

Geography Notes

Units 3 and 4

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GEOGRAPHICAL SKILLS & TERMINOLOGY

GLOSSARY: UNIT THREE

Abiotic: The non-living components of an ecosystem, such as temperature and light

Abundance: In a very large quantity

Adaption: Coping with the changes that are already happening or that are unavoidable in the future

Incremental: Gradual Process of Adjustment

Transformational: Major Change to the way people work/live their lives

Albedo: A measure of how much sunlight a surface reflects

Atmosphere: In the vast gaseous envelope of air that surrounds the earth. Its boundaries are not easily defined.

Attributes: Are characteristics of the elements that may be perceived and measured. For example; quantity, size, colour, volume, temperature and mass

Biodiversity: The type, number and variety of living organisms within a given environment

Biomagnification: Increasing concentration of a substance in the tissues of organisms at successively higher levels in a food chain

Biomass: Total amount of organic material

Biome: A community of life forms adapted to a large natural area

Biosphere: Part of the Earth where life is found

Biotic: Any living organism in an ecosystem that affects another organism, including animals that consume an organism

Boundary: Outer edge of system. Zone between one system and another system.

Dynamic Equilibrium: A system is said to be in dynamic equilibrium when the inputs and outputs are balanced

Ecosystem: A community of plants and animals and their physical environment interacting together

Ecosystem Structure: The abiotic and biotic features of an ecosystem, their interactions and a source of energy

Elements: Are the kinds of parts (things or substances) that make up a system. These parts may be atoms of molecules, or large bodies of matter like sand grains, rain drops, plants, animals, etc.

Endemic: A plant or animal that is native or restricted to a certain country or area

Flow/Transfer: Links between components in the system

Food Chain: The simplest representation of energy flow within an ecosystem, following a direct linear pathway of one animal at a time. They start from the producer organisms and end at the apex predators.

Food Web: The natural interconnection of food chains generating a graphical representation of what eats what in an ecological community

Hydrosphere (including Cryosphere): Describes the waters of the Earth

Input: Addition of matter, energy, or information to a system

Lithosphere: The solid inorganic portion of the Earth (composed of rocks, minerals and elements). It can be regarded as the outer surface and interior of the solid Earth.

Mitigation: Reducing the amount of climate change that occurs

Negative Feedback Loop: Where the effects of an action are nullified by its subsequent knock-on effects

Output: Movement of matter, energy or information out of a system

Positive Feedback Loops: Where the effects of an action are amplified or multiplied by subsequent knock-on effects

Relationships: Are the associations that occur between elements and attributes. These associations are based on cause and effect

Rehabilitation: The return of land in a given area to some degree of its former state (usually after processes of industry/mining)

Restoration: Ecological restoration of a site – a focus on improving degraded landscapes

Store/Component: Individual elements or parts of the systems.

System: A set of **natural** phenomena working/functioning together as part of the Earth's natural global system (e.g. Hydrological Cycle, Heat Budget)

Closed System: Is a system that transfers energy, but not matter, across its boundaries to the surrounding environment. Our planet is viewed as a closed system.

Isolated Systems: There is no inputs or outputs of energy or matter. The universe may be the only example of this.

Open System: Is a system that transfers both matter and energy across its boundaries to the surrounding environment. Most ecosystems are an example of an open system.

Trophic Level: The position an organism occupies in a food chain. Primary producers occupy the first trophic level, first degree consumers on the second level.

GLOSSARY: UNIT FOUR

Agglomeration: A group of similar, but not necessarily the same land uses that locate in the same area in order to benefit from a common infrastructure and each other's operations

Aggregation: A group of similar and related land uses that locate in the same area in order to achieve an economic benefit

Demographics: Statistical data about the characteristics of a population, such as the age, gender and income of the people within the population

Dynamic Zone: A zone that is currently undergoing changes

External Morphology: The study of the outside shape of a settlement, and the processes that affect that shape

Functional Zone: When similar functions and land uses are grouped together into a number of different zones

Gentrification: A trend in urban neighbourhoods, involving the process by which wealthier (mostly middle-income) people move into, renovate, and restore housing. This results in increased property values and the displacement of lower-income families and small businesses

Horizontal Zonation: The linear arrangement of functions

Infrastructure: The basic physical and organisational structures and facilities (e.g. buildings, roads) needed for the operation of a society

Internal Morphology: The study of the layout of functions within a settlement, and the processes and interactions that affect that layout

Invasion & Succession: A concept borrowed from biology and applied to urban areas. In zones of transitions (i.e. IMZ or RUF), land uses from neighbouring zones invade due to push and pull factors such as availability and prices of land. When the invading land use becomes dominant then succession has occurred

Land/Space Extensive: Where a certain area reaches out certain distances

Project Home: A publicly supported and administered housing development planned usually for low-income families

Segregation: The location of particular groups of people into distinct areas separate from the general population, usually based on race, religion or economic circumstances

Transitional Zone: A zone that is a transition between two other zones

Urban Sprawl: The expansion of human populations away from central urban areas into low density, mono-functional and usually car-dependent communities. In addition to describing a particular form of urbanisation, the term also relates to the social and environmental consequences associated with this development.

Vertical Zonation: The high-rise arrangement of functions by levels

MAPPING SKILLS

Site: The physical characteristics of the land on which a feature is located and influences a place's external morphology. When planning settlements, the site features determine many of a settlement's characteristics including where residential and industry will be located. (i.e. altitude and slope, landforms (floodplain, coastal plain, valley location river plain), drainage (streams, confluence location, presence of swamps, inundation of area), vegetation (type and density), soils (type and location))

Situation: The location of a feature in relation to other significant features, both cultural and physical. (i.e. longitude/latitude, direction & distance from things nearby, its position along a road/railway))

Gradient: The steepness of a slope (expressed as a fraction or a ratio)

$$\text{Gradient} = \frac{\text{Rise}}{\text{Run}}$$

Rise is the vertical interval (difference in height). Run is the horizontal distance. Both must be put into metres.

If it is a fraction such as (57/950), you would then divide 950 by 57, and the gradient would become (1:16.67 ~ 1:17)

Scale: Larger scale = smaller map. Smaller scale = larger map.

Natural Feature: A feature that occurs naturally on Earth's surface (i.e. landforms, rivers, lakes and native vegetation)

Cultural Feature: Human made or modified features (i.e. buildings, bridges, roads, orchards and towns)

Contour Lines: These will be the same throughout the entire map.

Latitude and Longitude: Latitude is the angular distance north and south of the equator (always 'S' in Australia). Longitude is the angular distance east and west of the Prime Meridian (always 'E' in Australia). Latitude stated first, followed by longitude. If the map is in Australia, latitude is the smaller reading and longitude is the larger reading.

Area: Done through a series of steps:

1. Determine in which grid square(s) the feature is located.
2. Estimate the amount of each grid is occupied by the feature.

Speed/Distance/Time: Measure the distance between the two points. If you are finding time, divide the speed by the distance to find time. If you are finding speed, multiply the distance by time (in km/hr)

Slope: Uniform slope is when contour lines are evenly spaced. Concave slope is when contour lines are widely spaced at the bottom and more closely spaced towards the top. Convex slope is when lines are closely spaced near the bottom (base) and more widely spaced towards the top.

Sketch Map: Technique used by Geographers to identify significant features of a particular location (landscape). Sketch maps can be based on observations made during fieldwork or based on topographic maps or remote sensing images, such as ground level or aerial photographic

Constructing a Sketch Map:

1. Sketch maps need to be drawn free hand using a pencil. Colour can be added after all features are included and annotated. Depending on the question, features can be labelled and/or included in a legend.
 2. Determine the scale at which the sketch map is to be drawn.
 3. Use the grid squares on the topographic map to assist in locating features more accurately
 4. Draw in the most significant or identifiable features first. This could include a major transport link; drawing in roads could be useful as it helps define the edges of areas.
 5. Draw in the remaining features that the question stipulates.
 6. Include all mapping conventions – title, legend, north point and scale.
-

EXTENDED RESPONSES

DIRECTIONAL WORDS

Directional Word	Meaning
Account For	State reasons for a series of event or transactions
Assess	Make a judgement of value, quality, outcomes, results or size
Compare	Show how things are similar
Contrast	Show how things are different or opposite
Describe	Provide characteristics and features
Discuss	Identify issues and provide points for and/or against
Explain	Relate cause and effect; make the relationships between things evident; provide why and/or how
Outline	Sketch in general terms; indicate the main features of

UNIT THREE: GLOBAL ENVIRONMENTAL CHANGE

OVERVIEW OF NATURE, EXTENT, CAUSES AND CONSEQUENCES OF LAND COVER CHANGE

(Refer to agriculture, global forests and urban land cover using illustrative examples drawn from different regions and countries at different scales.)

SYLLABUS DOTPOINT 1

The Concepts of Environment, Natural and Anthropogenic Biomes, Land Cover Change, Ecosystem Structure and Dynamics, Biodiversity Loss, Climate Change and Sustainability

Environment: The living and non-living elements of the Earth's surface and atmosphere. It includes human changes to the Earth's surface and atmosphere, for example: croplands, planted forests and buildings.

Natural Biome: A community of life forms adapted to a large natural area.

Types of Natural Biomes:

- Tropical/Subtropical
- Polar/Montane
- Temperate
- Dry
- Aquatic

It is a formation of plants and animals that have common characteristics due to similar climates and can be found over a range of conditions.

Anthropogenic Biome: Biomes created due to sustaining direct human interactions with ecosystems, therefore changing natural ecosystems and environments.

Types of Anthropogenic Biomes:

- Dense Settlements
- Croplands
- Forested Land
- Villages
- Rangelands
- Wildlands

Anthropogenic biomes are a global ecosystem unit defined by global patterns of sustained direct human interaction with ecosystems, creating a description of the terrestrial biosphere in its contemporary, human-altered form. Known as anthromes or human biomes.

Land Cover Change: Can be defined as physical or biological cover such as water, vegetation, soil and artificial structures.

There are four spheres of the Earth:

- Lithosphere/Geosphere: the abiotic elements that make up the earther
 - i.e. minerals, soils, mountains
- Hydrosphere: the water bodies of the earth
 - i.e. seas, oceans, lakes and rivers
- Atmosphere: the envelope of gases that surround the earth
 - i.e. nitrogen (71%), oxygen (22%), carbon dioxide, argon, methane, etc.
- Biosphere: where all living things exist in their ecosystems
 - i.e. plants, animals, humans

The natural operation of the spheres is most affected by anthropogenic forces. Examples of these forces are: deforestation, urban land use, agriculture and CO₂ emissions.

Land cover is the natural, physical and biological elements of the earth, such as the Indian Ocean other the Simpson Desert. Land cover change is the changes taking place in natural environments due to a variety of natural and/or anthropogenic causes, such as urbanisation as it is a steadily growing demand for a shift in land use.

Biodiversity: The type, number and variety of living organisms within a given environment.

Biodiversity Loss: The destruction of said living organisms, due to many ecological and social factors, such as climate change and deforestation. It is a decrease in species, genetic and/or ecosystem diversity. The threats to biodiversity are so high that around one in four mammals are facing the threat of extinction.

Ecosystem: an interacting community of organisms and their physical environment interacting together. For instance, a marine ecosystem: The Great Barrier Reef (large-scale) or spider crab's shell (miniscule).

Components: Abiotic elements are the non-living components of an organism's environment.

Biotic Elements are the living components of an ecosystem. They affect other organisms.

	Biotic	Abiotic
Examples	Plants Animals Bacteria Fungi	Water Temperature Sunlight
Factors	Competition Disease Parasitism Fungi Human Influence	Limit and/or changes in the water, temperature or sunlight.

An example can be seen in the Arctic Tundra:

	Biotic	Abiotic
Examples	Snow Geese Salmon Lichens Caribou Hawks	Ise Sheets Arctic Char Streams Rivers Sunlight

	Wolves Polar Bears	Cold Climate
Factors	Freezing Predators A loss in water supply	Permafrost (where the ground has been below 0°C for at least 2 years)

Flow of Energy:

Producers: (Autotrophs) Typically plants or algae. They do not typically eat other organisms, but receive nutrients from soil, ocean, sun, etc. They use this to manufacture their own food via photosynthesis.

Consumers: (Heterotrophs) Species that cannot supply their own food, so they eat other autotrophs and heterotrophs (as omnivores, carnivores or herbivores).

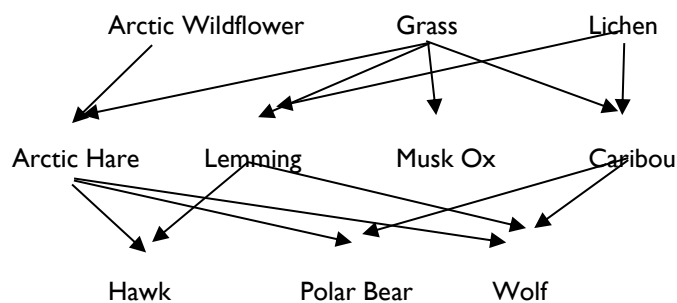
Decomposers: (Detritivores) Species that break down dead plant or animal matter/waste and release it again as energy and nutrients.

Food Chain/Web: A map that explains the pattern of flow of energy in an ecosystem. An example that can be used is the Arctic Tundra.

Food Chain:

Grass → Arctic Hare → Polar Bears

Food Web:



Ecosystem Structure and Dynamics: The network of interactions within the ecosystem community, these include nutrient cycles and energy flows. The abiotic and biotic features of an ecosystem, their interactions (For instance, the pollination process conducted by bees) and a source of energy make up the structure of an ecosystem.

Climate Change: The long-term shift in average weather conditions for a location, calculated over long periods of time. It is measured from long-term precipitation and temperature patterns and often expressed as monthly or seasonal averages

Sustainability: Meeting the needs of current and future generations through simultaneous environmental, social and economic adaptation and improvement.

SYLLABUS DOTPOINT 2

The Identification and Classification of Land Cover Change with Reference to Global Forests, Agriculture and Urban Land Cover

Agricultural Environments: Environments suitable for plant and animal farming to sustain and enhance human life. They affect the world's ecosystems as they cause land cover change. It damages soil, water and the air. A primary example is the intensive agricultural plantations in Vietnam. They are hazardous to the society as the production can destruct arable land. Around 38% of land is used for agricultural purposes in the world, and this number is projected to increase to 56% of land by 2050. Currently in Australia, 54% of total land is used for agricultural purposes. This land is caused by the clearing of forests, such as the clearing of the forests in Indonesia for the palm oil industry. This land cover change can be seen in Australia. In the 1700's, there were wild trees with wild woodlands in Australia, and this land has since been transformed into remote rangelands and populated croplands. Agricultural plantations have been intensifying dramatically in Europe, North America, India and China.

Urban Environments: Environments consisting of concentrated settlement forms, or buildings. The inhabitants largely are not involved in agricultural forms of production. As of 2016, roughly 54% of the world's population lives in urban areas, according to The World Bank Group, and it is predicted that 70% of the population will be living in urban areas by 2050. Urban areas are service-centred environment, which shifts people from rural to urban areas. They cover in total between 0.5-3% of total land cover in the world, but this number is expected to triple by 2030 – mainly in India and China. The people living in urban areas are dependent on agriculture for sustainability, and hence requires a total transformation of land to support it. Hence, it is the greatest influence on global environment change.

Global Forests: Forests cover around 31% of the Earth's surface, however they are being deforested at a rapid rate. Deforestation is the removal or clearing of forests generally for other uses, like agriculture or urbanisation. The different types of deforestation include fires, clear cutting, unstable logging for timber, and degradation due to climate change. It is estimated that between 74000 to 93000 km² are removed every year. Forests are responsible for providing oxygen, absorbing CO₂, and regulating the temperature of the Earth. Forests provide habitat for up to 80% of all terrestrial biodiversity.

Deforestation can be seen all over the world:

- The Amazon Rainforest has decreased by 17% since 1968
 - Since 1900, up to 90% of West Africa's coastal forest has been lost.
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SYLLABUS DOTPOINT 3

The Use of Remote Sensing Images, Other Spatial Technologies, and Fieldwork to Identify and Measure the Location, Nature, Rate, Extent and Consequences of Land Cover Change

Global Forests:

Nature: Forests are large areas dominated by trees. They are much sparser than in the past and are predicted to continue to decline.

Rate: 31% of land cover

Causes: Deforestation, Climate Change

Consequences: Loss of Biodiversity, increases CO₂ in the air, Leads to both land and soil degradation

Examples: Walpole National Park, Amazon Rainforest

Grasslands:

Nature: Areas of open country plain, covered with grass

Rate: Covers around 9% of land

Cause: It is changed into agriculturally improved grassland

Consequences: Land and soil degradation, a loss of habitat which leads to a loss of biodiversity

Examples: Avon Wheatbelt, Savannah Grasslands

Urban Cities:

Nature: Human settlements with high population density

Rate: Covers between 0.5-3% of land cover

Causes: Growing populations, higher levels of industrial needs

Consequences: Growing reliance on agriculture, and increase in CO₂ emissions

Examples: Perth City, Tokyo, New York

SYLLABUS DOTPOINT 4

The Implications of Anthropogenic Biomes to the Function of the World's Ecosystems

(More in [Dot Point 1](#))

Agricultural Environments:

- Causes land cover change.
- Damages water, soil and air.
- Example: intensive agricultural plantations in Vietnam.

Urban Environments:

- Requires the use of agricultural plantations
 - To provide food, clothing, etc.
 - Example: Perth relies on banana plantations in Carnarvon for banana supplies
-

SYLLABUS DOTPOINT 5

World Population Growth, Growing Affluence, Advances in Technology and their Impact of the Nature, Rate and Extent of Land Cover Change and Biodiversity Loss

World Population:

- Currently increasing at around 140 people/minute
- By 2050, world population is expected to surpass 90 million people

Affluence:

- Having a great deal of money and wealth
- Impacts:
 - Improved Health Care
 - Lowered Infant Mortality
 - Raising Children is expensive
 - Increased education rates of women
 - Higher participation in the workforce
- The higher the level of wealth, then the higher demand for resources.
 - The most affluence 20% of the world's population consumers 80% of world resources.

Soil and Crop Sensors:

- Smart sensors that can record data and enable on-the-go inputs based on the conditions of the field.
- Helps irrigation, as they measure water needs. Allows for the optimisation of water use and avoiding yield loss.
- Can detect parasites
- Detects different levels of different soils

Herbicide-Tolerant Canola:

- Genetic modification in the transgenic gene of canola plantations through a protein
 - During processing, this protein is removed, so no genetically modified material would remain
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SYLLABUS DOTPOINT 6

Processes of Land Cover Change (deforestation, the expansion and intensification of agriculture, rangeland modification, land and soil degradation, irrigation, land drainage and reclamation, and the growth of urban settlement, industry and mining)

Land Reclamation:

The process of creating new, usable land from lakes, oceans and rivers. Its primary use is to provide land for places that lack flat, usable land. It can be used to reshape coastlines to be used for specific purposes (ports and other maritime infrastructure)

Process:

- Using rock (or cement) to build up the structure of the land. The soil is poured over the top, sealing rocks beneath it and creating usable land
- Another method is to hold bodies of water back using dams, floodgates and dikes. This allows land that was previously underwater to be used. A prime example of this method is the Netherlands, which has used the aforementioned infrastructure to keep 26% of its land above water
- Rocks and other materials are used to build the foundations of the reclaimed area are often sources by demolishing large parcels of mountains and hills using explosives. This process is called blasting
- The softer materials (i.e. soil) are extracted from the sea floor in local areas. This process is called dredging.

Chek Lap Kok Airport – Hong Kong

Chek Lap Koki is a man-made island that houses the Hong Kong airport, which is the 8th busiest airport in the world. It was constructed to replace the small previous airport which was deemed unsafe due to its extreme landing conditions. The island was predominantly constructed from rock harvested from mountains and cliffs on the nearby Lantau Island. It added an extra 9.38km² to Hong Kong's land area, which is around 1% of Hong Kong.

The airport infringed upon the habitat of the endangered Pink Dolphins. The waterways surrounding this area were one of the only areas in which pink dolphins exist, and the airport was constructed over known breeding territory.

Advantages:

- Increases land area
- Provides more land for urban development within a city, slowing down the need to build on urban fringes
- Can provide more space for integral infrastructure like freight ports and airports to a region with minimal flat land

Disadvantages:

- Can destroy natural marine habitats such as wetlands and coral reefs. Occasionally these effects can be mitigated through relocating reefs.
 - The earth used for land reclamation may pollute the water it's located in. This could kill any local marine flora and fauna, devastating ecosystems.
 - Reclaimed land can easily sink or wash away in the event of an earthquake or tsunami.
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SYLLABUS DOTPOINT 7

The Differences in the Process of Land Cover Change between Countries due to Factors such as Government Policy, Institutional Arrangements, Land Ownership, Type of Economy, Ideology and Culture

	Australia	China
Population Size and Density	<ul style="list-style-type: none"> Australia is the 6th largest country in the world <ul style="list-style-type: none"> 7, 686, 850 km² 24 million people 88.9% of Australians live in urban areas Has only 2 cities with over 4 million citizens 	<ul style="list-style-type: none"> China is the 4th largest country in the world <ul style="list-style-type: none"> 9, 596, 960 km² 1.4 billion people 59.3% live in urban areas Has 662 cities, and 14 of them have over 5 million citizens
Economic World Standing	<ul style="list-style-type: none"> Australia has the 12th largest and 16th best economy in the world, according to the International Monetary Fund GDP: \$67,458.36 USD per capita 	<ul style="list-style-type: none"> China has the 2nd largest and 84th best economy in the world, according to the International Monetary Fund GDP: \$6,807 USD per capita
Types of Government and Economy	<ul style="list-style-type: none"> 3 levels of government (local, state & federal) 'Mixed-market economy' <ul style="list-style-type: none"> Capitalist & Socialist Allows for personal economic freedom Land Cover Change projects must be agreed on by the government As a developed country, most agriculture is done by individuals and corporations A dependence on mining and an increased rate of urbanisation leads to land cover change 	<ul style="list-style-type: none"> Centralised, single party government base on the Communist Party 5 levels of government, ranging from provincial to village level Government has control over the people and economy Socialist-Market Economy <ul style="list-style-type: none"> Largely state owns; very small open market China is a large exporter of goods in the world, and the 2nd largest importer Transforms large proportions of land cover in order for a rapid growth of urbanisation and need for agricultural production Large reserves of coal being mined

Institutional Arrangements and Land Ownership	<ul style="list-style-type: none"> • Land can be privately bought, owned and sold • All land ownership and transactions are recorded by state government authorities • A range of different land ownership and land use categories which impact on the processes and amount of land cover change (different titles): <ol style="list-style-type: none"> 1. <u>Freehold title</u>: rights over land for all time (ownership). Must comply to planning and environmental regulations 2. <u>Leasehold title</u>: lease land from the government for an agreed number of years. With access to water and grazing rights in compliance with environmental policies and restrictions 3. <u>Traditional land rights</u>: restricted process and land cover change allowed requiring agreement from Indigenous Australians 4. <u>Protected areas</u>: native conservation and preservation areas due to unique biodiversity and landforms and/or landscapes under government acts 	<ul style="list-style-type: none"> • Due to the type of government, there is no real private land ownership in China. It is all owned and controlled by the government • Before 1978, China's planned economy and fundamental communist ideology caused there to be no housing market • Post 1978, China experienced a reform allowed private housing ownership being recognised as a personal consumable commodity. <ul style="list-style-type: none"> ○ It did not conflict with the communist ideology ○ Increased personal wealth among the Chinese and private ownerships of houses and apartments • Farming land is owned by farming collectives where village leaders have the authority to make decisions regarding the land. Corruption and bribery is speculated to have become common among these leaders • China has experienced less control on land cover change due to rapid developments, It has to be facilitated by various levels of government. New laws were passed in Jan 2015 which allowed for the prosecution of polluters and the protection of natural areas
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Ideology and Cultural Views	<ul style="list-style-type: none"> • Great value of the natural environment and the outdoors <ul style="list-style-type: none"> ○ This significantly impacts land cover change and its processes • Authorities must provide individuals and interested parties with the opportunity to comment on the proposed changes to the land use/cover • Stakeholder groups such as Conservation Volunteers Australia (State) and Save the Beelie Wetlands (Local) can influence on the rate and scale of land cover change in Australia 	<ul style="list-style-type: none"> • Society has mixed opinions on the environment as their actions are based around cultural beliefs, and most importantly, the growth of wealth. • View that human beings are totally different from the world of natural things. They treat the world of nature as a world of objects, and there is barely any value for nature • China has a pollution issues (where up to 500,000 die each year due to pollution related illnesses). • Attitudes are starting to change due to outside pressure/awareness from worldwide organisations (such as Green Peace)
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SYLLABUS DOTPOINT 8

Projection Changes in Land Cover using Existing Spatial Models, Incorporating both Environmental and Socioeconomic Variables

Spatial Modelling is a methodology or set of analytical procedures used to derive information about present and future spatial relationships between geographic phenomena. Once potential impacts are identified for various regions and biomes, mitigation and adaptation strategies can be developed and implemented.

Spatial modelling is used to project changes in land cover and incorporates both environmental and socio-economic variables.

- Environmental variables take into account the natural ecological processes occurring within biomes at the local scale.
 - GIS = Geographical Information System - data creates maps
- Socio economic Variables take into account factors such as population growth and density, methods of energy production and demand plus economic activity and growth at a local scale and the influences of globalisation and economic interdependence at the global scale.

Scenario-based projections attempt to take into account many of the processes and factors driving land cover change. Scenario based models may produce a number of outcomes or scenarios based on the variables considered.

Quantitative measures = Based on Numbers

Qualitative measures = Based on words

Land use change models are often based on data gathered from remote sensing and Geographical Information System (GIS). Scenario Framework developed by the Intergovernmental Panel of Climate Change (IPCC) are often used as the base of such modelling. Series of maps will be produced to show the predicted changes over time.

SYLLABUS DOTPOINT 9

Indigenous Peoples' Land Management Practices and their Impact on Land Cover over Time, including those of Aboriginal and Torres Strait Islander Peoples

There is no pristine wilderness in Aboriginal lands. They in fact has a complex system of land management. Aboriginal people were nomadic and had lived in harmony with the environment. As of 2006, 159 million ha (20% of Australia) is owned and managed by Indigenous Australians. They worked to ensure they left enough resources for the environment to still flourish (only killing animals for immediate needs, only taking some eggs, spreading of seeds, etc.)

Fire:

- System of patch work burnt and regrowth areas.
- Fire was used to clear vegetation to make it easier to travel.
- It was also used to promote plant growth in some areas and to flush possums out of their habitats.
- Fires prevented weeds and other invasive pests
- There were less uncontrolled fires as we often witness in modern times

Caring for Country:

- The environment, cultural heritage and natural resource management by Indigenous communities is called 'caring for country'
- Traditional methods and modern practices.
- Modern practices include;
 - Protection of cultural sites of significance to Aboriginal people
 - The mapping and tracking of water source
 - Knowledge to reduce the risk of bushfires
- 20% of Australian land was used for nature conservation and other protected areas (indigenous use)
- Traditional methods (e.g. firestick farming) combine with modern methods (e.g. biodiversity surveys).
- More example includes: the creation of seasonal harvesting calendars from traditional knowledge, mapping and tracking water resources and the retention of traditional knowledge for future generations.

Replanting seeds

- Replanting of seeds reduced land cover change over time
 - Aboriginals and Torres Strait Islander people take what they need and leave the rest for the others
 - If they have taken all the food, they would replant the seeds so that then there would be more food in the future
 - This method resulted in the indigenous having not to have to find new areas to find food sources, the area with the replanting method was the area that had the sustainable food source
 - Replanting seeds resulted in very little land cover change, and this method has been incorporated in modern technology for replanting
 - Seeds (fruits and berries)
-

SYLLABUS DOTPOINT 10

The Impacts of Land Cover Change on Local and Regional Environments, including Changes to the Water Cycle, Soil Erosion and Degradation, Loss of Habitat and Biodiversity, the Degradation of Aquatic and Marine Environments, Loss of Ecosystem Services, Changes to Regional Climates, and Urban Heat Islands

Loss of Ecosystem Services:

- Ecosystems services are benefits that people and communities derive from an ecosystem, including
 - Flood and Disease Control
 - Food and Water
 - Cultural Services
 - Nutrient Cycling
- Management of ecosystem services in anthropogenic biomes determine the wellbeing of humanity

Source: waste management

Source: resources

Spirit: connections

Service: processes

What is a regional environment?

Regional places have:

- Population
- Services (government departments)
- Schools
- Employment Opportunities

Examples:

- Port Headland
- Albany
- Kalgoorlie
- Bunbury
- Busselton

Loss of Food Security: Source

- Food is secured and is able to be used in the event of an ecological or natural disaster that affects food supply
- Can be caused by sole reliance on one or two food sources
- Health concerns can be caused by food shortages or by pathogens

Loss of Energy Security: Source

- Wood provides fuel for energy in less developed countries
 - For instance, 80% of energy relies on fuel in Tanzania

Difficulty in Providing Clean Water: Sink/Service

- It is cheaper and more efficient to maintain a healthy ecosystem in a watershed area
- World Health Organisation stated that they witnessed an 'increase in quantity and diversity of pollutants in freshwater systems since 1970'

Million Acres A Year-

- Program where land which was not suitable for farming was opened up, initiated by the WA government
 - 5 pounds 6 shillings per acres, which is around \$155.68
-

- All in WA's South-West, which houses over a third of Australia's biodiversity

Impacts of Land Cover Change on Local Environments:

1. Weeds:
 - Plants that compete with and displace local native plants for space, light and nutrients
 - They deprive local fauna of suitable habitats
 - Located all over the Eastern Swan River Precinct in plants like dandelions
2. Inappropriate Human Use:
 - Inappropriate use of land
 - The use of boating and vehicles in the Eastern Swan River Precinct creates vehicle track in locations such as the Maylands Foreshore
 - Leads to the erosion of bushland and riverbeds
 - Introduces weeds and disease to the environment
3. Erosion:
 - Gradual destruction/diminution in natural areas
 - Results in species death and degrades natural areas
 - This can be seen in the erosion of land along the drainage lines in the Maylands Foreshore
4. Fire:
 - Bushlands lead to higher risks of uncontrollable bushfire
 - i. However, there is a low amount of bushland in the Eastern Swan River Precinct, and is not such a threat
 - ii. This can be seen in how there were 0 naturally caused fires in the 2016-17 season
5. Feral Animals:
 - Introduced animals that compete with/predate local fauna
 - They alter the ecosystem through grazing and soil disturbances
 - Not a high level in the Eastern Swan River Precinct. The most common perpetrators are dogs and foxes
6. Lack of Human Awareness:
 - The planting on non-native, highly invasive plant species, which leaves less nutrients for local plants
 - There is high awareness in the community about this issue, and the Swan River Eastern Precinct avoids planting these, as a community

Swan River Eastern Precinct: Comprised of Bassendean, Bayswater and Belmont.

3 good examples of land cover change:

- Weeds
- Inappropriate Human Use
- Erosion

3 bad examples of land cover change

- Fire
 - Lack of awareness
 - Feral Animals
-

Impacts of Land Cover Change on Regional Environments:

South-West WA:

1. Changes to Water Supply:

- Caused by a clearing of native vegetation, which leads to erosion and sedimentation of waterways, which reduces water quality. Rain falls better where trees grow, so the disposal of trees leads to less rain
 - Since 1970, rainfall in South-West WA has decreased by 30% (and 80% of land in the wheatbelt has been cleared since 1910)

2. Changes to Soil Quality:

- When trees/vegetation is cleared, salt is introduced from ancient salt deposits
- Due to a lack of transpiration, the water table rises, and intercepts the salts in the soil
 - Turns the groundwater saline
- This caused South-West WA from having one of the best nutrient-rich soils to having one of the worst

3. Changes to Ecosystem Services:

- European colonization brought in new species of animals but also wiped out some
 - Due to agricultural evolution in South-West WA, the countryside has opened up, allowing more widespread species
 - The Wheatbelt area has gained 5 new species of birds, but lost 9 different species as the introduced species (like the Laughing Kookaburra) threaten native species.
-

The Spatial Distribution of the World's Rainfall and Temperature Patterns

Spatial Distribution of the World's Temperature Patterns:

- January:
 - Summer in the Southern Hemisphere
 - Experiences temperatures around 20 – 40°C on average
 - Hottest around the tropic of Capricorn
 - Long days and short night
 - Time of heat surplus; heat energy builds up in the atmosphere
 - The warmest areas are the landmasses of South America, South Africa and Australia
 - Australia's rectangular shape makes it susceptible to periods of high temperature when a high pressure cell sits over the continent and moves hot tropical air from the north of the continent to the south
 - Generally, summer temperatures in the Southern Hemisphere are lower than that for the Northern Hemisphere
 - This is due to there being less land and more oceans in the south
 - Oceans moderate air temperatures
 - i.e. the annual sea temperatures for Perth is between 19-22°C
 - Sea breezes will cool coastal regions in summer and warm them in winter
 - Winter in the Northern Hemisphere
 - Experiences temperatures around -10 – 12°C on average
 - Decreases as location is further from the equator
 - Lowest temperatures occur over the northern continents with the lowest being across Siberia and Canada
 - Short days and long nights
 - As well as this, the large amount of landmass (continental land) pushes temperatures well below 0°C across a large area
 - Heat loss in these areas greatly exceeds insolation
 - Temperature variation between eastern and western coastlines is due mainly to the effects of ocean currents
 - The Gulf Stream carries warm water across the Atlantic from Central America to Western Europe
 - The prevailing westerly winds are warmed by the Gulf and this raises winter temperatures in this area

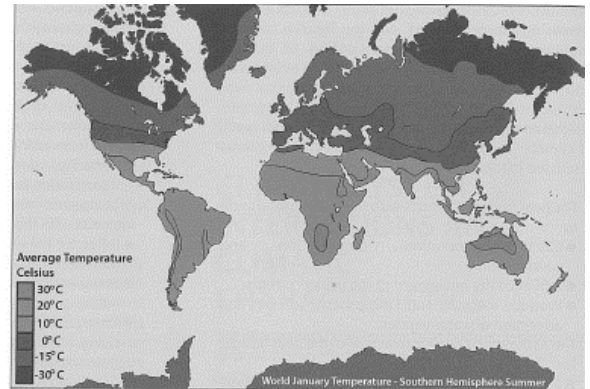


Figure 2.26 Global January average temperatures

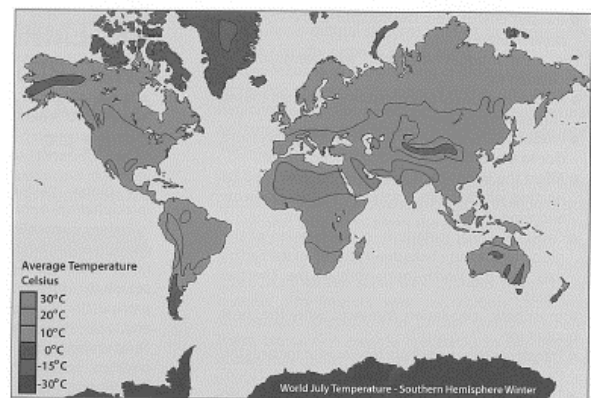


Figure 2.27 Global July average temperatures

- July:
 - Summer in the Northern Hemisphere
 - Experiences temperatures around 10 – 40°C on average
 - Hottest around the Tropic of Cancer
 - Northern continents are strongly heated
 - The hottest temperatures are in the desert areas of the Sahara, Arabia, Northwest India and California
 - The average temperature is well in excess of 30°C
 - Equatorial regions receive the most solar radiation, but are somewhat cooler than the deserts of the subtropical areas
 - This is as considerable amount of energy is consumed when evaporating the abundant moisture that precipitates there, and cloud cover reduces insolation
 - Winter in the Southern Hemisphere
 - Experiences temperatures around 10 – 30°C on average
 - Colder as it gets further from the equator
 - Average temperatures are moderated due to a higher proportion of ocean to land

This is explained due to the tilt of the Earth, where the Northern Hemisphere is tilted away from the Sun during January, and the Tropic of Capricorn is in direct fire of the sun. It is the opposite case for in July, and the Tropic of Capricorn is instead in direct line of the sun.

- There is greater temperature variations in the Northern Hemisphere when compared to the Southern Hemisphere
- Landmasses show greater variations in air temperatures than oceans
- Ocean currents affect land air temperatures when winds blow from seas
- Temperatures in both summer and winter generally decrease with an increase in distance from the Equator
- Coastal temperatures are generally more moderate than inland temperatures

Spatial Distribution of the World's Precipitation Patterns:

- Annually, an average of about 1m of precipitation falls across the entire surface of the world regionally
 - There are extremes, ranging from places which do not receive any significant rainfall for very large periods (Arica in Chile 0.8mm) to places where annual totals are very large (Mt Waialeale in Hawaii 11,680mm)
 - Highest rainfall totals occur near the Equator
 - Air is rising, and because it is warm, it is capable of storing considerable amounts of water vapour
 - Tropical belt
 - Rainfall is convectional, with prolonged heavy showers and frequent thunderstorms
 - Polar regions
 - Rainfall is low because the air is too cold to contain much water vapour
 - Subtropical high-pressure belts
 - Regions of very low rainfall due to stable atmospheric conditions associated with descending air
 - Northern temperate mid-latitudes
 - Moderate rainfall, much of it is frontal in nature, declining towards the interiors of North America and Asia
 - Shifting precipitation patterns
 - They shift north-south with the seasons and the movement of the Thermal Equator
 - Significant for tropical regions where the monsoons bring heavy summer rainfall
 - Other regions which experience seasonal variations
 - Mid-latitude west coast regions of continents, where the winter polar fronts bring rain and snow, followed by a summer dry season
 - Summarisation
-

- Equatorial regions have the highest average precipitation rates
- Deserts occur on the west coasts and interiors of continents in the latitudes dominated by high pressure systems
- Land areas adjacent to cool/cold ocean currents have less precipitation than areas where there are warm ocean currents
- Continental interiors tend to be drier due to their distance from the oceans
- Cold air masses over polar regions contain little moisture and therefore produce less precipitation
- Where humid maritime air meets cold air masses at polar front convergence zones, air temperature differences produce precipitation
- Mountain ranges both increase and decrease precipitation. Windward slopes facing moisture bearing winds produce orographic uplift and increased precipitation. Leeward slopes form 'rain shadows'.

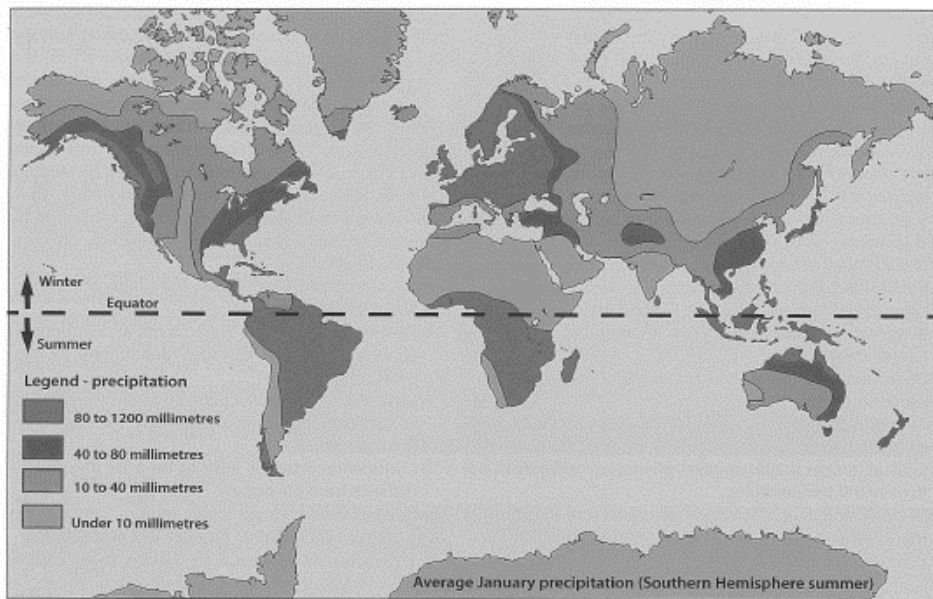
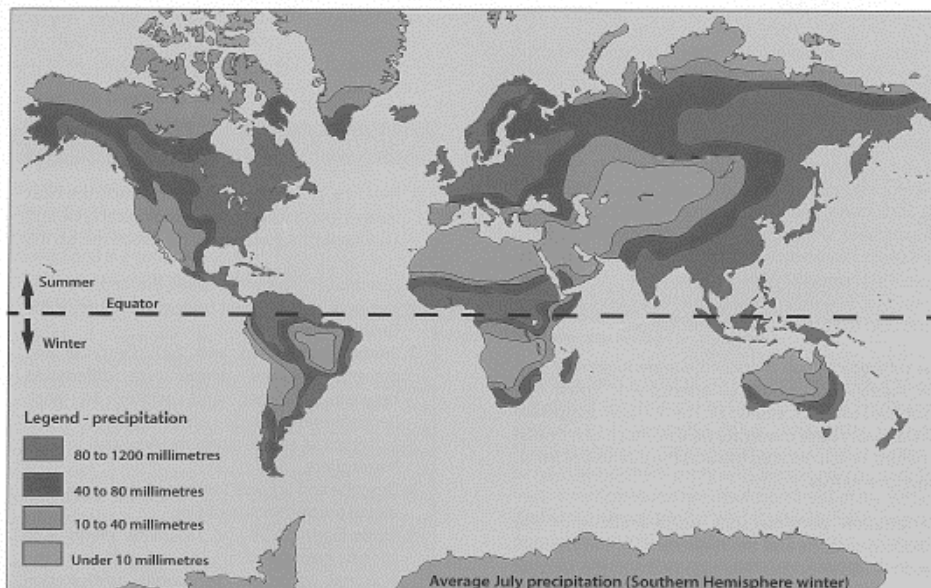


Figure 2.28 Global January precipitation



SYLLABUS DOTPOINT 12

The Key Elements of the Following Natural Systems: Heat Budget (including the greenhouse effect), Hydrological Cycle, Carbon Cycle and Atmospheric Circulation, and the Ways in Which they Interact to Influence the Earth's Climate

Glossary Terms:

System, Closed System, Open System, Boundary, Flow/Transfer, Input, Store/Component, Output, Dynamic Equilibrium, Atmosphere, Positive Feedback Loops, Negative Feedback Loops, Relationships, Attributes, Elements, Isolated Systems, Biosphere, Hydrosphere, Lithosphere.

Global Heat Budget:

The balancing of incoming and outgoing solar radiation.

Insolation is input received in the form of short-wave solar energy. Albedo is a measure of how much sunlight a surface reflects. Around 52% of insolation reaches the Earth's surfaces.

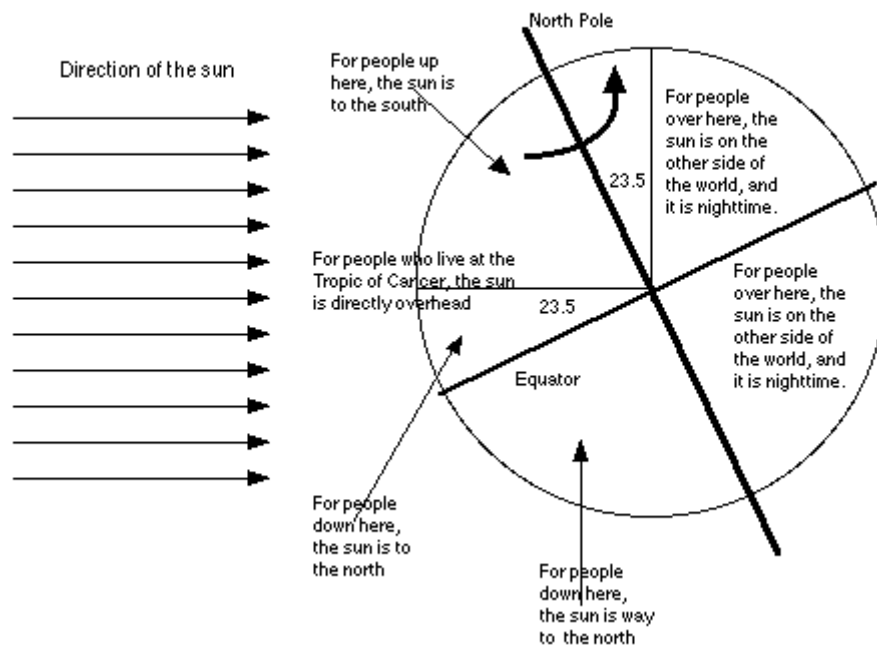
- Insolation is absorbed by water vapour, dust or clouds
- Insolation is reflected by the Earth's surface and scattered by particles in the air

Reflected heat, in the form of long-wave radiation, is trapped in our atmosphere and keeps the planet warm. This is the *natural greenhouse effect*.

Incoming Solar Radiation	Outgoing Solar Radiation
30% directly reflected back into space 20% by clouds 6% by particles in the air 4% by albedo (snow & ice)	23% carried into the atmosphere as either latent heat or as water vapour
19% absorbed into the atmosphere; water vapour, dust and the ozone	7% of energy is released by conduction & convection
Around 51% is absorbed by the Earth	64% of radiation is absorbed by clouds
	6% of terrestrial radiation is released into space

There is a net gain of solar energy in the tropical latitudes and a net loss towards the poles. The tropical latitudes receive more of the Sun's energy than polar regions.

Noon June 21, Summer Solstice

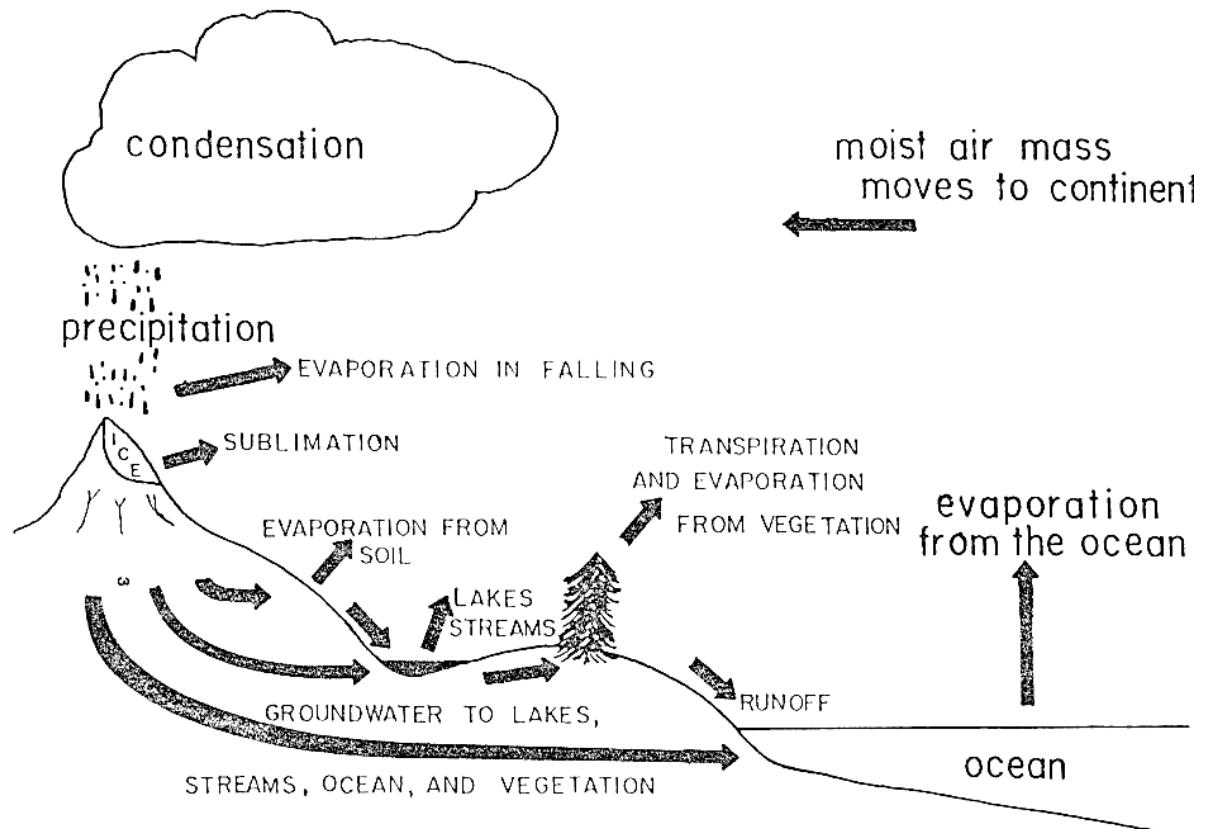


Atmosphere:

Composition: 23% oxygen, 71% nitrogen, 0.1% carbon dioxide, 1% water vapour, helium, methane, etc. (underlined gases are natural greenhouse gases)

Reactive gases have the ability to be able to hold or trap heats. This keeps the atmosphere warm to an extent that generates global warming and climate change.

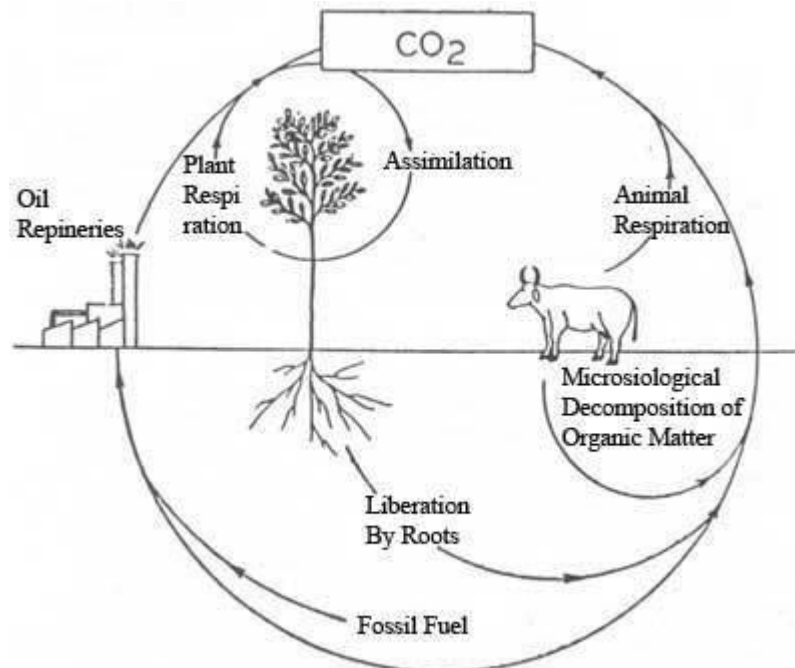
Hydrological Cycle:



Begins with the evaporation of water from the surface of the ocean. As most air is lifted, it cools, and water vapour condenses to form clouds. Moisture is transported around the globe until it returns to the surface as precipitation. Once it reaches the ground, one of two processes may occur:

1. Some of the water may evaporate back into the atmosphere
2. The water may penetrate the surface and become groundwater. This water may either seep into oceans, rivers and streams, or be released back into the atmosphere through transpiration.

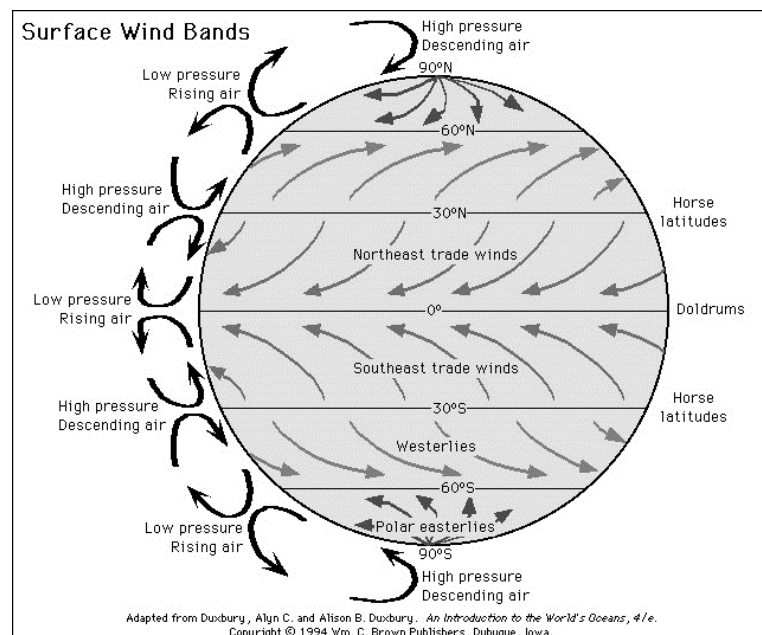
Carbon Cycle:



1. Carbon enters the atmosphere as carbon dioxide from respiration and combustion
2. Carbon dioxide is absorbed by producers to make carbohydrates in photosynthesis
3. Animals feed on the plants, passing the carbon compounds along the food chain. Most of the carbon they consume is exhaled as carbon dioxide formed during respiration. The plants and animals eventually die and release carbon.

Atmospheric Circulation:

- Large-scale movement of air, controls distribution of thermal energy across the Earth's surface (along with ocean circulation, which is very slow)
- The structure varies from year to year, but it has a fairly constant basic climatological structure
- Weather systems individually are random (predicted maximum 10 days prior)
- Climate is the average of weather systems and patterns, and is reoccurring and appears fairly stable over longer periods of time



Interactions between the 4 cycles:

Heat Budget/Natural Greenhouse Effect + Hydrological Circle

Creation of the Earth's temperature and precipitation patterns:

1. Energy (in the form of heat) is required to induce evaporation (in the hydrological cycle)
2. The formation of clouds (in the hydrological cycle) reflects radiation in the cloud-albedo effect (in the heat budget)
3. Water vapour (in the hydrological cycle) is a natural greenhouse gas and aid in absorption and re-radiation of terrestrial radiation (in the heat budget)
4. Energy (from the heat budget) is required to cause transpiration (in the hydrological cycle)
5. When water vapour (hydrological cycle) condenses from gas to liquid, it releases latent heat energy (in the heat budget)

Heat Budget/Natural Greenhouse Effect + Atmospheric Circulation

1. Heat energy (from heat budget) creates convection currents (from atmospheric circulation) as a cycle of warm and cool atmospheric particles, forming high and low pressure
2. High levels of insolation (from the heat budget) reach the equator, and low levels of insolation reach the poles, leading to the creation of high and low-pressure belts (from atmospheric circulation)
3. Movement of the 'heat equator' with the sun (from the heat budget) also shifts high and low-pressure belts (from atmospheric circulation)
4. Pressure systems, belts and cells (from the heat budget) influence the creation of wind (from atmospheric circulation)
5. Low pressure systems, belts and cells (atmospheric circulation) aid in the transfer of radiation (heat budget) from Earth back to space

Heat Budget/Natural Greenhouse Effect + Carbon Cycle

1. When carbon dioxide emissions increase (carbon cycle), the amount of greenhouse gases in the atmosphere increases, and the amount of terrestrial radiation (from the heat budget) is re-absorbed and reflected back towards Earth
2. Carbon sinks (from the carbon cycle) are features that absorb and store carbon. Hence, they decrease greenhouse gases (heat budget) and decrease the amount of terrestrial radiation
3. Insolation absorbed by the ocean (heat budget) creates differing ocean currents. Cold oceans and currents take carbon deep into the ocean, where it is stored (carbon cycle)
4. Insolation absorbed by ocean (heat budget) create warm oceans and currents. These bring carbon to the water surface, where it evaporates (carbon cycle).

Hydrological Cycle + Atmospheric Circulation

1. Upwards movement of water vapour (hydrological cycle) creates low pressure systems (atmospheric circulation), as well as clouds and precipitation (hydrological cycle)
2. Low pressure belts (atmospheric circulation) create higher levels of evaporation and precipitation (hydrological cycle)
3. High pressure belts (atmospheric circulation) creates lower levels of evaporation and precipitation (hydrological cycle)
4. Winds (atmospheric circulation) move clouds and hence shift precipitation away from their initial location (hydrological cycle)
5. North-South shift of the pressure belts (atmospheric circulation) effects spatial distribution of precipitation patterns (hydrological cycle)

Hydrological Cycle + Carbon Cycle:

1. Precipitation (hydrological cycle) aids in the removal of CO₂ (carbon cycle), which is absorbed by land, vegetation or oceans, leaving greenhouse gases
 2. Water sources (hydrological cycle) release carbon into the atmosphere (carbon cycle) through evaporation (hydrological cycle)
 3. Water sources (hydrological cycle) can act as a sink for carbon (carbon cycle) and stores it until it is brought to the surface
-

The Greenhouse Effect:

The greenhouse effect is the capacity for certain gases in the atmosphere to be able to trap heat. It is important for the climate system as it is the cause for a higher quantity of heat being stored in the atmosphere. This leads to a higher average temperature in the atmosphere.

*The Causes (Natural & Anthropogenic) and Rate of Global Climate Change***Natural Causes of Climate Change:**

- Volcanoes
 - Volcanic eruptions can contribute to both cooling and warming of the Earth's atmosphere as well as indirectly contributing to some ozone depletion. They can enhance global warming by adding carbon dioxide to the atmosphere which traps long wave energy and helps keep the atmosphere warm. However, volcanic eruptions have been estimated to produce about 110 million tonnes of carbon dioxide a year whereas human activities contribute almost 10,000 times that quantity.
 - Volcanic eruptions enhance the haze effect as suspended ash particles in the upper atmosphere block out some solar radiation. However, it is the same amount of sulphur-rich gases that are emitted that have the most impact
 - The sulphate aerosols combine with water vapour in the stratosphere to form dense cloud of tiny droplets of sulphuric acid that take several years to settle out. They are capable of significantly decreasing temperatures because they absorb solar radiation and scatter it back to space
 - The 1815 eruption of Mt Tambora in Indonesia produced the 'year without summer' as crops failed, glaciers advanced down mountain slopes and sea ice moved southwards in the North Atlantic Ocean. This was caused by the large amount of sulphate aerosols that has entered the upper atmosphere
 - The 1991 eruption of Mt Pinatubo in the Philippines produced the largest sulphur oxide cloud of the 20th Century that also led to mean world temperatures decreasing by about 1°C over the next two years
- El Nino and La Nina effects
 - El Nino and La Nina are different stages in a cyclical pattern of climate turbulence that is also referred to as the Southern Oscillation. Changes to surface water temperatures in the Pacific Ocean between Australia and South America affect the intensity of high and low pressure cells in this region.
 - In most years the Humboldt Current brings relatively cold water northward along the west coast of South America and there is an upwelling of this cold water along the coast of Peru. It then flows westward along the equator where it heats up, making the Western Pacific between 3-8°C warmer
 - This produces a La Nina phase in northern and eastern Australia as trade winds blow strongly from Asia and the monsoonal low pressure systems bring average and above average rainfall. The west coast of South America experiences little rain due to the presence of the cold ocean current that is not conducive to generating precipitation
 - At irregular intervals of between 3 and 7 years the El Nino phase of the cycle when the Humboldt Current is disrupted at the waters of the eastern Pacific become warmed and there is little variation in temperature across the Pacific
 - The trade winds weaken and monsoons collapse around Indonesia and Australia and there is a rise in surface air pressure that results in declining rainfall. Warm water spreads from the west Pacific taking the rain with it and bringing drought to western Pacific nations (e.g. Australia, Vanuatu)
 - Warm air now rises near Peru as the normally cold waters on the South American coast have been warmed by 2-8°C and cloudiness is enhanced. This increases rainfall across the eastern Pacific and can bring very wet weather along the coast of Peru and Ecuador and causing floods.
 - The number of El Nino events has increased over recent decades and it has been suggested that this may be as a result of global climate changes towards global

warming. However, written records of the serious effects of El Nino on Peru date back to the 1500s.

Anthropogenic Causes of Climate Change:

- **Urban Influences**
 - Climate change can be caused through anthropogenic means → it is estimated that urban living and industry is responsible for about 75% of total global carbon dioxide emissions. The amounts of greenhouse gas emissions has increased significantly since the Industrial Revolution began in the mid-18th century that saw the burning of large amount of fossil fuels to create an effective form of electrical energy.
 - Energy supply is the largest single contributor of greenhouse gas emission producing 25.9% of all greenhouse gases. It is estimated that nearly 80% of those industrial facilities are run on fossil fuels such as coal, natural gas and oil. Brown coal emits three times more carbon dioxide than natural gas. Power stations are generally large scale facilities designed for continuous operation and as of 2014 about 34% of USA's power stations are still coal-fired as coal is one of the most abundant fossil fuels. Another 30% were powered by natural gas and 1% by oil.
 - Cement production is another major contributor to urban anthropogenic emissions with over 3.3billion tonnes produced annually. Carbon dioxide is released through the chemical process of the heating of calcium carbonate. Further carbon dioxide is released through the use of energy during its production.
 - Industrial processes, including cement production, are responsible for about 19.4% of greenhouse gas emissions. Chemical plants, metals production factories, petrochemical plants and other heavy industry contribute to the steady rise of atmospheric greenhouse gases. Some industries and a number of consumer goods produce halocarbons, another set of greenhouse gases, which take a long time to break down in the atmosphere. These are often used as refrigerators, solvents, fire retardants and in aerosol applications.
 - Fuels used for transport are another major contributor with road transport (i.e. cars and trucks) being the major culprit. The movement of vehicles is essential for industrial activity and ultimately for the distribution of goods. In cities where low density residential is prevalent (e.g. Phoenix, Houston) there will be a greater consumption of fuel associated with high car ownership.
 - The average urban dweller uses energy for heating, cooling, electrical goods, waste disposal and transport and therefore contributes to this global problem. Residential and commercial buildings produce 7.9% of all greenhouse gas emissions.
 - Large cities also produce an urban heat island effect as the vast amounts of bitumen and concrete can reduce the albedo effect while large buildings can reduce the effects of cooling winds. Increased temperatures will often lead to the enhanced use of cooling (e.g. air conditioners) and therefore more energy consumption. Economic growth has also resulted in greater consumption of energy in many of the world's burgeoning cities.
 - **Deforestation**
 - Deforestation, or land clearing mostly for agricultural processes, has been a major contributor to increased carbon dioxide levels. Forests are a major carbon sink and their removal results in a net increase in carbon dioxide concentrations in the atmosphere. The United Nations' Food and Agriculture Organisation (FAO) estimates that forests are disappearing at the rate of 13million ha/year.
 - Up to 90% of West Africa's coastal rainforests have disappeared since 1900 in countries like Liberia, Ghana, Guinea and Côte d'Ivoire. Central America has lost 40% of all its rainforest in the last 40 years in countries like Honduras and Panama. It is estimated that two thirds of the lowland forest in this region has been changed to pasture land.
-

- South Asia has lost over 85% of its rainforests to agricultural practices. Large areas of Indonesia (and also Brazil in South America) are losing forest at incredible rates and the forests are being replaced with single crops (e.g. oil palm) or with pastures which both have much smaller carbon stores making them less able to absorb excess carbon dioxide.
 - It is estimated that tropical deforestation releases 1.5 billion tonnes of carbon each year into the atmosphere. When then biomass is burn it results in even more greenhouse gas production. Tropical deforestation is responsible for between 6 – 17% of world greenhouse gas emissions and with total deforestation contributing to 17.4% of all greenhouse gas emissions.
 - It is estimated that deforestation adds more carbon dioxide into the atmosphere a year than the sum total of cars and trucks on the worlds roads. Deforestation does not solely result from clearing for agriculture, an estimated 500,000ha of forest a week is logged for its timber while vegetation is also removed to make way for expansion of urban communities, transport networks and for mining.
 - Deforestation can therefore be linked directly to climate change. Ocean acidification has also increased because of the amount of carbon dioxide now present in the air and with fewer trees present to convert it into oxygen. The build-up of carbon dioxide is gradually seeping into oceans, raising the pH and killing off various species of plant and animal life.
-

SYLLABUS DOTPOINT 14

One Major Type of Evidence for Climate Change through Geological Time

We know that climate change has occurred throughout history. The Cretaceous Period was 5-7°C warmer than it is today, and there have been several glacial periods where the world was colder than it is now.

Evidence for climate change can be studied through geologic time through the use of proxy data. These include the study of ice cores or the study of tree rings (dendrochronology).

Tree Rings:

- Proxy data found within tree rings by paleo-climatology
- Characteristics in tree rings indicate changes in weather and climatic patterns
- Larger, thicker rings indicate a rainy season
- Thinner rings indicate a dry season
- Black rings indicate a bush/wildfire
- Differing colours express an early start to summer or winter

Therefore, it shows how climate in the area has changed over the years. For instance, an increased number of thin rings in the outer part of the tree ring indicates a decrease in rainfall over the past year. In this way, gathering samples from an area allow paleo-climatologists to understand how the climate of an area has changed.

Ice Cores:

- Obtained by drilling into ice sheets most commonly found in Greenland (i.e. Camp Century) and Antarctica (e.g. Lake Vida)
 - Can be used to reconstruct a climatic record over the age range of the ice core through isotopic analysis
 - As ice forms from the annual build up from layers of snow, it contains remnants of dust, ash, pollen and bubbles of atmospheric gases
 - As snow continues to accumulate, the snow beneath is compressed until the surface pores are closed off and traps the particles and bubbles within, providing evidence of past climatic patterns.
 - Some ice cores can be used to reconstruct an uninterrupted climate record
 - i.e. One ice core from Vostok in Antarctica has been able to provide paleo-climatologists with information for the last 420,000 years and clearly reveals four past glacial cycles.
 - Different substances in the ice core prove the occurrence of various different things. Trapped ash leaves evidence of past volcanic eruptions. Dust can be linked to an increased amount of surface desert or increases in wind velocity. Air trapped in bubbles can reveal the variations in carbon dioxide composition.
 - The ratio of stable isotopes of either oxygen or hydrogen in the water molecule is also related to the temperature at the time of snowfall. Higher levels of carbon dioxide are linked with increased temperature, and therefore global sea level variations, thus providing a record of the Earth's past climatic patterns.
-

SYLLABUS DOTPOINT 15

One Major Type of Evidence for Climate Change in Recent Human History

World Weather Records:

Evidence for climate change can be obtained from recent human history through data collection from meteorological records, documentation of extreme weather events, data from weather satellites and weather balloons, measurements in glacial extent and from observable changes to sea levels.

'World Weather Records' began in 1923 and produces a large volume of monthly data about temperature, precipitation and air pressure from hundreds of stations around the world. Some stations have been collecting data from the earlier part of the 1800s and provides us with excellent historical data for climate change.

The first national meteorological service in the world began in the United Kingdom in 1854. By the end of the century many other countries had established their own national meteorological services providing data that produced details about local and regional dominant climatic patterns and provided information that could be used for forecasting the weather.

From these records we have observed changes to local and regional patterns (e.g. a decline in the annual precipitation in the south-west of Western Australia and a significant increase in wet season rainfall over north-west Australia) and also to global patterns. Over time the quality, variety and quantity of observations has improved and it is now possible to map the distribution of temperature and other climate changes since the late nineteenth century.

From this we have observed that the globally averaged near-surface air temperature rose 0.8°C between 1850 and 2012, although there has been a cooler trend during this time, roughly between 1945 and 1975. In Australia, 7/10 of the warmest years on record have occurred since 2002.

Satellites:

- Track through imagery, the changes inland over which can be combined with data on weather that change is natural or not
 - Infrared emissions are used to measure land and sea temperatures. A rise in temperature varies around the world.
-

The Interrelationship between Land Cover Change and Climate, including Changes to Surface Reflectivity (albedo) and the Process of Natural Carbon Sequestration

Interrelationships between land cover change and climate:

- Humans also affect climate through changes in land use and land cover
 - Activities like growing food, cutting trees, or building cities
 - Land cover: refers to the physical characteristics of land surface
- Creates feedback loops that can affect the severity of future climate changes
 - Illustrates the interrelationship
- Decisions about land use/cover can also positively or negatively affect how much climate will change. This effect is examined in 2 sections; Changes in Surface Reflectivity and Changes in Carbon Sequestration

Changes in Surface Reflectivity:

- As the Sun's rays hit the Earth, a certain amount is reflected back into space. The amount of this is known as albedo. Albedo is different for different surfaces (for instances, ice has a better ability to reflect than dark, wet soil).
- The average albedo is 0.31, which proves that almost a third of all radiation is reflected back into space
- Earth is in radiative equilibrium when the gain of insolation is occurring at the same rate as the loss of terrestrial radiation
 - $\text{Insolation} > \text{Terrestrial Radiation} = \text{increase in temperature}$
 - $\text{Insolation} < \text{Terrestrial Radiation} = \text{decrease in temperature}$
- **The Cryosphere**
 - The amount of reflected energy tends to be a lot higher in areas where ice and snow dominate, as fresh snow, old snow, and ice are all good reflectors.
 - An increase in temperature would lead to a decrease in snow and ice cover. Less energy increases warming, more snow and ice melts, and causes a positive feedback loop.
 - This causes more warming across the planet
 - When there is less snow, less of the sun's rays are reflected back into space and are instead absorbed by the land and sea, leading to more warming.
- **The Lithosphere + Biosphere**
 - When vegetation is cleared, the surface becomes bare and reflects more sunlight back to space and cools the Earth.
 - Short term cooling
 - This process releases CO₂ into the atmosphere, and is not able to be absorbed as the vegetation is now cleared
 - Long term warming
 - The cooling trend is often followed by a warming trend much later on
 - Changes in dense vegetation and built structures after evaporative heat transfer from vegetation
 - Temperatures vary in different urban areas due to the urban heat island effect:
 - Caused by decreased albedo and reduced atmospheric circulation
 - Due to lack of vegetation (loss of shade and CO₂ removal), and higher levels of pollution
 - Highest temperatures in downtown areas
 - Great temperature changes at night

Changes in Carbon Sequestration:

SYLLABUS DOTPOINT 17

The Effects of Climate Change in Natural and Anthropogenic Biomes (vegetation, ice sheets, glaciers, coastal systems and coral reefs, agriculture, urban settlements and industry)

Natural Biomes

- Global Forests
 - A rise in temperatures would lead to an increased length of the growing season, but it would shift the suitable geographic regions for some species
 - Some species would be at risk of dying due to their location no longer being suitable for their survival
 - i.e. Some mountaintop trees would die out as temperatures get warmer, and they would not be able to shift to a higher altitude
- Coral Reefs
 - As water temperatures increase, the coral in the reef experience thermal stress, which leads to both infectious disease and coral bleaching
 - The Great Barrier Reef has become a centre to express how coral bleaching is a problem
 - In 2016 alone, one fifth of the coral in the reef died due to bleaching
- Ice Sheets
 - The mass of ice sheets decreases
 - As temperatures increase around the sheet, the ice melts and becomes a meltwater runoff, reducing the mass of the ice sheet
 - The Greenland Ice Sheet is a primary example of this loss of mass
- Deserts
 - Desert land has been expanding due to climate change
 - Climate change has led to a rise in temperatures and decline in rainfall in these areas
 - This means desert land has been expanding
- Tundra
 - Permafrost is decreasing due to increasingly warmer climates
 - Melting of permafrost leads to an invitation for different species, such as birds and insects
 - This is because the permafrost contained dead plants and creates small lakes
- Glaciers
 - Formation of glaciers is dependent on its snow not melting, so that it can condense into glacial ice
 - If the snow melts due to an increase in air temperature, the glacier will not be able to form
 - Glacial retreat
 - When a glacier's terminus (ending) retreats further upwards than before
 - When the ice melts faster than new glacial ice accumulates
 - Increase in temperature
 - Decreased snowfall
 - Environmental Consequences:
 - Global average of 10m a year loss for glaciers
 - Occurs for glaciers in all continents
 - Increase in meltwater off glaciers leads to a rise in sea levels → the water runs into the ocean
 - According to the reports of the Intergovernmental Panel of Climate Change, sea levels rose around 15cm in the 20th century, and glacial meltwater contributed to around 27% of this
 - The Panel also predicts that sea levels could rise as much as another 80 – 100cm higher by 2100

- Social Consequences:
 - Meltwater only provides fresh water to communities while the glacier still exists
 - Once the glacier has melted, the availability of water will become significantly reduced
 - Many communities that relied on it as their water source will have to find an alternative
 - Many coastal regions have recently stated developing a high exposure to flooding
 - The rise of sea levels is the largest contributor to the increased rate of flooding
 - Lakes often form at the end of melting glaciers, and are characteristically very unstable, meaning that any large motion would lead to a giant flood
 - Peru in 1970, where water was collated as a lake at the top of the glacier
 - A chunk of the glacier broke off due to an earthquake, and the lake emptied itself below
 - Led to the death of over 20000 people
 - Groups of people develop significant attachments to glaciers, so when they retreat and disappear from view, it can cause a significant sense of loss
 - i.e. the villagers of Southern Peru's Quelccaya icecap region reportedly experienced distress due to the summits of several nearby peaks turning darker (due to a loss of snow cover). The villagers had understood that these summits were home to powerful spirits
 - Political Consequences:
 - Glacial retreat is an international problem, so it involves nations across the globe
 - Individual natural disasters such as avalanches, floods or other glacial-related incidents require response from the nation the accident occurred in
 - Other nations can also offer support for that nation through volunteer aid
 - Also be used in order to form a specific response for a political vote
 - When there were floods in Kedarnath in North India, the chief minister (Harish Rawat) elected to continue the holding of the Kedarnath Yantra (an annual tradition) to show his opponents and the public that his government could serve the public
 - Economic Consequences:
 - When a glacier fully melts and water has become scarce, the community experiences a lack of water resources
 - They have to spend extra money in order to provide themselves with water
 - When a glacier which had spiritual or aesthetic meaning retreats, there is a decrease in tourism
 - Affects the community's economy
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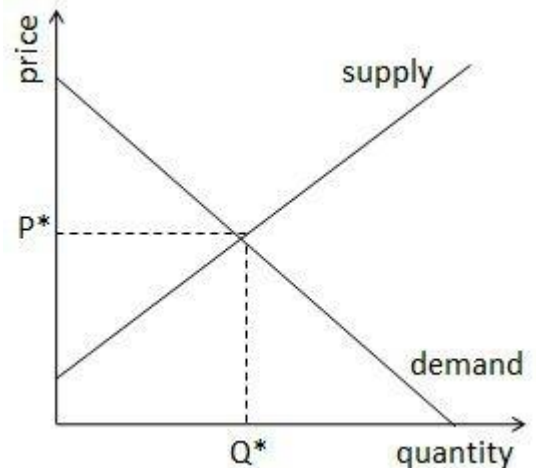
Anthropogenic Biomes

- Urban Settlements
 - Coastal urban areas are threatened and will eventually become submerged from a rising sea level
 - Rising sea levels are caused by the melting of ice from glaciers and ice caps
 - i.e. Miami is almost entirely over the ocean, it experiences large amounts of water on the ground particular near the ocean
 - Scientists predict that due to a rise in sea levels, Miami will be completely underwater by 2100
 - Rangeland
 - Due to both rising temperatures, and either a rise or decline in precipitation patterns, areas used for plant growth are becoming either wetter or drier
 - This allows for the ability for plants to be planted in areas where they can be properly produced, and leads to an increase in forage
 - This can be seen in the San Francisco Bay Area, where peak forage production has been increasing rapidly since 1961
 - Villages
 - Villages situated close to or on the ocean/ivers are threatened by climate change due to an increase in the number of storms they experience
 - When a village encounters a storm, the water rises and floods the villages
 - This forces the residents to have to either rebuild the village or emigrate away
 - This means a higher proportion of land is being used for villages
 - Storms have been present in many towns, ruining many such as that of Shaktoolik in Alaska
 - The water has been flooding the town and the town is predicted to no longer exist within the next 30 years
 - Agriculture
 - Different crops require growth in different specific climates in order to reap maximum yield
 - If it is too hot, cold, sunny or rainy, then the growth of these crops would be stunted or may not occur at all
 - Higher levels of carbon dioxide allow for a greater amount of photosynthesis, allowing crops to grow better
 - i.e. Cotton. It grows in a subtropical climate, where there is a good amount of wet and dry weather. If the temperature dips below 15.5°C if above 38°C, growth would slow down or stop. It requires full sunlight for photosynthesis, and not a lot of water, otherwise pollination will be disturbed
 - For crops to grow properly, the soils must have the right balance of the correct chemical, physical and biological factors. If one of these are out of proportion (i.e too much salt in the soil), then the plants will not grow well or at all
 - Agriculture relies on ideal climates in order to grow crops
 - *Rising Temperature*: Crops with a lower optimum temperature would experience a lower crop yield, and those with a higher optimum temperature would experience a higher one.
 - It can also lead to a higher vulnerability to disease and parasites for livestock (weeds, fungi and pests tend to survive best in warmer temperatures with an increase CO₂ concentrations and a wetter environment)
 - Weeds and fungi compete with crops for space and nutrients
 - Pests destroy crops
 - Aquatic agriculture; water temperature increases with an increase of air temperature
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- Aquatic species tend to seek out colder areas of streams, lakes or oceans.

○ Economic Consequences:

- When crop yield increases, farmers may increase the size of their plantations in order to grow a larger supply, changing the land around their farm
 - More money is spent on resources in order to expand
- When crop yield decreases, farmers may abandon the land, leaving it to die. Or they may uproot it and plant new crops
 - Economic loss as their crops died
 - It doesn't cost money to abandon them or uproot them and plant something else there
- If a certain food became scarcer, then the price for that item would increase as supply were lower, meaning that there would be more money having to be spent on it



○ Social Consequences:

- Decrease in crop yield would lead to the price of that crop increasing, leaving people unable to afford certain different foods
- Some farms would shut down, as their location would no longer have a suitable climate for growing crops

○ Political Consequences:

- More competition for resource in order to grow a certain crop would lead to a higher level of imports and exports, and cause the need for trade deals
- Greater interaction between nations as they attempt to receive sufficient levels of resource

○ Environmental Consequences:

- Farmers may wish to plant extra crops in order to attain more supply due to the increase in yield caused by climate change
 - More land that is arable will be introduced
- Natural disasters cause the destruction of crops
 - They need to replant new or old crops
- Aquatic species emigrate to colder areas
 - Creates competition with species there already for resources
 - Reduces the amount of land usable for farming fish
- Increase in temperature can lead to droughts, which threatens livestock due to the dwindling supply of pasture, and the promotion of disease
- Increase in carbon dioxide in the atmosphere would decrease the quality of crops which livestock consumes
 - Livestock would have to consume a larger amount in order to receive the same level of nutrients
 - Would change the land cover as more land would be used for crops in order to feed this livestock

SYLLABUS DOTPOINT 18

The Projected Impacts of Climate Change

Climate change can be seen through the global patterns of temperature and precipitation, often shown as trends, which reflect a gradual shift in climatic patterns. The majority of the globe is experiencing an increase in temperature, with a significant increase heading further north in the Northern Hemisphere. For Australia, the nation has also experienced an increase in temperature trends, with areas such as Central Australia experiencing up to 0.6°C increase every 10 years. Annual precipitation trends show that many locations across the globe are experiencing a change in rainfall patterns. We can see in areas like Central and Northern Africa are experiencing a great decline in precipitation rates. While areas like Northern American and Eastern Australia are experiencing a great increase in precipitation rates. In Australia, the overall trend is that the rate of rainfall is declining in the Southwest, while it is increasing in the North. Annual mean temperatures across Australia have also been increasing ever since around 1970.

What happens in the future is often based on trends from the past, and projections are hence based on probability and climate modelling. Temperatures have been expected to increase on average across Earth. Some locations are projected to experience an increase in precipitation, such as Canada, while other areas such as Australia are expected to experience a decrease in the rate of precipitation.

Climate Change

A long-term change in the climate system. It is a trending shift in the characteristics of the heat budget, atmospheric circulation, the carbon cycle and the heat budget, and is evidence of past climates and their changes, as well as being able to project future changes in the climate system based on the use of trends and modelling.

El Nino and La Nina are the natural cycles which have one of the strongest influences over Australia's annual climate variability. It is a natural cycle and are associated with a sustained period over many months of warming (El Nino) or cooling (La Nina). El Nino occurs in Eastern and the extreme Northern Australia, generally lasting from around May to November. El Nino events lead to reduced rainfall, warmer temperatures, an increase in frost risk, a reduction in the number of tropical cyclones, an increase in fire danger and a decrease in alpine snow depths. 9 of the 10 driest winter-spring periods on record have occurred over an El Nino event. La Nina occurs in Eastern and the extreme Northern Australia primarily, over the winter-spring periods. La Nina events lead to increased rainfall, cooler maximum temperatures, a decrease in frost risk, a higher number of tropical cyclones and a deeper relative snow covers. They occur more often due to shifting in the temperature of oceans like the Pacific, where high pressures lead to La Nina events and vice versa for El Nino. They are indicators of climate variability.

Anthropogenic Climate Change

There is new and stronger evidence that most of global warming observed over the past 50 years is due to human activities. Greenhouse gases make the largest contribution from human activities (CO₂). It is released by burning fossil fuels (such as coal) and biomass as a fuel. This burning could be from the clearing of forests for example. Emissions of carbon dioxide due to fossil fuel are noted to be the dominant influence on the trends in atmospheric CO₂ concentration during the 21st century.

“Human influences are expected to continue to change atmospheric composition throughout the 21st century” – IPCC’s Third Assessment Report

Projected Impacts of Climate Change: CO₂

Carbon dioxide in the atmosphere is measured from the middle of the Pacific Ocean as it is one of the most remote areas on Earth. It has been seen that an increase in carbon dioxide leads to an increase in temperature as well. 40% of all people get their drinking water from glacial meltwater which runs into rivers and lakes. 35 years ago, the Arctic permafrost was able to be driven on for around 225 days a year. That number has now decreased to less than 75 days a year. Arctic sea ice extent and thickness has dropped over 40% over the last 40 years, and it could be gone in summers in 40 to 50 years time. This affects all animals living in habitats around it, such as polar bears, which have been seen swimming 96km out into open water looking for ice to live on. This is also seen through how around 60 million people in Calcutta and Bangladesh would be displaced if either Greenland or West Antarctica melted (if West Antarctica melted, sea levels would rise up to 20 feet higher). In the past 14 years, all 10 of the hottest years on record have occurred, the hottest being 2005. In Europe’s heatwave of 2003, over 35000 people died. That same year, temperatures in India reached 50°C. In the past few decades, the river of Lake Chad in Africa has dried up to almost nothing. Due to climate change, approximately 30 diseases have emerged in the past 25 years. The current extinction rate is 1000 times greater than what would be the normal extinction rate.

DEPTH STUDY TWO: ADDRESSING LAND COVER CHANGE

SYLLABUS DOTPOINT 19

Approaches to Land Cover Restoration and Rehabilitation, and the Mitigation of Future Land Cover Changes, including Preservation Strategies

The aim of the rehabilitation/restoration of land cover is for:

- Conservation of Land
- Better management
- Protection of Fragile environments

Land Cover Restoration is the returning of the natural landscape and habitat within ecosystems back to their original state.

Land Rehabilitation is the actual process of returning that particular area of land to some degree of its former state after it has been degraded through possible projects associated with mining, farming, forestry or industry.

- *Example of Land Cover Change in WA:* introduction of bauxite mining in the Darling Scarp that first began around Jarrahdale in 1963. During the 1970s, further mining operations were developed at Del Park and Huntly, east of Dwellingup, and was followed by the opening of the Willowdale mine which was established in 1984 near Waroona.
- Bauxite is mined by surface methods known as open-cut mining, which sees the necessary removal of all vegetation, followed by the removal and stockpiling of about half a metre of topsoil and overburden by bulldozers and scarppers. This creates a scar on the landscape as mining disrupts the surface, it is estimated that every year the worldwide use of land related to bauxite mining is 40-50km².
- The two present operational mines in the Darling Scarp at Huntly and Willowdale supply 43% of Australia's alumina. After each mining pod is exhausted, ALCOA undertakes a major rehabilitation program to help restore the forest ecosystem by aiming to achieve full plant richness in the area. Each year approximately 600 ha are mined and rehabilitated at ALCOA's two Western Australian mine sites.
 - The rehabilitation begins with the collection of seeds from the original site to be mined. This ensures that the forest ecosystem is returned to as close to its original state as possible. Mine site rehabilitation aims to meet the key objectives of the long term stability and sustainability of the landforms, soils and hydrology of the site, the partial or full repair of ecosystem capacity and the prevention of pollution of the surrounding environment.
 - After mining has been completed there is a general landscaping of the site with steep walls removed and the area is shaped and contoured. This is followed by a pre-ripping of the pit floor to a depth of 1.5 metres so as to reduce clay compaction which may inhibit water infiltration and root penetration. Gravel and topsoil are returned either directly from new mining areas or from stockpiles.
 - Once the topsoil is returned the area is further scarified to a depth of 30 to 40 centimetres so as to improve surface infiltration and to reduce the potential of erosion from runoff. Logs and forest residue are now scattered through the area to provide potential habitats for burrowing animals
 - The pits are then broadcast with the locally collected understorey and tree species, usually during the wetter months. Adequate stocking of both jarrah and marri trees are required and many of these are developed from planted seedlings. Fertilising

with superphosphate and trace elements of copper, molybdenum and zinc is then completed by helicopter.

- This land cover rehabilitation process mitigates further land cover changes through a systematic monitoring program that is required to assess the establishment of the vegetation, the re-establishment of nutrient cycling and the return of fauna to this habitat.
 - The initial revegetation must establish the building blocks for a self-sustaining system. This should see a combination of ground cover, shrub and tree species being used. In some areas a cover crop could be sown with the native species to protect the replaced soil against erosion in the first year before the slower growing native species can afford some protection
 - The soil should have adequate infiltration capacity, adequate aeration and capable of supplying adequate plant nutrients while also being free from excessive salinity, acidity and alkalinity. Ongoing application of fertilisers may be necessary in some cases as the ecosystem develops so as to ensure that nutrient totals are achieved.
 - Animals will move back into rehabilitated areas once the vegetation is similar to surrounding areas. Further methods can be employed by transplanting grass trees, resspreading mulched vegetation and branches to provide shelter for reptiles and by establishing old dead trees that provide hollows, crevices and exfoliating bark.
 - Controlling the spread of weeds, employing baits for feral animals that are non-toxic to native animals and maintaining the ability of the soil to supply nutrients to store and supply water and to support root growth are all essential in developing a sustainable ecosystem. With practices such as these in place it ensures a high standard of the restoration of the ecosystem and environmental performance.
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SYLLABUS DOTPOINT 20

The Current and Proposed Strategies, at Local to Global Levels, Implemented to Mitigate the Adverse Effects of Global Climate Change

Natural Area Management Strategy:

- Encourage developers to consider ecological linkages during the design phase
 - Be prepared to alter management strategies in response to changing climates
 - Better management and control of irrigation for parks and open space
 - Maintain genetic diversity
 - Financial grants to NFP organisations to improve ecosystems
 - Keeping vehicles out of conservation reserves
 - Dogs to be kept on leads
 - Prevent rubbish dumping and littering
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SYLLABUS DOTPOINT 2 I

How Human Activity Has Adapted, or May be Required to Adapt, to either Global Climate Change or Loss of Biodiversity

Adaption of Human Activity to Climate Change:

- The orientation of windows
 - Generally facing north
- Double-doors to reduce the loss of air-conditioned cool air
 - When the first doors open, the other doors are not open, so the cool air still has not escaped the building
 - When the second doors open, the first doors are now closed, so the hot air doesn't enter the building.
 - This can be seen in various shopping centres such as Cockburn Central or Centro Galleria in Morley
- Planting trees to provide shade (adapt) and act as carbon sinks (mitigate)
- Reduce the land-extensive space of shopping centres
 - Seen in Cockburn Central with its underground carpark, or the multi-level carpark in Perth City
- The construction of a seawall
 - Malé, Maldives
 - The Maldives is the lowest country in the world, highest point is 2.4m above sea level.
 - A two metre seawall has been built around Malé, the capital city and one of the most densely populated cities in the world. (154000 people within 5.8km²)
 - Japan
 - 43% of Japan's coastline is lined with concrete seawalls to protect the country against high waves, typhoons and tsunamis. The world's largest seawall was built at Kamaishi in Japan and cost US\$1.5billion, but even this failed to stop the waves from the 2011 Tohoku tsunami. In recent years Japan has spent US\$6.8billion for a 400km chain of seawalls up to the height of four-storey buildings in place

SYLLABUS DOTPOINT 22

A Program Designed to Address the Impacts of Land Cover Change on Local and Regional Environments

SYLLABUS DOTPOINT 23

An Evaluation of the Program, Giving Consideration to Environmental, Economic and Social Benefit and Costs

SYLLABUS DOTPOINT 24

An Evaluation of At Least One Alternative Approach to the Management of Land Cover Change in the Area Being Studied, Using the Concept of Sustainability to Determine the Extent to Which the Approach has the Potential to Address the Issue into the Future

Land Cover Change refers to land surface changes in both the physical and cultural environments, often as a result of human activity. Human use of the land for agriculture, settlement and pasture has resulted in modifications that have produced deforestation, altered drainage systems, land reclamation, land clearing for mining ventures and a loss of natural ecosystems.

It is estimated that humans have altered between 39 – 50% of the Earth's land surface resulting in land cover change. Almost all of the natural grasslands (about 92%) have been converted to mostly grazing land and about 90% of all natural temperate savanna has been modified to make way for croplands. To ensure sustainability, programs have had to be developed to minimise the impacts of land cover change on local and regional environments.

Bush Forever

- The need to protect natural ecosystems from land cover change has resulted in a number of conservation programs that have been instituted to protect biodiversity on local and regional scales. One such local example is the 'Bush Forever' program that aims to protect 51000 ha of natural bushland in 287 sites on the Swan Coastal Plain portion of the Perth Metropolitan Area.
- In 2010 all of these sites were afforded statutory definition on the Perth Metropolitan Region Scheme map as a result of intense lobbying by the Urban Bushland Council. The program identified that much of Perth's bushland was under threat from land clearing, groundwater depletion, weed invasion and lack of legal protection and that at least ten ecological communities were under severe threat, as were a number of species of flora and fauna, such as the Western Swamp Tortoise.
- These sites have been set aside include; Conti Road Bushland in Wanneroo, Carine Swamp, Mount Henry Bushland in Salter Point, Shenton Bushland and Dianella Open Space. The overall program aims to provide a policy and implementation framework that will guarantee bushland protection and will tackle management issues that would be addressed in all future land use planning decisions.
- This program identified the need to retain bushland within Perth to contribute to the unique character of the city and conserve biodiversity through the assurance that the State and local governments, the community and landowners would work together to protect these resources. The vision is part of a general duty of care for future generations and to bring greater certainty to the processes of land use planning.

Gondwana Link

- On a regional scale the 'Gondwana Link' is an example of another conservation program that aims to restore and protect native vegetation systems across the south-west of Western Australia. It aims to reconnect the land so that it will create a continuous habitat that will stretch for 1000km from the dry mallee woodlands that border the Nullarbor Plain to the karri forests of the south-west corner of the state.
 - This region has been identified as a biodiversity hotspot but unfortunately two thirds of the overall south-west sector has been cleared to make way for agriculture. Patches of original bushland do not guarantee the survival of many of the local flora and fauna and so a reconnected ecosystem is required to ensure the sustainability of this locale.
 - This area is biologically rich with over 20% of Australia's flora species and 17 of Australia's 23 main vegetation groups being represented. Fortunately, much of this particular southern area has much of its habitat still intact as a result of manages National Parks and Nature Reserves in existence (Fitzgerald River National Park). The restoration of the links between these habitats is now the key objective and the approach of the 'Gondwana Link' program has been unprecedented in their efforts in increasing the scale and quality of their conservation management.
 - Land cover change in the area has seen many bird and animal species reduced to small isolated remnant populations that have been slowly leading towards the extinction of some
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of these varieties (e.g. Western Whipbird). Introduced feral animals also threaten biodiversity while significant threats exist and are emerging with plant disease in some parts of the region (e.g. phytophthora). Climate change also threatens increased fire risks, weed invasion and loss of native species.

- Through land acquisition and conservation covenants the program aims to protect these areas most at risk while at the same time be able to apply the latest revegetation techniques to create a connected native bush habitat. The environmental organisation, Greening Australia, has also been involved and helped fund a large amount of direct seeding and tree planting in the area.
 - The program also has a focus of revegetating at least 20 – 30% of the main river catchments in this areas so as to reduce salt, sediment and agricultural pollution, especially around the Pallinup and Bremer Rivers. Land that has been identified as the least suited to agriculture is planned to be rehabilitated so as to reduce degradation within this area.
 - The consensus had been that the overall management of these lands had been less than adequate so it is envisaged that this 'Gondwana Link' program will play a critical role in improving the standard of care in this whole regional environment.
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UNIT FOUR: PLANNING SUSTAINABLE PLACES

OVERVIEW OF PLACES

SYLLABUS DOTPOINT 1

The Processes of Urbanisation and its Implications for World Population Growth and Human Wellbeing in Urban and Rural Places

Concept of Urbanisation: Urbanisation refers to the overall increase in the proportion of urban dwellers in a region compared to the percentage of rural dwellers in that region over time. This is often linked to a population movement of people as they leave rural areas and relocate to urban areas due to various 'push and pull factors', such as employment opportunities. This trend has become evident in India – 11.4% of the population lived in urban areas in 1901. By 2001 it had increased to 28.53% and it further increased to 31.16% by 2011. Urbanisation doesn't necessarily mean that there is a decline in the rural population. It is simply that the proportion of urban dwellers is increasing over time.

Urbanisation – Global: From 1950-2050

- Europe: shift to rural areas
 - Demographics
 - Lifestyle
 - Employment
 - Cost of living in cities
- Africa: 5% - 20% growth in urban populations
 - Industrialisation
 - Growth in industry/manufacturing, though it is slow
 - Rural → urban migration
 - Climate change → change for agriculture
- North America: little to no change
- Latin America: Reduction in rural populations in recent years
 - Deforestation to create urban areas

Urbanisation – Regional: From 1911-2011

- WA:
 - 1911: Urban – 56.2%, Rural – 43.8%
 - 2011: Urban – 89.9%, Rural – 10.1%
 - ACT:
 - 1911: Urban – 0%, Rural – 100%
 - 2011: Urban – 99.7%, Rural – 0.3%
 - NSW:
 - 1911: Urban – 63.8%, Rural – 36.2%
 - 2011: Urban – 90.4%, Rural – 9.6%
-

- NT:
 - 1911: Urban – 28.5%, Rural – 71.5%
 - 2011: Urban – 71.7%, Rural – 28.3%

Drivers of Urbanisation:

1. Job Opportunities
2. Places for industry to expand
3. Technology: advancements & innovations
4. Safer in cities
5. Places to trade

What Makes a Good Urban Centre?

1. Transport
2. Safe
3. Social Engagement
4. High Level of Services & amenities
5. Sustainable/eco-friendly

What are some traits of poor planning?

1. Social Segregation
 2. Uncleanliness
 3. Homelessness/social dysfunction
 4. Poor accessibility
-

SYLLABUS DOTPOINT 2

The Economic and Environmental Interdependence of Urban and Rural Places

Economic Interdependence –

Agricultural products to be consumed locally and exported to both national and international markets is a significant interaction between rural & urban areas.

- **Food:** Food is produced in rural places and transported to urban places for further processing and distribution. In Australia, 40% of all farm produce is consumed domestically, and the other 60% is exported overseas. Rural banks, gazetting (announcing of) town and establishment of road and rail networks facilitate the expansion of agricultural activities in the area.
- **Raw materials:** Supplied from rural places to urban places including those from mining activities and forestry. It has been estimated that between 25-40% of all office space in Perth's CBD is linked to mining and exploration industries.
- **Energy Production:** For urban places predominantly, it occurs in rural areas. For instance, the town of Collie in WA, or the Hunter Valley in NSW are both examples of centres of coal-based energy productions
- **Jobs:** Mostly in urban areas. It experiences increased education, social, sporting and cultural opportunities due to the rural-urban shift. This is as many of the 15-25 year old demographic leave rural places and move to urban areas.
- **Capital and Profits:** Capital and profits accumulated in urban places are used to provide infrastructure, investments and facilities in rural places (e.g. food & fibre research, support for education). WA has a program called the 'Royalties for Regions' program which has the state government set aside millions of dollars to develop rural-based infrastructure and facilities.

Environmental Interdependence –

Rural areas are viewed as being 'far away' from urban places, leading to both positive and negative interactions/outcomes in terms of environmental interdependence.

- **Short-term:** The desire to experience opportunities for an escape, reflection, recreation and reconnection with nature is attractive to urban dwellers. It is generally in pristine areas of the wilderness, beside the ocean or in wide spaces.
 - **Long-term:** Urban dwellers may seek to relocate due to perceived or real benefits in terms of lifestyle, affordability, space and safety.
 - The vastness and remoteness of rural areas often results in the flow of waste from urban to rural places
 - Rural places are often viewed as suitable dumping grounds for urban wastes. Air pollution and acid rain threaten both cultural and physical environments.
 - Urban places rely on natural places to manage the environment effectively to ensure the needs of the growing population are met
 - Clean air and water, flood/drought mitigation, soils and soil fertility, pollution mitigation, etc. are all largely dependent on how well rural areas are managed.
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SYLLABUS DOTPOINT 3

The historical, cultural, economic and environmental factors that have contributed to the spatial distribution of urban and rural places in Australia

Historical Factors -

- Australia was not established as a single nation, rather 6 different colonies
- Each settlement was located on the coast and on a river, inlet or natural harbour
- Government controls for building of infrastructure were centred in these settlements and have become a hub of economic activity and employment
- Main ports - importing and exporting
- Need to be self - sufficient in food production meant that eventually exploration to find rural areas suitable was encouraged and new urban settlements were developed

Economic Factors -

- Capital cities and ports:
 - Economic inertia where change has been resisted (e.g. moving Fremantle port to Kwinana)
 - More transported = import and exports. The presence of the facilities and services mentioned has meant industry and commerce have always been attracted to the larger, coastal urban places
 - *Urban multiplier effect* = continued establishment of new businesses and associated employment
 - All centred their operations in largest urban centres
- Mineral Discoveries:
 - The discovery of gold and other mineral and energy commodities has continuously shaped the nature and location of urban and rural places across Australia.
 - Kalgoorlie Boulder. World's largest continually operating Gold Ore body is the only remixing urban centre.
 - Increased population - minimising primary reason
 - Jobs (fly in/fly out)
- Agriculture:
 - Residents are employed in non-primary industry forms of employment
 - Fibre production such as wheat and cereal grains gave rise to small rural series
 - *Farm Amalgamation* leads to *economies of scale.* Join or come together. No one left to inherit farms. As young go to city instead.
 - The overall trend is that many small centres are getting smaller and the fewer big entries are getting bigger.
 - Transport and railways positioned at main settlement allowing it to grow.
- Decentralisation and Settlement Schemes:
 - *Decentralisation*: moving services and people and companies out of the city
 - Returned soldier settlement - meaningful work and gives agricultural land
 - Irrigation schemes = win win scheme pop is steady - crop growth = industry at Ord river with Dam.

Environmental Factors -

First settlers = Sydney

- Climate:
 - Agricultural regions
 - The higher the productivity of the land the more services in the area.
-

- The soaring summer temperatures, cold winter temp inland and general lack of reliable rainfall, have resulted in the presence of few settlements not directly associated with mining and exploration.
- Hydrology:
 - Both for agriculture purposes and as a water supply.
 - Flat coastal plains along coastlines resulted in extensive, low diversity nature of Australia; large urban places = Low density Urban due to flat land.
 - Provides barriers (Great Dividing Range)
- Soils:
 - Nature of Soils
 - Fertile alluvial soils around more mountainous regions along east coast and southeast corner due to rainfall and runoff
 - Less fertile soil = less urban and rural settlement.
 - West contains sandy clay soil = less settlement

Cultural and Social Factors -

- Rural Urban Drift = rural to urban
 - Young adults from to more urban/city places education
 - Job opportunities
 - Cultural opportunities/social opportunities
 - Retirees often move to rural places and smaller coastal urban places
 - Mandurah - South of Perth, now has a pop of over 83,000
-

SYLLABUS DOTPOINT 4

The processes of urban sprawl, invasion and succession, renewal, planning, land use competition, inertia and agglomeration that have contributed to the characteristics and functions of urban and rural places in Australia

Definitions:

- *Urban Sprawl:* *check glossary*
 - *Invasion and Succession:* *check glossary*
 - *Renewal:* Urban renewal refers to larger, wholesale redevelopment projects, which can take place within an urban or rural location. As a process, it usually occurs in areas that are heavily blighted or rundown with the aim to rejuvenate the whole area. Renewal projects are often government led or funded, as they require coordination on a number of levels and a large financial backing.
 - *Planning:* Planning policies and regulations now play an all-pervasive role in shaping the land uses and characteristics of urban and rural places. Governments, at all three levels, have an influence on land use zoning, transport planning, the grouping of compatible land uses, the creation of buffer zones between incompatible land uses, determining residential densities, predicting future growth and overseeing urban renewal projects.
 - *Land Use Competition:* When more than one land use can benefit from a particular location, then competition for that location occurs. This has the effect of driving land prices up. Usually the land use that can deliver the highest return on the investment will locate there.
 - *Inertia:* The process where a land use prefers to stay in its original location even though the original factors for locating there no longer apply, and in often there is no real reason for that land use to still be there.
 - *Agglomeration:* *check glossary*
-

SYLLABUS DOTPOINT 5

The changing demographic, economic and social characteristics, including age, gender and socioeconomic and cultural distribution, in urban and rural places in Australia

- Difficult to find data in rural places
 - Distinct pattern: 73% of the 22 – 44 age groups reside in urban places
 - 70+ years is the smallest group residing in rural areas
 - Pull factors is one reason., the young age cohort moves from rural to urban
 - Tertiary education, services and jobs
 - Gender distribution
 - Every 100 females, there is 99 males
 - More females in Australia
 - Rural areas in Australia, has more males than females due to jobs in rural areas are male dominated jobs, such as mining, mineral discovery
 - Average income distribution
 - Urban places have highest averages due to highly specialised services, where the providers demand high wages
 - Rural areas have the lowest average income due to the lack of jobs. Unless there is a job boom for mining, mineral extraction which makes rural areas have the highest average income
 - Cultural distribution
 - The most migrants are in large urban places because of support services
 - Migrants will likely move to a place where there are relatives that resides there this is called 'chain migration'
 - Rural areas attract migrants with particular skills
 - Majority of migrants reside in large urban places
-
- *It can be seen that Australia has been a predominantly urbanized nation over the last 100*
 - *years or so. After federation (1911) After WWII (1947) In 1911, the urban distribution of the*
 - *population was at 43%, this then decreased to 25% in 1951 and in 1976 it was 14%, then to*
 - *decrease to 11% in 2001. Urban population distribution in 1911 was at 58% then increased*
 - *to 75% in 1951 and then steadily increased to 90% in 2011.*
-

OVERVIEW OF CHALLENGES FACING PLACES

SYLLABUS DOTPOINT 6

An overview of the challenges facing rural and remote places in Australia, including Indigenous communities. Challenges include; population loss, economic restructuring, employment, housing, service and water provision, concentrations of socially vulnerable populations, social inclusion and exclusion, transportation, resource degradation, land use conflicts, declining political influence, isolation and remoteness, fly-in/fly-out work patterns.

The main drivers of the challenges facing rural and remote places is both distance and isolation. Due to the high cost for the transportation of goods, along with the lack of services in these communities, the remoteness of the areas is unattractive to potential residents. This leads to a decrease in the number of residents in these areas, and hence leads to a decrease in the need to provide goods and services.

THE CHALLENGES:

- Rural and remote areas suffer from population loss due to the rural-urban migration.
 - This is caused by:
 - Young people moving to urban areas for tertiary education & employment opportunities
 - Increased competition in agriculture makes it unappealing to live there (jobs are harder to get in agriculture)
 - Lack of access to services and commerce. This causes people to not wish to live in these communities as they do not have proper access to required provisions.
 - This loss in population leads to a fall in the demand for goods and services
 - This leads to further job losses as there is a lesser need to provide these goods and services
 - This means that many people in the community are unemployed or have a very low income
 - The decrease in support services leads to a higher level of health-related risks
 - As hospitals would not be able to function supporting such a small community, they would not have sufficient income to be able to function.
 - The loss of population in rural and remote communities can be seen in the rural town of Newman, which suffered a decrease of over 3000 residents between 2011 and 2016, from 7500 residents to around 4500.
- Rural and remote areas suffer from a lack of services and infrastructure.
 - This is caused by:
 - The low population, which means that there is not enough demand for goods and services in the area to allow businesses to thrive economically
 - The vast distance that remote communities are from other locations means that there is a lack of fresh food in the area. There is a high cost associated with transporting fresh food over such a long distance, which the community cannot afford
 - Due to the low population level, there is not a high level of real estate in rural and remote regions. This means that the prices of housing are often much higher and is not very affordable for potential residents

- This lack of service and infrastructure causes a great risk for rural and remote places:
 - Due to the immense distance from any health services, there is a higher level of health-related risks
 - **see population loss**
 - A lack of a varied diet caused by the lack of fresh fruit can lead to serious dietary problems. An unbalanced diet can lead to health risks such as malnutrition or scurvy.
 - The lack of service and infrastructure experienced in remote/rural communities can be seen in the Telfer Gold Mine. In the Great Sandy Desert, it was once a community with over 100 people. However, population decreased significantly due to the introduction of fly-in/fly-out work patterns in 1996. Community services and family residences were removed, as well as the supermarket, police station, bank and library.
 - Fly-in/fly-out work patterns also contribute to the challenges experienced by rural and remote places
 - This is a work pattern which is based off an aim to reduce the required services in a mining town
 - This led to a financial benefit for the mining company as they do not have to support the services offered in the town
 - This causes many problems for these places:
 - Leads to what is known as 'economic leaking,' where a lack of spending leads to no financial structure in the area
 - Due to the lack of permanent residents in the region, the town loses its sense of identity
 - Causes many families to have absent members during the work season
 - This is linked to various mental health risks, as well as attaining to the heightened rate of sexual and domestic assault and alcohol abuse among associated people
 - On the border of South Australia and Queensland is the town of Birdsville, which is along a major transport route for supply businesses. Since 1900, the population has decreased from 300 to 100, 2 of the 3 hotels have shut down, and several services such as the police station have shut down
 - These rural and remote locations suffer from resource degradation and water supplies.
 - 60% of Australian land is used for agriculture, and 88% of this land (53% of Australian land) is used for livestock grazing
 - This land use degrades the quality of the biophysical environment, as livestock clears up the natural vegetation
 - The extensive level of land clearing in these farming environments also led to the rise of the water table, due to replacing of native trees (whose roots reached the water table 10-30m below the ground) with shallow rooted crops, the water table rose. Due to the higher water table, the water mingled with the soils, and when this water evaporated, it left behind its salt quantities. This raised the level of salt in the soil, leading to higher salinity.
 - This leads to soil erosion and desertification
 - The town of Wagga Wagga in New South Wales has to obtain \$500million every year to deal with the problems of corrosion and degradation in their area
 - Land use conflict is a prominent challenge facing rural and remote towns
 - Many different parties hold opposing views on what a certain area of land should be used for
 - Common ideas for land use include:
 - Mining
 - Land conservation
 - Reservation for Aboriginal Land Rights
-

- Agricultural plantations
 - These arguments can lead to duress and disagreements
 - May lead to dissatisfaction and a loss of community identity
 - An example of land use conflict can be seen in Margaret River. Recently, there was an unsuccessful bid for the region to be used for coal mining. However, many disagreed, as this would threaten the main land use of viticulture, as well as threaten the tourism industry associated with viticulture
 - Many remote and rural communities struggle with their declining political influence due to their dwindling population
 - Around 100 years ago, around 40% of the Australian population lived in rural/remote Australia. Now, only 10% do.
 - The declining population means that there are less people needing to be represented in the electorate, so the number of representatives in the area do not need to be as high
 - This is a problem, as this means that the communities lack the strong representation that they may have once held. The voice of that community is less important and weaker
 - The electorate of Durack is the 2nd largest electorate in the world, measuring 1.6km²
 - There is only one representative for all 87000 residents
 - The high level of socially vulnerable populations is a challenge for rural and remote places
 - Those whom are unable to move to a better location characterise rural populations
 - This includes:
 - Poor
 - Disabled
 - Uneducated
 - Elderly
 - Sick
 - They are then isolated and excluded, leaving them socially vulnerable (where they cannot withstand repeated changes and stresses associated with them)
 - This can be caused through social inclusion and exclusion:
 - Social inclusion and exclusion is another challenge for these places
 - Social inclusion = When a person has the opportunity to participate in their society and have access to required services. They can connect with their friends and family and their community
 - Social exclusion = When a person does not have these opportunities
 - Leads to a lack of connectedness and participation
 - Highly linked to mental health issues such as depression, and suicide
 - Social exclusion is heightened due to the lonely nature of the area, and the loss of relationships (younger people would be moving to urban places). They feel alienated due to a lack of understanding that there are different lifestyles, activities and customs in their community.
 - Significant losses (i.e. family, droughts) and unrecognised/untreated depression leads to a heightened lack of services and drug abuse.
 - Men in regional and remote areas are 1.3 to 2.6 times more likely to commit suicide than men in urban areas.
 - For Indigenous people, and men in extreme remote communities are 6 times more likely
-

SYLLABUS DOTPOINT 7

An overview of the challenges facing megacities and Australian metropolitan and regional centres. Challenges include; housing, economic restructuring, employment, transportation, congestion, environmental degradation, waste management, personal safety, land abandonment, urban sprawl, socio-spatial inequality, social inclusion and exclusion, changing demographics.

Challenges facing rural places:

Resource Degradation

- Resource degradation occurs when a land use deteriorates the quality of the biophysical environment on which is located or which it surrounds
- *Soil Degradation*
 - 60% land use is agriculture – 461 million hectares
 - 88% of activity of agriculture is livestock grazing, in arid and semi-arid areas
- *Overgrazing*
 - This leads to desertification and severe soil erosion
 - Also leads to drylands salinity
 - Which is the reduction in the quality of farming and agriculture
 - Evident in Alice Springs (Semi-Arid) and the North West of Western Australia in Wheatbelt

Population loss

- Population loss is a challenge facing a number of rural and remote locations Australia
- Population loss is the decline share of the population living in a place
- Caused by urbanisation
- Rural areas have population loss because:
 - Pull factors, young cohort moving to urban areas for tertiary education and employment opportunities
 - Loss in employment in remote location due to increase in global competition in agriculture
 - Appeal and development of larger regional centres due to availability of services and commerce
 - Amalgamation and cooperation of small farm buildings
- Areas affected:
 - Newman down 410 (2016)
 - Lanster-Leonara down 300 (2016)
- Population loss results in falling demands and services

Challenges facing megacities:

Housing

- Housing issue results from rapid urbanisation (hard to sustain)
 - More prevalent in megacities located in less economically developed countries
 - 32% of population of Manila live in slums
 - 50% of Mexico live in slums
 - Slums and shanty towns emerge due to inadequate housing. These are often built in high risk areas, for example, landslides, and flood prone areas
-

- Slums are often unplanned and illegally built, low cost and lack of proper infrastructure such as roads and sewerage

Urban Sprawl

Urban Sprawl: The expansion of human populations from the central urban areas into low-density, non-functional and usually car dependent communities

- Estates are seen on the fringe of metropolitan Perth, for example Butler (40km of CBD) and Ellenbrook (25km NE of CBD)
 - Sprawl is costly as they must provide essential services and infrastructure to new areas
 - Leads to social dislocation as well as long commutes to work which contribute to congestion
 - Sprawl is caused by population growth from 2 million to 2.6 million in 2031
 - Demand for housing will increase
 - Centrifugal forces pushed out and attract people in outer areas (rural)
 - Decreased land use competition
 - Attracts younger families (prices are low)
-

DEPTH STUDY ONE: METROPOLITAN PERTH

SYLLABUS DOTPOINT 8

The site, situation, internal and external morphology and functions of the Perth Metropolitan Area

Site:

- Sited on the Swan Coastal Plain
 - Sandy and Undulated
- Ranges in height from sea level to approximately 60m above sea level
- Coastal plain is generally stable and well-drained
- Limited growth of site:
 - West – Indian Ocean
 - East – Darling Escarpment & State Forest
 - Steep rise in elevation
 - Lateritic soils and granite which are not favoured
 - These lead to a higher cost in development
 - This leads to the encouragement of Perth's north-south orientation
- Swan and Canning Rivers divide the metropolitan area in half

Situation:

- South West Coast of Australia in Western Australia
- 31°57'S, 115°51'E (at CBD)
- One of the most isolated cities in the world:
 - 2700km away from Adelaide; the closest neighbouring capital city
- Closest Regional Centres:
 - 18km North of Bunbury
 - 424 km South-East of Geraldton
- 14km west of the Indian Ocean
- 17km north-east/upstream of the port of Fremantle

Functions

- Perth is a hub for commerce and finance
- Dominant retail operations in the CBD such as on Hay Street
- This equates to high population density
- Centre for major mining corporations in WA;
 - Woodside
 - Rio Tinto
 - BHP Billiton
- Home to many major legal and accounting firms

Internal Morphology: Land uses and transport patterns seen within the urban area

- Land Uses: residential, commercial, industrial, recreational, mixed use and special purpose land use zones.
- Transport patterns: roads, river ferries, rail lines (passenger trains and freight lines)

Perth's Eight Functional Zones:

- I. Central Business District (CBD)
 - Core of the metropolitan area
 - Recognisable by grid-like street patterns and dense, high-rise buildings
 - Main functions:
 - i. Commercial and Administrative
 - ii. It serves as a limited residential area
-

- iii. New apartments and high density living is becoming more popular with younger people
- High level of employment in the CBD
 - i. High daytime population, lower night-time population
- Location of the CBD is influenced by historical factors:
 - i. It is where Captain James Stirling established the original settlement in 1832
 - ii. The area is close to freshwater resources, but growth is restricted by both Mt Eliza and the Swan River
- It is the central transport node to a large commuting workforce
 - i. Train services all converge in the CBD, and are all linked to bus and road networks
 - ii. Major roads: Kwinana and Mitchell Freeways
- Area has high land value due to the high competition
 - i. Maximised land use
 - ii. High density leads to high-rise buildings
- Vertical Zonation:
 - i. Seen through the high-rise buildings
 - ii. Pedestrians are able to access commercial functions (such as cafes and newsagents) in the lower levels
 - iii. Upper levels are occupied by businesses or corporations as they do not rely on pedestrians (seen through the BHP Billiton offices)
- Horizontal Zonation:
 - i. Due to the aggregation of businesses in certain areas (i.e. St George's Terrace: Banking. Hay St/Murray St: Retail)
 - ii. Contains pedestrian-oriented walkways which encourage the movement of people (i.e. Hay St Mall and the Carillon Arcades)
- It is the retailing core of the metropolitan area
 - i. Largest range of franchises and well-known brands concentrated along Hay St and Murray St (such as Myer, H&M and David Jones)
- It is a dynamic zone, constantly changing with the demands of land use competition
- The city's value for historical importance is seen in the retention of the Heritage buildings
 - St George's Cathedral
 - Perth Town Hall

2. Inner Mixed Zones (IMZ)

- Transitional zone just beyond the CBD boundaries
 - i. i.e. Northbridge, West Perth, East Perth
 - Large range of functions
 - i. Including residential, commercial, recreational, entertainment, light industry, transport and administration
 - High accessibility, able to expand, cheaper land values and overheads, easier parking, cheaper parking, less traffic congestion
 - Dynamic zone, due to the process of invasion & succession
 - i. Small businesses have invaded Colin and Ord St in West Perth, which had once been mainly residential
 - ii. Northbridge's residential zones have been invaded by entertainment functions
 - Restaurants
 - Nightclubs
 - Bars
 - Aggregation of medical and mining offices in West Perth
-

- Experiences urban blight
 - i. This is where land owners have a reluctance to renovate property due to potential future invasion
 - Sever urban blight leads to urban renewal projects
 - i. i.e. East Perth Redevelopment Project which started in the 1990s
 - Mixed ethnicity: different areas attracting different ethnic clusters
 - i. i.e. Chinatown in Northbridge
3. Established Residential Zones (ERZ)
- Largest functional zone, dominated by the housing function
 - Examples include:
 - i. Mt Lawley
 - ii. Claremont
 - iii. Victoria Park
 - iv. Morley
 - There is a great variance in housing densities
 - There is a great variance on land values due to both location and attractiveness
 - i. i.e. Property values differ in each suburb:
 - Average Property Value in Claremont: \$1,400,000
 - Average Property Values in Morley: \$560,000
 - Houses tend to be older, with well-established gardens and good access to a variety of services
 - Access to shopping centres (such as Morley Galleria or Dianella Plaza), health services, cultural facilities, parks and public transport
 - Generally, there is an older population who have lived in this area for a long period, or those who can afford to buy into the area
4. Newer Growth Zones (NGZ)
- Located on the border of the ERZ and adjoining the rural-urban fringe
 - Examples include:
 - i. Ellenbrook
 - ii. Baldivis
 - Houses tend to be 'project' homes with less gardens
 - i. Hence they contain areas which have similarities due to housing designs
 - Areas lack access to services and infrastructure
 - i. Often, these areas are waiting for a substantial population in order to support them
 - Lower land value therefore attracts the younger population
 - The zone is a result of the growing population and demonstrates urban sprawl
 - Density is increasing due to consolidation and infilling
5. Industrials Zones
- Light and medium industrial areas
 - i. Less capital-intensive, is consumer-orientated
 - i.e. household plumbing organisations
 - ii. Scattered through the metropolitan areas
 - i.e. Osborne Park and Welshpool
 - Heavy industry
 - i. Capital intensive produces heavy articles
 - i.e. oil refinery
 - ii. Traditionally further away from residential areas
 - i.e. Kwinana is 40km south of the CBD
 - Characterised by agglomeration
 - i. Industrial functions gathering in one area
 - Influenced by the development of different modes of transportation
 - i. i.e. Fremantle Port, Malaga & Reid Highway
-

- Required a greater amount of land
 - i. Space extensive land use
 - ii. Larger block sizes, with warehouses, refineries, etc.
- Generally they are unsightly, noisy, and causes air pollution
 - i. Segregated areas as plans are taken to ensure these undesirable functions are separate from residential areas
 - Buffer zones

6. Rural-Urban Fringe (RUF)

- Outer edge: urban and rural land coverage
 - i. i.e. Upper Swan, Wanneroo
- Mixed land use, containing residential, rural, industrial, recreational and special purpose functions
 - i. i.e. prisons, speedways
- Land use conflict caused by undesirable functions
- Dynamic zone due to invasion and succession as urban areas expand
- Urban-shadow effect: rural land owners are reluctant to maintain property due to future invasion
- Lower land values attracts space extensive functions
 - i. i.e. Agriculture, rubbish tips, golf courses
 - Whiteman Park

7. Outer Business Districts (OBD)

- Zones dispersed throughout the metropolitan area, of in accessible locations among the residential area. Generally located among the major transport routes (e.g. Mitchell Freeman)
 - i. i.e. Joondalup, Midland
- Decentralises job opportunities out of the CBD, and also provides a variety of services to the general population in accessible locations
 - i. Larger OBDs are easily accessible by bus routes, train lines and main roads
- Predominant function is retail and they can also provide health, allow businesses to come together for consumer convenience through aggregation

8. Special Purpose Zones

- Scattered unevenly in the metropolitan area
 - Different purposes:
 - i. Education (UWA)
 - ii. Prison (Bandyup Women's Prison)
 - iii. Waste disposal/tips (Tamala Park)
 - iv. Airports (Perth Airport)
 - v. Recreation (Claremont Showgrounds, Optus Stadium)
 - vi. National Parks (Kings Park)
 - vii. Cemeteries (Fremantle)
 - viii. Other unique facilities
 - Many of them are space extensive and tend to be located further from inner city areas, where land is cheaper and more readily available
 - As some SPZs are undesirable (i.e. tips), plans are undertaken to ensure they are segregated
-

SYLLABUS DOTPOINT 9

The Demographics of the Perth Metropolitan Area

Population, Age and Gender

- Population reached 2.04million in 2015
 - Fastest growing areas; Armadale (30% increase) & Kwinana (28% increase)
- There is a greater level of children aged 0-14 in WA compared to Greater Perth
 - However, the converse is true from 15-35 years old. Possible due to the availabilities of Universities and higher education/work opportunities in Greater Perth
- In 2011, the median age of Perth's population was 35.7 years.
 - Higher median ages in suburbs towards Rockingham and along the Darling scarp
- Gender population distribution is roughly even (males : females is 49.6 : 50.4)
- Children under 14 make up 19.2% of the population
- People over 65 make up 12.5% of the population
- Higher proportion of younger populations in outer suburbs, such as the newer growth zone and further from the CBD

The ERZ has an established infrastructure and good access to public transport. This zone also has well-established health facilities. Most people in this area then tend to stay in the ERZ as it is both comfortable and familiar.

The NGZ tends to not attract people over 65 as they lack services like healthy facilities. This age group also do not find parts of the IMZ attractive where apartments are dominant, as there is high competition for parking, and lots of noise from entertainment services.

This area is considered to be appealing to DINKs (double income, no kids)

Socioeconomic

- Median weekly household income: \$1,459
- Median monthly mortgage repayments: \$2,000
- Median weekly rent: \$320
- Income trends:
 - Income patterns vary greatly across the metropolitan area
 - Suburbs with desirable locations (close to the coast or river) tend to have a higher weekly income than suburbs surrounding industrial functions
 - Medina has a median weekly household income of \$836, while Cottesloe has one of \$2494
- The ERZ has higher levels of home ownership.
 - Houses have generally been owned for longer
 - Mortgages already paid off
 - Incomes tend to be higher
- The NGZ has a lower level of home ownership
 - Lower weekly income
 - Younger families
 - Haven't had time to pay off mortgage

Education and Employment

- 30.5% of population was attending an educational institution
 - 26.9% in Primary School
 - 18.7% in High School
 - 23.5% in Tertiary/Technical Institution
-

- 900,494 people in the labour force
 - 60.2% employed full-time
 - 28.9% employed part-time
- Most common occupations include:
 - Professionals – 21.7%
 - Technicians and Trades Workers – 16.1%
 - Clerical and Administrative Workers – 15.3%
 - Managers – 11.4%
 - Community and Personal Service Workers – 9.7%

Cultural Distribution

- Perth is considered to be a multicultural city
 - 59.6% of citizens born in Australia
 - 38.5% had both parents born in Australia
 - 46.4% had both parents born outside of Australia
 - Aboriginal and Torres Strait Islanders make up 1.6% of the population
 - Most common countries of birth:
 - Australia
 - England
 - New Zealand
 - South Africa
 - India
 - Malaysia
-

Study four of the following challenges:

- *Housing*
 - *Economic Restructuring*
 - *Employment*
 - *Transportation*
 - *Congestion*
 - *Environmental Degradation*
 - *Waste Management*
 - *Personal Safety*
 - *Land Abandonment*
 - *Urban Sprawl*
 - *Socio-spatial inequality*
 - *Social inclusions and exclusions*
 - *Changing demographics*
-

SYLLABUS DOTPOINT 10

The nature, scope and causes of each of the four selected challenges being confronted, and the implications for the place

SYLLABUS DOTPOINT 11

The views and attitudes of major stakeholder groups related to each of the four selected challenges

SYLLABUS DOTPOINT 12

The range of planning strategies that have been used to address each of the four selected challenges, and how these compare with and/or have been informed by, responses implemented in other places, both inside and outside Australia.

SYLLABUS DOTPOINT 13

The extent to which the planning strategies adopted in the selected place have been, or could be, informed by the concept of sustainability.

SYLLABUS DOTPOINT 14

The strategies adopted in the selected place to address these challenges

SYLLABUS DOTPOINT 15

The extent to which these strategies have enhanced its sustainability and liveability

Challenges:

- Urban Sprawl
- Traffic Congestion and Transportation
- Provision of Housing
- Waste Management

Sustainability: The concept of sustainable planning and management refers to the ability of a city to meet the needs of the present population while not compromising the needs and wants of future generations. This is an ongoing process that aims to achieve a balance between the protection of the environment while maintaining the economic development necessary to satisfy the needs of the people, and ensuring that the social development is not impaired.

It involves the triple bottom line consisting of the protection of the environment, while maintaining the economic development necessary to satisfy the needs of the people, and ensuring that the social development of people is not impaired so that they can continue to lead healthy and productive lives.

5 criteria for measuring sustainability:

1. Stewardship of natural resources
 - Sustainable approaches to the local and global environment should include:
 - Seeking to protect and preserve irreplaceable existing resources
 - Use required resources efficiently
 - Improve and restore natural resources that benefit both humanity and nature
 2. Health and Productivity
 - The health and productivity of city dwellers is closely tied to the quality of the urban environment in which they live. Sustainability efforts should demonstrate that improvements to the environment also enhance the wellbeing of local residents, workers and visitors
 3. Economic Development
 - Sustainable development should seek to:
 - Support economic growth through new technologies and industries that do not harm the environment
 - Stimulate markets for 'green' products and services, e.g. economic activities that consume fewer resources and generate less waste than existing industries and technologies
 - Attract and retain a talented work force through the provision of a cleaner environment
 4. Efficient Government
 - Sustainable development should provide a useful framework for government when planning for future environmental efficiency, through its policymaking and regulatory functions.
 - Environmental problems often cross jurisdictional and inter-departmental boundaries, or are the unintended result of changing economics, technologies or systems. The ability of government to solve such problems is a key indicator of its efficiency and flexibility
 5. Education
 - Sustainable development should:
 - Engage the general public in civic and volunteer efforts
 - Raise awareness of the environmental impact of individual behaviours
 - Build support for long-term government initiatives
-

Liveability: An assessment of what a place is like to live in, using particular criteria, such as:

- Environmental quality
 - Crime and safety
 - Education and health provision
 - Access to shops and services
 - Recreational facilities
 - Cultural activities
-

URBAN SPRAWL

What: The low-density outward spread of a city mostly through the growth of largely unplanned housing developments. This is seen where the newer growth zone continues to expand into the rural urban fringe to take up land once occupied by natural bushland or agriculture.

Why: This has been possible due to the release of cheaper land on the periphery of the city that attracts lower income earners. High car ownership enables these people to live further from the city centre in areas less accessible by public transport (i.e. Banksia Grove). This trend has been further reinforced through the ability of these new residents to obtain a long-term mortgage through banks and finance companies as well as government incentives that were offered for “first home buyers” in these areas.

- Lower land rates; people do not want to pay a lot of money for land, so they buy cheaper land further out
- Improved infrastructure; there has been increased spending on infrastructure in NGZs
- Rise in the standard of living; people are able to pay more to travel/commute for longer distances
- Lack of Urban Planning; calmer and less trafficked places are more appealing
- Lower House Tax Rates; taxes are usually lower in outer suburbs
- Rise in population growth; people spread out so that there is more room
- Consumer preferences; people in high income groups have stronger preferences towards larger homes, which is available in outer areas

Where: This has been evident in Perth as the newer growth zone continues to expand into the adjacent rural urban fringe. This is visible in areas such as:

- Sinagra
- Tapping
- Ashby
- Carramar

These areas are in the north-west corridor where land once used for market gardens and other forms of intensive agriculture have been taken up by residential development. Natural bushland continues to be cleared as the north-west corridor continues its strong coastal orientation through Butler, Jindalee, Alkimos and Yanchep. This often occurs on an uneven front as individual developers gain development approval at different times.

The Perth Metropolitan area stretches from Singleton in the south, Two Rocks in the north, and east to The Lakes. Perth has 3.1 people per square hectare, and covers 6918km²

What: The change in land use in these areas is clearly seen as Perth continues to grow. In recent years this has seen the emergence of new housing estates in suburbs like:

- Brabham
- Harrisdale
- Allara
- Wellard
- Neerabup (small industrial estate)

Due to the impending change in land use, there is often some evidence of deterioration or **urban shadow** where owners of rural properties see no reason to spend money on their properties that will soon be taken up by urban functions. This can often produce a rundown appearance with rusted and dilapidated buildings, unpainted and damaged fences and land overgrown with weeds (seen in areas such as Success and Tapping)

Who: Certain stakeholders are affected by the challenge of urban sprawl. Stakeholders are the people who have a vested interest in a particular issue.

- Environmental Stakeholders;
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- Department of Parks and Wildlife
- Local Government (improving infrastructure)
 - Waste
 - Provision of transport
- Department of Water and Environmental Regulation
- Social Stakeholders;
 - Residents in the ERZ/RUF
 - Local/small business owners
 - Residents in the NGZ
- Economic Stakeholders;
 - WA Government Housing Department
 - Private Developers
 - Play Equipment
 - 'For Parks' suppliers
- Political Stakeholders;
 - WA Government; dedication of money from the budget
 - Department of Planning (WAPC)
 - Metro Redevelopment Authority

Newer Growth Zones: Over time, these new suburbs acquire a range of community services and necessary infrastructure such as schools, community centres, shopping centres and medical centres. One example is Banksia Grove which was first established in the late 1990s but had to wait until late 2014/early 2015 for its own district shopping centre and government secondary school.

Threats to the Environment: Arable land continues to be lost as Perth continues its pattern of urban sprawl. Over time, market gardens in Osborne Park, Gwelup, Spearwood and Wanneroo have disappeared to make way for residential and commercial development. Old dairy farms at Bayswater, Gosnells and Thornlie have over time suffered the same fate.

Planning Regulations: Deliberate legislated policies that are responsible for land use patterns within the whole Perth Metropolitan Area. With the introduction of zoning it precludes other land uses from locating in certain areas.

Zoning and Rezoning:

In the Perth CBD, planning policies were responsible for the rezoning of land that resulted in the rapid office development in the 1970s and 1980s. This was responsible for the decline of inner-city resident population at the time. It can be used to ensure that all industrial uses are located together and away from houses (agglomeration & segregation). It can also be used to protect places of environmental significance. It ensures local communities have all the services they need, through the zoning land for schools, shops, parks and medical facilities.

Once land is zoned, it can also be rezoned to change with the changing attitudes of the community.

Infilling and Consolidation:

One of the main objectives from *Directions 2031 and Beyond* was to improve the level of urban infilling in metropolitan Perth. This is the use of vacant land within an area and therefore increases the density of an area, and reduces the need to use new land or greenfield sites. In 2010 the city infill rate was 30-35% and it is hoped to reach 47% through this plan. It hopes to increase residential density from 10 dwellings per hectare to 15.

Urban Renewal:

This plan also aimed to have a more consolidated urban form through making better use of the already existing urbanised land – through encouraging the use of brownfield sites and increasing the density in the urban area.

East Perth Redevelopment:

An urban renewal project which underwent in 1990 – transforming a disused industrial area into a thriving residential and commercial community.

It rezoned areas to medium/high-density dwellings, from the light industry and low-density dwellings. This old industrial area required the removal of contaminated soil. The State and Local Governments invested in the public infrastructure; improving the attractiveness of streets, providing good lighting and calming traffic. This area now demands high prices and is considered an attractive place to live.

Overseas:

Manila Philippines:

Manila is the 5th largest urban area in the world, with a population of 22,000,000 – and it is estimated to be between 45-50million by 2050.

Density in Manila: *Inner areas:* 45,000 per km²

Outer areas: 11,000 per km²

Perth: 315 per km²

To what extent has a strategy adopted to address urban sprawl in the Perth Metropolitan area enhanced its sustainability and liveability?

Various strategies have been adopted throughout the Perth Metropolitan Area in order to address the urban challenge of urban sprawl. These strategies have been implemented in order to enhance the sustainability and liveability of Perth. One of these strategies is the use of zoning and rezoning, as Perth is divided into specific zones in order to function more efficiently. Urban sprawl is the occurrence of the spreading out of a specific population over a large area, leaving to a dysfunctional city structure. It is characterised by low-density areas. In Perth, the average density is 315 people per km², compared to cities such as Manila, which has a high density of around 45000 people per km².

Sustainability is the concept referring to the ability of a city to meet the needs of the present population while not compromising the needs and wants of future generations. It involves the triple bottom line consisting of the protection of the environment, while maintaining the economic development necessary to satisfy the needs of the people, and ensuring that the social development of people is not impaired so that they can continue to lead healthy and productive lives. Liveability is the concept referring to the ability of a location to provide sufficient resources to live there (such as access to water, recreational spaces, etc.).

Due to the zoning of Perth, many land uses often agglomerate together. This explains why industrial and commercial uses are often agglomerated together, seen in places such as Midland and Malaga. Residential areas also often agglomerate together, with services such as schools, shops and hospitals throughout. This allows for a much more liveable area due to there not being noise pollution from industrial land uses.

Rezoning occurs when zones transform to suit their changing community, seen in the rezoning of the Perth CBG in the 1970s-1980s, where residential services were pushed out in order to make way for office buildings. This provided Perth with a centralised business district. Rezoning enhances the sustainability of these areas as it reduces the level of environmental and economic costs by reducing commutation times, and increases the daytime social structure in the Perth CBD.

An example of rezoning in Perth can be seen through the East Perth Redevelopment Program, which was instituted during the 1990s. Beforehand, the land was primarily used for low-density residences and light industry. However, this program transformed the land into primarily medium or high level density. The liveability of East Perth was enhanced due to this program, as it improved the attractiveness of streets, and eased traffic congestion in the area. It also enhanced the sustainability of the Perth Metropolitan Area as it brought a higher number of dwellings into the centre of Perth, away from Newer Growth Zones. Since the redevelopment program, the medium house price in East Perth has surged to well over \$1 million, reflecting on the enhanced liveability of the area.

TRAFFIC CONGESTION AND TRANSPORTATION

What: The movement of goods and persons from place to place and the various means by which such movement is accomplished. The growth of the ability – and the need – to transport large quantities of goods or numbers of people over long distances at high speeds in comfort and safety has been an index of civilisation and in particular of technological progress

Scope: Perth is home to a variety of transport services, including bus, rail, CAT and ferry services. It also offers an extensive road network, currently facing repairs and upgrades. There is an average of 844 cars per 1000 people in Perth, with an average of 3.6 million car trips made in Perth a day. There is an average of 400,000 trips per day via public transport, and on average around 100,000 bike trips per day.

Causes:

- An increase in population means that there are more people needing to get around the city
 - Around 108 people move to Perth in a day
- Most of the Perth traffic congregates and congests on one north-south freeway
 - Mitchell & Kwinana Freeway
- Perth has an overworked transport system, with around 58 million trips conducted within a year
- Increased delays in rail projects such as the Perth Airport Link

Who: Certain stakeholders are affected by the challenge of urban sprawl. Stakeholders are the people who have a vested interest in a particular issue.

- Environmental Stakeholders
 - Parks & Wildlife
 - E.P.A
- Social Stakeholders
 - Public transport commuters
 - Residents whose properties have been reclaimed/rezoned
 - EST/IMZ residents where roads cannot cope with traffic volumes
- Economic Stakeholders
 - Business owners
 - Supermarkets
 - Food suppliers for Coles & Woolies
 - CBH (Wheat transport)
 - Truck freight companies
- Political Stakeholders
 - Transperth/TransWA
 - MetroNet
 - Department of Transport
 - Main Roads

Other Information:

- The number of registered vehicles in Perth increased by 17% between 2009 and 2013
 - The cost to run a car in Perth is cheaper than in other areas of the country. It is around \$300/week in Perth, and \$419/week in Sydney
 - The cheaper cost promotes the use of vehicles among the community – as not as many are affected by the cost
 - Urban sprawl leads to the inadequateness of the Perth Transport system. This inadequateness leads to an increase reliance on commuting via car. Many new suburbs, such as Banksia Grove and Piara Waters, do not have good access to public transport – meaning that they have to rely on the motor car.
-

- Perth has experienced improved living standards, meaning that the private car is more affordable
 - Higher ownership of motor vehicles (844/1000 people).
 - The average household has 1.8 vehicles, which ties with Darwin as the highest level of car ownership in all Australian states/territories
 - More cars means that there is a greater level of congestion on the roads
 - Especially during the peak traffic times in Perth
 - 6:30-9am
 - 4-6:30pm
- The Perth CBD is a major employment centre in Western Australia, with many major businesses such as BHP Billiton and Rio Tinto holding offices in the zone.
 - The over-emphasis of employment in the CBD means that the majority of cars travelling during peak traffic are travelling to or from the city, on roads which are not designed to carry a large level of traffic
 - Streets which do not suit a high level of car patronage include:
 - Beaufort St
 - William St
 - East Parade
 - Cambridge Street
- The increased number of commercial vehicles and trucks have also contributed to Perth's worsening traffic issues – they transport goods between major industrial areas and transport focal points (i.e. the ports and airports)
 - These slower-moving vehicles are not suited to the nature of Perth's arterial roads, due to the lack of free-flowing movement, and the number of traffic lights
- 90% of cars in Perth only contain one person
 - The freeways of Perth do not cope with such a high level of vehicles in one moment during peak hour traffic
 - Mitchell Freeway carries ~160,000 vehicles per day
 - Graham Farmer Freeway carries 110,000+ vehicles per day
 - Intersections where congestion is frequent:
 - Leach Highway/Welshpool Road
 - Wanneroo Road/Ocean Reef Road
 - Roads where congestion is notable:
 - East Parade
 - Connolly Drive
- It was reported in Nov 2012 that Perth commuters took 1,000,000 more train journeys and 1,200,000 more bus journeys than in 2011.
 - It was suggested that rail developments would not be sufficient enough to meet demand
 - It was reported in 2016 that due to a lack of rail investment, Perth will have 7/10 of the most congested roads in Australia by 2031
- It was reported in Dec 2017 that Main Roads is only working on 6/20 of Perth's worst intersections
- A \$900million project aiming to link Ellenbrook with the Midland Line had been proposed, and is eventually being carried out

Consequences:

- Increase in CO₂ emission and therefore an increase in pollution. Fuel consumption increases and an economic loss of productivity as people lost time caught up in traffic conditions.
 - High levels of stressful/anti-social behaviour can be seen through the increasing level of road rage incidents occur.
 - Many motorists take 'short-cuts' through quiet neighbourhoods to avoid congested roads
 - These put pressure on streets not built to handle large volumes of traffic
-

- i.e. taking Newburn Road to avoid Roe Highway
- Parking of vehicles is becoming an issue and can have financial implications.
 - Developers must provide significant amounts of land close to the city/major venues (such as Burswood/Crown) for parking
 - Vehicles are forced to park on the streets, which can lead to conflict with nearby residents while also narrowing the thoroughfare for other vehicles leading to slower moving traffic

Planning Strategies addressing the problem:

- The Graham Farmer Freeway/Northbridge Tunnel has been successful in moving traffic from east-west with ease.
 - It also reduces pressure on the streets of Northbridge and East Perth
 - The construction of the Windan Bridge has reduced pressure on the Causeway
 - The construction of the Duplication Narrows Bridge in 2001 has improved traffic flow in and out of the city, while the extension to the freeway system has assisted in making the north-west and south-west corridors more accessible, although problems do still exist during peak periods
 - The improvement in rail services (such as the Mandurah line) has reduced the number of cars on the roads to some extent, while exclusive bus lanes on the Causeway and Kwinana Freeway have also encouraged people to utilise public transport
 - The dispersion of many places of employment in outer suburbs also is important in reducing the number of cars converging on Perth's inner core in the mornings. This trend can also be seen through the relocation of many inner industrial sites (i.e. Jolimont, Wembley) to outer areas (i.e. Malaga, Wangara and Canning Vale)
 - General traffic flow has been improved through the extension of ring roads (e.g. Roe Highway, Reid Highway, Tonkin Highway) in moving traffic around the metropolitan area rather than towards the core. Improved traffic flow has resulted from greater employment of roundabouts as a preference to the use of traffic lights or stop signs.
 - The promotion of transit-oriented developments has seen the construction of higher density residential near major railway and bus stations (e.g. Cockburn Central). This should encourage people to utilise the public transport nearby to them
 - *Directions 2031* also aims to enhance the safety of using public transport so that people will feel inclined to use it.
 - A higher presence of the police and the prosecution of people guilty of anti-social behaviour would assist in achieving this
 - *Directions 2031* addresses problems and aims to control Perth's outward expansion and provide initiatives into sustainability practices that have been influenced by environmental, social, economic and political factors
 - This blueprint establishes a vision for future growth of metropolitan Perth and Peel region and provides a framework to guide the delivery of housing, infrastructure and services needed to accommodate this growth
 - It has identified three integrated networks that form the basis of this sustainable plan. These include an Activity Network based on a series of secondary centres and strategic metropolitan areas to act as focal employment and amenity providers (e.g. Karrinyup, Cockburn, Booragoon). These activity centres will be attractive places in which to invest, live and work. The plan also aims to increase housing diversity, affordability and choice
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To what extent has a strategy adopted to address traffic congestion and transportation in the Perth Metropolitan area enhanced its sustainability and liveability?

Transportation is major challenge facing the Perth metropolitan area, and strategies such as enhancing public transport needs to be adopted in order to address this challenge and enhances both sustainability and liveability of the area. In order to enhance sustainability, the area needs to meet the needs of the residents while not compromising the needs of future generations, and is focused socially, environmentally and economically. In order to enhance liveability, the overall quality of life in the area must improve in certain areas, such as access to shops and services.

Perth is a society which primarily relies on motor vehicles as a means of commutation. Due to the high level of employment in the Perth CBD (with major groups such as Rio Tinto being based in the core), a large number of workers congregate on a single north-south freeway (Mitchell and Kwinana Freeway) during peak periods. As many new suburbs such as Banksia Grove and Piara Waters do not have good access to public transport, they have to rely on the motor car. In order to reduce the level of congestion in Perth during peak period times, the Perth public transport system has had to upgrade. In order to do so, major lines such as the Mandurah and Joondalup lines were introduced to the Perth rail system. This cleared up the level of congestion of the roads along these lines as public transport is made cheaper and more accessible to use.

The improvement of the public transport system increased sustainability socially as it reduces the anti-social behaviours such as road rage which occurs frequently during commutation. It enhances sustainability environmentally as it reduces CO₂ emissions from cars, and economically as less money is wasted on commutation when public transport is used. This strategy also enhances liveability as it clears congestion on IMZ/ERZ roads such as Beaufort St and East Parade, which were not designed to deal with the level of traffic they experience during peak periods. It also enhances liveability by connecting those in outer suburbs to the CBD.

WASTE MANAGEMENT

What: Waste management is all of the activities that handle waste materials, from the time it is made to its disposal. The collection, transportation and disposal of garbage, sewerage and other waste products. The process of treating solid wastes and offering a variety of solutions for recycling items which can be reused as a valuable resource.

Scope: By recycling one tonne of paper you save 13 trees, 2.5 barrels of oil, 4100kWh of electricity, 4 cubic metres of landfill and 31,78s litres of water. 36% of all waste in Perth Metropolitan is recovered for reuse (as of 2009/10). 65% of rubbish will be recovered in Perth's waste by 2020. Many households such as those in the City of Stirling have 3 bins, which encourages recycling. Perth is currently a disposable society, with large levels of population growth leading to a consumerist lifestyle. Insufficient infrastructure, a lack of awareness of the benefits of recycling and expensive legal dumping contributes to Perth's waste challenge.

Benefits:

- Recycling reduces the amount of space occupied by landfills
- Harmful chemicals and greenhouse gases are released from rubbish in landfill sites
- Recycling reduces the need to use raw materials to create products, and reduces expenditure
- The reduced need for raw materials links to a decline in deforestation, which destroys habitats
- Raw materials can be reserved for future generations

Who: Certain stakeholders are affected by the challenge of urban sprawl. Stakeholders are the people who have a vested interest in a particular issue.

- Environmental Stakeholders
 - Minister for Environment – Hon. Stephen Dawson
 - Keen to improve waste management in WA
 - Innovation & Efficiency
- Social Stakeholders
 - Local Governments
 - Use the soil for new vegetation areas
 - Local businesses
 - 'Soils Ain't Soils'
- Economic Stakeholders
 - Suez Waste Operations
 - Reduce amount of money spent on fertilisers
 - Employment
 - Managers
 - Maintenance Crews
 - Transfer Operators

Other Information:

- City of Perth
 - Weekly Waste Collection
 - Waste disposals dedicated for different forms of waste in commercial properties:
 - Glass
 - Paper/Cardboard
 - Organic Waste/Green Waste
 - Separate bins in households for landfill, recycling and for greenwaste
 - Government of Western Australia
 - Avoid Landfill; strive for maximum re-use of resource
 - Reuse; reduce cost and conserve resources
 - Recycle; lower waste production in terms of good and efficient services
-

- Recover; energy or resource recovery results in benefits in cost savings
- Dispose; waste disposal is be considered the last resort
- Jakarta, Indonesia:
 - Jakarta relies on rubbish dump outside the city
 - This leads to a large amount of waste ending up in the river (~7 football fields a day)
 - The sea around Indonesia has the 2nd highest amount of plastic in it
 - Indonesia is the worst ocean polluters after China
 - Waste4change is an initiative where people are paid to collect waste and recycle it
 - Plastic Bag Tax
 - In order to reduce plastic litter in the environment, the government has enacted a 200-rupiah (\$0.014USD) tax on each bag
 - May add plastic water bottles to this tax
 - No landfill fees
 - As it is free to dump illegal dumping is avoided
 - Individuals can haul from businesses for a fee
 - Separate bins for dry/wet/recycle
 - Promotes recycling
 - Allows less rubbish to end up in the landfill

Planning Strategies addressing the problem:

- Waste-Wise Schools
 - Offers resources for schools to plan, implement and maintain waste minimising projects such as recycling, composting and worm farming
 - It is a free program
 - It targets schools with the strategies to reduce waste while developing positive environmental values among children
 - An example of these programs is the 'Message in a Bottle' program, employed in various schools such as Emmanuel Catholic School
 - This program is inserted into the school curriculum for year 7s
 - It is a 10-week program for Year 7s and is imbedded into their courses
 - Geography, English, Maths and Science
 - The students study bottled water and helps raise awareness of its contribution to landfill, with 582.9million litres of it being produced in a year
 - By teaching kids to not use plastic bottles, they will save approximately 12.5kg worth of waste per person
 - Geography
 - Children are taught about the impacts of production and consumption of bottled water
 - Maths
 - Children learn about the cost and amount of waste
 - Science
 - Studying the properties of water and comparing different characteristics between bottled and tap water (such as pH, fluoride levels, odour, taste, etc.)
 - English
 - Students focused on integrating their knowledge to write a persuasive speech encouraging people to not buy plastic bottles

To what extent has a strategy adopted to address waste management in the Perth Metropolitan area enhanced its sustainability and liveability?

Waste management is a challenge faced by the Perth Metropolitan area. This is due to the high level of waste currently being produced by Perth residents, which occupies space and releases harmful gases and chemicals into the atmosphere. A waste management strategy implemented into Perth's metropolitan area is Waste-Wise Schools, and it enhances Perth's sustainability and liveability. Sustainability is the practice of preserving natural resources and the environment for adequate use in society while not compromising the needs of future generations. It is influenced by the triple bottom line; social, environmental and economic sustainability. Liveability is an assessment of what it is like to live in a certain area, and it is measured through various indicators such as environmental quality.

Waste Wise Schools is a free program which teaches school students how to reduce the level of waste contributing to landfill. The program offers resources and supplies for schools so they can plan, implement and maintain waste-minimising projects such as recycling, composting and worm farming. An example of these projects can be seen in the 'Message in a Bottle' project, which has been implemented in many schools such as Emmanuel Catholic School. In this school, a 10-week program was implemented into the curriculum for various courses for Year 7 students. It did not interrupt their learning and was incorporated into their learning for Geography, English, Maths and Science. In Geography, students utilised geographical concepts to analyse the impacts that bottle water production and consumption had on environments. In maths, the program was incorporated into learning by looking at trends in the cost and amount of waste. It was incorporated into science by studying the properties of water, analysing and comparing characteristics between bottled and tap water (such as pH level, fluoride concentrations, taste and odour). In English, students then utilised their learning from the other three subjects to write and deliver a speech persuading audiences against the use of bottled water over tap water.

This program enhances the sustainability of Perth. Environmentally, it decreases the level of plastic bottles in waste, as around 12.5kg of plastic is reduced when a person switches from bottled water to tap water. This therefore decreases the level of landfill and allows for the saving of precious resources as recycling is encouraged. Socially, it teaches students to be environmentally aware and conscientious by promoting environmental values. Economically, it saves households money as less money is spent buying bottled water when tap water is cheaper. It also enhances the liveability of Perth, by increasing the environmental quality of the Perth Metropolitan area. It also provides and promotes a community value for the environment.

HOUSING AFFORDABILITY

What: The term 'housing affordability' usually refers to the relationship between expenditure on housing (prices, mortgage payments or rents) and household incomes. The concept of housing affordability is different to the concept of 'affordable housing', which refers to low-income or social housing. Affordable housing refers to housing units that are affordable by that section of society whose income is below the median household income. Housing is usually considered affordable if it costs less than 30% of the gross household income.

Scope: There were 116,427 people enumerated in the census who are classified as being homeless on Census night (up from 102,439 people in 2011). The cost of housing has risen by 78% between 1980 and 2015 (\$41,500 in 1980, \$520,000 in 2015). This means more money is being spent on housing, with the estimated weekly household expenditure to be around 18%.

Issues:

- Homelessness
 - Promotes crime and anti-social behaviour, depression and violence
- Poor living conditions
 - Overcrowding, lack of hygiene, noisy, reduction of facility accessibility
- People live further away from work and family
 - There is a loss of interconnectedness as houses are cheaper further out
- Financial Stress
- Lack of Access to Government Infrastructure
 - There isn't enough Government supported housing
 - Waitlists of around 150,000 people who need to meet certain criteria, such as working less than 28 hours a week. This motivates people to refuse jobs just so that they meet these requirements
 - These waitlists create tension and competition among those who need it

Who: Certain stakeholders are affected by the challenge of urban sprawl. Stakeholders are the people who have a vested interest in a particular issue.

- Environmental Stakeholders
 - Department of Parks and Wildlife
 - Careful consideration is being given to maintaining biodiversity and environmental protection
 - Department of Health
 - Focus on adequate delivery of water supply, sewerage systems, reducing the exposure of potentially harming substances
- Social Stakeholders
 - Newly Arrived Immigrants
 - Australian Citizens
- Economic Stakeholders
 - Stockland Property Group

Planning Strategies addressing the problem:

- The Burt Street Project → Fremantle
 - Aiming create a 'new, affordable community;
 - Lots 1873 and 1907 on Burt Street
 - 1.3745ha with 4 street frontages
 - Located 1km away from Fremantle's main retail and café strip
 - 12km south-west of the Perth CBD
 - Located 250m away from a bus stop and 1km away from the Fremantle train station
 - Capable of supporting up to 250 dwellings
-

- Many of these are with ocean or inner harbour views
 - Provides and opportunity for more people to work in Fremantle
 - Bentley 360
 - One of the most significant medium-high density infill developments in WA
 - Will provide at least 1500 new dwellings
 - High quality parkland and recreation spaces, as well as community, commercial and retail offerings
 - Safe, inclusive community with a strong sense of place and belonging
 - Located 8km south of the Perth CBD
 - It is in Bentley, an area which has mainly low-medium density residential
 - Located near various facilities;
 - Curtin University
 - Canning Vale College
 - Sporting Reserves (Collier Park Gold Course)
 - Shopping Centres (Bentley Plaza Shopping Centre)
 - 'Parkside' at Queens Park
 - 12km south of the Perth CBD
 - Surrounded by schools, parks and shops (such as Westfield Carousel)
 - 2-story developments
 - Reduces land size
 - This means it fits in more dwellings
 - Set by Queens Park Regional Open Space, which is a 'Bushland Forever' site
 - Next-door to the award-winning Quattro Estate
-

To what extent has a strategy adopted to address housing affordability in the Perth Metropolitan area enhanced its sustainability and liveability?

Perth has utilised various strategies in order to address the challenge of housing affordability, and these strategies help enhance the sustainability of the Perth Metropolitan area. One of these strategies is the Bentley 360 plan, a medium-high density infill development in Bentley, south of Perth's CBD. This plan helps enhance both the sustainability and liveability of Perth. Sustainability is the preservation of natural resources for future generations while meeting the needs of the current generation. It is informed by the triple bottom line of environmental, social and economic enhancement. Liveability however, is the assessment of what a place is like to live in, which is measured by certain criteria, such as crime and safety, and access to shops and services.

Bentley 360 is a moderate to high level density development which aims to provide 1500 more dwellings in Bentley, which is a low-density area. This would address the issue of housing unaffordability as housing would be more abundant, reducing the demand and hence reducing the cost of housing in Bentley. It enhances the environmental sustainability as it reduces the need for sprawl, hence reducing the need to use natural resources such as vacant land in the rural-urban fringe. By acting as stewards of the natural resources, Bentley 360 is a sustainable plan. It enhances social sustainability as it is located near various schooling and education services (such as Canning College and Curtin University), which allowing for more people to be close to the CBD, as Bentley is only 8km away from the central business district. It also enhances economic sustainability as it would reduce the cost of housing in the Bentley area, making housing accessible to more people. Liveability is enhanced by providing a safe and reputable housing community. This inclusive community is nearby natural parkland and the Swan River; hence it has a high level of environmental quality. It has a close proximity to public transport (through buses and ferries), shopping (Bentley Plaza) and recreational areas (Collier Park Golf Course).

DEPTH STUDY TWO: MEGACITY – NEW YORK

SYLLABUS DOTPOINT 16

The site, situation, internal and external morphology and functions of New York

Site:

- Near the Appalachian and Catskill Mountains
- Undulating coastal plain, referred to as the Atlantic Coastal Plain
- Generally flat land (The highest point is at 124.9m above sea level)
- On the banks of the Hudson River
- Occupies 784km²
- Population is around 8.4million in the city, around 20million in state
- Density in the city is around 13500/km²

Situation

- 40°70' N, 74°00'W
- South-East Corner of the New York State, west of Long Island
- Dissected by transport lines into 450 subway stations
- 350km south-west of Boston

External Morphology

- It is formed up of 5 boroughs; Manhattan, The Bronx, Queens, Staten Island and Brooklyn (see map below)

Urban Functions

- The megacity of New York is complex in terms of urban function
- It has worldwide trade hubs in finance and insurance
- The prominence of these hubs leads to the increased population density
- Also contains other industries such as media and fashion
- It also serves a diplomatic function as it homes the UN Headquarters



Internal Morphology

New York's transportation networks influenced both external and internal morphology

Central Business District:

- Multi nuclei
- Includes financial district and Midtown
- The Financial district was the site of the original Dutch settlement due to its harbour access
- Intense land use competition
- Area is an aggregation of commerce and finance
- Midtown shares high levels of accessibility

Inner Mixed Zone:

- Comprises of older inner neighbourhoods that fringe the CBD
- Transitional zone - semi intensive mixture of land uses. Dissimilar functions eg. warehouses, factories, restaurants
- In NYC mixed neighbourhoods surrounding the Financial District and Midtown make up the IMZ
- In Manhattan IMZ, includes former Industrial areas of SOHO, Tribeca and Chelsea, many residential areas in lower Manhattan were once slums

Residential Zone:

- Most dominant in terms of spatial extent
- Contains wide variety of dwellings of different ages, style and quality
- Manhattan Island residential regions begin around Central Park moving into Harlem and the Bronx. Residential density is very high
- Redevelopment has been going on since the 1950s, to clear former slums and tighten buildings in Manhattan. Attraction of suburbs includes affordable cheaper land, less congestion and larger blocks

Special Purpose Zones:

- Headquarters of the United Nations in Turtle Bay, Manhattan zone that is 'one of a kind'
 - Manhattan's Central Park and Brooklyn's Prospect Park significant in size
 - Airports + JFK (John F. Kennedy) La Guardia
 - Amusement area found at Cooney Island
 - Sporting venues - closely linked to public transport. Billie Jean King
 - Tennis Centre = US Open. Yankees Stadium in the Bronx
-

SYLLABUS DOTPOINT 17

The Demographics of New York

- Large and ethnically diverse pop.
- A cultural melting point
- African American, West Indians, Chinese, German, Italian, Irish and Russians
- Over 200 languages spoken in the City
- 2014 U.S Census data pop over 8 million
- 10,000 people per km²

Age and Gender -

- By 2030 median age will increase by 4 years. 85 years will increase by 12%
- All pop. groups below 50 will decline
- Females will continue to outlive male counterparts
- Manhattan island highest non family and single occupant household
- Outer boroughs have more families and Children under 18.
- Non family households
 - Manhattan: 59%
 - Brooklyn: 33.7%
 - Bronx: 32%
- Single Occupant Households
 - Manhattan: 48%
 - Brooklyn: 27.8%
 - Bronx: 27%
- Apartment living in high rise buildings
- Further from city centre = suburbia similar to Aus but far higher pop. density

Socio-economics:

- Ranges from poverty to considerable wealth
- District zones appear inner = rich commute via public transport and for food.
- Second (outer boroughs) poor commute via public transport and 3rd (Westchester). The rich drive.
- Anomalies do exist and Manhattan good example where low income salaries occur. China Town and Washington heights. both have a high number of poorer quality multi unit buildings
- Many of these buildings were developed in the 1950s' known as brownstone to rid U.S of slums (known as super block, super cheap and high density)
- Five counties in the U.S account for 5.1 % of the total residency population of America
- Manhattan has the highest per capita income in the U.S. \$100,000
- Wealthiest 20 % of pop earn 35 to 40 times the amount of the poorest 20%
- The divide between socio economic groups within New York City continues to grow

Cultural Distributions:

- Predictions are that the total pop of NYC will increase as will the ethnic distributions
 - Since 17th century, immigration fuelled NYC's pop growth. Coming for Work, to Flee etc. Most came from Germany, Ireland, Italy and Russia
 - Now 63 % Hispanic, African American and Asian, the city population by 2030 will comprise almost 80% of these groups as well as other Europeans
 - Total pop by 2030 predicted to be 9 to 9.5 million and will be diverse like never before
 - Despite being 'melting point' of different nationalities, the ethnic characteristics of NYC's neighbourhoods have not dramatically changed.
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- Staten Island
 - Population is smaller, older and wealthier
 - Staten Island has 5.5% of city's total pop, within 14.1% aged 65 or over
 - Average household income = \$72,500, over double that of the Bronx.
 - Pop is predominantly white - least diverse borough
 - Isolation may have made it undesirable for newly arrived immigrants
 - Fewer cultural enclaves
 - Public transport is limited.
 - Over time improvements in transport tech has made it more accessible to the rest of the city. Ferries and bridges
 - Quiet and relaxed urban environment - more recently exurbanites seeking this, and affordable housing may find Staten Island as their home
 - Recognised for its beaches and open spaces
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SYLLABUS DOTPOINT 18

The nature, scope and causes of each of the two selected challenges being confronted, and the implications for the selected megacity.

SYLLABUS DOTPOINT 19

The range of planning strategies that have been used to address each of the two selected challenges, and how these compare with and/or have been informed by, responses implemented in other world megacities

SYLLABUS DOTPOINT 20

The extent to which the planning strategies adopted in the selected megacity have been, or could be, informed by the concept of sustainability.

SYLLABUS DOTPOINT 21

The strategies adopted in the selected megacity to address these challenges.

SYLLABUS DOTPOINT 22

The extent to which these strategies have enhanced its sustainability and liveability of the selected megacity

TRAFFIC CONGESTION

What: New York is frequently clogged with traffic, especially in the central borough of Manhattan. Over 3.7 million people commute to Manhattan for work on a weekday, especially during the peak period times of 7-10am and from 3-8pm. Out of these 3.7 million, almost a million workers drive their cars to work in New York City, and the average commuting time is now 38.4min due to the unreliable and crowded roads. Average travel speed for Manhattan and large parts of Brooklyn and Queens in the morning peak period is 20km/hr

Causes:

- High number of cars with only a single person inside it as they commute to work
- Trucks are required to deliver goods to various areas such as supermarkets and retail outlets. New York does not have a rail freight system to compensate
- ~25000 for-hire vehicles roam the city during the day through means such as Uber/Lyft
- 13000 taxis
- 6000 buses
- Most streets in New York are either perpendicular or parallel to one other. This creates a very grid-like structure, which encourages the use of traffic lights and slows down the traffic.
- There is an inadequate number of tunnels and bridges connecting New York to its surrounds.
 - George Washington Bridge carries more than 100 million vehicles a year
 - Lincoln Tunnel carries over 120,000 vehicles a day
- Only 4 bridges in New York aren't tolled, so people are more motivated to use these bridges in order to avoid tolling. This increases the congestion in this area

Strategies:

- Citi Bike
 - Overview
 - Introduced in May 2013
 - Annual fee of \$169, subscribers are able to make an infinite number of 45min trips on public bikes located around the city
 - Located in all 5 boroughs
 - Takes advantage of infrastructure already provided due to the New York City Bicycle Master Plan
 - Dedicated cycling lanes
 - Secure storage spaces
 - Easy access to buses, ferries and the subway
 - Initially with 6000 bikes and 330 stations, now 12000+ bikes over 750 stations
 - Also available at \$3/trip or \$12/trip for tourists or those who need it
 - Influences
 - Draws off the success of other initiatives, such as Vélib' in Paris
 - Launched in 2007, one of the largest bike sharing schemes in the world in 2013 when Citi Bike was introduced
 - Paris is a megacity that has a larger commuter zone that has resulted in some of the worst traffic congestion in Europe. The photochemical smog in Paris is primarily generated by diesel vehicles and it's creating the greatest concern for officials. In 2007, Paris introduced Vélib' which is a bike share scheme. This scheme has been a success and has inspired other cities within Europe and abroad to adopt similar systems like how New York City has a similar scheme to Paris. New York City's Citi Bike scheme was conceived on the merits of the Vélib'. With over 250,000

subscribers and 30 million rentals annually, the system is the daily transportation for thousands of Parisians.

- Users of Vélib' purchase a subscription which enables them to an unlimited number of rentals within the purchased time period. The city intends to reduce traffic congestion by decreasing the availability of parking and increasing a network of bus lanes and cycle paths at the expense of private car lanes. The Vélib' system employs over 400 people to maintain the system 24/7
 - Other cities that has a similar planning strategy as New York City's is Amsterdam and Copenhagen which is also in Europe like Paris. Amsterdam's resident uses a bike on a daily basis, accounting for 38% of total traffic in the city. In Copenhagen, 52% of resident's commute by bicycle.
 - Influenced by Sustainability
 - Aims to enhance the health and productivity of city dwellers by allowing them to be more active while also minimising the amount of time wasted while commuting to work.
 - Aims to preserve natural resources by reducing the level of congestion on the roads and use required resources efficiently
 - Enhancing Sustainability
 - Environmental → reducing carbon dioxide emissions caused by motor vehicles. Less cars being used means less vehicles emitting these gases. Bikes used in 'Citi Bike' do not impact the surrounding environment
 - Social → Improves the wellbeing of users, improving their health and fitness. It is also promoted to be fun, with organised group rides and providing information about popular scenic routes on its website
 - Economic → Influences the economy in a positive way. Generated \$36million just in its first year, as well as creating 170 jobs for bike mechanics and call centres. The program was completely implemented through the support of various sponsors (CitiBank, MasterCard, Goldman Sachs Urban Investment) instead of taxpayer money
 - Enhancing Liveability
 - Environmentally → Improves NYC's environmental quality, focuses on shifting those who are dependent on automobiles to an eco-friendly service.
 - Socially → Reduces stress of citizens. Driving in congested traffic is extremely stressful, reducing congestion would therefore reduce the number of stressed people. Also decreases risk of injury, bicycle crashes are often less severe than car crashes. Also increases the productivity of citizens, it is currently faster to travel by bike, so it saves them time.
 - Economically → Provides a cheaper way for transportation. \$169 for a year is cheaper than two, monthly passes for the subway ($2 \times \$121 = \242) and much cheaper than a year's supply of petrol
 - Select Bus Service
 - Overview
 - Implemented in June 2008
 - Rapid bus transit system which eases congestion on both roads and subways
 - Subway-like buses travel around the city at a heightened rate, aided due to;
 - Dedication of lanes for buses
 - Traffic signal priorities
 - Frequent service during peak hours
 - Efficient boarding system
 - Commuting time for riders has decreased by almost 20%
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- Bus commuters increased to an extra 5000/day
 - Influences
 - Metrobus in Mexico City
 - Rapid Transit system opened in 2005
 - Alternative to using cars on Mexico City's most major road
 - Led to commuting times being reduced by almost half an hour
 - Reduced carbon dioxide emissions by almost 35,000 tonnes/year
 - Since its one initial line, it has been developed to include seven lines in total
 - Influenced by sustainability
 - Aimed to enhance the productivity of commuters by taking them off busy roads/subway lines and onto a more efficient means of transport
 - Aimed to develop New York's economy by reducing the amount of time wasted on these roads/lines and saving money spent on petrol/tickets
 - Enhancing Sustainability
 - Environmental → Reduces CO₂ emissions caused by motor vehicles. As less people are driving, less vehicles are emitting this. These buses have an advanced capacity, fitting more than the normal bus, taking more than the average bus. It did not require the use of any resources and it utilised existing infrastructure.
 - Social → Offers an alternative and accessible form of transport that is fast, frequent and reliable.
 - Economic → Easily funded. Cost for running the service is taken straight from the money it generates. High ridership provides it with suitable enough funds.
 - Enhancing Liveability
 - Environmental → eco-friendly mean of transport (runs on diesel)
 - Social → Easily accessible, improves mobility (bus fares are purchased before the bus arrives)
 - Economic → Do not waste as much money compared to those riding cars. Costs about the same amount as a normal bus fare
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HOUSING AFFORDABILITY

What: The unaffordability of housing in New York is considered to be a current crisis. The majority of New York's citizens have to spend a high proportion of their entire income on rent. New York is seen to be a prestigious place to live in due to its employment opportunities.

Causes:

- Wages in New York only rising by under 15% in the past 20 years, whereas the average monthly rent has increased by almost 40%. This means that they spend a high amount of their income on rent
- Around half of New York workers have a low wage that is associated with the service industry. As of December 2017, workers in the retail/hospitality industries only received an average income of \$11/hour.
 - The low pay means that many household have to spend over 30% of their income on rent, classifying them as rent-burdened
- The median rent-income ratio shows that NYC residents spend around 63.4% of their income on rent, according to the 2018 Income and Expense Study
- High level of migration to New York means there is more demand for housing
 - The city's population grew to 8.5million in 2016 (a 4.6% increase from 2005)
 - Population is expected to continue increasing and reach 9million by 2040
 - Private developers are not able to produce housing fast enough to accommodate for the demand, so the price of houses surge
- Low supply of publicly subsidised housing, meeting the needs of a very small proportion
 - Over 60,000 people have to line up to sleep in one of only 660 municipal homeless shelters

Strategies:

- Housing New York: A Five Borough, Ten Year Plan
 - Overview
 - Developed under Mayor Bill di Blasio in May 2014
 - Aims to provide 200,000 affordable dwellings over the next ten years
 - Through the construction of 80,000 units, and the preservation/restoration of another 120,000 units.
 - These sites are considered to be key development sites due to their proximity to public transport and growing employment clusters

Location (Borough of New York)	Examples of Development
Queens	Willet's Point, Hunter's Point South
Brooklyn	East New York, Cypress Hills, Pacific Park
Manhattan	East Harlem, Sherman Creek/Inwood
The Bronx	Jerome Avenue Corridor
Staten Island	St George

- Pacific Park
 - Development Site in Brooklyn
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- Consists of 17 high-rise apartments currently being constructed over an 8.9ha old, unused rail yard
 - Expected to consist of 6430 apartments, with 2250 of them dedicated for people with low-middle incomes
 - 10% of the housing is to be set aside for seniors in order to improve age diversity
 - Easily accessible; nearby an intersection for 11 subway lines
 - Close proximity of a newly established health centre and a preserved 3.2ha public park
 - Influences
 - Beijing's 5-year plans
 - Beijing releases a recurring 5-year plan regularly in order to make housing more affordable
 - The 12th 5-year plan was released in 2011, only a few years before *Housing New York*.
 - Plan aims to introduce around 200,000 housing units a year to help respond to Beijing's population levels
 - Prevented outward growth and used the land efficiently
 - Heightened productivity of dwellers in Beijing, as they remain close to the city centre
 - Allows for economic development as it aided in the reduction of those in poverty, providing them with suitable housing
 - Educates citizens on the importance of providing them with suitable housing
 - Informed by Sustainability
 - Aims to use land efficiently by preventing outward growth
 - By keeping dwellers in the city, it would increase their productivity
 - Puts more people in suitable housing, allowing for reduction of those in poverty and allowing for economic development
 - Educates citizens on the importance of providing them with suitable housing
 - Enhanced Sustainability
 - Environmentally → Redevelops underused areas (development of West Farms in the Bronx, replacing an unused warehouse with 10 apartment blocks). Many are near public transport, decreasing reliance of residents on motor vehicles and hence reducing carbon emissions
 - Socially → Improves citizen's access to health and education services (development of Hunter's Point South in Queens, located near a 1100-seat high school)
 - Economically → Reduced commuting times as it is very close to public transport (which is also cheaper than taking the car). Creates a large amount of jobs in construction (13000 jobs created for the development of Willet's Point in Queens)
 - Enhanced Liveability
 - Environmental → Develops and clears up unused brownfield functions, replacing them with various residences and restored natural areas
 - Social → Creates a safe and interconnected community in the residences, reduces the level of crime and improves the level of safety. Also promotes social quality (setting aside of units for seniors and the poor, seen though the 10% of housing reserved for seniors in *Pacific Park*)
 - Economic → Housing is more affordable and accessible to the public
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