**Year 12 Geography Overview and Depth Study Notes**

**Overview of Nature, Extent, Causes and Consequences of Land Cover Change**

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| What is the environment?  What are biotic elements?  What are abiotic elements?  What is an ecosystem?  What are the abiotic components of an ecosystem? | The environment consists of all of the elements that are on the Earth’s surface and in its atmosphere.  Elements of the environment that are living plants and animals.  Elements of the environment that are non-living  This includes changes to the Earth’s surface such as; agriculture, urban areas, transport, plantations and coastal changes.  An ecosystem is a community of plants and animals in a non-living environment. It examines the interrelationships between biotic and abiotic components.  Components include; isolation, atmosphere, soil, hydrology. |

**Factors Affecting Climate**

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| What is climate?  How does latitude affect climate?  How does altitude affect climate?  How does the position of mountain ranges affect climate?  How does proximity to the ocean affect climate?  How do prevailing winds affect climate?  How do ocean currents affect climate? | The long-term prevalent weather conditions of an area that is determined by latitude, altitude, positioning of mountain ranges, proximity of the sea, presences of prevailing winds and nature of ocean currents.  Near the equator the heating from the sun is more direct, in higher latitudes, heating is less concentrated.  The higher the altitude, the lower the temperature drops. For every kilometre rise above sea level, temperature drops roughly 6 degrees Celsius  Mountains force air to rise, once it rises it cools, this then forces it to condense precipitate. A rain shadow can then result on one side of the mountain.  Areas near the coast have a smaller temperature range. Inland areas have a greater temperature range. This is due to the ocean having a moderating effect, this is known as continentality.  By night, the land is cooler than the sea, this produces a high-pressure system over the land. The reverse occurs during the day.  Oceans affect the winds and their capacity to carry moisture. Air that is warmed by warmer ocean currents can carry more vapour. Once the air cools, there is increased rainfall due to greater concentration of water that was in the warmed air. |

**Concepts**

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| What is the environment?  What are natural biomes?  What are anthropogenic biomes?  What is land cover change?  What is ecosystem structure?  What is ecosystem dynamics?  What is biodiversity loss?  What is sustainability? | The environment are all of the elements that are on the Earth’s surface and in its atmosphere.  Natural biomes are communities of life forms adapted to a large area.  Anthropogenic biomes are global ecosystem units that have sustained human interaction, where land cover has been changed to that favourable to humans. E.g. urban landscapes, agricultural lands.  The changes that take place in natural environments due to human, human induced or natural causes.  The biotic and abiotic features of the ecosystem, their interactions and energy source.  The network of interactions within an ecosystem that include energy flows and nutrient cycles.  The decrease in the number and variety of different species of plant, animal and organism within an ecosystem.  Sustainability is the ability to meet the needs of current and future generations through simultaneous economic, social and environmental adaptions and improvements. |

**Types of Biomes Across the World**

**Tropical Forest:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | The biome is distributed approximately 15° North or South of the equator. Areas/countries include; the Amazon Basin, Brazil, North Queensland, Central America.  Average temperature of 20-30°C. Low diurnal temperature range  Heavy rainfall >1500mm, high humidity.  Latitude, heavy cloud cover and rainfall, low pressure systems dominate, monsoonal and convectional rain.  Agriculture including sugar cane, cattle and coffee.  Urban growth; village and city expansions. |

**Monsoon Climate:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | North of equator, Southern India, Thailand, Northern Australia, Sri Lanka, Bangladesh  Wet and dry season exist. Temperature range from 15°C in cold season to 32°C in hot season. Rainfall 600-1200mm.  Prevailing winds, onshore winds from low pressure systems at sea bring rain  Agriculture; rice farming |

**Tropical Savanna:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | Between 5° and 15° North or South of the equator. E.g. Northern Australia, Central South Africa, Central South America.  Summer rain, Winter dry. Distinct wet and dry seasons exist. Summer average temperature range approx. 32°C  Winter average temperature approx. 21°C  Prevailing winds, onshore winds from low pressure system bring rain, offshore winds from high pressure system reduce rain  Agriculture; rice farming, cattle stations |
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**Steppe Climate:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | Central Asia, China, Iran, Iraq, Central Africa, countries centred in continents.  Hot Summers approx. 26°C  Cold Winters approx. 10°C  Low erratic unreliable rainfall ranging 250-450mm  Latitude, continentality, positioning of mountain barriers.  Cattle and sheep grazing. |

**Desert/Hot Arid Climate:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | Central Australia, South West Africa, North Africa, Sahara, Central Asia, Central West USA  Rainfall is unreliable at less than 250mm per year.  Winter average temperature ranging from 15°C to as low as 5°C  Summer temperatures very high, average of 30°C but as high as 50°C. Dominated by high pressure systems.  High pressure systems, continentality, latitude, positioning of mountain barriers.  Mining, solar farms, nomadic herding, research |

**Mediterranean Climate:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | Approx. 30°- 40° North or South of the equator. Western sides of continents.  E.g. South West Australia, California, Italy  Summer approx. 22°C. Winter cool approx. 10°C  About 500-900mm, raining mainly in Winter.  Summer offshore winds, winter onshore winds, cloudless skies  Agriculture including; cotton, citrus fruits, olives, vineyards. |

**Warm Temperature Climate:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | Approx. 25° - 25° North or South of the Equator.  East parts of continents.  E.g. Eastern USA, SE Australia.  Summer approx. 26°C hot/warm  Winter 13°C mild  Monsoonal rain in summer ~900mm  Onshore winds.  Latitude  Agriculture including; dairy grazing and cheesemaking |

**Continental Climate:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | 35°- 60° North or South of the Equator  E.g. Canada, North USA, Russia, North China and Korea.  Summers approx. 18°C  Cold Winters approx. -18°C  High rainfall towards the end of northern hemisphere summer.  Continentality, latitude  Agriculture including; grain, mixed livestock farming (e.g. wheat and sheep) |

**Subpolar Climate:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | Northern Alaska, Canada, Siberia (Northern Russia)  Very high latitudes  Winters are cold, temperature range -30°C to - 45°C  Summers are mild, approx. 21°C  Rainfall in summer approx. 380mm  Latitude  Continentality  Onshore winds bring rain  Ski resorts, Forestry, tourism |

**Polar Climate:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | Greenland, Antarctica, Inland Iceland  Permanently below 0°C, blizzards are frequent, winter one continuous night, summer is one continuous day.  Latitude.  Research stations, tourism. |

**Alpine/Mountainous Climate:**

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| What is the spatial distribution of this biome?  What is the rainfall and temperature of this biome?  What are the factors affecting the climate?  What are the anthropogenic changes made to this biome? | Rockies, Himalayas, Andes.  Temperatures decrease with altitude, snowfall near tops of mountains  Altitudes, prevailing winds  Tourism |

**The Nature, Rate and Extent of Land Use and Cover Change**

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| What is the current world population and where in the world is it growing?  What has been happening to the death rate in the developing world?  What has higher populations led to?  How has population increases impacted arable land?  What has rapid urbanisation led to?  Where is rapid urbanisation and urban growth occurring?  What will be the state of urbanisation in China and India by 2050?  What can urbanisation lead to in terms of pollution?  What is affluence?    How is affluence spread across the world?  How is demand for goods and services changing?  What are the negative effects of affluence?  What are the effects of innovations in technology? | The current world population sits at around 7.6 billion. It is predicted to reach 9 billion by roughly 2048. It is increasing most in LEDCs.  The death rate of those in the LEDCS has been declining while the birth rate has remained constant, this leads to increased population growth.  Higher populations in both MEDCs and LEDCs has led to an increase in land cover change in order to build urban areas and expand rural ones.  As population has increased, arable land available for farming has reduced, this results in more intensive agricultural practices.  Rapid urbanisation has led to an increase in the number and size of mega cities as well as a loss in biodiversity.  Rapid urbanisation and urban growth is occurring in countries that still have large rural populations.  By the year 2050, China’s population will be 70% urbanised while India’s population will be 50% urbanised.  Increasing urbanisation can lead to more concentrated amounts of gas emissions in an area, this leads to more severe air pollution. Large cities have impacts at both global and local levels.  Affluence refers to having a great deal of money, goods, property and wealth.  In MEDCs, the populations have a far greater level of affluence than when compared with those in LEDCs, in general.  Demand for goods and services has been increasing in both LEDCs and MEDCs as the populations have been becoming more affluent and goods and services have become cheaper.  Increasing affluence has led to increased health problems such as obesity, heart disease etc.  Technology has led to increased efficiency in human processes across the world. Land cover change has started occurring at a faster rate and developments have led to changes in land use. |

**Processes of Land Cover Change**

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| What is a process?  What is deforestation?  What are the leading causes of deforestation?  What is expansion and intensification of agriculture?  How can expansion and intensification of agriculture affect soil?  What are the causes of expansion and intensification of agriculture?  What are some solutions for more sustainable farming?  What are rangelands?  What are rangelands used for?  What are the problems facing rangeland areas?  What are the four key principles in range management?  What is land reclamation?  What are the advantages of land reclamation?  What are the disadvantages of land reclamation?  What are the processes/impacts?  What is urbanisation?  What is urban growth?  What is sustainability?  What are the impacts of industry and mining?  What is soil erosion?  What is soil degradation?  What are the types of soil erosion?  What is land degradation?  What are causes of land degradation?  What are the underlying causes of land degradation?  What is irrigation?  What are the impacts of irrigation?  What is the role of the forest?  What is siltation?  What are the causes of siltation?  What are some mitigation strategies? | A process is a series of actions that lead to a planned outcome.  Deforestation refers to the process of clearing forest, generally in order to create land for housing and agricultural practices.  Agribusiness, areas are cleared for crops/grazing, illegal logging, its responsible for 10% of worldwide logging, mining, areas are disrupted and destroyed, roads, fragments the landscape and encourages illegal logging, hydroelectric dams, flood upstream forests, causes wide spread degradation.  This refers to the increase in the production and yield as a result of increased input of agricultural processes and resources.  The soil can become eroded, degraded as well as become saline.  Leading causes include; overgrazing, having too much livestock in an area, deforestation, forests are cut down for farming land, increase in population size, there becomes a greater demand for food and resources and use of agrochemicals, such as fertilisers.  Solutions include; crop rotation, planting crops that improve soil quality, fencing off areas to allow for re-vegetation, improving irrigation managements systems and collecting run off from irrigation.  Rangelands are expanses of land where native grasses and shrubs are the predominant type of vegetation in an arid to semi-arid area.  Rangelands are commonly used by farmers for livestock grazing due to the large amounts of vegetation that is suitable for livestock.  Leading problems facing these areas include; invasive alien species, both vegetative and animal, climate change, poorly thought/carried out burn offs, poor land management systems.    The four principles are; proper stocking rate, proper distribution of grazing animals, proper grazing system, proper kinds of grazing animals.  Land reclamation refers to the creation of new land from oceans, rivers or lakes by fillings in areas previously covered by water.  Advantages include; taking pressure of urban areas, relatively cheap, helps areas with restricted land use.  Disadvantages include; can disturb local ecosystems nearby the reclamation site, susceptible to earthquakes (liquefaction), susceptible for sea level rise.  Processes include loss of biodiversity, pollution and waste disposal issues, urban sprawl, monetary and environmental cost of infrastructure, ecosystem disrupted.  Urbanisation refers to the shift, generally an increase in the proportion of a population living in rural to urban areas and the ways in which the population adapts to the changes.  Urban growth refers to the increase the in absolute number of people that live in urban areas but not necessarily an increase in the percentage/proportion of people.  Sustainability refers to the ability to provide the needs of current and future generations through simultaneous social, economic and environmental changes, adaptions and improvements.  Major impacts include; land clearing, landslides, open cut mining, soil erosion, contamination and degradation, overburden and slag heaps. Mineral and energy are major drives of economic growth too. 1.1 million jobs in this sector.  Soil erosion is the washing away of the top soil layer through wind/water induced causes such as rain or irrigation.  Soil degradation is the decline in soil quality caused by improper use.  Soil erosion types include; wind, geological, accelerated, water, land slide.  Land degradation is the process in which the value of the land declines as a result of a combination of human and natural induced causes.  Causes include; overgrazing, improper crop rotations, deforestation.  Underlying causes include; population increase, poverty, land shortages, economic pressures and attitudes.  Irrigation refers to the artificial application of water to the land, generally for farming or garden upkeep.  Irrigation reduces water downstream, increases soil salinity, reduces availability of water for industry and households, reduces natural wetland areas, waterlogging due to rising water table.  The role of the forest is to absorb, hold and release water. Forests also keep soil from eroding. Therefore, deforestation can lead to increased runoff, flooding and siltation of water ways.  Siltation refers to the pollution of water by soil run off/degradation.  Causes include; soil degradation due to poor agricultural practices. Erosion sources are construction activities as land is cleared therefore material is easily eroded away.  Mitigation strategies include; in rural areas maintaining land cover to prevent soil erosion and in urban areas keeping the land uncovered for as short as possible. |

**Factors Affecting the Process of Land Cover Change Across Nations**

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| What are the general factors that affect the process of land cover change?  What is the population size and density of China?  What is the population size and density of Australia?  What is the economic world standing of China?  What is the economic world standing of Australia?  What is the type of government in China?  What is the type of government in Australia?  What is the institutional arrangement and land ownership like in China?  What is the institutional arrangement and land ownership like in Australia?  What is the ideology and cultural views of the people of China?  What is the ideology and cultural views of the people of Australia? | The general factors are; population size and density, economic world standing, agricultural practices, types of government, institutional arrangement and land ownership, ideology and cultural views.  China has a population of roughly 1.4 billion people. The country has a population density of roughly 145 people/km2.  Australia has a population of roughly 26 million people. The country has a population density of about 3 people/km2.  China has the second largest economy in the world. It is a socialist market economy (large government control), it has a low GDP per capita relative to economy size. It’s the world’s largest exporter and second largest importer of goods.  Australia is the 12th largest economy in the world. It is a mixed market economy meaning there isn’t as much government control. It has a relatively high GDP per capita roughly 67000 USD, it’s a primary industry economy.  China’s government is a single, centralised communist party. The government has a very large amount of control on the people and the economy.  Australia’s government is made up of three levels of government who are democratically elected. It is a constitutional monarchy. There are large amounts of personal, economic and social freedoms.  In China, private land ownership is very low due to the type of government. The land is owned by the government whereas the actual property can be owned by people. In rural areas the farming land is owned and controlled by farming collectives that are government operated.  Land can be privately owned, bought and sold in Australia. There are many legislative regulations for land use and cover change due to past and present situations e.g indigenous land. Government policies and authorities have been having increasing influence on rate and location of land cover change.  In China in the past, the people have seen themselves as separate to the nature and the environment, and by extension, see that environmental issues as a result of their actions are not a real problem. Attitudes are starting to change however as the effects of the country’s actions are being felt by those in power today.  In Australia many people embrace nature and the natural world around them in their lives every day. As a result, many stakeholders are vocal with their opinions on land cover change and uses and how it will affect the environment. |

**Indigenous Land Management Practices – Past and Present**

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| What practice was used by indigenous people and what was it used for?  What practices are used by indigenous people in the present? | Fire; a system of patchwork that consisted of burnt and regrown areas was created. It was used to clear land for easier, travel, to promote a particular type of plant growth and to flush animals into particular areas.  “Caring for Country” used by indigenous communities consists of seasonal use of resources, use of fire and is a combination of past and present land management practices and traditions. |

**Spatial Modelling**

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| What is spatial modelling? | Spatial modelling is an analytical process conducted in conjunction with GIS in order to describe processes that occur on the Earth’s surface for a particular set of spatial features. |

**The Impacts of Land Cover Change on Local and Regional Environments**

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| How does hydroelectricity impact the water cycle?  How does irrigation impact the water cycle?  How does deforestation impact the water cycle?  What are the causes of soil erosion?  What is soil salinity?  What is soil erosion?  What is soil compaction?  What is soil acidification?  What is habitat fragmentation?  What is the correlation between human population and size and number of extinctions?  What things compete for water usage in society?  What is the correlation between fish stocks and time?  What are ecosystem services?  What are supporting services?  What are provisioning services?  What are regulating services?  What are cultural services?  What is the heat island effect? | Hydroelectricity blocks rivers/streams. This impacts run off.  Irrigation affects run off, infiltration and soil salinity.  Deforestation impacts the water table, infiltration and run off.  Causes include but are not limited to; deforestation, overgrazing, agrochemicals.  Soil salinity is due to land clearing of native vegetation. As a result, the salt rises to the surface as the water table rises.  Soil erosion is due to land clearing. The top soil is then removed by wind and rain. Rill and gully erosion occur as a result.  Soil compaction occurs after heavy machinery or animals have travelled over the soil. It affects how well the soil can be infiltrated by water. This affects plants ability to grow.  Soil acidification occurs due to an overuse of agrochemicals.  Fragmentation of an organism’s preferred habitat causing population loss and ecosystem decay. E.g. land clearing of forests for urban growth.  There is a strong positive correlation. As the number of humans on Earth increase, the number of extinctions also increase.  Include; hydroelectricity, flood/tidal control, agricultural river diversion, industrial water usage, municipal water use, interference in water flow, fish habitat and passage, recreation.  The number of fish cause in unsustainable ways has been increasing while the number of fish cause in sustainable ways has been decreasing.  Ecosystem services are the benefits that people obtain from ecosystems.  Supporting services are services that are necessary for the production of all other ecosystem services. Includes biomass production e.g. solar energy, soil formation, water cycling.  Provisioning services are products obtained from the ecosystem. E.g. food, fibre, water.  Regulating services are benefits obtained from the maintenance of ecosystem services e.g. regulation of climate, water, soil, pests.  Cultural services are non-material benefits that people obtain from ecosystems. They include; spiritual enrichment, recreation, social relations.  The heat island effect is that the centres of cities are hotter than outer suburb areas. This is because of city building materials have better heat retention ability. |

**Depth Study One – Climate Change**

**The spatial distribution of the world’s rainfall and temperature patterns**

**Weather and Climate**

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| What is weather?  What is climate?  What is climate change?  What has been the impact of climate change on WA?  What is a low-pressure system?  What is a high-pressure system? | Weather consists of the short-term atmospheric conditions of an area. These conditions include temperature, wind speed and direction, humidity, air pressure and precipitation.  Climate consists of the long-term averages of weather conditions in a given area.  Climate change is the non-random change in the long-term average weather conditions of an area over several decades or longer. The change may be due to natural or human induced changes.  There has been a decline in rainfall and stream flow. WA is now hotter by 0.8°C over the past several decades. Rate of change makes it difficult for plants and animals to adapt.  A low-pressure system has air that is lower pressure at its centre than the air around it. Wind blows towards the centre and as a result the air rises and the water in it condenses and forms clouds, leading to more rainfall.  A high-pressure system has air that is higher pressure at its centre than the air around it. Wind blows away from the centre and air from higher in the atmosphere comes to fill it. This system does not form rain. |

**Spatial Distribution of Rainfall**

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| What are the low latitudes?  What are the high latitudes?  What are the mid latitudes?  What are wet and dry areas due to?  What is rainfall in the low latitudes due to?  What is convectional rain?  When do low latitude areas have low and high rainfall?  What are rain conditions of windward coats and mountain slopes?  What is orographic rain?  What are the two key causes of a dry area?  What are the general patterns of rainfall distribution? | The low latitudes are the areas that are near the equator.  The high latitudes are areas near the poles.  The mid latitudes are areas that are between the equator and the poles.  Whether an area is wet or dry is dependent on its location with respect to the general circulation of the atmosphere.  Low latitude areas have high rainfall due to equatorial low-pressure belts that create large amounts of convectional rain.  Conventional rain is rain that is created due the sun heating the ground and hence the air above it, this air then rises and eventually condenses forming rain clouds. Precipitation then occurs.  Areas in the low latitudes have high rainfall during the summer and lower amounts of rainfall during the winter.  Windward coasts and mountain slopes have heavy orographic rainfall.  Orographic rain that occurs as a result of moist air being forced to rise due to mountain ranges and eventually cooling to the point of cloud formation and eventual precipitation.  The belts of subpolar lows in high and mid latitudes have heavy rain because of frontal rain.  The two key causes are that the area has prevailing high-pressure systems and that the area is in a rain shadow due to mountains.  Equatorial regions generally receive about 2000mm of rainfall/year. Subtropical and polar regions receive less than 250mm of rainfall/year. Mid latitude areas receive about 1000mm/year. |

**Spatial Distribution of Temperature**

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| What is an isotherm?  How does temperature vary across latitudes?  How do seasonal variations vary across latitudes?  Where are the hottest parts of the world and at what time of year?  How does inland temperature vary?  How does coastline temperature vary?  What do ocean currents do? | An isotherm is a line on a map that that joins all places that have the same temperature at a given time.  The temperature of areas in the lower latitudes is higher than when compared to areas in higher latitudes.  Seasonal temperature variations are smaller in areas closer to the equator whereas they are larger in areas further North or South.  The hottest areas in the world are north of the equator in June/July and are in the south of the equator in December/January.  Inland areas are hotter during summer and colder during winter. They have a large diurnal temperature range due to continentality.  Areas along the coastline have a smaller diurnal temperature range and also smaller seasonal temperature variations.  Ocean currents carry warm water or colder water depending on where they originate. Ocean currents also affect the air’s ability to carry water. |

**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**

**The Heat Budget**

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| List the aspects of the heat budget.  How does the heat budget vary across latitude?  How does the heat budget vary across altitude?  How does the heat budget vary with distance from sea?  How do the seasons affect the heat budget?  How does day and night affect the heat budget?  How does albedo affect the heat budget?  How does humidity affect the heat budget?  How do ocean currents affect the heat budget?  How is atmospheric circulation affected by the heat budget? | * 100% incoming solar radiation * 24% reflected by clouds * 3% absorbed by clouds * 6% reflected by particles * 14% absorbed by particles * 6% reflected by surface * 47% absorbed by surface   Due to more direct insolation, towards equator the equator the temperature increases. The insolation is less direct and travels through more atmosphere at the poles and therefore temperature decreases. The North/South pole receive 42% less heat energy than the equator does.  The higher that you go, the colder the temperature gets, this is because the atmosphere gets thinner and heat retention lessens. The temperature drops 6 degrees for every 1000m above sea level.  Maritime locations generally have more moderate seasons and temperature locations. This is because the sea heats up and cools down more slowly than the land does, therefore remaining more moderate.  The tilt of the Earth produces changes in the angle of the sun’s rays hitting the Earth’s surface. This results in the northern hemisphere being hottest in the middle of the year and the south hemisphere being hottest at the ends and earliest parts of the year.  Due to Earth’ rotation, day accumulates heat while night loses heat, this means that insolation is greatest during the day and at a minimum during the night.  Albedo refers to a surfaces ability to reflect heat. Areas of lighter colour have higher albedo such as the poles, this means they will be cooler. Areas like rain forests have lower albedo meaning they will be hotter.  The higher humidity is, the more heat that is retained in the atmosphere. Cloudy days make the day cooler but the night warmer as incoming radiation is high energy and outgoing radiation is low energy meaning it can’t pass back through the clouds.  Ocean currents shift warm water from the tropics to where the colder is located.  The air that is heated at the tropics around the equator move towards the poles as it rises, cooler air is then returned towards the equator. A second cell is created where the initial air is descending. |

**The Carbon Cycle**

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| What is carbon?  What happens to carbon over time?  What is the carbon cycle?  What are the steps of the carbon cycle?  How is carbon stored in the ocean?  What can be done to increase carbon uptake/reduce carbon output?  What are the key elements of the carbon cycle? | Carbon is an element that is the basis of life on earth, it is found in rocks, the ocean, organisms and the atmosphere.  Carbon is used repeatedly by the Earth, it cycles between the Earth, atmosphere and its organisms.  The carbon cycle consists of the ways that carbon is transferred through the Earth, its organisms and its atmosphere through natural and anthropogenic causes.  The carbon cycle consists of plants and trees taking in carbon dioxide from the atmosphere through a process known as photosynthesis. This carbon would then be stored in the plant until it is eaten by an animal in which the carbon would then be stored in the animal or be released back into the atmosphere due to the animal exhaling the carbon through respiration. Plants and animals die and then deposit the carbon into the Earths soil as they decompose. This then becomes a new store of the carbon. Through human processes this carbon is then dug up and burned as fossil fuels which then re-enters the carbon into the atmosphere. The carbon can also be taken up by trees through root respiration and re-entered into the atmosphere through plant respiration.  Carbon that is in the atmosphere, overtime can dissolve into the ocean. This carbon is used by many animals for shells and exoskeletons. Animals die and carbon substances are deposited at the bottom of the ocean as sediments.  Promoting plant life by growing plants, trees, bushes and shrubs can increase the amount of carbon that is taken from the atmosphere.  Burning fewer fossil fuels/combustible materials can reduce the amount of carbon that is released into the atmosphere.  The carbon cycle consists of the atmosphere, vegetation, soil and fossil carbon, the oceans and anthropogenic carbon.  Atmosphere:   * There is more carbon stored in the atmosphere than the biosphere but less than fossil fuels * There is a link between the carbon in the atmosphere and the heat budget * CO2 concentration has increased from 280ppm to 405ppm in the last 200 years   Vegetation:   * Vegetation and photo plankton are important in the removal of CO2 from the atmosphere * Carbon intake by vegetation offsets the carbon given by soils * Vegetation is most effective at up taking carbon during the growing season   Soil and Fossil Carbon:   * Soil, rock and fossil fuels are all major stores of carbon * Most the worlds carbon is stored in stable rocks such as limestone * Permafrost soils lock carbon away until they thaw   The Oceans:   * The oceans, especially the deep oceans are a major carbon store * Overtime, carbon forms sedimentary deposits * Warms oceans release carbon * Releasing CO2 warms the ocean, a cycle effect is created where the problem grows exponentially   Anthropogenic Carbon:   * Increased carbon is released into the atmosphere due to human industrial, urban and rural processes * This increased release of CO2 is greater than the ability of the ocean and vegetation to uptake it * This imbalance results in an enhanced greenhouse effect   Image result for carbon cycle simplistic diagram |

**Key Elements of the Hydrological Cycle**

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| What is the hydrological cycle?  What are the steps of the hydrological cycle?  What are the key elements of the hydrological cycle?  What are the spatial variations of the hydrological cycle? | The hydrological cycle is the cycle that water goes through in the Earth.  The steps include firstly being water evaporated into the air, from there the water vapour rises, cools, then condenses into clouds. From there the clouds shift across the landscape until they are forced to rise due to mountains. From here the water vapour is forced to cool so much that it condenses into rain. Precipitation then occurs and water runs over the land, known as run off, and some water infiltrates the soil, known as infiltration. Infiltrated water travels through the soil and is part of the water table.  Water reservoirs, evapo-transpiration and condensation, advection and precipitation and infiltration and run off are the key elements of the hydrological cycle.  Water reservoirs – 97% of world’s water mass is in the oceans, 2% is in the ice caps and glaciers and 1% is in rivers, lakes and atmosphere.  Most water begins its journey in the tropics where it is, low pressure systems turn into cyclones due to atmospheric circulation.  There are different types of atmospheric movement, such as the Hadley, Ferrell and Polar cells, subsequently, there are three types of rainfall, frontal, convectional and orographic.  Finally, infiltration refers to water that returns to the soil and the water table whereas runoff is water that goes over the land and produces streams, rivers, etc.  Within the hydrological cycle, most of the evaporated water comes from the sea and is returned to the sea. Only about 9% of this water makes it to land.  Around areas of high-pressure systems, there are dry zones, where there is little precipitation. Around areas of low-pressure, there are wet zones, where there is large amounts of precipitation.  The amount of precipitation varies across maritime and continental regions. Maritime regions have more rain whereas as continental regions have less.  Local variations in topography can affect the hydrological cycle. Tops of mountains will have more rainfall than the bottoms do due to how orographic rain functions.  [http://upload.wikimedia.org/wikipedia/commons/thumb/9/94/Water_cycle.png/320px-Water_cycle.png](http://en.wikipedia.org/wiki/File:Water_cycle.png) |

**Atmospheric Circulation**

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| What is a Hadley cell and how does it work?  What is a Ferrell cell and how does it work?  What is an eddy and how does it work?  What is a polar front and how does it work? | A Hadley cell is the type of cell that is created either side, North and South, of the equator. Air rises from direct heating from the sun and travels pole ward. The air then sinks at roughly 30° N/S and then returns towards the equator.  A Ferrel cell is the average motion of air in the mid-latitudes. It involves the sinking of air near 30° N/S and then rising further pole ward. This cell involves rising air where it is relatively cold and sinking air where it is relatively warm.  An eddy is the change in normal conditions of the atmosphere. It occurs in regions of strong temperature gradient and act to balance temperatures.  A polar front involves cold air moving away from the poles and warm air rising towards the poles, where low pressure systems then result. The polar front is then wherever the temperature gradient is the greatest. |

**Interactions between the Earth’s Cycles that influence Climate**

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| What are the interactions between the heat budget and the hydrological cycle?  What are the interactions between the heat budget and atmospheric circulation?  What are the interactions between the heat budget and the carbon cycle?  What are the interactions between the hydrological cycle and atmospheric circulation?  What are the interactions between the hydrological cycle and the carbon cycle? | **Heat Budget (Natural Greenhouse Effect)**    **Hydrological Cycle Atmospheric**  **Circulation**  **Carbon Cycle**  The driving force of the water cycle is solar energy. Solar energy functions to power photosynthesis and evaporation. The heat budget influences formation of clouds in the atmosphere. The changes in water vapour, (evaporation and condensation) release latent heat into air. The amount of water vapour influences the greenhouse effect by storing more heat in the Earth’s atmosphere.  The heat budget is responsible for creating convection currents in atmosphere. This then drives the creation of high- and low-pressure belts. The movement of heat from the equator due to this circulation influences climatic conditions. The heat budget creates pressure systems that influence rain and finally, pressure belts help transfer radiation back to space.  Carbon sources directly impact on the greenhouse gas effect, this means that increasing carbon increases the heat stored on and in the Earth. Carbon sinks lower the amount of carbon in atmosphere thus decreasing heat stored and kept on Earth. Colder oceans take carbon down to deep ocean, warm water releases carbon.  The pressure belts influence the amount of moisture that is available in the atmosphere for precipitation. Low pressure belts bring precipitation whereas high pressure belts don’t. Winds are responsible for the movement of clouds. The distribution of pressure belts affects the distribution of precipitation.  Precipitation helps to remove carbon from the atmosphere as water sources can accumulate dissolved carbon in them, Water sources can also release carbon when the water is evaporated. |

**The causes (natural and anthropogenic) and rate of global climate change**

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| **Natural**  What are the natural causes of climate change and what are their key elements?  What are the rates of these natural causes of climate change?  **Anthropogenic**  What are the anthropogenic causes of climate change and what are their key elements? | The first natural cause is varying solar output. Insolation drives Earth’s natural systems therefore variations in output impact these systems. Solar flares reduce cloud cover and increase temperature of the Earth.  There are several Milankovitch Cycles which include the tilt of the Earth’s axis, the shape of Earth’s orbit and orbital variations such as wobble.  The variation of the tilt of the Earth’s axis involves the tilt varying between 22.1° and 24.5°  The variation of the shape of Earth’s involves how the orbit is generally circular but can become elliptical, this produces variation s in length and conditions of seasons.  The variation in the Earth’s wobble as it orbits the sun involves are the Earth wobbles between a tilt of 22° - 24°, this means the North pole changes where it points and in turn, impacts on the severity of seasons.  Volcanic eruptions are a short-term event that can naturally vary the climate. Large eruptions result in short term cooling has gases sent into the upper atmosphere scatter incoming insolation.  The rate of varying solar output is an 11-year cycle, there is a 0.1% variation in the solar energy released but the effects are still great.  The variation of the tilt of the Earth’s axis is a cycle that occurs every 40,000 years.  The variation of the shape of the Earth’s orbit is a cycle that occurs about every 100,000 years.  The variation in the orbital wobble of the earth is a 26,000-year cycle.  Volcanic eruptions can create cooling that lasts for up to 7 years. These eruptions are intermittent  There are five sources of greenhouse gas emissions through anthropogenic means. These include; energy production industrial processes, solvent and other product uses, agriculture and waste management and land-use.  Energy production involves the combustion of fossil fuels, in recent years there has been an increase in consumption and the amount of fuels burned. Examples include China where 75% of energy comes from coal.  Industrial processes involve the production of GHG from these processes as well as 80% of all industrial facilities running on fossil fuels.  Solvent and other product use involve the production of CO2, the most commonly emitted GHG, other gases can contribute to EGHE, Methane has 21 the global warming potential of CO2.  Within agriculture, GHG are emitted through burning vegetation, land clearing and agricultural practices such as cattle and rice farming. Deforestation releases large amounts of stored carbon. The agricultural sector produces most of Australia’s methane and nitrous oxide emissions.  Waste emissions are mainly methane and are less than 3% of emissions. Sprawling cities have poorer waste management and therefore greater air pollutions and GHG emissions. |

**One major type of evidence for climate change through geological time**

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| What is one major type of evidence for climate change?  Describe this type of evidence and how it is used? | Ice cores are one type of evidence. They are long cylinders of ice that are drilled out from the ice caps in the Arctic and Antarctic.  At the highest and lowest latitudes, ice is the only source of data, bubbles trapped in the ice capture the gas concentrations of the atmosphere at that time. The ice itself records other properties. The ice cores can be up to 800,000 years old and reveal up to 8 glacial cycles. They are removed by a special type of drill and are kilometres long. The amount of snow in a year can be determined by the thickness of the layers and also provide information on temperature, precipitation, atmospheric composition and volcanic activity. Colder temperatures lead to higher concentrations of heavier oxygen isotopes. Volcanic activity can be found as eruptions produce dust and the dust is contained within the layers of ice. |

**One major type of evidence for climate change in recent human history**

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| What is one major type of evidence for climate change?  Describe this type of evidence and how it is used? | Global temperature rise is one type of evidence.  Over the past 200 years there has been a distinct and visible rise in world temperatures. From 2014-2015 the hottest year on average was recorded. In the next 100 years the temperature is expected to rise by 1.8-4°C. This is due to the enhanced greenhouse gas effect due to human processes of burning fossil fuels and other activities. |

**The interrelationship between land cover change and climate, including changes to surface reflectivity (albedo) and the process of natural carbon sequestration**

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| What is albedo?  What is the albedo of the surface of the Earth?  What is carbon sequestration?  What is a carbon sink?  In what ways does land cover change affect climate? | Albedo refers to the degree of reflectivity of a surface, the amount of solar radiation it reflects.  On average, the Earth’s albedo is about 31%, reflecting radiation mainly off the icecaps and being absorbed mainly by the oceans.  Carbon sequestration is the process of up taking carbon the atmosphere by carbon sequesters. It keeps CO2 balances in a way that optimally supports life.  A carbon sink is a forest, ocean or natural environment that has the ability to absorb CO2 from the atmosphere.  Land cover change processes alter the amount of carbon that can be sequestered, the amount stored, release stored carbon into the atmosphere, and also change in the albedo of the surface of the Earth. By changing these, the cycles and circulations of the Earth’s systems are altered. Land cover change that changes amount of carbon sequesters alters the amount of CO2 that can be up taken, thus impacting the heat budget and carbon cycle, meaning that more heat is trapped. Altering land so that the amount of carbon sinks and stores is reduced alters the carbon cycle and heat budget  as more carbon will be released into the atmosphere, trapping more heat, heating the Earth and its climates. Altering land so that its albedo it changed will mean that incoming insolation is either absorbed or reflected more. In the case of the Earth, land is being altered so that the albedo is being decreased and the heat is being absorbed more. This extra absorbed heat is then creating more change in albedo, creating an increasing adverse feedback loop. |

**The effects of climate change on land cover in natural and anthropogenic biomes (vegetation, ice sheets, glaciers, coastal systems and coral reefs, agriculture, urban settlements and industry)**

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| **Natural**  What is an effect?  What is an anthropogenic biome?  What is a natural biome?  What are the effects on vegetation?  What are the effects on climate?  What are the effects on coastal systems and coral reefs?  What are the effects on ice sheets and glaciers?  **Anthropogenic**  What are the effects on agriculture?  What are the effects on urban settlements and industry?  What are the effects on ocean water levels?  What are the effects on natural hazard impact? | An effect is a change which is a result of an action or other cause.  An anthropogenic biome is an area with sustained direction human interaction, which has been altered in order to be favourable to human activity.  A natural biome is a large area of land with similar conditions and organisms that have been adapted to these conditions.  The vegetation of particular areas will shift due to changing ecological boundaries. Changing rainfall patterns such as more rain in equatorial regions and less in high pressure zones cause vegetation to spatially shift. Certain biomes will be replaced by other types.  The climate is drying, rising temperature lead to drying climates in areas, and as a result, there will be significant rise in bushfires, their frequency and intensity and this will also impact on flora and fauna’s ability to recover.  Climate change will cause sea level rise. This due to melting ice and thermal expansion where warmer oceans take up a larger area.  The predicted impacts include increased coastal erosion, increased storm surges, impact on vegetation in coastal regions due to changing salt and silt levels and the human impact – MEDCs can adapt while LEDCs can’t.  Warming temperatures will lead to reduced ice sheets and decrease in the albedo of the Earth. This then leads to an increase in sea level rise. A feedback loop is creased when ice melts, as this reduces albedo, increasing insolation absorbed, which causes temperature rises which then leads to further ice cap melt. There is evidence for worldwide glacial retreat. Mid latitude glaciers are retreating fast. 90% of Antarctic glaciers are showing signs of retreat.  Climate change is causing agricultural boundaries to shift. The high latitudes may benefit from increase in temperature and more rainfall but low latitudes have negative impacts. Lower rainfall and higher temperatures will reduce crop yield and put pressure on livestock. There has been a decrease in the amount of arable land available for agricultural practices.  The effects of climate change will be greatest in LEDCs and densely populated areas, as well as coastline areas.  Rising temperatures will affect human health, more energy will be required for cooling which creates a feedback loop as the fuel for energy is what is causing the heat, there will be additional demand on food and water supplies.  Changing rainfall patterns are causing more frequent and longer drought which will bring greater water costs. The higher rainfall in some regions will bring additional floods and storms. Food supplies will be impacted by changing agricultural practices. Since 1950 WA’s rainfall has reduced by 10%.  There has been erosion of shorelines. There has been increasing flood risks in low lying coastal areas, damaging property and infrastructure and flood control measures have become more costly.  Primary production sector will be impacted by atmospheric hazards. Hazards will increase in frequency, duration, magnitude and intensity. Sea level rises will lead to greater flooding of low-lying areas. |

**The projected impacts of global climate change**

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| What will happen to the temperature?  What will happen to precipitation?  What will happen to snow and ice?  What will happen to the sea level?  What will happen to the acidity of oceans?  What will happen to ocean current?  What will happen to severe weather events?  What will happen to clouds?  What will happen to the carbon cycle?  Define climate commitment.  What is a tipping point?  What are the four major tipping points? | In the next 20 years temperatures will rise 0.2°C globally. The rate of temperature rise will be different in different areas. During 21st century there will be 1.8-4°C rise.  High evaporation rates due to higher temperatures will lead to greater precipitation. There will be drier summers in some areas and more wet winters in some areas.  There will be an increase in snow and ice melt and a decrease in sea ice/glacial volume.  Sea levels will rise due to melting glaciers and sea ice, as well as due to thermal expansion. By 2100 there will be a 20-50cm rise globally.  Due to increased CO2 in the atmosphere, the pH of oceans will decrease.  The thermohaline circulation will cause warm water to become saltier.  The amount and severity of severe weather events will increase, this has appeared to already be happening.  More evaporation due to warmer temperatures will cause more clouds. This will cause more shade as well as more enhanced effect from GHG.  There will be changes to the length and timing of growing season which will affect carbon uptake. Earth will absorb less CO2 as climate change worsens which will make the problem worse, and create an adverse feedback loop.  Climate commitment refers to how as current conditions continue to worsen; climate change will continue.  A tipping point is a large abrupt change that cannot be stopped no matter what is done to prevent it.   1. The collapse of major ice sheets in Greenland and Antarctica 2. Disruption of thermohaline circulation 3. Sudden release of methane as permafrost thaws 4. Ocean uptake of CO2 will stop as the ocean becomes saturated. |

**Depth Study Two – Impacts of Land Cover Change**

**Approaches to Land Cover Restoration and Rehabilitation**

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| What is restoration?  What is rehabilitation?  What is mitigation?  What is adaptation?  What is preservation?  What are sequesters?  What are strategies?  What is land cover change?  What does endemic mean?  What are the key elements of the Beeliar Wetlands project and what are the outcomes?  What are the key elements of the Point Walter Reserve and what are the outcomes?  What are the key elements of the Rwanda project and what are the outcomes?  What are the impacts of mining on land cover?  What are the rehabilitation techniques associated with mining?  What are the key elements of the Marlee Reserve in Mandurah and what are the outcomes? | Restoration is the process of restoring land cover within an ecosystem back to its original state after it has been disrupted or degraded from either anthropogenic or natural interactions.  Rehabilitation is when an area is restored, such that the services that ecosystems that it provides are repaired, restoring its overall level of productivity.  Mitigation is the ability to moderate the severity of a hazard or other adverse event.  An adaptation is an alteration that is made in response to a change in an environment.  Preservation are the strategies that attempt to maintain natural environments that have not yet been altered through anthropogenic means.  Sequesters are things that set apart or separate a substance, e.g. CO2 sequesters uptake CO2 from the atmosphere.  Strategies are plans of actions that are designed to achieve a long-term goal.  Land cover change refers to the alteration of the Earth’s surface through either anthropogenic or natural causes, or both.  Endemic is when a plant, animal or organism is only found in one particular area of ecosystem.  The key elements include the damaged wetlands due to urban and agricultural processes, the 5-10 thousand under and over storey plants planted, the annual watering program for seedlings, the ongoing maintenance and checks of regrowth and removal of pests and weeds. The outcome is that since 1985, over 5.5 hectares have been successfully restored to its original state.  The reserve has been affected through anthropogenic and natural causes which have led to loss of beach and foreshore. The strategies put in place to rehabilitate the area include the removal of non-endemic trees, placement of gabion cages and limestone boulders to mitigate further erosion and the revegetation of 50 thousand native seedlings.  The key elements include high population meaning high pressure on land for urban and agricultural processes. The topography and rainfall are steep and high respectively meaning issues for erosion have arisen. In response, Eucalypts have been planted that have wide set and deep-rooted roots that stabilise the soil.  Impacts include; open cut mining removes the topsoil, rock layers and overburden, land clearing of trees and shrubs, loss of biodiversity and spread of dieback and run off and infiltration of the soil is affected.  There are 7 steps for rehabilitation. These include;   1. Landscaping – open mines are flattened, logs and boulders are returned 2. Pre-ripping – compacted soil ripped to allow plant growth 3. Soil return – overburden and topsoil are returned to original depths 4. Final contour ripping – top soil/overburden ripped, mounds created to stop erosion, seeds planted 5. Recalcitrant planting – species that re-sprout planted by hand, makes up 20% of vegetation 6. Fertilising – fertiliser applied by helicopter to promote seedlings 7. Ongoing monitoring and management – 9 months later the sites are checked and the welfare of the site is measured.   The key elements include the areas of remnant vegetation, that is areas of original vegetation, the separation of wildlife due to habitat fragmentation – the reserve is split up by roads and residential, wildlife corridors that allow species to move between regions, genetic, there is great biodiversity. The outcomes include a tree register that monitors the type of trees and their health, habitat boxes that provide shelter for animals such as microbats. |
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| What are national parks?  How much of the Earth has been devoted to national parks?  How many national parks are there in Australia?  How much of Australia is protected by national parks or other measures?  How many national parks are there in WA?  For what other reasons can national parks be important?  What kind of ecosystems do national parks usually cover?  What is one local national park? | A national park is a large area protected as it contains unspoilt ecosystems with high biodiversity. Commercial activities are strictly prohibited to protect native flora and fauna.  Over 13.25 million km2 have been protected to preserve threatened habitats. This is equal to about 9% of the Earth’s surface.  There are 500 national parks in Australia.  Over 28 million hectares of land, roughly 4% of Australia’s land areas have been dedicated to national parks. A further 6% has been dedicated to state forests, parks and conservation reserves.  There are 100 National parks in WA and 13 maritime parks.  National parks are important for tourism and recreation as well as allowing indigenous people the ability to stay spiritually connected to the land.  National parks usually cover ecosystems that are endemic to the area.  Wollemi National Park, that is South West of Perth. |

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

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| What is mitigation in terms of climate change?  What are the 5 things that need to be considered at a local level?  What are the mitigation measures for energy?  What are the mitigation measures for water?  What are the mitigation measures for waste?  What are the mitigation measures for urban footprint?  What steps should be taken in terms of urban planning?  What is reforestation?  What work is being done to reforest areas?  How much land has been reforested? | Mitigation in this context refers to reducing the rate of anthropogenic carbon emissions and increasing the rate of carbon uptake from the atmosphere.  The 5 things include; energy, water, waste, urban footprint and urban planning.  Mitigation measures include greater use of insulation, natural lighting, solar heating, reducing the size of houses and passive solar design.  Photovoltaic cells convert sunlight directly into electrical energy. They do not pollute at all and are a substitute for fossil fuels.  Perth’s rainfall has decreased by 20% in recent years. Mitigation measures for water usage include reusing treated water, reducing use of water, use of water saving appliances, hydro-electricity, tidal and wave power.  Waste can impact on climate and natural systems. The current waste disposal systems in many countries is not sustainable. Mitigation methods include reducing waste disposal, recycling, re-using, harvesting methane. Perth produces 2.5 million tonnes of waste per year.  By 2030 Perth’s population is expected to be 2.4 million. This puts pressure on urban fringes and increases demand for resources.  To mitigate growth, higher number of new homes made in existing areas of infrastructure, placing homes near employment housing to meet demographic characteristics, e.g. elderly moving out of bigger homes.  An aim for more liveable cities through; pedestrian orientated developments that reduce the need for cars such as walkable suburbs, transport orientated developments such as bus lanes and public transport.  Reforestation is the process of restoring and rehabilitating areas of cleared land back to their natural state. |

**How human activity has adapted, or may be required to adapt, to global climate change**

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**A program designed to address the impacts of land cover change on local and regional environments**

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| Identify and describe the four major land cover changes to the land and coastal waterways.  Identify and describe the main high-risk concerns of the City of Mandurah in their Climate Change Adaption Plan.  Identify the measures adopted by the City of Mandurah to address the impacts of climate and land cover change.  Identify the main stakeholders that City of Mandurah has to be involved with and briefly describe their viewpoint. | The four major land cover changes to the land include large scale clearing of vegetation, engineering work to alter natural hydrology, the construction of the Dawesville cut and the construction of canal estates.  The large-scale clearing of vegetation/land is due to urban growth and population increase. This has brought about a need to provide homes and services to the new population. This then leads to natural areas being put under development pressure which then leads to pressure on ecosystem services such as provisional, supporting, regulating and cultural services.  The engineering work that alters natural hydrology has impacted the infiltration of water and the groundwater itself. The groundwater is pumped for industrial, residential and commercial purposes. The impacts on infiltration are due to the construction of drains and other built features that direct water away from ground soils, affecting groundwater supplies.  The Dawesville cut was built to alleviate the excessive nutrients that were in the Peel inlet as a result of agricultural processes. The nutrients created algal blooms that reduced the oxygen content in the water. This resulted in large fish kills. The cut allows the nutrient rich water to be flushed into the ocean.  The construction of the canal estates has led to problems with sea level rise. The water levels are expected to rise by 0.5m by 2050 and by 2100, they are expected to have risen 1.2-1.7m. Current canal water walls will be breached exposing houses and infrastructure to flooding.  As outlined by the City of Mandurah’s report, the main high-risk concerns include:   * Sea and water level rise, both ocean and river on coastal infrastructure which will result in loss of community assets through destruction and disturbance to coastal recreation and infrastructure * Impact on coastal and estuarine systems. The systems may be impacted by erosion, changes in sand movement, decline of fresh water entering estuary and becoming more acidic * Changes to the estuary such as increase in water levels that lead to water rising over canal walls and decreased stability of ecosystems around the estuary * Increased mosquito borne diseases in wetland areas * Increased fire risk due to increasing intensity and frequency of fires in bushland areas due to increasing temperatures and dryness as these pose a direct threat to homes and infrastructure * Increased heat impacts and threats to the elderly and young   Mandurah  Measures adopted –   * Detailed mapping of the areas impacted or at high risk of sea level rise e.g. coastal and channels * construction of buffer zones – develop areas to be set back from coastline, assets moved inland * Planning and building design that can withstand severe weather events e.g. storm surges * Emissions monitoring platforms – electrical, water, waste, gas, in order to locate areas that are producing high levels of emissions * Geothermal heating of the recreational and aquatic centres * Solar plan – solar panels being installed on council and city buildings   Proposed future adaptions/mitigation measures   * Retrofitting street lights within the city of Mandurah * Battery storage of solar energy in order to use at night times etc. * WA Planning Commission – planning commission aims to develop urban areas that are least susceptible to climate and land cover change while being able to provide appropriate quality of life * Environmental Protection Agency – aims to protect natural and preserved areas from land cover change and to maintain the biodiversity of ecosystems * Department of water – aims to reduce water usage across state, and to use water in more efficient and sustainable ways in order to adapt to an increasingly water deficient future * Department of Transport – aims to encourage the public to use |

**An evaluation of the program, giving consideration to environmental, economic and social benefits and costs**

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| What is the impact of the land cover change program in terms of environmental sustainability?  What is the impact of the land cover change program in terms of economic sustainability?  What is the impact of the land cover change program in terms of social/political sustainability? | On a field trip to Mandurah, as told to us by one of the environmental officers, the plan will work to reduce the impact on land cover change by reducing the city’s greenhouse gas emissions, which will in turn mitigate the effects of climate change, reducing the impact on land cover change to the areas in and around the City of Mandurah. The geothermal heating being used by the city has reduced the annual GHG emissions of the city by 30% or 2000 tonnes. The solar plan already implemented has reduced the GHG emissions of the city by 5% or 400 tonnes. The LED retrofitting of council and city buildings has reduced GHG emissions by 1-4%. By reducing emissions, the enhanced greenhouse gas effect is decreased and therefore warming of the planet reduces, reducing land cover change. In the long term, the plan pays for itself by reducing future costs and providing jobs into the economy.  On a field trip to Mandurah, as told to us by one of the environmental officers, the plan will reduce the amount of money that the City of Mandurah will need to dedicate to areas of public and private concern. These areas include the geothermal heating of the aquatic and recreational centre, which will save the city $700,000/year, the introduction of solar panels on the roofs of city and council buildings will save the city $150,000/year and the retrofitting of LED lighting in council buildings will save a further $49,000/year. This money will then be available for other sectors of the City of Mandurah to use and utilise.  On a field trip to Mandurah, as told to us by one of the environmental officers, the aims of this plan developed by the City of Mandurah are designed to put the City of Mandurah as a forerunner of climate change prevention, engage the public in developing sustainable and manageable ways of mitigating climate change and providing a sustainable future. This has been done through its four-stage plan of research and assessment, decision making, planning and consultation with the public of Mandurah, implementation of the proposed strategies such as the geothermal heating and finally reflection of the implemented strategies with the public and then repeating the process again. |

**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**

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| Where is Gangneung, Korea?  What is needed in Gangneung?  What is causing damage to the coastline of Gangneung?  Where is most of South Korea’s infrastructure located?  How much has sea level risen in the past 50 years?  How high are the sea walls compared to the wave heights?  How many sandy beaches are severely eroded?  What are the impacts of sea level rise on Gangneung?  What are the proposed and currently implemented strategies to adapt to sea level rises?  Evaluate the sustainability of the strategies in terms of social sustainability.  Evaluate the sustainability of the strategies in terms of economic sustainability.  Evaluate the sustainability of the strategies in terms of environmental sustainability. | Gangneung is a tourist attraction located on South Korea’s east coast  In Gangneung, strategies that prevent the loss of sandy beaches and the damage caused by storm surges and high swell are required.  The coastline of Gangneung is being damaged by flooding and rising sea levels  Most of South Korea’s infrastructure is located near the coastline.  In the past 50 years, sea level has risen by 22cm in Gangneung, South Korea.  Sea walls that are currently in place are 4 to 5m high while some waves are now reaching up to 7m high, meaning that some waves are now breaching sea walls.  18 out of 34 of the sandy beaches in Gangneung have now been severely eroded.  The impacts of sea level rise include coastal erosion, squeezed beaches and shoreline roads.  The current and proposed strategies to adapt to sea level rises include reconnecting the pine forest and the beach to allow the circulation of sand. This is because the pine forest facilitates natural influx of soil and sand that stabilises the beaches. When the wave heights increase due to rising sea levels, the forest will act as a natural buffer protecting the coastline. The shoreline roads and commercial areas will be relocated to the hinterland of the pine forest, additionally relocating facilities from high-risk coastal areas to low-risk upland areas. The construction of boardwalk promenades that facilitate pedestrian access while allowing influx of water and sand to stabilise beach areas.  The adaption methods being implemented and those proposed have been deemed an exemplary design adaption for coastal areas. The plan has become a basis for land use policy in areas that are susceptible to erosion and flooding, creating simplicity for future situations. The plan has also established guidelines for publicly funded developments and is creating a sustainable and resilient future for coastal areas and cities.  The strategy will be costly in the short term, but it will be a one-time cost for a long-time solution to a prevalent and rising issue. The pine forest brings extra an extra tourism aspect, increases economic activity of the area. The boardwalks facilitate the ability for tourists and residents to access commercial areas to spend money.  The pine forest is an ecological relief system that works to help the area. The boardwalk promenades allow the movement of water and sand to stabilise the beach, this leads to less erosion by rising sea levels and less squeezed beaches. |

**Overview of Places and Challenges**

**The process of Urbanisation and its implications for world population growth and human wellbeing in urban and rural places**

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| What is an urban settlement?  What is a rural settlement?  What is a primate city?  **Implications of Urbanisation**  How much of the world’s population is in urban areas?  How much will world population grow by 2050?  How much has urbanisation increased in Asia and Africa?  What are the fastest growing agglomerations?  **Human Wellbeing**  What has happened as a result of urbanisation?  What does rapid urban growth do?  What else has urbanisation affected?  How are cities changing?  How have labour markets changed?  **Urban Models**    What is the concentric zone model?  Provide a labelled diagram of the concentric zone model.  What is the sector theory model?  Provide a labelled diagram of the sector theory model.  What is the multiple nuclei model?  Provide a labelled diagram of the multiple nuclei model. | Settlements e.g. Perth, where most of the population is involved in secondary industry (manufacturing) or tertiary industry (professional, retail, commercial). They have a higher functional complexity (range of goods and services) than rural settlements.  A centre in which the majority of the population is engaged in activities associated with primary industry such as agriculture and mining. E.g. Manjimup, Jurien Bay. The most common type of rural settlement is a farmstead.  A city that is the most dominant within the urban network of that area, as measured by both population and urban functions. E.g. Perth dominates region socially, economically and politically.  A primate city has at least 40% of the region’s population with the next largest settlement having less than 10%. E.g. Perth has over 80% of WA’s population.  54-55% of the world’s population is currently in urban areas.  By 2050 the world’s population is expected to increase by 2.5 billion.  There has been a roughly 90% increase in Asia and Africa.  The fasted growing urban agglomerations are medium sized cities and cities with less than one million inhabitants in Asia and Africa.    Urbanisation has brought about economic and social transformation which have brought about greater geographic mobility, lower fertility, longer life expectancy and aging populations.  Rapid and unplanned urban growth can threaten sustainability of the area. That is with increased urban sprawl, some cities won’t be able to cope, which will impact on environments.  There are generally higher levels of literacy and education, better healthcare, greater access to social services and enhanced cultural and political opportunities.  Cities are now offering more opportunities for populations such as greater healthcare, public transport, housing, water and sanitation.  Urban dwellers now have larger and more diversified labour markets.  This involves a single centre based on land/bid rent. The land uses are arranged in concentric zones with the highest rents closer to the middle. Rent costs decreases outwards and the areas are uniform in width and accessibility.  Related image   1. CBD 2. Wholesale Light Manufacturing 3. Low-class Residential 4. Medium-class Residential 5. High-class residential 6. Commuter’s Zone   This model is based on a single central point which includes sight and transport influences. The major transport routes increase accessibility and it is visible that corridors are formed near transport. The high land values are developed near transport.  Image result for sector theory urban model   1. CBD 2. Wholesale Light Manufacturing  1. Low-class residential 2. Medium-class Residential  1. High-class residential  1. Commuter’s Zone   This model shows that large urban areas are the result of many processes and influences such as planning, site factors, socioeconomic, land values and historical influences. Perth shows evidence of all models.  Image result for multiple nuclei urban model   1. CBD 2. Wholesale Light Manufacturing 3. Low-class Residential 4. Medium-class Residential 5. High-class residential 6. Commuter’s Zone 7. Heavy Manufacturing 8. Outlying Business District 9. Industrial Area |

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| **World/Global Population**  What is morphology?  What is external morphology?  What is internal morphology?  What is a functional zone?  What influences population change and structure?  What are the patterns of population growth?  What are the five stages of a world places population?  What are non-contributors to society?  What are the key characteristics of LEDCs?  What is urbanisation?  What is urban growth?  What are the advantages of urbanisation?  What are the disadvantages of urbanisation? | Morphology refers to the study of an objects shape and form.  External morphology is the general shape formed by the boundary of an urban area.  Internal morphology is the study of the internal structure and layout of an urban centre. For example, residential, CBD, special purpose areas, commercial, manufacturing.  A functional zone is a distinct group of similar land uses found in particular parts of an urban area.  Population change and structure are influenced by births, deaths and migration. Globally population levels have grown slowly except for the 1900s and 2000s.  The patterns of population growth include LEDCs have high population growth rates and high death rates, death rates have been decreasing but birth rates have stayed constant, MEDCs have low growth rates due to low birth and death rates.  The five stages are:   1. The total population is low but balanced due to high birth and death rates. 2. Total population rises as death rates fall due to improvements in healthcare and sanitation but birth rates remain the same. 3. Total population still rising rapidly, gap between birth and death rates narrow due to availability of contraception’s and needling less children. 4. Total population is high but balanced as birth and death rates become more equal. 5. Total population begins to decline due to aging population and desire for smaller families due to wealth   Non-contributors to society are those under the age of 15 and over the age of 65.  The key characteristics include many young people and few old as well as there being a large young population.  Urbanisation refers to the increase in the percentage or proportion of people living in urban areas.  Urban growth refers to the increase in the number of people living in urban places not necessarily percentage or proportion.  The advantages include:   1. Growth of industrial productions – the production in various industrial sectors like cement, iron and steel, etc. help the economic growth of countries. 2. Growth in trade and commerce – urbanisation helps the nation’s business sector, rural people come to urban places with their goods. 3. Development of tourism industries – people from foreign countries are attracted to cities and towns with better transport. Tourism is a good source of foreign currency. 4. Improvements in science, culture – urban places are the meeting point for culture, education, science and technological developments.   The disadvantages include:   1. Rapid inflow of rural population – rise of housing problems and therefore slums in poorly planned areas. 2. Decrease in rural population – impact on rural populations due to shortage of workers in rural areas. Young people leave for opportunities in urban areas 🡪 Employers can’t find labourers 🡪 Less investment happens and businesses shut down 🡪 Less money, less jobs and few people leave to services declining 🡪 People notice decline in quality of life. 3. Pressure on water, sanitation and other infrastructure – this results in environmental pollution and health hazards. 4. Unemployment in urban areas – this results in various criminal activities and corruption; increased law and order is required. |

**The economic and environmental interdependence of urban and rural places**

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| What is an urban centre?  What is a rural centre?  What are the urban and rural linkages and interdependencies?  What flows exist between rural and urban places?  What are the urban and rural economic interdependencies?  What do strong linkages do?  What do natural environments provide?  What is rural-urban migration?  What are the causes of rural-urban migration?  What is rural depopulation caused by?  What cycle exists in small rural centres?  What does a declining rural economy result in? | An urban centre is an area in which the majority of the population is employed in secondary and tertiary industry.  A rural centre is an area in which the majority of the population is engaged in primary industry and activities associated with it.  Rural and urban places interact with and rely on each other. Rural produces food and fibre while urban trade and transport it. Linkages and interactions that exist include:   * Urban places are agricultural distribution points while rural places are places of agricultural production * Rural places make use of machinery and agrochemicals, urban places repair and make machinery and agrochemicals * Urban places can provide services including health and education while rural has high demand for them * Urban places are points of innovation and information for new agricultural methods while rural places make use of this new information etc   Flows that exist include flows of goods and services, energy, minerals, information and people along transport routes between rural and urban places.  There are spatial links to the movements of people, goods, money and information.  Strong linkages can improve the living conditions and employment opportunities of both rural and urban populations. Cities are important drivers of development and poverty reduction.  Natural environments provide and maintain an array of ecological services including the provision of clean air and water, soil, food and shelter.  Rural-urban migration is the movement of people from rural to urban places.  The causes include urban growth, towns and cities are expanding, covering greater area of land and urbanisation, increasing proportion of people living in towns and cities.  Rural depopulation of smaller centres is the result of mechanisation of agriculture, expansion of bitumen roads to rural areas, more efficient motor vehicles, farm amalgamation and environmental degradation.  Young people leave for opportunities in urban areas 🡪 Employers can’t find labourers 🡪 Less investment happens and businesses shut down 🡪 Less money, less jobs and few people leave to services declining 🡪 People notice decline in quality of life.  A declining rural economy results in; rural depopulation, loss of health services, retail, law services, reduced teachers, loss of banking, transport services and government departments. |

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

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| What are cluster settlements?  What are dispersed settlements?  What are linear settlements?  What are nucleated settlements?  **Australia’s Population Distribution?**  What are the six population distribution characteristics for Australia?  **Factors that Contribute to Spatial Distribution of Australia’s Urban and Rural Places**  What are the historical factors?  What are the economic factors?  What are the environmental factors?    What are the cultural/social factors? | Cluster settlements are those that form at intersections of transport routes, where roads meet and those that are grouped together.  Dispersed settlements are those with little to no identifiable spatial distribution pattern.  Linear settlements are those that are developed along a line e.g. road, rail or coast. Not just rural areas are linear, e.g. Albany Hwy.  Nucleated settlements are similar to clustered and radiate from a centre. These tend to be newer.   1. Central, Northern areas have low population densities. 2. Approx. 88% of the population live in urban centres, most Australians are urban dwellers. 3. Sydney and Melbourne have approx. 40% of Australia 4. Most of Australia’s population is in crescent shape, East coast and South East coast of Australia, capital city dominance. 5. Low population density Australia wide of 3 people/km2. 6. Most of population within 80km of the coast.   The original settlements have become capital cities, these cities are located near the coast. Mechanisation of agriculture has led to rural depopulation. Economic restructuring has resulted in increasing industry, agriculture to industrial and industrial sites located near urban areas.  The capital cities and ports are centres of trade. There is an economic interrelationship between rural and urban places. This includes the opportunities for employment in urban places. Original centres experience inertia which keeps them there. High order goods and services are found in urban places. Bigger cities have more functions which make them more economically viable. Mining booms are linked to growth of cities, e.g. Perth skyline. Other economic factors include farm amalgamation which is the grouping of farms.  The first environmental factor is the climate including temperature and rainfall. Most of the population is in Southern Australian where there is a Mediterranean to temperate climate. Moderate temperatures lead to agriculture in those areas, too hot and things die, too cold they don’t grow. Coastal areas have high population in linear and nucleated settlement patterns. As temperatures rise and rainfall drop towards inland, population decreases too. Settlements are located near water sources. Agriculture requires adequate water. In areas of flat topography, are favoured for development.  There has been a rural to urban migration occurring in recent years. There are push and pull factors that cause migration. Push factors include: population pressure, no job offers, poor healthcare, natural disasters, lack of services, lack of infrastructure and skills such as police and teachers. Pull factors include: higher standard of living in urban areas, higher wages, future prospects and opportunities, better education, better services and skills available and better healthcare. Lifestyle choices such as overseas migration and migration to capital cities. The Australian values an dreams of outdoor coastal living. |

**The process 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**

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| **Spatial Interactions**  What is urban sprawl?  Why is urban sprawl occurring?  What is invasion?  What is succession?  What is urban renewal?  Why does urban renewal occur?  Give an example of urban renewal.  Who runs renewal projects?  Where else can renewals take place?  What is urban redevelopment?  What are planning regulations?  What has happened to transport?  What is land use competition bid-rent theory?  What is economic rent?  Where are the most desired areas?  Why are these areas the most desired?  What does competition for spaces do?  What functions can exist in the CBD?  Where do space extensive functions exist?  What is inertia?  What are the reasons for inertia?  What is agglomeration?  What is aggregation?  What is segregation | Urban sprawl is a process which results in uncontrolled outward growth of an urban centre which then encroaches on outer settlements.  Urban sprawl is occurring as a result of the desire of urban dwellers for space-extensive housing, development of modern transport, completion of Perth-Joondalup and Perth-Mandurah rail lines allow commuters to settle in outlying northern suburbs and high per capita car ownership.  Invasion is the process by which one function moves into an area occupied by another type of land use. E.g. South Perth residential turning to commercial.  Succession occurs when the process of invasion is complete and all evidence of the original function is gone. E.g. Stirling Shire Office.  Urban renewal involves the redevelopment and repairing of blighted areas. Old buildings are demolished and new ones created.  Urban renewal occurs as a need for space as functions develop and expand.  An example is the renewal of East Perth where it was transformed from a rundown area with poor housing and light industrial uses, into a sought-after area consisting of medium to high density housing, parks and retail outlets.  Renewal projects are large scale redevelopments run by the government/public sector, not private.  Renewals can also take place on the rural-urban fringe, upgrading and intensifying rural land use.  Urban redevelopment is the small-scale development of an area which may have experienced urban blight. It has older land activities that are no longer in operation, it is done by private sector.  Planning regulations are the deliberate process of grouping together like functions and setting aside areas for particular land uses as well as to segregate incompatible functions e.g. industrial and residential.  In recent years demand for public transport, provision of roads has increased as well as car ownership. Travel times have decreased.  Competition bid-rent theory refers to the sorting process where functions arrange themselves into concentric zones based on their ability to earn economic rent.  Economic rent is the expected return from occupying a given space.  The most desired areas are in the city.  This is because these areas have the greatest accessibility.  Competition forces up property values and economic rent.  Functions that can exist are those can out bid others, those that can earn more than the rent e.g. commercial can survive in the CBD.  More space extensive functions which yield less economic return such as industry locate further away e.g. Welshpool.  Inertia is the process which results in functions staying put and not relocating even though the original reason for its establishment is no longer evident. These include historical or cultural sites.  Reasons for inertia include; cultural values: places that contain great value to particular societal groups or reflect planning decisions.  This is when industrial functions group together to make use of common infrastructure or to supply related products in a product chain. E.g. industrial areas and major shopping centres.  Aggregation is where particular functions are grouped together.  Segregation is where different functions are separated. E.g. industrial separated from residential by roads and commercial. |

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

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| What is a demographic?  What does knowledge of demographics allow?  What are the general demographic characteristics of Australia?  What are the economic and social characteristics of Australia?  What are the age and gender demographic characteristics of Australia?  What are the socio-economic characteristics of Australia?  What are the cultural distinction characteristics of Australia?  What is migration?  What is internal migration?  What is international migration?  What are the reasons for migration?  What is economic migration?  What is political migration?  What is environmental migration?  What is a refugee?  What are the push factors?  What are the pull factors? | Demographics refer to the characteristics of a population such as their age, gender, ethnic or cultural background and socioeconomic status.  Knowledge demographics of allow government and private businesses to cater and provide for the current and future needs of a place.  The population of Australia sits at around 24 million, growth is at 2% per year, the fertility rate is 1.9, the median age is 38, it has an aging population with life expectancy of males at 80.4 years and females at 84.4 years, the percentage of females and males is roughly the same.  This includes employment trends, the tertiary and service sectors are growing steadily, manufacturing, agriculture and mining are all declining.  The middle ages, from 30 to 40 are the dominant ages, the number of over 65s are increasing steadily, the percentage of younger people, under 19 is declining due to fewer children and lifestyle choices as well as living longer.  This refers to the social and economic position of families, individuals and groups within society. This includes, income, wealth, education, occupation and place of residence. Urban places have a higher percentage of tertiary individuals. Rural places have higher percentages of trade. Urban have higher percentages of high income and rural places have higher percentage of lower income.  Urban areas are the most culturally diverse while rural areas are the least culturally diverse. Australia’s population growth due to natural increases is approx. 42% and migration is responsible for 58%. This migration occurs mainly from England, India, China and New Zealand. Migrants locate near each other and those who don’t speak English locate to urban areas more likely than rural areas.  Migration refers to the movement of people from one place to another.  Internal migration is when people move within a country. E.g. Melbourne to Perth.  International migration is when people move from one country to another. E.g. New Zealand to Australia.  Reasons for migration include economic, social, political and environmental.  Economic migration is when it occurs in order to find work or follow a career path.  Political migration is when it occurs to escape political persecution or war, or even for new opportunities politically.  Environmental migration is when people move in order to escape natural disasters and hazards.  A refugee is someone who has left their home with no place to go. They do not have many possessions and are unclear as to where they will settle.  Push factors are the reason that a person will leave a place. These include; lack of safety, lack of services, high crime, war, poverty, flooding, crop failure, drought.  Pull factors are the reasons that people move to a place. These include; higher employment, more wealth, better services, political stability, safer, less crime, better climate, less natural hazards. |

**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 and fly-in/fly out work patterns**

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| What is the population loss challenge facing Australia?  What is the economic restructuring challenge facing Australia?  What is the employment challenge facing Australia?  What is the housing challenge facing Australia?  What is the service and water provision challenge facing Australia?  What is the socially vulnerable population challenge facing Australia?  What is the social inclusion and exclusion challenge facing Australia?  What is the transportation challenge facing Australia?  What is the resource degradation challenge facing Australia?  What is the land use conflicts challenge facing Australia?  What is the declining political influence challenge facing Australia?  What is the isolation and remoteness challenge facing Australia?  What is the FIFO work patterns challenge facing Australia? | There is currently a low and decreasing rural population. This is due to a number of push factors such as mechanisation, lack of services, farm amalgamation, climate change and environmental degradation. There are also push factors towards the cities such as jobs, lifestyle choices, sea/tree change, tertiary education and better services.  There has been a decline in agricultural, manufacturing and mining employment across Australia. This is due to mechanisation, globalisation, mining booms and busts and farm amalgamation. There has been a growth in employment in tertiary and service industries.  There is currently higher unemployment in rural areas than urban areas. There has been a decline in services that seek to provide employment to populations. There has been a decline in full time, permanent, secure jobs. As well as this, there has is low educational attainment in rural areas. There has been an expansion in healthcare, retail and tourism.  There has been an increasing number of people in apartments and semi-detached houses. There has been an emergence of multi-generational households. This is when there are many generations living under one roof. There has been continued issues with affordability and availability of houses.  The rural decline in services due to urbanisation leads to a decrease in quality of life of residents. The service decline includes banking, education, government and transport. There has become a trend of out of town shopping. Due to the drying climate in WA, desalination has become the main water source.  Vulnerable people are those in need of special care, support, protection because of age, disability or those at risk of abuse or neglect. Social vulnerability refers to people unable to withstand repeated adverse events that they’re exposed to. There is greater concentrations of vulnerable people in rural areas. Rural communities have lower income, less financial security and less educational attainment.  Social inclusion when a person has the opportunity to participate in society through employment, access to services, connect with friends and family and community. Social exclusion is when a person doesn’t have these opportunities. Those who are often excluded are the aged, youth, rural communities, unemployed and mental health issue sufferers.  Smaller populations require less transport routes. Greater populations require greater transport routes. There is high car ownership resulting in high congestion. The maintenance of transport routes is expensive in remote areas. Effective routes vital to productivity.  Land degradation leads to salinity leads to loss of productivity which then leads to loss of income. Large areas of land have been cleared due to forestry, urban places needing space, mining and agriculture.  Conflicting views of the stakeholders such as government, indigenous groups, mean that some areas of land can’t be used for particular land uses as these uses are incompatible with other uses other stakeholders want to take place.  As the rural population continues to decline, it leads to a declining representation in state and federal parliaments. The increasing urban population leads to increasing representation of urban dwellers in state and federal parliaments.  Isolated and remote areas have a declining presence of services such as health, education, employment and cultural activities. Indigenous communities suffer from remoteness the most.  FIFO work patterns are linked primarily to mining activities. There are both pros and cons. Pros include; facilitation of employment of skilled individuals, good pay for employees, being able to live anywhere while working, ability to change jobs with minimal disruption to family life. Cons include; extended periods away from friends and family, relationship strain from being away, difficult to plan social events, strain on young families, highs of coming home vs lows of leaving. |

**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 and changing demographics**

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| What is a megacity?  What are the housing challenges facing megacities?  What are the housing challenges facing Australian metropolitan areas?  What are the economic restructuring challenges facing megacities?  What are the economic restructuring challenges facing Australian metropolitan areas?  What are the employment challenges facing megacities?  What are the employment challenges facing Australian metropolitan areas?  What are the transportation challenges facing megacities?  What are the transportation challenges facing Australian metropolitan areas?  What are the congestion challenges facing megacities?  What are the congestion challenges facing Australian metropolitan areas?  What are the environmental degradation challenges facing megacities?  What are the environmental degradation challenges facing Australian metropolitan areas?  What are the waste management challenges facing megacities?  What are the waste management challenges facing Australian metropolitan areas?  What are the personal safety challenges facing megacities?  What are the personal safety challenges facing Australian metropolitan areas?  What are the land abandonment challenges facing megacities?  What are the land abandonment challenges facing Australian metropolitan areas?  What are the urban sprawl challenges facing megacities?  What are the urban sprawl challenges facing Australian metropolitan areas?  What are the socio-spatial inequality challenges facing megacities?  What are the socio-spatial inequality challenges facing Australian metropolitan areas?  What are the social exclusion and inclusion challenges facing megacities?  What are the social exclusion and inclusion challenges facing Australian metropolitan areas?  What are the changing demographics challenges facing megacities?  What are the changing demographics challenges facing Australian metropolitan areas? | A megacity is an urban centre that has over 10 million people living in its greater area. It can also be defined as having over 1000 people per square kilometre of land.  There are issues with meeting the demand for new housing in urban areas. In LEDCs there has been a growth of slums. These are built in high-risk areas that are prone to climate change, flooding and natural disasters and have a lack of infrastructure/services. In Rio de Janeiro 22% of the population live in favelas.  There are issues with affordability and availability of housing. There is a lack of public housing especially in regional areas as well as a lack of transport and services.  In LEDCs the industrial growth seen has been linked to environmental degradation. In MEDCs there has been a continued shift from manufacturing, agriculture and mining towards the tertiary and service industries.  There has been a continued decline in the mining, agriculture and manufacturing industries due to mechanisation, globalisation, farm amalgamation and urbanisation. The service and tertiary industries have been increasing due to urbanisation and lifestyle choices.  In LEDCs there is a large amount of cheap labour e.g. textile industry in China and Bangladesh. There is a lack of OHS in these countries as well as hidden employment and underemployment. This includes the black market and subsistence employment. MEDCs have a continued shift to the tertiary and service industries.  There has been a decreasing in the percentage of employment in manufacturing, mining and agricultural industries. People have been directed away due to lifestyle choices, mechanisation, globalisation and farm amalgamation. There has been a decline in the amount of permanent full-time jobs. Capital cities are where most workers are found, e.g. Perth employs 75% of Western Australian workers.  In MEDCs there is more efficient public transport such as in Tokyo and Seoul. In LEDCs there is large amounts of congestion and pollution such as in Dhaka.  In Australia there is high car usage compared to public transport. Due to Australia’s size, infrastructure is expensive. Over long distances there is high emissions of GHG. Due to urban sprawl in capital cities there is need for more public transport. There is a lack of quality roads in remote areas due to the cost.  Due to congestion, there is increased pollution as cars run for longer times. There are increased wait times for travel and deliveries. In some countries there are restrictions on days cars can be used.  Congestion results in goods coming late. This costs the economy $15 billion per year. There are increased fuel costs and losses of productivity. Sometimes roads are closed due to peak hour traffic.  In LEDCs there are higher pollution levels, poorer air quality, polluted water ways due to toxic run off not being controlled, there is poor sanitation in slums that degrades environments.  Large cause of degradation is deforestation. Agricultural clearing and overgrazing are other causes. There is increasing soil acidification and salinity. Other degradation includes introduction of exotic species and infrastructure development on the coast.  In MEDCs, megacities produce 20,000 tonnes of waste per day and 7 million tonnes per year. Most waste is disposed of in landfills which is unsustainable as the waste seeps into soils and creates toxic soils as well as much of it being unbiodegradable.  Australia is moving to more sustainable methods. There are 3 types of bins used. A red, general waste bin, yellow recycling bin and green compost bin. There is beginning to be a shift from landfills due to the unsustainable nature of them.  In LEDCs there are higher crime rates than MEDCs. Industrial areas produce lots of pollution which can lead to illness. In urban areas there are large amounts of burglars, drug use and poor sanitation. In areas of high population density there is greater crime.  In Australia, urban areas have higher crime rates than rural. Isolation leads to lack of community feeling and safety.  In megacities there are many abandoned buildings and blighted areas. These are areas that have been left unrepaired as the owners know the value is in the land.  There are many abandoned and blighted areas in the inner mixed zones of megacities. These areas are composed of landlords waiting for land value to rise with the intention of selling the land.  This involves the uncontrolled outward growth of the city. There is rapid population increase. This creates high density congestion in many Asian cities such as Dhaka. Mexico has continued to grow into areas that are prone to flooding.  Urban sprawl has caused the loss of natural environment and agricultural land. There has been increased vehicle pollution from travelling from commuter zones to CBD by car. Low density living such as the Australian dream means that a large percentage of land must be devoted to transport and it costs the government a lot.  In LEDCs such as Mexico gated communities exist where there are lots of services, lots of wealth and the areas are safer. There is also slums that contrast against this that have low services, low wealth and higher crime rates. In MEDCs the opposite is the case.  In Australia the population is growing and alongside this there is a widening gap between the rich and poor classes.  People who don’t feel their values and differences are respected are said to be excluded. This is a problem in megacities with many different types of people mixing and minorities may feel left out.  Those who feel they are included feel more valued and more accepted.  The economic power and growth of megacities creates strong pull factors that cause population growth. Cities have grown more due to conurbation which is the process by which one city envelops another is it sprawls outwards. This leads to changing demographics and ability to provide. In LEDCs there is an increasing number of young people whereas in MEDCs there is an increasing aging population.  In Australia there has been an increasing aging population, this requires more aged care and more healthcare. In the last census, the average Australian was Claire, 38, female, 5-14 hours of domestic work, 2 children. Migrants move to big cities especially if they are non-English speaking. There are large amounts of Greek in Melbourne, Chinese in Sydney and New Zealanders in Brisbane. |

**Depth Study One – The Characteristics of Perth and Its Challenges**

**Perth’s Characteristics**

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| What are site features?  What are the coast line and coastal waters site features of Perth?  What are the Swan coastal Plain site features of Perth?  What are the Swan and Canning River site features of Perth?  What are the Darling Plateau site features of Perth?  What are situation features?  What are the physical situation features of Perth?  What are the historical situation features of Perth?  What are the political situation features of Perth?  What are the economic situation features of Perth?  What is the situation of Perth? | Site features are the physical features of a place or area. They include landscape, height ASL, aspect (direction the slope is facing), slope, drainage and vegetation.  The shallow water and offshore reefs make these areas difficult to navigate. There have been channels dug and dredged at Kwinana and Fremantle to gain access to port areas. The coastline is highly sought after as a residential space.  The Swan Coastal Plain is found between the Darling Plateau and the Indian Ocean. The Gnangara and Jandakot mounds, found roughly in the middle, are protected for groundwater usage. There are a number of swamps and lakes found here although many have been filled in. The flat to undulating sandy soil provides ease of construction and it is 0-60m ASL and approx. 30km wide.  The Swan River runs from the Darling Plateau to the Indian Ocean. The seawater reaches up to 15km inland. The River acts to divide the city in two, this also influences transport patterns such as the Narrows Bridge.  The Darling Plateau is sited approx. 300m ASL, it is steep and consisted of deeply dissected valleys. The soil is made up of clay, grain and laterites. The construction costs here are high, therefore this restricts the growth of the city to the East and forces expansion South and Northwards.  Situation features are those that describe the location of a place or area. These include latitude and longitude, distance and direction to other settlements and links to other places.  Perth’s CBD is 17km inland from the mouth of the Swan River. The city had its initial growth along the river but is now more so along the coastal plain and coastline.  Stirling convinced the British government that the Western side of the country was significant. The location of the CBD was in response to worry about invasion from other foreign forces.  Perth is the capital of the Western Australian colony. Transport has developed from Perth. The city dominates across the state as the major hub. Perth is a primate city meaning that it holds over 40% of the state’s population while the next biggest city holds less than 10%.  The city acts as the financial and commercial centre of the state. It is the HQ of many large companies ad its economic dominance has led to high amounts of job opportunities. The city has about 100,000 workers in it daily.    Perth is situation at 32 degrees South, 116 degrees East. It is located in the middle of the Swan Coastal Plain. The Darling Plateau is situated towards the East while the Indian Ocean is towards the West. It is the largest city in WA, located 180km North of Bunbury and 600km West of Kalgoorlie. It is 3500km West of Sydney |

**Perth Now**

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| What are the dimensions of Perth?  What are the four corridors of Perth?  What is internal morphology?  What is external morphology?  Account for the historical, economic, environmental and political factors that have influenced Perth’s external morphology. | Perth is approx. 1600km2 in area and stretches approx. 120km long, from Rockingham to Alkimos.  The first is the Northwards, it is fast growing along the coast due to its desirability, it includes Joondalup. The second is towards the East, its growth is restricted by the Darling Scarp, it includes Midland. The third is South East along the foot of the Darling Scarp and includes Armadale. The fourth is South, coastal along to Rockingham and will soon extend to Mandurah.  There is a possible fifth corridor, North Eastwards towards Ellenbrook.  Internal morphology is the functional morphology of a place. It includes the layout of the functions within a settlement and the processes and interactions that affect layout.  External morphology refers to the boundary and changes to the boundary of an area.  Historically, the Swan River Settlements, prior to 1890 were Perth, Fremantle, Midland, Guildford and Armadale. In the 1890s the Gold Rush Era occurred and between 1900 and 1930 railways were developed. After WW2 there was a large-scale European migration to Perth.  Economically, the flat to undulating land of the Swan Coastal Plain is cheaper to builder residential, industrial and transportation on.  Environmentally, the Indian Ocean, Coastal Plain, Darling Scarp and Swan/Canning Rivers influence the shape of the city.  Politically, urban plans such as Network City, Directions 2031, have influenced the construction of transport corridors and subsequently, the shape of Perth. |

**The Functions of Perth**

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| What are the characteristics of the CBD functional zone?  What are the characteristics of the Inner Mixed Zone functional zone?  What are the characteristics of the Established Residential functional zone?  What are the characteristics of the Industrial functional zone?  What are the characteristics of the Newer Growth Zone functional zone?  What are the characteristics of the Special Purpose Zone functional zone?  What are the characteristics of the Rural Urban Fringe functional zone?  What are the characteristics of the Outer Business District functional zone?  What are the general characteristics of Perth’s residential zones? | Perth is a multifunctional primate city. The CBD is located on the site of the original settlement. Its compact and central in its positioning relative to the city. It is boarded by the esplanade, St Georges Terrace, Victoria Avenue, Milligan Street and Wellington Street. It is the retail heart of the city but also has increasing residential activity which has brought Coles and Woolworths stores to the city. It is a major commercial, financial and business centre, with highly intensive land use, which has resulted in significant vertical development, leading to the size of the buildings being highest. There is significant vertical and horizontal zonation evident. The city has been shifting to a pedestrian orientated place, with a high day time population, with limited access for vehicles and parking. The high accessibility leads to great attraction. There is an aggregation of functions e.g. on St Georges Terrace there is banking and insurance. There are about 80,000 workers per day in the city and it is home to several historical sites such as the Cathedral.  The Inner Mixed Zone (IMZ) is a transition between the CBD and the Established Residential Zone (ERZ) as it boarders the CBD. It contains some light industrial activities such as textiles and jewellers. There is a great mix of land use such as in East Perth there is light industrial and residential. There is also a high degree of accessibility in this zone due to its location. There is again aggregation of functions and vertical and horizontal zonation. Urban blight occurs frequently and there are generally renewal and redevelopment projects occurring throughout the zone. Gentrification is common, such as the WA Boot Factory, resulting in an increasing number of inner-city dwellings. There is a large socioeconomic mix of rich and poor.  The ERZ is the largest functional zone. It consists of the older inner suburbs that have been established longer such as Subiaco, Leederville and Victoria Park. There are a large number of services and functions available here. Urban consolidation and infilling have been occurring to reduce urban sprawl. Ribbon commercial and retail developments such as Albany Hwy exist creating public spaces. There are a diverse mixture of housing and people with a generally older population.  The Industrial Zone is dispersed throughout the urban area. Light industrial such as warehousing, fabrication, textile and furniture can locate closer to residential areas than heavier industrial. Medium industrial is often located in planned industrial estates that have clear buffer zones. Heavy industrial or complex industrial is located on the edge of the metropolitan area such as in Kwinana. These are functions such as oil, Nickel or bauxite refineries. These produced obnoxious and polluting gases. There are strict planning regulations due to processes involved and agglomeration occurring as these functions benefit from one another, these attract other industries and businesses. Wide buffer zones exist to prevent land use conflict but sometimes it may still occur.  The Newer Growth Zone (NGZ) is the result of urban sprawl. These are recently developed residential areas such as Sienna Woods. There is low density housing, consisting of project home, homes which are similar or the same as each other. It is large scale and young families dominate as occupants. There is a poor provision of services in these areas but there are planned commercial and retail precincts. There is a small variety of land uses and an incomplete appearance. Curvy and linear road systems apply.  Special Purpose Zones (SPZ) are scattered in location. There is a diverse range of activities performed there such as education e.g. Curtin, UWA, Murdoch, research and development e.g. Technology Park, Medical e.g. Fiona Stanley, community and recreation e.g. Kings Park, Airport e.g. Perth airport, defence e.g. Naval base on Garden Island.  The Rural Urban Fringe (RUF) is located on the periphery of the city such as Ellenbrook. There is a mixture of land uses due to its dynamic and transitional nature. There is evidence of invasion and succession and the urban shadow effect. There are space extensive and intensive functions such as golf courses, training and racing tracks and intensive hobby farms. Residential functions are encroaching onto undesirable functions such as rubbish tips and prisons. It, like the NGZ has an untidy and incomplete appearance.  Urban sprawl has led to access to the CBD to be more difficult for those who live on the fringes of the city. There have been urban planning and policies that have encouraged decentralisation, creating outer business districts such as Carousel and surrounding area in Cannington. There is a focus on middle and lower order functions and retail. Professional and commercial services are also found here such as medical and accountants. Government services such as Centrelink have also been shifted.  There are a mosaic of dwellings of different ages, sizes, qualities and styles depends on which era they’ve been built in. There is higher density housing in former lower socioeconomic areas such East Perth and there is planned higher density housing in higher economic areas such as South Perth. There is low density housing in outer suburbs such as Kelmscott and in prestigious areas such as Peppermint Grove. There is a dominance of single unit dwellings on separate blocks that have led to urban sprawl throughout the city. There is a network of shopping centres in outer residential areas, these are outer business districts. Curvy linear roads are dominant in newer suburbs and grid patterns are present in older suburbs. |

**The Demographics of Perth**

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| What are demographics?  Why are demographics important to know?  What are the general demographics of Perth?  What are the population, age and gender demographics of Perth?  What are the education and employment demographics of Perth?  What are the cultural diversity and ethnic clustering demographics of Perth? | Demographics refer to the statistical data of the characteristics of the population of an area or region including their age, gender, socioeconomic status and ethnicity.  Spatial variations of particular demographics can determine government provision of services so as to ensure the successful provision of services and infrastructure for particular types of people to maintain a high standard of living. E.g. in established residential areas there is an aging population, therefore aged services are required.  Perth has been growing rapidly with 3.6% growth in 2018, approx. 800 people are added each week. Northern suburbs have more than doubled in the past 20 years. Some inner-city suburbs have grown in population. There is much social diversity throughout Perth however there has been residential segregation which refers to the tendency for various subgroups to concentrate in certain areas of the city, e.g. African people in Mirrabooka.    The average age of a person in Perth is 36 years, there is low population density at 313 people/km2. Perth is a cosmopolitan in that there are a high number of overseas births. There are slightly more women than men and there is a very small number of Indigenous people at just 30,000. In older inner suburbs such as Nedlands, there are a high number of older people, especially females. These areas are well provided with services although some services are underutilised. There is an increasing amount of aged care although these areas are becoming more popular with young people e.g. Claremont.  In 2011, 30.5% of Perth’s population was still in education/training. 26% of the 30.5% were in primary school, 19% were in secondary school, 24% in tertiary/technical training and the other 11% as other. There is a workforce of 900,000 people. 60% work full time, 30% as part time and 10% as unemployed/transitional.  Historically in Perth, after WW2 there was a large influx of southern European immigrants. Recently, there have been more South East Asian, African and Middle Eastern migrants. Sports and cultural lifestyle choices have meant that particular facilities have been constructed. As well as this, special schools such as religious schools, churches, mosques and synagogues have been built.  in Perth, 2.1% of the population are of a primarily non-English speaking background. Concentrations of particular ethnic groups are as follows. Italian in Dianella, Malaysian in Karawara, UK in Mindarie, Vietnamese and African ethnicities in Mirrabooka. |

**The Challenges of Perth, including; Housing, Urban Sprawl, Congestion and Transportation**

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| **Urban Sprawl**  Define the problem of urban sprawl.  How large is the problem?  What are the main causes?  What are the implications?  Define the term stakeholder.  Identify two stakeholders and describe their point of view on the challenge.  What is a planning strategy being used to address this issue?  What is a second planning strategy being used to address this issue?  Define the term sustainability.  How do aspects of one of the above planning strategies fit the parameters of sustainability?  Evaluate the extent to which the strategy is sustainable.  Define the term liveability.  Evaluate the extent to which the strategy has enhanced the liveability of the urban place.  **Traffic Congestion**  Define the problem of traffic congestion.  How large is the problem?  What are the main causes?  What are the implications?  Identify two stakeholders and describe their point of view on the challenge.  What is a planning strategy being used to address this issue?  What is a second planning strategy being used to address this issue?  How do aspects of one of the above planning strategies fit the parameters of sustainability?  Evaluate the extent to which the strategy is sustainable.  Evaluate the extent to which the strategy has enhanced the liveability of the urban place. | Urban sprawl refers to the uncontrolled outward growth of an urban area, generally characterised by low density housing developments encroaching onto the fringes of the city. It results in extensive road networks, freeways and large coastal corridors.  The Greater Perth metro area is projected to stretch 150km from Mandurah in the South to Alkimos in the North, although currently it stretches 120km. The population density of Perth is 315 people/km2 which highlights the extent of urban sprawl as this value is extremely low compared to other cities. NGZs have been expanding into the rural-urban fringe and it is expected that Perth will require an additional 800,000 houses to provide homes for an additional 1.1 million people by 2050.  The main causes of urban sprawl in Perth are; the availability and affordability of houses and land in NGZs, the government’s push for higher usage of public transport, attraction of semi-rural living, decentralisation and the Australian Dream. NGZs arise due to the cheaper land available further from the city. Decentralisation has resulted in OBDs that then create many surrounding suburbs, encouraging urban sprawl.  Invasion and succession and issues of land use conflict are some of the primary impacts. These occur on the rural-urban fringe when some functions may not relocate when becoming surrounded by the encroaching urban area. E.g. Barbagallo Raceway creates land use conflict with residential areas due to noise pollution. Other implications are that it is socially unsustainable as there is an isolation of low-income families and high commute times result in more CO2 emissions. There are fewer public services and amenities as well reducing the liveability of areas. Economically it is unsustainable due to the high cost of the provision of services and infrastructure. Environmentally, it disrupts the carbon cycle, heat budget and water cycle, resulting in more GHG emissions as well as the native fauna such as the Black Cockatoo, the population of which has decreased by 50% in the past 50 years. Further, there is also the urban shadow effect where the owners see no reason to repair their land lots.  The term stakeholder refers to a person, group or organisation that has a significant vested interested in a particular issue, event or topic.  The Department of Planning. The Department of Planning would be looking for consolidation and infilling of housing, increased housing density, planning policies and developments that increase the liveability of places and the developments of outer business districts in order to decentralise from the CBD.  Psaros. Psaros is a private housing developer who would aim to provide housing that will be affordable to a large number of Australians. Psaros would be interested in developing properties that meet the needs of the stakeholders such as the Department of Planning, which is to reduce urban sprawl.  One planning strategy being used is infilling and consolidation of current urban areas. In this strategy, blocks of land that are empty and cleared, are developed so that they can be used to construct high density housing such as an apartment block or a series of houses on a single block. This is known as infilling. Consolidation refers to when a block of land that originally had a single house on it is demolished so that multiple smaller houses can be built, increasing housing density of that block. By increasing housing density, this reduces the extent of urban sprawl as it reduces the need for houses to be built further away from the CBD as there are now more homes available in already established areas.  Sustainability refers to the ability to meet the needs of current and future generations through simultaneous social, economic and environmental adaptations and improvements.  The strategy of infilling and consolidation fit the parameters of sustainability as; socially, the services needed to maintain the liveability and high standard of living for an area are already there. As well as this, those who move into these new developments will already be part of an established community. This will increase community connectedness and reduce social isolation. Established residential zones also have lower commute times reducing travel stress. Environmentally, this strategy is classed as a brownfield development. It reduces the extent of urban sprawl, which reduces land cover change and thus doesn’t affect the natural systems of the Earth such as the carbon and water cycle and the heat budget, unlike greenfield developments which do. Economically, this type of development is cheaper for the government as it doesn’t require the provision of services for new neighbourhoods. It also doesn’t require the construction of large amounts of new infrastructure such as roads and freeways, it only requires the smaller cost of developing a singular block of land.  This strategy is extremely sustainable although there is a limit to the amount of this that can be done. Infilling and consolidation can only occur if there are vacant blocks or blocks that are going for sale, this means that this strategy may not be able to last forever although given the dynamic nature of Perth this would be unlikely to run out.  Liveability refers to the aspects of a place that improve the quality of life of that area. These include health and wellbeing, economic, environmental sustainability and public amenities.  This strategy doesn’t improve the liveability of the urban place in which it is taking place much. This is because the area is already established with services and public amenities. The strategy only seeks to combat the challenge of urban sprawl and not further improve the liveability of the established urban area.  Traffic congestion refers to the increase in the usage of transport networks that are not designed for a large number of users. It is characterised by slower speeds, longer trip times and increased vehicular queuing. The most common example is the physical use of roads by vehicles.  The issue is most significant around the CBD area where the roads built there were not designed for the high usage that they experience. Such streets such as St Georges Terrace experience significant congestion. Congestion also occurs significantly on freeways and highways that have margining lanes. This is because the same number of cars need to fit in a smaller space, reducing traffic flow. The peak hour congestion times for Perth are from 6:30am to 9:00am and 4:00pm to 6:30pm. While on a field trip I observed the vast amount of people that commute to work each day into the city by car. This created vast amounts of congestion along wellington street and St Georges Terrace.  Rapid population increases in Perth mean that a greater number of people need to use the transport networks of the city. This means that if particular areas don’t increase their capacity to accommodate this increase in demand, congestion will occur. Lack of public transport in NGZs force people to use private transport for large distances, increasing the number of people on the raods and therefore increasing congestion. Other causes include the high number of people that work in the CBD, which is over 100,000 people.  Congestion reduces the ability of an urban area to function effectively, a loss in productivity costing Perth’s economy $18m/year. Increased fuel consumption from longer trips and waiting results in higher levels of GHG emissions particularly in the CBD area. “Rat runs” are created by people attempting to use short cuts to avoid congestion. This puts pressions on suburban streets and creates noise pollution for suburban home owners. There are large costs associated with providing the infrastructure to ease congestion. Congestion also results in increased travel times and socially it causes stress, road rage and crashes.  The Department of Transport. This stakeholder would be aiming to provide services and infrastructure that encourage the public to use public transport services so as to reduce the amount of private car usage on Perth roads and therefore reducing congestion and increasing the efficiency of Perth’s transport networks.  One strategy is Transport @ 3.5 million. This strategy aims to connect the major activity centres such as Murdoch and to encourage TODs or Transit Orientated Developments. It aims to optimise transport networks such as rail, bus, ferry, cycle and walking paths. Connecting areas with previous poor provision of public transport services and to upgrade road networks in order to reduce congestion.  The Transport @ 3.5 million plan projects that once Perth has reached 3.5 million people, there will be 1.4 million public transport trips, 6.3 million car trips and 500,000 cycling trips per day. This is a large increase from the current measurements of Perth currently at 2.2 millionish. At the current population levels Perth has 400,000 public transport trips, 3.6 million car trips and 100,000 cycling trips per day. This shows the strategy will be successful as there is less than a doubling in population but there won’t be a doubling in car trips, but there will be a 5x increase in cycle trips and a 3x increase in public transport usage.  Decentralisation is a second strategy being used to ease congestion. This strategy aims to disperse places of employment and public services to the outer suburbs and create outer business districts so as to reduce the number of cars and people converging on Perth’s inner core. This strategy is also evident through the relocation of industrials sites to outer areas so as to reduce the number of large vehicles on Perth roads.  This strategy reduces the extent of congestion of as it reduces the need for people to head towards the centre of the city. This reduces the number of cars that go to the city and thus reduces congestion.  The strategy of decentralisation fits some of the aspects of sustainability but doesn’t fit others. Environmentally, the strategy reduces the number of cars travelling large distances to the city centre. This reduces the amount of GHG emissions and thus is environmentally sustainable. The strategy also reduces the need for large amounts of new transport infrastructure such as freeways and rail lines as the outer business districts will be close to people’s homes, however, the construction of OBDs will impact land cover change and affect natural cycles. Economically, the strategy would be costly initially as it requires the relocation of services and the construction of outer business districts. However, once they’ve been relocated and built, there is smaller costs to maintain as it doesn’t require maintenance of large transport networks like railways and freeways. Socially, the strategy is sustainable as it reduces the chances of road rage and travel stress as there will be smaller travel times as the services and amenities that people need will be closer by.  Based on the above aspects, the strategy is sustainable in a long-term aspect however not in the short term.  This strategy will enhance the liveability of the suburbs in which the OBDs are built. This is because the OBDs decentralise the services that were once only available in the CBD and inner-city areas. This increases the amount of services available to people in those suburbs and increases the amount of retail and commercial precincts also available. |