The socio-economic evaluation of peri-urban households adjacent to the Buffelsdraai Landfill Site Community Reforestation Project in the eThekwini Municipality, Durban

By

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ABSTRACT

In Africa, climate change mitigation and adaptation initiatives have been implemented to address its impacts and support livelihoods. In South Africa, the eThekwini Municipality established the Buffelsdraai Landfill Site Community Reforestation Project to reduce Durban's carbon footprint through the reforestation of degraded sugarcane lands surrounding the Buffelsdraai Landfill Site. The project contributes to climate change mitigation by creating a natural carbon sink and generating socio-economic benefits through a payment-for-ecosystem-services scheme that compensates local households for cultivating indigenous trees. Although such projects provide environmental, social and economic benefits, their socio-economic dimensions remain understudied and overlooked. Therefore, this study investigated household dependence on non-timber forest products, household perceptions of climate change and their determinants, and household preferences for forest ecosystem attributes associated with the Buffelsdraai Reforestation Project.

The study was conducted in two peri-urban communities adjacent to the project site in the eThekwini Municipality, KwaZulu-Natal. A stratified multi-stage sampling approach was used to select 434 household heads. Data were collected through household questionnaires, key informant interviews and focus group discussions. Principal component analysis, ordinary least squares regression, the double hurdle model and a choice experiment approach were employed to address the study objectives.

To examine climate change perceptions, principal component analysis was used to construct psychosocial indices, followed by the application of the double hurdle model. Households associated climate change with changes in seasonal temperatures, rainfall patterns and wind occurrences. Strong affective responses, individualistic worldviews and community engagement increased the likelihood of perceiving climate change. The intensity of climate change perceptions was higher among hopeful households, those with stronger social networks, and those holding individualistic and hierarchical worldviews. The findings highlight the importance of incorporating emotional and community-based communication strategies in climate change awareness programmes.

To assess household dependence on non-timber forest products, a regression-weighted dependence index was developed using behavioural indicators of such use. Principal component analysis was used to derive indices for cultural worldviews and social and psychological capital. The OLS results showed that dependence on non-timber forest products increased with the number of adults in a household, agricultural asset ownership, access to electricity and stronger social networks. In contrast, households with greater asset endowments and fatalistic and egalitarian worldviews were less dependent on non-timber forest products. These findings suggest the need to support livelihood diversification through home food gardens and the cultivation of marketable non-timber forest product species.

The choice experiment approach was used to assess household preferences for forest ecosystem attributes and the influence of cultural worldviews, psychological capital and socio-demographic characteristics. Principal component analysis was applied to identify the dominant dimensions of cultural worldviews and psychological capital, and a mixed logit model was estimated to account for preference heterogeneity. Households generally preferred improved forest management options over the status quo. Gender increased the likelihood of selecting improved forest management alternatives, while older household heads were less likely to support changes to the current management regime. Individualistic and hierarchical worldviews significantly influenced preferences for forest ecosystem attributes.

The study recommends livelihood support programmes that strengthen technical skills and reduce reliance on non-timber forest products, climate change communication through existing community networks, and gender-sensitive approaches to reforestation programmes. Future research should compare non-timber forest product dependence across rural and peri-urban contexts, examine perceptions of climate change longitudinally, incorporate climate literacy measures, and develop context-specific psychological capital constructs.

Keywords: Non-timber forest products, climate change perceptions, cultural worldviews, psychological capital, choice experiment

DECLARATION 1-PLAGIARISM

I, Karabo Donald Munonde, declare that:

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Professor Edilegnaw Wale Zegeye
(Supervisor)

DECLARATION 2-PUBLICATIONS

The following publications (published, submitted and under review) form part of the research presented in this thesis.

Manuscript 1 - Chapter 4

Munonde, KD and Zegeye, EW. Evaluating Non-Timber Forest Product dependence of Peri-Urban households in a payment for ecosystem service scheme in Durban, South Africa (*Published: Trees, Forests and People*, https://doi.org/10.1016/j.tfp.2025.101128)

Manuscript 2 - Chapter 3

Munonde, KD and Wale, E. Psychosocial determinants of household climate change perceptions in the eThekwini Municipality, South Africa (*work in progress - manuscript to be submitted to a relevant journal for publication)*

Manuscript 3 - Chapter 5

Munonde, KD and Wale, E. Household preferences and willingness to pay for forest ecosystem attributes: Empirical evidence from the eThekwini Municipality in Durban, South Africa (*work in progress - manuscript to be submitted to a relevant journal for publication*)

DEDICATION

This thesis is dedicated to my family and to those with the courage to continue pursuing education and knowledge despite adversity.

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LIST OF ABBREVIATIONS

BDT	Behavioural Decision Theory
CC	Climate Change
CCpl	Climate Change Perception Level
CDM	Clean Development Mechanism
CE	Choice Experiment
CEBA	Community Ecosystem-Based Adaptation
CVM	Contingent Valuation Method
CWV	Cultural Worldview
DH	Double Hurdle Model
DUVs	Direct-Use Values
EVs	Existence Values
FDI	Forest Dependency Index
FGDs	Focus Group Discussions
GHGs	Greenhouse Gases
IIA	Independence from Irrelevant Alternatives
IUVs	Indirect-Use Values
KMO	Kaiser-Meyer-Olkin
MWTP	Marginal Willingness to Pay
NTFPs	Non-Timber Forest Products
NUV	Non-Use Values
OLS	Ordinary Least Squares
OVs	Option Values
PCA	Principal Component Analysis
PC	Principal Component
PES	Payment for Ecosystem Service Scheme
PMT	Protection Motivation Theory
POB	Positive Organisational Behaviour
PsyCap	Psychological Capital
RUT	Random Utility Theory
Scap	Social Capital
SLF	Sustainable Livelihood Framework
TEV	Total Economic Value
TPB	Theory of Planned Behaviour
UV	Use Values
VBN	Value-Belief-Norm Theory
VIF	Variance Inflation Factors
WTP	Willingness to Pay
ZAR	South African Rand

CHAPTER 1

INTRODUCTION

1.1 Background

The National Aeronautics and Space Administration (NASA), the agency responsible for aerospace research and aeronautics in the United States of America, indicates that the Earth's climate has undergone several changes (NASA, 2018). Moreover, there have been seven glacial advance-and-retreat cycles over the last 650,000 years. Only 7000 years ago, the ice age ended, ushering in the modern climate and the rise of human civilisations. Many of those changes were caused by minor variations in Earth's orbit, which affect the amount of energy reaching the Earth's surface (NASA, 2018).

In the early 19th century, the study of the Earth's climate system began (BBC, 2013). In 1824, French physicist Joseph Fourier discovered the greenhouse effect and described the heat-trapping nature of the Earth's atmosphere. The Irish physicist John Tyndall discovered that water vapour and carbon dioxide (CO_2) contribute to the greenhouse effect. In 1896, the Swedish chemist Svante Arrhenius proposed that burning fossil fuels, specifically coal, would intensify the greenhouse effect and potentially prevent another ice age. One notes that this is the first instance in which the increase in atmospheric CO_2 has been attributed to an anthropogenic activity, such as coal burning. Furthermore, in 1938, a British engineer named Guy Callendar found that temperatures had risen slightly in the 19th century and that CO_2 levels had similarly increased over the same period and stated that increased concentrations of CO_2 caused this warming, and this has been coined in the literature as the "Callendar effect" (Le Treut et al., 2007; BBC, 2013). However, in 1958, Charles David Keeling provided accurate measurements of atmospheric CO_2 and demonstrated that CO_2 concentrations were increasing in Earth's atmosphere (Keeling, 1961).

In November 1965, the then-President of the United States of America, Lyndon B. Johnson, was warned about the impending effects of continued atmospheric CO_2 accumulation from burning fossil fuels (McNutt, 2015). However, it was only in 1987 that any significant actions were taken to protect the climate, and this was done through a multinational agreement known as the Montreal Protocol on Substances that Deplete the Ozone Layer, which sought to reduce the production, consumption and emissions of greenhouse gases (GHGs) (Velders et al., 2007; BBC, 2013). At that stage, the term "global warming" was commonly used to describe the warming effects caused by heat-trapping gases. In 1975, the term 'climate change' (CC) was first used by Wallace S. Broecker to describe climatic alterations resulting from high atmospheric CO_2 concentrations (Broecker, 1975). Before that time, studies had used 'inadvertent climate modification' to describe this phenomenon (Sutter, 2017).

At that time, climate science was still in its early stages. Thus, scientific progress (i.e., increased funding for climate science research, new research methods, and refined scientific instruments) was required to gather scientifically verifiable knowledge that the climate was changing and to identify the likely causes of those changes. In the long run, this knowledge will serve as a valuable reference for policymakers and decision-makers on CC issues. Hence, in 1988, the Intergovernmental Panel on Climate Change (IPCC) was established to assemble, analyse, and report on up-to-date evidence on climate change (IPCC, 2001). The IPCC has since generated a wealth of information on CC and communicates its findings through a series of assessment reports, which are published every 5-7 years (IPCC, 1990; IPCC, 1996; IPCC, 2001; IPCC, 2007; IPCC, 2014). The IPCC Working Groups (WGs) compile these assessment reports into three volumes. IPCC WG one (WG I) assesses the scientific aspects of the climate system and CC (i.e. observation of rainfall, temperatures, greenhouse gas changes, etc.). IPCC WG two (WG II) examines the impact of CC on socio-economic and natural systems and the various actions that could be taken to adapt to it. Lastly, the IPCC WG III focuses on the steps of strategies promulgated to resolve the CC problem.

These reports have been instrumental in elevating the CC agenda and raising awareness among decision-makers and policymakers about the policies that governments worldwide will need to adopt. More importantly, these reports have guided the nature of actions required to reverse or lessen the impact of CC. According to the United Nations Framework Convention on Climate Change, there are two actions needed to deal with CC: mitigation and adaptation (Klein et al., 2005). According to IPCC (2001), the term mitigation refers to 'an anthropogenic intervention to reduce sources or enhance the sinks of GHGs', and adaptation is the 'adjustment in natural or human systems response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities'. Examples of mitigation interventions include using renewable energy sources, improving energy efficiency, modifying business management practices, and reducing energy demands by changing consumer behaviour (e.g., driving less, purchasing high-efficiency vehicles) (IPCC, 2014). Adaptation measures would include improving water-use and irrigation efficiency, restoring and protecting natural landscapes, climate-proofing the built environment (i.e., reinforcing roads, houses, and buildings against storm damage), and supporting climate-resilient livelihoods (SANBI, 2016).

Greenhouse gas emissions have doubled since the 1970s, and CO_2 emissions from energy use are projected to rise above 70 per cent in 2008-2050 (OECD, 2012). Though CC is a global issue, industrialised nations are primarily responsible for this climate pollution. Developed nations will not be severely affected by it, primarily because of sounder policies and infrastructure capable of handling its impacts (Laukkonen et al., 2009). According to Klein et al. (2005), there was a strong focus on GHG mitigation rather than on adaptation strategies in these countries. However, scientists and policymakers noted that mitigation

strategies alone were insufficient to address the impacts of CC. Using one approach over another overlooks synergies between mitigation and adaptation in addressing CC, thereby adding to the mitigation-adaptation dichotomy (Biesbroek et al., 2009; Klein et al., 2005). Developing countries (i.e., Brazil, Russia, India, Indonesia, China, and South Africa) have accounted for two-thirds of the increase in greenhouse gas emissions in recent years (OECD, 2012). This is so because most people experiencing poverty now live in emerging economies, which has led to increasing energy demands and emissions (Rennkamp et al., 2012). Hence, there have been growing calls for mitigation and adaptation strategies to be used as complementary approaches in the developing world to achieve effective results (Nyong et al., 2007; Laukkonen et al., 2009; IPCC, 2014).

However, the nature of each strategy makes this objective challenging to achieve because of differences in purpose, scope, timing and the level of stakeholder involvement required (Wilbanks et al., 2003). Some trade-offs arise from competing objectives (i.e. resolving rural development needs and addressing long-term environmental issues), particularly in developing countries (Tol, 2005). Developing countries should ensure that both strategies support their sustainable development agenda, improving living standards and reducing CC risks. Then again, Tol (2005) argues that adaptation and mitigation should be separated because adaptation is local and implemented by various individuals at different spatial and temporal scales than mitigation. Because mitigation strategies are typically large-scale, they often divert resources from adaptation. However, the IPCC (2014) report states that the complementarity of mitigation and adaptation, particularly in developing nations, will significantly reduce emissions over the years and, consequently, the costs of adaptation.

Climate change mitigation and adaptation efforts require huge capital outlays. For instance, regarding adaptation, limiting temperature increases to 2 degrees Celsius would, on average, cost the world 1-3 percent of its gross domestic product (Hof et al., 2014). Moreover, the IPCC (2014) estimates that the global cost of adaptation ranges between US$70 and US$100 billion per year. When economic sectors are included, the value could reach US$500 billion by 2050 (UNEP, 2016). However, the accuracy of these estimates is disputed, with Rosen and Guenther (2015) arguing that the derivation of such economic estimates is based on flawed integrated assessment models. Nonetheless, adaptation costs will not be evenly distributed across regions, as future impacts are location-specific (UNEP, 2015). Resources will have to be prioritised for developing nations since adaptation costs will be higher. Developing countries are being prioritised because of the US$23-26 billion allocated to adaptation initiatives; 90 per cent of this money was invested in developing countries (UNEP, 2016). The cost of mitigation could be high, with investment requirements for implementing carbon capture and storage systems in power plants, as well as for adopting renewable energy sources and replacing fossil fuels (Hof et al., 2014). The investments required to meet

emission targets are estimated at around US$44 trillion over 40 years to limit the temperature increase to 2 ºC (UNEP, 2014). Significant investments have already been made by both private and public investors in energy efficiency and renewable energy. In 2012, the total cost was between US$310 billion and US$360 billion, with around US$250 billion allocated to renewable energy in 2013 (UNEP, 2014).

Given the capital required for mitigation initiatives, it is not surprising that developing nations, particularly in Africa, are not adequately meeting their mitigation targets to curb greenhouse gas emissions (IPCC, 2007). Lisk (2009) disagrees with the claim that Africa is not playing its part in CC mitigation and highlights that African countries are more concerned with understanding and addressing the impacts of CC. Especially when these impacts intersect with livelihood issues and might hinder the continent's future economic growth potential. Several African countries, including South Africa, are signatories to the Kyoto Protocol and thus participate in the Clean Development Mechanism (CDM) and carbon trading arrangements (Vosper and Mercure, 2016). These CDMs permit countries to obtain GHG emission-reduction credits by investing in projects that safeguard the environment (Lisk, 2009). The expectation with this initiative was that Africa and other developing nations could benefit through foreign direct investment and technology transfer from developed countries. Unfortunately, CDM has not successfully mobilised adequate financing to develop abatement technologies on the continent (UNEP, 2014). Tol (2005) found that emission abatement costs are high for many African and other developing countries. There is a greater chance of reducing CC impacts through development than through emission reduction. African countries cannot afford to make emission-reduction pledges to the world, especially when they face pressing development challenges (food insecurity and poverty) in their own countries.

This does not mean African countries cannot reduce emissions. Collier et al. (2008) highlight that Africans can take specific measures to reduce emissions, primarily related to land management. Hussein et al. (2013) suggest that land-use practices such as carbon sequestration are low-cost mitigation options for developing countries and could be adopted by African governments. People on the African continent are susceptible to CC shocks, mainly due to poverty (Collier et al., 2008). Therefore, designs and implementation must be affordable, well-integrated mitigation and adaptation strategies to reduce GHGs and build resilience to the impacts of CC. Moreover, numerous local and international initiatives have been established to address the impending impacts of CC and improve the livelihoods of those most affected. These initiatives include the Convention on Biological Diversity, Millennium Development Goals (MDGs), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, and the IPCC, amongst others (Sachs et al., 2009).

At a local level, mitigation and adaptation initiatives to CC are specific to each region. In South Africa, for instance, the eThekwini Municipality, the local government tasked with the management of the Durban

Metropolitan area, has, through the eThekwini Department of Environmental Planning and Climate Protection, launched a series of Community Ecosystem-Based Adaptation (CEBA) interventions to enhance Durban's ability to withstand climate change impacts (Roberts et al., 2012). One such CEBA initiative, launched in 2004, was the Municipal Climate Protection Programme. Within this plan, the Buffelsdraai Landfill Site Community Reforestation Project (henceforth referred to as the "reforestation project") was initiated (Douwes et al., 2017). The reforestation project was launched in 2008 to offset carbon emissions generated by hosting the 2010 FIFA World Cup in Durban (Mugwedi et al., 2018). It involves engaging several community members as "Tree-prenuers"; the project sought to restore degraded land, contribute to CC mitigation and biodiversity conservation, and provide socio-economic benefits to households through the cultivation and sale of indigenous trees (Viljoen, 2010).

The rationale for this intervention was that numerous low-income people in eThekwini's peri-urban areas are at a higher risk of CC, as some depend on ecosystem services for their livelihoods. Therefore, addressing the environmental and socio-economic dimensions of CC in these peri-urban areas will enhance the city's mitigation and adaptation capacity by providing an opportunity to reduce unemployment through ecosystem management. Failing to understand the socio-economic aspects of these communities could hinder the project's actual impact on their livelihoods.

1.2 Research problem and rationale

Developing countries will bear a heavier burden of CC impacts (Duguma et al., 2014). Currently, CC has lengthened and intensified droughts in eastern Africa, increased the incidence of floods in western Africa, and raised ocean surface temperatures along the African coast (Lisk, 2009). Moreover, CC is expected to alter weather patterns, threatening Africa's agricultural production, food security, health, water, and energy security. There is much at stake in Africa, as an estimated 1 billion people live on the continent, and almost 40 percent live in urban areas (Laros, 2012). Furthermore, population growth projections indicate that by 2050, 3.6 to 6.3 billion people worldwide will be living in urban areas, thereby intensifying economic activity and, in turn, increasing GHG emissions (Roberts, 2013). Likewise, the African population will increase to 1.2 billion, with 60 percent living in urban areas (Laros, 2012).

African nations have committed to addressing CC, as have most countries worldwide. Numerous countries, including African governments, use carbon sequestration projects to reduce atmospheric GHGs (Torres et al., 2010). However, as a CDM signatory, Africa had, as of 2010, implemented only 2 percent of the CDM forestry-based carbon projects registered with the UNFCCC (Hagbrink, 2010). For instance, CDM projects apply only to areas without forest cover for 50 years, which is unrealistic in many African countries due to the complexity of CDM rules, limited financing, and limited technical capacity (Makhado et al., 2011).

Nevertheless, several forest-based carbon projects have been implemented in some African countries, including South Africa (Jindal et al., 2008). In Ethiopia, for instance, Africa's first large-scale forestry project, the Humbo Assisted Natural Regeneration Project, was initiated to restore 2,700ha of indigenous tree species in the Humbo area, while supporting local incomes and generating employment. Moreover, the Senegal Plantation Project was implemented in 2006 to reforest approximately 10,000ha of acacia species in the African Sahel.

In South Africa, around 2004 -2005, a project was initiated to rehabilitate coastal dunes and riparian areas in Port St. John. Another project around the Letaba River was started to rehabilitate riparian forests. Recently, in KwaZulu-Natal, the iNanda Mountain Community Reforestation Project, a community-based reforestation initiative, was implemented between 2009 and 2015 to reforest 360 ha of coastal scarp forest and 200 ha of KZN sourveld around iNanda Mountain (Wale et al., 2022). Likewise, the KwaNibela Community Sand Reforestation Project was implemented in the KwaNibela Community, located around the Maputaland area, to protect and improve biodiversity in the Nibela forest by incentivising community members to propagate indigenous trees to establish carbon sinks (DFFE, 2018). And then there is the reforestation project, which addresses various CC issues in Durban, South Africa, strengthening the ability of poor urban communities to adapt to CC through economic development and biodiversity conservation (Douwes et al., 2017).

The projects considered above are examples of environmental projects known as payment for ecosystem services (PES) schemes, where people living in poverty adjacent to the projects are compensated for providing ecological public services. In PES, a conservation organisation pays a resource user to maintain or enhance an ecosystem service, such as clean water, carbon storage, or biodiversity, with payment made only if the service is successfully delivered (Wunder, 2005). Numerous carbon projects offer social, economic, and environmental benefits through sustainable land-use management and employment opportunities (IPCC, 2001). Like many around Africa, these projects are close to communities that often rely on forests for livelihoods, indicating that forests play a pivotal role in the fight against poverty and strengthening food security (FAO, 2011) and that paying people experiencing poverty to manage the environment generates benefits for their households (Milder et al., 2010). However, the socio-economic aspects of many environmental restoration projects are understated and overlooked (Aronson et al., 2010). The reforestation project under investigation is not an exception. Therefore, it is imperative to investigate and identify the socio-economic dimensions of the few carbon-related projects implemented in Africa, such as the reforestation project in South Africa.

According to Roberts (2008), CC will adversely affect the city of Durban, as minimum and maximum temperatures continue to increase. For example, recent projections suggest that mean annual temperatures

will increase by 1.5-2.5 degrees Celsius between 2045 and 2065 and that temperatures will exceed 30 degrees Celsius from 2070 to 2100 (Roberts, 2008; Lewis, 2010). Rainfall patterns will be affected, and rainfall is expected to increase slightly (Roberts, 2008; Diederichs and Roberts, 2015). Moreover, rainfall distribution is predicted to change, with more frequent periods of no rainfall and shorter, more intense rainfall events (Roberts, 2008; Lewis, 2010). Sea levels are expected to rise, so infrastructure and coastal vegetation will be significantly damaged (Mather, 2007; Roberts, 2008). Therefore, CC will exacerbate coastal erosion and water availability problems, and negatively affect existing ecological infrastructure (Roberts, 2008; Lewis, 2010), ultimately impacting the livelihoods of the peri-urban poor. Many of these poor people live far from the city centre in peri-urban areas where forests are an essential source of livelihood security (Cartwright et al., 2013). Many of these households rely on forest items, referred to as non-timber forest products (NTFPs), which are typically harvested for subsistence and commercial use (Shackleton and Shackleton, 2004; Kaimowitz, 2003). These NTFPs include biological materials other than timber, harvested from forests and woodlands for consumption, such as fruits, nuts, vegetables, medicinal plants, firewood, and bark (Belcher and Vantomme, 2003; Heubach et al., 2011). Furthermore, NTFPs account for a high percentage of household income in the developing world, with South Africa, for instance, having 85 percent of the rural households using NTFPs, and contributing between 10 and 33 percent of the total annual household income amongst poor households (Shackleton and Shackleton, 2006; Timko et al., 2010; Heubach et al., 2011; Kaoma and Shackleton, 2015). Several studies (Byron and Arnold, 1999; Angelsen and Wunder, 2003; Newton et al., 2016; Nerfa et al., 2020; Wale et al., 2022) refer to this relationship between forests and communities' reliance on NTFPs as forest dependency.

Communities highly dependent on forest resources can contribute to deforestation and land degradation, threatening livelihoods (Beyene, 2011; Arnold, 2001). Persha et al. (2011) indicate that to enhance the sustainability of forest resources while improving socio-economic conditions, local knowledge and community involvement must be integrated into decision-making processes. One mechanism to encourage communities to complement their land use practices with sustainable forest management is the PES scheme (Engel et al., 2008). As public goods, ecosystem services are non-excludable and non-rival, making it challenging to directly identify beneficiaries and exclude free-riders, which can complicate PES scheme designs (Muradian et al., 2010). Payment for ecosystem schemes typically requires government support to ensure that payments are made to ecosystem service providers, thereby encouraging participation. These PES schemes, by providing alternative income sources for people experiencing poverty, reduce reliance on the direct extraction of forest resources and improve their livelihoods (Wunder, 2008). According to Engel et al. (2008), information on the extent to which poorer households benefit from participation is limited, and there is a perception that participants are at least not worse off than they would be without the PES scheme. Understanding the extent of forest dependency can ensure that reforestation projects are designed

to succeed in restoring natural environments whilst also supporting livelihoods (Chazdon, 2008). Hence, it is important to investigate dependency levels on NTFPs in the communities adjacent to the reforestation project site, as this information will provide insights into the socio-economic factors that characterise forest-dependent communities, particularly in peri-urban settings, and inform and enable policy and future project designs geared towards sustainable forest use to include livelihood planning, which will reduce harvesting pressure on the forested area by presenting alternative livelihood options.

Public perceptions of CC are increasingly important for developing relevant and appropriate CC mitigation and adaptation strategies (Whitmarsh et al., 2013). Earlier research focused on assessing climatic trends and socio-demographic factors to understand the perceptions of CC (Deressa et al., 2011; Foguesatto et al., 2018). However, current research on CC perceptions has moved away from using one-dimensional, holistic measures in data-collection instruments, limiting insights into the determinants and components of CC perception (Leiserowitz, 2006). Several studies indicate that psychological traits, emotions and social constructs, such as cultural worldviews, are important in shaping people's perception of CC and subsequent efforts to address it (Slovic et al., 2004; Leiserowitz, 2006; Weber, 2006; Hitayezu et al., 2017; Smith and Leiserowitz, 2014). As important as these cognitive and affective mechanisms are in determining CC perceptions and actions towards it, research has limited capacity to explain how psychosocial dynamics influence CC perceptions outside typical rural or urban contexts (Weber, 2006; Ojala, 2012). Recent studies on CC perceptions in Africa have often focused on rural areas and communities (Maziya and Nkonki-Mandleni, 2022; Hitayezu et al., 2017; Mertz et al., 2009; Ndambiri et al., 2012). For instance, Hitayezu et al. (2017) assessed the CC perceptions of small-scale farmers using socio-demographic, affective heuristics, and cultural worldview-based indicators. Insightful as the study was, it did not take into account individuals' internalised psychological resources. Moreover, CC perception in peri-urban areas is understudied despite the unique social characteristics and natural environments, and a single framework would be limited in capturing the complex dynamics where forest dependency and increased access to urban centres and infrastructures converge (Allen, 2010; Simon et al., 2004; Narain et al., 2013)

In addressing these gaps, this study focused on peri-urban areas adjacent to the reforestation project. Buffelsdraai and Osindisweni are peri-urban communities, where rural and urban dynamics intersect, and households derive their livelihoods from multiple sources (Mancebo, 2011). This study integrates behavioural decision theory (BDT), cultural theory (Douglas and Wildavsky, 1983), and the positive organisational behaviour (POB) framework (Luthans et al., 2007) into a single psychosocial framework that offers valuable insights into perceptions of CC in African peri-urban areas. The BDT contributes to understanding how affective heuristics, cognitive biases, and risk perceptions influence climate-related judgements and decisions (Slovic et al., 2007; Weber, 2010). The CT places these processes within a social

and cultural context, showing how cultural worldviews such as individualism, egalitarianism, hierarchism, and fatalism shape individuals' interpretations and understandings of CC risk perception (Douglas and Wildavsky, 1983; Leiserowitz, 2006; Boholm, 1996). The POB introduces the psychological dimension, which highlights the role of psychological capital constructs such as hope, self-efficacy, resilience, and optimism as internalised resources that determine a person's behavioural response to perceived CC risks (Luthans et al., 2007; Ojala, 2012). These frameworks move further away from the rational, moralistic, or threat-based assumptions of the theory of planned behaviour (TPB), value-belief norm (VBN), and protection motivation theory (PMT) (Ajzen, 1991; Rogers, 1975; Stern et al., 1999) by including affective heuristics, culture, and psychological resources within an integrated explanatory pathway. The study model pathway showing a relationship that explains how emotion interacts with cultural background and psychological resources to influence CC perceptions and subsequent actions (e.g., affect → cultural worldview → psychological capital→ CC perception → behavioural response). The integration provides a broader understanding of CC perceptions, which is rare in empirical studies, especially in the African peri-urban context. Therefore, it presents a methodological and theoretical contribution.

Reforested areas create new forest systems that provide valuable ecosystem services to society, such as carbon sequestration, erosion prevention, medicinal plants, and biodiversity (Yao et al., 2014; Brey et al., 2007). In the case of the Reforestation project, the provision of these ecosystem services benefits the adjacent communities. However, knowledge of the importance of these newly established forest systems' benefits to the public is scarce (Brey et al., 2007). Environmental benefits are difficult to quantify because the market values of most ecosystem goods and services are not directly observable (Brey et al., 2007; Hanley et al., 2009). Furthermore, there is a lack of understanding of this value for public goods stemming from environmental restoration projects (Weber and Stewart, 2009). Still, these non-market value estimates can be acquired through various methods (Jakobsson and Dragun, 1996; Adamowicz et al., 1998; Rolfe et al., 2000; Hanley et al., 2009). One method is the choice experiment, which is used in marketing, transportation, environmental economics, and psychology, and has become a widely used stated-preference technique for valuing non-market environmental goods (Adamowicz et al., 1998). It has been applied in different environmental contexts to assess preference for environmental attributes (Brey et al., 2007; Chipfupa and Wale, 2019; Rolfe et al., 2000; Lee et al., 2014; Snowball et al., 2008). For instance, Rolfe et al. (2000) used the CE method for rainforest conservation, demonstrating how choice modelling techniques can capture the value of conservation preferences. Their findings showed that Australian respondents placed greater value on rainforest conservation in South America than on conservation options in their own country. The study employed a multinomial logit model; however, mixed models could better account for and potentially improve preference heterogeneity. In South Africa, Snowball et al. (2008) utilised the CE

approach to elicit household WTP for improving water attributes in the Eastern Cape. The study showed that respondents were willing to pay more for water services when bacterial quality decreased, water discolouration increased, and water supply interruptions occurred, with bacterial quality being the most important attribute in determining respondents' choice. However, the study focused only on middle-income urban households, limiting its generalisability to lower-income and rural households.

Additionally, Lee et al. (2014) applied the CE method to assess the economic value of recreational resources at the Sundays River Estuary. The study demonstrated that the physical size of fish caught was a predictor of recreational choice in the river estuary. It also found that recreational fishers and boat license holders were willing to pay an additional fee on top of existing license fees to reduce fishing. However, the study fails to consider behavioural responses to fee increases, such as illegal fishing or decreased compliance. Furthermore, CE was applied by Chipfupa and Wale (2019) to examine smallholder farmers' preferences for improved irrigation water management, finding that reliability and pricing structures significantly influenced their WTP and prioritised affordability and equity in water distribution. However, the study does not address the dynamic, gradual impact of CC on farmers' water resources, nor how these expected changes could influence preferences for irrigation water and WTP.

However, these studies tend to attribute preference heterogeneity to socio-economic factors and do not consider cultural and psychological mechanisms that explain preferences or WTP, particularly in PES services. According to Martín-López et al. (2012), there is a need to account for socio-cultural factors in establishing public preferences and trade-offs for ecosystem goods and services. Even more so in understanding their influence on WTP for forest ecosystem services in PES programmes (Obeng and Aguilar, 2018), such as the reforestation project. To address this gap, this study will incorporate cultural worldviews derived from cultural theory (Douglas and Wildavsky, 1983; Thompson et al., 1990) and psychological capital (Luthans et al., 2007) within the CE framework. In cultural theory, individuals' perspectives on issues are influenced by the dynamics of the social groups they belong to and by their sense of belonging to those groups. These perspectives can affect attitudes and understanding of risk perception and preferences (Edgar and Sedgwick, 2007). Psychological capital constructs can shape individuals' behaviour towards the environment and their willingness to engage with ecological sustainability programmes. These aspects are rarely incorporated in CE studies in South Africa. Therefore, this study utilises the CE method to examine how households' psychosocial characteristics and selected socio-demographic factors drive preferences and WTP for forest ecosystem goods and services in Durban, employing econometric models such as mixed logit to explain better the heterogeneity in WTP estimates identified in previous studies as due to methodological limitations. This approach offers an insightful and detailed understanding of preference heterogeneity in environmental valuation by considering cultural

worldviews and a person's psychological resources, both of which are important for designing culturally relevant and psychologically enhancing sustainable forest management policies.

1.3 The study objectives

To identify and understand the socio-economic dimensions of communities adjacent to the reforestation project in a peri-urban setting. The research could provide valuable knowledge to guide the planning and implementation of community-based reforestation projects in peri-urban areas of South Africa. Therefore, considering the gaps mentioned in the previous section, the specific objectives of this study were to:

a. assess how affective heuristics, cultural worldviews, psychological capital and other socio-economic characteristics jointly shape households' CC perception in peri-urban households;
b. derive an NTFP dependence index for peri-urban households using behavioural indicators of forest resource use;
c. examine the socio-economic determinants of NTFP dependence and assess how psychological capital, other forms of capital and cultural worldviews shape household dependence on NTFPs;
d. examine the influence of households' psychosocial characteristics and sociodemographic factors on preferences and WTP for forest attributes among peri-urban households.

1.4 Structure of the thesis

The thesis comprises six chapters, including an introductory chapter that provides a description and map of the study area, a discussion on the approach to primary data collection, and a concluding chapter that presents the study's conclusions and recommendations. Chapter 2 presents a review of the literature on urbanisation in African cities and CC. Furthermore, the chapter provides an overview of the concept of payment for ecosystem services (PES) and offers insights into NTFP dependence, CC risk perceptions, and environmental valuation.

Chapter 3 examines CC perception to identify the factors that influence household CC perception and the degree to which they do so. It also discusses the double hurdle (DH) model, which was the empirical model used in the analysis. Results and discussion are presented, including a summary. In Chapter 4, the study examines households' dependence on NTFP near the reforestation project site. It applies an adapted sustainable livelihood framework that integrates psychological capital as an additional form of livelihood capital. In the chapter, PCA was used to reduce the dimensionality of indicators for psychological capital, social capital, and cultural worldviews. Latent dimensions from the indicators were identified and subsequently used as proxies in the analysis. In the chapter, behavioural indicators of NTFP dependence are used to construct a regression-weighted index, with weights derived using Ordinary Least Squares (OLS). Results and discussions are presented, and the chapter concludes with a summary.

In Chapter 5, the CE method was applied to examine households' preferences for the attributes of forest ecosystem goods and services, as well as their willingness to pay for them. Furthermore, the chapter demonstrates how CE was used to ascribe monetary value to characteristics of the establishing forest, resulting from the reforestation project's efforts to rehabilitate a previously degraded land area into a restored indigenous forest. The chapter concludes with a presentation of the findings, discussion, and summary. Lastly, Chapter 6 presents the study's conclusions, policy recommendations, and directions for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature on CC in urban areas, particularly in the developing world and among the urban poor. It provides a concise overview of forest-based ecosystem service typologies and the concept of the PES scheme. In Section 2.6, the sustainable livelihoods framework and its elements are discussed in detail, providing the basis for the objective evaluation of NTFP dependence in the forested area. Sections 2.7 and 2.8 discuss risk perceptions and environmental valuation, respectively. A summary of the chapter is presented in section 2.9.

2.2 Urbanisation in Africa and climate change: *vulnerability and adaptation in peri-urban areas*

According to a recent United Nations report on global urbanisation, more people now live in urban areas than in rural areas, with over 50 percent of the global population residing in urban areas as of 2014 (UN, 2015). This proportion is projected to increase to 66 percent by 2050 (UN, 2015). Urbanisation is occurring across most regions globally, with Africa urbanising faster than many other regions. By 2050, an estimated 56 percent of Africa's population will reside in urban areas (Collier, 2015). Currently, approximately two-fifths of the African population lives in urban areas, with many urban centres concentrated along the coast. The growth of African cities is largely driven by internal migration from rural areas to urban centres (Barrios et al., 2006).

Urbanisation is often associated with economic growth, improved literacy and education levels, better access to health care, water supply, electricity, communication infrastructure, and enhanced opportunities for political and cultural participation (UN, 2015). Pollution-related problems are more prevalent in urban areas, and rapid city development often outpaces the capacity of existing infrastructure. Thriving urban industries attract investment, labour, further accelerating migration and urban expansion (Bloom et al., 2008), while cities play an important role in economic development and poverty reduction in both urban and rural areas (UN, 2015). However, the benefits of urbanisation and city life may attract a large pool of the rural poor, leading to rapid, unplanned urban growth that threatens to overwhelm key infrastructure. Unplanned urban growth frequently results in urban sprawl, environmental degradation, the expansion of informal settlements, increased unemployment and poverty, and increased urban violence (Bloom et al., 2008).

The projected increase in urbanisation in Africa has raised concerns about cities' capacity to absorb rapid population growth and manage the associated environmental pressures (Barrios et al., 2006). Particularly

concerning is the ability of African cities to cope with the impacts of CC. According to McGranahan et al. (2007), cities need to provide essential services such as safe water, sanitation, housing, public health care, and infrastructure amid the effects of CC, and coastal cities are at even higher risk of CC induced seaward dangers as a result of flooding, tornadoes and long-term projected sea-level rise (Table 2.1). The IPCC projects that African coastal areas will be increasingly affected by sea-level rise by the end of the twenty-first century (McCarthy, 2001).

The urban poor are disproportionately exposed to CC impacts and natural hazards, as many reside on the peripheries of cities in affordable yet environmentally risky areas (Dodman and Satterthwaite, 2008). These peri-urban areas are often characterised by informal settlements, insecure land tenure, poor service provision, limited accessibility and increased environmental threats (WorldBank, 2011). These characteristics make peri-urban communities vulnerable to the impacts of CC, as summarised in Table 2.1, which indicates the direct and indirect effects of CC on urban and peri-urban areas.

Table 2.1. Direct and indirect effects of climate change on urban and peri-urban areas

Changes in climate	Potential impact on urban and peri-urban areas
Temperature	Increased energy demands for heating/cooling
	Worsening of air quality
	Amplified by the urban heat islands
Precipitation	Increased risk of flooding
	Increased risk of landslides
	Distress migration from rural areas
	Interruption of food supply networks
Sea-level rise	Coastal flooding
	Reduced income from agriculture and tourism
	Increased saltwater intrusion
Extreme rainfall	More intense flooding
	Higher risk of landslides
	Disruption to livelihoods and city economies
	Damage to homes and businesses
Drought	Water shortages
	Higher food prices
	Disruption of hydro-electricity
	Distress migration from rural areas
Heat or cold waves	Short-term increase in energy demands for heating/cooling
Abrupt climate change	Possible significant impacts from rapid and extreme sea-level rise
	Possible significant impacts from rapid and extreme temperature change
Population movements	Movements from stressed rural habitats
Biological changes	Extended vector habitats

Source: Adapted from Dodman and Satterthwaite (2008) and Feiden (2011).

The vulnerability of the urban poor to CC and climate-related disasters has increased over time, with adverse implications for livelihoods, food security, and well-being (Dodman and Satterthwaite, 2008).

However, this vulnerability to CC can be reduced, often requiring multiple stakeholders to respond and promote adaptation measures. Adaptation, in this case, refers to the 'adjustments in natural or human systems in response to actual or expected changes in climate' (Satterthwaite, 2009). In urban and peri-urban contexts, adaptation measures include the provision of basic infrastructure such as reliable water supply, drainage systems, roads, secure property rights, and adequate housing, all of which can significantly reduce vulnerability to CC impacts (Lwasa, 2010). However, these facilities are often lacking in many rapidly growing urban and peri-urban areas (Baker, 2012).

Adaptation can assume various forms, especially in peri-urban areas. For instance, households can either withdraw (e.g., move valuable items or send children away) in the event of disasters, accommodate these changes, or build protective measures such as flood barriers around their homes. Agriculture remains an important livelihood activity in many peri-urban communities (Mattingly and Gregory, 2006). Typical adaptation strategies include crop diversification, adjusting planting dates, tree planting, and irrigation (Deressa et al., 2011). The adoption of these strategies is influenced by a range of factors, including household wealth, access to credit, education, access to climate information, government support, housing quality, sanitation and overall household health (Tschakert, 2007; Bryan et al., 2009; Deressa et al., 2011). This section provides the contextual background for the empirical chapters. It places the study within a rapidly urbanising, CC-vulnerable peri-urban setting. Also, it highlights why households in these areas continue to rely on forest resources and NTFPs as a part of their livelihood and adaptation strategies. Thirdly, it underpins the empirical analysis of household CC risk perceptions, as exposure and vulnerability to CC determine how households perceive these risks and respond to them. Lastly, this review provides a basis for valuing forest ecosystem services, as they contribute to CC resilience and livelihood security in peri-urban areas.

Therefore, improving basic services, facilitating coping strategies, and supporting sustainable livelihoods are important in building the resilience of these communities against CC (Satterthwaite, 2009; Baker, 2012). Therefore, this discussion informs the empirical approach in the empirical chapters.

2.3 A brief synopsis of ecosystem services

Ecosystem services are defined as the "benefits people obtain from ecosystems that support, directly or indirectly, their survival and quality of life" (Harrington et al., 2010). These services arise from ecological functions and are valued differently across space and time, depending on the socio-economic, cultural and environmental context (Wunder, 2005; Spangenberg et al., 2014). According to the Millennium Ecosystem Assessment (MEA, 2005), ecosystem services are classified into four categories: provisioning, regulating,

and cultural and supporting services, as shown in Table 2.2. This classification provides a framework for identifying ecosystem benefits relevant to human well-being and the sustainability of livelihoods.

Table 2.2. Ecosystem service typologies*

Provisioning services *(Products obtained from ecosystems)*	**Regulating services** *(Benefits obtained from the regulation of the ecosystem)*	**Cultural services** *(Nonmaterial benefits obtained from ecosystems)*	**Supporting services** *(Service necessary to produce all other ecosystem services)*
▪ Food ▪ Freshwater ▪ Fuelwood ▪ Fiber ▪ Biochemicals ▪ Genetic resources	▪ Climate regulation ▪ Disease regulation ▪ Water regulation ▪ Water purification ▪ Pollination	▪ Spiritual and religious ▪ Recreation and ecotourism ▪ Aesthetic ▪ Inspirational ▪ Educational ▪ Sense of place ▪ Cultural heritage	▪ Soil formation ▪ Nutrient cycling ▪ Primary production

******The list is not comprehensive; it is for illustrative purposes only*
Source: Haines-Young and Potschin (2009)

For effective management of the reforested area at Buffelsdraai, it is important to identify, quantify, and value the ecosystem services forests provide. Forest ecosystems provide a range of services, including food, NTFPs, nutrient cycling, soil stabilisation, erosion control, carbon sequestration, and air purification (Krieger, 2001). Baral et al. (2016), classify these forest ecosystem services according to the Millennium Ecosystem Assessment typology as presented in Table 2.3. Each ecosystem service, or combination of services, contributes to human well-being, especially for vulnerable groups such as low-income households that depend directly on natural resources for their livelihoods.

Table 2.3. Typology of ecosystem services provided by forests

Provisioning services	**Regulating services**	**Cultural services**	**Supporting services**
▪ Food ▪ NTFPs ▪ Freshwater	▪ Carbon sequestration ▪ Disease regulation ▪ Water regulation ▪ Water purification ▪ Pollination ▪ Fresh air regulation ▪ Erosion prevention and soil protection ▪ Natural hazard regulation	▪ Spiritual and religious ▪ Recreation and ecotourism ▪ Aesthetic ▪ Inspirational ▪ Educational ▪ Sense of place	▪ Soil formation ▪ Nutrient cycling ▪ Primary production

Source: Adapted from Baral et al. (2016)

The Ecosystem Services Cascade model provides a conceptual framework for understanding how ecosystem services are generated and how they translate into human welfare (Haines-Young and Potschin,

2009). The model describes a stepwise process linking biodiversity and ecosystem structure to ecological functions, services, benefits and human welfare (Spangenberg et al., 2014). Though the cascade model simplifies complex ecosystem processes, it offers a useful conceptual framework for understanding the link between environmental change and socio-economic outcomes (Potschin and Haines-Young, 2011). The framework is relevant to the rural and peri-urban context, where poor households depend on ecosystem goods and services for their livelihoods. Therefore, access to productive, healthy ecosystems is key to sustaining livelihoods and building resilience among the rural and urban poor. Safeguarding these ecosystems ensures they can continue to provide critical services that underpin household welfare, particularly amid CC.

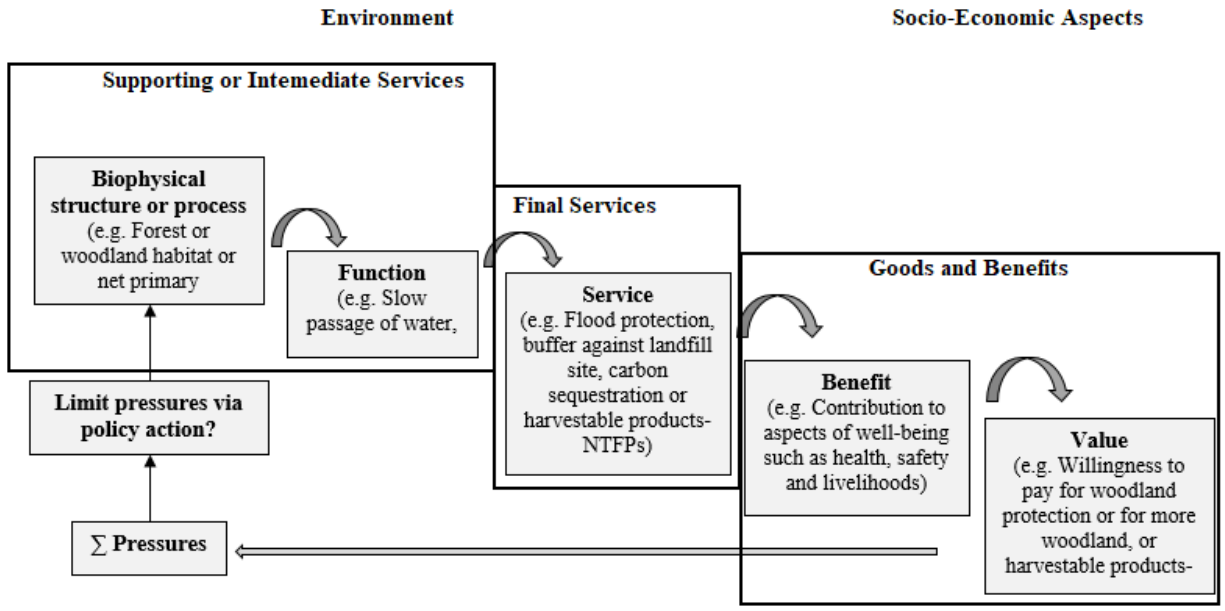


Figure 2.1 The cascade model shows the relationship between biodiversity, ecosystem functions, and human welfare. **Source:** Adapted from Potschin and Haines-Young (2011).

As a sustainable land management intervention, the reforestation project aims to improve the provision of ecosystem goods and services. Consequently, bio- or ecosystem indicators are required to monitor changes in ecosystem properties, functions, and services associated with this land management option. Typically, indicators are selected for each ecosystem service category, and relationships between these indicators and human welfare outcomes are established (Van Oudenhoven et al., 2012). Table 2.4 presents a typology of ecosystem services and related indicators. In this study, ecological indicators were obtained from ecological assessments conducted at the reforestation project site (Knowles and Theron, 2010; Knowles and Theron, 2014; Macfarlane et al., 2011; Macfarlane et al., 2015).

Table 2.4. Ecosystem service typologies and their indicators

Ecosystem properties	Ecosystem function	Ecosystem service indicators
Provisioning services		
Food	Presence of edible plants and animals	Total or average stock in kg/ha
Water	Presence of water reservoirs	Total amount of water (m^3/ha)
NTFPs	Presence of species or abiotic elements with potential use for timber, fuel, or raw material	Total biomass (kg/ha)
Regulating services		
Climate regulation	Influence of ecosystems on local and global climate through land-cover and biologically-mediated processes	Carbon sequestration- kg/ha/year
Natural hazard mitigation	Role of forests in reducing extreme events (flood protection damage)	Water storage capacity (m^3)
Water regulation	Role of forests in water infiltration and release of water	Water retention capacity in soils or at the surface
Erosion control	Role of vegetation and biota in soil retention	Vegetation cover Root-matrix
Pollination	Abundance and effectiveness of pollinators	Number and impact of pollinating species
Cultural services		
Spiritual and religious inspiration	Landscape features or species with spiritual and religious value	Presence of landscape features or species with spiritual value
Cultural heritage and identity	Culturally important landscape features or species	Number/area of culturally important landscape features or species
Inspiration for culture, art, and design	Landscape features or species with inspirational value to the human arts	Number/area of landscape features with inspirational value
Supporting services		
Nursery habitat	Ability of ecosystems to provide breeding, feeding, or resting habitat for transient species (i.e., birds)	Number of transient species and their spatial distribution

Source: Adapted from De Groot et al. (2010) and Van Oudenhoven et al. (2012)

Fisher et al. (2008) proposed a conceptual framework that links these ecosystem services to human welfare through a supply and demand relationship, shown in Figure 2.2. In this framework, the x-axis is the level of ecosystem service provision, and the y-axis represents marginal human welfare (in monetary terms). The demand curve, $D_{ES(M)}$ represents the marketed ecosystem service benefits, where the Rand value represents the market's willingness to pay for one more unit (marginal value). Moreover, $D_{ES(MNM)}$ is the demand curve for all ecosystem service benefits, including non-market services such as flood protection or erosion control. Because most ecosystem services are non-market goods, the $D_{ES(MNM)}$ demand curve is generally expected to lie above the $D_{ES(M)}$ demand curve.

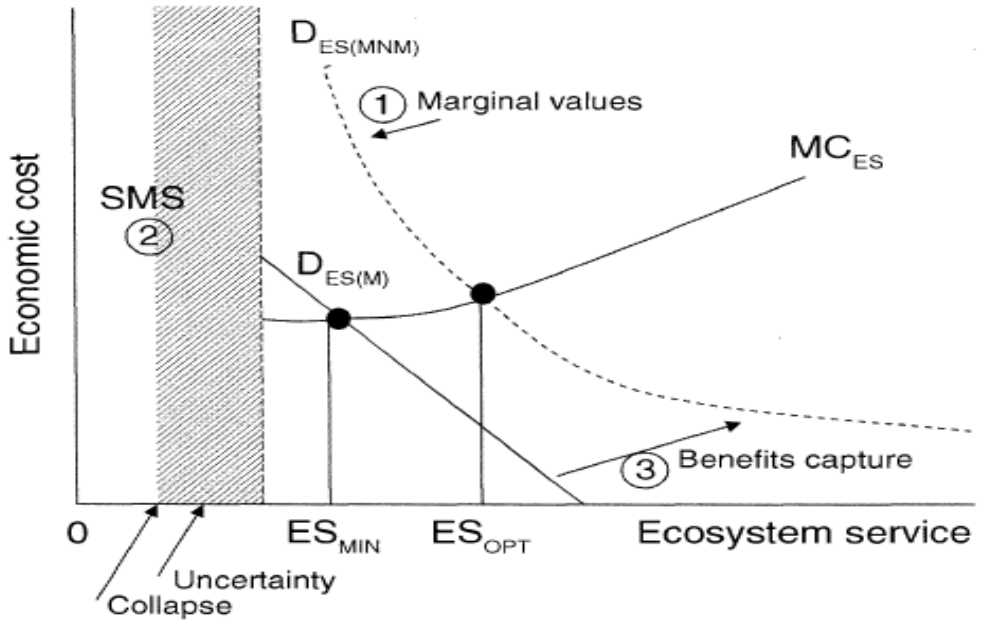


Figure 2.2 An economic framework for ecosystem service provision and human welfare
Source: Fisher et al. (2008)

Furthermore, Fisher et al. (2008) explain that MC_{ES} represents the supply curve, the marginal cost of acquiring and managing additional units of ecosystems. The minimum safe standard (SMS) is the minimum level of ecosystem structure and function at which a well-functioning ecosystem is maintained and capable of supplying services. Thus, if marginal changes occur beyond this point, ecosystem degradation and the potential collapse of the system result. Point ES_{MIN} and ES_{OPT} are derived from the equimarginal principle in economics, which states that the cost of providing an extra unit of the ecosystem equals the benefits derived from that unit. Moreover, ES_{MIN} is the point at which only marketed services of an area are provided (demanded), and E_{SOPT} is the optimal level of forest diversity and cover that supplies other services, such as water regulation. Any point to the left of ES_{OPT} means that the benefits of increased ecosystem functioning outweigh the costs.

Figure 2.2 above indicates the importance of maintaining ecosystem service provision above the SMS. The SMS is the ecological threshold below which ecosystem structure and functioning become compromised. Movement towards the SMS from either ES_{OPT} or ES_{MIN} shows a reduction in the provision of ecosystem conditions and services. As the provision of ecosystem services approaches the SMS, the risk of ecosystem degradation increases, reducing the ecosystem's capacity to provide both marketed and non-marketed services. Though Figure 2.2 does not explicitly identify a carrying-capacity or ecological collapse point beyond the SMS, such a threshold may be inferred to exist, where continued degradation eventually results in the loss of ecosystem functioning and the provision of ecosystem services.

However, from an economic perspective, the shift from ES_{MIN} to ES_{OPT} reflects an expansion of the provision of ecosystem services from marketed services to a broader set that includes regulating and supporting services, as represented by $D_{ES(MNM)}$. However, the provision and maintenance of additional ecosystem services are associated with increasing marginal costs, as shown by the MC_{ES} curve. Furthermore, as ecosystem use further increases and ecosystem condition deteriorates towards SMS, the public incurs not only the direct costs of ecosystem use but also increasing marginal user costs associated with the depletion of ecosystem assets and loss of future ecosystem service benefits. As a result, maintaining the provision of ecosystem services close to ES_{OPT} is preferable because it balances the marginal benefits represented by $D_{ES(MNM)}$ with the marginal costs represented by MC_{ES}, while avoiding a shift to ecological thresholds that may compromise the long-term sustainability of ecosystems.

The concepts discussed in this section inform the empirical approaches conducted in this study. It established the basis for identifying forest ecosystem services relevant to household livelihoods and NTFP dependence, as well as for environmental valuation. Also, regulating services such as flood control and climate regulation can influence how exposed households are to CC risks and, ultimately, their perceptions of CC risk, which are analysed in the subsequent chapter.

In the following section, an incentive-based land management approach, a payment for ecosystem services (PES) scheme, is discussed as a mechanism for improving ecosystems whilst improving livelihoods and environmental sustainability.

2.4 Payment for ecosystem services

The reforestation project is a PES programme through its tree-prenuer initiative. It is a system where land users are compensated for the environmental services they provide (Pagiola et al., 2002). On the other hand, Wunder (2005) presents a definition of PES as "a voluntary transaction in which a well-defined environmental service or a form of land use that is likely to secure that service is bought by at least one ecosystem service buyer from a minimum of one ecosystem service provider, if and only if the provider continues to supply that service." Additionally, there are various types of PES, including area- and product-based schemes, public and private schemes, and use-restricting and asset-building schemes (Wunder, 2008). The reforestation project fits the definition of the asset-building PES as it seeks to restore an area's ecosystem services.

The PES address market failures by converting external non-market environmental benefits into financial incentives (Engel et al., 2008; OECD, 2010). Communities whose land-use decisions impact the provision of ecosystem services are incentivised through direct payments to modify their behaviour to either reduce ecosystem service loss or improve their provision (OECD, 2010). Thus, payments made within a PES are

for land use and, consequently, are to land users (Pagiola et al., 2005). These PES stem from various market deals (Table 2.5).

Table 2.5. Different types of markets and PES

Market deals	Description
1. Public payment schemes for private landowners *(either to maintain or promote ecosystem services)*	These PES agreements typically involve direct payments from a government agency or another public institution to landowners and/or managers.
2. Formal markets with open trading between buyers and sellers: a. Under a regulatory cap or floor *(on the level of ecosystem services to be provided)*, or	a. Regulatory ecosystem service markets are formed through legislation that creates demand for specific ecosystem services by setting a cap on the damage to, or investment directed at, an ecosystem service. Service users respond either by complying directly or trading with others who meet the regulation at a lower cost. Buyers are defined by the legislation, but are usually private-sector or other institutions. Sellers may also be companies or other institutions legally permitted to sell.
b. Voluntarily	b. Voluntary market exchanges also exist. They occur, for instance, when organisations seek to reduce their carbon footprints to promote their brands, anticipate new regulations, or for other motivations.
3. Self-organised private deals *(individual beneficiaries of ecosystem services contract directly with providers of those services)*	Private PES deals exist in instances where there are no formal regulatory markets and limited government involvement. In these circumstances, buyers of ecosystem services may be private companies or conservationists who reimburse landowners to modify their management practices to enhance the quality of the ecosystem services the buyer seeks to maintain or depends on. The reasons for such transactions are as varied as the buyers.

Source: UNEP (2008)

The reforestation project is an example of a public payment scheme in which the eThekwini Municipality allocates funds to rehabilitate a previously agricultural area into a forest by paying surrounding communities to plant trees, thereby improving carbon sequestration services. According to Engel et al. (2008) and Smith et al. (2013), the basic logic of a PES can be illustrated in Figures 2.3 and 2.4 below. Farmers, loggers, and protected area managers usually receive few benefits from land use, such as forest conservation. Moreover, the benefits they receive are often less than those from alternative land uses (i.e., there is a greater probability of private benefits from conversion to pasture). However, this option incurs costs for downstream ecosystem beneficiaries, including reduced watershed services, biodiversity loss, and increased carbon emissions.

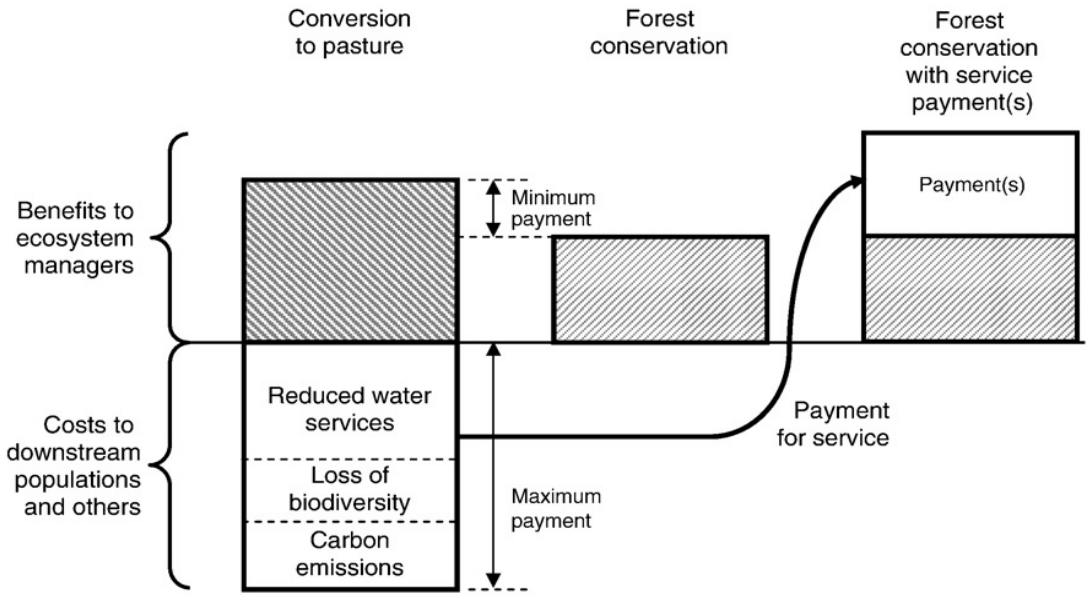


Figure 2.3. The basic logic of the PES mechanism
Source: Engel et al. (2008)

According to the OECD (2010), the 'minimum payment' that a landholder is willing to accept as compensation to preserve the forest is the missed opportunity cost of the subsequent best alternative land use, and the 'maximum payment' that a downstream service user is willing to pay for conservation is the total costs of damage sustained when the land was changed to pasture. So, if the potential benefits of conservation exceed the 'minimum payment' (see Figure 2.3), then PES schemes eventually become mutually beneficial (OECD, 2010). PES schemes are highly effective, provided that payments cover land managers' opportunity costs of changing their land-use practices to environmentally friendly activities (OECD, 2010). According to the OECD (2010), any payment made between the minimum and maximum should be suitable to encourage adjustments to improve ecosystem services.

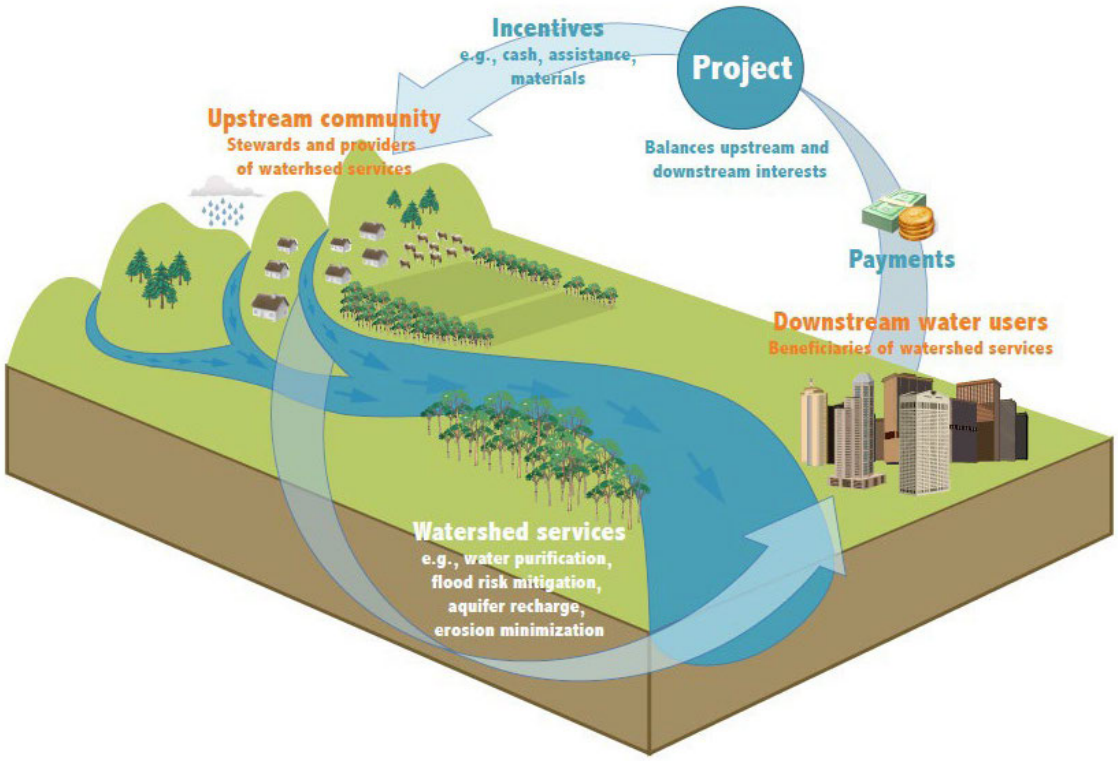


Figure 2.4. An illustration of the PES concept in terms of payment for watersheds
Source: Smith et al. (2013)

The PES system typically provides extra income to poor land-using households, thus helping to enhance their livelihoods (Pagiola et al., 2005). However, the impact of PES might not necessarily be positive. For instance, Kosoy et al. (2007), conducted a study to compare three cases of payments for water-related environmental services in Central America. It was found that opportunity costs are the amounts paid, indicating that trade-offs among various social and ecological goals have emerged, raising doubts about the capacity of PES to serve as instruments for environmental improvement and rural development. Moreover, a positive impact on poverty reduction will largely depend on the number of poor project participants, the poor's ability to participate, and the amounts paid (Pagiola et al., 2005). The issues or constraints that might thwart poverty reduction seem diverse and largely depend on the PES adopted. For example, if a PES scheme restricts land-use activities (capping them), the livelihoods of poor groups engaged in these activities will be harmed (Wunder, 2005).

The PES approach was not designed to be a pro-poor poverty-reduction strategy. It was designed to promote the efficiency of environmental management (Pagiola et al., 2005; Khanal and Paudel, 2012). PES programmes emerged because natural systems provide positive environmental externalities or ecosystem services that are not accounted for in individual economic decisions (Kosoy et al., 2007). According to

Wunder (2005), the Clean Development Mechanism (CDM) only recognises forest PES schemes in reforestation or afforestation projects, such as the Reforestation project, as having additionality. Additionality refers to the requirement that the environmental benefits created by a project exceed those that would have occurred in its absence. For example, in the CDM context, reforestation and afforestation projects are recognised because the carbon sequestration and ecosystem restoration benefits, they generate are additional to the baseline scenario in which restoration activity would occur. They make a difference relative to the baseline or provide environmental benefits. However, Engel et al. (2008) state that PES are not a panacea for all environmental problems but are instruments designed to address specific problems.

Engel et al. (2008) present a framework for measuring whether PES schemes achieve environmental improvements relative to the baseline scenario, i.e., their effectiveness (Figure 2.5). This framework maps land uses according to their net profitability (horizontal axis) and the net value of environmental services that they produce (vertical axis). Therefore, a land management practice in the top-right quadrant will be a 'win-win' when land users generate profits while generating positive externalities. The shaded area in Figure 2.5 represents the trade-off region between the value of the environmental service and on-site profits, where in the bottom-left quadrant, any land practice will be 'lose-lose, whereas in the bottom-right quadrant, land-use practices are profitable but generate negative externalities. In contrast, in the top-left quadrant, unprofitable land-use practices generate positive externalities. Accordingly, in the top-left quadrant, PES operate to encourage ecosystem-generating land-use practices. In Figure 2.5, the diagonal divides land-use practices that have a positive value to society (above) from those that have a negative value (below).

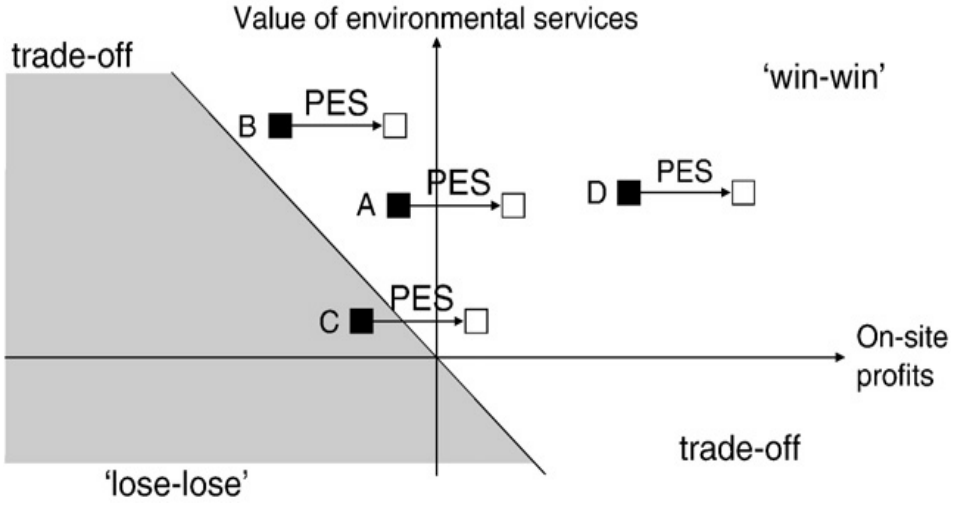


Figure 2.5. Framework for analysing the effectiveness of PES
Source: Engel et al. (2008)

Points A, B, C, and D, in Figure 2.5, illustrate cases of inefficiency that a PES scheme might encounter. For instance, point A illustrates a scenario in which a PES scheme aims to make unprofitable yet socially acceptable land-use practices profitable for land users. Moreover, case C represents a PES scheme that encourages socially undesirable land management practices to supply environmental services. But then, at a higher cost than the value of services, or case D, where a PES scheme pays for land-use practices that would have been adopted in any case, these inefficiencies could have broader implications, including reduced additionality and the permanence of the PES scheme. For instance, in the case of C, social inefficiencies typically arise when the social benefit of a practice is less than its costs, thereby reducing social welfare.

2.5 An overview of forestry-based carbon sequestration projects

High concentrations of CO_2, a greenhouse gas, in the atmosphere have caused rapid changes in the Earth's climate (Sundquist et al., 2008), and there are two strategies available to mitigate these high CO_2 levels. It is either by emission reductions or increasing plant-based biomass to serve as sinks for atmospheric CO_2 (Zomer et al., 2008). The term for the processes by which CO_2 is removed from the atmosphere or diverted from emission sources is carbon sequestration. There are three types: terrestrial, oceanic, and geological carbon sequestration (Sundquist et al., 2008; Zomer et al., 2008). This study focuses on the terrestrial carbon sequestration process.

Terrestrial plants, especially grasslands and forests, play a significant role in the global carbon cycle since they store large quantities of carbon (Figure 2.6) (Sundquist et al., 2008; Valencia, 2012). As shown in Figure 2.6, forests are both a source and a sink of atmospheric CO_2, since they emit carbon when disturbed, naturally or through human activities, and absorb atmospheric CO_2 due to increased vegetation biomass after reforestation (Zomer et al., 2008). Therefore, this shows that terrestrial carbon sequestration can be achieved by restoring and creating new forests, wetlands, and grasslands (Sundquist et al., 2008).

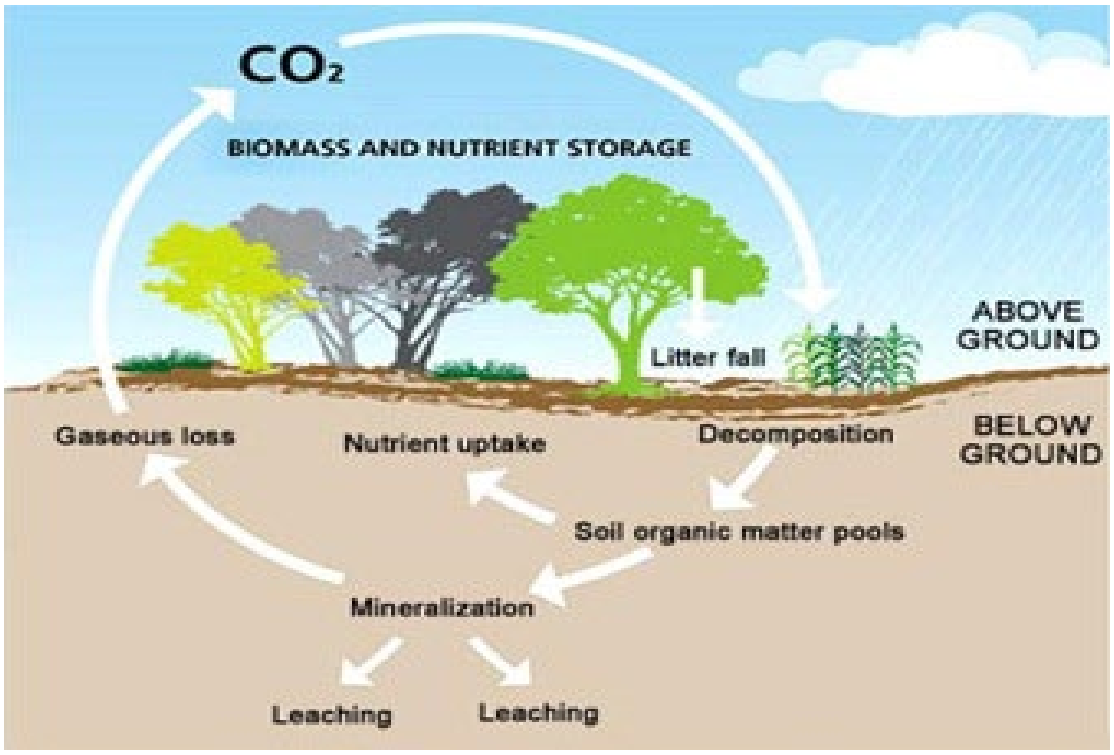


Figure 2.6. A depiction of the process of terrestrial atmospheric CO_2 sequestration
Source: Valencia (2012)

In developing countries, emission-reduction measures such as reforestation must consider socio-economic factors, including poverty reduction and social equity, to be sustainable in the long term (Boyd et al., 2007). Additionally, reforestation projects are considered successful when participants' income is guaranteed, degraded lands are restored, and sustainable development goals are achieved (Thomas et al., 2010). Still, some challenges can constrain the success of reforestation projects, such as long-term investments in the project, equitable sharing of benefits, natural hazards (i.e., fire and floods), unreliable land tenure, and retaining a political interest in such initiatives (Roberts, 2008; Thomas et al., 2010; Torpey-Saboe et al., 2015).

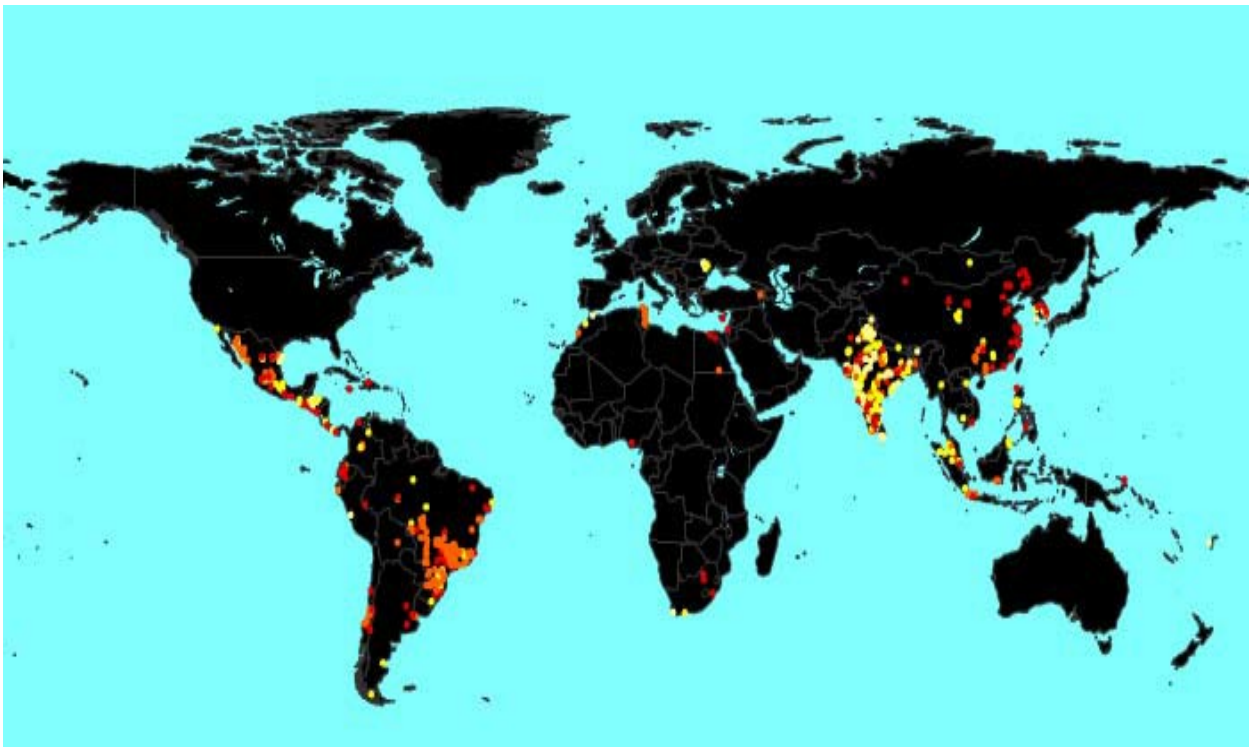


Figure 2.7. The distribution of CDM-registered carbon sequestration projects in the developing world
Source: Nanasta (2007)

Africa contributes the least to CC and will experience the harshest impacts of its effects (Unruh, 2008). However, developed countries have attempted to cut emissions and enhance carbon sequestration. The CDMs introduced by the Kyoto Protocol have enabled developed countries to finance carbon sequestration projects in developing countries in exchange for carbon offsets (Jindal et al., 2008). According to Nanasta (2007), usually, there are fewer carbon offset projects in Africa than in other developing regions. For example, there were 464 registered projects in Asia and the Pacific, 280 in Latin America and the Caribbean, and 21 in Africa as of 2007 (Figure 2.7) (Nanasta, 2007). The United Nations Framework Convention on Climate Change (UNFCCC) Secretariat has made an earnest request for Africa to initiate more carbon sequestration projects. This means that decision-makers and researchers have to find ways to help Africa improve its role in CC mitigation (Jindal et al., 2008).

Several reforestation projects, particularly those implemented in forests, provide tangible CC mitigation and adaptation benefits in Africa (Jindal et al., 2008). These projects are funded by different organisations around the world, namely, the World Bank through its World Bank BioCarbon Fund, the largest investor of carbon sequestration projects in Africa, the Global Environment Facility, the United States Agency for International Development, the Forest Absorbing Carbon Emissions Foundation, and the European Union (Jindal, 2006). However, most carbon sequestration interventions in Africa are relatively recent, and their

impacts on participants are not well documented (Jindal et al., 2008). Jindal (2006) and Jindal *et al.* (2008) report a list of carbon sequestration projects that have taken place, are ongoing, or are new. The authors reviewed over 20 carbon sequestration projects across 14 African countries. The review revealed that numerous carbon sequestration projects are located in East Africa. However, the location of these projects depends on rainfall and water availability across Africa. There are areas on the continent that are not conducive to large-scale tree planting for carbon sequestration. The average size of these projects is around 700 hectares. Some of these projects are initiated for commercial objectives without providing any benefit to local communities, while others serve as research initiatives aimed at improving carbon sequestration. These projects are estimated to sequester, on average, 1.79 million tons of carbon dioxide (MtCO2) per project, totalling 26 $MtCO_2$ (Jindal et al., 2008).

2.6 Non-timber forest product dependence

Poor households in rural and some urban areas with access to natural areas depend on various NTFPs for subsistence, traditional medicine, and materials used in home-based industries (Belcher and Vantomme, 2003). Numerous studies (Kamanga et al., 2009; Wale et al., 2022; Shackleton, 2004; Heubach et al., 2011; Nerfa et al., 2020) show that NTFPs play an important role in household income generation, either as a supplementary source of income or as a primary source of cash income for poor rural households. Beyond their economic role, forests and NTFPs also have social, cultural, and religious significance in many communities (Cocks and Wiersum, 2003; Sharaunga et al., 2013). However, the contribution of NTFPs to livelihoods varies spatially, temporally and across communities, as well as in the types and quantities of NTFPs utilised (Garekae et al., 2017; Pandey et al., 2016).

Forest degradation, deforestation, and biodiversity loss are significant challenges for forest management in developing countries, particularly where forests contribute significantly to rural livelihoods (Pandey et al., 2016; Shackleton, 2004). Global interest in NTFPs has increased as evidence accumulates regarding their importance in supporting forest-dependent households (Pandey et al., 2016). Despite this, the significance of NTFPs receives limited attention in poverty alleviation strategies, land-use planning and policy debates, and in the budgets of government departments responsible for forestry, agriculture, rural development, environmental management, and energy (Shackleton and Pandey, 2014; Pandey et al., 2016). Nevertheless, the economic importance of NTFPs has become increasingly recognised due to their contribution to household livelihoods and income security (Shackleton, 2004; Garekae et al., 2017; Wale et al., 2022).

In the South African context, there is limited empirical evidence on the determinants of forest dependence among rural households, leading to an incomplete understanding of forests' contributions to community livelihoods (Wale et al., 2022). This gap limits the development of effective community-based forest

management strategies that simultaneously support livelihoods and sustain forest ecosystems (Heubach et al., 2011). Thus, addressing this gap is a key empirical objective of this study: to examine the level and determinants of household dependence on NTFPs in peri-urban communities.

The concept of forest dependency is widely used in the literature, but its definition varies across contexts (Newton et al., 2016). Therefore, clearly defining forest dependency is important before empirical measurement (Masozera and Alavalapati, 2004; Illukpitiya and Yanagida, 2008; Heubach et al., 2011). Clear definitions enable stakeholders, including policymakers, donors, project managers, and non-governmental organisations, to interpret findings appropriately within the intended contexts (Newton et al., 2016). Studies have used different approaches to define and assess forest dependency (Nerfa et al., 2020).

For example, a few studies have defined forest dependency as reliance on specific forest products, using selected products as indicators of dependence (Heubach et al., 2011). Others adopted an income-based approach, measuring forest dependency as the proportion of household income derived from forest resources relative to total household income (Illukpitiya and Yanagida, 2008; Wale et al., 2022). In another study, Garekae et al. (2017) examined the socioeconomic factors influencing household forest dependence and measured dependency using a forest dependency index (FDI) based on the frequency and volume of forest product collection. These approaches show that income-based and activity-based measures have been extensively applied in the literature.

However, income-based measures of forest dependency have been criticised for assigning monetary values to forest products that are often consumed rather than sold, thereby underestimating dependence among subsistence households (Nerfa et al., 2020). Such approaches also fail to account for the non-monetary costs of NTFP collection, including time and labour. In addressing these limitations, some studies adopted multidimensional indices to measure various aspects of livelihood dependence on forests, such as forest product collection, collection effort, asset-based wealth, and non-forest livelihood strategies (Nerfa et al., 2020). Comparisons between index-based and income-based approaches show that multidimensional indices provide a broader understanding of household forest dependence across multiple dimensions. While several studies have used income to measure NTFP dependence (Kaoma and Shackleton, 2015; Garekae et al., 2017; Wale et al., 2022), this study used a behavioural approach. A regression-weighted NTFP dependence index was created from subsistence indicators. This approach captures NTFP dependence through actual engagement with NTFPs rather than relying on income data, which, according to Cavendish (2000), is unreliable and difficult to measure accurately.

2.7 Review of risk perceptions

Risk is the probability of experiencing an adverse consequence (Jones, 2001). In this study, risk is the likelihood that a detrimental environmental outcome will occur due to an action or condition (Jones, 2001). Individuals assess hazardous circumstances based on intuition or risk beliefs, often referred to as risk perceptions (Botzen, 2013). Accordingly, CC risk perception in this study is conceptualised as the perceived likelihood of negative consequences to individuals and society from CC-related phenomena. This conceptualisation informs the construction of the CC perception indicator utilised in the empirical analysis in Chapter 3.

According to IPCC (2021), CC is not an isolated event but a gradual process that occurs over decades. Although the annual changes are marginal, they accumulate over time to produce significant long-term effects. Therefore, individual actions to address possible CC-related risks depend on perceptions of risk, not necessarily on what actually happens. This distinction is empirically relevant, as household decisions regarding insurance purchases and public support for government risk-reduction or CC adaptation policies depend on perceived rather than observed risk levels (Botzen, 2013). Furthermore, household risk perceptions contribute to the credibility and legitimacy of compliance with risk-reduction and CC adaptation policies implemented by governments (Botzen, 2013), while higher risk perceptions have been associated with increased political buy-in for risk-reduction projects (Viscusi and Hamilton, 1999).

Environmental systems are characterised by complexity and interrelationships that can lead to uncertainty in environmental processes, events, and outcomes. This is especially true when global warming is involved, making environmental risk management probabilistic (Etkin and Ho, 2007). The problem, CC, is also multidimensional, multisectoral, and interconnected, and the uncertainty surrounding its impacts contributes to diverse risk perceptions and confusion in public discourse, thereby reducing individuals' willingness to engage in CC mitigation or adaptation efforts (Lorenzoni et al., 2007; Weber, 2010). Therefore, this study allows for heterogeneity in households' CC-related risk perceptions.

Public perceptions of CC are shaped by a complex interaction of psychological, social, moral and cultural factors which influence how climate risks are interpreted and how behavioural responses shape them (Van der Linden, 2015; Leiserowitz, 2006). Despite growing scientific consensus, CC is misunderstood by many in society due to its abstract nature, spatial variability, long temporal horizon, and high politicisation in public discourse (Etkin and Ho, 2007; Whitmarsh, 2011). These characteristics further support the need to examine how households perceive risks and the factors that influence these perceptions.

Studies suggest that CC awareness and concern are increasing, with public support for a range of policies to reduce its impacts (Leiserowitz, 2007; Gandure et al., 2013). For instance, Mertz et al. (2009) found that

local communities were aware of CC-related phenomena such as extreme droughts and excessive rainfall. Patt and Schröter (2008) showed that policies promoting adaptation to CC risks in Mozambique were not implemented due to disagreements among policymakers about the seriousness of CC risks, showing that scientific knowledge alone is inadequate for effective policy implementation. Likewise, a study in the Limpopo Basin of South Africa indicates that farmers' perceptions of CC are consistent with the climatic data record. In the U.S., Leiserowitz (2006) found moderate perceptions of CC risk and support for CC mitigation policies, with these perceptions influenced by psychological and sociocultural factors. These studies highlight the importance of considering community perceptions of CC in adaptation-based policy design, further supporting the empirical direction of this study.

Recent research into CC risk perceptions has moved away from one-dimensional, holistic measures due to their limitation in providing insights into the determinants and components of CC risk perception (Leiserowitz, 2006). Instead, there is recognition that CC risk perceptions are shaped by psychological and social dimensions that are scarcely considered in surveys, such as personal experience, emotion, imagery, trust, affect, and cultural worldviews (Slovic and Peters, 1998; Slovic, 1999). This suggests that CC risk perception should be analysed as a multi-dimensional construct. These psychological and social dimensions can enable decision makers to consider aspects previously deemed unnecessary. For instance, decisions made under risk can be influenced by 'Affect', defined as positive or negative feelings associated with specific objects, images, ideas and events, which have previously been underrepresented in decision theory (Leiserowitz, 2006; Loewenstein and Lerner, 2001). This "affective heuristic" describes how emotional reactions shape judgment and decision-making, leading individuals to rely more on emotions than on analytical reasoning (Marx et al., 2007). As a result, decisions might not always be rational, deviating from utility maximisation and leading individuals to respond more to perceived gains or losses than to objective outcomes (Tversky and Kahneman, 1974; Kahneman and Tversky, 2013; Slovic et al., 2007). These behavioural insights provide support for the inclusion of affective and experiential variables in the empirical analysis. Household factors, such as age, gender, education, and household size, have been shown to significantly shape perceptions of CC risk (O'Connor et al., 1999; Deressa et al., 2011). Hence, this study includes these characteristics to identify the determinants of household CC perception. Given the aforementioned literature, there is a need to assess CC risk perception, explore it as a multidimensional construct, and determine the socio-economic and psychosocial factors that shape it.

2.8 Environmental valuation

Monetary values used in social decision-making should be derived from the public rather than imposed by government authorities (Daily et al., 2000). The basis for environmental valuation is the concept of total

economic value (TEV) (Plottu and Plottu, 2007). The concept is applied in environmental and resource economics to quantify the benefits of ecosystem goods and services (Freeman et al., 2014).

The benefits derived from ecosystem goods and services include use values (UVs) and non-use values (NUVs) (Jakobsson and Dragun, 1996; Chee, 2004). The UVs capture the tangible and intangible benefits derived from interactions with environmental resources and are categorised into direct-use values (DUVs), indirect-use values (IUVs), and option values (OVs) (Kramer et al., 1995; Jakobsson and Dragun, 1996). This distinction is important empirically, as it informs the selection of valuation methods and the identification of attributes to include in preference elicitation.

The DUVs arise from an environmental asset's contribution to current production or consumption activities, such as recreation, fishing and forestry (Kramer et al., 1995). These values are typically assessed using market prices or travel cost methods (Freeman et al., 2014). The IUVs refer to benefits derived from ecosystem functions that support human well-being, including services such as pollination and water filtration provided by wetlands (Freeman et al., 2014). The values are estimated using the replacement-cost or production-function approaches (Plottu and Plottu, 2007). The OVs represent the value individuals place on preserving ecosystem goods and services for potential future use and are often estimated using stated-preference methods such as contingent valuation or choice experiments (CEs) (Jakobsson and Dragun, 1996; Freeman et al., 2014).

The NUVs reflect the value individuals assign to environmental resources, independent of any current or planned use, and include existence values (EVs) and bequest values (BVs) (Kramer et al., 1995; Chee, 2004). The EVs arise from the satisfaction of knowing that a species, ecosystem, or environmental service exists, even in the absence of direct use (Chee, 2004). The BVs reflect the desire to conserve environmental resources for the benefit of current and future generations. Both EVs and BVs are normally estimated using willingness-to-pay (WTP) surveys within stated-preference frameworks (Plottu and Plottu, 2007; Freeman et al., 2014). These values are more relevant in situations where communities value conservation over direct resource extraction.

Environmental valuation depends on the availability of relevant and accurate data on ecosystem processes and functions, as well as the appropriate application of economic valuation techniques (Turner et al., 2010). Environmental valuation methods are categorised into market-based, revealed and stated-preference methods (Chee, 2004; Atkinson and Mourato, 2008). Market-based methods rely on observed market transactions to infer environmental values, including the market price method, the production function approach, the replacement cost method, and the damage cost avoided (Croci et al., 2021; Hanley et al., 2009). The market price method uses direct market transactions to find values, the production function

method measures the effect of change in the quantity of the environmental goods and services on input costs and the output level of the marketed good, replacement cost method determines the value of replacing ecosystem goods and services with built alternatives, and the damage cost avoided method measures avoided costs due to environmental protection (Chee, 2004; Croci et al., 2021; Hanley et al., 2009).

Revealed preference and stated preference assign economic value to non-market environmental goods and services (Atkinson and Mourato, 2008). Typical revealed preference techniques include the travel cost method and hedonic pricing, which infer values from observed behaviour in related markets (Bateman, 1993). The travel cost method estimates values based on consumption behaviour associated with site visitation, while the hedonic pricing method uses the market price of the good to derive or estimate the value of its desirable features (Lancaster, 1966; Hanley et al., 2009). However, these methods are limited to observable behaviour and are not suitable for valuing passive use benefits.

Stated preference methods, by contrast, use survey-based methods and hypothetical markets to elicit preferences for environmental goods and services that lack observable market transactions (Atkinson and Mourato, 2008). The contingent valuation method (CVM) is a stated-preference technique based on the premise that individuals hold latent preferences that can be elicited through appropriately designed questions (Jakobsson and Dragun, 1996). Another stated-preference method used in valuation is choice modelling, which presents respondents with alternatives described by attributes and levels and requires them to make trade-offs among competing options (Adamowicz et al., 1998; Hanley et al., 2001). These trade-offs form the basis for estimating marginal values for specific attributes.

Therefore, selecting an appropriate valuation approach is important when assessing the benefits households derive from forest ecosystem goods and services. Communities living adjacent to forested areas derive a range of benefits from forests, including provisioning, regulating, and cultural services (Sharaunga et al., 2013; Wale et al., 2022). Many of these benefits, especially those associated with EVs and BVs, cannot be captured by market-based or revealed-preference methods because they do not involve observable market transactions (Chee, 2004). Therefore, stated preference methods are more suitable for estimating household preferences and willingness to pay for forest-based ecosystem services.

Among the stated-preference methods, this study adopts a CE approach rather than a CVM. The CVM is subject to hypothetical bias and strategic behaviour due to its reliance on unrealistic, direct WTP questions that do not reflect real-world decision-making processes involving trade-offs (Carson and Groves, 2007; Bennett and Blamey, 2001). In contrast, CE minimises these biases by presenting respondents with realistic trade-offs among multiple attributes, and by estimating implicit prices for these attributes rather than a single monetary value (Hanley et al., 2001). Since CE requires respondents to make trade-offs among

attribute levels, it avoids the scope insensitivity problem in CVM, in which WTP remains constant as the level of the environmental good or service changes (Kahneman and Knetsch, 1992). Additionally, CVM assumes homogeneous preferences, whereas CE allows for individual-specific preferences, which account for heterogeneity and make it more useful for policy decision-making in heterogeneous settings, such as peri-urban areas (Scarpa and Thiene, 2005). Based on the above discussion, the empirical analysis in Chapter 5 utilises the CE method to estimate household preferences and willingness to pay for forest ecosystem services.

2.9 Summary of the gaps identified in the literature

The literature review conducted identified several gaps relevant to this study. Despite the recognised importance of NTFPs in supporting household livelihoods, there is limited empirical evidence on the determinants of forest dependence within peri-urban communities, particularly in South Africa. Existing studies have mainly focused on rural contexts and have commonly measured forest dependence using income-based approaches. Such approaches may underestimate the contribution of NTFPs because many forest products are consumed directly rather than sold. Furthermore, few studies have employed behavioural measures that capture actual household engagement in NTFP collection and utilisation. Therefore, there remains a need for alternative approaches to assessing NTFP dependence that rely on observed subsistence behaviour rather than income alone.

Although CC risk perception has received considerable attention in the literature, many studies continue to rely on broad or one-dimensional measures of perception, which limit understanding of the factors shaping climate-related risk perceptions. The review further showed that psychosocial factors, such as affect, cultural worldviews, and psychological characteristics, remain underrepresented in empirical analyses, particularly in peri-urban contexts. Hence, there is a need to examine CC perceptions as a multidimensional construct and to investigate the influence of psychosocial and socio-economic factors on these perceptions.

Stated preference methods are widely applied in environmental valuation studies. However, there is limited research examining household preferences for ecosystem services generated by reforestation projects in peri-urban South African contexts. Moreover, most studies explain preference heterogeneity through socio-demographic characteristics, with limited attention to cultural worldviews and psychological factors that could influence household preferences and decision-making, thereby limiting understanding of the mechanisms underlying household preferences for ecosystem services.

Despite reforestation and carbon sequestration projects being promoted as CC mitigation and ecosystem restoration strategies, their socio-economic dimensions remain insufficiently understood. Existing research has focused mainly on environmental outcomes, with less attention paid to how households interact with

these projects through their dependence on NTFPs, perceptions of CC, and preferences for ecosystem service provision.

To address these gaps, this study adopted a multidisciplinary approach that integrates the Sustainable Livelihood Framework (SLF), psychosocial constructs, and environmental valuation methods. In particular, the study develops a behavioural NTFP dependence index, examines the socio-economic and psychosocial determinants of CC perceptions, and household preferences for forest ecosystem attributes associated with the reforestation project. So, the study contributes to the limited empirical evidence on the socio-economic dimensions of community-based reforestation projects and PES schemes in peri-urban South Africa.

2.10 Summary

This chapter reviewed literature on urbanisation in African cities and their vulnerability to CC. It also reviewed ecosystem service typologies, PES schemes, NTFP dependence, CC risk perception and environmental valuation. The review revealed that urbanisation and city life are attracting a large pool of poor rural individuals who wish to reside near urban centres, often settling on the periphery of cities, as these areas are the only locations they can afford. However, these peri-urban areas are frequently characterised by informal settlements, insecure tenure, poor service provision, limited accessibility, environmental degradation, and exposure to hazards associated with undesirable land uses such as landfill sites. Households residing in these areas often depend on natural resources, including forests and NTFPs, for subsistence, medicinal purposes and livelihood support.

The review further showed that peri-urban communities are vulnerable to the impacts of CC, which may undermine both livelihoods and ecosystem integrity. Addressing these challenges requires interventions that simultaneously support sustainable livelihoods, environmental conservation, resilience to CC-related shocks and stresses. In this regard, the Buffelsdraai Landfill Community Reforestation Project is an example of a sustainable land management initiative with an embedded PES framework that seeks to enhance the provision of ecosystem services while supporting livelihoods. The review also highlighted the importance of incorporating socio-economic considerations, such as poverty reduction and social equity, to ensure the long-term sustainability of such interventions

The literature demonstrates that household dependence on forests is multifaceted and cannot be fully captured by income-based measures alone. Consequently, this study adopts a behavioural approach to measuring NTFP dependence by constructing an index based on household subsistence activities. The review also showed that there is uncertainty about how CC perceptions are shaped by a complex interaction of psychological, social, moral, and cultural factors that influence how individuals interpret climate risks and respond, shaping their behaviour. Furthermore, the review highlighted the need for an appropriate

valuation approach to estimate the value peri-urban households place on forest ecosystem services and their preferences for improvements in these services. Accordingly, the choice experiment (CE) approach was identified as the most suitable method for this study.

CHAPTER 3

PSYCHOSOCIAL DETERMINANTS OF HOUSEHOLD CLIMATE CHANGE PERCEPTIONS IN DURBAN

3.1 Introduction

This chapter examines CC perception to identify the factors that influence household CC perception and the degree to which they do so. The behavioural decision theory (BDT) framework, cultural theory, positive psychological capital, positive organisational behaviour (POB), and the double hurdle (DH) model were used in the analysis. This chapter has been structured as follows. Sections 3.2 and 3.3 explain the conceptual framework and empirical methodologies applied in the study, respectively. Section 3.4 discusses and analyses the results, presenting insights into the factors influencing local community members' perceptions of CC. Finally, section 3.5 presents the study's summary.

3.2 Research methodology

3.2.1 Conceptual approach

Understanding the psychosocial determinants of CC perceptions is important for developing effective strategies to mitigate and adapt to CC impacts. Therefore, the framework used in this study is based on BDT, cultural theory, positive psychological capital, and positive POB. A multidisciplinary approach incorporating concepts from economics, psychology, sociology, statistics, and others is essential for understanding the cognitive processes and biases that influence individual decision-making (Payne et al., 1992). According to Tversky and Kahneman (1974), people use heuristics (mental shortcuts), which can bias their judgments and decisions. Heuristics offer insights into how individuals perceive and respond to CC risk. It is indicated that risk perception is shaped by familiarity, dread, and controllability and is not solely based on empirical data (Slovic, 1987). Thus, incorporating cognitive processes will enhance understanding of CC perceptions and their determinants.

Boholm (1996) presents a cultural theory for understanding how individuals judge danger, pollution, and threats, suggesting that their decisions are not independent of their social background. The theory developed by Douglas and Wildavsky (1983) proposes that individuals' views on specific matters are shaped by the dynamics of their social groups and the extent to which they feel bonded to them. Four cultural views were identified: individualism, egalitarianism, hierarchism, and fatalism. These factors shape attitudes and judgments on risk perception, including those related to CC. From this theory, Leiserowitz (2006) identified values that influence CC risk perception. By incorporating these values, cultural theory will enhance the

understanding of the socio-cultural determinants of CC perceptions, demonstrating how cultural biases influence cognitive processes and risk perceptions in the Buffelsdraai and Osindisweni communities.

The POB focuses on studying and applying positive psychological capital to improve performance (Luthans, 2002). In the context of CC, POB offers insights into how positive psychological constructs influence perceptions and behaviours of CC. The primary constructs in POB include hope, optimism, resilience, and self-efficacy (De Waal and Pienaar, 2013). Climate change and sustainability are about the future, and so is hope. Hope, a positive motivational state, can drive proactive environmental behaviours, encouraging individuals and organisations to engage in sustainability programmes regardless of challenges (Snyder et al., 1991). Optimism influences individuals' attitudes towards acting on CC by reinforcing the belief that efforts to mitigate CC will be effective (Scheier and Carver, 1985). So, individuals with high psychological capital, hope and optimism are likely to support green practice initiatives, advocate for sustainable policies and view environmental challenges such as CC as opportunities for innovation and adaptation (Avey et al., 2010; Ojala, 2012). Resilience, the ability to recover from setbacks and adapt to change, is crucial for coping with the impacts of CC (Luthans et al., 2004). Self-efficacy, or the belief in one's ability to achieve goals, encourages individuals to engage in climate-positive behaviours (Bandura, 1997). Individuals with high self-efficacy are likely to participate in sustainable initiatives and advocate for environmental policies, since such efforts are perceived as effective (Tabernero and Hernández, 2011). Moreover, individuals with self-efficacy have strong beliefs in their ability to influence climate outcomes, show resilience in facing environmental challenges, are proactive in problem-solving, and can often commit to long-term mitigation and sustainability efforts (Van Zomeren et al., 2010; Gifford and Nilsson, 2014). Thus, integrating these positive psychological constructs will provide insight into the psychological determinants of CC perceptions.

Nevertheless, alternative conceptual approaches to studying CC perceptions exist. They are the theory of planned behaviour (TPB) (Ajzen, 1991), the protection motivation theory (PMT) (Rogers, 1975), and the value-belief-norm (VBN) framework (Stern et al., 1999). These frameworks provide valuable insights, but have limitations relative to the objectives of this study. The TPB framework is associated with individual attitudes, norms, and behavioural intentions, but it does not consider the emotional and cultural dimensions. The PMT considers perceived severity, vulnerability, and self-efficacy to explain people’s responses to perceived threats. However, it focuses on threats and overlooks positive psychological traits, such as hope, optimism, or resilience, that are important for risk perceptions and adaptive behaviours in response to CC effects. Similarly, the VBN framework highlights how individuals' moral motivations and norms shape pro-environmental behaviours. Though it assumes that values and environmental beliefs (i.e., belief in the reality of CC) translate linearly into pro-environmental actions. So, this assumption makes the framework

less applicable, as it discounts affective heuristics or local context that could interrupt the VBN chain, since individuals might not always judge based on their values but on feelings about environmental issues, such as CC, as well as by local cultural norms and social capital. Therefore, to account for the limitations of each theory and maximise their benefits, the study draws on BDT, POB, and cultural theory to provide an integrated and flexible model that captures the cognitive, affective, heuristic, and cultural aspects of CC perception.

3.2.2 Empirical strategies employed for analysing climate change perceptions

The PCA was used to reduce the variables into interpretable dimensions. The Double Hurdle (DH)model employed the probit model in the first stage to analyse the likelihood of perceiving CC, and a truncated regression model in the second stage to understand the factors influencing the level of these perceptions.

3.2.2.1 Principal component analysis

The PCA is a statistical method that reduces the dimensionality of large datasets while preserving as much of the variation as possible from the original dataset (Nicol et al., 2007). The technique involves transforming data into a new set of uncorrelated variables, called principal components (PCs), which are linear combinations of the original dataset's variables (Jolliffe and Cadima, 2016). These PCs are organised by the variance they capture, with the first PC accounting for the greatest variation in the data and subsequent PCs capturing progressively smaller proportions of the total variation in the original dataset (Jolliffe and Cadima, 2016). Moreover, PCA has been used to generate composite indices in several studies (Nicol et al., 2007; Mabuza et al., 2015; Sinyolo et al., 2017; Hitayezu et al., 2017; Chipfupa et al., 2021; Phakathi and Wale, 2018) to aggregate multiple indicators representing a specific concept into index scores. In this approach, resultant dominant PCs with an eigenvalue greater than one are selected and subsequently used as indices (Mabuza et al., 2015). Hence, this study used PCA to analyse indicators of CC perceptions, social and psychological capital, and social values, and to extract PCs to create composite indices.

3.2.2.2 Double hurdle model

According to Deressa et al. (2011), the general practice in studying CC perceptions of natural resource-dependent communities is comparing household surveys or scenario-based statements with meteorological data, as the method assists in determining if respondents' perceptions of CC are consistent with observed, recorded meteorological data on temperature, rainfall and wind patterns (Foguesatto et al., 2018). However, the approach could be more effective in identifying determinants of CC awareness and perception (Deressa et al., 2011).

Perceptions of CC were obtained through a survey. However, some respondents may refuse to answer specific questions or interrupt their interviews, resulting in missing values for some variables (Martínez-Espiñeira, 2006; Jones and Yen, 2000). Nevertheless, there are techniques to address this issue, including Tobit, Heckman's selectivity, and Double-Hurdle (DH) models; researchers recommend the DH model over Tobit and selectivity models primarily because it is more flexible (Jones, 2000; Madden, 2008). The Tobit model assumes that the decision to perceive CC and the level of CC perception have similar determinants. The model treats zeros in the data as censored observations rather than the result of separate decision-making processes. This means households with zero values are assumed to have unobservable factors, just as those with positive values do. In the context of this study, households do not necessarily move from non-perception to a specific level of CC perception, as the Tobit model assumes. Instead, CC perception consists of two separate stochastic processes. The first is whether a household head perceives CC, which is a binary decision, and the second is the level of perceived CC. So, selecting a statistical technique to address these zero observations has implications for the empirical results, especially when inappropriately treated, which could yield biased and inconsistent coefficients (Jones and Yen, 2000).

The DH model, developed in the 1970s and widely used to model household expenditure, agricultural consumption, and loan defaults (Martínez-Espiñeira, 2006), is more flexible because it allows for two separate stochastic processes, making it more suitable than the Tobit model. Using the DH approach, CC perception is a two-stage stochastic process in which the household head must clear the first hurdle (1st hurdle) in the first stage to proceed to the next stage (Figure 3.1). According to Maddison (2007), this stage is influenced by several socio-economic factors, including age, gender, media exposure, education, and cultural beliefs. In this stage, the probit model was used to estimate the probability of perceiving CC. After the household head has crossed the perception threshold, the final stage (2^{nd} hurdle) is the intensity of CC perception (see Figure 3.1), which reflects how strongly the household head perceives CC. This stage was typically influenced by political ideology, experiences with extreme weather or social networks (Deressa et al., 2009). Hence, unlike the Tobit model, which assumes that factors influencing CC perception and level are the same, the DH model allows different explanatory variables to influence each stage of the process.

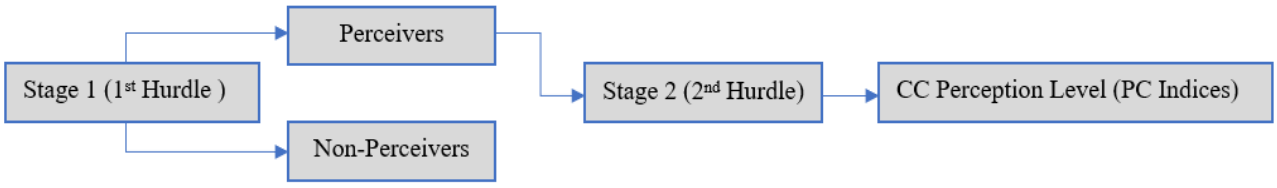


Figure 3.1. The sequence of CC perception analysis in a Double Hurdle model

The two stages of the DH model for CC perception (Martínez-Espiñeira, 2006) can be specified as follows:

$CCp_i = 1$ if $CCp_i^* > 0$ and 0 if $CCp_i^* \leq 0$ $\quad i = 1, 2, \ldots\ldots, n$

$$CCp_i^* = \alpha Z_i + \varepsilon_i \quad \textbf{3.1}$$

where $\boldsymbol{CCp_i^*}$ is a binary variable that takes the value 1 if the respondent perceives CC and 0, otherwise. $\boldsymbol{Z_i}$ is a vector of explanatory variables influencing the probability of perceiving CC, and $\boldsymbol{\alpha}$ is a vector of parameters. The model for the level of CC perception can be expressed as follows:

$CCpl_i = CCpl_i^*$ *if* $CCpl_i^* > 0$ $\quad i = 1, 2, \ldots\ldots, n$

$CCpl_i = 0$ *otherwise*

$$CCpl_i^* = \beta X_i + \mu_i \quad \textbf{3.2}$$

where $\boldsymbol{CCpl_i^*}$ is the observed level of CC perceptions, $\boldsymbol{X_i}$ is a vector of factors that explain the probability of a perceived level of CC, and $\boldsymbol{\beta}$ is a vector of parameters. The error terms $\boldsymbol{\varepsilon_i}$ and $\boldsymbol{\mu_i}$ are assumed to be independently distributed such that $\begin{pmatrix}\varepsilon_i \\ \mu_i\end{pmatrix} \sim N\left[\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}1 & 0\\0 & \sigma^2\end{pmatrix}\right]$. The log-likelihood function for the DH model (Martínez-Espiñeira, 2006) is:

$$LogL = \sum_0 ln\left[1 - \Phi(\alpha Z_i)\left(\frac{\beta X_i}{\sigma}\right)\right] + \sum_+ ln\left[\Phi(\alpha Z_i)\frac{1}{\sigma}\emptyset\left(\frac{CCp_i - \beta X_i}{\sigma}\right)\right] \quad \textbf{3.3}$$

where Φ and $\emptyset$ are the standard normal cumulative and probability density functions, respectively. So, considering the assumptions of normality and independence of the error terms, the likelihood function above will yield the probability of perceiving CC and the level of CC perception, and it is represented as follows:

$$Pr(CCp_i > 0) = \Phi(\alpha Z_i)\,\Phi\left(\frac{\beta X_i}{\sigma}\right) \quad \textbf{3.4}$$

and

$$E(CCp_i \mid CCp_i > 0) = \Phi\left(\frac{\beta X_i}{\sigma_i}\right)^{-1} \int_0^{\infty}\left(\frac{CCp_i}{\sigma_i\sqrt{1+\theta^2 CCp_i{}^2}}\,\Phi\left(\frac{T(\theta Y_i - \beta X_i)}{\sigma_i}\right)\right) dCCp_i \quad \textbf{3.5}$$

Therefore, the likelihood function integrated the probit (equation 3.4) and truncation (equation 3.5) regression model. Parameter estimates were obtained by running separate regression models in the first and second stages of the DH analysis. Moreover, marginal effects are suitable for assessing and interpreting DH model estimates. This occurs when the marginal effect on the probability of perceiving CC and the level of CC perception concerning the explanatory variables are decomposed, which can be expressed as:

$$E(CCp_i \mid X_i) = Pr(CCp_i > 0)\, E(CCp_i \mid CCp_i > 0) \quad \textbf{3.6}$$

$\boldsymbol{E(CCp_i \mid X_i)}$ is the expected value of CC perception given the explanatory variables. $\boldsymbol{CCp_i}$ is the observed CC perception for individual *i,* $\boldsymbol{X_i}$ is a vector of factors that explain the probability of CC perception. $\boldsymbol{Pr(CCp_i > 0)}$ is the probability that a respondent has a non-zero perception of CC in the first hurdle. $\boldsymbol{E(CCp_i \mid CCp_i > 0)}$ is the expected value of the CC perception level in the second hurdle, given that a respondent participates (i.e. perceives CC in the first hurdle).

Although the DH model allows different explanatory variables in the first hurdle (whether CC is perceived) and the second hurdle (CC perception level), this study specifies the same set of variables in both hurdles, enabling a direct comparison of whether determinants of CC perception differ across the two hurdles.

3.2.2.3 Variables in the double hurdle model

In the last stage of the DH model, the dependent variable was a composite variable derived from PCA and households' responses to eight questions on their perceived experiences of 'changes in temperature, rainfall and wind occurrences' over the years. PCA was used to reduce the dimensionality of the perception variables into a much smaller number of composite variables whilst retaining, as much as possible, the variation of the original variables (Jolliffe and Cadima, 2016).

Age was expected to influence CC risk perception and was captured as the age of the household's head, measured in years. Older farmers or persons have experience and are more likely to perceive CC through changes in rainfall or temperature, and to feel more vulnerable to extreme climatic events or environmental hazards (Maddison, 2007; Gbetibouo, 2009). A quadratic form for age (age squared) was included to account for the non-linear effect of age. Moreover, the gender of the household head also affects whether CC is perceived. Women are more likely to perceive the world as risky (O'Connor et al., 1999), so presumably they are more likely to perceive CC risks. Education in peri-urban settings is likely to be negatively associated with CC perception and awareness, since more educated household heads often have greater opportunities in nearby urban sectors of the economy and are less likely to pay attention to CC and its impacts (Hitayezu et al., 2017).

The adult equivalent is a scale for household resource needs, whether economic or nutritional, based on household characteristics such as age and gender (Demoussis and Mihalopoulos, 2001). Each household member is assigned a scaling factor relative to the household's adult member. Then the adult equivalence of the household equals the sum of the scaled equivalence values. Households with higher summed adult equivalence values are larger and likely have higher resource demands, which increases their sensitivity to and perception of CC incidents, such as droughts or floods, that affect food or water supplies. Studies have shown that adult equivalents are linked to CC perceptions, and, thus, CC perceptions are considered for

analysis in this study (Maziya and Nkonki-Mandleni, 2024; Hitayezu et al., 2017). The affect heuristic refers to the feelings individuals experience when making decisions under risk (Leiserowitz, 2006). In this study, affective heuristics were measured on a 5-point Likert scale, and household respondents were asked questions designed to capture their positive and negative emotions toward CC. These emotive responses have been shown to shape risk perception and decision-making processes (Slovic et al., 2013). According to Weber (2006), individuals tend to rely more on their affective responses than analytical reasoning when forming perceptions. Thus, by considering emotions, holistic affect offers insight into how households emotionally connect with CC, which, in turn, shapes their risk perception, levels of concern, and willingness to engage in proactive measures (Smith and Leiserowitz, 2014).

Table 3.1 Variables used in the Double Hurdle Model

Dependent variables	**Description of variables**
CC-Perception	Climate is changing: 1 = Yes, 0 = otherwise
CC-Perception Level	PCA estimated the CC perception index
Independent variables	
Age	Age of the household head in years
Age squared	Age of the household head squared.
Gender	Household head gender: 1= Female, 0= otherwise
Education	Education of the household head (categorical)
Adult equivalent	Number of equivalent adults in the household
Affect	Feelings/general impressions on climate change: 5-point Likert scale
Tree-prenuer	Number of years the household has been part of the project
Livestock	Value of livestock owned by the household head (Rand)
Agricultural assets	Value of agricultural assets owned by the household head (Rand)
Road	Walking distance to access the nearest road (in minutes)
Electricity	Walking distance to access electricity (in minutes)
Water	Walking distance to access water taps (in minutes)
Social capital	PCA estimated the social capital index
Cultural worldviews	PCA estimated cultural worldviews index
Psychological capital	PCA estimated the psychological capital index

Source: Household survey data (2018)

Tree-preneurs are beneficiaries of the reforestation project. They plant indigenous trees and are incentivised through a voucher system (Macfarlane et al., 2015). Incentives linked to reforestation efforts have been shown to shape risk perceptions, as economic reliance on environmental restoration projects increases perceptions of CC (Kaczan and Swallow, 2019), since the state of the environment is directly linked to their livelihoods. According to Maziya et al. (2024), environmental attitudes and perceptions are formed by exposure to environmental knowledge and economic benefits. Furthermore, participation in climate mitigation activities influences cognitive adaptation processes and, in turn, reduces perceived risk of CC through self-efficacy and local values (Peng et al., 2024). Duration of participation in environmental programmes affects risk perception by instilling a sense of control or complacency in addressing CC issues

(Shackleton et al., 2015). Therefore, selecting and including “Tree-prenuer” will provide insights into the relationship between the duration of participation in the reforestation project and perceptions of CC.

The study includes agricultural assets and livestock values, which explain how productive assets and wealth influence CC perceptions in the communities. Households with more agricultural assets and livestock are regarded as wealthy, incentivised to engage in land-based economic activities, and adapt to CC (Wale et al., 2022; Deressa et al., 2008). According to Smit and Wandel (2006), the community's occupancy characteristics, including agricultural assets, affect its exposure to and sensitivity to climate-related risks. The value of household livestock can serve as a financial safety net during climate crises (Thornton et al., 2009). Moreover, livestock further affects risk perception, as households with more livestock are better prepared to absorb the risk associated with CC (Eakin, 2005). In contrast, households that experience livestock losses due to adverse weather events become more concerned about CC (Seo and Mendelsohn, 2008), heightening their perception of CC. Adger (2006) emphasised that assets are essential in determining how economic security shapes climate risk perception. Therefore, information on how the value of agricultural assets and livestock shapes CC perceptions in the Buffelsdraai and Osindisweni communities is important.

According to Lanjouw et al. (2001), peri-urban areas have better access to roads and electricity than rural areas, which in turn leads to better economic opportunities. Most households in these areas rely primarily on non-farm income-generating activities, including small businesses, professional employment, and non-farm wages (Mandere et al., 2010). Roads significantly enhance mobility, for instance, more impact CC through greenhouse gas emission and increases the probability of contact with business centres, access to education, and media, thereby increasing the chances for improved climate knowledge, adaptation strategies and employment (Mandere et al., 2010; Lanjouw et al., 2001; Dercon et al., 2009). Furthermore, roads are important drivers of land-use changes, deforestation, and urbanisation, which alter local climates and shape perceptions of environmental change (Laurance et al., 2014). Hence, road access was included as an explanatory variable, measured as the distance to the nearest road (in minutes), to determine its influence on household-level CC perception.

In sub-Saharan Africa, access to electricity remains limited, and a considerable proportion of the population relies mainly on traditional biomass, such as wood and charcoal, to meet their energy needs (Ketlhoilwe and Kanene, 2018; Mpandeli et al., 2018). Without sufficient reforestation, unsustainable firewood extraction leads to deforestation and reduces forests' capacity to mitigate the impacts of CC (Ketlhoilwe and Kanene, 2018). Although there have been projects to extend electricity connections, some households continue to rely on biomass due to the perceived high cost of electricity (Mpandeli et al., 2018). Therefore, electricity is important for understanding CC perception, as it affects households’ exposure to information

through television, radio, and the internet, thereby shaping awareness and attitudes (Lee et al., 2020). Moreover, households with better access to electricity are likely to participate in climate discourse and associate CC with emissions, whereas those dependent on biomass may attribute CC to deforestation and unpredictable rainfall (Pachauri and Spreng, 2011; Van der Kroon et al., 2013). In both cases, households can form CC perceptions, but these perceptions can go in either direction. Since electrification typically improves living standards, affluent households may not form CC perceptions due to reduced and immediate vulnerability to extreme weather shocks, thereby decreasing their awareness of CC. Hence, another aspect of this study is investigating whether electricity access influences CC perception and level.

Access to water is important because changes in rainfall patterns, droughts, and water scarcity significantly affect the livelihoods of rural and agricultural communities (IPCC, 2021). In South Africa, water consumption has increased due to population growth, with water needs encompassing cooking, washing, agriculture, and other critical economic endeavours (Onyenankeya et al., 2021; Adeyeye et al., 2020). The percentage of South African households with access to tap water, both on-site and off-site, has increased by 4.3 percent since 2002 (StatsSA, 2021). In 2021, approximately 45.2 percent of households had access to tap water in their dwellings, 12.2 percent relied on communal taps, and 1.9 percent relied on neighbours' taps (StatsSA, 2021). Moreover, 29.4 percent of the population has access to piped water on their premises, while 2.3 percent utilise boreholes. Also, 1.5 percent of households collect water from rainwater-harvesting tanks installed at their residences, and 1.7 percent rely on tankers for water supply. Approximately 1.6 percent of households purchase water from vendors, whereas 0.9 per cent retrieve water from off-property boreholes. Furthermore, 1.8 percent depend on other sources, such as rivers and streams, whereas 0.1 percent collect water from standing water bodies such as pools, dams, or ponds. Meanwhile, 0.2 percent of households source water from wells, and 0.6 percent from natural springs. Some households with recurrent clean water shortages tend to link these disruptions to CC and, in turn, shape their perceptions of CC (Bryan et al., 2009; McMichael et al., 2006). CC perception is shaped by the affordability and reliability of water supplies, as households dependent on rainwater or unregulated sources are more exposed to CC than those with piped water infrastructure (Hope et al., 2020). Therefore, understanding how water access influences CC perception is important, particularly considering South Africa's water scarcity challenges exacerbated by CC's impacts on rainfall, water resources, and urban ecosystems (Adeyeye et al., 2020; Ahmed et al., 2020).

The model integrated cultural theory values based on established evidence linking these values to CC risk perception (Slovic and Peters, 1998; Leiserowitz, 2006). According to Rippl (2002), the hypothesised modes of risk perception for each prototypical cultural theory value are as follows: hierarchical individuals are inclined to accept authority and justify risks associated with decisions made by governments and

experts. These individuals are concerned about risks threatening the social order or status quo. Egalitarians tend to question risks that may result in irreversible harm to people or future generations. They are sceptical of risks imposed on them by decisions made by a small elite of experts or government authorities. Fatalists are strongly inclined towards socially assigned classifications but lack a sense of group identification. They prefer to ignore or remain unconcerned about things they cannot influence. Individualists perceive risk as an opportunity and view new technologies, for example, as possibilities rather than threats. The only risks they fear are those that could restrict their freedom. By considering these cultural theory values, studies would provide insights into perspectives that people from various cultural backgrounds may hold regarding CC risks (Rippl, 2002).

The study included PCA indices for psychological and social capital as independent variables. These indices were derived from indicators related to psychological and social capital. Social capital encompasses networks, social relationships, and group affiliations. Psychological constructs, including hope, resilience, optimism, and self-efficacy, were combined to form a composite index of psychological capital (Luthans and Youssef, 2004).

3.2.3 The data

3.2.3.1 Description of study area

The Buffelsdraai Landfill Site Community Reforestation Project is located approximately 25km north of Durban, in the KwaZulu-Natal Province, a province located on the eastern seaboard of South Africa (Figures 3.2 and 3.3) (2297km^2 area, 29.5- 30.3 °S, and 30.6- 31.2 °E) (Glenday, 2007; Knowles and Theron, 2010). The mean annual temperature in Durban is 21 °C, and precipitation ranges from 500mm to 1000mm, averaging 930mm (Glenday, 2007). The reforestation project area is situated in the buffer zone of the Buffelsdraai Landfill Site (Douwes et al., 2017). The Buffelsdraai Landfill Site was established in 2006 as a landfill for waste generated from the northern suburbs of Durban and adjacent areas, and it is managed by Durban Solid Waste (DSW) and located 5km east of Verulam, the nearest town (Figure 3.4) (Macfarlane et al., 2011; Knowles and Theron, 2010). The annual rainfall recorded for Verulam is approximately 766mm, with a monthly average of 108mm, and daily temperatures ranging from 22.2 °C to 27.4 °C on average (Knowles and Theron, 2010).

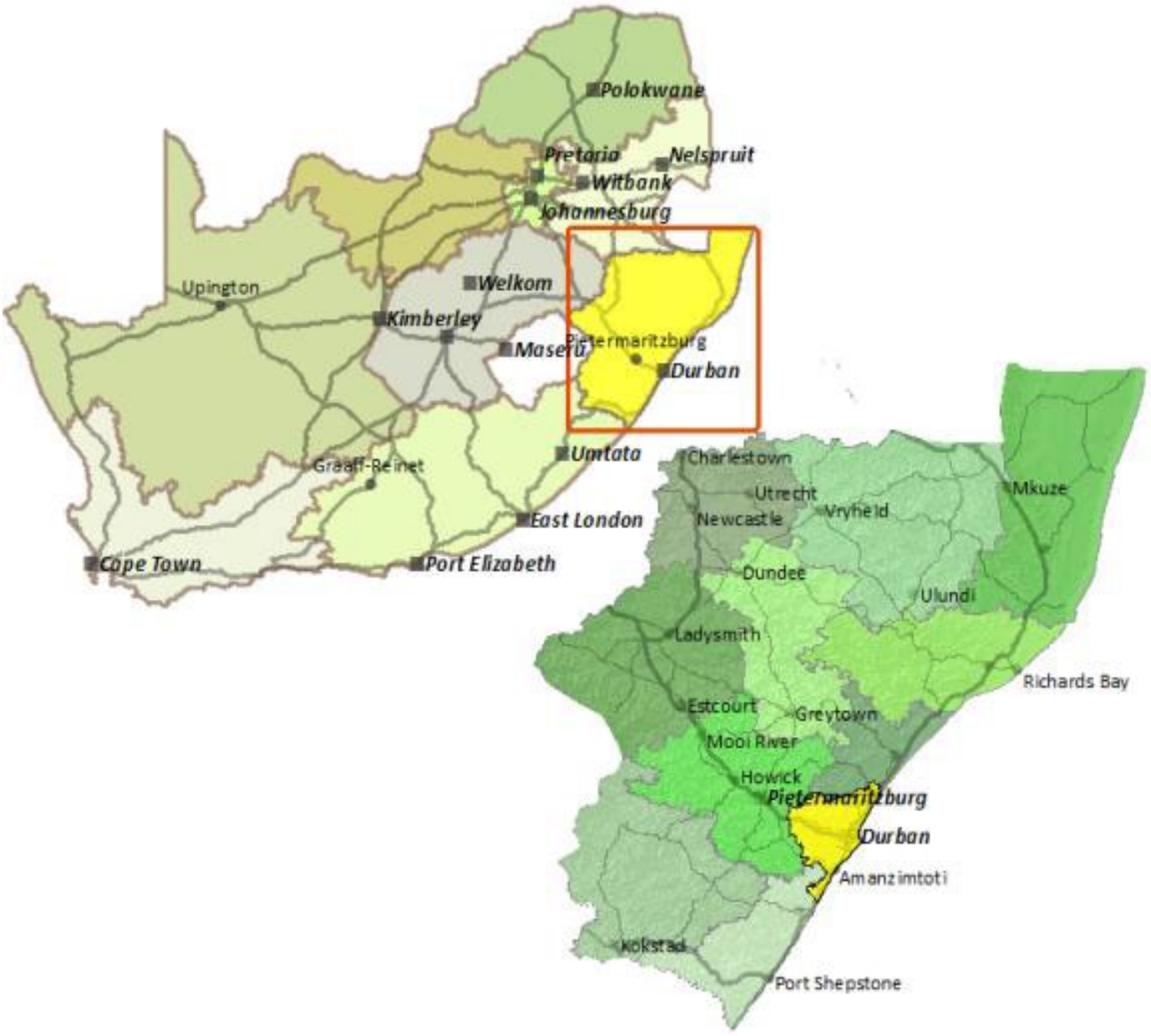


Figure 3.2. The geopolitical map of the Republic of South Africa showing the province of KwaZulu-Natal and the eThekwini Municipality in Durban
Source: eThekwini Municipality (2010).

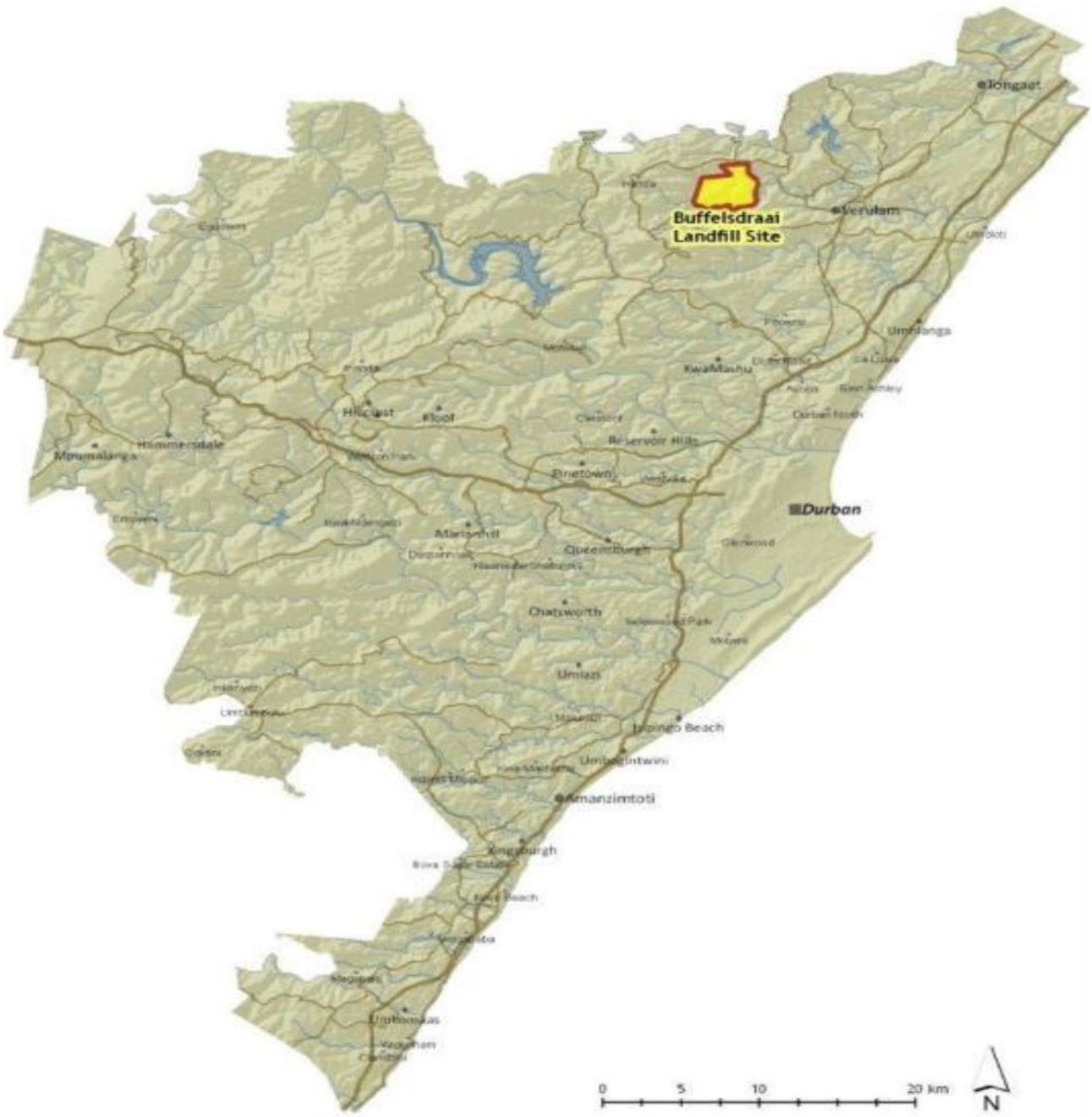


Figure 3.3. The location of the Buffelsdraai Landfill Site within the eThekwini Municipal boundary in Durban
Source: Whitley (2012)

Moreover, the site is 116.2ha in size and has been separated from the buffer zone by a fence (Douwes et al., 2017). The buffer zone is located between the active landfill and surrounding communities, covering approximately 787 hectares (Knowles and Theron, 2014). This area is required by law at any landfill site adjacent to communities, as it helps protect these communities from odours, noise, and unsightly operations associated with the landfill (Whitley, 2012). The project site was dominated by sugar cane fields, which

covered over 40 percent of the area. Large areas of natural vegetation types were present before the project's implementation. For instance, areas of indigenous and riparian forests and woodlands existed, ranging in size from 33.6 to 95.7 hectares (Macfarlane et al., 2011).

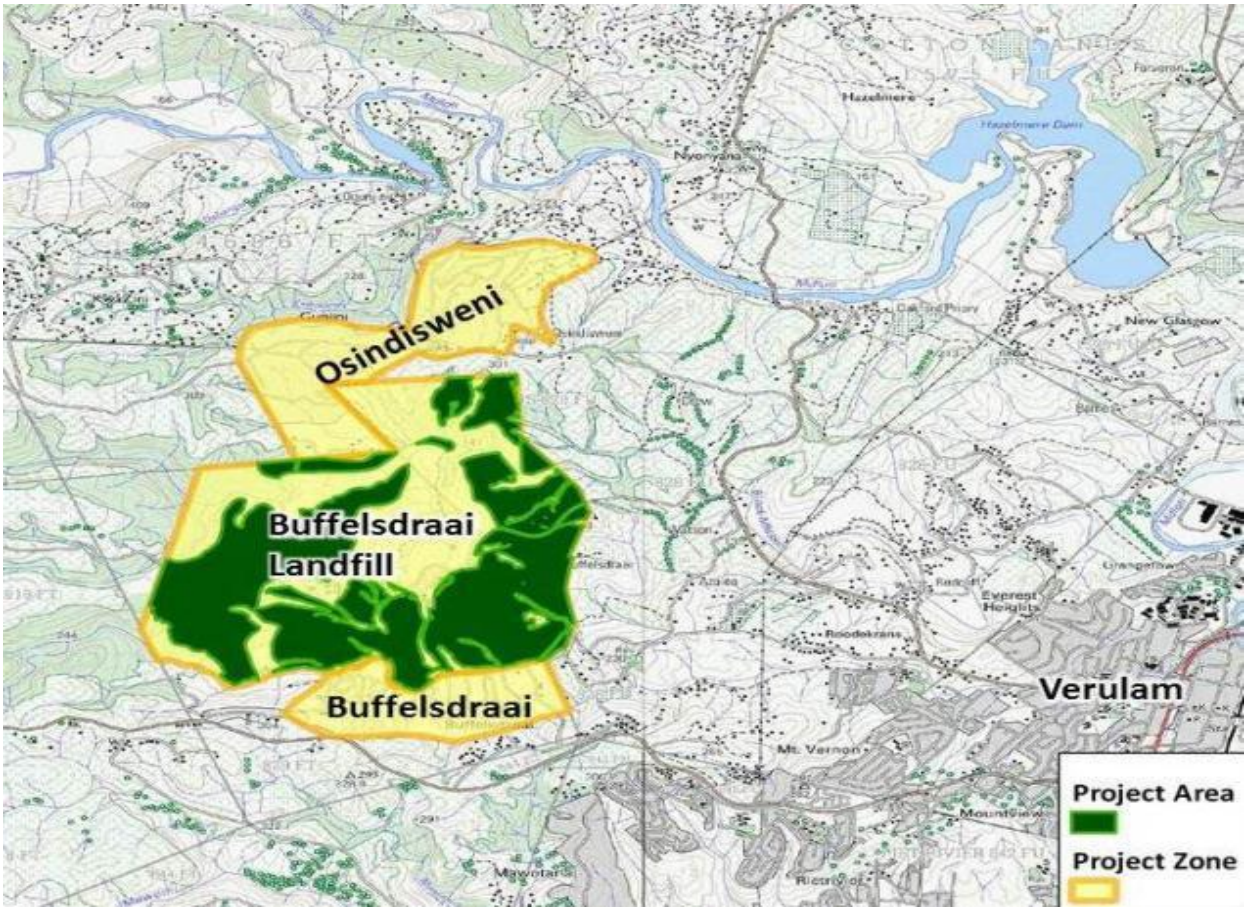


Figure 3.4. Location of Reforestation Project in the eThekwini Municipal area and two adjacent communities, Buffelsdraai and Osindisweni

Source: eThekwini Municipality (2010)

The reforestation project aimed to plant approximately 500 000 trees on 521-580 hectares of transformed or degraded natural habitats to form a continuous and functional forest buffer (Macfarlane et al., 2011)Thus far, over 595 476 trees have been planted, with 532 016 trees planted in the landfill buffer zone and 63,460 trees planted to form a 'living fence' with planting densities ranging from 125 to 3 850 saplings per hectare (Bertolli et al., 2013; Macfarlane et al., 2015). The trees planted under this project were selected for their suitability to the environment, specifically their indigenous status and alignment with local vegetation types, such as the KwaZulu-Natal Sandstone Sourveld and Coastal forest vegetation types, which are indigenous and considered threatened (Macfarlane et al., 2015). Indigenous tree species were propagated by 'Treepreneurs,' and selection was made in consultation with the eThekwini Municipality Environmental Planning and Climate Protection Department to ensure seedlings matched the ecological conditions

(Knowles and Theron, 2010). Peri-urban communities surround the project area to the west, south, and east, namely Buffelsdraai, Osindisweni, and KwaMashu (Mancebo, 2011). Buffelsdraai and Osindisweni are adjacent to the project site, whereas KwaMashu is farther away.

3.2.3.2 Sampling and data collection procedures

Quantitatively and qualitatively, data were collected through questionnaires, interviews and focus group discussions. The data collection procedure entailed sampling, determining the sampling design, selecting the sample size, conducting field surveys, and training enumerators, among other tasks. However, before these activities, contextual information on the dimensions being investigated in this study was obtained. This was done by identifying and interviewing key informants in the communities and in the reforestation project, who were likely to provide the required contextual information about the study areas and the dimensions under investigation. After conducting key informant interviews, open focus group discussions were held, comprising 8-12 participants per group, with four groups convened, including participants from the Buffelsdraai and Osindisweni communities. An isiZulu-speaking moderator facilitated the discussion sessions. These discussions were recorded with participants' consent and assurances that their responses would be kept anonymous. Households in these communities engaged in various livelihood activities, such as agriculture, livestock rearing, and the collection of non-timber forest products. Some were also participants in the reforestation project, known as ‘Treepreneurs’. The discussions centred on their perceptions and adaptations to CC, as well as their knowledge and use of ecosystem goods and services. They also explored their willingness to pay for the reforestation of the landfill site through contributions to a community trust fund, among other dimensions.

A questionnaire on the objectives of this study was then compiled (see Appendix A). The questionnaire included statements about the study's purpose and assurances of confidentiality, as well as sections on demographic information, capital endowment, and cultural worldviews in the first part; the second part included environmental valuation questions. The questionnaire was translated into isiZulu to aid comprehension of the questions when administered in person by enumerators to consenting respondents. Prior to the survey, five enumerators from the communities were trained to ensure consistency and accuracy in data collection. It is an approach that reduces response bias and minimises measurement errors, thereby enhancing replicability and enabling research across various contexts while maintaining validity, accuracy and quality (Jarbandhan and Schutte, 2006). Afterwards, a pilot survey was conducted to pretest the questionnaire with a selected number of households in either area. It provided an opportunity to observe and assess enumerator preparedness in the field and to identify any ambiguities or confusion regarding the questions. Moreover, it helped determine the time spent on each questionnaire, identify response bias and fatigue, and refine the wording of questions and the overall layout of the main survey.

Prior to the main survey, a sampling frame, an ordered list of possible individuals in the study communities, was constructed. The sampling frame for project participants (PES beneficiaries) was constructed with assistance from community facilitators in the target communities and from municipal project reports (Mancebo, 2011). Typically, the statistical requirement for obtaining reliable and representative statistics is 30 or more sample units. However, several factors determine the sample size, namely the study budget and time, the scale and nature of the study, and the possibility of nonresponse, which may reduce the sample size. According to Mancebo (2011), the Buffelsdraai and Osindisweni communities had populations of approximately 953 and 396, respectively. Thus, the sample size for each community was systematically determined as:

- For the Buffelsdraai community, with a population size (N) of 953, a margin of error at 5 percent, a confidence level of 95 percent and a sample proportion of 50 percent, the required sample size *(n)* was determined to be 274;
- Similarly, for the Osindisweni community, with a population size (N) of 396, a 5 percent margin of error, a 95 percent confidence level, and a sample proportion of 50 per cent, the required sample size *(n)* was 196.

This resulted in a total sample size of 470 households. However, due to budget constraints, the final sample size for this study was adjusted to 434 households. The study used a stratified multi-stage sampling approach to select household head respondents from the two communities. The list was not available for non-participating households. Therefore, selection for the project non-participants was field-based and random within each community. This approach allowed representation for both participants and non-participants across the study communities. Table 3.2 below shows the distribution of sampled households.

Table 3.2 Distribution of sampled households in each study area by reforestation project participation status and gender

Community	Participants		Non-participants		Total
	Male	Female	Male	Female	
Buffelsdraai	22	51	57	86	216
Osindisweni	16	64	62	76	218
Total	38	115	119	162	434

Source: Household survey data (2018)

Table 3.3 presents the relationships examined in the study and classifies the variables by their conceptual role. The outcome variables include CC perceptions, NTFP dependence, household preferences, and willingness to pay for forest ecosystem services. The main explanatory variables consist of the five livelihood capitals. Furthermore, psychosocial variables, including psychological capital, affect, and cultural worldviews, were included to capture the influence of values, emotions, beliefs, and psychological

characteristics on household behaviour, perceptions, and preferences. Finally, socio-demographic variables, such as age, gender, education, distance to the forest, adult equivalence and Tree-preneur status, were included as control variables to account for heterogeneity among the respondents. Further details on the description, measurement, and application of these variables are presented in the respective chapters addressing each of the study's objectives.

Table 3.3 Classification of the variables within the multidisciplinary framework of the study

Variable category	Variable
Outcomes variables	Climate change perceptions
	NTFP dependence index
	Ecosystem management preferences
Main explanatory variables	Livelihood capitals (human, financial, physical, natural and social capital)
Psychosocial variables	Social and psychological capital, and cultural worldviews, affect
Control variables	Age, gender, education, adult equivalent, tree-prenuer status, distance to forest area

Source: Author's construct

3.3 Results and discussions

3.3.1 Descriptive analysis of the study variables

Table 3.4 presents the variables used to assess household heads' perceptions of CC. The CC indicator "increase in unusual temperature" showed a significant difference between CC and non-CC perceivers, with a mean of 3.87 and 3.04, respectively. Accordingly, CC perceivers are likely to identify rising temperatures as an indication of CC. Additionally, CC perceivers reported significantly more abnormal hot days than non-CC perceivers did.

Table 3.4. Description of climate change perception variables

Climate change perception variable	Mean		T-statistic
	Perceivers	Non-Perceivers	
Increase in unusual temperature	3.87	3.04	***7.59
Abnormal hot days in summer	4.53	3.76	***3.43
Abnormal cold days in winter	3.86	3.24	**2.21
Abnormal rainfall	3.64	2.72	***5.74
Changes in rainfall patterns during the rainy season	2.98	2.88	0.57
Frequent drought occurrences	3.33	2.48	***4.41
Frequent flood occurrences	2.89	2.88	0.03
Abnormal changes in wind occurrences	3.75	3.2	***3.90

Note: ***, ** and * refer to significance at 1%, 5% and 10%, respectively
Source: Household survey data (2018)

Regarding 'abnormal cold days in winter,' the mean reported by CC non-perceivers was less than that reported by perceivers. This difference was statistically significant. Furthermore, those who perceived CC associated it with 'abnormal rainfall' (mean = 3.64), 'changes in frequent drought occurrences' (mean = 3.33), and 'abnormal changes in wind occurrences' (mean = 3.75), suggesting that respondents have awareness of extreme weather conditions in the community.

Table 3.5 presents summary statistics for the variables utilised in the estimation. There were no significant differences in age, gender, or education between CC perceivers and non-perceivers. Households, on average, consisted of 4.89 and 6.01 adult-equivalent members who had perceived and had not perceived a changing climate, respectively. Furthermore, CC perceivers had a higher mean level of Affective heuristic than CC non-perceivers. This suggests that households in this group experience an intense emotional response to extreme weather, which increases their emotional engagement with CC and may shape their perceptions of it.

Table 3.5. Summary statistics of climate change perceptions and socio-demographic variables

Dependent variable	Description	Mean		
		Perceivers	Non-perceivers	*t*-value
CCp	Climate is changing: 1 = Yes, 0 = otherwise	1	0	-
CCpl	CC perception level index (see section 3.3.2)	-	-	-
Explanatory variable				
Age	Age of household head in years	49.90	50.52	0.24
Age Squared	Age of household head squared	2649.68	2694.68	0.16
Gender	Household head gender: 1= Female, 0= otherwise	0.64	0.68	0.45
Education	Education of the household head (categorical)	6.64	6.92	0.29
Adults	Household size in adult equivalents	4.89	6.01	**2.14
Affect	Feelings on climate change: 5-point Likert scale	4.07	2.84	***5.32
Livestock	Average value of livestock owned (Rand)	2270.38	972	0.79
Agricultural assets	Average value of agricultural assets owned (Rand)	1146.81	416.44	0.29
Tree-prenuer	Experience in participation in the project (years)	0.36	0.28	0.78
Road	Walking distance to access the nearest road (in minutes)	7.67	9.24	0.58
Electricity	Walking distance to access electricity (in minutes)	0.39	1.08	**1.79
Water	Walking distance to access water taps (in minutes)	1.54	1.28	0.31
Social capital	PCA social capital index	-	-	-
Psychological capital	PCA psychological capital index	-	-	-
Cultural worldviews	PCA cultural worldviews index	-	-	-

Note: *. ** and * refer to significance at 10%, 5% and 1 % levels, respectively.
Source: Household survey data (2018)

Access to electricity was significantly different, with the mean of non-CC perceivers being 1.08 and that of CC perceivers, 0.39. The finding suggests that more households with access to electricity did not perceive abnormal or changing weather in the community. According to Pachauri and Spreng (2011), households with access to electricity tend to rely less on natural resources, which limits their exposure to and sensitivity to environmental factors, thereby reducing their awareness of CC. In contrast, fewer households have access to electricity and an understanding of CC. This further suggests that households in this group are directly dependent on environmental resources, increasing their likelihood of awareness of unusual weather changes.

3.3.2 Proxies for climate change perception

Table 3.6 presents the results of applying PCA to household heads' CC perception measures. The PCA produced three PCs with eigenvalues greater than 1. Furthermore, $CCpl_1$ accounted for 23.79 percent of the variation in the data, while $CCpl_2$ accounted for 16.61 percent and $CCpl_3$ for 12.82 percent. The components together explained 53.22 percent of the variation in the data.

Table 3.6. Dimensions of climate change perceptions

Climate change perception indicator	Principal Component		
	$CCpl_1$	**$CCpl_2$**	**$CCpl_3$**
Increase in unusual temperature	0.298	**0.517**	-0.026
Abnormal hot days in summer	0.234	**0.537**	-0.225
Abnormal cold days in winter	**0.419**	-0.269	0.198
Abnormal rainfall changes	0.389	0.172	-0.257
Changes in rainfall patterns during the rainy season	-0.345	0.320	**0.543**
Frequent drought occurrences	**0.400**	0.194	0.282
Frequent flood occurrences	0.354	**-0.428**	-0.219
Abnormal changes in wind occurrences	0.353	-0.139	**0.648**
Eigenvalue	1.90	1.33	1.03
Percentage of Variation	23.79	16.61	12.82
Cumulative Percentage	23.79	40.40	53.22
Kaiser-Meyer-Olkin (KMO)			0.636
Bartlett test of sphericity:			
Chi-square			230.82
Degrees of freedom			28
P-value			0.000

Note: PC loadings greater than |0.4| are highlighted in bold
Source: Household Survey Data (2018)

Moreover, two measures were used to assess the sampling adequacy of households' CC perception data for PCA: the Kaiser-Meyer-Olkin (KMO) measure and the Bartlett test of sphericity. The KMO test yielded a value of 0.64, indicating that the data are suitable for PCA. The results of Bartlett's test of sphericity indicated a chi-square statistic of 230.82 with 28 degrees of freedom. Since the p-value was 0.000, the null hypothesis that the correlation matrix was an identity matrix (i.e., no intercorrelations among the variables) was rejected. Hence, PCA was an appropriate technique for exploring the underlying dimensions in the households' CC perception data.

The first PC, $CCpl_1$, indicates that households' main perceptions were dominated by the abnormality of cold days in winter and the frequency of drought occurrences. The finding suggests that households perceive cold days in winter and drought incidents as abnormal and frequent, respectively. PC, $CCpl_2$, had dominant positive loadings related to the "increase in unusual temperature" and "abnormal hot days in summer, " indicating that households in this component associate CC with rising temperatures and abnormal heat. In

contrast, the negative loading on "frequent flood occurrences" suggests that households do not link flooding to CC or do not perceive CCs. Thus, this component captures households' CC perceptions of heat, suggesting that their perception is more focused on these specific climatic events. The third PC, $CCpl_3$, had positive dominant loadings on "change in rainfall patterns during the rainy season" and "abnormal changes in wind occurrences". Hence, this PC reflects households' CC perception due to changes in seasonal rainfall patterns and unpredictable wind incidences in the community.

Given that the three components reflect different dimensions of households' CC perceptions, this study retained them as the dependent variables in the second stage of the DH model. This will enable the inclusion and analysis of different CC perception level indicators, rather than relying on a single composite PC index and disregarding meaningful variation in the data.

3.3.3 Psycho-social dimensions

The PCA results reported in this chapter were derived from this study's full sample. Similar psychosocial dimensions were examined in Chapter 4 of this thesis, and those PCA results were generated from a sub-sample of NTFP participants and therefore not directly comparable. The results presented here are used to generate PC scores and identify the variable's relationships with the PCs for DH model estimation. For social capital, the PCA yielded nine PCs with eigenvalues greater than 1. These retained PCs accounted for 65.7 percent of the total variation in the data. In this study, PC loadings above |0.4| were considered significant, as they help identify variables with a stronger relationship to the PC and capture important information (Hair et al., 2013). Also, retaining high loadings enhances interpretability and minimises redundancy (Jolliffe, 2002), whereas low loadings represent noise rather than contribute meaningfully, justifying their exclusion from subsequent models (Hair et al., 2013).

Table 3.7 shows the dimensions retained after PCA of the social capital variables. $SCap_1$ and $SCap_3$ contributed 17 and 6.93 percent, respectively, to the variation in the data. Dominant indicators were related to social assistance, suggesting that having more family members and friends is beneficial, as they can turn to them for support. In $SCap_4$, financial assistance from their group had the dominant loading. $SCap_7$ had two dominant indicators related to community relationships and perception, suggesting that households no longer have a positive attitude toward living in the area. $SCap_8$ showed dominant loadings for community relationships, indicating that households turn to more community members for support when needed. Lastly, $SCap_9$ had two dominant loadings for community involvement, suggesting that households participate in local and national elections, indicating active public engagement.

Table 3.7. Dimensions of social capital (N = 434)

Social capital variable	Principal component								
	SCap$_1$	**SCap$_2$**	**SCap$_3$**	**SCap$_4$**	**SCap$_5$**	**SCap$_6$**	**SCap$_7$**	**SCap$_8$**	**SCap$_9$**
Community relationships									
Number of years in the community	0.005	0.093	0.223	0.161	0.097	-0.260	**0.473**	-0.214	-0.288
Level of trust of community members	-0.017	0.306	-0.007	0.005	0.323	-0.304	-0.068	0.339	0.122
Number of people you can turn to in the community	0.193	0.092	0.122	-0.035	0.126	-0.209	0.031	**0.588**	-0.053
Number of family members you can turn to	0.213	0.110	**0.544**	-0.049	0.077	0.136	-0.124	-0.009	-0.052
Social assistance									
Financial assistance from family members	**0.442**	0.037	-0.067	-0.026	-0.214	0.019	-0.021	-0.009	-0.091
Financial assistance from friends	**0.442**	0.037	-0.067	-0.026	-0.214	0.019	-0.021	-0.009	-0.091
Financial assistance from neighbours	0.354	0.052	-0.128	-0.031	-0.002	0.112	0.047	0.146	0.131
Financial assistance from a group we're part of	0.081	-0.087	-0.077	**0.498**	0.228	-0.012	-0.188	-0.025	0.181
Financial assistance from micro lenders or banks	-0.032	0.017	-0.222	0.186	-0.347	-0.069	0.051	0.091	0.154
Family runs out of food, and we get it from other family members	0.168	0.098	**0.503**	0.025	0.232	0.318	-0.061	-0.057	0.012
Family runs out of food, and we get it from friends	0.389	0.019	-0.112	-0.101	-0.044	0.098	0.086	-0.024	-0.088
Family runs out of food, and we get it from neighbours	0.186	0.102	-0.275	-0.005	0.213	0.289	0.172	0.168	0.235
Family runs out of food, and we get it from a group we're part of	0.213	0.210	-0.205	0.343	0.328	-0.042	-0.069	-0.104	-0.059
Social networks/groups									
The number of social groups in households is part of	0.121	0.136	0.147	0.395	-0.385	-0.198	0.101	-0.059	0.104
Annual cash contribution to groups	0.016	0.009	0.219	0.366	-0.227	-0.269	-0.292	0.166	-0.059
Community involvement									
Comfortable and confident in approaching organisations	-0.124	0.353	-0.001	-0.039	-0.255	0.279	-0.239	-0.071	-0.113
Ability to influence events	-0.093	0.345	-0.109	0.117	-0.202	0.281	-0.026	0.203	-0.185
Informed about local and national matters	-0.126	0.290	-0.148	0.229	0.189	0.178	0.074	-0.022	**-0.421**
Meet public officials and participate in local meetings	-0.089	0.344	-0.106	0.302	0.141	0.162	0.067	-0.025	0.028
Participate in local and national elections to vote	-0.023	0.064	0.184	0.164	-0.068	0.222	0.272	-0.163	**0.620**
Perceptions about community									
Happy with social customs in the community	0.106	0.337	-0.110	-0.195	0.050	-0.267	-0.298	-0.284	0.174
Happy with service delivery in the community	0.104	0.377	-0.091	-0.121	0.142	-0.273	-0.164	-0.383	0.109
I like living in the community	-0.001	0.251	0.012	-0.133	-0.049	-0.204	**0.549**	0.051	0.039
Not concerned about the level of crime in the community	0.219	-0.114	-0.080	0.106	0.033	0.002	0.117	-0.293	-0.268
Eigenvalue	4.08	2.54	1.66	1.55	1.31	1.28	1.21	1.12	1.03
Percentage of Variation	16.99	10.57	6.93	6.44	5.46	5.32	5.03	4.65	4.28
Cumulative Percentage	16.99	27.56	34.48	40.93	46.39	51.70	56.73	61.38	65.66
Bartlett test of sphericity									
Chi-square									17450.40
Degrees of freedom									276
P-value									0.000
Kaiser-Meyer-Olkin (KMO)									0.687

Note: PC loadings greater |0.4| are highlighted in bold

Source: Household Survey Data (2018)

In Table 3.8 below, the PCs for PsyCap accounted for 53.7 percent of the total variation in the data. The first PC, $PsyCap_1$, is dominated by PsyCap indicators, hope and optimism. This dimension suggests that households that pursue life goals with optimism about the future become more hopeful, thereby gaining mental strength. The dominant loadings in $PsyCap_2$ were obtained from self-efficacy indicators, confidence in raising and making recommendations during public gatherings and the ability to deal with problems and suggest solutions, which, according to Bandura (1997), describe self-confidence and leadership self-efficacy. This indicates that households in this dimension participate in public engagements, express their opinions, and offer solutions in those spaces. Furthermore, $PsyCap_3$ is characterised by loadings on self-efficacy, which is related to self-reliance (i.e., reduced reliance on the government) and resilience. This suggests that households value independence and personal responsibility. In $PsyCap_4$, the dominant loading is on the "confidence in approaching people external to my family and friends to discuss problems", a form of self-efficacy that Smith and Betz (2000) consider social self-efficacy. The finding indicates that households can initiate interactions and engagements beyond their immediate networks to address issues and seek support for various challenges.

Table 3.8. Dimensions of psychological capital (N = 434)

Psychological capital variable	**Principal component**			
	$PsyCap_1$	**$PsyCap_2$**	**$PsyCap_3$**	**$PsyCap_4$**
Self-Efficacy				
Confident in raising and making recommendations during public gatherings	0.038	**0.599**	0.308	0.025
Confident in my ability to deal with problems and suggest solutions	-0.007	**0.649**	0.168	0.066
Confident in approaching people external to my family and friends to discuss problems	0.231	0.062	-0.092	**0.789**
I do not believe the government is responsible for the well-being of people in the community	-0.010	-0.315	**0.501**	0.199
Hope				
When faced with a problem, I can think of many ways to resolve it	0.287	0.185	0.176	-0.235
I hope that the quality of work and life will improve for the better	0.343	-0.149	0.381	-0.185
Currently, I am pursuing my goals in life	**0.456**	0.045	0.049	-0.051
Optimism				
I am optimistic about my future	**0.429**	-0.102	0.107	-0.088
I do not give up easily	0.339	0.002	-0.208	0.359
I always look on the bright side of living	0.315	-0.151	0.161	-0.083
Resilience				
I can deal with extreme weather changes such as floods, droughts, high and cold temperatures and wind occurrences	0.221	0.159	**-0.474**	-0.307
When I have a setback, I have no trouble recovering from it and moving on	0.299	-0.009	-0.366	-0.056
Eigenvalue	2.56	1.60	1.26	1.02
Percentage of variation	21.31	13.35	10.51	8.52
Cumulative percentage	21.31	34.60	45.17	53.69
Bartlett test of sphericity				
Chi-square				622.84
Degrees of freedom				66
P-value				0.000
Kaiser-Meyer-Olkin (KMO)				0.698

Note: PC loadings greater |0.4| are highlighted in bold

Source: Household survey data (2018)

Retained PCs for cultural worldviews are presented in Table 3.9. Four PCs were retained. Cwv_1 had dominant dimensions in individualistic and hierarchic values. This indicates that households consider an individual's moral worth and existing social hierarchies to be important. Cwv_2 has two dominant loadings for individualism and hierarchism. This suggests that households have individualist tendencies, as they value pursuing their own interests. However, they are less hierarchical, as noted in the lower importance of patriarchy.

Table 3.9. Dimensions of cultural worldviews (N = 434)

Cultural worldview	Principal component			
	Cwv_1	**Cwv_2**	**Cwv_3**	**Cwv_4**
Egalitarianism				
Equal rights	0.228	0.061	0.388	0.123
Equal wealth distribution	0.273	-0.099	0.101	0.107
Affirmative action	0.383	-0.187	-0.059	-0.189
Equal opportunities	0.289	-0.130	0.277	0.186
Individualism				
Moral worth of the individual	**0.416**	0.095	0.098	-0.097
Virtues of self-reliance	0.152	-0.211	0.363	**0.416**
Value of personal independence	-0.026	0.373	**0.401**	0.225
Precedence of individual interest over social interest	-0.095	**0.411**	-0.029	**0.457**
Hierarchism				
Authority of hierarchy	**0.436**	-0.157	-0.014	-0.174
Top-down management	0.289	0.263	-0.354	0.153
Patriarchy	0.079	**-0.432**	-0.266	0.286
Technocracy	-0.113	-0.378	-0.167	**0.445**
Fatalism				
Lack of control over your life	0.219	0.201	**-0.445**	0.346
Events are predetermined	0.312	0.327	-0.173	-0.091
Eigenvalue	2.96	2.09	1.52	1.27
Percentage of Variation	21.11	14.9	10.9	9.1
Cumulative Percentage	21.11	36.10	46.90	56
Bartlett test of sphericity				
Chi-square				1163.77
Degrees of freedom				91
P-value				0.000
Kaiser-Meyer-Olkin (KMO)				0.720

Note: PC loadings greater |0.4| are highlighted in bold
Source: Household survey data (2018)

Cwv_3 had two dominant loadings related to individualistic and fatalistic variables, indicating that households highly value personal independence. Additionally, a dominant loading for fatalism suggests that households are fatalistic, meaning they feel they lack control over their lives. Cwv_4 had dominant loadings from indicators of individualism and hierarchism. Households showed self-reliance, further indicating that they prioritise their interests over social matters and find experts and professionals important.

3.3.4 Determinants of climate change perceptions

The probit model estimates are presented in Table 3.10. The overall goodness of fit of the model was assessed using a Wald Chi-squared test. The variable “Gender” was statistically significant and negative, suggesting that being a female household head is associated with a lower probability of having a positive CC perception. So, female-headed households in Buffelsdraai and Osindisweni communities are less likely to perceive CC. The marginal effect indicates that the likelihood of these households perceiving CC decreases by 3.8 percent. Owusu et al. (2019) showed that females are less likely to be informed about CC. The result can be ascribed to gender-related inequality in access to information, the burden of domestic responsibilities placed on women, and vulnerability resulting from their dependence on natural resources, in addition to disparities in access to and control of resources, contributing to variations in the perception and understanding of CC (Owusu et al., 2019; Henriksson et al., 2021). The Buffelsdraai and Osindisweni communities are characterised by high levels of poverty and unemployment, especially among women, owing to economic marginalisation and low access to education (Knowles and Theron, 2010), which could lead to insufficient information about CC. In the KwaZulu-Natal province, traditional leadership structures are important but marginalise women's contributions to the community and society (Beall and Ngonyama, 2009), including on CC issues. Moreover, households in the communities have dependency ratios of 4:1 and 6:1, respectively (Knowles and Theron, 2010), showing that women are preoccupied with household responsibilities and caregiving, which could limit their participation in climate-related discussions and contribute to decreased CC awareness and perception.

Concerning “Education”, for household heads with primary school education, the effect is statistically significant and positive compared to respondents with no schooling, indicating that they are more likely to perceive CC. Educational attainment, even at the primary education level, increases literacy and access to information, thereby raising awareness, understanding, and perception of environmental issues such as CC (Maponya et al., 2013; Unesco, 2024). This finding is consistent with Nkoana (2020), who found that environmental education significantly improved learners' awareness and perceptions of CC risks.

“Adults equivalents” is negative and statistically significant. This suggests that larger households in the Buffeldraai and Osindisweni communities face increased household resource stress (i.e., limited food and income) and, as a result, prioritise these needs over environmental issues such as CC, reducing the likelihood that they will perceive CC. According to Maziya and Nkonki-Mandleni (2024), larger households are typically food- and income-insecure and therefore engage less with CC issues because immediate economic needs take precedence, dominating their attention. Furthermore, persistent economic challenges can deplete a household's mental bandwidth, reducing its capacity to comprehend and address complex environmental issues such as CC (Mullainathan and Shafir, 2013; Verschelden, 2024). Therefore,

these findings demonstrate how larger households with more adult equivalents, burdened by economic pressures, have reduced CC perceptions by limiting their concerns to essential household needs.

Table 3.10. Model estimates of stage 1 (Probit Model) of the Double Hurdle model

Explanatory variable	**Coefficient**	**Std. error**	**Marginal effect**	**P>|z|**
Age	0.055	0.067	0.004	0.414
Age squared	-5.83E-04	5.95E-04	-4.2E-05	0.327
Gender	-0.526*	0.296	-0.038	0.076
Education (ref. category: *no schooling*)				
Primary school	0.799**	0.376	0.055	0.034
Secondary school	0.219	0.326	0.019	0.502
Higher education	-0.378	0.785	-0.045	0.530
Adult equivalents	-0.159***	0.048	-0.011	0.001
Affect	0.524***	0.096	0.038	0.000
Tree-prenuer	0.085*	0.050	0.006	0.087
Agric assets	3.53E-04	3.27E-04	2.55E-05	0.280
Livestock	2.78E-05	2.69E-05	2.00E-06	0.302
Roads	-0.003	0.006	-2.27E-04	0.570
Electricity	-0.117**	0.048	-0.008	0.015
Water	-0.012	0.040	-9.0E-04	0.755
$SCap_1$	-0.070	0.092	-0.003	0.469
$SCap_3$	0.152	0.095	0.011	0.112
$SCap_4$	-0.064	0.102	-0.005	0.532
$SCap_7$	-0.034	0.115	-0.002	0.766
$SCap_8$	0.013	0.119	9.37E-04	0.913
$SCap_9$	0.268**	0.121	0.019	0.026
$PsyCap_1$	0.103	0.063	0.007	0.102
$PsyCap_2$	-0.174	0.122	-0.013	0.152
$PsyCap_3$	0.134	0.101	0.009	0.172
$PsyCap_4$	0.149	0.099	0.011	0.128
Cwv_1	0.139	0.099	0.010	0.160
Cwv_2	-0.063	0.092	-0.005	0.493
Cwv_3	0.184**	0.088	0.013	0.036
Cwv_4	-0.372***	0.095	-0.027	0.000
Constant	-0.493	1.867		0.792
Number of observations	434			
Wald chi-squared	89.89 (28)			
Prob > chi-squared	0.000			
Log-likelihood	-58.28			

Note: ***, ** and * refer to significance at 1%, 5 % and 10 %, respectively
Source: Household survey data (2018)

"Affect" is positive and statistically significant, indicating that households emotionally engaged with CC issues are more likely to perceive CC, highlighting the role of emotions in shaping CC awareness. The result is consistent with findings in previous studies (Leiserowitz, 2006; Van der Linden, 2015; Hitayezu et al., 2017) on CC perception, indicating the significance of "Affect". According to Leiserowitz (2006),

the impact of "Affect" on CC perception suggests that the experiential process influences decisions about CC. Furthermore, Brosch (2021) indicated that "Affect" is vital in shaping CC perceptions and later actions. Thus, positive "Affect" implies that households in the Buffelsdraai and Osindisweni communities have strong feelings about CC, and that these emotions increase the likelihood of perceiving CC as a threat.

Tree-preneur is positive and statistically significant. suggesting that participation in the reforestation project increases the probability that a household head would perceive CC. The reforestation project was specifically designed, through the eThekwini Municipality's 'Climate Neutral Strategy', to address CC mitigation and adaptation through reforestation and ecosystem restoration (Whitley, 2013). Tree-prenuers engage in activities such as indigenous seed collection, tree propagation, nursery management, and tree planting (Whitley, 2014; Viljoen, 2010). Also, the programme has a training centre where community ecosystem management and capacity-building training take place, creating opportunities for participants to acquire knowledge of environmental management and the role of forests in CC mitigation and adaptation (Douwes et al., 2015). So, through these restoration activities and practical training, tree-preneurs are more exposed to climate-relevant information than non-participants, making it more likely to recognise and understand CC issues, thereby raising their CC perception. This finding is consistent with Munang et al. (2013), who show that participation in restoration and ecosystem management activities enhances local awareness, knowledge and understanding of CC whilst improving the community's adaptive capacity.

"Electricity" is negative and statistically significant, indicating that access to electricity is associated with a decreased probability of perceiving CC among households. The marginal effect indicates that for each unit increase in walking distance to access electricity, the likelihood of perceiving CC decreases by 0.8 percent among household heads. Access to electricity improves living standards by enabling households to use electric appliances and save time (Davis, 1998). This could insulate households from CC risks, reducing their concern or perception of CC. Also, electricity access reduces reliance on biomass fuels like firewood by reducing the time and effort spent collecting it (Dinkelman, 2011), leading to less exposure to the environment, reduced sense of vulnerability to CC, and, hence, households may feel less affected by CC, lowering their perception of CC. However, this relationship requires careful explanation because it can work in both directions. Electricity access is generally associated with higher socio-economic status and heightened environmental concerns (Franzen and Meyer, 2010; Kvaløy et al., 2012). Affluent households are usually exposed to climate information through the media, which could raise their perception of CC risks. Generally, this finding suggests that a complex dynamic exists, in which the relationship between electricity access and CC perceptions is not linear, and that there may be mediating or extraneous variables.

The positive coefficient for the "$SCap_9$" variable is statistically significant, suggesting that an increase in "$SCap_9$" is associated with a higher probability of perceiving CC among household heads. The marginal

effect of 0.019 indicates that for each unit increase in "$SCap_9$", the likelihood of perceiving CC increases by 1.9 percent among household heads. The findings indicate that household heads' involvement in local and national activities, as well as their connections with other community members and stakeholders, can facilitate the flow of information, thereby increasing their interest in public affairs. Therefore, enabling a few households to understand government policies, particularly those related to the environment, would influence their perspective on CC. Leiserowitz (2006) found that social constructs shape CC perceptions, highlighting the importance of social capital in shaping them and further corroborating this finding.

"Cwv_3" was significant, showing that it increases households' likelihood of perceiving CC. The marginal effect indicates that for each unit increase in "Cwv_3," the probability of recognising CC rises by 1.3 per cent. This suggests that individualist households prioritising personal independence are more aware of CC. According to Whitmarsh (2008), self-reliant individuals view themselves as independent decision-makers, which leads to sustainable behaviours and an acknowledgement of CC, thereby increasing CC perception. Self-sufficient household heads are more likely to adopt climate adaptation strategies, perceiving environmental risks as requiring proactive solutions rather than passive endurance (Fielding and Head, 2012). Households lacking control are less likely to acknowledge or engage with CC issues, reducing awareness. Fatalists typically avoid taking responsibility for environmental issues, believing their actions will have no impact (De Hoog et al., 2005). Corner et al. (2014) showed that worldviews influence public engagement with CC, with fatalistic values associated with climate scepticism. Moreover, fatalists are unsupportive of environmental policies and mitigation efforts (O'Connor et al., 1999), which may affect perceptions of CC.

Table 3.10 suggests that an increase in the "Cwv_4" variable is associated with a decreased probability of perceiving CC among household heads. The marginal effect shows that for each unit increase in "Cwv_4", the likelihood of perceiving CC decreases by 2.7 percent among household heads. The findings indicate that households with individualistic worldviews are self-reliant, prioritising self-interest over collective concerns, and may have a lower or no perception of CC. This finding corroborates studies suggesting that households prioritising self-sufficiency perceive reduced risks associated with CC (De Groot and Steg, 2010; Etana et al., 2021).

3.3.5 Determinants of the intensity of climate change perception

Table 3.11 reports DH model estimates. The education level of household heads, particularly those with primary or secondary education, is positively and significantly associated with $CCpl_2$ relative to households with no school education, whereas household heads with higher education are significantly and negatively associated with $CCpl_3$. This suggests that household heads with primary and secondary education form

stronger CC perceptions of heat-related climate signals. In contrast, higher education does not increase the intensity of CC perception, especially regarding irregular rainfall patterns and unusual wind events. Though primary and secondary education increases household heads' CC perception (Lekgeu and Davis, 2017; Nkoana, 2020), individuals with these educational levels typically are dependent on ecosystem services and NTFPs for livelihood and are frequently and directly exposed to the natural environment, increasing the likelihood of recognising climate-signals and which in turn reinforce CC perceptions, which may lead to formation of stronger CC perceptions (Bryan et al., 2009). However, higher education increases opportunities for formal employment and livelihood diversification, reducing the reliance of households on natural resources for livelihoods (Barrett et al., 2001), which in turn creates fewer opportunities for direct exposure and experience to and with the natural environment and the ensuing changes, resulting in a decreased level of the perceived risk of CC.

"Affect" is statistically significant for $CCpl_1$ and $CCpl_2$, suggesting that households with stronger feelings about CC perceive it intensely. The experiential processing of risk (risk-as-feelings hypothesis) explains this finding, in which decisions are based on emotions and experiences about a phenomenon (Slovic et al., 2004). Therefore, the findings indicate that households have stronger emotional responses to abnormally hot and cold days in the summer and winter, respectively, as well as to drought incidence and unusually high temperatures, shaping their perceptions of CC. Marx et al. (2007) show that individuals experience and process climate-related risks in affective ways, and the vividness of climate events can shape their risk judgment. In this case, people's emotional responses can be caused by their experiences with unusual weather changes, media reports about weather-related disasters or their perceived closeness to threatening CC impacts, increasing their attentiveness to and feelings about these CC related occurrences, thus influencing their risk perception (Weber, 2010; Van der Linden, 2015). Although emotions can override rational thinking, they can also serve as heuristic cues for households, helping them understand CC issues (Slovic et al., 2007). Also, Hitayezu et al. (2017) confirm these results, showing that CC perceptions were significantly influenced by "Affect," with emotions influencing farmers' perceptions of CC more than actual weather records. Such CC-related disasters (i.e., the 2021 KZN floods and the latest one in the Eastern Cape) can change mindsets. Similarly, Leiserowitz (2006) found that affective imagery significantly influenced perceptions of CC risk. Brosch (2021) identified affective responses as predictors of CC perception, which in turn influence risk perceptions and mitigation behaviour.

Table 3.11. Model estimates of stage 2 (Truncated regression) of the Double Hurdle model

Explanatory Variable	$CCPL_1$			$CCPL_2$			$CCPL_3$		
	Coeff.	**S. E**	**P>|z|**	**Coeff.**	**S. E**	**P>|z|**	**Coeff.**	**S. E**	**P>|z|**
Age	0.028	0.027	0.298	-0.007	0.026	0.774	-0.005	0.027	0.864
Age Squared	-2.24E-04	2.54E-04	0.378	5.76E-05	2.39E-04	0.810	1.21E-04	2.52E-04	0.632
Gender	-0.026	0.109	0.811	-0.036	0.103	0.725	1.87E-05	0.108	1.000
Education (ref. category: no schooling)									
Primary school	0.112	0.151	0.454	0.287**	0.142	0.044	0.183	0.149	0.219
Secondary school	0.138	0.149	0.355	0.284**	0.141	0.044	0.136	0.148	0.355
Higher education	0.329	0.435	0.449	0.203	0.409	0.621	-0.937**	0.431	0.030
Adult equivalents	0.019	0.022	0.379	0.015	0.021	0.463	0.003	0.022	0.902
Affect	0.139***	0.051	0.006	0.099**	0.048	0.038	0.057	0.050	0.252
Tree-prenuer	-0.052***	0.020	0.011	-0.034*	0.019	0.076	-0.068***	0.020	0.001
Agric assets	6.50E-06	4.10E-06	0.113	1.13E-05***	3.86E-06	0.003	-4.93E-06	4.06E-06	0.225
Livestock	-7.08E-06	6.34E-06	0.264	1.24E-06	5.98E-06	0.836	-4.13E-06	6.28E-06	0.511
Roads	3.61E-04	0.004	0.924	0.006	0.004	0.101	-0.004	0.004	0.255
Electricity	-0.013	0.030	0.677	0.033	0.029	0.251	0.007	0.030	0.827
Water	-0.014	0.013	0.285	-0.035***	0.012	0.004	-0.053***	0.013	0.000
$SCap_1$	0.109***	0.034	0.002	0.111***	0.032	0.001	0.008	0.034	0.808
$SCap_3$	0.017	0.041	0.679	-0.050	0.039	0.195	-0.116***	0.041	0.005
$SCap_4$	-0.033	0.046	0.479	-0.027	0.044	0.534	0.028	0.046	0.537
$SCap_7$	-0.071	0.045	0.117	0.064	0.043	0.132	-0.031	0.045	0.487
$SCap_8$	0.114**	0.049	0.023	0.059	0.047	0.217	0.006	0.049	0.900
$SCap_9$	0.197***	0.053	0.000	0.067	0.049	0.182	0.008	0.052	0.872
$PsyCap_1$	-0.050	0.036	0.167	-0.016	0.034	0.645	0.076*	0.036	0.034
$PsyCap_2$	0.061	0.044	0.167	0.064	0.041	0.123	0.052	0.043	0.227
$PsyCap_3$	-0.039	0.049	0.428	-0.219***	0.046	0.000	-0.150***	0.048	0.002
$PsyCap_4$	0.001	0.052	0.846	-0.106**	0.049	0.028	0.090	0.051	0.860
Cwv_1	0.082*	0.043	0.056	-0.042	0.040	0.293	0.132***	0.042	0.002
Cwv_2	-0.079*	0.044	0.072	0.217***	0.042	0.000	0.027	0.044	0.534
Cwv_3	0.013	0.042	0.761	-0.073**	0.040	0.070	-0.055	0.043	0.193
Cwv_4	-0.116***	0.045	0.010	-0.272***	0.042	0.000	-0.193***	0.045	0.000
Constant	-1.356	0.747	0.070	-0.413	0.704	0.558	-0.133	0.739	0.857
No. of observations			409			409			409
Wald Chi-Squared			83.60 (28)			260.22 (28)			115 (28)
Prob > Chi-Squared			0.000			0.000			0.000

Note: ***, ** and *refer to significance at 1%, 5 % and 10 %, respectively.
Source: Household survey data (2018)

"Tree-prenuer" participation in the second hurdle is statistically significant and negatively associated with CC perception intensity, suggesting that longer participation in the "Tree-prenuer" programme decreases the intensity of CC perception within a household. This result is consistent with the previous result in the previous section and suggests that prolonged involvement in the "Tree-prenuer" programme may have normalised CC discussions and decreased households' perceived risk of CC. Weber (2010) suggests that

repeated exposure to risk increases familiarity, which may, in turn, reduce perceived risk. Moreover, for "Tree-prenuer" participants, the reforestation programme could have created a sense that planting trees effectively mitigates CC, thereby lowering their vulnerability to CC and, in turn, reducing their level of CC perception. Peng et al. (2024) show that participants in environmental mitigation can be psychologically shielded against CC risks, decreasing their perceived vulnerability. Moreover, Van der Linden (2015) indicates that individuals involved in pro-environmental behaviours have low perceptions of vulnerability to climate-related risks. However, the gravity of the risk and its impact depend not only on individual actions but also on collective actions by the public. "Tree-prenuers" could be desensitised and motivated by immediate vouchers and financial incentives rather than long-term environmental threats, lowering CC perception levels. According to Shackleton et al. (2015), CC adaptation interventions lower CC perceptions as participants' household resilience or complacency grows. In their study, Maziya et al. (2024) showed that, among farmers participating in adaptation programmes, concerns about CC risks decreased when economic benefits were realised.

Furthermore, "Agric assets" is positive and significantly associated with $CCpl_2$, suggesting that households endowed with "Agric assets" have higher levels of CC perception regarding heat-related climate signals. The findings indicate that agricultural activities played a significant role in the livelihoods of households in these peri-urban communities. Viljoen (2010) highlights that several households engage in subsistence agriculture (i.e., home gardening for food), and some participate in the "Tree-prenuer" initiative, in which trees are traded for food, building materials, and school fees. Households engaged in these land-based activities are exposed to weather conditions. They are susceptible to environmental stressors, such as extreme heat, which can affect tree seedling collection, survival, and tree planting, and damage crops, making it easier to link them to CC and raising their perception of CC. According to Hitayezu et al. (2017), households that rely on agriculture tend to have a stronger perception of weather-related phenomena, such as unusual heat or changes in rainfall.

Water access had a statistically significant negative relationship with $CCpl_2$ and $CCpl_3$. The finding suggests that household levels of CC perception increase when access to water becomes poorer (i.e., it takes longer to collect water). In Buffelsdraai and Osindisweni communities, households rely on in-house water and communal taps (Knowles and Theron, 2010). Therefore, the findings suggest that limited water access may have been a historical issue in the community, rendering climatic events such as drought incidents and rainfall changes insignificant and attributing them to municipal service delivery problems. As water access worsens over time, households will likely attribute the problem to the municipality's lack of infrastructure development rather than to CC, thereby reducing their perception of CC. Households accustomed to walking longer for water consider shortages a regular part of their life, rather than linking them to erratic

weather conditions (Benebere et al., 2017). According to Leiserowitz (2006), when basic services such as water and electricity are inadequate, climate signals (e.g., droughts, changes in rainfall patterns, and temperature changes) can be dominated by community development concerns. Water shortage challenges are generally attributed to local governance failures and infrastructure deficits rather than CC (Adelekan and Asiyanbi, 2016), and these challenges can prevent the affective cues that usually stimulate CC concerns in people (Weber, 2010).

The results indicate that "$SCap_1$", "SCp_8" and "$SCap_9$" have a positive and statistically significant effect on $CCpl_1$ and $CCpl_2$, suggesting that households that receive financial and material assistance from family, friends, neighbours, and other forms of support from the community, and engaged in the community and national issues, including elections, are likely to have stronger CC perceptions amid more drought incidents, abnormally cold or hot days, in winter and summer, respectively. Improved social networks and community interactions facilitate information flow and access through shared experiences and discussions, thereby increasing households' awareness of CC. According to Adger et al. (2003), social networks are essential for publicising CC information and validating experiences. Pretty and Ward (2001) demonstrate that social capital is strengthened through reciprocity, which enhances connections among individuals and results in greater trust and confidence. Thus, strong social networks and community engagement strengthen the capacity to identify public issues, thereby intensifying risk perception through shared experiences and community narratives about CC risk (MacGillivray, 2018; Pretty and Ward, 2001). Additionally, the Buffelsdraai and Osindisweni communities are typically poor and more dependent on others, and they strongly feel and experience the effects of abnormal cold, heat, and drought (Table 3.11). According to Van der Linden (2015), vulnerable households perceive and emotionally respond to environmental threats because of their direct experience and reduced adaptive capacity. Moreover, Bubeck et al. (2012) highlight that an external locus of control can influence risk perception and heighten awareness of environmental threats, as individuals may believe they have limited control over the threat yet still acknowledge its existence and impact. So, the intensity of CC perception does not require control, but could increase when households feel vulnerable to environmental threats, even though they have limited control.

"$SCap_3$" shows a negative, statistically significant relationship with $CCpl_3$, suggesting that households with strong family support have lower CC perceptions. The finding indicates that households may be insulated against irregular rainfall patterns and unusual wind events through family support, which can meet their immediate needs and reduce pressure from these unusual weather changes, thereby reducing their sense of vulnerability and lowering their awareness of CC threats. Adger (2006) explains that social support can complicate the importance of environmental risks when informal coping mechanisms are available. Additionally, these households may attribute their food insecurity and other challenges to broader societal

issues, such as a lack of jobs and income, rather than to unusual rainfall and wind changes. Therefore, this reliance on family support could shift attention away from CC, lowering the perception that these unusual weather occurrences are due to CC and reducing their perceived intensity. According to O'Brien et al. (2007), when socio-economic difficulties overshadow other challenges, people are less likely to attribute those issues to environmental causes such as CC.

Results in Table 3.11 indicate that "$PsyCap_1$" has a positive and statistically significant influence on $CCpl_3$, suggesting that households with higher levels of hope and optimism have stronger perceptions of CC. Community-based CC adaptation initiatives in the Buffelsdraai and Osindisweni communities may explain this finding. The reforestation project, with its environmental awareness programmes, incentives, and recognition of "green heroes," gave participating households hope and optimism about the future, with many becoming "supergrowers" and climate leaders (Viljoen, 2010), thereby strengthening households' levels of CC perceptions. Similarly, Ojala (2012) found that hope can encourage individuals to engage with environmental issues, as these issues are about connecting the present to the future. Moreover, hope and optimism lead people to believe they can make a difference, thereby increasing their perception of CC-related signals (Dean and Wilson, 2023; Li and Monroe, 2019).

Psychological capital, "$PsyCap_3$", shows a negative, statistically significant relationship with $CCpl_2$ and $CCpl_3$. This suggests that households with higher psychological capital, as measured by self-efficacy, have lower CC perceptions. Self-efficacy in "$PsyCap_3$" is associated with limited government support, indicating self-reliance and resilience. These households have a better internal locus of control and are confident in their ability to influence outcomes through their efforts and actions (McCarty and Shrum, 2001). Therefore, the findings show that self-reliant households and those who can handle extreme weather changes perceive less risk, reducing CC perception levels. Kahan et al. (2012) show that self-reliance is associated with reduced concern for CC. Furthermore, resilience shapes interpretations and responses to extreme rainfall events, with some households viewing them as opportunities to learn and adapt rather than as stressors (Gottschalk et al., 2022; Zhang et al., 2023). Folkman and Moskowitz (2004) indicate that resilient individuals experience lower stress and anxiety, perceiving CC effects as unthreatening. Moreover, Ogunbode et al. (2019) suggest that coping moderates the relationship between extreme weather phenomena and negative emotions, decreasing the association between experiences with CC conditions and mitigation intentions. They referred to this as a 'resilience paradox', in which resilience to unusual climatic phenomena is associated with lower concern about CC.

In contrast, "$PsyCap_4$" is negative and statistically significant, suggesting that specific households with high social self-efficacy have lower CC perception levels, as indicated by $CCpl_2$. The distinction between "$PsyCap_3$" and "$PsyCap_4$" highlights different aspects of self-efficacy that influence CC perception. Self-

efficacy is multi-dimensional, influencing CC perception and adaptation behaviour differently (Akoni et al., 2025; Van der Linden, 2015). Hence, with "$PsyCap_4$", households are good at social interaction but may overlook changes in the weather. According to Santiago-Torner et al. (2025), people with high social self-efficacy tend to emphasise relationships and communication. Furthermore, high social self-efficacy can create an exaggerated internal locus of control in these households, leading them to believe that their social interactions and coping skills are sufficient to address challenges, which may make households feel less vulnerable to CC risks and underestimate their importance. This finding aligns with Maltby et al. (2021), who found that fishers with high self-efficacy were more likely to perceive CC as low risk, indicating that respondents were overconfident in their coping abilities, thereby reducing their concerns about CC.

Furthermore, "Cwv_1" and "Cwv_2" have statistically significant, positive coefficients for $CCpl_1$, $CCpl_2$, and $CCpl_3$. This suggests that households with higher "Cwv_1", those with a worldview that emphasises the moral worth of individuals and values the authority of hierarchies, are associated with higher perceived intensity of CC indicators as captured by $CCpl_1$, $CCpl_2$ and $CCpl_3$. Hierarchical households respect structured authority and order and are more receptive to and trust expert opinions about CC, which could lead to higher CC perception levels. Hierarchists perceive the natural environment as unpredictable and typically prefer well-structured institutions with effective leadership and experts to manage it (Ambrosio-Albala and Mar Delgado-Serrano, 2018; Xue et al., 2014). On the other hand, with "Cwv_2", households show low deference to patriarchal authority, indicating that some can recognise CC signals without needing validation from authorities. Moreover, individualistic households with a heightened sense of moral worth recognise the direct effects of weather changes on their off-farm and on-farm economic activities, creating a strong sense of responsibility to understand and address CC, increasing their perception of CC. According to Douarin and Hinks (2024), people with individualistic values are likely to perceive CC risks and be more willing to adopt individual-level climate-friendly behaviours.

Nevertheless, Table 3.11 shows that the coefficients for "Cwv_2" and "Cwv_3" were negative and statistically significant for $CCpl_1$, $CCpl_2$, and $CCpl_3$. Similarly, the coefficient estimate for "Cwv_4" was also negative and statistically significant across these CC perception measures. These findings do not contradict the previous results but demonstrate how different dimensions of cultural worldviews perceive various CC indicators. Nonetheless, "Cwv_2" showed a negative relationship with $CCpl_1$, indicating that as "Cwv_2" increases, $CCpl_1$ decreases. Cold days and droughts, captured as CC indicators in $CCpl_1$, are slow-onset events (Wilhite and Glantz, 1985), and these events can be less emotive and more likely to be overlooked (Weber, 2010). Households that prioritise themselves over society and reject authority may not be directly involved in land-based activities in the Buffelsdraai and Osindidweni communities; hence, they may not

perceive these weather changes as disruptive and may recognise only weather phenomena that affect them personally, thereby lowering their CC perception. Some weather events are more personal and emotional than others, and CC perception is lower amongst people with limited personal experience (Whitmarsh, 2008; Kahan et al., 2012). Moreover, Leiserowitz (2006) highlights that worldviews influence the risks individuals attend to, ignore or deny.

"Cwv_3", a bundle of individualism and low fatalism, is negatively related to $CCpl_2$. This finding indicates that households with better control of their lives can maximise their self-interest and underestimate CC risks. These households would view these risks as threats to personal autonomy, thereby reducing their perceptions of CC intensity (Xiang et al., 2019). For "Cwv_4", households with a combination of individualism and technocratic hierarchism also had lower CC perception levels for $CCpl_1$, $CCpl_2$ and $CCpl_3$. Community members with this blend of cultural worldviews accept CC as real yet distant, and believe that experts and professionals can manage it, particularly if it does not affect them personally. This reduces individual engagement with CC, thereby decreasing its perceived intensity. According to Gifford (2011), 'limited cognition,' in which people delegate climate responsibility to experts and disengage emotionally, is a barrier to CC engagement. Moreover, people who trust scientific and technological solutions will likely feel less personal responsibility for CC mitigation, believing this responsibility rests with experts and public officials (O'Neill and Nicholson-Cole, 2009). However, this mindset must change, as it ignores collective action. The CC issue has arisen gradually due to human actions, and addressing it will require a unified effort, not just the actions of experts and public officials.

3.5 Summary

Public perceptions of climate change (CC) are increasingly important, and understanding how peri-urban households perceive CC and how psychological factors, cultural worldviews, and socio-economic characteristics shape these perceptions is essential for planning and developing effective CC-focused strategies. A Principal Component Analysis (PCA) was applied to cluster households' CC perceptions and used to get proxies for psychosocial variables. The double-hurdle model examined how psychological and social capital, cultural worldviews, and other household characteristics shape CC awareness. The findings reveal that observed changes in seasonal temperatures, rainfall patterns, and wind occurrences shaped households' CC perceptions. Households with strong affective responses, individualistic views, and better community engagement had a higher probability of perceiving CC. Additionally, CC perception levels were stronger in hopeful households, which had better social networks and were characterised by individualistic and hierarchical views. The study's conclusions, policy implications, and limitations are covered in Chapter 6.

CHAPTER 4

EVALUATING NON-TIMBER FOREST PRODUCT DEPENDENCE OF HOUSEHOLDS IN A PAYMENT FOR ECOSYSTEM SERVICE SCHEME IN DURBAN

4.1 Introduction

This chapter examines the influence of socio-economic factors, cultural worldviews, and psychological and social capital on NTFP dependence in households adjacent to the reforestation project site. The sustainable livelihood framework (SLF), PCA and regression weights were applied to identify the determinants of NTFP dependence. The chapter introduces unique variables and an approach to measuring NTFP dependence, as well as different spatial contexts for analysing it. The chapter is organised as follows: Section 3.2 presents the methods employed, discussing the conceptual framework and empirical approaches. Section 3.3 then follows, presenting the results and discussion. The last section, Section 3.4, provides a summary of the chapter, whereas conclusions and recommendations form part of Chapter 6.

4.2 Research methodology

4.2.1 Conceptual framework

The SLF was adopted to understand the determinants of NTFP dependency. Also, the SLF provides a basis for evaluating people's livelihoods, especially those of the rural and urban poor (Small, 2007). Moreover, the framework presents a practical and accurate approach to understanding the interactions between factors that constrain or enhance livelihood opportunities (Morse and McNamara, 2013). The study draws from the framework to assess how different features of SLF interact to shape NTFP dependence. The features are presented in Figure 4.1, where livelihood maintenance depends on the availability of assets. The five principal assets are natural, human, social, physical, and financial capital (Krantz, 2001).

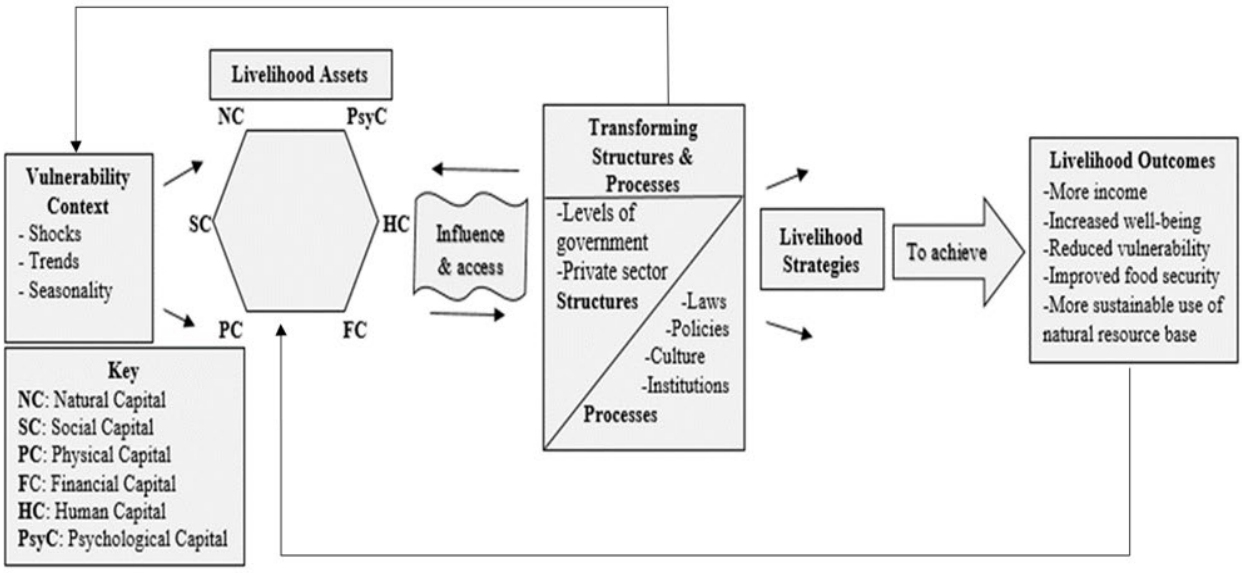


Figure 4.1. The Extended DFID Sustainable Livelihoods Framework
Source: Adapted from Krantz (2001)

Several household characteristics influence NTFP dependence (Shackleton et al., 2007; Shen et al., 2022), and form part of human, financial, physical and social capital and include age, gender, education, on-farm and off-farm income, social grants, remittance, vouchers, adult equivalents, capital endowment and cultural worldviews (Li et al., 2010; Sharaunga et al., 2013; Timko et al., 2010; Heubach et al., 2011; Wale et al., 2022; Garekae et al., 2017; Nerfa et al., 2020). These characteristics are explained below.

Age, gender, education, and adult equivalents are key indicators of human capital. Regarding age, older people are likely to participate in NTFP collection because the required physical labour is less demanding (Fisher, 2004). The opportunity cost of labour for older households is higher than for those in the productive age range. Thus, older household members can more easily access NTFPs and be more dependent on them (Fisher, 2004). Then again, younger households tend to engage in riskier, labour-intensive activities, thereby reducing their dependence on NTFPs (Masozera and Alavalapati, 2004). There are differences in how men and women rely on and control NTFPs (Timko et al., 2010). The collection of NTFPs is important for women, as this activity enables them to participate in income generation and household chores (Timko et al., 2010; Heubach et al., 2011). Additionally, most NTFPs are collected by women, making the availability of female labour important for their collection. This suggests that an increase in female numbers could lead to greater NTFP use (Illukpitiya and Yanagida, 2008; Kamanga et al., 2009; Heubach et al., 2011). Education levels in rural African communities can affect dependence on NTFPs (Timko et al., 2010). Thus, as another feature of human capital, education increases the opportunity cost of time and creates diverse formal employment opportunities with reliable income, decreasing the likelihood of NTFP utilisation (Masozera and Alavalapati, 2004; Kamanga et al., 2009). The adult-equivalent variable was

defined as the number of equivalent adults in a household, representing labour endowment. Larger households generally have more labour available to organise NTFP extraction and other income-generating activities (Kamanga et al., 2009). This could mean higher forest-based income relative to overall household income.

Financial capital, including social grants, employment, farm income, and vouchers, significantly shapes forest dependence among rural households (Wale et al., 2022; Mohammad Abdullah et al., 2016). Social grants are unearned income and reduce households' dependence on natural forests (Wale et al., 2022). Estimating income provides insight into household welfare and forest use (Shackleton and Shackleton, 2006). Therefore, households with fewer employment opportunities and income sources are more likely to depend on forest resources for their livelihoods, whereas households with better opportunities to allocate their labour to higher-value activities are less likely to devote effort to low-yield NTFP collection (Wale et al., 2022). Also, households with higher cash access or off-forest income have reduced need for forest-based income (Kamanga et al., 2009). Tree-preneurs, community members who collect seedlings and grow indigenous trees, are given vouchers that serve as currency within the reforestation project (Douwes et al., 2015). These vouchers are exchanged for essential goods, providing economic incentives for participation in the project while supporting livelihoods (Whitley, 2014). Wale et al. (2022) found that households using vouchers relied significantly on natural forest products.

Furthermore, physical capital, including household capital endowment and infrastructure access, has been shown to influence NTFP collection and use (Handavu et al., 2019; Wale et al., 2022) and is included in this study to examine the relationship between household resources and NTFP dependency. Households with higher capital endowments can access additional income and resources, reducing their dependence on natural forest products (Wale et al., 2022; Handavu et al., 2019). Access to modern infrastructure by local communities impacts their dependence on NTFPs (Timko et al., 2010). In rural areas, households rely more on forests to meet their basic energy needs (Tanner and Johnston, 2017). However, better electricity connectivity reduces dependence on forests, decreasing deforestation rates in rural communities (Tanner and Johnston, 2017).

Social capital influences households' interactions with natural resources, community organisations and institutions (Barnes-Mauthe et al., 2015). As a multidimensional concept, it involves trust, social assistance, networks and groups, community relationships and engagement (Plummer and FitzGibbon, 2006). It reduces the transaction costs of working together by facilitating cooperation, thereby making individuals more likely to participate in collective activities to address environmental issues (Pretty and Ward, 2001). According to Chan et al. (2012a), PES schemes can benefit from considering cultural contexts, particularly in initiatives such as reforestation projects. This study included cultural worldviews, drawn from cultural

theory, as a unique variable. Cultural theory distinguishes four worldviews: egalitarianism, hierarchism, individualism and fatalism (Hoogstra-Klein et al., 2012). Each worldview shapes households' views about the environment and the degree of resource use (Chan et al., 2012b). Furthermore, beliefs play an important role in shaping social dynamics within families and communities, influencing the distribution of roles and responsibilities, and thereby impacting household behaviour and decision-making (Sharaunga et al., 2013). Therefore, their inclusion in the study will provide insights into whether cultural worldviews drive NTFP dependence in the peri-urban communities.

However, these forms of capital do not exhaustively represent human endowment, and other forms can be identified (Scoones, 1998). Hence, this study considers psychological capital (see Figure 4.1), denoted as PsyC. Psychological capital draws on the field of positive organisational behaviour. It focuses on applying people's positive attributes (strengths and psychological capacities) that can be measured, developed, and managed to improve performance (Luthans et al., 2007). According to Luthans and Youssef (2004), the positive organisational behaviour framework comprises psychological constructs such as hope, resilience, optimism, and self-efficacy that, when combined, constitute psychological capital. Unlike other forms of capital stated above, which focus on 'what you know (human capital) and whom you know (social capital)', psychological capital is concerned with 'who you are' (Luthans et al., 2004). A person has self-efficacy when they have confidence in their ability to summon the motivation, mental resources, and courses of action necessary to execute specific tasks (Bandura, 1997). Hope refers to an individual's ability to accomplish their goals through their sense of agency and, in turn, the willpower to invest the necessary energy to achieve them (Snyder, 2002). Optimism is an individual's tendency to attribute favourable circumstances to internal, enduring causes and adverse events to external factors (Luthans and Youssef, 2004; Beattie, 2009). Resilience represents the individual's ability to rebound from adversity, uncertainty, and failure (Masten, 2001; Luthans et al., 2006). Therefore, psychological capital, as an additional component of livelihood endowment, will provide insights about the influence of positive psychological constructs on livelihood outcomes. Livelihood outcomes will depend on the optimal combination of these endowments, not on a single category (Krantz, 2001).

Table 4.1 presents the variables included in this study's empirical analysis and their roles within the conceptual framework. The variables are grouped into dependent, explanatory, psychosocial, and control variables based on the hypothesised relationship discussed above. This delineation and classification show how SLF is linked to other variables included in the study.

Table 4.1 Classification of study variable**s** for NTFP dependence analysis

Variable category	Variable	Role in the study
Dependent variable	NTFP dependence index	Response variable measuring household dependence on NTFPs
Livelihood capital variables	Household and agricultural assets, livestock, social grants, voucher, on and off income, and electricity access	Explanatory variables derived from SLF
Psychosocial variables	Social and psychological capital, and cultural worldviews indices	Variables expected to influence the perceptions of households and behaviour towards NTFPs
Socio-demographic variables	Age, gender, education, adult equivalent and distance to forest area	Control variables used to account for heterogeneity amongst households

Source: Authors construct (2018)

4.2.2 Empirical approach

4.2.2.1 Principal component analysis

Most studies generate large datasets, which often makes them challenging to interpret. Hence, a method is required to reduce their dimensionality for a simplified interpretation (Jolliffe and Cadima, 2016). The PCA linearly transforms large data into a new, smaller set of uncorrelated variables called principal components (PCs), which, when ordered, typically account for most of the variation in the original variables (Dunteman, 1989). According to Essa and Nieuwoudt (2003), the transformation is as follows:

$$PC_1 = a_{i1}X_1 + a_{i2}X_2 + \ldots\ldots a_{ip}X_p \quad \textbf{4.1}$$

where PC_1 is the first PC; a_{i1}, a_{i2},……a_{ip} are the coefficients or loadings and X_1, X_2…..X_p are the observed original variables. The first PC, PC_1, captures the largest variance, and the second PC, PC_2, will have the second-largest variance if it is uncorrelated with PC_1, and so on. X_p variables are converted into new uncorrelated variables, which account for as much variance as possible in descending order (Essa and Nieuwoudt, 2003). Therefore, PCA was applied to obtain indices using the indicators of psychological and social capital and values, following (Keshavarz et al., 2017; Chipfupa and Wale, 2018). PCs were obtained, and only dominant PCs (i.e., PCs with eigenvalues greater than 1) were retained. The Kaiser selection criterion was used to determine the number of PCs to extract, with eigenvalues greater than 1 (Yeomans and Golder, 1982). So, when PC loadings are obtained, the size of each indicates the variable's contribution to the PC's variance (Dunteman, 1989), and loadings greater than 0.4 were used in this study.

As indicated in Table 3.2 (section 3.2.3.2), a total of 434 households were surveyed during data collection. However, the analysis presented was conducted in keeping with the objective of this chapter, which was to examine the factors of NTFP dependence among household heads who collected NTFPs, rather than the determinants of NTFP participation. Therefore, the NTFP dependence index, discussed in the next section, will be constructed only for households that reported collecting NTFPs. Of the 434 surveyed, only 226 reported using NTFPs, forming the sample for NTFP analysis. Households that did not collect NTFPs could not provide information on NTFP use behaviour and were excluded from the construction of the NTFP dependence index.

4.2.2.2 Regression weights - NTFP dependence index

This study constructs NTFP dependence by creating a regression-weighted index using Ordinary Least Squares (OLS) to derive the weights. This practice has been followed previously (Wagstaff et al., 2007). The derivation expression for the index for each household is:

$$Y_i = \alpha + \sum_{j=1}^{k} \beta_j X_{ij} + \varepsilon_i \quad \textbf{4.2}$$

Where Y_i is the index for NTFP dependence, α is the intercept in the regression model, β_j is the coefficient, and X_{ij} is the NTFP dependence variable. Then, the index, which is the weighted sum of all variables considered, is expressed as:

$$Y_i = \sum_{j=1}^{k} \beta_j X_{ij} \quad \textbf{4.3}$$

Each regressor or NTFP dependence variable, *Xij*, is weighted by the coefficient or marginal contribution to NTFP dependency.

The inclusion and construction of the NTFP dependence index were based on relevant and empirically supported NTFP dependence variables. For instance, the frequency of NTFP collection was included to create the index. According to Tugume et al. (2017), the frequent collection of NTFPs indicates the importance of these resources to rural households. Additionally, Shen et al. (2022) demonstrated that the frequency and effort of NTFP collection were significantly important to communities adjacent to nature reserves. Despite stricter regulations, longer distances, and longer collection times, communities continued collecting, indicating households' high dependence on NTFPs. Regarding usage frequency, a significant number of households use NTFPs frequently to meet daily energy, food and shelter needs, worsened when income is insufficient, increasing their consumption of NTFPs (Shackleton and Shackleton, 2004; Wale et al., 2022), suggesting that households' frequency of NTFP use is important in shaping their livelihood

strategies. Apart from obtaining NTFPs from the forested area, households can opt for alternative sources to reduce their dependence on NTFPs (Wale et al., 2022). According to Wale et al. (2022), access to various forest locations and the collection of different NTFPs are important for sustaining livelihoods, implying that multiple NTFP collection sources decrease harvesting pressure on the reforestation project site. Hence, an alternative source of NTFP was included to form the NTFP dependence index.

According to Tugume et al. (2017), NTFP variety significantly influences the extent of NTFP dependence. Moreover, Shen et al. (2022) highlighted the various types of NTFPs collected over time, which included edible vegetables, medicinal plants, bamboo shoots, fruits, and mushrooms. Likewise, Wale et al. (2022) report on the different NTFPs consumed by rural households, including firewood, construction poles, traditional medicinal herbs, wild fruits and spinach, honey, and hunting, highlighting the importance of NTFP diversity and use to household livelihoods. The sale of NTFP was included in the index since it has been demonstrated to be an important source of household income. NTFP sales and purchases contribute to household income, particularly among poorer households (Kaoma and Shackleton, 2015), indicating that selling NTFPs is a livelihood strategy and shapes household NTFP dependence.

4.2.2.3 Empirical model

This study utilised OLS regression to analyse the relationship between the NTFP dependence and socio-economic variables. The OLS regression was selected for its suitability for estimating linear relationships between the dependent variable (the NTFP dependence index) and multiple independent variables. The NTFP dependence index combines indicators into a composite score using coefficients as weights. It acts as a continuous variable, so OLS is an appropriate and practical choice for modelling. The model provides unbiased and efficient estimates under the assumptions of homoscedasticity and no multicollinearity. Even when assumptions such as constant error variance are violated, the method remains robust, as adjustments such as heteroskedasticity-robust standard errors can be applied. Following Gujarati (2009), the model is expressed as:

$$Y_i = \beta_0 + X_{1i}\,\beta_1 + X_{2i}\,\beta_2 + \ldots\ldots + \varepsilon_i \qquad \textbf{4.4}$$

where Y_i is the NTFP dependence index for household i, X_i is a vector of socio-economic variables, β_0 is the intercept term, β_i is the coefficient to be estimated, and ε_i is a vector of error terms. For the analysis of NTFP dependence, the empirical model is specified as follows:

$$NTFPD_i = \beta_1(Age)_i + \beta_2(Gender)_i + \beta_3(Adult\ equivalents)_i + \beta_4(Education)_i + \beta_5(Social\ grant)_i + \beta_6(Off\text{-}farm\ income)_i + \beta_7(On\text{-}farm\ income)_i + \beta_8(Voucher)_i + \beta_9(Livestock)_i + \beta_{10}(Household\ assets)_i + \beta_{11}(Agricultural\ assets)_i + \beta_{12}(SCap)_i + \beta_{13}(Cwv)_i + \beta_{14}(PsycCap)_i + \beta_{15}(Distance\ to\ forested\ area) + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{4.5}$$

To ensure straightforward interpretation and comparison of coefficient size effects, all continuous variables were standardised prior to estimation. This involved transforming each variable into a z-score by minusing its mean and dividing it by its standard deviation. Then the coefficients are interpreted as the change in NTFP dependence when one of the explanatory variables has a one standard deviation. Education and distance to the forest are categorical variables and were included as dummy variables.

4.3 A Tobit model was not considered appropriate because the zero observations do not represent censored values of the NTFP dependence index. Rather, they correspond to households for which NTFP dependence is not observed, as they did not participate in NTFP collection. Including these households by assigning them zero values would combine two distinct behavioural processes: the decision to collect NTFPs and the degree of dependence among NTFP users. **Results and discussions**

4.3.1 Descriptive analysis of study variables

4.3.1.1 Measurement of NTFP and socio-demographic variables

Presented in Table 4.2 below are the descriptive statistics of the variables used to construct a weighted NTFP dependence index from 226 surveyed households in the Buffelsdraai and Osindisweni communities. The mean monthly collection frequency per household was 3.39, suggesting that some households collect NTFPs to varying degrees. Additional NTFP sources had a mean of 1.89 with a range of 1 to 4, indicating that households get NTFPs from other sources. The average number of NTFP types households use is 2.86. Moreover, 17 per cent of households reported selling NTFPs, as indicated by a mean of 0.17 for the binary market participation variable. Regarding utilisation, the mean NTFP usage was 2.13 on a scale of 1 to 3, indicating that most households use NTFPs at specific times of the year.

Table 4.2. Variables used in NTFP dependence index construction

Variables	Description of variables	Mean	Std. dev	Min	Max
Frequency of collection	Number of household visits to collect NTFPs per month (continuous)	3.39	2.69	1	20
NTFP source	Additional source of NTFPs (categorical)	1.89	0.66	1	4
NTFP variety	Number of different NTFPs collected (continuous)	2.86	1.49	1	9
NTFP market engagement	Sale of collected NTFPs (categorical)	0.17	0.38	0	1
NTFP usage	Level of NTFP utilisation (categorical)	2.13	0.67	1	3

Source: Household survey data (2018)

Households were asked to indicate the type of NTFPs collected in and around the reforestation project site. Table 4.3 presents the most commonly collected NTFPs and the proportion of households that harvest each

NTFP. As shown in Table 4.3, fuelwood was harvested by 96.9 per cent of household respondents, followed by wild spinach, mushrooms, wooden poles, traditional medicine and honey. Fewer households engage in hunting, harvesting edible plants, or collecting grass for thatching or livestock feeding.

Table 4.3. Most commonly collected NTFPs by households in Buffelsdraai and Osindisweni communities

Non-timber forest product	Percentage of households
Firewood	96.90
Untreated wooden poles	22.57
Traditional medicines	21.24
Edible plants	15.93
Mushrooms	44.25
Honey	22.12
Wild spinaches	45.13
Hunting animals	4.42
Grass for thatching	3.54
Sand	16.81
Grass for livestock	5.31
Other	1.33

Source: Household survey data (2018)

Regarding the explanatory variables in Table 4.4, the mean age was 49.39 years, with a range of 27 to 87 years, indicating that households are predominantly middle-aged. To capture the potential non-linear effects of age on NTFP dependence, age-squared was included in the estimation model. Since it is a derived variable included for model specification, only the descriptive statistics for the original age variable are presented in Table 4.4. The gender distribution revealed that a significant number of respondents were female, accounting for 69.4 percent. The majority of respondents had attained secondary education (43.4 percent), followed by primary education (34.5 percent). Only 0.9 percent had a tertiary education, and 21.2 per cent had no formal schooling. Social grants were R1,385.27 per household per month, and off– and on-farm income averaged R2 594.60 and R253.58 per month, respectively. The values of vouchers, livestock, household, and agricultural assets vary widely, with livestock and household assets ranging from R250 to R511 200, and agricultural assets ranging from R76 500. Households, on average, were 0.58 minutes from an electricity source, indicating that a higher proportion had close access to electricity. Most households were located within a 30–60-minute walking distance to the forest area (44.2 percent), followed by 30.1 percent who live 60 minutes' walking distance from the forest, with only 25.7 percent living relatively closer to the area within a 30-minute walking distance.

Table 4.4. Socio-demographic characteristics of NTFP collectors

Dependent variables	Description of variables	Mean/proportion	Std. dev/error	Min	Max
Age	Age of household head (years)	49.39	12.38	27	87
Age squared	Age of the household head squared (continuous)	-	-	-	-
Gender	Household head gender (nominal)	0.69	0.46	0	1
Education					
No schooling		0.212	0.027	-	-
Primary School	Education of household head (categorical)	0.345	0.032	-	-
Secondary school		0.434	0.033	-	-
Tertiary education		0.009	0.006	-	-
Adult equivalent	Equivalent adults in the household (continuous)	3791.99	1673.66	1000	8655
Social grant	Government social grant per month (Rands)	1385.27	1273.79	0	6700
Off-farm income	Off-farm employment income per month (Rands)	2594.60	3810.18	0	19500
On-farm income	On-farm employment income per month (Rands)	253.58	1428.32	0	15000
Voucher	Value of voucher received per month (Rands)	765.10	1689.24	0	15000
Livestock	Value of livestock owned (Rands)	2533.34	7887.77	0	76500
Household assets	Value of household assets owned (Rands)	52712.82	73009.11	250	511200
Agricultural assets	Value of agricultural assets owned (Rands)	1593.86	16642.62	0	250633
Electricity access	Distance to access electricity(minutes)	0.58	2.12	0	15
Distance to the forest:					
Less than 30 minutes	Walking distance to forest areas (categorical)	0.257	0.0291	-	-
Between 30 and 60 minutes		0.442	0.033	-	-
More than 60 minutes		0.301	0.031	-	-
Psychological capital	PCA estimated index (see Table 4.8)	-	-	-	-
Cultural worldviews	PCA estimated index (see Table 4.9)	-	-	-	-
Social capital	PCA estimated index (see Table 4.10)	-	-	-	-

Source: Household survey data (2018)

4.3.1.2 Measurement of psycho-social variables

Table 4.5 presents the psychological capital constructs and the associated questions administered to community household respondents. Measurement of this variable followed Luthans et al. (2007), who used a Psychological Capital Questionnaire (PCQ) comprising 24 questions and utilising a 5-point Likert scale. For this study, the PCQ was adapted for use with household respondents in a peri-urban context. Household respondents were posed 12 questions, captured using a 5-point Likert scale. Households were asked to rate their level of agreement with a statement that applies to themselves. The results indicate that households had a higher mean, above 4, suggesting that respondents had high psychological capital in the form of self-efficacy, hope, optimism and resilience. The reliability test, as measured by Cronbach's alpha, yielded an overall value of 0.5.

Table 4.5. Psychological capital constructs of NTFP collectors

Psychological capital variable	Mean	Std. dev
Self-efficacy		
I am confident in raising and making recommendations during public gatherings	4.08	1.13
I am confident in my ability to deal with problems and come up with solutions	3.88	1.22
I am confident in approaching people external to my family and friends to discuss problems	4.28	1.06
I don't believe the government is responsible for the well-being of people in the community	3.02	1.47
Hope		
If I am faced with a problem, I can think of many ways to resolve it	4.43	0.68
I have hope that the quality of work and life will improve for the better	4.40	0.77
Currently, I am pursuing my goals in life	4.41	0.78
Optimism		
I am optimistic about my future	4.32	0.82
I do not give up easily	4.59	0.76
I always look on the bright side of living	4.57	0.56
Resilience		
I can deal with extreme weather events such as floods, droughts, high and cold temperatures, and wind occurrences	3.66	1.16
When I face a setback, I have no trouble recovering from it and moving on	4.45	0.81
Alpha (α)		0.50

Source: Household survey data (2018)

Table 4.6 presents the cultural worldview constructs and related statements for households. Households were asked to indicate their level of agreement with a statement, captured using a 5-point Likert scale. The results indicate strong egalitarianism among households, as evidenced by their support for equal rights, fair wealth distribution, and equal opportunities, with affirmative action being less important. Moreover, results show that for households, it is moderately to very important for people to have the freedom to do what they want in life and rely on themselves, but also show low importance on the 'precedence of individual interest over social interest', suggesting that they do not consider themselves people who put their needs and wants before those of society. Furthermore, households find the 'authority of hierarchy' moderately important, while 'top-down management', 'patriarchy' and 'technocracy' did not apply. Households did not hold fatalistic beliefs, with low scores on 'lack of control over your life' and 'events are predetermined', suggesting a high sense of agency and control over their lives.

Table 4.6. Cultural worldviews constructs of NTFP collectors

Cultural worldview variable	Mean	Std. dev
Egalitarianism		
Equal rights	4.38	0.99
Equal wealth distribution	4.19	0.84
Affirmative action	3.79	1.35
Equal opportunities	4.29	1.01
Individualism		
Moral worth of an individual	3.52	1.25
Virtues of self-reliance	4.36	1.06
Value of personal independence	3.99	1.14
Precedence of individual interest over social interest	2.49	1.37
Hierarchism		
Authority of hierarchy	3.44	1.59
Top-down management	1.85	1.16
Patriarchy	1.91	1.42
Technocracy	2.52	1.64
Fatalism		
Lack of control over your life	1.75	1.17
Events are predetermined	2.24	1.58

Source: Household survey data (2018)

Table 4.7 summarises various social variables utilised to construct the social capital composite index. Households, on average, have been in the communities for 21 years, ranging from 1 to 87 years, indicating that the communities have both new arrivals and long-term members. Trust levels among community members are moderate, with slight variations. Households generally have fewer people and family members they can turn to in the community, with some having no one. The results indicate that households in the community receive financial and food assistance, with the majority receiving help primarily from family members. Though it is moderate, friends and neighbours also offer financial and food support to households.

However, some household heads engage with fewer social or community groups and depend less on them, as well as on micro-lenders or banks, for food or financial assistance, suggesting that these groups may primarily serve as venues for social interaction or savings. The considerable variation in annual cash contributions to groups is evident. Household heads are generally confident and comfortable participating in community activities. Additionally, most households prefer living in the community and are content with the social customs. But they are not pleased with municipal service delivery and the level of crime in the community.

Table 4.7. Social capital constructs of NTFP collectors

Social capital variable	Description of variable	Mean	Std. dev	Min	Max
Community relationships					
Years in the community	Number of years the household has been in the community (continuous)	21.31	15.58	1	87
Trust of community members	Level of trust of the household for community members (categorical)	3.35	1.13	1	5
People you can turn to in the community	Number of people a household can turn to (continuous)	2.45	1.22	0	5
Family members you can turn to	Number of family members a household can turn to (continuous)	3.52	1.64	1	5
Social assistance					
Financial assistance from family members	The level to which the social assistance statement applies to a household (categorical)	2.69	1.47	1	5
Financial assistance from friends		2.72	1.45	1	5
Financial assistance from neighbours		2.67	1.46	1	5
Financial assistance from a group we're part of		2.20	1.49	1	5
Financial assistance from micro lenders or banks		2.39	1.55	1	5
Family runs out of food, and we get it from other family members		3.55	1.63	1	5
Family runs out of food, and we get it from friends		2.48	1.45	1	5
Family runs out of food, and we get it from the neighbours		2.53	1.48	1	5
Family runs out of food, and we get it from a group we're part of		1.42	0.84	1	5
Social networks/groups					
Social groups in households are part of	Number of social groups the household is a part of (continuous)	2.47	1.05	1	5
Cash contribution to groups	Household cash contribution to groups per year (Rands)	3375.27	6110.74	0	78000
Community involvement					
Comfortable and confident in approaching organisations	The level to which the community engagement statement applies to a household (categorical)	4.32	1.14	1	5
Ability to influence events		3.80	1.09	1	5
Informed about local and national matters		3.71	1.03	1	5
Meet public officials and participate in local meetings		3.84	1.01	1	5
Participate in local and national elections		4.66	0.95	1	5
Perceptions about community					
Happy with social customs in the community	The level to which the community perception statement applies to a household (categorical)	3.36	1.24	1	5
Happy with service delivery in the community		2.89	1.3	1	5
I like living in the community		4.10	1.17	1	5
Not concerned about the level of crime in the community		2.43	1.24	1	5

Source: Household survey data (2018)

4.3.2 Psycho-social attributes of peri-urban households

In Table 4.8, the PCA of the psychological capital constructs yielded four PCs that together explained 55 percent of the total variance in the data. The first PC, $PsyCap_1$, accounted for 20.5 percent of the variation in the data, indicating that households had high levels of optimism about the future. The PC had dominant loadings related to hope, indicating that households were hopeful about improvements in the quality of their work and lives. Additionally, the loadings indicate that household heads are actively pursuing life goals. Further indicating an optimistic outlook and a proactive attitude toward achieving personal aspirations.

Table 4.8. Dimensions of psychological capital

Psychological capital variable	Principal component			
	$PsyCap_1$	**$PsyCap_2$**	**$PsyCap_3$**	**$PsyCap_4$**
Self-efficacy				
I am confident in raising and making recommendations during public gatherings	-0.077	**0.601**	-0.168	0.081
I am confident in my ability to deal with problems and come up with solutions	-0.144	**0.587**	0.039	-0.185
I am confident in approaching people external to my family and friends to discuss problems	0.149	0.262	0.197	**-0.419**
I do not believe the government is responsible for the well-being of people in the community	0.121	-0.105	**-0.556**	0.236
Hope				
If I am faced with a problem, I can think of many ways to resolve it	0.139	0.368	-0.258	0.012
I have hope that the quality of work and life will improve for the better	**0.420**	0.011	-0.370	0.099
Currently, I am pursuing my goals in life	**0.465**	0.172	-0.004	0.070
Optimism				
I am optimistic about my future	**0.509**	-0.015	0.015	0.013
I do not give up easily	0.305	-0.085	0.321	-0.373
I always look on the bright side of living	0.323	-0.052	0.013	-0.242
Resilience				
I can deal with extreme weather events such as floods, droughts, high and cold temperatures, and wind occurrences	0.034	0.189	**0.403**	**0.596**
When I face a setback, I have no trouble recovering from it and moving on	0.258	0.049	0.391	**0.401**
Eigenvalue	2.46	1.72	1.31	1.12
Percentage of Variation	20.48	14.33	10.89	0.093
Cumulative Percentage	20.48	34.81	45.70	55.03
Bartlett test of sphericity:				
Chi-square				359.33
Degrees of freedom				66
P-value				0.000
Kaiser-Meyer-Olkin (KMO)				0.670

Note: PC loadings greater |0.4| are highlighted in bold

Source: Household survey data (2018)

For $PsyCap_2$, the dominant component loadings were associated with psychological capital indicators of self-efficacy. In this PC, community members are confident in their ability to participate in discussions at public gatherings, handle problems, and present solutions. This dimension suggests that households feel empowered and find it worthwhile to engage others and solve problems. Table 4.8 shows that, with $PsyCap_3$, the dominant negative component loading was on the self-efficacy dimension, and the positive loadings were on the psychological capital and resilience dimensions. This indicates that although households are resilient and able to endure extreme weather, they also exhibit lower self-efficacy due to a growing belief that the government is responsible for their well-being. In the PC, $PsyCap_4$ showed two positive dominant component loadings on the resilience dimension and one negative dominant loading on self-efficacy. This component suggests that households experiencing extreme weather conditions and recovering quickly from setbacks tend to have lower confidence in engaging with individuals or entities to address their challenges.

In Table 4.9, following the Kaiser criterion, four PCs for cultural worldviews were derived, each with an eigenvalue greater than one, collectively representing 58 percent of the total variation in the data. The first PC, $Cwv_{1,}$ explained 17 percent of the variation and exhibited dominant loadings on hierarchism. This suggests that household heads place considerable importance and respect on the authority of hierarchies. Moreover, Cwv_2 shows two positive dominant loadings for variables on individualistic and fatalistic values. This suggests that households emphasise personal independence, reflecting their individualistic nature. Additionally, they hold beliefs in predetermined events, indicating a fatalistic worldview.

Cwv_3 had two dominant loadings on variables related to fatalism and egalitarianism. The strong positive loading on the ‘lack of control over your life’ variable indicates that households have limited personal agency or control over their circumstances. A negative loading on the ‘equal rights’ variable suggests that when households are fatalistic, egalitarianism is lower amongst households. So, community members' worldviews are shaped by feelings of powerlessness rather than a sense of equality. In Table 4.9, positive dominant loadings were observed for the self-reliance and technocracy variables in Cwv4, indicating a combination of technocratic and individualistic worldviews among household heads. This further suggests that households value technical expertise and professionals and hold individualistic values of independence and personal responsibility.

Table 4.9. Dimensions of cultural worldviews

Cultural worldview variable	Principal component			
	Cwv_1	Cwv_2	Cwv_3	Cwv_4
Egalitarianism				
Equal rights	0.243	0.125	**-0.404**	0.063
Equal wealth distribution	0.307	-0.061	-0.183	0.116
Affirmative action	0.392	-0.118	0.095	-0.263
Equal opportunities	0.345	0.059	-0.265	0.100
Individualism				
Moral worth of an individual	0.360	0.297	-0.039	-0.082
Virtues of self-reliance	0.215	-0.039	-0.293	**0.439**
Value of personal independence	-0.122	**0.422**	-0.315	0.294
Precedence of individual interest over social interest	-0.213	0.352	0.047	0.357
Hierarchism				
Authority of hierarchy	**0.422**	-0.107	-0.030	-0.192
Top-down management	0.231	0.278	0.348	0.121
Patriarchy	0.213	-0.348	0.215	0.367
Technocracy	0.023	-0.333	0.167	**0.490**
Fatalism				
Lack of control over your life	0.185	0.146	**0.507**	0.233
Events are predetermined	0.163	**0.479**	0.289	-0.091
Eigenvalue	2.33	2.15	2.00	1.61
Percentage of variation	16.67	15.38	14.30	11.52
Cumulative percentage	16.67	32.05	46.36	57.87
Bartlett test of sphericity:				
Chi-square				706.25
Degrees of freedom				91
P-value				0.000
Kaiser-Meyer-Olkin (KMO)				0.713

Note: PC loadings greater |0.4| are highlighted in bold

Source: Household survey data (2018)

In Table 4.10, the first PC, $SCap_1$, accounted for 14.69 percent of the variation in the data. For PC loadings greater than 0.4, the dominant loadings were associated with variables related to social assistance. This suggests that some households in this PC receive financial assistance from family and friends. Moreover, $SCap_2$ had a positive dominant loading on a variable related to perceptions about the community, specifically whether they are happy with service delivery. This finding suggests that households in the community are generally satisfied with the local government's service delivery. The third PC, $SCap_3$, was dominated by a variable related to social assistance. This indicates that social groups in the community benefit households by providing support when food runs out. Concerning $SCap_5$, Table 4.10 shows that the

dominant loading included social groups/networks. This indicates that groups and public life are essential to households, which value belonging to multiple social groups and contribute financially (or otherwise) to them.

$SCap_6$ had two dominant component loadings, one positive and one negative, and highlighted community perception and social assistance. The findings indicate that household heads were more likely to seek support from other family members when facing food shortages and expressed dissatisfaction with the level of service delivery within the community. $SCap_7$ explained 6.17 percent of the variation in the data, and the dominant loading was positive, highlighting community involvement, suggesting that households participate in local and national elections and indicating their engagement in public processes. Furthermore, in Table 4.10, the dominant loading in $SCap_8$ accounted for 5.16 percent of the variation in the data and was negative, indicating a relationship with social assistance. This indicated that households were unwilling to turn to their social groups for financial assistance. Regarding the ninth PC, $SCap_9$ showed a dominant negative loading related to community perception, suggesting that some households in the community tend to have negative perceptions and attitudes toward living there.

Table 4.10. Dimensions of social capital

Social capital variable	Principal component								
	$SCap_1$	**$SCap_2$**	**$SCap_3$**	**$SCap_4$**	**$SCap_5$**	**$SCap_6$**	**$SCap_7$**	**$SCap_8$**	**$SCap_9$**
Community relationships									
Number of years in the community	-0.011	0.029	-0.137	0.312	-0.141	-0.214	-0.247	0.497	0.238
Level of trust of community members	-0.039	0.386	0.133	0.166	-0.041	0.080	0.241	-0.015	-0.265
Number of people you can turn to in the community	0.273	0.185	-0.003	0.124	0.094	0.135	0.088	0.067	-0.276
Number of family members you can turn to	0.261	0.134	-0.381	0.202	-0.142	0.230	-0.020	0.051	0.241
Social assistance									
Financial assistance from family members	**0.432**	0.034	0.023	-0.145	0.131	-0.029	-0.178	0.000	-0.064
Financial assistance from friends	**0.425**	0.038	0.056	-0.158	0.153	-0.041	-0.159	-0.007	-0.063
Financial assistance from neighbours	0.346	0.099	0.147	-0.105	0.060	0.004	0.022	-0.019	0.059
Financial assistance from a group we're part of	0.031	-0.078	0.311	0.362	0.137	0.026	0.043	**-0.429**	0.134
Financial assistance from micro lenders or banks	-0.064	-0.065	0.169	-0.101	0.394	-0.094	0.244	0.385	0.386
Family runs out of food, and we get it from other family members	0.179	0.105	-0.288	0.247	-0.194	**0.433**	0.113	0.019	0.255
Family runs out of food, and we get it from friends	0.353	0.067	0.102	-0.217	-0.096	0.099	-0.063	0.098	-0.088
Family runs out of food, and we get it from neighbours	0.128	0.138	0.366	-0.169	-0.093	0.219	0.318	0.136	0.155
Family runs out of food, and we get it from a group we're part of	0.171	-0.191	**0.438**	0.314	-0.080	-0.045	0.007	0.044	0.095
Social networks/groups									
Number of social groups in households is part of	0.102	0.109	-0.217	0.216	**0.493**	-0.108	-0.057	-0.008	-0.039
Annual cash contribution to groups	0.055	0.048	-0.094	0.359	0.358	-0.087	-0.022	-0.246	-0.079
Community involvement									
Comfortable and confident in approaching organisations	-0.143	0.321	-0.106	-0.301	0.197	0.091	-0.172	-0.161	0.234
Ability to influence events	-0.140	0.273	0.064	0.064	0.343	0.142	-0.186	0.052	0.257
Informed about local and national matters	-0.192	0.194	0.259	0.259	-0.008	0.229	-0.324	0.251	-0.161
Meet public officials and participate in local meetings	-0.167	0.247	0.231	0.231	0.092	0.273	-0.096	0.161	-0.116
Participate in local and national elections to vote	0.000	-0.079	-0.155	0.044	0.209	0.039	**0.625**	0.183	-0.021
Perceptions about community									
Happy with social customs in the community	0.056	0.385	0.061	0.044	-0.131	-0.396	0.165	-0.172	0.205
Happy with service delivery in the community	0.019	**0.411**	0.064	0.047	-0.258	**-0.402**	0.023	-0.063	0.192
I like living in the community	-0.074	0.271	-0.149	-0.067	0.002	-0.201	0.149	0.206	**-0.450**
Not concerned about the level of crime in the community	0.186	-0.134	0.045	0.129	0.078	-0.286	-0.116	0.308	-0.068
Eigenvalue	4.18	2.39	1.69	1.56	1.42	1.32	1.24	1.10	1.03
Percentage of Variation	14.69	7.4	7.37	7.25	6.95	6.31	6.17	5.16	5.14
Cumulative Percentage	14.69	22.09	29.45	36.71	43.66	49.96	56.14	61.30	66.44
Bartlett test of sphericity:									
Chi-square									1807.33
Degrees of freedom									276
P-value									0.000
Kaiser-Meyer-Olkin (KMO)									0.635

Note: PC loadings greater |0.4| are highlighted in bold

Source: Household survey data (2018)

4.3.3 Factors shaping non-timber forest product dependence

This section examines the factors influencing NTFP dependency in the Buffelsdraai and Osindisweni communities. The OLS regression model was estimated using the weighted variable, NTFP dependence, and socio-economic factors. Furthermore, model diagnostics were conducted to assess the model's suitability. Variance Inflation Factors (VIFs) were calculated to assess multicollinearity among the variables, and the mean VIF was less than 10, indicating no significant multicollinearity (Gujarati, 2009). Additionally, robust standard errors were estimated to address heteroscedasticity (Table 4.11). Furthermore, the Ramsey RESET test did not detect evidence of misspecification, indicating that the model's functional form is adequately specified.

The findings in Table 4.11 indicate that adult equivalents have a positive impact on household dependence on NTFPs. This observation is associated with the various components of NTFP dependency, suggesting that larger households with more active adults tend to utilise a broader range of NTFPs to meet their needs. Additionally, larger households are better endowed with labour and are better positioned to maintain collection schedules, further enhancing their reliance on forest resources. Additionally, households with more adults often rely on firewood for energy, even when they have access to electricity, because electricity may be insufficient for cooking or heating. This finding aligns with the conclusions drawn by Heubach et al. (2011), who identified household size as a factor influencing NTFP dependency, particularly in rural contexts. Similarly, Suleiman et al. (2017) noted that households with more adults could provide the labour necessary to access and efficiently utilise NTFPs and other forest resources.

The results also show a negative and statistically significant relationship between household assets and dependence on NTFPs, indicating that wealthier households are less dependent on NTFPs. Households with more assets have better access to alternative resources and livelihood options, reducing their dependence on forests for daily sustenance or income. Wale et al. (2022), note that asset-endowed households are likely to use modern energy sources, thereby reducing their reliance on NTFPs for energy. This finding is further supported by Mamo et al. (2007), who found that asset-endowed households engage in NTFP extraction less often, as they can invest in higher-income opportunities, such as farming and off-farm employment, and afford substitutes for NTFPs, such as firewood. Moreover, a statistically significant positive relationship exists between agricultural assets and dependence on NTFPs. Households engaged in agriculture rely on NTFPs to support their farming. Wale et al. (2022) highlight that forests are important agricultural inputs, particularly in resource-scarce rural areas where households depend on forests for energy.

Table 4.11. Standardised regression estimates of factors shaping NTFP dependence

Explanatory variable	NTFP dependence		
	Standardised coefficient	**Robust std. error**	**P>|t|**
Age	-0.005	0.006	0.399
Age squared	7.55E-05	5.02E-05	0.134
Gender	0.129	0.139	0.356
Adult equivalent	0.217***	0.082	0.009
Education (ref. category: *no schooling*)			
Primary school	0.075	0.184	0.685
Secondary school	-0.046	0.183	0.800
Higher education	-0.411	0.384	0.286
Social grant	-0.009	0.085	0.910
Off-farm income	-0.068	0.079	0.388
On-farm income	-0.012	0.050	0.807
Voucher	0.032	0.073	0.660
Livestock	0.042	0.056	0.457
Household assets	-0.168***	0.055	0.003
Agricultural assets	0.115***	0.028	0.000
Electricity access	0.136**	0.062	0.030
Distance to the forest (ref. category: > *60min*)			
<30min	-0.147	0.182	0.420
30-60min	0.079	0.158	0.619
$SCap_1$	0.180**	0.089	0.045
$SCap_2$	0.131*	0.076	0.084
$SCap_3$	0.084	0.074	0.256
$SCap_5$	0.086	0.076	0.262
$SCap_6$	-0.072	0.079	0.364
$SCap_7$	0.142*	0.074	0.056
$SCap_8$	0.054	0.066	0.416
$SCap_9$	1.85E-04	0.071	0.998
Cwv_1	0.124	0.077	0.107
Cwv_2	-0.091	0.084	0.278
Cwv_3	-0.167*	0.089	0.064
Cwv_4	0.009	0.074	0.903
$PsyCap_1$	-0.108	0.079	0.171
$PsyCap_2$	-0.030	0.076	0.690
$PsyCap_3$	0.027	0.076	0.727
$PsyCap_4$	-0.063	0.085	0.459
Constant	-0.031	0.369	0.933
Number of observations			226
F (33, 192)			24.86
R-squared			0.303
Prob > F			0.000
Mean VIF			1.58
Ramsey Reset test			
F (3, 189)			0.82
Prob > F			0.486

Note: ***, ** and * refer to significance at 1%, 5 % and 10 %, respectively
Source: Household survey data (2018)

Electricity access was positively and statistically significantly associated with NTFP dependence. Despite high electrical connectivity (see Table 4.4), the result implies that households still utilise NTFPs. Studies (Kaoma and Shackleton, 2015; Guild and Shackleton, 2018) have revealed that fuelwood NTFP markets are widespread in areas with good electrical connectivity, suggesting that increased electrical access does not reduce NTFP consumption. Households remained strongly reliant due to the high cost of electricity and its unsteady supply. This indicates that electrical connectivity does not entirely replace NTFP use in Buffelsdraai and Osindisweni; instead, households combine both energy sources. According to Kaoma and Shackleton (2015), such households would use firewood for cooking and heating, and electricity for lighting and home appliances.

Social capital shapes dependence on NTFPs within communities, as the standardised coefficients for $SCap_1$, $SCap_2$, and $SCap_7$ were positive and significant. Suggesting that households financially assisted by family members and friends, with positive perceptions about the community and actively participating in civic activities such as elections, are more likely to depend on NTFPs. Financial assistance from close social networks could indicate that these households have limited income and likely depend on NTFPs for subsistence. Moreover, a positive perception of community service delivery could indicate the presence of trusted, engaged local institutions that enable NTFP collection and use through knowledge sharing, thereby increasing NTFP dependence. Additionally, active households in civic matters build stronger social networks that promote information sharing and collective action, enabling them to access forest resources more effectively and thereby increasing their dependence on NTFPs. These findings align with studies (Newton et al., 2016; Agrawal and Gibson, 1999), which showed that social capital, in the form of trust and a sense of connectedness to institutions, facilitates cooperation and the collective management of natural resources, and that social networks can increase NTFP dependence by increasing access to resources, knowledge, and collective bargaining opportunities.

Cwv_3 is negative and statistically significant, suggesting that fatalistic and egalitarian households are less dependent on NTFPs. This appears counterintuitive. For example, Sharaunga et al. (2013) found that rural households experiencing marginalisation and a lack of agency often rely on communal resources, such as forests, for their livelihoods. Nevertheless, a likely explanation is that households may believe they are disempowered and marginalised, and thus withdraw from NTFP activities, particularly given the access restrictions on the project site, which ease pressure on the forest and lower NTFP dependence. This finding aligns with several studies (Masozera and Alavalapati, 2004; Heubach et al., 2011) that have found restricted forest access reduces NTFP activities but raises conflicts and food insecurity among rural households. However, when access restrictions are implemented in consultation with traditional and local government leadership and communities, environmental marginalisation decreases, and forest management

strengthens (Fabricius and Collins, 2007; Angelsen and Wunder, 2003). Proximity to urban centres might offer households alternative livelihoods, such as wage employment, enabling them to shift away from forest-based activities and reduce their dependence on NTFPs. In peri-urban areas, urbanisation offers households opportunities to diversify their incomes by participating in urban markets (Wale et al., 2022; Shackleton et al., 2011).

4.4 Summary

Among poor households in South Africa, non-timber forest products (NTFPs) are an important source of livelihood security. NTFP dependence can lead to deforestation and exacerbate land degradation. Therefore, PES schemes, such as the reforestation project, are important tools for encouraging communities to adopt land-use practices that improve forest ecosystem services while safeguarding their livelihoods. Most studies have focused on NTFP dependence in a rural context, while few have examined the peri-urban setting in South Africa. Even fewer studies have captured NTFP dependence through actual household subsistence behaviour rather than income data. Even more so when considering how psychological and social capital constructs shape dependence on NTFPs. Regression estimates indicate that NTFP dependence increases with the presence of more adults, a better agricultural endowment, access to electricity, social capital related to strong personal social networks, and individualist and hierarchical worldviews. Meanwhile, well-endowed, fatalistic, and egalitarian households are less likely to depend on NTFPs. Larger households need support to diversify their livelihoods by starting home food gardens and cultivating economically viable NTFP crops to improve market linkages. Conclusions, policy implications, and recommendations for this chapter are presented in Chapter 6.

CHAPTER 5

HOUSEHOLD PREFERENCES AND WILLINGNESS TO PAY FOR FOREST ECOSYSTEM ATTRIBUTES: EMPIRICAL EVIDENCE FROM DURBAN

5.1 Introduction

This chapter employed a Choice Experiment (CE) to study households' preferences for ecosystem goods and services and their willingness to pay for these environmental attributes. The CE approach has been used to evaluate ecosystem goods and services in South Africa. This chapter demonstrates how CE was used to ascribe monetary value to the environmental features of an established forest, resulting from the reforestation project's efforts to rehabilitate a previously degraded land area into a restored indigenous forest. This initiative aimed to enhance biodiversity and ecosystem services, while also increasing climate resilience. This chapter is organised as follows: Section 5.2 presents details of the research methodology. Section 5.3 presents the results and discussion, and Section 5.4 provides the summary of the study.

5.2 Research methodology

5.2.1 The conceptual framework

Theoretically, CE is based on random utility theory (RUT) (McFadden, 1974), which posits that, assuming rational behaviour, individuals select options from a set of alternatives that maximise utility (Espino et al., 2008). This utility has a deterministic part consisting of observable attributes and a random component accounting for unobservable and stochastic effects (Vidogbéna et al., 2015). The model describes the utility (U_{ij}) of choice as a systematic and an error component (Rolfe et al., 2000).

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad j = 1,2,\ldots..,J \qquad \textbf{5.1}$$

where U_{ij} is the utility of alternative j for the ith household head. V_{ij} is the observed utility component, modelled as a linear function of households' environmental attributes and socio-demographic characteristics. The error component, $\varepsilon_{ij,}$ represents the unobservable component of the utility function. The precise estimation of the choice model depends on the assumption that the error component, ε_{ij}, has a random distribution.

Moreover, the probability that any respondent will select alternative j in the choice set over alternative h is given by equation 5.2 below, which states that the utility associated with alternative j exceeds that associated with all other alternatives (Hanley et al., 2001).

$$P\,[(U_{ij} > U_{ih}) \forall h \neq j] = \mathrm{P}[(V_{ij} - V_{ih}) > (\varepsilon_{ih} - \varepsilon_{ij})] \qquad \textbf{5.2}$$

For the derivation of equation 5.2, obtaining the distribution of the error terms (ε_{ij}) is essential. If the error terms are Gumbel (double log) distributed and independently and identically distributed (McFadden, 1974, cited in Rolfe *et al.,* 2000), equation 5.3 gives the distribution of the error term:

$$P\ (\varepsilon_{ij} \leq = F(t)) = e^{(-e\ -t)} \qquad \textbf{5.3}$$

According to Hanley et al. (2001), equation 5.3 suggests that the probability of a specific alternative *j* being selected as the most preferred can be expressed as a logistic distribution. The model specification for this distribution is called the conditional logit and takes the general form:

$$P\ (U_{ij} > U_{ih},\ \forall h \neq j) = \frac{e^{\mu V_{ij}}}{\sum e^{\mu V_{ij}}} \qquad \textbf{5.4}$$

where μ represents a scale parameter and is inversely proportional to the standard deviation of the error distribution (Hanley et al., 2001). The scale parameter is typically normalised to 1 in any data. The assumptions about the distribution of the error terms in the model specification impose the Independence from Irrelevant Alternatives (IIA) property (McFadden, 1974). This condition states that the relative probabilities of a selected alternative are unaffected by the addition or removal of other alternatives from the choice set (Rolfe et al., 2000). Therefore, assuming that choices from the data set are consistent with IIA in equation 5.4, the probability of a household head *i* choosing alternative *j* can be represented below as:

$$P_{ij} = \frac{e^{V_{ij}}}{\sum_{j=1}^{J} e^{V_{ij}}} = \frac{e^{\beta X_{ij}}}{\sum_{j=1}^{J} e^{\beta X_{ij}}} \qquad \textbf{5.5}$$

where X_{ij} are the observed variables and β' represents the coefficients derived from the model. In this study, the observed variables and unobserved random variables of the utility, where there are *m* attributes, are modelled as:

$$V_{ij} = \beta_j + \beta_m X_{mj} + \beta_{ij} X_{ij} + \varepsilon_{ij} \qquad \textbf{5.6}$$

where V_{ij} is an indicator variable that takes the value of one if household head *i* selected *j* and zero otherwise. β_j are alternative-specific constants. β_m are coefficients for attributes, X_{mj}. B_{ij} are coefficients for socio-demographic variables, $X_{ij.}$

As mentioned above, the conditional logistic regression model imposes the independence of irrelevant alternatives (IIA) property on the choice probabilities (McFadden, 1974). The assumption is that attributes and levels in each alternative would not influence the relative probabilities of other alternatives in the model and the choices made. However, it is implausible that choices in the data set will be consistent with the IIA property (Luce, 1960). Significant heterogeneity in household preferences and socio-demographic

characteristics in this study violates the IIA conditions. If the error terms are correlated, choice probabilities do not take the form of equation 5.6 above, violating the IIA assumption (Hausman and McFadden, 1984). Nonetheless, mixed logit models do not exhibit IIA and relax this condition, allowing the error terms to vary across alternatives within a choice set (Hensher and Greene, 2003; Lee et al., 2014). Then, the probability of household *i* selecting alternative *j* with a mixed logit model is:

$$P_{ij}(\beta) = \int \left(\frac{e^{\beta' X_{ij}}}{\sum_{j=1}^{J} e^{\beta' X_{ij}}} \right) f(\beta) d\beta \qquad \textbf{5.7}$$

where the distribution function is $f(\beta)$ for β and X_{ij}, a vector of observed variables. Moreover, where there are *m* attributes, the utility is expressed as:

$$V_{ij} = \beta_j + \beta_i X_{mj} + \beta_m X_{mj} + \beta_{ij} X_{ij} + \varepsilon_{ij} \qquad \textbf{5.8}$$

V_{ij} is an indicator variable taking the value of one if household *i* selects *j*, and zero otherwise. βj are alternative-specific constants. β_m are coefficients for attributes, X_{mj}; and B_{ij} are coefficients for socio-demographic variables, $X_{ij.}$ In a mixed logit model, attribute variables are modelled with random coefficients (Hensher and Greene, 2003); thus, β_i are random coefficients that vary across households within communities for attribute X_{mj}. In this study, following Lee et al. (2014), the payment/cost variable was assumed to be fixed and not randomly distributed, while other attributes of interest were randomised. According to Scarpa et al. (2008), restricting the payment vehicle allows for the easy computation of WTP distributions from non-price coefficient distributions. Given that all attributes are normally distributed and the payment/cost variable was not randomised, the WTP will also be normally distributed (Carlsson et al., 2003). Lastly, the restriction allows the payment attribute to be non-positive for individual household heads in this study (Carlsson et al., 2003).

5.2.2 Socio-demographic variables

This study included socio-economic and demographic variables to understand their influence on household choices. So, those variables shown to affect choices and WTP estimates are age, gender, education, social grant, employment income (*on and off-farm*), social values and psychological capital (Greiner et al., 2014; Jones et al., 2015; Snowball et al., 2008; Lee et al., 2014; Spash et al., 2009; Halkos and Matsiori, 2012; Yao et al., 2014).

Age has been observed to be negatively correlated with WTP estimates; i.e., the older the respondents, the lower their WTP, and the younger, the higher their WTP (Brouwer and Spaninks, 1999; Yao et al., 2014). Gender significantly affects WTP, with males more likely to contribute and to have higher WTP for environmental amenities. However, this relationship is dynamic and could be the opposite in another

context (Brouwer and Spaninks, 1999). Income levels have a positive and significant impact on WTP and the levels of education attained (Halkos and Matsiori, 2012; Yao et al., 2014). Therefore, respondents with higher levels of education and income are expected to understand the importance of reforestation and be willing to pay more for it. Respondents who are employed tend to have higher WTP estimates than those who are unemployed. Social grants are an important source of unearned income in South Africa, accounting for a substantial share of poor households' income (Sinyolo et al., 2017). Therefore, a social grant variable was included in the analysis to obtain its influence on WTP.

Assessing social factors in environmental management studies provides insight into the needs, values, norms, and behaviours of the study area's people, institutions, and organisations (Cowling et al., 2008; Bryan et al., 2010). Moreover, variables that capture culture and social values were included to explain household WTP. Hierarchism, fatalism, egalitarianism, and individualism are social values in cultural theory that categorise people and their solidarities (Rippl, 2002). Another important variable included is psychological capital. According to Luthans and Youssef (2004), psychological capital is a construct within positive organisational behaviour (POB), which comprises psychological constructs such as hope, resilience, optimism, and self-efficacy. The variable will help explain how households' psychological abilities influence preferences and WTP. PCA-derived indices for psychological capital and cultural worldviews, used in the present chapter as explanatory variables, were obtained in Chapter 3, Table 3.8 and 3.9.

5.2.3 Choice experiment design

5.2.3.1 Approaches to attribute selection

The design and implementation of CEs require a detailed survey design, with the crucial aspect being the identification of contextually relevant attributes and their levels (Kragt and Bennett, 2008; Hoyos, 2010). While the project's primary objective is carbon sequestration, forests can also provide ecosystem goods and services essential to surrounding communities. This study selected characteristics of the establishing forest important to these communities and estimated monetary values for different forest attributes. Literature reviews, focus group discussions, and expert consultations helped identify and select the relevant attributes.

Forest valuation studies usually identify several environmental attributes such as non-timber forest products (NTFPs) collection, recreation/livelihood (hunting, fishing, etc.), carbon sequestration, water supply and regulation, nutrient recycling, erosion control, and biodiversity conservation (Adamowicz et al., 1998; Brey et al., 2007; Fisher et al., 2008; Al-Assaf, 2015). Moreover, reports from Macfarlane et al. (2011) and key informants (community facilitators) in the reforestation project indicate that ecosystem goods and services are essential to adjacent communities. These include water provision from rivers, seeds, fishing, grazing

land for livestock, collection of NTFPs (i.e., traditional medicine), sand mining, reeds, mud, and stones for construction, and hunting (i.e., birds).

Focus group discussions (FGDs) held in the communities indicate that participants considered forests essential to the environment and derived NTFPs, such as fuelwood and medicinal herbs. A common and significant concern amongst community members during discussions was air quality. Focus group participants thought planting trees would alleviate the odours from the landfill site and provide shade/cover. Moreover, community members emphasised the importance of trees and forests in providing habitats for vervet monkeys (Chlorocebus pygerythrus), as these animals can invade their homes. Community members also indicated that trees prevent muddy water from entering their homes during rain and sweep away their land. FGDs revealed that the area was used for livestock grazing (fodder from invasive plant species). The rivers (Black Mhlasini and Umdloti), which flow through both communities (only the Black Mhlasini river runs next to the project site), are used for fishing and for watering home gardens and nurseries. The ecosystem service attributes in the reforestation project site are presented in Table 5.1 below.

Table 5.1 Main attributes found to be relevant in the reforestation project site through key informants, focus group interviews, and project reports.

i.	Air quality in the communities
ii.	Carbon sequestration by trees
iii.	Forest habitats for intrusive animals
iv.	Buffer against landfill activities, odours, and fire protection against the explosive risk presented by landfill gas methane
v.	Livestock grazing (fodder)
vi.	Environmental education (environmental awareness)
vii.	Employment (no. of local community members employed)
viii.	Faunal species richness and abundance (hunting: small mammals, birds)
ix.	Tree species diversity (pharmaceutical products, fuelwood)
x.	Water availability (for watering nurseries, home gardens, mud formation, and reed growth)
xi.	Payment vehicle (community trust fund to pay for environmental attributes)

5.2.3.2 Description of establishing forest attributes

This study constructed CE using attributes in Table 5.1 under various project site management scenarios. Air quality is typically assessed by measuring the extent to which tree cover removes air pollutants (Dobbs et al., 2011). Thus, an increase in tree cover area would indicate improved air quality, and *vice versa*. According to Macfarlane et al. (2011), the reforestation project aims to plant approximately 500 000 trees on 521-580ha of transformed or degraded natural habitat to offset 42 214 tons of CO_2 over 20 years. Thus far, 595 476 trees have been planted, with 532 016 trees planted in the landfill buffer zone and 63 460 trees planted to form a 'living fence'. Before rehabilitation, the project site was dominated by sugar cane fields covering over 40 percent of the area (Figure 5.1). Large areas of natural vegetation types were present

before the project's implementation. For instance, areas of indigenous and riparian forests and woodlands existed, ranging in size from 33.6 to 95.7ha (Macfarlane et al., 2011).

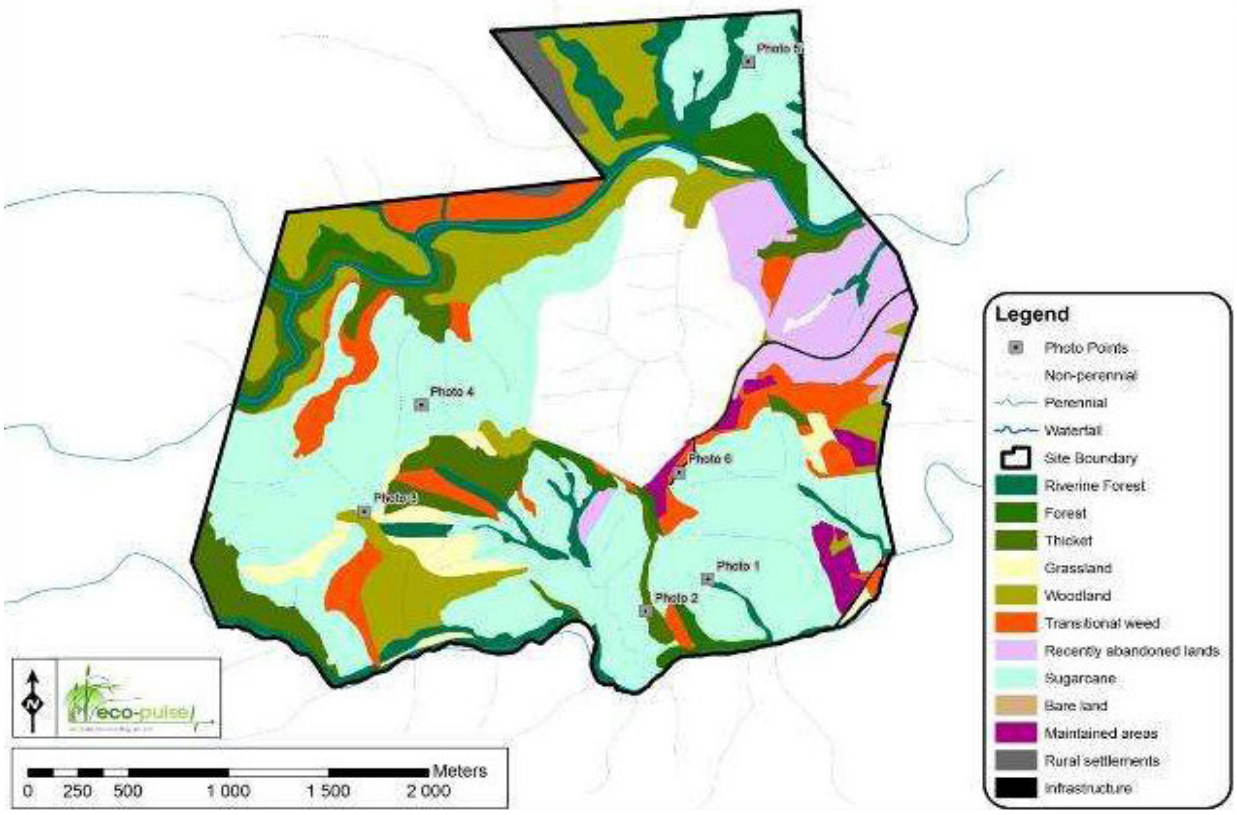


Figure 5.1. The baseline vegetation map of the Reforestation project site
Source: Macfarlane et al. (2011)

FGD participants identified the education attribute as an essential aspect of the reforestation project. Participants reported that their level of environmental awareness had improved significantly due to the environmental advocacy and outreach initiative implemented to enhance the community's understanding of natural ecosystems and the importance of protecting them (Douwes et al., 2017). According to Viljoen (2010), Wildlands introduced a rewards programme in 2009 that organised environmental education trips for 'tree-prenuers'. These trips were rewarded based on how many trees a tree-prenuer could grow annually. For instance, a tree-preneur who raised more than 100 trees per year would receive a day trip to a nature reserve or outdoor education venue, an overnight experience, or a longer stay at a game reserve if more than 250 to 500 trees were planted annually.

Over 176 faunal species were recorded by 2015, compared to 68 species recorded in the 2009 baseline survey in forest habitat types (Macfarlane et al., 2011). The Biodiversity Monitoring report for 2015 highlights that 29 invertebrate species have been recorded, mainly derived from the riparian forest habitat

(Macfarlane et al., 2015). Moreover, regarding avifauna, 17 bird species were recorded in the 2009 baseline survey, compared with 29 in the south-facing forest habitat in 2015. Meanwhile, 31 and 37 bird species were recorded in the riparian forest habitat in 2009 and 2015, respectively. The woodland forest habitat supported some 20 bird species in 2009 and 22 in 2015. According to Macfarlane et al. (2015), the 2015 assessment of small mammals across all forest habitats showed no significant increase in small-mammal species richness relative to the 2009 baseline. For instance, in the south-facing forest, only two rodent species were recorded: one in the riparian forest habitat and three in the woodland forest habitat. However, during FGDs, participants reported seeing small antelopes and wild pigs in the area.

As of 2015, 51 tree species were found on the landfill site (Douwes et al., 2017). For instance, 29 tree species were recorded, compared with 22 in the 2010 baseline survey (Macfarlane et al., 2015). The riparian forest habitat only registered 27 tree species. Still, most of these tree species are indigenous, have a low abundance, and appear to be naturally colonising the site. This means no planting has occurred to actively re-vegetate the area as part of the reforestation project. The woodland forest habitat is reported to have the highest number of planted trees, with an estimated density of new tree growth of 3 850 saplings per hectare.

Moreover, FGD participants identified water availability as an essential environmental attribute for several reasons (Table 5.2). However, specialist assessment reports and discussions with key informants revealed that the hydrological profile of the Black Mhlasini River is unavailable. Therefore, riparian forest vegetation will represent water availability in the Black Mhlasini River. According to Cooper and Merritt (2012), vegetation responses to hydrological regimes (variations in water availability) are directional, meaning that the characteristics of riparian vegetation (e.g., growth) occur under optimal moisture gradients. For example, this is the case for declines and collapses of existing plant populations, the establishment of new populations, or shifts in vegetation distribution. Therefore, the characteristics of riparian forest vegetation can reveal the hydrological regime of the riparian area. Hence, in this study, it is assumed that the species community (in terms of numbers and abundances) will reflect the hydrological conditions of the riparian forest habitat.

During FGDs, participants were asked if they would make a once-off payment to plant trees around the landfill site. Participants were further informed about the benefits of planting these trees; for instance, they will naturally shield against emissions from landfill activities, such as trapping dust, air pollutants, and foul odours, and screen them from the landfill. Furthermore, participants were informed that the funds would be sourced from the community and their households and deposited into a community trust fund over 20 years. However, participants raised several concerns about the cost of reforestation around the landfill site. During the FGDs, others argued that the government was primarily responsible for funding such initiatives and that

they were unwilling to pay since they were largely unemployed. However, participants stated they would be willing to pay if they had employment opportunities and received greater control over the area.

The reforestation project is a public-good improvement initiative to restore degraded land, contribute to CC mitigation, support biodiversity conservation, and provide employment opportunities for households through the cultivation and sale of indigenous trees (Viljoen, 2010). Therefore, the valuation context was selected as a willingness-to-pay (WTP) problem rather than a willingness-to-accept problem. WTP is appropriate because the hypothetical market includes improved ecosystem services, such as carbon sequestration, buffer formation, increased biodiversity, and habitat, rather than a decrease in benefits. Furthermore, FGD participants were asked how much they would contribute towards reforestation. The payment amount that FG discussants indicated they were ready to contribute was R1.00 to R10.00 a month (R12.00 to R120.00 annually) for the reforestation of the buffer zone. This payment vehicle reflects the support and value households place on reforestation activities, which is consistent with the CE application in environmental valuation (Hanley et al., 2001; Adamowicz et al., 1998).

5.2.3.3 Reforestation project management scenarios

Initiatives on investment in natural resources and environmental assets in developing countries are driven by development. They are designed to restore natural capital whilst addressing poverty in the affected communities. However, future results of environmental restoration projects, especially as they relate to ecosystem service typologies, are characterised by uncertainty and unpredictability. The reforestation project often takes diverse paths and yields varied outcomes. Therefore, this section explores project management conditions to account for alternative future consequences by creating scenarios that describe possible circumstances that might reasonably occur (Duinker and Greig, 2007).

Nevertheless, scenarios do not offer an exhaustive representation of the future; they are constructed to direct attention to one or more segments of reality (Kosow and Gabner, 2008). Moreover, every scenario created is based on assumptions about the future (Potting and Bakkes, 2004; Duinker and Greig, 2007; Kosow and Gabner, 2008), which may or may not hold. Selected management scenarios and the reasons for their selection are presented in detail in Table 5.2.

Table 5.2. Reforestation project management scenarios

Scenario	Description	Importance
Scenario A A medium-term implementation/current scenario-*in-medias res*	Reforestation project objectives achieved thus far (6 years completed), resulting in increased or improved ecosystem services.	*Scenario A* directly relates to the objectives of the Reforestation project. Measuring project benefits under a medium-term implementation scenario, *in medias res,* will greatly interest policymakers in the eThekwini Municipality.
Scenario B No funding *(Status quo)* scenario-*(2009 baseline)*	No expansion or restoration will occur over the next 20 years.	*Scenario B* assumes that the project was never implemented. The habitats, species, and provision of ecosystem services remained at baseline, with a gradual decline in habitat conditions.
Scenario C No further funding- *discontinued*	No further investment in the reforestation project is available, resulting in a decline in the provision of ecosystem services.	In *Scenario C*, the Reforestation project is assumed to have been discontinued/with no further funding. Therefore, the valuation of ecosystem benefits under this scenario will provide decision-makers with information on the impact of funding withdrawal on the level of ecosystem services and related values.
Scenario D Long-term implementation/best-case scenario-*ex-post*	The objectives of the reforestation project were achieved over 20 years, resulting in increased or improved ecosystem services and the establishment of the site as a conservancy.	*Scenario D* directly aligns with the project's objectives. The ex post valuation of the forest ecosystem under a complete, long-term implementation scenario will be helpful to policymakers in the eThekwini Municipality.

Source: Authors' construct

5.2.3.4 Establishing forest attribute levels

The levels of ecosystem service attributes used in this study for CE reflect changes that could occur under various environmental management scenarios over the expected 20-year lifespan of the reforestation project. CE questions were designed based on the attributes and scenarios described in Tables 5.1 and 5.2. Section 5.2.3.2 described the ecosystem service attributes identified as beneficial to the local community. This section provides definitions of the selected attribute levels and the impacts that the described scenarios could have on the supply of ecosystem services at the reforestation site.

Under a full implementation scenario-*in medias res*, scenario *A*, the project is expected to have sequestered 15,489.9 tCO_2e (Glenday, 2007). Only areas under sugarcane cultivation will be directly affected by reforestation. Carbon stocks are expected to change significantly as a result of the project. Therefore, in the long run, carbon stocks above- and below-ground would be reduced under a baseline scenario. Moreover, the land would likely be infested with transitional weeds and would probably continue to be used for sugarcane production. Thus, sugarcane cultivation would generate CO_2 through land preparation, planting, applying fertilisers and herbicides, pre-harvest burning, transport, and the delivery of machinery to the mill (Knowles and Theron, 2014).

Under the status quo scenario (without the project), scenario *B* assumes the carbon pool of the sugarcane that would grow is zero. Thus, sugarcane would generate GHG emissions from production activities (e.g., land preparation, fire). The total CO_2 emissions over 20 years are estimated at 2 589 tCO_2e (Glenday, 2007). Currently, legislation limits land use within the landfill site's buffer zone to agricultural activities. However, no legislation obligates the eThekwini Municipality to restore the area to its original state, other than clearing it of invasive alien plant species (Knowles and Theron, 2014). Therefore, if the project is withdrawn, any carbon sequestration gains made thus far will decline because fewer trees would have been planted to sequester carbon. Under scenario *C,* it is assumed that 15 489.8 tCO_2e gained would decrease. This means that the capacity of the reforested area to capture and store carbon will decline, and the sequestration gains will be offset, reducing the climate mitigation benefits of the reforestation project. Under scenario *D*, project objectives have been achieved, and the 520.6ha of the project site have sequestered the expected 42 214 tCO_2.

Under scenarios *A* and *D*, the project is expected to yield positive environmental and community outcomes. As of 2012, the number of jobs created (permanent, part-time, and temporary) was 374, and by 2014, it had increased to 455 (Whitley, 2012). Therefore, the number of jobs created since the project's inception has steadily increased as it progressed through various phases. It is projected that additional jobs will be created. According to Whitley (2012), '*many years of maintenance will need to be planned for, and there are plans for a conservancy'*. Therefore, it is assumed that jobs will exceed the current level under scenario *D* and will decrease under scenario *C*, resulting in fewer jobs than the current level (Table 5.2).

In 2012, 284ha of land had been planted with trees (Whitley, 2012), and by 2013, an additional 100ha (Whitley, 2013). The 2014 Reforestation project report states that in 2013/2014, 24.88ha of the reforestation site had been planted with trees (Whitley, 2013). Thus, the reforested area will be 408.88ha by 2014. In section 5.2.3.2, it was highlighted that 201.5ha of forest habitat were present in the area. Thus, under scenario *B*, it is assumed that there would be no change from the baseline conditions and that the provision of forest habitat would remain the same or decline. Under scenario *D*, the entire reforestation project site would be rehabilitated, and the forest habitat would be restored in accordance with the project's objectives. As a result, 520.6ha would be rehabilitated. However, under scenario *A*, the provision of the forest habitat would be significantly closer to what was projected from the outset of the project. Under scenario *C*, the current level of forest habitat is assumed to decline (see Table 5.2).

Table 5.3 Reforestation project site ecosystem service attributes and levels

Ecosystem Service Attributes	Description	Levels
Carbon sequestration	Level of CO_2 sequestrated by new trees and forests(tCO_2e)	15 489.8 (Current level-in medias res) -2 589 (Status quo) ≥ 15 489.8 (Withdrawn) 42 214 (Ex-post)
Habitat for local wildlife	Area of forest habitats rehabilitated in hectares (ha)	408.88 (Current level-in medias res) 201.5 (Status quo) ≥ 408.88 (Withdrawn) 520.6 (Ex-post)
Buffer (air quality, fire protection)	Number of trees planted in the buffer zone	595 476 (Current level-in medias res) 0 (Status quo) ≥ 595 476 (Withdrawn) ≤ 595 476 (Ex-post)
Environmental Education	Environmental awareness trips	Yes No
Employment	Number of jobs created in the local community	455 (Current level-in medias res) 0 (Status quo) ≥ 455 (Withdrawn) ≤ 455 (Ex-post)
Faunal species	Number of animal species in the forest habitats of the Reforestation project site	176 (Current level-in medias res) ≥ 68 (Status quo) ≥ 176 (Withdrawn) ≤ 176 (Ex-post)
Tree species diversity	Number of tree species in the forest habitats of the Reforestation project site	61 (Current level-in medias res) 0 (Status quo) ≥ 61 (Withdrawn) ≤ 61 (Ex-post)
Water availability/regulation	Number of tree species in the planted riparian habitat	8 (Current level-in medias res) 0 (Status quo) ≥ 8 (Withdrawn) ≤ 23 (Ex-post)
Payment	Annual contribution to a community trust fund for reforestation (Rand)	0, 12, 60, 120

Source: Author's construct

Under a complete implementation scenario (*in medias res*), scenario *A*, the effectiveness of the buffer in improving air quality and serving as fire protection would increase before project completion. The number of trees planted at the reforestation site serves as an indicator of the buffer's effectiveness. Thus, under scenario *B*, where no project exists, there would be no trees, forest, or buffer. Regarding scenario *C*, it is assumed that if the project is withdrawn, the current number of planted trees will decline, and the buffer will be reduced. It was expected that more than 500 000 trees would have been planted in the buffer zone

by the time the project was fully completed. Therefore, scenario *D* assumes that more than 500 000 trees indicate an adequate buffer. As explained in section 5.2.3.2, the reforestation project conducted environmental awareness campaigns, during which 'tree-prenuers' were taken to nature-based learning locations. Therefore, the environmental education attribute description indicates whether the community member received this trip. Thus, the attribute level will take the definite form of 'Yes' or 'No'.

One hundred seventy-six faunal species represent scenario *A*'s first level of faunal attribute, followed by scenario *B*'s baseline faunal species number (Table 5.2). In scenario *C*, if the project were to be withdrawn, the number of faunal species *in medias res* would decline from 176. Under scenario *D,* complete project implementation would increase the number of faunal species from baseline conditions. Under this scenario, the number of species currently found in the area will increase more than *in medias res* conditions.

Sixty-one tree species were recorded in the restoration area by 2015, with some species showing higher-than-expected densities due to their ease of propagation and rapid growth (Macfarlane et al., 2015). Scenario *A* represents an implementation of the reforestation project in which six years of continuous active planting and management of indigenous tree species have increased tree species diversity to 61. Thus, in scenario *A*, the tree species diversity attribute is assigned a current level of sixty-one. However, under the no-funding/no reforestation project scenario, scenario *B* assumes that no tree species will be planted. Under scenario *C*, the number of tree species will decline from 61 to 0 if project funding is withdrawn. Macfarlane et al. (2015) report that some tree species have naturally regenerated, thereby increasing species richness over time. In scenario *D*, under a 20-year full implementation, it is assumed that the number of tree species will increase from its current level to a maximum. Unfortunately, the reforestation project reports do not indicate the number of tree species expected to be present at the end of the project.

According to Macfarlane et al. (2015), the composition of planted trees in the targeted riparian habitat is far less than the expected composition observed in the reference riparian habitat (*23 indigenous tree species observed*). However, eight tree species were observed in the planted riparian habitat. Macfarlane et al. (2011) suggest their presence could have resulted from natural colonisation by indigenous trees. Trees provide several hydrological benefits by increasing the filtering and erosion capacity of rehabilitated areas and reducing turbidity in receiving rivers (Macfarlane et al., 2011). Therefore, the current number of tree species under scenario *A* is eight. Scenario *B* assumes that no trees would be planted in the riparian forest habitat, resulting in non-existent associated hydrological benefits. Under scenario *C*, the assumption is that the current number of tree species would decline. In scenario *D*, it is assumed that a complete implementation of the project would result in conditions similar to those of the reference riparian forest habitats, thereby positively influencing hydrological conditions in the riparian area.

5.2.3.5 Experimental design and construction of choice sets

In this section, statistical design theory combines the number of attributes and levels into a few alternative scenarios or profiles to offer respondents. An experimental design was used to select the sets of profiles presented to respondents. After this step, choice sets were created, and respondents were asked to choose between the status quo (scenario *B*) and one of the three alternative scenarios. Inappropriately constructed experimental designs can produce unidentifiable choice models or biased parameter estimates (Kerr and Sharp, 2009). Nonetheless, one experimental design commonly used in the CE literature is the full factorial design, which encompasses all possible combinations of attributes and levels. The design allows for the estimation of main and interaction effects independently. In Table 5.3, eight attributes are assigned four levels, except for EE, which has two levels. Hence, choice sets containing all possible combinations of attribute levels can be created from a $4^8 \times 2^1$ full factorial design (this notation reflects the number of likely profiles: $48 \times 21 = 131\ 072$). However, these combinations were too large for the CE in this study. Two design strategies can be adopted, namely, D-efficient and a fractional factorial (orthogonal) experimental design, to reduce the number of combinations of attribute levels (Brey et al., 2007; Scarpa and Rose, 2008).

D-efficient designs typically require prior information about expected parameter estimates from previous or similar studies (Kerr and Sharp, 2009). However, this study explored a unique combination of variables, including cultural worldviews and psychological capital, along with other socio-economic variables, in a peri-urban and reforestation context where no prior parameter estimates existed. Hence, a fractional factorial design (*orthogona*l) was employed in this study to provide a robust baseline for estimating the main effects. The Buffelsdraai and Osindisweni communities are peri-urban, characterised by households with varying levels of literacy and limited understanding of environmental concepts, as observed during FGDs. Since fractional factorial designs retain the independence of attribute levels (Brey et al., 2007), they make the experimental design comprehensible, thereby minimising confusion for respondents in the sampled communities (Bennett and Blamey, 2001). Pretesting showed that respondents experienced cognitive fatigue after completing four choice sets, each with nine attributes. Often, cognitive load occurs when an individual is overwhelmed by the information presented, which limits their ability to process information, make decisions, and complete tasks (Kalyuga, 2011). In CE design, respondents' cognitive load must be considered, as excessive choice sets can reduce data reliability (DeShazo and Fermo, 2002).

To ensure high completion rates for the choice sets, each attribute was translated and described in isiZulu for each household head, and pictures were inserted into the choice cards to illustrate each attribute, thereby aiding comprehension. Attributes were reduced from 9 to 6 to balance design efficiency with respondent capacity/efficiency (i.e., habitat for local wildlife, buffer, animal and tree species, employment, and payment). An orthogonal design was created using the Generate Orthogonal procedure in IBM SPSS v26.

Thirty-two alternatives were generated and were divided into sixteen choice sets of three alternatives, including the status quo option. However, the survey results indicated that most respondents lost interest and were unable to proceed beyond the fourth-choice set.

Therefore, in the CE, four choice sets were presented to each respondent surveyed. Each choice set had three alternatives: a status quo representing the baseline conditions of the reforestation project site, and two alternatives representing management options characterised by different attribute levels (see Tables 5.3 and 5.4). Each household head was asked to choose one alternative from each choice set, giving four choice observations per respondent. Therefore, an analysis was conducted on four choice sets, which were answered by the majority of community respondents.

Table 5.4 Choice card/set example applied in the study

Attribute		Alt. 1 - *Status quo*	Alt.2	Alt.3
	Area of forest habitat rehabilitated	201.5 ha (no additional area)	520.6ha (expanded area)	520.6ha (expanded area)
	Number of trees planted in the buffer zone	0 trees (no trees planted in the buffer)	595 476 trees (current no. of trees planted in the buffer)	595 476 trees (increase in no. of trees planted in the buffer)
	Number of animal species	68 species (status quo animal species no.)	176 species (decrease in animal species no.)	176 species (current animal species no.)
	Number of tree species	0 species (no new tree species planted)	61 species (increase in tree species no.)	61 species (current tree species no.)
	Number of jobs created in the local community	0 jobs (no jobs)	455 jobs (current no. of jobs)	0 jobs (no jobs)
	Annual payment to a community trust fund for reforestation (Rand)	R0	R120	R60
Please mark your choice (X)				

Source: Household survey data (2018)

The choice card illustrates the quantitative levels for each non-payment attribute, consistent with those shown in Table 5.3. During piloting, numeric values were accompanied by simple verbal descriptors and pictorial aids to support respondents' understanding without altering the attribute's meaning.

5.3 Results and discussions

5.3.1 Descriptive data results

In Table 5.5, the average age of respondents is approximately 50 years, with a standard deviation of 12.57 years, suggesting a relatively mature population. Regarding gender, 64 percent of respondents were female. Thirty percent of respondents were participating as tree-prenuers. The mean education level among respondents is 1.33, suggesting that most have primary schooling. Regarding social grants, the average amount received by households is R1353, with a standard deviation of R1238.70, indicating significant variability in grant income.

Table 5.5. Summary of socio-demographic variables

Explanatory variable	Description	Mean	Std.dev
Age	Age of household head in years (continuous)	49.94	12.57
Gender	Household head gender: 1= Female, 0= otherwise	0.64	0.48
Education	Education level: categorical	1.33	0.78
Tree-prenuer	Tree-prenuer: 1 = Yes, 0 = otherwise	0.35	0.48
Social grant	Government social grant (continuous)	1333.9	1238.7
Off-farm income	Off-farm employment income (continuous)	2507.4	4000.8
On-farm income	On-farm employment income (continuous)	195.07	1127.9
Remittance income	Remittance income (continuous)	166.59	617.48
Psychological capital	PCA psychological capital index (see Table 3.8)		
Cultural worldviews	PCA cultural worldviews index (see Table 3.9)		

Source: Household survey data (2018)

The mean off-farm income is R2507.40, with a high standard deviation, suggesting significant disparities in off-farm income. Similarly, the average on-farm income is R1560.70, with a standard deviation of R1717.90. The average remittance income is R1695, with a very high standard deviation, indicating that remittances vary widely among household heads.

5.3.2 Choice experiment findings

5.3.2.1 Household preferences for attributes

This study estimated a mixed logit empirical model and a dataset of 5208 observations, corresponding to 434 questionnaires × 3 alternatives × 4 choice sets/cards. The mixed logit model was estimated using the attribute levels associated with each alternative in the choice sets. During estimation, the attribute levels for each alternative were entered into the mixed logit model as explanatory variables, with choice as the

dependent variable. Attributes had continuous values and were therefore coded using their numerical values.

Table 5.6 shows that the positive coefficient of "Forest Habitat" is statistically significant, indicating that for households, an expanded forested habitat area increases the probability of selecting alternative 2 and 3 (Alt. 2 and Alt. 3) over the base alternative, Alt. 1 – *status quo*. This preference may indicate that households have a heightened desire for enhanced ecosystem services in their communities and are aware of the benefits of environmental improvements resulting from reforestation efforts. Studies (Adamowicz et al., 1998; Hanley et al., 1998) have demonstrated that improvements in forest ecosystems can significantly improve public preference for conservation efforts. Moreover, larger and more diverse forest habitats can provide more ecosystem services, enhancing their perceived value to the public (Yao et al., 2014). According to Bertolli et al. (2013), local communities adjacent to such project areas can be involved in reforestation efforts, especially by providing trees for planting. Through the Tree-prenuer programme, community members plant indigenous trees in return for vouchers that can be exchanged for food, bicycles, school uniforms, or building materials, and they also receive training in environmental and nursery management skills (Macfarlane et al., 2015). Thus, the programme could contribute to a positive perception of the reforestation project in the community, influencing their preference for establishing forest habitats and biodiversity.

The "Buffer" attribute coefficient is negative and statistically significant, suggesting that households are not likely to choose Alt. 2 and Alt. 3 as the buffer increases. This means households in the Buffelsdraai and Osindisweni communities are more likely to select the status quo when buffer formation is included alongside other alternatives. To establish the buffer area, natural resource harvesting will have to be restricted. Therefore, households may view the buffer as a disruption to their livelihoods and current informal uses, thereby increasing the likelihood that they will choose the status quo alternative. For several poor households reliant on forests, these land-use restrictions can disrupt livelihoods whilst delivering enhanced ecosystem services (Shackleton et al., 2001; Charnley and Poe, 2007).

In Table 5.6, the "Animal Species" attribute has a positive coefficient. It is significant, indicating that the number of animal species in the forest under establishment increases the probability of selecting Alt. 2 and Alt. 3 compared to the base alternative. These results suggest that household heads are more likely to prefer alternatives in which the forest under establishment supports a variety of animal species. In some natural resource-dependent communities, wild animals can be linked to spiritual and cultural beliefs and thus be valuable to households (Sharaunga et al., 2013), or they may be seen as indicators of an improving ecosystem due to reforestation efforts. Similarly, Lee et al. (2014) found that species richness in recreational

fisheries significantly influences choices, indicating the value placed on biodiversity and the ecosystem services it provides.

Furthermore, the "Tree Species" coefficient is positive and significant, indicating that households prefer Alt. 2 and Alt. 3 to Alt. 1. This result implies that households value tree species diversity and are likely to select alternatives that provide this attribute in the forest under establishment over the status quo. According to Macfarlane et al. (2015), various indigenous tree species were planted to create a diverse, functioning woodland that improves ecosystem processes. Additionally, these indigenous plants may hold cultural significance for households or serve as a potential source of non-timber forest products. Studies have shown that forests are used and valued differently, and that tree species diversity can significantly enhance their perceived value and public preference (Hanley et al., 1998; Adamowicz et al., 1998; Sharaunga et al., 2013).

Payment, framed as the monthly contribution to a community trust fund to support the reforestation project, was positive and statistically significant, suggesting that payment increases the probability of selecting Alt. 2 and Alt. 3 over Alt. 1. This suggests that household heads in the communities do not see the payment as a monetary cost but rather view their contribution as increased support for a community project that improves valued ecosystem services and livelihood benefits, rather than as a reduction in household welfare. Similarly, a few studies (Snowball et al., 2008; Lee et al., 2014; Yao et al., 2014) found positive and significant payment coefficients, highlighting most respondents' preference to incur costs and pay for ecosystem attributes and their improvements, which they view as valuable.

5.3.2.2 Socio-demographic determinants of preferences

In Table 5.6 below, Gender has a positive and significant effect on preferences for the alternatives. This suggests that being female increases the preference for Alt. 2 and Alt. 3 compared to Alt. 1. Several studies (Bayeh, 2016; Tadesse et al., 2022) indicate that female households, particularly in Africa, show higher levels of concern about environmental issues. Thus, the results reaffirm that female-headed community households are more likely to support the reforestation project and prefer reforestation alternatives over the status quo.

The education coefficient is negative and statistically significant, indicating that household heads with higher education were less likely to select Alt. 2 than respondents with no schooling, compared to the status quo alternative, Alt. 1. This finding implies that households with more education assessed the forest attributes and their management scenarios differently than less educated household heads. So, individuals with higher education tend to have better environmental awareness and understanding and can apply greater scrutiny to environmental management, which can influence their assessment of and preference for the environment (Turpie, 2003; Mensah et al., 2017).

Table 5.6. Mixed logit model estimation results

Attribute	Coefficient	Std. error	P>z
Forest habitat	0.718***	0.093	0.000
Buffer	-1.531***	0.149	0.000
Animal species	0.771***	0.061	0.000
Tree species	0.912***	0.069	0.000
Employment	0.103	0.090	0.252
Payment (Rands)	0.007**	0.003	0.011

Socio-demographic variable	Alternative 2			Alternative 3		
	Coefficient	Std. error	P>z	Coefficient	Std. error	P>z
ASC	0.249	0.926	0.787	-0.247	0.967	0.798
Age	-0.026	0.019	0.180	-0.021	0.019	0.272
Gender	0.735*	0.388	0.058	0.953**	0.413	0.021
Education (ref. category: *no schooling*)						
Primary school	0.324	0.552	0.557	0.366	0.574	0.524
Secondary school	0.216	0.496	0.664	0.029	0.525	0.956
Higher education	-1.981**	0.970	0.041	-1.611	1.029	0.188
Tree-prenuer	1.109**	0.532	0.037	0.715	0.538	0.184
Social grant	1.15E-04	1.99E-04	0.564	2.16E-04	2.10E-04	0.297
Off-farm income	3.59E-05	4.21E-05	0.394	3.88E-05	4.62E-05	0.401
On-farm income	1.5E-05	1.30E-04	0.908	-1.09E-04	1.41E-04	0.438
Remittance income	-3.42E-04	2.32E-04	0.141	-1.76E-04	2.65E-4	0.507
Cwv_1	0.246**	0.123	0.046	0.609***	0.133	0.000
Cwv_2	0.118	0.164	0.473	-0.023	0.165	0.889
Cwv_3	0.079	0.119	0.502	0.137	0.129	0.290
Cwv_4	-0.378***	0.132	0.004	-0.387***	0.139	0.006
$PsyCap_1$	0.017	0.113	0.879	-0.048	0.119	0.684
$PsyCap_2$	0.004	0.154	0.982	-0.068	0.165	0.681
$PsyCap_3$	-0.011	0.188	0.955	0.125	0.191	0.514
$PsyCap_4$	0.122	0.187	0.512	-0.007	0.195	0.971
Number of observations						5208
Wald $\chi 2$ (42)						507.46
Prob > $\chi 2$						0.000
Log-likelihood						-981.49

Note: The base level is alternative 1, which represents the status quo. *** = ($p < 0.01$), ** = ($p < 0.05$), and * = ($p < 0.1$), indicating significance at 1%, 5%, and 10% levels, respectively.
Source: Household survey data (2018)

The coefficient for "Tree-prenuer" is positive and significant, indicating that participation of community members in the reforestation project increases the likelihood of preference for Alt. 2 over the base alternative. Mugwedi et al. (2018) evaluated various restoration activities and found that prioritising

biodiversity improved biodiversity and carbon sequestration and created considerable employment opportunities for communities adjacent to the project site. Therefore, the findings indicate that involving community members in reforestation projects as Tree-preneurs increases the preference for alternatives that deliver socio-economic and environmental benefits.

The results in Table 5.6 indicate that "Cwv_1" is statistically significant and has positive coefficients on Alt. 2 and Alt. 3 over Alt. 1. Rissman et al. (2017) showed that cultural worldviews, such as individualism and hierarchism, influence individuals' perceptions and responses to environmental issues and policies. This implies that households in the Buffelsdraai and Osindisweni communities view changes as necessary, make choices when they believe the changes align with their individual value systems, and that these choices are guided by clearly defined and appropriate authorities within the community.

Furthermore, the negative and significant coefficient for "Cwv_4" on Alt. 2 and Alt. 3 suggests that some households are characterised by strong individualism, self-reliance, personal interests over social concerns, and a preference for relying on experts. This finding further indicates that as these cultural values increase amongst household heads, the probability of selecting Alt. 2 and Alt. 3 over Alt. 1 decreases. Households holding these cultural values were less likely to express interest in supporting initiatives that require collective action, such as the reforestation project, even when the project's benefits were positive. Similarly, Obeng and Aguilar (2018) found that individuals with strong egoistic values and a tendency to prioritise personal benefits negatively influenced WTP for ecosystem services in a Payment for Ecosystem Services (PES) programme. People who are preoccupied with their own marginal self-interest tend to care less about public goods, including natural resources and the environment. Likewise, De Groot and Steg (2010) reported that egoistic cultural values, indicating personal interests, are associated with lower self-determined pro-environmental intentions.

5.3.2.3 Willingness to pay for attributes

The coefficients from the mixed logit model were used to estimate households' marginal willingness to pay (MWTP). The payment values were derived by applying a negative payment coefficient to the marginal rate of substitution between forest attributes. Therefore, the ratios of the attribute coefficients to the payment coefficient can be interpreted as the MWTP for changes in each attribute's value (Hanemann, 1984). As Lee et al. (2014) show, the MWTP value is the change from one attribute level to another. MWTP was estimated as follows:

$$MWTP = -\left(\frac{\beta_{Forest\ Habitat}}{\beta_{Payment}}\right) \quad \textbf{5.9}$$

Table. 5.7 presents the MWTP estimates for the respective attributes of establishing forests on the reforestation project site. The estimated payment coefficient is positive, varying from the expectation that higher costs reduce utility. Nevertheless, the MWTP results indicate that household heads from the Buffelsdraai and Osindisweni communities are willing to pay R218.71 per month for an improvement of the buffer zone, suggesting that this attribute is valued relative to the status quo. According to Snowball et al. (2008), less-preferred attributes can have positive WTP estimates, provided that households are aware of and expect to benefit from the environment. Bertolli et al. (2013) also showed that reforestation benefits the forest ecology and the community. In this case, the buffer provides a natural shield from the landfill, helping shield the community from noise and air pollution. For "Forest habitat", the WTP was R102.57 and negative despite a positive preference. This indicates that households would prefer compensation rather than contributing financially to expanding the habitat area for tree planting. The negative WTP suggests that the costs and trade-offs associated with increasing the habitat, such as reduced access to areas traditionally used for livestock grazing, food gardening, and non-timber forest product harvesting, outweigh the perceived benefits of reforestation. Chipfupa and Wale (2019) reported that MWTP did not always match preferences for specific ecosystem improvements.

Table 5.7. Marginal willingness to pay for establishing forest attributes

Attribute	Coefficient	P-value	WTP estimate	Std. error
Forest habitat	0.718	0.000	-102.57	± 38.24
Buffer	-1.531	0.000	218.71	± 89.21
Animal species	0.771	0.000	-110.71	± 43.02
Employment	0.103	0.252	*	*
Tree species	0.912	0.000	-130.29	± 47.74
Payment	0.007	0.011	*	*

Note: WTP Estimate is per household per month and in South African Rands (ZAR)
Source: Household survey data (2018)

Household heads have MWTP of R110.71 and R130.29 for animal and tree species, respectively. Despite positive preferences (Table 5.7), there is a significant reluctance to pay for reforestation. This unwillingness may result from concerns about dangerous animals, such as snakes, which may offset the perceived benefits of investing in biodiversity. Although households prefer the presence and increase of various animal species, this does not translate into a WTP. Similarly, the WTP for tree species remains low. This suggests that households are unwilling to pay for a greater variety of tree species. Horne et al. (2005) reported that households that valued biodiversity conservation in forest areas had a WTP constrained by cost and perceived responsibility concerns. This suggests that some households in the communities may view the responsibility for reforestation as the government's and believe the government should fund the

reforestation of the area, thereby reducing their WTP. The low WTP could also have resulted from the design of the reforestation project. The project involves Tree-preneurs and community members who receive vouchers and other incentives for collecting seeds and growing saplings for the reforestation site. Consequently, paying for increased tree diversity while some community members receive direct participation benefits could create a sense of inequity, contributing to a low WTP for this attribute.

5.4 Summary

In this chapter, the choice experiment method was applied to assess household preferences for forest ecosystem attributes. It examined the marginal willingness to pay for ecosystem attributes associated with the forest under establishment in Durban. Principal component analysis was applied to identify the dominant dimensions of psychological capital and cultural worldviews. This was followed by applying the mixed logit model to further identify the forest attributes that influence household preferences and the socio-economic characteristics that affect these preferences. The findings indicate that households preferred non-status-quo forest attributes, with gender increasing the probability of selecting them. Household heads with higher levels of education than those with no schooling prefer to maintain the status quo. Households' individualistic and hierarchic worldviews influenced preferences for forest attributes. Households are WTP for the buffering attribute of establishing the forest. The conclusions and policy implications of these findings are highlighted in Chapter 6.

CHAPTER 6

CONCLUSIONS, POLICY IMPLICATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

6.1 Recapping the purpose of the study

South Africa, like several other African nations, will bear a heavier burden of CC impacts and has thus committed to addressing CC. Forest-based carbon sequestration projects are typically initiated to achieve this. In Durban, the eThekwini Municipality's Department of Environmental Planning and Climate Change Protection initiated a reforestation project to address CC by creating natural carbon sinks through the rehabilitation of degraded sugarcane lands into indigenous forests within a buffer zone around the Buffelsdraai Landfill Site. Literature, however, showed that urbanisation and city life are attracting a large pool of poor rural people who informally settle on the periphery of urban cities, areas also characterised by insecure tenure, inadequate services, haphazard layout, limited accessibility, and environmental threats and prone to hazards or located near undesirable activities (e.g., landfills). They typically depend on natural areas, such as forests, for NTFPs, natural remedies, and other materials for their livelihoods. Therefore, people in these communities are highly susceptible to CC shocks due to poverty. Making it important to design cost-effective, well-integrated ecological restoration and CC mitigation and adaptation projects to reduce vulnerability by improving the livelihoods of those impacted. Therefore, failing to understand the socioeconomic context of adjacent communities may reduce the project's impact on improving livelihoods. Hence, this study sought to identify and understand the socio-economic dimensions of Buffelsdraai and Osindisweni communities. The specific objectives of this study were to: 1) assess factors shaping NTFP dependence, 2) evaluate the determinants of CC perceptions, and 3) examine how households' psychosocial characteristics and selected socio-demographic factors drive preferences and WTP for forest ecosystem goods and services.

In chapter 3, the factors shaping CC perception and intensity were analysed. An integrated psychosocial framework is needed to explain how affective heuristics, cultural worldviews, psychological capital, and socio-economic characteristics jointly shape households' perceptions of CC in peri-urban communities of Durban, which are vulnerable to CC impacts and policy-relevant, yet understudied. Again, PCA was used to generate indices from indicators of CC perceptions, social and psychological capital, and social values, and to extract PCs to create a composite index. The double hurdle model was used in the analysis. In this model, estimates were obtained by running separate regression models in the first and second stages. In the first stage, a probit model was used to estimate the likelihood of perceiving CC. In the last stage, the level of CC perception was estimated using truncated regression. In chapter 4, the sustainable livelihood

framework was used to understand the determinants of NTFP dependence. PCA was used to generate proxy variables for PsyCap, social capital, and cultural worldviews. The study proxied NTFP dependence using an OLS-weighted regression, which was then used in subsequent analyses.

The last empirical chapter, Chapter 5, advances understanding of stated-preference methods by integrating psychosocial constructs into CE analyses of ecosystem services. The inclusion of psychological capital and cultural worldviews was novel, as few studies have incorporated these psychological aspects into environmental valuation. Furthermore, the study enhances understanding of how demographic and socio-economic factors, forest attributes, and cultural worldviews influence preferences for forests in an understudied African peri-urban context. The CE method was employed to elicit household heads' preferences and environmental values. PCA was once again used to identify the dominant dimensions of psychological capital and cultural worldviews. The empirical model employed was a mixed logit model, used to identify the factors explaining household preferences for forest attributes and the socio-economic characteristics that influence these preferences. In the chapter, the conclusions and policy implications are presented in Sections 6.2 and 6.3, respectively. Section 6.4 follows, highlighting the study's limitations and providing recommendations for further research.

6.2 Conclusions

This study examined household dependence on NTFPs, CC perceptions, and household preferences and willingness to pay for forest ecosystem services associated with the Buffelsdraai Landfill Site Community Reforestation Project. The study contributes to the literature on environmental restoration by integrating SLF with psychological capital, social capital and cultural worldviews to explain household behaviour, perceptions and preferences in a peri-urban context. In doing so, it extends conventional livelihood analyses by showing that environmental decision-making is influenced not only by livelihood assets and socio-economic characteristics, but also by psychosocial factors that influence how households perceive and respond to environmental change.

The findings show that a combination of livelihood assets, socio-economic and psychosocial characteristics shapes household interactions with environmental restoration projects. While access to livelihood capital remains important in shaping household welfare and resource use, the study shows that cultural worldviews, social relationships, and psychological characteristics significantly influence household dependence on NTFPs, perceptions of CC, and preferences for ecosystem service provision. These findings highlight the importance of adopting a more integrated approach to environmental restoration that considers the psychological and behavioural dimensions underlying environmental decision-making.

The study further showed that reforestation projects provide benefits that go beyond ecological restoration. Besides restoring degraded ecosystems and enhancing biodiversity, the reforestation project contributes to livelihoods, environmental stewardship and the provision of ecosystem services valued by surrounding communities. However, households face socio-economic challenges that shape their dependence on natural resources. Therefore, the long-term sustainability of restoration projects depends on balancing ecological objectives with the livelihood needs and priorities of local communities.

The analysis of CC perceptions revealed that respondents generally recognised changes in seasonal rainfall patterns and temperatures, with climate signals, affective responses, social capital, and cultural worldviews significantly shaping these perceptions. These findings indicate that CC awareness is shaped by experience with weather phenomena and psychosocial factors, suggesting that adaptation strategies should account for how ay households interpret and respond to climate-related risks rather than focusing only on the physical signs of CC.

Household composition, livelihood assets, social capital and community perceptions influence NTFP dependence. Larger households, stronger social networks, and better agricultural endowments were associated with greater dependence on NTFPs, whereas greater household asset ownership was associated with reduced dependence on NTFPs. These findings highlight the importance of supporting livelihood resilience and expanding economic opportunities to reduce pressure on natural resources and improve household well-being.

The study demonstrated that the CE method was suitable for valuing environmental attributes, particularly related to forest ecosystems. The findings showed that households value improvements in forest ecosystem services and are willing to support reforestation efforts to enhance biodiversity, strengthen the buffering function of forests and improve the general ecosystem quality of the reforestation project site. Household preferences, however, varied by socio-demographic characteristics, participation in the Tree-preneur programme, and cultural worldviews, highlighting the heterogeneity of community preferences. These findings show the importance of designing restoration and PES projects that account for differences in community values, priorities, and socio-economic conditions.

The study demonstrated that for environmental restoration projects and management to succeed, they will require more than ecosystem rehabilitation. The sustainability of restoration projects depends on their capacity to address environmental objectives and community livelihood needs simultaneously, and also recognising the connections between livelihoods, psychosocial factors and ecosystem management. Incorporating these dimensions into restoration plans can improve community participation and the success of reforestation projects and increase the resilience of peri-urban communities to CC challenges

6.3 Policy implications

Based on the findings of this study, a few recommendations are made. Reforestation projects should adopt an integrated approach that recognises the interdependence among ecological restoration, sustainable livelihoods, and psychosocial factors. Policies that focus exclusively on restoring degraded ecosystems without addressing the livelihood conditions of surrounding communities are unlikely to be sustainable. Environmental restoration projects should therefore be designed to improve both ecosystems and household well-being. CC communication should move beyond providing technical information and instead consider how households perceive and experience climate-related risks. Communication strategies should use locally relevant examples of changing rainfall patterns, rising temperatures, and extreme weather events, while engaging existing community organisations, social networks, and local leadership structures to publicise information. Recognising that households hold different cultural values and worldviews will also improve the effectiveness of CC awareness and adaptation projects.

Reducing dependence on NTFPs requires policies that support household livelihoods rather than restricting access to forest resources. Supporting home food gardens, promoting economically viable NTFPs, and improving access to market opportunities can diversify livelihood opportunities and reduce pressure on forests. Also, improving access to affordable and reliable alternative energy sources should complement efforts to reduce dependence on fuelwood. Community-based restoration projects should strengthen social capital and community participation. The findings demonstrated that social relationships and civic engagement influence both CC perceptions and household dependence on NTFPs. Therefore, restoration projects should create opportunities for participation, recognise community contributions and assign clear roles to community organisations, local leaders and other stakeholders. Such approaches can encourage local ownership and improve the sustainability of restoration projects.

Future restoration and PES projects should take into account that households value ecosystem services differently. Project designs should therefore incorporate community preferences by prioritising ecosystem attributes that local households consider most valuable, such as improvements in tree and faunal species diversity and establishment of buffer zones, especially around landfill sites. Particular attention should also be given to promoting women's participation and ensuring that the benefits arising from environmental restoration projects are equitably distributed among community members.

Lastly, the study demonstrated the importance of incorporating psychosocial factors into environmental policy and natural resource management. Psychological capital, social capital and cultural worldviews provide important insights into household behaviour that are not captured by typical socio-economic variables. Including these behavioural dimensions in policy design can improve community engagement,

increase support for restoration projects and enhance their effectiveness. These policy implications provide a basis for developing inclusive, socially responsible and sustainable environmental restoration strategies that improve ecosystems while improving the livelihoods of peri-urban communities.

6.4 Recommendations for further research

The study was limited in that the NTFP dependence index relied on self-reported behavioural data and did not include income or imputed value data, which could introduce recall bias, as household respondents may over- or under-report. It can affect accuracy, misrepresent the economic significance of NTFPs, and limit the relevance of the findings and recommendations. Therefore, future research should consider including behavioural indicators alongside income or imputed value to provide a broader measure of NTFP dependence. Furthermore, the long-term livelihood impacts of the reforestation project should be addressed. A longitudinal study would be necessary to determine whether the project has decreased NTFP dependence in established forested areas while improving livelihoods. Moreover, future studies must assess community involvement and perceptions through time. Such a study could provide valuable insights into engagement and attitudes, offering project stakeholders feedback on projects and opportunities to refine approaches to achieve positive societal impact. Additionally, future studies can assess NTFP dependence by comparing rural and peri-urban areas. Due to rapid urbanisation, it is increasingly important to understand the spread of NTFP dependence in the country, and future studies should include disability status and health indicators to better assess their influence. This could provide insights into the effects of location and access to infrastructure, socioeconomics, and the relevance of psychological capital and cultural worldviews.

Future research should also apply the triple hurdle model to identify the sequential processes underlying CC engagement. It will enable the determination of how unique factors, such as psychological capital and cultural worldviews included in the study, affect individuals' perceptions of CC and its depth, as well as whether they take adaptive actions to address it. The findings of this part of the study are based on cross-sectional data, yet CC perceptions form over time. Another suggestion for future research is to conduct a longitudinal study to determine how changing climate signals shape CC perception across seasons. One limitation is that the PCA composite indices used as dependent variables are based on perceptions and do not account for their accuracy. Therefore, studies should incorporate climate literacy scales to assess how well individuals understand CC, controlling for knowledge.

A further limitation was the incorporation of psychological capital into the CE model. Psychological capital was statistically insignificant. Therefore, the scale used to assess psychological capital may not have been culturally relevant. The communities are poor, so this may override the effects of psychological resources. Therefore, future studies should develop context-specific, culturally appropriate, validated psychological

capital indicators. Moreover, although applicable to Durban, the findings may not apply to other peri-urban areas. So, future research should adopt comparative approaches and include areas engaged in similar environmental restoration projects to gain a deeper understanding of forest ecosystem service preferences over time across different contexts. This approach would facilitate and further enrich the development of more inclusive, applicable, and locally grounded environmental policies.

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APPENDIX A: STUDY QUESTIONNAIRE

THE REFORESTATION PROJECT COMMUNITY SURVEY 2018

INFORMED CONSENT

This survey is part of a research project entitled "**The socio-economic evaluation of peri-urban households adjacent to the Buffelsdraai Landfill Site Community Reforestation Project**". This research is made possible by the University of KwaZulu-Natal in partnership with the eThekwini Municipality in Durban, South Africa.

The information captured is for research purposes, and the outcomes of this study will be disseminated to decision-makers and various stakeholders to assist with future planning, funding, and the implementation of similar projects.

Participation in this survey is voluntary, and no financial or non-financial benefits will be paid during or after participation. Respondents should be the household head or someone well informed about the household. Respondents can withdraw from the survey at any time. Data from this survey will be treated with the utmost confidentiality, and the names of interviewees or their households will be coded to maintain strict anonymity.

The interview will take 1-2 hours. **Your time and valuable information are much appreciated.**

Are you willing to be part of this study? _____ *(Yes or No)*

ISISAYINO MVUMELWANO

Loluphenyo luyingxenye yocwaningo lwephrojekthi ekuthiwa "**The socio-economic evaluation of peri-urban households adjacent to the Buffelsdraai Landfill Site Community Reforestation Project**". Lolucwaningo Lwenziwe lwaba impumelelo yi-University of KwaZulu-Natal ibambisene noMasipala waseThekwini, eNingizimu Afrika.

Inhloso yalolucwaningo ukufunda ngesimo sezomnotho somphakathi ngokuthi iphenye iphinde itshengise izindlela zokuphila abancike kuzona, izingozi abazibonayo ngokuguquka noma ngokushintshashintsha kwezulu, namanani enzuzo abayitholayayo kwezemvelo, nokusabalala kwezindleko zomphakathi kanye nenzuzo etholakala kwi phrojekthi yokutshalwa kwezihlahla. Imiphumela yalolucwaningo izosabalaliswa kubathathi bemithetho kanye nabafaki zimali abahlukahlukene ngokuthi kushicilelwe imibhalo iphinde itshengiswe nasezinhlanganweni.

Ukuba yingxenye yalolucwaningo akuphoqeleliwe, azikho izimali ezizotholakala ngokuba yingxenye yalolucwaningo. Izinhloko zamakhaya okanye abantu abanolwazi ngaleyo mizi yibona okumele bathathe iqhaza kulolucwaningo. Abantu abazothatha iqhaza kulolucwaningo abaphoqiwe bangayeka noma kunini. Ulwazi oluzotholakala kulolucwaningo, luzophathwa kahle luphinde lugcinwe luyimfihlo namagama abantu azogcinwa eyimfihlo.

Inkulumo mpendulwano izothatha ihora elilodwa kuya kwamabili (1-2hours)

Ngabe uzimisele ukuba yingxenye yaloluhlelo? _____ *(Yebo noma Cha)*

RESPONDENT IDENTIFICATION

Please express your full consent to participate in this survey by filling in your name below.	
1. Mr/Mrs	
2. Signature	
3. Mobile phone	
4. Questionnaire number	
5. Area *(Buffelsdraai or Osindisweni)*	
6. Date	
7. Household number in the community	
8. Are you a registered Tree-prenuer? *(1= No; 2 = Yes)*	*(If **Yes**, skip to 10)* *(If **No**, skip to 9)*
9. Were you ever a registered Tree-prenuer? *(1 = No; 2= Yes)*	*(If **Yes**, skip to 10)*

10. How long have you been a Tree-prenuer? *(Tick next to your choice)*	
Just started	
1 year	
2 years	
3 years	
4 years	
Other (please specify)	
Since the beginning	

RESPONSE DETAILS

	Interview			**Next visit (planned)**	
Visit No.	**Start time**	**End time**	**Result code***	**Date**	**Time**
1					
2					
3					
4					

***Result code:** *(1= Completed; 2= Partly completed; 3= Error; 4=Other)*

PART 1: DEMOGRAPHIC INFORMATION OF HOUSEHOLD

SECTION 1. HOUSEHOLD HEAD CHARACTERISTICS

1.1 Household member characteristics						
No.	**Household member's name** *(Start with the oldest member, including the HH head)*	**Relationship to the HH head[1]**	**Gender:** ***1****= Male;* ***2****= Female*	**Age:** ***0*** *= All infants (indicate who's an infant;* ***1*** *= < 1-year-old*	**The highest level of education completed[2]**	**The most important activity for members > 6 years old**
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						

[1]Codes: ***1****= Head;* ***2*** *= Wife;* ***3*** *= Son/Daughter;* ***4*** *= Son/Daughter in law;* ***5*** *= Father/Mother;* ***6*** *= Father/Mother in law;* ***7*** *= Grandchild;* ***8****= Sister,* ***9****= Brother;* ***10****= Other relative;* ***11*** *= Non-family/Non-relative*

*[2]****1*** *= Grade 0;* ***2****= Grade 1;* ***3****= Grade 2;* ***4****= Grade 3/std 1/ABET 1;* ***5****=Grade 4/std 2;* ***6****= Grade 5/std 3/ABET 2;* ***7****= Grade 7/std 5/ABET 3;* ***8****= Grade 8/std 6;* ***9*** *=Grade 9/std7;* ***10****= Grade 10/std 8;* ***11****= Grade 11/std 9;* ***12****= Attended Grade 12 but not completed;* ***13****= Grade 12/std10 without university exemption;* ***14****= Grade 12/std 10 with university exemption;* ***15*** *=Certificate with Grade 12/std10;* ***16****= Diploma with Grade 12/std 10;* ***17****= Bachelors degree; 18= BTech; 19= Post graduate diploma; 20= Honours degree; 21= Higher degree(Masters/PhD);* ***22****= No schooling;* ***23****= out of scope(children under five years of age)*

1.2 Household income sources	**Number of individuals contributing to household income**	**Amount per month**	**Rank** *(Rank according to their importance, where 1 is the most important)*
Voucher(s)			

Forest resources (i.e. wood, herbs, mushrooms, etc.)			
Food gardens/farming			
Social/government grant (i.e. SASSA)			
Remittances (i.e. Money market, eWallet, etc.)			
Off-farm job opportunities (i.e. wages, salary)			
On-farm job opportunities (i.e. wages, salary)			
Other (please specify) ……			

SECTION 2: CAPITAL INFORMATION

SOCIAL/CULTURAL CAPITAL

2.1 Community relationships

How many years have you been staying in this community?		**Where are you originally from?**		**What is your level of trust in the community members?[1]**		**How many people in the community can you turn to in case of need?**		**How many family members can you turn to in case of need?**	

[1] ***1****= I do not trust anyone;* ***2****=many are not trustworthy;****3****= Neutral****; 4****=many are trustworthy;* ***5****=Everyone is trustworthy*

2.2 Social assistance *(Indicate if you agree or disagree with the following statements)*

Statement	**Strongly disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly agree (5)**
When my family needs financial assistance, we often get it from other ***family*** members					
When my family needs financial assistance, we often get it from ***friends***					
When my family needs financial assistance, we often get it from ***neighbours***					
When my family needs financial assistance, we often get it from ***a group*** we are part *of (please specify……)*					
When my family needs financial assistance, we borrow from ***microlenders or banks***					
When my family runs out of ***food***, we often get it from other ***family*** members					
When my family runs out of ***food***, we often get it from ***friends***					
When my family runs out of ***food***, we often get it from ***neighbours***					
When my family runs out of ***food***, we often get it from the ***group*** we are part of *(please specify……)*					

2.3 Social networks/groups *(Please indicate the group (s) you belong to from among the following)*

Group	Y/N	How many individuals or households are part of this group?	How often are you involved[1]	Average cash contribution in a year to the group
Production cooperative				
Marketing cooperative				
Another type of cooperative *(please specify……)*				
Farmer's group				
Traders/Business association				
Trade/labour union				
Religious group				
NGOs/civic groups				
Political party/movement				
Burial society				
Credit & savings group (Stokvel)				
Traditional/tribal authority				
Other (please specify) ……				

[1] ***1****= Not at all; 2 =Neutral;* ***3****= Sometimes;* ***4****=Most of the time;****5*** *= All the time*

2.4 Community involvement *(please indicate the extent to which the following statement applies to you)*

Statement[1]	Response
I am comfortable and confident in approaching organisations (i.e. banks, police stations, etc.) at any given time when the need arises	
I can influence events/others	
I am well informed about local & national matters	
I meet regularly with public officials & public representatives. Moreover, I get involved in local development meetings.	
I always participate in local and national elections to vote for leaders I want	

[1] ***1****= Not at all; 2 =Neutral;* ***3****= Sometimes;* ***4****=Most of the time;****5*** *= All the time*

2.5. Perceptions of the community area *(please indicate the extent to which the following statement applies to you)*

Statement[1]	Response
I am happy with the social customs/norms in this community	
I am happy with the service delivery in this community	
I like living in this community	
I am not concerned about the level of crime in this community	

[1] ***1****= Not at all; 2= Neutral;* ***3****= Sometimes;* ***4****= Most of the time;* ***5****= All the time*

NATURAL CAPITAL

2.6 Does your household engage in crop production *(food gardens)*? _____ *(**1**=No; **2**= Yes)*. **If** *No*, skip to **2.7. If** *Yes*, **please indicate the crops grown, output/yields, and** *if you sell them*, **the selling price of each crop in the past**

Type of crop	Quantity harvested (kg)	Quantity sold (kg)	What price would you take for the crop	Number of times sold
Maize				
Potatoes				
Onions				
Tomatoes				
Cabbage				
Beans				
Sugarcane				
cowpeas				
Spinach				
Herbs				
Other (please specify) ……				

2.7 Current livestock ownership

Livestock type	Current herd size owned (number)	Number sold in the past 12 months	If you were to sell it in its current condition, how much would you be able to get on average?	Number slaughtered for family purposes in the last 12 months
Cattle				
Chicken/duck/turkey				
Pigs				
Goats/sheep				
Donkey				
Horse				
Other (please specify) ……				

HOUSEHOLD DEPENDENCY ON NON-TIMBER FOREST PRODUCTS (NTFPs)

2.8 How far is the nearest establishing forest from your homestead? _____ *(1= less than 30min; 2= between 30-60min; 3= more than 60 min)*

2.9 Do you visit the establishing forest to collect NTFPs for sale or household consumption *(1= No; 2 = Yes)* _____**. If** *No*, **skip 2.10, 2.11,2.12 and 2.13. If** *Yes*, **how many times per month do you visit the area?** _____

2.10 Please name the most common non-timber forest products (NTFPs) you harvest from the establishing forest, and please rank the products, where 1 represents the most harvested product.

Non-timber forest products	**The number of times you use it:** *1=Every day; 2=Occasionally; 3=Seasonally*
Firewood	
Untreated wooden poles	
Traditional medicines	
Edible plants	
Mushrooms	
Honey	
Wild spinaches	
Hunting animals	
Grass for thatching	
Sand	
Grass for livestock	
Other (please specify) ……	

2.11 If you sell these NTFPs as indicated in 2.10, where is the market located? _____ *(1= Local people; 2= Local towns and cities; 3= On the road; 4= Local supermarket;5= No market)*

2.12 How far (walking distance) is the nearest establishing forest to the market? _____ *(1= less than 30min; 2= between 30-60min; 3= more than 60 min)*

2.13 How far is your homestead from the market where you sell NTFPs? _____ *(1= less than 30min; 2 =between 30-60min; 3 = more than 60 min)*

2.14 Apart from this establishing forest, where else would you get these main forest products? _____*(**1**= Buying from elsewhere; 2= Get them elsewhere for free; **3** =Growing them yourself; 4= Don't get them anywhere else)*

2.15 Why didn't you get them from the establishing forest? _____ *(**1** = We are prohibited; **2** =Bought them somewhere else; **3** = Got them somewhere else for free; **4**=Not interested; **5**= Any other reason, please specify_____)*

2.16 Do you think the use of the establishing forest in your community should be monitored, controlled, or limited? *(**1**= No; **2**=Yes)* _____. **If** *No*, **skip to 2.19**

2.17 Who should be involved in monitoring the use of the establishing forest? *Please tick* next to the management option below according to the level of importance

Management	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Traditional and local political leadership (councillors, chiefs)					
Local government (i.e. municipality)					
Community members					
Collective action (government, community members and traditional leaders)					

2.18. Do you think there will be challenges in monitoring or managing the establishing forest? *(1=No; 2=Yes)* _____. **If** *Yes*, **what are those challenges**?_____

PHYSICAL ASSETS

2.19 Agricultural assets

Type of agricultural machinery	Number of assets	Average price per asset (R)	Type of agricultural machinery	Number of assets	Average price per asset (R)
Tractor			Spade		
Hoes			Wheelbarrow		
Shovel			Truck		
Cane knives			Rake		
Gumboots			Animal drawn plough		
Animal drawn cart			Other *(please specify)*		

2.20 Household assets *(Please indicate the number owned and resale price of the asset, zero [0] if not owned)*

Asset	Number of Assets	Average price per asset (R)	Asset	Number of Assets	Average price per asset (R)
Block, tile house			Radio		
Block, zinc house			Landline telephone		
Round, thatch house			Bicycle		
Mudhouse			Vehicle		
Cell phone			Motor-cycle		
TV			Refrigerator		
Computer			Water tank		
Stove			Other *(please specify)*		

2.21 Access to infrastructure *(Distance from home to an infrastructure access point)*

Infrastructure	**Spazza /Tuck shops**	**Tarred road**	**School**	**Clinic**	**Electricity** (0 if the house has electricity)	**Water taps (0 minutes house has a tap)**	**Communication infrastructure** (internet, landline phone, and cell phone)
Walking distance to the nearest (***in minutes***)							

2.22 Homeownership status

Tenure status	**Mark (X)**
Owned and fully paid off	
Owned but not fully paid off	
Rented	
Occupied rent-free	
RDP house	
Other *(please specify)* ……..	

FINANCIAL CAPITAL

SAVINGS AND CREDIT

2.23 Have you received a credit or loan facility in the past 12 months? _____ *(**1**= No;**2**= Yes)*

2.24 If *Yes*, **please specify the organisation(s) that have provided you with credit in the last 12 months and then indicate the amount they lent to you.**

Financial service providers	**Amount (R)**
Relative/friend	
Savings club/Stokvel	
Money lenders (Loan sharks)	
Input supplier	
Formal banks (i.e. ABSA, FNB, Capitec, etc.)	
Other *(please specify)* …….....	

2.25 How many members of your household have bank accounts? _____.

2.26 How many members of your household have taken bank loans during the last 12 months? _____.

2.27 How many members of your household have taken loans from other sources *(excl. banks)* during the last 12 months? _____.

HOUSEHOLD CONSUMPTION STATUS

2.28 List of foodstuffs that you usually purchase per month and the amount spent on each item

Items	Quantity (Kg, Litres, etc)	Amount (R)
Maize meal		
Rice		
Chicken		
Beef		
Pork		
Cooking oil		
Vegetables		
Tripe		
Canned food		
Other *(please specify)* …….....		

PSYCHOLOGICAL CAPITAL

2.29 These statements describe *how you may think about yourself right now*? *(Tick below to indicate your level of agreement or disagreement with each statement)*

Statements	Strongly disagree (1)	Moderately disagree (2)	Neutral (3)	Moderately agree (4)	Strongly agree (5)
Self-efficacy					
I am confident in raising and making recommendations during public gatherings					
I am confident in my ability to deal with problems and come up with solutions					
I am confident in approaching people external to my family and friends to discuss problems					
I do not believe the government is responsible for the well-being of people in the community					
Hope					
If I am faced with a problem, I can think of many ways to resolve it					
I have hope that the quality of work and life will improve for the better					
Currently, I am pursuing my goals in life					
Optimism					
I am optimistic about my future					
I do not give up easily					
I always look on the bright side of living					
Resilience					
I can deal with extreme weather changes such as floods, droughts, high and cold temperatures and wind occurrences					
When I have a setback, I have no trouble recovering from it and moving on					

2.30 Are these values important to you? *(Please tick the value and the level of importance to you)*

Values	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Egalitarianism					
Equal rights					
Equal wealth distribution					
Affirmative action					
Equal opportunities					
Individualism					
Moral worth of the individual					
Virtues of self-reliance					
Value of personal independence					
Precedence of individual interest over social interest					
Hierarchism					
Authority of hierarchy					
Top-down management					
Patriarchy					
Technocracy					
Fatalism					
Lack of control over your					
Events are predetermined					

SECTION 3: VULNERABILITY CONTEXT

HOUSEHOLD FOOD SECURITY

Type	*(1=No; 2=Yes)*
3.1 In the last 12 months, did you worry that your household would not have enough food?	
3.2 In the last 12 months, where you or your household been unable to eat the foods you preferred because of a lack of resources?	
3.3 In the last 12 months, did you or your household have to eat a limited variety of foods owing to a lack of resources?	
3.4 In the last 12 months, did you or your household have to eat foods you did not want to eat because of a lack of resources to obtain other types of food?	
3.5 In the last 12 months, did you or your household have to eat a smaller meal than you felt you should because there was not enough food?	
3.6 In the last 12 months, did you or your household have to eat only once a day because there was not enough food?	
3.7 In the last 12 months, did you or your household have to eat fewer meals in a day because there was not enough food?	
3.8 In the last 12 months, was there ever no food to eat of any kind in your household because of a lack of resources to get food?	
3.9 In the last 12 months, did you or members of your household go to sleep at night hungry because there was not enough food?	
3.10 In the last 12 months, did you or members of your household go for a complete day and night without eating anything because there was not enough food?	

PERCEPTIONS OF CLIMATE CHANGE

Local Community's Perception of Change in *TEMPERATURE* *(COLD AND HEAT)*

3.11 Over the years, there has been an unusual temperature increase in my area *(i.e. hotter than in previous year (s))*. _____ *(1 =strongly agree; 2 = disagree; 3= neutral; 4= agree; 5= strongly agree)*

3.12 The number of abnormally hot days during summer in my area over the years has changed._____*(1 =strongly agree; 2 = disagree; 3= neutral; 4= agree; 5= strongly agree)*

3.13 The number of abnormal cold days during winter in my area over the years has changed._____*(1 =strongly agree; 2 = disagree; 3= neutral; 4= agree; 5= strongly agree)*

Local Community's Perception of Change in *RAINFALL* Pattern

3.14 I have observed abnormal changes in rainfall in my area over the years_____ *(1 =strongly agree; 2 = disagree; 3= neutral; 4= agree; 5= strongly agree)*

3.15 Rainfall pattern during the rainy season in my area has changed_____ *(1 =strongly agree; 2 = disagree; 3= neutral; 4= agree; 5= strongly agree)*

Local Community's Perception of Change in *DROUGHT* Occurrences

3.16 I have observed more frequent droughts in your area over the years. _____ *(1 =strongly agree; 2 = disagree; 3= neutral; 4= agree; 5= strongly agree)*

Local Community's Perception of Change in *FLOODS* Occurrences.

3.17 I have observed more floods in my area over the years. _____ *(1 =strongly agree; 2 = disagree; 3= neutral; 4= agree; 5= strongly agree)*

Local Community's Perception of Change in *WIND* Occurrences.

3.18 I have observed abnormal changes in wind in my area over the years. _____ *(1 =strongly agree; 2 = disagree; 3= neutral; 4= agree; 5= strongly agree)*

3.19 Generally, do you believe that climate change is **occurring?** _____ *(**1**= No; **2**=Yes)*. If ***No***, skip to **3.22**

3.20 Generally, what is your feeling about climate change (*Affect*)? (Please tick below)

	Very negative (1)	**Negative (2)**	**Neutral (3)**	**Positive (4)**	**Very positive (5)**
I ***see*** climate change as something					
I ***feel*** that climate change is something					

3.21 What do you think is the reason behind climate change? _____ *(**1**= Land use/land cover change; **2**=Air/water pollution; **3**= God; **4**= Ancestors; **5**= other)*

3.22 If *No*, explain the reasons you do not believe in climate change_____
_____

3.23 Are you doing anything to protect your household from climate change? _____ (*1= No;2= Yes).*

If ***Yes***, what do you do? Please indicate the type of CC adaptation you apply in the table below.

Adaptation activities	**Level of climate change adaptation[1]**			
	Abnormally hot days	**Abnormally cold days**	**Abnormally rainfall**	**Abnormally wind**
Move valuable items during heavy rains				
Constructing barriers around the home				
Constructing barriers around farm/home garden				
Fortify the house (e.g., by adding more mud, metal sheets, insulation, etc.).				
Planting trees				
Crop diversification				
Partial abandonment of home				
Buying insurance				
Migration				
Use pesticides on farm				
Use improved crop varieties				
Crop rotation				
Other *(please specify)* ……				

[1] ***1****= Strongly disagree;* ***2*** *=Disagree;* ***3*** *= Undecided;* ***4*** *= Agree;* ***5****= Strongly agree*

PART 2: ENVIRONMENTAL VALUATION

SECTION 4: CHOICE EXPERIMENT

In this part of the questionnaire, you are being asked to choose between alternative features of the restored area around the Buffelsdraai Landfill Site. The restored area around the landfill site will impact the provision of ecosystem goods and services.

Choice sets

In the questions, you will be asked to pick your preferred alternative. Before selecting your preferred alternative, please consider:

- **The outcome of different management scenarios**
- **The estimated once-off payment you will make for the management of the reforestation site**
- **Consider the options carefully and make your choices as if they were real**

Alternative 1 is the same in each question. It represents the conditions at the Buffelsdraai Landfill site that would prevail if the project were never implemented. The choice set involves ***no*** investments, no expansion, and no new management strategies. Alternatives 2 to 12 include combinations of management scenarios and the likely outcomes around the landfill site. The reforested area around the landfill site is expected to provide:

- **Forest habitat**
- **Natural shield and protection from landfills *(Buffer)***
- **Animal species**
- **Tree species**
- **Employment for local people**

Once-off payment

Improving environmental conditions around the landfill site incurs costs. The money will come from all households in the communities through a once-off annual payment to a community trust fund. An independent auditor will ensure that the money is used appropriately.

It is important to note that the questions below are ***hypothetical***, but we expect you to treat them as real. The answers you provide will be valuable for decisions about the management of the landfill site.

Please select your preferred choice for each question. Furthermore, answer each question ***independently*** of other questions.

4.1 Consider the choice set below for the Reforestation Project site. Suppose only alternatives 1, 2 and 3 are *available*. Which alternative would you prefer?

Attribute		Alt.1 – Status quo	Alt2	Alt3
	Area of forest habitat rehabilitated	201.5 ha (no additional area)	520.6ha (expanded area)	520.6ha (expanded area)
	Number of trees planted in the buffer zone	0 trees (no trees planted in the buffer)	595 476 trees (current no. of trees planted in the buffer)	595 476 trees (increase in no. of trees planted in the buffer)
	Number of animal species	68 species (status quo animal species no.)	176 species (decrease in animal species no.)	176 species (current animal species no.)
	Number of tree species	0 species (no new tree species planted)	61 species (increase in tree species no.)	61 species (current tree species no.)
	Number of jobs created in the local community	0 jobs (no jobs)	455 jobs (current no. of jobs)	0 jobs (no jobs)
	Annual payment to a community trust fund for reforestation (Rand)	R0	R12-00	R12-00
Please mark your choice (X)				

4.2 Consider the choice set below for the Reforestation Project site. Suppose only alternatives 1, 4 and 5 are *available*. Which alternative would you prefer?

Attribute		Alt1-Status quo	Alt2	Alt3
	Area of forest habitat rehabilitated	201.5 ha (no additional area planted)	408.88ha (reduction in the area planted)	520.6ha (expansion in area planted)
	Number of trees planted in the buffer zone	0 trees (no trees planted in the buffer)	0 trees (no trees planted in the buffer)	595 476 trees (decrease in no. of trees planted in the buffer)
	Number of animal species	68 species (status quo animal species no.)	176 species (current animal species no.)	68 species (status quo animal species no.)
	Number of tree species	0 species (no new tree species planted)	0 species (no new tree species planted)	61 species (decrease in tree species no.)
	Number of jobs created in the local community	0 jobs (no jobs)	455 jobs (increase in no. of jobs)	455 jobs (increase in no. of jobs)
	Annual payment to a community trust fund for reforestation (Rand)	R0	R12-00	R0-00
Please mark your choice (X)				

4.3 Consider the choice set below for the Reforestation Project site. Suppose only alternatives 1, 6 and 7 are *available*. Which alternative would you prefer?

Attribute		Alt1-Status quo	Alt2	Alt3
	Area of forest habitat rehabilitated	201.5 ha (no additional area planted)	408.88ha (reduction in the area planted)	201.5 ha (no additional area planted)
	Number of trees planted in the buffer zone	0 trees (no trees planted in the buffer)	595 476 trees (decrease in no. of trees planted in the buffer)	595 476 trees (current no. of trees planted in buffer)
	Number of animal species	68 species (status quo animal species no.)	176 species (current animal species no.)	68 species (status quo animal species no.)
	Number of tree species	0 species (no new tree species planted)	61 species (increase in tree species no.)	61 species (current tree species no.)
	Number of jobs created in the local community	0 jobs (no jobs)	455 jobs (current no. of jobs)	455 jobs (increase in no. of jobs)
	Annual payment to a community trust fund for reforestation (Rand)	R0	R60-00	R60-00
Please mark your choice (X)				

4.4 Consider the choice set below for the Reforestation Project site. Suppose only alternatives 1, 8 and 9 are *available*. Which alternative would you prefer?

Attribute		Alt1- Status quo	Alt2	Alt3
	Area of forest habitat rehabilitated	201.5 ha (no additional area planted)	520.6ha (expansion in area planted)	201.5 ha (no additional area planted)
	Number of trees planted in the buffer zone	0 trees (no trees planted in the buffer)	595 476 trees (increase in no. of trees planted in the buffer)	595 476 trees (increase in no. of trees planted in the buffer)
	Number of animal species	68 species (status quo animal species no.)	176 species (current animal species no.)	176 species (current animal species no.)
	Number of tree species	0 species (no new tree species planted)	61 species (current tree species no.)	61 species (increase in tree species no.)
	Number of jobs created in the local community	0 jobs (no jobs)	455 jobs (increase in no. of jobs)	455 jobs (current no. of jobs)
	Annual payment to a community trust fund for reforestation (Rand)	R0	R60-00	R0-00
Please mark your choice (X)				

SECTION 5: UNDERSTANDING CHOICES PREFERRED

5.1 Did you always choose alternative 1 *(No project)*? _____ *(**1**= Yes; **2**= No)*. **If** *No*, **go to 5.2.**

If you always preferred alternative 1, what explains your primary reason(s) for making that choice?

Reasons	Mark (X)
I do not believe that the reforestation project will provide the specified environmental benefits	
I support the reforestation project, but the once-off payment is expensive	
I support the reforestation project, but I am not the only one who should support it	
I object to paying into the community trust fund	
Other reasons *(please specify……)*	

5.2 When you chose any of the alternatives 2 to 9, what was the main reason(s) for doing so?

Reasons	Mark (X)
I always chose the alternative with the lowest payment	
I was looking for the highest number of different trees	
I was looking for the highest number of different animals	
I was looking for the highest number of jobs created	
I was looking for the largest forested area	
Other reasons *(please specify……)*	

5.3 When you made your choices, were *all* the attributes equally important to you? _____ *(**1**= Yes; **2**= No)*.
If *No,* **please mark the attribute(s) you considered when making your choice**

Attributes	Mark (X)
Forest habitat	
Natural shield and protection from landfill *(Buffer)*	
Animal species	
Tree species	
Employment for local people	
Payment (Rands)	

Thank you

APPENDIX B: FOCUS GROUP DISCUSSION POINTS

Question guide:

1. Are you currently participating in the Buffelsdraai Landfill Site Community Reforestation Project?
2. How did you first hear about the reforestation project?
3. Why did you decide to participate in the project, and what do you understand its purpose to be?
4. Do you support the reforestation project? Why or why not?
5. Would you recommend the project to other members of the community? Please explain.
6. Are there any aspects of the project that you think should be improved or changed?
7. Do the credit notes provided through the Tree-preneur programme benefit your household? If so, how?
8. Are you satisfied with the groceries and other products that you receive through the credit note system? Why or why not?
9. Is the Tree-preneur programme your household's main source of income, or do you have other sources of income?
10. If you are a Tree-preneur, do you feel that the project coordinators treat participants fairly and respectfully?
11. Since the trees were planted, have you noticed any changes in the area? Please explain.
12. Would you prefer to have fewer trees, more trees, or to keep the forest as it is? Please explain your reasons.
13. The reforested area serves as a buffer between the community and the Durban Solid Waste landfill site. In your opinion, does it fulfil this role? Please explain.
14. Do you visit the reforested area? If so, for what purposes?
15. Do you collect any non-timber forest products from the area, such as fuelwood, medicinal plants or other resources? What do you use them for?
16. Do you use the forested area for cultural or religious activities, such as prayer or traditional rituals?
17. Would you be willing to make a once-off contribution to a community trust fund to support the planting of more trees, forest protection and the maintenance of the reforested area?
18. If yes, how much would you be willing to contribute, taking your household income into consideration?
19. Have you heard of climate change or global warming? What does it mean to you?
20. Have you noticed any changes in the weather over the years, such as changes in rainfall, temperature or an increase in flooding or drought?
21. Has the community experienced any weather-related disasters, such as flooding, fires or droughts, since you have lived here?
22. How have these weather changes affected your household and daily life?
23. What do you normally do when rainfall is irregular or when temperatures are unusually hot or cold for extended periods?

24. Do you have a title deed for your property?
25. Does your household have a food garden or keep livestock? If yes, what crops do you grow and what livestock do you keep?
26. Do you sell any of your produce or livestock? If so, where do you sell it, and how far is the market?
27. Does the municipality provide adequate services such as water, electricity, roads, sanitation, schools and clinic facilities?
28. Have you or members of your household experienced any health problems that you believe are related to living near the landfill site?
29. In your opinion, what are the greatest benefits of the reforestation project for the community?
30. What are the main challenges facing the project or the community?
31. Is there anything else you would like to share about the reforestation project, the community or your experiences living in the area?

APPENDIX C: KEY INFORMANT INTERVIEW SCHEDULE

Question guide:

1. What is your role in the Buffelsdraai Landfill Site Community Reforestation Project?
2. How long have you been involved in the reforestation project?
3. What are the main objectives of the reforestation project?
4. Who funds the reforestation project?
5. Was the community consulted prior to the implementation of the project?
6. Does the community understand the purpose and objectives of the reforestation project?
7. Does the community know who the key stakeholders and implementing organisations are within the project?
8. Does the project have the support of the local leadership (councillors and izinduna) and the community?
9. How many community members currently participate in the Tree-preneur programme?
10. Are community members aware of the importance of trees and forests? If so, what benefits do they associate with them?
11. What have community members learned since joining the Tree-preneur programme?
12. Have the Tree-preneur programme and the credit note system benefited participating households? If so, how?
13. Are community members satisfied with the goods and services they receive through the credit note system?
14. Apart from the credit notes, what other benefits do community members derive from the project?
15. Are there plans to recruit additional community members into the Tree-preneur programme?
16. Do community members have access to the reforestation site?
17. Under what circumstances are community members permitted to enter the site?
18. Does restricting access to the reforestation site contribute to the protection and conservation of the forest? Please explain.
19. What are the main challenges experienced by Tree-preneur participants?
20. Have there been any conflicts between the project and the local leadership regarding the zoning or boundaries of the reforestation site?
21. Do community members living adjacent to the landfill site have title deeds for their properties outside the landfill boundaries?
22. Does the community have access to basic services such as electricity, potable water and sanitation (i.e. connection to the municipal sewer system or reliance on pit latrines)?
23. What other organisations are implementing projects within the community, and how have these initiatives benefited local residents?
24. How long is the reforestation project expected to continue?

25. Are community members aware of the expected duration of the project?
26. If the project were to end, what impact would it have on participating households, and how would they adapt?
27. In your opinion, is the reforestation project sustainable? Please explain.
28. Are there any reports, publications or other documentation relating to the project that you would be willing to share for the purposes of this research?
29. Is there anything else you would like to add about the reforestation project or the surrounding communities?

APPENDIX D: ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

1 August 2018

Mr Karabo Donald Motau (209501788)
School of Agricultural, Earth & Environmental Sciences
Pietermaritzburg Campus

Dear Mr Motau,

Protocol reference number : HSS/0614/018D
Project title: Evaluation of the socio-economic impacts of the Buffelsdraai Landfill Site community Reforestation Project in the eThekwini Municipality, South Africa

Full Approval – Full Committee Reviewed Protocol

In response to your application received 5 June 2018, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

[redacted]

.....

Professor Shenuka Singh (Chair)
Humanitities & Social Sciences Research Ethics Committee

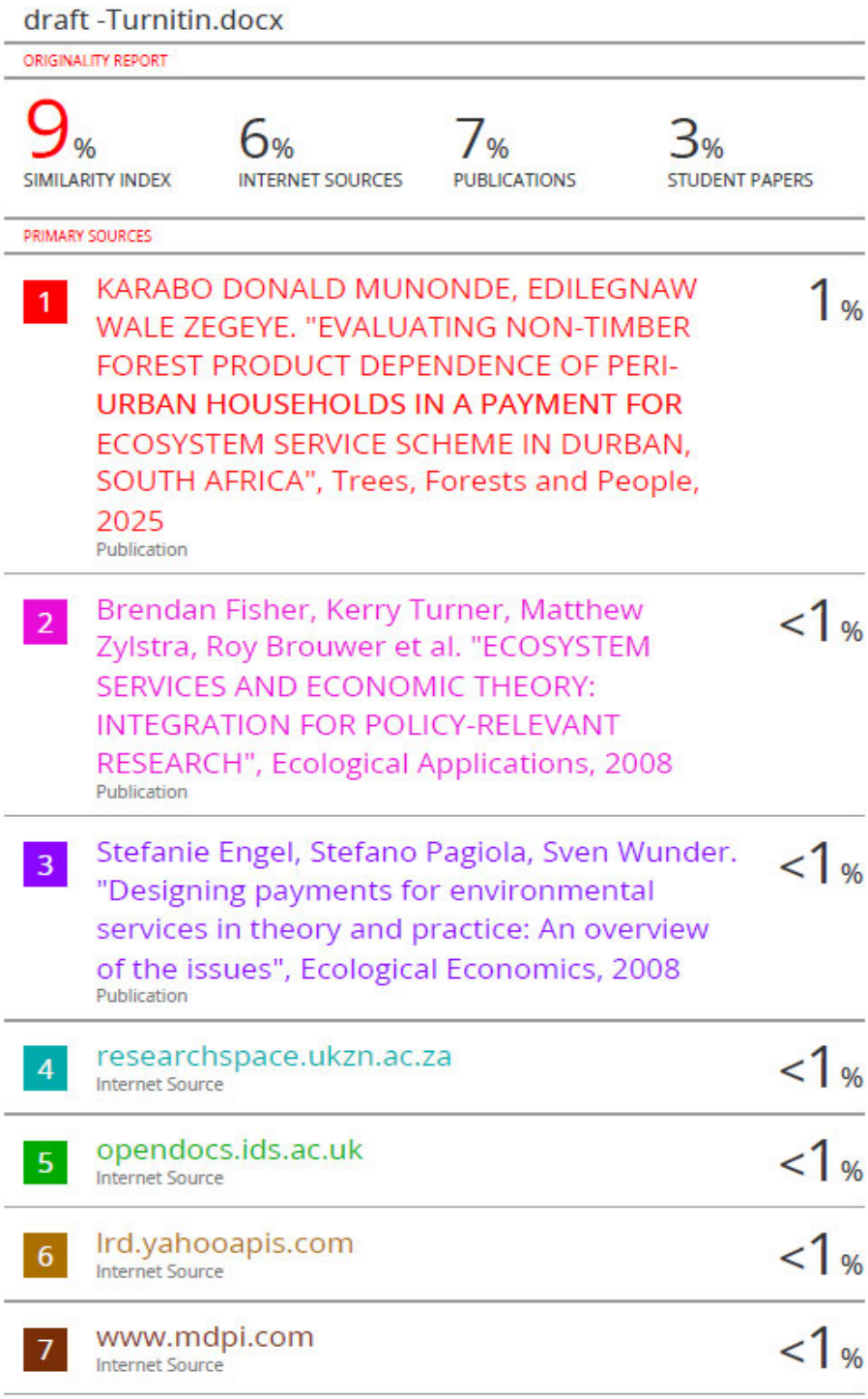
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cc Academic Leader Research: Professor Hussein Shimelis
cc School Administrator: Ms Marsha Manjoo

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
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