

Ecosystem-based approaches to adaptation: strengthening the evidence and informing policy

Research results from the Climate Resilient Livestock Production on Communal Lands project, South Africa

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Summary

Ecosystem-based adaptation (EbA) is the use of biodiversity and ecosystem services as part of an overall strategy to help people to adapt to the adverse effects of climate change. Under the 'Ecosystem-based approaches to adaptation: strengthening the evidence and informing policy' project, IIED, IUCN and the UN Environment World Conservation Monitoring Centre (UNEP-WCMC) are working at 13 sites in 12 countries to gather practical evidence and develop policy guidance for governments on how EbA can best be implemented. The project has developed a definition of effective EbA and a framework for assessing EbA effectiveness which has been applied at all 13 sites and the results will be collated and compared to draw conclusions that are based on more than single case studies. This report presents the findings from a literature review, and interviews with a wide variety of stakeholders conducted by Conservation South Africa at the project site in the Succulent Karoo, South Africa, where activities focused on the rehabilitation of critical rangeland and wetland ecosystems.

The report concludes that wetland restoration had improved access to water and reduced the risk of disasters, and thus improved the resilience and adaptive capacity of some community members. Rangeland restoration takes a long time and while it was too soon to identify specific outcomes from restoration efforts, community vulnerability will be less due to new land management plans and practices. Improvements in ecosystem resilience and services provision were also apparent, particularly following the wetland restoration activities. Semi-arid Succulent Karoo ecosystems may have thresholds relating to overgrazing or climate change, which if crossed could lead to irreversible change. Both the rangeland and wetland restoration approaches were considerably more expensive than other adaptation options, and the rangeland restoration in particular was not financially viable for landowners. Despite this, EbA options provide many broader economic benefits, such as job creation, providing a strong economic case for wider application using government funding channelled through South Africa's expanded public works programmes. Despite a number of policy and institutional barriers to the implementation of effective EbA initiatives, these public works programmes offer great potential for scaling up EbA implementation. Mainstreaming is also occurring as EbA is incorporated into various national policy making and planning processes in South Africa.

Acronyms

CSA	Conservation South Africa
CBD	Convention on Biological Diversity
DEA	Department of Environmental Affairs
EbA	Ecosystem-based adaptation
IIED	International Institute for Environment and Development
IUCN	International Union for Conservation of Nature
PES	Payments for ecosystem services
SDGs	Sustainable Development Goals
UNEP-WCMC	United Nations Environment Programme World Conservation Monitoring Centre
UNFCCC	United Nations Framework Convention on Climate Change

Introduction

The global climate is changing rapidly, and as nations and the international and bilateral organisations and processes that support them plan how best to adapt to climate change, they need evidence on where to focus adaptation efforts and direct financial resources accordingly. The main approach to climate change adaptation to date has tended to involve investment in engineered interventions, such as sea walls or irrigation infrastructure (Jones et al. 2012). There is growing realisation, however, that ecosystem-based adaptation (EbA) may sometimes provide the optimal adaptation solution, particularly for poorer countries where people are more dependent on natural resources for their lives and livelihoods. A growing number of organisations and countries are implementing EbA and integrating it into emerging climate change policy responses (Seddon et al. 2016a; 2016b).

EbA is defined by the United Nations Convention on Biological Diversity (CBD) as the “use of biodiversity and ecosystem services to help people adapt to the adverse effects of climate change as part of an overall adaptation strategy” (CBD 2009). This definition was later elaborated by the CBD to include “sustainable management, conservation and restoration of ecosystems, as part of an overall adaptation strategy that takes into account the multiple social, economic and cultural co-benefits for local communities” (CBD 2010). Examples of EbA include: restoring coastal ecosystems to lower the energy of tropical storms and protect local communities against erosion and wave damage; wetland and floodplain management to prevent floods and to maintain water flow and water quality in the face of changing rainfall patterns; conservation and restoration of forests and natural vegetation to stabilise slopes and prevent landslides, and to regulate water flows preventing flash flooding; and the establishment of diverse agroforestry systems to help maintain crop yields under changing climates. Box 1 describes some of the key attributes of effective EbA, derived from a review of relevant literature (taken from Seddon et al. 2016b).

Box 1: Key attributes of effective ecosystem-based approaches to adaptation (EbA)

1. **Human-centric.** EbA emphasises human adaptive capacity or resilience in the face of climate change.
2. **Harnesses the capacity of nature to support long-term human adaptation.** It involves maintaining ecosystem services by conserving, restoring or managing ecosystem structure and function, and reducing non-climate stressors. This requires an understanding of ecological complexity and how climate change will impact ecosystems and key ecosystem services.
3. **Draws on and validates traditional and local knowledge.** Humans have been using nature to buffer the effects of adverse climatic conditions for millennia. Traditional knowledge about how best to do this should thus be drawn upon when implementing EbA.
4. **Based on best available science.** An EbA project must explicitly address an observed or projected change in climate parameters, and as such should be based on climatic projections and relevant ecological data at suitable spatial and temporal scales.
5. **Can benefit the world’s poorest,** many of whom rely heavily on local natural resources for their livelihoods.
6. **Community-based and incorporates human rights-based principles.** Like community-based adaptation (CBA), EbA should use participatory processes for project design and implementation. People should have the right to influence adaptation plans, policies and practices at all levels, and should be involved with both framing the problem and identifying solutions. EbA initiatives should be accountable to those they are meant to assist and not simply those providing support (ie donors or governments). EbA should consistently incorporate non-discrimination, equity, the special needs of the poor, vulnerable and marginalised groups, diversity, empowerment, accountability, transparency and active, free and meaningful participation.

7. **Involves cross-sectoral and intergovernmental collaboration.** Ecosystem boundaries rarely coincide with those of local or national governance. Moreover, ecosystems deliver services to diverse sectors. As such, EbA requires collaboration and coordination between multiple sectors (eg agriculture, water, energy, transport) and stakeholders. EbA can complement engineered approaches, for example combining dam construction with floodplain restoration to lessen floods.
8. **Operates at multiple geographical, social, planning and ecological scales.** EbA can be mainstreamed into government processes (eg national adaptation planning) or management (eg at the watershed level), provided that communities remain central to planning and action.
9. **Integrates decentralised flexible management structures** that enable adaptive management.
10. **Minimises trade-offs and maximises benefits with development and conservation goals** to avoid unintended negative social and environmental impacts. This includes avoiding maladaptation, whereby adaptation 'solutions' unintentionally reduce adaptive capacity.
11. **Provides opportunities for scaling up and mainstreaming** to ensure the benefits of adaptation actions are felt more widely and for the longer term.
12. **Involves longer-term 'transformational' change** to address new and unfamiliar climate change-related risks and the root causes of vulnerability, rather than simply coping with existing climate variability and 'climate-proofing' business-as-usual development.

Sources: Travers et al. (2012); Jeans et al. (2014); Faulkner et al. (2015); Reid (2014a); Reid (2014b); Girot et al. (2012); Ayers et al. (2012); Anderson (2014); Andrade et al. (2011); GEF (2012); ARCAB (2012); Bertram et al. (2017); Reid et al. (2009).

If properly implemented, EbA can meet objectives under all three Rio Conventions (Seddon et al. 2016b). For example, its emphasis on restoring natural ecosystems and increasing habitat connectivity helps countries meet their commitments under the Convention on Biological Diversity (CBD). EbA often involves maintaining the ability of natural ecosystems to control water cycles or supports effective management regimes for dry areas, and thus aligns with the goals of the United Nations Convention to Combat Desertification (UNCCD). Many EbA activities sequester carbon and some prevent the greenhouse gas emissions that would be emitted from hard infrastructure-based approaches to adaptation, thus helping meet mitigation targets under the United Nations Framework Convention on Climate Change (UNFCCC). EbA promotes sustainability across a range of sectors, including agriculture, forestry, energy and water, and as such could help countries meet their Sustainable Development Goals (SDGs) (Seddon et al. 2016b). Lastly, by increasing the resilience of vulnerable communities to extreme events such as flooding and landslides, EbA helps countries to meet the goals of the Sendai Framework for Disaster Risk Reduction (Renaud et al. 2013).

Despite its strong theoretical appeal, many positive anecdotes from around the world and the acknowledged multiplicity of co-benefits, EbA is not being widely or consistently implemented, or sufficiently mainstreamed into national and international policy processes. Relative to hard infrastructural options, EbA currently receives a small proportion of adaptation finance (Chong 2014). There are four major explanations for this (Biesbroek et al. 2013; Ojea 2015; Vignola et al. 2009; Vignola et al. 2013; Seddon et al. 2016b).

1. First, there is uncertainty around how best to finance EbA. International climate finance, through mechanisms such as the Green Climate Fund or the Adaptation Fund, is one possibility, but this will not provide enough to address adaptation challenges at the scale required to meet the needs of the world's poorest. Payments for ecosystem services (PES) is another possibility, and may provide an alternative source of funding, or large-scale government social protection, employment generation or environmental management programmes. However, in the context of providing finance for adaptation, both are in their infancy.
2. Second, many climate change impacts will be long-term, but this does not sit well with what are usually short-term political decision-making processes often based on standard electoral cycles. Photogenic engineered adaptation solutions with immediate but inflexible benefits are thus often

favoured over the long-term flexible solutions offered by EbA, under which benefits may only be apparent in the future.

3. Third, the evidence base for the effectiveness of EbA (especially its economic viability) is currently weak. Much evidence is anecdotal and comes from single case studies, and often the costs, challenges and negative outcomes of EbA activities are under-reported. More robust quantitative evidence, or at least consistently collated qualitative evidence, on the ecological, social and economic effectiveness of EbA projects relative to alternative approaches is needed (Doswald et al. 2014; Travers et al. 2012; Reid 2011; Reid 2014a; UNEP 2012).
4. The final major challenge to EbA relates to issues around governance. EbA necessitates cooperation and communication across multiple sectors and varying administrative or geographical scales. This is challenging for most models of governance, where decision making is often strongly based on sectors and administrative boundaries, and opportunities for supporting participation and locally driven approaches are limited.

Ecosystem-based approaches to adaptation: strengthening the evidence and informing policy

The 'Ecosystem-based approaches to adaptation: strengthening the evidence and informing policy' project was conceived to address the third (and fourth) challenge in the above list. The project aims to show climate change policymakers when and why EbA is effective: the conditions under which it works, and the benefits, costs and limitations of natural systems compared to options such as hard infrastructural approaches. It also aims to promote and provide tools to support the better integration of EbA principles into policy and planning. The project is supported by the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) supports IKI on the basis of a decision adopted by the German Bundestag. The project is being implemented by the International Institute for Environment and Development (IIED), the International Union for Conservation of Nature (IUCN) and the United Nations Environment World Conservation Monitoring Centre (UNEP-WCMC) in collaboration with 13 in-country partner organisations in 12 countries across Asia, Africa and the Americas (see Table 1). The project runs from July 2015 to September 2019.

Table 1: 'Ecosystem-based approaches to adaptation: strengthening the evidence and informing policy' project countries, partners and case studies

Project partner country	In-country partner institution	Project case studies
China	Centre for Chinese Agricultural Policy, Chinese Academy of Science	Participatory plant breeding and community-supported agriculture in Southwest China
Nepal	IUCN	Ecosystem-based adaptation in mountain ecosystems programme (Nepal)
Bangladesh	Bangladesh Centre for Advanced Studies	Economic incentives to conserve hilsa fish in Bangladesh – a supportive research project to the Incentive-based hilsa fishery management programme of the Department of Fisheries
Kenya	Adaptation Consortium; Kenya Drought Management Authority	Adaptation Consortium – supporting counties in Kenya to mainstream climate change in development and access climate finance
South Africa	Conservation South Africa	Climate-resilient livestock production on communal lands: rehabilitation and improved management of dryland rangelands in the Succulent Karoo

Uganda	IUCN	Ecosystem-based adaptation in mountain ecosystems programme (Uganda)
Burkina Faso	IUCN	Helping local communities to prepare for and cope with climate change in Northern Burkina Faso
Senegal	IUCN	Ecosystems protecting infrastructure and communities (EPIC)
Peru	IUCN	Ecosystem-based adaptation in mountain ecosystems programme (Peru)
	ANDES	Indigenous people biocultural climate change assessment, Potato Park
Chile	IUCN	Ecosystems protecting infrastructure and communities, South America geographical component (EPIC Chile)
Costa Rica	IUCN	Livelihoods and adaptation to climate change of the Bri Bri indigenous communities in the transboundary basin of Sixaola, Costa Rica/Panama
El Salvador	IUCN	Mangrove ecosystem restoration and responsible fishing

In order to address the weak evidence base for EbA, the project has developed a definition of effective EbA and a framework for assessing EbA effectiveness. It defines effective EbA as “an intervention that has restored, maintained or enhanced the capacity of ecosystems to produce services. These services in turn enhance the wellbeing, adaptive capacity or resilience of humans, and reduce their vulnerability. The intervention also helps the ecosystem to withstand climate change impacts and other pressures” (Reid et al. 2017, based on Seddon et al. 2016b). This definition generates two overarching questions that need to be addressed in order to determine whether a particular EbA initiative is effective:

1. Did the initiative allow human communities to maintain or improve their adaptive capacity or resilience, and reduce their vulnerability, in the face of climate change, while enhancing co-benefits that promote wellbeing?
2. Did the initiative restore, maintain or enhance the capacity of ecosystems to continue to produce services for local communities, and allow ecosystems to withstand climate change impacts and other stressors?

By definition, EbA should also be financially and/or economically viable, and for benefits to materialise it needs support from local, regional and national governments and to be embedded in an enabling policy, institutional and legislative environment (Seddon et al. 2016b; Reid et al. 2017). This leads to two further overarching questions:

1. Is EbA cost-effective and economically viable?
2. What social, institutional and political issues influence the implementation of effective EbA initiatives and how might challenges best be overcome?

These questions encompass much important detail regarding how to assess and compare effectiveness in ecological, social and economic terms. They lead to a further set of nine more specific questions (Table 2) that reflect the growing consensus around the key characteristics of effective EbA (Box 1).

This framework is being applied in 13 project sites in 12 countries, and results from all sites will be collated and compared to draw conclusions that are based on more than single case studies and help answer the question of whether EbA is effective or not. Reid et al. (2017) provide detailed guidance on the way that researchers and project managers can use the framework to draw conclusions about the effectiveness of an EbA project, or to shape project design or assess the progress of an ongoing EbA project or a project that has ended.

Research conducted under the project will then be used to help climate change policymakers recognise when EbA is effective, and where appropriate integrate EbA principles into national and international climate adaptation policy and planning processes. An inventory of EbA tools and a 'tool navigator' are also being developed to support this process.

Table 2: Framework for assessing EbA effectiveness

<p>1) Effectiveness for human societies</p> <p><i>Did the initiative allow human communities to maintain or improve their adaptive capacity or resilience, and reduce their vulnerability, in the face of climate change, while enhancing co-benefits that promote long-term wellbeing?</i></p>
<ol style="list-style-type: none"> 1. Did the EbA initiative improve the resilience and adaptive capacity of local communities, and help the most vulnerable (eg women, children and indigenous groups)? If so, over what time frames were these benefits felt, and were there trade-offs (or synergies) between different social groups? 2. Did any social co-benefits arise from the EbA initiative, and if so, how are they distributed and what are the trade-offs between different sectors of society? 3. What role in the EbA initiative did stakeholder engagement through participatory processes and indigenous knowledge play? Did/does the use of participatory processes support the implementation of EbA and build adaptive capacity?
<p>2) Effectiveness for the ecosystem</p> <p><i>Did the initiative restore, maintain or enhance the capacity of ecosystems to continue to produce adaptation services for local communities, and allow ecosystems to withstand climate change impacts and other stressors?</i></p>
<ol style="list-style-type: none"> 1. What were/are the factors threatening the local ecosystem(s)? How did/do these pressures affect the resilience of the ecosystem(s) to climate change and other stressors and their capacity to deliver ecosystem services over the long-term? 2. After the EbA initiative, which ecosystem services were restored, maintained or enhanced, and did the resilience of the ecosystem change? Over what geographic scale(s) and time frame(s) were these effects felt, and were there trade-offs (or synergies) between the delivery of different ecosystem services at these different scales?
<p>3) Financial and economic effectiveness</p> <p><i>Is EbA cost-effective and economically viable over the long-term?</i></p>
<ol style="list-style-type: none"> 1. What are the general economic costs and benefits of the EbA initiative? How cost-effective is it, ideally in comparison to other types of interventions, and are any financial or economic benefits sustainable over the long term?
<p>4) Policy and institutional issues</p> <p><i>What social, institutional and political issues influence the implementation of effective EbA initiatives and how might challenges best be overcome?</i></p>
<ol style="list-style-type: none"> 1. What are the key policy, institutional and capacity barriers to, or opportunities for, implementing EbA at the local, regional and national levels over the long term? 2. What, if any, opportunities emerged for replication, scaling up or mainstreaming the EbA initiative or for influence over policy, and how? 3. What changes in local, regional and/or national government or in donor policies are required to implement more effective EbA initiatives?

Climate-resilient livestock production on communal lands: rehabilitation and improved management of dryland rangelands in the Succulent Karoo

Conservation South Africa (CSA) has been working in the Namakwa District Municipality in the Northern Cape Province of South Africa to conserve, manage and rehabilitate dryland rangelands through climate-resilient livestock production and water supply restoration on communal lands. Project activities have focused on the rehabilitation of critical rangeland and wetland ecosystems. The conditions for implementing EbA were also improved through mainstreaming activities at various levels and aligning these within enabling policy frameworks (Bourne et al. 2015b).

The Northern Cape is one of South Africa's poorest provinces. Under climate change, the Namakwa District Municipality will likely become hotter and drier, with more intense storms, floods and droughts. Local adaptive capacity levels are very low (Bourne et al. 2015a). Households living in the Leliefontein communal area rely on livestock farming as one of their main sources of livelihood, but due to the aridity of the area, farming is on the margins of economic viability, with very large areas of land needed to sustain relatively few animals (Bourne et al. 2015a). The project aimed to rehabilitate 25,000 hectares of communal rangeland to improve livelihood security for the 100 farmers relying on this rangeland (Bourne et al. 2015b). As a result of the arid nature of the Succulent Karoo biome, pastoralists have adopted opportunistic strategies in their use of the available natural resources and rely on the wetlands of the Kamiesberg uplands as part of their seasonal grazing system. Small ephemeral wetlands are both a source of livestock drinking water and a source of livestock fodder during the dry summer months, and are thus critical for the maintenance of livestock stocking rates throughout the year (Bourne et al. 2015b; Black and Turpie 2013). These wetlands are extensively degraded. The project also aimed to rehabilitate wetlands in the Kamiesberg uplands with a view to supporting adaptation to the predicted impacts of climate change on livestock-carrying capacities in the Leliefontein communal area (Black and Turpie 2013).

Roughly 40,000 people reside in the communal areas of the Namakwa District municipality. The Namaqualand region is rife with poverty (Bourne et al. 2015a) and local municipalities face numerous associated challenges and limitations. Although the value of the ecosystem services of the Succulent Karoo is relatively low, these services are crucial to local communities (Ziervogel et al. 2014; De Villiers 2013). Ecosystems that deliver valuable water resources for people in this arid and water-scarce region are particularly important (Bourne et al. 2015a; CSA 2012).

The project is in the Succulent Karoo – a global biodiversity hotspot with exceptionally high levels of endemism – and project activities were specifically designed to adopt ecosystem-based adaptation (EbA) as a means of improving pastoral livelihoods and conserving biodiversity in the face of climate change in this semi-arid area.

The project was part of a broader global initiative called 'Ecosystem-based adaptation in marine, terrestrial and coastal regions as a means of improving livelihoods and conserving biodiversity in the face of climate change,' which ran from 2011 to 2015. The project operated in three countries (Brazil, South Africa and the Philippines) and was funded through the German Ministry of Environment, Building, and Nuclear Safety's International Climate Initiative. Ongoing EbA work in South Africa in 2016 has been funded by the Embassy of the Federal Republic of Germany (Pretoria).

Methodology for assessing effectiveness

The methodology applied for assessing EbA effectiveness is detailed in Reid et al. (2017). This guidance describes a process, based around asking a detailed set of questions, that can be used to draw conclusions about the effectiveness of an EbA project that is ongoing or has ended such as the CSA project. Table 3 describes the CSA project stakeholders interviewed for this paper.

Table 3: CSA Project Stakeholders Interviewed

Level of interviewees	Those interviewed
National	Key policy and decision makers connected to the CSA project at the national level: representatives from the South African National Biodiversity Institute, the adaptation and biodiversity branches of the Department of Environmental Affairs (DEA), Stellenbosch University and independent consultants working with the DEA. Many of these interviewees did not have detailed project implementation knowledge, but could provide information on the context within which EbA projects operate and on bringing lessons to scale.
Local authority	Representatives from the provincial and local governments in areas where project activities were implemented: the Namakwa District Municipality, Kamiesberg Municipality and the Northern Cape Department of Environment and Nature Conservation.
Project implementers	Civil society project implementers: CSA staff and representatives from SaveAct and the Environmental Monitoring Group.
Beneficiaries	Representatives from community groups, including the Manager of the Heiveld Cooperative, Chairperson of the Biodiversity and Red Meat Cooperative, manager/founder of Eco Tourism, and manager/founder of NAM Petroleum.

Along with the 14 interviews conducted, publications on the CSA project were also reviewed to assess the characteristics of CSA project activities that contribute to EbA effectiveness. Those who are working on other EbA projects in the region were also interviewed to garner their perspectives. The results of this assessment are described in the following results section.

Research results

Effectiveness for human societies: did the initiative allow human communities to maintain or improve their adaptive capacity or resilience, and reduce their vulnerability in the face of climate change, while enhancing co-benefits that promote long-term wellbeing?

Did the EbA initiative improve the resilience and adaptive capacity of local communities, and help reduce vulnerability?

The project improved the resilience and adaptive capacity of some community members through wetland restoration¹ and therefore better access to water and reduced risk of disasters. Other benefits came from training and capacity building on climate resilient landscape management (see Box 2), for example, and business management to increase financial resilience (see Table 4). Benefits also emerged from improved market access.

¹ Interviewees and the literature studied use the terms 'restoration' and 'rehabilitation' in relation to CSA project activities implemented, and these are taken to have the same meaning under this study.

Box 2: Training conducted to increase climate change resilience under the CSA project

- A total of 55 Leliefontein and 51 Steinkopf farmers were trained to use an ecological monitoring protocol to collect information on selected indicators (plant cover, plant diversity, ratio of palatable to less-palatable species, grazing intensity, erosion and livestock quality). Information from this environmental monitoring is then used to guide management and decision making, for example to determine when an area should be rested or what the correct carrying capacity for implementation should be.
- Training was given to 38 Leliefontein and 60 Steinkopf farmers on how to address soil erosion with low-cost low-tech structures.
- Basic animal health training was attended by 60 Steinkopf and 25 Leliefontein farmers (covering identifying infections, and endo- and ecto-parasites and the relevant treatment options) as well as practical animal handling. This is based on the premise underlying the improved livestock scheme, which assumes that healthier animals spend less time on the veld, which in turn leads to a healthier veld.

Table 4: Business training provided to farmers 2012-2017

Name of training	Year	Topics covered	Number of participants
Renewable energy	2012	Introduction to renewable energy, long-term weather forecasting, weather monitoring, energy audits, climate technology planning.	2 farmers
Skeppies workshop	2013	Business registration, marketing and branding, Black Economic Empowerment compliance, climate change adaptation.	4 farmers
Business ethics	2013	Business ethics, tourism	4 farmers
Learning exchange visit – Heiveld	2014	Harvesting rooibos, olive farming processes, community projects.	4 Biodiversity and Red Meat Cooperative farmers; 2 Steinkopf farmers.
Lessons learned workshop	2014	Cheese farming, climate change.	4 farmers
CSA training workshop	2015	Finance, costing and pricing, marketing (how to approach different markets; how to advertise through media), climate resilient businesses, effective and ethical internet and email use, cooperatives for farmers / entrepreneurs, funding options.	4 farmers
Business structures workshop	2016	Business structures (advantages and disadvantages), Small Enterprise Development Agency information, climate change, leadership skills, lessons learned from the Biodiversity and Red Meat Cooperative and Namaqua Pride.	16 farmers
Market readiness and costing workshop	2017	Market readiness, costing and pricing.	8 farmers

Rangeland restoration takes a long time in this particular landscape so specific restoration outcomes were not apparent over the project cycle, but local communities gleaned benefits from engaging in sustainable management and restoration activities. Management plans were developed for the Steinkopf and Leliefontein commonage (both within Namakwa District). CSA stewardship projects, alongside local municipalities and farmers, have been working to implement these plans since 2015, but it has not yet been achieved. A total of 166 conservation agreements in the Leliefontein commonage and 61 in the Steinkopf commonage were also drawn up to improve land management practices. Some community members are inevitably less vulnerable to climate change due to the above approaches, but this has not yet been specifically monitored or measured. This work is ongoing through CSA's Meat Naturally Initiative, which addresses monitoring and evaluation for future adaptation. The Namakwa District Municipality Climate Vulnerability Assessment (Bourne et al. 2015a; CSA 2012) also includes an index for monitoring changes in vulnerability for the whole district over time; this will continue to be tracked.

CSA project experiences mirror those from other EbA initiatives in the region, where implementing partners and local communities report improvements in resilience and adaptive capacity, and reductions in vulnerability, as a result of EbA project activities.

Which particular social groups experienced changes in resilience, adaptive capacity or vulnerability as a result of the initiative?

Interviewees were clearly and strongly of the opinion that the initiative benefitted the poorest and most vulnerable communities most, especially women, children and the elderly. Implementing partners and local communities involved with other local EbA projects supported this view, adding that indigenous groups were also beneficiaries from their projects.

Farming is an important livelihood source in the Leliefontein communal area, and those relying on the municipal communal grazing land may benefit more than others. Black and Turpie (2013) argue that local elites benefit more. But for many communities within the communal area, livestock farming represents a "hedge against fluctuations in other incomes". These incomes come from various sources including wage labour (in commercial farms, schools, the government 'Working for wetlands' programme, government posts or as shop assistants), remittances and government grants (Black and Turpie 2013; Black et al. 2016).

Trade-offs in terms of who experiences changes in resilience, adaptive capacity or vulnerability, where changes occur and when

In terms of *who* benefits, the project focused on small-scale farmers and also on certain district/local municipalities, but this was not to the cost of other groups or municipalities and no-one was excluded. One provincial government official commented that adaptation benefits are accrued by one social group at the expense and exclusion of others, but provided no details.

Local communities benefitting from other nearby EbA projects felt that no adaptation benefits were accrued by one social group at the expense or exclusion of others. Rather, communities outside the project area were better able to access resources and thus experienced improvements in adaptive capacity and resilience.

No other trade-offs in terms of where adaptation benefits accrued were apparent.

In terms of *when* adaptation benefits accrue, rangeland restoration is a long-term process – longer than the project duration – so benefits will take time to accrue. This also mirrors the experiences of local communities benefitting from other EbA projects in the area.

Social co-benefits from the EbA initiative

A number of social co-benefits arose from the initiative, most importantly a reduction in disaster risk and the provision and diversification of livelihoods. Some 937 jobs were also created in the area through two public works programmes funded by the DEA Expanded Public Works Programme Natural Resource Management Programme and building on CSA project activities (De Villiers 2013) – 611 jobs under the 'Working for wetlands' programme activities (implemented by South African National Parks)

(see Table 5), and a further 326 jobs under the 'Working for water' programme implemented by CSA between 2014 and 2017. These focused mainly on restoration activities and support for the livestock improvement scheme implemented by CSA and the stewardship farmers.

Table 5: Jobs created under the 'Working for wetlands' programme

Year	Budget (rand)	Person days	Jobs
2009-10	1,500,000.00	5378	41
2010-11	1,767,000.00	6538	45
2011-12	1,470,000.00	5105	49
2012-13	1,559,401.00	5658	42
2013-14	1,716,004.00	5878	78
2014-15	2,058,476.00	6503	68
2015-16	2,181,986.00	6121	153
2016-17	2,130,929.00	5448	135
Total	14,383,796.00	46629	611

Policies improved, as did social cohesiveness (from project work with farmers) and sustainable water provision. Knowledge on sustainable land management and business management was enhanced and training provided for nearly 100 local government officials in addition to many farmers (see Box 2 and Table 4). Improved market access and food security were important over longer time frames. For example, direct access to a private market was provided to the Leliefontein communal farmers during 2016, and 18 farmers sold a total of 133 small livestock (goats and sheep) at an average price of 879.14 rand per animal using this route. During November 2017, direct access to the private market was provided to people in Steinkopf through an auction model. Some 13 farmers made use of the opportunity and sold a total of 191 small livestock at an average price of 1,236.09 rand. Farmers from the Leliefontein area feel that this direct access to markets has financially benefitted them. Livestock provides employment and income, and acts as a social and economic safety net in hard times (Bourne et al. 2012; Bourne et al. 2017a; Black and Turpie 2013). Rangelands provide additional benefits related to culture and medicinal herb provision (De Villiers 2013).

Implementing partners and local communities benefitting from other local EbA projects supported this view. Social co-benefits from these EbA initiatives included livelihood provision and diversification, improved food security and market access, sustainable water provision, reduced conflict over resources, improved social cohesiveness, improved policies and governance, enhanced knowledge and climate change mitigation. The Strategic Framework and Overarching Implementation Plan for Ecosystem-Based Adaptation (EbA) in South Africa also acknowledges the importance of EbA co-benefits by stating that these "contribute towards a broader set of socio-economic and development goals, including job creation, poverty reduction and rural/peri-urban development. In a developing country context where limited resources need to be used efficiently, providing for multiple outcomes is particularly important" (DEA and SANBI 2016).

Distribution and trade-offs relating to social co-benefits

For effective rangeland rehabilitation, livestock may need to be excluded or grazing restricted for roughly five years. Those with stock would therefore suffer in the short term. Whether livestock need to be excluded is unclear, however, as grazing appears to have a complex relationship with vegetation dynamics in the Succulent Karoo biome and it is not known for certain whether grazing is a key ecosystem process or a contributor to degradation (De Villiers 2013).

If grazing is restricted, other project co-benefits can help offset these costs until longer-term benefits from improved rangelands materialised. For example, a government-funded enhanced public works programme for rangeland restoration already provides employment for some. Such programmes particularly benefit the youth (classified as being aged between 18 and 35) and they preferentially employ women. Of the 326 jobs created under the 'Working for water' programme, 148 went to females

and 129 to youths. Those excluded from grazing, however, are unlikely to be the same people as those benefiting from the jobs that restoration creates.

Implementing partners from other local EbA projects felt that no social group benefitted more than any other from the project co-benefits. Community beneficiaries felt that women and youth benefitted from the projects slightly more than men.

The role of participatory processes and local/indigenous knowledge

Project activities involved extensive engagement with local farmers, surrounding communities, civil society stakeholders, and local and district-level government officials to guide and inform the development of a range of adaptation options including EbA. This engagement was interactive and collaborative, with project staff acting as facilitators to engage the community and other stakeholders through formal workshops, peer learning exchanges in the field, regular stakeholder meetings and the co-design of project activities. The project also incorporated local/indigenous knowledge and practices. Examples of community engagement include the following:

- Farmers in Steinkopf participated in the design of a drylands restoration trial focusing on bringing grazing ecosystem services back to the landscape in areas that had been degraded by historical ploughing and over-grazing. Farmers also donated land for the trial (Bourne et al. 2017a).
- Farmers in Leliefontein co-designed an EbA project focusing on grazing management and climate resilient livestock farming, which was subsequently funded by the Adaptation Fund. The farmers also assisted with the development of a monitoring and evaluation framework for tracking improvements in wetlands and rangeland ecosystem services after the implementation of restoration and management actions. Farmers identified important plants and ways of differentiating degraded from productive land.
- Civil society organisations brought adaptation ideas to a planning workshop in Springbok that were then used to define adaptation actions for a funding proposal. This resulted in more than 6 million rand in climate finance being made available for adaptation in Namaqualand.
- Local government officials and conservation agencies worked with the project to align regional government programmes, enabling large-scale rangeland and wetland restoration with the science and local knowledge collated by the CSA project team.
- Processes to develop the municipal government Integrated Development Plan included stakeholder engagement and the incorporation of local knowledge. The 'Let's Respond' toolkit (DEA 2012) for mainstreaming climate change into development planning² was used to facilitate this. Formal ways for stakeholders to provide inputs include giving information, extensive training, speaking with external professionals (consultants) and responding to invitations (adverts) to comment on various projects before adoption. The project and other EbA initiatives facilitated this engagement, and also benefited from it in that these processes end up supporting EbA project implementation and building local capacity.

Project implementing partners and municipal and provincial authority officials agreed that participation in the various ways described above built adaptive capacity. At the project level, participatory processes helped people negatively affected by the impacts of climate change to see the links between their daily activities and current livelihoods, the environment they live in, and how they might manage their essential natural resources differently as an effective response to climate change. For example, the provision of incentives and the use of conservation stewardship agreements, which provide information on which practices can help communities increase their resilience, have improved the capacity of local farmers to manage their land. Farming techniques have significantly changed as a result. In addition to working closely with local communities, Bourne et al. (2015a) also emphasise the importance of "participatory municipal planning" with special emphasis on working with district government officials to respond better to climate change.

The importance of participation in contributing to adaptive capacity is acknowledged by guidance on EbA produced by the DEA (DEA and SANBI 2017) and interviews with implementing partners and

² See www.letsrespondtoolkit.org

communities involved with other local EbA initiatives. These interviewees reported that highly participatory processes had been adopted, to the extent that the community had mobilised itself and sought external support for what it wanted to do. Indigenous knowledge had informed and been incorporated into project activities. As with the CSA project, these strong levels of community engagement had improved EbA project effectiveness and increased local adaptive capacity.

Effectiveness for the ecosystem: did the initiative restore, maintain or enhance the capacity of ecosystems to continue to produce ecosystem services for local communities, and allow ecosystems to withstand climate change impacts and other stressors?

Factors threatening local ecosystem resilience and service provision

Climate change is a major factor threatening local ecosystem resilience. Climate change models for the Succulent Karoo biome and Namakwa District predict that the average temperature will increase, that rainfall is likely to decrease overall, and that the frequency and intensity of both droughts and flood events are likely to increase (Bourne et al. 2012; Black et al. 2016). Increases in temperature and aridity mean that the Namakwa District is likely to change from a semi-desert to a desert within the next 50 years. This will reduce rangeland productivity and livestock-carrying capacity, negatively impacting livestock farmers (Bourne et al. 2015b). Interviewees commented on how climate change was already affecting the ability of ecosystems to function properly, with springs drying up because of late rains given as an example. The ecosystem is now less able to absorb shocks. Lower vegetation cover and high levels of run-off are leading to more flash floods, for example, which in turn causes top soil erosion.

Overstocking and overgrazing is also a major cause of rangeland degradation in the Namakwa District municipality, but it is important to note that grazing may well be a key ecosystem process as well as a contributor to degradation in the Succulent Karoo (Bourne et al. 2017a; De Villiers 2013). Snyman (2010) argues that whilst livestock grazing can be detrimental to vegetation cover and diversity in Namaqualand, other environmental drivers could be equally influential – perhaps even more so. It is known, however, that grazing at high densities causes the replacement of palatable plant species with a few unpalatable plant species. Diversity is reduced, and the less diverse the system, the less resilient it is and the fewer options for adaptation it can offer (Bourne et al. 2017a). In the study area, rangeland degradation has not yet advanced beyond repair and action can still be taken both to address the current damage and to buffer against the expected threats ahead (De Villiers 2013).

Overgrazing occurs as a result of weak or absent governance on communal rangelands, which are considered an open access resource that can easily be overexploited if not managed carefully. The mining industry is downscaling in the region and many re-trenched employees are using their pay-out packages to purchase livestock. This places additional pressure on the land.

Invasive alien species also threaten Succulent Karoo ecosystems. Trees such as poplar and eucalyptus use large amounts of water, yet many were historically planted near wetlands. Alien species reduce the groundwater supplies needed for other purposes and can out-compete indigenous vegetation (Black et al. 2016).

Other poor land-care practices have degraded the Succulent Karoo ecosystem, particularly in wetland areas. Wetlands used to be ploughed and cultivated for vegetable gardens and many were drained or suffered from over-abstraction of water. This has led to soil erosion, siltation, displacement of natural vegetation and an altered wetland hydrological regime. In addition to the planting of alien species and overgrazing in wetland areas, indigenous vegetation has been removed and excessive burning of vegetation has occurred (Bourne et al. 2015b; Nieuwoudt and Kotze 2015). The result of all these practices has meant that more than 60% of the wetlands in the Kamiesberg uplands have been severely degraded. This has severely compromised their ability to provide fodder and water services (Black and Turpie 2013; Black et al. 2016).

Namaqualand is rich in minerals, and mining activities have historically degraded the rangelands of the Namakwa District municipality (De Villiers 2013; Bourne et al. 2012). Over-abstraction of groundwater also puts pressure on the landscape (Bourne et al. 2012).

Boundaries influencing ecosystem resilience

It was unclear whether there were important boundaries that influenced ecosystem resilience. Local authority interviewees felt there were important boundaries, but couldn't specify what these were.

Thresholds influencing ecosystem service provision

Scientific evidence and interviews with local and provincial government officials suggest that semi-arid ecosystems have thresholds which, if crossed, lead to irreversible degradation, but much more information is needed on this. The National Framework for Sustainable Development in South Africa (DEA 2008) states that, "analysis confirms that thresholds are now being reached which if ignored will generate dysfunctional economic costs that will undermine investments in growth and exacerbate poverty as poor people experience the loss of supportive ecosystem services". In the case study site, Bourne et al. (2017a) argue that "large areas in Nama Khoi are degraded beyond biotic or abiotic thresholds, requiring active intervention", which is both expensive and difficult. They state that "[d]egraded Succulent Karoo appears not to return to a state comparable with less disturbed sites through rest alone, even if left undisturbed for several decades". Implementing partners on other local EbA projects, however, believed there were no thresholds beyond which ecosystems could no longer provide key ecosystem services, which perhaps indicates a lack of understanding of the local ecology.

No specific study of the levels of degradation in the Succulent Karoo beyond which changes are irreversible or ecosystems reach a new stable state has been undertaken. In addition, knowledge about the conditions under which the plant community will not return to the initial climax state after a disturbance is scarce. It is known, however, that overgrazed rangelands reach a state where they become dominated by few, usually highly unpalatable species and exhibit high levels of interspecies competition, which hinders the re-establishment of other species and reduces species diversity. Autogenic recovery is very slow and unlikely to occur within human lifetimes, if at all (Van der Merwe and van Rooyen 2011). Rangeland restoration is notoriously hard, and in some instances it may not even be possible to directly reverse degradation along the same pathway that led to it in the first place, in this instance by excluding grazing (James et al. 2013; Bourne et al. 2017a).

The projected climatic shift from a mostly semi-arid regime to a desert regime will likely decrease the water holding capacity and soil retention of rangelands. This could initiate a negative feedback loop whereby flood and erosion damage increases, and rangeland productivity is further reduced (Bourne et al. 2012). Studies in Spain suggest that this negative feedback cycle of reduced plant cover and soil erosion could result in "irreversible soil degradation in semi-arid regions" (Castillo et al. 1997). De Villiers (2013) consequently argues that "now is the golden hour to act to protect and enhance the natural resources that are still available" in the Succulent Karoo rangeland, because while the land has not yet been degraded as severely as reported in other regions in South Africa, climate change will likely intensify degradation and a lack of action could have extreme costs.

Climate change may also alter the fire regime in Namaqualand. The impact of this will depend on the physical characteristics of particular sites as well as the interaction of fire with secondary disturbances such as grazing.

EbA initiative impacts on ecosystem resilience and services provision

Interviewees consistently agreed that the EbA initiative had a positive impact on ecosystem resilience and ecosystem service provision. They listed various services that were maintained, restored or enhanced: provisioning services such as wood, food (for livestock and people), water, fibre and fuel provision; regulating services such as disease control, carbon sequestration, flood regulation and water purification; cultural services such as recreational and educational opportunities; and supporting services such as primary production, soil formation and nutrient cycling.

Improvements in ecosystem resilience and services provision were most apparent with wetland restoration activities. The 'Working for water' programme worked in 42 wetlands in the Kamiesberg local municipality between 2009 and 2017, and Table 6 details the cubic metres of gabions built and micro-catchments made as part of this work. Table 7 details the many ecosystem services provided by wetlands such as those in the project area. Unlike rangeland restoration, techniques for wetland restoration are known, effective and show immediate benefits in terms of forage and water production.

Restored wetlands will be more resilient under increasingly arid conditions in the future than degraded ones (Bourne et al. 2015b). In a study on the Xharas wetland near Leliefontein, for example, Nieuwoudt and Kotze (2015) showed that the water table was rarely close to the soil surface in the degraded section of the wetland, compared to minimally impacted sections where water levels were frequently close to the surface. The abundance of hydric (water-loving) plant species was also less in degraded areas.

Wetland restoration involved a number of core activities under the project. The removal of alien vegetation, which uses more water than native vegetation, increases the quality and quantity of available surface and soil water. The re-vegetation of cleared areas with native wetland vegetation stabilises soils and provides forage for livestock. This increases the biomass of palatable species and thus dry season grazing for livestock. This in turn contributes to improved, or at least maintained, long-term livestock productivity (Bourne et al. 2015b). Such improvements in livestock production (and hence income) were observed under the project, although they could not all be attributed to project activities. Improvements in water availability and absorption levels were also observed, but water quality was not checked. Gabions also tackled erosion problems. These results mirror those from studies of wetlands elsewhere in South Africa, which show that restoration increases resilience to climate change and provides broader community benefits (Kotze and Ellery 2009).

Whilst project activities stopped rangeland degradation in places, demonstrable improvements in ecosystem resilience and service provision resulting from rangeland restoration activities were less clear. Table 6 provides one estimate of the area under improved grazing management based on wetland restoration and improvements in livestock health. It was expected that rangeland rehabilitation would also improve plant cover and soil water retention, possibly buffering against the expected increases in drought frequency ahead and thus improving rangeland resilience (de Villiers 2013; Bourne et al. 2017a). Restoration activities included re-seeding, mulching with plant material and animal manure, micro-catchment management and brush packing with *Galenia Africana*. Results showed, however, that where active restoration took place, resilience was unaffected due to the short duration of the project, slow growing rates of species in the Succulent Karoo, and because the methods and tools needed to successfully restore rangelands are not yet well understood. This includes knowledge on seed biology, interspecies competition, species growth and recovery rates, and how these processes can increase structural and species diversity and improve grazing capacity. Restoration activities conducted under other projects in the Kamiesberg and Nama-Khoi rangelands showed similar results, with no improvements in services provision. These results also mirror experiences elsewhere around the world, which show that rangeland restoration is difficult and has low success rates (James et al. 2013).

Table 6: Current measures of restoration

	2014	2015	2016	2017	Totals
Gabions built (m ³)		1,321.80	374.47	1,400.23	3,096.50
Micro-catchments made		6,034	1,135	2,010	9,179
Livestock handled and provided with medicine under the livestock improvement scheme implemented by CSA and farmers	3,661	12,910	2,774	5,629	24,974
Improved grazing management (measured in terms of the area in hectares used by farmers benefitting from the measures above)					774,600

Table 7: Ecosystem services supplied by wetlands

Indirect benefits	Regulating and supporting benefits	Flooding attenuation	The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream	
		Stream flow regulation	Sustaining stream flow during low flow periods. Wetlands help recharge shallow sub-surface groundwater, which is vital to the existence of springs and dug well water levels sufficient for livestock to access.	
		Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
			Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters, thereby enhancing water quality
			Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters, thereby enhancing water quality
			Toxicant assimilation	Removal by the wetland of toxicants (eg metals, biocides and salts) carried by runoff waters, thereby enhancing water quality
			Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation
		Carbon storage	The trapping of carbon by the wetland, principally as soil organic matter	
Biodiversity maintenance	Through the provision of habitat and maintenance of natural processes by the wetland, a contribution is made to maintaining biodiversity in one of South Africa's highest priority conservation areas			
Direct benefits	Provisioning benefits	Provision of water for human use	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes	
		Provision of harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc	
		Provision of cultivated foods	The provision of areas in the wetland favourable for cultivation	
	Cultural benefits	Cultural heritage	Places of special cultural significance in the wetland, eg for church baptisms or gathering of culturally significant plants	
		Tourism and recreation	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant wildlife	
		Education and research	Sites of value in the wetland for education or research	

Source: Black and Turpie (2013).

Geographic scale of ecosystem services provision and trade-offs or synergies between geographical scales

The project operated at a scale linked to the communal grazing areas of local villages. This included various wetlands in the local water catchment area within the Namakwa District Municipality.

Interviewees didn't feel there were any major trade-offs or synergies between the delivery of ecosystem services at different geographical scales, but some felt that downstream water users may have also benefitted from project activities. For example, most of the land users downstream from the Kamiesberg wetland sites were private farmers, who may have access to enough capital to allow them to construct and maintain dams and thus benefit from the improved availability of clean water resulting from project activities. However, this hypothesis was not proven by project studies.

Time frame over which ecosystem services are provided, and trade-offs or synergies between timescales

Wetland and rangeland restoration involved no discernible trade-offs between the delivery of different ecosystem services at different timescales, but some ecosystem services did take longer to materialise than others. Wetland restoration led to improvements in provisioning and regulating services after the first rainy season (ie within a year) due to decreases in water run-off and the control of soil erosion. The provision of supporting services and further regulating services followed. Primary production – ie observed gains in biomass – took one to two years to be restored. The time it took for cultural services to be provided varied according to the level of community engagement in activities at any particular wetland.

Rangeland restoration stopped or controlled further degradation in the short term. Restoration activities included soil erosion control measures, improved livestock management and grazing systems, and provision of livelihood diversification opportunities. Longer-term benefits from these activities took more time to materialise, however. Initially, CSA project planners felt 20 years would be needed for changes to be seen, which is well beyond the project lifetime. Local authority interviewees felt, however, that ecosystem services had been maintained, restored and enhanced in two to five years, and that the improvements were likely to last more than ten years. This longevity also mirrors experience from other local EbA projects, where communities felt that ecosystem services would be maintained, restored or enhanced for a period of between five and ten years.

Longer-term changes to rangeland ecosystem services provision are also likely as a result of project activities relating to capacity building on climate-resilient natural resource management, securing large-scale government grants, establishing sound governance systems for land management, exploring business opportunities and furthering research and developing techniques on improving ecosystem management.

Financial effectiveness: is EbA cost-effective and economically viable over the long term?

How cost-effective is the EbA initiative?

A study of two sites in the Namakwa District municipality showed that rangeland rehabilitation – the EbA scenario in Table 8 – was not cost-effective at any of the discount rates used when the costs of road maintenance were included in the analysis (De Villiers 2013). When road maintenance costs were excluded, rangeland restoration was not cost-effective at the standard South African discount rate of 8%, but it was at both the 3% and the 1.3% discount rate (Bourne et al. 2017a). This mirrors findings from other studies in Namaqualand and the Succulent Karoo, which have found that rangeland rehabilitation is risky, expensive and requires considerable initial investments in terms of labour and resources, and it can take decades before any notable positive returns are seen (Crookes et al. 2013; Carrick and Krüger 2007; Mitchell et al. 2012; Simons and Allsopp 2007). Schmiedel et al. (2016) argue that despite benefits from improved livestock stocking rates and carbon sequestration, rangeland rehabilitation in the Namakwa District (by building check dams to stop erosion and restoring bare patches of soil) is not financially feasible for private landowners over a 20-year period.

Despite the rangelands rehabilitation study conducted by CSA and described above, interviewees felt there was a serious shortage of EbA cost-benefit analysis data. National government interviewees felt that EbA projects often had benefits which could contribute to programmes such as the expanded public works programmes, but that these benefits needed to be better understood. They said links with disaster risk reduction and the avoided costs of coping with disasters accrued by insurers and government need to be understood better. Provincial authority interviewees felt that EbA initiatives were cost-effective. Local authority interviewees said that studies assessing the costs and benefits of EbA initiatives in relation to their service delivery (eg job creation) mandates are needed.

How did the EbA approach compare to other types of intervention?

Rangeland rehabilitation in the local municipalities of Nama Khoi and Kamiesberg – both in the Namakwa District municipality – was compared to a number of other adaptation scenarios and also to the status quo (Table 8). De Villiers (2013) compared the costs and benefits of four adaptation scenarios. All scenarios considered the following two climate change vulnerabilities: the detrimental impact of floods and soil erosion on roads, and reductions in rangeland productivity and thus livestock production. Bourne et al. (2017a) limited their analysis to livestock production. The studies calculated the least-cost option, the net present values (NPV) and cost-effectiveness. Lag periods were included to account for the time required for EbA benefits to manifest as the local ecological processes recovered. Analyses were performed over a 50 and 60-year time period starting in 2020 to take account of the long period of time before EbA benefits would be apparent, with discounting rates of 1.3%, 3% and 8% (De Villiers 2013; Bourne et al. 2017a).

Table 8: Four adaptation responses in the Nama Khoi and Kamiesberg municipalities

Adaptation scenario	Costs and benefits
The status quo	Annual road maintenance costs – in De Villiers (2013) study only – and annual costs to provide fodder aid for livestock, on the basis that rangeland productivity will decrease due to climate change and rangeland degradation (no action is taken to address degradation). No additional benefits are accrued from either action.
An engineering scenario	Costs relating to the upgrading of all roads and stormwater infrastructure in the local municipality to limit flood damage, and subsequent benefits of reduced road flood damage (in De Villiers study only). Annual costs of providing fodder aid for livestock accrued, but no additional benefits from this.
An EbA scenario, under which 25% of the local municipality's rangeland was regarded as degraded and thus rehabilitated	Costs relating to recovering the depleted seedbank of degraded rangelands by clearing unfavourable or unpalatable shrubs, seeding with indigenous plant species, and applying mulch to promote the establishment of seedlings. Costs also included the opportunity costs of excluding livestock from restored areas during the initial five-year period of seedling re-establishment. Benefits were from stabilised soils reducing erosion, and increased rangeland production due to improved grazing (measured in terms of meat production). Annual road maintenance costs will fall (in De Villiers study only) due to decreased erosion risk. Potential benefits from tourism through tourists coming to see Namaqualand flowers have not been included as there are more flowers on disturbed rather than rehabilitated land (Van der Merwe and van Rooyen 2011).
The mid-way scenario: a scenario that combines engineered and EbA options, involving upgrading 50% of roads and rehabilitating 50% of the degraded rangelands.	Costs and benefits as in the above two rows for engineered and EbA options, but combined and adjusted.

Source: De Villiers (2013); Bourne et al. (2017a).

Continued maintenance of the status quo in Nama Khoi was the least-cost scenario at all discount rates used, while the EbA scenario was the most expensive. At the 8% discount rate, the cost of the EbA scenario is more than double that of the status quo (Bourne et al. 2017a).

The EbA scenario also compared poorly in terms of cost-effectiveness with other scenarios. It was only cost-effective at lower discount rates, whereas continued maintenance of the status quo was cost-effective at all discount rates (Bourne et al. 2017a). De Villiers (2013) found, however, that when road maintenance costs were included, none of the four adaptation scenarios was cost-effective and the status quo was still the most cost-effective option.

Wetland restoration was also compared to alternative adaptation options, including installing boreholes or buying supplementary feed (maize and lucerne) for livestock to deal with the expected impacts of climate change in the Leliefontein communal area. Results showed that even the lower cost estimates for wetland restoration are more than the cost estimates for all alternative adaptation options. EbA as a means of sustaining livestock stocking rates is likely to be twice as costly for landowners as alternative adaptation options. Analysis was conducted over the period from 2013 to 2050, using discount rates of 3%, 5% and 8%. All cost estimates included follow-up and maintenance expenditure. Wetland restoration can be very costly, especially where structural work is required to repair damage caused by draining wetlands for cultivation. High costs are largely due to the 'engineered' components of rehabilitation: installation of gabions, concrete structures and earth works. Clearing invasive alien trees was by far the cheapest form of restoration, but this is still a very costly exercise (Black and Turpie 2013; Black et al. 2016).

Comments from interviewees did not always tally with the research conducted above. Provincial authority interviewees felt EbA initiatives compared well with other approaches, with costs and benefits roughly equivalent for EbA projects where the interviewee had experience. Local authority-level interviewees felt cost-benefit analyses were lacking and that further research was needed.

Broader economic costs and benefits from the EbA initiative

EbA activities provide a number of broader economic benefits and costs that the analyses described above did not capture. Few studies have quantified these, but Black and Turpie (2013) comment that if the co-benefits of wetland restoration were quantified and taken into account, this may favour the EbA option in the cost-benefit study described above. De Villiers (2013) also argues that due to the importance of rangeland production to the local communities, rangeland rehabilitation initiatives within the Namakwa District municipality should not be dismissed solely on the basis of simple cost-benefit analysis.

Livestock plays a major role in the local economy of the Namakwa District municipality, employing 24% of the population (Chidley et al. 2011). Livestock production is still a major contributor to the socioeconomic security of poor communities on communal lands in the study area (Bourne et al. 2012). Some households rely heavily on livestock farming as a primary source of income, but for others it makes a smaller contribution to household income levels and "serves primarily as a safety-net against unemployment" (Bourne et al. 2017a). Farming reduces risks from financial losses elsewhere in poor people's lives, and acts as "an income-smoothing strategy" (Black and Turpie 2013). Rangeland and wetland restoration would both serve to increase the total value of services (grazing and water) provided locally, thus benefiting local farmers (Black and Turpie 2013). By contrast, an absence of activities to rehabilitate the rangeland is extremely undesirable as it would lead to significant reductions in agricultural productivity in what is already marginal farmland.

EbA can also reduce dependency on external goods and services. For example, compared to EbA options, drilling boreholes or trucking in food from outside the area could be expensive or unreliable. The 130,000 residents of Namakwa District could rather benefit from improved planning and the application of locally proven adaptation models.

Restoration programmes are labour-intensive and can create employment opportunities, which are badly needed in poor rural areas where unemployment levels are high. Unemployment levels are currently 40–70% in Namakwa District municipality (Bourne et al. 2015a). The two cost-benefit studies described above classify the labour required for wetland and rangeland restoration as a cost, but such job creation could also be perceived as a benefit. South Africa has a number of public works programmes, and restoration activities can and do help meet employment creation targets under these

(Black et al. 2016). For example, some efforts to rehabilitate wetlands in the area have already been made by the government's 'Working for wetlands' programme, a joint initiative of the DEA, Department of Water and Sanitation and Department of Agriculture, Fisheries and Forestry (see Table 5). Rehabilitation actions include clearing alien species, revegetating degraded areas, and installing gabions, concrete structures and earth works to repair damage from canalisation and erosion (Black and Turpie 2013). In such instances, the economic costs of restoration work are borne by the government programme, and hence South African taxpayers. But this is not considered problematic because the very aims of these programmes are job creation, poverty relief and skills development in marginalised communities, while restoring ecological integrity and ecosystem services. These criteria are far more important than whether or not the work is cost-effective (Black et al. 2016). When choosing between EbA and other adaptation options, decision makers should thus consider the wider benefits of EbA rather than just the economic efficiency of a project (Bourne et al. 2017a).

Black and Turpie (2013) also argue that while “cost-effectiveness analysis of EbA as against conventional options is a useful step to identify obvious winners, it can be limited when the problem is framed in terms of limited goal for a defined community”. The higher costs of rangeland or wetland restoration compared to alternative adaptation responses (boreholes and bringing in fodder) does not necessarily mean these EbA options are not a justifiable means of adaptation to climate change. Issues relating to who bears the costs and benefits of implementing the adaptation measures also need to be considered (Black et al. 2016). Communities living in the study area would not be able to afford any of the rangeland or wetland adaptation options – EbA or otherwise – described in the cost-benefit analyses above, so government support is needed to avoid disaster. And if government is choosing which option to subsidise, it would do well to choose the EbA options, with their greater reach in terms of employment benefits from restoration work and their multiple and often sustained economic benefits and co-benefits as detailed in the previous two sections of this paper (Black et al. 2016).

De Villiers (2013) describes a number of additional potential economic co-benefits associated with rangeland restoration, which were difficult to monetise and so were excluded from his cost-benefit analysis. These include benefits from game farming or hunting, research opportunities, historic and cultural activities, carbon storage and sequestration, sand and dust control, medicinal herbs and water infiltration.

Rangeland restoration also helps reduce local economic loss from soil erosion and road damage (most roads in the area are gravel roads, so erosion is problematic).

Rangeland restoration comes with opportunity costs, however, as grazing is controlled to let the rangeland recover. Restoration is a slow process. At least five years without grazing is needed, but full restoration can take over 25 years in dryland areas (during which time, use for grazing is controlled). This is a huge cost for those relying on grazing, although these costs can be partially offset by income from restoration work conducted under a government-funded public works programme.

Financial and economic trade-offs at different geographical scales

Locally implemented EbA activities also have economic benefits for those outside the project area. For example, restored wetlands help maintain dry season water flow, which benefits commercial farmers and other communities in the surrounding lowland areas (Black and Turpie 2013). The cost-benefit study described by Black et al. (2016) only included benefits to those directly affected (the landowners), and not the benefits to broader society. It also excludes potential costs and benefits in other areas, for example from importing food or water from these areas to the study site. These trade-offs have not been considered in the two cost-benefit studies described above.

Changing financial and economic benefits and costs over time

Wetland restoration will realise medium- to long-term economic benefits, but benefits from rangeland rehabilitation will take much longer to materialise. Low and very variable rainfall patterns make the recovery of indigenous vegetation after disturbance slow and difficult – it can take about 20 years for rehabilitated rangeland to begin to provide ecosystem services close to the level of unmodified rangeland in the Succulent Karoo. Some benefits can be seen, however, in terms of production improvements over a shorter (five- to ten-year) timespan. Other adaptation responses such as fodder provision and borehole drilling would have immediate economic benefits (De Villiers 2013).

For communities, if grazing is controlled more or prevented as part of a rangeland restoration programme, costs are felt in the short to medium term. However, these costs can be partially offset by immediate and short-term benefits from employment under government public works programmes.

Policy and institutional issues: what social, institutional and political issues influence the implementation of effective EbA initiatives and how might challenges best be overcome?

Local-level barriers to implementing EbA

Unclear mandates and a lack of local government authority

A major barrier to implementing EbA at the local level is unclear mandates and a lack of local government authority needed to take the necessary actions. Interviewees from the local authority, project implementing partners, and local communities were all in agreement on this issue. Local government does not prioritise EbA, and whilst it must implement poverty alleviation and job creation programmes, it is not always clear how addressing climate change (which is viewed as an environmental issue) aligns with these mandates. Medium- and long-term planning is often neglected as short-term gains in service delivery take precedence (DEA 2017). Bourne et al. (2017b) suggest making climate change response a core responsibility and performance area for all local government departments. However, dedicated climate change posts should not be placed in environmental departments in order to avoid them being side-lined (Bourne et al. 2017b). Reflecting on experience in South Africa more broadly, Ziervogel et al. (2014) state that one of the challenges faced by local government in mainstreaming adaptation is the lack of authority held by environmental departments to address climate change.

Insufficient cross-sectoral collaboration

Insufficient cross-sectoral collaboration was also a key challenge. There is a lack of coherence when scaling up from local to national levels, and more coordination and trust-building is needed between local-level actors. Bourne et al. (2017b) describe a ‘silo mentality’, whereby local government departments and individuals work in sectors, independently of each other. The DEA (2017) also refers to the need to “break turf protection” and enhance horizontal coordination and cross-sectoral linkages.

Knowledge gaps

Interviewees from the local authority, project implementing partners, and local communities were all in agreement that knowledge gaps remain. Most notably, knowledge on the quantifiable benefits of rangeland rehabilitation and how to monitor and evaluate these is lacking (De Villiers 2013). National-level interviewees added that communicating the results of monitoring is also critical at the local level. Evidence of the benefits and costs of EbA, and how these link to local government service delivery mandates, is sorely needed in order to build the ‘business case for adaptation’.

Funding

Local municipalities face obstacles regarding budgeting and funding (Bourne et al. 2012). Many interviewees – especially local communities and project implementing partners – felt that the lack of local-level financial resources for EbA was a key barrier. Ziervogel et al. (2014) point out that at the local municipal level, addressing climate change is contested and regularly referred to as an ‘unfunded mandate’. New policies are changing this, but municipal budget allocations do not yet reflect the need to respond to climate change. Bourne et al. (2017b) note that even when climate change information was included in local policy and planning documents, this did not necessarily translate into resources allocation and project implementation. The National Climate Change Response Policy (2011) is clear that the fiscal mechanisms to support local government spending currently do not incentivise municipalities to mainstream effective climate change responses into local government activities, and that this situation needs to change (DEA 2015).

Local-level capacity and institutional effectiveness

The lack of both local-level capacity and local institutional effectiveness were also considered by some interviewees to be barriers. Although support from non-government organisations was strong, local-

level institutions – such as ward committees, community-based organisations and traditional leadership – all had limited technical skills to implement EbA. There are no dedicated local government staff for climate change work (Bourne et al. 2017b), and officials do not always comply with relevant legislation where it does exist. Namakwa District municipality has no dedicated environmental staff at the local municipality level and only eight environmental staff at the District level (Bourne et al. 2017a). During a vulnerability assessment of Namakwa District municipality, local government officials rated their own capacity to respond to climate change poorly (Bourne et al. 2015a). This mirrors observations by Pasquini et al. (2013) and Ziervogel et al. (2014), who note that historically, smaller municipalities in South Africa lack the capacity to act on climate change and undertake systemic adaptation planning, and receive little financial or technical support from the national level for this (Ziervogel et al. 2014). Bourne et al. (2017b) note the importance of committed local ‘champions’ who drive municipal climate change mainstreaming, and recommend compulsory climate change adaptation training for all senior local government officials. The Namakwa District municipality vulnerability assessment also calls for “climate change capacity building for its own staff and associated institutions” (Bourne et al. 2015a). Support is increasing, however, with the introduction of the Local Government Climate Change Support Programme,³ and the ‘Let’s Respond’ toolkit (DEA 2012) for integrating climate change risks and opportunities into municipal planning.

Weak legal frameworks and policy support for user rights on communal land

Weak legal frameworks and policy support for user rights on communal land were also important. Although Namaqualand has been inhabited by nomadic Nama-speaking Khoikhoi pastoralists for 1,800 years, the communal systems of natural resource management historically practiced by the Khoikhoi have been weakened, which undermines EbA. Current land use and management in the region is largely a product of the historical imposition of laws and regulations by Dutch colonists who acquired and privatised grazing land, and the British who established missions and introduced cultivation to try and make the nomadic Nama people more sedentary. During the 19th century, Coloured Areas (reserves) were established in Namaqualand under the Cape Colony. Under apartheid, the land was further subdivided and units were rented to individuals or set aside for communal use. Only after apartheid ended in 1994 was land handed over to municipalities. These days, communal land is unfenced and has permeable boundaries, and whilst cropping and grazing activities are subject to regulation, rights and regulations are often poorly defined or are poorly implemented due to shortages of funds and capacity. Prescribed stocking densities are not adhered to, community members with influence sometimes benefit the most from the commonage, and pastoralists have adopted opportunistic grazing strategies. All of this leads to over exploitation of the resource base (Black and Turpie 2013; Bourne et al. 2017a), thus undermining EbA.

High levels of poverty

Lastly, high levels of poverty, unemployment and dependency undermine the ability of people living in Namakwa District municipality to respond effectively to climate change. Bourne et al. (2012; 2015a) argue that skills development, and health- and education-related interventions, are needed to improve adaptive capacity.

Provincial-level barriers to implementing EbA

Funding

A key issue limiting EbA implementation at the provincial level is the availability of finance. In the Northern Cape Province (and several others too), no funding is provided for provincial-level climate change adaptation planning and development (DEA 2015). Whilst this is partly by design (provincial-level authorities are responsible for providing technical support to local government rather than for project implementation), there is even a lack of finance available for support provision. This means provincial environmental departments across South Africa face challenges in terms of financing for National Climate Change Response Policy implementation (DEA 2015).

³ See <http://www.letsrespondtoolkit.org/>

Low government priority and inadequate policy support

EbA implementation is inhibited by the low priority that government places on climate change at the provincial level, and by inadequate policy support. A provincial climate change strategy is being developed for the Northern Cape Province but this has not yet been finalised (Bourne et al. 2017b). Interviewees from the community, project implementing partners, the local authority and the DEA agreed this was problematic. Many also felt that mandates to integrate climate change in provincial-level planning were unclear and that officials lacked the authority to address climate change. There is no legal requirement for mainstreaming climate change adaptation measures into provincial-level regulatory frameworks, particularly the planning and developmental processes (DEA 2015), and one DEA official commented on the lack of specific EbA policy tools available to support the process.

Fragmented government structures and uncoordinated governance

Another key issue is fragmented governance structures, which affect service provision, and a lack of coordination, which leads to duplication of efforts in some areas and absences in others. Cross-sectoral institutional collaboration needs to be improved. The DEA (2015) argues that relationships between it, provincial departments and research institutions need to be improved to ensure the availability of province-specific climate information and services.

Inadequate capacity

Institutional and implementation capacities were inadequate. Whilst the DEA (2015) states that it should help provinces undertake their roles as mandated by the National Climate Change Response Policy and that each province should establish a Climate Change Office manned by skilled personnel accordingly, technical skills at the provincial level are low. Most provinces in South Africa have capacity gaps as far as climate change adaptation planning and development is concerned, and the Northern Cape is no exception. Indeed, the Northern Cape Province is one of the poorest in South Africa and service delivery capacities in all areas are low. Whilst climate change is a standing agenda item in provincial level meetings, there is no body or dedicated unit to coordinate climate change planning. This means provincial level climate change information sharing and services receive little attention, and staffing for climate change is poor. Capacity to guide the implementation of the National Climate Change Response Policy (2011) or to mainstream and integrate climate change adaptation response plans/strategies within provinces is limited, as is capacity to conduct vulnerability assessments or climate risk analysis at the level of the province (DEA 2015). The Local Government Climate Change Support Program has been working to address this challenge.

Lack of knowledge

A lack of knowledge and fora for exchanging knowledge was also problematic. Few provincial officials in South Africa are exposed to climate change science or know how to access data/information relevant to their province. There are few platforms within the provincial sphere which are specifically dedicated to discussing climate change related issues. The DEA (2015) recommends that each province establishes a high-level forum to highlight the need for climate change inputs across sectors.

National-level barriers to implementing EbA

Poor cross-sectoral collaboration and inadequate mainstreaming

The cross-sectoral nature of EbA posed a major challenge to implementation. National-level and project-level interviewees felt that EbA should not be treated as a stand-alone issue, but rather should be mainstreamed and used as a vehicle for unlocking resources across sectors. Currently, however, there is a lack of coordination between activities at local, provincial and national levels, and poor communication and collaboration between sectors, institutions and ministries. This is despite the presence of two committees established to operationalise cooperative governance in the sphere of climate change (the Intergovernmental Committee on Climate Change) and to advise and consult the DEA on matters relating to national responsibilities with respect to implementation of the National Climate Change Response Policy as well as international commitments (the National Committee on Climate Change).

The current institutional home of climate change is the DEA, but even within the DEA there are two directorates focusing on climate change: the Biodiversity and Climate Change directorate (which

focuses on biodiversity planning and climate change, including EbA) and the Climate Change and Air quality directorate (where adaptation is a key focus area as well as mitigation, and where EbA has received significant attention). Work under these two directorates is not always coordinated, although this is improving.

Housing climate change within the DEA inhibits EbA implementation at times because climate change is seen as an additional responsibility that stakeholders from other departments must undertake without additional funding or support from the department. This gives it a negative reputation. Disaster management, by contrast, has a positive reputation as the agency responsible provides support for integrating disaster management into ongoing programmes.

Linking EbA more closely to disaster management work or housing climate change in a different department, or even closer to the presidency, could facilitate the integration of EbA into and across planning in other sectors. Positioning climate change as a development issue rather than an environmental issue could also help. Better links with the presidency, the treasury and the agencies responsible for cooperative governance, poverty alleviation and other sectors such as mining, energy, water, land reform, agriculture, forestry and fisheries are needed. Outside the cadre of government climate change experts, however, agencies are delivering programmes without considering climate change issues. For example, those working in the agriculture and water sectors need to be more aware of climate smart agriculture and water management that emphasises EbA approaches. EbA should not be siloed within any one sector, but rather mainstreamed and treated as a cross-cutting issue. This requires policies and legal frameworks that support cross-sectoral planning, and a dedicated mechanism to assist with impacts and adaptation assessments. And it requires coordinated efforts to align EbA with South Africa's development priorities (DEA and SANBI 2016). The DEA has done much to support this process through the National Climate Change Response Policy (2011) and the National Long-Term Adaptation Scenarios (see Box 3), along with extensive cross-sectoral impact and vulnerability assessments, but better coordination is still needed as well as a specific cross-sectoral programme of work. Rhetoric and policy are changing, but institutions also need to change to support more integrated cross-sectoral responses. This is important both within government (between sectors, institutions and ministries) but also between different stakeholder groups in South Africa (government, civil society, researchers, practitioners, the private sector) (Ziervogel et al. 2014; DEA and SANBI 2016).

Inadequate capacity and skills

Institutional capacity and the availability of technical skills for implementation are also key challenges. Interviewees felt South Africa has a strong policy framework for EbA but lacks the capacity needed for implementation. The ability to monitor EbA effectiveness (and communicate emerging evidence to the right audience) is currently weak. Human resources are limited (in terms of both numbers of people and expertise levels) and high government department staff turnover is problematic (Ziervogel et al. 2014). The capacity to mobilise funding for EbA is also weak. Climate change needs to be treated as a cross-cutting issue and mainstreamed within various government departments, but capacity to do this is low.

Knowledge availability

Knowledge availability was raised as an important issue by many interviewees. They felt that the difference between EbA and alternative adaptation approaches was poorly understood, and further research (and communication of recent research) on the costs and benefits of EbA was needed in order to inform national decision making on funding allocation. They also felt the science of EbA needed to be interpreted and made more accessible to make the case for relevant programmes. An institution to build scientific knowledge co-generated with local people to inform long-term planning would help with this. Ziervogel et al. (2014) add that understanding of the biophysical and socioeconomic impacts of climate change is limited, as is expertise on how to tackle the problem. Integrated climate change assessments are needed to support climate-resilient development planning, and the ability to take adaptation lessons from case study sites and use these to inform national-level cross-sectoral planning is limited. Very little is known about what institutions and governance systems are needed to foster adaptation and deal with uncertainty, complex system feedbacks and non-stable states (Ziervogel et al. 2014). DEA and SANBI (2016; 2017) argue that effective EbA monitoring mechanisms are needed, along with vulnerability assessments to direct EbA towards areas that are most at risk and an inventory of existing EbA-related activities in South Africa. To address these knowledge and capacity gaps, the DEA (2015) and several

national-level interviewees suggested introducing EbA into the South African curriculum; developing short courses, exchange visits and field trips with higher education institutions; and professionalisation to raise the credibility of EbA practices and nurture EbA champions.

Supportive policies and government commitment

Interviewees and the literature reviewed were inconsistent in terms of whether the policy framework, mandates and government commitment needed to support EbA were sufficient. Ziervogel et al. (2014) state that the National Climate Change Response Policy (2011) has yet to translate into policy that mainstreams adaptation into everyday practice and longer-term planning in all spheres and levels of government. Bourne et al. (2017b) add that there are no strong or clear mandates in South African legislation to address climate change specifically, and that the way such mandates are currently stated in the legislation requires interpretation. The National Adaptation Strategy (which will strongly emphasise EbA) and the Overarching Strategic Framework and Implementation Plan for EbA will help address this once they are finalised, and there is a wide range of existing strategies and policies to enable EbA (see Box 3), but some interviewees feel these are not sufficient. Interviewees also agreed that key stakeholders lack the necessary authority to take the actions needed to implement EbA, and that government (outside the DEA) is not sufficiently prioritising the issue. One national-level interviewee called for a Climate Change Act to support mandates and help leverage finance. One implementing partner stated that whilst EbA was in fact sufficiently prioritised at the national level, getting funds to the local level for implementation was challenging, in particular delivering the financial and human resources needed to implement cross-sectoral projects. One DEA interviewee felt that mandates were unclear or in some instances overlapping, which tends to create confusion between sectors or institutions within government. A project implementing partner disagreed, however, and felt that mandates were clear at the national level under each sector, and it was rather the cross-sectoral nature of EbA that was challenging.

Funding

Funding was also an issue. The DEA (2015) recommends that the National Treasury should make funds available to assist with the development of climate change response strategies, establishment of climate change offices, and implementation of provincial-level projects. Interviewees felt EbA should be mainstreamed into existing mechanisms, such as National Research Foundation grants. Government must be able to define its adaptation priorities and secure external donor funding directly to support these priorities – a process known as direct access – rather than through intermediary agencies. One example of this is the enhanced direct access project currently funded by the Adaptation Fund for small grants in Namakwaland and Mopani Districts. Examples like this need to be expanded.

Local-level opportunities for implementing EbA

Local government capacity and cross-sectoral collaboration

Despite the insufficient cross-sectoral collaboration mentioned by some interviewees in an earlier section, experience with project implementation and the ability to collaborate with those working in other sectors were considered by others to be a key opportunity for EbA implementation at the local level. Whilst higher levels of government provide direction and support, it is local government in South Africa that must implement activities on environment, disaster reduction, service delivery, job creation, poverty alleviation, and so on. Officials are more used to working together at the local level than at higher levels of government. This increases opportunities to align projects, work collaboratively across sectors and with civil society and research institutes, mainstream climate change into development activities, and access or redirect existing funding for EbA using by-laws and standards. This reflects experience from South Africa more broadly, which suggests that smaller municipalities are more successful implementers of adaptation planning because of their smaller, less complex organisational nature, and because key individuals across functions are well-networked and have a history of working together (Pasquini et al. 2013). It is also at this level that climate change can be integrated into budgets, job descriptions and work programmes across a range of different sectors (Bourne et al. 2017b). Opportunities are particularly apparent where key champions from different sectors work closely together towards a broader common goal (CSA 2017).

Supportive policies and plans

The Namakwa District municipality has a number of policies and plans relevant for EbA implementation, and whilst climate change is not currently mandated, legislated or budgeted for at the local government level, processes are underway to change this and there is broad support for mainstreaming. The municipality already includes the provision of local leadership on environmental sustainability and climate change response in its mission statement and has undertaken district-level climate change vulnerability assessments (Bourne et al. 2017b). The Namakwa District Municipality Integrated Development Plan (2015/2016) targets, in part, the provision of basic services by providing direction on municipal environmental infrastructure projects. The Namakwa District Municipality Environmental Management Framework and Strategic Environmental Management Plan (2011) promotes sound environmental management and sustainable land-use practices. It describes the state of the environment and resources for sustainable service provision in the district. The Namakwa Municipality Bioregional Plan (2010) ensures biodiversity information can be accessed and used by local municipalities within the district. The Namakwa Municipality Biodiversity Sector Plan (2008) guides land-use planning, environmental assessments and authorisations, and natural resource management to promote sustainable development. Whilst these plans don't directly address climate change, the National Climate Change Response Policy (2011) has made a provision that the National Treasury is to lead a process to re-examine the current fiscal measures and the appropriate incentives for adaptation and mitigation measures by local government. It states that climate change should be integrated into municipal development planning tools such as Integrated Development Plans, and municipal service delivery programmes (DEA 2015). CSA is also working with local municipalities to mainstream climate adaptation into their Integrated Development Plans using the 'Let's Respond' tool (DEA 2012).

Other opportunities

Whilst some interviewees felt local capacity and institutional effectiveness were weak, others described how the strength or potential strength of local institutions could support EbA implementation. In particular, non-government organisations working in the Namakwa District municipality have strong capacity. The Local Government Climate Change Support Program now provides stakeholders with information and tools to respond to climate change at a local level, and the South African Local Government Association (representing municipalities) works to integrate climate into Integrated Development Plans and their spatial component, Spatial Development Frameworks. There are also incentives in place to motivate appropriate action, clear mandates, as well as prioritisation by local government and widespread awareness and access to information. Whilst not always effective, commonage management systems do exist to try to ensure sufficient fodder and water for livestock throughout the year (Black and Turpie 2013), and the Namakwa District has good rates of basic service delivery (water, sanitation, electricity, etc) which indicate it could respond well to new needs and challenges such as climate change (Bourne et al. 2015a).

Provincial-level opportunities for implementing EbA

The key provincial-level opportunity for implementing EbA related to government prioritisation of the issue, and a supportive policy environment. Interviewees also mentioned the importance of good technical capacity and EbA 'champions', because core staff drive what happens and their motivation is critical. The Northern Cape Province has a number of policies relevant for EbA: the Northern Cape Province Growth and Development Plan, the Northern Cape Provincial Spatial Development Framework (which addresses sustainable development in the context of environmental realities) and the Northern Cape Rural Development Strategy. The National Climate Change Response Policy (2011) requires each province to develop a climate response strategy, which evaluates provincial climate risks and impacts and seeks to give effect to the policy at the provincial level. As such, the Northern Cape Climate Change Response Strategy is under development and a process to review and incorporate climate change into the Provincial Spatial Development Framework is underway (DEA 2015). CSA is working with provincial officials to integrate climate change adaptation into provincial response strategies, and the Local Government Climate Change Support Program provides tools and information to build sub-national government level capacity to address climate change.

National-level opportunities for implementing EbA

South Africa's policies and legislative arrangements for environmental governance (see Box 3) are considered amongst the best in the world, and provide clear support for EbA (DEA and SANBI 2016).

Box 3: Key policies and legislative arrangements in South Africa for environmental governance and support to EbA

- The Constitution of the Republic of South Africa (1996) entitles every South African to an environment which will not harm them and will be maintained for future generations through ecologically sustainable development and use of natural resources.
- The **National Development Plan** (Vision 2030) aims to improve lives and livelihoods through a variety of development initiatives that ensure environmental sustainability and build resilience to climate change, particularly in poorer communities. It mentions maintaining the integrity of ecosystems and the many services that they provide.
- The **Medium-Term Strategic Framework** guides government's programme of work in a particular electoral period. The current framework (2014-2019) recognises the vulnerability of the economy, water, food security, health and natural resources to climate change and addresses this further under Outcome 10: "protect and enhance our environmental assets and natural resources".
- The **National Framework for Sustainable Development in South Africa** (2008) recognises the value of ecosystem services in South Africa, particularly to the poor who are most reliant on them, and emphasises the need for development not to degrade such ecosystems to the point where the services are lost. Other aspects include job creation based on ecosystem health, for instance the 'Working for water' programme. The framework acknowledges that biodiversity protection is not 'just a green issue' linked to tourism but that ecosystem services need to be integrated into the mainstream economy (Muir and Marais 2009).
- The **National Strategy for Sustainable Development and Action Plan** (2011-2014) prioritises ecosystems and natural resources as the route to sustainable development. This strategy builds on National Framework for Sustainable Development it and takes it a step further towards implementation.
- The **National Environmental Management Act** (1998) provides for co-operative environmental governance and addresses adaptation issues, for example by allowing for the designation of high value biodiversity areas, including those important for climate change adaptation.
- The **National Water Resources Strategy II** mentions climate change. The water sector plan does not specifically mention EbA but often refers to the importance of protecting ecosystems and watersheds.
- The **National Climate Change and Health Adaptation Plan** (2014-2019) does not specifically mention EbA, but it does link health to ecosystems.
- The **Adaptation Strategy for Rural Human Settlements** (2013) speaks to EbA.
- The **National Biodiversity Assessment** (2011) specifically mentions EbA and how to protect ecosystems in the context of building climate change resilience. The **Climate Change Biodiversity Sector Plan** (2013) and **Climate Change Adaptation Plans for South African Biomes** (2015) both include EbA. The revised **National Biodiversity Strategy and Action Plan** (2015) states that EbA is known to achieve multiple benefits in the context of sustainable development.
- The **Department of Agriculture Forestry and Fisheries Strategic Plan** (2013) speaks explicitly to EbA.

- The **Disaster Management Amendment Bill** No 16 of 2015 speaks specifically to EbA. It states that every organ of state (national, provincial and municipal) is to "provide measures and indicate how it will invest in disaster risk reduction and climate change adaptation, including ecosystem and community-based adaptation approaches." The **National Disaster Management Act** and the **Policy Framework for Disaster Risk Management in South Africa** provide numerous opportunities for the adoption of EbA as a response measure.
- The **National Climate Change Response Policy** (White Paper) (2011) outlines a number of flagship programmes for implementation, notably the Climate Change Response Public Works Flagship Programme, the Water Conservation Flagship Programme, and the Adaptation Research Flagship Programme. The Policy adopts a strongly sectoral approach, but also identifies the need for coordination of responses between sectors (Ziervogel et al. 2014). It clearly states the importance of adaptation and EbA, noting that these can contribute significantly to job creation and other sustainable development goals. It also provides for climate change to be integrated into local planning tools, including Integrated Development Plans, and municipal service delivery programmes (Bourne et al. 2017b).
- The **National Long-Term Adaptation Scenarios** fall under the Adaptation Research Flagship Programme. Research is led by the DEA, which has released technical reports on climate change impacts, sector-based adaptation threats and opportunities for biodiversity, forestry, marine fisheries, human health, agriculture, disaster risk reduction, human settlements and water. EbA is a key strategy for adaptation under all long-term scenarios. The third phase of the research - currently underway - involves provincial downscaling. Research conducted under these scenarios is informing policy processes under the Intended Nationally Determined Contribution, the third National Communication, the National Adaptation Strategy and the National Adaptation Plan.
- South Africa's **Intended Nationally Determined Contribution** was submitted to the UNFCCC in 2015. It includes ecosystems but not EbA or links between ecosystems and adaptation specifically.
- The third **National Communication** to the UNFCCC was completed in June 2017 but has yet to be released. This will supersede previous National Communications (submitted in 2011 and 2003) and will include EbA.
- The **National Adaptation Strategy** is under development and is due to be completed in 2018 when consultations with different sectors have occurred. It will also be submitted (in some form) to the UNFCCC as South Africa's **National Adaptation Plan** when finalised. CSA is working with the DEA as part of the project team to ensure EbA and lessons from district implementation are integrated into the plan. The current version has extensive references to EbA in it.
- An **Overarching Strategic Framework and Implementation Plan for EbA** in South Africa was developed in 2016 (DEA and SANBI 2016). This details financial and human resources to support EbA mainstreaming and aims to ensure EbA approaches align with the National Adaptation Strategy implementation.

South Africa has a number of expanded public works programmes into which EbA can be, and is being, integrated. These include 'Working for water', 'Working for wetlands', 'Working for land', 'Working on fire' and 'Working for energy' (DEA and SANBI 2017). All address critical political priorities such as job creation, poverty reduction and water scarcity, and are funded with tax allocations. Many of the programmes also work to maintain, restore or rehabilitate ecosystems and thus reduce South Africa's environmental and social vulnerability to climate change. As such they can be classified as EbA even though not designed as such (Midgley et al. 2012; Bourne et al. 2017a), although DEA and SANBI (2017) argue that to be classified as EbA they would need to be adjusted to show the 'intentionality' and 'additionality' of addressing climate change. The DEA recognises the need to consider the wide range of benefits from EbA, and efforts are currently underway (supported by CSA and the South African National Biodiversity Institute) to develop 'socio-ecological' metrics for these programmes that measure success in terms of adaptive capacity gains, and not just gabions constructed or jobs created. This will

help mainstream and retrofit EbA into new and existing public works programmes and guide decision making on where these activities should take place in the future. Experiences from the CSA project are informing this process.

Interviewees mentioned a number of additional national-level factors that supported EbA implementation, namely, the strength of national institutions, appropriate incentives in place to motivate action, government prioritisation of the issue, EbA 'champions', and high levels of technical capacity (the DEA is very strong on EbA, with the Department of Water and Sanitation, and the Department of Agriculture, Forestry and Fisheries good too). The Department of Rural Development and Land Reform has developed a climate change training program toolkit⁴ to provide resources for national and provincial department and DEA development planners within the rural development sectors. CSA also ran a workshop in June 2017 to share tools for EbA and to develop government EbA implementation capacity (CSA 2017). Cross-sectoral planning is improving too as the DEA and CSA seek buy-in from different sectors for the National Adaptation Strategy before it is finalised in 2018. South Africa also benefits from having a small group of scientists who are very capable and strongly integrated into international climate change research (Ziervogel et al. 2014), and the DEA and the Adaptation Network both maintain information about South African EbA projects (DEA and SANBI 2016).

Is the EbA initiative sustainable?

Local authority and local community interviewees felt there was not enough local, provincial and national-level policy and institutional support for the EbA initiatives described to be sustainable over the long term. They felt local government in particular needs more support for this to occur. There is currently a Local Government Climate Change Support Programme which receives assistance from provincial and national levels of government to ensure sustainable local project implementation, and financial support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The South African Local Government Association also provides some financial support. Assistance is limited, however, and it remains to be seen whether it will be sustained. Interviewees felt that local government mandates were unclear, and that until EbA and climate change responses are included in job descriptions and resources are allocated accordingly, current initiatives can only be sustained through partnership with a highly motivated external agency. There is no shortage of interest in promoting EbA, and financial support is available for developing strategies, but resources and ongoing support from provincial and national departments are scarce when it comes to implementation.

Another challenge for local sustainability is the difficulties of ecological restoration. Wetland revegetation work, for example, struggled due to the low survival of transplanted wetland species outside fenced areas.

At the provincial level, interviewees were more positive about whether sufficient support was available to ensure sustainability. Policy support for action on climate change is growing, and EbA is part of this. The cohort of skilled technical staff is growing, which will also help maintain momentum despite the challenges of cross-sectoral collaboration.

At the national level, opinions were mixed. Interviewees felt that South Africa's policies relating to climate change were strong, interest in mainstreaming was growing, and alignment between the priorities of the treasury and those of the DEA relating to natural resources management was improving. However, climate change is still seen as an environmental issue and so of lower priority than social or economic issues, and until this changes the current momentum is unlikely to be supported with sufficient resources for implementation. For example, the Overarching Strategic Framework and Implementation Plan for EbA in South Africa lacks the financial and human resources needed for implementation. Work to address this is ongoing, but until funding can be secured, the long-term sustainability of framework activities is uncertain.

⁴ See www.climatechangetraining.org

Opportunities for replication, scaling up or mainstreaming the EbA initiative or for influencing policy

Interviewees agreed that EbA should not be a standalone issue but rather should be mainstreamed as part of an overall integrated approach. They described a number of ways that EbA is being mainstreamed into local, provincial and national levels of policy, planning and implementation. The CSA projects described in this paper aim, in part, to communicate how EbA can contribute to local and national adaptation planning. CSA has been working with policymakers to integrate lessons from local case studies into national adaptation policy processes.

EbA is being mainstreamed into national policy in a number of ways. The National Adaptation Strategy and South Africa's National Adaptation Plan will strongly emphasise EbA, in part due to CSA support with drafting. Existing policies, such as the National Climate Change Response Policy (2011) and the Overarching Strategic Framework and Implementation Plan for EbA in South Africa, already emphasise EbA and others are likely to follow suit, such as South Africa's Intended Nationally Determined Contribution under the UNFCCC, and national commitments made under the international conventions on desertification and biodiversity. CSA and others have also been working to integrate EbA into national policies such as the National Water Resource Strategy. Policymakers support EbA and stronger links are being forged between different government bodies to support cross-sectoral planning accordingly.

The government-funded expanded public works programmes have great potential for further mainstreaming EbA implementation across South Africa. These include existing programmes, such as 'Working for water', and new ones, perhaps on dryland management. Such mainstreaming would need greater emphasis on areas critical for climate adaptation and ecosystem services, and longer-term measures of programme success that incorporate adaptation metrics. The DEA Natural Resource Management Land User Incentives Programme is currently funding alien clearing in priority catchments and eco-rangers (environmental herders/monitors) to work with farmers on rotational grazing (with co-finance from CSA donors).⁵ This work supports sustainable rangeland and watershed management in Namakwa District municipality and Alfred Nzo District municipality. Integrating EbA metrics into this and similar programmes provides an important opportunity to implement EbA programmes at scale in South Africa (DEA and SANBI 2016).

Mainstreaming is also occurring at provincial and local levels. The National Long-Term Adaptation Scenarios began as a national-level exercise, but projections have since been downscaled to the provincial level and these are guiding the revision of provincial climate change response plans. CSA is currently supporting development of the Northern Cape Climate Change Response Strategy as part of this process. Further downscaling to district levels more generally in South Africa is now underway. Devolution is occurring and district-level adaptation plans are being developed in some areas. Application of the 'Let's Respond' toolkit (DEA 2012) has helped integrate climate change into district- and local municipality-level planning. EbA is also being integrated into provincial Spatial Development Frameworks. One interviewee agreed with the need for replication, but warned that efforts need to be context specific, as South African landscapes and social contexts are hugely diverse.

A number of tools have helped with efforts to mainstream and replicate EbA, notably 'Let's Respond' (DEA 2012) and also tools for developing National Adaptation Plans. 'Let's Respond' is designed to help integrate climate change risks and opportunities into district- and local municipality-level planning related to service delivery and job creation. The National Adaptation Plan technical guidance (LDC Expert Group 2012) and tool for integrating ecosystems into a National Adaptation Plans (Conservation International 2015) are informing South Africa's National Adaptation Strategy, which is under development and will be completed in 2018.

Donors are increasingly supportive of EbA and this has opened up avenues for further funding. Various donor-funded local projects followed the German International Climate Initiative support for the project described above. The Adaptation Fund has provided 6 million rand to support six projects in Namaqualand, for example, each with 1 million rand. The climate resilient livestock farming project in Leliefontein is one of these projects.

⁵ See <http://www.panorama.solutions/fr/node/1121>

Summary and conclusions

The EbA rangeland and wetland rehabilitation initiatives described in this paper allowed communities to maintain or improve their adaptive capacity or resilience, and reduce their vulnerability, in the face of climate change. The initiatives were able to benefit vulnerable groups, especially those relying on pastoralism for their livelihoods. Few social trade-offs were observed, but because of the slow nature of rangeland restoration, the associated gains in resilience took time to accrue. Numerous social co-benefits emerged from the EbA initiatives, and few costs. Project activities built on local knowledge and adopted a range of participatory processes, which helped build adaptive capacity.

The EbA initiatives also restored, maintained or enhanced the capacity of ecosystems to continue to produce services for local communities, and allowed ecosystems to better withstand climate change impacts and other stressors. However, improvements in ecosystem service provision from rangeland restoration were much less apparent than from wetland restoration. Whilst few trade-offs in terms of ecosystem service provision were observed, ecosystem-related benefits from rangeland restoration took several years to emerge. It may also be that semi-arid Succulent Karoo ecosystems have thresholds relating to overgrazing or climate change, which if crossed could lead to irreversible change.

EbA rangeland restoration was not financially viable from the perspective of landowners. EbA approaches (rangeland and wetland restoration) were also considerably more expensive than other adaptation options. Despite this, EbA options provide many broader economic benefits such as job creation, providing a strong economic case for wider application using government funding channelled through South Africa's expanded public works programmes.

A number of policy and institutional barriers influenced the implementation of effective EbA initiatives at local, provincial and national levels, most notably the lack of local government authority to implement EbA, inadequate policy support at the provincial level, insufficient cross-sectoral collaboration at all levels, knowledge gaps, funding shortages, low capacity levels, weak institutional effectiveness and high levels of poverty.

A number of policy and institutional opportunities also supported EbA implementation at local, provincial and national levels, most notably local government capacity, a supportive national and provincial legislative and policy environment, and opportunities for integrating EbA into expanded public works programmes. These programmes provide great potential for scaling up EbA implementation and moving away from stand-alone EbA projects with limited and locale-specific impacts. Mainstreaming is also occurring as EbA is incorporated into various national policymaking and planning processes in South Africa. Tools and guidance have been developed to support this process.

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Ecosystem-based adaptation (EbA) is the use of biodiversity and ecosystem services as part of an overall strategy to help people to adapt to the adverse effects of climate change and promote sustainable development. This report presents the results of using our Framework for Assessing EbA Effectiveness at the Climate Resilient Livestock Production on Communal Lands project, South Africa. The findings will be combined with those from 12 other sites in 11 other countries to help show climate change policymakers when and why EbA is effective.



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