



Linking sustainable local economic development to a market-based carbon control regime: Carbon restoration projects in the Eastern Cape province of South Africa using *Portulacaria afra*

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Orientation: There is growing interest in how international climate change mitigation and adaptation programmes play out at the local level.

Research purpose: The aim of this study was to investigate the link between land restoration and carbon sequestration projects in the Eastern Cape, using *Portulacaria afra* (Spekboom), and market-based approaches to address global climate change.

Motivation for the study: The Eastern Cape is one of the poorest areas of the country, and there is great emphasis on the establishment of economically and environmentally sustainable, as well as socially just, local economic development (LED) initiatives. However, LED projects are often not sustainable in the long run.

Research design, approach and method: A mixed methods design, using data on international carbon markets, and key stakeholder interviews with those involved in LED land restoration programmes, was used. Qualitative results were analysed using Connelly's (2007) framework for sustainable development, which included indicators for environmental protection, economic growth and social justice.

Main findings: Stakeholders perceive the long-term financial sustainability of such projects as resting on their ability to earn carbon credits, despite the current very low international carbon prices.

Practical/managerial implications: The long-term success of carbon-based restoration projects may depend on the establishment of a local carbon market or continued public funding. Upfront costs of land restoration projects are high and return only starts years later.

Contribution/value-add: The establishment of a South African carbon market that helps carbon sequestration LED projects to meet the technical and administrative requirements needed to sell carbon credits will be an important determinant of their sustainability.

Keywords: local economic development; climate change; sustainability; Spekboom; carbon control regimes.

Introduction and research objective

Climate change has been identified as a serious environmental, social and economic global threat which is widely believed to be induced by anthropogenic activity (Stern 2007). Africa is particularly vulnerable to climate change, partly because of its insufficient adaptive capacity to cope with the changes amid developmental stresses (Callaway 2004; IPCC 2007; Stringer et al. 2009).

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 Bulkeley and Betsill (2003) argue that the response to climate change is an opportunity for localities to reposition themselves as potential destinations for new forms of low-carbon-based investments and partnerships. Jonas, While and Gibbs (2010) add that contemporary environmental issues are having an increasingly important impact on the politics and practice of regional and local economic development (LED). In South Africa, there is a growing awareness of the importance of incorporating climate change mitigation into future local development initiatives (Faling, Tempelhoff & Van Niekerk 2012; Rogerson 2016).

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Portulacaria afra, commonly known as Spekboom, is endemic to the subtropical Albany Thicket biome which falls in the south-west region of South Africa. *P. afra* grows in semi-arid conditions and sequesters a remarkably large amount of carbon, relative to its height and water uptake (more than 20 kg/m²/annum). As such, *P. afra* is being used for land restoration projects which are part of LED strategies in the Eastern Cape province of South Africa, with the expectation of earning carbon credits on national and international markets in the future (Curran et al. 2012; Sigwela, Cowling & Mills 2014).

Sustainable local economic development involves the incorporation of environmental protection, economic growth and social justice in the development process (Polak & Snowball 2016). However, LED projects have not always been successful in South Africa. This article seeks to establish a link between sustainable LED and a market-based approach to addressing global climate change, using *P. afra* carbon credit restoration projects in the Eastern Cape.

Literature review

Adaptation can be described as a strategy that involves those most affected by climate change deliberately adopting social and environmental strategies that prepare them for 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, for example drought early warning systems, or 'autonomous, locally driven adaptation' which takes a bottom-up approach, for example changing the dominant community livelihood strategy (Stringer et al. 2009:749).

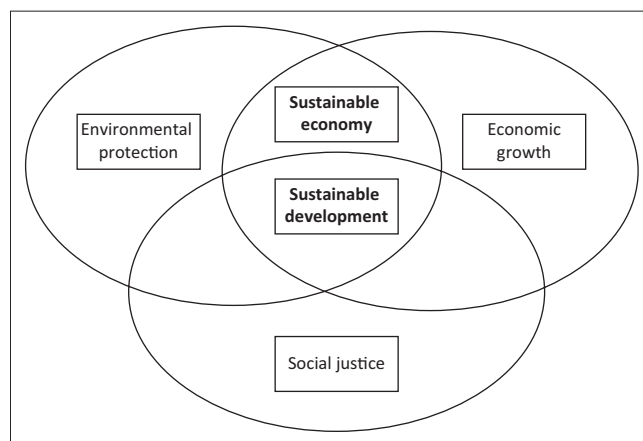
Although this global issue requires an urgent global response (Stern 2007), Ostrom (2012) argued that a global solution is not necessarily realistic. For a global solution to work, it needs to be backed up at the national, regional and local level. Ostrom (2012) goes on to argue that a polycentric collective approach should, thus, be taken. 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.

Despite international agreements about technical climate change adaptation support that should be provided to developing countries, many African countries have struggled to draw on the Clean Development Mechanism (CDM) carbon credit projects. This is despite efforts by the European Union to prioritise carbon credits from least developed countries on their European Union Emissions Trading Scheme (EU ETS) (Kreibich et al. 2016; Lambe et al. 2015). Kreibich et al. (2016) attribute this to the high upfront costs involved with these projects and the collapse in carbon prices, rendering them financially infeasible.

There are linkages between development and responses to climate change (African Development Bank et al. 2003; Giannini et al. 2008; Schipper 2007; Stringer et al. 2009; Twomlow et al. 2008; Yohe et al. 2007). Katircioglu, Dalir and Olya (2016) argue that projects under the Kyoto Protocol's CDM have the potential to generate economic, social and environmental benefits in developing countries.

Connelly (2007) defines sustainable development as development that occurs within the constraining bounds of three broad spheres of concern: the environment, the economy and society. He argues that development projects may have a focus on one sphere of concern (either environmental protection, or economic growth, or social justice) 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 1).

Connelly (2007) points out that sustainable development occurs where the three spheres converge. 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. Environmental sustainability issues can debilitate LED projects. For example, Bek, Binns and Nel (2013) argue that LED projects based on harvesting of wildflowers within the Cape Floristic Region of South Africa have led to the endangerment of certain endemic species. During South Africa's apartheid era prior to 1994, South African municipalities implemented LED projects that were limited in scope and that were predominantly restricted to the country's largest cities (Rogerson 2010, 2014). Arguably, this added significantly to the extreme inequality which is currently present in South Africa (Bek et al. 2013).



Source: Adapted from Connelly, S., 2007, 'Mapping sustainable development as a contested concept', *Local Environment* 12(3), 264. <https://doi.org/10.1080/13549830601183289>

FIGURE 1: A visual representation of sustainable development.

Post-1994, LED has been advocated as a development strategy in South Africa, with a pro-poor focus (Rogerson 2010, 2014). Local economic development 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 sustainable economic entity, within a global context (Bek et al. 2013).

However, LED initiatives in South Africa post-1994 have been prone to failure (Bek et al. 2013; Nel et al. 2007; Rogerson 2010), much of which can be attributed to backing economically unfeasible community-based initiatives without access to markets (Bek et al. 2013). Factors contributing to this failure include unsuccessful partnerships and lack of 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. South Africa has introduced several policies to mitigate climate change (Klausbruckner et al. 2016), perhaps the most prominent of which is the South African National Treasury's (SANT) 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 has since been postponed to January 2019 (Cronje, Head & Gibson 2018; Klausbruckner et al. 2016). The tax will be implemented incrementally, as part of a suite of climate change mitigation interventions (South African National Treasury 2013). It will start at ZAR 120 tCO₂e and increase by 10% per annum (pa), creating a forecasted peak in Green House Gas Emissions (GHGEs) between 2020 and 2025, a forecasted plateau period in 2035 and an overall decline in GHGEs forecasted from 2036 onwards. The proposed carbon tax will allow the purchase of carbon credits to offset a proportion of emissions (Hood & Guelff 2013; South African National Treasury 2013), which may offer LED projects, based on carbon sequestration, an opportunity to generate income.

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 sustainable LED (Furniss, Cowling & Mills 2014). This article 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) suggest.

Research design

Approach

The mixed methods approach was used to collect both qualitative and quantitative data from government policy documents, literature and key informants in the Eastern Cape's carbon credit industry. Quantitative data on the state of the EU ETS, the Regional Greenhouse Gas Initiative (RGGI)

and the CDM's market for Certified Emission Reductions (CERs) were downloaded from the Thompson Reuters Eikon's suite for monitoring, forecasting, charting and analysis. 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, which was also used to generate the graphs. Results were then triangulated and observed through the lens of Connelly's (2007) framework for sustainable development.

Strategy

The first stage of the research was to determine to what extent international carbon markets provide the potential to sustainably fund local carbon sequestration LED projects. Two international carbon markets based on cap-and-trade regimes were chosen for the analysis: the United States' RGGI and the EU ETS. Relevant historical, current and forecasted supply and demand data for these markets were sourced from Thomson Reuters' Point Carbon research division. Data on average monthly carbon credit future and spot price and trade volume data were examined, using the CER market for comparative purposes.

To investigate the functioning and expectations of carbon sequestration projects in the Eastern Cape, key informants involved with carbon credit restoration projects using *P. afra* were interviewed. Three groups of stakeholders were included: people working on a publicly funded project based on government land; private landowners involved in a carbon credit restoration project; and a researcher involved in projects using *P. afra*. An interview with an official in the SANT completed the local context.

Research method

The mixed method approach was chosen. This 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, that is, a need for a problem-driven approach (Denscombe 2010; Feilzer 2010). This method is particularly useful when there are opposing views on a 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.

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, Lohfeld & Brazil 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, Pizer and Raimi'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.

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 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 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.

Quantitative data were also obtained from the key informants interviewed to establish the costs involved in the carbon credit restoration process. Data in this regard were gathered from the Gamtoos Irrigation Board from the project inception date, during the 2003–2004 financial year, through to the 2016–2017 financial year.

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 & 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, as listed in Table 1. They 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.

TABLE 1: Key stakeholders interviewed.

Respondent	Designation
Respondent A	A researcher for the Rhodes Restoration Research Group at Rhodes University, Makhanda (Grahamstown).
Respondent B	Port Elizabeth's area manager for the Gamtoos Irrigation Board, which has played a direct role in carrying out land restoration projects under the Subtropical Thicket Restoration Programme.
Respondent C	Provincial coordinator and technical advisor for the Eastern Cape's Working for Wetlands programme under the auspices of the South African National Biodiversity Institute (SANBI), who serves as a technical advisor to the Subtropical Thicket Restoration Programme.
Respondent D	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 of <i>P. afra</i> .
Respondent E	A senior economist within the environmental and fuel taxes division at the South African National Treasury who had a direct input into South Africa's proposed carbon tax policy.

Ethical considerations

Ethical clearance was obtained from the Rhodes University Research Ethics Committee (ethical clearance number: ECO2016/1).

Results

The results are presented in two sections: firstly, the analysis of the performance of international carbon markets is analysed and discussed. Secondly, the results of the potential of local carbon sequestration projects to contribute to sustainable LED in the Eastern Cape are presented.

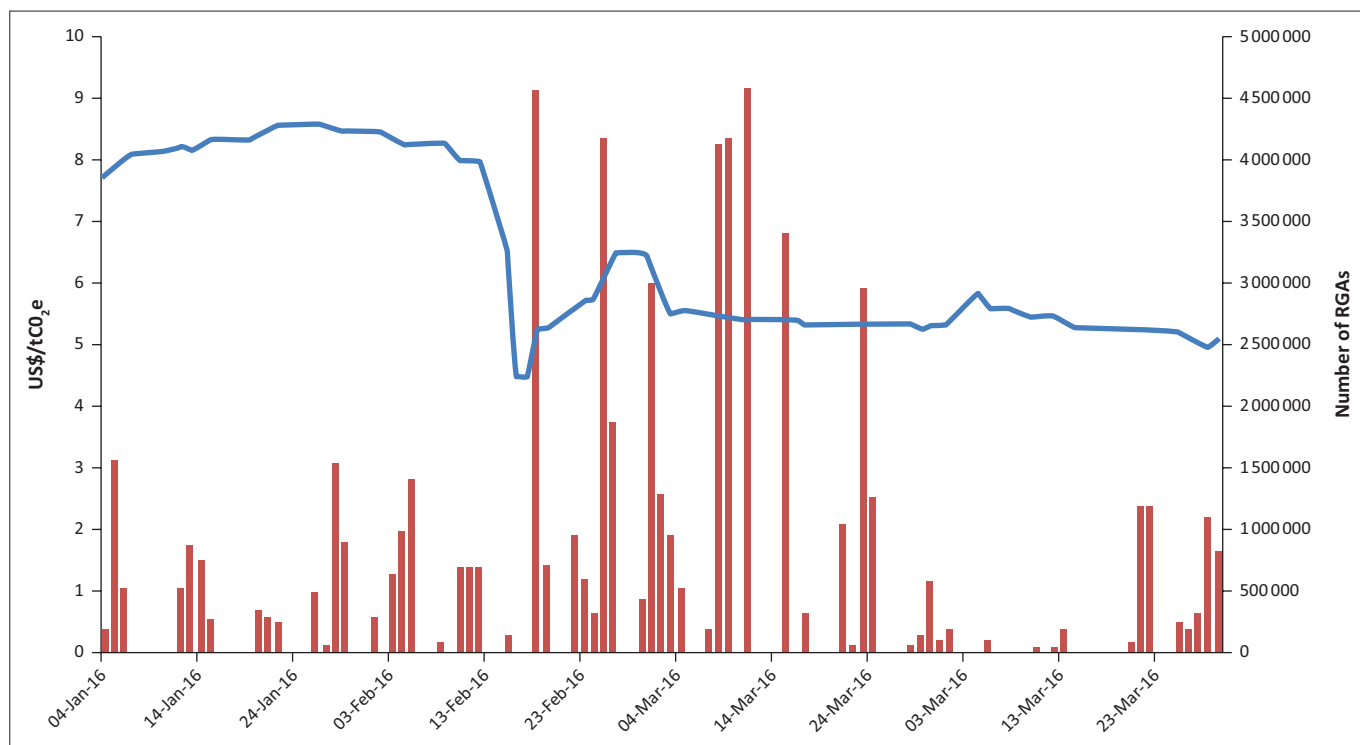
International carbon markets

The 2008–2009 financial crisis had a detrimental effect on global carbon markets (Chan 2009; Hood & Guelff 2013). Chan (2009:153) argues that carbon markets are also subject to speculative market bubbles, and carry credit risk, especially when the carbon credit is sourced from a carbon sequestration project, because of the complex and costly regulatory requirements and long-term nature of these projects (Chan 2009). Between 2006 and 2007, carbon market prices roughly doubled and continued to grow by as much as 84% in 2008 (Chan 2009). However, 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, which caused carbon market prices to collapse (Chan 2009; Kreibich et al. 2016).

The RGGI, the first cap-and-trade scheme introduced in the United States, started in 2009, and was designed as a market-based instrument to reduce GHGs from power producers (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 United States' overall GHGs (91 MtCO₂e), with the aim of reducing carbon emissions by 15% below 2012 levels by 2020. Its market value is €359 000 000 (Thomson Reuters Eikon 2016).

Figure 2 shows the historical spot prices for Regional Greenhouse Gas Initiative permits equivalent to 1 tonne of CO₂ (commonly referred to as 'RGAs') traded on the ICE for secondary permits. 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 tCO₂e on the 12 February 2016 to US\$4.50 on the 16 February 2016, was because of speculators being concerned about the systemic oversupply of RGAs and choosing to sell off many of their RGA holdings. Prices since stabilised around US\$5 tCO₂e.

An indication of how oversupplied the RGGI is can be obtained by examining 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).



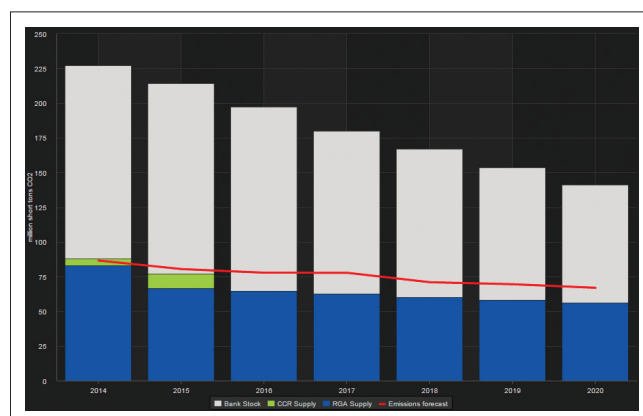
Source: Figure generated in Thomson Reuters Eikon 2016

FIGURE 2: The spot price of RGAs traded in US\$/tCO₂e (line graph) and the number of permits traded between January and April 2016 (bar graph).

Marcello (2016) states that these data show that the supply-to-demand ratio was 2.6:1 in 2016 and was forecasted to decrease to 1.9:1 by 2020. To address the oversupply, the RGGI made the decision to decrease the emissions cap by 2.5% annually between 2012 and 2020 (Marcello 2016). The forecasted RGA supply (where an RGA is a permit equivalent to 1 tonne of CO₂ equivalent traded on the RGGI) in Figure 3 is, thus, based on a decreasing emissions cap of 2.5% pa, which is expected to increase 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, thus reducing the price (Thomson Reuters Eikon 2016).

The EU ETS is currently the largest cap-and-trade ETS in the world by market size and coverage. In 2015, the EU ETS represented about 80% of the world's carbon trading in terms of volume, and 77% in terms of trade value (Thomson Reuters Eikon 2016). The EU ETS is the European Union's central tool for abating GHGs within the European Union (Thomson Reuters Eikon 2016). The scheme allows for a limited number of carbon offset credits obtained through the Kyoto Protocol. The scheme aims to reduce GHGs by 21% below 2005 levels by 2020 (Thomson Reuters Eikon 2016).

Figure 4 shows the amount of industrial emissions produced by firms operating under the EU ETS in the European Union relative to baseline emissions, from 2008, forecasted to 2030. The line graph shows the past, current and forecasted supply and the composite bar graph shows the corresponding demand values. Where the composite bar graph is below the line graph (emissions cap), the market is oversupplied with EU emission allowances or European

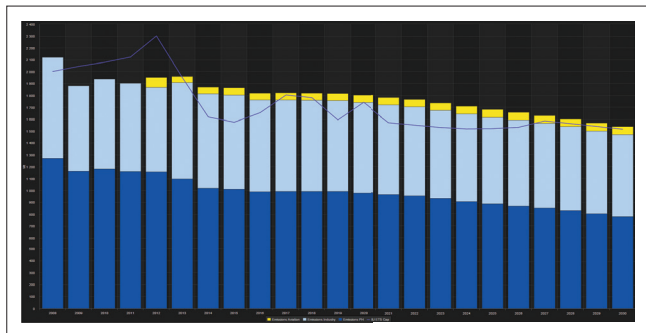


Source: Figure generated in Thomson Reuters Eikon 2016

FIGURE 3: Line graph showing the forecasted emissions by power producers under the Regional Greenhouse Gas Initiative scheme within a composite bar graph showing bank stocked RGAs, RGA supply and cost containment reserve supply in millions of short tons.

Union Allowances (EUAs), where one EUA represents 1 tCO₂e. The total annual cap was set at 2084 MtCO₂e for 2013, excluding the aviation sector and any adjustments such as auctions of the new entrants' reserve (NER) surplus permits (European Commission 2016; Thomson Reuters Eikon 2016). This cap is set to decrease by 1.74% pa. The EU ETS introduced the aviation industry into the scheme in 2012, which has helped to stem the oversupply of permits (Thomson Reuters Eikon 2016). Nevertheless, the analysis shows that, for considerable periods, there was an oversupply in this market as well, decreasing prices.

Hood and Guelff (2013) point out that baseline scenarios do not necessarily consider demand-side economic shocks, such



Source: Figure generated in Thomson Reuters Eikon 2016

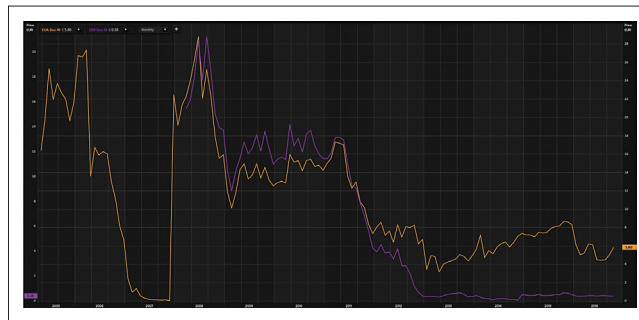
FIGURE 4: Composite bar graph showing the past, current and forecasted emissions by sector (industry in light blue vs aviation in yellow) in the European Union Emissions Trading Scheme baseline scenario. Alongside, a line graph showing the European Union Emissions Trading Scheme emissions cap in MtCO₂e between 2008 and 2030.

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. Phase 3 of the EU ETS, initiated in 2013, has attempted to address the oversupply as well as introduce a uniform EU-wide market cap (European Commission 2016).

As the data in Figure 5 show, the market for CERs has dwindled significantly since the financial crisis. The demand for CERs comes mostly from voluntary offset programmes and from governments fulfilling their Kyoto commitments (Thomson Reuters Eikon 2016). Certified Emission Reductions 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, Thompson Reuters Eikon (2016) argues that there is hope for the CER market beyond the second Kyoto Protocol commitment period, ending on the 31 December 2020 (UNFCCC 2016). The CDM Executive Board has announced that it wishes to extend the CER market beyond 2020, and the International Civil Aviation Organization (ICAO) is set to implement a carbon offset programme 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 CER permits will be allowed, potentially allowing internationally sourced CER permits in the future. There have also been sporadic mass purchases of carbon credits in the aviation industry for voluntary offset programmes. For example, the Delhi International Airport purchased 112 000 domestically sourced CERs in September 2016 (Thomson Reuters Eikon 2016). A careful balance is required to make sure that short-term costs are kept low for firms, while at the same time, prices are high and stable enough so that firms have an incentive to invest in low-carbon technology in the long term (Hood & Guelff 2013).

The examples show that international carbon markets seem to be systemically oversupplied, keeping prices low. The oversupply may also pose a threat to the economic



Source: Figure generated in Thomson Reuters Eikon 2016

FIGURE 5: Line graph showing the average monthly price of European Union Allowance futures (in orange) and Certified Emission Reductions futures (in purple) being traded on the European Climate Exchange, both expiring in December 2016, in €/tCO₂e between April 2005 and October 2016.

sustainability of local economic development initiatives that rely on income from international carbon markets. The Eastern Cape case studies are discussed in the next section.

The potential of carbon sequestration projects to contribute to sustainable local economic development in the Eastern Cape

The potential for carbon restoration projects in the Eastern Cape using *P. afra* has been noted in the literature (Clarke, Shackleton & Powell 2012; Curran et al. 2012; Sigwela et al. 2014) – the planting of *P. afra* on degraded land can result in not only local and regional environmental benefits, but also social and economic development.

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 as being a potentially useful LED strategy for capacity building and job creation. Other potential benefits identified through key stakeholder interviews are the development of public–private sector partnerships, encouraging entrepreneurship, capacity building, creating development links through international carbon markets and enhancing social capital through education and training. 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 & Snowball 2016). The following sections consider some of these factors within the context of carbon restoration projects in the Eastern Cape province of South Africa using *P. afra*.

Considerations for economic growth

Although the international carbon markets seem to be systemically oversupplied, keeping prices low there is still interest in generating carbon credits through Spekboom LED projects in the Eastern Cape. According to Respondent A,

this interest stems from both the private sector and the South African government, at both the national and local level.

Respondent B, the area manager for the Gamtoos Irrigation Board, states that the Board has been mandated to restore degraded regions of publicly owned land, including public nature reserves (the Addo Elephant National Park and the Great Fish River Reserve) as well as some private land. Funding comes from the Department of Environmental Affairs' Working for Water programme, the Department of Agriculture, Forestry, and Fisheries' (DAFF) Natural Resource Management programme and the Department of Public Works' Expanded Public Works Programme. According to Respondent B, the annual budget received from these various government programmes for restoring these lands has grown substantially, from just over 100 000 rand in 2003–2004 to more than 11 million rand in the 2015–2016 financial year.

Private landowners may also receive funding for land restoration through the DAFF Natural Resource Management programme's Land User Incentive. According to Respondents A and B, this funding equates to roughly 150 rand per person per day, although Respondent B estimates that restoration work costs average of 218 rand per person per day. A total of nearly 2000 ha were restored during the 2015–2016 financial year, which included degraded areas, where *P. afra* was planted, as well as 'blanked' areas (Respondent B, 2016). 'Blanking' involves the removal of dead *P. afra* and replanting of *P. afra* where any gaps are formed (Becker 2013). An overview of what sort of costs are involved in these projects, using the Gamtoos Irrigation Board expenditure as an example, shows that the biggest expenditure categories are wages (51% of the total) and transport for workers (17%).

The restoration project has employed 917 people from poor surrounding rural communities who were unemployed beforehand. Respondent B and Respondent C both suggest that these restoration projects have the potential to augment poverty alleviation in these surrounding rural communities.

However, to be able to sell carbon credits, the projects 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 accreditation requirements, and Respondent A pointed out that many of these processes 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. Respondent A estimated that validation, auditing and baseline measurements can cost up to 2 million rand for an average sized (5000 ha) project, depending on which regulatory body is used. Each time carbon credits are sold (every 5–6 years), an audit is required which incurs further transaction costs. Only the additional carbon captured (from the baseline audit) can be sold, and after 30–50 years, *P. afra* reaches an upper limit in terms of carbon sequestration.

At this point, additional carbon capture begins to decline and taper off because of natural growth processes, such as litter fall (Respondent A, 2016).

Unofficial voluntary variants also exist (Respondent A, 2016). These involve corporations voluntarily offsetting a given amount of emissions by granting a private landowner funding under a 'goodwill agreement', where the landowner agrees to offset an agreed amount of emissions through land restoration without being required to attain accreditation.

Respondent D, a private landowner in the Eastern Cape who has made land available for carbon restoration, states 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, which is the loss of income from using the land for livestock farming. Respondent D estimated that the opportunity cost of allotting 1500 ha of his land to restoration was 3.6 million rand in net profit over the 15-year tenure agreement, in nominal terms. Respondent A also noted that the exorbitant costs of these projects require public–private sector partnerships to be sustainable in terms of funding, as neither the government nor private landowners are likely to sustain the full cost alone. Theoretically, these costs should be borne by firms who produce GHGs to internalise their external costs of production into their production processes (Stern 2007; Tietenberg & Lewis 2014). Respondent D, 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, high costs involved and no income from the projects for at least the first 5–6 years, each of the key informants interviewed was optimistic about the financial future of these projects. This optimism stems from the Treasury's proposal to introduce a carbon tax with a carbon offset allowance which may be sourced from carbon credit restoration projects locally or internationally (South African National Treasury 2013).

Given the low international carbon prices and oversupplied markets, Respondent C suggested that it would be more viable for projects to sell credits on a local carbon market. This 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.

The fact remains that land restoration projects in the Eastern Cape using *P. afra* are not yet selling any carbon credits, despite being in existence for over a decade, and are largely supported by the public sector, which may not be sustainable in the long run.

Considerations for social justice

In addition to being economically viable, Connelly (2007) argues that LED projects also need to consider 'social justice'

to be sustainable. New employment opportunities provided by carbon sequestration projects, coupled with training, may offer potential for LED to build capacity and improve social capital (Crul et al. 2016). The South African Department of Public Works (2015), which funds many of these projects, requires that 55% of employees in the Expanded Public Works programme must comprise both women and youth workers. Both groups have suffered high levels of unemployment: 29.8% among women and 32.2% among youth aged 15–24 (Statistics South Africa 2017). The South African Department of Public Works (2015) also requires that employees should be sourced locally, from poor households, and be unemployed.

Funding from the Expanded Public Works programme requires employers to provide 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 (Respondent B, pers. comm., 2016). Employees are trained in a wide range of areas, including first aid, health and safety, HIV and AIDS awareness, basic numeracy and bookkeeping skills, and in-field training for tool use and herbicide application (Respondent C, provincial coordinator and technical advisor for the Eastern Cape's Working for Wetlands programme, pers. comm., 19 October 2016; Respondent B, area manager for the Gamtoos Irrigation Board, pers. comm., 22 September 2016). According to Respondent C, the objective of the training is to enable employees to become entrepreneurs and to find work in other sectors once the projects have ended.

An issue noted by both Respondents A and C is that private landowners, who do not bear the full costs of land restoration (because it is funded by government), have an incentive to contravene the land user agreement by continuing to allow livestock to graze on restored land. Pastoralism poses a serious threat to the sustainability of these projects, being the primary cause of the land degradation to begin with.

To conclude, the public funding provided to land restoration projects currently mandates a pro-poor focus and requires worker education and training that give local communities transferable skills. However, the employment offered by the projects is short term, and private landowners do not have to meet all the training requirements, even when the restoration is publically funded.

Considerations for environmental protection

To determine 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 & Snowball 2016).

The Eastern Cape is among 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) propose that carbon credit restoration projects may prove a useful tool in tackling these issues. Restoration projects also prevent topsoil runoff and promote groundwater regeneration.

P. afra is used in carbon credit projects 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) 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. (p. 742)

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). However, if it is planted in regions that fall outside of the subtropical Albany Thicket biome to which it is endemic, Respondent A noted that it could pose a threat to environmental protection. In some cases, private landowners, who have had their land restored through Spekboom planting projects that were publically funded, have returned to using the land for grazing, thus allowing it to degrade once more.

Table 2 summarises the main findings, using Connelly's (2007) framework for sustainable development as a lens through which to view the findings.

Conclusion

This article explored the potential for local economic development carbon credit projects to be sustainably financed

TABLE 2: 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	<ul style="list-style-type: none"> Climate change mitigation Water benefits Viewing <i>P. afra</i> as an ecosystem engineer 	<ul style="list-style-type: none"> Overgrazing through pastoralism and browsing Planting <i>P. afra</i> outside the subtropical Albany Thicket biome
Economic growth	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Job opportunities geared towards alleviating inequality Capacity building and building social capital through education and training Skills geared towards encouraging entrepreneurialism† 	<ul style="list-style-type: none"> Limited requirements for private investors in terms of social justice Contravention of conservation agreements

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

†, Skills geared towards encouraging entrepreneurialism is an opportunity for both social justice and economic growth.

through international and local carbon markets. The research sought to establish a link between sustainable LED and a market-based approach to addressing global climate change, using *P. afra* (Spekboom) carbon credit restoration projects currently operational in poverty-stricken regions of the Eastern Cape province of South Africa.

Despite the potential of LED projects to tap into local comparative advantage, engage local communities in 'bottom-up' development and to create jobs, they have often not been sustainable in the longer run. Using Connelly's (2007) framework for sustainable development, the article analysed the opportunities and challenges facing carbon sequestration LED projects in the Eastern Cape, linking local environmental LED projects to sustainable development goals in terms of environmental protection, economic growth and social justice.

In terms of economic growth and long-term sustainability, none of the carbon sequestration projects examined was generating income by selling carbon credits. Two examples of international carbon markets based on cap-and-trade regimes are the United States' RGGI and the EU ETS. Analysis showed that both markets are systemically oversupplied, keeping prices low, which may pose a threat to the economic sustainability of local economic development initiatives that rely on income from international carbon markets. Interviews with stakeholders involved in carbon sequestration projects in the Eastern Cape also revealed that the technical and administrative requirements to become a registered carbon credit provider are prohibitive.

Nevertheless, the local Spekboom planting projects continue, expanding over time through the provision of public funding to support the projects. Without continued public funding, such projects are not likely to be sustainable. The carbon tax proposal by the SANT may provide a more promising source of income because it allows for the purchase of carbon credits. It is this local carbon market that Eastern Cape LED carbon sequestration projects are most hopeful will provide sustainable income streams in the future.

In terms of environmental goals of the projects, Spekboom has been shown to be highly effective in carbon sequestration, is indigenous and can grow in semi-arid climates. However, there are some cases where private landowners, who have had parts of their land restored at public expense, have reverted to using the land for grazing, allowing the land to become degraded once more.

Finally, Connelly (2007) argues that sustainable LED projects are also socially just. The public funding for land restoration requires that job opportunities be created for local communities, and that a certain amount of training is offered in skills that can be transferred to other jobs. However, the land restoration work is of limited duration, and not all the training requirements are mandatory for private landowners.

In conclusion, although the Spekboom land restoration projects in the Eastern Cape are meeting some of the requirements for sustainable LED, they are vulnerable in terms of funding. Much depends on how the South African carbon market develops in the future.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

J.P. was the project leader who collected and analysed the data. J.S. was the supervisor who made conceptual contributions to the thesis and helped to write the article.

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Data availability statement

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