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From Pasture to Pavement: Urban Expansion and Its Environmental Consequences in Perth

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Abstract

This thesis addresses the pressing issue of ecological problems of urban sprawl and its intricate impacts on urban health, with a particular focus on vulnerable communities in Perth, Australia. Chapter 1 presents the city's historical background and emphasizes the depletion of ecosystem services, underscoring the need for environmental justice. It also introduces the causes and effects of the sprawl in Perth and draws upon a diverse range of environmental problems created by suburbia, such as air pollution, biodiversity loss, water pollution, and runoff. As these threats translate into urban health declines, such as respiratory problems and increased healthcare issues, Chapter 1 addresses the potential ways to deal with these sets of problems. The following chapters apply interdisciplinary perspectives. Chapter 2 delves into the history of environmental problems and the development of urban sprawl in the suburbs of Perth and correlates the findings with the increase in healthcare problems. Chapter 3 explores human rights issues, such as equal accessibility to educational and healthcare institutions, which expands the discussion of environmental injustice mentioned in Chapter 1. Chapter 4 focuses on environmental politics by analyzing the environmental and urban policies from the past and present while examining their effectiveness and consideration for communities and the ecosystem. Chapter 5 synthesizes the interdisciplinary analysis and formulates a set of concrete policy recommendations to mitigate healthcare issues, accessibility disparities, and ecological waste. These recommendations underscore the need for comprehensive urban planning, transportation reform, affordable housing initiatives, and strengthened environmental regulations. Moreover, they emphasize that with the changes, the city will become economically cost-effective and sustainable. As urban sprawl poses a twofold threat: it erodes urban well-being while exacerbating environmental degradation, this thesis underscores the complex relationship between urban development patterns and equity and offers a holistic policy framework for addressing this critical issue.

Keywords: urban sprawl, health equity, accessibility, ecological footprint, economic analysis, policy recommendations, environmental justice, Australia, vulnerable communities.

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Introduction: Taking the Easy Route: Suburban Crawl

Bordering emptiness on three sides and the vast expanse of blue from the West, Perth, the capital of Western Australia is the most isolated city in the world. This was my first impression when I landed at the airport with four of my friends, planning to do the famous loop from Perth to Exmouth through the outback. We departed early in the morning, aiming to set up our tents at our first stop before sunset. I was in charge of directions. While we had both maps and a GPS, I went for the old-school approach and used only the maps. According to these maps, which were likely several years old, Perth should have ended miles back, replaced by a rural landscape. Instead, we found ourselves in a suburb with low-rise dwellings. Thus, I had to abandon my traditional navigation methods and consult Google Maps, where I noticed the differences. Perth's boundaries had expanded considerably over the years. So, despite us leaving the capital at 7 in the morning, by 9 am we were still, technically, in Perth.

While the coast offers a paradise for some residents, for others living far from the city center, it presents challenges. The effects of this isolation manifest slowly over time. The vast spaces and limited public transport between suburbs and the city center have led many to depend on cars. As a result, hydrocarbons are pumped into the ecosystem, increasing pollution. For those without cars, in emergencies, they might be distant from hospitals, or they can't travel to their preferred schools. So, while suburbs promise peaceful streets, spacious homes, and a break from city chaos, they might not offer the most affordable or convenient lifestyle. They also bring environmental issues like air pollution, biodiversity loss, and water runoff problems, which have broader implications for both people's health and the ecosystem.

Perth’s sprawl stretches from Two Rocks to Dawesville, which is approximately 94 miles. Perth's suburban sprawl has developed through time under the impact of numerous

historical, economic, environmental, and political variables. Over the years, Perth's urban landscape has stretched its boundaries outward, often at the expense of rural lands and ecosystems. In addition to altering the city's physical form, this development had a significant impact on the city's infrastructure, transit systems, and general quality of life.

The following chapters will investigate the causes and effects of urban sprawl, analyze the policies and actions taken for or against it throughout history, and evaluate the benefits and losses on the city's ecosystem services and economics. Chapter 1 lays out quantitative data on the issue of air pollution, biodiversity loss, and water runoff, discusses the damages done to ecosystem services from a historical perspective stretched throughout the years, and proposes the challenges that have to be answered to develop Perth as an inclusive and sustainable city. Chapters 2-4 explores interdisciplinary approaches such as historical, jurisdictional, and political dimensions of the environmental field. Chapter 2 accentuates tracking back the ecological footprint from a historical perspective, discussing the data of the physical growth of the city and the numerical growth of the health and mental issues following the outcome lifestyle of created suburbia. Chapter 3 stresses the need for environmental justice and expands on the problem with accessibility mentioned in the previous chapters. Chapter 4 presents the field of environmental politics, by going through the policies that were adopted in the past. This chapter will focus on the importance of community actions and the power of policymaking and will discuss the economic influence on the policies that are necessary for the city's development. In the final chapter, all these perspectives are brought together, comparing the costs of current practices to the value of lost ecosystem services. The costs for existing development and the monetary value of ecosystem service loss are juxtaposed, highlighting the importance of cost-effective changes that ensure full-cost pricing of environmental damages. Finally, a range of policy recommendations will be introduced that may aid in the creation of a sustainable and smart city.

Chapter 1: What's Wrong with Suburban Crawl?

Perth, Australia, has been growing continuously since 1950. Both the population and the city's area have grown extensively, with the city's metropolitan area currently growing to over 2400 square miles, and the population growing to over 2 million as of 2022 (ID Community). This suburban sprawl in Perth has contributed to the dispersion of its population, where the outer regions are much less dense than in the city. This can be seen in figure 1, where the black dot highlights the comparatively small city of Perth, while the shaded region shows the much larger Perth metropolitan area. The ratio between those two-colored regions is extremely large and it is apparent how the borders of the city have grown from its main metropolitan area. Based on the U.N's growth projections, linear population growth is predicted in the coming decades, which will result in further expansion of the metropolitan area, exhausting environmental resources and worsening physical and mental health conditions (see Figure 2).

In Chapter 1, we will delve further into the quantitative aspects of this phenomenon, land use patterns and environmental issues such as exhaustion of ecosystem services that have characterized the extensive urban sprawl in Perth.

Figure 1. Metropolitan area of Perth and the city of Perth

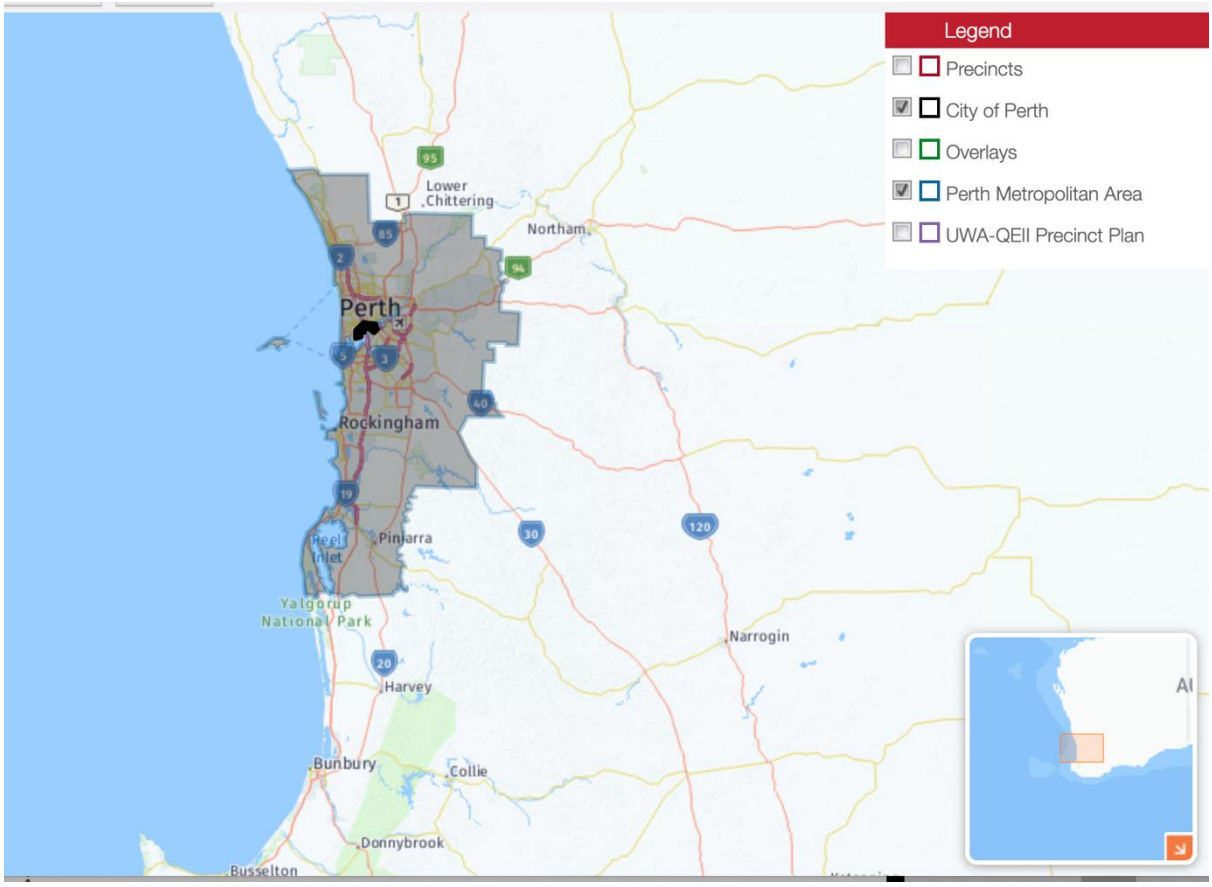
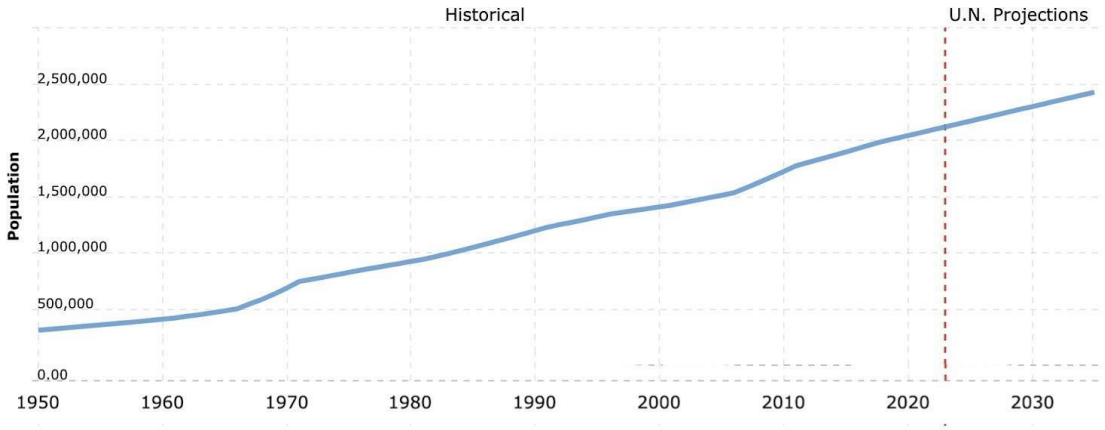


Figure 2. UN Projections on population growth in Perth



a. Suburban Crawl and Ecosystem Services. Suburban crawl damages all aspects of ecosystem services. There are four types of services that the ecosystem provides to self-restore and benefit society. One of the services is provisioning services, which are goods obtained from the ecosystem such as water, food, and materials. These services, along with regulating services, face some of the most severe and irreversible damages. Urban sprawl expands into valuable agricultural land, leading to a significant loss of arable land. A study published in the journal PNAS found that urban expansion is projected to consume 1.6 to 3.3 million hectares of prime agricultural land annually between 2000 and 2030. This could result in a 2% to 3% reduction in global cropland area. With this decline in arable land, the provisioning of food, one of the most crucial ecosystem services, is threatened. Furthermore, with increased infrastructure, groundwater recharge areas are often paved over, reducing the amount of clean water available for urban populations.

Regulating services, which in other words are the benefits obtained from the ecosystem are air, water runoff, and biodiversity are the three most important regulating services that the ecosystem regulates by itself if not interfered with (V. Reid et al. 2005). Urban air quality is severely damaged by pollutants emitted from various sources such as transportation, industry, heating, and waste incineration. These pollutants, including ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and particulate matter, harm both the environment and human health, leading to increased respiratory and cardiovascular diseases. With the advancement of urban development, the volume of stormwater runoff significantly increases in correlation with the expansion of impenetrable surfaces. For example, an expansion of these types of areas from 1% to 32% can lead to an annual runoff that's 490 times larger (Umeå Universitet). Water runoff is especially problematic in Australia, since as cities grow and more surfaces are paved, the risk of floods increases. As sprawl continues, there's less vegetation, which reduces the rainwater absorbed by plants. City areas with lots of paving can

therefore lose much of their rainfall to runoff, compared to forested areas. This means that this type of city expansion can also lead to flooding and water issues.

Adding to the aforementioned issues, pollination is also a concern linked to unsustainable urban development. The processes of pollination, pest regulation, and seed dispersal are vital for the functional diversity of urban ecosystems. However, these are endangered by the loss and fragmentation of habitats caused by urban expansion. As cities expand, natural habitats are converted into built environments, causing a decline in pollinators, pest regulators, and seed dispersers. Other environmental impacts including the destruction of natural landscapes, fauna habitat and fragmentation of ecosystems are also critical concerns associated with suburban sprawl.

Apart from tangible benefits, ecosystems offer intangible cultural services, such as recreational and cognitive advantages. In other words, services that help recreation, cognitive development, and peace in general. Unfortunately, urban sprawl and suburbia force its inhabitants into sedentary lifestyles and cause mental health problems. Since suburbs are far away from the city, the commuting distance demands transport, usually by car. The usage of cars for minor errands and transport further decreases exercise time, time that could be spent walking or biking and improving overall health.

Urban sprawl encourages isolated lifestyles, where every day, Perth residents make more than 400,000 private car trips shorter than half a mile(equivalent to less than a 10 minute walk). In addition, two out of three primary school students in the Perth metropolitan area are driven to school, even though most children live within one mile (or a 20 minute walk) of their school (Government of Western Australia 2017). Because many people spend a lot of time on the road, they are also less likely to socialize with people, which along with many other health benefits is an important factor when trying to minimize and prevent depression, for example.

There is a clear link between cognitive development and exposure to nature, which further shows the importance of preserving natural spaces. Exposure to nature is frequently referred to as a natural antidepressant and motivator - for example, a park experience may reduce stress, enhance contemplativeness, rejuvenate the city dweller, and provide a sense of peacefulness and tranquility (Kaplan 1983). Moreover, in 2009, a study was conducted to see the effect and correlation of ADHD and time spent in parks versus the correlation in urban areas. Children who had been diagnosed with ADHD participated in three different walks: one in a city park and two in urban street settings. Before the walks, the children were given a puzzle that was intended to cause symptoms of ADHD to become more prominent. After the walks, the children were asked to take the "Digit Span Backward test," which requires repeating a series of numbers given in reverse order. The study found that the children performed significantly better on the test after walking in the park than after walking in the urban street settings. The study also unexpectedly found that, in some cases, the effect size of the park walk was comparable to that of Ritalin, a stimulant drug commonly used to treat ADHD (A. Faber Taylor and Kuo 2009). This shows the therapeutic potential of natural environments and the need for thoughtful urban planning.

Besides encouraging people to sedentary lifestyles, depleted ecosystem services affect aboriginal communities. The cultural service maintained the aboriginal people's spiritual and cultural wellbeing, while preserving its importance. Since urban sprawl, the cultural services for aboriginal people are damaged (Latimore 2018). There are 75,978 Aboriginal and Torres Strait Islander people residing in Western Australia, which makes it the third largest state with Aboriginal population (Latimore 2018). Besides that, the gentrification that is caused by the sprawl, is pushing aboriginal people to relocate and leave their households. For most of the Aboriginal population, the location of their livelihood is important spiritually, those

places carry the traditions that their ancestors followed. Having no other choice but to abandon their roots is one of reasons for the depletion of ecosystem services.

Supporting or habitat services, a type of ecosystem service, are crucial for natural processes like photosynthesis, nutrient cycling, soil creation, and the water cycle. These processes are essential for maintaining water availability in regions like Perth, which has been facing significant rainfall reductions. One example of a vital component in these processes are the Swan Coastal Plain wetlands, which form part of the urban stormwater and rural drainage network, and contribute to flood control and better water quality. This is done by removing suspended matter and naturally processing nutrients and other contaminants.

Because all these services and processes play such a vital role in the ecosystem, any damage done to them needs to be traced to their root cause, in order to deal with the issue in a sustainable and lasting way.

b. Causes and Effects of Suburbia. Today, the appeal of moving away from urban areas and embracing a "greener" suburban lifestyle has grown. Construction companies promote this lifestyle as highly desirable, encouraging people to help decongest the city. At first glance, creating less dense cities seems sustainable as it could lead to less traffic, fewer residential buildings, and reduced waste. Additionally, the undeveloped lands surrounding cities are typically cheaper, attracting developers and construction companies. They purchase these lands at lower prices, develop them, and sell them to individuals seeking a quieter life outside the bustling city, while remaining close enough for commuting or enjoying the city's amenities. Often, it's in the interest of major cities to have developed suburbs to prevent overpopulation and maintain their original character and aesthetic. However, the development of suburbs isn't always driven by aesthetic preferences; it's also a natural response to economic conditions. Individuals who find city living unaffordable may opt for suburban life,

commuting to the city for work. Therefore, the suburban sprawl continues to extend into more affordable areas to cater to lower-medium income people.

In addition to this, there are some other major causes of the suburban crawl. For example, the availability of automobiles and the development of extensive highway networks is vital, since without these, commuting to the city for work would not be possible. Zoning and land use policies also significantly contribute to the expansion of cities as well. Many regions implement regulations that promote low-density development, such as the construction of single-family homes on large plots of land. However, while trying to protect private property rights, these policies can unintentionally lead to inefficient use of land and promote extensive suburban growth.

This zoning approach can worsen the issue of suburban sprawl, leading to fragmented, car-centric communities. Economic factors play a vital role in the expansion of suburban areas. Lower land costs in suburbs, united with the perception of an enhanced quality of life, including larger homes and yards, can be a strong attraction for both individuals and businesses. This economic incentive drives migration from urban cores to the suburbs, contributing to the outward spread of communities. Additionally, preferences for suburban living, characterized by perceptions of spaciousness, lower crime rates, and quieter surroundings, further contribute to the perpetuation of suburban sprawl as people seek to fulfill these desires in suburban environments.

The effects of suburban sprawl are far-reaching and impact various aspects of society and the environment. One of the most serious consequences is increased traffic congestion.This diminishes air quality, which by itself creates an array of health and environmental problems, such as respiratory problems and excessive carbon emission in the atmosphere and climate change. Moreover, traffic congestion and increased traffic overall decreases transportation efficiency which can be linked to sedentary lifestyles and mental

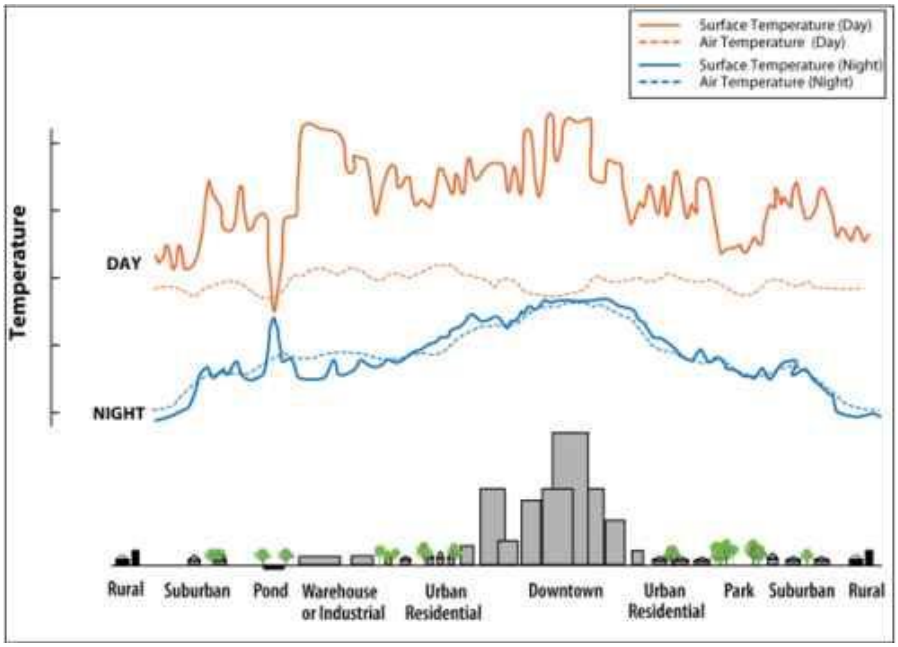
health problems, such as less exercise time and emotional distress by standing in the congestions.

Suburban sprawl can also foster urban heat islands, where large expanses of concrete and asphalt absorb and retain heat, causing localized temperature increases that affect the overall climate of an area. “With lower socio-economic neighborhoods most at risk, the costs are not just environmental. The urban heat island effect contributes to a range of socio-economic and public health issues that disproportionately impact low-income communities” (Beeke 2022).

The temperature noticeably increases during the night, and decreases during the day. This is called the Urban Heat Island (UHI) effect. UHI is a phenomenon characterized by urban areas having higher temperatures than the rural areas surrounding them. This temperature difference is mainly a result of alterations in land use and the built environment brought about by urbanization and deforestation.

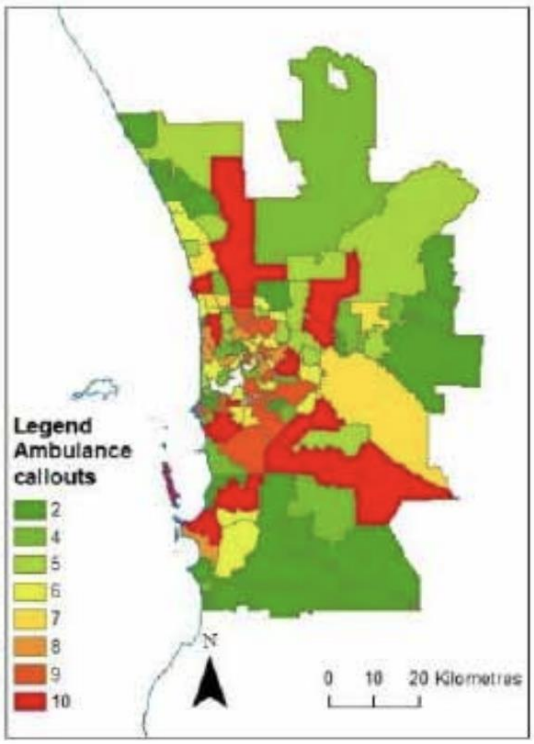
The ambient temperatures in the urban environment have been shown to be between 10 and 15 degrees Celsius hotter during the day and 5–10 degrees hotter at night (Figure 3). This is because the built form of the urban environment, including buildings, roads, paving and car parks, absorbs and re-radiates heat. Urban environments also produce heat from vehicles, air conditioners and other appliances and industrial processes. Roads are one of the largest contributors of heat and can comprise up to 30 per cent of land space in urban areas, while off-street parking can take up an additional 20 per cent of land space.

Figure 3. Variation of surface and atmospheric temperatures across a city



The Urban Heat Island effect, not only devastated the environment but is putting inhabitants in danger. Below is the graph (see Figure 4) related to heat related ambulance callouts. The red colour is the most callouts, which is the same legend as the most urbanized areas.

Figure 4. Ambulance callout legend in the Metropolitan area of Perth



Moreover, there are serious social consequences of suburban sprawl such as reduced social interaction and potential health impacts. Low-density, car-dependent suburbs can lead to social isolation, as residents have fewer opportunities for spontaneous interactions with neighbors.

Economically, suburban sprawl can be inefficient in terms of land use. Vast areas of land are dedicated to housing and commercial developments that are spread out, making it costlier for municipalities to provide services and maintain infrastructure. Additionally, the migration of people and businesses to the suburbs can result in a decline in urban centers, characterized by economic downturns, decreased property values, and population loss, further extending the cycle of sprawl.

Lastly, suburban sprawl can exacerbate social inequities, as those without access to private vehicles may face barriers in accessing jobs, education, and healthcare in sprawling areas. The car-dependent nature of suburban living can disadvantage individuals and communities with limited mobility options.

c. *How to Deal with It.* To address these issues, efforts to mitigate suburban sprawl often involve better urban planning, zoning reforms that encourage denser and more mixed-use development, investment in public transportation to reduce car dependency, and the promotion of sustainable, walkable, and environmentally friendly communities. These measures aim to create more balanced and livable urban and suburban environments.

To restore ecosystem services, more community based activities are needed, such as planting more trees to help ameliorate air quality, popularizing green roofs, which help reduce water runoff, and decrease the flood threats. Also, green roofs may delay the timing of peak runoff, thus lessening the stress on storm-sewer systems (Clausen 2007; Villarreal and Bengtsson 2005; Shuster et al. 2008). To maintain biodiversity and help pollination allotment gardens, private gardens, and other urban green spaces can serve as important refuges and sources for these essential ecological functions. Sustainable management practices in these spaces can enhance populations of pollinators and seed-dispersing birds, contributing to the resilience of urban ecosystems.

Economically speaking, if we compare the profits of urban sprawl as a whole and impose full cost pricing on the damages brought by the expansion, the non-monetary value of the environmental and health damage will heavily surpass the profits.

New Urbanism is a planning development approach towards more walkable streets, having housing and shopping in close proximity, and having accessible public spaces. Since, Australian cities are an interesting hybrid of European and US cities, taking the best from both. Having dense, mixed-use, urban layout is the best for New Urbanism (Steuteville 2001). “Liveable Neighborhoods,” a design code for urban development designed by Western Australian Government uses the New Urbanism concept (Newman 2010). To mitigate the severe consequences of suburban sprawl, it is crucial to have the Liveable Neighborhood

codes and New Urbanism concept. As well, as change the policies and laws that permit having low density, low dwelling single homes scattered around the urban areas.

Having frequent floods and other threats throughout the year, Perth's inhabitants have to adapt to the hazards. Being resilient after the catastrophe is one of them. Understanding and Managing Flood Risks Perth project has outlined some of the advice on how to deal with the floodings. The plan assesses the vulnerability of the public and the spaces, setting the scenarios of the flood, and having a stage by stage prepared plan to rescue and rebuild people and the spaces after the flood strikes (EMRC 2020).

Dealing with the environmental hazards need to be approached from several perspective, first being the plan to avoid them: with policy changes and ameliorated urban plans, second being the restoring the already damaged, planting the trees, which have big canopies to reduce the water runoff and erosion, thirdly, making sure that the economically the plan is profitable to attract the government and private investors and fourthly making communities resilient in case of the future hazards.

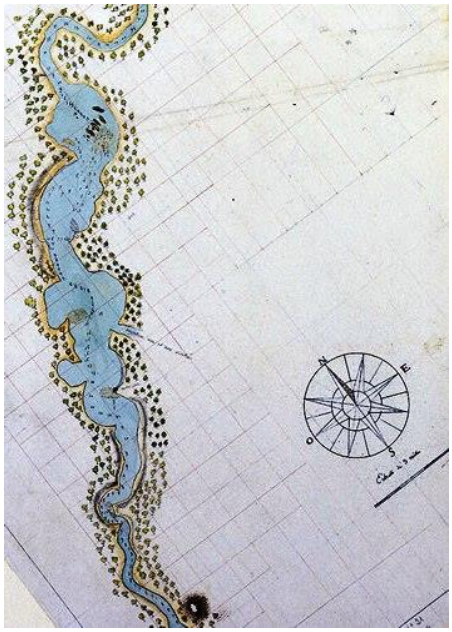
Chapter 2: Tracking Back the Footprint

The city of Perth has expanded over the years, and this expansion has had an impact on the natural environment. In this chapter, we will take a detailed journey through Perth's history of growth and development. Moreover, we will examine how this urban expansion has affected the way people live, often leading to a more sedentary lifestyle. The primary focus will be on exploring the ecological problems that emerged during the expansion of Perth and later, how it tied with the health problems as a result of this increasingly inactive way of life. Environmental History

a. Expansion of Perth. The Noongar people are the traditional owners of the Perth region and the Swan Coastal Plain in particular. At the time of colonisation in 1829, Perth

Noongar people were composed of four principal groups – Mooro, Beeliar, Beeloo, Weeip – loosely determined by the Swan River (or Derbarl Yerrigan). The city grew on the shores of the Swan River (Figure 5).

Figure 5. Drawing of a Swan River in Perth



In 1849, after 15 years of slow growth, Perth became a penal colony and in the next 16 years received an influx of over 9000 convicts. This significantly changed the social and economic dynamics of the colony. The convicts were involved in the construction of a large amount of infrastructure and this shaped the character of the city. The town hall in Figure 6 was built by convicts.

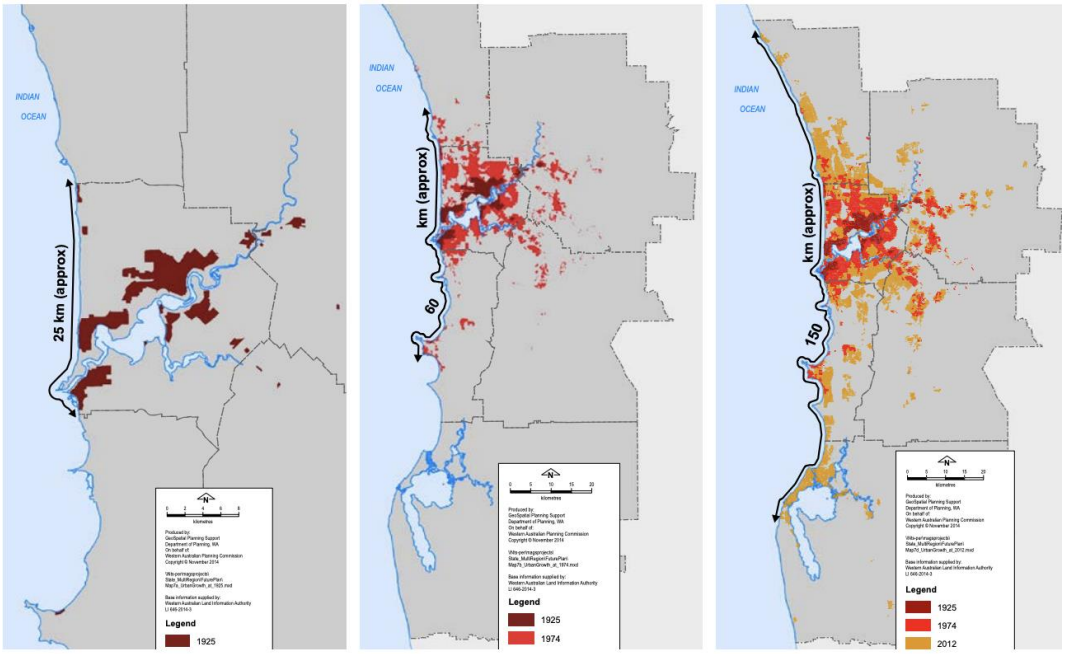
Figure 6. Example of a building built by convicts: Town Hall

Despite being proclaimed a city by Queen Victoria in 1856, fourteen years later a Melbourne journalist described Perth as: "...a quiet little town of some 3000 inhabitants spread out in straggling allotments down to the water's edge, intermingled with gardens and shrubberies and half rural in its aspect ... The main streets are macadamised, but the outlying ones and most of the footpaths retain their native state from the loose sand."

Everything changed with the discovery of gold in the Kimberley, Murchison and Kalgoorlie regions in the 1880s and 1890s, which had a huge impact on the development of Perth. This resulted in a huge increase in population. In just 10 years, the population of the city tripled from 8447 in 1891 to 27553 people in 1901 (Herriot 2017).

Perth's history is marked by multiple rapid expansion phases, each being connected to a large economic (but also social) transformation. These growth phases were followed by longer periods of slow and steady development in order to stabilize. In Figure 7, it is visible how the city dispersed from the center and spread to neighboring suburbs.

Figure 7. Urban development of Perth from 1925 - 2012



For example, in 1928, the Town Planning and Development Act introduced modern town planning in Perth to manage the growing population. This plan aimed to prepare for a population of 1.4 million by 2005, and included a more detailed layout and structure of the city, with urban areas separated by green spaces, which can still be seen today. This was expanded upon in 1963 with the Stephenson-Hepburn Plan, which still serves as the main planning framework for the Perth metropolitan area today. In 1970, the Corridor Plan aimed to help the city grow by forming separate communities along certain paths, with green areas in between, and by 1990, the Metroplan was initiated to expand towards the outer areas of the city (Department of Planning, Lands and Heritage 2018).

By the beginning of the twentieth century, Perth was completely transformed. It now had many multi-storey buildings and the population had spilled into suburbs around the city. On February 20, 1962, Perth became known as the "City of Light", with the city having an impressive skyline, which included multiple skyscrapers (Donohue 2023).

b. Ecological Depletion. With the growth of the city, new complications arose. Before, no one questioned what the consequences would bring - the main focus was on economic

growth and maximizing the gold mining income and development of new settlements. However, the fast expansion negatively affected the aforementioned ecological aspects, especially considering the southwestern region of Western Australia boasts one of the most diverse plant life and landscapes in the world, with 80% of Australian mammals and 90% of all the plant species which are nowhere else to be found on Earth. For example, just within the southern Swan Coastal Plain, there have been records of 1,700 endogenous species living in approximately 30 distinct plant communities in a close proximity to the urbanized areas (Gibson et al. 1994, Keighery 1999b). Another example are the Banksia woodlands, which are particularly vulnerable to various challenges, including wildfires, invasive weeds, diseases like dieback, declining groundwater levels, improper waste disposal, and the presence of both feral and domesticated animals. Now, land fertility, water runoff systems, air quality, and endemic and non endemic species' wellbeing all came into question, since the clearing of land for this urban expansion was significantly affecting the natural bushland and biodiversity of the region (Wardell-Johnson 2016).

On the Swan Coastal Plain for example, roughly 90% of the initial vegetation has over the years given way to things such as urban centers, rural settlements, agricultural fields, vineyards, orchards, and industrial zones. Native bushlands are no longer untouched, which can be exemplified through the nearby Jarrah-Marri forest, where biomass has been significantly reduced and the structure of the forest has drastically changed (Wardell-Johnson 2016).

The expansion and ecological changes in Perth have also had a notable impact on various species, some of which hold cultural significance. For instance, the Black Cockatoo is an integral part of the ecological cycle and is revered for its beauty and unique, somewhat mournful call. It's a symbol of change and enlightenment, and traditionally believed to herald

the arrival of rain. Moreover, they are seen as guides and guardians for the spirits of loved ones transitioning to rest with the Ancestors (Ngaora, n.d.).

Similarly, the Donkey Orchid, which thrives in sandy or sandy clay soils, particularly in areas experiencing winter flooding, is now facing survival challenges. The loss of its natural habitat and the intrusion of invasive weeds, primarily due to extensive land clearing, has significantly reduced its living spaces. Now, it's mostly found on privately owned or local government properties in the Perth Metropolitan Region (USDA Forest Service 2016).

Quokka, which now only exist in Rottnest Island, are located exactly west of Perth on a little island. Known as the happiest animal in the world, because of their everlasting smiley face, unfortunately they are going extinct. Being a herbivore in the food chain, Quokkas are hunted by foxes and feral cats, and as the food chain mechanism works, their extinction will cause predators extinction, as well as putting in danger other herbivores such as Numbats and Northern Quolls. Therefore, Quokkas which were very friendly to people living near the populated areas are now only secluded on an island.

The Quenda, also known as the Southern Brown Bandicoot, is another example of a species affected by these ecological changes. While it's now scarcely found in the inner Perth region, it continues to exist in suburban areas on the Swan Coastal Plain and the Darling Scarp. The Quenda has a preference for natural bushland and vegetation near wetlands, although it can also be spotted in nearby residential gardens. The primary threats to the Quenda include habitat loss from the clearing of native vegetation, increased numbers of introduced predators, and vehicular accidents due to urbanization.

Historically, settlers depended on surface water until they began collecting and storing water from local springs, which was the primary water source until the end of the 19th century. With Perth's expansion, particularly following the 1885 discovery of gold in the Goldfields, there was a need to change its water supply infrastructure to accommodate the

increasing population. As a result, dam construction started around the start of the 1900s, ensuring the capture and storage of surface water. However, the amount of water in Perth's dams reached a record-breaking low in 2001, leading to an urgent call to explore other water sources (Rogers et al. 2015).

While there are several efforts to preserve ecology near the urban and suburban developments, overall decline continues. Governments are implementing species recovery programmes, having scientists on board, they are monitoring the programmes to have the best results (Australian Government 2018). Government has dedicated 30 million dollars to the threatened species recovery hub. They are planting 20 million trees under the Green Army Initiative (Green Army 2022). Community groups are also engaged in similar programs and efforts. 90% of the Australian population accepts that climate change exists, which is more than average in the world countries who state the same (obvious). Australian citizens are well educated on the matter, not to mention that they have experienced it first hand. Still with the combined effort of government, businesses and individual citizens it is hard to cease the actions of and stop the snowball effect of climate change. The whole country cant cease the usage of cars and close down the factories that contribute to CO2 emissions, which then causes various environmental hazards.

Urban air pollution continues to be a substantial factor contributing to sickness and loss of life, notably impacting the well-being of vulnerable individuals and communities. Over 3,000 deaths in Australian cities are tied to air pollution yearly. Besides causing deaths, it harms health, leading to early death or illness from city air pollution. Research has shown significant links between changes in particle and ozone levels in Perth and increased hospital admissions for conditions like asthma, chronic obstructive pulmonary disease, pneumonia, and respiratory ailments (Piracha and Chaudhary 2022).

According to a recent survey, the main concern for Perth's status as a desirable place to live is "clean air" rather than pollution and exhaust fumes. In this survey, 94 percent of participants indicated that this was either important or very important to them (Australia State of Environment 2021).

An overall rise in average ozone levels has been observed, and this trend is expected to intensify with the onset of warmer summer temperatures. Ozone is produced through the interaction of precursor gases like nitrogen oxides and volatile organic compounds when exposed to heat and sunlight. The main origins of ozone include emissions from vehicles, industrial combustion activities. Additionally, vegetation and soil contribute to the presence of volatile organic compounds, contributing to elevated baseline levels of ozone (Hui et al. 2023).

Vehicle emissions represent a significant contributor to air pollution in urban areas. Vehicles stand out as the largest individual source of substances that form smog, such as volatile organic compounds and nitrogen oxides (Union of Concerned Scientists 2018). The Perth Airshed Emissions Study showed that vehicle emissions accounted for roughly 79 percent of carbon monoxide emissions, 46 percent of nitrogen oxide emissions, 43 percent of volatile organic compounds (Union of Concerned Scientists 2018).

c. Sedentary Lifestyle Consequences on Mental and Physical Health. According to the Department of Planning, urban sprawl accounts for almost three quarters of all new development, while 64 percent of all jobs are in the Central sub-region (Department of Planning, Lands and Heritage 2018). This means that inhabitants of these new developments need to commute into the city. These longer commutes and sedentary lifestyles are indirectly causing health problems such as higher BMI, lower blood circulation, diabetes and mental health problems. Unfortunately, the average commute from Perth's suburbs is 16 miles. The Australian Burden of Disease Study in 2018 indicated that insufficient physical activity

contributed to 20% of type 2 diabetes cases, 16% of coronary heart disease cases, and 9.2% of stroke cases. Moreover, based on exploratory research on commute distance and body size, it was found that commute distance was positively correlated with an increase in BMI in all western capitals of Australia except Darwin (Carroll et al. 2021). This suggests that there are various health implications that can arise due to increased commutes.

The World Health Organization has stated that physical inactivity causes 2 million deaths a year worldwide. Moreover, lack of physical activity can lead to cardiovascular disease, type 2 diabetes, and obesity, as well as increasing the risk of bowel and breast cancer (Aid 2022). Furthermore, it should also be noted that the historical increase in the mean body mass index (which is often a natural consequence of low physical activity) of Perth's population correlates strongly with the rate of suburban development, especially between the years 1980 and 2000 (Gearon et al. 2015). Moreover, besides physical healthcare problems, spending small amounts of time in the green spaces cause mental and psychological problems such as depression, anxiety disorders, and develop anger issues. Green spaces promote cognitive development and raise the happiness hormones such as ACTH which regulates the cortisol levels in the body (high cortisol is associated with anxiety and fatigue) (Weir 2020).

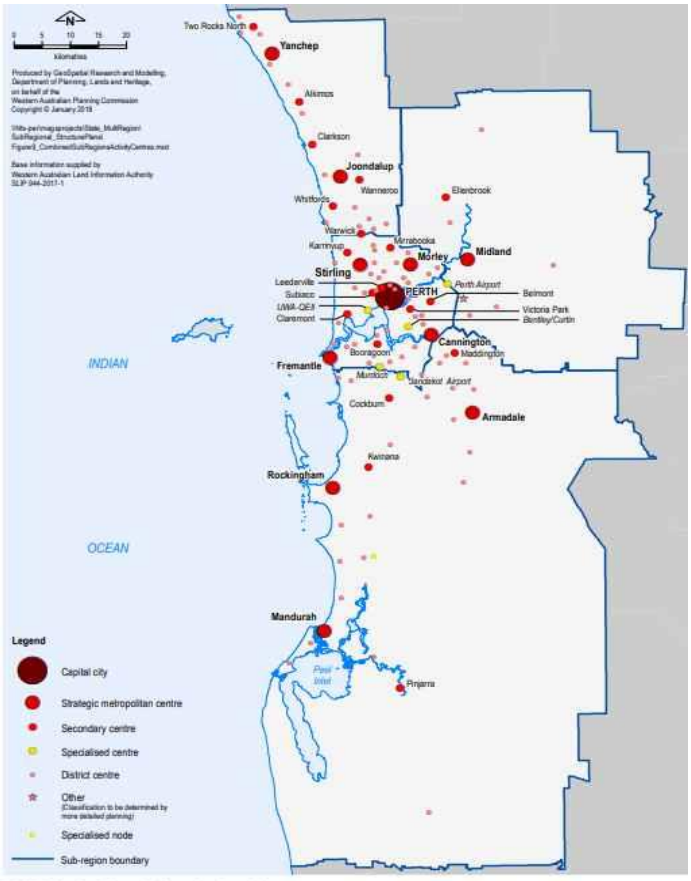
For indigenous Australians, health conditions are worse, since they live in more remote areas. This causes them to be 3 times more susceptible to type 2 diabetes compared to non-indigenous Australians. Indigenous Australians are also at greater risk of complications than non-indigenous Australians, with 10 times higher risk of kidney failure and up to 8 times higher risk of high blood pressure (Baker IDI 2017).

Despite the health problems, industrial and urban development is a major pressure on Aboriginal heritage in the Perth and Peel regions. A lack of street life, homelessness, and crime and safety have emerged as some of the top issues affecting the city, according to

participants in several workshops and a wide ranging online survey on how to improve Perth (Taylor 2017).

As previously mentioned, one of the potential reasons for Perth having some of the highest car usage globally could be the distant spacing of suburban areas from each other (see Figure 8). This may be one of the contributing factors for the high vehicle use and driving in Perth, which could potentially have long-term health consequences for the population.

Figure 8. Sub-regions' activity centers in Perth Metropolitan area



d. History of Aboriginal People. Western Australia, home to 2 million people, various animal and plant species, amazing landscapes and rich cultural heritage, has also been a home to Aboriginal people for longer than any of the previously mentioned. However, frequently Aboriginal people are overlooked when talking about urban living, policy making or

implementing new developments. These communities are marginalized and not taken into account.

History of aboriginal people in the perspective of history of Australia is complex, excluded, and mostly unwritten. Research into maternal genetic lineages shows that Aboriginal groups settled in Australia approximately 50,000 years ago. They quickly migrated along the west and east coasts simultaneously, eventually converging near the Nullarbor, just west of present-day Adelaide. This means that Aboriginal Australians have been in their country as long as modern human populations have been outside of Africa (Cooper, Williams, and Spooner 2018).

Aboriginal people lived freely on their land for centuries, before British colonization, which began in 1788 with the establishment of a penal colony. The Aboriginal peoples of Australia experienced profound disruption and devastation. As the colonizers viewed Australia as “terra nullius” or “nobody’s land” they ignored the previously existing settlers, their traditions and practices. As settlers spread out they forcibly removed Aboriginal people from their ancestral lands. This displacement, combined with introduced diseases to which Indigenous people had no immunity, such as smallpox, influenza, and measles, led to dramatic declines in Aboriginal populations (Berndt and Tonkinson 2019).

Government policies which completely overlooked and marginalized Aboriginal culture and autonomy further damaged the communities. Aboriginal children were removed from their families in what is now known as the Stolen Generations, a practice that continued into the mid-20th century, aiming to assimilate them into white society but often leading to loss of cultural identity and personal trauma (Aboriginal Heritage Office 2022).

Despite the history, Aboriginal people maintained strong cultural connections to their past. Today, they still continue to seek recognition of their rights and restoration of their

autonomy through legal and political channels, highlighting both the resilience of their cultures and the ongoing impacts of colonization.

Aboriginal people frequently live in the outskirts of the city and less in urban areas. However, they have the same human rights as other people. However, the scarcity of schools and healthcare facilities in these suburban areas significantly complicates their lives compared to those living in city centers. For instance, the age-specific mortality rate from cardiovascular disease among Australian Aboriginals is estimated to be four to seven times higher than that of the general population, leading to premature deaths. Preventing cardiovascular diseases requires regular checkups and a healthy lifestyle. Yet, for communities that need several hours to reach the nearest healthcare facility, or those without well-equipped amenities like schools and playgrounds, the added stress and physical health issues intensify their challenges (Bradshaw et al. 2010).

Chapter 3. Weight of Injustice

Suburban sprawl, along with all the problems mentioned in Chapter Two such as ecological depletion and healthcare issues, is also spurring injustice and creating an unequal environment for its inhabitants. It supports socio-economic development by promoting the development of exclusive, car-dependent communities that are often out of reach for lower-income individuals. Furthermore, the impact it has on ecosystem services is in large part paid by lower-income families who can't afford to live in these kinds of neighborhoods themselves, sometimes lacking access to cleaner air or water (Mattioli et al. 2020).

This spatial segregation exacerbates inequality in access to quality education, healthcare, and employment opportunities. Furthermore, suburban sprawl contributes to environmental injustice as it consumes vast areas of land, leading to deforestation and wildlife habitat destruction, while also increasing greenhouse gas emissions due to car-

dependent lifestyles. It puts a disproportionate burden on marginalized communities as they often face the drawbacks of environmental pollution, health issues, and limited access to green spaces. Because of this, suburban sprawl deepens disparities in income, education, health, and environmental quality, creating an unjust and unsustainable urban landscape.

The main contributors to environmental injustice are inaccessibility to educational institutions, inaccessibility to healthcare institutions, and unjust impact on Aboriginal culture. Furthermore, these factors are not determined by peoples' choices but by the decisions made while creating a blueprint of the city and the policies surrounding it.

a. *Accessibility to Educational Institutions.* Accessibility to educational institutions is one of the most important aspects of a just society. Schools and universities are and should constitute a significant portion of children's and adolescents' daily routines. Therefore, challenges associated with traveling to and from these educational institutions can impact students' mental and physical health, as well as their academic performance. This is because the time and energy spent on long commutes to educational institutions can lead to increased anxiety, reduced focus, and a decline in academic performance, particularly affecting younger students. Physically, those who commute by vehicle or public transport may experience health issues related to a sedentary lifestyle such as the aforementioned problems surrounding sedentary lifestyles mentioned in Chapter 2. This combination of mental and physical strain can diminish a student's energy and engagement in both academic and extracurricular activities, impacting their overall well-being and educational experience. Children attending the same schools might have different performance levels depending on their commute. Therefore, urban planning that prioritizes accessibility to schools and other essential services can help reduce the need for long commutes, and enhance the quality of education and life for all residents.

In Perth, transport is a key determinant of access to education. Urban expansion in Perth has led to increased distances between residential areas and educational institutions. This expansion not only stretches the physical distance but also amplifies the socio-economic divide, as not all families have the means to manage the demands of long-distance commuting. Many children in rural and remote parts of Western Australia travel to and from school under extreme conditions due to distance, road quality, and climate. Along with flooding, heat and dust are common challenges in travel in rural and remote regions (Sidoti 1999). In Australia, educational transportation grants are commonly distributed based on a per-kilometer travel distance. Schools and families in remote locations struggle with the costs of travel for any school-related activity, often resulting in very limited, if any, attendance in such activities (Human Rights and Equal Opportunity Commission 2000).

Addressing this issue is challenging, but some schools have initiated distance education programs. These programs rely on radio or computer connections, which in turn depend on unreliable power sources or inadequate and costly telecommunications infrastructure. While these programs offer a potential solution, they also highlight the broader implications of urban expansion in Perth.

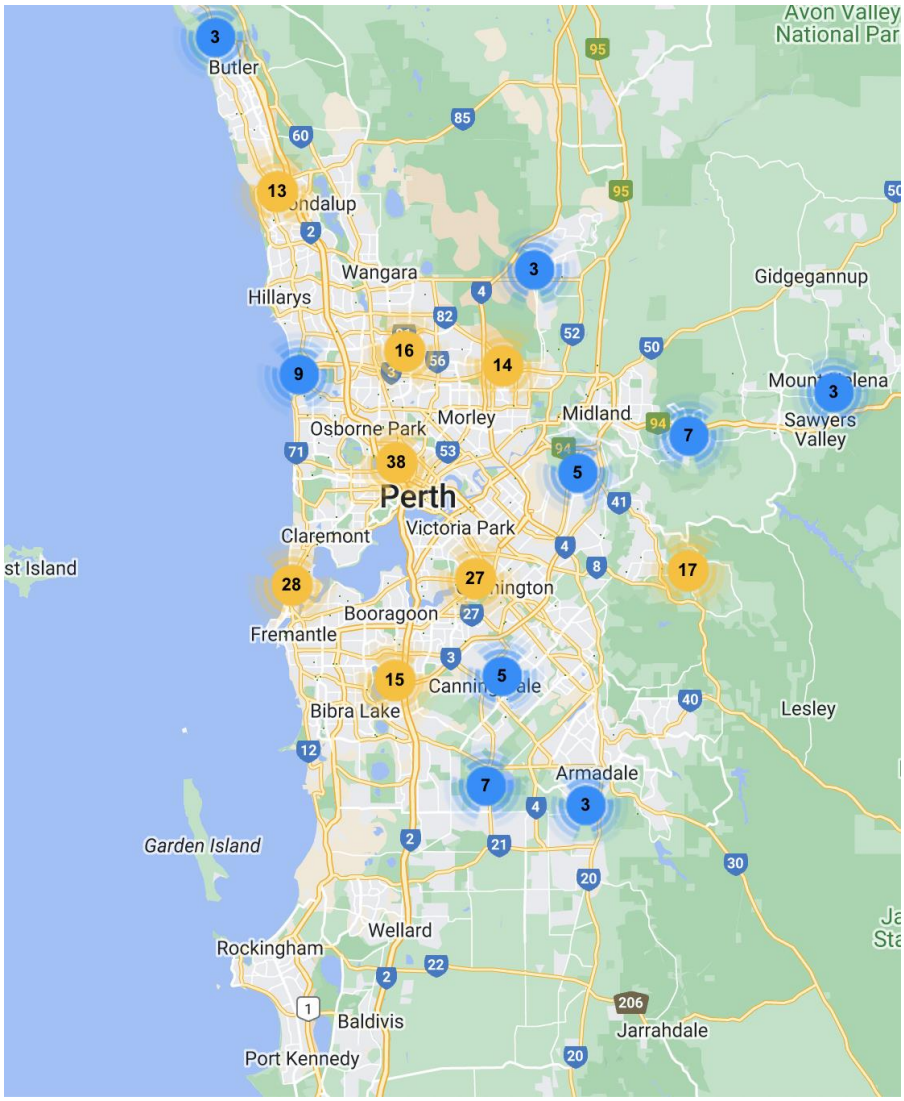
Aboriginal children are most affected with the injustice to educational access. On top of that, they are affected by inaccessibility to private schools which are mainly located in the city centers. Therefore, it creates challenges for them in the future, and makes it difficult for them to succeed in their careers (Australian Human Rights Commission 2001).

Data reveals that a large proportion of the Aboriginal population has limited formal education, with very few having bachelor's degrees or higher. School attendance rates for aboriginal Australians are 64% in Western Australia which is way below average for their non aboriginal fellows (ABC News 2023). School completion rates and literacy/numeracy skills of Aboriginal students are considerably lower compared to the non-Aboriginal

population, and these gaps widen as students progress through their schooling. It can also be seen as a positive feedback loop: children are raised in poverty, far from the city center, not having access to better education. Therefore, their future careers and adulthood are affected, which then negatively affects their children's success in the same way the parents were affected during their childhood (Parliament of Australia 2004).

This private school map illustrates how a majority of schools are in the city center or central district, and how there are only a handful of them around the suburbs. We have to keep in mind that the distance between the suburbs and the city center is more than several dozen miles, which is impossible to cover for a school/ elementary student or even for a university student.

Figure 9. *Map Highlighting Private School Locations*



b. Accessibility to Healthcare Facilities. Access to healthcare, which is important for human well-being, is limited by many factors. One of the main factors is how long it takes for people to travel to a healthcare facility. Therefore, it is more than just an urban health injustice, it is a priori a human right to have well-planned healthcare facility access (Riley 2012). However, due to spatial clustering of healthcare facilities in densely populated areas, individuals living in rural regions often face increased travel times and extra cost when seeking healthcare. This situation can be exacerbated by poor transportation infrastructure and lack of motorized transport, which further increase the time required for travel and could

disproportionately affect lower-income populations (Syed, Gerber, and Sharp 2013). As such, people facing long travel times to healthcare facilities are less likely to seek care when it is needed, and the consequences of failing to seek care include increased mortality and morbidity from treatable conditions.

On the map in Figure 10, the heatmap of travel time to healthcare is demonstrated, where Australia is one of the darkest areas. As a developed country and compared to other developed countries, the travel time should not be more than one hour. However, as seen in the heat map, it varies from five hours to more than a day, with a decrease in travel time only present in certain coastal areas.

Figure 10. *Word Heat Map for Travel Time to Nearest Hospital*

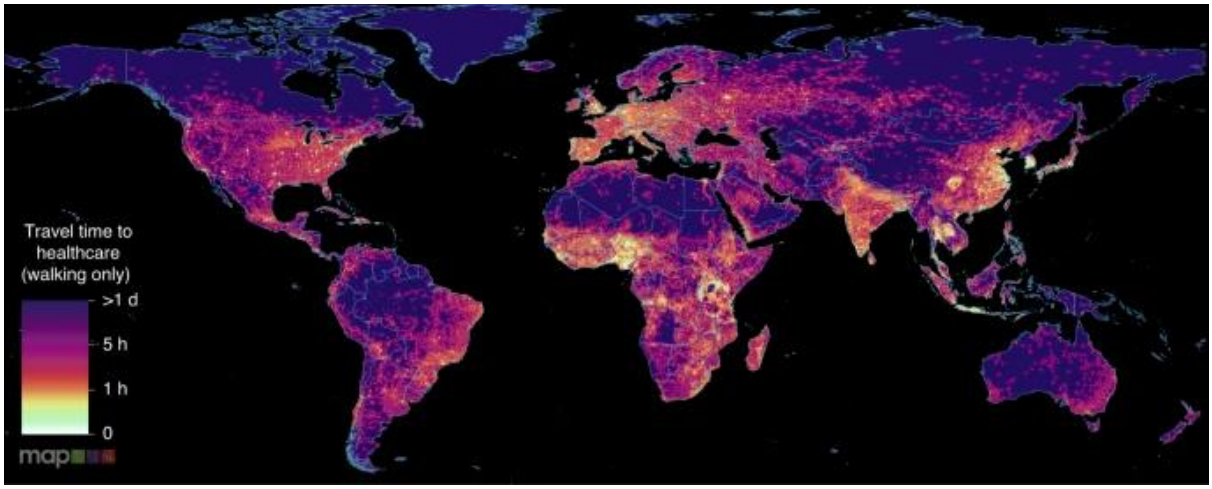
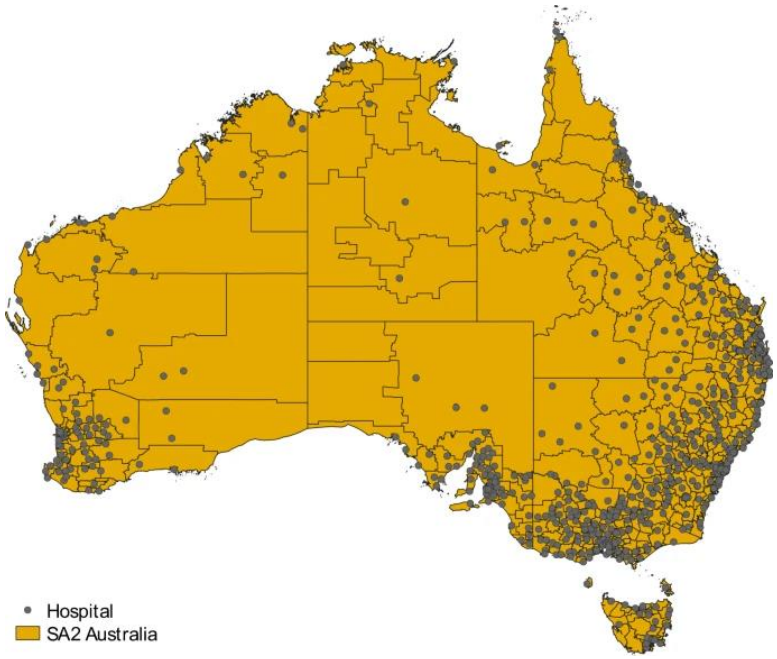


Figure 11 highlights all hospitals in Australia. It is clear that the number of hospitals in the western part of Australia is significantly less dense than in the eastern part, which has many more facilities. Therefore, patients aren't just traveling long distances for their education, as mentioned in part A, but also to hospitals and other important facilities. This has a drastic effect on their access to important locations, and could potentially also lead to the worsened decisions mentioned previously, such as not seeking care as frequently.

Figure 11. *Australia's Hospital Map*

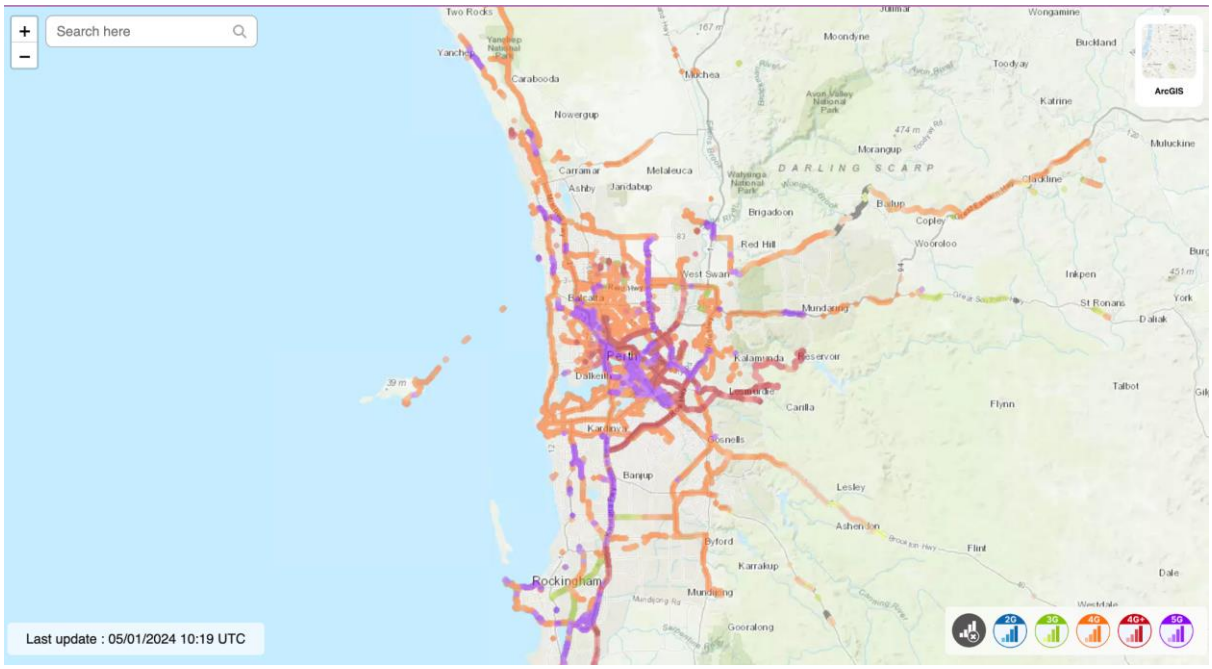


Patients who live farther from healthcare facilities have lower rates of usage after adjustment for need than those who live closer, this is also called as the distance-decay association, when patients don't go to hospitals since they are so far away, not because they are not in need (Barbieri and Jorm 2019). Between the 8 states and territories of Australia, Western Australia was in 5th place in estimated travel time. However, in the last 3 states, were Tasmania, Northern Territory and Australian Capital Territory, which are much less populated than Western Australia. The longest arrival after an emergency call was 75 minutes, which in some cases is a fatal waiting time, especially in Western Australia (Barbieri and Jorm 2019).

Moreover, even though there are emergency services in most of the places of Australia, despite the travel time, there is no network coverage to call the ambulance. This is the map of network coverage by the provider Optus, in Perth and Peel region. From firsthand experience I can advocate that during my backpacking trip in Western Australia, I had connection very

few hours per day (around 3-4). Therefore, it is not only the concern of the emergency arrival time but also the accessibility to call them (Network Coverage Map 2024). Imagine, if one of the Network stations is down for several hours per day the whole region might be left without the coverage.

Figure 12. *Network Coverage in Perth and Peel Region*



Since the emergency's arrival time is so long in some locations, those neighborhoods should be prepared to prevent fatalities. For example, having the necessary education against poisonous bites, animal attacks and environmental hazards like fire and flooding is detrimental in these cases. Because of these some schools have the Emergency Aid Class in their schools, which goes through the main precautions that children and adults should have when encountering venomous animals or an environmental hazard. As well as ways to prevent getting Melanoma and diminishing sun exposure. Since, Australia ranks first in Melanoma frequency in the world, because of its proximity to equator (World Cancer Research Fund International 2020). However, if 36% of aboriginal children are not attending

schools in Western Australia, for them to be in the same information loop as their fellows is very difficult. So, not having well connected schools and healthcare facilities are correlated to have proper education and news exposure in times of emergencies.

c. Impact on Aboriginal Communities. Urban expansion in Perth and its accompanying environmental consequences also present challenges in relation to social justice for Aboriginal peoples. The rapid sprawl of Perth, stretching from north of Yanchep to south towards Waroona, encompasses lands that are of deep cultural, spiritual, and historical value to the Aboriginal communities of the region.

This expansion has led to the clearing of land that holds big cultural value for Aboriginal peoples. These areas are not just habitats for local flora and fauna but are also integral to the cultural narratives, traditions, and practices of the Aboriginal communities. The loss of such land to housing and urban infrastructure not only disrupts ecosystems but also severs the deep connection that Aboriginal people have with their ancestral lands, thus creating mental health problems, such as anxiety, and trauma. Furthemore, the environmental impact of such expansion - fragmentation of rural land, degradation of the Swan Coastal Plain's biodiversity, and increased distance from amenities - further marginalizes Aboriginal communities. These groups often rely on the land and its resources for their livelihoods and cultural practices. The urban sprawl therefore damages their cultural identity and heritage.

Besides destroying the lands, it also endangers different species important to Aboriginal culture. For example, as mentioned before in chapter one, the Black Cockatoo (Ngaora) represents change and enlightenment, and heralds coming rain. They are believed to be the guides and guardians of the spirits of loved ones on their journey to rest amongst the Ancestors. Droughts, bushfires, and urban expansion, all three are interconnected with the unnecessary and irrational human interference in the city suburbs. Unfortunately, those

events destroy fruit trees which are their main habitat and also a main source of food for Black Cockatoos (Black Cockatoo Conservation Center, 2023).

There are many other endangered animals. One notable example of this is the koala, an endemic species of Australia, which is also a symbol and totem of Aboriginal culture (Kelly 2012). This is true for the Bangerang tribe, for example, where the Nargoon (koala) is a totem and important part of their culture. Therefore, as a people they are responsible for the protection of their totem (WWF Australia 2022), and the rapid expansion of Perth should not interfere or hinder this in any way.

Inequalities emerged from urban sprawl, also uncovers the issue of inadequate representation and consultation of Aboriginal voices in urban planning. Despite warnings about the need to curb urban sprawl, there seems to be a lack of engagement with Aboriginal communities in the planning process. This not only exacerbates the social injustices faced by these communities, but might also deprive urban planning of valuable Aboriginal perspectives that could lead to more sustainable development.

To better understand the challenges that Aboriginal communities face, I decided to interview Mrs. Mia Tucker who is a member of the Wiluna Aboriginal Corporation, teacher and a research fellow in Curtin University WA.

How has urban sprawl directly affected your community, particularly in terms of access to essential services and opportunities?

As a member of the Wiluna community, I've witnessed firsthand the damaging effects of urban sprawl on our people. The spread of urban development into traditional lands not only damages the environment but also our connection to the country and complicates our access to essential services like healthcare and education.

How has urban sprawl directly affected your community, particularly in terms of access to essential services and opportunities?

Hospitals and clinics, often situated in urban centres, are now farther from our communities, necessitating longer travel times and increased transportation costs, which many cannot afford. Similarly, job opportunities tend to concentrate in city centers and more urban areas, making it challenging for community members to find employment without relocating or facing lengthy commutes from suburbs.

What are your thoughts on the accessibility of private educational institutions for members of Aboriginal communities? How do you think this inaccessibility impacts the educational opportunities for Aboriginal youth and their future careers?

Regarding education, the situation is very much troubling. Private educational institutions are predominantly located in urban areas, far from many Aboriginal communities. This geographic and, also, financial inaccessibility limits the educational opportunities for our youth. Without ready access to these institutions, our children miss out on the benefits of educational programs and resources that these schools offer. This inaccessibility contributes to a cycle of disadvantage, affecting future career prospects and economic inequalities.

What changes/solutions would you propose to address the issues of educational and healthcare inaccessibility caused by urban sprawl?

First of all it will be decentralisation of services: Government and private sectors should work to decentralise services, establishing more hospitals, clinics, and schools within or closer to Aboriginal communities.

Secondly, improvement of accessible and affordable public transportation: With a better connected city the accessibility problems will decrease and slowly aboriginal communities will be able to integrate with the urban life.

One of the very important problems I see is that there is no Aboriginal education for Aboriginal Studies. Therefore, developing community-based Education programs that are culturally relevant can help mitigate the impact of inaccessibility to private institutions.

And lastly, Aboriginal involvement in the urban planning process will bring to life changes adapted to our needs, which frequently are silenced. This change will guarantee that growth is more equitable and respectful of Aboriginal lands and traditions.

Thank you very much!

Aboriginal communities are all over Australia, and everywhere they are below average when it comes to accessibility and normal quality of life. For future inclusive cities it is a necessity to have aforementioned changes in policy making and planning.

Chapter 4. Politics, Power, and Policies

Is there a solution to the injustices and damage caused by urban sprawl? This chapter will uncover the intricate interplay between politics, power, and policies, and how these are the key to a lasting solution. Furthermore, this chapter will discuss the impact of policies, and show how these can either save or continue to jeopardize certain communities and environments.

Firstly, it’s important to trace the consequences of urban sprawl back to the political history of cities. This analysis reveals critical moments where policy decisions have led to either detrimental or beneficial outcomes. Legislative measures, often covered to carry good intentions such as growing the economy or creating more jobs, neighborhoods, are frequently facade by the wish to short-term gains. These policies frequently fulfill their masterplans, however, unfortunately while undermining the sustainable growth and neglecting smaller communities. The exploration of zoning laws and the development of building codes that ignore environmental concerns highlights the unintended consequences of such policies.

Fortunately, there are green activists, sustainable governmental initiatives and community outreach programs that manage to oppose the policies that kill the environment. Most of the environmentally friendly policies and the infill development goals that are portrayed in this chapter have lots of resistance and are very hard to be founded as laws. Government on the one hand gives subsidiaries to continue urban sprawl and on the other hand comes up with initiatives to create resilient communities. Ironically, there would be no need for the later without the first.

Finally the chapter challenges the current investment mindset of urban expansion in Perth, as it seems to be relatively short-term. Last part of Chapter 4 focuses on how to attract big businesses and governments to invest in sustainable growth over the fast monetary gain. By introducing the green taxes and readjusting the government budget it is very feasible to avoid depletion of ecology and encourage cost effective and eco-friendly growth.

a. Policies That Kill. Even though WA has recognized the need to stop the sprawl, they have failed to meet their target of 47% infill (developing within existing urban areas). Instead, policies continue to support sprawl, as evidenced by the 2020 COVID-19 recovery incentives which boosted construction in new, undeveloped areas. The government's focus on extending a northern highway that translates into spending of 100 million dollars on unlocking 10,000 new housing blocks, rather than investing in inner-city transit and public transport, has been seen as a significant public policy failure. This approach has encouraged people to live further from city centers and public transport, exacerbating the issues of sprawl (Pettitt 2022).

Besides not focusing on the incentives to stop the urban sprawl, the new medium-density codes, under development for four years, were indefinitely deferred by the West Australian Minister for Housing, John Carey. This deferment of the new codes has had a ripple effect, putting a number of planned projects at risk. A survey by the WA Local

Government Association (WALGA) revealed that 198 medium-density dwellings in the planning stages have been affected by the suspension of these codes. This has created an uncertainty for developers, particularly those focusing on sustainable projects that align with the anticipated new standards (Brookes 2023). These codes were created to elevate design standards, focusing on aspects like energy efficiency, solar orientation, and access to green spaces. They also aimed to provide more flexibility in both greenfield and infill development. These regulations define the permissible type and density of buildings in residential zones, covering details such as minimum site area, outdoor space requirements, and street setbacks (Wayne 2023). The new medium-density policy was intended to unlock land for diverse housing types, such as terraced housing and townhouses, while ensuring the maintenance of essential urban elements like tree canopy coverage. The deferral of the medium-density codes was attributed to the radically changed housing market since 2019, including significant cost escalations (MacLachlan et al. 2017). The concern was that implementing these new codes could hinder project development due to increased costs. According to the Property Council, the new codes could potentially increase housing costs by about $100,000 per house. Kate Fitzgerald, a sustainable developer, critiques the current non-effective planning policy of infill development. It favors volume builders who can bypass certain development approvals, leading to quicker and cheaper housing developments, often at the cost of environmental considerations like preserving trees. Fitzgerald suggests the creation of a 'green lane' for medium-density projects to be assessed more swiftly based on design merit. This includes the establishment of a specialized team of planners to quickly approve sustainable high-quality projects, thereby leveling the playing field for developers focused on sustainable and medium-density projects.

The existing policies make it easier and more cost-effective for developers to engage in greenfield developments, typically resulting in single, oversized homes that require more land

and contribute to the spread of the city's boundaries. This approach contrasts with the more sustainable and space-efficient infill development, which utilizes existing urban spaces more effectively and is essential for accommodating the anticipated population growth. Without supportive policies and the implementation of initiatives like the proposed 'green lane,' the trend of urban sprawl is likely to continue, as developers opt for easier and less costly greenfield projects over complex and time-consuming infill developments. This trend not only challenges the state government's target for infill housing but also impacts the environmental sustainability and overall urban design of Perth (London 2016).

Over the past decade and a half, Perth has seen remarkable economic progress, with its Gross State Product (GSP) growing by 218%. Initially named as the 'Cinderella State' due to its isolated position and perceived lack of attention from the rest of Australia, Western Australia (WA) has witnessed a continuous boom in the discovery and extraction of natural resources since the early 2000s. Therefore, it translated to an urban expansion boom, since people started moving to Perth for work and investments. Unfortunately, this growth has been at a rate that is not sustainable. The Western Australian Planning Commission (WAPC) reported that the urban area of Perth expanded from 631 square kilometers to 870 square kilometers over a decade, from 2002 to 2012 (Dhakal 2014).

Another policy that drew public anger was related to the state's planning reforms. The McGowan government introduced several tranches of planning reforms aimed at streamlining processes and promoting development (Government of WA 2023). These reforms were criticized for potentially overriding local planning schemes and diminishing community engagement in the planning process. Planning Minister Rita Saffiioti stated that: “We know that in the current housing market, we must do everything we can to bolster the supply of housing across Western Australia, these reforms will streamline, will make it easier to assess [and] to provide certainty regarding the delivery of housing in Western Australia.” Which is

exactly opposite to what's important in housing development (Hastie 2023). Instead of giving the rights to build houses everywhere, the planning committee should be focused on having a detailed plan on how to stop sprawl and reflect the interests of the welfare of local communities, without causing gentrification, healthcare problems or ecosystem depletion.

b. Policies That Save. Policies that are designed with sustainable objectives in mind can turn around the unsustainability trend and save the health of the people and the environment. There were several urban development policies enacted that took the step towards an ecologically positive direction. In general, Perth's urban planning and development have been characterized with low-density suburban growth, which was accustomed towards the customer needs, who wanted single-family dwelling spread far enough from each other to have private lands (Glaeser 2003). However, there's a growing recognition of the challenges associated with such irrational urban expansion, particularly in terms of economic, environmental, and social costs.

To address these challenges, the government has adopted sustainable policy objectives that emphasize managing new development by focusing on existing urban areas, meaning developing already inhabited suburbs rather than spreading onwards (MacLachlan et al. 2017). This approach aims to make more efficient use of current infrastructure and therefore minimize the need for expansive new developments.

This policy change is efficient from an economical, environmental and social perspective. Concentrating development within existing urban areas can reduce the costs associated with extending services and infrastructure to new, low-density suburbs. This approach promotes economic efficiency by utilizing existing resources more effectively. By limiting outward expansion, there's less habitat fragmentation and a lower impact on the natural environment. This approach helps in preserving biodiversity and maintaining ecological balances, which are crucial for long-term environmental sustainability. Denser

urban areas often lead to reduced reliance on automobiles, encouraging public transport, walking, and cycling. This shift can significantly reduce the carbon footprint of urban areas, aligning with broader environmental goals. Focusing on current communities can enhance social cohesion and integration. This is achieved by avoiding neighborhood segregation and fostering more inclusive urban environments. Therefore, the government's shift towards more sustainable urban development practices represents a positive change towards a better environment and aligns with the principles of sustainable urban growth, which advocates for balanced development that meets present needs without compromising the future generations to meet their own needs (MacLachlan et al. 2017).

One of the policies designed to cease the sprawl and focus on healthy urban growth is Directions 2031 and Beyond. This strategic plan aims to accommodate population growth sustainably while managing urban sprawl. It promotes higher-density living around activity centers and transport hubs, thus encouraging more compact urban development. The vision of the plan is: “By 2031, Perth and Peel people will have created a world class liveable city; green, vibrant, more compact and accessible with a unique sense of place” (Government of Western Australia 2015). One of the main objectives is to connect communities with their jobs and services, and create more jobs around the settlements and neighborhoods with equal job distribution.

Another initiative is to have a major public transport system, covering most of the suburbs across Perth and Peel region. This initiative is called Metronet. By improving public transport options, Metronet aims to reduce dependency on cars and encourage development near transit stations, thus reducing the pressure for sprawl. With approximately 72 kilometres of new passenger rail and 23 new stations, Metronet is turning more than 8,000 hectares of land around new stations into desirable places to live and work (Western Australia State Budget 2023).

Besides the government initiatives, some of the individuals have come up with action plans to infill development on contrary to sprawl. Limnios Property Group Managing director, who is strictly against Perth expansion talked about the initiatives mimicking Copenhagen's urban planning, to make Perth appealing for families and young adults, so that the infill development would boost. As a company that focuses on development of infills, and already urbanized areas, Limnios showed their disapproval of the massive taxpayer infrastructure subsidies that the government gives to suburb development (Burton 2023). It is evident that the government, besides having some policies and recommendations for infill development, is straightforwardly giving subsidies in favor of suburban sprawl, since it is more beneficial in the short term.

While having policies for ameliorating public transport, and better managing the populations in the rural areas, it is crucial to cease the sprawl. What seems profitable now will become the biggest loss in the future, since there will be no environment to develop.

c. Cost-effective is the New Profitable. As already discussed, in Perth's urban development, the short-term profit from suburban sprawl is a significant issue. Developers and the government often prefer this approach because of lower initial costs and quick revenue from new housing projects. This trend is visible in the expansion of Perth's urban areas, like the Mitchell Freeway extension and new housing in Alkimos and Bullsbrook, which are seen as solutions to immediate housing demands, encouraged by incentives such as the first home-buyers grant for new builds (Burton 2023).

However, this expansion has in many ways been unsustainable, and does not consider the long-term financial effects fully. James Limnios from Limnios Property Group, an industry expert, points out that urban sprawl has substantial hidden costs, such as heavy financial burdens for taxpayers (Burton 2023). Suburbs with lower population density often feature larger, initially more budget-friendly homes. However, over time, these areas can

become less cost-effective and less convenient due to limited access to community facilities, job opportunities, and public transportation. This leads to a higher dependence on private vehicles and results in extended commuting times (Carroll et al. 2021). Additionally, to take into account the long term healthcare costs caused by the sedentary lifestyle and polluted environment, the cost becomes a non monetary price for a healthy life. Therefore, Financing infrastructure for new developments proves to be significantly more costly over time compared to promoting infill housing near existing facilities. According to the State Infrastructure Strategy, the expense of equipping new greenfield locations with infrastructure is two to four times higher than that for infill projects. This is corroborated by Curtin University's Sustainability Policy Institute, which estimates that each new home in suburban fringe areas necessitates approximately $90,000 more in government subsidies than those in infill locations (Burton 2023).

The New Climate Economy finds that compact growth, as opposed to urban sprawl, can generate $17 trillion in economic savings between now and 2050. In fact, bold climate action overall—including low-carbon growth in cities—can yield at least $26 trillion in economic benefits between now and 2030 (Haddaoui 2018).

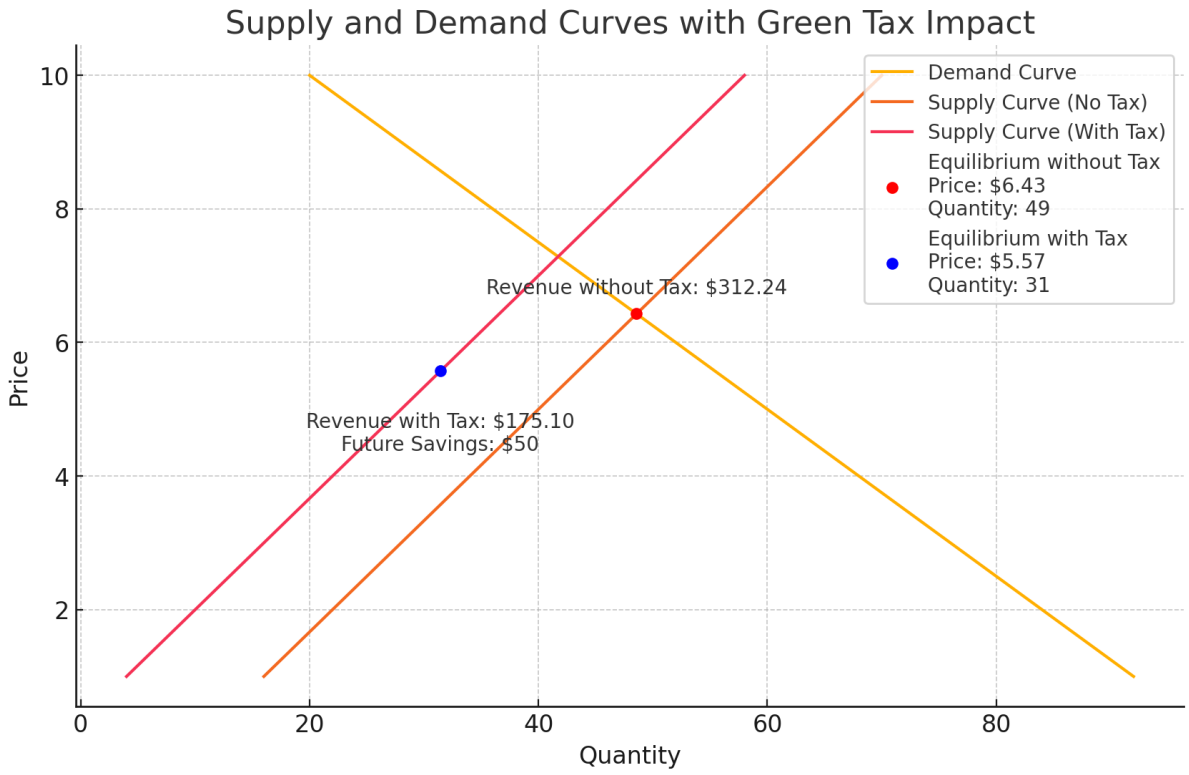
If urban sprawl was evaluated by full cost pricing, meaning that environmental factors were given the monetary value, then urban sprawl would not have any profit at all. Since the extreme depletion of the ecosystem today will account for the scarcity problem in the future, making even the smallest development or usage of the environment services extremely expensive.

Because of aforementioned reasons in 1920, American economist Pigou introduced the concept of Green taxation, which was a monetary punishment towards harmful use of the environment. Therefore, by incorporating the environmental costs of goods and services into their market price, green taxes help to correct market failures that arise from externalities not

traditionally accounted for in economic transactions. This pricing mechanism is essential for reflecting the true cost of environmental degradation and for promoting practices that protect ecosystem services for future generations.

So, instead of big development companies getting subsidies for tax, they should be green taxed. As natural assets of the environment become more limited due to factors like pollution, habitat destruction, and climate change, their value and the cost to replace or restore them rise.

Figure 13. *Green Taxation and Cost-effectiveness*



The graph illustrates the impact of a green tax on supply and demand curves. Without the tax, the equilibrium price and quantity are the red dot where demand meets supply. Introducing a $2 green tax shifts the supply curve left, reflecting higher production costs and reducing supply at each price point. This shift results in a new equilibrium with a higher price and lower quantity. Although the immediate revenue from sales decreases with the tax, the

long-term savings of $50—due to reduced environmental damage and resource scarcity—demonstrate the tax's cost-effectiveness. Essentially, the tax encourages more sustainable practices, balancing short-term economic impact with significant future benefits.

However, the moment harmful use of the environment becomes costly, business models will adjust prices, increase efficiency and switch to more sustainable alternatives. Including full cost pricing in business models will cancel the previously existed notion of profitableness, and make the cost- inclusivity more effective and profitable. Moreover, this will limit urban inequalities, and create more inclusive and sustainable developments.

Besides, for the government, which is paying for the healthcare aid for their citizens, limiting suburban development appears to be also cost effective, since the healthcare problems that arise through the disturbed livelihoods of the citizens cost more money than it was to build cheaper neighborhoods. In total Western Australia's healthcare budget is more than the national average by 20% (Department of Health 2018), which recently increased even more. Since coming to office, the McGowan Government has increased WA Health's annual budget significantly, up 33.4% from $8.8 billion in 2016-17 to $11.8 billion in 2023-24. As well as the Mental Health Commission's annual budget increased by 57.3%, from $863 million in 2016-17 to $1.4 billion in 2023-24 (WA State Budget 2023). As already mentioned, safe and sustainable neighborhoods account for a big portion of physical and mental wellbeing, having monetarily contributed to the infill and ecological development from the budget, it can be debated that it would have decreased healthcare aid for the Western Australian people.

Chapter 5: What Can Be Done

This research has shown that the rapid expansion of Perth's suburbs is harming the environment and creating social issues. This growth, driven by the city's prime location and rich resources, has led to weaker environmental politics which made quick and easy money, but has also widened the gap between different social groups. To address these problems, this chapter suggests several recommendations. These aim to stop the harmful effects of this growth and promote a more inclusive and environmentally friendly approach to urban development in Perth.

a. Sustainable Transportation and Urban Equity. One of the important themes from Chapter 3, which discusses the impact of urban sprawl on accessibility, is the significant distance to educational and healthcare facilities in Perth. This challenge, brought on by expansive urban growth, underscores the necessity for sustainable transportation solutions. Long distances to crucial services like schools and healthcare centers pose a considerable barrier, especially for those residing in the outer suburbs. This situation highlights the broader implications of urban expansion, where the accessibility and equity of essential services are directly affected by the transportation infrastructure and urban planning decisions.

The long commutes required in sprawling urban areas exacerbate mental and physical health issues (see chapter 3). Long travel times not only contribute to increased stress and sedentary lifestyles but also pose significant barriers to accessing essential services. This brings to light the injustices faced by people living in remote areas of the city, who are often disadvantaged in terms of accessing educational institutions and healthcare facilities.

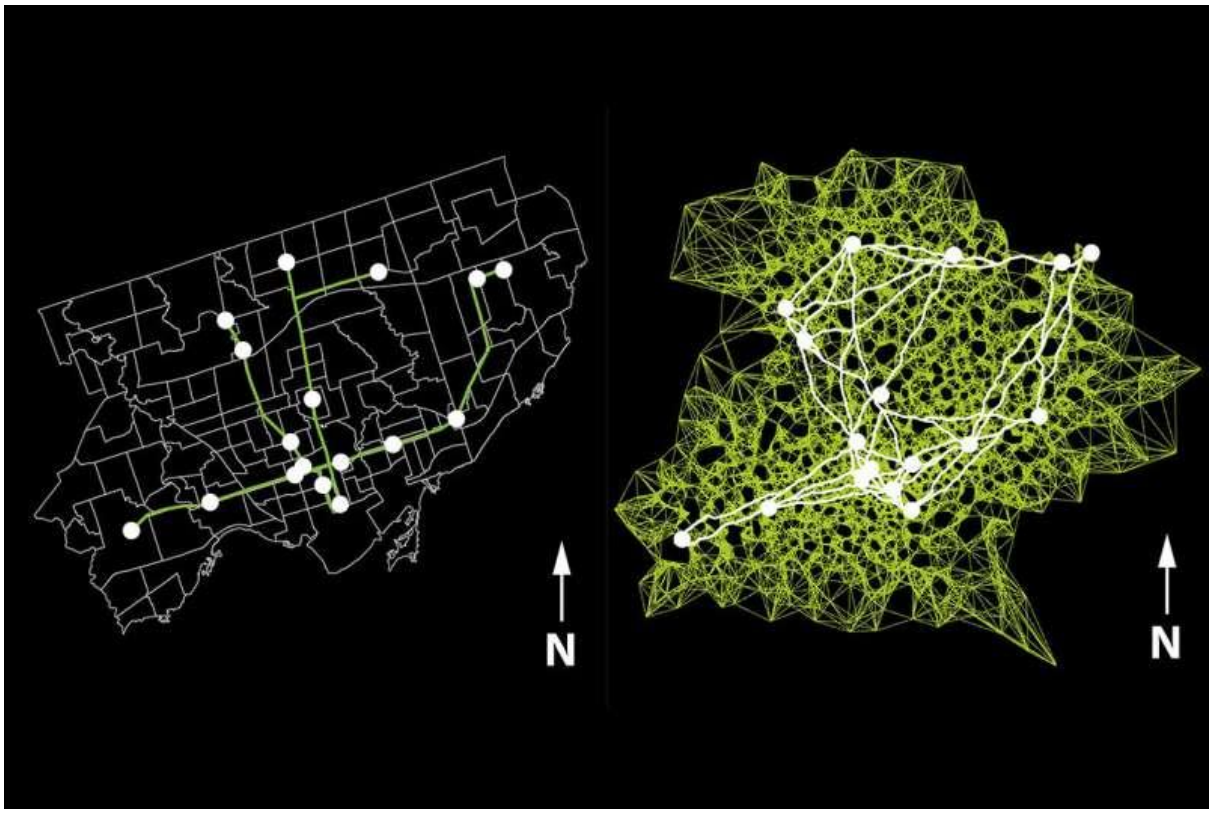
To address these challenges, a complete overhaul of Perth's transportation system is needed. Specifically, the development of an efficient, affordable, and environmentally friendly public transportation system should in theory significantly mitigate these issues. This approach would reduce the reliance on personal vehicles, thereby decreasing carbon

emissions and the overall environmental footprint of urban transportation. In addition to this, an improved public transit system would improve the accessibility of vital facilities such as education and healthcare facilities, ensuring that all residents, regardless of their location, have equitable access to these types of resources.

Furthermore, investing in an improved transportation system is an important step towards reducing the social inequities exacerbated by urban sprawl. By providing accessible public transportation, Perth can promote a more inclusive urban environment, which this research has shown can promote a more inclusive urban environment (Lazer, Khandelwal, and Wellman 2020). In line with this approach, the government's priorities should potentially be adjusted. Rather than extending a northern highway to develop more housing blocks, it would be more beneficial to allocate the proposed 100 million dollars towards implementing a sustainable and future-proof transportation plan, which would improve urban connectivity and show a commitment to sustainable and equitable urban development.

To include biomimicry in Perth’s transportation development, and get the most affordable, efficient and accessible plan, we can use the same method as one of Tokyo's urban planning companies used. Slime molds, brainless, single-celled amoeboid organism that grows as a greenish system of veins. Apparently, these slime molds are able to find the most efficient and fast way from point A to point B in less than 24 hours. Therefore, scientists recreated a mini map of Tokyo, implementing the landscape characteristics and they placed the nutrients those amoeboids would slime to at the main stations all around Tokyo. As expected, the worms found the way to the stations/nutrient points crawling through the exact transportation path that already exists in Tokyo (Irving 2022).

Figure 14. *Slime Worm Tranportation Plan*



What took several dozen years to perfect by Japanese planners, it took under 24 hours for the slime worms. Therefore, using the amoeboids in Perth, would be very insightful to see how they would plan out the most efficient and affordable transportation map.

b. Accessibility Mandates. To improve urban expansion in Perth effectively, one solution is to implement a policy mandating the inclusion of essential facilities and public spaces in all new suburbs. Some of the facilities/spaces that should be considered in this policy are healthcare facilities, schools/educational institutions, parks, emergency services, elderly care facilities, and recreational spaces. These elements ensure equitable access to vital services and amenities, a concern raised in earlier chapters about urban health and social equity.

The importance of accessible healthcare and quality education is self-evident, with schools and healthcare centers being cornerstones of any thriving community. Public parks and green spaces, as discussed in Chapter 1, not only serve as recreational areas but also play

a significant role in maintaining environmental health. The inclusion of public transport hubs is also important, aligning with the previous recommendation to improve the public transportation system, thereby improving accessibility and reducing dependence on personal vehicles. Furthermore, the presence of emergency services is fundamental for a safe living environment. Childcare and elderly care facilities address the needs of the most vulnerable groups in the community, ensuring support and care are accessible and minimizing inequality.

Integrating these facilities into new suburban developments brings several significant benefits. It leads to more self-sufficient communities, where residents have most of their needs met locally. It also reduces traffic congestion and pollution, contributing to a more sustainable urban environment. This plan aims to create a strong community and spirit, and create a livable city where people can easily move around and access what they need.

This policy also promotes a holistic vision of urban development. This is in line with the discussions from earlier chapters that emphasized the need for sustainable and inclusive urban growth strategies. By ensuring that new suburbs are well-equipped with these essential facilities from the outset, this supports a more equitable and sustainable Perth that supports long-term growth instead of short-term monetary gain. If implemented, this recommendation should improve the immediate quality of life for residents and set a sustainable precedent for future urban development.

From the conducted research, I found that Western Australia has the scarcity of hospital beds. The research also showed that on average in one month, hospitals have around 100 bed shortages and 56 times declared code yellow, which means infrastructure and other internal emergencies in Australian hospitals (Metlam 2022). It is evident that on top of lacking hospitals, in suburban areas, even when there are hospitals, those experience overcrowdedness and shortages, stressing the doctors and other patients. However, there is no

law or mandate that will require a calculated minimum of hospitals or beds in the hospitals per neighborhood, moreover, there is no such mandate anywhere around the world that will ensure the equality and human right justice for healthcare users. However, as it is considered a human right and a common sense, some developments simply overlook the need. Therefore, if Australia is the first country to implement mandates for minimum hospitals in the close proximity to the neighborhood, they will set an international standard and become the pioneers of human rights preservation.

c. *Reforming Housing and Urban Development Policies.* The failure of Western Australia to meet its target of 47% infill development, as discussed in the 'Policies That Kill' section, highlights a critical area for policy reform. The continued support for urban sprawl, exemplified by the 2020 COVID-19 recovery incentives and the extension of northern highways, has prioritized and encouraged development in new, undeveloped areas over inner-city transit and public transport by popularizing the affordability of new developments and subsidizing the infrastructure taxes for the suburb developers. This policy direction has not only encouraged residents to live further from city centers and public transport but also exacerbated urban sprawl issues. Therefore, a significant policy recommendation is the reversal of these trends by focusing on infill development and sustainable urban growth.

This policy change involves revising the current medium-density codes, which have been indefinitely deferred, causing uncertainty and hindering sustainable development projects. The new medium-density codes, designed to improve design standards and promote diverse housing types while preserving essential urban elements, need to be implemented without further delay. The concerns over cost escalations and their potential impact on housing affordability should be addressed through a balanced approach that does not compromise environmental sustainability and urban design quality (Reid 2023).

Moreover, the establishment of a 'green lane' for medium-density projects, as suggested by sustainable developer Kate Fitzgerald, could expedite the approval process for sustainable and high-quality projects. This would create a more level playing field for developers focused on sustainable and medium-density projects, countering the current bias towards easier and more cost-effective greenfield developments. Such a reform would not only support the state government's target for infill housing but also enhance the environmental sustainability and overall urban design of Perth.

Values that include the future wellbeing is not enough to attract developers and make the government policy makers stricten their laws. As mentioned in Chapter 4: *Cost-effective is New Profitable* section, for long term development and bypassing the future scarcity problems, it is more cost effective to set green taxes and restrictions as soon as possible. Having taxes will ensure that in the future the resources which are so abundant right now, such as fresh water, clean air or good quality of soil, will still exist and sustainable development will still be possible. Because of tax it is anticipated to have higher production costs today, meaning higher prices, lower quantity and lower revenue. However, over long term the savings are prognosed and moreover, reduced environmental damage and avoidance of scarcity show how much more cost effective it is to have the restrictions and taxes today than pay for them triple in future.

d. Zoning and Land Use Policy. Besides focusing on infill development over new suburban projects, new policies regarding biodiversity protection should be enacted to protect culturally and biologically important flora and fauna. A similar policy exists in the Eastern part of Australia, specifically in New South Wales and Queensland. The regulations that aim to protect endangered Koalas, have mapped 714,040 hectares of koala habitat, including over 332,278 hectares classified as koala priority areas where development is prohibited. These regulations are part of the broader South East Queensland Koala Conservation Strategy

2020–2025 (Queensland Jurisdiction 2009). The strategy also includes funding and initiatives to protect koalas, such as habitat conservation and rehabilitation efforts for already damaged suburban and rural lands.

Another example of zoning and land use policy is the Environment Protection and Biodiversity Conservation Act of 1999 (EPBC Act), that ensures that animals, plants, habitats, and places of national significance are clearly identified. It mandates that any potential harmful effects on these important environmental animals or features are thoroughly evaluated before approving any land use changes or new development projects (EPBC Act 2023). However, unfortunately, many of Western Australia's lands are not protected or listed in the EPBC guidelines. Moreover, EPBC guidelines are responsible for avoiding present damages from the adverse land use, however, they do not incorporate future effects they will cause by changing the landscape, which is the nature of urban sprawl's consequences.

If Perth, under Western Australian jurisdiction, develops a similar strategy to conserve biodiversity of Perth's metropolitan area, then suburban sprawl will be more or less controlled, and the cultural importance of specific animals and sacred lands will be maintained.

e. Deliberative Democracy for Smart Growth. Adopting a "deliberative democracy approach", can be a fair and effective way to address the controversies surrounding urban sprawl and smart growth (Resnik 2010). This involves sponsoring open community forums, public debates, and meetings to share information and come to a mutual understanding. This ensures that all stakeholders, especially those with limited political influence, have a say in the urban planning process. This recommendation ties back to emphasizing the importance of inclusive and informed decision-making in urban policy.

One of the key strengths of this method is its inclusivity. It ensures that voices from all corners of the community are heard, especially those who traditionally have less say in

political matters. This could include local residents, small business owners, environmental activists, Aboriginal peoples, or others who are affected by urban planning decisions. Through this, participants would be able to voice their concerns and ideas and also gain a better and fuller understanding of the various aspects that need to be considered in potential future urban planning projects.

f. *Aboriginal Protection and Inclusion.* Channeling the recommendations given by Mrs. Mia Tucker, a member of the Wiluna Aboriginal Corporation, who I interviewed in Chapter 3, I wanted to stress out the importance of several changes that need to be addressed through policy making. First of all, acknowledge the Aboriginal Australian culture and integrate the sacred locations and meaningful animals and plants in the EPBC Act for land use policies to preserve their traditions and values. Second of all, after creating a detailed list of Aboriginal livelihoods, create a buffer zone between their spaces and new developments that might disturb their living. Additionally, build healthcare and educational institutions in close proximity (accepted distance by the mandate) to increase their accessibility. As Mrs. Tucker mentioned, without ready access to these institutions, their children miss out on the benefits of educational programs which contributes to a cycle of disadvantage, affecting future career prospects and economic inequalities. Additionally, it is important to have an aboriginal history integrated into the syllabi, which will expand the knowledge of all Australian kids on their countries first settlers. This program will also have community-based education that is culturally relevant and will mitigate the rupture of non aboriginal and aboriginal communities.

Thirdly, ameliorating the transportation plan with more connectedness and affordability to ensure aboriginal communities integration in urban life. This will most efficiently be possible if the urban development department will have Aboriginal members as their consultant to better understand the needs of marginalized communities. Moreover, this

example should be also shared on other levels of the government, so that the inhabitants of Western Australia have equal representation in policy making and decision process.

Policies and politics leave an unerasable mark on past and future. Perth, a city of goldmines and industrial development, was formed as the most isolated and fast growing city of the world. Abundant in an exceptional variety of animals, plants and landscapes, Perth has the potential to become a model of sustainable and innovative growth, following the example of their first settlers that took care of the land for tens of thousands of years.

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