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CARBON CREDIT RESTORATION PROJECTS IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA: CONSIDERATIONS FOR SUSTAINABLE LOCAL ECONOMIC DEVELOPMENT

By

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Declaration

I, James Samuel Polak, hereby declare that this half-thesis is a result of my research investigations and findings. All the work that was written by other authors and used in the half-thesis is fully acknowledged and a reference list is included. This work has not been previously submitted in part or entirety for degree purposes to any other university.

Signed on this _____day of _______________, 2016

By _________________________

(James Polak)

Dedication

I dedicate this thesis to my loving family, to you, the reader, and to everything good in the world. To my mother, Fiona Polak (née Whittle-Bennetts) who set me on a path in the pursuit of knowledge. To my sister, Margaret-Anne (Annie) Polak, and to my late grandmother, Joyce Whittle-Bennetts, both of whom shared a sense of optimism which is both contagious and inspiring.

“There is no path to happiness. Happiness is the path.” - A. J. Muste

Abstract

Although global climate change has been identified as a serious global economic, social, and environmental threat to society, national governments have been slow to respond on a global scale. Environmental economic theory offers market-based solutions to address climate change efficiently through carbon control regimes, such as carbon taxation and cap-and-trade policy. A major political milestone was reached when an international agreement entered into force in 2008, known the Kyoto Protocol, which incorporated a market-based solution to address climate change on a global scale. This allowed a global market for emissions to form through the Clean Development Mechanism. Although the Kyoto Protocol aimed to address a global issue on a global scale through a single global market for emissions, fragmented sovereign cap-and-trade schemes have since emerged in the form of national and regional emission markets, commonly referred to as carbon markets. The Clean Development Mechanism offered the opportunity to generate carbon credits through carbon offset projects, such as carbon restoration projects. Although the Kyoto Protocol did not achieve the objective of forming an internationally accepted global carbon control regime, it seems to have set a trend of including offset programs in newly emerging carbon control regimes, such as South Africa's proposed carbon tax.

This study set out to assess the extent to which carbon control regimes are enabling sustainable local economic development, based on carbon restoration projects in the Eastern Cape province of South Africa using *Portulacaria afra*, commonly known as spekboom. As a starting point, this study assessed the current state of the international carbon markets using significant international cap-and-trade based markets as examples. Based on Newell *et al.*'s (2013) selection of significant carbon markets and data availability, the United States' Regional Greenhouse Gas Initiative and the European Union's Emission Trading Scheme were selected. Historical, current and forecasted supply and demand data were gathered from Thomson Reuters' Point Carbon research division. Further, historical futures and spot market price and volume data were gathered from the markets to compare how prices have fared over time. The Clean Development Mechanism's market for Certified Emission Reduction credits was used for comparative purposes. The markets were found to be systemically oversupplied, leading to systemically low prices. The systemic oversupply in credits provides a limited incentive to initiate carbon offset projects, however, South Africa's proposed carbon tax may be able to stimulate demand for domestic offset projects.

Key success factors established through a comparative literature review on local economic development theory were incorporated into key informant interviews. The results were then analysed through the lens of Connelly's (2007) model for sustainable development to provide recommendations for sustainable local economic development, regarding carbon restoration projects in the Eastern Cape using *P. afra*. The following opportunities were identified: the planting of *P. afra* on degraded land has the potential to mitigate climate change, offer water benefits to the surrounding communities, and promote biodiversity regeneration. There is potential for economic growth through job creation and the economic multiplier effect. Government funding is available and voluntary offset agreements do exist, eliminating a large portion of the cumbersome accreditation requirements. These projects also offer potential for social justice through the government funding requirements which stipulate that youth and women should be given preference for employment, potentially helping to alleviate inequality. The funding further stipulates that employees should be trained in transferable skills, offering potential for capacity building and social capital accumulation through education. These transferable skills include skills geared towards encouraging entrepreneurialism.

Corresponding challenges were also found: excessive overgrazing through pastoralism has rendered some land degraded beyond restoration. Opportunists may resort to planting *P. afra* outside of the subtropical Albany Thicket biome to which it is endemic, leading to potential biodiversity loss rather than gains. Sufficient buy-in is required from private landowners for these projects to be sustainable, however, the projects entail a large opportunity cost to farmers as returns take at least 5 to 6 years. This may render these projects undesirable to most landowners and provides scope for free-riding, should pastoralists not have to bear the full costs of the project and property rights not be enforced through land user agreements. The projects require an exorbitant amount of upfront funding. Cash flow received from the projects does not extend in perpetuity. Requirements for social justice pertain only to government funded projects. A working model, generating and selling carbon credits through land restoration using *P. afra*, has not yet been established.

As it stands, these carbon restoration projects are still highly speculative and carry a significant amount of investment risk, given the high mortality and low growth rates associated with the current planting method. The current systemic oversupply of carbon credits in the international markets signal that returns from carbon credits are set to be low, at least until the oversupply issues are resolved. Should these challenges be overcome, carbon restoration projects using *P. afra* may have the potential to bolster sustainable local economic development in the impoverished regions of province as well as provide a locally-driven adaptation and mitigation strategy to address global climate change

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Above all, I wish to extend my gratitude to God, the ultimate source of all knowledge, love, and all things good.

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List of Abbreviations

BRICS	Brazil, Russia, India, China and South Africa
CCBS	Climate, Community and Biodiversity Standard
CCR	Cost Containment Reserve
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CO_2	Carbon Dioxide
COP21	21^{st} meeting of the Conference of Parties
ECX	European Climate Exchange
ET	Emissions Trading
ETS	Emission Trading Scheme
EU	European Union
EUA	A permit, equivalent to 1 tonne of CO_2 equivalent, traded on the EU ETS
EU ETS	European Union Emission Trading Scheme
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GHGEs	Greenhouse Gas Emissions
GS	Gold Standard
HIV	Human Immunodeficiency Virus
ICAO	International Civil Aviation Organization
ICE	Intercontinental Exchange
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LED	Local Economic Development
NER	New Entrants' Reserve
PPE	Personal Protective Equipment Expenditure
RECLAIM	California's Regional Clean Air Incentives Market
REDD+	Reducing Emissions from Deforestation and forest Degradation in Developing countries
REFIT	Renewable Energy Feed-In Tariff

RGA	A permit, equivalent to 1 tonne of CO_2 equivalent, traded on the RGGI
RGGI	Regional Greenhouse Gas Initiative
SANBI	South African National Biodiversity Institute
SANT	South African National Treasury
SO_2	Sulphur Dioxide
STRP	Subtropical Thicket Restoration Programme
UIF	Unemployment Insurance Fund
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
VCS	Verified Carbon Standard

Chapter 1. Introduction

Backed by a large body of research, global climate change has been identified as a serious environmental, social, and economic threat (Stern, 2007; Tietenberg and Lewis, 2014). Stern's (2007) review found that the economic costs of inaction towards climate change are far outweighed by the economic benefits of a strong and timeous response. However, this global threat has yet to be addressed adequately (Wuebbles, 2016).

A major political milestone was reached in 1997 when the United Nations Framework Convention on Climate Change (UNFCCC) met in Kyoto, Japan (Manne and Richels, 2000; Nordhaus and Boyer, 1999; Stringer *et al.*, 2009; UNFCCC, 2016). Ratified by 192 parties, including South Africa, an agreement to reduce greenhouse gas emissions to 5% below that of their relevant 1990 emission levels entered into force between the years 2008-2012, known as the Kyoto Protocol (Holgate, 2007; Kibwami and Tutesigensi, 2016; UNFCCC, 2016). Although the Kyoto Protocol has expired, the UNFCCC proposed an amendment to continue the Kyoto Protocol known as the Doha Amendment. However, the Doha Amendment is not yet legally binding as several signatories have backed out of the agreement (UNFCCC, 2016). Nonetheless, at the 21st meeting of the Conference of Parties (COP21) in Paris, it was unanimously agreed that signatories should formulate national mitigation plans to keep average surface temperatures on Earth from rising by more than 2°C (Robbins, 2016; UNFCCC, 2016). This agreement entered into force on the 4th of November 2016 and will be legally binding for the next three years for all signatory countries (United Nations, 2016). This agreement serves as a noteworthy political milestone, post the Kyoto Protocol, in addressing climate change on a global scale, based on a legally binding international agreement (Thompson Reuters Eikon, 2016; United Nations, 2016).

Stern (2007: i) identifies global climate change as a distinctive economic challenge as, "…it is the greatest and widest-ranging market failure ever seen". To address the situation efficiently, the Kyoto Protocol considered contemporary environmental economic theory in the construction of the three core mechanisms, namely: The Clean Development Mechanism (CDM), Joint Implementation (JI); and Emissions Trading (ET) (Tietenberg and Lewis, 2014). The CDM and JI allow industrialised-country signatories of the Kyoto Protocol to fund emission reduction projects in developed and developing countries in exchange for certified emission reduction (CER) credits for each tonne of emissions avoided. These CER credits can then be traded under the ET mechanism on a formal international market, commonly referred to as a 'carbon market', or used towards their own reduction targets (UNFCCC, 2016). Several other multinational, national, and sub-national carbon markets have since emerged alongside the CDM CER credit scheme (Newell *et al.*, 2014). For example, the European Union's Emissions Trading System (EU ETS), California's cap-and-trade program, and Quebec's carbon market, amongst several others (Newell *et al.*, 2014).

Emission reduction projects can take the form of carbon sequestration, for example, afforestation and land restoration projects, amongst others (Katircioglu *et al.*, 2016; Kibwami and Tutesigensi, 2016). A linkage between the development process and responses to climate change has been noted in the literature (African Development Bank *et al.*, 2003; Giannini *et al.*, 2008; Schipper, 2007; Stringer *et al.*, 2009; Twomlowet *et al.*, 2008; Yohe *et al.*, 2007). Development in itself, however, is a contested concept which is often vaguely defined and even misunderstood (Connelly, 2007; Rist, 2007). Connelly (2007) points out that various development projects should consider aspects of environmental protection, economic growth, and social justice to at least some degree. Those that don't will fall outside the bounds of sustainability. In addition, Connelly (2007) points out that each of these three spheres of concern are interlinked; therefore, for development to occur and to be sustainable, development projects must ensure that economic and social advancements take place, whilst additionally ensuring that effective environmental protection measures have been put into place to prevent environmental overexploitation. Polak and Snowball (2016) show that Connelly's (2007) framework can be applied to local economic development (LED) projects, offering a broader approach to assessing the sustainability of such projects. Katircioglu *et al.* (2016) argue that CDM projects have the potential to create economic, social, and environmental benefits in developing countries. Therefore, CDM projects offer the potential to facilitate sustainable LED, per Connelly's (2007) interpretation.

In the Eastern Cape province of South Africa, *Portulacaria afra* (more commonly known as Spekboom) has been identified as being ideal for carbon credit restoration projects, given its ability to achieve high carbon-fixation rates despite the semi-arid conditions in which it grows (Furniss, Cowling and Mills, 2014). Having identified *P. afra* as such, a subtropical thicket restoration program has been instigated by the Department of Environmental Affairs in partnership with the Development Bank of Southern Africa, Eastern Cape Parks and Tourism Authority, and South African National Parks (Furniss, Cowling and Mills, 2014). Several privately funded carbon credit projects using *P. afra* have also emerged in the Eastern Cape (Powell, Pers. Comm., 2016).

Unemployment in the Eastern Cape has been a notoriously troublesome issue, with the official rate being 28.6% during the second quarter of 2016, and the expanded rate, which also includes discouraged work-seekers, being the highest out of all the provinces in South Africa at 43.8% (Statistics South Africa, 2016). Carbon credit projects using *P. afra* have the potential to foster community participation, capacity building, public-private partnerships, and job creation (Furniss, Cowling and Mills, 2014). Rodríguez-Pose and Palavicini-Corona (2013) note these factors as being amongst the prerequisites for successful LED projects.

There are hindering factors in the industry, however. For example, carbon prices seemed to have peaked around the 2008/2009 financial crisis, with carbon credit prices dropping to near zero levels following the global economic recession that followed on from the crisis (Chan, 2009; Kreibich *et al.*, 2016; Lohmann, 2012). This was because of a large over-supply in CER credits post the crisis, amidst the economic downturn (Kreibich *et al.*, 2016).

Nevertheless, the South African National Treasury's (SANT) proposal to implement a carbon tax starting on the 1st of January 2017, alongside the proposed option for firms to offset 5-10% of their emissions (depending on their sector) through carbon credits (The Carbon Report, 2016), may provide the extra demand needed for the carbon market in South Africa to viably expand.

1.1. Outline of the Research

The aim of the research is to assess the extent to which carbon control regimes are enabling sustainable LED, based on carbon restoration projects in the Eastern Cape province of South Africa using *P. afra*.

Sub-goals are to:

- Assess the current state of selected international carbon markets;
- Discuss South Africa's proposed carbon tax policy;
- Evaluate the impact that carbon credit restoration projects have on LED.

This research will be based on a post-positivist approach, whereby clear cause and effect relationships will be identified through the reductionism process (Creswell, 2009; Lenzholzer and Brown, 2016). Based on these relationships, conjectures will be applied and tested.

Two international carbon markets based on cap-and-trade regimes were identified and used as examples, based on Newell *et al.*'s (2013) selection of significant carbon markets and data availability. The following markets were selected: The United States' Regional Greenhouse Gas Initiative and the European Union's Emission Trading Scheme. Relevant historical, current, and forecasted supply and demand data for these markets were then garnered from Thomson Reuters' Point Carbon research division, available through the Eikon software package. Average monthly carbon credit future and spot price and trade volume data were also garnered for these selected markets, using the CER market for comparison purposes to compliment the analysis. A graphical analysis was then conducted to assess the state of these selected markets, complimented by a comparative literature review and information from analysts from Thomson Reuters' Point Carbon research division, available through the Eikon software package.

Key informants involved with carbon credit restoration projects using *P. afra* were identified in the Eastern Cape province of South Africa. These key informants were then interviewed based on their ability to provide relevant solicited information, as suggested by Bryman (2008), and who demonstrate some of the characteristics of the 'ideal key informant', suggested by Marshall (1996). Key informants were garnered from a government funded carbon credit restoration project in the Eastern Cape; private landowners involved in a carbon credit restoration project in the Eastern Cape; and from researchers in the Eastern Cape who are currently researching carbon credit restoration projects using *P. afra*. A further key informant was identified in the SANT and interviewed, based on their ability to provide relevant solicited information regarding South Africa's proposed carbon tax.

To determine to what extent carbon credit projects in the Eastern Cape are a viable option to promote sustainable LED, a comparative literature review was conducted, determining some of the success and failure factors leading to sustainable LED. The theory was then tested via key informant interviews. The data obtained were then analysed through the lens of Connelly's (2007) framework for sustainable development, to provide considerations for sustainable LED. Further, information regarding South Africa's proposed carbon tax was used to compliment the analysis. Information in this regard was obtained through the key informant interview as well as from relevant policy documents and literature.

The study is organised as follows. Chapter 2 provides a brief overview of global climate change and the effects thereof. This chapter considers both environmental concerns surrounding climate change as well as global political responses. Chapter 3 provides an overview of the economic instruments which may be used to mitigate climate change. Using case studies, each instrument is briefly considered in practice. Chapter 4 provides an overview of local economic development theory. This chapter considers LED within the context of both sustainability and South Africa. Chapter 5 sets the context of the research by considering carbon credit projects as a means to address climate change as well as to enable sustainable local economic development within the Eastern Cape province of South Africa. Chapter 6 lays out the methods used for this research as well as ethical considerations for the study. Chapter 7 discusses the data obtained through the key informant interviews and from Thomson Reuters' Point Carbon research division. The data is viewed through the lens of Connelly's (2007) framework for sustainable development. Considerations for each dimension of Connelly's framework, economic growth, social justice and environmental protection, are provided in this chapter. Chapter 7 also provides an overview of two significant regional carbon markets, based on data obtained through Thomson Reuters' Point Carbon research division: The Regional Greenhouse Gas Initiative and the European Union's Emissions Trading Scheme, using the CDM for comparative purposes. Chapter 8 concludes the study by summarising the main findings. This chapter also considers possibilities for future development in carbon credit projects based on *P. afra*.

Chapter 2. Global Climate Change

2.1. Introduction

During the 1970s and 1980s, the literature was filled with a growing global concern amongst the scientific community regarding the threat of climate change accentuated by anthropogenic activity (Flavin, 1990). This concern stemmed from a scientific consensus that carbon dioxide (CO_2) emissions, induced by anthropogenic activity, were on the rise, alongside other gas emissions such as methane and nitrous oxide (Andrew, 2008; Baes *et al.*, 1977; Flavin, 1990; Hartmann, 1990; Le Treut *et al.*, 2007; Schneider, 1975; van Nes *et al.*, 2015). The accumulation of CO_2, alongside other gases, in Earth's atmosphere has been found to have a blanket effect, whereby solar radiation enters Earth's atmosphere freely. However, a portion of outgoing infrared radiation, naturally exiting Earth's atmosphere, is reflected onto Earth's surface by the gases (Baes *et al.*, 1977; Schneider, 1975). The accumulation of these gases in Earth's atmosphere, thus, has a positive feedback effect in warming Earth's surface (van Nes *et al.*, 2015). This positive feedback effect has been labelled accordingly as the 'greenhouse effect' in the literature (Baes *et al.*, 1977: 310; Green Tech Box 2016). Figure 1 illustrates this process.

Rising global temperatures have led to the term 'global warming', although the preferred term amongst contemporary scientists is 'climate change' since the effects of climate change are not geographically limited to the source of the greenhouse gas emissions (GHGEs) (Robbins, 2016: 1-2; Whitmarsh, 2008: 16).

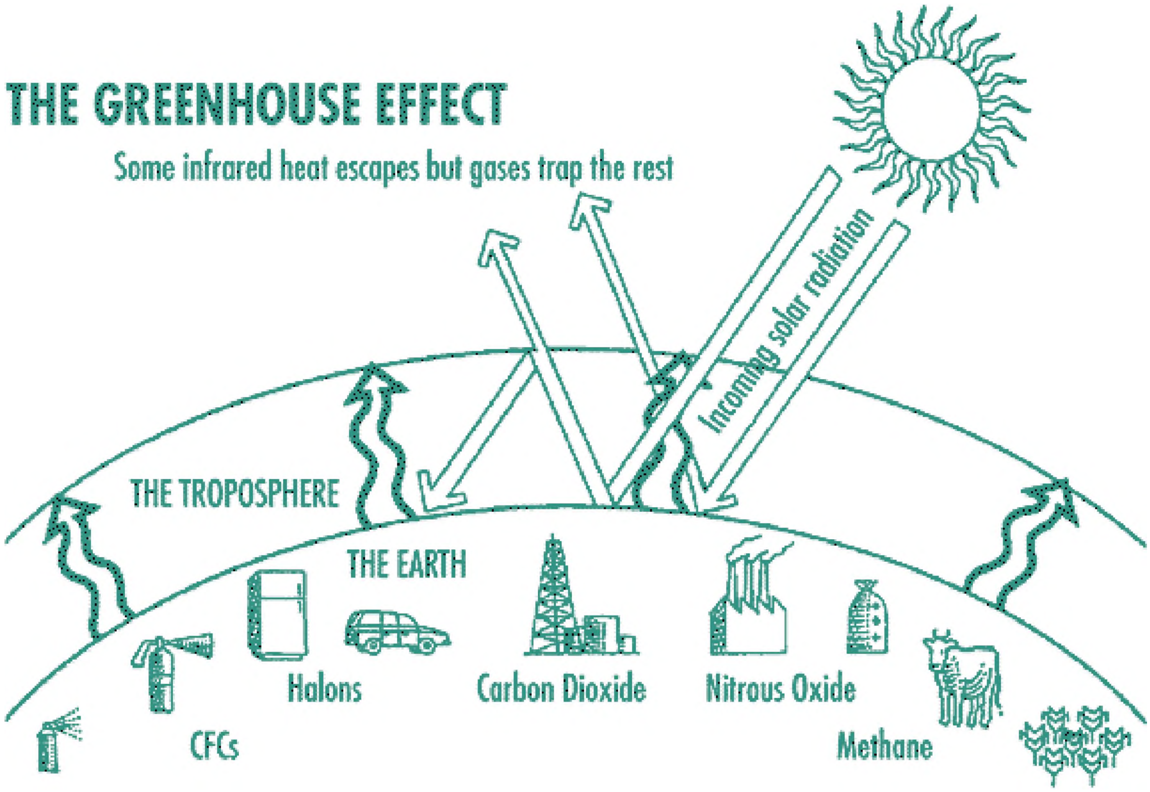


Figure 1. The Greenhouse Effect
Source: Green Tech Box (2016)

2.2. The Environmental Implications of Climate Change

It has been argued that rising global temperatures will be accompanied by rising sea levels caused by thermal expansion and melting glaciers, altered weather patterns, increased disease, food security issues, mass extinction, desertification, untimely rainy seasons, as well as more frequent and intense storms (Gleick, 1989; Rogerson, 2016; Stern, 2007). Although industry and transport related GHGEs remain a significant contributor towards climate change, land use changes, particularly deforestation, and agriculture, which is usually the motive behind deforestation and the causal factor behind land degradation in most cases, are becoming increasingly significant contributors (Rogerson, 2016; Stern, 2007; Tubiello *et al.*, 2015).

Ziervogel *et al.* (2014) argues with certainty that global temperatures are on the rise. Across the globe, mean annual temperatures have risen by 1.5 times the global average, or more. Uncertainty continues to underlie the projection and prediction of the resulting geophysical and climatic effects, although it is agreed that the severe effects of climate change are not evenly experienced across the globe (Gleick, 1989; Qian *et al.*, 2016; Stern, 2007).

The concern surrounding the possible adverse effects of climate change has prompted many scientists to conduct further research. For example, Farbotko (2010) investigated the Tuvalu islands in the pacific region which are being severely affected by climate change. Rising sea levels are causing the islands to disappear underwater. Farbotko (2010) emphasises the failure on the part of the world's biggest emitters to address climate change. Farbotko (2010: 58) suggests that, within the global political economy, the current environmental crisis is analogous to a debate between 'saving the climate refugee and watching the islands drown': An indeterminate state in which politicians can either choose to counter climate change or continue business as usual. At the time he was writing, little to no intervention had taken place in the Tuvalu islands besides negligible coverage in the media by journalists (Farbotko, 2010). Figure 2 illustrates the severity of rising sea levels in the Tuvalu islands.

Figure 2. Journalists filming sea water flooding the Tuvalu islands at high tide.
Source: Farbotko (2010: 49)

The African continent has been noted in the literature as being particularly vulnerable to climate change, notably due to the continent's higher sensitivity to climatic changes in projection models and insufficient adaptive capacity to cope with the changes amid developmental stresses (Callaway, 2004; IPCC, 2007; Stringer *et al.*, 2009). Southern Africa is projected to experience higher increases in mean annual temperatures relative to any other part of the globe (Lotz-Sisitka and Urquhart, 2014). Lotz-Sisitka and Urquhart (2014) note that mean annual temperatures are projected to rise by 3.4°C in the region between the years 2080 and 2099, relative to the period between 1980 and 1999. Pio *et al.* (2014) also highlight the major threat that climate change has on southern Africa. Desertification has become prevalent in the region and tree growth along with palatable shrub growth are declining due to increased occurrences of drought. Such changes are leading to extinction and biodiversity loss within the region (Pio *et al.*, 2014). Pio *et al.* (2014) project that the Kalahari will likely experience the highest extinction rate of mammals on the African continent.

A large body of literature has highlighted the stress that climate change would place on agriculture in Africa. For example, Henderson *et al.* (2015) find that projected climate change will have an overwhelmingly negative impact on agriculture in Africa due to declining moisture levels and rising average annual temperatures. Henderson *et al.* (2015) argue that this may lead to increased urbanisation due to increased rural to urban migration instigated by crop failure. Henderson *et al.* (2015) highlight the large dependence that Africa has on their agricultural sector along with the fact that most subsistence farmers are unable to adapt to climatic changes through the adoption of expensive farming technologies due to financial constraints. This magnifies the negative effects of climate change in the region. Martin *et al.* (2014) find that climate change poses a serious threat to pastoralists due to associated increases in rainfall variability.

There is a small body of literature that argues that a few regions may benefit positively from climate change. For example, Sabaté *et al.* (2002) project increased rainfall in the Mediterranean which would positively affect forest growth; however, increased temperatures would negatively affect growth. Depending on which is greater, climate change may in fact benefit the region positively. Jones *et al.* (2015) project increased solar radiation in northern parts of KwaZulu-Natal, South Africa, which will increase sugar cane growth and reduce weeding costs, promoting the sugar cane industry in South Africa. However, increases in evapotranspiration associated with the increase in solar radiation will require more efficient irrigation techniques to be used, and irrigation to be introduced into rain-fed crop production which is costly.

Overall, an overwhelming consensus amongst scientists has been reached: 'more than 95% of active climate scientists attribute recent global warming to human causes' (Plutzer *et al.*, 2016). Global warming will continue for the next few hundred years even if greenhouse gases were to stabilise because of climatic processes and feedbacks (Stern, 2007; Tietenberg and Lewis, 2014). Overwhelming scientific evidence indicates that climate change poses a serious environmental, social, and economic threat globally which requires an urgent global response (Stern, 2007). Earth's atmosphere has already been significantly altered by anthropogenic activity through the build-up of greenhouse gases (GHGs) since the industrial revolution, a pressing political and environmental issue which has yet to be addressed adequately (Flavin, 1990; Gleick, 1989; Katircioglu *et al.*, 2016; Wuebbles, 2016).

2.3. Political and Public Consensus

Public and political uncertainty regarding the mitigation of climate change continues to prevail, despite repeated warnings from the scientific community (Flavin, 1990; Ross *et al.*, 2016). Ross *et al.* (2016) attribute this lack of 'foresight intelligence' economically to the absence of tangible payoffs for those individuals and cooperative communities who contribute towards the mitigation of climate change. Cooperative communities, however, are likely to receive local benefits nearer in time and space relative to individuals, therefore, encouraging cooperation is key to realising co-benefits when it comes to combating climate change (Ross *et al.*, 2016). This uncertainty can also be attributed to the myopic nature of finance and profiteering. 'Shareholders often care more about short-term financial returns than the longer-term sustainability of their companies and the damage they do to the environment' (Ross *et al.*, 2016: 363).

Although severe environmental concerns were raised politically on a large scale at the United Nations Conference on the Human Environment in 1972 (Gleick, 1989), it was not until the late 1980s that the wide acceptance amongst the scientific community (that these environmental issues were in fact caused by climate change) was finally realised politically (Flavin, 1990). Flavin (1990:170) stated that: 'In November 1988, representatives of 30 countries met in Geneva under the auspices of the United Nations Environment Programme (UNEP) and the World Meteorological Organization.' This made it possible to form the Intergovernmental Panel on Climate Change (IPCC) which has thus far established that the issue of climate change will affect all countries, developed and developing, and that industrialised countries were and still are the primary cause (Farbotko, 2010; Flavin, 1990; Gleick, 1989; Sauter *et al.*, 2016).

The IPCC became the scientific supporting body behind the UNFCCC which was formed in 1992 (Schipper, 2006). The UNFCCC serves as a global legal framework for the abatement of climate change. The UNFCCC aims to stabilise greenhouse gases in the atmosphere at a level which ensures sustainable economic development whilst at the same time ensuring that Earth's climatic system is not dangerously compromised (Schipper, 2006). A dichotomy in strategic action to combat climate change has since emerged in the literature: adaptation versus mitigation (Schipper, 2006; Stern, 2007). The former has received less attention in the literature (Vale, 2016).

Adaptation can be described as a strategy that involves those most affected by climate change deliberately adopting social and environmental strategies which prepare them against the associated stresses and external stimuli of climate change (Schipper, 2006; Stringer *et al.*, 2009). Such strategies may involve building resilience and decreasing vulnerability to climate change through either 'managed, policy-driven adaptation' which takes a top-down approach, e.g. drought early warning systems; and 'autonomous, locally driven adaptation' which takes a bottom-up approach, e.g. changing the dominant community livelihood strategy (Stringer *et al.*, 2009: 749). Mitigation involves those causing the most amount of climate change adopting strategies which lessen their external impacts (Schipper, 2006). This usually involves strategies implemented through policy and/or legislation, for example, implementing policies that reduce emissions and energy consumption in cities (Holgate, 2007). Tietenberg and Lewis (2014) suggest that climate engineering has also emerged as a possible strategic action in the literature, whereby technology is used to combat climate change, either through capturing carbon dioxide, or controlling solar radiation.

A major political milestone in climate policy was reached in 1997 when the UNFCCC met at a conference in Kyoto, Japan (Manne and Richels, 2000; Nordhaus and Boyer, 1999; Stringer *et al.*, 2009; Tietenberg and Lewis, 2014; UNFCCC, 2016). At the conference, both developed and transitional countries agreed to reduce their GHGEs to 5% below that of their relevant 1990 emission levels using mitigation strategies (Kibwami and Tutesigensi, 2016). The agreement was forged into a legal framework known as the Kyoto Protocol that became a legally binding protocol of the UNFCCC. In February 2005 the agreement was ratified and reductions of emissions were to take place between the years 2008-2012 (Tietenberg and

Lewis, 2014). South Africa ratified both the UNFCCC and the Kyoto Protocol in 1997 and 2002, respectively (Holgate, 2007). On the 21st of December 2012, the UNFCCC proposed an amendment to continue the Kyoto Protocol known as the Doha Amendment, subject to the acceptance of all signatories of the Kyoto Protocol (UNFCCC, 2016). To date, the Doha Amendment has not entered into force as several signatories have backed out of the agreement. South Africa agreed to the Doha Amendment in 2015 (UNFCCC, 2016). Nonetheless, the international community has failed to agree on a legally binding follow-up agreement to the Kyoto Protocol (Almer and Winkler, 2015).

The most recent widespread political consensus amongst state representatives on climate change, which was backed by 40 000 advocates, scientists, and investors, was reached on the 13th of December 2015 in Paris at the 21st meeting of the Conference of Parties (COP21) (Robbins, 2016). All representatives agreed that global climate change affected everyone and that some sort of agreement should be made, even if it was a frail one. It was agreed that developed countries will offer technical and financial support for adaptation strategies in developing countries; that all countries will develop national mitigation plans to be implemented from 2020 and revised every five years from 2023 to adapt to global changes, with the aim of keeping average global surface temperatures from rising by more than 2°C; and that a transparent system of emissions reporting and evaluation should be used, set by the IPCCC (Robbins, 2016; UNFCCC, 2016). The United Nations (2016) and Thompson Reuters Eikon (2016) states that the agreement met its threshold on the 5th of October 2016 and entered into force on the 4th of November 2016 and will be legally binding for all signatory countries for the next three years.

Although this global issue requires an urgent global response (Stern, 2007), Ostrom (2012) argues that a global solution is not necessarily realistic. For a global solution to work, it needs to be backed up at the national, regional, and local level. Ostrom (2012) goes on to argue that a polycentric approach should thus be taken, as the collective action required to tackle climate change involves several public and private organizations at various scales. Therefore, actions taken by one decision-making entity concurrently produce costs and/or benefits for other decision-making entities organised on another scale. Ostrom, (2012) refers to these costs and benefits as 'nested externalities.' This adds complexity to the problem-solving process. Ross *et al.* (2016) argue along similar lines when it comes to collective action. In addition, Ross *et al.* (2016) stress the need for a bottom-up approach to tackling climate change collectively, with effective leadership from above, giving rise to gradual changes in societal behaviour and norms, leading to a more coordinated and effective response to climate change.

2.4. Conclusion

This chapter considered the effects of climate change to establish the motivation behind climate change mitigation. The current public and political consensus regarding intervention was also discussed to establish whether current intervention is sufficient. The following chapter highlights contemporary environmental economic theory and literature concerning the economic instruments which may be used as tools for intervention.

Chapter 3. Using Economic Theory to Shape Climate Change Mitigation Policy

3.1. Introduction: Viewing Climate Change as an Externality

Economic analysis can serve as a useful tool in assisting policy makers (Stern, 2007). In economic terms, the global climate can be considered a public good (Andrew, 2008; Stern, 2007), defined by Perman *et al.* (2003) as a good which is both non-excludable and exhibits non-rivalry. One cannot feasibly and practically exclude users from the good and one user's consumption of the good may not impede another user's consumption of the good (Perman *et al.*, 2003). Given these characteristics, public goods are often subjected to market failure caused by externalities, especially when the environment is concerned (Merlo and Briales, 2000). Jaffe *et al.* (2005: 165) define an externality as, 'an economically significant effect of an activity, the consequences of which are borne (at least in part) by a party or parties other than the party that controls the externality producing activity.' In the case of the global climate, GHGEs contributing towards climate change form market externalities (Ostrom, 2012; Stern, 2007; Weitzman, 2013). Since regions other than the regions emitting greenhouse gases are either damaged through climate change (such as the Tuvalu islands) or may benefit from climate change (such as the Mediterranean), both external diseconomies (negative externalities) and external economies (positive externalities) are created, respectively (Farbotko, 2010; Kolstad, 2000; Sabaté *et al.* 2002; Tietenberg and Lewis, 2014). Arguably, a far larger number of external diseconomies will prevail (Ostrom, 2012; Stern, 2007).

Climate change is the largest externality in existence, given its global impact (Andrew, 2008; Tol, 2009; Weitzman, 2013). Averting excessive climate change by means of reducing GHGEs on a global scale can also be considered a public good, as no individual can be feasibly and practically excluded from the resulting benefits and the benefits are non-rivalrous (Ostrom, 2012). These characteristics encourage free-riding (Angelovsk *et al.*, 2016). Using Angelovsk *et al.*'s (2016) notion of free-riders, in the case of averting excessive climate change by means of reducing GHGEs, free-riders would be those entities which do not contribute at all.

Inefficiencies and market failures, such as externalities, occur because of a lack of well-defined property rights (Kolstad, 2000; Tietenberg and Lewis, 2014). Tietenberg and Lewis (2014) list three characteristics of property rights that need to be upheld in order to establish an efficient market structure, namely: *exclusivity*, whereby all costs and benefits accrue only to the rightful owner of the resource; *transferability*, whereby all property rights of the resource should be transferable from one owner to another in a voluntary exchange; and *enforceability*, whereby all property rights should be secure from involuntary encroachment or seizure by other parties. In the case of environmental pollution and climate change, one firm's or, more broadly speaking, one country's polluting activities create an external cost on other entities on a global scale, violating the exclusivity characteristic which creates a negative externality, leading to market failure (Tietenberg and Lewis, 2014). Because the individual firm (country) does not consider their external costs when making economic decisions, their marginal private cost of production curve (S_1) falls below the societal marginal cost of production curve (S_2), which considers both the external costs of pollution and the costs of production, as shown in figure 3 (Brigham Young University Idaho, 2011; Tietenberg and Lewis, 2014). Vale (2016) defines this societal cost of production as being the costs of inaction in the case of global climate change. Firms (countries) produce a quantity of goods equivalent to 'Market Quantity' in figure 3, which exceeds the socially optimal level of production at 'Social Optimal'. Consequently, too much pollution is produced; products are inefficiently priced too low, as external costs are not factored into production; no economic incentives exist to encourage firms to adopt 'greener' technologies in the production process; and the costs of pollution are inefficiently low (Andrew, 2008; Brigham Young University Idaho, 2011; Tietenberg and Lewis, 2014). This results in a deadweight loss, or loss in welfare, for society, as indicated in figure 3 (Brigham Young University Idaho, 2011).

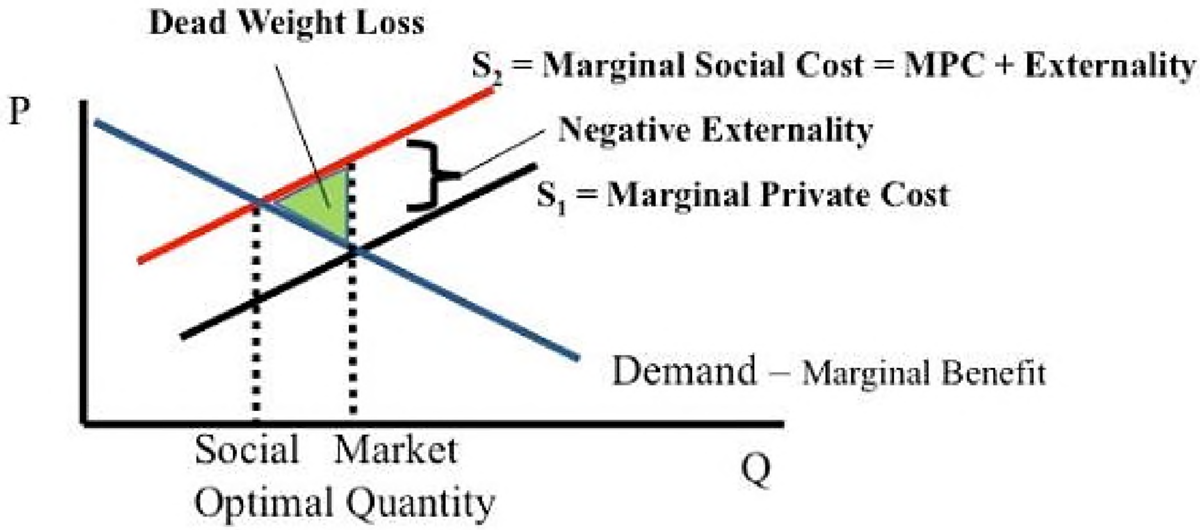


Figure 3. Negative economic externalities.
Source: Brigham Young University Idaho (2011)

To factor these external costs into the production process, some authors have argued in favour of using taxes, policy and technology with the aim of mitigating climate change. CO_2 reduction can come in the form of investing in more efficient and cleaner forms of transportation, energy, and industry, as well as by slowing population growth and investing in reforestation projects (Flavin, 1990; Stern, 2007). Such investment, however, requires a large amount of capital. Flavin (1990), Lépissier and Barder (2014), along with Mathur and Morris (2014) suggest that a carbon tax could potentially fund these investments. Using carbon tax revenue to fund green investment and support those most burdened is referred to in the literature as tax recycling (Parry, 2004; Vale, 2016). During the 1990s, taxes and direct regulation (command-and-control approach) were the economic instruments of choice amongst policy makers across most of the world, especially in Europe, to mitigate climate change (Spash, 2010). More recent economic literature has been in favour of cap-and-trade policy alongside a command-and-control approach to abating climate change (Spash, 2010; Stern, 2007; Tietenberg and Lewis, 2014).

Some authors suggest that, although climate change requires a global response, any target reductions in emissions should be predominantly restricted to industrialised countries, with limited emission reduction targets in developing countries, essentially allowing developing countries to advance their industrial output at the same time (Flavin, 1990; Stern, 2007).

3.2. The Stern Review

Renowned economist, Professor Sir Nicholas Stern, conducted a review of the economic implications of climate change (Stern, 2007). Stern (2007) suggested three key areas to shape climate change mitigation policy to create an effective global response: carbon should be priced efficiently by using modern environmental economic theory, such as by using a Pigovian tax equivalent to the marginal social cost of production, allocating property rights and allowing the trading of permits/allowances (cap-and-trade policy) in line with Coase's (1981) theorem, and direct regulation (a command and control approach). Emissions trading plays a key role in pricing efficiency. Second, green technology should be implemented and innovation in this sector should be encouraged through policy. Finally, barriers opposing energy efficiency should be removed and policy should implement education programs, educating individuals about climate change and mitigation strategies (Stern, 2007).

Stern (2007) considered the notion that future growth in emissions would most likely be sourced in developing countries associated with economic growth and development, thus, global policy needs to take this into account. Developing countries should not be expected to restrict emissions to the point where economic growth is limited. However, Stern (2007) noted that averting climate change should not be considered a trade-off to growth and development. Stern (2007) argued that the aversion of climate change will promote low-carbon based technology and goods and services, fuelling these markets and, thus, promoting employment and growth in the sector. Stern (2007) suggested that policy should be implemented to reduce emissions sharply in the short-run. Stern (2007) found that the economic costs of inaction against climate change will cost global gross domestic product (GDP) at least 5% each year to perpetuity (more than 20% if a wider range of impacts and risks are factored in). The costs of action against climate change, on the other hand, could be limited to as low as 1% of global GDP (Stern, 2007). Stern (2007) thus found that the economic cost of not addressing the pressing issue of climate change far outweighed the benefits of a strong and timeous response. Many uncertainties were present in Stern's (2007) economic models, however. Per Stern (2006), these included multiple jurisdictions, long-term horizons, issues on how to represent future generations, and the global magnitude of the problem.

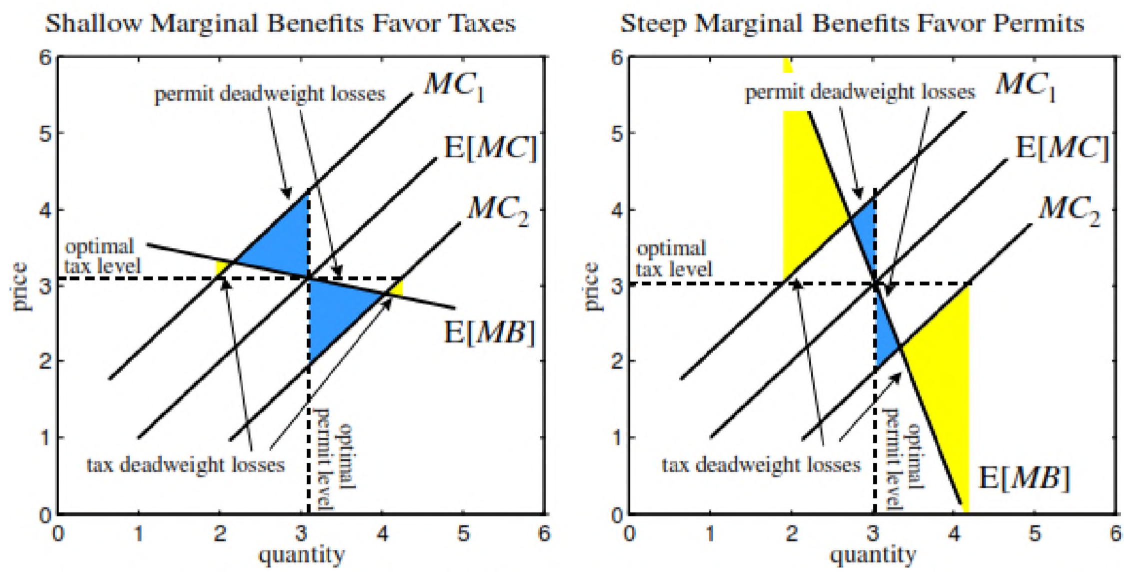
Stern's (2007) review has been criticised for the use a discount rate that was unjustifiably low (Vale, 2016). A low discount rate values future generations more so than the present generation. Using an infinite timescale, a low discount rate almost nullifies the needs of the present generation (Vale, 2016). Stern (2007) arrived at an unusually low interest rate of 1.4% for discounting future consumption as opposed to the more widely accepted rate of 6% (Cole, 2008). The discrepancy in discount rates inflates future damages by as much as two orders of magnitude. Cole (2008) emphasises that, should Stern (2007) have used a discount rate of 3%, the estimated damages would have been significantly lower, at between 10 and 20% of the estimates published in Stern (2007). Nonetheless, a lower discount rate may be justified on moral grounds, placing a larger emphasis on future generations, along with the fact that there are structural uncertainties associated with climate change damage estimates (Cole, 2008).

3.3. Carbon Tax

A carbon tax involves combating climate change by means of placing a per-unit tax on all greenhouse gas emitting sources (Tietenberg and Lewis, 2014). The notion behind a carbon tax is to financially encourage changes in consumer decisions by altering the structure of the economy as well as by incentivising efficient energy use (Benavente, 2016). This form of policy thus sets a price on emissions and forces the quantity emitted to be adjusted (Lépissier and Barder, 2014). This provides polluting firms with an incentive to adopt environmentally friendly technologies, as well as generates revenue for authorities (Tietenberg and Lewis, 2014). However, carbon taxes do have significant economic impacts. At the national level, carbon taxes can affect GDP, international competitiveness, and net exports. At the firm level, carbon taxes can also have significant economic impacts (Kuo *et al.*, 2016). Carefully designed policy can result in enterprise advantages, as they may prompt improved production efficiency and innovative responses (Kuo *et al.*, 2016). On the other hand, badly priced carbon taxes may prompt enterprises to pay the tax rather than reduce their emissions (Kuo *et al.*, 2016).

Although a carbon tax is a relatively simple economic tool to use to combat climate change, Tietenberg and Lewis (2014) point out several shortcomings: if the taxation authority is an international organisation, as Flavin (1990) suggests, this syphons revenue out of national economies and private firms, thus, firms and national governments would most likely lobby against such legislation; and leakage may occur as firms may attempt to pass the financial burden onto consumers. Additionally, Kolstad (2000) points out that a uniform carbon tax is inefficient since it is based on equalised expected control costs of pollution across all firms. However, different firms have different marginal costs of abatement resulting in a deadweight loss associated with such a tax. This can be explained by the fact that firms pollute up until the point where their marginal costs of pollution are equal to their marginal benefits from pollution, therefore, different firms will have different optimal tax levels (Kolstad, 2000; Lépissier and Barder, 2014; Tietenberg and Lewis, 2014). Weitzman (2013) argues that a carbon tax should be used in cases where the efficient price of carbon emissions is known, but total emissions are uncertain.

In 1920, economist A.C. Pigou proposed that, to internalise negative externalities, a per unit tax should be placed on each unit of output, equal to the marginal external cost (Hackett, 2011). This is more commonly known as a Pigouvian tax. However, this is not a practical solution, as determining marginal external costs with precision is a difficult task (Hackett, 2011). An optimal carbon tax level should be set at the point where the equalised marginal costs (expected marginal costs function, E[MC], in figure 4) are equal to the equalised marginal benefits (expected marginal benefits function, E[MB], in figure 4) across the industry, illustrated in figure 4 as the ‘optimal tax level’, to minimise the resulting deadweight loss (Kolstad, 2000; Lépissier and Barder, 2014; Tietenberg and Lewis, 2014). Figure 4 highlights the resulting deadweight loss from a carbon tax in yellow. Lépissier and Barder (2014) along with Pizer (1997) argue that a carbon tax will be favoured if the marginal cost of abating emissions far exceeds that of the marginal benefit of abatement. In



[a] E[MB] indicates expected marginal benefits, E[MC] indicates expected marginal costs, and MC_1 and MC_2 indicate alternative cost outcomes.

this case, the slope of the marginal benefit function is relatively shallow compared to the slope of the marginal cost function, minimising the deadweight loss associated with the tax, as shown in figure 4 under the heading 'Shallow Marginal Benefits Favor Taxes'.

Figure 4. The economic impact of a uniform carbon tax vs a permit system.

Source: Pizer (1997)

Karp and Zhang (2012) investigated the firm's decision making process when a carbon tax or quota is imposed on them. Karp and Zhang (2012) found that firms will also consider future abatement costs when making investment decisions, thus, policy announcements on future policy changes should be made by policy makers well in advance to influence current investment decisions. Given the fluid nature of tax rates over time, a carbon tax may not be 'information-constrained efficient' (Karp and Zhang, 2012). Karp and Zhang (2012) suggest that, given the fact that climate change is caused by the accumulation of greenhouse gases over time, a tax is not favourable as it does not allow emissions to be optimally allocated over time.

In practice, carbon taxes have had mixed results (Kuo *et al.*, 2016). For example, Benavente (2016) use a static computable general equilibrium model to assess the economic impact of a carbon tax in Chile which aims to reduce their GHGEs by 20% below their business as usual projection by the year 2020. Benavente (2016) estimates that a carbon tax will have a slightly negative effect on Chile's gross domestic product (GDP) of about 2%. Additionally, Benavente (2016) estimates that a carbon tax imposed on households will have no significant impact on total abatement, as the household sector in Chile represents only a small proportion of total emissions (6%) and, because the household sector does not have the same ability to switch between fuels as producers do. A carbon tax imposed on both households and producers will, thus, have an unnecessarily negative effect on GDP. Benavente (2016) thus recommends that a carbon tax of about US$26 should be placed on producers only to attain Chile's goal of reducing GHGEs by 20%. In this case, a carbon tax placed on producers only seems to be an effective method to reduce GHGEs, at a relatively small cost to GDP.

In another example, Australia implemented a carbon tax on the 1 July 2012, covering a wide array of emitters and GHGEs (Robson, 2014). In contrast to theory, Robson (2014: 35) states that, '(t)he main effect of Australia's carbon tax has been to significantly increase electricity prices for households and businesses, with no reduction in CO_2 emissions.' Additionally, Robson (2014) points out that the carbon tax will likely have a negative effect on Australia's

GDP for every year that it is in place. Robson (2014) attributes the failure of the carbon tax in achieving its objectives to the setting of the tax at an inefficient price level and a lack of consideration for alternative methods in dealing with climate change. These alternatives include considering adaptation to climate change and a direct command-and-control approach. The Australian government abolished the carbon tax in July of 2014 (Chan, 2015).

Although Robson (2014) argues that Australia's carbon tax was largely a failure, Chan (2015) disagrees. Chan (2015) argues that the increase in electricity prices was only fractionally attributable to the carbon tax and that the abolishment of the tax will see no deduction in electricity prices in the years to come. Furthermore, Chan (2015) argues that the carbon tax did achieve its goals through the following ways: (1) Australia's total GHGEs dropped by 8.2% during the first two years of the tax being in effect; (2) the revenue raised through the tax was used to fund clean energy and biodiversity protection projects, assist negatively affected households, and energy intensive industries; (3) the tax reduced the quantity of electricity demanded by households and achieved the goal of encouraging consumers to use electricity more efficiently; (4) the Australian economy continued to grow, despite the tax and despite a reduced demand from China for Australia's mining products, a key industry in Australia's economy which was negatively affected by the tax; and (5) the tax made clean energy more profitable by raising the cost of traditional fuels. Chan (2015), thus, argues that the move to abolish the carbon tax was largely politically motivated and argues that it is a myopic approach to economic growth. Australia, one of the world's largest emitters of GHGs per capita, is the only country in the world to retract on their GHGE reduction commitments, despite experiencing climate change in the form of increased summer temperatures and an increased frequency in the associated destructive bush fires (Chan, 2015).

3.4. Command-and-Control

A command-and-control policy entails a centralised system putting an authoritative ban on substances or processes resulting in environmental harm (Kolstad, 2000; Newell and Paterson, 2010). This approach is generally implemented through a legislative permit system, under which, the regulated activity or substance is banned unless a permit is obtained (Yamin, 2012). Uniform standards are set and applied either through technology-based standards or through performance-based standards (Hackett, 2011). Under technology-based standards, authorities set a mandate for the incorporation of certain technologies or equipment in the production processes of targeted polluting firms. Under performance-based standards, authorities mandate uniform emissions standards across all targeted polluting firms but allow the firms leeway as to how to the set targets should be met (Hackett, 2011). The command-and-control system thus allows authorities to predict how much pollution will be emitted in total under such legislation, with a large degree of certainty (Kolstad, 2000). This makes this policy especially useful in market environments where authorities are uncertain as to what degree polluters will react to economic emission reduction incentives.

Yamin (2012) points out several drawbacks with this approach in attaining the goal of economically efficient environmental protection. To list a few, it requires effective monitoring; does not provide much leeway when it comes to implementation; is costly and bureaucratic; does not encourage technological innovation; and it is non-transparent in its approach. Kolstad (2000) points out that the relevant authority requires a substantial amount of information to make economically efficient legislation. This results in enormous information costs and can result in possible information asymmetry, as polluting firms are incentivised to distort the information that they provide to authorities. In most cases, authorities are acting on largely incomplete information, leading to serious inefficiencies. Additionally, Kolstad (2000: 141) points out that this system is almost inherently economically inefficient, as it is, 'almost impossible for authorities to ensure that the marginal costs of pollution control are equalised among different polluters generating the same pollution.' Nonetheless, Tietenberg and Lewis (2016) point out that, depending on local circumstances, command-and-control policy may prove to be cost effective to a large degree.

Command-and-control policy has had success and failure in different economies. For example, the command-and-control approach was prominently used by the former Soviet Union to manage its economy on all fronts but failed, as the policy proved to be too burdensome (Kolstad, 2000). In Germany, however, the application of command-and-control policy in reducing sulphur dioxide (SO_2) emissions proved to be economically efficient (Tietenberg and Lewis, 2016). German authorities set stringent deadlines for polluting firms to comply with performance-based uniform standards regarding SO_2 emissions. The only way to comply with the stringent standards was for polluting firms to install a certain type of desulphurisation technology. The uniformity in technology used meant that polluting firms had an almost uniform marginal cost from the outset. However, the excessive demand for the technology within a narrow time frame drove up the price of the technology, indicating that the policy's temporal inflexibility led to cost inefficiencies (Tietenberg and Lewis, 2016).

3.5. Cap-and-Trade (Permit/Allowance System)

This form of policy entails the capping of emissions at a fixed level and allocating tradable permits amongst polluting firms by a central authority (Lépissier and Barder, 2014; Spash, 2010; Tietenberg and Lewis, 2014). This policy should, thus, be used in cases where the efficient total amount of emissions is known to authorities but the efficient price of these emissions is uncertain (Weitzman, 2013). Since this policy encapsulates attributes of the command-and-control approach as well as market based efficiency, it can be referred to as, 'a command and control *plus* instrument' (Yamin, 2012: 85). The notion is to build on a command-and-control policy by incorporating flexibility, cost-effectiveness, and technological innovation (Yamin, 2012).

In theory, the polluting firms with the highest marginal abatement costs would find it cheaper to buy permits rather than reduce their emissions whilst the polluting firms with the lowest marginal abatement costs would resort to reducing their emissions and selling their excess permits for profit. The market price of the permits would, thus, adjust to make these actions economically efficient, based on the principle of arbitrage (Spash, 2010). This approach merges the 'polluter pays' principle encapsulated in carbon tax theory with the command-and-control approach to create an economically efficient approach to climate change mitigation, in theory (Spash, 2010). Permits are usually allocated to firms either free of charge based on their respective prior emissions, known commonly as 'grandfathering', or by means of an auction held by the permitting authority (Clò, 2010; Parry, 2004).

The biggest advantage of a cap-and-trade permitting system is that it is extremely cost-effective. A permitting authority simply needs to allocate the permits and allow the market to allocate the efficient number of permits amongst polluting firms (Karp and Zhang, 2012). No knowledge about firm control costs are required (Tietenberg and Lewis, 2014). Additionally, given the asymmetrical information regarding abatement costs that exist between firms and authorities, quota systems allow firms' investment policy to be information-constrained efficient (Karp and Zhang, 2012).

There are some problems with this system, however. Kolstad (2000) points out the following: (1) the initial allocation dilemma: although the initial method of allocation does not affect market efficiency, it does create the potential to transfer wealth from polluting firms to authorities, which will most likely cause polluting firms to lobby against the legislation; (2) a dominant polluting firm manipulating permit prices: if a dominant firm is initially allocated either too little or too few permits, that firm will have incentive to drive permit prices beyond the efficient level; (3) market thinness: few firms in the market for permits results in infrequent or non-existent transactions which promotes anticompetitive behaviour, as new entrants may be forced out by existing firms withholding permits; and (4) transaction costs: these may drive permit prices beyond their efficient level (these include search and information costs, bargaining and decision-making costs, and monitoring and enforcement costs). Additionally, Andrew (2008) points out that cap-and-trade systems are characteristically more exposed to fraud and evasion compared to a carbon tax.

Spash (2010) argues that initial permit allocations may affect the pollution control function of a firm, influencing technological innovation and change. Based on Thaler's (1980) endowment effect, firms are more likely to stick with their initial permit allocation rather than to actively trade, which implies that equity and efficiency are interlinked (Spash, 2010). Furthermore, true abatement costs are open to contestation, as, 'control costs themselves can involve all the same aspects that typically fall under benefit assessment' (Spash, 2010: 175).

Referring to figure 4, Lépissier and Barder (2014) along with Pizer (1997) argue that a permit system will be favoured if the firm's marginal benefit of abating emissions far exceeds that of the marginal cost of abatement. In this case, the slope of the marginal benefit function is relatively steep compared to the slope of the marginal cost function, minimising the deadweight loss associated with the permit system, as shown in figure 4 under the heading 'Steep Marginal Benefits Favor Permits.' The resulting deadweight loss associated with the permit system is highlighted in blue in figure 4. The deadweight loss arises because of an error in permit allocations due to uncertainty underlying the optimal capping point of emissions (Lépissier and Barder, 2014).

In the case where emission allowances can fluctuate inter-temporally, the price will fluctuate accordingly, resulting in a price in early periods that is either higher or lower than the social optimum, resulting in abatement efforts that are either sub-optimally too fast or too slow, respectively (Holt and Shobe, 2016). This increases the costs of fulfilling emission reduction targets and calls for a regularity environment to improve the market performance of permits (Holt and Shobe, 2016).

The world's first large-scale cap-and-trade emissions trading scheme (ETS) was instigated by the European Union (EU) with the aim of meeting their Kyoto target and, additionally, to meet the European set target of reducing their GHGEs to 20% below that of their relevant 1990 levels, by the year 2020 (Trotignon, 2012). The scheme, known as the European Union Emissions Trading Scheme (EU ETS), is the largest carbon pricing regime in the world, covering roughly 40% of EU GHGEs and extending across 31 European states (Schmalensee and Stavins, 2015; Thompson Reuters Eikon, 2016). The scheme regulates 11 500 emitters, mostly covering electricity producers and large industrial sources. The scheme has been implemented in three phases. Phase I was implemented as a pilot phase between the years 2005-2007; phase II was implemented to meet the EU's Kyoto target between the years 2008-2012; and phase III was implemented to meet the European set target between the years 2013 to 2020, currently still in effect (Schmalensee and Stavins, 2015; Trotignon, 2012). Each phase involves the allocation of permits based on a set cap of emissions to meet emission reduction targets (Trotignon, 2012).

Initially, the EU ETS had a decentralised allocation system in which member states could allocate their own national cap, at the discretion of the European Commission, which gave member states incentive to over-estimate their allocation. This caused an excess number of permits to be administered in phase I which drove prices and activity down substantially in the spot market for these instruments (Schmalensee and Stavins, 2015). Although, Schmalensee and Stavins (2015) point out that forward markets can remain active in the absence of scarcity, such as in southern California's Regional Clean Air Incentives Market (RECLAIM). The spot market can be defined as, 'the markets for debt and equity instruments which are settled as soon as possible' (Faure, 2015: 10). Forward markets, on the other hand, can be defined as a derivative contract 'between a buyer and a seller that obliges the seller to deliver, and the buyer to accept delivery of, an agreed quantity and quality of an asset at a specified price (now) on a stipulated date in the future' (Faure, 2015: 23). Other forms of derivative markets also exist for carbon credits, such as futures and options, depending on the market (Thompson Reuters Eikon, 2016)

The Market Advisory Committee to the California Air Resources Board (2007) point out two other factors which caused permit price volatility during the initial phase of the EU ETS: (1) electricity prices were volatile during that period, and (2) emitters were unable to bank emission allowances for future use. The second phase of the program saw the introduction of additional member states and a tightening of the cap as well as banking being introduced; however, permit prices fell once again. This can be attributed to the onset of the 2008/2009 financial crisis, labelled by some authors as the 'Great Recession' (Grusky *et al.*, 2011). Emitters also made excessive use of the option to offset their emissions during this period, through the Clean Development Mechanism of the Kyoto Protocol, causing demand for permits to wither and, consequently, prices to fall (Schmalensee and Stavins, 2015; Trotignon, 2012).

The third phase of the EU ETS saw the following improvements: (1) a more stringent, centrally determined cap being introduced; (2) a greater proportion of emission allowances set to be auctioned, whereas the previous phases allowed most permits to be allocated freely, based on historical levels; (3) more stringent restrictions regarding the use of offsets; and (4) the unlimited use of banking of permits (Schmalensee and Stavins, 2015). Nonetheless, permit prices remained low, raising concerns regarding the sluggish pace of the Europe's economic recovery following the 2008/2009 financial crisis (Löfgren *et al.*, 2015; Schmalensee and Stavins, 2015).

Another interesting example of a cap-and-trade scheme in practice is California and Quebec's ETS, developed by the California Air Resources Board, which was linked to Quebec's ETS in January 2014 (Borenstein *et al.*, 2014; Schmalensee and Stavins, 2015). Interestingly, the scheme combines the use of a reservation price during the auctioning of permits, essentially establishing a price floor for permits, with the use of a soft price ceiling for permits, known as the emission allowance price containment reserve mechanism (Borenstein *et al.*, 2014). The price floor attempts to prevent an over allocation of permits, as unsold permits are 'held until the reservation price is exceeded for six consecutive months' (Schmalensee and Stavins, 2015: 12). If the auction price escalates above the specified price ceiling, additional permits are released into the market from a reserve. The combination of a price floor and price ceiling establishes a price collar (Faure, 2015; Schmalensee and Stavins, 2015). In the case of a cap-and-trade scheme, a price collar essentially transforms the scheme into a hybrid between a cap-and-trade system and a carbon tax (Schmalensee and Stavins, 2015). Schmalensee and

Stavins (2015) note this as being advantageous as it reduces price volatility by creating a stable price for permits. This proves useful during changing economic conditions, which could otherwise lead to excessive permit prices or render a cap non-binding. However, Borenstein *et al.* (2014) note that a price collar can only be effective in a cap-and-trade scheme if the choice of price floors and ceilings are relevant price levels to the market at hand.

Holt and Shobe (2016) conducted economic laboratory experiments to determine the price trajectory of emission permits based on the EU ETS. Financially motivated participants were faced with random firm-specific and market-based structural shocks and observed. Interestingly, Holt and Shobe (2016) observed that a price collar smoothed the price trajectory in both the short and long-term horizons, despite the collar rarely being binding. Holt and Shobe (2016) suggest that a collar may lessen the price risk of the futures being traded by providing a value signal or by signalling to the market a commitment to the policy. Since the futures market consists of standardised forward contracts (Faure, 2015), the futures market, in this case, would consist of standardised forward contracts for emission permits. This smoothing suggests that collars can create stability in cap-and-trade scheme futures markets, even if they are non-binding (Holt and Shobe, 2016).

Although the mandate to reduce GHGEs has largely been put into effect by developed countries, some developing countries have also adopted a market-based approach to mitigating GHGEs. For example, the world's biggest developing economy and the world's highest CO_2 emitter, China, has recently put in place a cap-and-trade ETS (Jiang *et al.*, 2016). Initially, a regional cap was put into effect in seven provinces and cities between the years 2013 and 2014 as a pilot phase. The scheme was a success and second only to the EU ETS in size (Jiang *et al.*, 2016). The success of the pilot phase has led China's National Development and Reform Commission to put into effect a nationwide cap-and-trade ETS. China's national ETS may play a pivotal role in mitigating global climate change as well as in boosting global carbon trading (Jiang *et al.*, 2016).

Newell *et al.* (2013) list the following significant additional regional, national, and subnational markets to the CDM which have also emerged: The Regional Greenhouse Gas Initiative (RGGI), which exists in the north-eastern part of the United States of America

(USA), the New Zealand Emissions Trading Scheme, the Australian ETS, and the South Korean ETS.

3.6. The Kyoto Protocol Revisited

Through a cooperative agreement, the Kyoto Protocol took into consideration contemporary environmental economic theory when authorising three implementation mechanisms, namely: The Clean Development Mechanism (CDM); Joint Implementation (JI); and Emissions Trading (ET) (Tietenberg and Lewis, 2014). Under the CDM, industrialised signatories of the Kyoto Protocol with emission reduction targets, 'Annex B' countries, can finance emission reduction projects in non-Annex B countries in exchange for CER credits for each tonne of emissions avoided, which can then be traded or used towards their own reduction targets (Kibwami and Tutesigensi, 2016; Lema and Lema, 2016; Tietenberg and Lewis, 2014).

The objectives of the CDM are twofold: to promote sustainable development in developing signatory countries through investment and to offset emissions from developed signatory countries (Kibwami and Tutesigensi, 2016; Lema and Lema, 2016). Emission reduction projects can take the form of carbon sequestration, e.g. afforestation and restoration projects, green technology transfers, and renewable energy projects amongst others (Katircioglu *et al.*, 2016; Kibwami and Tutesigensi, 2016).

Similarly, the JI mechanism allows Annex B countries to finance emission reduction projects in another Annex B country in exchange for CER credits, rather than reduce emissions domestically to reach their emission reduction targets (Tietenberg and Lewis, 2014; UNFCCC, 2016). This allows more flexibility and a more cost-efficient means of fulfilling their emission reduction targets as well as promoting green technology transfers and foreign investment, essentially creating an enabling environment for sustainable development (UNFCCC, 2016).

Under the ET mechanism, signatories to the Protocol are assigned emission quotas based on reduction targets and emission history (Tietenberg and Lewis, 2014; UNFCCC, 2016). The ET framework is based on a cap-and-trade system, allowing signatories to trade emission credits with one another (Schmalensee and Stavins, 2015; Tietenberg and Lewis, 2014; UNFCCC, 2016). For example, a signatory with excess emission capacity may sell emission credits to a signatory with deficit capacity. A formal international market was thus established (UNFCCC, 2016). Since most emissions are in the form of CO_2, emission credits are more commonly referred to as 'carbon credits' and, since these credits are tracked and traded on a formal exchange just like any other commodity, the international market is more commonly referred to as the 'carbon market' (UNFCCC, 2016). Even though the total number of international credits are capped internationally based on these assigned quotas, signatories may create more credits through the JI mechanism and the CDM (UNFCCC, 2016).

Several issues with the Protocol have been noted, however. Kolstad (2000) points out that, given the additional emission allowances in developing countries, developing countries are incentivised to specialise in carbon-intensive activities and export the resulting goods to signatory developed countries, resulting in a 'carbon leakage'. Rosen (2015) points out several other issues with Protocol, including an inadequate time frame for signatories to develop green technology and the fact that the Protocol did not endorse a bottom-up approach which would have allowed state, sub-state, and non-state actors to experiment with and formulate innovative policies.

The Kyoto Protocol took a top-down, global approach to limiting each signatory nation's emissions (Weitzman, 2013). The notion behind the Protocol was to encourage signatories to create a comprehensive, binding system of national emissions caps, based on largely incomplete emission assignments. Placing these comprehensive national emission caps on an international free market would have, thus, created an efficient worldwide, uniform market price for emissions (Weitzman, 2013). Unfortunately, the Protocol did not meet this goal and has resulted in 'a highly non-optimal patchwork of sporadic regional volunteerism that does not address centrally how to correct the critical externality of global warming' (Weitzman, 2013: 3). Weitzman (2013) attributes this to the failure amongst sovereign nations to negotiate binding caps amongst themselves and the incentive to free-ride.

In reality, consumers do not always act in their own economic interest, in contrast to theoretical assumptions (Hood and Guelff, 2013). Economic entities may not have enough information available to them regarding mitigation opportunities or are able to make accurate forecasts regarding future carbon prices, or both, and, therefore, may be reluctant to make long-term investments in alternative technologies (Hood and Guelff, 2013). Emission reduction policies, therefore, requires several, often inter-related, policies to be effective (Hood and Guelff, 2013).

3.7. Conclusion

This chapter considered carbon taxes, command-and-control, and the cap-and-trade approach as potential tools to internalise the social cost of greenhouse gas emissions. The Kyoto Protocol was further discussed in relation to the economic instruments used. Table 1 provides a summary of the main advantages and disadvantages of the tools discussed. The following chapter considers local economic development a possible policy response to climate change under the precinct of sustainable development.

Table 1. The main advantages and disadvantage of carbon taxes, command-and-control, and the cap-and-trade approach to internalising the social cost of greenhouse gas emissions

Carbon Regulation Tool	**Main Advantages**	**Main Disadvantages**
Carbon Tax	• Relatively simple to implement • Can encourage improved production efficiency and innovative responses • Generates income for authorities • Most efficient method if the marginal cost of abating emissions far exceeds that of the marginal benefit of abatement • Useful if the efficient total amount of emissions is not known to authorities but the efficient price is known	• Can negatively affect GDP, international competitiveness, and net exports • Requires careful planning to get the price at an efficient level • Different firms will have different optimal tax levels • Does not allow emissions to be optimally allocated over time • Leakage can occur as firms can attempt to pass the financial burden onto consumers
Command-and-Control	• Allows authorities to predict how much pollution will be emitted in total with a large degree of certainty • Useful in market environments where authorities are uncertain as to what degree polluters will react to economic emission reduction incentives	• Offers little leeway when it comes to implementation • Requires effective monitoring • Requires a substantial amount of information which can lead to information asymmetry • Costly and bureaucratic • Does not encourage technological innovation • Non-transparent in its approach • Almost inherently economically inefficient
Cap-and-Trade (Permit/Allowance System)	• Useful if the efficient total amount of emissions is known to authorities but the efficient price of these emissions is uncertain • Incorporates flexibility, cost-effectiveness, and market based efficiency • Encourages technological innovation • No knowledge about firm control	• Initial permit allocation dilemma • Dominant polluting firms can drive permit prices beyond the efficient level • Possible market thinness can result which would promote anticompetitive behaviour • Transaction costs can

	costs are required • Most efficient method if the firm's marginal benefit of abating emissions far exceeds that of the marginal cost of abatement	drive permit prices beyond their efficient level • More exposed to fraud and evasion relative to a carbon tax

Source: Own data based on literature review

Chapter 4. Local Economic Development (LED)

4.1. Introduction

Stringer *et al.* (2009) note that linkages between development and responses to climate change have been found in the literature (African Development Bank *et al.*, 2003; Giannini *et al.*, 2008; Schipper, 2007; Twomlowet *et al.*, 2008; Yohe *et al.*, 2007). Katircioglu *et al.* (2016) argue that projects under the Kyoto Protocol's CDM have the potential to generate economic, social, and environmental benefits in developing countries. These projects, thus, have the potential to enable sustainable development, defined by Connelly (2007) as being development that occurs within the constraining bounds of each broad sphere of concern (the environment, the economy and society), whilst at the same time advancing all three.

At the local level, carbon credit restoration projects in the Eastern Cape using *P. afra* have the potential to foster community participation, capacity building, public-private partnerships, and job creation, thus, offering potential for local economic development (Furniss, Cowling and Mills, 2014). This half-thesis investigates whether carbon credit projects can be used as a tool to promote development in impoverished regions at the local level and facilitate a bottom-up adaptation strategy to climate change, as Stringer *et al.* (2009) suggests.

4.2. Defining Sustainable LED

The term 'development' has been incorporated into society and political agendas without a prior grounded definition of the term being established (Rist, 2007). Rist (2007) describes development as being a 'buzzword' used generally to create optimism surrounding the idea of improving people's lives in some way. It has become a part of the 'natural world order', being desirable and just, and often accepted with erroneous understanding (Rist, 2007: 486). The concept of development extends beyond just economic growth and plays an integral role in contemporary society (Rist, 2007; The World Bank, N.D.). As Slim (1995: 144) states, 'development is not just about having more, but also about being more.' Economic growth alone provides no indication about how the additional wealth is allocated amongst a given population (The World Bank, N.D.). Economic growth alone thus ignores the social equity element of development.

Rist (2007: 488) offers the following definition of development, '…the essence of 'development' is the general transformation and destruction of the natural environment and of social relations in order to increase the production of commodities (goods and services) geared, by means of market exchange, to effective demand.' Rist (2007) argues the destructive element of development on the following grounds: destruction is the reverse side of production and production is an integral component of development. Since all production processes involve pollution of some kind (the reverse side of production), there is a destructive element within the environment in which development occurs. Social bonds are jeopardised in some sense through the development process as well. Goods and services previously considered to be intimate and personal, supposedly beyond the realm of the market, are formally integrated into the market through the development process. In most cases, this destructive aspect refers to human beings essentially being turned into resources and integrated into the market. Rist (2007), thus, highlights three key components to development: an environmental component, an economic component, and a social component.

Although Rist (2007) argues that the concept of sustainable development is an oxymoron, as development cannot occur without destruction, Connelly (2007) along with the World Bank (N.D.) argue that development can be sustainable. Connelly (2007) argues that development projects can be sustainable so long as they take into consideration at least some factors from each of the following spheres of concern: environmental protection, economic growth, and social justice. Development projects may have a focus on one sphere but, so long as at least some of the factors from each of the other two spheres of concern are considered and incorporated, the development project may remain sustainable. Nonetheless, sustainable development is a contested concept with a large amount of ambiguity surrounding the core meaning (Connelly, 2007). Connelly (2007) maps the concept through visual representation. Figure 5 attempts to encapsulate the concept of sustainable development.

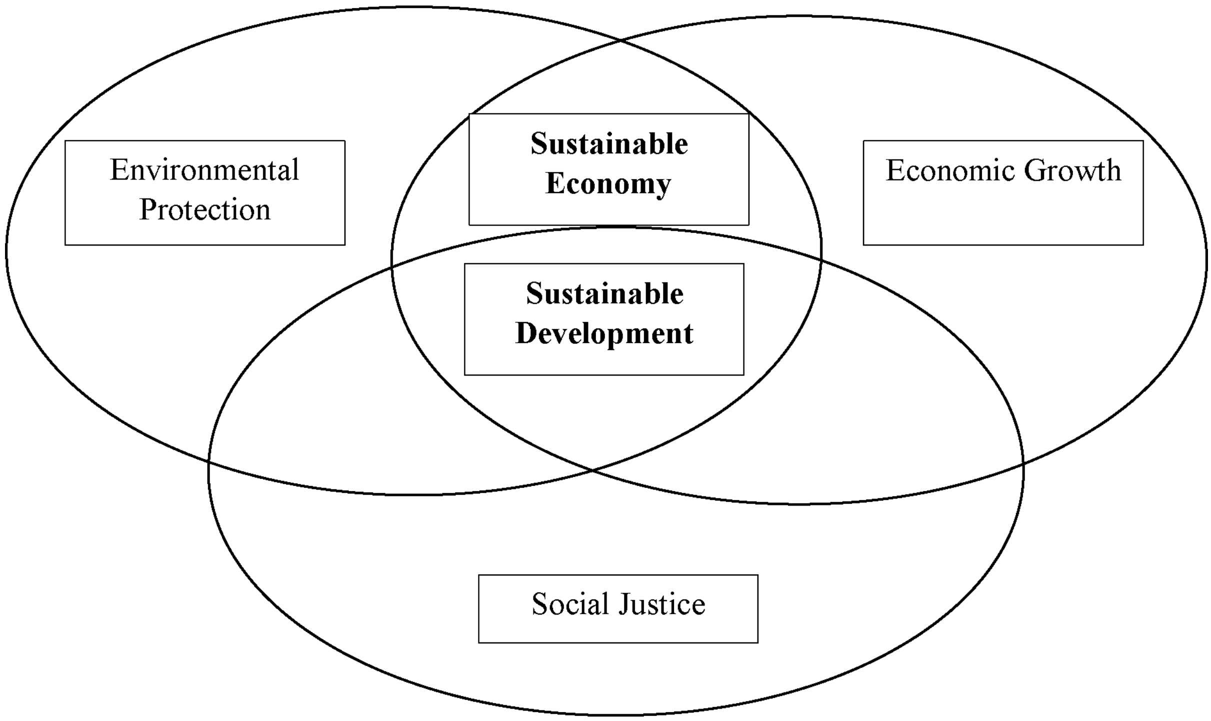


Figure 5. A visual representation of sustainable development
Source: Adapted from Connelly (2007: 264)

Connelly (2007) points out that sustainable development lies somewhere at the centre where the three spheres (social justice, economic growth, and environmental protection) converge, as shown in figure 5. Given the fact that the centre is 'blurred', 'weak' and 'strong' forms of sustainable development exist, depending on the degree to which each aspect is accounted for during the development process (Connelly, 2007). 'Strong' forms of sustainable development prioritise both environmental protection and social justice, whereas 'weak' forms consider only environmental constraints or social equity, the traditional development debate (Connelly, 2007). Connelly (2007) further points out that the goal of achieving sustainability lies in the process rather than in an end-based goal.

LED is also open to multiple interpretations and contestation (Akudugu and Laube, 2013). Akudugu and Laube, (2013: 4) offer the following definition: 'an approach to local development that seeks to mobilize actors and resources to initiate actions jointly that will stimulate the local economy and make it competitive.' Sustainable LED would thus involve more than just enhanced economic activity and job creation. It would involve the advancement and consideration of each of the three spheres of development during the development process, namely environmental protection, economic growth, and social justice (Polak and Snowball, 2016).

4.3. The Evolution of LED Theory

The origin of LED can be traced as far back as the 1930s (Akudugu and Laube, 2013). LED gained popularity amidst the pressing need to create job opportunities beyond the traditional manufacturing sector during the Great Depression. LED originated in Western Europe and North America, the countries most affected by the Great Depression (Akudugu and Laube, 2013). Given that the world economy is becoming increasingly globalised and more competitive, there is an increasing need for communities to make themselves more visible and competitive (Akudugu and Laube, 2013). LED has, thus, been gaining popularity as a regional or territorial alternative or complimentary development strategy in the developing world (Akudugu and Laube, 2013). As Blakely and Leigh (2010: 1) note, when it comes to development, 'cities, towns, countries and all local entities in a global economy have the challenge and opportunity of crafting their own economic destinies.' Regions need to position themselves in such a way that they attract a portion of the fluid capital circulating through the increasingly globalised world economy (Akudugu and Laube, 2013).

Over the past four decades, LED theory has been adapted to fit the changing consensus surrounding the correct implementation of the theory (Raco, 2000). Akudugu and Laube (2013) note that, because of the popularity of LED amongst development agencies, the discourse on LED has been dominated by international development agencies. The dichotomy in the discourse lay prominently in the debate between which is more effective, top-down implementation versus a bottom-up implementation (Raco, 2000).

It was during the 1970s that municipalities began to realise the importance of capturing investment from the global economy and incorporated LED into their policies (Akudugu and Laube, 2013). During that same decade, community participation in the development process remained at the focal point of LED and so democratic processes were incorporated into the strategy and process behind LED projects (Raco, 2000). Prior to the 1980s, Keynesian policies were also incorporated into the development process (Amin, 1999). This involved policy making revolving around social welfare policies that aimed to stimulate aggregate demand that would, in turn, stimulate economic growth, as well as income redistribution policies. It also involved the implementation of state incentives for firms to set up infrastructure in regions targeted for LED (Amin, 1999).

Keynesian economic theory gave way to neoliberal economic theory during the 1980s, which led to the endorsement of neoliberal economic policies, notably in Africa (Amin, 1999; Akudugu and Laube, 2013). Neoliberal economic policies involved the deregulation of markets, notably capital and labour markets, under the notion that this would enable entrepreneurism (Amin, 1999). Akudugu and Laube (2013) argue that this deregulation served as the 'fertile ground' on which LED intervention could thrive, particularly through private sector development. During this decade, LED theory reverted to non-participatory policies (Raco, 2000). Raco (2000: 574) notes that, at the time, the consensus was that communities were viewed as 'the bastions of local vested interests over whom authority and policy should be wielded from above.' This resonates with the endorsement of an institutionalist, top-down approach to development, which was the consensus at the time (Akudugu and Laube, 2013). This institutionalist, top-down approach was incorporated into LED policy making (Raco, 2000). For example, urban development corporations were establishment by local governments (Raco, 2000). The institutionalist consensus was that regional development policy should be firm-centred, standardised, incentive based and state-driven (Amin, 1999). Per Amin (1999) and Helmsing (2003), the incorporation of institutionalist and neoliberal ideology into LED policy led to failure, more so than under the Keynesian era. As Helmsing (2003: 67) points out, LED is a multifaceted process and 'getting the prices right is not enough.'

The institutionalist approach to development postulates that a universal, top-down approach can be implemented in all regions and successfully result in development (Amin, 1999). The institutionalist approach, thus, argues that institutions play a major role in facilitating economic development by establishing rules, norms, and enforcement mechanisms (Alston *et al.*, 2014). The basis for this approach is the assumption that economic success can be attributed to a fixed set of common factors. These factors include the following: a firm can be viewed as a basic economic unit, individuals behave rationally, and entrepreneurs make profit maximising decisions (Amin, 1999). This resonates with neoclassical economic theory (Howells, 2005). Although the institutionalist approach may have increased income levels and promoted employment in targeted areas, Howells (2005) found that it did not encourage self-sustaining growth, nor mobilise local resources and interdependencies, disturbing the 'natural' development process. Amin (1999) and Howells (2005) argue that this approach may not be appropriate development at the regional level, as regional conditions vary.

The 1990s saw the reintroduction of community participation in LED policy making, through the recognition of the importance of creating partnerships into LED theory (Raco, 2000). The importance of creating partnerships stems from the need to create dialog between and mobilise actors, including institutional and community-based actors, organisations and resources to develop new institutions and local systems, thereby, enabling successful LED (Helmsing, 2003). This idea is reiterated by Akudugu and Laube (2013), who emphasise the need for local actors to cooperate with each other and to support the development process. Partnerships can be viewed as the institutional mechanisms that facilitate and mediate community participation as well as being the basis on which new urban policy initiatives can be built (Raco, 2000). Nonetheless, LED partnerships created during this era were still the result of top-down policy making, despite the consensus reached at the time to move towards a bottom-up approach to LED (Raco, 2000).

Over the past decade or so, the literature has progressively moved towards the endorsement of a bottom-up approach to LED and has highlighted the need to move away from the top-down, institutionalist approach (Akudugu and Laube, 2013; Rogerson, 2010). This movement is accentuated by the failure of the top-down, institutionalist approach in achieving economic growth at the local level (Akudugu and Laube, 2013). This failure can be attributed to the fact that many central states, particularly those in developing countries, simply do not possess the ability to effectively intervene at the local level (Rogerson, 2010). Poverty and poor economic growth have also accentuated the need for locally based initiatives (Rogerson, 2010). LED has, thus, gained prevalence in the developing world as a regional development strategy (Akudugu and Laube, 2013).

Despite the changing consensus revolving around LED theory, the desired outcomes of LED have remained the same. LED aims to alleviate poverty and uplift targeted communities (Rogerson, 2010).

4.4. Key Factors Behind Successful LED

As previously noted, regional conditions vary; therefore, LED strategy should vary from region to region to be effective (Amin, 1999; Howells, 2005). Nonetheless, there are several key factors which permeate the literature, serving as catalysts for effective LED. For example, Rodríguez-Pose and Palavicini-Corona (2013) highlight seven aspects behind effective LED, namely: sustainability; forming and implementing a development plan;

entrepreneurship; participation mechanisms; capacity building; autonomy; and development links. This section seeks to highlight some of these key factors.

Economically, for a development initiative to be rewarding, development needs to take place simultaneously in corresponding sectors, as each economic entity is dependent on another (Helmsing, 2003). Helmsing (2003) illustrates this by using a simple example. If a farmer were to invest in a new cash crop with the intention of introducing it into the local market, whether the initiative is to be successful or not depends on various other economic factors beyond the farmer's control. These may include local market conditions, and whether the finance, packaging, transport, and trade industries are developed sufficiently for the new cash crop to get to market. For example, the farmer's initiative may fail if one or more of the following events take place: the farmer lacks access to sufficient finance; finds that there are too few buyers in the local market; or finds that, either the local transport or packaging industry is underdeveloped. Any of these would create a gridlock in the development process and may render the initial investment worthless. This example highlights the need for collective local economic participation in LED initiatives (Helmsing, 2003). This example also illustrates the supply and demand synthesis and the need to engineer LED projects around an effective demand rather than focus on creating an ineffective supply (Howells, 2005). This ties in with Rist's (2007) definition of development, mentioned above, which stresses the need to transfer goods and services to an effective demand, by means of a functional market exchange.

Collective local economic participation can include the development of supporting infrastructure and services which requires the intervention of local government, at least to some degree. Therefore, local governments play a role in enabling effective LED (Helmsing, 2003). The literature is divided, however, as to what role local governments should play to encourage effective LED. Some argue that local governments should directly intervene in and support LED initiatives, while others advocate an indirect approach by creating an enabling environment in which LED initiatives can prosper (Rogerson, 2010). Given the contemporary consensus favouring a bottom-up approach to LED, contemporary literature tends to favour local governments taking a decentralised role in LED initiatives, with community-based initiatives being at the focal point of LED (Rogerson, 2010). Bek *et al.* (2013) note that successful community-based variants of LED do exist and are often supported by partnerships between communities and non-government organisations (NGOs), or with external donor agencies, or both. These partnerships allow communities to feel a part of LED initiatives taking place within their communities, thereby, promoting regeneration activity and ownership over LED initiatives (Raco, 2000). Nonetheless, power struggles may occur and local governments may use community participation to promote their own agenda, as opposed to a community developed mandate (Raco, 2000). Participation should not be limited to the local community, however. It includes all stakeholders concerned, such as voluntary organisations, universities, cooperatives, development agencies, the private sector, trade unions, amongst others (Rodríguez-Pose and Palavicini-Corona 2013). This brings forth the difficult task of creating support institutions who facilitate the inclusion of all stakeholders and ensure that their individual needs and goals are incorporated into LED mandates (Rodríguez-Pose and Palavicini-Corona 2013).

Another key factor present in the literature is the inclusion of the concept of social capital in the creation of successful LED initiatives (Evans and Syrett, 2007; Pileček *et al.*, 2013). Although social capital is a sociocultural factor rather than an economic factor, it has been shown to affect economic growth, either positively, negatively, or ambiguously (Pileček *et al.*, 2013). Social capital pools together individual human capital which allows civil society to mobilise available resources (Pileček *et al.*, 2013). Flora (2016: 4-5) describes human capital as being, 'the skills and abilities of people to develop and enhance their resources…', and social capital as being, 'the connections among people and organizations or the social glue to make things, positive or negative, happen.' Bonding social capital 'refers to those close ties that build community cohesion' (Flora, 2016: 5). Flora (2016) argues that, when it comes to effective LED, entrepreneurial social capital is preferred, as it encourages the 'local mobilization of resources, and willingness to consider alternative ways of reaching goals' (Flora, 2016: 5). Social capital also involves a component of trust, without which, participation through civic engagement and democracy would prove to be ineffective (Putnum, 1995). Reciprocity norms govern the behaviour in social networks as they encourage co-operation amongst individuals by restraining opportunistic behaviour and reinforcing trust (Pileček *et al.*, 2013).

Within the context of LED, Evans and Syrett (2007: 55) offer the following definition of social capital: 'features of social organisation such as networks and norms which facilitate mutually beneficial co-ordinated action.' Studies have shown that education levels, income, and equality rates all have a positive relationship with the mobilisation of social capital through civic engagement (Pileček *et al.*, 2013). South Africa has high levels of income inequality (Bek *et al.*, 2013) which may hinder the mobilisation of social capital in LED initiatives. The World Bank (2016) estimated South Africa's Gini coefficient to be 0.63 in 2011, placing South Africa amongst the most unequal countries in the world. Reducing inequality along with improving employment and education levels, therefore, should play a role in LED policymaking. Woolcock (1998) argues that social capital issues are often neglected during policymaking in developing and transitional countries. The focus is placed on correcting financial and human capital deficiencies instead of taking advantage of existing social capital which could potentially amplify LED initiatives.

Another key sociocultural factor present in LED literature is capacity building. Capacity building can be defined as, 'the process by which individuals, groups, organisations, institutions and societies increase their abilities to perform core functions, solve problems, define and achieve objectives; and understand and deal with their development needs in a broad context and in a sustainable manner' (Solomon and Ofori, 2014: 206). Capacity building plays an integrative role in LED (Rodríguez-Pose and Palavicini-Corona 2013; Rogerson, 2010). Edwards (2015: 7) argues that, for community-based development initiatives to be successful and sustainable, 'communities must possess or develop the capability for collective action, the internal resources to support the process, and the necessary skills and knowledge to successfully identify local problems and their solutions.' Edwards (2015) goes on to argue that communities who possess more capacity are better able to mobilise resources when tackling local issues, generally have a more consistent shared vision, and are less confined to existing economic and political practices. Developing local capabilities should, thus, be at the core of LED initiatives.

Rodríguez-Pose and Palavicini-Corona (2013) suggest that local capabilities include the ability to create socio-economic systems which encourage individual participation, which properly diagnose the local environment and productive prospects, which can recognise and support economic entities that promote successful businesses, and which can advance public service policy. Capacity building thus involves an element of empowerment and requires supporting institutions (Rodríguez-Pose and Palavicini-Corona 2013). Therefore, a proactive dialogue between the community, the private sector, local government, and LED policy makers is also required to make significant advancements in the improvement of local capabilities (Rogerson, 2010). This dialogue needs to be headed by educated and experienced individuals to create LED strategy which benefits every stakeholder concerned (Rogerson, 2010).

Arguably, if implemented correctly, LED will result in job creation (Bartik, 2003; Rogerson, 2014). Bartik (2003) argues that this adds an element of economic sustainability to LED, as job creation and the expansion of local business results in secondary economic impacts through an expanded tax base. These secondary economic impacts may include an increased government allocation of funds directed towards LED initiatives as well as social security safety nets for the impoverished (Bartik, 2003).

4.5. LED in South Africa

Under South Africa's apartheid era prior to 1994, South African municipalities implemented LED projects that were limited in scope and which were predominantly restricted to the country's largest cities (Rogerson, 2010; Rogerson, 2014). Arguably, this added significantly to the extreme inequality which is currently present in South Africa (Bek *et al.*, 2013).

Post-1994, LED has been advocated as a development strategy in South Africa, with a pro-poor focus (Rogerson, 2010; Rogerson, 2014). The notion behind this is to re-engineer local governments and to reduce inequality in South Africa (Rogerson, 2010). LED is particularly attractive in the South African context, given its potential to promote economic growth, empower individuals, create jobs, aid community-based development, instil economic vitality in impoverished regions, and establish the targeted locality as a vibrant, sustainable economic entity, within a global context (Bek *et al.*, 2013). LED theory is particularly attractive to the South African government because it offers a viable path for economic growth and enterprise development whilst, at the same time, alleviates poverty and empowers previously marginalised communities (Bek *et al.*, 2013). Nel *et al.* (2007: 117) state that, 'in poor areas, where access to natural, social and financial resources is often limited, there is an urgent need for development endeavours that can mobilise indigenous skills and capitalise on the collective strengths of communities.' Given LED's theoretical ability to achieve this, it is best suited for the task.

The mandate for LED has fallen under local governments in South Africa since it was constitutionalised in 1996 (Rogerson, 2014). Several legislative acts followed, instilling a number of key LED functions and responsibilities into local government mandates (Rogerson, 2014). For example, the Local Government Municipal Systems Act, which was legislated in 2000, required many functions of LED to fall under the control of local governments (Rogerson, 2010; Rogerson, 2014). However, it was only in 2006 that local governments were actually allocated a framework which provided a common understanding and the envisioned goals of LED, named the National Framework for Local Economic Development (Rogerson, 2014). Per Rogerson (2010). prior to this affirmation, local governments lacked the capacity to effectively implement LED, as there was an erroneous understanding of LED and the correct implementation thereof amongst local governments.

In general, LED initiatives in South Africa post-1994 have been prone to a large degree of failure, even after a common framework was adopted (Rogerson, 2010; Bek *et al.*, 2013; Nel *et al.*, 2007). Much of this failure can be attributed to the backing of economically infeasible community-based initiatives which, coupled with scarce access to markets (ineffective demand), proved to be unsustainable in the long-run and resulted in no lasting impact on poverty reduction (Bek *et al.*, 2013). Another factor attributed to this failure includes unsuccessful partnerships and cooperation between the local private sector, local government, and the voluntary sector. Bek *et al.* (2013) also note that government-led LED initiatives took a top-down rather than a bottom-up approach to development. This, along with the lack of effective partnerships and cooperation, side-lined non-state actors through the development process and resulted in failure.

4.6. LED and Sustainability

The issue of climate change is transitioning from a global and national issue into a local and regional issue and, as such, should be incorporated into local development strategies (Rogerson, 2016). Bulkeley (2010) and Bulkely and Betsill (2003) argue that the pressing issue of climate change can be seen as an opportunity for localities to reposition themselves as potential destinations for new forms of low-carbon based investments and partnerships. Jonas *et al.* (2010) add that contemporary environmental issues are having an increasingly important impact on the politics and practice of regional and local economic development. In South Africa, there is a growing awareness of the importance of incorporating climate change mitigation into future local development initiatives (Faling *et al.*, 2013; Rogerson, 2016). The importance of sustainable development and environmental protection was enshrined in South Africa's constitution in 1996 (Rogerson, 2016).

Nel *et al.* (2007) have highlighted that there is increased recognition of and demand for economic processes and products which exist in ways that are alternative to mainstream capitalism, termed 'alternative economic spaces.' These include economic processes and products that are deemed 'socially just' and can further be used as tools for LED (Nel *et al.*, 2007: 113; Si and Scott, 2015). Jonas *et al.* (2010) argue that there are important links between carbon control regimes and 'alternative economic spaces' as well as with sustainable development. National carbon control regimes can, thereby, be 'scaled-down' to the local and regional scale by means of territorial carbon control regimes to create an 'alternative economic space', creating potential for sustainable LED (Jonas *et al.*, 2010).

Environmental sustainability issues can also debilitate LED projects. For example, Bek *et al.* (2013) argue that the overharvesting of wildflowers within the Cape Floristic Region of South Africa has led to the endangerment of certain endemic species within the region. Bek *et al.* (2013) thus argue that environmental constraints may render LED initiatives unsustainable and should be considered to promote sustainable LED initiatives.

A major problem pointed out by Ziervogel *et al.* (2014: 614) is that South Africa's municipalities, especially those in remote and economically distressed areas, 'have almost no capacity to act on climate change.' Rogerson (2016), thus, stresses the need for capacity building around climate change in South Africa's local governments. Perhaps carbon credit restoration programs may be able to provide the linkage between the South African government's goal to mitigate climate change and promote LED.

4.7. Conclusion

This chapter has considered some of the key factors behind local economic development as well as highlighted the need to incorporate sustainability into local economic development projects. Local economic development theory was discussed from an evolutionary perspective as well as within the context of South Africa. The following chapter provides an overview of the context of this research.

Chapter 5. Context of the Research

5.1. Introduction

Carbon offset projects were initiated under the CDM with the aim of reducing GHGEs whilst at the same time promoting sustainable development and promoting 'green' investment in developing countries (Kibwami and Tutesigensi, 2016; Lema and Lema, 2016; Tietenberg and Lewis, 2014). These projects entail some form of carbon sequestration, such as afforestation and reforestation, fossil fuel switching, and landscape restoration projects, amongst others (UNEP DTU CDM/JI Pipeline, 2016). As such, a carbon offset can be defined as 'a measurable avoidance, reduction or sequestration of carbon dioxide (CO_2) or other GHG(E)s' (South African National Treasury, 2014: 12).

Carbon offset projects are developed and evaluated under explicit standards and methodologies set out by a specific standard, such as the CDM, to generate CER credits or carbon credits certified by regulatory bodies other than the CDM (South African National Treasury, 2014). Each standard uses idiosyncratic techniques and procedures to ensure the following: (1) that carbon credits are not double counted; (2) are in fact additional measures in terms of capturing and storing CO_2; (3) verified and monitored; (4) synchronised with the time of sale; (5) measured correctly; and (6) are permanent in nature (South African National Treasury, 2014). Following this, credits may then be approved by the regulatory standard as carbon credits and may then be sold on either compliance or voluntary carbon markets, depending on the standard used (South African National Treasury, 2014).

Carbon credit projects have the potential to achieve co-benefits through carbon sequestration, such as benefiting land owners and other stakeholders, contributing to biodiversity conservation, enforcing human rights by empowering communities, and alleviating poverty (Robinson *et al.*, 2016; South African National Treasury, 2014). Carbon credit projects, therefore, may play a pivotal role in enabling sustainable LED.

5.2. South Africa's Contribution to Climate Change

Per international conventions, South Africa is classified as a middle-income developing country and, therefore, is subjected to less international pressure to reduce GHGEs, even though South Africa is the largest GHG emitter in Africa and hosts the second largest economy in Africa (Altieri *et al.*, 2016; Klausbruckner *et al.*, 2016). In 2012, South Africa emitted 462.60 megatonnes of carbon dioxide equivalent emissions ($MtCO_2e$), excluding land-use change and forestry (World Resources Institute, 2016). In per capita terms, this equates to an estimated 8.84 tonnes of CO_2 equivalent emissions (tCO_2e) per person, well above Africa as a whole, which stood at 2.53 tCO_2e per person, and the world as a whole, which stood at 6.36 tCO_2e per person (World Resources Institute, 2016).

South Africa's economic growth has largely been linked to energy-intensive industries, with 79% of GHGEs coming from the energy sector (Altieri *et al.*, 2016). South Africa's heavy reliance on coal for electricity production has led South Africa to attain the status of being one of the most carbon intensive economies in the world (Klausbruckner *et al.*, 2016). The South African economy also exhibits a high degree of low-skilled workers as a result of South Africa's former apartheid system which systematically limited education for the majority race (Altieri *et al.*, 2016). This has led to a contemporary economy comprising largely of low-skilled workers who are reliant on the energy-intensive manufacturing, mining, and energy industries. This makes the switch to a low-carbon intensive economy a difficult task, considering the high prevalence of poverty and unemployment in the country (Altieri *et al.*, 2016; Klausbruckner *et al.*, 2016). The national unemployment rate in South Africa was 26.6% during quarter two of 2016 (Statistics South Africa, 2016).

Figure 6 graphically illustrates South Africa's gross domestic product (GDP) year-on-year percentage change versus the year-on-year percentage change in South Africa's CO_2 emissions for the past fifteen years, in comparison to Brazil, China, and the EU. From a graphical analysis, figure 6 seems to show a weak direct correlation between GDP growth and carbon dioxide emissions in South Africa. This correlation appears to be stronger in Brazil and China, as well as in the EU.

Thomson Reuters Eikon's analytical tool indicates that the correlation coefficients between the GDP year-on-year percentage change and the year-on-year percentage change in CO_2 emissions for each, for the past fifteen years are as follows: South Africa 0.21; China 0.54; Brazil 0.73; and for the EU 0.67 (Thomson Reuters Eikon, 2016). The correlation coefficients provide an indicator as to what extent changes in one variable are reflected in changes in another variable (Creative Research Systems, 2016). The coefficient lies between the values negative 1 and positive 1, where negative 1 indicates a potentially perfect inverse relationship, 0 indicates potentially no relationship, and positive 1 indicates a potentially perfect direct relationship between the two variables (Creative Research Systems, 2016). From these correlation coefficients, there seems to be a positive relationship between GDP growth and CO_2 emissions for the past fifteen years in South Africa, Brazil, China, and the EU, being strongest in Brazil and weakest in South Africa. Although these correlation coefficients suggest that there may be a positive relationship between GDP growth and CO_2 emissions, Stern (2004) argues that the relationship between pollution and income is monotonic. Counter to the post-Brundtland Report consensus that developing countries do not have adequate resources to address environmental issues, Stern (2004) argues that pollution levels may be decreasing in both developed and developing countries over time. However, developing countries may be slower to adopt innovative solutions to environmental degradation (Stern, 2004).

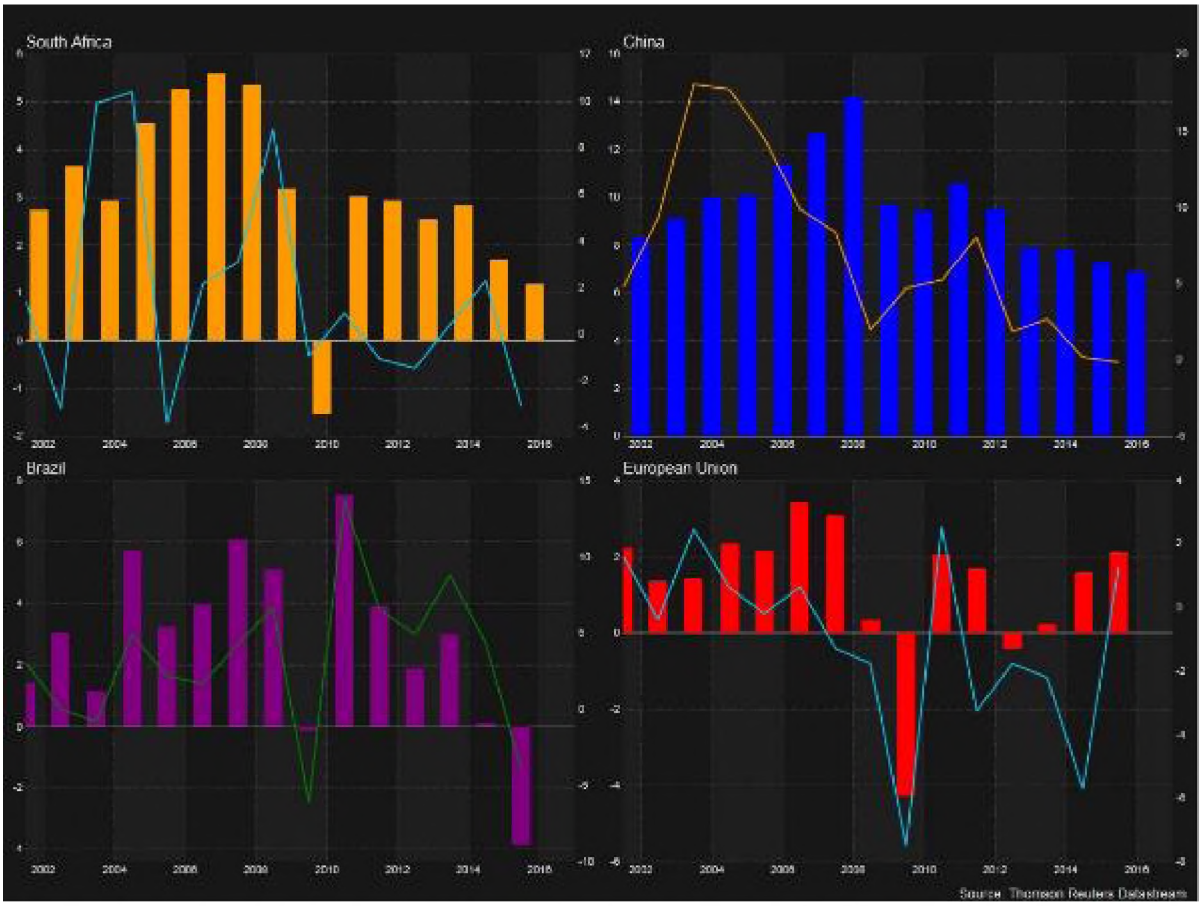


Figure 6. Four pane graph comparing year-on-year carbon dioxide emission changes (line graph) to year-on-year changes in GDP growth (bar graph) for South Africa, China, Brazil, and the European Union between the years 2001 and 2016

Data Source: Thomson Reuters Eikon (2016)

The BRICS nations (Brazil, Russia, India, China, and South Africa), have included the issue of climate change on the BRICS agenda, with the aim of creating a 'green economy strategy' which promotes both sustainability and competitiveness (International Union for Conservation of Nature, 2016). Economic, social, and environmental considerations have, thus, been included in the BRICS agenda (International Union for Conservation of Nature, 2016). The EU has also incorporated climate change with their agenda. For example, in 2014 the European Council endorsed a climate and energy policy framework for 2030, which included a binding GHGE reduction target of 40% compared to 1990 levels (Frank *et al.*, 2016).

5.3. South Africa's Response to Climate Change

Despite little international pressure to reduce GHGEs, South Africa has voluntarily ratified major international treaties regarding climate change. This includes the 1992 United Nations Convention on Climate Change (UNCCC) and the 1997 Kyoto Protocol, and further voluntarily commitments to reduce GHGEs by 34% by 2020 and 42% by 2025, in comparison with the 'Business as Usual' trajectory, at the 15^{th} meeting of the UNFCCC Conference of the Parties in Copenhagen in 2009 (Altieri *et al.*, 2016; Hood and Guelff, 2013; Klausbruckner *et al.*, 2016). The issue of sustainability has also been included in South Africa's National Development Plan (The Presidency, 2014).

In terms of policy responses to climate change, South Africa has introduced several policies to mitigate climate change. Klausbruckner *et al.* (2016) list the following notable policies: a levy of ZAR 2c per kilowatt hour (kWh) on electricity produced from non-renewable sources, introduced in 2009; an environmental levy of ZAR 75 for every gram of CO_2 emissions per kilometre (gCO_2/km), exceeding 120 gCO_2/km, for every new vehicle purchase from 2010 onwards; and additional energy efficiency standards being incorporated into the South African building sector in 2011; as well as the Renewable Energy Feed-In Tariff (REFIT) which promotes the use of renewable resources in energy production. Perhaps the most prominent government intervention regarding the mitigation of climate change is the South African National Treasury's proposal to implement a carbon tax (Altieri *et al.*, 2016; Klausbruckner *et al.*, 2016; South African National Treasury, 2013).

A carbon tax was scheduled to be introduced in South Africa in 2015 but was postponed to 2016 (Klausbruckner *et al.*, 2016). However, the draft bill indicates that the tax is only scheduled to be implemented from the 1st of January 2017 (The Carbon Report, 2016). The tax is scheduled to be implemented incrementally, as part of a suite of climate change mitigation interventions (South African National Treasury, 2013). The tax is scheduled to start at ZAR 120 tCO_2e and is scheduled to be increased by 10% per annum (p.a.) until the year 2019, creating a peak in GHGEs around 2020-2025, a plateau period around 2035, and eventually an overall decline in GHGEs forecasted for the year 2036 onwards (Hood and Guelff, 2013; South African National Treasury, 2013). A carbon tax was favoured over a cap-and-trade scheme, given the oligopolistic nature of the energy sector in South Africa and the fact that there is currently no binding target reduction in GHGEs for South Africa which is required to set the cap in a cap-and-trade scheme (Machingambi, Pers. Comm., 2016; South African National Treasury, 2013).

The following points are pertinent regarding South Africa's proposed carbon tax: (1) only emitters producing more than 100 000 tCO_2e p.a. will be required to pay the tax; (2) emitters will be granted a 60% tax-free threshold for the first five years, shrinking thereafter; (3) sectors where the options for reducing emissions are limited, such as the iron and steel, glass, cement, and aluminium sectors, will be granted 10% exclusion from the tax; (4) sectoral benchmarks will be set and those companies performing better than the benchmark will be granted additional tax-free benefits, limited to 90% of their carbon tax obligations, including the 60% emission allowance; (5) emitting entities will be granted the option to offset 5-10% of their emissions, depending on which sector they are in, using carbon offset schemes such as the CDM; and (6) certain sectors will be completely exempt from the tax for the first five years (Hood and Guelff, 2013; South African National Treasury, 2013). Table 2 tabulates the offset allowances alongside the tax-free allowances and thresholds per sector.

Table 2. South Africa's planned emissions tax-free thresholds and offset allowances by sector

Sector	Basic tax-free threshold (%)	Maximum additional allowance for trade exposure (%)	Additional allowance for process emissions (%)	Total (%)	Maximum offset (%)
Electricity	60	–	–	60	10
Petroleum (coal to liquid; gas to liquid)	60	10	–	70	10
Petroleum – oil refinery	60	10	–	70	10
Iron and steel	60	10	10	80	5
Cement	60	10	10	80	5
Glass and ceramics	60	10	10	80	5
Chemicals	60	10	10	80	5
Pulp and paper	60	10	–	70	10
Sugar	60	10	–	70	10
Agriculture, forestry and land use	60	–	40	100	0
Waste	60	–	40	100	0
Fugitive emissions from coal mining	60	10	10	80	5
Other	60	10	–	70	10

Source: South African National Treasury (2013: 14)

Some concerns regarding South Africa's proposed carbon tax have been raised. For example, the carbon tax would likely result in an increase in energy prices which would affect the poor the most (South African National Treasury, 2013). A shift to alternative technologies may result in low-skilled workers being made redundant, which would be problematic for a country whose economy is comprised mostly of low-skilled workers and whose economy is troubled by high unemployment rates (Altieri *et al.*, 2016; Klausbruckner *et al.*, 2016). Hood and Guelff (2013) suggest that revenue 'recycling' options should also be considered to minimise the negative effects of the tax on the economy. The South African National Treasury (2013) suggests that employer tax and social security contributions can be reduced. The resulting shortfall can then be made up through the increased revenue received from the carbon tax, thereby, recycling carbon tax revenues and reducing the burden placed on employers. The South African National Treasury has suggested that the output-based thresholds for free allocation will minimise the percentage of the tax being passed-through onto final product prices (Hood and Guelff, 2013; South African National Treasury, 2013).

Although carbon taxes are generally less socially accepted given the notion that they will have negative impacts on poorer households, this notion is not always justified (Beck *et al.*, 2015). Beck *et al.* (2015) found that the incidence of a carbon tax in British Columbia fell mostly on more wealthy households. Beck *et al.* (2015) rationalise their finding by suggesting that poorer households are generally heavily reliant on government transfers which are generally inflation-linked, therefore, rising prices because of a carbon tax are less likely to affect poorer households, *ceteris paribus*.

5.4. Carbon Credit Projects

Kreibicha *et al.* (2016) argue that Africa, particularly the least developed countries in Africa, have struggled to draw in CDM carbon credit projects, despite the high potential for these projects in the region. This is despite efforts by the EU to prioritise carbon credits from least developed countries on their EU ETS (Kreibicha *et al.*, 2016; Lambe *et al.*, 2015). Kreibicha *et al.* (2016) attribute this to the high upfront costs involved with these projects, regardless of the size of the projects, and the collapse in carbon prices, rendering these projects financially infeasible. Despite the high upfront costs and collapse in prices, new projects are still being initiated across the world, albeit at a much lower rate (UNEP DTU CDM/JI Pipeline, 2016).

Other international standards regulating carbon credit projects, in addition to the CDM, also exist. For example, the Reducing Emissions from Deforestation and forest Degradation in Developing countries (REDD+) and the Gold Standard which both focus on regulating carbon credit projects that empower local communities (Robinson *et al.*, 2016). In South Africa, carbon credit projects have developed under the following regulatory carbon offset standards: (1) the CDM; (2) the Verified Carbon Standard (VCS); (3) the Gold Standard (GS); and (4) Climate, Community and Biodiversity Standard (CCBS) (South African National Treasury, 2014).

Under the CDM standard, there are currently 8464 active projects in existence, of which, only 245 are based in Africa, roughly a meagre 2.9% (UNEP DTU CDM/JI Pipeline, 2016). Table 3 tabulates the number of carbon credit projects registered in South Africa, as at April 2014, under their respective regulatory carbon offset standards.

Table 3. Carbon credit projects registered in South Africa

Carbon-Offset Standard	Number of Projects in South Africa (as of Feb 2013)
Clean Development Mechanism (CDM)	80 projects have been registered (12 issued with CERs) and 58 are at different stages of the project cycle
Voluntary Carbon Standard (VCS)	6
Gold Standard (GS)	22
Climate, Community and Biodiversity Standard (CCBS)	3
Total Registered Projects	**111**

Source: South African National Treasury (2014: 23)

5.4.1. Carbon Credit Projects in Practice

Carbon credit projects cover a wide range of carbon sequestration techniques and have had mixed results in practice in attaining the goal of sustainable development. For example, Donaldson *et al.* (2013) investigated the Kuyasa CDM pilot project in Khayelitsha, Cape Town, South Africa. The project involved a housing project in the region whereby houses were retrofitted with energy efficient lighting, insulation, and solar geysers. The project was the first registered CDM project in South Africa for CER credits and involved a public-private partnership between the community of Kuyasa and various South African government entities (Donaldson *et al.*, 2013). The project had several positive impacts on environmental protection, social justice, and economic growth within the community of Kuyasa, thus, contributing towards sustainable development. These included: (1) energy use reduction; (2) energy efficient technology training; (3) life skills training; (4) job creation; (5) creating awareness within the community of the CDM; (6) social inclusion, regardless of socio-economic status; and (7) sustainability through monitoring and a transparent problem solving process between all stakeholders (Donaldson *et al.*, 2013).

In another example, Nijnik and Halder (2013) investigated the impact of carbon credit projects under the CDM and REDD+, using a sample of countries from south and south-east Asia, specifically: Indonesia, India, Bangladesh, Nepal, Malaysia, Philippines, Vietnam and Thailand. Land tenure in these countries is largely subjugated by the state and these countries have experienced a high degree of land degradation (Nijnik and Halder, 2013). Unproductive degraded land is, thus, frequently used for carbon restoration projects, generally through afforestation and reforestation. These projects generally involve the mass planting of a single species, such as the creation of *eucalyptus* plantations in India (Nijnik and Halder, 2013). Nijnik and Halder (2013) argue that the large majority of these projects were not sustainable, as they have various negative impacts on environmental protection, social justice, and economic growth within their respective communities. Nijnik and Halder (2013) list the following negative impacts: (1) ecological impacts, including biodiversity and soil loss; (2) disrupting social norms and practices and limiting access to natural resources; (3) social justice and equity issues regarding the stakeholders who actually benefit from these projects, as the projects largely occurred on state owned land; (4) alienation from land and natural resources resulted in job loss; and (5) legal and political issues regarding corruption, fraud and land tenure conflicts.

Nijnik and Halder (2013) conclude that carbon credit projects do not always result in sustainable development and do present several challenges.

5.4.2. Carbon Credit Projects in the Eastern Cape Province of South Africa Using Portulacaria afra

The South African government has announced that it plans on addressing climate change by using a 'package of measures' (South African National Treasury, 2014). 'This will include the proposed carbon tax, environmental regulations, renewable energy projects and other targeted support programmes' (South African National Treasury, 2014: 5). These measures offer potential for carbon credit projects. The South African National Treasury (2014) argues that carbon credit projects may have the potential to augment development in the rural parts of South Africa through job creation, land restoration and protection from degradation, biodiversity and energy conservation, and low carbon growth. As such, it is proposed that all carbon offsets stemming from South Africa's carbon tax be sourced from South African based carbon credit projects. The South African National Treasury (2014) has identified the restoration of subtropical thicket regions and the restoration and management of grassland, amongst others, as being potential carbon credit project areas.

The Eastern Cape province of South Africa is the second largest province in the country and has been identified by the South African government as being one of the provinces requiring augmented socio-economic development as a matter of urgency (Sigwela *et al.*, 2014). The province has suffered from chronically high unemployment rates (Statistics South Africa, 2016). The official unemployment rate was 28.6% during the second quarter of 2016, and the expanded rate, which also includes discouraged work-seekers, was the highest out of all the provinces in South Africa, at 43.8% (Statistics South Africa, 2016). The south-western part of the province is covered mostly by the subtropical Albany Thicket biome (shown in figure 7) which is endemic to the semi-arid conditions that exist within the region (Mills *et al.*, 2009; Sigwela *et al.*, 2014). A large degree of the biomass within the biome consists of the succulent shrub *P. afra*.

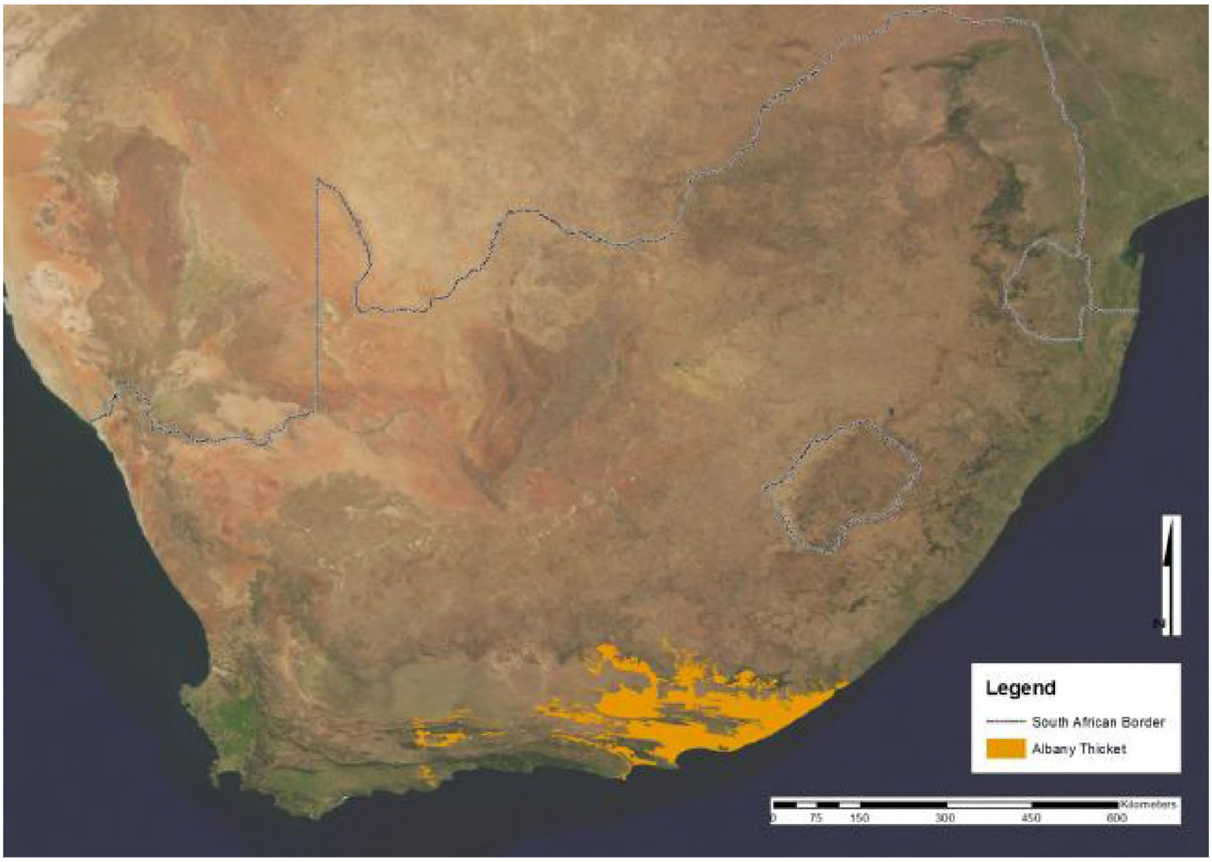


Figure 7. Map showing the subtropical Albany Thicket biome within South Africa
Source: Furniss (2014)

The subtropical Albany Thicket biome is threatened by several factors. The thicket has been degraded by pastoralists (Curran *et al.*, 2012; Sigwela *et al.*, 2014). The thicket is also threatened by climate change which is hypothesised to result in more frequent droughts and higher temperatures, increasing the risk of desertification within the biome (Sigwela *et al.*, 2014). Degraded thicket will not restore itself, without the aid of human intervention (Sigwela *et al.*, 2014). Given these threats and the fact that *P. afra* sequesters a comparatively large amount of carbon, relative to its height and water uptake (in excess of 20 kg/m^2/annum for intact thicket, rivalling rainforest carbon sequestration rates), restoration carbon credit projects involving the re-planting of *P. afra* have become popular within the region (Curran *et al.*, 2012; Sigwela *et al.*, 2014).

The South African Department of Environmental Affairs' Natural Resource Management Program commenced an experimental Subtropical Thicket Restoration Programme (termed STRP) with the intention of 'kick-starting' a large-scale carbon restoration initiative (Clarke *et al.*, 2012; Sigwela *et al.*, 2014). The project involves the planting of *P. afra* on degraded land within the biome which can further be certified for carbon credits by a regulatory body such as the CDM, given the carbon sequestration benefits of *P. afra* (Curran *et al.*, 2012; Mills *et al.*, 2015; Sigwela *et al.*, 2014). The Gamtoos Irrigation Board has been mandated to carry out most land restoration under the STRP (Knipe, Pers. Comm., 2016). The intention was to create a flagship carbon credit project which would incentivise the private sector to buy into the carbon credit restoration industry to attain the goal of restoring the 1 400 000 hectares (ha) of degraded thicket (Mills *et al.*, 2015; Sigwela *et al.*, 2014). The incorporation of the private sector is crucial, given the estimated cost of the project being at about US$ 600 000 000 (Mills *et al.*, 2015). The project covers parts of Addo Elephant National Park, the Great Fish River Nature Reserve, and the Baviaanskloof Nature Reserve (Sigwela *et al.*, 2014). Figure 8 shows the impact that the STRP is having on the landscape by comparing a restored area that was previously degraded to a degraded area (Mills *et al.*, 2015). The restored area is protected by a fence to prevent degradation from livestock.

Figure 8. Fence line contrast between degraded and restored land under the STRP.
Source: Mills *et al.* (2015)

Sigwela *et al.* (2014) found that restoration projects involving the planting of *P. afra* on degraded land, such as the STRP, had co-benefits, including socio-economic and environmental benefits. Perhaps carbon restoration projects using *P. afra* can be used as a tool for sustainable LED within the poverty-stricken province.

5.5. Conclusion

This chapter has provided an overview of carbon credit projects within the context of South Africa. The potential for promoting local economic development through carbon restoration projects using *P. afra* within the Eastern Cape province of South Africa was also highlighted. These projects may have the potential to mitigate climate change whilst, at the same, enable sustainable development on a local scale. This half-thesis aims to investigate the extent to which carbon markets are enabling sustainable LED projects based on carbon sequestration in the Eastern Cape province of South Africa. The following chapter outlines the research methods used within this half-thesis.

Chapter 6. Research Methods

6.1. Introduction

The mixed methods approach was identified as being the most appropriate research method for this half-thesis. A mixed methods approach, 'combines alternative approaches within a single research project' (Denscombe, 2010: 137). The research method thereby transcends the boundaries between orthodox paradigms of research. This approach is particularly beneficial to small-scale research projects, as it improves accuracy through corroboration, provides 'a more complete picture', and offsets any weaknesses pertaining to a single research method (Denscombe, 2010).

The mixed methods approach is applied to this study by garnering both qualitative and quantitative data from government policy documents, literature, and key informants in the Eastern Cape's carbon credit industry. In particular, carbon restoration projects using *P. afra* to restore degraded land are investigated. Further quantitative and qualitative data on the current state of the European Union Emissions Trading Scheme (EU ETS) and the Regional Greenhouse Gas Initiative (RGGI) were collected, using the Clean Development Mechanism's market for Certified Emission Reductions (CERs) for comparative purposes. These data were collected from Thompson Reuters Eikon's suite of monitoring, forecasting, charting, news and analytical tools. Information regarding the ETS supply and demand forecasts, alongside news pertaining to these carbon markets were acquired from Thompson Reuters' Point Carbon research division included in the Eikon software package. Results were then triangulated and observed through the lens of Connelly's (2007) framework for sustainable development to provide considerations for sustainable LED.

6.2. Justifying the Mixed Methods Approach

The mixed method approach is a method used for social research which incorporates three distinctive characteristics, namely: (1) the inclusion of both quantitative and qualitative approaches within a single research project; (2) the need to establish a link between alternative approaches to reach a triangulated result; and (3) an overarching concern to find answers to the research problem i.e. a need for a problem-driven approach (Denscombe, 2010; Feilzer, 2010). This method is particularly useful when there are opposing views on a particular subject, as the method takes a pragmatic position (Denscombe, 2010; Feilzer, 2010). Given the possibility that the literature surrounding carbon credit projects may diverge from practical experiences, opinions and data within the local industry, a pragmatic position is deemed necessary, along with the need to formulate triangulated results from literature and both qualitative and quantitative data.

6.3. Applying the Mixed Methods Approach

Quantitative research is based on positivism, the notion that there is only one truth, a truth that exists independent of human perception, and that the phenomenon being observed can objectively be reduced to empirical indicators (Sale *et al*, 2002). In the case of this research, quantitative data were garnered from selected key international carbon markets. The following carbon schemes were selected, based on Newell *et al.*'s (2013) selection of significant carbon markets across the world: The RGGI and the EU ETS, using the CDM's CER market for price comparison purposes.

Quantitative data were also obtained. Spot price data pertaining to RGGI permits sold on the Intercontinental Exchange (ICE) were obtained between January and April 2016, along with the volume of permits sold during this period. Past, current and forecasted bank stocked permits, permit supply and cost containment reserve (CCR) data were obtained for the RGGI between the years 2014 and 2020, alongside forecasted emissions within the scheme. Past, current and forecasted emissions by sector were obtained for the EU ETS against baseline data, alongside EU ETS cap data, between the years 2008 and 2030. Data pertaining to EU ETS permit futures being traded on the European Climate Exchange (ECX) were obtained, alongside volume data, between April 2005 and October 2016. Corresponding CER future price data and volume data were obtained for comparative purposes. Both futures had the same expiry date, 31 December 2016. Further quantitative data were attained from the key informants interviewed to establish the costs involved in the carbon credit restoration process. Data in this regard was gathered from the Gamtoos Irrigation Board from the project inception date, during the 2003/2004 financial year, through to the 2016/2017 financial year. Plotted data was then analysed graphically to determine the current state of the international carbon markets and the costs involved in the restoration process. Recent literature along with research from Thomson Reuters' analysts were used to corroborate the findings.

Qualitative research is based on the notion that reality is socially constructed and, therefore, there are multiple truths based on multiple interpretations of reality (Sale *et al*, 2002). This research takes a post-positive approach, whereby, reductionism is used to understand complex social cause and effect relationships and conjectures are then applied to derive results (Creswell, 2009; Lenzholzer and Brown, 2016). For this research, key informants were identified within the Eastern Cape who are involved in the planting of *P. afra* on degraded land for carbon credits. Key informants were then interviewed to examine the extent to which carbon markets are enabling sustainable LED based on carbon sequestration in the Eastern Cape. The questionnaires were designed around the key informant's area of expertise and key success factors relating to LED and sustainability. A sample questionnaire is included in appendix I.

A key informant is an individual who can provide solicited expert information (Bryman, 2008; Marshall, 1996). Marshall (1996) lists the following five characteristics pertaining to an ideal key informant: (1) playing a societal role which enables them to gain deep insight into the kind of information that a researcher is soliciting; (2) possessing a significant amount of knowledge surrounding the kind of information that the researcher is soliciting; (3) a willingness to communicate and co-operate with the researcher; (4) the ability to communicate with the researcher in a manner in which the researcher can understand; and (5) having an impartial view on the information which the researcher is soliciting, or making any biases known to the researcher. Considering these characteristics, the following key informants were chosen: Mr. Pieter Kruger, a private landowner in Willowmore in the Eastern Cape who made 1500 ha of degraded land available for a carbon restoration project involving the planting *P. afra*; Mr. Japie Buckle, the provincial coordinator and technical adviser for the Eastern Cape's Working for Wetlands program under the auspices of the South African National Biodiversity Institute (SANBI), who serves as a technical advisor to the Subtropical Thicket Restoration Programme (STRP); Mr. Andrew Knipe, Port Elizabeth's area manager for the Gamtoos Irrigation Board which has played a direct role in carrying out the restoration side of the STRP; Mr. Mike Powell, a researcher for the Rhodes Restoration Research Group at Rhodes University; and Dr Memory Machingambi, a senior economist within the environmental and fuel taxes division at the South African National Treasury (SANT) who had a direct input into South Africa's proposed carbon tax policy.

Mr. Japie Buckle and Mr. Andrew Knipe were selected as key informants given their role played within the STRP. The STRP offers insight into the potential of carbon restoration projects in the Eastern Cape province of South Africa using *P. afra*, being the pioneer large scale project (Mills *et al.*, 2015; Sigwela *et al.*, 2014). Mr. Pieter Kruger was selected to gain insight into the potential of private investment within the industry. Mr. Mike Powell was selected based on his knowledge of the industry and Dr Memory Machingambi was selected to gain insight into South Africa's proposed carbon tax as a national carbon control regime for South Africa.

6.4. Ethical Considerations

Ethical clearance has been obtained from the Department of Economics and Economic History to conduct key informant interviews for this research. Participants were informed on the following fronts: of the purpose of the research study and their involvement in it; that they may withdraw from the research study at any stage without any penalty; that their participation in this study is done purely on a voluntary basis; that they will receive no payment for participating in this study; that they may choose to remain anonymous; and that their interviews will be recorded and stored temporarily for the sole purpose of accurate data capture for this half-thesis. Participants were also provided with the interview questions prior to the interview.

Chapter 7. Discussion and Results

7.1. *Introduction*

Newell *et al.* (2013) estimate that the global market value of emission allowances would be in the region of US$300 000 000 000, should each tonne of emissions be valued at US$10 and further estimate that the global market value would be in the region of US$750 000 000 000, should each tonne of emissions be valued at US$25. The value of the market can be indicative of the annual cost to the global environment or the potential transfer of wealth as emissions are constrained and property rights are enforced (Newell *et al.*, 2013).

The Kyoto Protocol aimed to trade carbon permits on a single market, obtained through the Clean Development Mechanism (CDM), thereby, maximising efficiency (Newell *et al.*, 2013). The notion behind this was to address a global issue on a global scale by equalising the economic incentive to address the issue across the world. However, this top-down, theoretically economically efficient scheme has caused several carbon markets to emerge (Newell *et al.*, 2013). This detracts from the initial centralised, top-down approach to climate change and has allowed a new, bottom-up carbon market and climate change policy landscape to form (Newell *et al.*, 2013; Robinson *et al.*, 2016). This resonates with the bottom-up approach to development that LED encapsulates.

This half-thesis will briefly investigate the current state of the Regional Greenhouse Gas Initiative (RGGI) carbon market and the European Union's Emission Trading Scheme (EU ETS) in comparison to the CDM's market for Certified Emission Reductions, each of which have been included in Newell *et al.*'s (2013) list of significant carbon markets. Quantitative data obtained from Thomson Reuters' Point Carbon division for each market will be graphically illustrated, showing the historical market performance of marketed carbon contracts from these schemes along with forecasted supply and demand values. Given the significance of these markets (Newell *et al.*, 2013), they may be considered as substantial examples and, therefore, may have the potential to provide a brief overview of the current state of the global carbon markets.

Connelly's (2007) framework for sustainable development is then coupled with elements of LED theory to create a lens through which to view LED projects involving carbon sequestration. This is done to investigate the extent to which the carbon markets are enabling sustainable LED, specifically, LED based on carbon restoration projects using *P. afra* in the Eastern Cape province of South Africa.

7.2. The International Carbon Markets: An Overview Using Regional Examples

The 2008/2009 financial crisis had a detrimental effect on global carbon markets (Chan, 2009; Hood and Guelff, 2013). Chan (2009: 153) argues that carbon markets are also subject to speculative market bubbles, which form when 'too much money chases too few viable investments'. Carbon instruments also carry credit risk, where the risk is generally higher when the carbon credit is sourced from a carbon credit project due to the complex and costly regulatory requirements and long-term nature of these projects (Chan, 2009). The credit risk in credits sourced from carbon credit projects is encapsulated in the nature of the forward contract. Sellers make a promise to sell a certain number of carbon credits before the credits are obtained, creating room for default (Chan, 2009; Faure, 2015). For this reason, government issued emission allowances are considered to carry much lower credit risk (Chan, 2009).

Between 2006 and 2007, carbon market prices roughly doubled and continued to grow by as much as 84% in 2008 (Chan, 2009). The onset of the 2008/2009 financial crisis resulted in a significant decrease in demand driven emissions and, thus, reduced demand for carbon credits to historical lows, creating an oversupply in international carbon markets (Chan, 2009; Kreibich *et al.*, 2016). This caused carbon market prices to collapse (Chan, 2009; Kreibich *et al.*, 2016). Chan (2009) thus argues that carbon markets should not only be well regulated but also simpler and conducted on a smaller scale. As a sub-goal, this half-thesis aims to assess the current state of the selected international carbon markets.

7.2.1. The Regional Greenhouse Gas Initiative (RGGI)

The RGGI was the first cap-and-trade scheme introduced in the USA and formed as a market based instrument to reduce GHGEs from power producers in Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Vermont and New Jersey (who participated between 2009 and 2011), and entered into force in January 2009 (Chistyakova, 2016). The scheme allows for a limited amount of domestic carbon offset credits through approved regulatory bodies but does not allow credits obtained through the Kyoto Protocol. The RGGI covers about 25% of the US's overall GHGEs (91 $MtCO_2e$) with the aim of reducing carbon emissions by 15% below 2012 levels by the year 2020 (Thomson Reuters Eikon, 2016). Its current market value is €359 000 000 (Thomson Reuters Eikon, 2016).

Most RGGI emission allowances (RGAs, where one RGA represents 1 tCO_2e) are sold via quarterly, regional auctions, however, a secondary market for RGAs does exist (Regional Greenhouse Gas Initiative, 2016). The emission allowances were originally over allocated and, therefore, sold merely around the auction reserve price, essentially the price floor (Borenstein *et al.*, 2014), of US$2 tCO_2e from mid-2010 through to 2012 (Thomson Reuters Eikon, 2016). The over allocation issue was addressed and cost containment reserve (CCR) provisions were incorporated into the scheme in 2014 (Chistyakova, 2016). The CCR creates a soft price ceiling by holding back a predefined amount of emission allowances and injecting them into the market when the carbon price exceeds a predefined price (Borenstein *et al.*, 2014; Regional Greenhouse Gas Initiative, 2013). The RGGI set these predefined prices at US$4 for 2014, US$6 for 2015, US$8 for 2016, and $10 for 2017, thereafter rising by 2.5% each year (Regional Greenhouse Gas Initiative, 2013). Measures implemented to address the over allocation issue allowed the price to reach a high of US$6 tCO_2e during the September 2015 auction (Chistyakova, 2016).

Figure 9 shows the historical RGA spot prices on the Intercontinental Exchange (ICE) for secondary permits, alongside the number of permits traded, between January and April 2016. Marcello (2016), an analyst for Thomson Reuters, states that the likely cause of the significant drop in price shown in the data, from US$8.00 tCO_2e on the 12th of February 2016 to US$4.50 on the 16th February 2016, was due to speculators being concerned about the systemic oversupply of RGAs and choosing to sell off a large number of their RGA holdings. Prices since stabilised around US5$ tCO_2e.

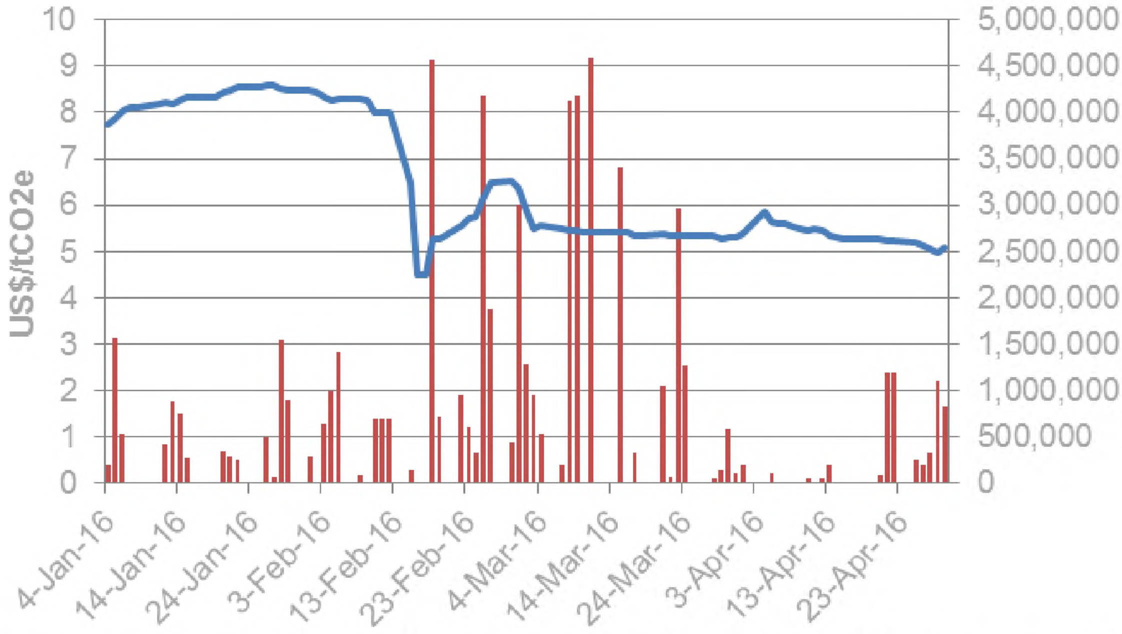


Figure 9. Line graph showing the spot price of RGA's traded in US$/t$CO_2$e alongside a bar graph showing the number of permits traded between January and April 2016

Source: Thomson Reuters Eikon (2016)

Figure 10 provides an indication of how oversupplied the RGGI is through the amount of banked and vintage credits held, relative to historical, current and forecasted emissions from power producers within the region (Thomson Reuters Eikon, 2016). The line graph essentially sets demand values and the composite bar graph essentially sets the supply values of the RGGI. Therefore, where the composite bar graph exceeds the line graph, the market is essentially oversupplied (Marcello, 2016).

Marcello (2016) states that these data show that the supply-to-demand ratio is 2.6:1 in 2016 and is forecasted to decrease to 1.9:1 by 2020. Given the oversupply in credits, Marcello (2016) predicts that the CCR credits will not be released between now and 2020. To address the oversupply issue, the RGGI made the decision to decrease the emissions cap by 2.5% annually between 2012 and 2020 (Marcello, 2016). The forecasted RGA supply in figure 10 is, thus, based on a decreasing emissions cap of 2.5% p.a. Due to the decreasing emissions cap, Marcello (2016) has a bullish outlook on RGA prices. However, there is a degree of uncertainty as to whether the RGGI will be continued beyond 2020, which may signal participants to sell off their excess permits (Thomson Reuters Eikon, 2016).

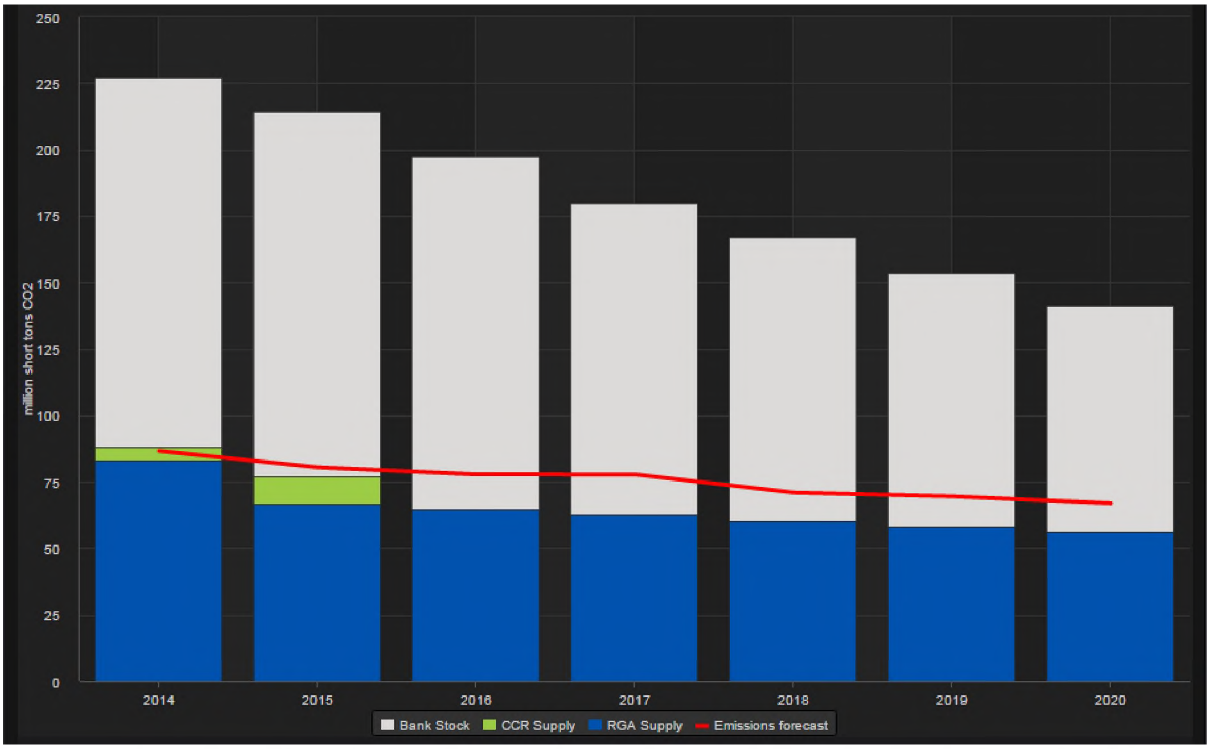


Figure 10. Line graph showing the forecasted emissions by power producers under the RGGI scheme within a composite bar graph showing bank stocked RGAs, RGA supply and CCR supply in millions of short tons

Source: Thomson Reuters Eikon (2016)

7.2.2. European Union Emissions Trading Scheme (EU ETS)

The EU ETS is currently the largest cap-and-trade ETS in the world by market size and coverage, covering a total of 2084 $MtCO_2e$ in 2014, and the latest market value available for the scheme being €36 000 000 000 in 2013 (Thomson Reuters Eikon, 2016). In 2015, the EU ETS represented about 80% of the world's carbon trading in terms of volume traded, and 77% in terms of trade value (Thomson Reuters Eikon, 2016). The EU ETS is the EU's central tool for abating GHGEs within the EU (Thomson Reuters Eikon, 2016). The scheme allows for a limited number of carbon offset credits obtained through the Kyoto Protocol, however, qualitative restrictions apply. A total limit of 1600 Mt of carbon offsets are allowed for the 2008-2020 period (Thomson Reuters Eikon, 2016). The scheme aims to reduce GHGEs by 21% below 2005 levels by 2020 (Thomson Reuters Eikon, 2016).

Figure 11 graphically quantifies the amount of industrial emissions produced by firms operating under the EU ETS in the EU along with aviation emissions in the EU, relative to baseline emissions, from 2008, forecasted through to 2030. The line graph shows the set market cap of permits (EU emissions allowances or EUAs, where one EUA represents 1 tCO_2e). The line graph, thus, essentially establishes the past, current and forecasted supply values within the scheme and the composite bar graph essentially sets the corresponding demand values. Where the composite bar graph falls short of the line graph (emissions cap), the market is essentially oversupplied with EUAs. The total annual cap was set at 2084 $MtCO_2e$ for 2013, excluding the aviation sector and any adjustments such as auctions of the new entrants' reserve (NER) surplus permits, such as from the NER 300 program which entails low-carbon projects funded by the EU (European Commission, 2016; Thompson Reuters Eikon, 2016). This cap is set to decrease by 1.74% p.a. (Thompson Reuters Eikon, 2016). The forecasted values in figure 11 from Thompson Reuters Eikon's (2016) Point Carbon research division factor into account predicted changes in the NER as well as the set decrease in emissions cap. As noted in figure 11, the EU ETS introduced the aviation industry into the scheme in 2012 which has helped to stem the oversupply of permits (Thompson Reuters Eikon, 2016).

Hood and Guelff (2013) point out that baseline scenarios do not necessarily consider demand-side economic shocks, such as the 2008/2009 financial crisis. The financial crisis led to a dramatic collapse in prices in the EU ETS, as the cap was locked into an estimated baseline scenario in which demand-driven emissions increased over time, rather than decreased (Hood and Guelff, 2013). Phase 3 of the EU ETS, initiated in 2013, has attempted to address the oversupply issues resulting from the financial crisis as well as introduced a uniform EU-wide market cap (European Commission, 2016).

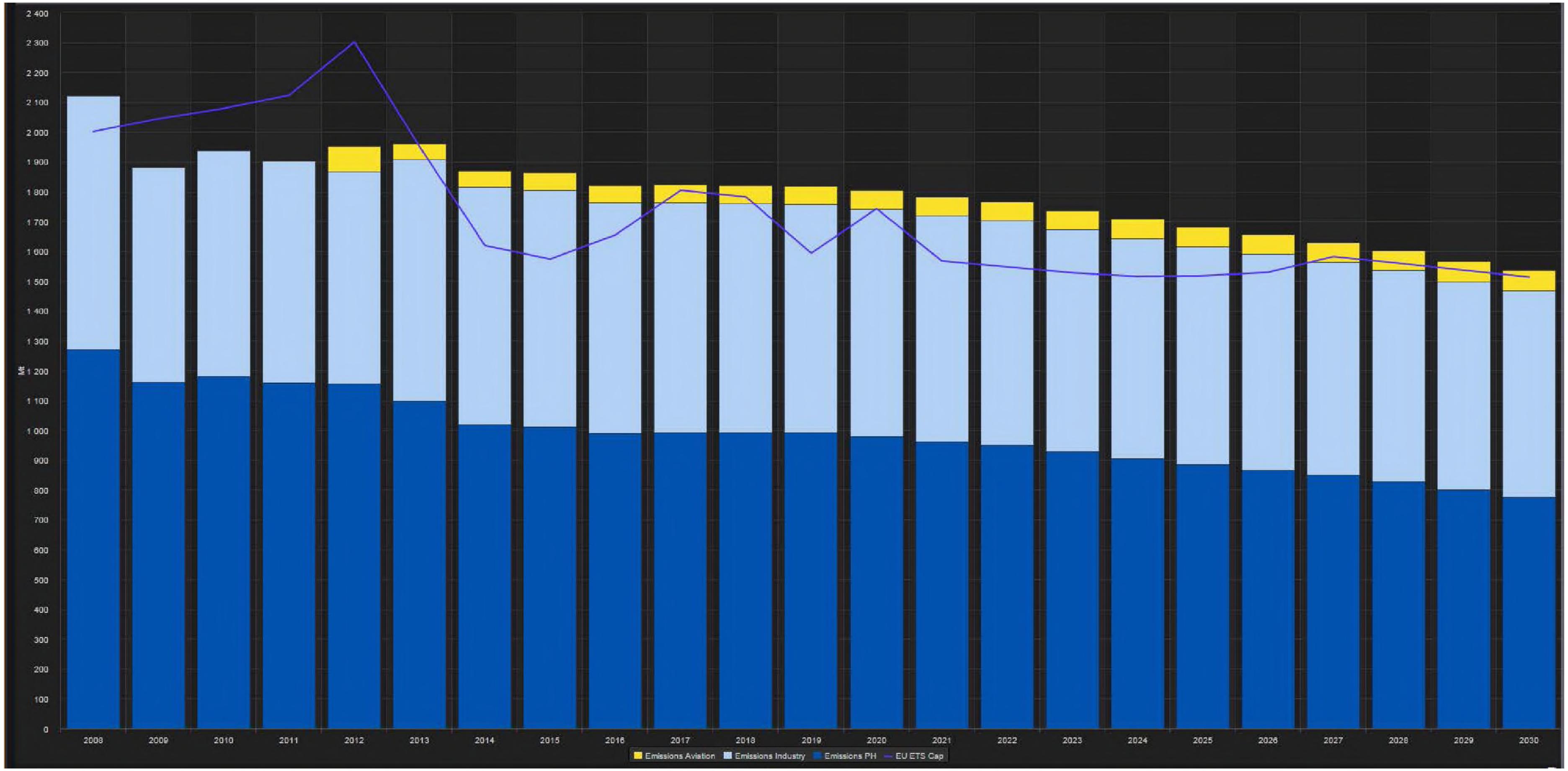


Figure 11. Composite bar graph showing the past, current, and forecasted emissions by sector (industry in light blue vs aviation in yellow) in the EU ETS in the EU ETS baseline scenario. Alongside, a line graph showing the EU ETS emissions cap in $MtCO_2e$ between the years 2008 and 2030

Source: Thomson Reuters Eikon (2016)

Figure 12 shows the historical prices of EUA and CER future contracts traded on the European Climate Exchange (ECX), both expiring in December 2016. Faure (2015) notes that the price of future contracts varies closely with the spot price of the underlying instrument, in this case EUAs and CERs, but will always converge upon expiry. Given that future contracts are based on future transaction obligations; the market performance of future contracts provides some insight as to how the price of the underlying instrument is expected to perform over time (Faure, 2015).

From these data in figure 12, the EUA future contracts closed at €4.96/tCO_2e on the last day of September 2016, compared to €4.47/tCO_2e on the last day of August 2016. In terms of volume, a total of 319 MtCO_2e of EUAs were traded during the month of September 2016, compared to 197.8 MtCO_2e during the month of August 2016 (Thomson Reuters Eikon, 2016). In comparison, CER future contracts traded at €0.38/tCO_2e on the last day of September 2016, compared to €0.40/tCO_2e on the last day of August 2016. In terms of volume, a total of 0.8 MtCO_2e of CERs were traded during the month of September 2016, compared to 0.8 MtCO_2e during the month of August 2016 (Thomson Reuters Eikon, 2016).

Qin (2016), an analyst for Thomson Reuters, notes that the United Kingdom's referendum to leave the EU in late June caused the price of EUAs to drop, following the announcement of the result. Qin (2016) also notes that power producing firms within the EU ETS have switched to cleaner fuels at a higher rate since June 2016 by reducing their coal dependency and, consequently, reducing their need for EUAs. Qin (2016) argues that these factors led to a three-year low being reached in September 2016. This can be seen in the data shown in Figure 12. Qin (2016), however, notes that the profit margin for coal-fired power stations may increase in the future due to rising gas prices, accentuating demand for EUAs towards the end of 2016. Nonetheless, 2017 will see an additional 26 MtCO_2e of EUAs being injected into the market as Iceland, Liechtenstein and Norway hold their government auctions for EUAs. For this reason, Qin (2016) has a bearish outlook on prices for EUAs. The EU ETS, like the RGGI, seems to have a systemic oversupply issue which is feeding into the price (Thomson Reuters Eikon, 2016).

As the data in figure 12 shows, the market for CERs has dwindled due to hampered demand and market activity post the 2008/2009 financial crisis (Thomson Reuters Eikon, 2016).

Thomson Reuters Eikon (2016) estimates that a total of 196 000 000 CERs will be issued between 2016 and 2021, despite dwindling demand.

The demand for CERs is sourced mostly from voluntary offset programs as well as from governments fulfilling their Kyoto commitments (Thomson Reuters Eikon, 2016). CERs can be used in lieu of permits to a limited extent on certain ETSs. For example, polluting firms who are a part of the EU ETS and the South Korean ETS can source a limited number of permits from CER projects (Thomson Reuters Eikon, 2016). Despite the collapse in CER prices, as shown in figure 12, there is hope for the CER market beyond the second Kyoto Protocol commitment period, ending on the 31st of December 2020 (UNFCCC, 2016). Thompson Reuters Eikon (2016) cite the following reasons: the CDM Executive Board has announced that it wishes to extend the CER market beyond 2020; the International Civil Aviation Organization (ICAO) is set to implement a carbon offset program after 2020, with a good possibility that CER credits will be allowed into the scheme; Mexico has announced its intention of starting its own ETS, in which, domestic CERs will be allowed, potentially allowing internationally sourced CERs in the future; and there have been sporadic mass purchases of CERs in the aviation industry for voluntary offset programs, for example, the Delhi International Airport purchased 112 000 domestically sourced CERs in September 2016.

As Hood and Guelff (2013) point out, a careful balance is required to make sure that short-term costs are kept low for firms, whilst at the same time, high and stable enough so that firms have an incentive to invest in low-carbon technology in the long-term. The examples show that the carbon markets seem to be systemically oversupplied, keeping prices systemically low. The 2008/2009 financial crisis seems to have had a detrimental effect on the global demand for carbon credits, accentuating the systemic oversupply issue in the CER and EU ETS carbon markets (Chan, 2009; Kreibich *et al.*, 2016). Thomson Reuters Eikon (2016) estimates that the price of EUAs is set to increase between 2016 and 2030 as oversupply issues are addressed within the EU ETS. The oversupply in the markets identified in this section may pose a threat to the economic sustainability of future LED initiatives involving carbon credits, as returns on carbon investments will remain systemically low until the oversupply issues are addressed adequately.

Figure 12. Line graph showing the average monthly price of EUA futures (in orange) and CER futures (in purple) being traded on the ECX, both expiring in December 2016, in €/tCO_2e between April 2005 and October 2016.

Data Source: Thomson Reuters Eikon (2016)

7.3. Carbon Credit Restoration Projects in the Eastern Cape Province of South Africa: A Tool for Sustainable LED?

The promising potential for carbon restoration projects in the Eastern Cape province of South Africa using *P. afra* has been noted in the literature (Clarke *et al.*, 2012; Curran *et al.* 2012, Sigwela *et al.*, 2014). Clarke *et al.* (2012) note that the potential of these projects stems from the co-benefits derived from these projects: not only can the planting of *P. afra* on degraded land result in local and regional environmental benefits, but also social and economic benefits.

The South African National Development Plan, the South African government's vision for 2030, has made an explicit case for carbon offset projects with the aim of driving public-private sector investments to address climate change and promote development (South African Department of Environmental Affairs, 2015). C4 EcoSolutions (2014), an environmental consultancy firm, along with the Camdeboo Local Municipality (2009) have identified carbon restoration projects using *P. afra* in the Eastern Cape province of South Africa as a being a potential tool for LED within the region through capacity building and job creation. These projects may have the potential to also drive LED through public-private sector partnerships, encouraging entrepreneurism, capacity building, creating development links through the international carbon markets, and enhancing social capital through education and training (Buckle, Pers. Comm., 2016; Crul *et al.*, 2016; Knipe, Pers. Comm., 2016; Powell, Pers. Comm., 2016).

The primary goal of this half-thesis is to assess the extent to which carbon markets are enabling sustainable LED based on carbon sequestration in the Eastern Cape province of South Africa using *P. afra*. To attain this goal, Connelly's (2007) framework for sustainable development will be applied to the following section, bringing into account elements from LED theory. The following section will comprise of considerations for economic growth, environmental protection, and social justice, regarding carbon credit restoration projects in the Eastern Cape based on the planting of *P. afra* on degraded land.

7.3.1. Considerations for Economic Growth

Although the international carbon markets seem to be systemically oversupplied, keeping prices low, Powell (Pers. Comm., 2016), a researcher for the Rhodes Restoration Research Group at Rhodes University, states that there is still interest in generating carbon credits in the Eastern Cape. This interest stems from both the private sector and the South African government, at both the national and local level (Powell, Pers. Comm., 2016). The following section considers some opportunities and challenges for economic growth regarding carbon credit restoration projects in the Eastern Cape using *P. afra*.

Knipe (Pers. Comm., 2016), Port Elizabeth's area manager for the Gamtoos Irrigation Board, states that the Gamtoos Irrigation Board has been mandated to restore degraded regions of the Baviaanskloof Nature Reserve, Baviaanskloof Hartland, the Addo Elephant National Park and the Great Fish River Reserve through the STRP as well as to restore some private land through private contractors (Knipe, Pers. Comm., 2016). The board has received funding from South Africa's Department of Environmental Affairs' Working for Water Program, South Africa's Department of Agriculture, Forestry, and Fisheries' Natural Resource Management Program, and South Africa's Department of Public Works' Expanded Public Works Program. Restoration involves the planting of *P. afra* on degraded land (Knipe, Pers. Comm., 2016; Powell, Pers. Comm., 2016).

Figure 13 shows the Gamtoos Irrigation Board's annual budget received from these various government programs, earmarked for restoring these lands, between the 2003/2004 and 2016/2017 financial years (to date). From the data shown in figure 13, it is evident that the annual budget has grown substantially from ZAR 111 321.60 for the 2003/2004 financial year to ZAR 11 046 863.83 for the 2015/2016 financial year.

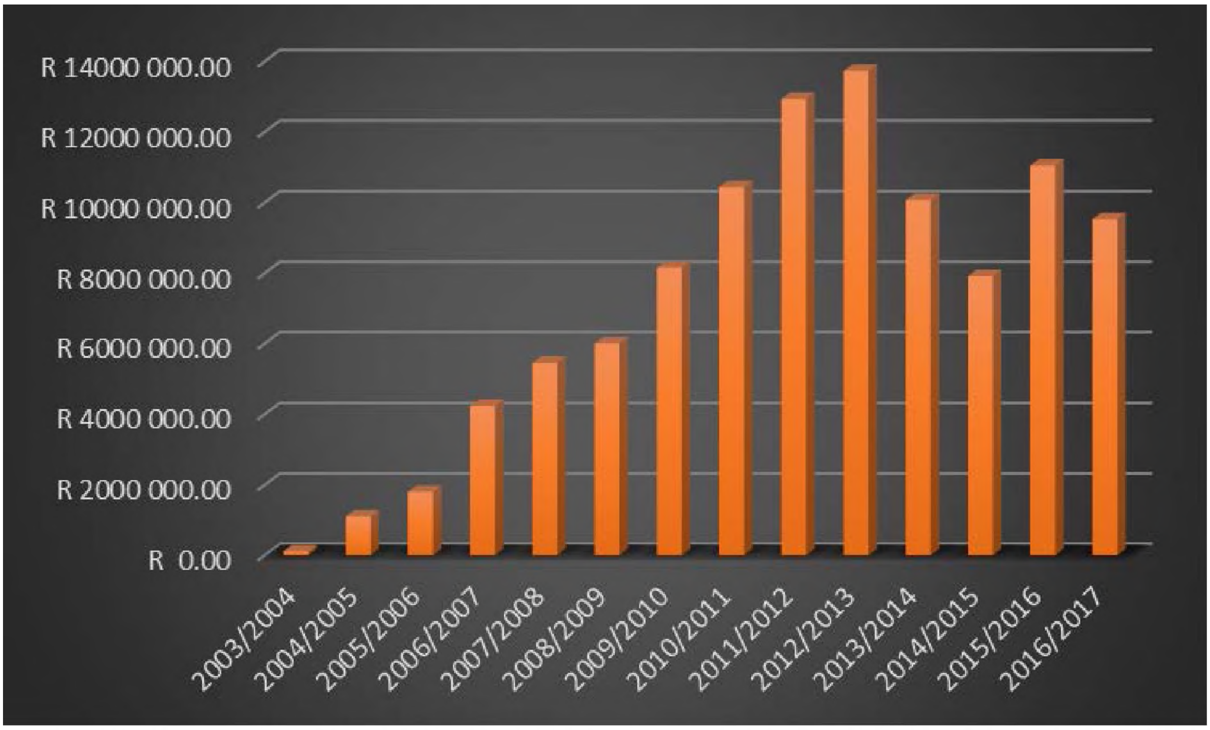


Figure 13. Bar graph showing annual budgeted expenditure (ZAR) in nominal prices by the Gamtoos Irrigation Board on *P. afra* restoration in the degraded regions of the Baviaanskloof Nature Reserve, Baviaanskloof Hartland, the Addo Elephant National Park, the Great Fish River Reserve, and for private contractors in the Peddie region between the 2003/2004 and the 2016/2017 financial years (funding received to date).

Data Source: Knipe, Pers. Comm. (2016)

Private landowners may also receive funding through South Africa's Department of Agriculture, Forestry, and Fisheries' Natural Resource Management Program's Land User Incentive to initiate a land restoration project. This funding equates to roughly ZAR 150 per person per day (Buckle, Pers. Comm., 2016; Powell, Pers. Comm., 2016). Although, data from Knipe (Pers. Comm., 2016) shows that restoration cost the Gamtoos Irrigation Board an average of ZAR 218.40 per person per day and an average of ZAR 3 351.03 per hectare during the 2015/2016 financial year. A total of 1958.57 ha were restored during the 2015/2016 financial year, which included degraded areas where *P. afra* was planted as well as 'blanked' areas (Knipe, Pers. Comm., 2016). 'Blanking' involves the removal of dead *P. afra* and replanting of *P. afra* where any gaps are formed (Becker, 2013).

Figure 14 provides a breakdown of the total expenditure by the Gamtoos Irrigation Board to date by category of expenditure. This figure provides an overview of what sort of costs are involved in these projects. From these data, it is evident that the biggest expenditure categories are wages (51% of the total) and transport for workers (17% of the total). Although labour for these projects is sourced from surrounding rural communities, most projects are taking place on state protected land which lies in remote, uninhabited regions, hence, transport and, occasionally, camping for labour is required (Knipe, Pers. Comm., 2016). The Gamtoos Irrigation Board has spent about ZAR 93 000 000 on land restoration to date to restore a total of 6929.50 ha and 'blank' a total of 3808.31 ha (Knipe, Pers. Comm., 2016).

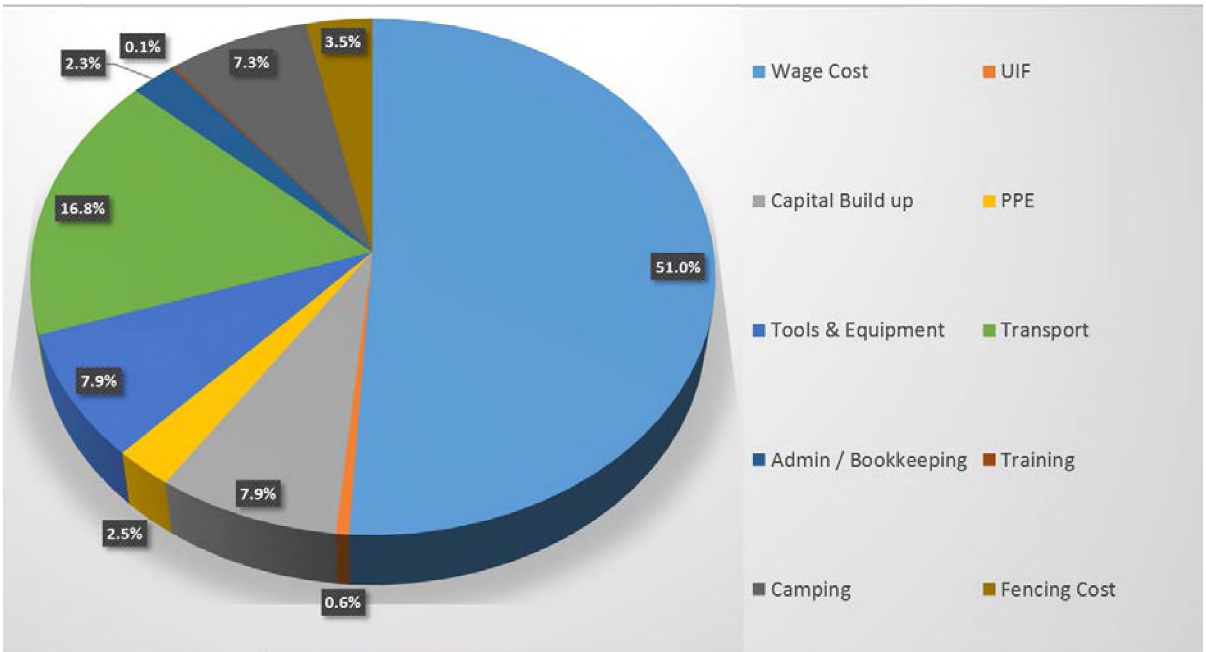


Figure 14. Pie chart showing total expenditure to date by category by the Gamtoos Irrigation Board. Expenditure pertains to the planting of *P. afra* in degraded regions of the Baviaanskloof Nature Reserve, Baviaanskloof Hartland, the Addo Elephant National Park and the Great Fish River Reserve, and through private contractors in the Peddie region.

Data Source: Knipe, Pers. Comm. (2016)

Notes: UIF stands for unemployment insurance fund expenditure and PPE stands for personal protective equipment expenditure. Figures represent the respective percentage of the total expenditure, rounded to one decimal place.

A total of 917 people have been employed to date by the Gamtoos irrigation Board for these land restoration projects (Knipe, Pers. Comm., 2016). Knipe (Pers. Comm., 2016) specifies that these employees were unemployed beforehand and are from poor surrounding rural communities. Knipe (Pers. Comm., 2016) and Buckle (Pers. Comm., 2016), the provincial coordinator and technical adviser for the Eastern Cape's Working for Wetlands program, both suggest that these restoration projects have the potential to augment poverty alleviation in these surrounding rural communities through job creation and the multiplier effect. The economic multiplier effect refers to the cascading effect that new or increased income in one sector has on other sectors (Jacobsen *et al.*, 2014). New employment opportunities in the land restoration for carbon credit sector in the Eastern Cape may, therefore, have a positive effect on other sectors within the communities where labour is sourced.

The expenditure side of these projects is not limited to land restoration fees (Powell, Pers. Comm., 2016). For these projects to be able to sell carbon credits, they need to be formally accredited by a regulatory body such as the CDM. There are currently about 16 different regulatory bodies in existence, each with their own methodology (Powell, Pers. Comm., 2016). Powell (Pers. Comm., 2016) points out that many these methodologies are not geared towards the South African context making validation cumbersome. To attain validation, a baseline measurement of the current level of carbon sequestration needs to be conducted and a project specification needs to be drawn up. This includes any social impacts that the project may have, methods that will be used to prevent 'carbon leakage', where carbon gained is lost elsewhere in the region due to anthropogenic activity, and a monitoring and management plan (Powell, Pers. Comm., 2016). Powell (Pers. Comm., 2016) states that the STRP has gained carbon accreditation through the Verified Carbon Standard (VCS).

Powell (Pers. Comm., 2016) estimates that validation, auditing and baseline measurements can cost around ZAR 2 000 000 on an average sized (5000 ha) project, depending on which regulatory body is used. Each time carbon credits are sold, an audit is required which incurs transaction costs (Powell, Pers. Comm., 2016). Powell (Pers. Comm., 2016) suggests that credits should be sold every 5 to 6 years to maintain cash flow and avoid excessive auditing costs. The amount of carbon that can be captured through *P. afra* growth plateaus between 30 and 50 years meaning that cash flow will not be maintained into perpetuity (Powell, Pers. Comm., 2016). Only the additional carbon captured can be sold after each audit and after 30 to 50 years, *P. afra* reaches an upper limit. Thereafter, additional carbon capture begins to decline and taper off due to natural growth processes (Powell, Pers. Comm., 2016).

Unofficial voluntary variants also exist (Powell, Pers. Comm., 2016). These involve corporations voluntarily offsetting a given amount of emissions by granting a private landowner a given amount of funding under a 'goodwill agreement' (Powell, Pers. Comm., 2016). The 'goodwill agreement' entails that the landowner will offset the given amount of emissions through land restoration without being required to attain accreditation.

Powell (Pers. Comm., 2016) and Kruger (Pers. Comm., 2016), a private landowner in the Eastern Cape who has made land available for carbon restoration, both state that the exorbitant upfront costs and long-term commitment required for these carbon restoration projects have hindered buy-in from private landowners. This stems from the opportunity cost involved. Kurzban *et al.* (2013: 664) describe an opportunity cost as being, 'the value of the next best alternative to the current choice'. In the case of Kruger (Pers. Comm., 2016), the opportunity cost of participating in a land restoration for carbon credit program is the loss of income from livestock farming. Kruger (Pers. Comm., 2016) estimates the opportunity cost of allotting 1500 ha of his land to restoration at roughly ZAR 3 600 000 in net profit over the 15-year tenure agreement, in nominal terms. Kruger (Pers. Comm., 2016) states that, should there have been no financial support from the various South African governmental programs, there would have been no economic incentive for private landowners to participate in land restoration programs for carbon credit, given the exorbitant costs involved and the long waiting period between the planting of *P. afra* and gaining carbon credits. Powell (Pers. Comm., 2016) points out that the exorbitant costs of these projects require public-private sector partnerships to be sustainable in terms of funding, as the government is unlikely to sustain the full cost alone to perpetuity. Theoretically, these costs should be borne by firms who are emitting GHGs to internalise their external costs of production into their production process (Stern, 2007; Tietenberg and Lewis, 2014). Machingambi (Pers. Comm., 2016), a senior economist within the environmental and fuel taxes division at the SANT, states that South Africa's proposed carbon tax aims to achieve this goal.

Despite the low international carbon prices, exorbitant costs involved, and no income from the projects for at least the first 5 to 6 years, each of the key informants interviewed were optimistic about the financial future of these projects (Buckle, Pers. Comm., 2016; Knipe, Pers. Comm., 2016; Kruger, Pers. Comm., 2016; Machingambi, Pers. Comm., 2016; Powell, Pers. Comm., 2016). This optimism stems from the South African National Treasury's proposal to introduce a carbon tax with an offset allowance for polluting firms which may be sourced from carbon credit restoration projects such as STRP (South African National Treasury, 2013). Machingambi (Pers. Comm., 2016) states that the proposal is currently at the final stage prior to implementation, awaiting approval from South African Parliament.

Machingambi (Pers. Comm., 2016) states that the proposed carbon tax will allow carbon offsets to be obtained through the international carbon market by firms to fulfil a limited amount of their carbon tax obligations. Ideally, firms would choose to rather offset their emissions domestically, thereby, supporting local carbon initiatives (Machingambi, Pers. Comm., 2016). Given the low international carbon prices and oversupplied markets, Buckle (Pers. Comm., 2016) suggests that it would be more viable for projects to sell credits on a local carbon market driven by a local carbon control regime. Although South Africa does not currently have one, the SANT anticipates that the proposed carbon tax will lead to a local carbon market being formed in the future (Machingambi, Pers. Comm., 2016). Machingambi (Pers. Comm., 2016) also states that the South African government is considering forming their own regulatory body to verify carbon credits with a methodology which is specific to the South African context. The intention is to 'streamline' the domestic verification process and reduce the costs of accreditation, thereby, encouraging firms to initiate domestic offset projects. This idea resonates well with Jonas *et al.*'s (2010) suggestion of scaling-down international and national carbon regimes to the local and regional scale by means of creating territorial carbon control regimes. This would create an 'alternative economic space' around carbon which could possibly enable sustainable LED (Jonas *et al.*, 2010).

Although the carbon tax is expected to be implemented from the 1st of January 2017 (The Carbon Report, 2016), Powell (Pers. Comm., 2016) states that the known land restoration projects for carbon credit in the Eastern Cape using *P. afra* are not, as yet, selling any carbon credits, despite being in existence for over a decade. This is due to parts of the STRP being initiated before verification was obtained, making accurate baselines measurements difficult to obtain, as well as environmental and social obstacles to be discussed in the following sections. These projects, therefore, are not yet ready to participate in South Africa's proposed carbon tax offset program and are still experimental in nature (Buckle, Pers. Comm., 2016; Powell, Pers. Comm., 2016).

This section has highlighted the major costs involved in carbon restoration projects using *P. afra*. The funding available from various government programs seems to have allowed these projects to continue despite the lack of carbon sales. Notwithstanding the lack of carbon sales, key informants view these carbon restoration projects as being financially viable in the long-run, citing South Africa's proposed carbon tax as the source of their optimism. Nonetheless, these projects will not be able to participate in South Africa's proposed carbon tax offset program, as they are still at the experimental stage. The following sections consider factors pertaining to social justice and environmental protection to assess the extent to which these projects are enabling sustainable LED, based on Connelly's (2007) framework for sustainable development.

7.3.2. Considerations for Social Justice

Connelly (2007) argues that, to attain sustainability, the development process should consider elements of social justice and environmental protection as well as economic growth. To achieve sustainable LED based on natural resources, a similar process should be followed (Polak and Snowball, 2016). This section considers opportunities and challenges for social justice regarding carbon credit restoration projects in the Eastern Cape using *P. afra*.

Although the multiplier effect generally refers to cascading economic effects in the literature (Jacobsen *et al.*, 2014), a study by Crul *et al.* (2016) shows that the multiplier effect can also refer to the advancement of intergenerational social capital through new opportunities for upward mobility. Crul *et al.* (2016) identify education as being at the source of these opportunities, particularly for low-educated individuals. New employment opportunities coupled with training, therefore, may offer potential for LED through capacity building and improving social capital.

Knipe (Pers. Comm., 2016) and Buckle (Pers. Comm., 2016) both state that the Expanded Public Works Program requires any funding granted to be used to fulfil set requirements regarding social upliftment. The South African Department of Public Works (2015) states that 55% of employees working for projects under the Expanded Public Works Program must comprise of both women and youth, where youth are workers between the ages of 16 and 35. Unemployment has been stubbornly higher amongst women and youths in South Africa, being at 29.1% amongst women compared to 24.6% amongst men, and 37.5% amongst youths aged between 15 and 34 years old during the second quarter of 2016 (Statistics South Africa, 2016). The South African Department of Public Works (2015) also states that employees should be sourced locally, that workers be sourced from poor households, and be unemployed. Given South Africa's historically significantly high inequality rates, encapsulated in the GINI coefficient (The World Bank, 2016), these projects may, therefore, provide an opportunity to alleviate inequality and promote social justice within the region.

The Expanded Public Works Program requires employers to provide their employees with a set amount of training (South African Department of Public Works, 2015). The Gamtoos irrigation Board has allotted a total of 77 days of training for their employees to date (Knipe, Pers. Comm., 2016). Employees are trained in the following respects: first aid; health and safety, including HIV and aids; basic numeracy and book keeping skills; and in-field training for tool use and herbicide application (Buckle, Pers. Comm., 2016; Knipe, Pers. Comm., 2016). The skills learned are mostly transferable, with the objective being to enable employees to become entrepreneurs and better enable employees to find work in other sectors once the projects have ended (Buckle, Pers. Comm., 2016). Buckle (Pers. Comm., 2016), however, points out that these comprehensive training requirements are not applicable to privately funded land restoration for carbon initiatives.

An issue noted by both Powell (Pers. Comm., 2016) and Buckle (Pers. Comm., 2016) is that employees are trained chiefly in what to do rather than why they are doing it. This creates a gap in environmental awareness regarding the effects of climate change and the importance of land restoration, as well as in preventing further degradation through pastoralism. Pastoralism poses a serious threat to the sustainability of these projects, being the primary cause of the land degradation to begin with (Buckle, Pers. Comm., 2016; Knipe, Pers. Comm., 2016; Powell, Pers. Comm., 2016).

An issue noted by both Buckle (Pers. Comm., 2016) and Powell (Pers. Comm., 2016) is that landowners who buy into these projects are without income for at least 5 to 6 years. Landowners generally do not engage in land restoration themselves but rather allow contractors to conduct the land restoration for them (Buckle, Pers. Comm., 2016; Powell, Pers. Comm., 2016). Since funding is available from the government for these projects, the biggest cost to landowners who buy into these agreements is the loss in income from the land. Livestock owners, therefore, may be incentivised to contravene the land user agreement and continue to allow livestock to browse on restored land. Using Angelovsk *et al.*'s (2016) notion of free-riding, this would occur when landowners do not bear the full costs of land degradation within these projects. Free-riders, in this case, may render these projects unsustainable. This ties into market failure due to a lack of well-defined property rights, as the exclusivity and enforceability characteristics become unenforced (Tietenberg and Lewis, 2014). Buckle (Pers. Comm., 2016) recommends that fences be used to enforce property rights and to prevent pastoralists from continuing to graze on restored land, however, this adds to the costs of the projects.

7.3.3. Considerations for Environmental Protection

To holistically consider whether carbon credit restoration projects in the Eastern Cape offer potential for sustainable LED, considerations for environmental protection should be included in the development process (Connelly, 2007; Polak and Snowball, 2016). This section considers opportunities and challenges for environmental protection regarding carbon credit restoration projects in the Eastern Cape using *P. afra*.

The Eastern Cape is stated as being amongst the most vulnerable provinces in South Africa in terms of climate variability and climate change (Clarke *et al.*, 2012). The province has also sustained high levels of soil erosion and vegetation degradation through overgrazing which poses a long-term threat to farmers' livelihoods. Clarke *et al.* (2012), thus, propose that carbon credit restoration projects using *P. afra* may prove a useful tool in abating climate change and maintaining livelihoods. Buckle (Pers. Comm., 2016) points out that these land restoration projects also prevent topsoil runoff, preventing sediment build up in rivers and dams, as well as promote groundwater regeneration. These projects, thus, generate water benefits for surrounding communities as well (Buckle, Pers. Comm., 2016).

P. afra is used in land restoration projects for carbon credit not only because of its impressive carbon sequestration ability but also because it acts as an ecosystem engineer (Van der Vyver *et al.*, 2013). Van der Vyver *et al.* (2013: 742) define an ecosystem engineer as 'an organism that physically creates, maintains or modifies habitats by causing physical state changes in abiotic and biotic materials and thus governs the accessibility of resources to other organisms within the system.' In the case of *P. afra*, planting the species in degraded regions can boost the regrowth of canopy species along with other components of thicket biodiversity (Van der Vyver *et al.*, 2013). Powell (Pers. Comm., 2016) points out, however, that, although *P. afra* may be viewed as an ecosystem engineer, the biodiversity benefits may fall away, should it be planted in regions that fall outside of the subtropical Albany Thicket biome (shown in figure 7) to which it is endemic. Such an action may pose a threat to environmental protection as it may result in biodiversity loss rather than biodiversity regeneration (Powell, Pers. Comm., 2016).

Another environmental concern noted by Knipe (Pers. Comm., 2016) is that certain regions may be degraded beyond restoration. The lack of soil nutrients in heavily degraded land may be contributing to the high mortality rates and low growth rates of planted *P. afra* in the Eastern Cape's carbon restoration projects (Knipe, Pers. Comm., 2016). Extreme overgrazing leads to erosion which results in topsoil runoff and nutrient loss (Pimentel, 2006). The result is stunted plant growth which poses a serious threat to the ecosystem (Pimentel, 2006). The high mortality and growth rates may also be linked to unexpected browsing and trampling by game in state protected regions which are being restored through these projects (Buckle, Pers. Comm., 2016). Buckle (Pers. Comm., 2016) is currently working with several research institutions, including Rhodes University and Nelson Mandela Metropolitan University, to find a new and improved planting method which would improve growth and reduce mortality rates. The aim is to boost cost efficacy and improve carbon sequestration rates through increased growth rates which would boost the financial practicality of these projects.

Table 4 summarises the findings from chapter 7, using Connelly's (2007) framework for sustainable development as a lens through which to view the findings.

Table 4. Sustainability analysis of carbon credit restoration projects in the Eastern Cape based on the planting of *Portulacaria afra*

Sustainable Development Indicator	**Opportunities**	**Challenges**
Environmental Protection	• Climate change mitigation • Water benefits • Viewing *P. afra* as an ecosystem engineer	• Overgrazing through pastoralism and browsing • Planting *P. afra* outside the subtropical Albany Thicket biome

Economic Growth	• Job creation • Economic multiplier effect • Voluntary 'goodwill' offset agreements eliminate a large amount of cumbersome accreditation requirements and expenditure • Government funding available • South Africa's proposed carbon tax with an option for polluting firms to offset a limited amount of emissions	• Sufficient buy-in required from private sector • Exorbitant upfront costs • Opportunity cost associated with land use • Returns take at least 5-6 years • Cash flow from projects does not extend to perpetuity • Systemically oversupplied international carbon markets
Social Justice	• Job opportunities geared towards alleviating inequality • Capacity building and building social capital through education and training • Skills geared towards encouraging entrepreneurialism *	• Limited requirements for private investors in terms of social justice • Free-riding

Source: Own data analysed through the lens of Connelly's (2007) framework for sustainable development.

Notes: * Skills geared towards encouraging entrepreneurialism is an opportunity for both social justice and economic growth. Given the extreme inequality in South Africa, the author saw fit to list this as an opportunity for social justice.

7.4. Conclusion

This section has highlighted the most prominent opportunities and challenges found within the Eastern Cape's carbon credit restoration projects using *P. afra*, with input from the key informant interviews, data, and literature analysed. Although potential for sustainable local economic development was found, there are also corresponding challenges. Various government programmes have provided funding for these projects, allowing them to continue despite no carbon sales being made, as yet. Nonetheless, the systemically oversupplied carbon markets offer limited returns for future carbon credit sales. Although, South Africa's proposed carbon tax may allow a local carbon market to form in the future which may create additional demand for locally sourced credits. This may allow an 'alternative economic space' to form, as suggested by Jonas *et al.* (2010), which would be conducive to sustainable local economic development.

Chapter 8. Concluding Remarks

Climate change has been identified as a global issue which is widely believed to be induced by anthropogenic activity (Stern, 2007). The effects are believed to have a particularly detrimental effect on southern Africa (Lotz-Sisitka and Urquhart, 2014). The detrimental effects of climate change pose a serious environmental, social, and economic threat which prompts an urgent global response (Stern, 2007). Even if greenhouse gases in Earth's atmosphere were to stabilise, the effects are projected to continue for the next few hundred years, requiring responses through both adaptation and mitigation (Stern, 2007; Tietenberg and Lewis, 2014).

The global political arena has seemed to lag behind the scientific community regarding the acceptance of, and responding to, the environmental, social, and economic threat which climate change poses (Ross *et al.*, 2016). The Kyoto Protocol and the Paris Climate Change agreement have been the most noteworthy global political responses to date (Robbins, 2016). Authorities can use environmental economic theory to respond to climate change in the form of command-and-control, carbon taxes, and cap-and-trade policy (Tietenberg and Lewis, 2014). Contemporary environmental economic literature shows that carbon taxes are preferable when the efficient price is known to authorities, whereas, cap-and-trade emission trading schemes are preferred when the mandate is to reduce emissions by a known amount (Weitzman, 2013). Although the Kyoto protocol attempted to incorporate a global market based response to climate change, it resulted instead in splinter markets forming as sovereign carbon control regimes emerged (Newell *et al.*, 2013). It did, however, seem to initiate a trend to offset emissions which seems to have been included in most of these sovereign carbon control regimes, including South Africa's proposed carbon tax. The potential for carbon offset programs using *P. afra* prompted the South African Department of Environmental Affairs' Natural Resource Management Program to initiate the Subtropical Thicket Restoration Programme (Sigwela *et al.*, 2014). The intention was to create a proof of concept for the planting of *P. afra* for carbon credits, thereby, creating room for development in an emerging global industry (Clarke *et al.*, 2012).

This half-thesis set out to assess the extent to which carbon markets are enabling sustainable local economic development, based on carbon restoration projects in the Eastern Cape province of South Africa using *P. afra*. Using the European Union's Emissions Trading

Scheme, the Regional Greenhouse Gas Initiative, and the Clean Development Mechanism as examples, the international carbon markets were found to be systemically oversupplied, keeping prices systemically low. Although the prospect for carbon offset programs seems to be weak at this stage, given the state of the international carbon markets, perhaps carbon credit restoration projects in the Eastern Cape province of South Africa using *P. afra* may still be able to offer local landowners a means to engage in locally-driven adaptation to, and mitigation of, climate change. These projects also have the potential to change local livelihoods whilst, at the same time, advancing income in the long-term. Carbon offsets projects also have the potential to result in co-benefits (Robinson *et al.*, 2016; South African National Treasury, 2014). These co-benefits may have the potential to promote sustainable local economic development, which may stem from the following environmental, economic, and social opportunities by restoration projects (summarised in table 4).

P. afra has the potential to promote biodiversity, sequester carbon, and increase groundwater infiltration. Voluntary offset agreements and sporadic large investments may bolster investment in and demand for these projects, along with South Africa's proposed carbon tax which aims to create a local carbon market in the future, given the inclusion of offset allowances. A local carbon market offers the opportunity to 'scale-down' international carbon control regimes to the local and regional level, creating an 'alternative economic space' which may be conducive to sustainable local economic development (Jonas *et al.*, 2010). These projects have the potential for job creation, capacity building, generating social capital, as well as encouraging entrepreneurialism.

There are corresponding challenges, however. Excessive overgrazing may render degraded land beyond restoration. *P. afra* may be planted outside of its natural biome resulting in biodiversity loss. The projects require exorbitant upfront expenditure and will not see a return for at least 5 to 6 years resulting in a large opportunity cost for landowners. Projects do not provide perpetual income. Current government funding for carbon restoration projects in the Eastern Cape is limited and uncertain to continue. Opportunities for capacity building, developing social capital, and encouraging entrepreneurialism are a requirement for government funded projects and are less likely to be incorporated into privately funded projects. Given the large opportunity cost involved, available government funding, and length of time required for the projects to generate income, landowners and pastoralists may be incentivised to free-ride. This free-riding may stem from a lack of well-defined property rights.

The introduction of a carbon tax in South Africa offers a means to factor in the external costs of production of greenhouse gas emitting firms into their respective production processes. This provides a theoretically economically efficient approach to mitigating climate change (Stern, 2007). The introduction of this tax may create a local market for carbon credits, creating an enabling environment for a bottom-up carbon market and climate change policy landscape to form, which would resonate well with local economic development. This would aid in the fulfilment of South Africa's development objectives as well as South Africa's climate change mitigation objectives. Perhaps some of the future revenue from the proposed carbon tax can be used to help initiate further carbon restoration projects or be used to compensate landowners and pastoralists for their loss of income in the interim, limiting the incentive to free-ride.

As it stands, the Subtropical Thicket Restoration Programme has not yet resulted in a working commercial model. This is due to the high mortality rates and low growth rates associated with the current planting method as well as unauthorised pastoralism and unexpected browsing and trampling from game. As such, carbon credit restoration projects in the Eastern Cape province of South Africa using *P. afra* are still highly speculative and carry a significant amount of investment risk, especially privately funded projects. The systemically oversupplied carbon markets indicate that returns from carbon investments at this stage are very limited and will continue to be so until this issue is adequately addressed within the markets. Should these issues be solved, carbon credit restoration projects in the Eastern Cape using *P. afra* may be able to serve as a tool in enabling sustainable local economic development whilst, at the same time, promoting investment in impoverished regions of the province.

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Appendix I. Sample Questionnaire

Background Information

Thank you for your interest in my study. As you may be aware, a number of carbon credit restoration projects have emerged in the Eastern Cape which involve the planting of spekboom to generate carbon credits. These carbon credits may then be sold off in the international carbon markets, should they be successfully generated.

As part of my master's half-thesis, under the auspices of Rhodes University's department of economics and economic history, I wish to find out more about the impact that these projects are having on local economic development and their sustainability. As a key stakeholder in the industry, I wish to find out more from you about some of the success and constraining factors in the industry, which may be contributing towards or hindering sustainable local economic development.

Your participation in this research is purely voluntary and you may withdraw from the study at any point. You do not have to answer all the questions if you do not wish to do so. The information that you provide will be recorded under your name and title, however, if you wish for your answers to be recorded anonymously or by title only, that is also fine. In the instance of a face-to-face interview, the interview will also be voice recorded for the sole purpose of capturing accurate information, however, if you do not want the interview to be recorded, that is also fine.

Are you happy to carry on with this interview under these circumstances? (Please strike out whichever is not applicable) **YES/NO**

RHODES UNIVERSITY

INFORMED CONSENT FORM

Department of Economics and Economic History

Research Project Title:	Carbon Credit Restoration Projects in the Eastern Cape Province of South Africa: Considerations for Sustainable Local Economic Development
Principal Investigator(s):	James Polak

Participation Information
• I understand the purpose of the research study and my involvement in it • I understand that I may withdraw from the research study at any stage without any penalty • I understand that participation in this study is done on a voluntary basis • I understand that while information gained during the study may be published, I have the option to not be personally identified in the publication, should I choose to remain anonymous • I understand that I will receive no payment for participating in this study • I understand that this interview may be voice recorded (with my permission) for the sole purpose of capturing accurate information and that this recording will not be shared with anyone other than the interviewer **I wish to remain anonymous or by title only (please strike out whichever is not applicable): YES/NO** **If YES, please specify:** ____

Information Explanation
The above information was explained to me by: James Polak
The above information was explained to me in: English and I am in command of this language.

Voluntary Consent		
I, , hereby voluntarily consent to participate in the above-mentioned research.		
Signature:	Witness signature:	Date: / /

Investigator Declaration	
I, James Polak, declare that I have explained all the participant information to the participant and have truthfully answered all questions asked by the participant.	
Signature:	Date: / /

Questions

1. Please explain your role in the Eastern Cape's carbon credit industry.
2. What role does the national, provincial, and local government play in the industry?
3. What sort of costs are involved in these projects? Are you able and willing to provide any financial information? Otherwise, rough estimates are fine.
4. Generally speaking, what would land be used for, should it not be used for carbon restoration projects?
5. In your opinion, do you see these projects as being financially viable in the long run, relative to other land use, such as livestock farming? Please elaborate.
6. Are the projects that you are involved with funded privately or by the government, or both and in roughly what proportion? E.g. 60% private, 40% government funded
7. In your experience, do carbon projects generally provide any training to employees? If yes, what sort of training do they provide and are the skills transferable?
8. How many employees are generally involved in these projects, both skilled and unskilled?
9. Do these projects have any social impact on the communities surrounding them, such as education programs, word-of-mouth knowledge transfer regarding the severity of climate change and the importance of these projects, or any other form of social impact? Please elaborate.
10. What sort of impact do these projects have on the local environment?
11. The South African treasury has proposed an introduction of a carbon tax starting next year (2017) with the option for firms to offset 5-10% (depending on the sector) of their emissions by buying carbon credits from carbon projects. In your opinion, do

you think that this tax will result in more of these projects being started and promote existing ones?

12. In your opinion, what factors are holding these restoration projects back, if any?
13. Is there any other information that you would like to add regarding the social, economic, or environmental impact that these projects have on people living in the Eastern Cape?