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Elaboration of a “Climate Change Hazard, Vulnerability and Risk Assessment” Study to the benefit of the City of Cape Town

Economic Risk Analysis Report

Réf. AFD/DOE/EBC/CLD | ACH-2017-026

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PROJECT BACKGROUND

This report is submitted under the French Development Agency (AFD) project: Elaboration of a "Climate Change Hazard, Vulnerability and Risk Assessment" Study to the benefit of the City of Cape Town. The project falls under the CICLIA Framework Agreement for Studies and Technical Assistance for the Cities and Climate Change Initiative in Sub-Saharan Africa, funded by the French Development Agency (AFD), EU and the Swiss State Secretariat for Economic Affairs (SECO). This report is submitted on the back of the outcomes of Phase 3 and the Focus Group Discussions with the City of Cape Town (CCT) held on the 9th and 10th of April 2019, in accordance with the requirements of the Contract for Réf. AFD/DOE/EBC/CLD | ACH-2017-026. As such, this report constitutes Deliverable 3 under this contract and includes: i) a background discussion of the City economy in the context of Climate Change; ii) the Economic Risk Analysis methods and approach; iii) linking the Vulnerability and Hazard Assessment to the Economic Risk Analysis; iv) a discussion and interpretation of key results; and v) concluding remarks towards setting up the adaptation options assessment.

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Abbreviations and Acronyms

AFD	French Development Agency (Agence Française de Développement)
CCT	The City of Cape Town
ERA	Economic Risk Analysis
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GVA	Gross Value Add
HVA	Hazard and Vulnerability Assessment
ToR	Terms of Reference

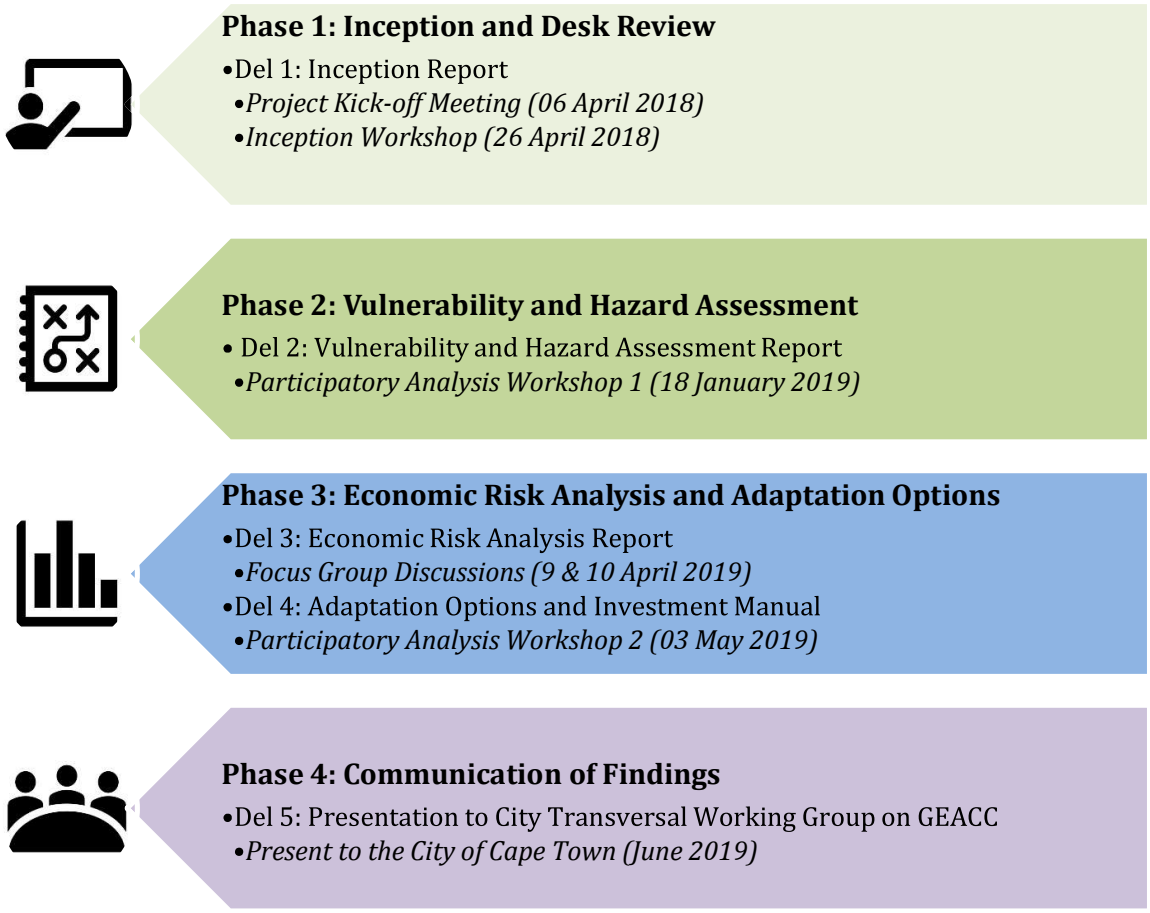
A. Introduction

This report is Deliverable 3 of the project **Elaboration of a "Climate Change Hazard, Vulnerability and Risk Assessment" Study to the benefit of the City of Cape Town**, commissioned by the French Development Agency (AFD).

Réf. AFD/DOE/EBC/CLD | ACH-2017-026.

The project is being delivered in line with a four-phased approach, with key deliverables and fieldwork activities under each phase, as illustrated in Figure 1. Building on the outcomes of Phases 1 and 2, the Focus Group Discussions (FGDs) held with the City of Cape Town (CCT) on the 9th and 10th of April 2019, this report includes: i) a background discussion of the City economy in the context of Climate Change; ii) the Economic Risk Analysis methods and approach; iii) linking the Vulnerability and Hazard Assessment to the Economic Risk Analysis; iv) a discussion and interpretation of key results; and v) concluding remarks towards setting up the adaptation options assessment.

Figure 1: Phased Project Approach



A.1 Addressing the Terms of Reference

The technical approach in terms of the sectoral focus identified in the ToR was shifted during the inception phase to a more integrated thematic approach. The focus of this report is less to quantify the monetary value of specific risks to each sector, seeking rather to quantify broader economic risks of climate change (through the capital theory approach) and apply these to understanding sectoral risk pathways. In this way, the approach produces commensurable outcomes with the previous Hazard and Vulnerability

Report. This allows for the direct comparison and analysis of climate risks in relation to economic capital and broader human/system resilience. Ultimately, the purpose of this report is to broadly analyse and quantify climate change risks to the City's economy to provide the basis for the forthcoming adaptation options assessment and investment manual.

More specifically, this includes a contrasting 'best case' vs 'worst case' scenario analysis of economic capital and climate change exposure over the mid-future projections. The report identifies key climate change risk pathways for economic sectors, which provides the opportunity for adaptation options to focus on risk pathways that would impact sectoral GDP and/or jobs the most, as well as the population segments most likely to be impacted through these various risk pathways. However, the results of the analysis did not make it possible to identify risks to specific sub-sectors because of the nature of how the economic sectors in South Africa are classified and the complex risk pathways and how different risks affect multiple sectors simultaneously. Moreover, an analysis of the different types and extent of possible direct and indirect impacts on key economic sectors is presented. It should be noted that the contents of this report have been structured to set up the final component of the project, the identification and analysis of adaptation options and investment planning. Thus, any potential adaptation opportunities to improve and/or create economic resilience for the economic sectors will be assessed in the forthcoming work.

B. Context and Background

B.1 The Nature of Climate Change and its Impacts on the Economy of Cape Town

There are a number of studies that focus on climate change and its potential impacts on the City of Cape Town. A study on changes in rainfall and precipitation include forecasts of a decrease in wet days, an increase in dry spells and thereby a decrease in annual precipitation (Abiodun *et al.*, 2017:407). Combined with increased temperatures and evaporation, decreased water availability is probable and changes to the city's water resource management are likely to be necessary. Moreover, the entire country's commercial farming is detrimentally affected by these climate changes with specialized commercial crop and subsistence farming projected to be most vulnerable (Tibesigwa *et al.*, 2017:630). Heat stress will impact the deciduous fruit and wine industries, while reduced rain affects wheat and rye farming. Any changes to the agriculture and productive sector are likely to have knock-on effects in the realms of employment, economic opportunity and food security (Tadross & Johnston, 2012:24). With the poor being more dependent on the natural environment, this latter impact should raise red flags regarding vulnerable groups in the municipality. Moreover, informal settlements are likely to be more vulnerable to increased flooding and risk of fires given their limited access to services and resources (Mukheibir & Ziervogel, 2006:43). The risk to Cape Town as a coastal city further includes sea-level rise which threatens infrastructure as well as real estate and tourism industries (Colenbrander *et al.*, 2015:13). With much of Cape Town's industrial, commercial and residential areas lying below 10m above sea-level, sea-level rise increase the vulnerability of beaches and coastal developments. These projections have sparked debate over reviewing established coastal set-back lines and the details regarding this policy strategy. Additionally, storm water strategies may be necessary as sea-level rise, storm surge and heavy rainfall are projected to cause water pollution, compromise drinking water and damage coastal treatment plants (Kessler, 2011:516).

Broadly, climate change happens at two distinct levels: as events and disasters in the short term (climate shocks) and as gradual changes over longer time periods (climate stressors). Both these changes will generally impact three 'types' of economies in the City of Cape Town: the real economy, which measures production and consumption, the financial economy, pertaining to the financial means of the city to respond to climate change, and the 'governance of the city' economy, which concerns the maintenance and expansion of public services. Furthermore, these economic impacts translate into consequences for different people, environments and assets in the city. Inhabitants and visitors are affected by changes to economic production and consumption while the municipal government is responsible for changes to public service provision. Moreover, municipal managers are likely to reach out to the financial sector to formulate bilateral agreements, take out loans or to issue bonds in an effort to raise funds to meet the demands of the population in the context of climate change.

The impacted economies and populations provide a helpful categorization of risk pathways between climate change and economic risk:

i. Climate shocks to the productive economy

ii. Climate stresses on the productive economy

iii. Climate shocks to the population

iv. Climate stresses to the population

B.2 The Vulnerability and Hazard Assessment

The Vulnerability and Hazard Assessment conducted on the City of Cape Town identifies key climate driven risks (stressors and shocks) by modelling changing climate indicators over time (OneWorld, 2018).

It highlights this vulnerability spatially to determine different levels of risk and resilience as well as to identify areas of highest concern. Specifically, the Vulnerability and Hazard Assessment anticipates a drier and warmer climate for the City of Cape Town while the top climate-related hazards facing the city include drought, fire, heatwaves, floods and strong winds. The province's water supply system is at risk to drought, with indirect impacts of a water availability crisis affecting the economy, environment and people of the City of Cape Town. Moreover, fires pose a direct impact to human life and assets. In terms of the spatial dimension, the areas most vulnerable to climate change induced hazards are those with limited access to resources and services to hedge against these risks. Specifically, vulnerability to climate change is assessed as a function of exposure and resilience. Various indicators of exposure and resilience are used to map out future 'hotspots' of vulnerability and to produce a vulnerability scatter plot for different areas in the municipality.

B.3 A Typology of the Economy

While the nature and impact of climate shocks and stressors can be determined using Vulnerability and Risk Assessments, a means of measuring economic risk remains necessary. In other words, a typology of the economy must be developed in order to quantify these risk pathways. Generally, economic output (e.g. measured by GDP) is seen as a function of capital, labour, technology and knowledge as well as natural assets like land and energy. One way of thinking about the City of Cape Town's economy is in terms of different types of capital or assets that provide a flow of benefits or services to the economy and society.

A natural complement to the above typology is the capital theory approach to evaluating economic risk and change over time (De Wit & Blignaut, 2000). This theory states that sustainability is determined by maintaining a constant aggregate capital stock over time. The argument is that once capital is used to produce or consume, the rents (over and above an acceptable level of profit) should be re-invested to ensure that the same level of capital will be available for posterity in the future. Ultimately, to ensure sustainability the same level of capacity should be gifted to future generations. For example, in the case where natural capital is used, the rents from the depletion of natural resources can be re-invested in manufactured capital. When full substitutability between types of capital is assumed, what is referred to as "weak sustainability" is the easiest to achieve as this concept simply entails that the aggregate capital stock not be reduced over time. On the other hand, when substitutability between types of capital is not assumed, what is referred to as "strong sustainability" is only achieved when separate aggregate capital stocks are maintained. The latter is advocated by some environmentalists for example, to ensure that natural capital is not over-used in production and consumption. CCT is aiming to embrace the 'strong sustainability' paradigm as there is generally a move towards acknowledging that natural capital cannot be completely exchanged for manufactured capital and that at some point this leads to a complete breakdown of the whole system.

Following mainstream economic growth models, the following four forms of human-made capital are distinguished:

1. Financial capital:

   The pool of funds available including debt, equity and grants generated through private and public operations and investments.

2. Manufactured (durable) capital:

   Includes tools, machinery, buildings, equipment and other infrastructure (roads, bridges, ports, railways, and water and treatment plants).

3. Human capital:

Investment in skills, education and training determining the individual's competencies, capabilities, training and overall productivity.

4. Intellectual capital:

Intellectual property (patents, software, copyrights and licences), organizational capital (tacit knowledge, protocols and systems) and other intangibles (city brand and reputation).

In addition to these above-mentioned forms of assets, socio-environmental drivers and linkages between society, the natural environment and the economy necessitate the inclusion of:

5. Social capital:

Institutions and customs organising economic activity (shared norms, common values, non-physical culture, trust and willingness to engage).

6. Natural capital:

Natural systems including atmosphere, lithosphere, aqua-sphere and biosphere.

Overall, the measurement of different stocks of capital provide indicators for the health of the economy in a holistic way.

C. Economic Risk Analysis Methodology

This section outlines the technical methodology adopted for the Economic Risk Analysis, which includes the Economic Capital Assessment and Economic Framing Analysis.

C.1 Economic Capital Assessment

C.1.1 Overview

For each climate stressor or climate event (or composite of such stressors and events, i.e. exposure) impacting on the capitals used in the economy, the economic risks needs to be assessed. Risk assessment basically involves an estimation of the magnitude of potential consequences or the levels of impacts, and the likelihood or the levels of probability of such impacts happening. The spatial and temporal extent of the risks can also be evaluated.

The approach used in this study is to evaluate the risks to the economy because of climate stressors and shocks according to the following step-wise approach:

1. Develop a "baseline" of economic capitals that are already functional in the City. The output in the productive economy (as measured by GDP) is dependent on the well-functioning of these categories of capitals.
2. Develop alternative futures for the capitals on the continuum of relatively weak capital functioning to strong capital functioning.
3. Overlay climate change exposure future scenarios with economic capital future scenarios to identify areas where the economy, as measured through various indicators for capitals, is relatively higher and lower at risk in the mid-future (2030).
4. Four combinations of these scenarios are developed on the basis of this analysis, namely:
    - scen1: higher climate exposure; weaker capitals
    - scen2: higher climate exposure; stronger capitals
    - scen3: lower climate exposure; weaker capitals
    - scen4: lower climate exposure; stronger capitals

C.1.2 Baseline Indicators

Baseline metrics are measured according to the six types of capital identified above. Table 1 summarizes sub-categories in each type as well as possible metrics typically used to measure them.

Table 1: Indicators for six types of capital

Capital Type	Indicator	Data/ Measurement
Financial	Operating cost (actual/budget) of city	Service charges, property rates, government grants, other own revenue, investment revenue
	Capital costs (actual/budget) of city	Borrowing, internally generated funds, national grants, provincial grants, public donations
Manufactured	Areas and property values over various built environment categories (e.g. commercial, industry, residential)	Median freehold residential property values, properties by suburb (770 units) and value band

	Roads, bus-roads, railways	Kilometres of roads, bus-roads, railways
	Vehicles over various categories	Number of households with motorcars
	Critical infrastructure	Proxy of travel time to critical infrastructure and service centres (e.g. fire departments, police stations)
Human	Economically active population	Number employed, unemployed, discouraged and non-active persons
	Indicators of (un)employment, poverty and inequality	Number (un)employed, median household income, income range by suburb, households with cell phone/internet access
	Educational attainment across age groups	Percentage of population with no schooling (aged 20+), with matric (20+), with higher education (20+)
	Health indices	Pneumonia incidence and malnutrition incidence (under 5), hepatitis A incidence, typhoid incidence, HIV incidence, percentage positive TB tests
	Informal settlements	Percentage area of informality
Intellectual	Size of knowledge sector	Number of people with higher education
	Money spent on research and development	R&D as percentage of GDP
	Brand awareness	Brand perception
	Science outputs	Number of publications
	Number and value of knowledge, technology patents	Number of patents
Natural	Area of land across natural categories	Area of land declares urban conservation areas, as nature reserves, as urban conservation areas, designated as wetland
	Water stocks and use	Average monthly household water use
	Measures of biodiversity integrity and resilience	Percentage of suburb area that are critical biodiversity and protected areas
	Pollution metrics	Water, air and solid pollution
	Waste metrics	Percentage of households with no rubbish collection
	Ecosystem services metrics	SANBI ecosystem status (mean)
	Valuation of environmental quality of air, land, water, biological systems	Value of ecosystem services
Social	Measures of trust, reciprocity and cohesion	Racial integration index
	Indicators of livelihoods and dependency	Household dependency ratio Number of street people
	Metrics of involvement in social and cultural initiatives	Number of early childhood development forums
	Metrics of citizen satisfaction	Percentage of people who voted for governing party Number of service requests lodged
	Metrics of social wellbeing	Access to piped water, electricity Housing owned/paid off Population density

		Incidences of crime

Source: Own analysis

C.1.3 Leading and Composite Indicators

Not all indicators as presented in Table 1 are equally well developed in the City's various databases and related available data, nor are these mapped at the same spatial resolution. The overall objective of this analysis is to broadly analyse and quantify climate change risks to the city's economy with the purpose of informing municipal planning for adaptation. It will therefore not add sufficient value to use all the indicators in the analysis to determine the relative levels of risk facing the different capitals. Thus, the question of which leading or main indicator(s) and/or composite indicators to use as a measure of the various capitals needs attention. Leading indicators refer to the use of individual metrics to broadly represent a stock and/or flow of a particular system (i.e. number of employed people can be considered a leading indicator for human capital). A composite indicator is a function of two or more metrics combined to represent a specific aspect of a system (i.e. combining metrics of biodiversity and vegetation cover to represent natural capital).

An indicator-led approach is useful when decision-makers need information to operationalise sustainable development goals but it remains a static approach (De Wit & Blignaut, 2000:120). The question whether it is acceptable to trade-off one stock of capital for another (the degree of capital substitutability) is not answered explicitly by measuring the various stocks of capital against a set of indicators. Moreover, focusing on static measures of capital does not effectively address the development path that may result from these capital stocks. An integrated and dynamic approach is needed to do better justice to such questions, but this would require a scale of modelling effort far beyond the scope of the project. Nevertheless, an initial assessment of the stock of different capitals within the City would provide the platform for increasingly integrated and dynamic assessments of the City economy.

The importance of combining systematic indicators with complex adaptive approaches when dealing with sustainability issues is acknowledged in a number of studies. For example, simple linear sustainability assessment tools were found to be inadequate when evaluating the sustainability of tourism in a park in Queensland, Australia as these tools disregarded the complex and dynamic nature of the system (Schianetz & Kavanagh, 2008:601). Furthermore, the use of a systematic indicator-led approach allowes for socio-cultural, economic and environmental issues to be taken into account. The value of the approach is based on acknowledging the interdependence of all natural and social systems and the nonlinear feedback loops between different levels of these systems. Overall, this methodology is emphasised as an effective decision aid for planners and developers. In reviewing ecological approaches to fisheries, the use of indicators is again hailed as useful in giving management advice. Indicators are used in evaluating the performance of management strategies via simulations (Rochet et al. 2007:4). Simple static indicators are useful, but should be used with caution in interpreting trends in complex and dynamic systems (such as cities).

C.1.4 Baseline and Future Scenarios

The leading indicator approach adopted for this assignment has been tested with FGD participants from CCT, which necessitated the use of both leading and composite indicators to represent the six types of economic capital. Metrics for these indicators were used to represent the baseline scenario, which provided the basis for projecting future scenarios. Two future scenarios were generated for each capital indicator to represent both a 'strong' and 'weak' capital future. Table 2 shows the chosen metrics and associated projections for the six capital classes.

Table 2: Metrics and Projections for the Six Capital Classes

Capital	Main Indicator(s)	Measure	Scenarios (strong/weak)
Financial	Total Revenue	Total Budget Expenditure (Rands)	↑ 2.4 % ; ↓ 2.4 %
Human	Employment	# of Employed People	↑ 5 % ; ↑ 2 %
Natural	Ecosystem Functioning	Ecosystem Services Index	↑ 3 % ; ↓ 3 %
Social	Crime Rate	# of crimes	↓ 2 % ; ↑ 2 %
Manufactured	Residential Property Value	Mean Property Value (Rands)	↑ 10 % ; ↑ 5 %
	Commercial and Industrial Property Value	Mean Property Value (Rands)	↑ 10 % ; ↑ 5 %
	Access to Critical Infrastructure	Mean Travel Time to Hospitals and Fire Stations (Minutes)	↑ 2 % ; ↓ 2 %
Intellectual	Education Levels	# of People with Higher Education	↑ 3 % ; ↑ 1 %

The future scenarios were based on historical trends for these variables and the extent of possible changes in the future, which represent realistic worst case and best case scenarios. The data used to represent each capital metric was projected up until 2030 and then normalised against a range from 0-1, to ensure commensurability of the different metrics and equal contributions towards the overall capital score. The overall capital score was derived by combining all 6 capital scores. To ensure spatial commensurability and that the spatial dimensions align closely with the approach adopted under Deliverable 2 – Hazard and Vulnerability Assessment, all capital scores were computed at the Major Suburb level.

The overall capital score was then combined with the mid-future exposure index (derived from the Hazard and Vulnerability Assessment) to indicate the areas where capital is most at risk within the City. Table 3 outlines the different variables that the exposure index is a function of, as well as approximated high and low bounds of uncertainty associated with these mid-future projections. These uncertainty bounds were used to develop measures of high and low exposure for the mid-future (± the year 2030). The combined capital and exposure assessment was undertaken for all four possible combinations of these scenarios. Importantly, this approach provides for both a spatial and temporal analysis of climate risks to the City's economy.

Table 3: Exposure Index Variables and Scenario Bounds

Exposure Variables	Mid-Future Exposure	
	High Bound	Low Bound
Average, maximum and minimum temperature	↑ 3 °C	↑ 1 °C
Very hot days	↑ 20 Days	↑ 0 Days
Heat-wave days	↑ 10 Days	↑ 0 Days
High fire-danger days	↑ 20 Days	↑ 0 Days
Rainfall	↓ 120 mm	↓ 60 mm

Extreme rainfall	↓ 3 Days	↓ 0 Days

C.1.5 Assumptions and Limitations

Any broad assessment of risk and/or an economy (or aspect thereof) necessitates making a number of assumptions to ensure consistency in logic and approach. A key assumption of the Economic Capitals Assessment is that the chosen leading indicators and/or composite indicators are representative of the specific capital distribution throughout the City. Moreover, the projected changes in these indicators are representative of possible changes over time of the various capital stocks. Although the indicators were tested with the City and the associated future scenarios are based on historical trends and formal projections, the choice of indicator metrics was heavily influenced by available data at suitable spatial scales.

Further limitations of this assessment are focused specifically on the indicator variables for Financial and Social Capital. Total Budget Expenditure or Total Revenue only represents the available financial capital available to the City and does not incorporate the productivity of the broader economy (e.g. private sector financial capital). Certain areas are invested in more by the City than others, these are often areas that experience service delivery deficits and are generally lower income areas. Thus, this may in some cases act to narrow the gap in aggregate scores between areas of higher capital and lower capital because higher investment in those areas is considered as a relatively higher financial capital score. Moreover, the inverse of the crime rate is a proxy for Social Capital in some respects, but this assumption is likely not to hold in all cases (e.g. higher rates of crime in some areas might result in improved social cohesion in response to the crime).

C.2 Economic Context Evaluation

C.2.1 Overview

The Economic Context Evaluation builds on the Economic Capital Assessment to provide a broader economic assessment through multiple lenses:

1. Population
2. GDP
3. Land-use
4. Employment

Specifically, analysing the capitals at risk through these lenses includes a comparison against baseline and future projections of GDP and population, as well as a sectoral breakdown of GDP, land-use and employment. These lenses allow for the assessment of knock-on impacts throughout the broader economy in relation to the relative risk to economic capital and how these might manifest through various sectors.

C.2.2 GDP and Population Projections

Understanding the spatial and temporal risks to a City's economy requires a broader assessment of the relative productivity of the economy, as well as an understanding of the extent and distribution of the participants in said economy. When projecting economic risks over time it is important to acknowledge that both economic and social indicators will change relative to a given baseline. Thus, GDP and population data were assessed against a given baseline and projected in line with the futures scenarios developed for the Economic Capital Assessment (i.e up to 2030). Table 4 shows the two indicators used to represent the productivity of the economy (i.e. GDP) and segments of the population, as well as the future scenarios for these indicators.

Table 4: GDP and Population Projections

Economic Framing Indicators	Measure	Scenarios (high/low)
Population	# of People	↑ 1 % ; ↑ 0 %
Gross Domestic Product (GDP)	GDP (Rands)	↑ 2.4 % ; ↓ 2.4 %

The scenario projections are based on GDP projections from CCT (the low growth scenario illustrates a period of recession of the same magnitude). The population growth projections are area specific (for the 116 Wards in Cape Town) and are derived from the average population growth rate between 2011 and 2016 (from the 2011 Census to the 2016 Community Survey). Comparing these socio-economic variables against the outcomes of the Economic Capital Assessment provides the basis for identifying risks to economic productivity and participants in the economy. This analysis provides insight into possible knock-on effects and areas facing heightened and/or weakened risks from climate change due to identified population and GDP growth trends across space and time.

C.2.3 Sectoral Breakdown

Sectoral components of GDP, employment and land-use were broken down to provide insight into the possible risks to different sectors and provide insight into how these risks might manifest through different sectoral aspects of the economy. Current GDP, employment and land-use data are assessed both in aggregate and against their relative sectoral contributions for the 8 CCT Planning Districts. Gross Value Add (GVA) data is analysed by sectors according to Standard Industrial Classification (SIC) System (see StatsSA, 2012), which is aggregated and used to determine total GDP. Current employment data was sourced from the 2011 Census, which separate employment numbers down by similar economic sectors to the SIC classification. The 2018 CCT Integrated Zoning and recent Land Cover spatial data was used to calculate broad land-use classes by surface area. Using both land cover and integrated zoning data provides the opportunity to cross-compare and analyse land-use across the City.

D. Linking Hazard, Vulnerability and Risk Assessments to the Economic Risk Assessment

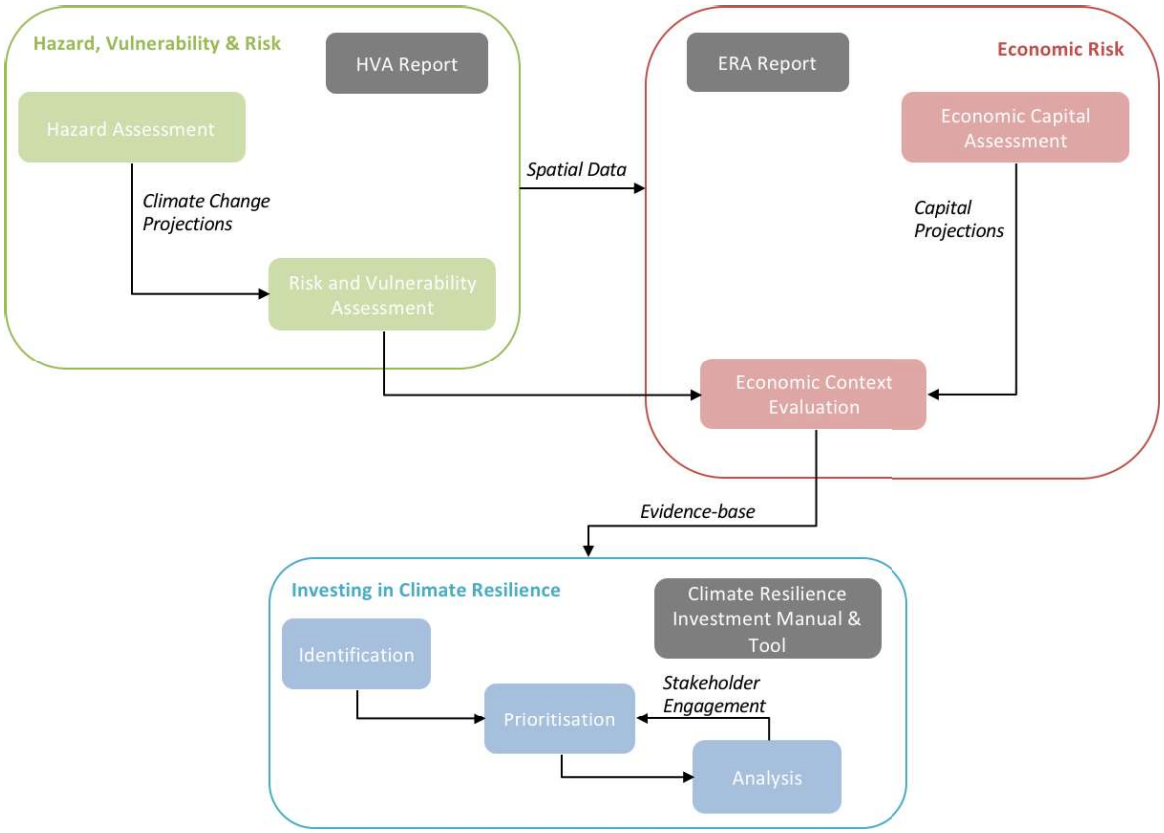
The relative exposure of the categorized forms of capital to climate shocks and stressors is indicative of the different aspects of the economy-at-risk. The likelihood, magnitude and extent of economic risks resulting from climate change is portrayed in this study as the relative change of these indicators between the baseline and various future scenarios across the City.

This project's aim is to focus on the prioritization of adaptation actions from the perspective of the municipality. Better-informed decisions can be made when the focus is on spatially refined data on the various capitals in the economy. Policy-makers will be able to recognise the possible impact of dynamic futures through the development of various scenarios across both climate and economic futures.

Climate risks are one source of unsustainability. The more spatially and temporally refined the information provided to decision-makers, the more informed are the adaptation decisions to be made. One important implication of such an approach is that the focus is not on measuring absolute levels of sustainable development, but on the relative priority of various adaptation options across space and time. In other words, implementing a set of adaptation options is no guarantee that unsustainable development paths will not occur but it does reduce the risks of such an outcome.

The Economic Context Evaluation situates the Economic Capital Analysis and Hazard and Vulnerability Analysis within the broader City economy and the various sectors. This framework provides the opportunity to develop the sectoral analysis of climate change impacts through various pathways in the economy. Figure 2 shows the conceptual framework for linking the Hazard and Vulnerability Assessment and Economic Risk Analysis. Specifically, the Economic Context Evaluation provides the broader filter to assess the evidence generated from both the Risk and Vulnerability Analysis and the Economic Capital Assessment to ultimately provide the basis for identifying, prioritising and analysing adaptation options in response to climate change.

Figure 2: Conceptual Framework for Linking HVA and ERA



E. Results and Discussion

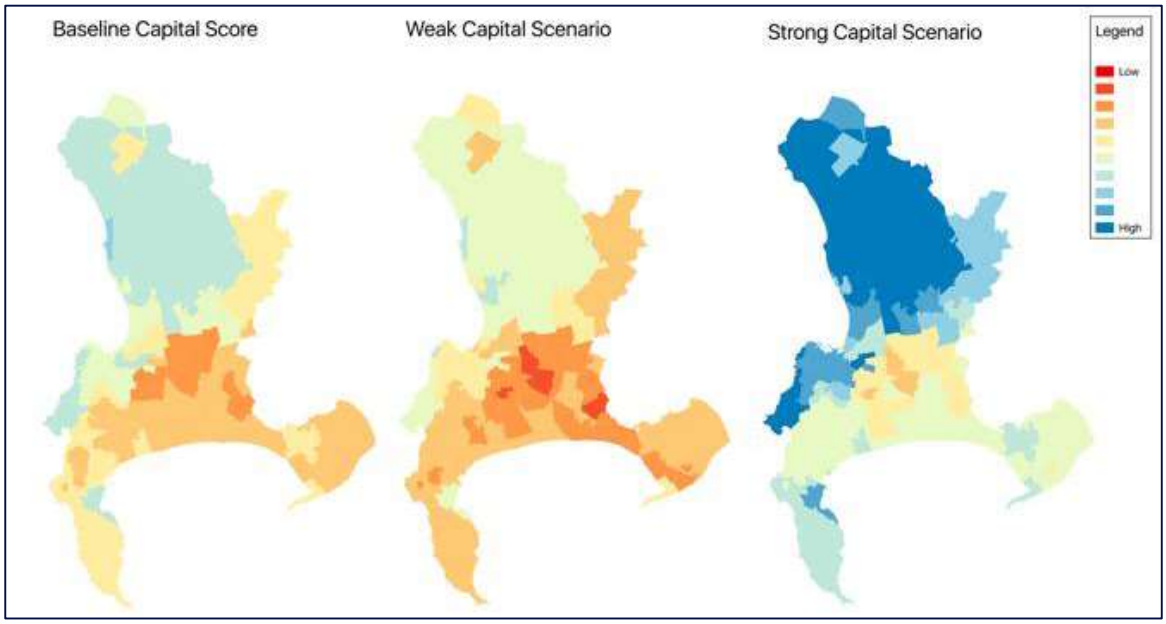
The results of the Economic Capital Assessment are presented below, followed by the findings and evidence that make up the Economic Context Evaluation. Key findings are discussed in relation to the possible knock-on and indirect impacts, key sectors at risk and how these risks might manifest, population segments and locations likely be the most affected and possible opportunities that may arise.

E.1 Economic Capital Assessment

E.1.1 Capitals Assessment

Figure 3 shows the maps that illustrate the aggregate result for the strength of all capital types across the three different scenarios for Major Suburbs in the City of Cape Town. See Appendix A for the locality map for the 77 different Major Suburbs in Cape Town considered in this analysis. The highest relative composite baseline scores for the six capitals in the City are found in areas such as Melkbosstrand, Table View, Sea Point, Camps Bay, Hout Bay, Pinelands, Plattekloof and Simons Town. Whereas the lowest relative baseline capital scores are exhibited by the suburbs of Elsies River, Bishop Lavis, Hanover Park, Airport, Athlone, Bellville and Eerste River. A broad pattern of higher baseline capital scores across the Western seaboard from Cape Farms North down to Cape Point occurs. In contrast, the central and eastern areas of the City display generally lower capital scores.

Figure 3: Baseline and Future Scenario Capital Scores by Major Suburb in the City of Cape Town.



Considering the temporal changes in capital across the two future scenarios it is evident that capital growth and/or decline are greater for suburbs which start with a higher level of capital in the baseline scenario. Thus, under either capital scenario, suburbs with a higher baseline level of capital will experience greater change in capital levels than suburbs which have lower levels of capital. This applies for both growth and decline across the various types of capital. Although the rank order of suburbs endowed with relatively higher / lower capital scores remains largely the same over time, future scenarios occasionally result in a relatively lower or higher net capital scores for some areas compared to others. For example, Observatory exhibits the 11th highest baseline capital score, but is projected to have the 15th highest score in the strong capital scenario and only the 19th highest score in the weak capital scenario.

These disproportionate changes over time are indicative of the different capital mixes that make up each of the aggregate capital score. See Appendix B for illustrations of the baseline and future scenario capital scores for the 6 different capital types. Analysing the different capital contributions provides the necessary context for understanding the relative capital scores and how these may be interpreted in terms of developing a suite of adaptation options. For example, Cape Point exhibits notably high scores for Natural Capital owing to the fact that the area is largely a nature reserve maintained in pristine condition with minimal development. Accordingly, Cape Point scores very low on indicators of human and intellectual capital for obvious reasons as there are very few people residing in the area.

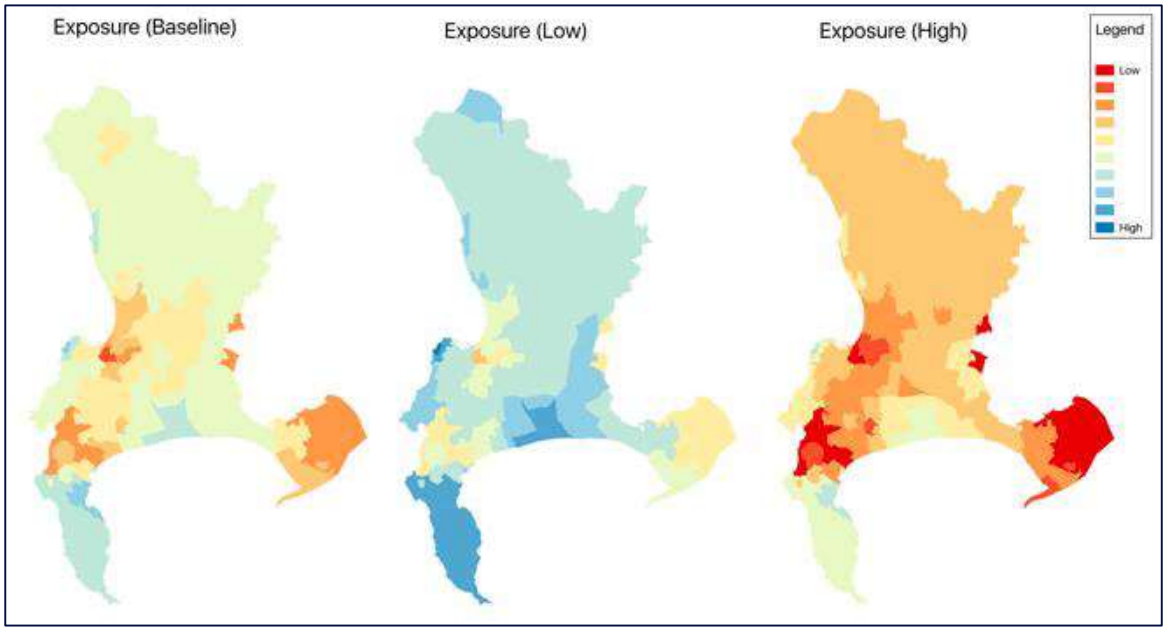
Although these discrepancies reflect an overall moderate capital score for Cape Point, this does not necessarily reflect low levels of capital across all capital types. The City operates as an integrated system within a broader regional economy, thus it is not necessary for all Suburbs to have equally high scores of all capital types. But rather there needs to be sufficient levels of capital across the City, within reasonable distances from one another to be substitutable in a way that lends itself towards resilience and improving service delivery. Additionally, knock-on impacts of unbalanced capital stocks and flows could lead to lower levels of resilience and vice versa. Notable variations in capital distributions also present possible opportunities to target investment in certain areas across different timeframes. There is no formula for an optimal capital mix at an optimal scale, this notion is discussed further in the next section and will be explored further through the development of adaptation options in the next report.

E.1.2 Exposure Assessment

Different capital stocks throughout the City are exposed to relatively different levels of climate stressors and shocks in space and time. Figure 4 shows maps depicting relative levels of exposure to climate change for the baseline and futures scenarios respectively. Unlike with capital stocks, there is no clear spatial trend in levels of exposure across the City. Broadly, the southern peninsula is less exposed while the central and eastern areas are more exposed. Areas that show relatively high levels of exposure include Observatory, Cape Farms South, Stellenbosch Farms, Paarden Eiland, Pinelands, Gordons Bay and Brooklyn. Areas with relatively low levels of exposure include Sea Point, Simons Town, Cape Point, Signal Hill/Lions Head, Kommetjie, Green Point and Mitchells Plain.

It is important to note that **the variance in exposure is relatively small across the City.** The colour spectrum used to represent that data in Figure 4 was chosen to clearly show these small discrepancies. Moreover, as with the aggregate capital scores, exposure is a function of multiple metrics which influence aggregate levels differently. See Deliverable 2 “Hazard and Vulnerability Report” for a break-down of the underlying drivers of exposure across the City.
Under a low climate change future the City’s exposure decreases substantially, whilst a high climate change future leads to a much higher exposure to climate change for the city. Suburbs which are more exposed to climate change risks in the baseline scenario experience greater growth in exposure when faced with a high climate change future. Additionally, these areas also experience the greatest decreases in exposure in a low climate change future.

Figure 4: Baseline and Future Scenario Exposure Scores by Major Suburb in the City of Cape Town.



E.1.3 Analysis of Capital-at-Risk

Capital-at-risk within the City was derived by combining relative exposure and capital scores for all three scenarios. Figure 5 presents a scatter plot directly comparing relative baseline capital scores and levels of exposure to current climate change, with the size of the circles showing relative population densities in each Major Suburb (disaggregated by the 8 CCT Planning Districts).

From this graphic it is evident that areas such as Pinelands, Plattekloof, Langa, Table View, Rondebosch, Newlands, Eversdal, Milnerton, Durbanville and Welgemoed have the highest levels of economic capital at risk to climate change. Whereas areas such as Ocean View, Macassar, Noordhoek, Muizenburg, Blue Downs, Fish Hoek and Kalk Bay exhibit relatively low levels of capital and exposure. Importantly the population density dimension helps to analyse how capital stocks are spatially distributed per capita. For example, Langa has a relatively high population density and exhibits a moderately high exposure and capital score. Even though an area such as Pinelands has a higher net 'capital-at risk score', the per capita capital endowment is notably lower than Langa. Thus, these population segments and the economic capital they generate and rely on are at greater risk.

Interestingly, Langa exhibits a moderate to high capital score because of its notably high human capital score as there are a high number of people employed in the area. Furthermore, there is a clear trend across the City showing areas of higher population generally correlating with lower capital scores and relatively higher levels of exposure (i.e. are found in the lower righthand quadrant). There are likely several explanatory factors for this trend, however, it appears that the pattern is largely the result of South Africa's history of population seperation which is still evident in population distributions and settlement patterns today. These areas have seen less investment in infrastructure and are situated further away from areas of stronger natural capital. Although government investment in these areas has been increasing over time (i.e. the financial capital indicator), they remain with severe infrastructure deficits and attract little private investment. Many of these areas exhibit lower levels of resilience, as identified in Deliverable 2 "Hazard and Vulnerability Report". The relatively high levels of exposure in these areas is likley a combination of poorer people settling in hazard prone areas and the variable nature of geography and climate impacts.

Figure 5: Graphic Representation of the Capital Score Against Exposure by Major Suburb in Cape Town.

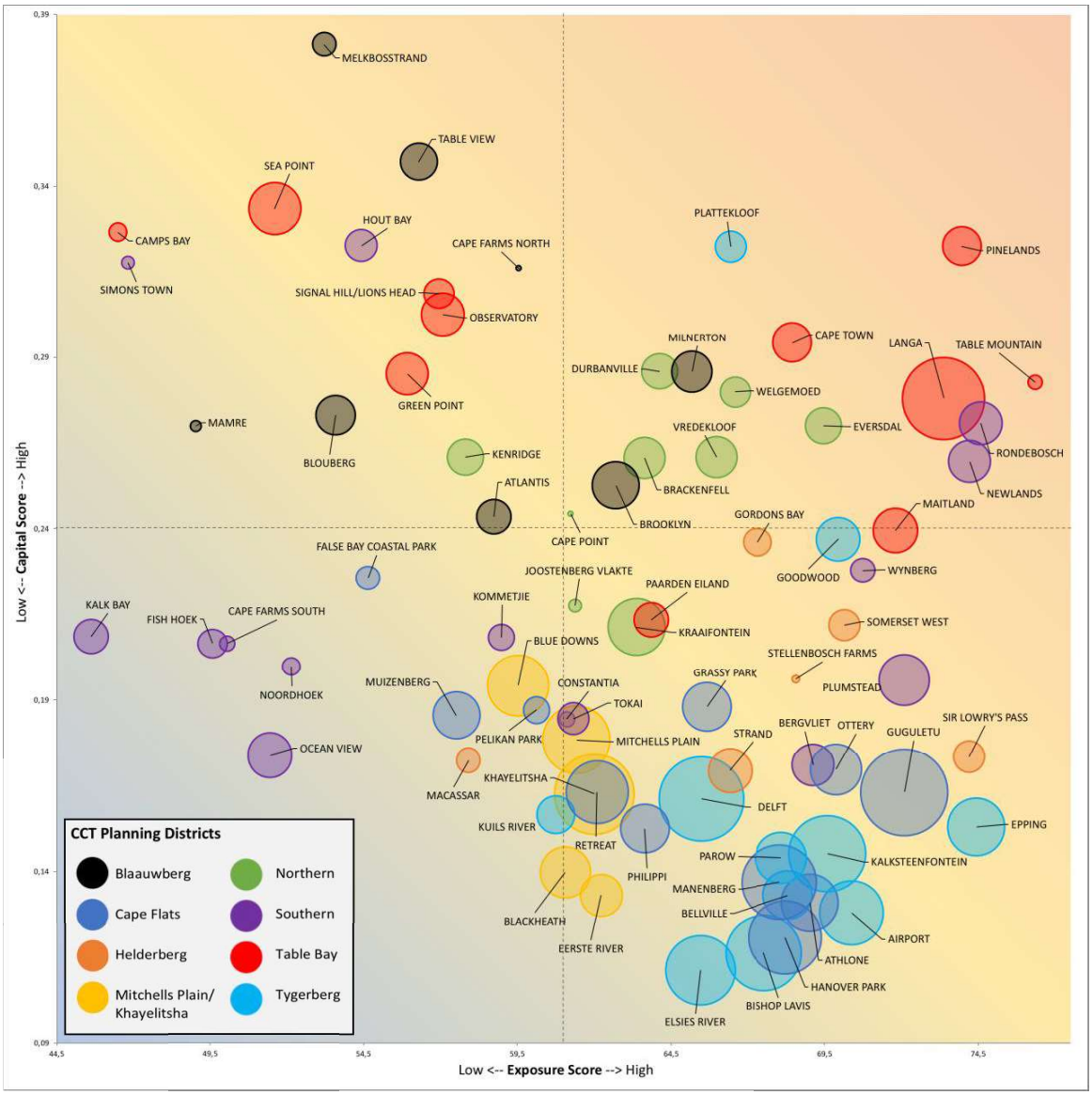


Figure 5 is intended to provide a snapshot of relative capital and exposure scores for the current time period. When combined into aggregate 'capital-at-risk scores', the spatial and temporal distributions become clearer. Figure 6 presents the relative spatial distribution of the four futures scenarios for combined capital and exposure scores. Tables 5 and 6 show the top and bottom 10 suburbs for each of the four scenarios. Across all four scenarios Pinelands, Table Mountain, Table View, Simons Town and Plattekloof exhibit the highest 'capital-at-risk' scores in the same order. Whereas Elsies River, Hanover Blackheath, Kuils River, Bishop Lavis and Eerste River are consistently at the bottom ranked in terms of 'capital-at-risk' scores. The key trend that emerges across these scenarios is that changes in capital over time have a notably larger impact on overall risk than changes in exposure over a similar time period. This is evidenced by greater standard deviation in the data across both types of capital scenarios compared to the data across the exposure scenarios, as well as Figure 6 that clearly shows a strong differences between the left hand quadrants and the right hand quadrants (i.e. capital scenarios) compared to the top and bottom quadrants (i.e. exposure scenarios).

Table 5: Top 10 Major Suburbs for Future Exposure and Capital Scenarios

Score Rank	Strong Capital * High Exposure	Strong Capital * Low Exposure	Weak Capital * High Exposure	Weak Capital * Low Exposure
1	Pinelands	Pinelands	Pinelands	Pinelands
2	Table Mountain	Table Mountain	Table Mountain	Table Mountain
3	Table View	Table View	Table View	Table View
4	Simons Town	Simons Town	Simons Town	Simons Town
5	Plattekloof	Plattekloof	Plattekloof	Plattekloof
6	Milnerton	Milnerton	Gordons Bay	Gordons Bay
7	Rondebosch	Rondebosch	Rondebosch	Rondebosch
8	Langa	Langa	Milnerton	Milnerton
9	Gordons Bay	Gordons Bay	Newlands	Newlands
10	Melkbosstrand	Newlands	Langa	Langa

Table 6: Bottom 10 Major Suburbs for Future Exposure and Capital Scenarios

Score Rank	Strong Capital * High Exposure	Strong Capital * Low Exposure	Weak Capital * High Exposure	Weak Capital * Low Exposure
68	Manenberg	Manenberg	Airport	Airport
69	Bellville	Airport	Bellville	Bellville
70	Airport	Bellville	Mamre	Philippi
71	Philippi	Philippi	Philippi	Hanover Park
72	Kuils River	Kuils River	Hanover Park	Mamre
73	Eerste River	Eerste River	Eerste River	Eerste River
74	Hanover Park	Hanover Park	Kuils River	Bishop Lavis
75	Bishop Lavis	Bishop Lavis	Bishop Lavis	Kuils River
76	Blackheath	Blackheath	Blackheath	Blackheath
77	Elsies River	Elsies River	Elsies River	Elsies River

These scenarios represent the best and worst case mid-future positions based on currently available data. Intuitively, scenario 3 (weak capital growth and a low exposure to climate change) leads to the least risk to capital across the city, whilst scenario 4 (strong capital growth and a high exposure to climate change) leads to the greatest risk to capital. For the most part suburbs that have higher baseline capital stocks translate into the areas with the highest capital risk under all scenarios. The changes in capital risk based on the scenario can be broken down into spatial and temporal effects. Appendix C provides further detail on the relative capital scores and exposure across Major Suburbs in Cape Town.

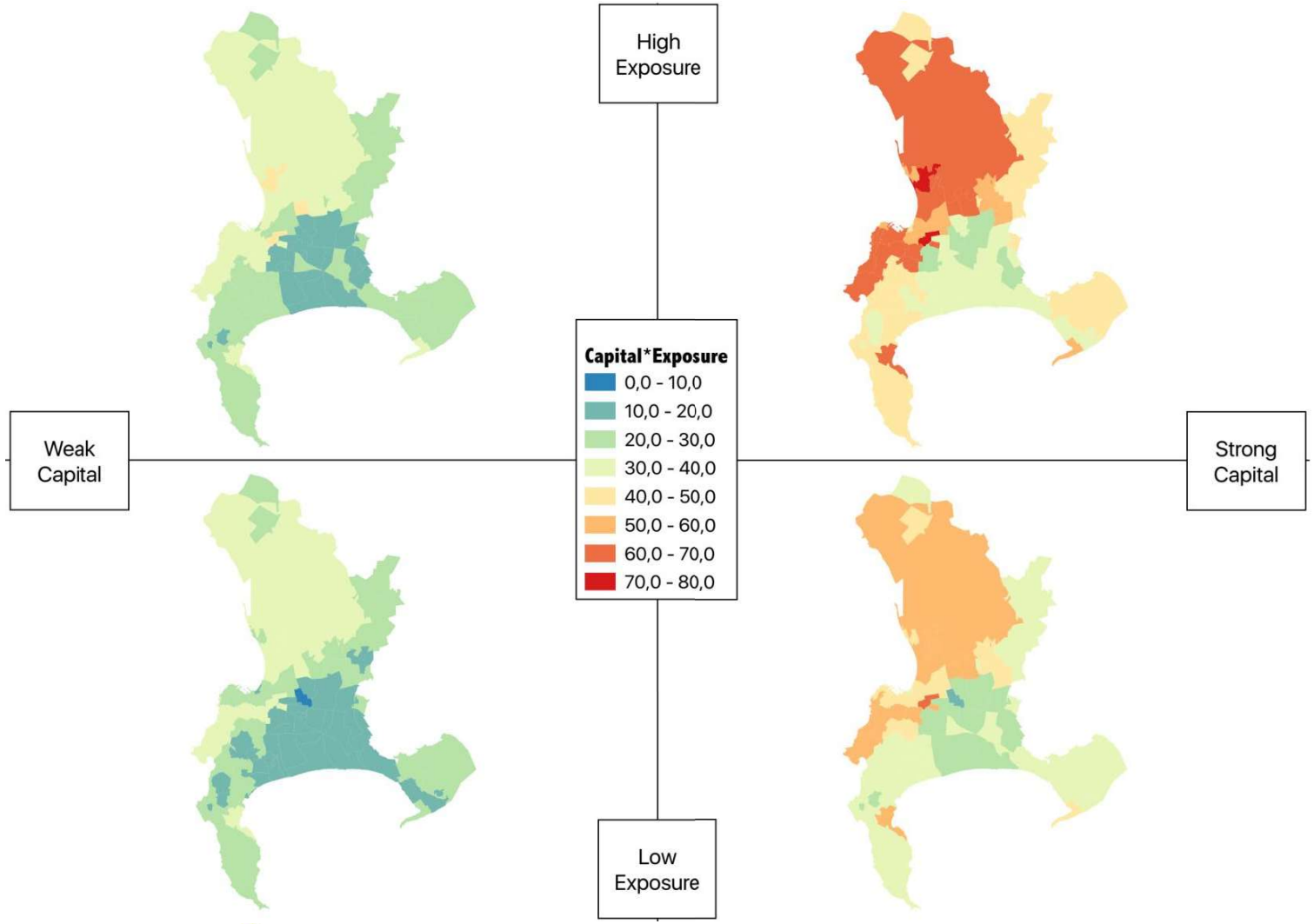
Spatially, with reference to Appendices B and C, the suburbs with the highest levels of capital generally have high levels of financial capital and then varying (but all relatively high) levels of manufactured, social, natural, and intellectual capital. These suburbs are generally on the Western seaboard (from Cape Farms North to Cape Point) as these suburbs generally have a much higher property value (which feeds into manufactured capital), generally contain more employed people (feeds into human capital), have more natural vegetation land coverage (contributes to natural capital) and less crime (feeds into social capital). An exception to is Langa, which has the highest human capital of all the suburbs and low levels of all other types of capital (except financial). Spatially these areas tend to spread northwards and southwards from the Cape Town CBD.

Temporal differences in capital at risk are based on how exposure to climate change and capital changes over time. The capital growth under weak and strong scenarios is based on the underlying capital score in the current baseline. Thus, areas with high capital scores will have relatively greater growth / declines in the capital scores under the different capital scenarios (i.e. they have more to gain/lose from percentage based capital growth or decline). Suburbs which have high capital levels in the strong capital scenarios exhibit higher levels of risk to climate change as capital growth rates affect levels of higher capital to a much greater extent than areas of lower capital. Additionally, the suburbs with lower levels of capital under

the baseline do not experience nearly as much growth, even under the strong capital scenario as they are growing off a smaller base.

It is important to note that this analysis is designed to provide a robust departure point for more detailed assessments of how risks may manifest differently across space and time. For example, an area may exhibit high levels of capital risk, but investigating the underlying data might reveal that the area is exposed only to expected increases in temperature, which would be ameliorated to a certain degree by strong natural capital. Certain climate related risks would pose greater threats to different types of capital, for example fire would pose a significant risk to natural capital and floods would pose a greater risk to manufactured capital. Moreover, areas of strong capital are not necessarily highly resilient and vice versa. There are also a myriad of interlinkages and interdependencies which limit or reinforce possible knock-on impacts of climate change. Thus, one needs to understand how risks might manifest throughout multi-scalar systems within the context of the broader economy to effectively target adaptation responses. But this analysis provides a strong departure point to assess the area specific risks in relation to capital assets.

Figure 6: Capital-at-Risk Scenarios by Major Suburb



E.2 Economic Context Evaluation

This section highlights some of the indicators which frame the City of Cape Town's economy and how it functions. Specifically, this includes analysing spatially disaggregated data on GDP, population size, employment and land-use through a sectoral lens. Broader economic value is generated from a combination of economic resources such as land, capital and labour, however, individual indicators cannot capture the relative contributions of these different resources. Ultimately, this contextual analysis provides the framework for assessing both resilience and economic capital in relation to climate change risks.

E.2.1 GDP and Population Scenarios

Figure 7 illustrates the combined GDP of the various planning districts across the City of Cape Town for the current scenario and both high and low growth future scenarios. The eight planning districts were used as this is the lowest spatial scale that GDP data is calculated for in CCT. The Helderberg and Mitchells Plain / Khayelitsha districts have the least productive economies as measured by GDP, closely followed by the Northern and Cape Flats areas under all scenarios. Table Bay district has the highest total GDP production closely followed by Tygerberg and then Blaauwberg and the Southern districts.

Figure 7: GDP Baseline and Projections

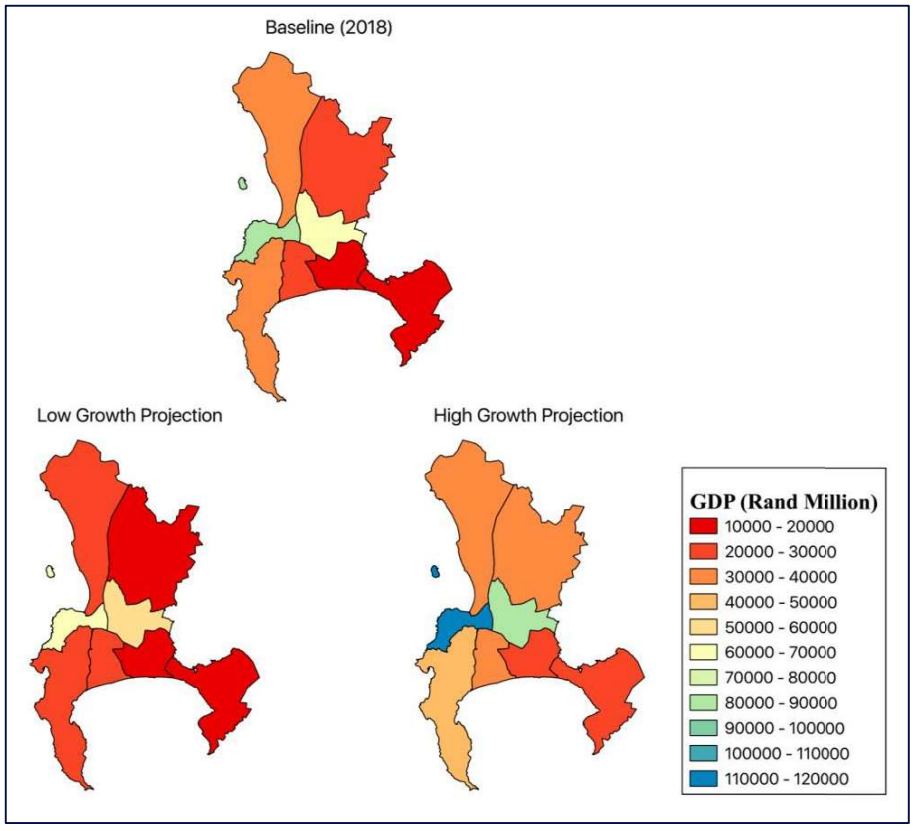
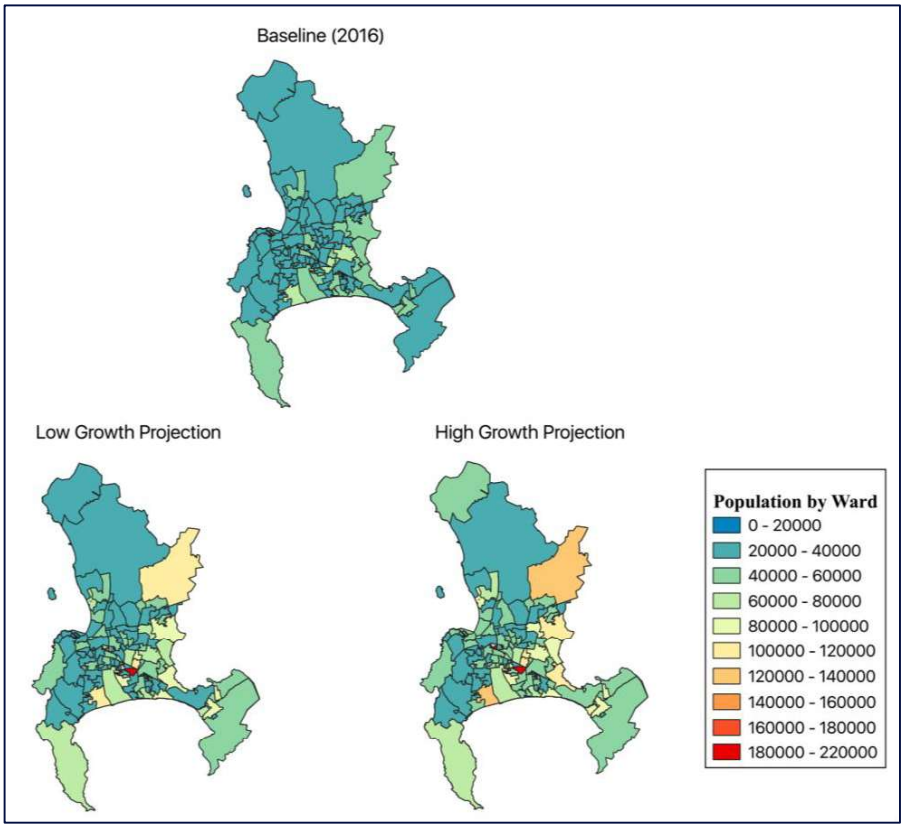


Figure 8 shows the total population of the 116 different wards across the City of Cape Town for the baseline scenario and both high and low growth future scenarios. It is important to note the distinction between the future scenarios for GDP and population: GDP future scenarios were derived from blanket growth/decline projections across the City, while population scenarios were determined against estimated ward level population growth rates. Thus, population growth scenarios represent estimations of ward level population change over time. Blaauwberg and Southern Cape Town have the lowest populations, while the Cape Flats, Mitchells Plain / Khayelitsha and Tygerberg have the highest populations.

Figure 8: Population Baseline and Projections



As expected there is little correlation between population size and GDP. Most people live far away from where they work, for example populations across Table Bay are relatively low but this area has the highest GDP productivity by far. Moreover, wealth inequality across the City generally follows the GDP and population distributions, as high capital areas have a fairly strong correlation with high GDP producing areas. Like the capital projections, future GDP scenarios illustrate higher growth / declines in areas with higher GDP baselines because the absolute value change is higher in both directions.

All in all, the districts which have low GDP scores in the baseline do not experience GDP growth/ loss as heavily as districts with higher GDP scores. GDP however is not a perfect analysis tool, it does not explain the nuanced economies that characterise these areas (such as high/low population, inequality, access to services etc.). Although these scenarios highlight that high GDP and strong capital areas have the most to lose from low growth scenarios and perhaps experience higher risk as a result, this does not take into consideration the importance of resilience and structural inequalities around the City. For example, GDP data does not directly capture the productivity of the informal economy which provides a critical economic safety net and resilience pathway for poorer communities, such as those generally situated within the lower GDP areas.

Interestingly, both low and high growth population projections present similar pictures of disproportionately high population growth in the low income, weaker capital and generally lower GDP areas. In-migration is a significant driver of population growth across the City and poses a significant risk to certain population segments. In-migration will see more people move to generally poorer and underserviced areas as they will be looking for jobs and they'll have to settle where they can afford. Thus, higher capital areas are likely to see lower rates of population growth, while areas of lower resilience are likely to see higher rates.

This stark differential in population growth will act to systematically increase the vulnerability of these systems, which will have a variety of knock-on impacts throughout the broader economy and society. For

example, there will be continually increasing pressure on urban transport systems as people will be settling in areas further away from high GDP centres. This will in turn reduce access to emergency services in the face of a disaster. This will also increase the burden on service delivery from the City and National Government, further pressurising a stressed system that is under resourced to provide adequate services to all citizens. However, on the other hand this projected increase in settlement in areas of lower formal economic activity provides a number of opportunities to take advantage of the increasing human capital and possible latent economic potential in these areas. It also provides the opportunity for densification of development in areas of stronger capital to provide alternatives to settlement in economically peripheral locations. Housing, water, energy and food systems will also face ripple effects of these demographic changes as these services need to be provided to all people. One key example is the distribution of the electricity grid to new settlements and consideration of the possibility of alternative energy sources and distribution systems.

E.2.2 Towards a Sectoral Risk Analysis

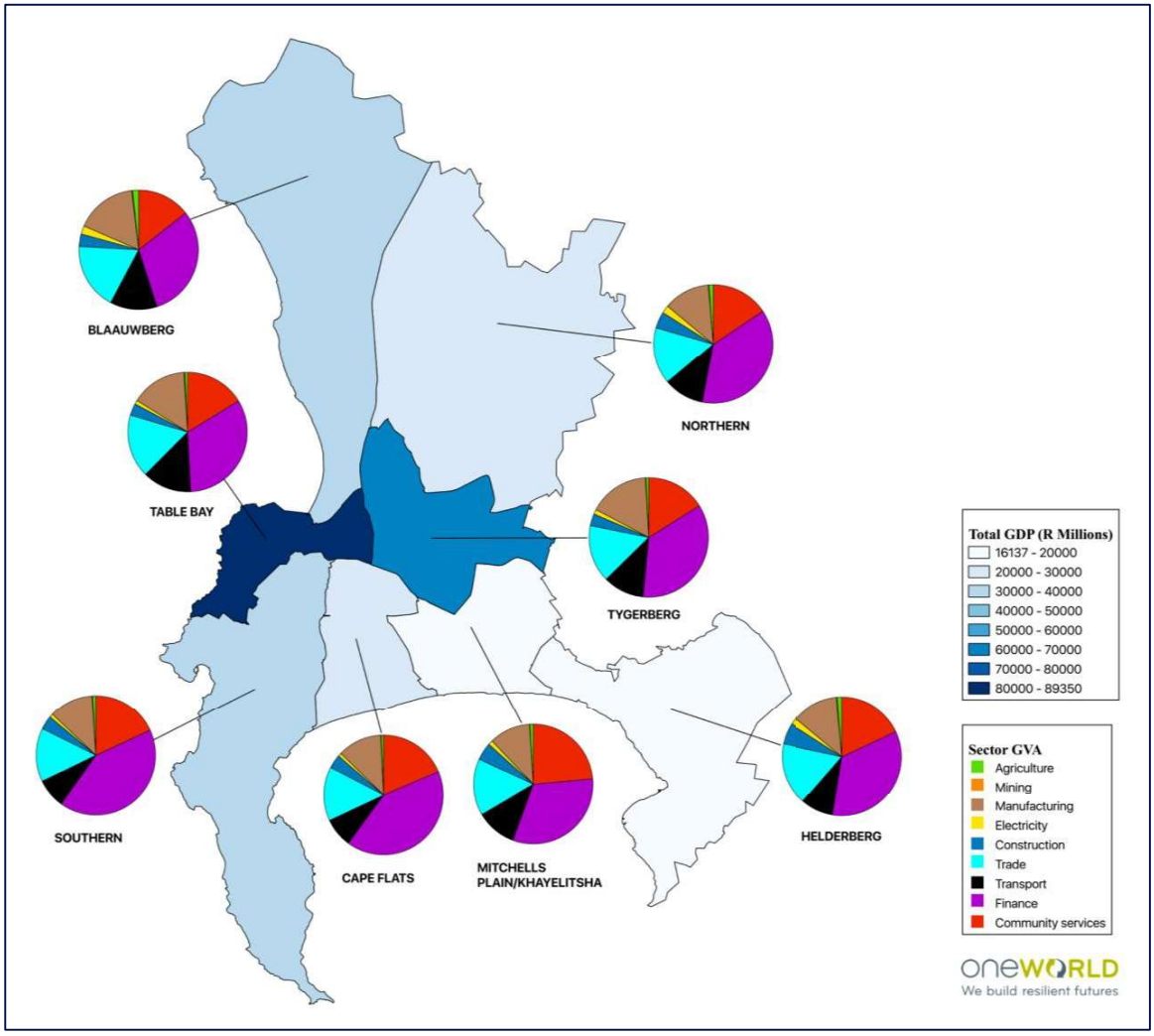
Analysing climate change risk to societies and economies through a sectoral lens presents a number of advantages and disadvantages. Notably, sectoral analyses can provide a structured and directed appraisal of risks against specific sectoral components, which can feed directly into sectoral plans, policies and directives. However, the cross-cutting nature of climate change necessitates increasingly integrated approaches towards managing and mitigating the projected risks to society and the economy at large. Moreover, the knock-on impacts of climate change on (and within) different sectors will be largely determined by market dynamics and how these respond to local and regional changes in climate (IFC, n.d.). Therefore, to bridge these two approaches a multi-disciplinary analysis of different sectoral categorisations is undertaken. This includes an analysis of a variety of key sectoral contributions towards GDP, employment and land-use across the different planning regions of the City of Cape Town.

E.2.2.1 Gross Domestic Product

Figure 9 below presents a sectoral break-down of GVA and total GDP across City's planning districts (See Appendix A for a locality map of the various planning districts). Each district has a similar GVA breakdown per sector, with finance dominating the sectoral composition for all districts. Community services, trade, manufacturing and transport make up the bulk of the rest of the GDP for the City. The relative similarities in contributions by different economic sectors across the City could be attributed to the spatially autonomous nature of each of these areas. For example, there is a need for economic activity of a relatively similar degree in each of these sectors to create productive economies in each region. This is related to the highly interlinked nature of these sectors and how they support and/or complement one another. For example, agriculture requires transport infrastructure and financial services to function effectively, while the transport sector is developed through moving agricultural produce and the finance sector through providing insurance and real estate services. Theoretically, some of these services would be provided from other regions (i.e. financial services throughout most of the City might be largely provided from Table Bay).

On the other hand the relatively smaller differences could likely be explained by socio-economic circumstances. For example, Mitchells Plain / Khayelitsha and Cape Flats exhibit slightly higher relative contributions from the Social Services sector, which could be a result of the relative weakness of the financial sectors in relation to the larger district economies in the City. This is also likely a result of the need for greater levels of social services in these areas because they are relatively poorer and populations are higher. Whilst other differences can be explained by geographical features. The manufacturing sector contributes more to the total GDP of Tygerberg than any other district. This is because the manufacturing heartland of the City is situated within this district, while the same applies for agriculture to the Northern, Blaauwberg and Helderberg districts.

Figure 9: GDP Breakdown by Sector and Planning District



E.2.2.2 Employment

Figure 10 presents a sectoral breakdown of employment by planning district across the City. Given the high rates of unemployment and wealth inequality in South Africa, understanding any correlations or lack thereof between employment and economic growth in different sectors is essential. Especially in the context of a changing climate and economy of the future.

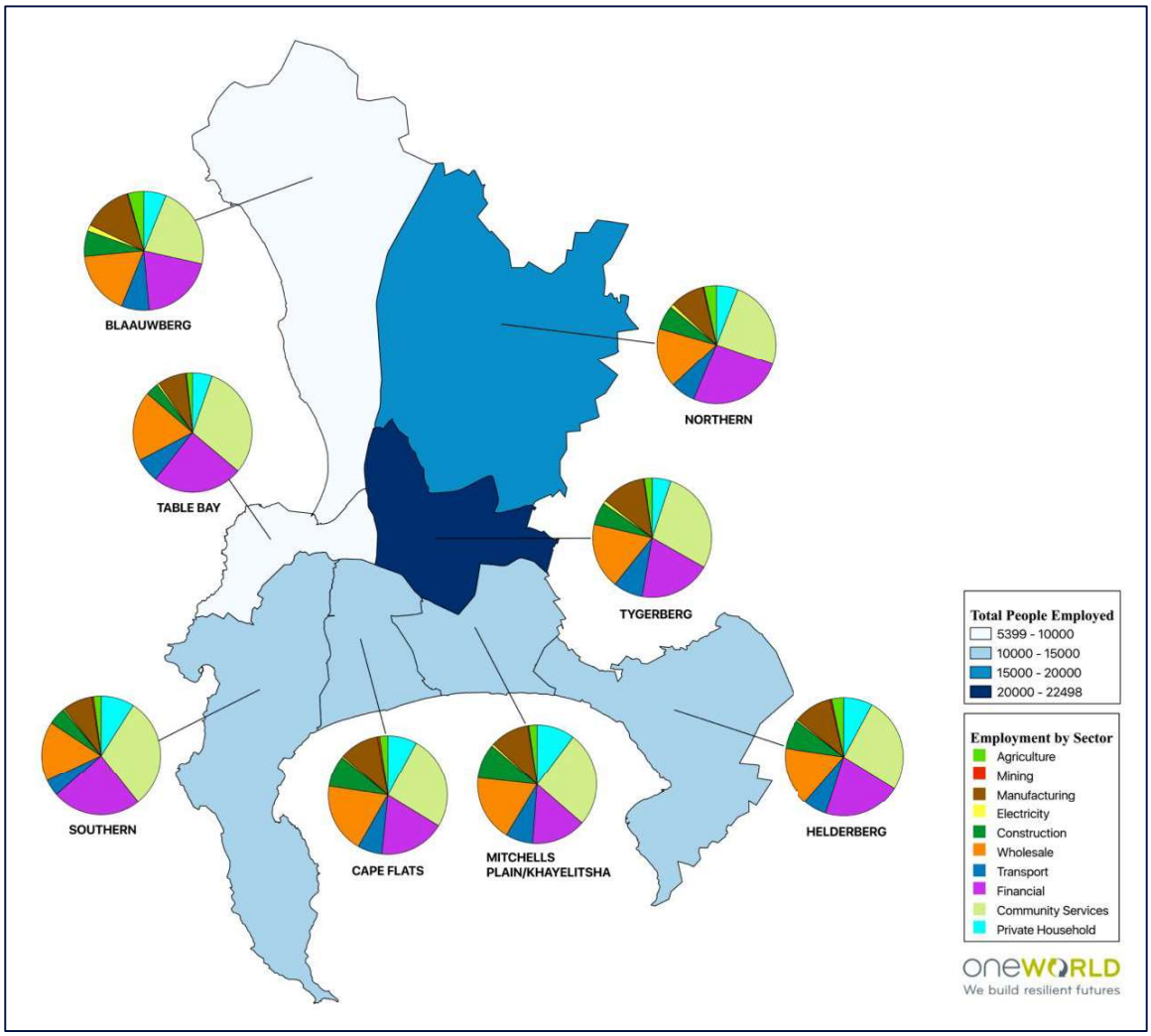
The Cape Flats and Mitchells Plain / Khayelitsha Districts have some of the wards with highest populations (and future populations) shown in Figure 8, yet only have an average amount of total people employed, as well as low total GDP scores. Table Bay however employs relatively few people, yet is the strongest performing district in terms of GDP, which indicates a possible history of wealth accumulation in contrast to other districts. The district of Tygerberg has the most employed people and has the second highest relative total GDP score.

From a sectoral perspective, community services contributes to employment notably more than it does to GDP, whereas this is the opposite case for the finance sector. The transport and manufacturing sectors contribute moderately less to employment than to GDP, while agriculture employs significantly more people in relative terms compared to its own GDP contribution (mostly in the Blaauwberg, Northern and

Tygerberg districts). Much of the discrepencies between different districts can be explained by socio-economic and geographic circumstances. For example, employment in the construction sector is relatively higher in the Cape Flats and Mitchells Plain / Khayelitsha districts than other 'higher GDP' districts such as Table Bay, Tygerberg and Southern. Although much of the construction activities these people are involved in are likely in the 'higher GDP' districts, the employees live in the 'lower GDP' districts. This same pattern applies for industries that employ generally large numbers of medium to low income employees.

Analysing employment statistics give important insight into the dynamics of the informal economy, a critical component of the broader economy in Cape Town providing livelihoods and services to a significant proportion of the population. This is largely captured through agricultural and private household employment, which make a significant contribution towards overall employment yet are barely captured in GDP figures. The informal economy plays a larger role in generally poorer areas, this is evidenced by the notably lower contribution of these two key sectors in the Table Bay district. Lastly, the contrast between sectoral GDP and employment figures highlights the scale of wealth accumulation and inequality within and across the City. For example, in areas such as Tygerberg the finance sector contributes approximately double the relative GDP compared to employment.

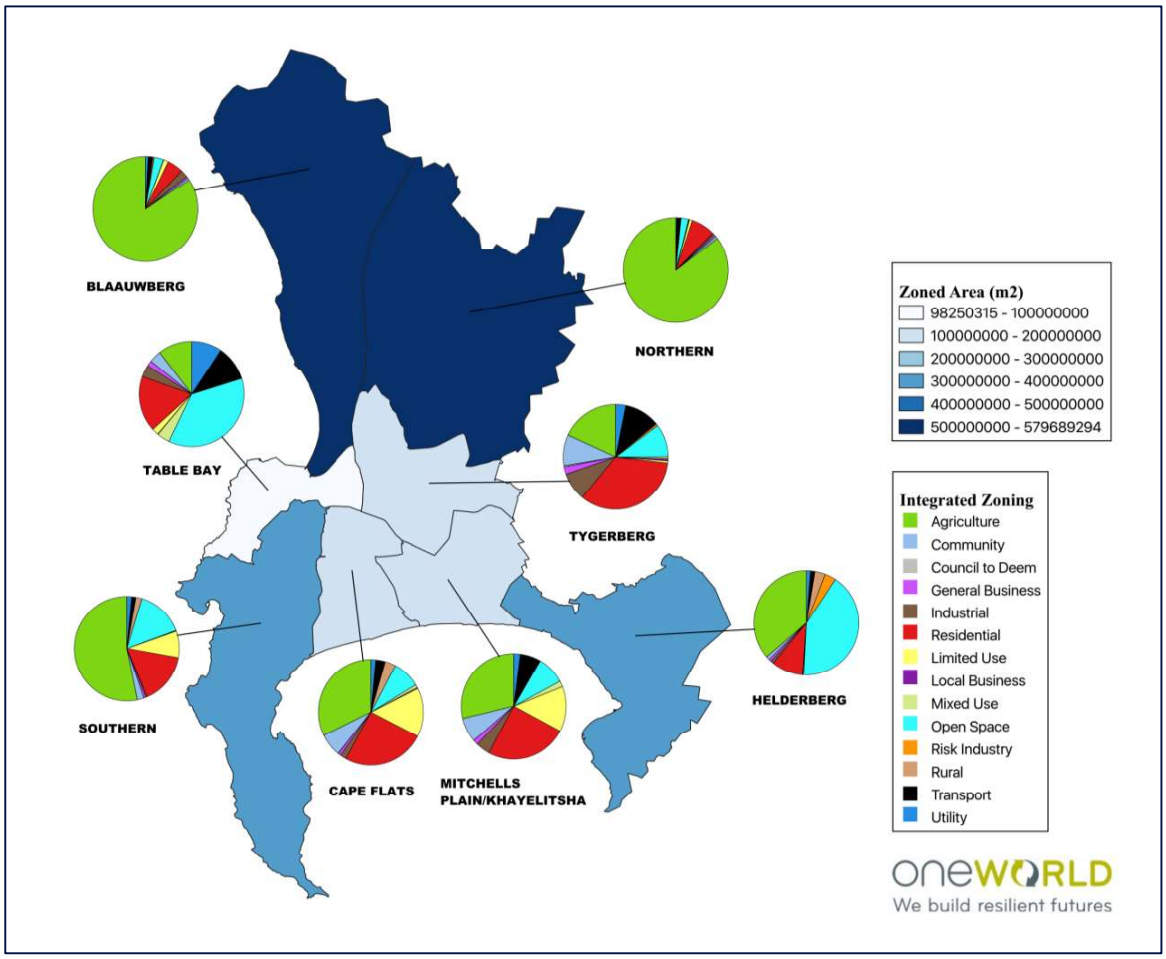
Figure 10: Employment Breakdown by Sector and Planning District



E.2.2.3 Land-use

Land-use refers to all forms of management and/or modification of the natural environment. Within an urban setting land-use can be analysed for multiple planning objectives through different tools. Two of these include land-use zoning and land cover. Figures 11 and 12 illustrate the zoned land-use breakdown by sector and planning district for the City (Figure 12 excludes agriculture from the sectoral analysis). Figure 13 shows the land cover breakdown by sector and planning district. An obvious takeaway from these graphics is that the Northern and Blaauwberg districts are the largest in terms of area and Table Bay is the smallest.

Figure 11: Zoned Land-use Breakdown by Sector and Planning District

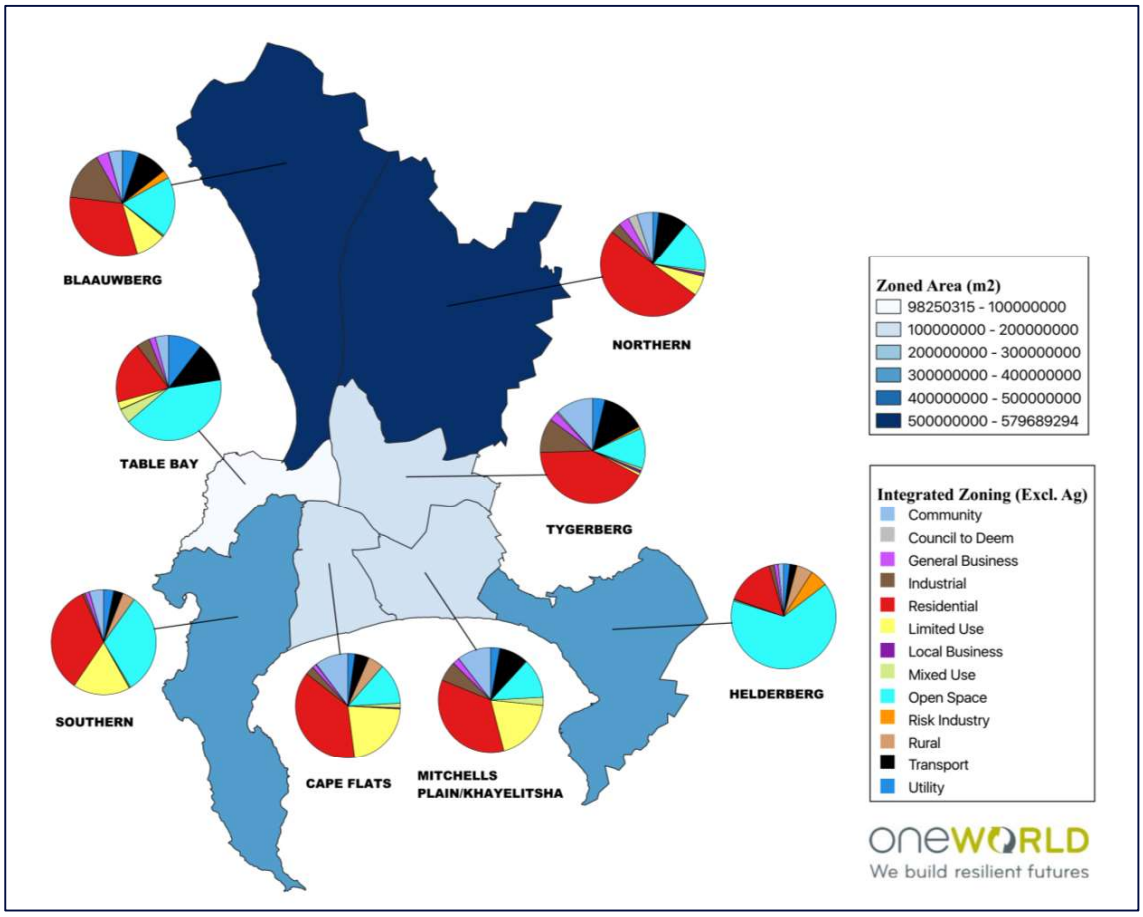


Agriculture covers the largest zoned area throughout the City, covering more than 75% in the Blaauwberg and Northern districts and more than 50% in the Southern district, together three account for more than 80% of the agricultural land in Cape Town. These distributions of agriculturally zoned land are indicative of the relatively higher agricultural employment and GDP figures in these districts. Nevertheless, agriculture is a land-intensive activity that is seemingly contributing relatively very little to GDP and moderately to employment. However, local and regional food security is dependent on agriculture, which is arguably the most at risk from direct impacts of climate change. Moreover, urban farming is becoming ever more important for food security and providing livelihoods, for example the Phillipi Horticultural Area in the Cape Flats district plays a diverse role in creating jobs and providing affordable and healthy food within the City.

It should be noted that some zoning areas remain artefacts of historical zoning activities. For example, in the Southern district several green spaces and nature reserves remain zoned as agriculture (such as the Cape Point Nature Reserve) when they should in fact be classified under the broader open space classification. Comparing Figures 11 and 13 highlights these discrepancies, for example almost 75% of the Southern district's land cover is shown to be green space and forestry and this roughly correlates with the open space and agriculture area zoned for the same district. Aside from the Southern district, green space and forestry make up more than 50% of land cover in Helderberg, Blaauberg and Table Bay districts, while comprising 25-50% for the remaining districts. This proportion of green space and forestry is uncommon and resultant of Cape Town's unique urban geography and focus on conservation of natural vegetation in the Cape Floristic Kingdom. This is a critical aspect of the City's local tourism industry, which is the top grossing tourism industry in Africa.

Apart from green space and/or agriculture, Tygerberg, Mitchells Plain/ Khayelitsha, the Cape Flats and Table Bay are the residential hot spots for the City (Figure 11) in terms of area zoned. When coupled with the population data illustrated in Figure 8, it is evident that the majority of the population live between the Cape Flats, Mitchells Plain/ Khayelitsha and Tygerberg areas. However, in Tygerberg there is more residential land use than in the Cape Flats and Khayelitsha. Accordingly residential population densities are notably higher in these lower income areas. These areas also exhibit the highest coverage of urban townships and informal settlements (Figure 13), which are generally lower income areas where the most vulnerable people reside. Building on this, the land zoned for transport infrastructure is much greater in Table Bay and Tygerberg compared to the Cape Flats and Mitchells Plain/ Khayelitsha.

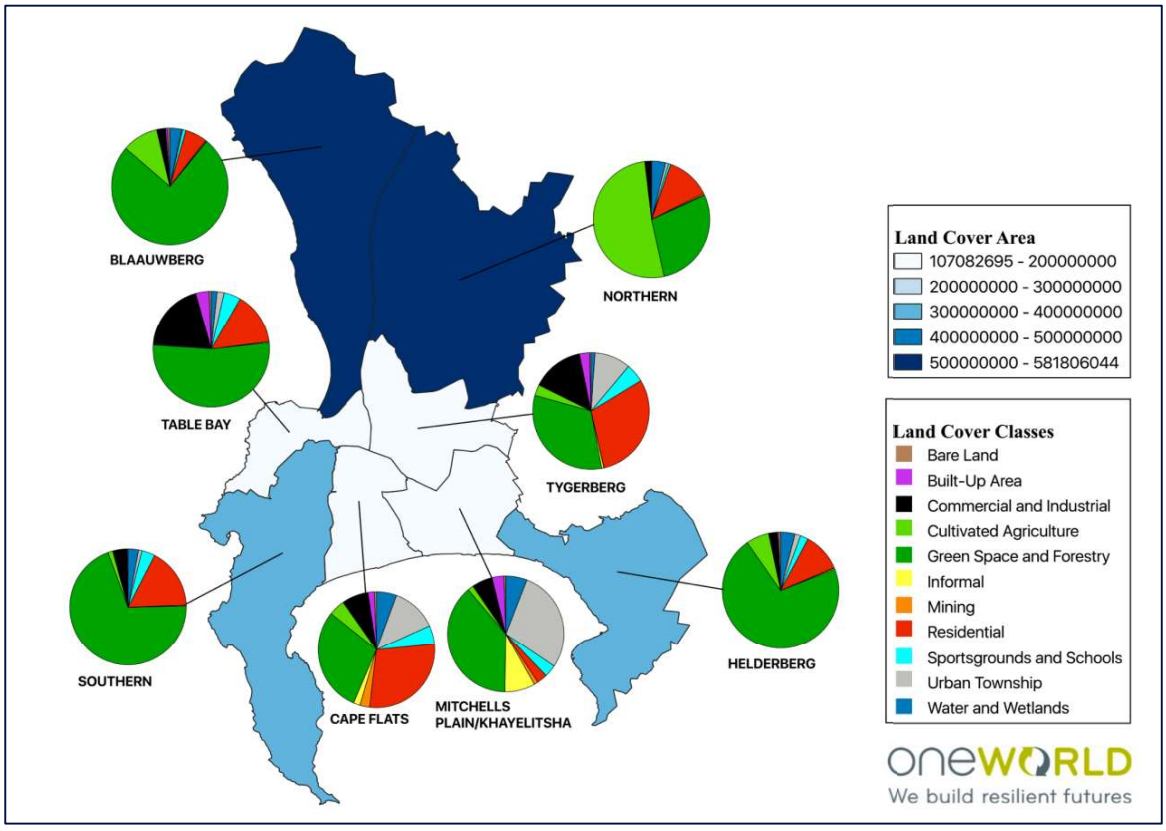
Figure 12: Zoned Land-use Breakdown by Sector and Planning Region (Excluding Agriculture)



The spatial distribution of land, capital and employment consistently illustrate the inequalities in access across the City, which are magnified by climate change through large differences in individual and

community resilience. The strong focus on land zoned for residential use is indicative of the value CCT places on residential property rates, as this is a central revenue generating activity for the City. Moreover, much of the rates revenue is used to cross-subsidise the poorer less resilient communities, such as those in the Cape Flats and Mitchells Plain / Khayelitsha districts. It is important to note that these areas have a large amount of land which has limited use, it is likely these areas are largely unsuitable for residential development due to environmental factors such as wetlands and flood lines or hazardous land (Figure 13). Moreover, the relatively lower amounts of greenspace in these areas are indicative of human encroachment into areas of natural vegetation, which reduces the natural capital in these areas and concomitantly increases their vulnerability to flooding and other climate shocks.

Figure 13: Land Cover Break Down by Sector and Planning Region



E.2.2.4 Sectoral Risk Pathways

Although some sectors might contribute greater GDP or employment or use less space (or different types of land) to generate these different types of value, this does not necessarily mean these sectors are facing a greater or lesser risk to climate change. Some sectors will be more directly impacted by changes in climate than others. Agriculture (especially dryland agriculture) for example is largely dependent on climate. Whereas other sectors such as finance, mining or construction will feel the impacts largely through second or third order economic and/or policy responses to climate change. Thus, sectoral risks are best identified through possible risk pathways that demonstrate how specific climate change risks might impact a sector directly or indirectly, as well as the population segments that would be most affected by these changes. This framework allows for adaptation planning that addresses multiple risk pathways related to economic sectors, as well as broader societal resilience.

These complex sectoral interlinkages create a multiplicity of possible climate change ripple impacts through different market dynamics, as well as possible opportunities to take advantage of projected changes. Thus, when considering that the impact of climate change within sectors and associated sub-

sectors will be driven largely by market dynamics and how these respond to cumulative shocks and stressors over time, a broader analysis of the economic risk is necessary to understand possible knock-on impacts and possible opportunities these might create for people and the broader economy. Table 7 demonstrates key direct and indirect risks facing the various economic sectors in the City of Cape Town, as well as relative contributions in terms of GDP and employment, and approximate land-use (in terms of area).

This analysis does not provide a framework for prioritising adaptation investment across different sectors, but rather it serves to elucidate the nuances of the different sectors and how different climate risk pathways may affect them. Importantly, this does not capture key aspects such as the informal economy, which we know plays an important role in terms of employment. Thus, an adaptation investment strategy should not prioritise investment in one sector over another, but should rather focus on addressing key risk pathways that could result in the greatest impact across the economy as a whole because of the complex interlinkages and interdependencies between and within these sector.

Table 7: Key Sectors at Risk and Possible Pathways

Key Sectors at Risk	Description	GDP Contribution	Employment Contribution	Land-Use	Possible Risk Pathways
Agriculture	Cultivated agriculture, livestock, hunting, forestry, fishing and fish farms.	Low	Moderate - Low	High	In all its forms is highly susceptible to climate change shocks and stressors. Direct impacts include heat stress and drought that limit agricultural production and flooding/fires that destroys crops and durable capital. There are a myriad of indirect impacts related to soil health, pollination, land-use etc. For example, changes in temperature may decrease populations of essential pollinators for certain types of cultivated agriculture.
Community Services	Public administration and defence, education, health and social work.	Moderate - High	Moderate - High	Moderate - Low	Climate change will cause greater risk to people's health posed by flooding, heat waves, drought, etc. which will increase their dependence on health systems such as hospitals and the need for community services. Moreover, critical infrastructure (such as hospitals, fire stations and police stations) will be at risk to extreme events.
Construction	All building and construction related activities.	Moderate - Low	Moderate	Moderate	Construction could be significantly affected by climate change as buildings would need to be built more resilient to projected climate change. Not only will changes in climate stressors and shocks impact the current built environment through physical risks to structures (i.e. heat stress, flood damage etc.), these could also lead to further increases in the costs of doing business as building regulations are likely to become more stringent. Although damage to and destruction of buildings might create more construction business in the short term, this will likely have larger negative impacts on the construction industry in the longer term. Property valuations may change in response to anticipated climate impacts, which would have knock-on impacts for the construction sector.
Electricity & Water	Electricity supply and the collection, purification and distribution of water.	Low	Low	Moderate	Climate change imposes huge risks to water, which will likely be more scarce due to droughts affecting the collection and distribution, but also purification would become more costly and necessary because of the decreased impact of dilution. Indirectly, increasing attention on climate change has put pressure on South Africa's current electricity system to become less carbon intensive, which has significant implications for the

					electricity sector in terms of generation and distribution. Extreme events could also increase operational and maintenance costs across the grid.
Finance	Finance and insurance, real estate and other business activities.	Moderate - High	Moderate - High	Low	The insurance industry would be directly affected through increases in premiums due to higher risk of loss and damage to economic assets such as cars, buildings etc. As finance is directly linked to all other sectors, the impact on the finance sector would be determined by the magnitude of impacts on related sectors and the possibility of developing opportunities through these changes. Rapidly changing policy and regulatory requirements will affect the finance industry, but relative risk varies and will be largely determined by the market.
Manufacturing	Manufacturing of food, textiles, wood, machinery and transport equipment.	Moderate - High	Moderate	Moderate	Manufacturing is indirectly affected by climate change as many of the inputs are derived from agriculture and so could be highly susceptible to diminished and more expensive agricultural inputs. Minimal direct impacts apart from damage to capital and disruption of work due to extreme events.
Mining	Extraction of lignite, gold and other metal ores	Low	Low	Low	Direct impacts of climate change are limited to extreme events such as flooding and storms that disrupt operations. Possible indirect impacts include disruption of supply chains and thus financing through extreme events, changes in market conditions due to global climate impacts and the cost of doing business as operating machinery may become more costly under different climate regimes. Health impacts of climate change might have a negative impact on worker productivity in large labour force environments.
Trade	Wholesale and retail trade, vehicle and fuel sale and hotels and restaurants.	Moderate - High	Moderate - High	Moderate - Low	Direct impacts are limited to the impacts of extreme events on durable capital. However, there are a myriad of indirect impacts on the trade industry related the large supply chains and various industries that contribute towards this. For example, restaurants are likely to become less competitive if food supply systems are threatened by changes in climate and lead to increased costs of food production and distribution. With trade-related value chains being largely global in nature, some of the localised impacts of climate change may be negated. However, other impacts such as decreases in tourism due to possible increases in costs of travel and/or local resource availability due to climate change will have a direct impact on the trade sector.

Transport	Land, sea and air transport, post and telecommunications.	Moderate	Moderate	Moderate	Direct impacts include damage and destruction of durable capital such as roads, railways and harbours due to extreme events. Indirect impacts are largely related to broader changes in market dynamics that may limit certain sectors and create opportunity for transport in others, as general costs of transport go up. Climate related in-migration might increase pressure on the transport sector in lower-income areas of the City, which will have a number of knock-on impacts for other industries dependent on effective transport systems.

F. Conclusion

Both the productive value of the economy and the population is at risk due to climate change, but this varies across space and time. Different capital stocks and combinations thereof are subject to different levels of risk from the various climate shocks and stressors that make up exposure, moreover these risks will manifest differently throughout the City's various socio-economic and environmental systems. Thus, understanding appropriate adaptation responses at the local level will require a nuanced understanding of both the specific climate risks facing different areas, as well as both the relevant resilience dynamics and capital stocks. This will in turn provide the basis for understanding aggregate City-wide adaptation options that can act to build on local level dynamics while making provision for City-wide risks and socio-economic aspects.

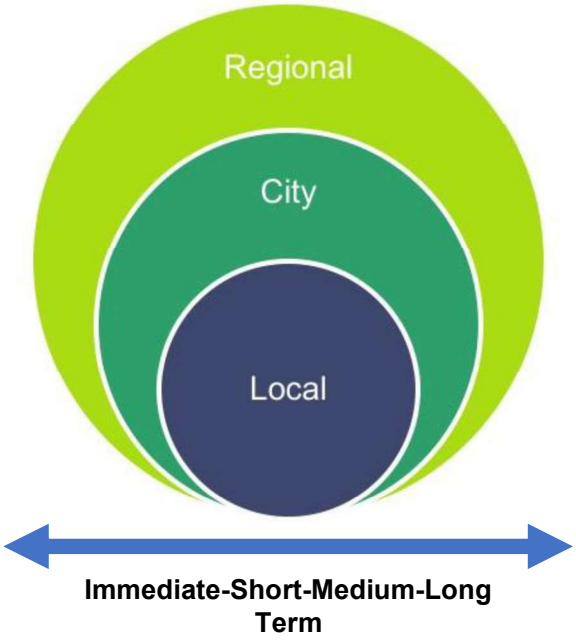
Understanding economic risks of climate change is essential for effective adaptation investment planning. The Capital-at-Risk analysis is designed to provide a robust departure point for more detailed assessments of how risks may manifest differently across space and time. There are a myriad of interlinkages and interdependencies which limit or reinforce possible knock-on impacts of climate change. Thus, one needs to understand how risks might manifest throughout multi-scalar systems within the context of the broader economy to effectively target adaptation responses. Hence, this assessment provides the framework to assist investment planning and the implementation of adaptation options through the understanding of relative levels of capital endowment *vis-à-vis* relative levels of exposure and through various climate-related hazards. Moreover, disaggregating the economy into employment, GDP and land use provides an appropriate framework to understand relative risks of climate change to different sectors.

There are clear disparities between stocks of economic capital and broader economic indicators across the City, which expose the City to a variety of climate change risks. Climate change shocks such as floods, fires and heatwaves present a myriad of immediate impacts to several economic sectors such as agriculture, transport and water and electricity, which will manifest through multiple risk pathways throughout other economic sectors as well. Longer term stressors present an emergent and systematic change to natural, social and economic systems that are fundamentally linked, which will also result in multiple ripple effects throughout the broader economy. Thus, an adaptation investment strategy should not prioritise investment in one sector over another because of the complex interlinkages and interdependencies between these sectors, but should rather focus on addressing key risk pathways that could result in the greatest impact across the economy as a whole.

F.1 Towards Priority Adaptation Investments

Building on the outcomes of the Economic Risk Analysis and the Hazard and Vulnerability Assessment, Figure 14 illustrates a conceptual approach to applying the climate risk evidence-base to developing a suite of adaptation investment options that will minimise the multiplicity of risks across space and time. This approach will focus on developing a range of local, City-wide and regional adaptation options to be implemented over a variety of timeframes from immediate responses to long-term multidecadal investments.

Figure 14: Conceptual Model for Spatial and Temporal Aspects of Adaptation Investments



The complexity and interdependencies of the risk pathways that threaten economic, social and environmental, wellbeing indicate a clear need for cross sectoral, coherent strategies and investments for long term adaptation. These must be predicated by sustainable development and underpinned by a developmental approach, in line with the CCT's strategic approach. As such, the investments required need to be underpinned by long term goals and objectives, with indicators and incremental targets. The investment plan will therefore be applicable as a flexible M&E framework that integrates incremental investments across the CCT's sectors and functions, along indicative timelines that the CCT can adjust as it monitors its progress in strengthening adaptative capacities to climate change.

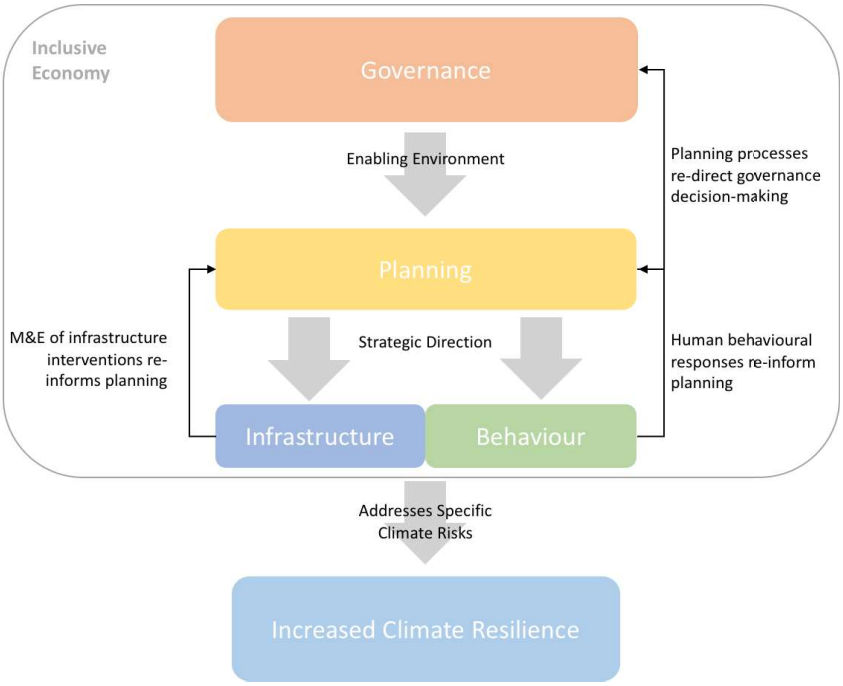
Integrating the findings of the Hazard, Risk and Vulnerability Assessment, and the Economic Risk Assessment strongly highlights the necessity for inclusive urban development that aims to increase the resource 'wealth' of its citizens – leaving no one behind. At present, resource poverty is synonymous with climate-vulnerable populations, meaning that the most vulnerable are also those with very limited access to sustainable land uses, and enough water and energy. At the same time, all these resources are threatened, in different ways, by climate change, along with poor governance and low levels of economic growth across the country.

The interactions between the different threats that face the City, plus the climate change implications for governance and planning, economic development, management of green and grey infrastructure and the behaviour of citizens and decision makers, requires altered approaches, much more of the same approaches, and transformational approaches across the spectrum of functions and life throughout the CCT and society.

This calls for a suite of adaptation interventions that maximise co-benefits across them, while minimising the potential for maladaptation. These need to include short-term responses that are designed to build longer term resilience, which are nested within long-term strategies and goals. Each response should actively address one or multiple risk pathways related in order of priority to the key climate change risks of drought, fire, heat waves, floods and strong winds. The various costs, both tangible and intangible, and how different investments could be financed should further inform the most appropriate course of action. Moreover, key cross-cutting elements such as disaster risk reduction and technology need to be considered as integrated aspects of a broader adaptation framework.

Building and sustaining resilience in the City is thus conceptualised as undertaking integrated investments across the spheres of transforming governance and planning, including through greater levels of stakeholder participation in cross sectoral and cross societal planning approaches, incentivising behaviour change, paving the way for climate resilient businesses and SMEs, and ensuring that grey infrastructure investments are sustainable because they can rely on optimal ecosystem functioning. The conceptual framework is presented in Figure 15 below.

Figure 15: Climate Resilience Investments: A Conceptual Framework



The integrated approach briefly outlined above, including in Figure 14, gives rise to the need for adaptation pathways that combine a range of incremental investments to address the specific economic, social and environmental climate change risks and impacts that face the City now and into the future. Framed by a set of adaptation pathways, the forthcoming investment strategy will be forward looking, relevant to the future City of Cape Town, and how the make-up of the economy and distribution of the population will look like then. This is critical given the disproportionate rates of change in these areas and the uncertainty that accompanies future projections. The adaptation pathways, that respond to the identified climate risk pathways will aim to ensure that the impact of an integrated adaptation investment strategy will be greater than the sum of its parts and actively contribute towards simultaneously reducing economic risks and improving human resilience in a sustainable manner.

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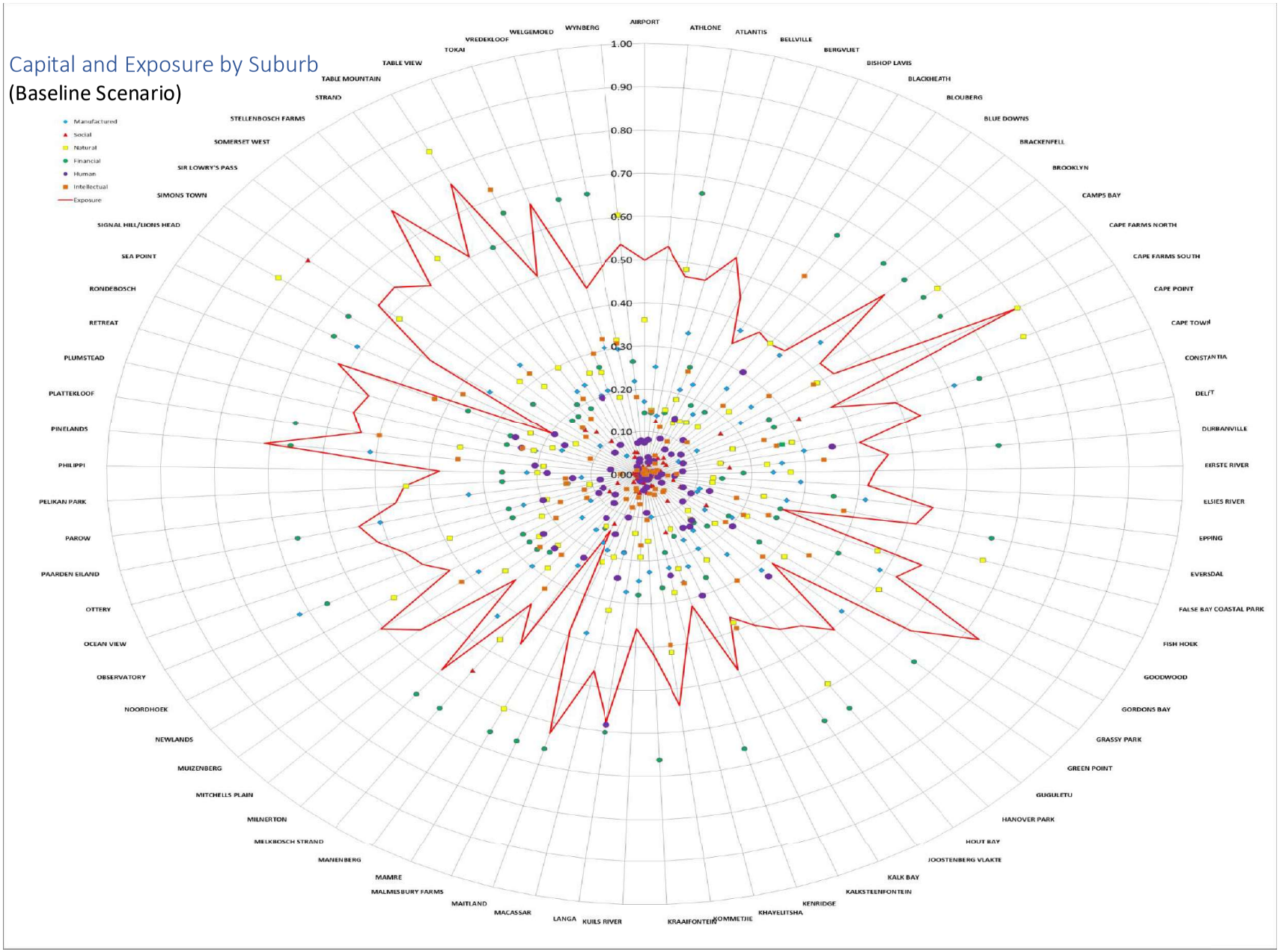
Appendix A: Major Suburb and Planning District Locality Maps

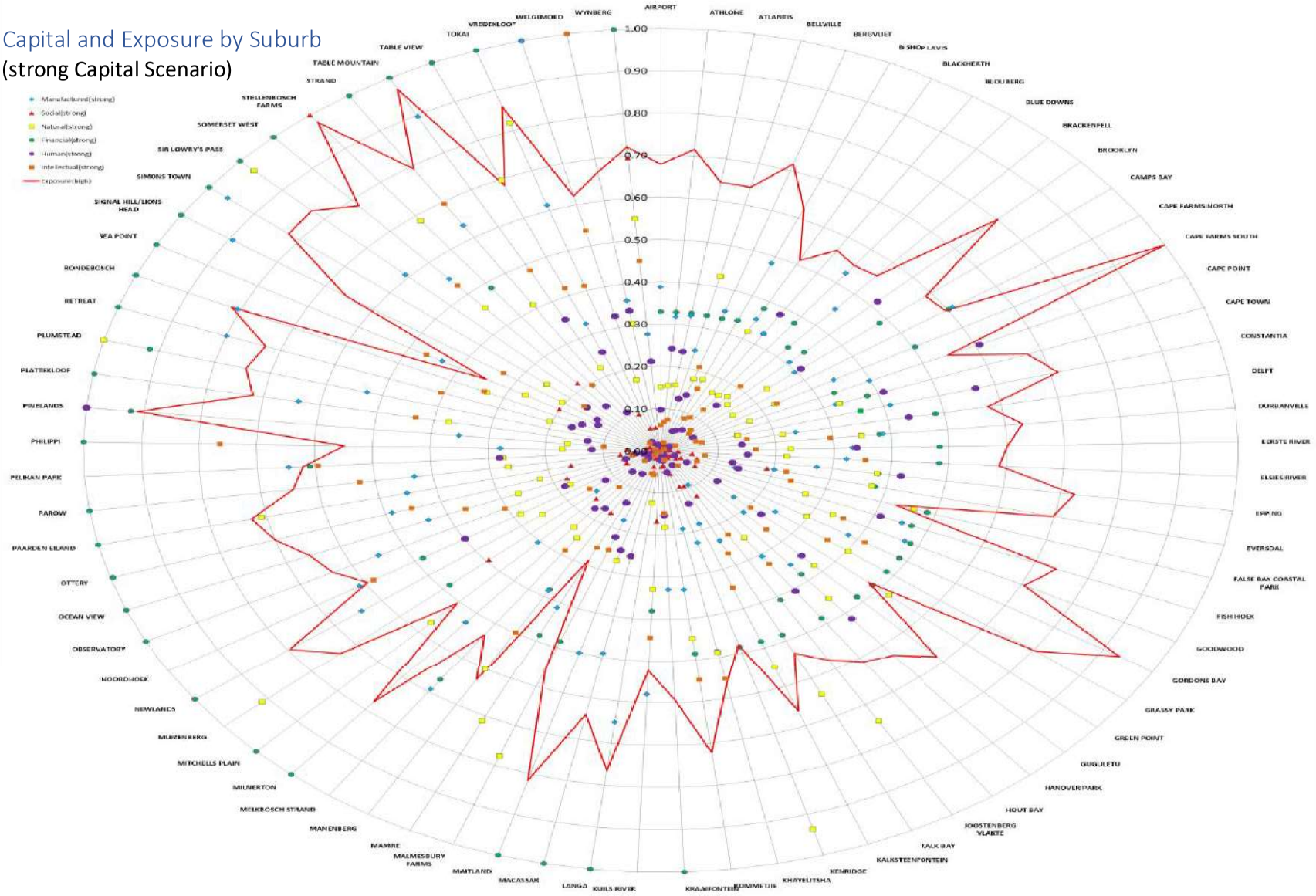
Appendix B: Economic Capital Indicators by Major Suburb

Appendix C: Capital Indicator Metrics and Exposure by Major Suburb

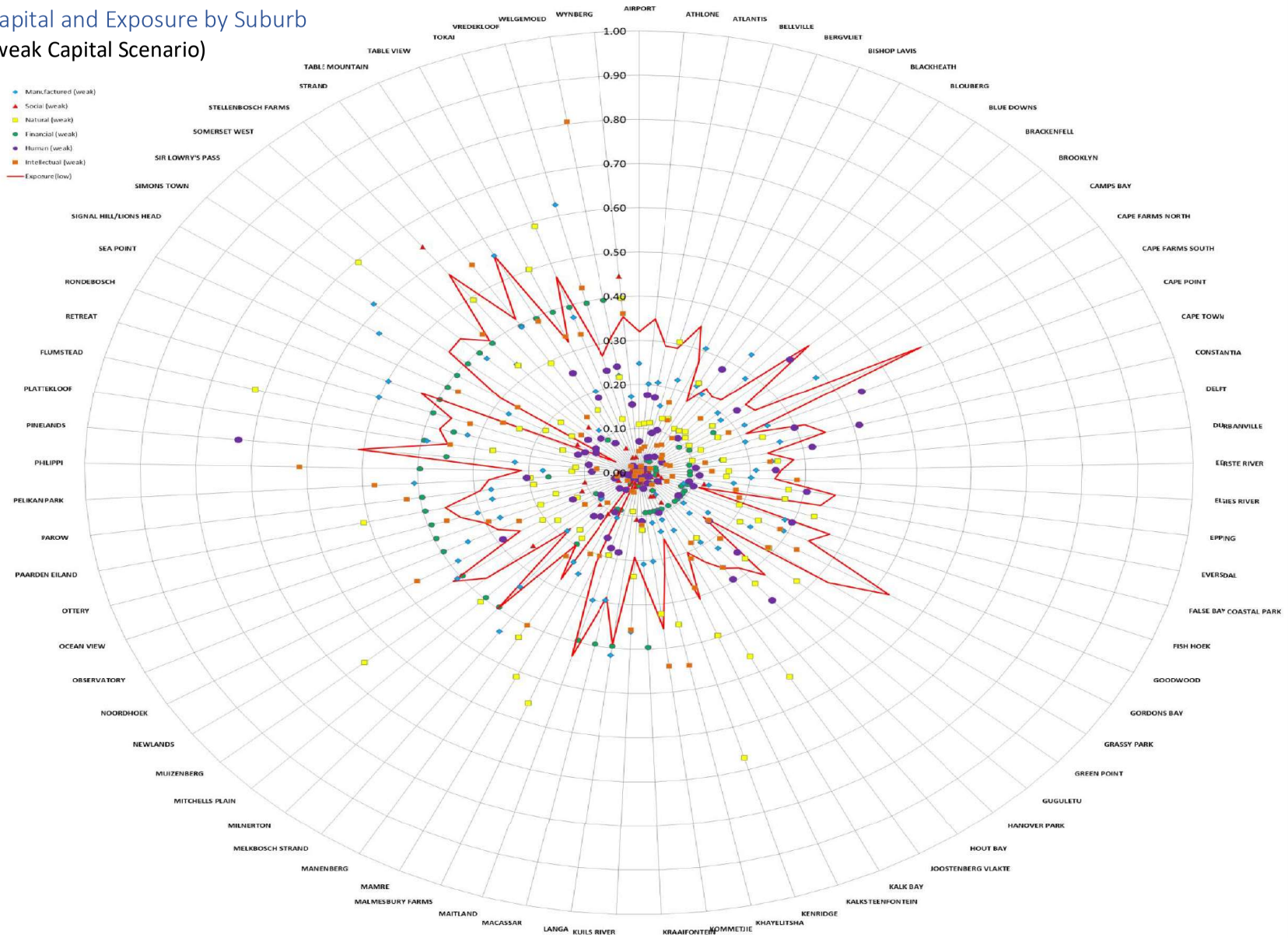
Capital and Exposure by Suburb
(Baseline Scenario)



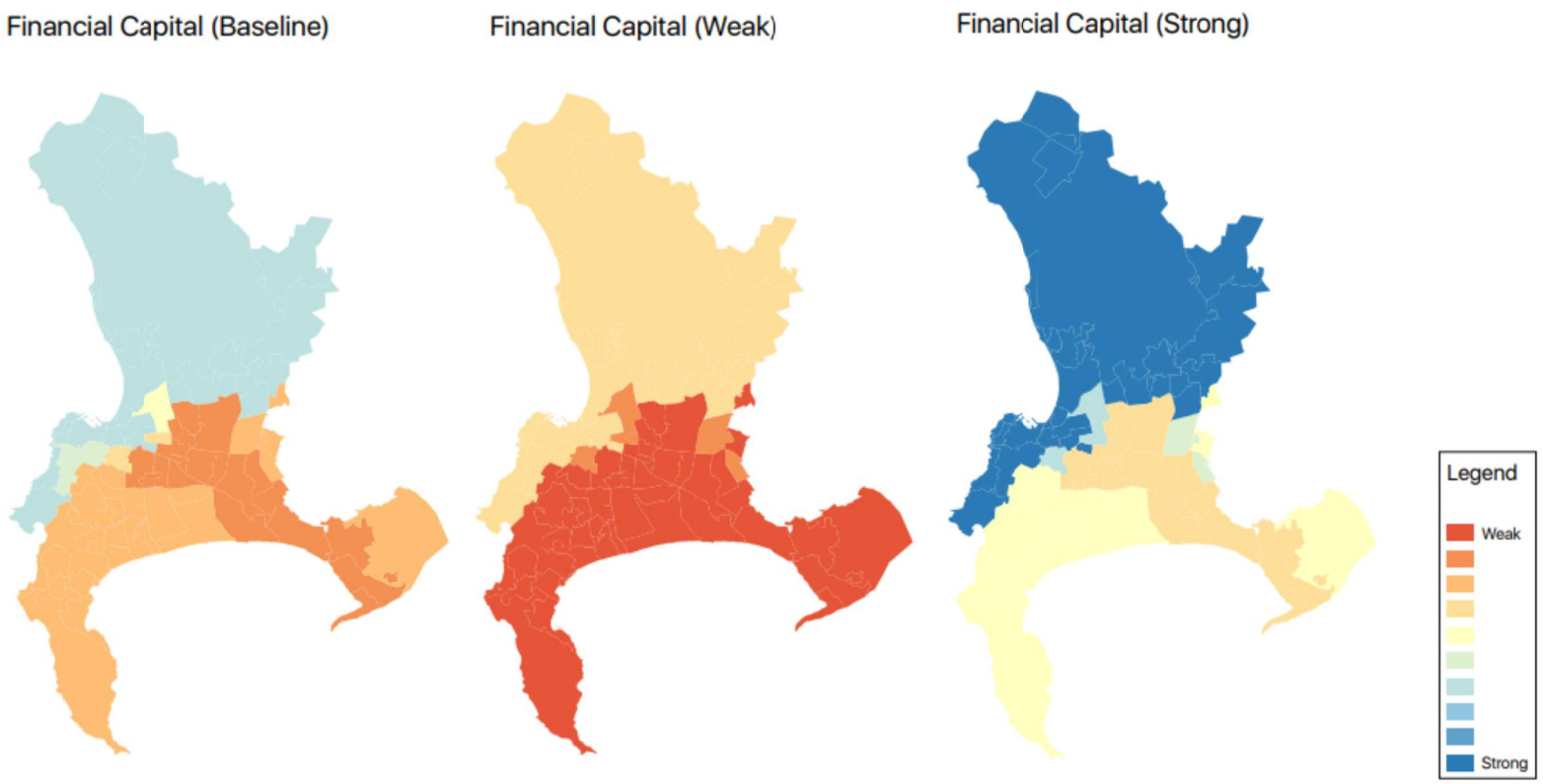
Capital and Exposure by Suburb
(strong Capital Scenario)



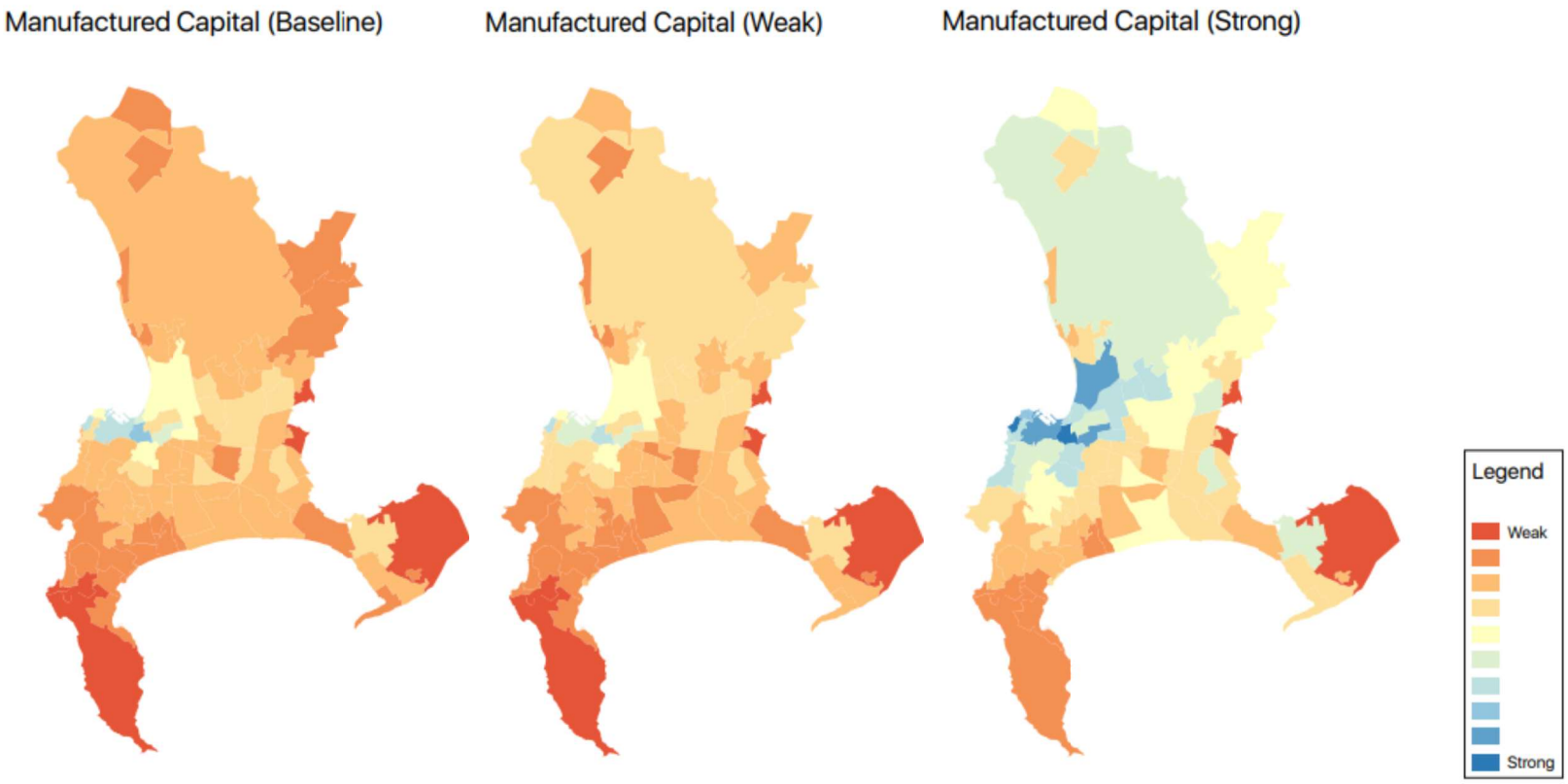
Capital and Exposure by Suburb
(weak Capital Scenario)



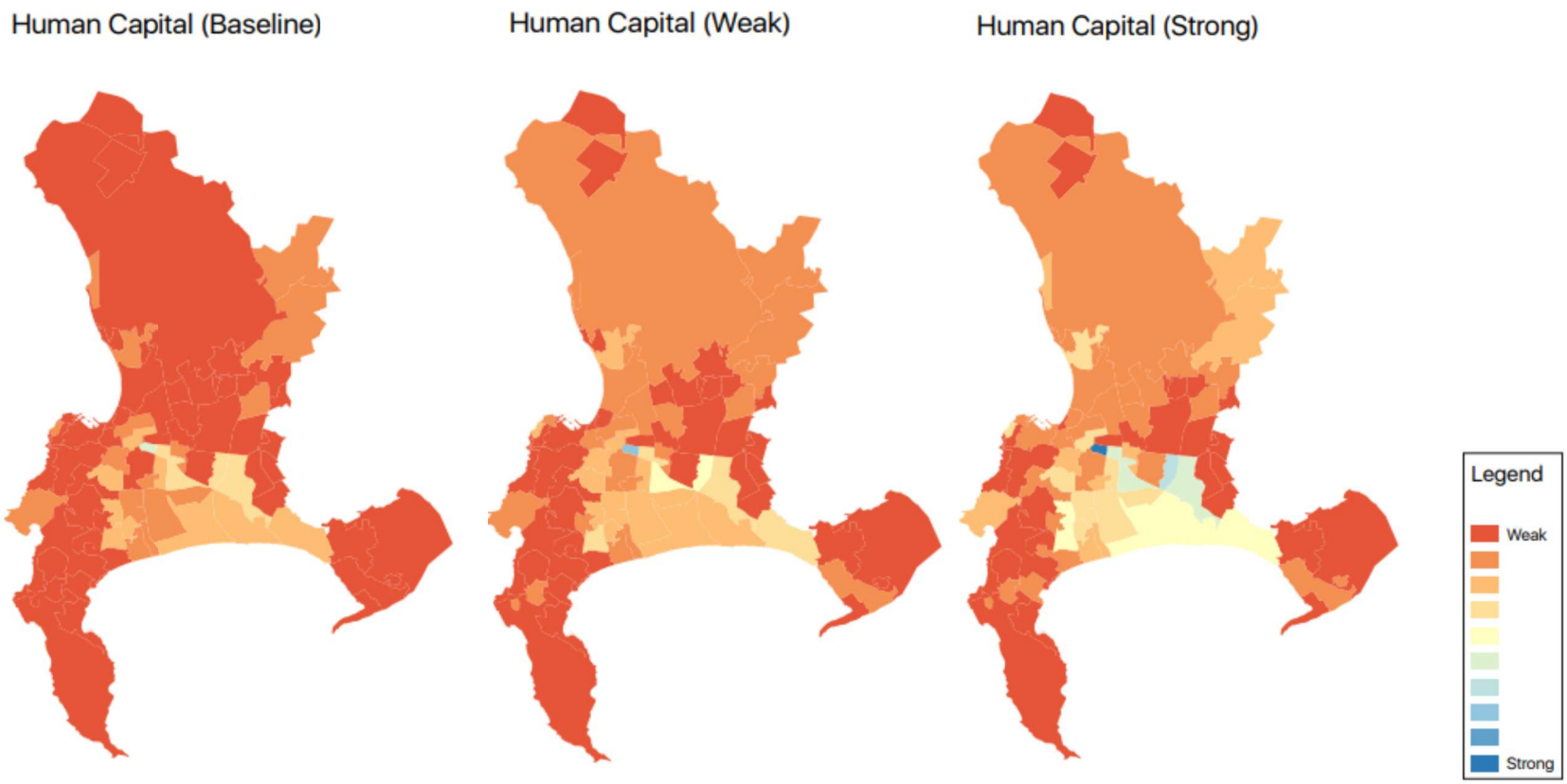
Financial capital under different capital scenarios (weak and strong)



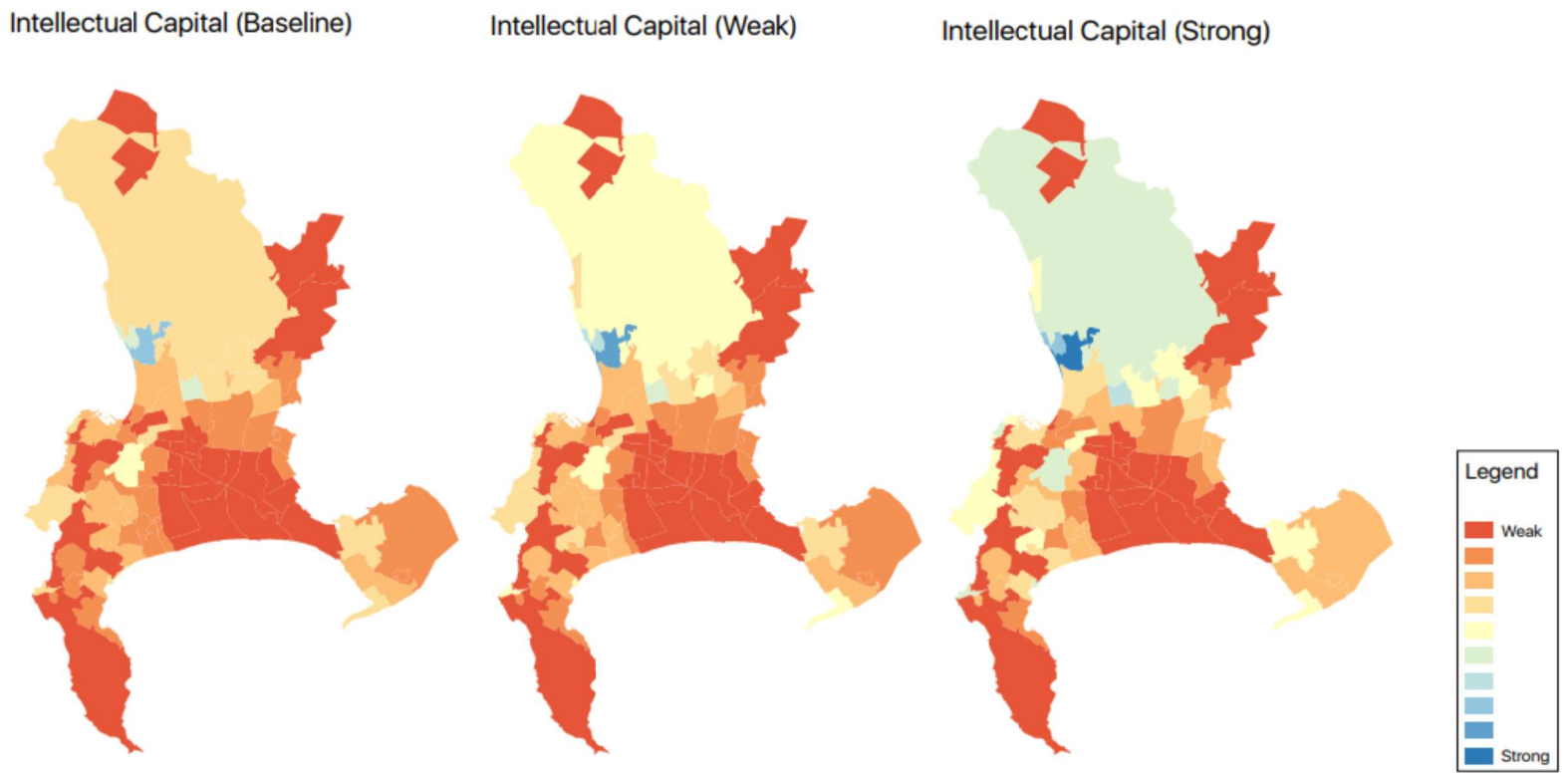
Manufactured capital under different capital scenarios (weak and strong)



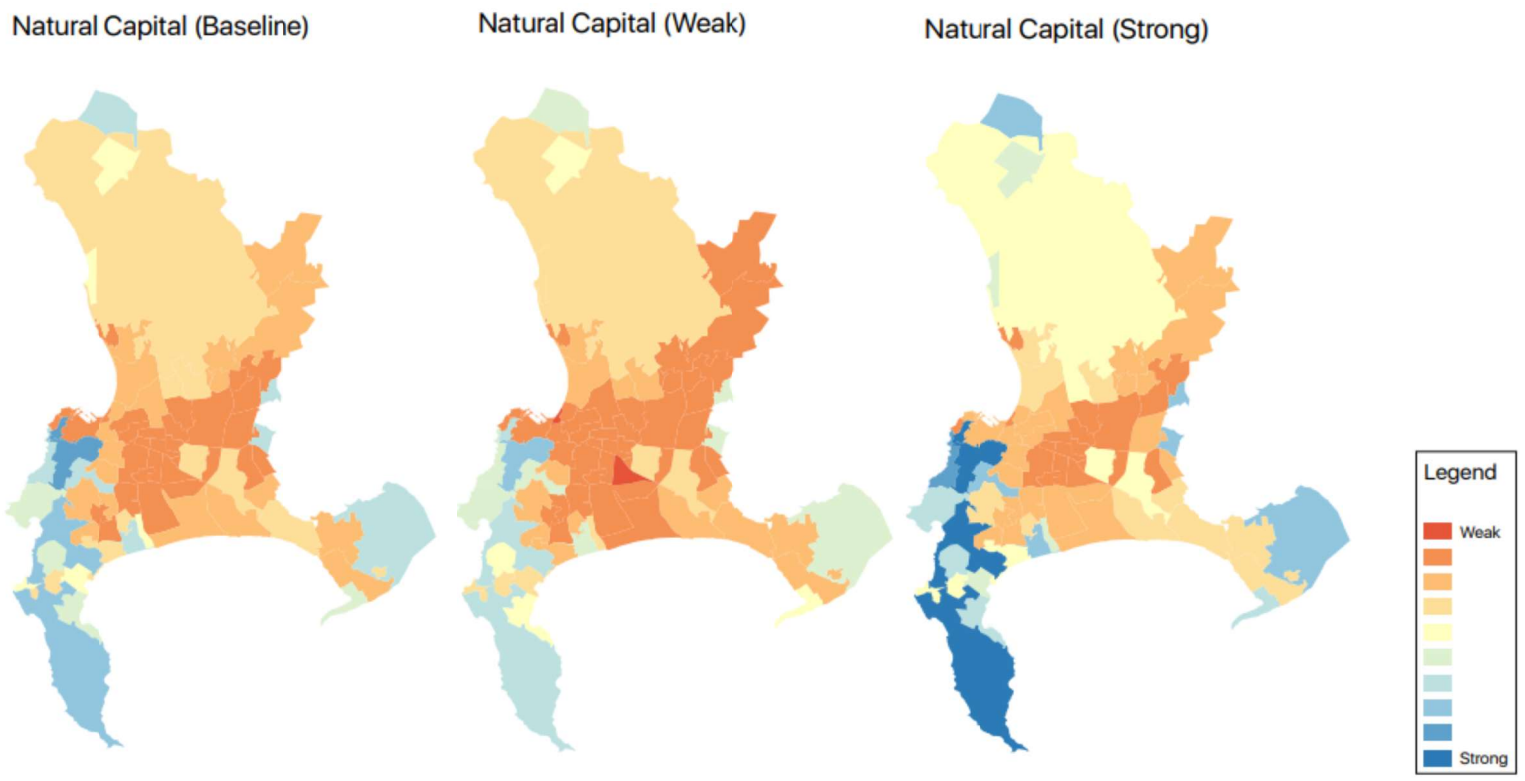
Human capital under different capital scenarios (weak and strong)



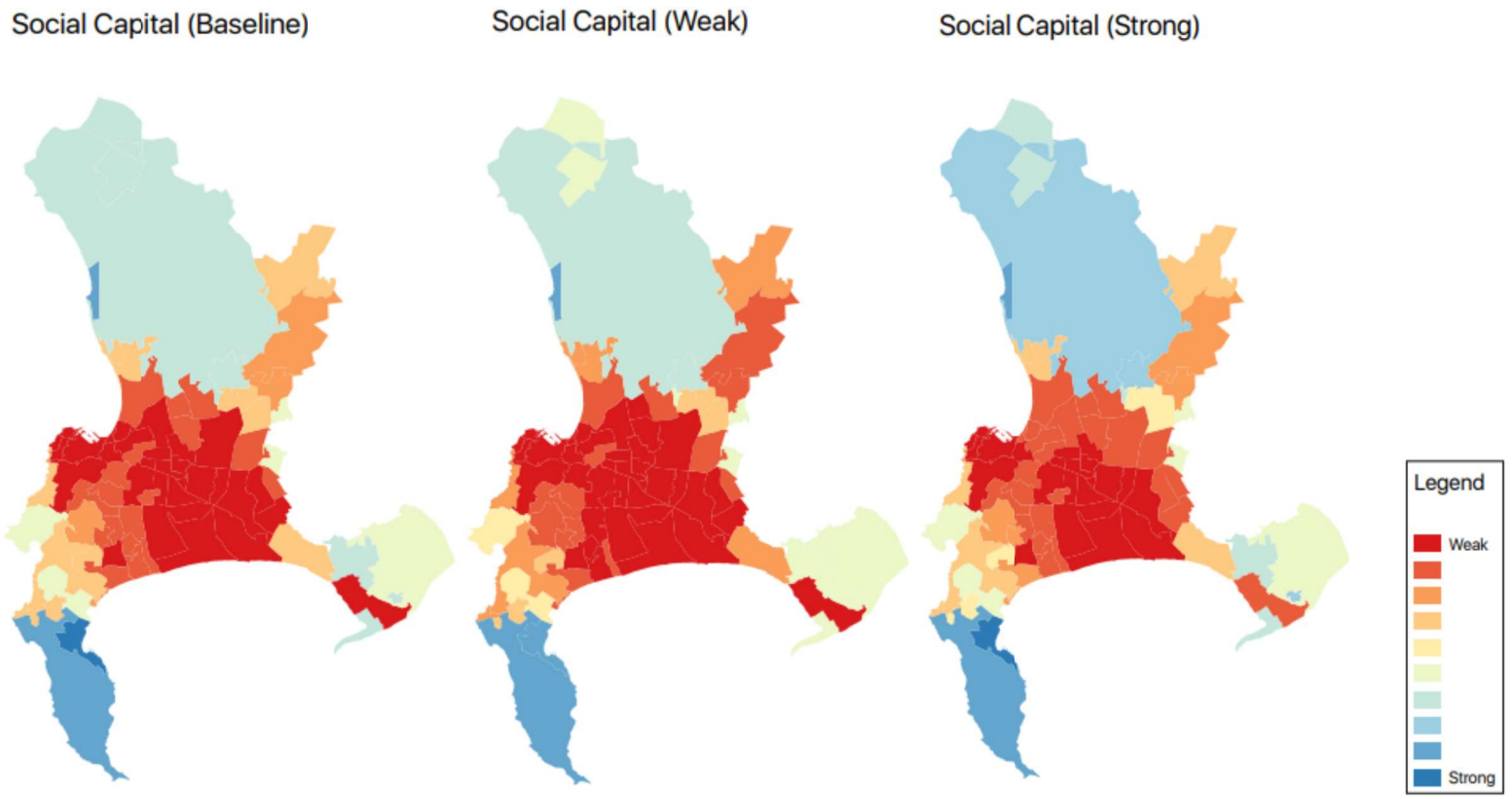
Intellectual capital under different capital scenarios (weak and strong)

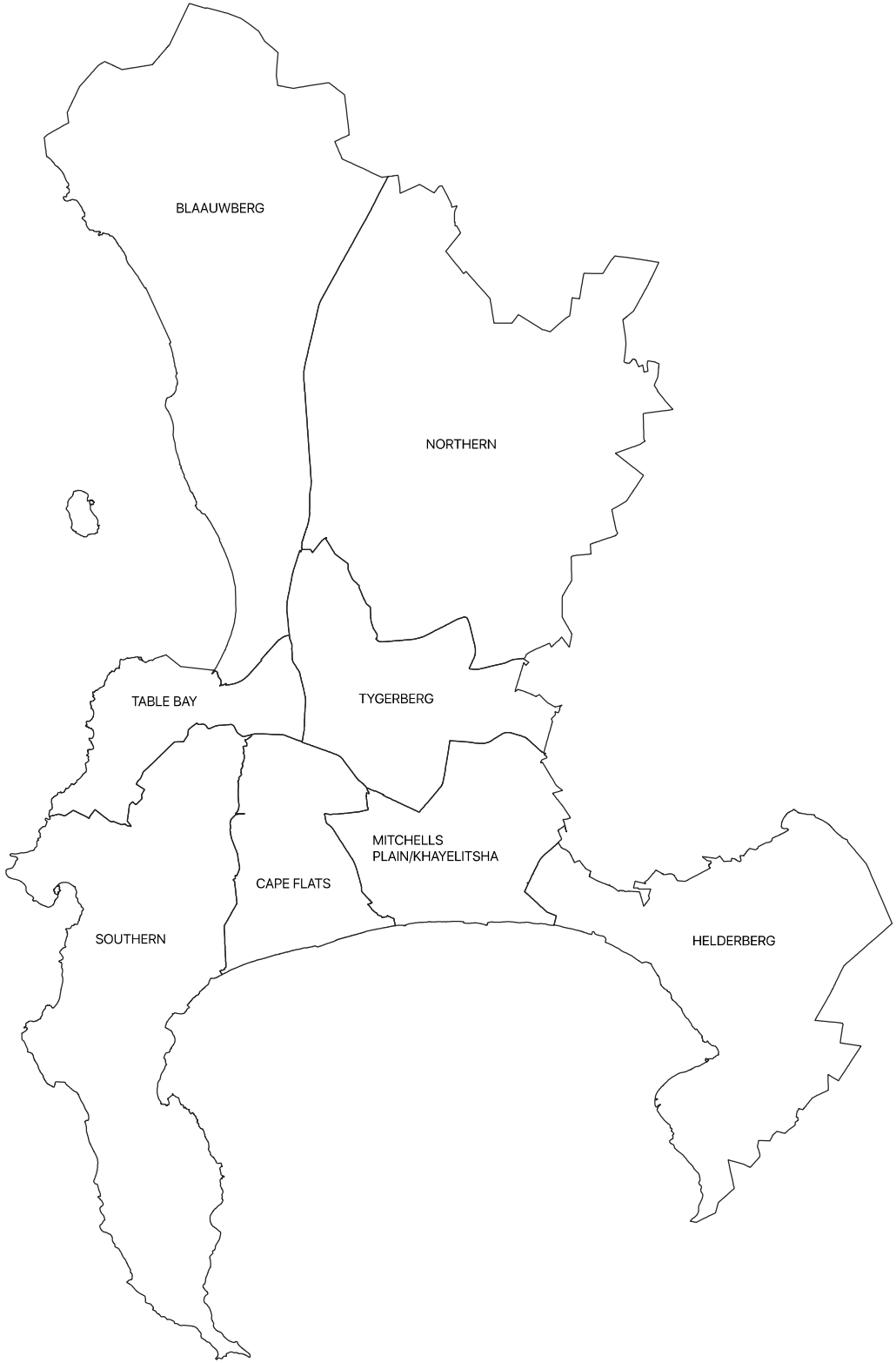


Natural capital under different capital scenarios (weak and strong)



Social capital under different capital scenarios (weak and strong)

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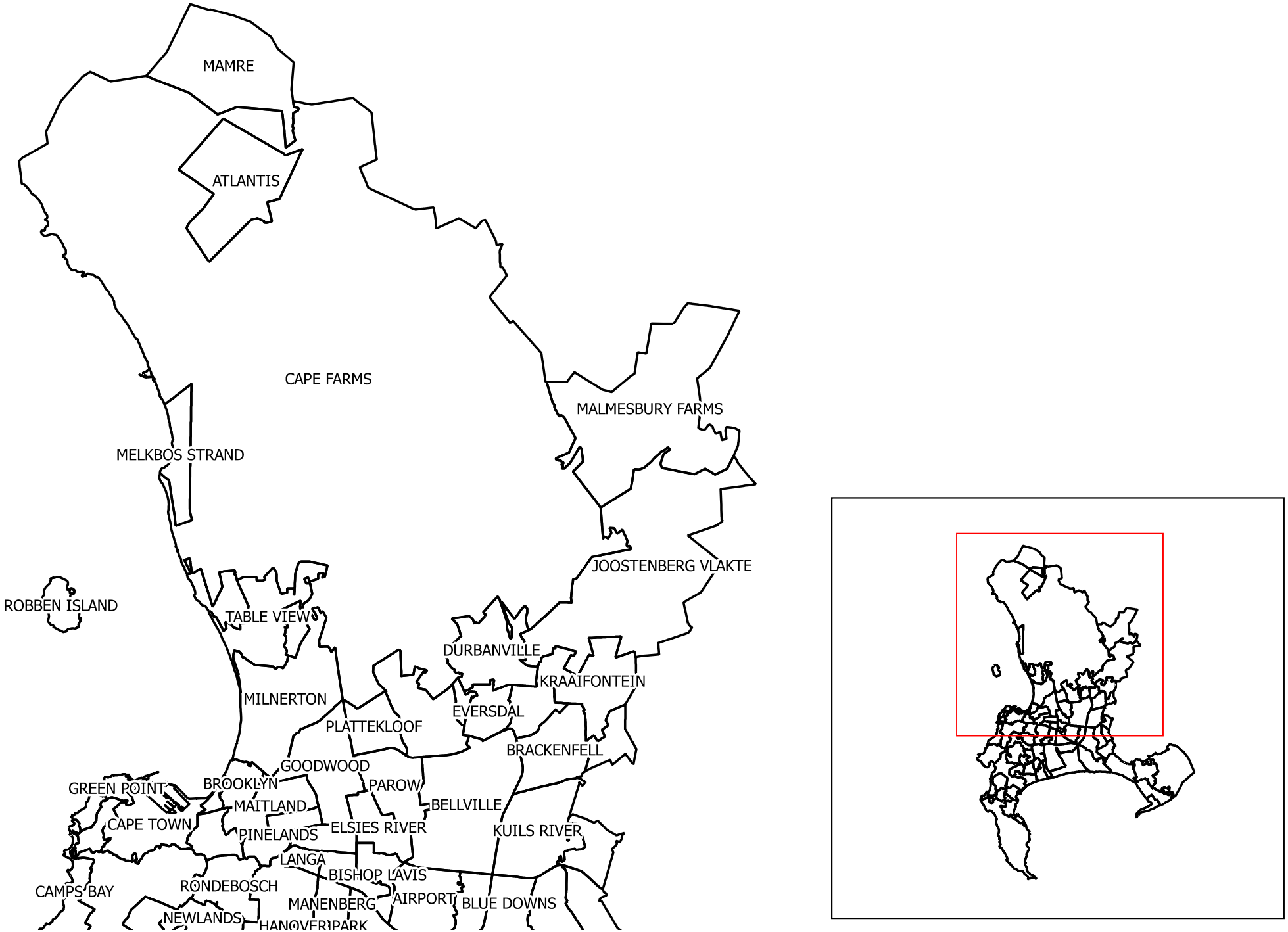
NORTHERN
TABLE BAY
TYGERBERG
MITCHELLS
PLAIN/KHAYELITSHA
CAPE FLATS
SOUTHERN
HELDERBERG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ATLANTIS
CAPE FARMS
MALMESBURY FARMS
MELKBOS STRAND
JOOSTENBERG VLAKTE
ROBBEN ISLAND
TABLE VIEW
DURBANVILLE
KRAAIFONTEIN
MILNERTON
EVERSDAL
PLATTEKLOOF
BRACKENFELL
GOODWOOD
GREEN POINT
BROOKLYN
PAROW
MAITLAND
BELLVILLE
CAPE TOWN
PINELANDS
ELSIES RIVER
KUILS RIVER
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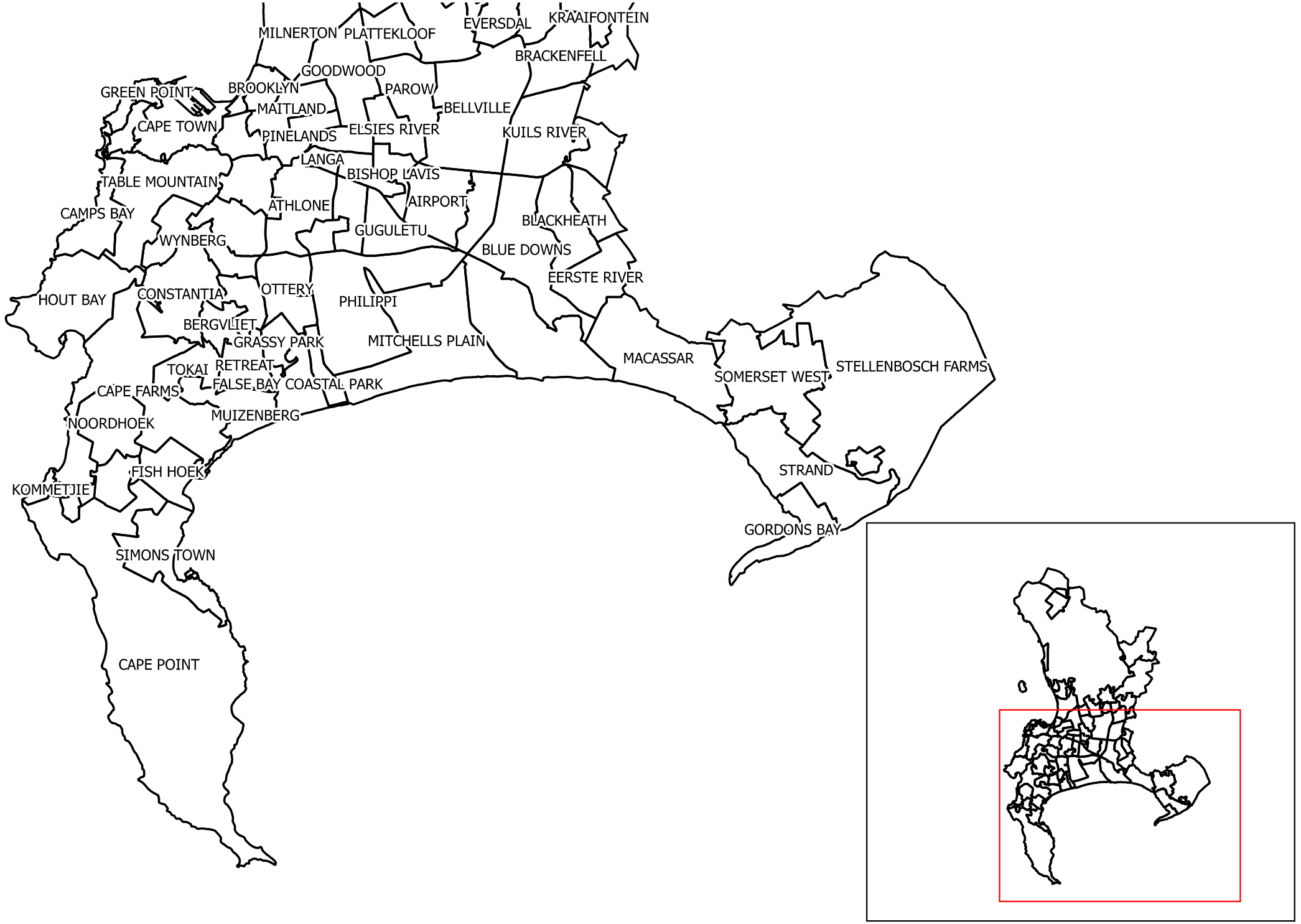
RONDEBOSCH
AIRPORT
MANENBERG
BLUE DOWNS
NEWLANDS
HANOVERPARK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KUILS RIVER
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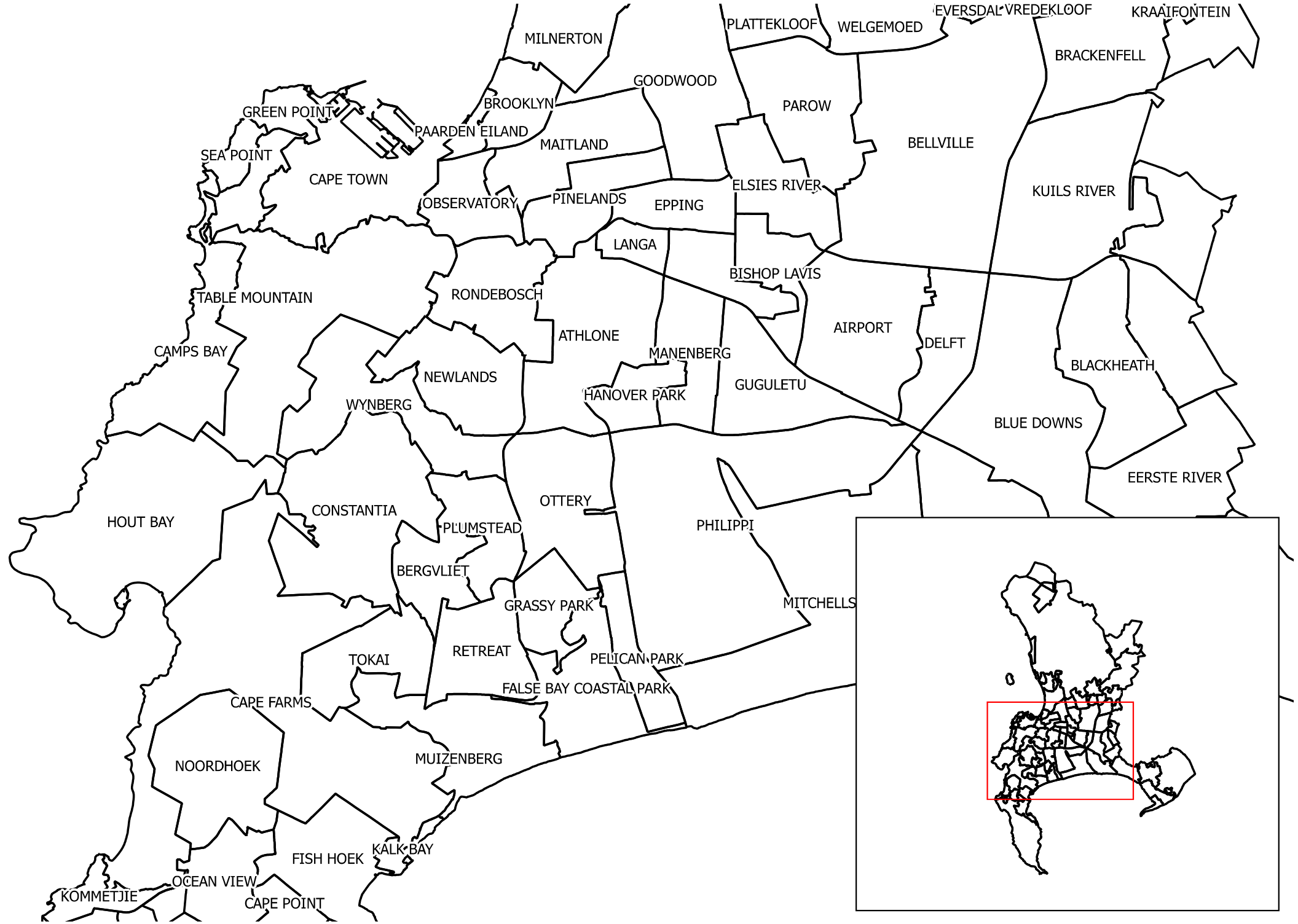
BISHOP LAVIS
TABLE MOUNTAIN
ATHLONE
AIRPORT
CAMPS BAY
BLACKHEATH
GUGULETU
WYNBERG
BLUE DOWNS
EERSTE RIVER
HOUT BAY
CONSTANTIA
OTTERY
PHILIPPI
BERGVLIET
GRASSY PARK
MITCHELLS PLAIN
MACASSAR
SOMERSET WEST
STELLENBOSCH FARMS
TOKAI
RETREAT
FALSE BAY COASTAL PARK
CAPE FARMS
MUIZENBERG
NOORDHOEK
FISH HOEK
STRAND
KOMMETJIE
GORDONS BAY
SIMONS TOWN
CAPE POINT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PAARDEN EILAND
PAROW
MAITLAND
BELLVILLE
SEA POINT
CAPE TOWN
ELSIES RIVER
KUILS RIVER
OBSERVATORY
PINELANDS
EPPING
LANGA
BISHOP LAVIS
TABLE MOUNTAIN
RONDEBOSCH
AIRPORT
DELFT
ATHLONE
MANENBERG
CAMPS BAY
NEWLANDS
BLACKHEATH
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HANOVER PARK
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KOMMETJIE
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