion
- It has reduced traffic on local roads by 40%

Rio Niteroi Bridge

- The bridge was built to replace a one-hour ferry crossing or an 80 km road journey
- Although effective in reducing journey time, it experiences bottlenecks and congestion due to its popularity

Metro Rio

- Three subway lines cross Rio de Janeiro
- There are 41 subway stations
- The metro carries over 1 million passengers a day

Trams

- A tram system connecting the port to the city centre and the airport
- There are no emissions
- There are 300 000 users per day

- The trams decrease journey times

Bike Rio

- Bike Rio began in 2011
- It is a bicycle-sharing scheme
  - There are 600 bicycles available at 60 rental stations across Rio de Janeiro
  - The cycle lanes cross 450 km
  - Solar panels power the bike stations

Your notes

Land Use Changes

Your notes

Contested Land Use Changes – Slum Clearance

- **Contested land use** refers to areas of land where many **stakeholders** have views about how the land should be used
- This may lead to conflict between different groups, as they want the land for different purposes
- The main issues around contested land use are:
  - The clearance of 'slums'
  - Urban redevelopment
  - Depletion of green space

'Slum' clearance

- The term 'slum' is used to describe:
  - Illegal settlements or inadequate housing in LICs
  - Older 19th-century housing in industrial areas in HICs
- The UN's definition of 'slum' is

> Where the inhabitants suffer one or more of the following:
>
> 1. Lack of access to improved water source
> 2. Lack of access to improved sanitation facilities
> 3. Lack of sufficient living area
> 4. Lack of housing durability (poor building materials)
> 5. Lack of security of tenure (there is no protection against forced eviction)

- Clearance of these areas can be controversial

Illegal settlements in LICs

- The settlements are built **illegally** often on **wasteland** at the edge of cities in LICs

- Local authorities or local government may order them to be cleared:
  - For **new infrastructure developments**, such as roads or train lines
  - To improve the area
- This issue is contested because local governments or businesses typically decide whether to clear these areas
- These organisations have more power than the people living in the settlements
- 'Slum' clearance often involves forced evictions
- Any new housing is often too expensive for the original residents to afford


Your notes

Dharavi, Mumbai

- Over 1.2 million people live in the illegal settlement of Dharavi, which covers an area of 1 square mile
- It has developed on low-lying land which used to be a waste tip and mangrove swamp
- Conditions in the informal settlement are often poor:
  - Many houses are made from scrap materials
  - Only 24% of people have access to clean water
  - The level of toxic waste is three times the recommendation
  - Over 4000 cases of disease a day are reported
- There is a strong community spirit
- Many people are employed in the informal sector and the annual business turnover is over $650 million a year
  - The settlement has over 5000 businesses and 15 000 single-room factories
- The settlement is located next to Mumbai's financial district, which means the land is valuable

Contested land use in Dharavi

- **Vision Mumbai** in 2004 aimed to:
  - Replace inadequate housing with high-rise tower blocks
  - Improve water, sanitation and healthcare
  - Improve transport
  - Increase businesses
- By 2007, 45 000 homes were demolished and 200 000 people were moved

- The new apartment buildings were not popular
  - They split communities apart
  - People had to pay rent
  - The apartments were very small
  - Many people were made homeless because they could not prove they were Dharavi residents


Your notes

Contested Land Use Changes – Urban Redevelopment

- As well as slum clearance, urban land use change may also include:
  - Gentrification
  - Urban redevelopment
- Both gentrification and redevelopment are controversial because they may not provide affordable homes for local people

Gentrification

- Development of a city neighbourhood from low to high-value
- A poor area experiences an influx of educated or wealthy individuals who gradually renovate and push up property values
- This often forces out poorer families as the area becomes too expensive to live in
  - Portland Road in Notting Hill, was one of London's most run-down and deprived areas; now houses sell for £2 million
- Ultimately, the character and demographic make-up of the neighbourhood are changed completely through new services and functions of the area

Urban redevelopment

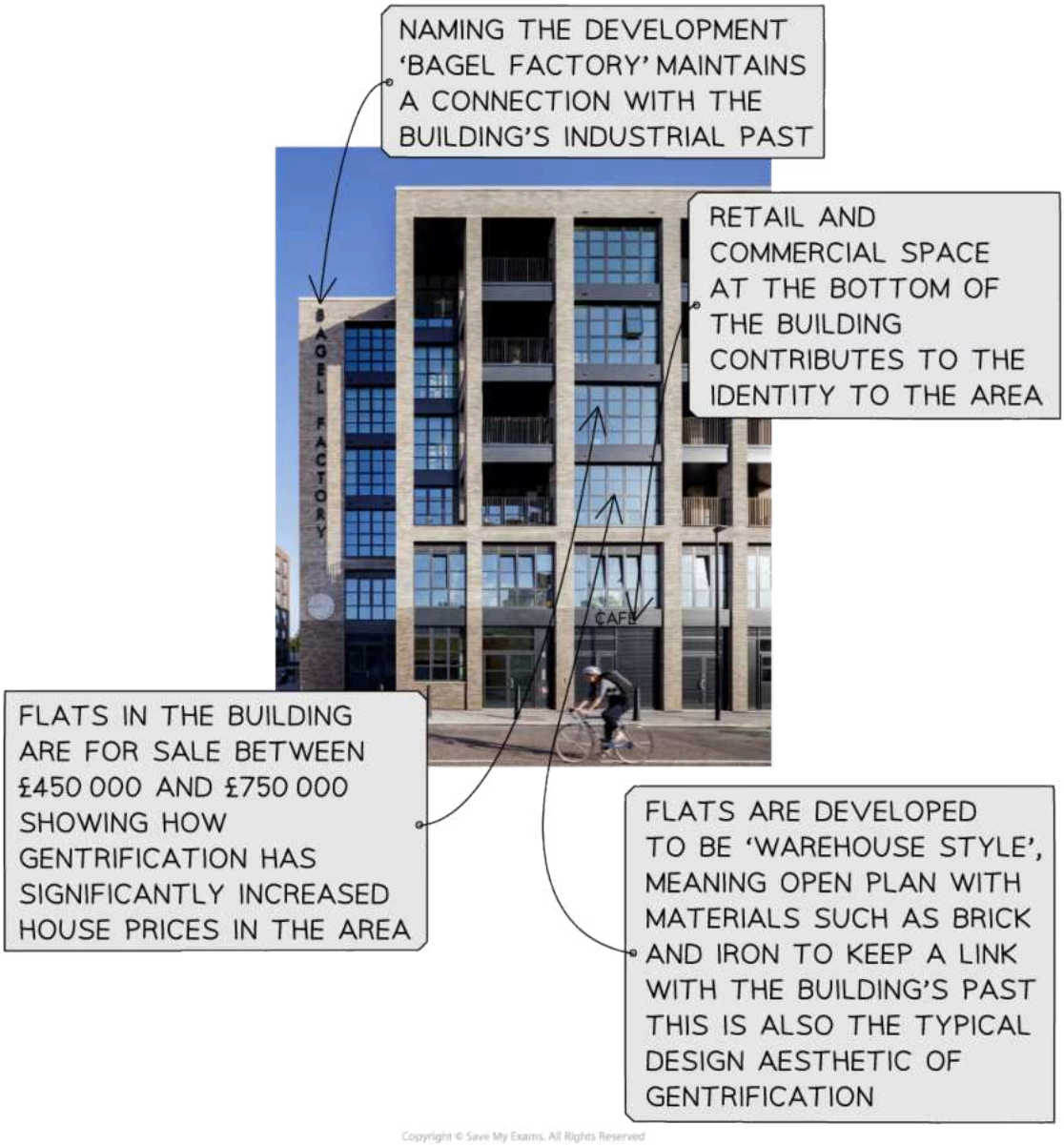
- Urban **redevelopment** attempts to reverse inner city decline by improving an urban area through:
  - Demolition of buildings
  - Reconstruction
  - Renovating existing buildings and infrastructure

Redevelopment in Hackney Wick, East London

- The renovation of buildings such as the Bagel Factory in gentrified Hackney Wick, east London

- The building is full of residential apartments now but in the early twentieth century, it was the site of a bagel factory.

Your notes



Contested Land Use Change – Depletion of Green Spaces

- As urban areas grow, the green spaces within them are at increased risk of development

- The value of the land for economic use outweighs the value for social use, such as parks
- Green spaces are at risk of development into illegal settlements in areas where there are high levels of rural-urban migration
- The loss of green spaces leads to a reduction in:
  - Air quality
  - Biodiversity and habitats
  - Areas for physical activity and community events
  - The urban heat island effect
- In the UK, 9.6 million people live in areas which lack green spaces


Your notes

Auckland, New Zealand

- In 2011, green space made up 47% of the urban area
  - Approximately, 50% of this was residential gardens and 33% were public parks
- Green space per person in Auckland decreased by 30% between 1980 and 2016
- The causes of the decrease include:
  - Infill development, where open spaces between buildings are built on
    - This includes building on gardens
  - Higher-density buildings in new developments
    - In new developments, the average amount of green space has decreased from 55% (pre-2016) to 28% (post 2016)
- It is estimated that the loss of green space will:
  - Increase average temperatures; every 10% decrease in green space could increase temperatures by 0.3°C
  - Increase surface runoff; a 10% increase in impermeable surfaces could increase runoff by 18%

Urban Social Deprivation


Your notes

Social Deprivation

- There is significant **inequality** in urban areas both in HICs and LICs
- In many areas groups and areas are experiencing **social deprivation**
- **Social deprivation** can be defined as people or communities lacking access to the resources they need to have a reasonable quality of life
- In the UK social deprivation is measured on the **index of multiple deprivation** which measures deprivation using measures of:
  - Income
  - Employment
  - Education
  - Health
  - Crime
  - Housing and services
  - Environment

Cycle of deprivation

- The cycle of deprivation occurs when poverty is passed from one generation to the next
- The limited resources of one generation mean that the next generation's opportunities are limited
  - Parents can't afford or access educational resources, which disadvantages their children
- The educational disadvantages mean that educational attainment is lower and this affects job prospects
- Lower standards of living and low incomes affect health and well-being

Barcelona

- Barcelona has a population of over 5.7 million people
- The highest levels of deprivation in Barcelona are located in:
  - **El Raval** which is an inner city area with old, substandard housing

- **Can Peguera** is situated at the city edge
    - It is one of a number of estates of social housing built in the 1960s
- Deindustrialisation in the 1970s and 1980s led to unemployment in Barcelona reaching 20%
    - Leading many areas to become rundown and derelict
- The areas of deprivation have a number of features in common, including:
    - Low and very low incomes
    - Higher than average unemployment
    - Higher than average numbers of single-parent families
    - Lower levels of educational attainment
    - Higher incidence of crime and anti-social behaviour


Your notes

Geographic Patterns of Crime

- Crime rates are higher in urban and industrial areas
- Much crime is concentrated in areas of **high population densities**
    - The exceptions to this are crimes such as fraud and sexual offences, which are more common in areas of low population density
    - The wealthier areas see car theft, kidnapping, and property damage
- Within urban areas, crime rates tend to be higher in areas of **social deprivation**
    - Crime is partly due to a lack of job opportunities and large-scale unemployment
    - Gangs and intimidation are more likely to rule in areas of social deprivation
    - Rates of vandalism, burglary and vehicle crimes are higher in more deprived areas
- **Crime hotspots** are areas where crime rates are particularly high
- These areas often have similar characteristics, including:
    - Easy access and lack of security
    - Higher numbers of offenders
    - High levels of residential buildings
    - A lack of services
    - A lack of a police station

Managing urban crime


Your notes

- There are several ways to reduce urban crime, including:
  - Increased police presence
  - Use of CCTV
  - Improved street lights
  - Women only taxis
  - Greater number of taxi services around closing time of clubs and bars
  - Zero tolerance of crime