A participatory approach to developing a holistic and interdisciplinary adaptive capacity index for urban livelihoods

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Plagiarism declaration

I know the meaning of plagiarism and declare that all of the work in the dissertation, save for that which is properly acknowledged, is my own.

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Abstract

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Evaluating the success of the growing number of climate adaptation initiatives is challenging. Assessment of adaptive capacity has been used to focus, prioritise and track the progress of adaptation interventions as well as to identify key barriers to and opportunities for implementing adaptation. Many adaptive capacity assessments have relied on secondary data and expert judgement. Given the call in climate change research and practice for bottom-up approaches that value communities' insight, it is clear that more participatory approaches for the assessment of adaptive capacity need to be developed. This research aims to address this gap by developing an adaptive capacity index that adopts a mixed methods approach and prioritises input from local stakeholders.

Many adaptive capacity assessments have focussed on rural areas where livelihoods are directly exposed to climate variability. There is growing recognition that increasing numbers of people are settling in urban areas and many of these livelihoods are often at the margin. This thesis focuses on urban livelihoods where a more holistic understanding of adaptive capacity is required which recognises that a community's capacity to adjust to climatic stressors is interlinked to its capacity to adjust to environmental, social, economic and political challenges. An adaptive capacity index is developed in this thesis that includes and characterises the more subjective determinants of adaptive capacity, rather than giving precedence to material resources as the key determinant of a community's adaptive capacity. To achieve this richer understanding, the index is informed by a framework that incorporates aspects of individuals' agency and social cohesion.

Using a case study of four towns in the Bergrivier Municipality, South Africa, this research develops an index of adaptive capacity that is holistic, collaborative and interdisciplinary. The scores generated by the index are analysed using statistical and regression analyses that are contextualised by stakeholders' inputs to explore the variation in adaptive capacity across socially differentiated groups. Key insights from these analyses relate to the variation in adaptive capacity between the four towns and differences in the adaptive capacity of males and females. Interestingly, the analyses revealed the absence of a positive correlation between schooling level and both adaptive capacity and wellbeing variables which could be attributed to limited economic opportunities in the area, particularly for high-skilled workers. The analyses also highlighted the need to support initiatives that strengthen the social cohesion within the community to improve the inclusion of marginal demographic groups.

The thesis reflects on the participatory and collaborative research process, finding that combining quantitative and qualitative data through an interdisciplinary process has the potential to provide an index that is more reflective of subjective capacity. This more holistic understanding of adaptive capacity can align with the field of wellbeing, to offer valuable insight into building adaptive capacity for urban livelihoods that is grounded in both academic and applied fields.

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Chapter 1.   Introduction

1.1. Background to the study

In the Fifth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) (2014) concluded that there has been 'unequivocal' warming of the climate system since the 1950s due to anthropogenic influences. The report stressed that the impacts of climate change are already being observed and that the frequency and severity of these impacts will accelerate in the coming century (IPCC, 2014). This has highlighted the necessity of adaptation to deal with the impacts and manage the future risks of climate change (Commission on Climate Change and Development, 2009). However, the rapid growth in the number of adaptation initiatives has exposed the challenge of designing appropriate adaptation initiatives and evaluating their success (Vincent, 2007).

Assessments of adaptive capacity have been widely used to focus, prioritise and track the progress of adaptation initiatives as well as to identify key barriers to and opportunities for implementing adaptation (Engle, 2011). However, many adaptive capacity assessments have relied on top-down, expert-driven analyses that use secondary data and neglect local perspectives (Van Aalst *et al*., 2008). While adopting a bottom-up, participatory approach can be logistically difficult, expensive and time-consuming; there are a multitude of advantages to prioritising the insights of the communities who have the deepest understanding of their own capacity (Fraser *et al.,* 2006; Preston *et al*., 2011). A participatory approach can increase the authenticity of findings, encourage local support for adaptation interventions, and promote capacity building in the community (Estrella & Gaventa, 1998; Dobson *et al*., 2015). In addition to neglecting the insights of local stakeholders, many adaptive capacity assessments prioritise material assets and resources access as key determinants of adaptive capacity, failing to incorporate the subjective social, human and cultural factors that have been shown to be instrumental in defining adaptive responses (Jones *et al.,* 2010; Brown & Westaway, 2011). Although adaptive capacity can be highly dependent on material aspects in some contexts, an objective focus alone does not provide a holistic understanding of adaptive capacity (Pelling & High, 2005).

Given the call for bottom-up, integrated approaches that value communities' insights, it is clear that more participatory approaches for assessing adaptive capacity need to be developed (Few *et al*., 2007; Ross *et al*., 2015; Smit & Wandel, 2006). This research aims to address this gap by developing an adaptive capacity index (ACI) that adopts a mixed methods approach and engages the local community. Additionally, the ACI focuses on urban livelihoods, as opposed to the many existing indices which focus on rural contexts. Research into the urban context is necessary given the rapid urbanisation occurring worldwide where many poor urban communities are living at the margin (Revi *et al*., 2014).

The ACI developed in this study is used to characterise the adaptive capacity of individuals from four towns in the Bergrivier Municipality, a small urban municipality in the Western Cape Province of South Africa. The Bergrivier Municipality was one of the first local governments to develop a Climate Change Adaptation Plan (CCAP) in South Africa (Ziervogel *et al*., 2016a). This brought together the municipality, researchers from University of Cape Town's African Climate and Development Initiative (ACDI) and the local community

(Bergrivier Municipality, 2014). This multi-stakeholder collaboration led to another initiative, the FLOW Programme (Fostering Local Well-being), which seeks to support the key objectives of the CCAP through an innovative and transformative approach to building resilient communities (Ziervogel, 2014b). This initiative has trained unemployed local youths as FLOW Ambassadors who support the Programme's activities, which have included the introduction of a complementary community currency system and the production of local videos show casing green entrepreneurial ventures, local small businesses and water, waste and energy services.

The overall aim of the FLOW Programme is to build the adaptive capacity of local communities 'in the face of climate change, resource depletion, increasing economic inequality and high rates of unemployment, particularly among the youth' (Ziervogel, 2014b, p. 10). Accordingly, this research aims to provide a representative characterisation of the adaptive capacity in the Bergrivier community at the outset of the FLOW Programme by developing an ACI that adopts a bottom-up, participatory approach and incorporates subjective influences.

1.2. Aim and objectives

The central aim of this research is:

> To assess the adaptive capacity of the Bergrivier community holistically through the collaborative development of an adaptive capacity index (ACI).

The aim has the following underlying objectives:

- To develop a local scale ACI that provides a holistic characterisation of individuals' adaptive capacity in the Bergrivier community

- To refine the ACI through an iterative process of expert review and participatory input

- To examine the variation in the ACI scores across socially differentiated groups using a mixed methods approach that integrates statistical analysis and stakeholder inputs

- To use regression analysis to investigate the link between the ACI scores and financial and general wellbeing outcomes

- To analyse how the adoption of a participatory and holistic approach impacts the assessment of adaptive capacity

1.3. Structure of this thesis

This research is divided into six chapters. This introductory chapter has outlined the study's background, aim and objectives. Chapter 2 considers the relevant literature concerning adaptation and adaptive capacity and discusses how these concepts have evolved in the literature. The chapter introduces the importance of assessing adaptive capacity and analyses the different approaches used in its assessment, focussing on indices of adaptive capacity. Chapter 3 outlines the mixed methods approach used in both the development of

the ACI and the analysis of the ACI results. Chapter 4 presents the insights into the adaptive capacity of the Bergrivier community gained through the application of the ACI, first outlining the final ACI and then analysing the ACI scores. This analysis includes a statistical analysis looking at the variation of adaptive capacity across socially differentiated groups and a regression analysis exploring the explanatory power of certain socio-economic variables and the ACI scores in predicting wellbeing outcomes. Chapter 5 discusses the areas central to developing more meaningful and representative adaptive capacity assessments. Chapter 6 presents the conclusions, summarising key findings and outlining areas for future research.

Chapter 2.   Literature Review

2.1. Adaptation

2.1.1. Defining adaptation

Sub-Saharan Africa is particularly vulnerable to the impacts of climate change and these impacts will be exacerbated by the high poverty rates and numerous developmental challenges that this region experiences (Brooks *et al.,* 2005). Adaptation will be essential in preventing the impacts of climate change from undermining development goals (Commission on Climate Change and Development, 2009). Adaptation to climate change for human systems is defined by the IPCC as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities" (IPCC, 2012, p.556). There is however, an alternative approach that has been adopted by some researchers who propose an integrated understanding of adaptation.

An integrated understanding of adaptation recognises that adaptation is rarely a pure response to climatic stressors and must be understood within the context of interlinking social, environmental, economic and political stressors on a socio-ecological system (Smit *et al*., 2000; McGray *et al.* 2007; Moser & Ekstrom, 2010; Rasanen *et al*., 2016). This view of adaptation has been reflected in the way in which adaptation interventions have evolved. Early adaptation interventions primarily incorporated technological or policy adjustments within existing agricultural, infrastructural and institutional systems, and did not grapple with adaptation in social systems (Pelling, 2011; Eakin & Patt, 2011; Kates, 2009). This approach to adaptation has been replaced by an integrated view of adaptation, driven by the challenges of adaptation in developing nations, which recognises the synergies between adaptation and sustainable development and emphasises building the adaptive capacity of vulnerable communities (Adger *et al*., 2003; Schipper, 2006). This view also moves towards the recognition of the importance of cultural, psychological and social factors in enabling adaptation within a community (Adger *et al*., 2003, O'Brien, 2009). Through these evolutions, climate change adaptation has emerged as a multi-faceted and transdisciplinary research area, open to a number of interpretations and approaches (Smit & Wandel, 2006). However, while adaptation research has rapidly progressed to embrace a more holistic approach, adaptation interventions still tend to consist primarily of incremental adjustments to existing practices, rather than larger-scale, transformational changes (Kates *et al.,* 2012).

2.1.2. Characterising different forms of adaptation

Adaptation can take on a variety of forms and categorising adaptation actions and their outcomes is rarely a simple exercise; a consequence of adaptation's contextualisation within interacting social, environmental, economic and political domains. Pelling (2011, p.41) draws from the work of Smit *et al*. (2000) to provide useful insights into the typology of adaptation, categorising adaptation as "individual or collective", "purposeful or incidental", "spontaneous or planned" and "proactive or reactive". Pelling (2011) further classifies adaptive actions by the degree to which they address the source of a problem or its symptoms, the degree to which the adaptation is successful in enhancing future wellbeing and the degree to which adaptation is an isolated act or integrated within development

activities. Faced with the intensifying impacts of climate change, reactive and incidental adaptation measures are insufficient and it is essential to devise collective, purposeful and anticipatory adaptation strategies that align with wellbeing and development objectives (Lavell *et al.,* 2012).

One categorisation of adaptation that is particularly relevant to this research is incremental versus transformational adaptation. O'Brien *et al.* (2012, p.439) define incremental adaptation as actions that "aim to improve efficiency within existing technological, governance, and value systems" and transformational adaptation as "alterations of fundamental attributes of those systems". Both kinds of adaptation are essential in effectively responding to climate change. However, transformational adaptation is important in populations that are highly vulnerable to climate change, where the existing systems exacerbate these vulnerabilities (O'Brien *et al.*, 2012; Kates *et al*., 2012; Tschakert *et al.,* 2013). The FLOW Programme is a transformational initiative that promotes sustainable economic and social development in the Bergrivier Municipality by promoting local economic exchange, encouraging active citizenship and strengthening the community's ability to access and interact with the municipality (Ziervogel, 2014a). This transformational adaptation initiative aims to address economic and social transformation that would not be possible through smaller adjustments in existing systems.

2.2. Adaptive capacity
2.2.1. Defining adaptive capacity

The central focus of many adaptation strategies, including the FLOW Programme, is to build adaptive capacity in a system. Adaptive capacity is defined by the IPCC (2012, p.556) as "the combination of strengths, attributes, and resources available to an individual, community, society, or organisation that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities". This thesis draws on this definition as it indicates a move to an integrated understanding of adaptive capacity which recognises that a system's capacity to adjust to climatic stressors is interlinked to its capacity to adjust to environmental, social, economic and political challenges within the system (Brooks, 2003; Smit & Wandel, 2006; Marshall *et al*., 2009; Yohe & Tol, 2002).

The notion of adaptive capacity as a response to multiple interlinked stressors can be unpacked by differentiating between generic and specific adaptive capacity. Eakin *et al*. (2014) describes these two dimensions of capacity, defining generic capacity as attributes that contribute to meeting fundamental human needs (e.g. health and education) and specific capacity as attributes that facilitate management of and adjustments to specific climate stressors (e.g. use of climatic information). The FLOW Programme's primary focus is on building generic capacity in the Bergrivier community. Generic capacity is essential in the response to climate change as in a population with low generic capacity, it is challenging to implement strategies that mitigate specific climate risks and unlikely that any effective interventions can be sustained by the population (Eakin *et al.*, 2014). Building the generic capacity of a socio-economic system to adapt to non-climatic stressors can enhance its capacity to adapt to future climatic stressors (Pelling & High, 2005). Eakin *et al.* (2014, p.4) conclude that "there is a positive feedback between specific and generic capacities", where

a low generic capacity limits any improvements to specific capacity and a limited specific capacity exposes the population to impacts that further degrade the existing generic capacity.

2.2.2. Adaptive capacity, vulnerability and resilience

Adaptive capacity is an integral concept in both vulnerability and resilience literature (Engle, 2011). While these fields offer different interpretations and treatments of this concept; adaptive capacity is depicted as a desirable quality, where building adaptive capacity adaptive capacity can reduce vulnerability and strengthen resilience (Engle, 2011; Cutter *et al.*, 2008).

In vulnerability literature, the adaptive capacity of a socio-ecological system is inherently linked to its vulnerability to climate change and other threats (Adger, 2006; Cutter *et al.*, 2008). The Fifth Assessment Report (AR5) of the IPCC defines vulnerability as "the propensity or predisposition to be adversely affected" (Oppenheimer *et al.*, 2014, p. 1048). In the AR5, vulnerability is conceptualised as a key component of risk, where risk results from the interaction between vulnerability, exposure and hazards, as shown in Figure 1.
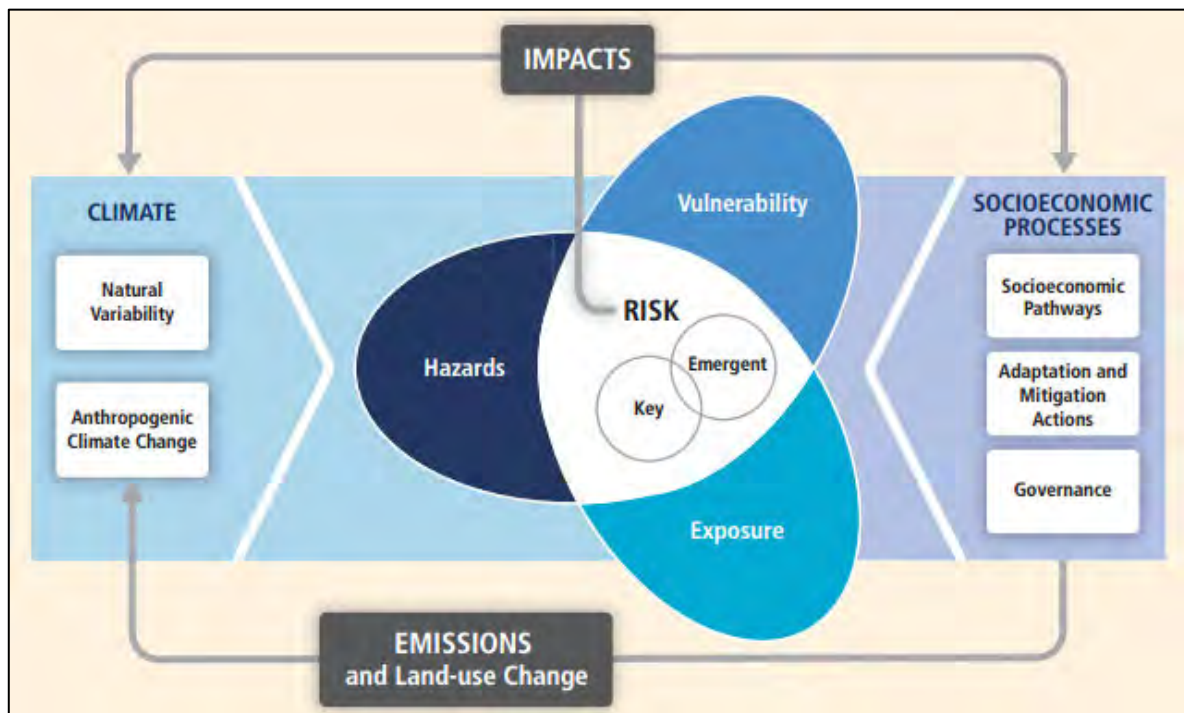
Figure 1: The conceptualisation of risk in AR5 of the IPCC (Oppenheimer *et al.*, 2014)

Within the model of risk depicted in Figure 1, vulnerability is conceptualised as a function of two determinants: the sensitivity or susceptibility to a disturbance and the adaptive capacity of the system to adjust to the changed conditions resulting from the disturbance (Oppenheimer *et al.*, 2014). The significance of adaptive capacity as a determinant of vulnerability is that an improvement in adaptive capacity can reduce a system's vulnerability and accordingly reduce the risk posed by climatic and non-climatic stressors on the system. Marshall *et al.* (2009) point to adaptive capacity as the component of vulnerability that has the greatest scope for adaptation interventions in influencing the vulnerability of a socio-ecological system. In line with this, the FLOW Programme targets building adaptive capacity

as a key element in reducing the vulnerability of the Bergrivier community to multiple stressors.

The concept of adaptive capacity is also drawn on in resilience literature; however, the proposed relationship between adaptive capacity and resilience varies widely in literature (Cutter *et al.*, 2008). Resilience is defined by the IPCC (2012, p.563) as "the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions". Resilience has been conceptualised as an integral component of adaptive capacity (Gallopin, 2006), while other researchers conceive adaptive capacity as a contributor towards resilience (Carpenter *et al.*, 2001). Resilience and adaptive capacity have also been used interchangeably, where a loss in adaptive capacity directly follows any loss in resilience (Folke, 2006; Smit & Wandel, 2006). Furthermore, other researchers offer more complex descriptions where adaptive capacity is the ability of a system to manage its resilience (Walker *et al.*, 2004).

Resilience can be linked to the concept of transformational adaptation, as is envisaged for the Flow Programme. Some researchers conceptualise resilience as linked to transformation, where resilience not only considers the ability of a system to return to its previous state after a disturbance, but includes the ability of a system to undergo transformation and re-organisation from one state to a new state that is more 'desirable' in coping with the changed external environment (Miller *et al.*, 2011). A system with higher adaptive capacity has a greater chance of maintaining its current state or transitioning to a more 'desirable' state (Engle, 2011). The Flow Programme aims to build adaptive capacity in the Bergrivier Municipality to enable its communities to move to a more 'desirable' state with increased local economic exchange and strengthened community networks.

2.3. Assessing adaptive capacity
2.3.1. Introduction to adaptive capacity assessments

Globally, as the observed and predicted impacts of climate change intensify, there has been a growing focus on the need to finance adaptation to climate change, especially in vulnerable developing countries and small island states which will experience the impacts of climate change most severely (Caravani *et al.,* 2013). Various funds have been established to finance adaptation initiatives, mainly through agreements made under the United Nations Framework Convention on Climate Change (UNFCCC). Key funds include the Least Developed Countries Fund, the Special Climate Change Fund and the Adaptation Fund which are funded predominantly by pledges from the governments of developed countries. This growth in adaptation finance is accompanied by the need to design effective adaptation initiatives and to evaluate the success of these initiatives. In designing such initiatives, an assessment of adaptive capacity allows vulnerable areas to be identified and adaptation interventions to be more clearly focussed, prioritised and evaluated (e.g. Swanson *et al.*, 2007; Sietchiping, 2007). Once an initiative is implemented, an assessment of the change in a community's or region's adaptive capacity as a result of the initiative has been widely used as a measure of the initiative's success (e.g. Pelling & Zaidi, 2013).

Adaptive capacity assessments have employed a variety of qualitative and quantitative methods such as case studies, mapping, ethnography, indices and surveys (Engle, 2011). These different methods involve varying levels of stakeholder engagement as well as a range of data collection approaches. The method selected will be dependent on the purpose of the assessment and the available resources. This study assesses adaptive capacity through the use of a quantitative tool, an adaptive capacity index (ACI), which is supported by qualitative input from stakeholder engagement.

Assessments of adaptive capacity have been carried out at varying levels within a social system, including governmental, institutional, community, household and individual levels (Marshall *et al.*, 2009). Assessing adaptive capacity at different levels requires varying approaches as some aspects of adaptive capacity are relevant at multiple levels, while others are level-specific (Marshall *et al.*, 2009). Nevertheless, Smit & Wandel (2006) note that while adaptive capacity can be assessed at different levels, the adaptive capacity of each level is interdependent. For example, the adaptive capacity of a household is influenced by the capacity of its community, which in turn is affected by the capacity at the governmental level. While the nature of adaptive capacity differs from the national to individual levels, it can also vary within a level as the relevance of an aspect of adaptive capacity to one group is not necessarily the same to another group due to the different local contexts of each group (Smit *et al.*, 2001; Engle, 2011). The input of relevant stakeholders is crucial in identifying the relevant aspects of adaptive capacity for the specific context (see Section 2.4.3). This study focuses on adaptive capacity at the individual level in an urban context. This provides insights into the more subjective factors influencing adaptive capacity that are experienced at the individual level and allows for an investigation into the variations in adaptive capacity between socio-economic groups within the Bergrivier community.

2.3.2. Adaptive Capacity Indices (ACIs)

ACIs have been widely used as an adaptive capacity assessment method. The attractiveness of an index lies in its ability to assign a quantitative value to adaptive capacity, enabling the assessment of changes in adaptive capacity over time and variations in adaptive capacity across different regions or social groupings. However, the complex nature of adaptive capacity means that it cannot be directly quantified. Therefore, adaptive capacity must be measured by proxy, through measuring the factors that contribute to a system's adaptive capacity (Jones *et al.*, 2010). Once these factors are measured, constructing an ACI summarises this larger volume of data into a single quantitative value. A wide range of factors that influence adaptive capacity have been identified in adaptive capacity literature. These factors, called the determinants of adaptive capacity, include factors such as "economic and natural resources, social networks, entitlements, institutions and governance, human resources, and technology" (Adger *et al.*, 2007, p.719). The determinants that are chosen to be measured in an adaptive capacity assessment depend on the framework for adaptive capacity that is employed in the research (Jones *et al.*, 2010).

There has been no consensus on a universal framework for adaptive capacity as it is such a dynamic entity and thus many frameworks have been developed that characterise adaptive

capacity in different contexts (Jones *et al.*, 2010). Some frameworks have broad applications (e.g. Brooks *et al.*, 2005; Adger *et al.*, 2004); while others are tailored to prioritise key determinants depending on the nature of the stressors and characteristics of the group for which the ACI is developed (e.g. Swanson *et al.*, 2007; Berkes & Seixas, 2005; Hahn *et al.*, 2009). Table 1 summarises the determinants used in a selection of existing individual ACIs that are aimed at the local level, as is relevant for this research. A detailed description of existing ACIs aimed at all levels is included in Table 10 in Appendix A.

Table 1: The determinants used by existing ACIs of individuals at the local level

Author	Index description	Determinants of adaptive capacity
Vincent (2007)	ACI of individuals at local scale in rural agricultural communities	Five determinants: Economic wellbeing and stability, demographic structure, interconnectivity in higher level processes, natural resource dependence, housing quality.
McClanahan *et al.* (2008)	ACI of individuals at local scale in West African coastal communities	Eight determinants: Recognition of causality, occupational mobility, change anticipation, social capital, occupational multiplicity, material assets, infrastructure, technology.
Brown *et al.* (2010)	ACI of individuals at local scale for land managers in Australia	Five determinants: Natural, physical, financial, human and social capital.
Maldonado & Moreno-Sánchez (2014)	ACI of individuals at local scale for Latin American fishing communities	Three determinants, each with three sub-determinants: Socio-economic (poverty, infrastructure and occupational characteristics), socio-political (social capital, institutional, perceptions), socio-ecological (resource dependence, ecological awareness, anticipatory ability).
De Villiers *et al.* (2014)	ACI of individuals at local scale for land managers	Six determinants: Personal control, record keeping & monitoring, learning, innovation, leadership and group participation, diversity of income.

In developing an ACI, once an appropriate framework has been selected and the associated determinants have been identified, measurable indicators for each determinant must be chosen. For determinants that involve material aspects, the possible indicators are relatively straightforward to define and measure. For example, a determinant of access to economic resources could have indicators of employment rates, average income and ownership of property or other financial assets (Wall & Marzall, 2006). For determinants that are more qualitative in nature, selecting or devising indicators is challenging (Jones *et al.,* 2010). Such indicators are often measured using Likert scales, where a respondent is asked to express the degree to which they agree or disagree with a certain statement (e.g. Wall & Marzall, 2006). Some ACIs only use one indicator for each determinant (e.g. Pelling & Zaidi, 2013; Alberini *et al.*, 2005); while others use multiple indicators for each determinant (e.g. Swanson *et al.,* 2007; Engle & Lemos, 2010; Defiesta & Rapera, 2014; De Villiers *et al.*, 2014).

Figure 2 shows the general structure of ACIs, as used by Swanson *et al.* (2007), Vincent (2007), Gupta *et al.* (2010) and others.
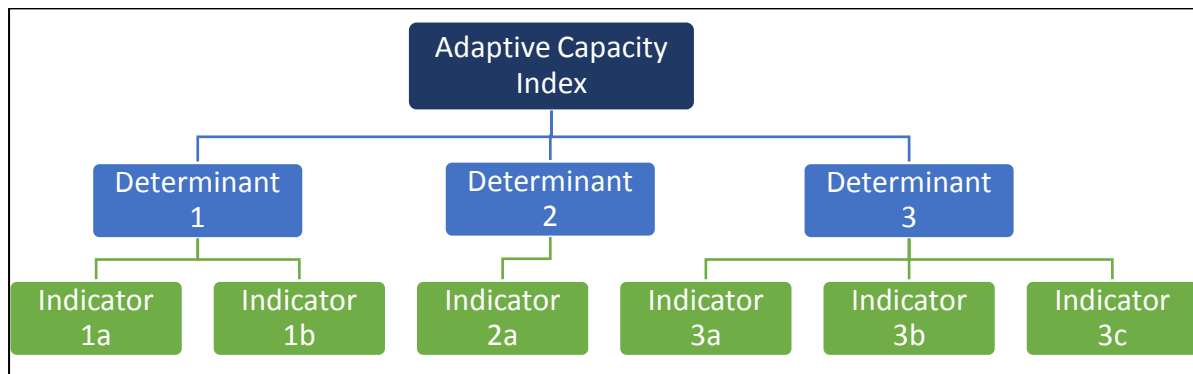
Figure 2: The general structure of ACIs

In deriving a final adaptive capacity score from the chosen indicators, a number of techniques have been applied. Complexity arises in that not all indicators are independent and can interact quite strongly (Sietchiping, 2007). Additionally, not all indicators are equally significant to the adaptive capacity of a system (Swanson *et al.,* 2007). In dealing with this complexity, many indices apply variable weightings to indicators and determinants (Sietchiping, 2007). To calculate the final adaptive capacity score, the indicators for each determinant are normalised and aggregated using the specified weighting to derive each determinant value. Determinant values are then aggregated using the specified weightings to arrive at an overall adaptive capacity score which is analysed by looking at the range of possible scores that could be obtained from the index.

While a quantitative index of adaptive capacity is a useful tool, there are some limitations to this method. As indices rely on preselected determinants of adaptive capacity, Smit & Wandel (2006, p.285) argue that they do not "identify the processes, determinants or drivers of adaptive capacity and vulnerability as they function in each system—they are taken as given". One approach to overcoming this limitation is the use of a mixed methods approach, as applied by Pelling & Zaidi (2013), to interrogate the drivers behind low or high adaptive capacity scores. However, if the determinants are poorly selected and do not appropriately describe the characteristics of the adaptive capacity relevant to the system; the adaptive capacity score will not reflect the system's actual adaptive capacity (Swanson *et al.,* 2007). Therefore, developing a relevant framework that provides a holistic characterisation of adaptive capacity is essential in constructing an ACI.

Another issue in the assessment of adaptive capacity is that a high level of adaptive capacity does not necessarily translate into adaptive action for various reasons (Adger *et al*., 2007). Owing to the multifaceted nature of adaptive capacity, two individuals with the same adaptive capacity may not realise their adaptive capacity to the same extent and the degree of adaptive action they take may differ significantly. Nevertheless, building the components of adaptive capacity has the potential to lead to increased adaptive action. In light of this, adaptive capacity assessments are useful in identifying the adaptive capacity components that could be strengthened.

2.4. Critique of existing ACIs

2.4.1. Limited focus on the local level outside of the rural context

The focus of this study is assessing individual adaptive capacity at the local level. However, a large portion of ACIs in the literature focus on adaptive capacity at the national, regional and institutional level (e.g. Brooks *et al.*, 2005; Metzger *et al.*, 2005). While national, regional and institutional level assessments are useful for comparative studies and can help to identify trends in the spread of adaptive capacity as well as enablers and obstacles to adaptive capacity at these levels, insight at the local level is essential for adaptation research. Many adaptation interventions are targeted at the local level. Understanding adaptive capacity at the local level, such as the nuanced variations in the adaptive capacity between socio-economic groups, is therefore vital in enabling the implementation of effective and successful interventions (Jones *et al.,* 2010; Smit & Wandel, 2006).

While the focus given to local level indices of individual adaptive capacity was limited in initial adaptation research, there has been a growing number of local level ACIs. These local level indices focus primarily on rural communities that depend on agriculture, livestock or fisheries as their main livelihood and employ frameworks that are tailored to the specific stressors and livelihood challenges that rural agricultural and coastal communities face (e.g. Sietchiping, 2007; Nelson *et al.*, 2010; Marshall, 2007). However, this research aims to assess the adaptive capacity of individuals from a low-income community in an urban setting, where there has been limited research (Birkmann *et a*l., 2010; Commission on Climate Change and Development, 2009). Some frameworks have been proposed that provide a generic approach to assessing adaptive capacity at the local, individual level across contexts (e.g. Hahn *et al.*, 2009; Jones *et al.*, 2010). However, these indices often fail to provide a holistic characterisation of both the subjective and objective factors that influence adaptive capacity. Additionally, when using such indices, care must be taken to ensure that they are tailored to the specific context of the assessment.

Research into the urban context is necessary given the rapid urbanisation occurring worldwide, with more than half the global population residing in urban centres (United Nations Department of Economic and Social Affairs Population Division, 2014). This rapid urbanisation is concentrated in low-income countries where many poor urban communities are living at the margin and are highly vulnerable to the impacts of climate change (Revi *et al.*, 2014; Commission on Climate Change and Development, 2009). In light of this, there is an urgent need to identify opportunities for adaptation and initiate adaptive action in urban areas (Revi *et al.*, 2014). However, in comparison to the rural setting, where communities' livelihoods can be threatened directly by climate impacts and the availability of natural resources; in the urban setting, the stressors faced by communities can be far more complex and intertwined with development, social and economic issues (Birkmann *et al.*, 2010). This requires new approaches to the assessment of adaptive capacity and innovative adaptation strategies that adopt an integrated understanding of adaptive capacity. Integrated approaches are therefore especially important in furthering the understanding of adaptive capacity in the multi-stressor urban context.

2.4.2. Addressing the subjective factors influencing adaptive capacity

In many of the existing ACIs in the literature, there is a tendency to prioritise material aspects such as financial and technological resources as key determinants of adaptive capacity, with limited attention given to more subjective factors that influence adaptive capacity (Grothmann & Patt, 2005; Jones *et al*., 2010). Adaptive capacity is highly dependent on material aspects and access to financial capital can be crucial in enabling adaptive responses; however, these alone do not provide a holistic understanding of adaptive capacity (Pelling & High, 2005; Jones *et al*., 2010). Brown & Westaway (2011, p.322) argue that "although research and policy highlight the need to understand subjective human factors in determining adaptive capacity, these are seldom integrated into current models and frameworks." Jones *et al.* (2010, p.1) further this argument, noting that resource-based frameworks provide no insight into the immaterial processes that enable adaptation, such as "decision-making and governance; the fostering of innovation, experimentation and opportunity exploitation; and the structure of institutions and entitlements." In obtaining a holistic understanding of adaptive capacity, it is essential to consider the intangible processes that determine how a system translates its available resources and assets into adaptive action (Werg *et al*., 2013). In moving towards achieving a more holistic understanding in ACIs, this research adopts a framework for adaptive capacity that takes a holistic approach by recognising the importance of both subjective and objective determinants in characterising adaptive capacity.

2.4.3. Strengthening participation in the development of adaptive capacity indices

A call for the uptake of collaborative, transdisciplinary and participatory research processes has recently emerged across the environmental change literature; however, the successful implementation of such research processes remains nominal (Few *et al*., 2011; Ross *et al*., 2015; Smit & Wandel, 2006). The lack of participatory processes is evident in the literature on adaptive capacity indices, which largely use removed, top-down approaches that rely on expert input rather than bottom-up, participatory processes (Van Aalst *et al*., 2008). A limited number of ACIs have adopted participatory elements in their approach to assessing adaptive capacity, for example Sietchiping (2006) used extensive engagement with local stakeholders in the development of the index and Bhadwal *et al.* (2003) used participatory methods for data collection. However, ACIs rarely adopt a participatory approach throughout the research process.

While adopting a bottom-up, participatory approach can be logistically difficult, expensive and time-consuming; there are a number of advantages. A key advantage of a participatory approach is a move from an orientation towards the needs of the funders of a programme, to a greater focus on the needs of the community being assessed (Estrella & Gaventa, 1998). This focus on and engagement with the local community can lead to a multitude of additional benefits, including "increased authenticity of M&E [Monitoring & Evaluation] findings that are locally relevant; improvement of sustainability of project activities … and increasing local level capacity" (Estrella & Gaventa, 1998, p.16). Additionally, the qualitative inputs from local stakeholders that participatory processes provide are crucial in understanding the more subjective elements of adaptive capacity that are often neglected

in adaptation research. Ultimately, a participatory, bottom-up approach prioritises the insight of local individuals who have the deepest understanding their own and their community's capacity.

Brooks & Fisher (2014) also note the usefulness of a participatory approach in measuring the change in adaptive capacity and resilience brought about by adaptation initiatives. They highlight the difficulty with attributing any changes that are observed in the selected indicators to the influence of a particular initiative. For example, adaptive capacity indicators may have improved; however, the intensity of climate hazards may have decreased and thus the increase in adaptive capacity cannot be attributed purely to the impact of an adaptation initiative that had been implemented. This difficulty with attribution is a consequence of adaptation's contextualisation in a broader social, economic, environmental and political context. In dealing with attribution issues, long term climate and wellbeing data can be used to statistically compare outcomes to the counterfactual; however, this is often not possible due to a lack of data. Practically, attribution issues can be explored through the narratives and input from local stakeholders. This is an important consideration in tracking success for longer term adaptation initiatives; however, in this research only a baseline is analysed.

2.4.4. Reliance on secondary data sources

In many existing ACIs, a key limitation is a reliance on secondary data sources, such as national statistics and census data (Jones *et al.*, 2010). This is seen mainly in national and regional level assessments (e.g. Alberini *et al.*, 2005; Swanson *et al.,* 2007; Metzger *et al.,* 2005) as their broad scale makes data collection difficult, time consuming and expensive, but is also true for some individual level assessments. Hahn *et al.* (2009, p.75) highlights the limitation of this approach as researchers are forced to "structure their analytical framework around available data, contend with inconsistent or missing data, and sometimes must combine data collected at different temporal or spatial scales". This results in ACIs relying on generic indicators such as education levels, dependency on agriculture or marine resources, health care access and gross domestic product per capita; with limited insight into the more intangible aspects of adaptive capacity such as innovation, flexibility and decision-making processes that could be obtained through collection of primary data.

2.5. Wellbeing in adaptation research

In the field of research on adaptation, the concepts of adaptive capacity, vulnerability, resilience, risks, exposure and hazards are well defined and numerous researchers have mapped and debated the nuances of the relationships between these concepts (Gallopin, 2006). However, one concept that has not been included extensively in these theoretical discussions, but has been increasingly drawn on in the practical application of adaptation initiatives is wellbeing. In light of this, this study incorporates wellbeing as a complementary concept to adaptive capacity and explores the link between the two fields.

Wellbeing has rapidly emerged as a popular concept in recent academic discourse and has been drawn on by diverse fields. However, the concept of wellbeing has been subject to debate, with some researchers equating wellbeing with economic measures such as income

and GDP and others using wellbeing interchangeably with concepts such as happiness (White, 2008). This research uses the former, material-focussed concept, defined here as 'financial wellbeing'; however, it focuses on 'general wellbeing', which is in line with more recent conceptualisations of wellbeing that incorporate subjective and relational aspects along with more objective aspects.

This concept of 'general wellbeing' is in line with McGregor's (2008, p.1) definition of wellbeing as "a state of being with others, where human needs are met, where one can act meaningfully to pursue one's goals, and where one enjoys a satisfactory quality of life". This approach recognises that individuals' circumstances, actions and decisions are shaped by subjective, relational and objective aspects. As Armitage *et al.* (2012, p.1) notes, a wellbeing approach "goes beyond the material and basic needs conception … and reflects the importance of social, psychological, and cultural needs required to thrive".

A number of conceptual frameworks have been proposed for wellbeing, most notably McGregor's (2007) framework, which looks at the outcomes, structures, and processes that lead to a state of wellbeing. Much of the wellbeing literature has drawn from McGregor's work, such as the three dimensional framework developed by White (2010) which looks at wellbeing as arising from the interplay of the subjective, relational and material dimensions. White's (2010) framework is illustrated in Figure 3.

Fig. 1. The triangle of '3D' wellbeing.
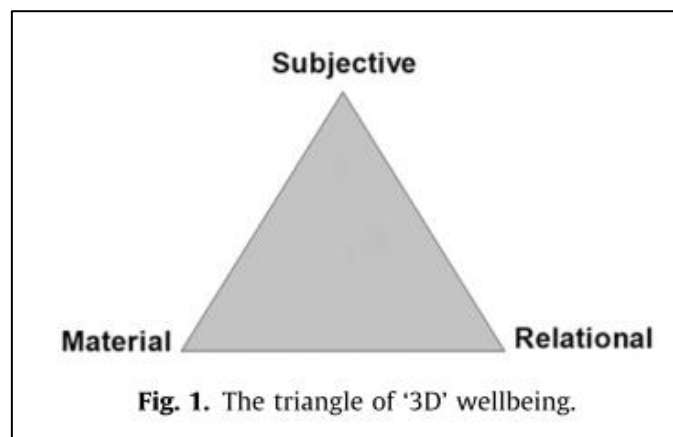
Figure 3: The three dimensional framework for wellbeing proposed by White (2010) and presented diagrammatically by Britton & Coulthard (2013)

This research draws from White's (2010) three dimensional framework as it provides a simple yet comprehensive approach to understanding wellbeing. The material dimension encompasses the natural, physical, financial and other tangible resources available to a person. The relational dimension recognises how social interactions and the degree of trust, mutual respect, equity and collaboration in these relationships shape the social context in which wellbeing is achieved. The subjective dimension recognises that a person's decisions are influenced by their satisfaction with their life and their perceptions, values and beliefs. Considered together, the three dimensions of wellbeing provide "a helpful framework to articulate and understand people's motivation and behaviour both in short and longer terms" (Armitage *et al.*, 2012, p.4).

A number of approaches have been developed to measure wellbeing, varying in their simplicity and in the extent of participation required from local stakeholders. An example of a very comprehensive, in-depth and engaged approach is the methodology proposed by McGregor (2007) and adapted by Britton & Coulthard (2013). However, this research uses a much simpler approach to measure wellbeing as wellbeing is not the central focus of the research, but is considered as a complementary concept to adaptive capacity in the effort to develop a more holistic understanding of socio-ecological systems. This simpler approach to measuring wellbeing uses the question "All things considered, how satisfied are you with your life as a whole these days?" to assess individual wellbeing. This question has been accepted as an efficient measure of wellbeing and is used in wellbeing assessments such as the 'Gallup life satisfaction measure' and the 'Satisfaction with Life Scale' (White & Abeyasekera, 2014).

2.6. Conceptual framework for adaptive capacity

The FLOW programme is centred on the 'Theory of Change' framework, which identifies three key determinants (hereafter referred to as domains) through which adaptive capacity at the individual level is built, namely agency, social cohesion and access to resources. The domains are envisaged as the driving forces behind adaptive capacity and by developing these domains within the community, the FLOW programme hopes to generate greater adaptive and transformative capacity. The ACI is informed by this framework and is motivated by the idea that by characterising the community's adaptive capacity and tracking its performance within these domains will strengthen and inform future adaptation initiatives. The 'Theory of Change' framework is depicted in Figure 4.
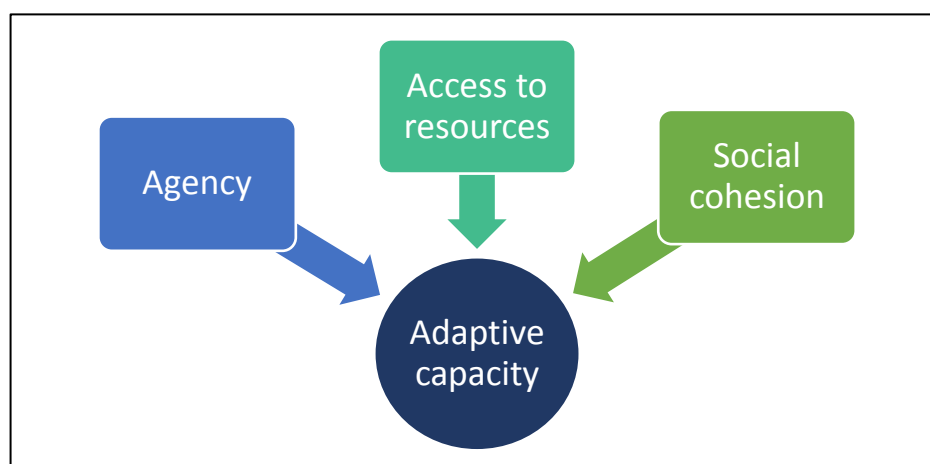
Figure 4: Theory of Change framework for the FLOW Programme (Ziervogel, 2015)

This framework incorporates both the objective and subjective aspects of adaptive capacity through the identified domains to obtain a more holistic characterisation of adaptive capacity that is applicable to many contexts, but is particularly important in characterising adaptive capacity in the multi-stressor urban context. A brief description of key features of each domain is presented in Table 2. For an in depth conceptual justification of the frameworks development and description of the key literature informing the framework, the reader is directed to Ziervogel *et al.* (2016b).

Table 2: A description of the adaptive capacity domains identified in the 'Theory of Change' framework

Domain	Example of features that represent a high level of capacity in each domain
Agency	Able to cope with change and recognise opportunities. Willing to take risks. Strong convictions and self-assurance. Independence and self-reliance.
Social cohesion	Strong social networks characterised by trust, reciprocity and respect. Able to act collectively and collaborate with social institutions. A sense of belonging and facing shared problems.
Access to resources	Able to access natural, physical, financial and other tangible resources. Support from social and municipal institutions. A sense of being adequately provisioned.

Chapter 3.   Methods

3.1. Research site

This research was undertaken in the Bergrivier Municipality, which covers an area of 4407 km^2 in the West Coast District of the Western Cape (BM, 2014). The Municipality includes 9 urban settlements, of which Piketberg is the administrative centre (BM, 2014). Figure 5 shows a map of the Bergrivier Municipality.
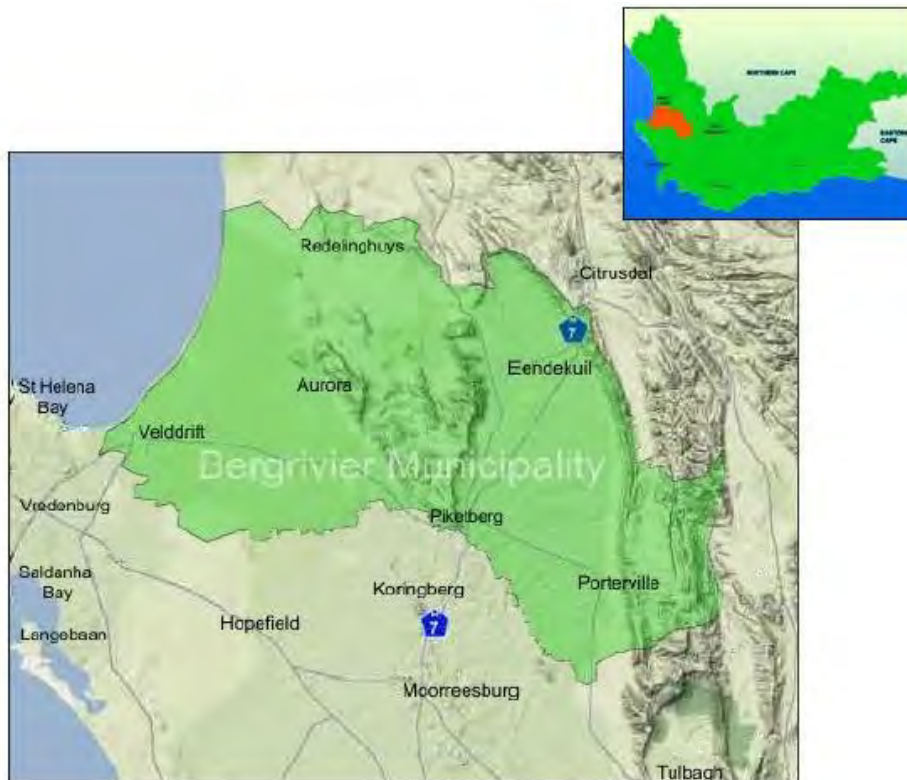
Figure 5: A map of the Bergrivier Municipality (BM, 2014)

The population of the Bergrivier Municipality was recorded as 61 897 in 2011 (BM, 2014). While the dominant employment sector in the Bergrivier Municipality is the agriculture, forestry and fishing sector, the economic activity in the area is becoming more diversified and "is shifting in favour of manufacturing, construction, retail & wholesale and other services" (Western Cape Provisional Treasury, 2013, p.131). The Bergrivier population experiences a high poverty rate, with 25.2 % of the households in the municipality classified as indigent, defined as a household receiving a total monthly income of less than 2 state pensions plus 10 % (BM, 2014). The unemployment rate in the area is 6.8 %, and there is a higher youth unemployment rate of 9.6 % (Statistics South Africa, 2011).

The Bergrivier Municipality also faces a number of environmental hazards such as climate change, alien vegetation infestations, loss of ecosystems due to urban development and pollution and flooding from poor storm water systems (Ziervogel, 2014a; Midgley *et al.,* 2005). Climate models have suggested that the impacts of climate change for the Western Cape region will be increased temperatures, increased wildfire frequency, significant biodiversity losses and fewer but more intense rainfall events, resulting in more frequent periods of drought but also increased flooding (Midgley *et al.,* 2005). Furthermore, climate

change may exacerbate the current high poverty rates and socioeconomic challenges that the Bergrivier population faces through impacts such as food insecurity, poor health, damage to infrastructure and threats to the agriculture, forestry and fishing sector (Midgley *et al.,* 2005).

This research focussed on four towns in the Bergrivier Municipality, namely Piketberg, Goedverwacht, Porterville and Velddrif. Key characteristics of each town, according to the 2011 census of South Africa, are described in Table 15 in Appendix D. Goedverwacht is a much smaller town compared to the other three towns and also differs in that it is a Moravian town. In a Moravian town, the Moravian Church acts as a private landowner and the land is managed by a local Church Council consisting of community members. The Moravian Church is responsible for providing services such as waste collection and electricity to the Goedverwacht community who lives on the land. The community pays the Church for these services, which then directly pays the service provider such as Eskom or the Department of Water Affairs. This is in contrast the other three towns included in this research, where services are provided by the municipality. However, the Bergrivier Municipality is still involved with Goedverwacht's affairs, especially with regards to spatial planning, where the municipality supports the Church Council in improving and maintaining road and service infrastructure (Bergrivier Municipality, 2013).

3.2. Organisational context

As described in Section 1.1, this research was conducted through the FLOW Programme and the key participants in this research were the FLOW Programme Project Team and the FLOW Ambassadors. The FLOW Project Team is a multidisciplinary group with diverse perspectives and skills. This team had prior experience working with the Bergrivier Municipality and community during the creation of the Bergrivier Climate Change Adaptation Plan and have been involved with the community since the conception of the FLOW Programme in 2014 (Ziervogel *et al*., 2016b). In light of these factors, and the role of the FLOW Project Team in developing the theoretical framework on which this research is based, this team provided the expert input required during the research process. The FLOW Ambassadors are local community members from Piketberg and Goedverwacht who have grown up in the Bergrivier Municipality and were employed by the FLOW Programme. The FLOW Ambassadors were key participants in the workshops where they provided valuable insight into the local context. For further detail on the FLOW Programme see Ziervogel *et al*. (2016b).

3.3. Method development

This research aims to assess the adaptive capacity of the Bergrivier community through the development of an ACI that explores the three domains of adaptive capacity in the 'Theory of Change' framework. The research is divided into two areas, firstly the development and refinement the ACI and secondly the analysis of the results from the ACI. A mixed methods approach is required to answer the overall research question as the development of the index entails a quantitative approach while refining the index requires qualitative input and analysis of the results incorporates both quantitative and qualitative aspects. The overall approach and various inputs used in this research are summarised in Table 3.

Table 3: Summary of the method development for this research

Chapter	Research component	Inputs informing each research component
4.1. Adaptive capacity index	Selection of indicators from the baseline survey questions	Initial selection by researcher refined by discussion with experts and input from FLOW Ambassadors at a workshop.
	Analytical approach to the ACI	Literature and document review.
	Validation of indicator selection	Input from FLOW Ambassadors at a workshop.
	Rating of indicators under each domain	Input from FLOW Ambassadors and the FLOW Project Team at a workshop.
4.2. Statistical analysis of ACI results	Quantitative analysis of index results to determine trends in the ACI scores between different Bergrivier Municipality towns, genders, age groups etc.	ACI scores generated for each completed baseline survey in Excel. Analysis of trends in the ACI scores using Pivot tables in Excel. Statistical hypothesis testing of results using Matlab 2014.
	Contextualise quantitative index results to understand why certain trends are occurring. Additionally, gain an understanding of any barriers to adaptation.	Discussion of the general trends observed in the ACI results at a workshop with the FLOW Ambassadors to provide local context to the results.
4.3. Regression analysis of ACI results	Regression analysis to investigate how certain socio-economic variables and the ACI domain scores influence an individual's financial and general wellbeing.	Regression analysis completed using STATA. Input from FLOW Ambassadors about individual wellbeing at a workshop.
4.4. Implications for adaptation	Identifying key insights from the mixed methods approach	Quantitative results combined with the qualitative input from FLOW Ambassadors at both workshops.

3.4. Data collection

Data collection was done through the administration of a baseline survey by the FLOW Ambassadors, through workshops with the FLOW Ambassadors and through discussions with experts.

3.4.1. Baseline surveys

The baseline survey was developed as part of the FLOW Programme by the FLOW Project Team. The survey was designed to gather general socio-economic information as well as to assess the different adaptive capacity domains from the 'Theory of Change' framework. The

survey had input from the FLOW Ambassadors regarding the development and phrasing of the questions, which familiarised the FLOW Ambassadors with the questions and ensured that the survey was appropriate for the local context. The survey respondents were local individuals involved with small businesses in the four towns. These respondents were identified in an economic activity mapping exercise completed by the FLOW Ambassadors. Purposive sampling drew on the FLOW Ambassador's local knowledge to identify business owners and this was complemented by snowball sampling, where the business owners helped to identify their peers. The FLOW Ambassadors themselves also completed the survey (Ziervogel *et al.*, 2016b). Respondents answered the questions anonymously through a mobile application. The survey questions primarily required the respondent to select an answer from between 2 and 8 possible responses. The survey was completed by 450 respondents from the four Bergrivier Municipality towns over a period of three months. The number of surveys collected in each Bergrivier Municipality town is displayed in Table 4.

Table 4: The number of surveys collected in each Bergrivier Municipality town

Bergrivier Municipality Town	Number of completed baseline surveys
Goedverwacht	53
Piketberg	147
Porterville	47
Velddrif	203

The comprehensive descriptive statistics for the sample of the 450 respondents can be found in Tables 11, 12 and 13 in Appendix B.

3.4.2. FLOW Ambassador feedback workshops

Two workshops were held with the FLOW Ambassadors during which discussions around the theoretical framework, the ACI construction and the ACI results were facilitated. The following section provides a brief description of each workshop.

The first workshop familiarised the FLOW Ambassadors with the concept of an index and with the three adaptive capacity domains. The FLOW Ambassadors were asked to give instances where they felt people from their community showed good or bad examples of agency, social cohesion and access to resources. The workshop structure was as follows:

1. Introductory PowerPoint and discussion
   - The purpose of measuring and reporting on progress was introduced.
   - The concepts of quantitative and qualitative data were introduced.
   - The use of indicators to measure a more complex concept was presented.
   - The 'Theory of Change' framework was explained.
2. Session on each adaptive capacity domain
   - After an introductory discussion on each domain, workshop participants were split into pairs and asked to identify 4 examples where a person or a group in their community demonstrated a high level of that domain as well as 4 examples demonstrating a low level of that domain. Participants wrote their

examples on coloured post-its and then presented their examples to the group. See Figure 13 in Appendix C.1 for a depiction of this exercise.

- Discussion around the examples was encouraged and similar examples from different pairs were grouped together and stuck up on A2 worksheets for each domain.

3. 'Rich picture' exercise on adaptive capacity

- Workshop participants were asked to imagine the Bergrivier region, their community and themselves in 10 to 20 years where there was a very high level of adaptive capacity. Participants were then left with minimal facilitation to write down words or draw pictures that came to mind from this scenario on a large A1 worksheet with colourful pens. See Figure 14 in Appendix C.1 for a depiction of this exercise.
- Workshop participants discussed their responses with the group.

4. Wrap-up and debrief

This workshop provided qualitative examples of the adaptive capacity of the Bergrivier community which added a richer understanding to the quantitative analysis of the ACI scores. Additionally, the workshop provided an introduction to the second workshop which involved more complex concepts.

The second workshop had a number of outcomes. Firstly, this workshop provided context to the trends observed in the quantitative analysis of the ACI scores. Secondly, the workshop assessed how accurately the ACI represented adaptive capacity at the individual level by asking the FLOW Ambassadors to assess how well their personal ACI scores represented themselves. The workshop also involved an indicator rating exercise to derive indicator weightings. Lastly, the workshop introduced and explored the concept of wellbeing at the individual level. The workshop structure was as follows:

1. Introductory PowerPoint and discussion
- The process conducting the baseline survey was discussed.
- The use of the baseline survey data to construct an ACI was introduced.
- Results from the ACI were introduced, followed by a discussion on what factors could have contributed to the key trends in the results.
- The researcher presented her individual score from the ACI, in the form of a 'spider diagram' for each domain and offered an explanation as to why she felt the index was an accurate representation of herself.

2. Session on individual scores from the ACI
- Each workshop participant received a worksheet detailing the indicators chosen for each adaptive capacity domain and a spider diagram representing their personal score for each indicator in that domain. The worksheet ended with a spider diagram of their overall score for each domain.
- Each domain was introduced with reference to the examples of that domain that had been offered in the previous workshop. This was followed by a

discussion of the 5 indicator questions from the baseline survey selected for that domain.

- This was followed by a rating exercise where each participant individually rated the relative importance of each indicator by distributing 15 stickers between the 5 indicators, with more stickers allocated to questions that viewed as a more important. The rating was discussed among the group.
- Then participants broke into pairs and discussed their individual scores for the indicators of that domain and evaluated if their overall domain score was an accurate representation of themselves. Each pair gave feedback to the group.
- Participants looked at their overall adaptive capacity score and discussed these in the group. For an example of this worksheet, see Figures 15 and 16 in Appendix C.2.

3. Exercise on subjective wellbeing
- The workshop was concluded with an individual wellbeing exercise. Each participant received a handout asking them to identify 3-5 of ''things that you need to have, need to be able to do, or able to be'' to have a good life (e.g. having close family relationships, a secure job etc.).
- Participants indicated how satisfied they were with each aspect that that had identified using a scale from 1 to 5, where 5 is fully satisfied. For each aspect participants were asked to describe what they could do increase their satisfaction with that aspect.
- Finally, participants were asked answer on a scale of 1 to 5: "All things considered, how satisfied are you with your life as a whole these days?" For an example of this worksheet, see Figure 17 in Appendix C.2.

4. Wrap-up and debrief

The rating exercise from this workshop was repeated in later meetings with the FLOW Project Team, 3 members of the Bergrivier Municipality and 8 community members from Goedverwacht and Piketberg. These meetings were facilitated by a member of the FLOW Project Team who had attended the second workshop.

3.5. Development and refinement of the ACI

The development of the ACI began with the selection of indicators for inclusion in the ACI, followed by the construction of the ACI which dealt the mathematical treatment of the data. The ACI was then refined by considering the input of stakeholders. This was followed by a participatory weighting process to derive weightings for indicators. During this process, a number of choices and assumptions were made. In the ACI's found in the literature, a variety of approaches to index development have been used; however, the selected approach was seldom described in detail. The Organisation for Economic Co-operation and Development (OECD) Handbook on Constructing Composite Indicators provides the following guidance: "From a pragmatic point of view, however, compromises need to be done when constructing a composite. What we deem essential is the transparency of these compromises" (OECD, 2008, p.23). Brooks & Fisher (2014) also emphasise the need for

transparency, noting that while an index is a useful tool to understand variations and track changes in adaptive capacity, an index can disguise important details and interesting trends within individual indicators. Therefore, transparency in the index's construction is central in ensuring that the disaggregated data is still accessible and underlying changes can be identified and explored. In line with this need for transparency, the choices made in each step of the development of this ACI are described in detail in the following sections.

3.5.1. Selection of indicators

Pragmatically, while indicator selection is guided by the theoretical framework, the selection of indicators is largely a subjective process based on an assessment of the local context, participatory and expert inputs and data availability (United States Agency for International Development, 2014). However, the selection of good indicators is essential as poor data will not lead to meaningful results.

As the ACI is assessing adaptive capacity at the individual scale, primary data collection through the baseline survey was necessary and this limited indicator selection to the set of questions included in the survey. Nevertheless, the survey questions were informed by the 'Theory of Change' framework and the use of a primary data source means that the quality of the data source is assured, timelines are consistent and data collection methods are known. The initial indicator selection for the ACI was completed by assessing the questions included in the baseline survey and identifying between 7 and 10 questions as potential indicators for each adaptive capacity domain from the 'Theory of Change' framework. This initial indicator selection was then refined through an iterative process.

The first step in this process involved a discussion with the FLOW Project Team members who were responsible for the development of the 'Theory of Change' framework and had extensive experience working with the Bergrivier community. Owing to their understanding of the theoretical basis of the index, these individuals provided expert judgement on the selection of indicators to ensure that each domain was appropriately represented. This discussion led to the exclusion of some of the initial indicators and the movement of some indicators to an alternative domain.

Following the expert review of the initial index, the indicator selection was further refined through the input from the FLOW Ambassadors during the two workshops. In the first workshop, the FLOW Ambassadors provided examples of adaptive capacity in their community and these examples were used to inform the exclusion and grouping of certain indicators. In the second workshop, the limitations and assumptions regarding certain indicators were discussed. In some instances; where two indicators were concerned with a very similar concept, these indicators were combined to form one more complex and robust indicator; unless there was consensus that one indicator was a better representation of that concept.

3.5.2. Analytical approach to the ACI

Once the indicator selection for each domain was finalised, an adaptive capacity score for each survey respondent was generated. This generation of the ACI scores involved a process of normalisation of the data for each indicator followed by aggregation of the normalised

indicator values to determine each individual's adaptive capacity score. This was completed using Excel.

The data for the selected indicators from the baseline survey is ordinal as the survey questions primarily required the respondent to select an answer from 3, 4 or 5 point Likert Scale or to provide a binary yes or no answer. Thus, while the indicator questions are qualitative in nature, the responses can be assigned a quantitative value (Brooks & Fisher, 2014). A low integer (0 or 1) is assigned to the response indicating the lowest level of adaptive capacity with the next greatest integer is assigned to the response that indicates a slightly higher level of adaptive capacity and so on.

> For example, the following indicator was selected for the domain of agency and the response could take on three possible values, with a score of 1 representing a low level of agency and a score of 3 representing a high level of agency.
>
> > Do you feel that you are able and willing to try new things in your life?
> >
> > Possible responses: 1 - Not able and willing to try new things,
> > 2 – Sometimes able and willing to try new things
> > 3 – Able and willing to try new things

Normalisation of the responses for each indicator was necessary as the selected indicators were measured on varied scales of between 2 and 8 response choices. The responses were normalised to a value between 0 and 1, where a value closer to 1 represents a greater adaptive capacity. A minimum-maximum approach to normalisation was used, where a value of 0 was assigned to response indicating the lowest level of adaptive capacity and a value of 1 was assigned to the response indicating the highest level of adaptive capacity. The normalisation formula is displayed in Equation 1.

$$Normalised\ value\ of\ indicator = \frac{Individual's\ response - Minimum\ response\ value}{Maximum\ response\ value - Minimum\ response\ value} \quad \text{(Eq. 1)}$$

Descriptive statistics for the selected indicators and the possible values each indicator could take on in the normalised form can be found in Table 14 in Appendix B.

Following normalisation of the data, the normalised indicator values for each respondent were aggregated to determine that respondent's score for each domain between 0 and 1. The aggregation was done by a weighted average, with the weighting for each indicator derived from the rating exercises described in Section 3.5.4. For the domain scores, a value closer to 1 indicates a higher level of that domain. The aggregation of indicators to domain scores is shown in Equation 2 for the agency domain.

$$Agency\ score = \sum_{i=1}^{5}(Weighting\ of\ agency\ indicator\ i) \times (Value\ of\ agency\ indicator\ i)$$
$$\text{(Eq. 2)}$$

These domain scores were then aggregated to determine each individual's overall adaptive capacity score. As explained in Section 3.5.4, the domains were equally weighted. Again the adaptive capacity score was between 0 and 1, where a value closer to 1 indicates a higher level of adaptive capacity. The aggregation of domain scores to an adaptive capacity score is shown in Equation 3.

$$Adaptive\ capacity\ score = \frac{Agency\ score + Social\ cohesion\ score + Access\ to\ resources\ score}{3} \text{ (Eq. 3)}$$

This was completed for each respondent. During the process of constructing an index, a number of issues were dealt with and a discussion of these issues is detailed in are dealt with in Table 5 in order to ensure transparency of the index.

Table 5: Discussion of key issues related to the construction of the ACI

Issue	Discussion of issue
The nature of the indicator data	As discussed previously, the baseline survey questions predominantly required a response to be selected from a Likert-type scale. When converting these responses to an indicator there is the inherent assumption that the ordinal response scales can be treated as interval scale. However, the assumption of an interval scale implies a notion of equidistance between each response on the scale, i.e. that the response "I never take risks" represents a level of adaptive capacity that is x % lower than the response "I seldom take risks", which in turn represents a level of adaptive capacity x % lower than the response "I sometimes takes risks". While there is debate regarding the mathematical accuracy of this equidistance assumption for qualitative responses (Allen & Seaman, 2007), it is a necessary assumption in the construction of the ACI. Brooks & Fisher (2014) note that pragmatically, in the construction of an index it is often necessary to use a range of different indicator types, including categorical, binary and continuous indicators. Moreover, it is an assumption that has been made, often without remark, in many of the ACIs in the literature. Additionally, care was taken with the phrasing of the baseline survey response scales to ensure that the intervals between responses are approximately equidistant.
	The ordinal nature of the data had certain consequences for the data analysis as for the descriptive statistics of the data in Appendix B, the mean and standard deviation are not valid parameters and rather the median, mode and range are used. In the quantitative analysis of the ACI results, the nature of the data necessitates the use of non-parametric tests and a probit regression.
The use of stakeholder and expert input in indicator refinement rather than statistical tests	As an alternative to stakeholder engagement processes, a range of statistical techniques can be used in refining the indicator selection. These statistical techniques look at the underlying structure and degree of correlation in the complete data set and include methods such as principal component analysis, factor analysis and Cronbach's alpha analysis (e.g. Engle & Lemos, 2010). However, this ACI did not employ these statistical techniques in indicator refinement as there was a limited set of indicators and a stakeholder engagement process with the local community and relevant experts was possible. Additionally, a more participatory process contributed to meeting the aims of the research.
Imputation of missing data	One indicator question that was selected for the domain social cohesion was "On a scale of 1 to 5 how much do you trust the local municipality?" The relationship between the community and the municipal authorities is an essential element of the social cohesion domain; however, 135 respondents declined to answer this question and no other questions probed this relationship. In order to include this indicator in the ACI, imputation of the

	missing data was required. Missing data imputation can be dealt with in a number of ways, including case deletion, unconditional mean/median imputation, regression imputation and random imputation (OECD, 2008). In this ACI, as the missing data imputation was only required for one indicator and simplicity and transparency were key aims; unconditional median imputation was used for the missing data entries. The median was selected rather than the mean due to the ordinal nature of the data. A disadvantage of this method is a decrease in variance in the data for; however, this was assumed to have an insignificant effect on the overall results of the ACI.
Use of minimum-maximum normalisation	A variety of approaches are available for the normalisation of indicators, including minimum-maximum normalisation, z-score normalisation, distance to a reference, and above/below the mean (OECD, 2008). Of these, minimum-maximum normalisation is one of the least complex methods and one of the most versatile normalisation methods as it can be used with any weighting or aggregation method (OECD, 2008). For these reasons, this ACI uses a minimum-maximum approach to normalisation, as does a number of ACIs found in the literature (e.g. Maldonado & Moreno-Sánchez, 2014). Furthermore, as the time point of data collection is consistent across the data and there are no extreme outliers (as respondents had to select an answer from a predetermined range), more complex normalisation methods are not necessary.

3.5.3. Validation of the indicator selection through individual feedback

In the second workshop, participants were asked to assess if their individual scores from the ACI were accurate representations of themselves. An individual's score was depicted using a spider diagram showing their score for each indicator with reference to the average score of all respondents. The use of the average as a reference was important as the ACI does not provide an absolute value for an individual's adaptive capacity but provides a relative measure based on an individual's perception of their level of adaptive capacity compared to others in their community.

The individual feedback was facilitated through discussions in pairs followed by a discussion with the workshop group. This activity helped to validate the indicators selected and further informed the refinement of the ACI. While this activity provided important participatory input that informed the development of the ACI, it also provided a way to communicate the results of the ACI to local stakeholders.

3.5.4. Weighting of indicators

Once the indicator selection was finalised, the weighting of the indicators under each domain was determined. In the literature on ACIs, a number of weighting approaches have been used. Some researchers use equal weightings and others use statistical or participatory methods to derive weightings. While an equal weighting approach "avoids the loss of transparency that a data transformation through weighting can produce" (Pelling & Zaidi, 2013, p.19); a number of researchers argue that this approach is limited in its implication that all indicators are equally important measures of adaptive capacity (Sietchiping, 2007). In this ACI, the three adaptive capacity domains were equally weighted as the 'Theory of

Change' framework defines these domains equally important contributors to an individual's adaptive capacity. This framework resulted from extensive discussions between the FLOW Project Team before this study began and a key consensus that arose during the development of the framework was that the three domains are equally important contributors to adaptive capacity (Ziervogel *et al.*, 2016b). Additionally, equal weighting at the domain level assists in creating a transparent index. However, the weighting of the indicators under each domain was explored.

In deriving the indicator weightings, statistical methods such as Principal Component Analysis and Factor Analysis can be used (e.g. Nelson *et al.*, 2007) or participatory methods such as the Analytical Hierarchy Process (AHP) and Budget Allocation Process (BAP) can be used (e.g. Sietchiping, 2007; Defiesta & Rapera, 2014; McClanahan *et al.*, 2008). Statistical methods provide a weighting that corrects for highly correlated indicators but does not indicate the theoretical importance of each indicator (OECD, 2008). Alternatively, participatory methods, where relevant stakeholders rate or rank indicators, account for the relative importance of each indicator as a proxy measure for its respective domain. As this research was interested in the theoretical importance of each indicator, participatory methods were used.

This study used BAP as the participatory weighting method as it is transparent, straightforward and does not require a large time commitment. The alternative method, AHP, is more rigorous but is cognitively demanding for participants (OECD, 2008). The use of BAP ensured that the rating process was accessible to local stakeholders and the rating exercises were conducted during the second workshop and during meetings with the FLOW Project Team, the Bergrivier Municipality and Bergrivier community members. Participants were asked to rate the relative importance of each indicator by allocating 15 dots between the 5 indicators included under each domain, as described in Section 3.4.2. The ratings received from the completed rating exercises were averaged to determine the overall weighting of each indicator.

3.6. Analysis of the ACI results

Once the ACI indicator selection and weightings were finalised, the domain and overall ACI scores for each respondent were generated. These scores were analysed quantitatively and this was complemented by contextualisation from qualitative inputs.

3.6.1. Statistical analysis of ACI scores

The quantitative analysis of the domain and adaptive capacity scores was done using Excel and Matlab 2014. Excel was used to produce summary tables that explored the trends in the average domain and adaptive capacity scores of respondents from the different Bergrivier Municipality towns, as well as trends related to other variables including the gender, age group, schooling level and race of respondents. Matlab 2014 was used to carry out non-parametric hypothesis tests, namely the Mann-Whitney U test and Kruskal-Wallis test, to test the statistical significance of any trends that were observed. Non-parametric tests were used due to the ordinal nature of the underlying data, the uncertainty regarding the data's distribution and the wide applicability and robustness of these tests.

This quantitative analysis was followed by a qualitative analysis in order to provide context to the trends that were observed in the domain and ACI scores. This qualitative input was gained during the second workshop where general trends seen in the ACI scores (e.g. higher adaptive capacity in certain towns) was presented to the FLOW Ambassadors by the researcher. During the presentation, the FLOW Ambassadors were encouraged to discuss how the trends correlated with their perception and understanding of the adaptive capacity in their community. The examples of adaptive capacity in the Bergrivier community from the first workshop were also used as a complementary source in the qualitative analysis.

3.6.2. Regression analysis

Following the characterisation of adaptive capacity in the Bergrivier community, the regression analysis investigated how the adaptive capacity variables and certain socio-economic characteristics impact an individual's financial and general wellbeing. While the construction of the regression analysis may seem contrary to some previous studies, which conceptualise income and wellbeing as key determinants of individual adaptive capacity, this thesis does not attempt to pose any causal links but aims rather to explore the implications of any relationships between these concepts in order to inform future work. Nevertheless, in justifying the chosen construction of the regression analysis, while it is possible to hypothesise that being richer or more satisfied with life leads to greater agency, it is also plausible to hypothesise that having a sense of agency results in more satisfaction with life and may help create opportunities that lead to a higher income. Similar causality arguments can be made for social cohesion and access to resources; however, this is not the focus of this analysis.

In the regression model, the predictor variables used were the socio-economic variables of gender, race, town, level of schooling and the number of years as a resident in Bergrivier Municipality as well as the adaptive capacity variables of the agency, social cohesion and access to resources domain scores. Three dependent variables of income, expenditure and wellbeing were tested in three separate regression models all using the predictor variables mentioned previously. Both income and expenditure were tested as measures of individual's financial wellbeing as income is known to be a poorly reported indicator by survey respondents, especially when recorded through a single-question. Micklewright & Schnepf, (2010, p. 22) question the reliability of responses where a single-question is used to measure income; however, they do comment that when individuals are asked to report their own income rather than household total income, "a single question can result in a distribution that corresponds very closely to the distribution based on detailed questions" at the macro level. As the baseline survey asked individuals to report their own income, it is hoped that the reliability of the responses are adequate; however, this was not robustly tested. The data set used for the regression analysis was taken from the baseline survey. As the dependent variables were all measured on ordinal scales (i.e. for wellbeing, respondents were asked to rate how satisfied they were with their life on a scale of 1 to 5 and for income and expenditure, respondents were asked to select one of 10 categories), an ordered probit regression model on STATA was used. A linear dependence between the dependent and predictor variables was assumed. The regression model for income is described in Equations 4 and 5.

$$I_i^* = \alpha\, SE_i' + \beta\, AC_i' + \epsilon_i \qquad\qquad (Eq.\ 4)$$

$$I = \begin{cases} 1\ if\ I^* \leq 1, \\ 2\ if\ 1 < I^* \leq \mu_1 \\ 3\ if\ \mu_1 < I^* \leq \mu_2 \\ etc\ ... \\ 8\ if\ \mu_6 < I^* \leq \mu_7 \\ 9\ if\ \mu_7 < I^* \leq \mu_8 \\ 10\ if\ \mu_8 < I^* \end{cases} \qquad\qquad (Eq.\ 5)$$

The variable I_i^* is the exact but unobserved dependent variable representing income. Equation 5 described how I^* is related to the ordinal income variable, I. The variables μ_i where i = 1 - 8 are unobservable thresholds. The variables SE_i and AC_i are the vectors of the socio-economic and adaptive capacity predictor variables respectively and α and β are the vectors of the regression coefficients that the regression model estimates. Similarly, the regression models for income, E*, and wellbeing, WB*, are described in Equations 6 and 7.

$$E_i^* = \gamma\, SE_i' + \delta\, AC_i' + \epsilon_i \qquad\qquad (Eq.\ 6)$$

$$WB_i^* = \tau\, SE_i' + \theta\, AC_i' + \epsilon_i \qquad\qquad (Eq.\ 7)$$

E* is related to the ordinal expenditure variable and WB* to the ordinal wellbeing variable in the same way as the ordinal income variable is related to I*, as described in Equation 5. The model clustered the data by town to account for the unobserved characteristics shared between individuals from each town. In the wellbeing regression model, the data set included 425 individuals (25 respondents were excluded where respondents declined to disclose their gender or race). In the income and expenditure regression models, a subset of 229 individuals out of the 425 individuals was used to exclude respondents that declined to disclose their financial information. The wellbeing regression model was also run for this subset of individuals. The quantitative regression analysis was complemented by qualitative insights gained from the wellbeing exercise from the second workshop, which explored the concept of wellbeing at the individual level.

3.7. Limitations

The key limitation for this research is that the indicators selected for the ACI are constrained to the questions that were included in the household survey and the quality of the completed surveys. It is also necessary to note that the baseline survey targeted a certain subset of the population as the respondents were individuals involved with local businesses that had been identified in an economic activity mapping exercise. However, this subset includes a good spread of the population with regards to the socio-economic characteristics of age, gender, town, race and level of income.

This research does not assess the change in adaptive capacity achieved through the implementation of the FLOW Programme. Rather, it provides a baseline assessment of the adaptive capacity of the Bergrivier community at the outset of the FLOW Programme. Additionally, this research does not attempt to test the utility of the ACI through the use of a dependent variable serving as a proxy for 'adaptations'. However, in the multi-stressor urban context, such a proxy would be very hard to define and little literature exists on this

topic. In general, this is a limitation seen in the majority of ACIs in the literature and is certainly an area for future research.

Another limitation experienced in this research was a language barrier, as the first language of the FLOW Ambassadors is Afrikaans. However, the language barrier was managed through the use of a translator and by switching between English and Afrikaans during workshop conversations. It is important to note that all quotations included in this thesis have been translated from Afrikaans.

There are also limitations to the regression analysis. Some variables that might influence wellbeing (such as marital status and size of household) were omitted from the analysis due to data limitations, which may lead to a bias in the results. Additionally, the regression analysis assumed a certain causality between variables where wellbeing was the independent variable. However, this may not hold for all variables, for example an individual's wellbeing may affect their sense of agency, rather than the reverse, which was assumed in the regression. Thus, while the regression analysis provides interesting insights, it is interpreted with an element of caution. The regression analysis does not attempt to model income, expenditure and wellbeing robustly, but rather investigates the link between adaptive capacity and wellbeing.

Chapter 4.   A characterisation of the adaptive capacity of the Bergrivier community

This chapter presents the final ACI that was developed to characterise the adaptive capacity of the Bergrivier community and then outlines the insights that were gained about this community through the analysis of the ACI scores. This analysis includes a statistical analysis that looks at the variation of adaptive capacity across socially differentiated groups and a regression analysis that explores the influence of socio-economic variables and the ACI scores on individual wellbeing. The chapter concludes by discussing key implications of the analysis for the Bergrivier community.

4.1. Adaptive capacity index

4.1.1.   Selected adaptive capacity indicators

The final index that resulted from the expert review of the index and the discussions with the FLOW Ambassadors during the two workshops is described for each adaptive capacity domain. The major decisions, comments and limitations associated with each indicator are discussed. The first adaptive capacity domain deals with the subjective aspect of agency of individuals. Agency was described by participants in the first workshop as the idea of being independent, self-assured and demonstrating active citizenship. The selected indicators for this domain are described in Table 6.

Table 6: Final choice of indicators for the agency domain in the ACI

Agency indicators	Questions from the baseline survey	Notes from expert consultation and workshop discussions
Taking risks	How often do you take risks? and How often do you take risks on creative projects or business decisions, even when you have no guarantee of a positive outcome?	During the second workshop, there was a discussion regarding whether taking risks was a positive or negative attribute. Taking too much risk (e.g. gambling) can lead to one giving up their agency; however, not taking risks can also indicate a low level of agency where one does not try to improve their circumstances or take advantage of opportunities. The participants agreed that by combining two questions regarding risk taking, where one question was related to general risk taking and the other specifically to taking risks on creative projects, it would produce a better indicator of agency.
Being willing and able to try new things	Do you feel that you are able and willing to try new things in your life?	These question were included to align with the idea that emerged in the first workshop where participants described agency as:
Feeling in control of decisions that affect your life	How much control do you feel you have in making decisions that affect your everyday activities?	*"not being a passive recipient of your circumstances"*
Making decisions independently	Are you forced to consult other people when you have to make decisions?	There was some debate regarding the inclusion of this question during the expert consultation. While it is good to be independent, self-reliant and decisive when making decisions, it is also good to consult

		others for advice when one goes through a decision making process as long as one has the final say in taking the decision. Nevertheless, it was decided that this was a good agency indicator when considered alongside the other agency indicators.
Making a positive impact on your community	Overall, how much impact do you think you have in making Bergrivier area a better place to live?	This indicator was not initially selected as it was felt that an individual could have a lot of agency without positively impacting their community. However, it was later included as making a positive impact on your family and community emerged as a strong theme in the discussion of agency in the first workshop. Some examples that were given for agency by the workshop participants were: *"Jane's[1] mother in law has raised 5 orphans as her own children."* *"Matthew took initiative to develop sport in Piketberg amongst the youth"*

The second domain also deals with a subjective aspect of adaptive capacity but looks beyond the individual, to the social cohesion that the individual experiences and observes within their community. Social cohesion was described by participants in the first workshop as the idea of being connected to others in their community though frequent interactions and mutual support. The indicators selected for this domain are described in Table 7.

Table 7: Final choice of indicators for the social cohesion domain in the ACI

Social cohesion indicators	Questions from the baseline survey	Notes from expert consultation and workshop discussions
Trust in the community	Generally speaking, would you say that most people in your community can be trusted?	These three questions all concern different aspects of the social cohesion within the community. As indicators of social cohesion, these questions explore an individual's experience and perception of the social cohesion within their community, rather than an individual's personal contribution to the social cohesion in their community (this is probed in the fourth social cohesion indicator).
Closeness of the community	Would you say that all things considered this is a close-knit community?	
Support from community in times of need	Are most people in your community/ neighbourhood willing to help if you need it?	
Giving time and money to support others in the community	Over the last one month how much did you give in money and non-work time to support people or groups without expecting compensation?	Initially there were some concerns regarding the inclusion of these questions as one could be willing to help others but not be asked or not have the time or money to contribute. However, the examples of social cohesion that emerged in the first workshop repeatedly concerned both individual initiatives and community welfare programmes, such as the following: *"A soup kitchen run by Badisa gives food and clothes*

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[1] This is a pseudonym and all further names have been changed to protect individuals' identities.

		to impoverished kids."
		"Anna runs a sowing centre in Piketberg where she teaches unemployed people to sow for free and is creating jobs in the community."
		These questions were important and relevant indicators for social cohesion in Bergrivier Municipality from the perspective of the individual's contribution to their community's social cohesion rather than their experience of the community's social cohesion which is explored in the first three questions. Initially these two questions were included as separate indicators; however, by combining these questions, the indicator accounts for individuals who do not have the means to help others in monetary terms, but show their concern for others by giving their time.
Trust in the municipality	On a scale of 1 to 5, how much do you trust the local municipality?	In the urban context, the municipality plays an important role in supporting and meeting the needs of the community. From both the expert and workshop discussions, it was agreed that trust in the municipality was important to include under social cohesion alongside the other indicators that deal with social cohesion within the community.

The final domain dealing with the more objective material aspects is access to resources. Access to resources was described by participants in the first workshop as the idea of having the resources you need on a day to day basis while also respecting the way you use natural resources so as to not deplete them. The indicators selected for this domain are described in Table 8.

Table 8: Final choice of indicators for the access to resources domain in the ACI

Access to resources indicators	Questions from the baseline survey	Notes from expert consultation and workshop discussions
Financial status	How would you describe your financial situation? (range of very underprivileged to rich)	Initially, two financial status indicators were selected, one concerning an individual's financial situation and another concerning the diversity of an individual's income sources. While the former explicitly deals with financial status, the latter was selected as many ACIs in the literature, typically those in a rural context (e.g. Sietchiping, 2007), identify access to multiple income sources as an indication of greater adaptive capacity as an individual has multiple livelihood options. However, in the expert and workshop discussions, it became evident that the urban context, one secure income source may be better than multiple income sources as multiple income sources may indicate that an individual does not have one stable job but rather does odds jobs whenever the opportunity arises.

		Therefore, it was decided that the diversity of income sources indicator was unsuitable in the urban context and only the financial situation indicator was included.
Access to resources that you need	Do you have access to the resources you need to make changes to your life when there are difficulties?	This question deals very broadly with access to resources and could include natural, physical, financial and other tangible resources.
Being supported by the municipality	In the last 3 months, has the municipality provided you with any support that has enabled you to live a better life? and In the last 3 months, have you contacted the municipality for assistance?	The important role the municipality plays in meeting the needs of an urban community means that the support received from the municipality and the availability of municipal services is an essential component of the access to resources domain. In the expert discussion, the time frame of this indicator was questioned; however, it was agreed that 3 months was an appropriate time period to capture the municipality's involvement in assisting the community
Having enough food	Over the last 3 months has your household had a sufficient amount of food in the household?	While this indicator is quite specific, it is indicative of the broader idea of an individual being able to meet their basic daily needs and was thus is important as an indicator for access to resources.
Helping people and the environment through your activities	Do your business or livelihood activities help people/the environment at all?	While this indicator does not strictly deal with the material resources available to an individual, it explores the idea of 'connection to life support systems', where individuals recognise how their actions impact the natural resources and other life support systems that support them. This is a strong theme of the FLOW Programme, which recognises the importance of an awareness of one's context in the broader environment and one's impact on this environment, especially in the face of adapting to the impacts of climate change in the multi-stressor urban context. Through the expert consultation and workshop discussions, it was decided to include this indicator.

4.1.2. Weighting of indicators within each domain

The rating exercise was carried out with a range of stakeholders, including the FLOW Ambassadors, the FLOW Project Team, the Bergrivier Municipality and members of the general community. This exercise aimed to garner insight into the value assigned to the range of indicators by different individuals and show if there were any indicators that were seen as far more important than others. However, when the indicators weights were calculated from the ratings that were collected, the majority of the indicators were weighted very close to 1, where 1 represents an equal weighting approach. Additionally, the standard deviations of the indicator weights were large, with the majority greater than 0.3, showing a large variation in the way indicators were weighted by different individuals. Interestingly, no distinct pattern was observed within the ratings of the different

stakeholder groups, indicating that the rating that individuals gave to indicators was a very personal choice that was not strongly influenced by their role in the community.

In light of the large range in indicator ratings and the proximity to 1 of the indicator weights, it was decided to adopt an equal weighting approach. It is not entirely surprising that none of the indicators were viewed as far more or less essential compared to the other indicators given the participatory process that was used in the selection and refinement of the indicators used close engagement with the FLOW Ambassadors and FLOW Project team. Consequently, concerns and issues regarding certain indicators had been dealt with early on in the process of developing the ACI. Finally, this provided evidence that the index does contain a range of indicators that are representative and provide a holistic characterisation of adaptive capacity.

4.2. Variation in adaptive capacity across socially differentiated groups

The scores generated using the ACI were analysed to explore the variation in adaptive capacity across socially differentiated groups. While this analysis looks at the variation in adaptive capacity with place, by assessing the differences in the adaptive capacity in the four Bergrivier Municipality towns, it also looks at the variation in adaptive capacity with other socio-economic variables, including gender, age, race and education. This is in line with the conclusions of Hogan *et al.* (2013) who found that it is not sufficient to focus on the variation in adaptive capacity between places when developing adaptation initiatives as consideration must also be given to the variation in adaptive capacity between sub-groups within a community.

4.2.1. Town

Figure 6 below shows the variation in the average domain and overall adaptive capacity scores of residents in the four Bergrivier Municipality towns.
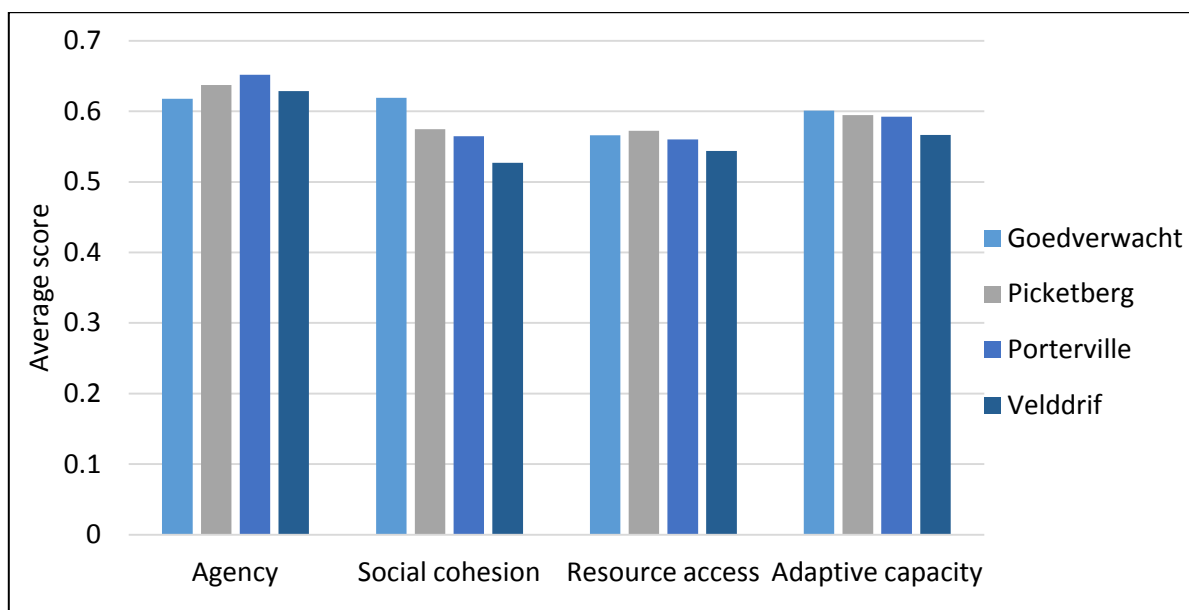
Figure 6: Variation in adaptive capacity between the four Bergrivier Municipality towns

Porterville residents have the highest average agency score, followed by Piketberg and then Velddrif, while Goedverwacht residents have the lowest average agency score. However, a Kruskal-Wallis test shows that there is no statistically significant difference in the agency scores between the four towns.

The average social cohesion score of Goedverwacht residents is highest by a large margin, followed by Piketberg and Porterville residents, while Velddrif residents have a substantially lower average social cohesion score. A Kruskal-Wallis test shows that there is a statistically significant difference in the social cohesion scores of Goedverwacht and Velddrif residents (p=0.018), and in the social cohesion scores of Piketberg and Velddrif residents (p=0.062). The low social cohesion observed in Velddrif's was explained by a participant in the second workshop:

"It's because of the social challenges they have … lots of crime and drugs and many school leavers."

These social challenges could contribute to low levels of trust and inhibit the sense of being supported by others in the community.

On the other hand, Goedverwacht's high social cohesion score could be attributed to the smaller population of Goedverwacht compared to the other three towns, which contributes to a stronger sense of community and trust. Additionally, the historical context of Goedverwacht being a mission town means that many of the families have lived and farmed in the valley for generations. A number of examples from the first workshop mentioned the strong sense of community in Goedverwacht:

"The Goedverwacht rugby team isn't very good but the support is always strong from the community and there is lots of patriotism."

"The Brand [community currency] in Piketberg was hindered because of low levels of trust between businessmen, and people went back on their word after saying they would trade. In Goedverwacht people are more willing to trade with each other."

During the workshop discussions, it was clear that the Goedverwacht community has strong bonds so it is not surprising that they had high social cohesion scores. The Goedverwacht community has experienced some difficulties regarding service provision from the Moravian Church; however, it is evident that these frustrations are directed at the larger Moravian Church Organisation based in Cape Town and have not significantly impacted on the social cohesion within the community. These frustrations may have actually strengthened cohesion through the collective confrontation with the Church.

Piketberg residents have the highest average access to resources score, followed by Goedverwacht and the Porterville residents, while Velddrif residents have the lowest average access to resources score by a large margin. However, a Kruskal-Wallis test showed that there is no statistically significant difference in the access to resources scores between the four towns. In the second workshop, participants commented on the Velddrif's low access to resources score:

"In Velddrif there is more poverty so it makes sense that they score low. Also the high seasonality of fishing would have an impact."

"There are some shacks in Velddrif. There were some shacks in Piketberg but the municipality upgraded them to 'Wendy houses' that have toilets and water. Piketberg and Porterville are similar in terms of poverty."

Further evidence can be drawn from the economic data for the Bergrivier Municipality towns collected in the 2011 census (see Figure 8 in Appendix D), which shows that Velddrif has a significantly higher proportion of residents with no income compared to the other three towns. While the census includes a much larger sample than the ACI and is a comparatively older data source, this is evident in Velddrif's lower average access to resources score.

The economic data from the 2011 census shows that Piketberg and Porterville have similar income distributions, while Goedverwacht has a higher percentage of residents falling into the lower income categories compared to Piketberg and Porterville, and Velddrif has the highest percentage of residents with no income. The census recorded that Goedverwacht residents have a substantially lower access to amenities such as weekly refuse removal, sewerage connected flush toilets and electricity for lighting (see Table 15 in Appendix D), which is linked to Goedverwacht's service provision through the Moravian Church rather than the Bergrivier Municipality. In the first workshop, evidence of Goedverwacht's difficulties with access to basic amenities as well as their displeasure with the Moravian Church's service provision was seen in the comments:

"Not everyone has water in Goedverwacht every single day because it is a gravity fed system and sometimes the water level gets too low."

"There was an issue in Goedverwacht with Eskom [the electricity provider] and the Church made decisions that were not in the interest of the community."

In light of the census data and the comments of Goedverwacht residents, it is interesting that the average access to resources score in Goedverwacht is not comparatively lower to that of the other towns, but is similar to the average scores in Porterville and Piketberg. This higher than expected access to resources score can in part be explained by other characteristics recorded in the census, where Goedverwacht has a higher number of formal dwellings and significantly more residents report that their house is fully owned/ paid off compared to the other towns. This indicates financial stability among Goedverwacht residents. Additionally, Goedverwacht is a much smaller and more cohesive community with strong traditional systems of support such as bartering, which contribute to their access to resources even though this is not directly measured. Additionally, Goedverwacht's tourism industry is growing, which is evident in one participant's comment in the first workshop:

"The snoek and patat [fish and sweet potato] festival created a market for Goedverwacht's goods and brings tourism to the town."

These results are attributed to the access to resources domain not focussing purely on monetary wealth, but including the concept of being adequately provisioned.

The average adaptive capacity score is highest for Goedverwacht residents, followed by similar average scores for Piketberg and Porterville residents, while Velddrif residents have a much lower average adaptive capacity score. A Kruskal-Wallis test shows that there is a statistically significant difference in the adaptive capacity scores of Goedverwacht and Velddrif residents (p=0.008), and in the adaptive capacity scores of Piketberg and Velddrif residents (p=0.019). The variation in the social cohesion scores between the different towns is the key source of the variation in the ACI score between towns.

An additional interesting data set with respect to the differences between the four Bergrivier Municipality towns is a question that was included in the baseline survey that asked respondents to select the problems from a list which they felt were key issues facing their community. Figure 7 shows the percentage of respondents from each town who identified a particular problem as a key issue.
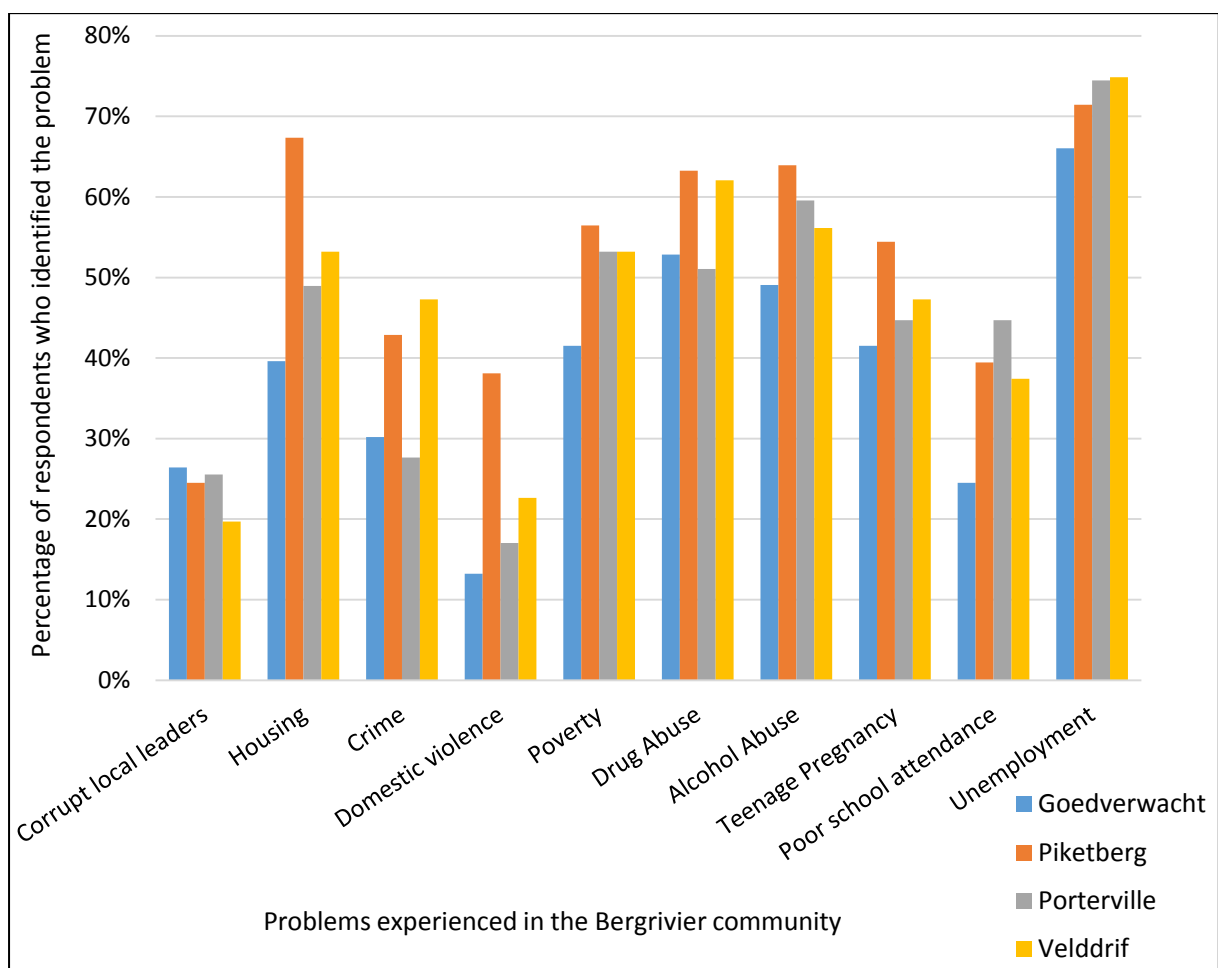
Figure 7: The percentage of respondents from each town who identified a certain problem as a key issue facing the Bergrivier community

The social challenges Velddrif residents face have already been alluded to in the discussion regarding the social cohesion of the four towns; however, Figure 7 provides more evidence as crime and unemployment were greater problems in Velddrif compared to the other towns. Conversely, Goedverwacht's high social cohesion scores are further explained by the comparatively lower percentage of Goedverwacht residents who identify crime, domestic

violence, poverty, drug and alcohol abuse, poor school attendance and unemployment as problems.

A comparatively high percentage of Piketberg residents identified problems such as housing, domestic violence, drug abuse, alcohol abuse and teenage pregnancy as key issues. This high percentage of problems identified did not translate into a much lower social cohesion score. This may be due to the large number of social and welfare programmes active in Piketberg. As Piketberg is the administrative centre of the municipality, there are a number of community activities, such as a community sewing centre, a sports programme run by an NGO, a soup kitchen and a large church choir, all of which were identified as examples of strong social cohesion by participants in the first workshop. The identification of housing as a key issue in Piketberg was alluded to in a comment in the first workshop:

"There was a miscommunication between the Piketberg community and the municipality where the municipality did not go according to the housing waiting list and this broke the trust"

While the municipality has upgraded all informal housing in Piketberg, it is evident that residents are still unhappy with the arrangements and with the way in which the municipality has dealt with the housing issue.

4.2.2. Gender

Figure 8 below shows the difference in the average domain and overall adaptive capacity scores of males and females.
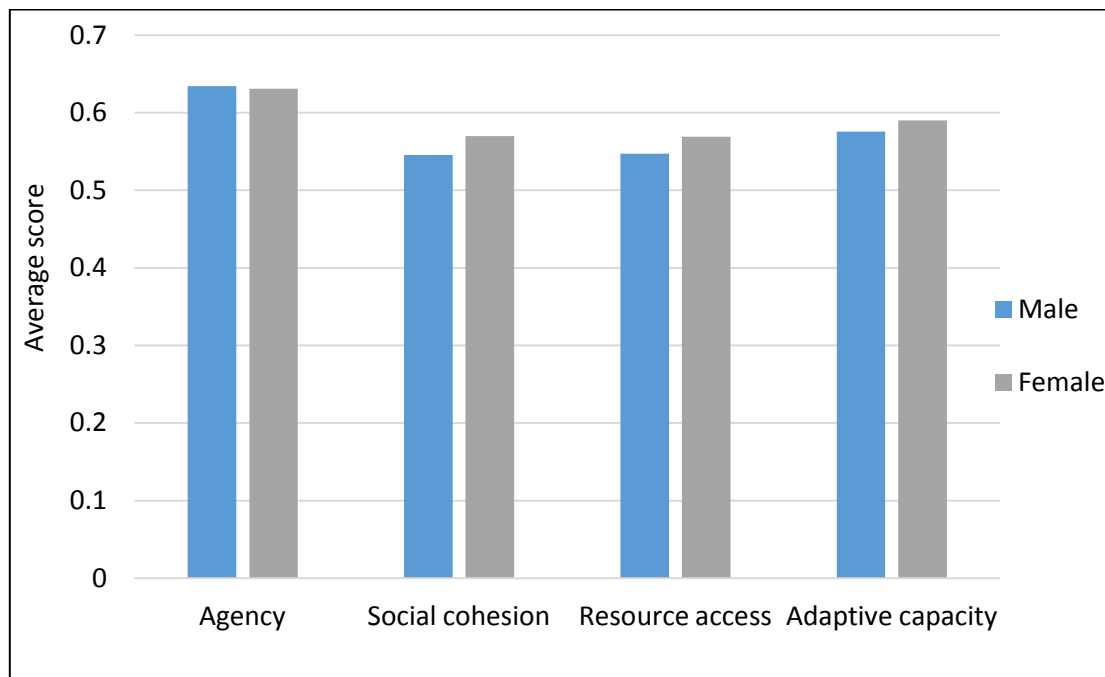
Figure 8: Variation in adaptive capacity between genders

There is a relatively even split of males and females among the survey respondents, resulting in large sample sizes for both gender groups. Males scored higher for the agency domain, while females scored higher in both the social cohesion and resource access domains. Overall, females have a slightly higher average adaptive capacity score compared

to males. A Mann-Whitney test showed only moderate evidence of a statistically significant difference in the social cohesion scores between genders (p = 0.258) and the access to resources scores between genders (p=0.210).

Traditional gender stereotypes associate the male gender with characteristics related to a high level of agency such as independence and risk-taking; while the female gender is associated with characteristics related to a lower level of agency such as passiveness and risk aversion. While traditional gender roles are evident in the Bergrivier communities, particularly in relation to the family structure, there is not strong evidence for traditional gender stereotypes as the agency scores of females and males were very similar. Further evidence of the strong agency of females in the Bergrivier community was seen in many of the examples given in the first workshop.

The largest margin in the scores between the two genders is in the social cohesion scores, where females score higher than males. In the second workshop, participants were not surprised by this result and commented:

"Women don't hesitate to ask for something if they need it, but the men are very proud and more hesitant to ask for anything, they would rather stay without it."

For males in the Bergrivier community, it appears that asking for help is seen as a weakness, leading to weaker social connections and an attitude of 'fending for oneself'. On the other hand, females in the Bergrivier community are less hesitant to rely on their community when they need help, resulting in females feeling more supported and connected to their community, evident in their higher social cohesion scores compared to males.

It is interesting that females score higher in the access to resources domain, as in the next section detailing the regression analysis, it is evident that being male has a positive effect on the variables of income and expenditure. However, as discussed in the previous section on the Bergrivier Municipality towns, access to resources is a far broader concept than monetary wealth. The higher score of females is likely to be influenced by the greater social cohesion and community support that females in the Bergrivier community experience.

4.2.3. Age

Figure 9 shows the variation in average domain and adaptive capacity scores with age.
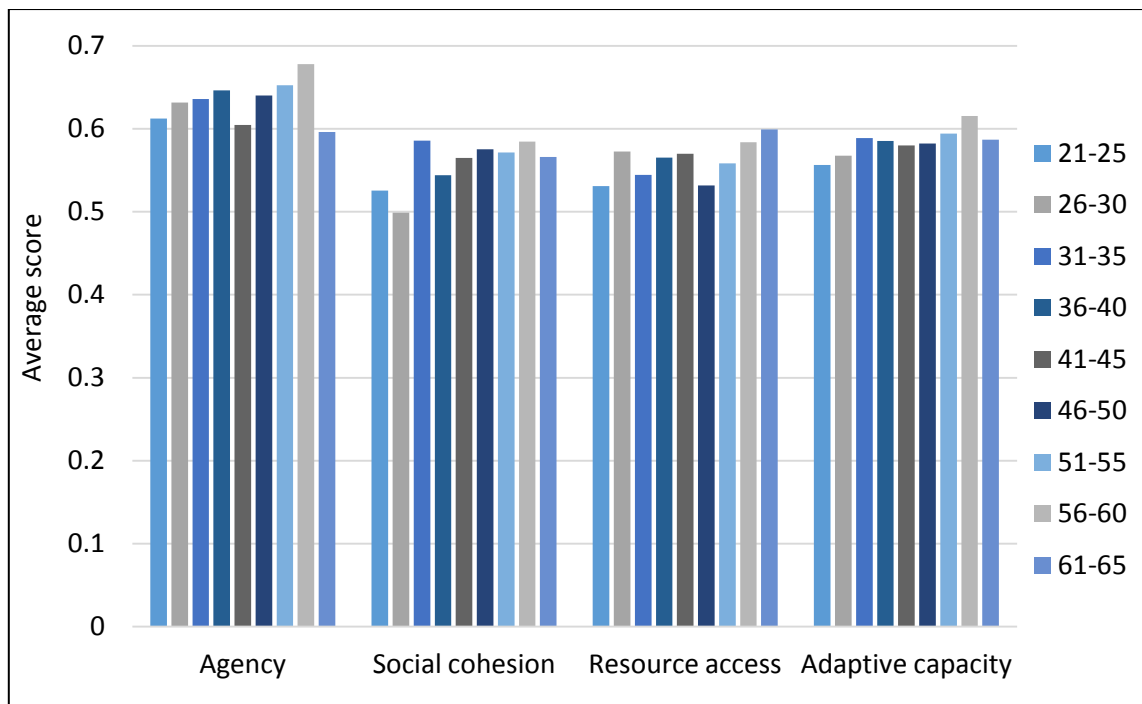
Figure 9: Variation in adaptive capacity between age groups

Age categories younger than 21 years and older than 65 years were excluded as they included less than 10 respondents. A Kruskal-Wallis test showed that there is no statistically significant difference in the domain and overall adaptive capacity scores of different age groups. Nevertheless, there does seem to be an increasing trend in the domain and overall adaptive capacity scores with increasing age; however, agency and social cohesion decrease for the oldest age category. It may be expected that adaptive capacity might begin to decrease more substantially for older age groups, driven by factors such as health problems and decreased employment opportunities; however, this was not a clear trend seen in the results. In line with this observation, a number of examples were given in the first workshop that centred on older individuals who work hard to provide for and support their families and community:

"Jeremy is a 70-year-old man who builds stone houses for people in the community."

"Jane's mother is 63 and she works shifts even though she is too old to make sure there is food on the table."

4.2.4. Race

Figure 10 shows the variation in domain and overall adaptive capacity scores of different race groups.
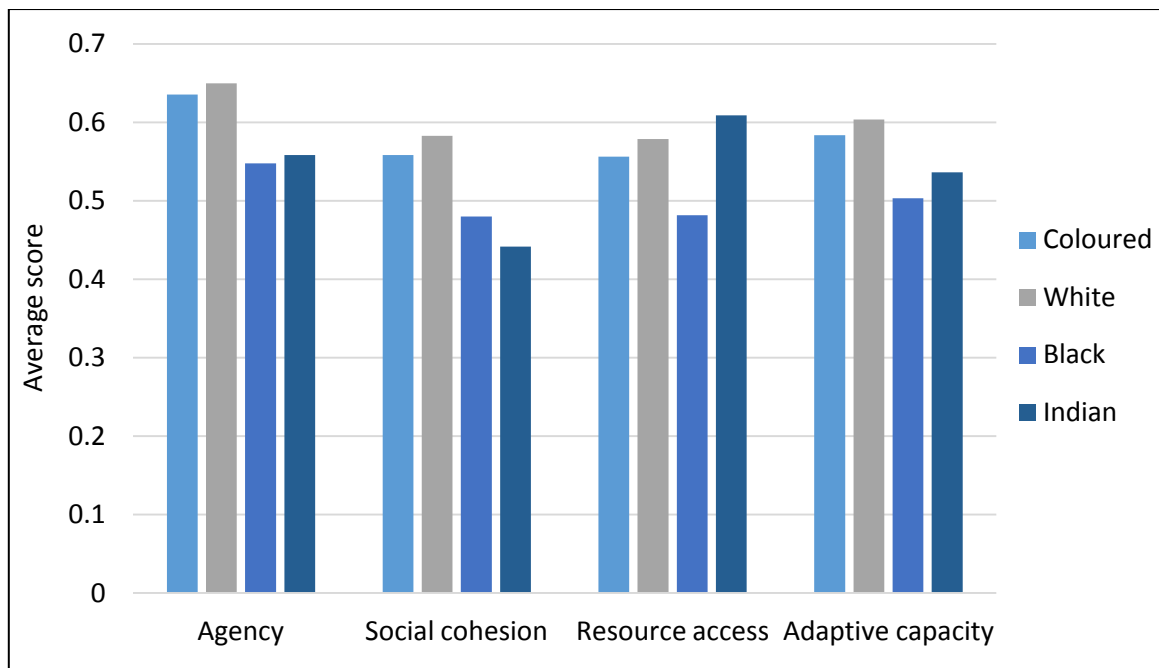
Figure 10: Variation in adaptive capacity with race

There were only 6 Indian respondents and 24 Black respondents so the results for these groups are interpreted with caution. White and Coloured respondents have similar scores; however, White respondents have slightly higher scores in all domains and in overall adaptive capacity. Black and Indian respondents score substantially lower than White and Coloured respondents in all domains, apart from the average access to resources score of Indian respondents which is the highest score of all groups. A Kruskal-Wallis test shows that there is a statistically significant difference in the adaptive capacity scores of Black and Coloured respondents (p=0.048), and in the adaptive capacity scores of Black and White Respondents (p=0,005).

The average agency scores of White and Coloured respondents were greater than those of Black and Indian respondents by a large margin. A Kruskal-Wallis test showed that there is a statistically significant difference in the agency scores of Black and Coloured respondents (p=0.088), and in the adaptive capacity scores of Black and White respondents (p=0,070). Possible explanations for the lower average score for agency and other domains of Black respondents will be explored in the following discussion.

As the Black and Indian populations are much smaller compared to Coloured and White populations in Bergrivier Municipality, it is not surprising that the average social cohesion scores of these groups are substantially lower than those of White and Coloured groups who are likely to feel supported by and connected to a much larger community. White respondents have a slightly higher average social cohesion score compared to Coloured respondents. A Kruskal-Wallis test showed that the differences in the social cohesion scores of different race groups were not statistically significant. Participants in the second workshop commented on the social cohesion results:

"It's surprising that the White community has higher social cohesion scores compared to the Coloured community because they live so far apart and they don't need to rely on each other."

However, the participants went on to comment that the White population in Bergrivier Municipality is wealthier than other race groups and consequently, they did not need much support from each other.

White respondents have a slightly higher average access to resources score than Coloured respondents, while Indian respondents have the highest average access to resources score and Black respondents have a substantially lower average access to resources score. It is interesting that White respondents do not have a significantly higher average access to resources score despite the comment that this group has more extensive monetary wealth. Again, this is a consequence of the broad interpretation of access to resources that this ACI adopts.

While Black respondents constitute a small sample, the comparatively lower average score of this group across all domains was investigated further. Black respondents have a slightly lower average level of schooling compared to Coloured respondents, while White respondents have the highest average level of schooling among the race groups. Moreover, Black respondents are comparatively much newer residents in Bergrivier Municipality, averaging around 4-5 years as a resident and are a comparatively younger population, averaging around 30 years old. As the Black respondents are generally younger and newer residents compared to the respondents included in the other race groups, the lower scores of this group cannot only be attributed to race-related issues.

4.2.5. Schooling level

Figure 11 shows the variation in the average domain and adaptive capacity scores with schooling level.
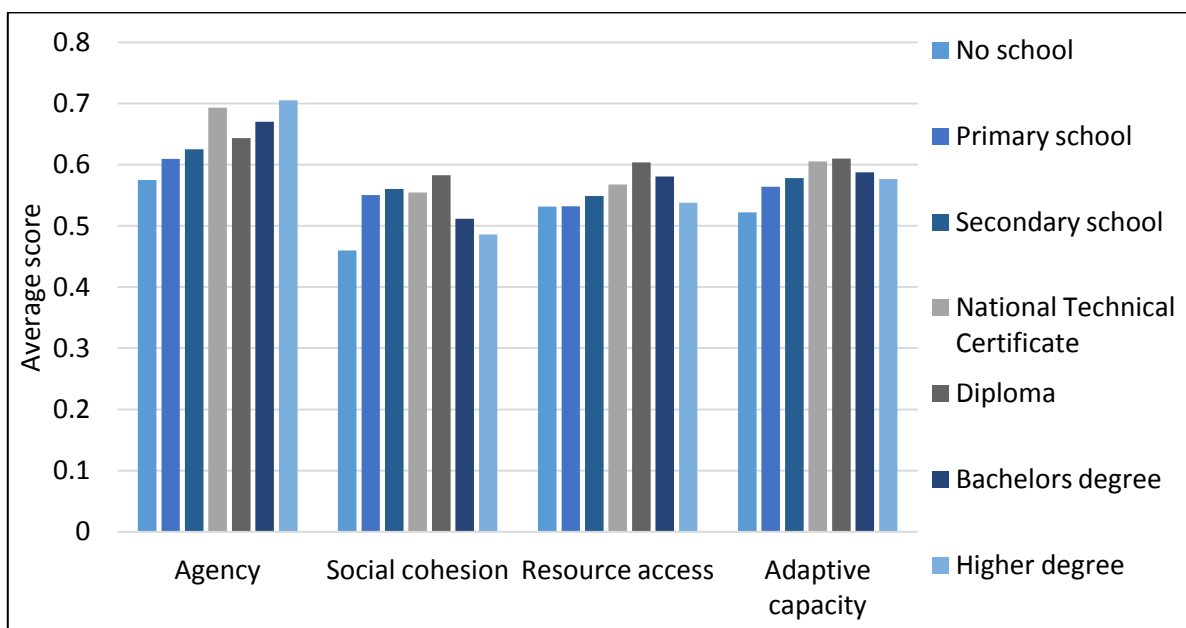
Figure 11: Variation in adaptive capacity with schooling level

Schooling categories 'no school' and 'higher degree' have less than 10 respondents, while 58% of respondents fall into the category of secondary schooling level. The average agency score of respondents increases with schooling level. The average social cohesion score is greater for respondents with a schooling level between the schooling levels of primary school to diploma and is lower for respondents with no schooling and respondents with tertiary education. The average access to resources score increases between the schooling levels of no school to diploma, after which it decreases for respondents with tertiary education. The average adaptive capacity score of respondents also follows this trend. A Kruskal-Wallis shows that there is a statistically significant difference in the access to resources score of respondents with primary schooling and those with a diploma ($p=0.052$) as well as for respondents with secondary schooling and those with a diploma ($p=0.056$). No other statistically significant differences were observed.

The increase in the average scores for the agency and access to resources domains with increased level of schooling is expected. An example from the first workshop demonstrates how education is a means to improve one's situation:

"Tom grew up poor but he went to varsity and is now an art lecturer at North Link and won a prize for his art."

However, it is interesting that the average access to resources score decreases for respondents with tertiary education. One explanation for this trend may be the limited opportunities for high skilled workers in Bergrivier Municipality. This may lead to individuals with tertiary education doing similar work to those with secondary schooling and diplomas, resulting in less differentiation in monetary wealth and resource access between those with and without tertiary education. Additionally, individuals with tertiary education may feel that their skills are underutilised in low-skilled employment and may experience longer periods of financial instability while trying to find adequate high-skilled opportunities.

The low social cohesion scores of individuals with no schooling and individuals with tertiary education may be explained by these smaller groups having limited social networks. Individuals with no schooling may not have access to the social connections made with one's peers during schooling. On the other hand, those with tertiary degrees would have had to leave Bergrivier Municipality to obtain this education as there are no tertiary institutions in the area and this could have resulted in a loss of social connections with others in their community. The types of businesses that these smaller groups are involved in may also involve smaller and more distributed colleague relationships and business networks.

Throughout the discussions regarding education in the first and second workshops, it was clear that education is highly valued in the Bergrivier community. An example provided in the first workshop demonstrated the high regard given to those who further their education:

"Mary … quit her job, went to study agriculture and came back and she is now a farmer. She followed her passion and took a big risk."

Additionally, in the 'rich pictures' exercise in the first workshop, participants were asked to envision themselves and their community with a high level of adaptive capacity in the future and a number of the ideas generated were around education. Participants envisioned the creation of a Bergrivier college and one participant imagined themselves having gone to university to study engineering. This was again evident in the exercise on subjective wellbeing in the second workshop, where one participant saw going to university to get new skills as a way to improve their wellbeing and another hoped to have greater financial stability in order to ensure their children could have a good education.

4.3. Regression analysis of ACI results

Following the analysis of the variation in adaptive capacity scores between socially differentiated groups, the ACI scores are used in a regression model that investigates how socio-economic characteristics and adaptive capacity influence and inform individual wellbeing. The regression analysis uses an ordered probit model to investigate the relationship between measures of an individual's financial and general wellbeing and a number of predictor variables, including certain socio-economic variables and the adaptive capacity domain variables.

As described in Section 2.5, 'financial wellbeing' is used to refer to a materialistic understanding of wellbeing that equates wellbeing with financial stability and uses indicators of income and expenditure for wellbeing at the individual level. On the other hand, 'general wellbeing' is used to refer to a holistic understanding of wellbeing that incorporates subjective and relational influences and uses an indicator of satisfaction with life at the individual level.

The data set used for the regression analysis consists of the ACI scores and responses to the baseline survey. While the full data set includes 425 individuals, a subset of 229 individuals is used for the financial wellbeing regression analyses to exclude respondents that declined to disclose their financial information. The wellbeing regression was run for this subset as well as for the full sample for comparative purposes. The results of the regression are shown in Table 9 (on the next page).

In interpreting the results of the regression analyses, it is important to note that there may be other unobserved variables that might influence income, expenditure and wellbeing which were not included. Where possible, additional regression runs were done as robustness checks; however, the results were interpreted with caution. The discussion of the results does not attempt to draw conclusions about the underlying causal mechanisms and the directionality of the observed effects but rather focuses on the possible explanations for and implications of the relationships that are evident.

Table 9: Results of the ordered probit regression model for the independent variables of income, expenditure and wellbeing with clustering for towns

Variable		Coefficient			
		Income	Expenditure	Wellbeing	Wellbeing (full sample)
Age	Age	-0.003 (0.029)	0.004 (0.037)	0.067 (0.020)***	0.064 (0.014)***
Gender	Female	-0.568 (0.135)***	-0.275 (0.038)***	0.083 (0.134)	0.203 (0.091)**
Race	Coloured	0.370 (0.145)**	0.272 (0.309)	0.004 (0.182)	-0.037 (0.062)
	Indian	0.342 (0.131)***	-0.058 (0.219)	-1.116 (0.193)***	-0.707 (0.057)***
	White	1.003 (0.197)***	0.930 (0.182)***	-0.276 (0.151)*	-0.128 (0.068)*
Years in Bergrivier	Years in Bergrivier	0.073 (0.041)*	0.046 (0.060)	-0.130 (0.033)***	-0.077 (0.028)***
Town	Piketberg	0.299 (0.043)***	0.052 (0.096)	-0.088 (0.012)***	0.062 (0.023)***
	Porterville	0.254 (0.068)***	0.053 (0.015)***	0.123 (0.023)***	0.276 (0.029)***
	Velddrif	0.053 (0.046)	-0.317 (0.144)**	-0.002 (0.034)	0.092 (0.043)**
Schooling level	Grade school	0.026 (0.258)	0.070 (0.440)	-4.528 (0.295)***	-0.943 (0.737)
	Secondary school	0.333 (0.278)	0.621 (0.186)***	-4.443 (0.324)***	-1.247 (0.706)*
	Technical Certificate	0.400 (0.169)**	-0.093 (0.407)	-4.658 (0.424)***	-1.409 (0.506)***
	Diploma	0.204 (0.151)	0.601 (0.113)***	-4.482 (0.366)***	-1.170 (0.667)*
	Tertiary degree	0.219 (0.603)	1.477 (0.183)***	-4.783 (0.523)***	-1.495 (0.801)*
	Higher degree	-0.274 (0.176)	0.254 (0.514)	-4.976 (0.354)***	-1.504 (0.854)*
Adaptive capacity	Agency score	0.491 (0.477)	1.423 (0.327)***	1.073 (0.360)***	1.272 (0.148)***
	Social cohesion score	0.343 (0.457)	-0.220 (0.355)	0.424 (0.263)*	0.574 (0.232)**
	Resources access score	1.095 (0.361)***	0.883 (0.366)**	2.164 (0.103)***	1.971 (0.105)***
N		229	229	229	425
Log pseudolikelihood		-433.923	-453.359	-277.967	-510.526
Pseudo R^2		0.0512	0.0629	0.0689	0.0680

Note 1:*significant at the 10 % level, **significant at the 5 % level, ***significant at the 1 % level.

Note 2: The reference groups for the independent variables were: Gender (Male); Race (Black); Town (Goedverwacht); Level of schooling (No schooling).

Note 3: The results of the same regression analysis without clustering for towns can be found in Table 16 in Appendix E.

4.3.1. Financial wellbeing regression analysis

In the financial wellbeing regression analysis, both income and expenditure are tested as independent variables. As discussed in Section 3.6.2, the analysis included a subset of 229 individuals, excluding respondents who declined to disclose their financial information. Age does not have a statistically significant effect on income or expenditure. Looking at the effect of gender, female gender has a negative effect on both income and expenditure which is significant at the 1 % level, a result that is common in financial indicator regression analyses.[2] The magnitude of the negative effect of female gender is larger in the income regression analysis than in the expenditure regression analysis.

The effect of race on income, with Black as the reference group, is positive and significant at the 5 % level for the Coloured group and is positive and significant at the 1 % level for the Indian and White groups. The magnitude of the positive effect is substantially greater for the White group, while the magnitude of the positive effect is similar for the Coloured and Indian groups. The effect of race on expenditure is only significant in the case of the White group, where a large positive effect significant at the 1 % level is observed. Considering the economic racial inequality that is still evident in South Africa due to long-lasting impacts of the Apartheid regime, these results are not surprising.

The number of years spent as a resident in Bergrivier Municipality has a small positive effect on both income and expenditure; however, it is only significant for income (at the 10 % level). The effect of town on income, with Goedverwacht as the reference town, is positive and significant at the 1 % level for both Piketberg and Porterville. The effect of town on income may be impacted by town size, where the three larger towns all have positive effects on income owing to the greater range of employment opportunities. In the case of expenditure, Porterville has a small positive effect on expenditure that is significant at the 1 % level, while Velddrif has a large negative effect on expenditure that is significant at the 5 % level.

Schooling level has a variable effect on income and expenditure. This is surprising as it is expected that schooling level would have a significant positive effect on income and expenditure. With the reference group as 'no schooling', the only statistically significant effect that is observed is for 'technical certificate' which has a significant positive effect at the 5 % level. In the case of expenditure, with the reference group as 'no schooling', 'secondary school', 'diploma' and 'tertiary degree' have a positive effect on expenditure that is significant at the 1 % level. The magnitude of this positive effect is similar for 'secondary school' and 'diploma', and much larger for 'tertiary degree'. These expenditure results are more in line with expectations that individuals with higher education levels aspire to higher standards of living, and consequently have higher expenditure levels. The other schooling levels did not have significant effects on expenditure.

The absence of a significant positive correlation between schooling level and income could be attributed to limited opportunities for higher skilled employment in Bergrivier

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[2] Explanation of language used in the regression analysis: The 'negative effect' of female gender on the financial wellbeing variables can be understood as females experiencing lower levels of income and expenditure compared to males.

Municipality, especially in some tertiary sectors, leading to minimal financial returns on education. In general, the level of education in Bergrivier Municipality is quite low, as the majority of respondents reported to have some level of secondary school education, although respondents in this category had not necessarily completed secondary school. However, where respondents had a higher level of education such as a diploma or tertiary degree, their employment opportunities in Bergrivier Municipality may not be very different to those of the majority of the population who has only secondary schooling. This leads to far less differentiation in the income received by groups with varying education levels than would have been expected, as was seen in the income regression analysis.

In the regression model for income, the adaptive capacity variable of access to resources has a large positive effect significant at the 1 % level. This result can be attributed to the fact that individuals with a greater income are likely to score higher for many of the indicators included under the access to resources domain. For example, individuals with a greater income would be more likely to have enough food in their household and have access to the resources they need when facing difficulties. In the regression model for expenditure, agency and access to resources scores have a significant positive effect on expenditure, at the 1 % and 5 % level respectively. The positive effect of agency is much larger compared to that of access to resources. The social cohesion is not statistically significant.

4.3.2. General wellbeing regression analysis

In the wellbeing regression analysis, the regression model is run for both the subset and full sample; however, this discussion focuses on the full sample. There are no major inconsistencies in the subset and the full sample when considering the effects of the independent variables included in the regression analysis; however, this subset may differ from the full sample with regards to other unobserved characteristics and therefore the full sample is more representative of the Bergrivier community. The dependent variable of wellbeing was based on the question included in the baseline survey that asked respondents to rate their satisfaction with life.

Age has a small positive effect on wellbeing, significant at the 1 % level. In light of the challenges reported by Bergrivier residents (see Figure 7 in Section 4.2.1), which include unemployment, a high school drop-out rate, teenage pregnancy and prevalent drug and alcohol abuse, the slightly lower satisfaction among the younger population is not surprising. Looking at the effect of gender, female gender has a significantly positive effect on wellbeing at the 5 % level. This is the opposite effect compared to the effect of female gender on both income and expenditure. However, the positive effect of female gender on wellbeing is not unexpected considering the discussion in Section 4.2.2, which detailed the stronger social connections that females in the Bergrivier community experience. This social aspect is an important contributor to individual wellbeing.

The effect of race on wellbeing, with Black as the reference group, is negative and significant for the Indian and White groups at the 1 % and 10 % level respectively. The magnitude of the negative effect is greater in the case of the Indian group. The lower wellbeing experienced by the Indian group could be explained in part by the lower social cohesion experienced by this group, as discussed in Section 4.2.4.

The number of years spent as a resident in Bergrivier Municipality has a small negative effect on wellbeing, significant at the 1 % level. This is unexpected, as residents who have lived in Bergrivier Municipality for longer are likely to have stronger social networks and receive more support from their community. Nevertheless, this effect could be explained by limited economic opportunities in Bergrivier Municipality, as mentioned earlier.

The effect of town on wellbeing, with Goedverwacht as the reference town, is positive and significant at the 1 % level for both Piketberg and Porterville. Velddrif also has positive effect on wellbeing, significant at the 5 % level. The magnitude of the effect is small for Piketberg and Velddrif and slightly larger for Porterville. This result is surprising as Goedverwacht is a smaller and closer community with higher social cohesion than the other three towns. However, as mentioned in Section 4.2.1, Goedverwacht residents generally fall into lower income categories compared to the other three towns, which may explain the comparatively lower satisfaction with life in Goedverwacht. In this case, income may be driving wellbeing to a certain extent.

The effect of schooling level on wellbeing, with the reference group as 'no schooling', was negative. The negative effect on wellbeing of the schooling level 'technical certificate' is significant at the 1 % level and has a larger coefficient compared to grade school, secondary school and diploma. The negative effects of schooling levels 'secondary school', 'diploma', 'tertiary degree' and 'higher degree' are significant at the 1 % level. The coefficients related to the two highest schooling levels, namely 'tertiary degree' and 'higher degree', are larger in magnitude than the coefficients of all other schooling levels. These results are contrary to the findings of Brereton *et al.* (2008), who found that satisfaction with life increases with education level in a study in Ireland. However, considering the Bergrivier Municipality context, the negative effect of schooling on wellbeing that is largest for the two highest schooling levels can be attributed to limited economic opportunities in the area, as discussed previously. Individuals who have completed higher levels of schooling may have higher expectations for their career and living standards compared to those with limited schooling. These higher expectations could lead to dissatisfaction and frustration when individuals are not able to meet their financial expectations.

The adaptive capacity variables of agency, social cohesion and access to resource scores all have a large positive effect on wellbeing. The positive effects of agency and access to resources are significant at the 1 % level. The positive effect of social cohesion is significant at the 5 % level. Access to resource has the largest positive coefficient, followed in magnitude by the coefficients of the agency and social cohesion respectively. The significant positive correlation of all three adaptive capacity domain scores with wellbeing provides evidence for a close link between these two concepts.

As a robustness check, the wellbeing regression was rerun, once with income included as an independent variable and once with expenditure included, to determine if the link between adaptive capacity and wellbeing was still observed. The results of this analysis are presented in Table 17 in Appendix E. When controlling for income, the adaptive capacity variable of social cohesion no longer has a significant effect on wellbeing, while the positive effects of agency and resource access remain significant at the 5 % and 10 % level respectively.

Income has a small positive effect on wellbeing, significant at the 1 % level. The effect of the socio-economic variables on wellbeing does not change significantly. The loss of significance in the effect of the social cohesion variable when controlling for income could be explained by the interaction between these two variables. Poorer individuals may be more reliant on each other so might display greater social cohesion; while wealthier individuals might experience greater resource access and be less reliant on their social connections.

However, when controlling for expenditure, all three adaptive capacity variables of agency, social cohesion and resource access have a significant positive effect on wellbeing at the 5 %, 10 % and 1 % level respectively. The effect of expenditure on wellbeing is significant at the 5 % level but the magnitude of the effect of expenditure on wellbeing is much smaller than the magnitude of the effects of the three adaptive capacity variables. Again, the effect of the socio-economic variables on wellbeing does not change significantly. This robustness check shows that the inclusion of the financial indicators as independent variables does not result in a large decrease in the explanatory power of the adaptive capacity variables in predicting wellbeing outcomes, thereby strengthening the evidence for the link between these two concepts.

4.3.3. The interface between financial and general wellbeing

As discussed previously, the concept of wellbeing has evolved from the idea referred to as 'financial wellbeing' which adopts a material focus, to a more holistic concept referred to as 'general wellbeing' which incorporates subjective, relational and objective aspects. From this regression analysis it is evident that the independent socio-economic and adaptive capacity variables have different relationships with the two different conceptualisations of wellbeing. In the general wellbeing regression analysis, gender has a significant positive effect while education and years as a Bergrivier resident have significant negative effects. However, the opposite is true in the financial wellbeing regression analysis. Additionally, the effect of race and town varies between the financial and general wellbeing regressions. The outcomes of the financial wellbeing regressions can be explained by looking at economic data. On the other hand, the general wellbeing regression analysis provides more nuanced insights that are interpreted by drawing on the understanding of the local context that was developed during the participatory research process.

Looking the relationship of financial and general wellbeing with the adaptive capacity variables in the regression analyses, the more objective domain of access to resources has a significant positive effect across all regression models. However, the adaptive capacity domains of agency and social cohesion which incorporate subjective and relational factors do not have a significant effect in the financial wellbeing regression analyses but become significant and have a large positive effect in the general wellbeing regression analysis. This is in line with the conceptualisation of general wellbeing which acknowledges the importance of including subjective and relational factors alongside objective factors. It is also interesting that in the general wellbeing regression analysis, the adaptive capacity variables had a much larger effect compared to many of the socio-economic variables, suggesting a close link between general wellbeing and adaptive capacity. The implications of this will be explored in Section 5.3.

4.4. Implications for adaptation in Bergrivier Municipality

The input gained during the workshops and the results of the statistical and regression analyses provide insight into the adaptive capacity and wellbeing of the Bergrivier communities and expose key issues relating to the economic conditions in the Bergrivier Municipality and the importance of building the social cohesion in the community.

The lack of returns on education in both the statistical and regression analyses can be attributed to limited economic opportunities in Bergrivier Municipality, particularly in some tertiary sectors. A lack of economic self-sufficiency as a town and the limited access to markets results in an outflow of money from the community and a dependence on external systems in meeting basic needs like food and energy. This limits the circulation of money within the community and dampens local economic growth, exacerbating Bergrivier Municipality's high poverty and youth unemployment rates (Ziervogel, 2014a). Boosting local economic growth will provide better employment opportunities for individuals with all levels of schooling and help to ensure that individuals who have a higher level of education are not forced to leave the community to find adequate work. The FLOW Programme's initiatives such as the complementary currency, mapping of local businesses, skill development among the youth and community education events are important initiative for boosting economic growth, as is the support from the Bergrivier Municipality. However, despite the indications of limited economic opportunities in Bergrivier Municipality, one workshop participant noted that a company operating in the area complains about a lack of qualified skilled local workers and claim they have to bring in workers from outside Bergrivier. This suggests that there is scope for improving local economic opportunities if local companies support residents in acquiring qualifications that are suited to the local economic context.

Despite the lack of financial returns on education, the ACI scores analysis showed an increase individuals' agency scores with education, although this increasing trend is less evident for the other adaptive capacity domains. This gives an indication of the value and prestige given to education by the Bergrivier community. Further evidence of this was seen in the workshop discussions. In both workshops, improving one's education was identified as a means to improve individuals' adaptive capacity and wellbeing. In the 'rich pictures' and individual wellbeing exercises, education emerged as a recurrent theme, as mentioned earlier. The value accorded to education by the Bergrivier community is clearly high; however, limited economic opportunities in the area might undermine any increases in financial and general wellbeing that individuals might receive by improving their education.

A strong theme that emerged in the workshop discussions was the role of welfare programmes, community events and engagement with the Bergrivier Municipality in strengthening the community's social cohesion and facilitating long term adaptive capacity. Maintaining and supporting the growth of such initiatives is important for the Bergrivier community, especially to ensure improved inclusion of certain demographic groupings within the community who had lower social cohesion scores, such as the Black and Indian communities and individuals in the younger age groups. In this regard, the initiatives of the FLOW Programme and the Bergrivier Municipality have played key roles. The FLOW

Programme has a number of initiatives that support the growth of social cohesion in the community, such as community screening of films created by the FLOW Ambassadors about local job opportunities, municipal services and local entrepreneurs. The FLOW Programme's introduction of a community currency is another example of an initiative which has the potential to strengthen the connections and relationships among business owners and broaden the community's business networks. The FLOW Programme has also facilitated a closer engagement between the FLOW Ambassadors and the Bergrivier Municipality. The value of this relationship was evident in the rich pictures exercise, where one of the ideas identified that could lead to a more adaptive community was to "make people more collaborative and active citizens who engage with the municipality". Closer engagement between the municipality and the wider Bergrivier community can be facilitated through initiatives such as stakeholder participation in developing policies such as the Integrated Development Plan or the Bergrivier Climate Change Adaptation Plan and the social functions held for Piketberg youth by municipal councillors. Continuing to encourage and introduce such initiatives in the small towns can strengthen the community's social cohesion and these initiatives may also be associated with positive impacts on the other adaptive capacity domains of agency and access to resources.

Chapter 5.   The importance of integrating subjective and participatory approaches into adaptive capacity research

This chapter analyses the quantitative and qualitative data to present three themes that have emerged through the process of developing and applying the ACI.

5.1. The importance of incorporating subjective factors when characterising adaptive capacity

A key insight from the development of this ACI was the value of incorporating the subjective factors that influence adaptive capacity along with the objective factors. As introduced in Section 2.4.2, adaptive capacity indices found in the literature have tended to focus on objective indicators of adaptive capacity, drawing on generic economic and demographic data and relying on asset-based frameworks (Jones *et al*., 2010). While objective approaches are used in ACIs for ease of method due to the availability and reliability of more quantitative metrics, these subjective factors are essential to include in an ACI in order to obtain a representative picture of the adaptive capacity of individuals and communities (Pelling & High, 2005).

A growing recognition of the value of including subjective factors in assessments is evident in the environmental change and associated development literature (Jones & Tanner, 2015; Armitage *et al*., 2012; Werg *et al*., 2013). As Brown & Westaway (2011, p.321) found in their review of the literature around agency, capacity and resilience to environmental change, there is a "need to consider subjective and relational factors in addition to objective measures of capacity and to view these as reflexive and dynamic, as well as differentiated socially and temporally." Adding to this, the necessity of combining objective and subjective approaches has been eloquently described by Costanza *et al*. (2007, p.269) in their review of Quality of Life (QOL) assessments, where they stated that "Subjective indicators of QOL gain their impetus, in part, from the observation that many objective indicators merely assess the opportunities that individuals have to improve QOL rather than assessing QOL itself." As with QOL assessments, adaptive capacity assessments will be more insightful if they adopt a holistic approach to understand the more subjective factors that contribute to an individual translating their capacity to adapt into adaptive action (Bizuneh, 2013). However, while there has been a shift in the theoretical literature that advocates for the inclusion of subjective factors, objective assessments with limited integration of psychosocial factors still prevail (Brown & Westaway, 2011).

The material focus that is evident in many of the local scale ACIs in the literature is in part a consequence of the rural context in which the majority of these assessments have been undertaken, as discussed in Section 2.4.1. In the rural context, the livelihoods of communities often depend on the availability of natural resources and their adaptive capacity can be severely compromised by a decrease in this availability and direct climate impacts. Thus, there is some justification for assessments that prioritise resource-based determinants in rural contexts. However, in the urban context, the adaptive capacity of a community is much more complex and characterising a community's adaptive capacity requires a holistic understanding which recognises that a community's capacity to adjust to climatic stressors is interlinked to its capacity to adjust to environmental, social, economic

and political challenges (Birkmann *et al*., 2010; Revi *et al*., 2014). As the ACI in this research was focussed at the urban context, the integration of subjective and objective factors was especially important.

In response to the critique that many existing ACIs prioritise material, resource-based determinants but largely neglect or fail to sufficiently characterise the subjective aspects, this ACI is informed by a framework that incorporates subjective and objective factors. The three domains of the 'Theory of Change' framework of agency, social cohesion and resource access deal with the subjective, relational and objective aspects to provide a meaningful characterisation of the Bergrivier community's adaptive capacity. This holistic characterisation of adaptive capacity was invaluable in this research. For example, if a material, objective focus had been adopted, Indian respondents would have displayed the greatest adaptive capacity of all the race groups as they displayed the highest average access to resources score. However, Indian respondents displayed low average agency and social cohesion scores and thus had a lower average adaptive capacity score compared to White and Coloured respondents. By including the subjective and relational domains along with the objective domain, a more representative characterisation of the variation in adaptive capacity among the different race groups was obtained. If the subjective elements that influence adaptive capacity are not appropriately considered in adaptive capacity assessments, any adaptation initiatives based on these assessments could be maladaptive and unsuccessful.

While the 'Theory of Change' framework was integral to providing a holistic characterisation of adaptive capacity in this ACI; the selection of a range of indicators for each of the objective, relational and subjective aspects also played an important role. With the inclusion of the more subjective aspects of adaptive capacity, it was important to recognise that there are different ways in which individuals display their adaptive capacity. This idea can be expanded by looking at agency, where one individual might take risks to improve their circumstances while another may be risk averse but show their agency by being decisive and self-reliant. If the index does not include a range of indicators, it might not fully characterise the adaptive capacity of the community and may be biased towards certain personality types or socio-economic groups. The way in which individual's display their adaptive capacity in different ways also in part explains the large variation in the rating of indicators where respondents may have given greater scores to the indicators in which they were personally stronger. While indicator selection for this ACI was limited to those questions included in the baseline survey, the ACI strove to ensure that it could accurately represent a variety of individuals through refining and validating the indicator selection using the input of local stakeholders at the workshops. By including a range of indicators for the subjective domains, which are often harder to characterise, ACIs can better capture the nuances in variations in adaptive capacity between sub-groups in the community.

While the value of adopting an integrated subjective and objective approach is evident, it is more complex. The development of a holistic framework and the selection of a range of relevant indicators is difficult due to the limited number of approaches documented in the literature that deal with the inclusion of these more intangible, subjective factors (Jones *et al*., 2010). Additionally, indicator data is not readily available for subjective indicators as this

often requires data beyond the available datasets that detail commonly reported demographic and economic trends. While these difficulties may slow the uptake of more holistic approaches, the discussion and debate around the inclusion of subjective factors will expand rapidly as more assessments adopt such approaches. Such discussion and debates will be important in developing approaches that explicitly include subjective factors in assessments. Additionally, the adaptive capacity field can draw from insights in other fields, as will be discussed in Section 5.3. Aside from the need to expand the literature around holistic approaches, an essential part of implementing such approaches in practice is increasing the participation of local stakeholders in the research process. In this study, the engagement with local stakeholders was a key element that enabled a holistic and meaningful characterisation of adaptive capacity.

5.2. Stakeholder participation as central to building a representative ACI

A central finding of this study is the value of adopting a participatory and collaborative approach in developing an ACI that is able to generate useful insights into adaptive capacity at the local level. This supports the call in the environmental change and climate change adaptation literature to develop bottom-up approaches that value community engagement in order to undertake better assessment of adaptive capacity (Few *et al.*, 2011; Ross *et al.*, 2015; Smit & Wandel, 2006).

Adaptation research has largely been dominated by top-down approaches with minimal involvement of local stakeholders (Van Aalst *et al.*, 2008). The ACIs found in adaptation literature provide an example of this critique as many have been developed through removed, expert-driven approaches that rely on secondary data sources. This removed approach might be justifiable when an ACI aims to characterise adaptive capacity at the country level, given the practicalities of involving multiple stakeholders; however, the generation of a quantitative value to represent a complex concept can result in a loss of meaning if the validity and implications of the values generated from the index are not explored. As argued by Smit & Wandel (2006, p.288), participatory assessments can unpack this complexity as they "allow for the recognition of multiple stimuli beyond those related to climate, to include political, cultural, economic, institutional and technological forces." Participatory assessments are especially valuable at the local level where it is important to understand and 'ground-truth' what the quantitative values imply about the local community. This idea is demonstrated in Schipper & Langston's (2015, p.13) comment that "Indicators are intended to provide data that will help decision-makers make better decisions… but will not provide answers alone." In this study, the qualitative input from the stakeholder engagement in the workshops was essential in contextualising the quantitative results and exploring the more subjective indicators to contribute to a richer understanding of the community's adaptive capacity.

In contrast to a detached and quantitative approach, this ACI embraced a bottom-up, mixed methods process that was iterative, involving a constant process of feedback and interaction between researchers and local stakeholders. While some ACIs have incorporated participatory elements in their approaches, this study aimed to engage stakeholders throughout the research process. This approach is in line with Reed's (2008, p.2422)

recommendation for best practice that "stakeholder participation should be considered right from the outset, from concept development and planning, through implementation, to monitoring and evaluation of outcomes." In this study, input from local stakeholders influenced both the development of the baseline survey and the selection of indicators from the baseline survey, ensuring that the indicators were representative and appropriate for the Bergrivier community. This local input is vital as researchers cannot "presume to know the exposure and sensitivities that are pertinent to the community" (Smit & Wandel, 2006, p.288). The iterative engagement process also provided an avenue for individual feedback from stakeholders through the validation process in the second workshop where FLOW Ambassadors were asked to assess if their individual scores from the ACI were accurate representations of themselves. The FLOW Ambassadors generally felt that their scores were accurate and one participant commented:

"I think it's a good reflection of how I am, my relationships and the resources I have."

Participatory approaches allow for a mutually beneficial collaboration between local stakeholders and the researchers. An integral aspect of participatory approaches is their ability to facilitate education, capacity building and empowerment in the community (Fraser *et al.*, 2006). In addition to this, involving local stakeholders in the research process can promote greater buy-in and support from the community for adaptation initiatives, as was found by Dobson *et al.* (2015) in their study on participatory approaches to build resilience in Ugandan informal settlements. The collaborative approach in this study encouraged debates about the challenges the Bergrivier community faces around how individuals can make a positive contribution to their community. Additionally, it ensured that the results of the ACI were conveyed back to the community rather than remaining as a removed academic exercise, which is one of the major critiques of external, expert-driven approaches (Preston *et al.*, 2011). During the presentation of results in the second workshop, the comments of two participants showed how the participatory approach provided an opportunity for both the researchers and stakeholders to learn from one another and ensured that the stakeholders had access to the findings about their own community's adaptive capacity:

"It's interesting to see how all that information is packaged and displayed using the index and can now be understood better. I also understand the big words like adaptive capacity and social cohesion better."

"I can now see why we did it [the survey] and how it contributes to the FLOW programme."

The presentation of results encouraged discussion around possible reasons and explanations for the key findings which provided and were essential in contextualising the ACI results.

While there are many advantages to adopting a participatory approach, such an approach can be logistically difficult, expensive and time-consuming if not carefully managed with clear objectives. In a case study on a wellbeing assessment, Fraser *et al.* (2006) found that a lengthy community consultation process significantly delayed the assessment and incurred additional costs. This leads to the question of how to implement an efficient process of

stakeholder participation that does not compromise on the level of engagement achieved. Reed (2008) provides a number of guidelines on achieving successful stakeholder engagement, one of which is clearly defining the objective and scope of the stakeholder participation at the outset of the research process. This is echoed by Few *et al.* (2007) who also highlight that the approach used to engage stakeholders must be flexible, adaptable, and tailored to the context in which it is used. Few *et al.* (2007) add that participatory approaches must ensure that a range of appropriate and relevant stakeholders are identified, that trust is built with these stakeholders and that the engagement process considers and is sensitive to the power dynamics within the stakeholder group. Finally, as was used in this study, Few *et al.* (2007) suggest that more genuine engagement with stakeholders can be achieved by ensuring that workshops are small and that a variety of tools and methods are used.

Finally, the participatory process aids in adding to the debates around adaptive capacity and how to measure it. Schipper & Langston (2015, p.21) comment on the process of discussion and reflection that is involved in the effort to develop better indicators and note that "even if the indicators themselves fail to be useful, the path toward their development, involving countless meetings, documents, presentations and debates provides a robust theoretical platform on which to build more knowledge."

5.3. Insights from the wellbeing field can strengthen approaches used in adaptive capacity research

The close linkage between adaptive capacity and wellbeing that was identified in the regression analysis has a number of implications. This study finds that the adaptive capacity field could draw valuable lessons from the subjective and participatory approaches that have been developed in the wellbeing field. Before outlining these lessons, this section will first explore the link between these two fields.

The close link between the concepts of adaptive capacity and general wellbeing was evident in both the quantitative and qualitative inputs to this research. The quantitative regression analysis on general wellbeing revealed a significant positive correlation between all three adaptive domains and general wellbeing. Additionally, the correlation coefficient of the three adaptive capacity domains with wellbeing is greater and more significant than the correlation between wellbeing and a number of the other socio-economic variables that were tested. The close linkage was also evident in the workshop exercises on adaptive capacity and wellbeing. The themes identified in the 'rich pictures' exercise, which involved imagining a future well-adapted Bergrivier Municipality, and those that emerged in the individual wellbeing exercise were very similar. The common themes that emerged were improving one's education and skill set; starting one's own business; owning a house; having a close and supportive spouse and family; having a permanent job; having financial security and access to necessary resources; and living in safer towns with better access to basic services and amenities. Although these themes might not seem directly related to specific capacity to cope with climate risks, they are elements that build generic capacity in a multi-stressor context. As discussed previously, building generic capacity is important for

supporting adaptation in a multi-stressor urban context, as climate impacts are often indirectly experienced through impacts on businesses, housing and service delivery.

As alluded to in the discussion in Section 2.5, wellbeing has been increasingly drawn on in the practical application of adaptation initiatives. For example, the Adaptation at Scale in Semi-Arid Regions (ASSAR) project and Tracking Adaptation Measuring Development (TAMD) initiative both incorporate wellbeing as one of the outcomes of implementing adaptation initiatives (Few *et al.*, 2016; Brooks & Fisher, 2014). The idea of wellbeing as one of the goals of adaptation interventions is also evident in the comments of some adaptation researchers such as Brooks (2014, p.1) who suggests, "The ultimate purpose of adaptation is to secure and improve human wellbeing". However, wellbeing has not been comprehensively dealt with in the theoretical discussions around adaptive capacity, despite the wealth of literature that deals with the relationship between adaptive capacity and a number of other complementary concepts such as resilience and vulnerability.

While the link between adaptive capacity and wellbeing has not been dealt with extensively in theoretical discussions, there has been some empirical work on this topic. Hogan *et al.* (2013) found a similar relationship between adaptive capacity and wellbeing as was found in this research. Hogan *et al.* (2013) examined the relationship between adaptive capacity and wellbeing; however, they used a single indicator to measure adaptive capacity which is a less comprehensive measure of adaptive capacity than the ACI used in this study. Nevertheless, Hogan *et al.* (2013) also found a positive correlation of 0.331 between individual adaptive capacity and subjective wellbeing that was significant at the 5 % level. From their findings, Hogan *et al.* (2013, p.3449) concluded that "wellbeing may serve as a useful and parsimonious proxy measure for resilience and adaptive capacity".

The findings of this study suggest that wellbeing could be used as a proxy measure for adaptive capacity. In fact, this study found an even stronger correlation than that observed by Hogan *et al.* (2013), with larger positive correlation coefficients between the three adaptive capacity domains and general wellbeing that were significant at the 1 % level. One possible explanation for the stronger correlation that was observed in this regression analysis is that the measure of adaptive capacity is more complex and robust than that used by Hogan *et al.* (2013). This more complex measure of adaptive capacity incorporates both subjective and objective aspects of adaptive capacity and, as the inclusion and integration of subjective and objective aspects is central in the conceptualisation of wellbeing, this could have played a part in the stronger correlation that was observed. However, this correlation is tenuous due to the low variance explained by the regression models and the issue of causality mentioned in Section 3.7. Thus it is not the focus of the discussion.

A more significant implication of the link between wellbeing and adaptive capacity is that drawing from wellbeing approaches can add great value in developing adaptive capacity assessments that better incorporate subjective factors. The importance of incorporating subjective factors into adaptive capacity assessments has already been outlined in Section 5.1. Both the concepts of adaptive capacity and wellbeing have undergone similar paradigm shifts to incorporate subjective and relational dimensions alongside objective, material dimensions (Armitage *et al.*, 2012, Pelling & High, 2005; Brown & Westaway, 2011).

Furthermore, in this research, the adaptive capacity domains in the 'Theory of Change' framework map closely to those in White's (2010) wellbeing framework. Agency maps to the subjective dimension, social cohesion to the relational dimension and access to resources to the material dimension. This close mapping between the two concepts was also evident in the similar themes that emerged in the 'rich pictures' and individual wellbeing workshop exercises, which both included subjective, relational and objective themes (e.g. improving one's skill set; having a close and supportive family; having financial security).

While these concepts of adaptive capacity and wellbeing have undergone similar paradigm shifts, in practice the conceptual evolution has been more widely adopted in the wellbeing field, as the adaptive capacity field still involves a number of material and resource-based assessments and initiatives. This is evident in Brown & Westaway's (2011, p.322) comment about environmental change literature where they suggest that "psychosocial factors and how they affect people's capacity to respond to environmental stressors are poorly understood and are rarely accounted for in integrated analyses." In light of this, this study has provided an example of an adaptive capacity assessment that adopts a wellbeing approach in including subjective, relational and objective factors to provide a more holistic assessment of adaptive capacity. The wellbeing field offers a number of insights into achieving this necessary inclusion of the subjective and relational dimension, one of which is the adoption of mixed methods and participatory approaches to explore these dimensions at the individual level.

This leads to the next key implication of the link between the adaptive capacity and wellbeing fields, which is that the adaptive capacity field should draw on the mixed methods and participatory approaches that are integral to wellbeing research. This study adopted a more participatory approach compared to many other ACIs and found such an approach to be valuable, as outlined in Section 5.2. However, to strengthen and expand the adoption of such approaches in the adaptive capacity field, it will be useful to learn from practices in the wellbeing field. Wellbeing approaches such as the 'Inner Wellbeing' approach developed by the Wellbeing and Poverty Pathways project (White & Jha, 2014) and the Batteries Tool developed by the Catholic Agency for Overseas Development (Jones, 2014) provide strong examples of participatory processes in practice. White & Jha (2014, p.62) highlight that to effectively implement wellbeing approaches, "qualitative data and analysis are vital to interpret quantitative measures of subjective dimensions of wellbeing." This idea is similar to the thinking that informed the adoption of a mixed methods approach in this research, in the attempt to provide an alternative approach to ACIs that use a removed and expert driven approach that prioritises material determinants. In addition to better characterising the subjective and relational dimensions, a participatory approach provides local insight that is essential in contextualising quantitative results. White & Jha (2014) stressed this importance of understanding the local context in wellbeing assessments, highlighting that each of their study sites had a local understanding of wellbeing that was unique. The idea of strengthening practice in the adaptive capacity field through insights from the wellbeing field is depicted in Figure 12.
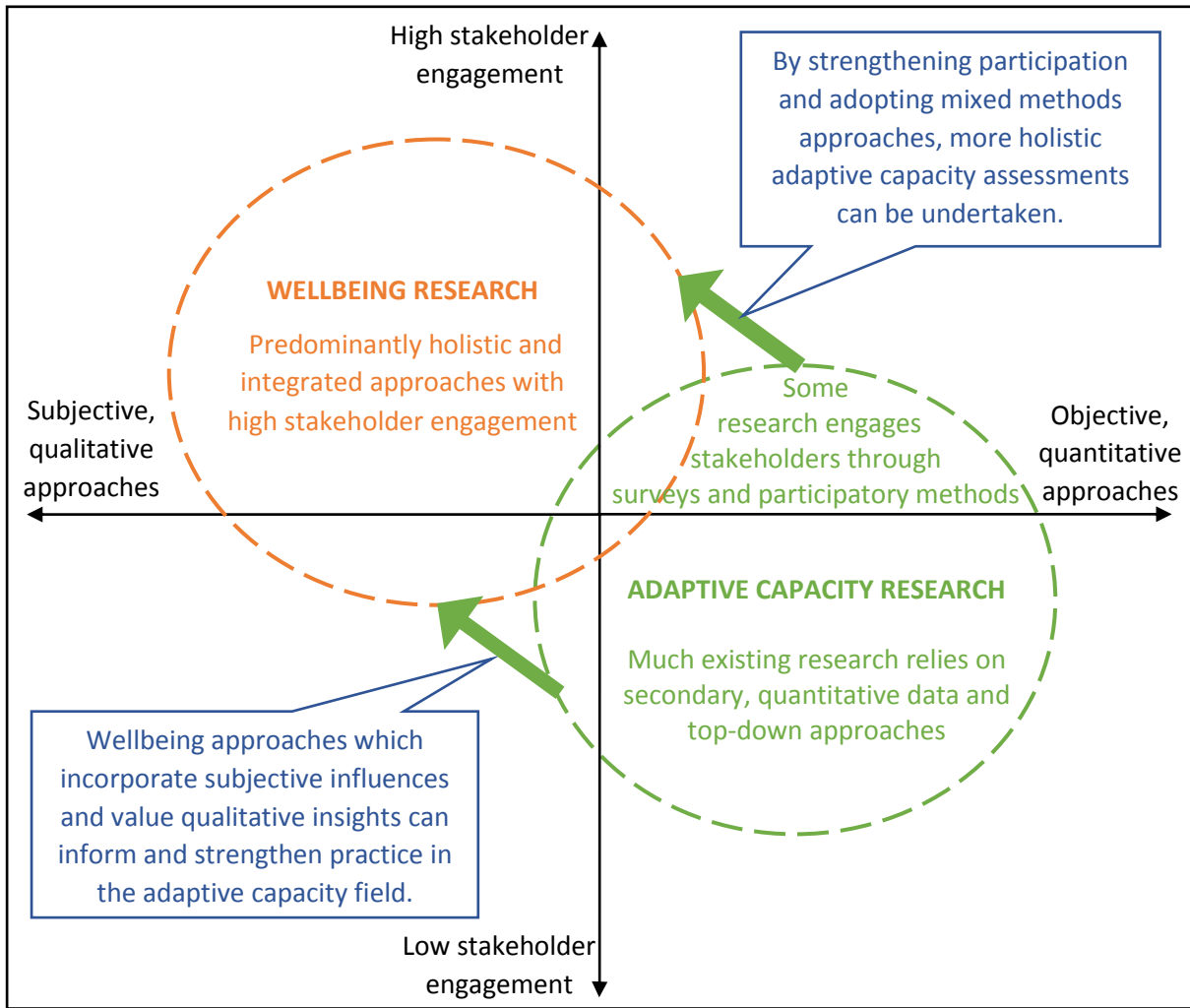
Figure 12: Strengthening practice in the adaptive capacity field through insights from the wellbeing field

Meaningful participation of local stakeholders in the research process is integral to the methods and practices developed in the wellbeing field. Through the inclusion of participatory practices, the adaptive capacity field can develop relevant indicators, holistic frameworks and more effective assessments (Brown & Westaway, 2011; Thomalla *et al.,* 2006). The value of incorporating transdisciplinary practices is expanded by Brown & Westaway (2011, p.321) who conclude that the environmental change field can develop "more integrated and human-centred approaches to understanding environmental change" by drawing from insights across the disaster, development and wellbeing literature base.

Chapter 6.   Conclusion

6.1. Summary of findings

Many ACIs in the literature have been developed through expert-driven processes that rely on secondary data and prioritise material, resource-based determinants (Van Aalst *et al*., 2008). However, given the call for adaptation research to adopt bottom-up, integrated approaches that value communities' insights, it is clear that better approaches for the assessment of adaptive capacity need to be developed (Few *et al*., 2011, Smit & Wandel, 2006). In light of this, the aim of this research was to assess the adaptive capacity of individuals in the Bergrivier community holistically through the collaborative development of an ACI. This was achieved through a participatory approach that involved multiple stakeholders and the adoption of a holistic framework for adaptive capacity that incorporated subjective, relational and objective influences.

The scores generated by the ACI were used in statistical and regression analyses that were contextualised by stakeholders' inputs to investigate the variations in adaptive capacity by town, gender, age, race and schooling level. These analyses revealed interesting variations in adaptive capacity across socially differentiated groups in the Bergrivier community. One of the most striking findings was that, contrary to expectations, respondents' adaptive capacity scores, financial indicators and wellbeing did not increase with schooling level. This was also true for respondents' income and expenditure. The absence of a positive correlation between schooling level and both the adaptive capacity domains and wellbeing variables indicates that there are minimal financial and psychosocial returns on education. This could be explained by limited economic opportunities in the Bergrivier Municipality, especially for high-skilled employment, leading to dissatisfaction among individuals with higher schooling levels. The statistical analysis also highlighted the need to support initiatives that strengthen the social cohesion within the community to ensure improved inclusion of certain demographic groupings who had lower social cohesion scores, such as the Black and Indian communities and individuals in the younger age groups. In this regard, the initiatives of the FLOW Programme and the Bergrivier Municipality play important roles.

This research found that the adoption of a holistic and participatory approach was integral in providing a nuanced and in-depth assessment of adaptive capacity. While the need for participatory approaches has long been established in adaptation literature, many assessments have fallen short in this regard; however, this research provides an example of a participatory approach in practice and reemphasises the benefits gained by prioritising local perspectives. While it was a more complex and time-consuming approach to undertake, the input of local stakeholders provided a rich and nuanced understanding of the variations in adaptive capacity in the Bergrivier community. Additionally, this approach provided insights into the more subjective factors of adaptive capacity in order to characterise this multi-dimensional concept at the individual level. Importantly, a participatory approach ensured mutually beneficial collaboration where the results were conveyed back to the community and the ambassadors explicitly expressed their interest and learning from the findings. This is preferable to many removed academic exercises that do not engage stakeholders or feed back results (Preston *et al*., 2011). Consequently, this thesis contends that if adaptive capacity assessments fail to incorporate local stakeholders'

insights and neglect the subjective factors influencing adaptive capacity, any initiatives based on the assessment's results run the risk of being maladaptive and unsuitable to the local context.

This thesis contributes to theoretical discussions around adaptive capacity and wellbeing by reflecting on the implications of the positive correlation observed between the three adaptive capacity domains and general wellbeing in the regression analysis. This correlation suggests that there is a close linkage between the concepts of adaptive capacity and wellbeing. The alignment of these two fields is also evident in the conceptual evolution both fields have undergone, which recognises the importance of including the subjective and relational dimensions alongside the objective dimension (Armitage *et al*., 2012, Pelling & High, 2005; Brown & Westaway, 2011). A key implication of the link between adaptive capacity and wellbeing is that insights from wellbeing approaches can strengthen practice in the adaptive capacity field. Mixed-methods approaches that value stakeholder inputs and subjective influences are established practice in wellbeing research and these approaches can provide valuable insights into developing more meaningful adaptive capacity assessments.

If better adaptive capacity assessments are developed, an improved understanding of the multi-dimensional nature of adaptive capacity will be obtained and more effective adaptation interventions can be designed. To improve the assessment of adaptive capacity, this research has highlighted the value of adopting participatory approaches that are informed by holistic frameworks and relevant indicators. In developing such approaches, there will be great value in looking across disciplines to the approaches used by the environmental change, development, disaster and wellbeing fields (Brown & Westaway, 2011; Thomalla *et al*., 2006).

6.2. Recommendations for future research

Future research could examine the link between adaptive capacity and wellbeing using more comprehensive methods to assess wellbeing than used in this research. Additionally, the link between these two concepts could be explored in a variety of contexts, including rural communities and large urban centres as well as in communities that have different economic circumstances in terms of their dependence on the primary, secondary and tertiary sectors. When examining the link between adaptive capacity and wellbeing using regression analyses, care must be taken when drawing conclusions about the underlying causal mechanisms and the directionality of the observed effects. Assessments of adaptive capacity can expand on the participatory approaches presented in this research by drawing from wellbeing approaches in order to ensure improved inclusion of stakeholders' perspectives and subjective influences across the adaptive capacity field as well as in the broader environmental change field.

This research looked at the generic capacity of the Bergrivier community, a concept that defines adaptive capacity as the ability to respond to and cope with a number of interlinked stressors (Eakin *et al*., 2014). This research argues that this holistic understanding is essential in the urban setting and that a community with limited generic capacity will not be able to make sustainable improvements in their specific capacity. However, future research

could expand this argument by looking at whether building generic adaptive capacity is sufficient to improve a community's adaptive capacity to climate change or if building specific capacity should be explicitly addressed. Additionally, future research should look into the development of dependent variables that could serve as proxies for 'adaptations' (especially in the urban context where such proxies would be hard to construct, as mentioned in Section3.7) in order to test the utility of indices such as the generic index proposed here.

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Appendix

A. Summary of ACIs found in the literature

A comprehensive description of ACIs that have been developed is included in Table 10 below.

Table 10: A comprehensive description of the ACIs found in the literature

Author	Description	Framework, determinants and indicators of adaptive capacity	Data source	Comments on the ACI
Yohe & Tol (2002)	ACI at national and regional level	Eight determinants developed from 2001 IPCC report: available technological options, resource access, institutional capacity, human capital, social capital, access to risk spreading mechanisms, information management, public awareness.	International or national databases	ACI formed part of a coping capacity analysis.
Bhadwal *et al.* (2003)	ACI at regional level for agricultural regions in India	Three determinants developed from literature, each with sub-determinants: biophysical vulnerability (soil degradation, ground water availability), social vulnerability (agricultural workers, literacy, gender discrimination, child mortality, fertility), technological vulnerability (irrigation, infrastructure). Variable number of indicators per sub-determinant. Determinants weighted evenly.	National databases	Social indicators include broad aspects but do not provide a holistic view of social vulnerability.
Metzger *et al.* (2005)	ACI at national and regional level	A number of macro-scale socio-economic indicators such as GDP per capita, female activity rate, income distribution, number of patents issued and age dependency ratio. Weighting procedure not described.	International databases	Individual adaptive capacities not quantified.
Brooks *et al.* (2005)	Vulnerability index at the national level	Eleven indicators selected by their correlation strength with decadal mortality focused on governance, education and health. Even and variable weighting of indicators tested.	International databases	Of the vulnerability indicators, the most significant indicators of adaptive capacity were identified to be governance, literacy rates and political and civil rights.
Alberini *et al.* (2005)	ACI at national level focussed on human health	Seven indicators developed through literature review and expert consultation: Income per capita, distribution of income, information access, life expectancy, physicians per 100 000 capita, type of health care system. Indicators weighted evenly.	International databases	Health care systems and high information access were found to be crucial indicators of adaptive capacity. ACI was a good predictor of climate-related mortalities.
Swanson *et al.* (2007)	ACI at regional level for agricultural	Six determinants based on the work of Smit *et al.* (2001): economic resources, technology, infrastructure, information, management and skills, networks and institutions, equity. Four indicators per determinant.	National databases	Index used to guide policy interventions. Provides a comparative measure of adaptive capacities across the region but cannot be

	communities in Canada's Prairie region	Determinants weighted equally.		assumed to measure the actual level of adaptive capacity that exists.
Vincent (2007)	ACI at local level for rural agricultural households	Five determinants derived from literature: Economic wellbeing and stability, demographic structure, interconnectivity in higher level processes, natural resource dependence, housing quality. One to two indicators per determinant. Equal weighting of determinants.	Household surveys conducted	A national ACI is also described by Vincent (2007) but is less relevant for this research.
Sietchiping (2007)	ACI at regional level for the wheat belt in Victoria, Australia	Three determinants developed from literature and consultation with experts and stakeholders: socio-cultural, institutions and infrastructure, economic. Variable number of indicators and sub-indicators per determinant. Variable weightings determined through stakeholder ratings.	Regional government databases	Stakeholder participation extensively used in index construction. Acknowledge data availability and reliability as key limitations. Socio-cultural and economic indicators identified as most important.
McClanahan et al. (2008)	ACI at local scale, applied to West African coastal communities	Eight indicators of adaptive capacity developed from literature and local context: recognition of causality, occupational mobility, change anticipation, social capital, occupational multiplicity, material assets, infrastructure, technology. Variable weightings derived from expert consultation.	Household surveys and stakeholder interviews conducted	Identified a broad spread of adaptive capacities at the local level that is not reflected in a national level ACI. Focussed on local level as this is where practical interventions are implemented.
Marshall et al. (2009) -	ACI at individual level	Sixteen indicators of adaptive capacity. Indicators include material aspects such as access to financial, technological and informational resources, as well as more subjective aspects such as risk perception, social networks and ability to plan, learn and adjust. Weighting of indicators not discussed.	Individual surveys required	ACI proposed as part of a theoretical framework for vulnerability assessments. An ACI aimed at the community and industry scale is also discussed.
Hahn et al. (2009)	ACI at individual level for rural Mozambique communities	Three determinants developed from literature: Socio-demographic profile, livelihood strategies, and social networks. Variable number of indicators per determinant Equal weighting of determinants used.	Household surveys conducted	ACI forms part of a Livelihood Vulnerability Index (LVI). LVI used to pinpoint vulnerable areas and compare the vulnerabilities of different districts
Gupta et al. (2010)	ACI at the organisational level	Five determinants of adaptive capacity developed from literature: Fair governance, variety, learning capacity, room for autonomous change, leadership, resources. Variable number of indicators per determinant. Determinants weighted equally.	Stakeholder interviews, document analysis	ACI constructed as an adaptive capacity wheel. Useful for comparative and progressive assessment.
Nelson et al. (2010)	ACI at regional level for Australian rural communities	Five determinants adapted from the Rural Livelihoods Framework developed by Ellis (2000): natural, physical, financial, human and social capital. Two to three indicators used per determinant. Even weighting and variable weighting of determinants tested.	National farm survey database and census data	Weighting the determinants evenly or variably did not significantly alter adaptive capacity scores. Noted that there are limitations of measuring human capital from secondary data.

Brown *et al.* (2010)	ACI at local scale for land managers in Australia	Same framework as Nelson *et al.* (2010), but used local consultation to select relevant indicators. Determinants weighted evenly.	Self-assessment by land managers	Self-assessment provided comprehensive local insight into adaptive capacity.
Engle & Lemos (2010)	ACI at local governance level	Nine determinants developed though literature review: representation, participation, knowledge and information use, equality of decision making and knowledge availability, flexibility, commitment, networks, experience, resources. Variable number of indicators per determinant. Determinants weighted equally.	Database of previous council member survey	Excluded flexibility and commitment in final index as their indicators were not sufficiently robust (determined by Cronbach's alpha analysis)
Pelling & Zaidi (2013)	ACI at national level for Guyana	Five determinants developed through literature review and consultation with experts and stakeholders: critical self-reflection, improving foresight, support for experiments, organizational structure, resources to enable adjustments. Stakeholders rated the level of each determinant on a scale of very limited to optimal. Determinants weighted equally.	Stakeholder surveys conducted	Ratings by stakeholders are subjective but allowed deeper insight into more elusive aspects of adaptive capacity. Index used to track improvement in adaptive capacity over time.
Maldonado & Moreno-Sánchez (2014)	ACI at local level for Latin American fishing communities	Three determinants developed through literature review, each with three sub-determinants: socio-economic (poverty, infrastructure and occupational characteristics), socio-political (social capital, institutional, perceptions), socio-ecological (resource dependence, ecological awareness, anticipatory ability). Variable indicators per sub-determinant. Determinants weighted evenly. Indicators weighted variably.	Household surveys conducted	The in-depth household survey was developed specifically for the ACI and provided key insights into the local context. Elements of social capital are explored comprehensively in the ACI.
Defiesta & Rapera (2014)	ACI at local scale for rural agricultural communities	Five determinants derived from literature: physical, financial, information, human, livelihood diversity. Variable number of indicators per determinants. Variable weightings derived from expert consultation.	Household surveys conducted	Social aspects not qualified in the ACI. Human resources related primarily to farming experience and education.
De Villiers *et al.* (2014)	ACI at local scale for land managers	Six determinants: Personal control, record keeping & monitoring, learning, innovation, leadership and group participation, diversity of income. Variable number of indicators per determinant. Determinants weighted equally.	Land manager surveys conducted	Greater incorporation of social and human aspects by quantifying community participation, learning processes and leadership qualities.
Cinner *et al.* (2015)	ACI at local scale for natural resource dependent communities	Nine determinants developed from literature: Human agency, access to credit, occupational mobility, occupational multiplicity, social capital, material style of life, gear diversity, community infrastructure, trust. Variable number of indicators per determinant. Weighting procedure not described.	Surveys conducted with local fisherman	ACI used to identify particularly vulnerable groups (e.g. youth and migrants) and to suggest community-level interventions that target areas of adaptive capacity that are relatively low.

B. Descriptive statistics for data collected in the baseline survey

Table 11: Gender of respondents

Gender	Number of respondents	Notes
Female	213	Three entries were excluded from the analysis as the respondent answered 'other'.
Male	234	

Table 12: Race of respondents

Race	Number of respondents	Notes
Black	24	Six entries were excluded from the analysis where the respondent chose not to answer.
Coloured	291	
Indian	6	
White	106	
Other	13	

Table 13: Descriptive statistics of the socio-economic data of respondents

Indicator	Question in the baseline survey	Answer range	Descriptive statistics of sample			
			Max.	Min.	Mode	Median
Age	Q3 - How old are you today?	1 = (15-20), 7 = (46-50), 14 = (older than 80)	13	1	7	6
Years as a Bergrivier resident	Q1 - How many years have you lived in the Bergrivier area?	1 = less than one year, 6 = nine years or more	6	1	6	6
Level of schooling	Q2 - What is the highest level of schooling you have obtained?	1 = no school, 7 = higher level education	7	1	4	4
Wellbeing/ Satisfaction	Q61 - All things considered How satisfied are you with your life as a whole these days?	1 = unsatisfied with life, 5= very satisfied with life	5	1	4	4
Income	Q46 - Considering the income from ALL of your	1 = Not applicable, 2 = R0-	10	1	1	2

	jobs, how much income did you bring home in the last month?	R500, 10 = more than R40 000				
Expenditure	Q47 - What was your total expenditure in the last month? Include money spent on food, clothing, transport, rent and rates, alcohol and tobacco, school fees, entertainment and any other expenses.	1 = Not applicable, 2 = R0-R500, 10 = more than R40 000	10	1	1	3

Table 14: Descriptive statistics for the questions selected from the baseline survey to be used as adaptive capacity indicators in the ACI

Adaptive capacity domain	Indicator selected from the baseline survey	Answer range	Indicator description				
			Max. value	Min. value	Mode	Med-ian	Possible values for normalised indicator
Agency	Q59 - How often do you take risks	1 = never take risks; 5 = always take risks	5	1	3	3	0; 0,25; 0,5; 0,75; 1
	Q60 - I take risks on creative projects or business decisions, even when I have no guarantee of a positive outcome	0 = never take risks, 1 = seldom, 2 = always take risks	2	0	1	1	0; 0,5; 1
	Q66 - Do you feel that you are able and willing to try new things in your life?	1=not able/willing to try new things, 3=able to try new things	3	1	3	3	0; 0,5; 1
	Q62 - I am forced to consult other people when I have to make decisions	1 = never consult other people, 5 = always consult other people	5	1	3	3	0; 0,25; 0,5; 0,75; 1
	Q63 - How much control do you feel you have in making decisions that affect your everyday activities? Do you have…	1 = no control, 5 = control over all decisions	5	1	4	4	0; 0,25; 0,5; 0,75; 1
	Q65 - Overall, how much impact do you think	1 = no impact, 3 = big impact	3	1	2	2	0; 0,5; 1

	you have in making Bergrivier area a better place to live?						
Social Cohesion	Q53 - Generally speaking, would you say that most people in your community can be trusted	0 = no, 1 = sometimes, 2 = yes	2	0	1	1	0; 0,5; 1
	Q56 - Most people in my community/neighbourhood are willing to help if you need	0 = no, 1 = sometimes, 2 = yes	2	0	1	1	0; 0,5; 1
	Q57 - Would you say that all things considered this is a close-knit community?	0 = no, 1 = sometimes, 2 = yes	2	0	1	1	0; 0,5; 1
	Q55 - On a scale of 1 to 5 how much do you trust the local municipality?	0 = choose not to answer, 1 = not trusted, 5 = very trusted, *	5	1	5	3	0; 0,25; 0,5; 0,75; 1
	Q49 - Over the last one month how much did you give in money to support people or groups without expecting compensation?	1 = no money, 8 = lots of money **	8	1	1	2	0; 0,25; 0,5; 0,75; 1
	Q51 - Over the last one month how much did you give in non-work time to support people or groups without expecting compensation?	1 = no time, 8 = lots of time given **	8	1	1	2	0; 0,25; 0,5; 0,75; 1
Access to resources	Q7 - Think about your financial situation. Would you describe yourself as ***	1 = very underprivileged, 6 = rich	6	1	4	4	0; 0,2; 0,4; 0,6; 0,8; 1
	Q9 - I have access to the resources I need to make changes to my life when there are difficulties	5 = always access to resources, 1 = sometimes access to resources	5	1	3	3	0; 0,25; 0,5; 0,75; 1
	Q10 - In the last 3 months, has the municipality provided you with any support that has enabled you to live a better life?	1 = municipality has not provided, 2 = municipality has provided	2	1	1	1	0; 1
	Q11 - In the past 3 months, have you contacted the municipality for assistance?	1 = did not contact municipality for help, 2 = did contact municipality for help	2	1	1	1	0; 1

	Q8 - Over the last 3 months has your household had a sufficient amount of food in the household?	1 = never enough food, 4 = enough food	4	1	3	3	0; 0,333; 0,667; 1
	Q52 - Does your business or livelihood activities help people/the environment at all?	0 = no, 1 = sometimes, 2 = yes	2	0	2	2	0; 0,5; 1

* When respondents chose not to answer (I.e. they selected '0' in the answer choices), they were given the median score.

** The indicator was transformed to span a shorter scale where any answer choice in category 5, 6, 7 or 8 was given the maximum score of 1.

*** During the second workshop, the phrasing of the Afrikaans version of this financial status question was discussed. The Afrikaans version was slightly ambiguous and could have been interpreted as being satisfied or adequately provisioned rather than specifically asking about the extent of one's financial resources. However, despite the limitations of this indicator, the group came to a consensus that it should still be included as it was an important indicator of access to resources.

C. Material related to the workshops

C.1. Workshop on the domains of adaptive capacity

Figure 13 shows an example of the exercise on the adaptive capacity domain of social cohesion, where workshop participants identified examples in their community where individuals or a group demonstrated either a high or low level of social cohesion. This exercise was done for all three adaptive capacity domains. Figure 14 shows the 'rich picture' exercise where participants wrote words or drew pictures that depicted a more adaptive future for themselves and their community.

Figure 13: Exercise on the social cohesion domain in the first workshop

Figure 14: 'Rich pictures' exercise depicting a more adaptive future

C.2. Workshop on the ACI results and rating of indicators

Figure 15 shows an example of a completed worksheet for the agency domain which was used for the rating of indicators and for the assessment of the validity of the index at the individual level. Workshop participants received this worksheet for each domain as well as a spider diagram of their overall performance for the three domains, which is shown in Figure 16. This worksheet was completed with an individual wellbeing exercise to assess the aspects needed for a good life. An example of a completed individual wellbeing exercise is depicted in Figure 17.
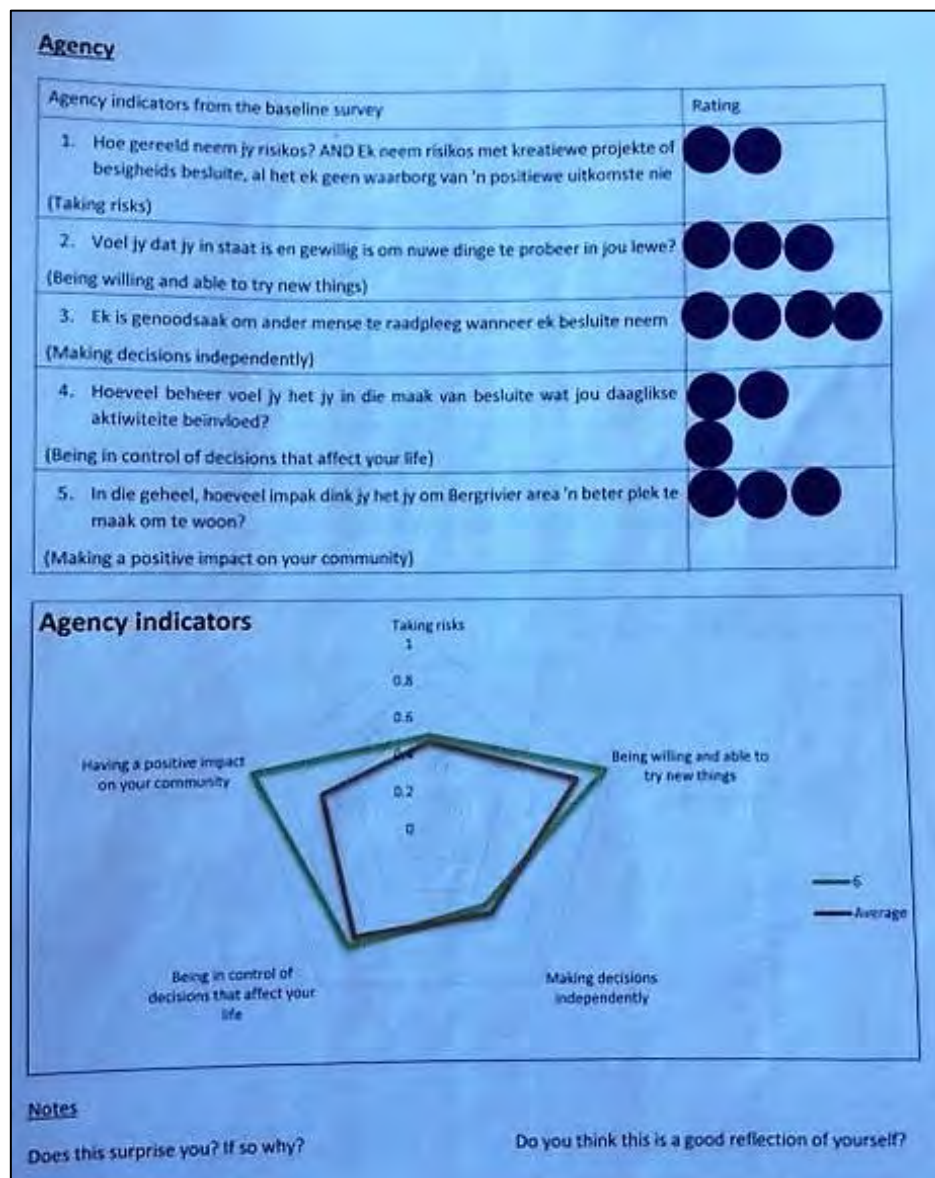

Figure 15: An example of a completed worksheet for the adaptive capacity domain of agency
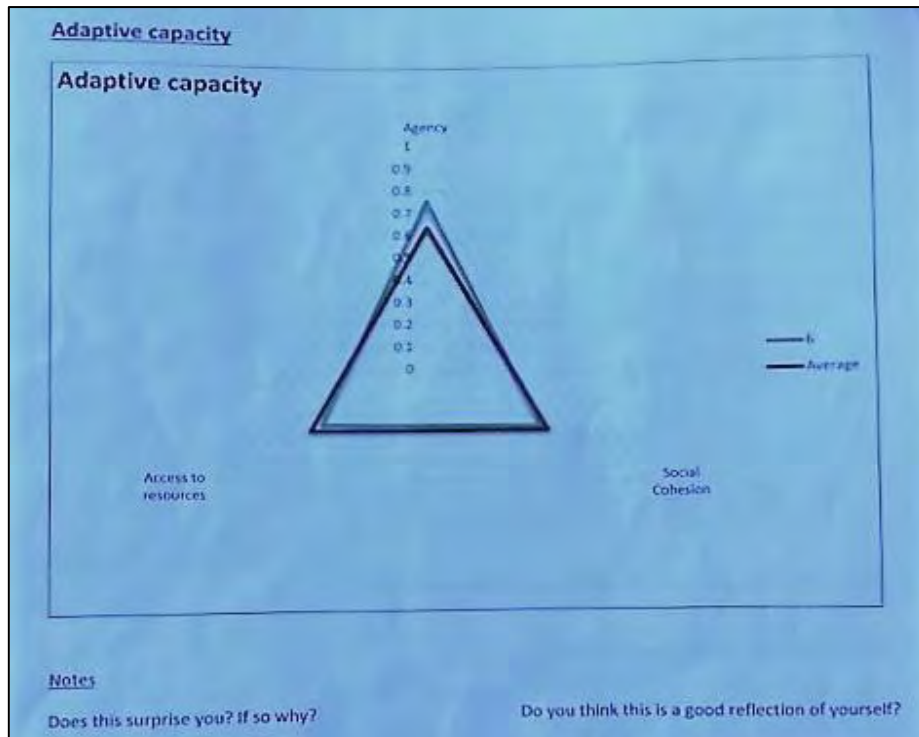
Figure 16: An example of a spider diagram displaying a workshop participant's individual adaptive capacity domain scores with reference to the average scores in the Bergrivier community.

Figure 17: An example of a completed exercise on subjective wellbeing

D. Census data for Bergrivier Municipality

Table 15 and Figure 18 summarise the key characteristics and income distribution of the four Bergrivier towns included in this study. This data was collected in the 2011 census.

Table 15: Key characteristics of the four Bergrivier towns (Statistics South Africa, 2011)

| Characteristic	Goedverwacht	Piketberg	Porterville	Velddrif
Total population	1 979	12 075	7 057	11 017
Young (0-14) (%)	23	26	25	23
Working Age (15-64) (%)	68	68	66	66
Elderly (65+) (%)	10	6	9	11
Population density (person/km^2)	663	910	884	1 242
No schooling aged 20+ (%)	1	4	6	3
Higher education aged 20+ (%)	6	8	10	8
Matric aged 20+ (%)	25	25	25	30
Number of households	539	2 920	1 949	3 622
Average household size	3,5	3,8	3,5	2,9
Female headed households (%)	34	37	37	38
Formal dwellings (%)	96	91	93	90
Housing owned/paying off (%)	81	66	55	65
Sewerage connected flush toilet (%)	50	91	96	79
Weekly refuse removal (%)	89	97	99	99
Piped water inside dwelling	86	83	88	89
Electricity for lighting	79	96	97	98
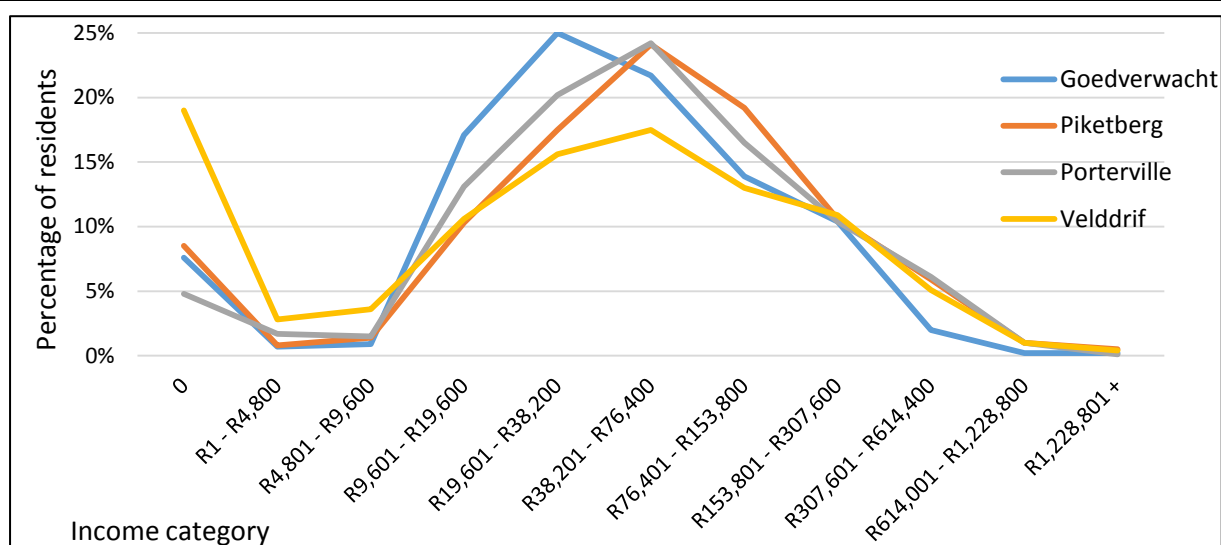
Figure 18: The variation in the income of residents between the four Bergrivier towns (Statistics South Africa, 2011)

E. Regression outputs

Table 16 presents the results of the regression analysis where the data was not clustered by town.

Table 16: Results of the ordered probit regression model for three different dependent variables without clustering for town

Variable		Income	Expenditure	Wellbeing	Wellbeing (full sample)
		Regression coefficients			
Age	Age	-0.003 (0.029)	0.004 (0.029)	0.067 (0.031)**	0.064 (0.022)***
Gender	Female	-0.568 (0.145)***	-0.275 (0.142)*	0.083 (0.152)	0.203 (0.111)*
Race	Coloured	0.370 (0.325)	0.272 (0.324)	0.004 (0.341)	-0.037 (0.260)
	Indian	0.342 (0.678)	-0.058 (0.700)	-1.116 (0.698)	-0.707 (0.497)
	White	1.003 (0.359)***	0.930 (0.360)***	-0.276 (0.376)	-0.128 (0.276)
Years in Bergrivier	Years in Bergrivier	0.073 (0.057)	0.046 (0.058)	-0.130 (0.064)**	-0.077 (0.046)*
Town	Piketberg	0.299 (0.221)	0.052 (0.219)	-0.088 (0.237)	0.062 (0.188)
	Porterville	0.254 (0.294)	0.053 (0.293)	0.123 (0.320)	0.276 (0.238)
	Velddrif	0.053 (0.224)	-0.317 (0.224)	-0.002 (0.240)	0.092 (0.186)
Schooling level	Grade school	0.026 (1.073)	0.070 (1.073)	-4.528 (131.300)	-0.943 (0.761)
	Secondary school	0.333 (1.068)	0.621 (1.067)	-4.443 (131.300)	-1.247 (0.749)*
	Technical Certificate	0.400 (1.113)	-0.093 (1.116)	-4.658 (131.301)	-1.409 (0.783)*
	Diploma	0.204 (1.074)	0.601 (1.073)	-4.482 (131.300)	-1.170 (0.763)
	Tertiary degree	0.219 (1.100)	1.477 (1.103)	-4.783 (131.301)	-1.495 (0.787)*
	Higher degree	-0.274 (1.246)	0.254 (1.228)	-4.976 (131.302)	-1.504 (0.872)*
Adaptive capacity	Agency score	0.491 (0.523)	1.423 (0.529)***	1.073 (0.559)*	1.272 (0.386)***
	Social cohesion score	0.343 (0.381)	-0.220 (0.379)	0.424 (0.409)	0.574 (0.299)*
	Resource access score	1.095 (0.507)**	0.883 (0.504)*	2.164 (0.551)***	1.971 (0.400)***
N		229	229	229	425
Log likelihood		-433.923	-453.359	-277.967	-510.526
Pseudo R^2		0.0512	0.0629	0.0689	0.0680

Notes: See notes following Table 17.

Table 17 presents the results of the regression analysis for wellbeing where the explanatory power of the financial indicators of income and expenditure was explored.

Table 17: Results of the ordered probit regression model for wellbeing where the explanatory power of income and expenditure was explored

Variable		Regression coefficients		
		Wellbeing with income	Wellbeing with expenditure	Wellbeing excl. financial indicators
Age	Age	0.069 (0.025)***	0.067 (0.016)**	0.067 (0.020)***
Gender	Female	0.219 (0.160)	0.132 (0.114)	0.083 (0.134)
Race	Coloured	-0.075 (0.212)	0.043 (0.211)	0.004 (0.182)
	Indian	-1.210 (0.251)***	-1.119 (0.221)***	-1.116 (0.193)***
	White	-0.511 (0.227)**	-0.420 (0.182)**	-0.276 (0.151)*
Years in Bergrivier	Years in Bergrivier	-0.153 (0.040)***	-0.139 (0.022)***	-0.130 (0.033)***
Town	Piketberg	-0.171 (0.017)***	-0.095 (0.014)***	-0.088 (0.012)***
	Porterville	0.059 (0.031)*	0.112 (0.025)***	0.123 (0.023)***
	Velddrif	-0.017 (0.040)	0.049 (0.036)	-0.002 (0.034)
Schooling level	Grade school	-4.552 (0.352)***	-4.550 (0.304)***	-4.528 (0.295)***
	Secondary school	-4.537 (0.351)***	-4.552 (0.311)***	-4.443 (0.324)***
	Technical Certificate	-4.775 (0.482)***	-4.647 (0.434)***	-4.658 (0.424)***
	Diploma	-4.535 (0.383)***	-4.587 (0.367)***	-4.482 (0.366)***
	Tertiary degree	-4.861 (0.454)***	-5.024 (0.421)***	-4.783 (0.523)***
	Higher degree	-4.966 (0.386)***	-5.034 (0.361)***	-4.976 (0.354)***
Financial indicator	Income/ Expenditure	0.146 (0.042)***	0.088 (0.045)**	N/A
Adaptive capacity	Agency score	0.971 (0.399)**	0.815 (0.323)**	1.073 (0.360)***
	Social cohesion score	0.373 (0.296)	0.468 (0.279)*	0.424 (0.263)*
	Resource access score	1.966 (0.168)***	2.049 (0.071)***	2.164 (0.103)***
N		229	229	229
Log likelihood		-272.413	-275.194	-277.967
Pseudo R^2		0.0875	0.0782	0.0689

Notes: See next page.

Notes for Table 16 and Table 17

Note 1: *significant at 10 % level, **significant at 5 % level, ***significant at 1 % level.

Note 2: The reference groups for the independent variables were: Gender (Male); Race (Black); Town (Goedverwacht); Level of schooling (No schooling).

Note 3: Some of the regression runs use a sample size of 229 individuals. This subset is where necessary to exclude those respondents who declined to provide their financial information in the baseline survey.