

Managing Green-Burbia: Utilising Urban Management Practices to Address the Urban Heat Island as a Call to Adapt to Climate Change Impacts - the Case of Melville in Johannesburg.



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Abstract

Suburban areas are considered major contributors to the Urban Heat Island Effect (UHIE) and climate change due to their high consumption levels. This has a greater impact on lower-income communities than suburbia. This research report argues the City of Johannesburg lacks alignment between climate change policies and requires looking at an urban management model to resolve this. This research investigates the best way for suburbs to reduce their impact on the UHIE through urban management practices and tools to help streamline it into policy. Residents responded to an online questionnaire, sent through social media sites, on the UHIE and how they have adapted to its effects. The results indicate knowledge of the UHIE and climate change influence a resident's chances of implementing adaptation measures. An urban management model incorporating the needs of residents will require inclusive, participatory and resilient characteristics.

Keywords: Urban heat island, urban management, suburbia, climate change adaptation

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Table of Contents

Abstract	1
Acknowledgements.....	1
List of Figures	5
Table of Tables	6
List of Acronyms.....	7
Chapter 1 – Introduction	8
1.1 Introduction	8
1.2 Background	9
1.3 Problem statement	12
1.4 Research Question	13
1.5 Sub-questions.....	13
1.6 Aim of the study.....	14
1.7 Expected findings	14
1.8 Key concept definitions.....	14
1.8.1 Urban Heat Island	14
1.8.2 Urban Management	15
1.9 Chapter outlines.....	15
Chapter 2 – Literature Review	16
2.1 Introduction	16
2.2 Conceptual Framework.....	16
2.3 Causes of the Urban Heat Island.....	17
2.3.1. Urban geometry	17
2.3.2. Urban cover	17
2.3.3. Urban vegetation.....	18
2.4 Global urban management approaches	19
2.4.1 Traditional Management Approach	19
2.4.2 Market-based management approach.....	20
2.4.3 Humanistic management approach	21
2.4.4 New Urbanisation management approach	21
2.5 Urban management tools for urban heat island reduction in suburbia.....	22
2.5.1 Urban Acupuncture	22
2.5.2 Tradeable Permits	23
2.5.3 Urban Ecosystem Modelling.....	23
2.5.4 Strategic Environmental Assessment (SEA).....	24

2.5.5 Retrofitting Suburbia	24
2.5.6. Co-Production of knowledge.....	25
2.6 Mapping of Policy Misalignment	25
2.6.1 Paris Climate Agreement.....	26
2.6.2 Sustainable Development Goals (SDG)	26
2.6.3 National Climate Change Response White Paper (NCCR)	27
2.6.4 National Climate Change Adaptation Strategy (NCCAS)	28
2.6.5 Joburg 2040: Growth Development Strategy (GDS).....	28
2.6.6 Integrated Development Plan 2016-2021 (IDP)	29
2.6.7 Climate Change Adaptation Plan (CCAP).....	30
2.6.8 Climate Change Strategic Framework (CCSF)	31
2.6.9 Environmental Sustainability Strategy and Action Plan (ESSAP).....	32
2.6.10 Policy Misalignment Review.....	34
2.7 Conclusion.....	35
Chapter 3 - Research Methods.....	36
3.1 Introduction	36
3.2 Research Design	36
3.2.1 Qualitative Research.....	36
3.2.2 Case Study	37
3.2.3 Sampling Techniques.....	37
3.2.4 Sampling Population.....	37
3.3 Research Instruments	38
3.3.1 Spatial Mapping and Observations	38
3.3.2 Online Questionnaire	38
3.4 Study Limitations.....	38
3.5 Ethical Requirements	39
Chapter 4 - Contextualisation	40
4.1 Introduction	40
4.2 Demographics	41
4.3 Case Study.....	43
4.4 Johannesburg Urban Management Model.....	49
4.5 Conclusion.....	52
Chapter 5 – Findings and Analysis.....	53
5.1 Introduction	53

5.2 Sample of Interviews.....	53
5.3 Household Experiences.....	53
5.3.1 The impact of the UHIE on Melville.....	53
5.3.2 Changes made by residents to adapt to impacts of the UHIE.....	56
5.3.3 How urban management practices reduce the UHIE in the CoJ	63
5.4 The New Urban Management Model	66
5.5 Key Components of the New Model.....	66
5.5.1 New Relationship Between Stakeholders	68
5.5.2 Tools Tackling the UHI	68
5.5.3 Urban Management Principles.....	69
5.6 Conclusion.....	70
Chapter 6 - Conclusion and Recommendations	72
6.1 Introduction	72
6.2 Summary of findings	72
6.3 Re-evaluating the Research Questions	73
6.3.1 How the CoJ Understands the UHI.....	74
6.3.2 How the CoJ Integrated the UHIE into Policy.....	73
6.3.3 The Impact of the UHIE on Melville.....	74
6.3.4 Changes Made by Melville Residents.....	75
6.3.5 How Urban Management Practices Reduce the UHIE in Melville...	75
6.4 How the model addresses the main question	75
6.5 Discussion.....	77
6.5.1 Implications for Scholarly Work	77
6.5.2 Implications for the Future of Planning.....	78
6.6 Opportunities for an Improved Melville	79
6.6.1 UHIE Adaptation Changes in Melville.....	79
6.7 Suggestion for Further Research	82
6.8 Concluding Remarks.....	82
Reference List	84
Appendices	95
Appendix A – Plagiarism Declaration	95
Appendix B – Ethics Clearance	96
Appendix C – Questionnaire	97

List of Figures

Figure 1.1: Average temperatures of the CoJ from 2010-2020	10
Figure 1.2: Visualisation of the UHI in the CoJ.....	11
Figure 2.1: Conceptual framework.	16
Figure 2.2: Timeline of climate change policy influencing the CoJ.....	26
Figure 2.3: Relationship between departments	32
Figure 2.4: Matrix of policy influence on UHI mitigation and adaptation.....	34
Figure 2.5: Misalignment between important climate change policy impacting the CoJ.	35
Figure 4.1: Contextualisation of Melville in South Africa.	40
Figure 4.2: The layout of Melville	40
Figure 4.3: Demographics of Melville.....	43
Figure 4.4: Green open spaces in the surrounding region of Melville.	44
Figure 4.5: Tree coverage seen throughout Melville.....	47
Figure 4.6: Slope analysis of Melville	47
Figure 4.7: Land uses found in Melville.	48
Figure 4.8: Heights of buildings in Melville.....	49
Figure 4.9: Roof types and materials in Melville.	50
Figure 4.10: Colour of roofs in Melville	50
Figure 4.11: Changes and opportunities occurring in Melville.....	51
Figure 4.12: Current Urban Management model in CoJ.....	52
Figure 5.1: Temperatures from 1 January – 24 October in 2019 and 2020	55
Figure 5.2: A summary of the effects felt by residents associated with the UHI.	56
Figure 5.3: UHIE sources in homes from respondents.	57
Figure 5.4: Presence of environmentally-friendly concepts in the households of Melville.	59
Figure 5.5: Physical changes made to the dwelling by respondents.....	62
Figure 5.6: Ideas brought forward by residents for new policy	65
Figure 5.7: New urban management model.....	67
Figure 6.1: Changes that bring design principles into play.....	81
Figure 6.2-6.5: Retrofitted dead-ends	82
Figure 6.6-6.9: Retrofitted corner of 7 th Street and 4 th Avenue	82

Table of Tables

Table 1.1: the effects that the UHI can have on surrounding communities.	10
Table 2.1: How the CoJ is responding to ensuring environmental sustainability.	30
Table 4.1: Alignment of urban management model ideals in climate change policies.....	51
Table 5.1: Responses to the effect of climate change felt by residents of Melville.....	53
Table 5.2: Classification of understanding for the UHI.....	54
Table 5.3: Correlation between changes made and understanding of climate change.....	61
Table 5.4: Reasoning for changes made to dwelling.	62
Table 5.5: Whom the main stakeholder ought to be in UHI mitigation	63
Table 5.6: Recommendations on a new plan, strategy or program by residents	66
Table 5.7: Overlapping characteristics of proposed urban management approaches.	67
Table 5.8: Overlapping approaches of new urban management model.....	70

List of Acronyms

CBD – Central Business District

CCAP – Climate Change Adaptation Plan

CCN – Cool Cities Network

COP21 – Paris Climate Agreement

CCSF – Climate Change Strategic Framework

COJ – City of Johannesburg

DA – Democratic Alliance

DPD – Development Planning Department

EIA – Environmental Impact Assessment

EISD – Environment and Infrastructure Services Department

ESSAP – Environmental Sustainability Strategy and Action Plan

GDS – Growth Development Strategy

GHG – Greenhouse Gasses

HWRP – Heatwave Response Plan

IDP – Integrated Development Plan

LST – land Surface Temperature

NCCAS – National Climate Change Adaptation Strategy

NCCR – National Climate Change Response White paper

PPP – Public-Private Partnership

QoL – Quality of Life

RSDF – Regional Spatial Development Framework

SDG – Sustainable Development Goal

SEA – Strategic Environmental Assessment

UHI – Urban Heat Island

UHIE – Urban Heat Island Effect

UNFCCC – United Nations Framework for Climate Change

WWF – World Wide Fund for Nature

Chapter 1 – Introduction

1.1 Introduction

The City of Johannesburg (CoJ) has seen a rise in policies associated with sustainable development and the natural environment. The Policy Coordination Progress Report, states the total number of policies aligned with sustainable development and environmental sustainability amass to 241 (City of Johannesburg Mayoral Committee, 2019). However, the lack of integration between policies due to differences in terminology, objectives, targets and responses has limited the application of sustainability goals. Furthermore, the incorporation of the Urban Heat Island (UHI) into policy is overlooked and acknowledged in only 2 policies. The CoJ urgently needs to streamline the UHI into policy and link it to sustainable development practices and climate change mitigation.

The role of stakeholders in adapting to the Urban Heat Island Effect (UHIE) is widely debated. Brooks and Adger (2005) argue local governments and urban planning bodies should be in charge of resolving climate change-related issues, whereas Williams *et al.* (2012) believe local governments need to take charge while collaborating with residents and developers. Establishing the correct network of stakeholders for adapting to UHIE is part of the urban management domain. Urban management practices often called upon include retrofitting and co-production of knowledge, however, additional practices include urban acupuncture, strategic environmental assessment, tradeable permits and urban ecosystem modelling.

Suburban neighbourhoods are regularly associated with urban sprawl and population growth (Mabin *et al.*, 2013). The nature of suburbs varies with characteristics and variables including age, street orientation, micro-climate, street layout, location, access to services and proximity to public transport (Williams *et al.*, 2012). The same variables impact the natural environment in an assortment of manners. Kahn (2000) argues that regardless of the variables involved, suburbia will always be associated with negative environmental outputs. The negative impact of suburbia on the natural environment is creating long-term effects on city dwellers by directly impacting human behaviour and the natural environment.

The purpose of this research is to develop a model implementable by the CoJ for the integration and streamlining of UHIE adaptation into policies utilising urban management practices. An assessment of the UHIE in the CoJ, and specifically in Melville will be made.

This will be followed by an investigation into the appropriate urban management practices required to reduce the impact of the UHIE in the suburb of Melville. The conclusion allows for the creation of a strategy tackling the specific problems associated with the UHIE in Melville and provides a design supporting it.

1.2 Background

The additional population is affecting migration patterns into major cities where economic prosperity is believed to be stronger. The socio-economic conundrum facing urban planners and managers is immense. However, the equally important environmental dilemma cannot be overshadowed. Land degradation, biogeochemical cycle breakages and biodiversity loss are direct effects of urban sprawl and have an impact on how heat is dealt with in urban environments (Scholes *et al.*, 2018). According to Todes *et al.* (2018), the CoJ is one of a handful of major physically densifying cities around the world. However, many middle-to-high-income suburbia do not contribute to the densifying nature of the CoJ. This is partly due to the Regional Spatial Development Framework (RSDF) which negotiated minimum lot sizes, reducing the ability to convert to dense forms and the provision of additional units in the future. This lack of densification ensures the continuation of urban sprawl but similarly allows for additional greenery in the form of street trees and backyards. Therefore, to reduce the UHIE, suburbs must be made a priority for **policy** intervention.

The 'city temperature effect' was first discovered by English chemist Luke Howard in 1833. Howard surveyed three sites outside London and took daily temperatures, doing the same with one site in the city centre and found sites in the peripheries have a cooler overall temperature (Stewart, 2019). Although this study is not focused on identifying the existence of the UHI, the history of studying UHIs remains important. According to Stewart (2019), recent studies' poor knowledge of UHI history has limited the growth of knowledge in urban climatology. Experience of historical methodologies and gaining access to historical work are cited as the best methods of ensuring similar mistakes are not made.

Today the effect of the UHI is stronger and at times visible due to the associated air pollution. The UHI thus has numerous influences ranging across social, economic and environmental dimensions (see table 1.1). The nexus of effects arising from the UHI requires careful integration into climate change adaptation and mitigation policy as the increasing

danger of exacerbating effects will become reality (Musco *et al.*, 2016). The social and economic impacts further embrace the need for planning and management of urban spaces.

Table 1.1: Effects UHIs have on communities (Sources: ARUP, 2014; City of Johannesburg, 2009).

Environmental	Social	Economic
Pollution dome (poor air quality)	Heatstroke	Increased energy usage
Land degradation	Cardiovascular disease	Increased water usage
Loss of biodiversity	Respiratory conditions	Peak demand increased
Over-reliance on biogeochemical cycles	Death	Increased infrastructure costs (urban sprawl)
Micro-climate changes	Pregnancy complications	Carbon emissions rise
Higher aquatic temperatures	Kidney malfunctioning	Private transportation (fuel, insurance, maintenance)
Ecosystem damage	Discomfort	Drop in Efficiency and GDP
	Exhaustion	

The CoJ indicates that increases in extreme weather cases are likely to intensify, with heat and rainfall their biggest concern (CoJ, 2015). The trendline with a change in heat below in figure 1.1 exemplifies the CoJ's growing temperatures. The average temperatures taken by World Weather Online (2020) has drawn a trendline from the January base points. The years 2015-2020 especially show a surge in increased temperatures proving the likeliness of extreme weather occurrences feared in 2009 by the CoJ. The rapid change visible in only the last 10 years calls for urban management and planning to reduce the urban heat levels.

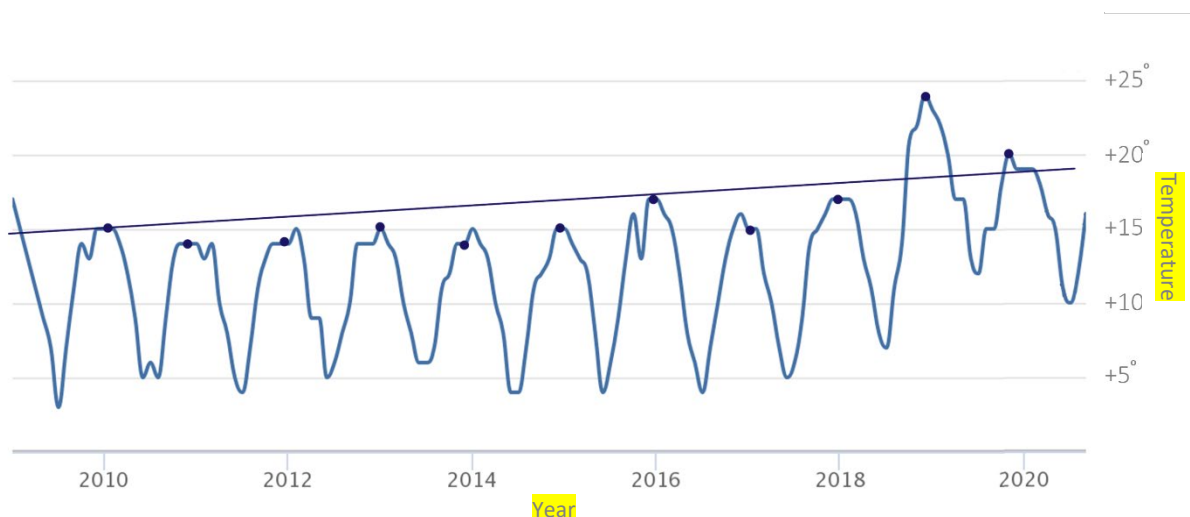


Figure 1.1: The average temperatures for a diurnal cycle of the CoJ between 2010-2020 show the growing trendline based on January temperatures (Source: World Weather Online, 2020).

Figure 1.2 below outlines the excess of heat in the northern suburbs and Central Business District (CBD) through the prominent red shades seen in these locations (Hardy and Nel, 2015). The UHI of the CoJ is directly caused by what Arnfield (2003) calls anthropogenic heat

and net solar radiation absorption. This is regardless of the urban canopy which is estimated to consist of 6-10 million trees and is most prolific in the northern suburbs (Johannesburg City Parks and Zoo, 2007). The associated impacts of the sprawling suburbs, vehicular traffic and private transport are easily identifiable in suburbs. The middle and high-income suburbs are associated with higher consumption levels, access to better technology, and amenity (Davoudi *et al.*, 2009). The CBD rather faces heat caused by the lack of greenery, traffic, the mine belt to the south, urban surfaces and tall structures. The location of Melville is thus interesting as it is classified as a suburb while located within a 5km radius from the CBD. Melville shows signs of the UHI aligning with the findings of Hardy and Nel (2015) whereby suburbs have a warmer temperature when compared to the surrounding areas.

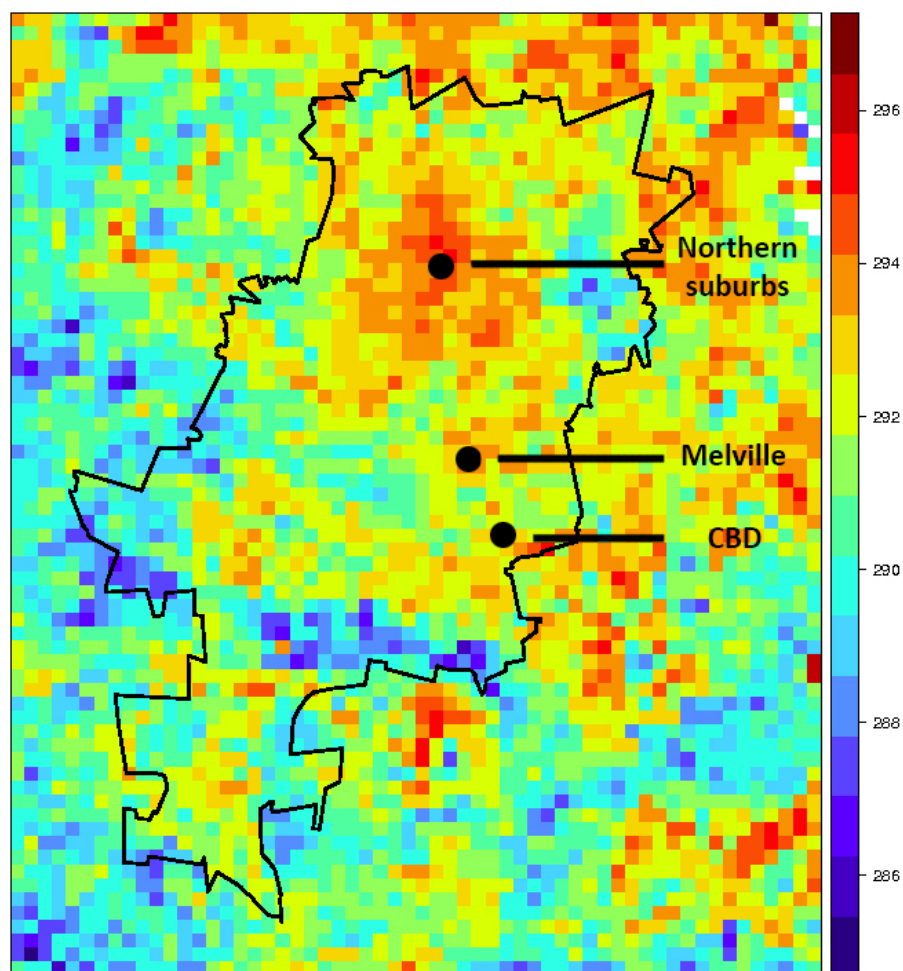


Figure 1.2: Visualisation of the UHI in the CoJ illustrates the northern suburbs and CBD as main centres of heat (Source: Hardy and Nel, 2015:204).

1.3 Problem Statement

In my Urban and Regional Planning Honours thesis, I found affluent areas are being prioritised when it came to the provision of services; most notably in terms of parks and green infrastructure (Elbertse, 2019). This was due to political pressure on the Democratic Alliance (DA) to retain its position of power (*ibid*). The middle and high-income areas are often associated with voting for the DA. This is seen in ward 69 (containing Melville) where 59.28% of the local election votes were for the DA (IEC, 2016). The succumbing to political pressure sparked an interest in the level of equitable prioritisation given to dealing with climate change.

Regardless of whether affluent suburbs are being provided with a greater frequency of maintenance and services, suburbs are not key focus areas in policy when it comes to climate change and UHI mitigation. Therefore, suburban areas are not being coerced into adapting to climate change. This is problematic as high consumption levels, private transport usage and waste-heat created are exacerbated in low-income communities. This problem could be avoided as climate-change mitigation policy is becoming more detailed, for which the CoJ must be commended, but lacks any contextual implementation ability at the smallest scale and excludes suburbia.

The physical condition of suburbia is a concern due to their ageing characteristics, especially closer to the CBD. Buildings older than 60 years old require heritage permits when implementing physical changes. Additionally, infrastructure in place was not designed to deal with greater densities if those are ever to be proposed. Any changes made are thus likely to be at a private scale and incremental at most. Furthermore, proposed changes are likely challenged if the aesthetics of the neighbourhood is compromised or if there are economic repercussions. Therefore, bringing change to a suburb like Melville poses its challenges.

Although sustainability principles are now found in 241 policies across the CoJ, the link between urban managers and climate change adaptation is limited. This is because urban managers are reliant on major policies like the 2040 Growth and Development Strategy (GDS), Integrated Development Plan (IDP), and Spatial Development Framework (SDF) which have no focus on suburbs. This is due to the socio-economic development, poverty reduction, and historical injustice repairing objectives seen across IDPs. Urban management

focus on specific projects when the desired result is not achieved, the performance of a policy is limited or policy is not being enforced in a satisfactory manner (CoJ, 2013). The need for environmental, climate change and UHI projects needs to be enforced to ensure urban management steps in when required and policies and projects are given a greater possibility of success.

The CoJ is aware of the heat-related problems expected to increase with time. Therefore, the Heat Wave Response Plan (HWRP) was highlighted as a key priority in 2009, however, this is yet to be completed and implemented. This has repercussions on the resilience of the CoJ when heatwaves occur and the UHI intensifies. Additionally, the focus of the HWRP is disproportionately based on social aspects rather than economic and environmental. The HWRP is designed to deploy resources and inform communities on extreme heat events while its main use is for the Johannesburg Water and City Power to implement any changes where necessary. The problem, therefore, lies in the lack of ability for suburbia to reduce UHIE as policy lacks inclusivity towards both factors regardless of being prominent actors in climate change.

1.4 Research Question

“How could the CoJ streamline the concept of UHIE in its policies and urban management practice to adapt Melville to the effects of climate change?”

The main question I ask is how the CoJ can implement the concept of the UHIE into its current and future policies. This further asks how affluent areas, which are part of the cause, can be integrated and aligned into these policies. This question will help find the best methods urban management in the CoJ can implement any required changes and have an impact on the reduction of the UHI.

1.5 Sub-questions

To break down the research question, 5 sub-questions allow for an easier understanding of the question and provide further detail.

- How does the CoJ understand the UHI?
- How has the CoJ integrated the concept of the UHIE in policy as a response to climate change?
- What is the impact of the UHIE on the suburb of Melville?

- What changes have Melville residents made to adapt to the impacts of the UHIE?
- How could urban management practices help reduce the UHIE in the CoJ using Melville as a case?

1.6 Aim of the Study

Global rising temperatures coincide with locations of high population growth. “Warming and extreme heat events due to urbanisation and increased energy consumption are simulated to be as large as the impact of doubled CO₂ in some regions” (McCarthy *et al.*, 2010:1). The heat caused by urbanisation is causing the human and natural environment to reduce its natural resilience and adapt to slow oncoming changes.

The aim of this study is thus threefold: Firstly, to explore the level at which the UHIE has been integrated into policy. By understanding the political landscape in which the UHI finds itself, the perception of the UHI by the CoJ can be analysed. This includes the definition, causes, consequences and methods of mitigating. Secondly, this study has singled out the suburb of Melville. The aim is to find the level of adaptation and mitigation Melville has undergone and what future adaptations are being made. Figuring out if suburbs are capable of change and what level of assistance they require in the future plays a large role in this. Thirdly, I aim to identify efficient urban management practices to be used in tackling the UHIE in suburbia like Melville. These will be implemented in a new model aiming to bring alignment to climate change policy in the CoJ.

1.7 Expected Findings

The assumption is made that UHI integration into climate change policy is minimal.

Furthermore, any alignment between policies and strategies is currently lacking. In Melville, I expect adaptations to UHI not to extend further than the greening of backyards and front yards. Residents are likely to have felt the effects of UHI and climate change but may not understand these as UHI side effects. I further expect the integration of needs from Melville residents into a future strategy to be difficult to align with the current policy as the contextual nature of each suburb will vary.

1.8 Key Concept Definitions

1.8.1 Urban Heat Island

The UHI is universally understood as urban areas consisting of higher air and surface temperatures than in surrounding rural, natural or green areas caused by anthropogenic

waste (United Nations Environmental Program, 2020). Man-made surfaces are known to absorb rather than reflect incoming solar radiation, the combination of this with emissions from combustion engines, appliances and heat waste products cause urban areas to heat up more than the surrounding rural areas. The definition provided by the CoJ (2009:94) aligns itself with this general understanding and defines the UHI as a “metropolitan area which is significantly warmer than its surrounding rural areas. The temperature difference usually is larger at night than during the day and larger in winter than in summer and is most apparent when winds are weak.”

1.8.2 Urban Management

Urban management is argued to be the process of designing and maintaining an environment requiring people to work together (Chakrabarty, 2001). Additionally, urban managers must deliver infrastructural services while implementing and designing spatial strategies or programs to improve the economic, social and environmental development of areas (McGill, 1998).

1.9 Chapter Outlines

This report will be organised into 6 chapters. Chapter 1 consists of the introduction to the report and outlines the problem and objectives. Chapter 2 comprises the literature review. This will entail reviewing international scholarly publications on the definitions, arguments and debates surrounding the UHI and how their theories plan to address these problems. Chapter 3 will outline the research methods. This chapter will discuss the research design, instruments used, sample sizes and techniques, ethical considerations and limitations. Chapter 4 will contextualise the CoJ and the case study of Melville through detailed analysis and discussions. Chapter 5 entails the findings and analysis from the engagements with respondents, spatial mapping analysis and policy reviews. Chapter 6 concludes the report and reviews the key findings from the report and provides the implication for planning. Recommendations for the future will also be made to conclude the study.

Chapter 2 – Literature Review

2.1 Introduction

Chapter 2 consists of the literature associated with the understanding of the UHI and its effects. Additionally, the current urban management methods in the CoJ are summarised and analysed. The relationship between suburbia, urban management and UHIs is stressed and clarified. The literature below will help to unpack how the UHI can be challenged by utilising urban management methods within suburbia. The misalignment of policy is highlighted in this chapter and builds the framework for developing a new model.

2.2 Conceptual Framework

The UHI and suburbia are situated in a cycle continuously exacerbating effects as time continues (see figure 2.1). Causes of the UHI through anthropogenic output of suburbia is strengthening the UHIE and simultaneously increasing the consequences felt. Removing suburbia from this cycle would not get rid of the UHI but reduce its consequences. It is, therefore, important suburbia is kitted with the correct tools to adapt to climate change and the UHI inter alia policy. Intervening in this cycle is the incorporation of new urban management practices and tools that help ensure climate change adaptation policy is completely aligned slowing the cycle. The introduction of urban management tools and approaches to redefine the urban management model will provide the tools for adaptation and further align climate change policies interfering in the continuation of the cycle.

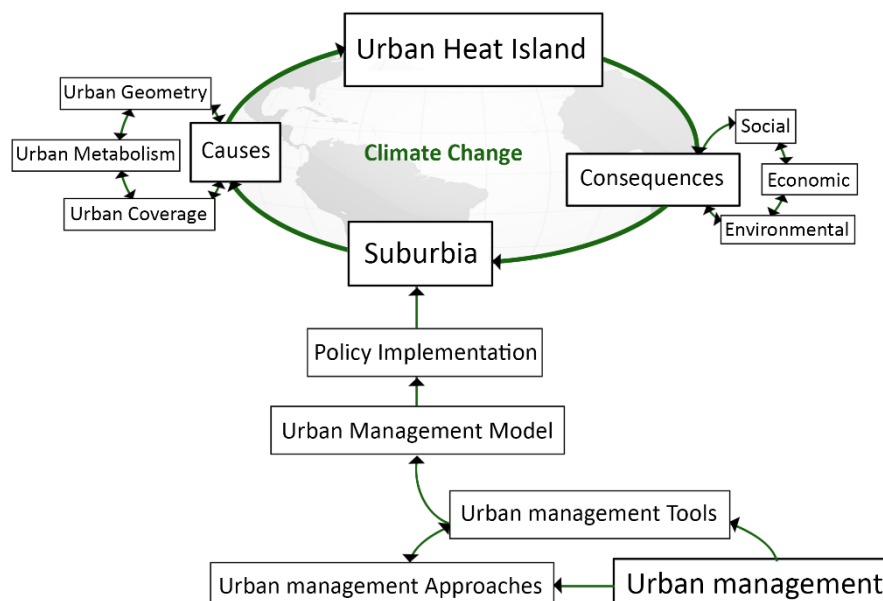


Figure 2.1: Conceptual framework to reduce the UHI in the CoJ through urban management.

2.3 Causes of the Urban Heat Island

The existence of UHIs is circumstantial. Contexts of cities vary and, therefore, have different contributing factors. Regardless of geography and micro-climates, numerous scholars agree with Oke (1988) on three major contributing factors of the UHI being urban geometry, urban cover and urban vegetation. Rapid changes in urbanisation, urban sprawl, growing populations, increased anthropogenic energy wastage and increased demand and consumption of goods are placing pressure on how urban geometry, urban cover and urban vegetation are designed, planned and managed (Mohajerani *et al.*, 2017).

2.3.1. Urban Geometry

Urban geometry is based on the physical layout of a city's ability to alter the orientation of shade and wind impacting its surroundings (Jamei *et al.*, 2016). Any shadow which is specifically designed to reduce the heating within an area can be determined through street orientation (*ibid*) or the compactness index (Emmanuel and Fernando, 2007).

Street orientation describes the angle and direction along which streets are aligned. This represents the amount of sun a street will receive and impacts the direction of shade. In the southern hemisphere, north-facing structures are proven to reduce the thermal impact of and on these buildings (Knowles and Berry, 1980). Additionally, Sanusi *et al.* (2016), found East-West streets to be cooler as tree coverage cooled the street by 2.1°C rather than 0.9°C on North-South facing streets in Melbourne, Australia. To apply street orientation designs to Johannesburg's suburban areas, buildings ought to be North orientated for energy reduction purposes, whereas, streets need to be planned along an East-West trajectory.

The compactness index refers to the impact the shape of a building has on the surrounding temperature (Bekkouche *et al.*, 2013). The idea is to reduce the number of surfaces on a building receiving solar insolation, whereas the volume of the building remains the same. Therefore, the required energy for cooling or heating is reduced (*ibid*). Although this is an architectural approach to reducing the UHIE, urban planners have a say in the decision-making of the typology of buildings, the number and density of erven, and subdivisions as the call for greater densities increases (Boyko and Cooper, 2011).

2.3.2. Urban Cover

Urban cover refers to all surface materials and looks at the texture, colour, distribution and transparency of these to see how these affect the absorption of heat (Lehmann and Sharifi,

2014). According to Gu and Li (2018), the most common method in understanding urban surface cover and its impact on the UHIE is through the albedo effect and emissivity.

The albedo effect refers to the reflective nature of surfaces. The reflection of incoming solar radiation allows for a cooler material which in turn promotes cooler land surface temperatures (LST) (Morini *et al.*, 2018). Although albedo is contextual in its ability to reduce the heat, in a study by Morini *et al.* (2018), creating an albedo of 0.8 (1.0 being completely reflective and 0.0 completely absorbing all solar radiation) reduces the temperatures by 2.5°C. Additionally, the age of materials is important for the maximisation of albedo, arguing the albedo effect is strongest in the first few years of its production before the life cycle starts to impact its abilities. Therefore, constant management of these surfaces is required to keep the albedo effect maximised especially in older suburbia like Melville where the infrastructure is ageing.

Emissivity is described as the ability of surfaces to emit heat. Emissivity is similarly measured to albedo with measurements between 0-1, 0 being no absorption and 1 complete absorption. The lower the emissivity, the lower the LST will be (Mohamed *et al.*, 2017). The higher the albedo, the lower the emissivity as most incoming solar radiation is reflected. In Ecuador, Torres-Quezada *et al.* (2019) concluded a study proving emissivity had a greater impact on the UHI than the albedo effect. This study was held in a suburb where 70% of the buildings are one-story tall and roofing consists of lightly coloured steel plates. The emissivity of roofs older than 5 years old was found to be at 0.65 compared to the 0.12 when newly implemented. The findings from this research argue temperatures increase by 6°C with such conditions and must be taken into consideration for Melville.

2.3.3. Urban Vegetation

Urban vegetation is based on the level of the natural landscape visible in the urban environment and the effect this has in reducing surface temperatures (Lehmann and Sharifi, 2014). Urban vegetation additionally acts as a form of urban cover. The most common strategies in implementing urban vegetation come in the form of street trees, urban parks and green open spaces (Jamei *et al.*, 2016). Urban vegetation has proven, through the effects of shade creation, photosynthesis and evapotranspiration, that lower temperatures are created with urban vegetation present.

Suburban areas have a much higher frequency of urban vegetation than inner-city locations. According to Aboelata and Sodoudi (2019) trees need to be contextually chosen due to the canopy height and size, water demands, indigenoussness, albedo and root development. The C40 Cities Climate Leadership Group (2016) argue streets with trees reduce LST by 5°C more than streets without trees leading to reduced UHIE. Strong winds and lack of sunlight may not make it possible for trees to survive, thus a balance between urban geometry and urban vegetation needs to be struck. The common nature of trees in Melville shows possibilities for heat reduction opportunities.

Parks and green open spaces have the greatest cooling effect on surrounding areas (Jamei *et al.*, 2016). The size of green spaces makes it difficult to plan for, especially in already existing sites. New developments and infill sites are the easiest ways to ensure new green spaces are provided within cities. A green network between parks allows for a greater cooling effect within the entire city (Declat-Barreto *et al.*, 2013). The idea of an open space system is often viewed as the main component of green-infrastructure within cities. Singular parks thus create 'cool pools' but an entire system reaches greater parts of the city. Besides cooling abilities, ARUP (2014) identify parks as being able to improve the air and water quality, reduce energy costs, improve drainage and help with biodiversity preservation all of which help reduce the UHIE. Lack of urban vegetation in cities is, therefore, problematic for health, comfort and economic reasons and if not provided in sufficient amounts could have disastrous impacts on the UHIE.

2.4 Global Urban Management Approaches

Henao *et al.* (2020), state urban management strategies in response to the UHIE can include the introduction of green spaces, urban vegetation, albedo changes, lighter street surfaces and change in the materials used in buildings. However, not all urban management models cater to these services and must be understood to develop a new model approach. The following approaches have been used around the world, which have and can be applied in the CoJ. These are important for the development of the new CoJ model.

2.4.1 Traditional Management Approach

During the modernist turn, urban management provided traditional services to residents (Zhou and Wu, 2015). During the 1960s master planning relied on expertise from professionals to make decisions on the future of cities. Scientific knowledge and decision-

making involved little public participation and one-size-fits-all approaches in a bid to reduce inefficiencies in local government (Olum, 2004). According to Chakrabarty (2001), productivity and efficiency were crucial to the characteristics of the traditional approach to urban management but was criticised due to its lack of humanism and insensitivity. Provided services were based on an institutional, hierarchical, bureaucratic and apolitical model ensuring those in power were protected (Mohamed, 2009). This epoch is known for its lack of participation as citizens trusted government to provide what they needed, in return taxes were limited and infrastructural services were made available.

Policy implementation and creation was the role of local government and remained an exercise based on technical advice. The top-down nature of policy appropriation led to main sectors being covered whereas minor sectors were neglected by urban managers (Wekwete, 1997). The rational and scientific approach to urban management is now considered out of date and not suitable for dealing with current demands. However, the drive for efficiency is still seen in CoJ urban management practices.

2.4.2 Market-based Management Approach

The market-based approach to urban management is associated with the neo-liberal turn taken in the 1970s. The belief that the free-market would lead to greater efficiency, cost-effectiveness and competition in service delivery led to local government administrations losing importance (Mohamed, 2009). The idea of using private-sector models to run the state was implemented to ensure financial efficiency and decision-making was guided towards economic growth. Jenkins (2000) expresses that during this time the role of urban management was limited to stimulating economic development, efficiency and productivity while acting as a regulator rather than an actor in providing services. The new state which had become decentralised was now based on privatisation and corporatisation in previously state-run enterprises.

The new role of local government does not allow for policy-making and implementation as it works against the in-place economic principles (Mohamed, 2009). Quality of life (QoL) was expected to improve through economic prosperity, rather, market performance led to poor infrastructure delivery and citizens were no better off from private than local government providers. Again, this system is still seen in global urban management practices as economic

prosperity remains an important objective and urban management is viewed as a system to achieve this.

2.4.3 Humanistic Management Approach

Neo-liberal influences on cities and infrastructure provision caused citizens to become increasingly unhappy with local government. Growth in social movements, NGOs and advocates for humanistic approaches representing peoples demands led to the reform of local government's decision-making ability (Jordan and Van Tuijl, 2000). The role of citizens shifted from being a client to a co-decision-maker. According to Peters (1996), this system of urban governance had taken the shape of the participation government model. This meant government was based on public participation to inform decision-making. Hoppe (2011) states participation must have consultative purposes; create a partnership between interest groups; standing and influence the direction in which policies go; the greatest utility; the final say on implementation and redesigning of policy. Unfortunately, participatory processes in the CoJ remain viewed as tick-box exercises (Eglin and Ngamlana, 2015) and must become reformed.

The humanistic model varies from the participatory model according to Zhou and Wu (2015) as public participation is used to enhance public satisfaction to create liveable cities, increase the current QoL and meet people's needs. This gives the impression cities are managed with a human orientation rather than a focus on economics. This approach makes use of the Behavioural school of management where science is not the decision-maker; and efficient working environments allow for greater participation, teamwork and efficiency are ensured which are all criteria Hoppe (2011) outlines in his views on participatory governance. The Humanistic mode has to ensure decisions are made for the well-being of the people which includes the development of climate change policy and implementation. Using such an approach is highly sought after as it has the potential to deal with the voices coming from public participatory meetings, thus improving this system.

2.4.4 New Urbanisation Management Approach

New urbanisation is an urban management approach incorporating the recent environmental turn with developmental objectives (Zhang *et al.*, 2020). This approach deals with growing populations and environmental degradation continuing to cause problems (Griffiths and Schiavone, 2016). Characteristics including social fairness, sustainable

development and urban governance draw on the idea of the humanistic approach as human liveability is promoted (Zhou and Wu, 2015). Although the link between new urbanisation and new urbanism has not been drawn, their similar objectives are used for urban management practices. The Congress of the New Urbanism (2000) indicates neighbourhoods must be designed to be compact, pedestrian-friendly, diverse in typologies and uses, provide appropriate public transport opportunities and open spaces to its citizens. Both approaches are driven by humanistic principles where the QoL, public participation and public satisfaction are drivers for their designs and objectives. New urbanisation and new urbanism add a pure environmental approach not seen in current urban management approaches.

2.5 Urban Management Tools for Urban Heat Island Reduction in Suburbia

Urban management tools are implemented through design and policy. Finding a balance between using urban design and policy together has the potential to generate a new urban management process that can tackle climate change in cities, this includes the UHI and its effects on the communities living in them.

2.5.1 Urban Acupuncture

Urban Acupuncture is based on viewing the city as a living organism and tackling 'pressure points' to release positive impacts (Shidan and Qian, 2011). For Petrova *et al.* (2016), urban acupuncture provides an insight into the behaviour of citizens informing decisions on policy and strategy formulation. Urban acupuncture can make use of social media geo-locating to find patterns in how spaces are used, where people avoid spaces and what attitude is given towards certain spaces. For UHI adaptation, the locating of green spaces, shaded spaces and spaces with high activity can be analysed and used in determining how policies are implemented. Ultimately, urban acupuncture ensures citizens are involved in the decision-making process (Petrova *et al.*, 2016). However, urban acupuncture is associated with the urban renewal processes which influence gentrification or positively improve public spaces (Wang, 2013). Urban acupuncture as an urban management tool builds off the technical component from the humanistic approach orientating towards an improved public satisfaction through public participation.

2.5.2 Tradeable Permits

Tradeable permits target the reduction in carbon emissions by setting a limit to the carbon emissions in a city before allocating each household a per capita share (Andersson *et al.*, 2011). The permit system allows for the buying and selling of permits on the market, thus giving an economic opportunity to those not reaching their emission capacity (Mi *et al.*, 2019). Additionally, households are not forced to sell and may therefore reduce the total emissions released if the permit remains unused or unsold. Using tradeable permits aims for social justice and fairness through decreasing the unequal distribution of emissions; improve the QoL through providing economic opportunities for all and reduce emissions. However, implementing this system is more complex than introducing a new tax system. According to Howe (1994), this process will only have financial benefits if the markets are competitive which simultaneously creates pressure on emerging businesses and markets constraining their economic abilities. The complexities of tradeable permits could have major benefits but require transformations that will likely see problems arise if not planned correctly.

2.5.3 Urban Ecosystem Modelling

Urban ecosystem modelling is the regeneration construction of environmental systems that have been damaged by or built over in the urban setting. This takes into account an interdisciplinary approach to understanding the environmental properties in urban situations (Chen *et al.*, 2014). Understanding urban ecosystems provide urban management with the ability to make trade-offs between designing the environmental, social and economic components in suburbs and support policy development through raising educational awareness (Posner *et al.*, 2016).

According to Cortinovis and Geneletti (2018), the mapping out of urban ecosystems is vital to the regeneration of brownfield sites into usable open spaces. Urban ecosystem modelling will require coordination between urban management, Environment and Infrastructure Services Department (EISD) and the Development Planning Department (DPD) to find possible locations where changes may be made available. Urban ecosystem modelling builds on the importance of creating an environment powered by sustainable development and practices from the new urbanism approach. Urban ecosystem modelling is required at the smallest scales and, therefore, must maximise the decentralised nature of the participatory approach to additionally help educate people on the benefits and consequences of ecosystem modelling.

2.5.4 Strategic Environmental Assessment (SEA)

SEA ensures that environmental policies are in place for the entire lifecycle of plans including management and decommissioning phases (Noble and Nwanekezie, 2016). According to the OECD (2006), SEA considers a multitude of scenarios to ensure all outcomes are catered for. Partidario (2015) believes SEA is important for the formulation and implementation of creating strategic initiatives and policy-making. The CoJ develops such strategies enabling the integration of all policies into it.

SEA has multiple benefits including the integration of environmental problems into developmental policies, providing environmental-based evidence to inform decisions and build public engagement in the decision-making process (*ibid*). However, SEA has been known to overlook sustainability factors, be unclear about stakeholder roles, make use of varying techniques and can be costly which are important factors to take into account when attempting to improve suburban settings (Torreta and Capodaglio, 2017). SEA, therefore, builds upon humanistic and new urbanisation approaches by providing greater QoL and liveable cities through the humanistic approach. This ensures a political and technical understanding of decision-making and works at a decentralised level due to the participatory approach.

2.5.5 Retrofitting Suburbia

Retrofitting is the transformation of urban areas with long-lasting effects in mind (Rice, 2010). Sustainability of the entire system is the main objective whereby previously unavailable technology is used (Dunham-Jones and Williamson, 2008). Vall-Cassas *et al.* (2011) argue that retrofitting works with the objectives of urban management as the problems of urban growth are possible to reduce through the increase in connectivity, accessibility and diversity.

Infill development refers to the construction of structures in an area where previous developments have occurred (Izvin *et al.*, 2018). This is most often seen in residential areas, specifically spaces which have either never been built on before, or have had access to infrastructure and require only a structure. Barelkowski (2014) introduces the strategy of blending as a method for urban managers. This consists of merely maintaining the flow of people within the suburb and plugging in new users. This does not create strain on service provision, rather it flows into the ideas of Belanche *et al.* (2016) whereby more users of

services allow for greater sustainability. This opposes the idea of Dunham-Jones (2005) who argues infill is likely to lead to greater strain on services and create more traffic. The strategy of blending uses open spaces in suburbs and subdivides land parcels which are wasteful and provide new opportunities for the suburb, build on previous buildings and makes use of backyard dwellings. The costs of infill sites are believed to be a third of greenfield site developments and therefore have an economic standing (Hamilton and Kellett, 2016) especially in cities like the CoJ where financial resources are limited.

2.5.6. Co-Production of Knowledge

Recent debates have called for a notion of co-production in urban management (Kotus and Sowada, 2017). According to Siame (2018), co-production requires a dependency to be placed on all stakeholders to make sure decisions are made fairly while maintaining unity between them. Additionally, the co-production of knowledge helps the understanding of local problems and provides a way forward in reducing these problems (Corburn, 2008). Rather than retrofitting the physical nature of cities, co-production lays down the platform to create policy, programs and strategies to be used.

Similarly, to co-production, public-private-partnerships (PPP) is a relationship built between the public and private sectors in creating and implementing projects, strategies or programs (Taylor and Harman, 2016). PPPs differ in the financial and organisational relationship between stakeholders and the risks involved. Harmann *et al.* (2015) point out many of the objectives seen in these projects are for climatic and environmental purposes and therefore are used for creating knowledge and using it to implement programs. Unfortunately, the public sector refers mostly to local government as residents are not often part of the process. However, the private sector is often specialised in what it has been contracted to provide and has the expertise to produce what is required of it. Urban management must balance the gain in expertise and lack of contextualisation.

2.6 Mapping of Policy Misalignment

Nine policies have been analysed in the order of scale, therefore international policies are followed by national policies, ending in local policy. This allows for the visualisation of the misalignment between different spheres of governance and how this impacts climate change adaptability.

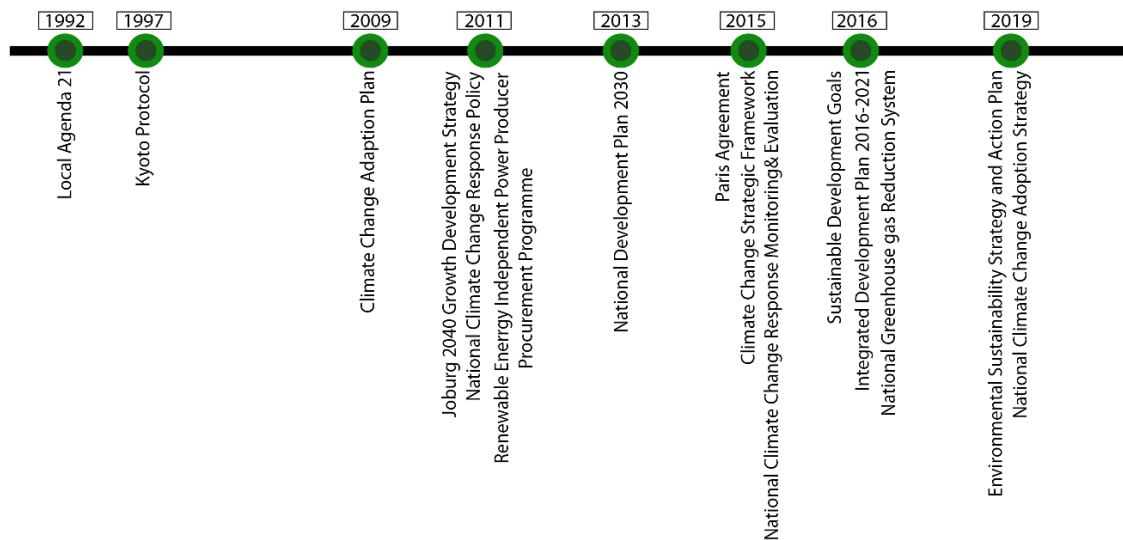


Figure 2.2: Timeline of climate change policy impacting the CoJ's climate change adaptation ability (Author, 2020).

2.6.1 Paris Climate Agreement

The Paris Climate Agreement (COP21) is dedicated to keeping global temperatures below pre-industrial times, increasing the adaptability to climate change, and ensuring financial flows in local governments are aligned with GHGs reduction and climate-resilient development (United Nations Framework for Climate Change, 2015). The South African Climate Change Adaptation Strategy, National Climate Change Response White paper, National GHG reduction system, National Climate Change Response Monitoring and Evaluations System Framework and Renewable Energy Independent Power Producers' Program were directly implemented after the ratification of COP21 (Mapulane, 2016). CoJ's urban management principles are seen within the COP21 approach as efficiency, integration and participation in developing carbon-neutral states (not South Africa) are continuously highlighted. The ratified international policy provides the cornerstone for all alignment thus, making COP21 vital for South Africa's climate change tackling program.

2.6.2 Sustainable Development Goals (SDG)

The SDGs outline 17 goals to develop objectives and set out reachable and integrated goals. The reduction of UHIE deals specifically with two of these. Goal 11: Sustainable cities and communities, and Goal 13: Climate action. SDG 11 is based on cities becoming safe, resilient, inclusive and sustainable. Objectives were outlined which are connected to reducing the UHIE. Improving human settlement management actively manages how settlements are produced, where they are located and how these are going to ensure

anthropogenic and GHG emissions are minimalised. Goal 12: Responsible consumption and production, is equally important in suburban landscapes. This goes hand in hand with the promotion of sustainable land-use planning and management where environmental infrastructure, transport systems and sustainable energy systems are promoted and incorporated into settlements.

SDG 13 ensures climate change ideas are translated into national policies where smaller scales build from. SDG 13 aims to develop institutional capacity on the mitigation and adaptation aspects of climate change through education and awareness. Participatory approaches in the SDGs are an important component of these goals as the public is seen as a key component in driving change. If the CoJ merges institutional growth in understanding and awareness of SDG 13 with the physical changes made by urban management and planning of SDG 11 then the UHIE is likely to reduce.

2.6.3 National Climate Change Response White Paper (NCCR)

The NCCR sets out principles expected to be used in future strategies. However, the NCCR was released in 2011 before COP21 or the SDGs were introduced. This means climate change mitigation policy in South Africa is based on the Kyoto Protocol of 1997 whereby countries are merely asked to develop policies and measures for the reduction of carbon emissions. NCCR is the national guideline pre-dating the NDP and thus influences this vital national policy simultaneously limiting what the NDP provides in the environmental department. The misalignment between the current international policy and national policy becomes evident here.

Urban management and urban planning are called upon to respond to the climate change challenge South African cities are facing through introducing principles such as polluter pays, participation, equity and differentiated responsibility (DEA, 2011). Promoting low-cost housing in relation to a low-carbon transportation system, encouraging sustainable water-sensitive **urban design**, and enforcing land use regulations to ensure settlements and ecosystems live in harmony. The NCCR further aligns with the CoJ urban management model through its emphasis on creating public awareness and developing tools ensuring management and efficiency in rolling out programs. Although not directly aimed at the UHI, these responses create the base wherefrom the CoJ can draw inspiration for future strategies.

2.6.4 National Climate Change Adaptation Strategy (NCCAS)

The NCCAS is viewed as a policy providing a reference point for climate change adaptation across sectors through delivering guidelines, coordination and support. How adaptation will take place is not provided and is left for lower spheres of government to specify. 2020-2030 are outlined as years wherein South Africa must develop necessary policies, strategies and capacity to tackle the future of climate change mitigation and adaptation. The vision for the NCCAS is to “transition to a climate-resilient South Africa, which will follow a sustainable development path, guided by anticipation, adaptation and recovery from a changing climate and environment to achieve our development aspirations” (DEA, 2019:19). The NCCAS is linked closely to the ideals spoken of in the SDGs and COP21 and incorporates the NCCR objectives.

The objectives of the NCCAS point towards the development of knowledge and capacity to deal with climate change and ensuring these ideas trickle down to provincial and local spheres. The expected outcomes are not directly related to the UHIE. Rather outcomes speak off greater research and knowledge which will provide future planning assistance; strengthened institutional structures; assuring financial resources required to tackle climate change are available; improved PPPs are more common; and the approval of the Climate Change Act which when promulgated is likely to have a great effect on UHIs around South Africa. In terms of the urban management principles, clear support for integration and public participation is shown, however, the efficiency principles do not go further than monitoring and evaluation.

2.6.5 Joburg 2040: Growth Development Strategy (GDS)

The GDS is a long-term plan implemented by the CoJ guiding the development of the municipality up to 2040. The GDS is aware of the climate-change-related issues the city will face. The GDS paradigm which drives the strategy and allows for the adaptation to change is based on 4 interrelated concepts which lead to a resilient, liveable and sustainable city (CoJ, 2011). To achieve this the GDS has set outcomes and principles which can be used for UHIE reduction.

Outcome 1 refers to an improved QoL and development which is driven by resilience (CoJ, 2011). Resilience is especially important as the urban environment will get increasing pressures from climate change and the UHIE. Outcomes are guided by principles that

provide the CoJ's approach to development. Principle 4 – ensuring resource security and environmental sustainability is linked with outcome 1. Where the CoJ manages and reduces its resource usage, greater environmental sustainability may be associated as the carbon footprint is lowered. This will improve the resilience of the CoJ as the impacts and effects of UHIs are reduced. The GDS thus is a powerful tool laying down a guide for the reduction of the UHIE.

Ebrahim (2017) states the GDS lacks the short-term programs to deal with the highlighted issues. The GDS does not include the ideas of either the NCCR and NCCAS regardless of its updates, showing developmental policy in the CoJ is misaligned from national policy. The GDS is a showcase for the CoJ urban management model as participation, efficiency and integration make up core parts of this policy. The environmental ethics of the GDS are poor as the responsibility for environmental problems is not taken by the GDS for environmental purposes but rather as a source of international accreditation for development (Sihlongonyane, 2015).

2.6.6 Integrated Development Plan 2016-2021 (IDP)

The IDP consists of objectives around spatial transformation and service delivery placing importance on the integration of social, economic and environmental resource management. The IDP highlights 4 areas where climate change is most likely to be exacerbated within the CoJ (see table 2.1). For each area, the CoJ has programs in place to deal with the problems. This takes climate change mitigation a step further than the GDS.

Table 2.1: How the CoJ is responding to ensuring environmental sustainability according to the IDP (Source: CoJ, 2016:50).

Drivers	Carbon Emissions	Resource Consumption	Environmental Consumption	Impacts on Natural Environment
Programs	Climate Change Management	Water Demand-side Management	Water-Resource Management	Biodiversity Conservation
		Energy Diversification	Air Quality Management	Open Space Management
			Integrated Waste Management	

Carbon emissions and resource consumption are two of the greatest culprits to the existence of the UHIE and will require an integrated program to resolve this. It is, therefore, no surprise the reduction of carbon emissions is one of the prominent environmental targets within the CoJ. The IDP sets out to measure and track its GHG emissions, mainstream its climate-change objectives throughout the city, enhance energy efficiency, incorporate climate-change into all future developmental actions, improve public awareness and educate communities around the CoJ (CoJ, 2016). The IDP thus sets out further environmental objectives which must be taken forward in future policies. However, the disintegration of programs may cause a lack of alignment in achieving certain environmental goals and make the reduction of UHIE difficult as a result of this.

The 2016-2020 IDP is not aligned with the NCCAS due to its release date, but still relies on the instructions of the GDS to help its long-term planning ability and is strongly integrated with its ideals and objectives. The IDP is thus aligned with the GDS but remains disconnected with further national objectives which are not aligned with international objectives. Due to misalignment between national and international policy, local policy has become affected in minimalising its climate change impacts.

2.6.7 Climate Change Adaptation Plan (CCAP)

The CCAP is a policy created by the CoJ in 2009 to help assess the dangers of climate change and the impact this may have on the municipality. The CoJ highlighted the greatest risks

associated with increased heat and UHIs including death amongst those with existing medical conditions, increased energy and water demand, biodiversity impacts, fire risks, environmental degradation, efficiency disruptions and poor air quality. The UHIE is a marked problem requiring adaptation. However, there is no heatwave plan; and urban greening projects alongside placing air-conditioning systems at public transport stops are the only plans in place to make any change to the temperatures. This alone is a paradox with the cooling causing more released heat in the city.

The CCAP recommends where urban management can assist in and reduce the UHIE; stating the CoJ needs to create a heatwave response plan, generate shade, improve energy-efficient building codes and continue tree-planting programs. Long-term highlighted objectives lack proper guidance and need a review. This is the first instance where the UHI is mentioned in policy in the CoJ and remains the only plan to tackle the UHI. The CCAP is not aligned with any international or national policies important in today's climate. The CCAP is not mentioned in the IDP or the GDP and shows a clear misalignment of policies. This is especially worrying due to its importance in tackling environmental problems within the CoJ.

2.6.8 Climate Change Strategic Framework (CCSF)

The CCSF guides the CoJ towards the creation, recommendation and implementation of climate change strategies (EcoMetrix Africa, 2015). EISD, in particular, will be guided in the CCSF. The objective of the CCSF thus is to improve the internal organisational skills in ensuring strategies and plans are created that deal with the pressures caused by climate change meanwhile incorporating the private sector for maximised results. Besides providing a guideline, the CCSF has climate change goals running parallel to this and are expected to be aimed for by various departments throughout the CoJ. The long-term goals relate to the reduction of greenhouse gases (GHG), a reduction of 43% from the 2007 numbers by 2050. The CCSF was developed to assist policies such as the CCAP, however, this has not happened. The CCSF is rather seen as the main climate change policy in the CoJ, neglecting what the CCAP brings to the table. The UHI is mentioned in the CCSF as a cause of concern. However, it tables the UHI as a smaller concern than previously stated and rather looks to be a tool that integrates the COP21 ideals into the CoJ. This is problematic as national policy has varying objectives not looked at by CoJ.

The second objective of the CCSF aims for the enhancement of infrastructure for resilience against heatwaves and future warmer climates. This is important for the creation of plans and strategies which will have to incorporate the associated problems of heat. A retrofitting program within municipal buildings has been proposed whereby buildings are made to be more energy efficient. Where local government leads by example by making environmentally-minded changes, larger-scale projects may be implemented by the private sector.

In the CCSF, urban management is regarded as the tool allowing for the coordination between the public and private spheres to raise awareness in problems such as climate change. Herein lies a cause of the misalignment as urban management is portrayed as a public participation tool. The CCSF is placing all the pressure on the EISD and DPD for the development of strategies. The inclusion of urban management as a tool for the reduction of climate change and UHIE will raise awareness to the public. By integrating 3 departments, (see figure 2.3) strategies incorporating environmental services and spatial planning may be implemented.



Figure 2.3: Relationship between departments and what they add to UHIE reduction if integrated (Author, 2020).

2.6.9 Environmental Sustainability Strategy and Action Plan (ESSAP)

The ESSAP aims to institutionalise environmental sustainability as a responsibility across the municipal departments and programs to ensure the CoJ becoming resilient and sustainable. Additionally, the ESSAP outlines 3 objectives that allow for coherence across all policies in

the CoJ. The first objective is to define environmental sustainability and what it should mean for the CoJ. The definition used by the CoJ (2019:20) is stated in its vision, “to secure and protect natural systems and build resilience towards environmental sustainability for human wellbeing and economic prosperity.” This means natural systems are used to strengthen the resilience of urban spaces ensuring any shocks to the system are dealt with and the socio-economic situation remains stable. This definition will be put forward into all future documents in the CoJ to ensure consistency in defining key issues and monitoring any progress. In terms of reducing the impacts and effects of the UHI, it is important to note this definition will play a role in ensuring the UHI will work towards creating environmental sustainability.

The second objective is to define all environmental sustainability issues the CoJ faces. This helps with creating an overarching view on the matter and allows for alignment in policies. The CoJ names 8 environmental sustainability issues, of which 2 directly relate to this research. Issue 2 relates to GHG which are emitted, how set out goals have not been achieved, and the effect this will have on climate change and extreme weather events. The direct impact of anthropogenic heat and GHG have a big impact on the UHIE which is resolved through the implementation of a plan towards the UHI.

Issue 8 argues the lack of accountability and responsibility laid on the CoJ and citizens alike for addressing causes and responses to climate change. There is no policy in the CoJ which directs environmental planning and decision-making, this means citizens are not aware or have been asked to make changes. **Urban management needs to ensure all parties are involved in dealing with environmental sustainability and are held accountable in some way.**

The ESSAP is a key policy enabling the alignment of policies within the CoJ. However, it will not be able to improve national and international alignment.

2.6.10 Policy Misalignment Review

The matrix in figure 2.4 illustrates the relative importance of international and national policies for the development of UHI focused policy in the CoJ. The shift from international to local further expresses the importance of planning for realising UHIE mitigation. From institutional growth and political backing, the planning and developmental stakeholders implement strategies and programmes tackling the UHIE. The specificity associated with local policy means future policies are likely to grow further towards the top right of the 1st quadrant as climate change is integrated into further developmental policy.

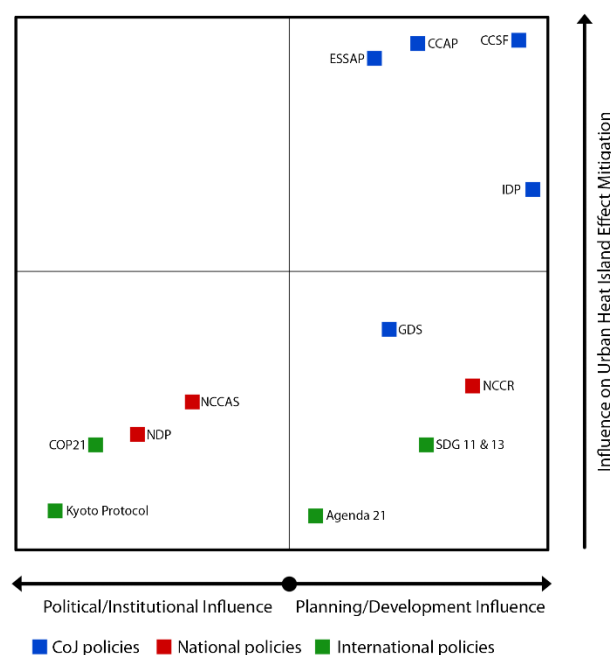


Figure 2.4: Matrix of policy influence on UHI mitigation and adaptation (Author, 2020).

The matrix illustrates that policies with the greatest influence on the UHI (CCSF and CCAP) were made in 2009 and 2015 respectively. This means the CCSF does not incorporate the views of the current IDP, GDS nor the SDGs. The CCAP also does not incorporate international policies like COP21 and SDGs and needs to be revised. Furthermore, the Climate Change Act which is under current review will cause a new range of strategies and plans to be created or reviewed throughout all spheres of governance. The NCCAS and ESSAP need to be viewed as policies guiding the country and the CoJ towards greater environmental sustainability and climate change mitigation which in turn will help with the reduction of the UHIE.



Figure 2.5: The misalignment between important climate change policy impacting the CoJ (Author, 2020).

Figure 2.5 demonstrates the misalignment between policies due to the mix-up of years in which policies were developed. Arranged from international to local, each sphere is then arranged by the scale of importance and the impact it has on consequent policies. If alignment was to be ensured policies following one another will include similar goals and objectives, however, the policies precede each other in various scales. Misalignment is especially seen between the spheres of governance where the outdated policies do not allow for an overlap of sufficient components. The creation of new policies is not including older works and is also not derived from recently published policies. This means that policy becomes ineffective and is overlooked in developments and suburban climate change adaptation.

2.7 Conclusion

Urban management approaches have varied over time and have all had their limitations. The need for a new model is seen by the lack of compatibility with modern urban management tools which are currently underused and do not point towards a sustainable future. This is seen in the policy misalignment whereby policy from all scales is struggling to come together in the CoJ when it comes to reducing the UHIE and make an attempt at forcing suburbia into making adaptations climate change purposes. Once more, current policy does not align itself with the urban management principles outlined by the CoJ and is hindering the process of achieving desired changes in both the UHI and suburbia.

Chapter 3 - Research Methods

3.1 Introduction

Chapter 3 delves into methods and instruments that have been employed for research design, data collection, the analysis thereof, sample size, sampling techniques and ethical considerations. The main instruments used for data collection were site observations and online questionnaires. Spatial mapping exercises were completed to provide a contextual analysis of Melville and for future recommendations.

The research aims to develop an implementable urban management model for the CoJ to help with streamlining the UHI adaptation into policies, strategies and programs for suburbia. The aims for this research are thus threefold as firstly, I explored the level at which the UHIE has been integrated into policy. By understanding the political landscape in which the UHI finds itself, the perception of the CoJ UHI was analysed. This included the definition, causes, consequences and methods of mitigating UHIs. Secondly, this study singled out the suburb of Melville to find the level of adaptation it has undergone. Finding if suburbs are at all capable of change and what level of assistance they required in the future plays a large role in this. Thirdly, I identified efficient urban management practices, approaches and tools to be used in tackling the UHIE in suburbia.

3.2 Research Design

3.2.1 Qualitative Research

Qualitative research is perceived as subjective and personal due to personal observations and experiences driving the process. The nature of qualitative research according to Patton (2015:3) is based on the “background, experience, training, skills, interpersonal competence and capacity for empathy” of the researcher. Subjectivity is shown by respondents as their unique setting and daily experiences provide for original and unique information. The decision to select Melville as a case study contextualises the research question based on suburbs and their impact on the UHIE.

Peterson (2019) believes qualitative research consists of two characteristics. Principles of trustworthiness and triangulation are both seen in qualitative research. Triangulation refers to the utilisation of at least two data instruments or methodological approaches to conclude (Flick, 2014). For this research, spatial mapping, observations and online questionnaires were used as opposed to a singular form of data collection. Trustworthiness in qualitative

research is based on principles the researcher ought to have. According to Patton (2002), these include the researcher's position on the research topic, where they have gained this knowledge, knowing what questions are appropriate for the context, and how they engage in personal questions. This report is highly influenced by the environmental turn, a change in thought towards sustainability and the importance of nature in a balanced system, and questions are therefore geared towards this inspiration.

3.2.2 Case Study

The suburb of Melville was chosen as the case study for this research. Case studies provide the reader with a smaller sample of the entire unit (Gerring, 2007) which allows the researcher to conclude, but understands a varying sample may cause different results. For this research, Melville was the chosen case allowing for an understanding of other suburbs that face similar issues to reduce their impacts on the UHI and climate-change. The UHIE over suburbs (including Melville) shown in figure 1.2 was a further reason to choose Melville. Additionally, this case study was chosen for accessibility to approach residents during the COVID-19 pandemic.

3.2.3 Sampling Techniques

The constraints of the COVID-19 pandemic made face-to-face interactions non-negotiable for this research, regardless of the desire to use the option or not. Therefore, I have made use of electronic questionnaires made on SurveyPlanet. These were sent out on the Facebook page 'I Love Melville' and a WhatsApp group to which I have access. Sampling followed the ideals of convenience sampling which according to Etikan *et al.* (2015:2) looks to "target populations that meet certain practical criteria, such as easy accessibility, geographical proximity, availability at a given time, or the willingness to participate." The social media platforms used are accessible to Melville residents as a selection process either allows or denies access. Additionally, the questionnaire asked respondents to provide demographic information, inter alia length of stay in Melville, to ensure that information given would be from Melville residents.

3.2.4 Sampling Population

Online questionnaires in the form of a structured interview were held with Melville residents. The original goal population was set at 25 which was chosen to ensure a wider range of answers while not saturating the data with similar answers. This research has

ensured no participants younger than 18 had their information recorded. The exact desired number of respondents has been achieved.

3.3 Research Instruments

Addressing the research question required primary data to figure out the localised impact of the UHIE in Melville and further find how residents have attempted to adapt to the effect of climate change.

3.3.1 Spatial Mapping and Observations

Spatial mapping is part of the primary data collection. Spatial mapping is based on the observations made while walking through the suburb of Melville and the use of Google satellite imagery. Understanding the status quo of the current layout of Melville and other observations have been represented graphically through spatial mapping. This refers to the land uses, location of open spaces, infill opportunities, densities, roof colours and orientation of the buildings. Spatial mapping supplements the information gathered from the questionnaire and highlights the changes made in Melville. The Melville base map was an adaptation through the use of Auto CAD of the CoJ GIS maps.

3.3.2 Online Questionnaire

Structured questionnaires were completed by 25 respondents and residents of Melville. The respondents provided information with regards to the impacts of the UHI in Melville, how they have dealt with these problems, why they chose the options they did and what changes they are willing to make. Questions with a direct correlation to the impacts of the UHI were asked to ensure the UHIE remained in focus. Questionnaires were structured as assumed participants are not experts in the fields of urban climatology, urban management or urban planning. Additionally, according to Kahneman *et al.* (2019), this reduces bias evaluations made on impressions, positioning and status. Furthermore, sent questionnaires cannot be personalised for participants which ensure comparisons between answers and effective analysis.

3.4 Study Limitations

COVID-19 has limited the number of methods possibly used for interactions with respondents. An increased number of participants, enriching the data, could therefore have been used to deepen the analysis. Additionally, research on suburbs in the CoJ is very limited making comparisons difficult. The same can be said of UHI and UHIE articles in the

CoJ. The limited research done in these fields does not affect the results but restricts the knowledge from being used on a larger scale.

3.5 Ethical Requirements

An ethics application for Human Research was submitted to the Ethics Committee as the research will involve communication with people. Questionnaires adhered to the ethics codes and procedures set out by the University of the Witwatersrand. Participants were provided with consent forms and made aware of the purpose of the interview and the research. Therefore, the participant's personal information will remain confidential and questions were asked in a transparent and respectful nature.

Chapter 4 - Contextualisation

4.1 Introduction

Chapter 4 comprises the contextualisation study. This includes a spatial mapping exercise and finding the status quo about problems and opportunities that can be exploited for UHI reduction in Melville. Additionally, the current urban management approach taken in the CoJ is analysed to find areas of improvement for a new model.

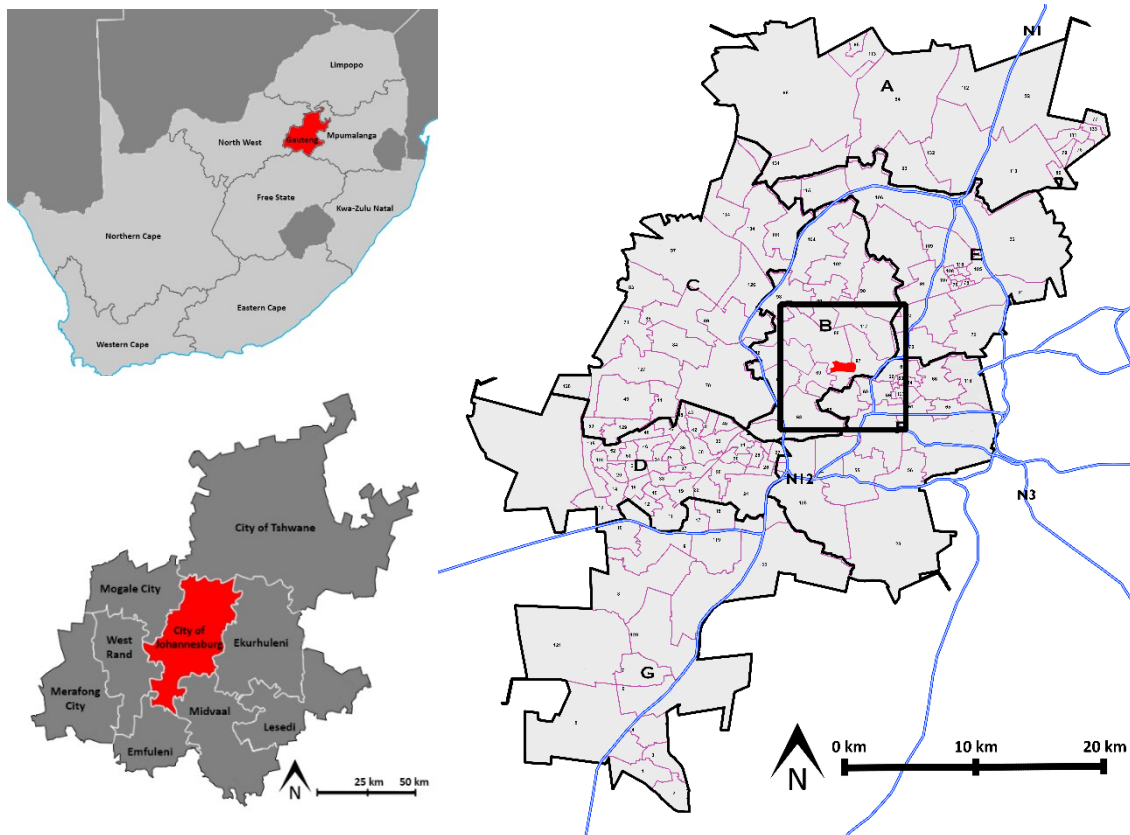


Figure 4.1: Contextualisation of Melville in South Africa (top left), Gauteng Province (bottom left) and the CoJ (right) (Source: Adapted from Municipal Demarcation Board, Author)



Figure 4.2: Layout of Melville (Source: Adapted from City of Johannesburg Corporate GIS, Author).

4.2 Demographics

The demographics page below for Melville outlines statistics linked to the UHI and its development. The most recent available data is from the 2011 census, sourced from Quantec EasyData. The age of the data could imply inaccuracies in certain demographics, however, as certain maps below will highlight Melville has shown limited change over the past decade, therefore, allowing the reader to have a relatively accurate view of the numbers. Household sizes within Melville are relatively small, with 96.64% of the entire suburb living in a household with 4 or fewer members. This is an unexpected number as the same figure for the entire CoJ stands at 83.41%. However, the CoJ's numbers are affected by migration, restrictions on urban living space and remuneration. These factors are unlikely to be as strong in a middle-income suburb like Melville (Wittenberg *et al.*, 2017). The smaller household implies a large carbon footprint due to the lower densities, greater consumption and lower sharing of goods along with a reliance on private transport exacerbating the UHIE (Heinonen, 2017).

Tenure status most common in Melville is renting (40.59%) and aligns with the city-wide figure (41.15%). However, renting is often associated with poor environmental impacts as homes are less likely to be energy efficient (Pitt and Sherry, 2014), and tenants are higher energy consumers than owners themselves due to flat rates (Melvin, 2018). This means rented out homes deal differently with the challenges of climate change but simultaneously reduces the chance of retrofitting occurring as owners do not feel the effects. Renting nature is especially strong due to the backyard housing seen in Melville. Cottages and backyard housing, are additional reasons for the low household size as they are not designed for large groups of people.

The dwelling type most common in Melville is the detached house (69.23%). The socio-economic status of Melville provides the reason for this as privacy and safety are large factors for the detached dwelling. The semi-detached housing comes in the form of originally built houses that have been subdivided. This reduces the UHIE due to a higher compactness index. The socio-economic demographics prove that Melville has all the factors that point towards a poor performance in UHIE mitigation and is a suitable case study.

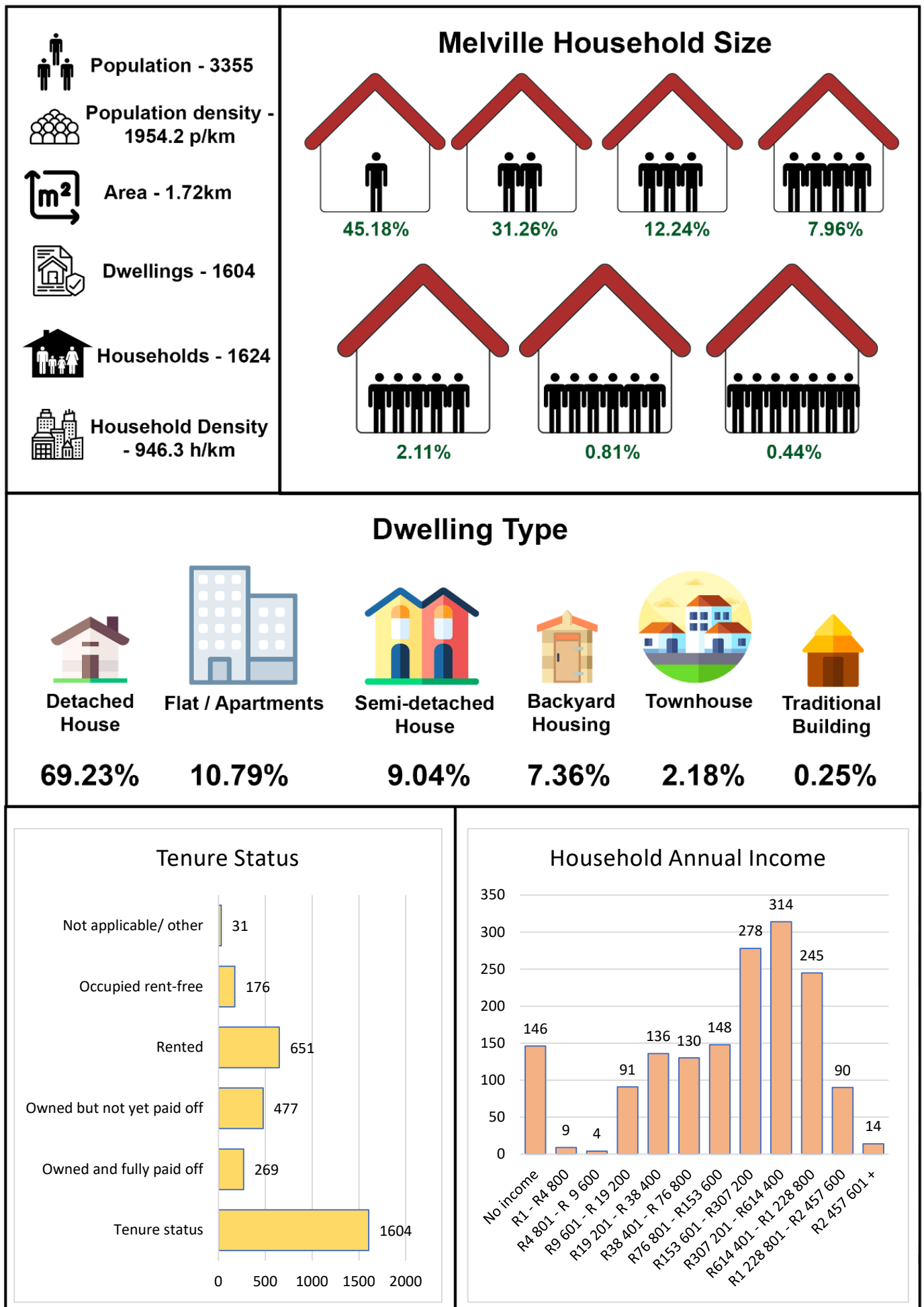


Figure 4.3: The demographics found in Melville illustrating the middle-income suburban life.

4.3 Case Study

Melville is a suburb located in region B of the CoJ surrounded by Auckland Park to the South, Westdene to the West, Emmarentia to the North and Westcliff, Parktown and Richmond to the East. Melville was proclaimed before 1899 when the Braamfontein farm was subdivided. Melville is named after the land surveyor, Edward Melvill, who subdivided the now suburb (Raper *et al.*, 2014). Melville is split into East and West by the M5. And cuts the suburb into two wards where the west falls under ward 69 and the east under 87.

Melville is surrounded by natural and man-made green spaces (see figure 4.3). Melville Koppies is the only remaining untouched conserved ridge in the CoJ (Shaw, no date). The Melville Koppies are the centre of the green spaces in the Melville region. To the North lies the Westpark Cemetery, Marks Park and the Johannesburg Botanical Gardens, all of which are man-made. The Parkview Golf Club and the sports fields lie to the East of the Melville Koppies and North of Melville and are also man-made. The Westdene Dam to the southwest of Melville is an extension of the Melville Koppies and the Botanical gardens as this is where the Westdene Spruit starts and runs into the Emmarentia Dam (Johannesburg City Parks and Zoo, 2020). To the south of Melville, the country club can also be found featuring numerous green spaces. The abundance of natural vegetation and water has a cooling effect on Melville and provides ecosystem services to the suburb. Without green spaces, Melville would likely be much warmer as absorbing urban vegetation is one of the biggest UHI challenges and can keep suburbia cool. The importance of green spaces around suburbia is thus highlighted again.

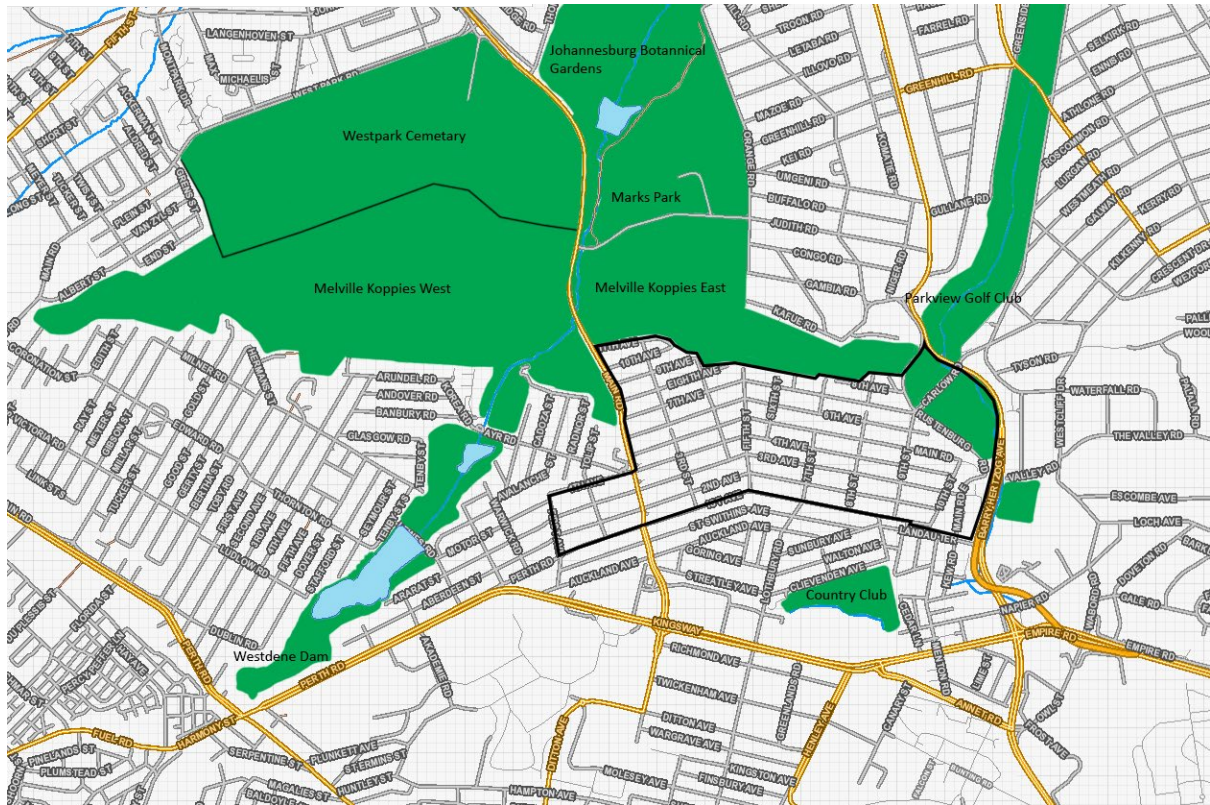


Figure 4.4: The green open spaces in the surrounding region of Melville (Source: Adapted from City of Johannesburg Corporate GIS, Author).

Natural vegetation in Melville is also in abundance. Streets running east-to-west are all aligned with trees. The densest populations of trees are found in the northwest of Melville, where the trees are also larger. The eastern part of Melville overall has greater tree coverage than what is seen in the west. This is likely due to the steep slopes. What is evident is trees are scarce where land-uses and densities increase. 7th street, 4th avenue and main street all lack the vegetation which is seen along the residential streets.

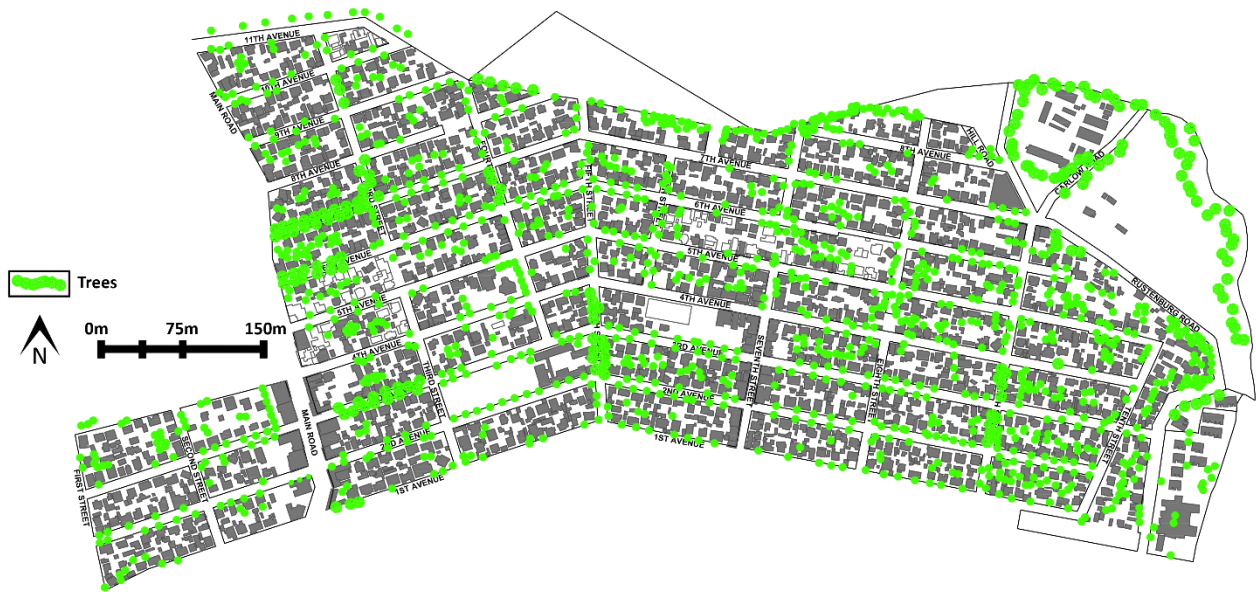


Figure 4.5: Tree coverage seen throughout Melville (Source: Adapted from City of Johannesburg Corporate GIS, Author).

The Melville Koppies affect the physical landscape of Melville. The steep slopes have an impact on the ability to build certain structures. Slopes have a positive impact on shade provision and have been used in designs since 300AD (Potchter, 1990). However, the single dwelling and single-storey buildings are not able to provide sufficient shade for the street. Changes in design and planning must be made to create the maximum shade on streets with minimal resource usage. The steep slopes further provide opportunities for green space development as building density is lower in the highest slope ratios whereas lower ratios can be used for adding residents.



Figure 4.6: Slope analysis of Melville showing the high intensity of slopes around the suburb and a contributor to the micro-climate (Source: Adapted from City of Johannesburg Corporate GIS, Author).

The land use in Melville is predominantly residential, with the dwelling house being the majority of this. However, the suburb houses a couple of streets where economic activity is dense. This occurs along the main road which divides the east and west, 4th Avenue, and 7th Street which is famous for its restaurants, bars and nightlife activities. What appears to lack in these buildings is a mixture of uses as only a few buildings have both business and residential associated with them. An increase in density is the key to unlocking a greater mix of land uses according to Alexander and Tomalty (2002) and must be considered if Melville wants to improve **environmental sustainability**.



Figure 4.7: Land uses found in Melville (Source: Adapted from City of Johannesburg Corporate GIS, Author).

The majority of Melville is built up to 1 storey, which is associated with the detached house common in older suburbs. Taller buildings align themselves with businesses and residential which are not single dwellings. There are, however, a few residential single dwelling buildings that have 2 storeys or more. These are modern buildings that have undergone rebuilding or a retrofit. The lack of multi-storey buildings provides an opportunity for growth and retrofitting to reduce the UHIE in Melville. The neighbourhood residential building type density as Boyko and Cooper (2011) describe it, stands at 932 parcels per km². The number of dwellings is therefore only at 9.3 per hectare. According to Barton *et al.* (2003), a suburb can reach densities of 50 to 80 dwellings per hectare. However, this will require a radical change in the mode of suburbia in the CoJ.

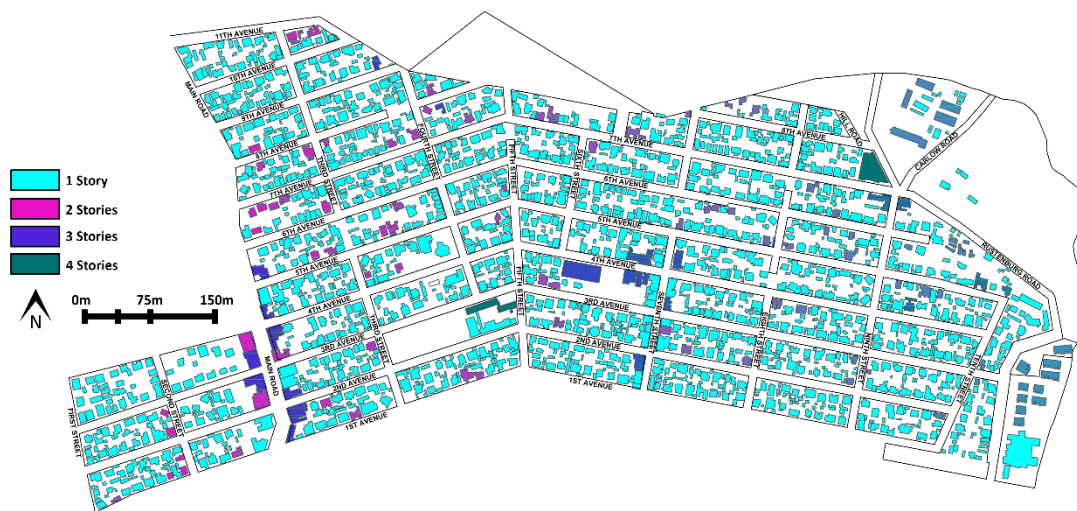


Figure 4.8: The heights of buildings in Melville that impacts the shadow, use and density (Source: Adapted from City of Johannesburg Corporate GIS, Author).

The old nature of Melville means many buildings remain in original condition on the outside. This includes the roofing material which consists of corrugated steel plates. The age of these roofs is poor for reflectivity, additionally, the material is a poor reflector (Suehrcke *et al.*, 2004). Flat-roofed buildings, made often of tar, gravel or metal sheets, are associated with larger sized buildings and provide a better opportunity for reducing the UHIE. These are a viable option for green roofs and the material has a greater reflective ability than corrugated steel (Vijayaraghavan, 2016). Tiles are limited around Melville but are used in residential homes which have been renovated. These also have a greater reflective ability than corrugated steel and mixed with the correct land-use is a method in reducing the UHIE in Melville.



Figure 4.9: Roof types and materials which have an impact on the absorption and reflectivity of incoming solar radiation (Source: Adapted from City of Johannesburg Corporate GIS, Author).

The roof colour most commonly seen in Melville is grey. However, the map does not depict the various shades as age and material have caused differences within them leading to altering reflective abilities. White roofs are the least common colour with less than 50 out of a total of 1604 roofs. The most reflective colour (white) is thus the second least represented colour after blue and again provides an opportunity for retrofitting within Melville. The ideal move forward would involve replacing the corrugated steel with reflective tiles, and/or paint all roofs in a lighter colour (preferably white) to reduce the UHIE.

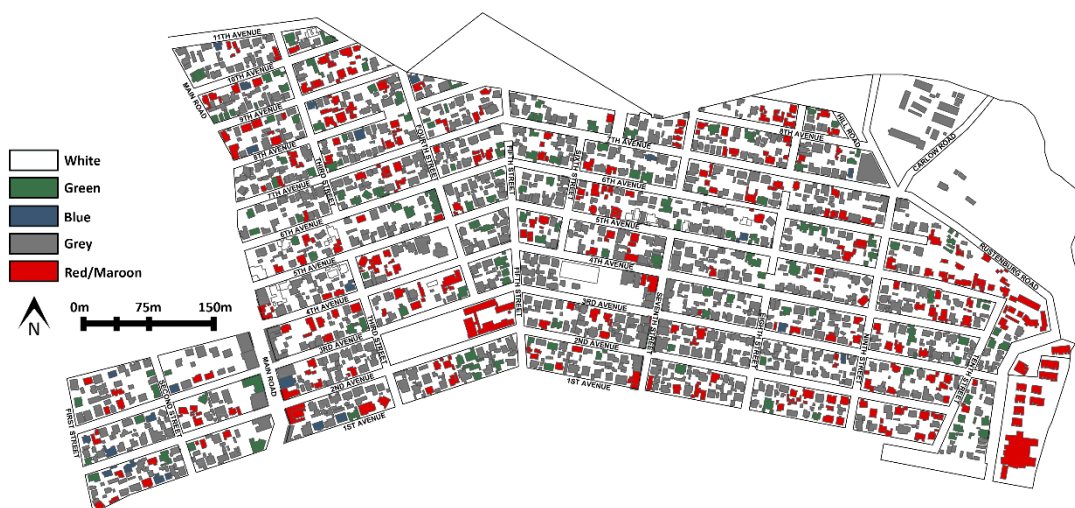


Figure 4.10: The colour of all roofs in Melville has an impact on the reflectivity of insulation (Source: Adapted from City of Johannesburg Corporate GIS, Author).

According to Mohamed (2009), urban management throughout South Africa is based on efficiency, participation and integration. IDPs are seen as the tool to ensure municipalities manage their affairs and plan their developmental objectives through integrating actors and sectors under a common goal (Gueli *et al.*, 2007). Harrison (2006) argues IDPs are fundamentally based on the neo-liberal designs that created the market-based urban management approach. The decentralised state, non-state agencies involved in local government and privatisation of enterprises ensured objectives of local government were aligned with fiscal and monetary policies. Harrison also states that the new Republic of South Africa showed an interest in community building, participation, poverty reduction and integration. This showed signs of a humanistic approach to urban management. The South African approach to urban management was thus a mixture of ideals, most commonly known as the third way.

The idea of the third way is not to diverge politics moving too much to the right or the left, but rather move in a new direction. “Public policy should support business in the creation of knowledge-rich products and services” (Driver and Martell, 2000:150). Social justice and economic objectives become intertwined as both are tackled at the same time. The need for integrated planning becomes evident here. Public participation plays a key role in the third way. Abbott (2013) argues for public participation in the decision-making process if infrastructure provision is to be efficient.

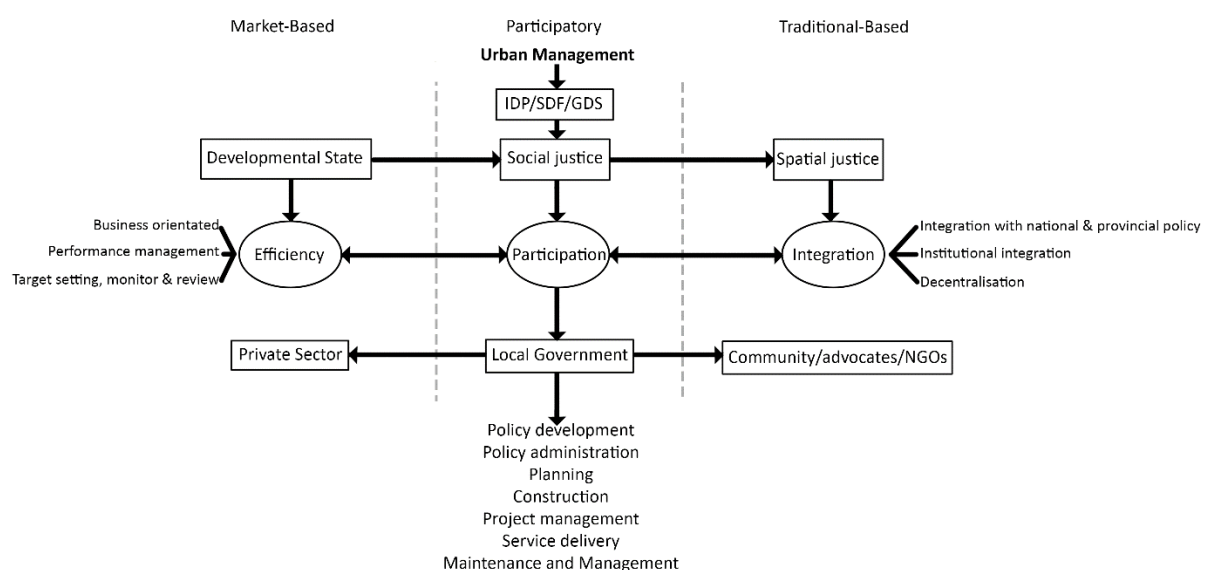


Figure 4.12: Current model of urban management in the CoJ making use of market-based, participatory and traditional-based approaches (Author, 2020).

The CoJ **draws on** a multitude of approaches for its urban management (as depicted in figure 4.11). These are three contrasting models struggling to integrate completely with one another. This causes problems down the line when policy needs to be drawn parallel with one another and climate change objectives need to be introduced and aligned.

Urban management feeds off policies such as the IDP, SDF and GDS within the CoJ. The objectives within these policies are driven towards a developmental state and aim for social and spatial justice. To achieve these objectives, urban management in the CoJ is driven by principles of efficiency, participation and integration. These cannot be seen in isolation and must be used together if objectives are to be achieved. Public participation is the key urban management tool leading to the provision of services. Additionally, the three sectors are not linked as local government is tasked with communicating between the private sector and communities.

Table 4.1 further illustrates why the lack of alignment between policies occurs and why the development **of a new urban management model is necessary**. The participatory turn is well-represented in policy around the world, including the CoJ. However, the search for efficiency is much more limited. The performance parameters, business outlook and monitoring and evaluation (M&E) are often overlooked. The $\pm$ symbol is used to signify where M&E is the only parameter found in the efficiency of a policy. This is a common trend. It is **not unexpected** that **because** urban management model principles are not found in climate change policy that they are not tackled by the urban management department.

Table 4.1: The alignment of urban management model ideals in climate change policies ranging from international to local.

Policy	Participation	Efficiency	Integration
COP21	✓	$\pm$	✓
SDG	$\pm$	✗	✓
NCCR	✓	✓	✓
NCCAS	✓	$\pm$	✓
GDS2040	✓	✓	✓
IDP	✓	✓	✓
CCAP	✗	$\pm$	$\pm$
CCSF	✓	✓	$\pm$
ESSAP	✓	$\pm$	✓

4.5 Conclusion

Melville has shown a mixture of positive and negative aspects in terms of UHIE reduction ability. The results illustrating high level of absorbing materials, low reflective colours, low densities and homogenous land uses on one hand and the high level of vegetation and green space on the other highlight that both positive and negative contributions to the UHIE exist in Melville. The current urban management approach has struggled to show its main principles in Melville as efficiency is limited and participation does not show. Therefore, the responses from residents become detrimental in defining a new approach in urban management to help change the status quo and lead to the UHIE becoming targeted.

Chapter 5 – Findings and Analysis

5.1 Introduction

Chapter 5 analyses the findings from the data collection. An attempt to answer the sub-questions outlined in chapter 1, using the answers from the questionnaire have been answered separately. A total of 25 questionnaires were filled in by the residents of Melville, all of whom have remained anonymous. The respondents acted as spokespersons for their households of which the average stood at 2.8 members with a range of 1-8 members. The questionnaire was divided into 5 sections inquiring about demographics; understanding of climate change and the UHIE; the impact of climate change and UHIE on residents; finding what residents have done to tackle the effects of climate change; and what future urban management and planning may add to Melville.

5.2 Sample of Interviews

Respondents answering the questionnaire were not targeted for experience or knowledge in the field of climate change and UHIE. The uniqueness of each resident provides an invaluable insight into the future of Melville and what the contextual problems are. The objectives of the questionnaire are to better understand the impact of the UHIE on Melville residents and how this could be resolved through local government and resident input.

5.3 Household Experiences

5.3.1 The Impact of the UHIE on Melville

Climate change was not identified as a concept impacting the lives of the respondents. 9 of the 25 respondents claimed climate change had started to take effect in their homes and daily living. This is after the unanimous belief that climate change was real. The absence of feeling the effects of climate change may be due to the average length of living in Melville set at 9.8 years. According to Duerden (2004), newcomers to communities do not notice a change in events linked to climate change as the older generation may perceive them. Hence, only 2 of the 25 respondents felt added heat as a cause of discomfort in their homes.

Table 5.1: Responses to the effect of climate change felt by residents of Melville.

	Yes	No
Have you felt the effect of climate change in Melville?	9	16
Is added heat causing you discomfort?	2	23

Comprehension of the definition for the UHI was sought after to find whether any effects felt by respondents could be associated with the UHI. Analysing the level of comprehension requires a reference point to which standards are categorically compared (Yockey and Kruml, 2009). A good reply was based on understanding where the UHI is found and why it occurs. Respondent 15 described the UHI as “an urban centre is hotter than its surrounding countryside. This is because of the nature of infrastructure and economic activities.” This answer understood both the location and the reason for its existence and was therefore deemed as understanding. 8 respondents had a good understanding of the UHI. A further 4 had a limited understanding answering with an understanding of either its definition or causes. Respondent 17 stated it is the “effect concrete and tarmac have on temperatures of cities” whereas respondent 18 believed the UHI “involves greater carbon emissions because of dense human populations.” A further 13 respondents had either never heard of the term or did not have an idea of what it entails, why it exists or what the repercussions of it are.

Table 5.2: The classification of understanding of the UHI.

	Yes	No	Slightly
Are you aware of the UHI?	8	13	4

Respondents were then given a list of known causes and effects of the UHI and were asked to tick all felt effects. Discrepancies start to occur with answers provided about the effects felt from climate change and an increase in heat (see figure 5.2). Heat related-illnesses were completely unfelt. This may be due to personal reasons, causes not known linked to heat, or heat not causing any damage.

An increase in heatwave and drought occurrences was stressed by 7 respondents as events becoming more regular. This aligns with the expectation of the CoJ (2009) and the information provided by Accuweather (2019) with daily highest temperatures recorded in 2019 regularly higher than the highest temperatures on average felt (timeline for average unknown) (see figure 5.1). 2020, however, does not identify with similarly high temperatures as 2019. The average temperature from 1 January 2019 up until 31 December 2019 stood at 23.84°C and the same dates for 2020 stood at 22.43°C. According to Maithani *et al.* (2020), urban areas with large open spaces and medium to low density felt the greatest drop in temperature in land surface temperatures during lockdown periods for

COVID-19. Therefore, Melville's 2020 temperatures could be consistently lower than the average. Kumar *et al.* (2020) similarly found air pollution in major Indian cities dropped by as much as 54%, thereby reducing the UHIE. Fluctuations in temperatures could be a sign of climate change, as they lead to invariable weather conditions and have an impact on the way residents perceive the idea (Lang, 2014).

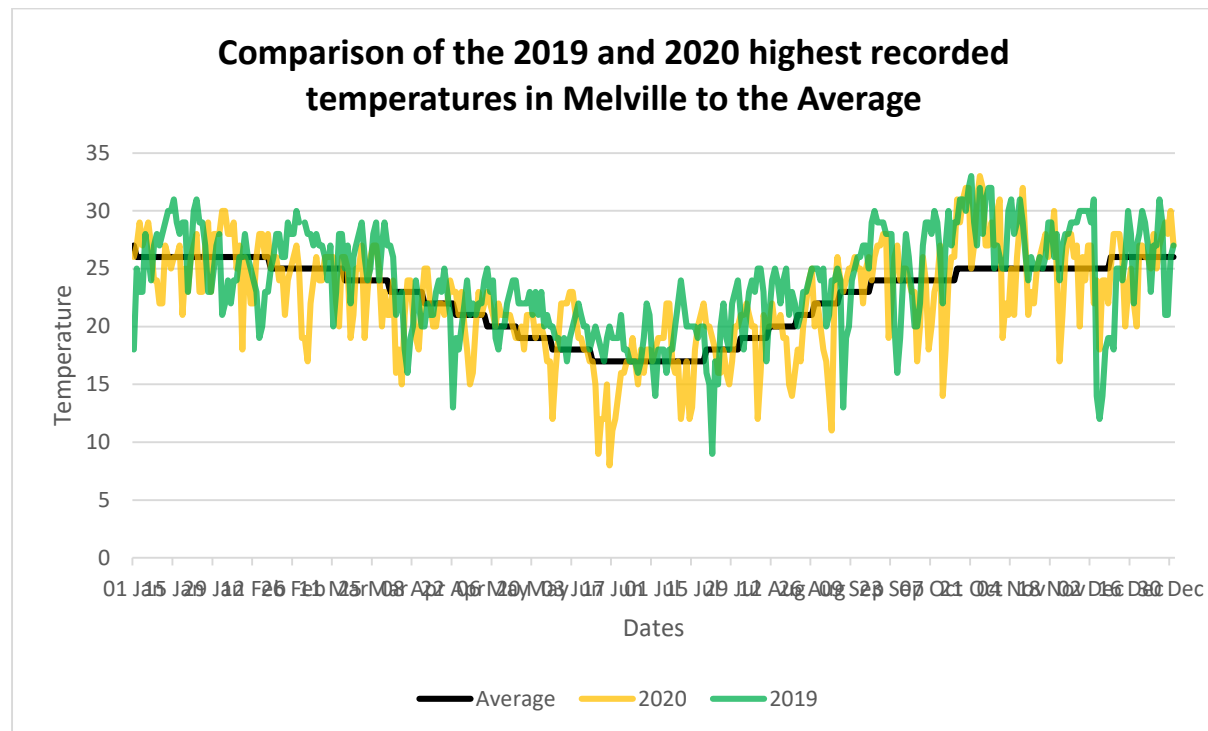


Figure 5.1: Temperature highs from 1 January – 31 December in 2019 and 2020 compared to the average high recorded temperature.

Decreasing presence of vegetation was selected by 6 respondents, whereas the lack of shade by 3. Although the number of responses was unexpected, the satellite imagery from Google (2020) indicates street frontages show a greater greenery presence than backyards. Trees in backyards appear to be clustered rather than evenly spread like street trees. There are visibly more trees in backyards, however, these are smaller in scale than street trees. This can be down to the pruning of trees for the reducing of fire hazards and structural damage to roofs (Stewart, 2016); or reduction of backyard sizes with time (Head and Muir, 2005). These numbers align with the estimations made back in 2006, where the total urban forest was valued at 10 million trees of which 6.4 million were expected to have come from backyards (Johannesburg City Parks and Zoos, 2007).

The most common felt change is increased vehicular traffic. Due to the emissions associated with vehicles, this is possibly the greatest source of the UHIE in Melville. Additional traffic comes from Kingsway/Perth Road where drivers are looking for a shortcut between Main Road and Barry Hertzog. This is especially seen on 1st, 2nd, 3rd and 4th Avenues. The steep streets in Melville previously did not allow for traffic calming features to be implemented, although current changes are being made to the application process by the Johannesburg Road Agency. Increased vehicular traffic is related to the change in land use which 9 respondents emphasised was changing. An increase in the number of bed and breakfasts, bars and businesses spread over Melville are visible changes. Suburbs are thus evolving and providing opportunities for future modifications.

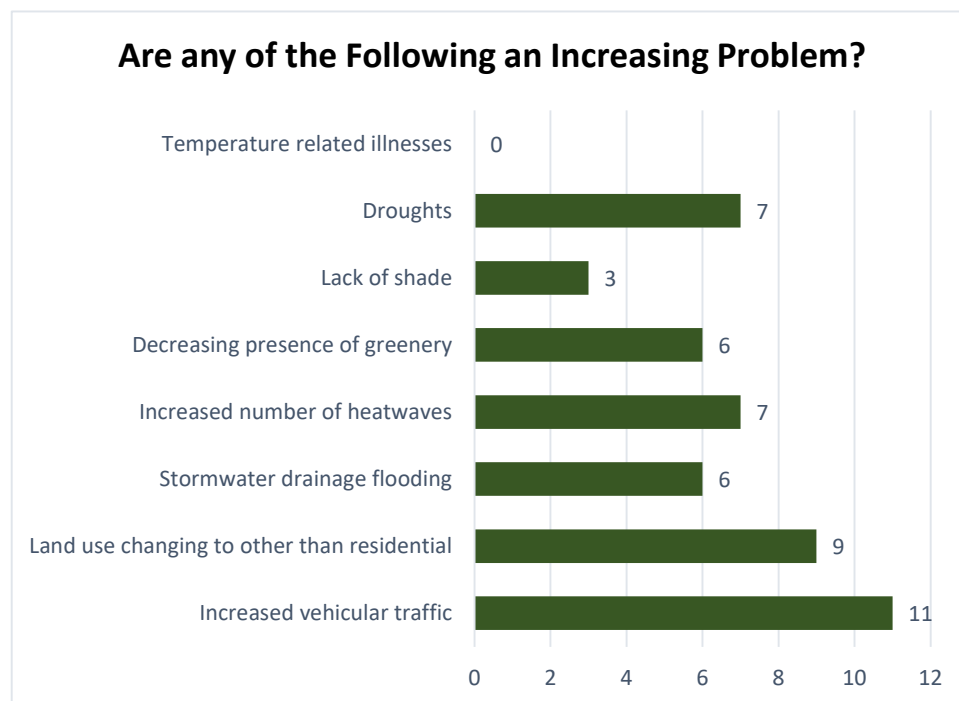


Figure 5.2: Summary of the effects felt by residents associated with the UHI.

5.3.2 Changes Made by Melville Residents to Adapt to the Impacts of the UHIE

To find whether residents are further exacerbating the UHI, adding to the cause of climate change or adapting to the impacts of climate change, respondents were asked to indicate whether their homes had certain features contributing to the UHIE (see figure 5.3). Man-made surface coverage rather than natural vegetation was a highlighted problem in Melville. 14 respondents replied by stating man-made (brick, cement, wood or asphalt) surfaces were a prominent feature in their backyards. The perceived backyard greenery is again not entirely accurate as the façade of the wall ensures backyards remain unseen but is assumed to be vegetated (Parker, 2008).

In terms of dealing with direct heat and light, 6 respondents believe their homes are poorly insulated and are struggling with excess heat. An additional 5 respondents do not have sufficient natural light filtering inside, placing a need for electrical lighting and heating for warmth or airflow for cooling. This is backed up with 18 respondents stating they have a heater at home. Fascinatingly, only one respondent had an air-conditioning system at home. Heating and cooling devices are one of the largest contributors to the UHIE as the waste heat from used electricity to warm homes and provide light inside influences the growing urban metabolism (Jain *et al.*, 2018).

Dependency on private transportation is undeniable as poor walkability, lack of security, sprawled state of the city and external job opportunities led to 24 car owners. Emissions associated with transport are often cited as the biggest influencers on the UHI and a change in mindset towards public transport is a clear starting point for tackling the UHI (Che-Ani *et al.*, 2009).

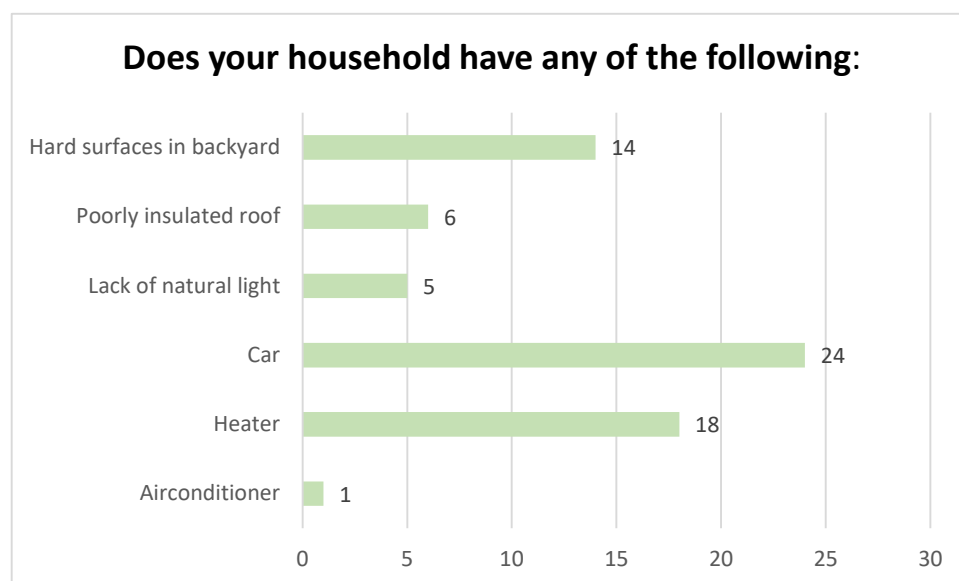


Figure 5.3: UHIE sources at home.

Respondents were asked to indicate from a list of environmentally-friendly initiatives that they have participated in (see figure 5.4). Recycling is the most common activity residents participated in with 18 respondents actively recycling. However, respondent 23 highlighted that recycling must be made “easier” and be done “in a way where it doesn't cause littering due to people rummaging through bins and spilling the contents all over the street.”

Vegetation found outside the walled area, in the public domain, is the second-highest indicator for positive adaptation to the UHI. 11 respondents indicated having green space outside. This is important for the aesthetic of the suburb while the associated ecological services are important for reducing the UHI (Schiappacasse and Müller, 2015). The absence of outside greenery could point towards the existence of a sidewalk. These are commonly found on only one of the sides of the street. The balance between greenery and urban coverage needs to be found and highlighted in urban management strategies that negotiate the amount of green coverage required per household.

The addition of vegetation inside the walled space in the form of vegetable gardens and fruit trees providing multifunctional purposes was highlighted by 14 respondents. Improvements in air quality, recreational ability, urban food supply and creating a synergy between biogeochemical cycles are associated with urban agricultural activities (de Zeeuw and Drechsel, 2015). Growing food is likely to be cheaper and can also be sold if a surplus is created. However, the greatest benefit comes from people not travelling to shops to buy fruit and vegetables thereby releasing GHGs into the atmosphere and reducing the demand for large-scale agricultural activities.

Roofing plays an important role in heat absorption and reflection. It is problematic that only 1 respondent has a white roof maximising the albedo rate, and 1 further respondent with a green roof backing up figure 4.9. Although, 7 respondents indicated that they had insulated roofs installed. According to Bowden *et al.* (2019), the lack of adaptation is merely due to climate change rejection. However, all respondents indicated the opposite. The fear of losing property value or the characteristic of the suburb is driven by socio-economic solidarity (Lupi and Musterd, 2006).

Introduction of solar panels and solar geysers with 6 and 4 respondents having implemented them respectively shows the willingness and ability for households to make changes with long-term devices. Improvements in technology will continuously reduce the cost of installing these devices and become more popular with time (Baran *et al.*, 2017). The impact these have on urban metabolism is evident as a reduced energy requirement allows for less wasted energy.

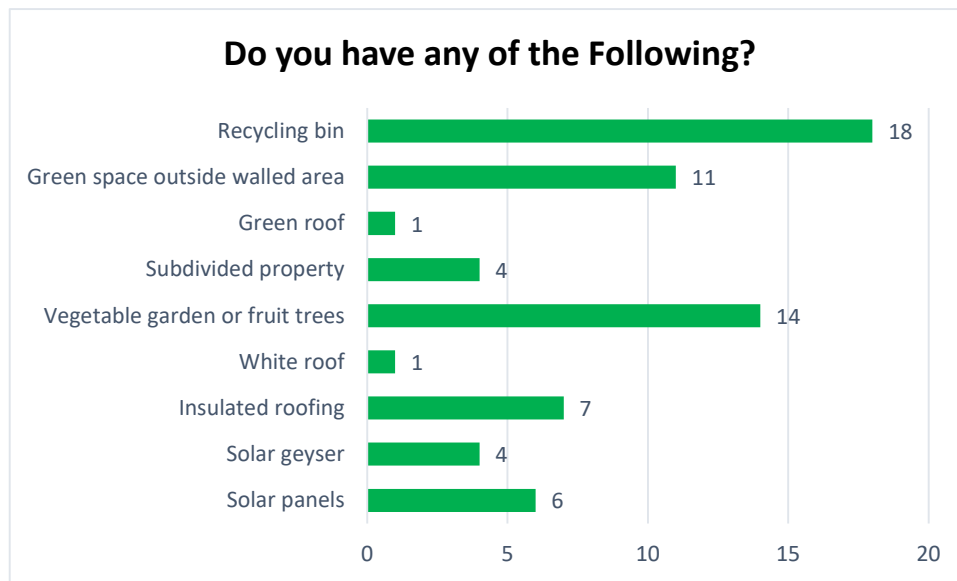


Figure 5.4: The presence of environmentally-friendly concepts in the households of Melville.

The environmentally-friendly concepts implemented by residents are mirrored by physical changes (see figure 5.5). Not all changes made benefit the reduction of the UHIE. 1 respondent recently covered their patio, whereas a further 2 removed greenery and trees from their dwelling. The addition of urban coverage and reduction of natural vegetation is extremely counterproductive to UHIE reductions. However, 6 respondents have added additional plants. 1 of these 6 indicated that they removed non-indigenous tree species before planting endemic genera.

Positive changes have been made in energy-saving features. Most notably the installation of gas instead of electricity by 2 respondents, installation of solar panels by 3 respondents, and installation of solar power lighting by 2 respondents. Options related to solar power have greater long-term gains than gas and simultaneously reduce the UHIE through its benefits (Santamouris *et al.*, 2019).

The recycling of greywater by 1 respondent and the addition of catchment water tanks by 2 have minimal impact at the current level of UHI reduction. However, it does have implications for climate change as water is not wasted in stormwater drainage and heating of waterways. Where the ground is moister from water in the garden the ability to cool down the surrounding area is vastly improved and the UHIE is reduced through evapotranspiration (Mauree *et al.*, 2019).

Physical changes to the outside of **houses** have also been made. 5 respondents indicated that they painted their house's exterior. Although the colour is not specified, dark colours are of a lower frequency than lighter colours when observing Melville. However, the possibility of respondents painting the house in a darker colour cannot be ruled out. The same is stated of the roof colour, as it is not clear what colour was chosen. However, newer paint is likelier to be beneficial to the reduction of the UHI rather than an ageing material due to its reflective ability (Sen and Roesler, 2016).

Table 5.3 illustrates the correlation between respondents making adaptations to their homes and an understanding of climate change and the UHI. When no understanding of the UHI is provided 5 respondents made physical changes, whereas 7 did when the concepts were understood. In all circumstances where no understanding of the UHI and climate change are provided, no changes have been made. **This is interesting as it emphasises the importance of education in urban management and how co-production of knowledge is the driving force to ensuring proper education is provided.** Additionally, 2 respondents did not provide a clear definition of climate change but did for the UHI both of whom made significant changes to adapt to the UHI. Where an understanding of both the UHI and climate change are provided 6 respondents made a change, whereas 4 did not make a change. **If extrapolated, the numbers could point towards the importance of knowledge on these concepts must be prioritised if major changes to the UHI want to be seen in suburban landscapes, however, this is based on causality rather than the evidence from the questionnaire.**

Table 5.3: The correlation between changes made and understanding of climate change and UHI.

Respondent	UHI Understanding	Changes Made	Climate Change Understanding
1	✗	✗	±
2	✓	Painted exterior	✗
3	✓	Painted exterior, covered patio, solar panel implementation, vegetable garden	✓
4	±	✗	✓
5	±	Planted trees	±
6	✗	Painted roof, planted vegetation	✓
7	✗	Planted vegetation	✓
8	±	Painted, implemented solar panels, insulated roof	✓
9	✓	✗	✓
10	✗	✗	±
11	✓	✗	✓
12	✓	Maintained tree coverage	✓
13	✓	✗	✓
14	✓	Painted, implemented solar panels, greywater system, gas installed	✓
15	✗	Insulated roof	✓
16	✗	✗	±
17	✗	Water tank, planted vegetation	✓
18	✗	Painted, planted vegetation	✓
19	✗	✗	✗
20	✓	Painted, water tank implementation, solar panel implementation	✗
21	✗	✗	✗
22	✗	Painted and waterproofed roof	✓
23	✗	✗	✓
24	✓	Painted roof, implemented solar panels	✓
25	✗	✗	✓

The total changes registered by all respondents add up to 30, averaging out to 1.2 changes per household. However, 6 respondents had made 0 changes, while a further 5 left the question unanswered. Therefore, no less than 14 respondents had made physical changes. With more than half the respondents making changes a positive stance can be taken on the results. In isolation, these small changes could look insignificant, but if extrapolated, the

total number of changes amounts to 1948 in Melville alone. If each household would make 1 positive change in their household then the UHI could indeed be reduced.

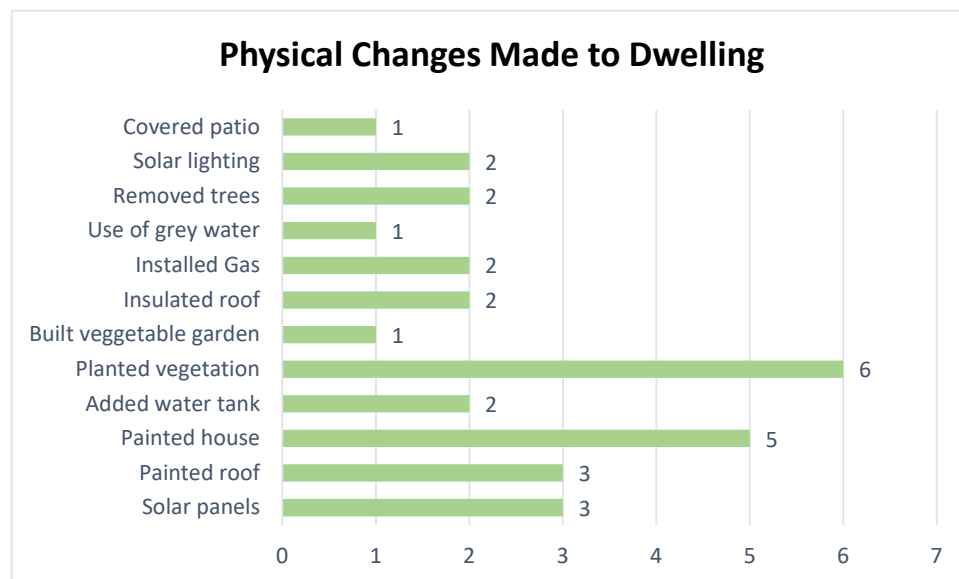


Figure 5.5: Physical changes made to dwellings by respondents.

When asked to provide a reason for set changes, 12 respondents stated comfort and environmental reasons for the change. Interestingly, only 3 respondents did this for cutting long-term financial costs. This could point towards limited knowledge of the financial benefits of making environmentally-friendly changes. Furthermore, a lack of financial reasoning could be due to low levels of concern for financials as comfort and aesthetics are regarded as more important. This could be problematic in itself as aesthetics could overlook the importance of the environmental degradation process. However, the high importance placed on changes with environmental sustainability in mind does not align with this. Rather changes made appear to combine comfort, aesthetics and environmental factors when making physical changes to their homes.

Table 5.4: Reasoning for making changes to the household.

Reason for changes made	
Aesthetic	8
Financial	3
Environmental	12
Comfort	12

5.3.3 How Urban Management Practices Help Reduce the UHIE in the CoJ

Urban management plays a prominent role in the provision of services but requires policy to support it. Respondents were therefore asked whether they are planning on making future environmental changes to their homes before the existence of any policy. 16 respondents shared intent in making changes shortly which would have positive environmental impacts. Residents thus appear to be willing to make changes as residents are seeing the effects of climate change first hand.

Urban management is local governments responsibility. However, according to the Gauteng City-Region Observatory's (2017) Quality of Life Survey, only 30.2-41.2% of Melville residents were satisfied with the local government. When asked whether it should be residents or local government to take charge in reducing the UHIE, 16 respondents articulated there should be a partnership. Respondent 24 stated "residents can implement environmentally friendly ways of living. However local government should have policies and ordinances encouraging people to live in an environmentally friendly way." Implementing policy created for suburbia will require one stakeholder from any side to get the process started. Respondent 20 rather emphasises that "without the help of local government, the burden is too much on the residents alone, especially without policies to assist and without the residents contributing and willing to help, local government can only do so much." Understanding municipalities are limited in financial ability to provide climate change policy (Ziervogel *et al.*, 2010) and according to Pasquini *et al.* (2013:228) further lack the "credible, practical and relevant information on climate change impacts as well as possible adaptation measures" is critical for residents to take the lead.

Table 5.5: Choices given to decide who the main stakeholder ought to be in UHI mitigation in Melville.

Who should reduce the UHIE in Melville?	
Residents	3
Local government	1
Both	16
The focus needs to be elsewhere	3

The above question raised an emphasis on PPPs to guide the process of UHI mitigation. 22 respondents would be willing to follow and stick to a newly implemented policy. This would

likely reduce the UHIE in the surrounding area. The provision of an implementable strategy creates trust between the municipality and residents.

Respondents were asked what a new plan or strategy ought to entail which would reduce the UHIE and simultaneously allow residents to make changes (see figure 5.6). 11 respondents thought strategies related to planting vegetation or sustainable gardening projects are assumed to be easily implementable, require minimal maintenance and have quick showing results. However, Carmichael and McDonough (2018) found the lifecycle of such projects was not incorporated into plans and financial or human resources could not be plausibly provided by the CoJ. Rather this should be a community initiative.

Calls for rebates, tax reductions and subsidisations for the implementation of environmentally friendly and energy-efficient products was recommended by 7 respondents. Subsidising solar panels and solar geysers had 2 recommendations, similarly to rebates for those who recycle and 3 who argued for the option to sell unused electricity into the grid. A reward system, based on market-based instruments much like tax reduction and incentives are often seen as a system to try and capture residents to change habits and lifestyles (Rashid, 2018). Providing this option would open the conversation between residents and local government. Additionally, this could grow public participation and the efficiency of rolling out environmentally friendly services to reduce the UHIE in suburbs.

Transportation was also highlighted as a future opportunity. Although “reducing vehicle emissions” is not directly the role of the urban manager, reducing traffic, creating walk-only streets, and increasing public transport is. The Melville Residents Association (2016) is currently attempting to approve a precinct plan making 7th street a pedestrian zone thus cutting out unwanted traffic; creating connectivity to the Rea Vaya BRT system; developing a sustainable economy integrating with the ideals of the original Corridors of Freedom plan. This plan furthermore emphasises the safety of streets such as Beyers Naude Drive and is looking to bring a level of walkability to Melville.

Education on the effects of the UHI has only been proposed by 1 respondent. With the sharing of knowledge, people may learn about new opportunities resulting in financial and environmental benefits. This in turn starts the process to enable people to make changes.

An interesting idea brought forth by 1 respondent was business accountability. According to Hadziosmanovic (2017), this requires businesses to recognise their impact on climate change, remain transparent in their impact on climate change, and accept responsibility for making changes. Business accountability ensures businesses follow public objectives and simultaneously educate residents. Successes then spread to individual homes where the UHIE is combatted.

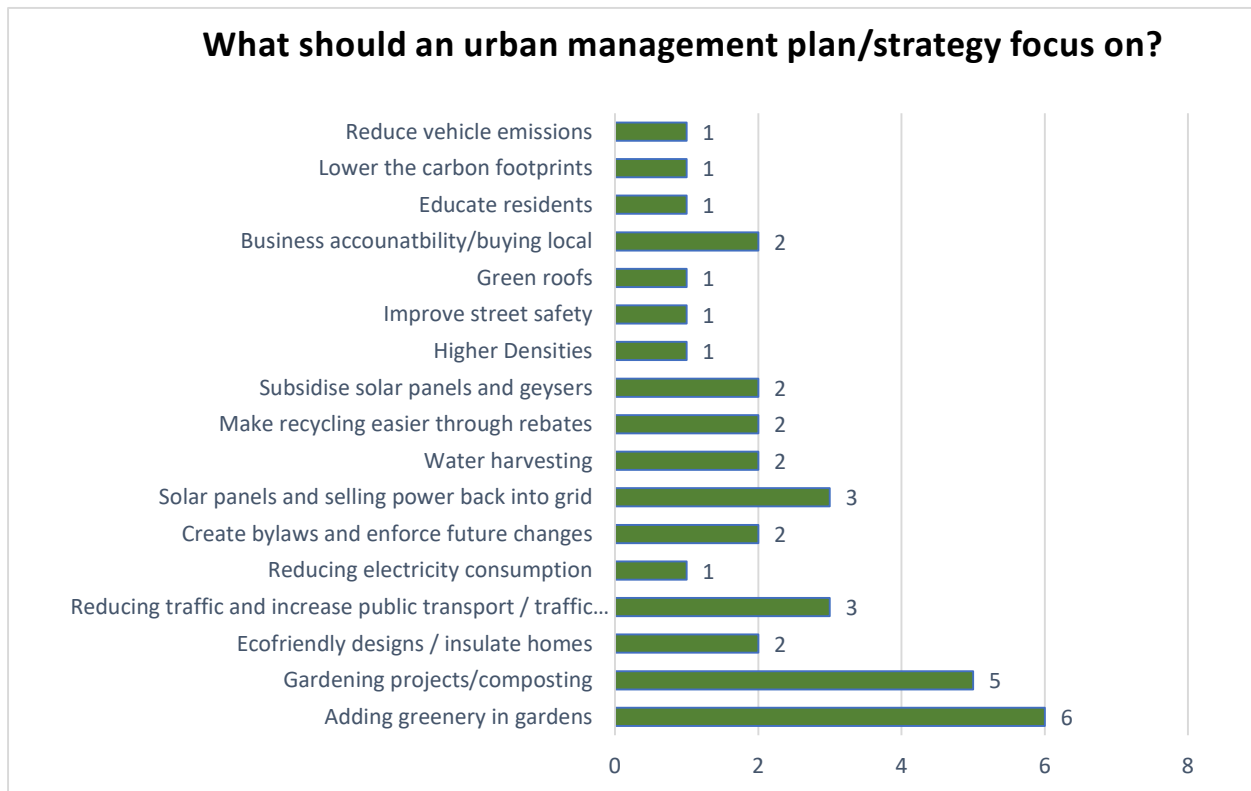


Figure 5.6: Ideas brought forward by residents which should be incorporated into new plans and strategies to combat the UHIE.

Table 5.6: Recommendations on how a new plan, strategy or program should go ahead in resolving the UHIE problems in Melville.

What is required to make these changes?	
More planting programmes	2
Reduce electricity consumption	1
Policies & by-law creation	4
Co-operation between professionals and government	1
Provision / encourage recycling	2
Subsidised alternative energy generation	4
Large scale food garden projects	1
Government guidance	1
Green space preservation	1
Eco-friendly architecture	1
Education, weekly talks and website maintenance	2
Water tanks and borehole installation subsidization	1
Local councillor takes greater responsibility	1
Indigenous vegetation planting	1

5.4 The New Urban Management Model

Findings from respondents have indicated the methods used by residents in their attempts to make climate change adaptations. Contextual knowledge must drive a new approach to ensure the applicability and willingness to use the model. The findings have produced a clear need for an approach to driving the human and environmental components of cities which have been neglected up until now. Furthermore, the creation of partnerships between all stakeholders is highlighted clearly as the desire for co-operative learning is required to ensure a better understanding of climate change and the UHIE. Instead of using approaches with opposite aspirations, principles and views on managing urban areas, the humanistic, participatory and new urbanism approaches allow for these opportunities to be created with overlapping characteristics (see figure 5.7) allowing for different urban management tools to be implemented.

5.5 Key Components of the New Model

The current urban management model lacks efficiency in delivering environmentally just programs to residents. The model below is not designed to create a new method in policy-making but rather attempts to bring a cohesive approach that streamlines its efficiency and brings into play new tools and processes in the hope of achieving this. In doing so, this approach is geared towards being able to incorporate environmental objectives to go hand

in hand with national, provincial and local objectives. The inclusion of UHI policy in specific has been tackled here in the hope that they may be enforced in areas including suburbia making the transformation towards environmental justice easier.

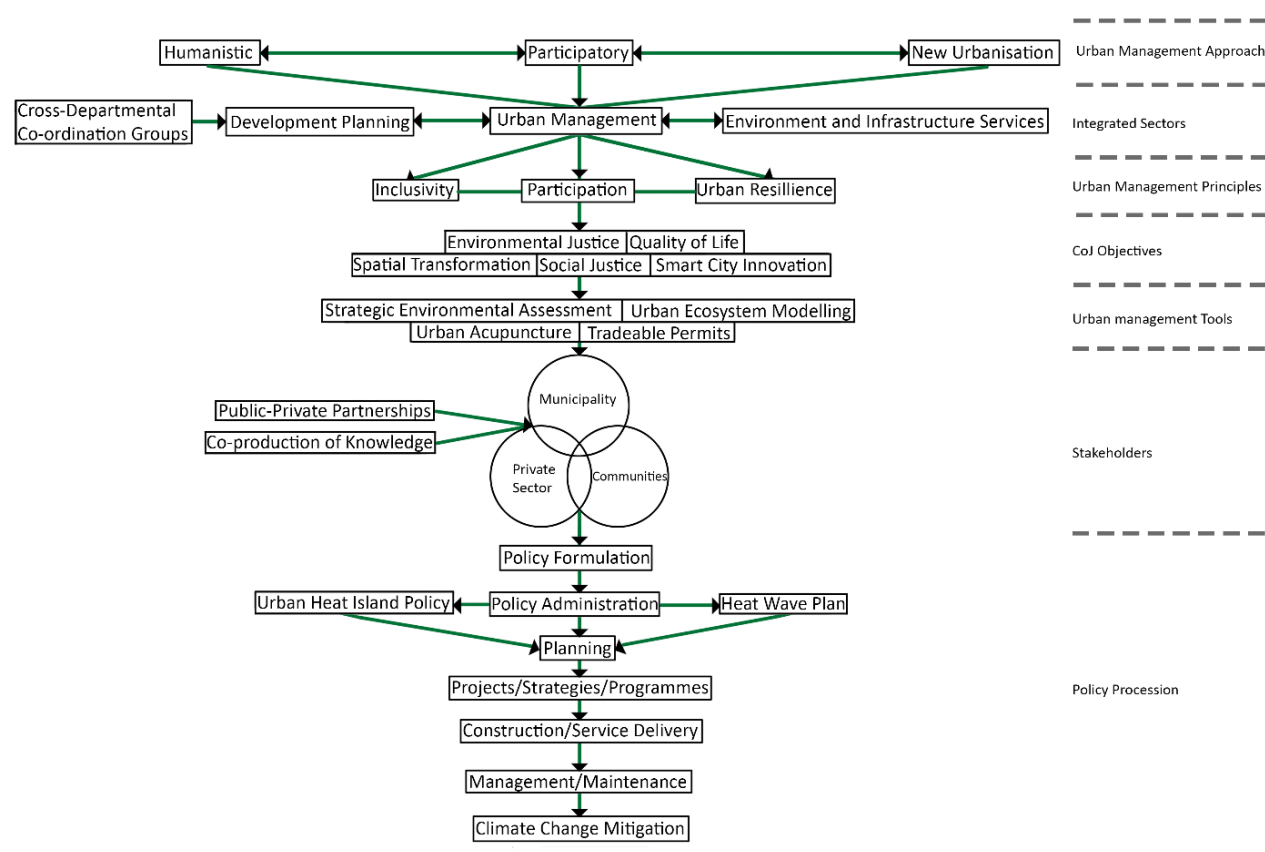


Figure 5.7: New urban management model allowing for alignment of policies through the introduction of new approaches, principles and tools.

The urban management approaches chosen to drive the environmental transformation have overlapping characteristics to build from each other (see table 5.7). Human decisions are placed at the heart of these approaches and place the community in the driving seat for developing a relationship with the private sector and the municipality. Ensuring the base of the model allows for multiple approaches to work together sets a strong base wherefrom the rest can be built.

Table 5.7: Overlapping characteristics of the new proposed urban management approaches

Humanistic	Participatory	New Urbanisation
Human-orientated	Social justice	Social fairness
Quality of Life	Political and technical understanding	Sustainable development
Public participation	Public participation	Power of community
Public satisfaction	Decentralisation	Dynamic ecology

5.5.1 New Relationship Between Stakeholders

Characteristics of the urban management approaches bring into play the EISD and DPD.

Urban management plays a central role in the development of new policy, and bring in key developmental and environmental planning principles into policy. The cross-departmental collaboration envisaged in the model reduces barriers to policy development and coordination (Yang, 2021) (see figure 2.3). Gustafsson *et al.* (2019), argue for a cross-departmental coordination group. These groups are temporary fixtures that are disbanded when mutual understanding is reached and departments have an understanding of one another's goals and objectives. This is an important feature for this new model and must be developed to ensure maximum efficiency and alignment in environmental policy implementation. This model does not aim to place less importance on the objectives the CoJ currently has in place, rather a greater emphasis on environmental and climate change policy through better management of inter-departmental relations.

5.5.2 Bringing into Play New Tools for Tackling the UHI

The highlighted urban management tools help ensure that urban geometry, urban coverage and urban vegetation are tackled accordingly. This ensures policies incorporate the UHI into climate change policy and allow for urban management to play a role in mitigating and adapting to climate change. Urban retrofitting and urban ecosystem modelling provide opportunities for densification and compactness to increase while ensuring a sustainable approach and inclusion of green spaces. The inclusion of CoJ objectives will allow for the alignment with developmental policy, thus ensuring these are not compromised and continue to operate without any change. Urban management, EISD and DPD will require coordination as they each play an important role in the lifecycle of these projects. Urban management especially is needed in the planning and maintenance of new projects.

Urban coverage can use urban acupuncture to find where the areas of need are located. This provides information as to where projects may be implemented in the future, what resources to use and at what scale this should be implemented. The participatory approach comes through strongly in this tool allowing for the personalisation of projects. The new urban management tools will be used in conjunction with a new policy such as the newly approved green building draft in the CoJ. This allows for the inclusion of new policies and tools to go hand in hand with each other, ensuring an alignment between the objectives.

Urban vegetation will make use of the urban ecosystem modelling tool to develop how vegetation can be maximized in suburban developments. This tool is important in driving inclusion and equity principles in the spreading of vegetation and reaping these benefits. In terms of the UHI, ensuring strongly vegetated suburbia is likely to reduce the impact on the surrounding communities. The misalignment in climate change policies is reduced by providing new methods in creating urban spaces that are integrated with natural components and provide economic growth.

Strategic Environmental Assessment brings all approaches together through creating strategies integrating environmental economic and social issues. This provides a base in long-term development planning policies, helping guide the direction into which climate change policy will go. By ensuring urban geometry, vegetation and coverage are tackled, UHI adaptation and mitigation may become a locally understood concept.

Table 5.8: Overlapping approaches of the urban management tools explored in the new urban management model.

Urban acupuncture	Strategic Environmental Assessment	Tradeable permits	Urban ecosystem model
Humanistic	Humanistic	Humanistic	
Participatory	Participatory	Participatory	Participatory
	New Urbanisation	New Urbanisation	New Urbanisation

5.5.3 Urban Management Principles

Three main principles defining the new model are seen in all tools. Urban resilience is a well-documented principle used in various policies in the CoJ. McGill (2020) provides a checklist for the making of a resilient city. The list includes investing in infrastructure to help reduce the impact of climate change, protecting ecosystems and natural ecosystems to mitigate climate change impacts and enforce realistic land use planning principles. Urban resilience is also a main component of the new urbanisation approach as social fairness, sustainable development and ecological features are a driver of new urbanisation. Setting urban resilience as the main principle ensures a focus on developmental, economic and social factors, but at the same time has environmental applicability. The entire urban environment is thus tackled and provides an opportunity for city-wide application. Suburbia, which is not resilient due to its high consumption levels and dependency on electricity, cars and oil (Newman *et al.*, 2017), will undergo a transformational process with a resilient approach.

Public participatory processes are mandatory in South Africa as per Section 152(1) of the Constitution. The current model of urban management feeds this notion due to the lack of PPPs and communication between stakeholders. Lack of municipalities' financial power has rendered participatory raised problems near-impossible to incorporate into budgets regardless of traditional and market-based approaches raising taxes (Kariuki, 2020).

Participation will remain a core principle of the new urban management model, however, certain tools will have to be implemented. The notion of co-production of knowledge is the key to enable change. Klenk *et al.* (2017) argue local co-production of knowledge is required to inform decision-making at larger scales for climate change mitigation. Urban management officials can thus learn what is required from locals and combine this with scientific knowledge. The participatory approach especially creates changes while drawing on the humanistic approach to ensure participation is held for a greater QoL rather than economics as a decision-making tool.

The principle of inclusivity is drawn from participation. Urban spaces need to be inclusive in all departments. Through the use of urban management tools like urban acupuncture, crime hotspots are identified and reduced through proper planning. Converting such spots into inclusive and available spaces introduces walkability and reduces the dependency on vehicles in suburbs. Importantly, environmental improvements are also implemented through social objectives integrated by participatory and humanistic approaches. Tradeable permits similarly do not have to be introduced for carbon emissions, but perhaps the reduction of car travel and congestion (Brands *et al.*, 2020). In terms of inclusivity, by reducing the need for cars, public transport becomes better used. This will have an impact on the income of public transport systems and likely expanding of networks, thus including more people. Inclusivity, therefore, has long-term plans brought about by SEA while simultaneously implementing environmental objectives linked to social and economic plans.

5.6 Conclusion

The questionnaire highlighted the problems seen in Melville with regard to urban coverage and urban geometry. Simultaneously, environmentally-friendly activities that households are completing have been identified, before finding what residents are doing to tackle the UHIE. The planting of vegetation, re-using of water, painting of surfaces, implementation of solar panels, solar geysers and gas as alternative energy sources were the clear points of

change made by residents. It became clear that households with an understanding of climate change and the UHI were likelier to have made changes to their homes. Regardless of the scale of the changes, respondents that were unaware of the UHI were unlikely to participate in environmentally-friendly activities. Furthermore, the number of respondents involved in creating change is limited. The recommendations for the resolving of the UHIE came in the notable forms of greening programs, policy creation, eco-friendly designs, education, subsidisation, and traffic reduction strategies. Public and contextual knowledge on the needs and problems of Melville has been identified and was used in the development of the new urban management model to align policies for UHI reduction. Besides the satellite data compiled by Hardy and Nel (2015) to indicate the presence of a UHIE in Melville, this is currently the only form of data that can back up the graphic illustration.

Chapter 6 - Conclusion and Recommendations

6.1 Introduction

This research report has attempted to provide an insight into the UHIE felt by residents of Melville, how they have adapted and how urban management practices help ensure the alignment of climate change policy. The original hypothesis arguing the unlikeliness of alignment of climate change policy in the CoJ was correct. However, residents proved that adaptation had evolved further than adding additional greenery. I expected that there would be a misunderstanding of the impacts of climate change as actual UHI effects. This was clear from the responses as known causes of the UHI were highlighted, regardless of not originally feeling the effects of the UHI. The urban management model helps align future policies and integrates the issues raised by residents, therefore, justifying it.

Chapter 6 summarises the findings of this research. Further recommendations for the future design of Melville are provided incorporating the identified problems by residents and providing implementable changes. This chapter concludes by answering the sub-questions and what the implications will be for future literature, urban planning and urban management.

6.2 Summary of Findings

Misalignment between policies of all scales is evident in table 2.2. The biggest misalignment lies between developmental and environmental policies. The IDP and GDS are, as expected, aligned with each other in terms of the criteria provided. However, the CCAP has no participatory component to it; limited efficiency understanding; and is not designed for integration between policies, departments and sectors. The CCSF and ESSAP further have limited integration tools and efficiency plans respectively. This limits the ability of environmental and climate change policy to be integrated with the likes of international, national and local developmental policies. This impacts the ability to integrate climate change policy in the CoJ and could point towards the lack of applicable and up-to-date policy available in the CoJ. Gaps in the policy alignment were caused due to the out-of-date urban management approaches deciding their principles.

The lack of climate change policy and local implementation projects were clear from the policy review and simultaneously by the residents. The online questionnaire showed 32% of respondents had a limited understanding of climate change, whereas a further 68% had

limited to no understanding of the UHI. Lack of local knowledge on climate change pointed towards the made changes. Of the 25 respondents, 30 changes were made impacting the reduction of the UHI. However, only 14 respondents made physical changes to their homes, implying a significant proportion of respondents not making changes. Additionally, the correlation between the lack of climate change or UHI knowledge and the possibility of making physical changes was seen. The chance of homes not implementing changes with limited knowledge stands at 42%, whereas knowledge of the UHI improves the implementation rate to 58%. Understanding both climate change and the UHI showed a 60% chance of change.

Knowledge of the UHIE did not point towards feeling effects with only 8% of respondents feeling the UHIE. However, the effects of **climate change** were widely felt. 28% saw an increase in droughts, 28% felt an increased number of heatwaves, 12% a decreasing presence of shade, 24% a decreasing presence of greenery and vegetation, 24% experienced extra flooding, 36% found a growing diversity in land uses and 44% found an increase in vehicular traffic in Melville. The increase in carbon emissions and decreasing natural vegetation to absorb these emissions while providing shade to counter urban surfaces from absorbing incoming solar radiation are both core components of the UHI. The UHIE is therefore masked by the amenities which are not equitably available throughout the CoJ.

The new urban management model was developed for the alignment of policies and urban management practices through new tools. The introduction of urban acupuncture, SEA, tradeable permits and the urban ecosystem model is compatible with the new urban management model approaches and each other. Adoption of these tools could allow the introduction of improved information creation and sharing; to integrate, stakeholders and sectors thus improving the original model; and the alignment between all local developmental and climate change policy.

6.3 Re-evaluating the Research Questions

6.3.1 How the CoJ Understands the UHI

Lack of the UHI term in all policies in the CoJ does not project confidence of understanding. However, the CoJ provides a good definition of the concept in the CCAP, stating that urban land modification and waste heat are its main contributors. This was evident in Melville as consumption levels generate a large amount of waste heat. A single definition cannot,

however, be argued as a great understanding of the UHI. The lack of policies, strategies and plans point towards little understanding. The severity of these concepts could have disastrous outcomes when heatwaves inevitably increase in frequency. The deficiency of policy integration has possibly harmed residents understanding of climate change phenomenon due to the lack of grassroots projects and implementation thereof. 52% of the respondents had no idea what the UHI was, and a further 16% appeared to guess the concept due to its name. 68% of the respondents thus had little to no knowledge on the topic and point towards the UHI being an underdeveloped concept in policy.

6.3.2 How the CoJ Integrated the UHIE into Policy

Policy misalignment mapping showed the disorder between policies, including environmental objectives. The UHI is only looked at in the CCAP and CCSF. With 6 years between them, the UHI is merely mentioned in policies as a concern but needs to be seen as a threat to the health of residents with regards to reducing air quality, increasing costs at home and strain on the healthcare system. This is the extent to which the UHI is integrated into the CoJ policy. The Heat Wave Plan which has been in the pipeline for 11 years is still to be released to the public. The future for UHI adaptation and mitigation in the CoJ is limited and has not been prioritised. This is partly due to spatial transformation and service delivery being the CoJ's biggest priorities at the moment. However, the rise of sustainability policies in the CoJ points towards a lack of resource availability to deal with this problem. This includes human resources for education and training but also financial resources for the implementation of plans and strategies.

6.3.3 The Impact of the UHIE on Melville

Direct impact of the UHIE was limited in Melville. However, all effects of the UHI which were provided to respondents were felt, apart from major health complications. Lack of knowledge on UHIs played a large role in the original understanding of its impacts. However, once a definition was provided it became evident the UHI was having a greater impact on the residents than previously understood. An analysis of the recorded temperatures in Melville illustrates an increase in temperatures and high peaks along with extreme lows. Climate change is silently impacting Melville residents where it appears that many did not know to attribute these felt and seen changes to the UHIE. Changes occurring in and surrounding Melville will continue to be exacerbated with time if changes are not made. Numerous households are poorly insulated, have a low albedo effect, lack natural lighting,

depend on cars, increase urban surfaces in backyards and implemented heating or cooling apparatus all adding to the strength of the UHI. Melville residents themselves have the opportunity to mask the effects through air-conditioners and private transport, but this is increasing UHIE.

6.3.4 Changes Made by Melville Residents

Changes residents have made were not all in response to the increasing impacts of climate change. Although 48% of respondents stated changes were made partially for environmental purposes, another 48% stated comfort decided reasoning for changes, whereas 32% made changes for aesthetics. Changes made included: solar lighting, covering of patios, removal of trees, recycling of greywater systems, gas installations, roof insulations, vegetable garden development, planted vegetation, added water catchment tanks, exterior painting of homes, painting of roofs, and the addition of solar panels. Although some changes were not made by the current owners or renters, changes made in Melville point towards reducing the impact of the UHIE.

6.3.5 How Urban Management Practices Reduce the UHIE in Melville

The urban management model provides a new method to take when aiming to develop an environmentally-related policy, including the UHI. Introducing a humanistic, participatory and new urbanism approach unlocks the potential for different urban management tools to run efficiently. These tools include urban acupuncture, urban ecosystem modelling, tradeable permits, and SEA. These tools have been tried and tested across the world allowing the CoJ to profit from previous mistakes. Introducing these practices will provide creative methods for achieving climate change policy alignment and implementation of plans or strategies.

6.4 How the Model Addresses the Main Question

Policy misalignment is seen across the world due to inconsistent or incomplete policies, lack of stringency in policies, and lack of effectiveness with implementation, monitoring and enforcement (Ashford and Renda, 2016). The new urban model provides alignment at the local scale, as opposed to a complete alignment with national and provincial spheres through a change in principles. An aligned policy approach is important for the coordination of efforts to provide services to meet the needs of multiple stakeholders and ensure effectiveness and efficiency (Daze *et al.*, 2018).

Alignment of policy is coupled with the developmental level of a country or city. According to a continuum developed by Daze *et al.* (2018) for policy alignment, South Africa is perceived to stand between informal and strategic alignment. This suggests policy is developed on a needs basis or policy is developed independently from each other but is searching for synergy. The new model aims for the complete strategic alignment of policy. Strategic alignment is based on the complete synergy between policy documents, formal coordination mechanisms for alignment and initiatives are shared between departments and stakeholders (*ibid*). The new model provides a structure for strategic alignment between climate change policies through its principles and tools.

The new model addresses the educational awareness gap in the old model. Cruz and Ospina (2019) state that to align policy there is a need for information-sharing tools between stakeholders. Cross-departmental coordination has been highlighted through a balanced relationship between urban management, EISD and DPD. Cruz and Ospina further highlight the necessity for greater institutional capacity at local government. Education and co-production of knowledge at all levels in local government are enhanced through the integration of stakeholders involved, rather than separate stakeholders with limited communication between them. The participatory approach especially is key for the implementation of participatory processes in the CoJ. Furthermore, ensuring better reporting on the monitoring of policies is enhanced as a major pillar for policy alignment (*ibid*). The new model aims at monitoring and evaluating policies through ensuring a continuous policy cycle and re-integrating the environmental principles at each level of the model.

The OECD (2015) have highlighted the importance of transformation in policy alignment models. The most important component for policy alignment is to ensure policy does not limit itself within a certain sector. Policies flowing over sectors improve through investment, taxation, innovation, skill, trade and adaptation. Additionally, if climate change ideals are to be integrated into policy, they must be done so within both the public and private spheres. Ensuring climate change policies are not merely linked to environmental improvement has been made by warranting the original CoJ developmental objectives remain in place.

6.5 Discussion

6.5.1 Implications for Scholarly Work

The literature covered in previous sections shows both similarities and differences between the results of this report. Urban cover has played the most important role in the UHI of Melville through the albedo effect and emissivity. Sen and Roesler (2016) found surfaces more than 2 years old start to lose their albedo effects and emissivity potential. 84% of the respondents stated their homes were older than 60 years old. Although this does not define the age of the roof, the original roofing materials are associated with these homes, thus making the age of the roof potentially old enough for poor reflective abilities. This research aligns with the findings from Ecuador (Torres-Quezada *et al.*, 2019) where much like Melville urban surfaces make up a core component of Melville. 54% of respondents stated having added impervious surfaces in their backyards decreasing the albedo effect and increasing emissivity. This has implications for heat absorption and stormwater drainage. Urban coverage findings in Melville correlate with those in the literature.

Urban geometry in Melville provides an opportunity for UHI mitigation. Xu *et al.* (2019), found the compactness index of the population does not require high values if densities of green spaces surrounding a location are high enough to overcome this. Melville consists of 69% single-standing dwellings with a population density of 1954 p/km². The poor compactness index of Melville directly impacts the heating of dwellings, thus creating more anthropogenic heat and waste. The observations found south and west-facing exterior walls providing shade for the public, whereas north and east-facing walls provided shade for private dwellings. Bekkouche *et al.* (2013) found smaller buildings to be better equipped to deal with heat and have a lower compactness index. The land use scheme for the CoJ indicates residential buildings of one story cannot exceed 50% coverage for a structure, thus limiting the size of the structure and the compactness index. Stahle and Caballero (2010) found inner-city ring suburbs oppose the compact spatial planning ideals and harm environmental sustainability, but are necessary for the decline of sprawling suburbs. This research suggests the green natural surroundings of Melville is enough to create a balance in environmental sustainability with the surrounding greenery as 92% of respondents initially did not feel the effects of the UHI. This aligns with the study Harlan *et al.* (2006) concluded where suburbia with higher green space percentage and higher socioeconomic

standing than surrounding areas were less likely to feel the effect, but not reduce its impacts.

Urban vegetation, other than surrounding green spaces, have a large presence. 24% of respondents added forms of greenery in their gardens, and 4% built a green roof. This aligns with the findings of Turner *et al.* (2016) who found 36% of suburban respondents had included some form of green infrastructure in their gardens. Williams *et al.* (2013) backup the small return of green roofs in Melville as residents are unlikely to implement projects like green roofs if they are unfamiliar with the concept. Similar numbers in changes made by respondents with similar suburban settings support the literature that exists, especially as knowledge on the topic is limited. Therefore, Melville fits in with the general understanding of an inner-ring suburb that does indeed have an active UHIE.

In terms of contextual approaches to the UHIE, the CoJ has recently approved the Green Building Policy (GBP) draft. Similar to Tokyo's nature conservation ordinance, the GBP states that any new buildings or major changes to buildings must be compliant with the GBP to achieve a net zero-carbon offset for all new buildings by 2030. The GBP is not specific in its demand which will become clearer after the bylaws are developed. Once this exists, the CoJ will have developed a policy that matches leaders in UHIE reduction, Washington DC.

Reducing stormwater, creating reflective roofs and using alternative sources of energy is the obvious route to take. The development of this policy allows for all suburbia, new and old to be forced into making environmental changes. Green building policies are seen around the world and the implementation thereof has been especially popular in cities with low population growths (Matisoff *et al.*, 2016). This does not align with the CoJ but shows institutional changes are slowly being made allowing for the development of UHI mitigation policy.

6.5.2 Implications for the Future of Planning

Environmental knowledge and experience based on an educational background are regarded as the core methods of providing planners with environmental stimuli (Boo and Park, 2013). Therefore, planners must be provided with the opportunity to learn about climate change effects which can be done concurrently with residents. The new model provides an additional basis for education through the co-production of knowledge and

bringing together experienced groups and contextual knowledge towards projects and policy development.

Environmental practices cannot be the last component to be analysed in new developments, rather they must be seen as the tool to create change for social, economic and cultural components (Wang *et al.*, 2016). If planners cannot realise the importance of environmental integration into all decision-making, the long-term objectives cities set out could be drastically impeded. Angelo and Wachsmuth (2020:2216) argue cities can “save the world” if sustainable development principles are integrated and adhered to, but planners have to achieve this. The new model assists in this, but it is up to planners to ensure these are followed through

Spatial inequalities in the CoJ are evident daily. Urban planners and urban managers continue to struggle to fix the past wrong-doings as persisting low-income segregation remains (Pieterse and Owens, 2018). Targeting previously disadvantaged areas is completely justified, however, it is also overlooking the source of certain environmental problems felt within these areas. The future of planning should focus on higher-income areas, for worsening environmental reduction reasons. A call for social and environmental justice is answered through a new view on dealing with the subject but will require planners and managers to change the approach to environmental problems while integrating it into numerous policies.

6.6 Opportunities for an Improved Melville

There is a plethora of design principles to establish sustainable suburbs and guide urban ecosystem modelling. However, the design must be compatible with current designs, is cost-effective and incorporates socio-economic factors. To develop a Melville which incorporates the environmental ideals sought after, I propose making use of Jacobs and Appleyard (1987) urban design principles, Bentley *et al.* (1985) responsive environment principles, and the principles for new urbanism (Charter of the New Urbanism, 2000). These principles remain relevant in improving the city for pedestrians and the environment.

6.6.1 UHIE Adaptation Changes in Melville

Figure 6.1 takes into account small changes to be made over time and improve the effect Melville has on the UHIE. Additional buildings have been added where open spaces are clear. These take the form of detached homes, cottages or multi-storey developments. 76

new possible buildings sites for a variety of typologies have been highlighted. The additional living and business opportunities will improve the density of Melville without compromising the infrastructure in place at the moment. Currently, using backyard cottages for suburban businesses has gained popularity especially during the COVID-19 pandemic. Higher densities have an impact on the walkability of the streets, create variety in uses and provide inclusive spaces for differing income groups which are important new urbanism principles.

7th Street and 4th Avenue are proposed to turn into pedestrian only-streets, with access to only public transport. Parking is available under 27 Boxes and is accessed from 3rd and 4th Avenue to provide an opportunity for private transport. Making pedestrian-only streets places a hold on through traffic diverted from Empire/Perth Street for a thoroughfare, as a throughway is not possible. Ensuring pedestrian safety, and access to opportunity due to the added transport route builds inclusivity and robustness of suburban streets as they serve a new purpose.

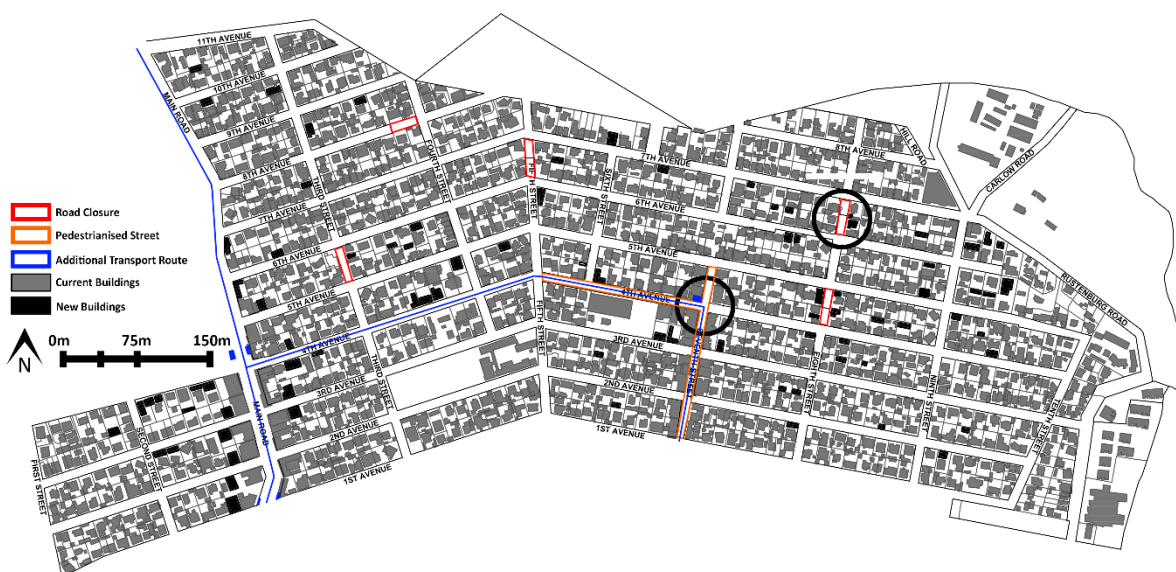


Figure 6.1: Small changes bringing responsive environments, urban design principles and new urbanism into play.

There are 5 highlighted dead-ends in Melville which may be retrofitted into inclusive green spaces (see figure 6.2-6.5). This improves permeability for pedestrians while creating an identity for Melville residents through unique green space creation. This improves public life and livability which are responsive environments and urban design principles. These are all changes made to the public sphere and will require major planning review and alterations for this to take shape.

Two circled spaces highlighted in figure 6.1 are zoomed in on figures 6.2-6.9. Figure 6.2-6.5 illustrate a rendering for the development of a dead-end into a public green-space. Additional buildings allow for new land uses to surround the green spaces and at the same time provide safety through eyes on the street. These new developments similarly increase the density through building multi-storey buildings, rather than a single-story building. These dead-ends are associated with a steep topography which may cause difficulties if not planned out properly. New buildings are possible to be built with new green regulations providing white roofs thus reducing the UHIE in Melville. The additional greenery will have a similar effect on the area and act as sinks for wastes within the suburb. The purpose of these spaces is not purely environmental, but allows for social development through community bonding, and provide economic savings with the increased greenery reducing electrical costs and wastage but improving land costs.

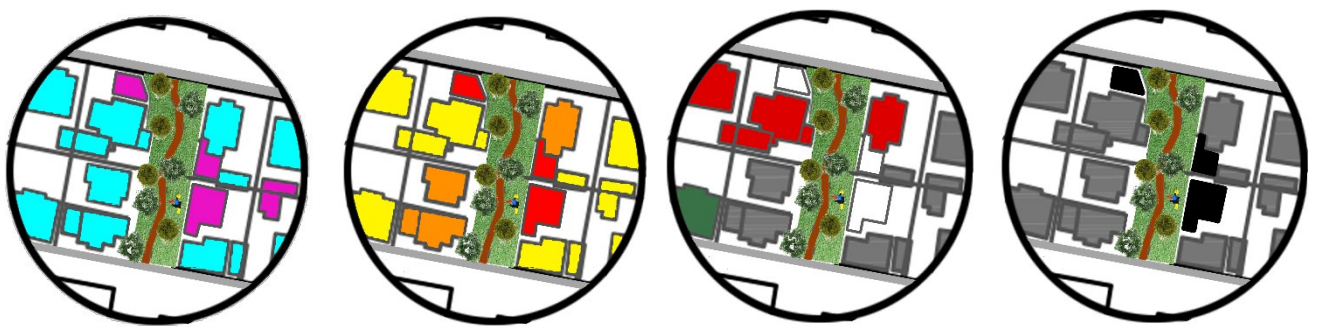


Figure 6.2-6.5: Retrofitting dead-ends into small urban parks, allows for surrounding development to apply additional changes. From left to right: density, land-use, roof colour and physical changes.

7th Street and 4th Avenue are commercial streets in Melville. Pedestrianizing these blocks reduces traffic looking for time-saving shortcuts. This causes excessive noise and air pollution. Ensuring only public transport accesses these roads will dramatically reduce traffic with no building falling outside a 15-minute walking radius. A multi-modal transport stop can be created at the intersection between 7th Street and 4th Avenue. This part of Melville is already compact; however, roofs can change into flat roofs, green roofs or electricity harvesting roofs. This way businesses show accountability for the waste produced by looking to mitigate the source of the problem. Safer streets can be used for expanding restaurants and public green space. The economic opportunity for businesses here has the potential to grow making this a win-win situation for the residents of Melville.

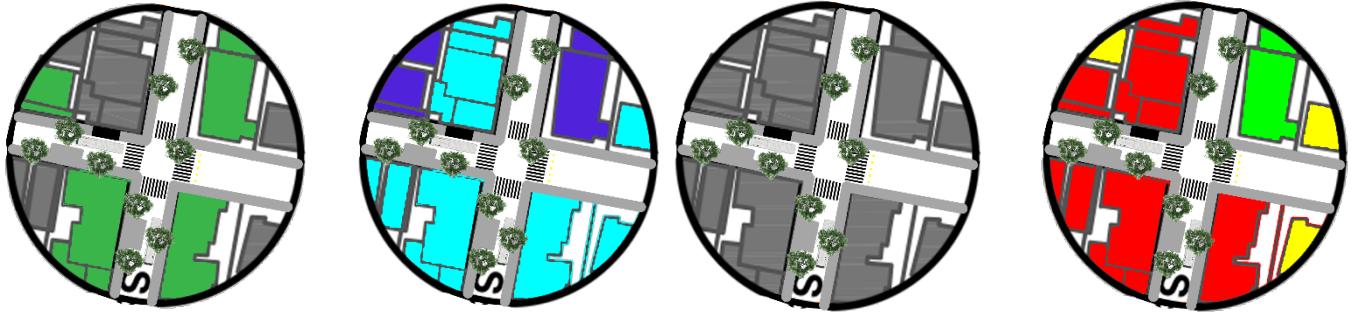


Figure 6.6-6.9. 7th Street and 4th Avenue transforming into spaces prioritising pedestrians and public transport. From left to right: changes in roofing, density, physical alterations and land use.

6.7 Suggestion for Further Research

UHIs consist of impacts ranging further than heat and must be analysed for a complete picture of the UHIE. Through analysing the impact on the water cycle related to climate change different findings may be found. This will require additional research before a conclusion can be found on the entirety of the UHIE.

Comparisons between various other suburbs, ranging in size and socio-economic background could prove different approaches may be necessary. Looking into a range of suburbia could improve an understanding of the needs of suburbia and the range of their impact on surrounding areas. Suburbia will have different contexts which cannot all hide the UHIE due to an abundance of green spaces, and must therefore be looked into.

The UHI impacts more urban configurations than only suburbia. Looking into more sectors, locations or typology of uses could point towards the UHI requiring different approaches to mitigation. Furthermore, approaches to mitigating the UHI around the CoJ will differ from those in commercial or industrial locations.

Quantifying data associated with the UHI in Melville could also provide a better insight into the reasons for the UHI. Finding specific points of heat in Melville will provide a detailed description of specific surfaces and colours and their heat absorption ability. Quantifying the data is important for providing a backup to the subjective statement given by respondents.

6.8 Concluding Remarks

This research report attempted to provide insight into the CoJ UHIE with emphasis on the suburb of Melville. It has become evident that the current urban management approach in the CoJ has not allowed for the integration of environmental objectives into policy. The

effects, especially in Melville are mitigated firstly through the ability to deflect all impact by creating additional heat wastage through cooling systems. Secondly, impacts are reduced through the increased presence of greenery and changing of surface texture and colour within homes. The UHI is a relatively unknown concept by most residents, however, once explained it became apparent respondents were keen to make changes in the future to reduce the impact of the UHI. Knowledge on the topic appeared to be the key for deciding the level of changes made to households and is thus the key to the success of the model. The new model attempted to align environmental policy and ensure the UHI becomes a common topic in more than two policies within the CoJ.

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Appendices

Appendix A – Plagiarism Declaration

Faculty of Engineering and the Built Environment

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PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I CASPAR ELBERTSE (Student number: 1419452) am a student
registered for the degree of MUS (URBAN MANAGEMENT) in the academic year 2020-2021

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.

Signature:  Date: 03/01/2021

Appendix B – Ethics Clearance

SCHOOL OF ARCHITECTURE AND PLANNING HUMAN RESEARCH ETHICS COMMITTEE



CLEARANCE CERTIFICATE

PROTOCOL NUMBER: SOAP054/06/2020

PROJECT TITLE: Managing green-burbia: Utilising urban management practices to address the Urban Heat Island as a call to adapt to climate change impacts – The case of Melville in the CoJ.

INVESTIGATOR/S: Elbertse Caspar (Student No: 1419452)

SCHOOL: Architecture and Planning

DEGREE PROGRAMME: Master of Urban Studies (**MUS UM**)

DATE CONSIDERED: 05 August 2020

EXPIRY DATE: 05 August 2021

DECISION OF THE COMMITTEE: Approved

CHAIRPERSON

(Dr Brian Boshoff)

DATE: Signed under lockdown: 10.8.20

cc: Supervisor/s: Tsepang Leuta

DECLARATION OF INVESTIGATORS

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to endure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

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Appendix C – Questionnaire

Researcher name: Caspar Elbertse

Student number: 1419452

Degree: MUS Urban Management

Research Topic: Utilising urban management practices to address the Urban Heat Island as a call to adapt to climate change impacts – The case of Melville in the CoJ

Section A – community members demographics

Please tick the correct box	Yes	No
1. Do you currently live in Melville?		
2. Is the home where you live older than 60 years old?		
3. Are you renting out space in the backyard (e.g. cottage)		
4. How long have you lived in Melville? (in years)		

Please tick the most correct answer:

5. In what age bracket do you fall?	Less than 18	18-44	45-65	More than 84
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6. What type of house do you live in?	Separate stand	Apartment	Townhouse	Backyard Dwelling
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Section B – Understanding of Climate Change and UHIE

7. What is your understanding of climate change?

8. Do you believe in the effects of climate change?

9. Are you aware of the Urban Heat Island? How do you understand it?

Section C - Impact of Climate Change and the UHIE on Residents in Melville:

Please tick the correct box	Yes	No
10. Have you felt the effect of climate change in Melville?		
11. Is the added heat in Melville causing you or your family any discomfort?		

12. Are the following an increasing problem in Melville?	Yes	No
Warmer night-time temperatures		
Increased energy consumption for cooling purposes		
An increased amount of vehicular traffic		
Land-uses changing to other than residential		
Stormwater drainage flooding		
Increased number of heatwaves		
Decreasing presence of greenery (e.g. trees, flowerbeds)		
Lack of shade		
Droughts		
Illness related to higher temperatures		

13. What do you feel is the biggest impact of climate change in Melville?

Section D – What have residents done?

14. Have you made physical changes to your home? If so, what? (e.g. efficient lightbulbs, painted roof etc.)

15. Are the changes made conscious of the environment?

16. What other changes, if any, have you made to reduce the impact of climate change?

17. Do you make use of public transport? Why / why not?

18. Do you ever walk instead of drive to places in the immediate area? If yes, what could be done to change this?

19. Do you have any of the following at home?	Yes	No
Solar Panels for electricity generation		
Insulated Roofing		
White coloured roof		
Vegetable garden		
Subdivided property		
Green space outside your yard (outside walled area)		

Section D – View on urban management and planning?

20. Is it the duty of local government or residents to reduce the impact of the urban heat island in Melville? Why? What is required to make these changes?

21. Should changes be made to the structure of Melville (e.g. street patterns, land-use, density etc.)? Explain your reasoning?

22. If the local government created a plan or strategy to reduce the effects of the Urban Heat Island, would you be willing to make any changes to be in accordance with this strategy or plan?

23. What should such a plan focus on? And what contribution could you make to achieving this plan?
