Western Cape Government
Environmental Affairs and Development Planning

BETTER TOGETHER.

ASSESSMENT OF ECONOMIC RISKS AND OPPORTUNITIES OF CLIMATE RESILIENT INVESTMENT IN THE WESTERN CAPE

Project Report 5:

Summary Report on the Cost-benefit Analysis of Western Cape Climate Change Responses

DOCUMENT DESCRIPTION

Document Title and Version:

Assessment of the Economic Risks and Opportunities of Climate Resilient Investment in the Western Cape: Summary Report on the Cost-benefit Analysis of Climate Change Responses

Version 1: Draft - 12 March 2018

Version 2: Final – 15 March 2018

Author Information:

A. Cartwright – Econologic

M. Mander – FutureWorks

J.N. Blignaut – FutureWorks

N. Diederichs Mander – FutureWorks

Western Cape Government Project Management Team:

Sarah Birch, Frances van der Merwe, Lize Jennings-Boom, Goosain Isaacs, Western Cape Government, Department of Environmental Affairs and Development Planning, Climate Change Directorate.

Western Cape Government Contract Reference:

EADP3/2016

Document Copyright:

TABLE OF CONTENTS

1 KEY MESSAGES 4

2 FOCUS OF THE STUDY 5

3 COST BENEFIT ANALYSIS METHOD 5

3.1 IDENTIFYING CLIMATE CHANGE RESPONSES 5

3.2 APPLYING THE COST BENEFIT ANALYSIS 8

4 RESULTS 9

5 CONCLUSIONS 13

6 REFERENCE LIST 14

1 KEY MESSAGES

CLIMATE CHANGE IS MULTI-SECTORAL RESPONSIBILITY

Cost-effective climate change responses are being implemented across a wide range of Western Cape Government departments, highlighting that reducing climate change risks is a province-wide and multi-sectoral responsibility.

- The various economically attractive climate change responses that emerged from the Cost Benefit Analysis (CBA) included both adaptation and emissions mitigation actions, emphasising the importance of both.

INVESTING IN "SYSTEMS" RESILIENCE OFFERS GOOD VALUE FOR MONEY

Many of the best performing climate change responses address the functioning of an entire social-technical or social-ecological system and produce multiple benefits.

- Climate change responses that offer work creation, developmental or ecological co-benefits are often economically attractive and cost effective.
- Some climate change responses actually reduce current expenditure by decreasing dependence on energy, water or other resources.

CBA SHOULD BE USED AS A DECISION-SUPPORT TOOL, NOT A DECISION-MAKING TOOL

Cost-benefit Analyses (CBA) provides a useful framework for comparing climate change investment options on the basis of "best bang for buck". However, they never fully reflect all costs and benefits across all contexts, and the results will always require interpretation by decision-makers.

- Capital-intensive climate change responses may have poor cost to benefit ratios in a purely financial analysis but may impact positively on a significant percentage of the population. The high costs of these projects are sometimes justified for addressing specific climate change risks.
- Different climate responses generate different suites of benefits over different time frames. Some may address immediate climate risks and others may deal with long-term resource security or greenhouse gas emissions reductions.
- Project costs and benefits can be separately viewed and ranked to provide specific insights for decision-makers.
- CBA models do not take decisions, and do not replace the responsibility and obligation on decision-makers to manage the difficult trade-offs in choosing which investments to pursue in reducing climate change risk and impacts.

2 FOCUS OF THE STUDY

The Western Cape Government (WCG) has recognised the risks posed by climate change to its economy, population, ecosystems and infrastructure. These risks are already being experienced as escalating costs to the public and private sector for remediation and repair of damage resulting from more frequent and intense storms, floods, droughts, wildfires and ill-health. Critically for the Western Cape, climate change is predicted to compound these pressures not only on environmental systems, but on social and economic systems too, escalating social inequality due to the disproportionately high impacts on the poor and their limited capacity to adapt.

As described in several key WCG policy documents (including the Western Cape Climate Change Response Strategy, 2014), the need to address vulnerability and build resilience in response to climate change risks offers an unprecedented opportunity to direct investment in a manner that accelerates the process of transitioning the Western Cape economy and society towards a more just, equitable and sustainable future. The challenges, however, are where to begin and how to prioritise climate adaptation action across a diverse range of impacts, vulnerabilities and risks.

The WCG has commissioned the "Assessment of Economic Risks and Opportunities of Climate Resilient in the Western Cape" study to evaluate the economic costs of climate change and the potential economic benefits of investing in climate resilience. This report presents the outcomes of a Cost Benefit Analysis (CBA) undertaken as a component of this study to analyse a suite of Western Cape climate change responses based on best economic and social outcomes for lowest financial cost. The CBA combines a traditional financial method with a people- and development-focused 'Human Benefit Index' to also reflect the social costs and benefits associated with different climate change responses.

The CBA analysed 16 climate change responses currently considered relevant / important and that are being implemented in the Western Cape. These responses do not represent all possible climate change responses and do not replace the Western Cape Climate Change Response Strategy (2014), which identifies a much broader suite of climate change responses required across multiple sectors and timescales in the province. The CBA outcomes presented here are, however, useful to provide high-level insights into how distinct types and scales of climate change responses may perform in terms of their cost to benefit ratio. In addition, the CBA process is a useful decision-support tool which may be used for further climate change response prioritisation exercises in the future.

3 COST BENEFIT ANALYSIS METHOD

3.1 Identifying Climate Change Responses

The first step in the CBA process involved identifying existing or planned government responses to climate change in the Western Cape, particularly those considered most relevant or important for addressing existing climate impacts. Public officials in the WCG, the City of Cape Town, and in supporting agencies such as GreenCape and Wesgro, were asked to identify potential climate change responses that aligned with the following criteria:

- **Falls within the WCG mandate or sphere of influence.** There are many good climate change responses, but they are not all the responsibility, or within the influence, of provincial governments under South Africa's constitutional allocation of mandates across its three spheres of government.
- **Actionable within the next five years.** This requires there to be both the capacity to implement as well as the realistic possibility of being able to finance the climate change response within the next 5 years.
- **Reduces climate risk, enhances climate resilience or reduces greenhouse gas emissions.** While the systemic nature of climate change impacts was acknowledged, this criterion remained important given the focus of the study.
- **Scalable or capable of have a significant impact on climate resilience in the province.** This excludes projects that are specific or limited to a single household or a confined location.
- **Capable of securing political buy-in.** This was considered important for implementation, and to reflect the influence of social acceptability.
- **Supporting job or work creation, poverty alleviation and a reduction in inequality - all of which are important within the context of the Western Cape.** Capable of delivering other co-benefits, including ecological rehabilitation, reduced financial dependence on the State, reduced inequality and social cohesion.

An initial list of 68 current and planned climate change responses in the Western Cape was developed. Together with government officials, and using the above criteria as a guide, this list was narrowed down to 16 responses that would be analysed in the CBA (see Table 1). A critical consideration in developing this short-list was the availability of reliable project cost and impact data. Where promising climate change responses did not have these data, they were not short-listed for analysis.

Table 1: Summary of 16 climate change responses evaluated in the CBA

Climate Change Responses
Conservation Agriculture A programme run by the Western Cape Department of Agriculture, with support from the National Department of Agriculture that promotes reduced tillage, mulching and the use of cover crops to enhance soil carbon and water retention in the soil. This is considered particularly helpful in a drying climate. It is assumed that Conservation Agriculture impacts on 80% of the Western Cape population, primarily through stabilising staple food prices.
Fruitlook Fruitlook is a precision farming farmer support programme implemented by the Western Cape Department of Agriculture. The programme enables more accurate crop watering and fertiliser use, resulting in less water use and better yields.
LandCare Landcare is a community works programme funded by national government but manged by the provinces, aimed at countering the impact of erosion and soil degradation. Teams of people working for the Landcare programme rehabilitate dongas and gullies that would otherwise lead to accelerated erosion and loss of topsoil, particularly during high rainfall events.

Agricultural Disaster Management Agriculture disaster relief is a reactive measure provided from the national or provincial fiscus once a natural disaster has been declared for the agricultural sector. Historically, crop and livestock losses caused by drought, flood and hail have been the reasons for mobilising disaster relief and management.
Upgrading Informal Settlement Programme (UISP) The informal settlement upgrading programme run by the Provincial Department of Human Settlements, works with residents in informal settlements to map the lay-out of housing units, use more resilient building material and provide services such as water, sanitation and energy.
Desalination: Large Large scale desalination refers to any project capable of delivering over 50 million litres of potable water per day. The modelling for this study was based on the cost of providing 220 million litres of potable water per day.
Desalination: Small (Harmony Park) Modelling of small-scale desalination in this study was based on the Harmony Park project under construction in False Bay. The project will produce 8 million litres of potable water per day.
PV on government buildings The installation of photovoltaic (PV) and monitoring technologies on buildings owned or occupied by provincial government to reduce greenhouse gas emissions and reduce the money paid to Eskom (via the local municipality in some instances) for electricity. The falling cost of photovoltaic electricity results in these installations saving the provincial government money over time.
Water re-use (50Ml / day) Re-using wastewater by using reverse osmosis technology to augment the supply of potable water. The model reflected a planned 50 million litres per day project in Cape Town.
Atlantis SEZ An existing project that creates a Special Economic Zone (SEZ) near the dormitory town of Atlantis in which new businesses enjoy agglomeration benefits, green energy, water recycling and concessionary tariffs and rentals. The demarcation of such a zone required investments by provincial and national government.
Hout Bay recycling co-op roll-out The roll-out of waste diversion sites run by community-based co-operatives that sort, recycle and upcycle waste from municipal waste streams. These sites reduce waste to landfill, create employment and reduce greenhouse gas emissions.
BRT - phase 1A The first phase of the City of Cape Town's Bus Rapid Transit (BRT) system, costing R4 billion, and servicing the Atlantis Corridor and Inner City.
Mbekweni artificial wetland Construction and maintenance of a wetland to assist in the remediation of industrial effluent from Mbekweni before it enters the Berg River near Paarl.
Berg/Breede upper catchment National Department of Public Works programme aimed at removing invasive alien tree species from water catchments that supply water to the City of Cape Town, adjacent municipalities and farmlands.
Boreholes (hospitals & schools) Installation of groundwater abstraction facilities, water meters and filters at hospitals and schools to ensure that these public facilities can cope in the instance of severe drought.
GreenCape A special purpose vehicle aimed at generating new research and business support capacity that positions the Western Cape as a global leader in the global green economy and attracts the investment that accompanies this growing economy to the Western Cape. This agency is

considered a key driver and facilitator of climate change response interventions at an economy-wide scale in the province.

3.2 Applying the Cost Benefit Analysis

As a first step, the following assumptions were developed for the CBA model:

- The term over which the model is run: 25 years was selected for use in the current CBA model.
- A discount rate[1] that could be applied to capital and operating costs incurred by the respective climate responses. In this analysis a 1% discount rate was used to reflect a government which places high value on the future.

The second step involved scoring each of the 16 climate change responses for "intrinsic merit". Each option was scored by government officials in terms of its ability to:

- Improve adaptation to climate change impacts;
- Mitigate emissions;
- Contribute to economic development; and
- Contribute to general societal well-being.

The third step involved calculating the costs of each climate change response measure. This included public expenditure across all three spheres of government, including a combination of actual costs contained in existing budget data, contracted costs in newly procured projects and anticipated costs.

The fourth step involved calculating the benefits and required an estimation of the number of people positively impacted by each climate change response measure, and the degree of positive impact on respective sub-portions of the population, over the 25-year modelling period. The assumptions about the importance of each measure (i.e. does it save lives or just improve people's lives to some degree) and the number of people benefiting were used to generate a "population impact factor" for each measure.

The fifth step involved multiplying the "population impact factor" by the weighted "intrinsic merit" score assigned to each response measure to generate a proxy for benefit, called the "Human Benefit Index".

The sixth and final step involved comparing the costs of each measure with the "Human Benefit Index" score for that measure. This comparison provided a cost to benefit ratio that could be interpreted as the cost, in present value terms, that is required to generate 1 unit of benefit in the context of climate change.

[1] A "discount rate" refers to the time value of money. The higher a discount rate is, the higher the depreciation of the value of money over time (or, money loses its purchasing power over time). The lower a discount rate, the slower money loses its purchasing power relative to today. Discount rates are intended to capture human behaviour and particularly peoples' perceived risks of the future – the higher the perceived risk the more people prioritise the current period and the higher the discount rate.

This approach to conducting a CBA was deliberate in seeking to address some of the documented limitations of conventional climate change CBA (Cartwright *et al.* 2013; Stern, 2016). The advantages of this approach include:

- It recognises that provincial government is mandated to be developmental and to pursue a notion of "benefit" that involves more than avoided GDP loss and instead speaks to the public good.
- It includes both adaptation and mitigation responses, and can accommodate projects, programmes and more systemic climate responses involving institutional reform or ecological rehabilitation.
- It puts people and their well-being at the centre of the metric for "benefit" and recognises the importance of employment creation, for example, as part of effective climate responses.
- It introduces multiple criteria into the notion of benefit and requires public sector decision makers to engage this set of criteria, thereby forcing them to consider issues that may not be directly related to their position, but which remain in the public's interest in the Western Cape.
- Whilst the analysis does not explicitly include a criterion related to ecological degradation or inequality, these factors can be introduced by officials in the weighting and scoring of response options for "intrinsic merit".
- It provides a long-term analysis – 25-year time horizon as a default value - but can accommodate different time horizons.
- The analysis can accommodate different discount rates to reflect the very different views of the future, and risk aversion, of people in the Western Cape.

4 RESULTS

The results of the CBA model are reported as cost to benefit ratios. These are shown in ranked order in Table 2, where the lower the ratio, the more economically efficient the climate change response measure is.

Table 2: Ranked summary of CBA results (over 25 years)

Climate change response	Human Benefit Index	Discounted cost (R'000)	Cost-Benefit ratio
Rooftop PV on gov. buildings	129 417	-597 029	-4,61
Conservation agriculture	3 073 304	126 920	0,04
Berg/Breede upper catchment	1 700 126	114 969	0,07
Hout Bay recycling co-op roll-out	70 004	10 393	0,15
Mbekweni artificial wetland	126 007	25 944	0,21
Fruitlook	732 930	199 189	0,27

LandCare	583 364	506 533	0,87
Boreholes (Hospt & schools)	916 437	954 793	1,04
Agric. disaster management	1 106 350	1 651 737	1,49
Atlantis SDZ	163 474	246 299	1,51
Wastewater recycling (50Ml/day)	1 253 545	4 019 226	3,21
Upgrading Informal Settlement Programme	2 418 578	8 544 984	3,53
BRT - phase 1A	951 504	8 287 376	8,71
Desal: Large	4 546 189	42 269 083	9,30
Desal: Small (Harmony Park)	129 672	1 607 690	12,40

It is clear from Table 2 that installing PV technologies on government buildings ranks "best" as a climate response amongst the 16 options evaluated in the CBA model. This is followed by the existing conservation agriculture programme, the removal of invasive alien species from critical water catchments, and the roll-out of labour intensive solid-waste recycling measures.

Figures 1 and 2 depict the same results in the form of a "climate change response cost curve". The width of the columns in Figures 1 and 2 reflect the Human Benefit Index score, while the height of each column is inversely proportionate to the cost-benefit ratio, i.e. lower is better.

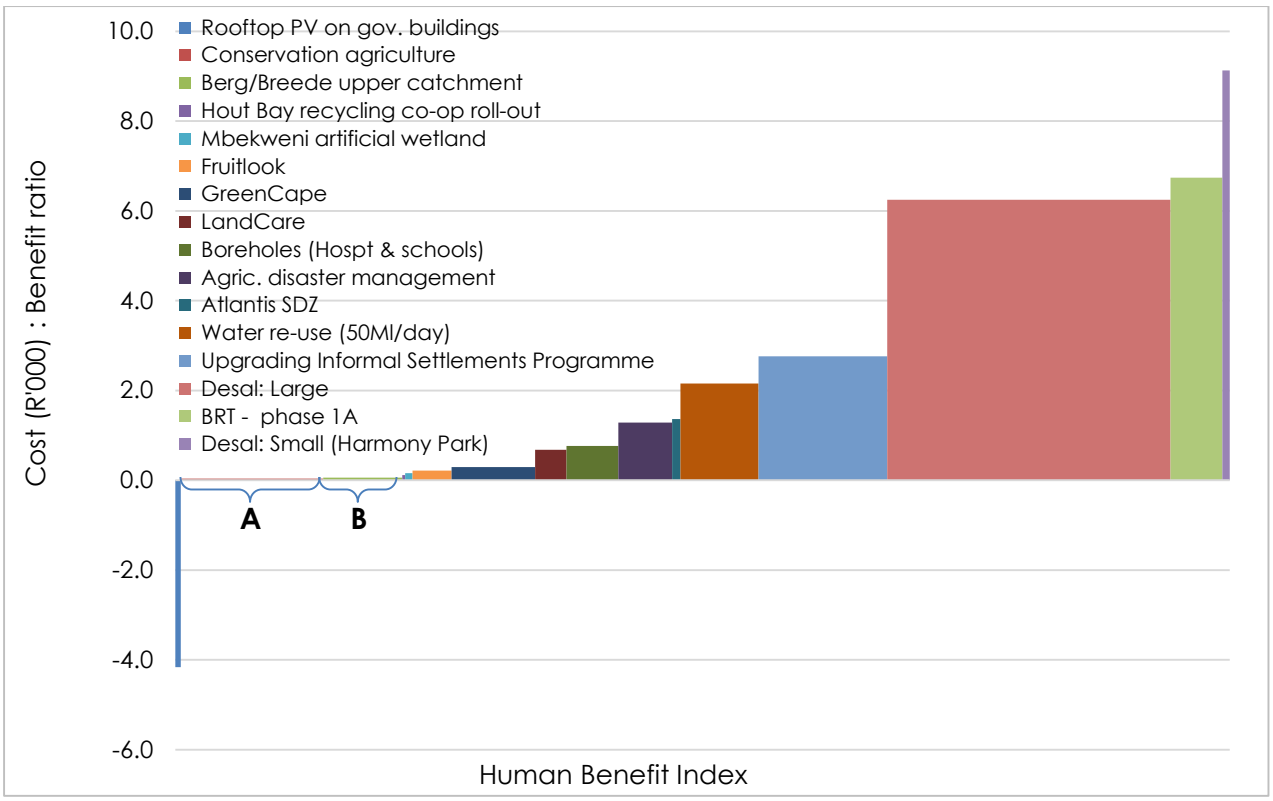

Figure 1: Summary of CBA results for the 16 climate change responses (note the blank space occupied by conservation agriculture (A) and invasive alien plant clearing in the Berg/Breede upper catchment (B), which have a cost-benefit ratio that is not visible relative to the horizontal axis)

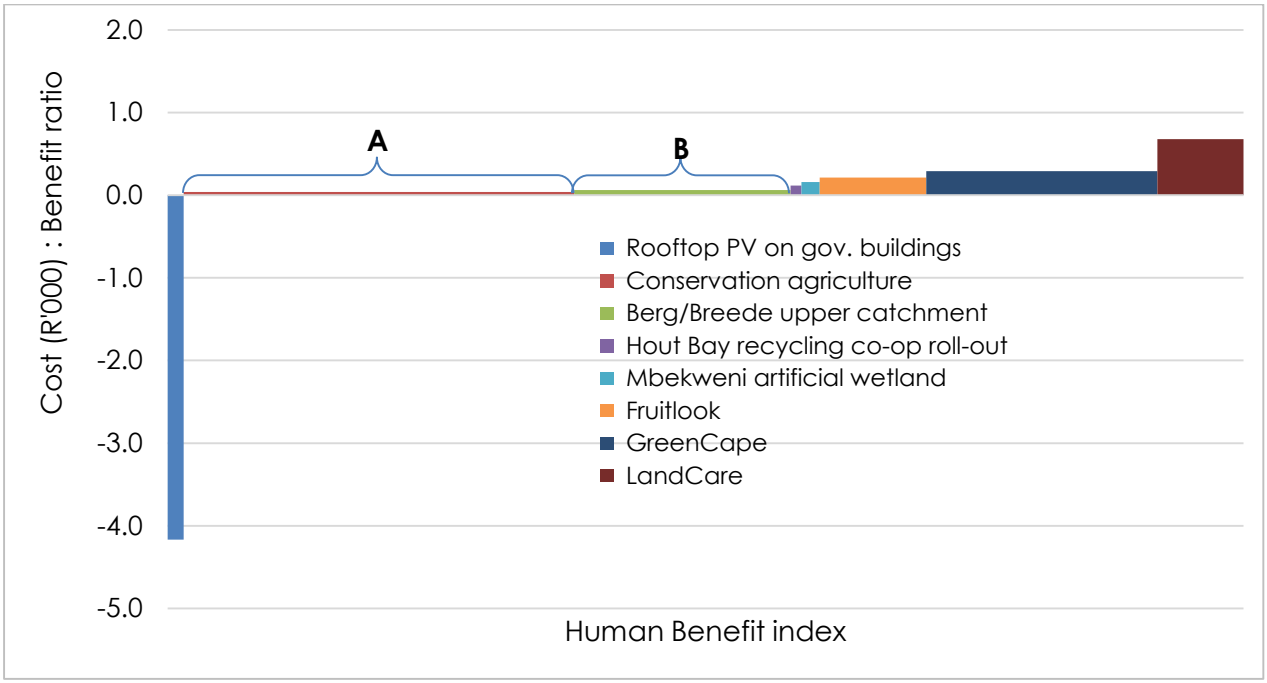

Figure 2: The eight climate change responses with the best cost-benefit ratios, where the height of the bar reflects the cost per unit of benefit, and the width of the bar the magnitude of the Human Benefit Index (note the blank space occupied by conservation agriculture (A) and invasive alien plant clearing in the Berg/Breede upper catchment (B), which have a cost-benefit ratio that is not visible relative to the horizontal axis)

Figures 1 and 2 show that the installation of PV technology on government buildings reduces current expenditure while responding to climate change. The 15 other responses present varying degrees of cost-effectiveness. From the perspective of financial efficiency, the CBA results could be used to prioritise project implementation from left to right on the graph. However, the level of human benefit of each option should also be considered, and therefore this prioritisation process may be more complex.

When interpreting these results, it's important to bear in mind that money is not the only consideration when choosing which climate change responses to prioritise for implementation. The kinds of benefits created are also a key consideration, with some benefits addressing immediate climate risks and others focused on long-term resource security or greenhouse gas emissions reductions. As a tool, the CBA model does not take decisions, and it does not replace the responsibility and obligation on senior management within the WCG to manage these difficult trade-offs in reducing climate change risk and impacts.

Even for the money-saving climate change response, it remains the case that the money must be reallocated or borrowed from some or other allocation to implement the project. It is worth noting, however, that cost-effective climate change responses can be found across a range of sectors and departments, underscoring the observation that reducing climate change risks is a province-wide responsibility and not the domain of a single department or unit within the WCG.

The various economically attractive climate change responses that emerged from the CBA modelling include both adaptation and emissions mitigation actions, emphasising the importance of both. Many of the best performing climate change responses are programmatic in the sense that they address the functioning of an entire system – e.g. energy regimes, soil, ecological health, information and knowledge – as opposed to a single problem. From this it seems clear that climate change responses that alter socio-technical (Geels *et al.* 2016) or socio-ecological (Cote and Nightingale, 2012; Daron *et al.* 2014) systems, as opposed to addressing a discrete problem, offer good value for money. Within the context of the Western Cape, climate change responses that offer work creation, developmental or ecological co-benefits emerge as economically attractive and cost effective.

It is equally notable that large infrastructure projects (e.g. BRT and desalination) perform poorly in the model due to the high cost of their construction. There may, however, be other important reasons why the high costs of these projects are justified: they offer visibility and assist in instilling confidence in an anxious public, they are familiar to the government procurement teams and present the types of 'known risks' (such as late delivery or budget over-runs) that the government has evolved to accommodate. Where public authorities push ahead with these types of projects, they must be able to indicate that they are familiar with the foregone opportunities and have a rationale (other than CBA) that is defensible. In this way, the CBA findings do not, and should not, preclude these projects, but rather enable their planning within the broader fiscal and climate change context.

Despite its innovations, the CBA model has some limitations that are important to note. It remains very difficult to include all costs, especially the costs imposed by climate change if no responses are mobilised by the provincial government. The first phase of the "Assessment of Economic Risks and Opportunities of Climate Resilient in the Western Cape" study (involving economic modelling) revealed that climate change, if left unchecked, is expected to damage the Western Cape economy, but this finding is not imputed in the CBA analysis of response options.

Similarly, it is difficult, despite the model's best efforts, to incorporate all benefits, particularly when these benefits manifest over incommensurate pathways and timeframes, e.g. ecological restoration (invasive alien plant clearing), versus informal settlement upgrading, versus knowledge generation (GreenCape). The value of a cubic metre of water produced from desalination, for example, depends on the availability of water more generally. This is something that varies over time.

The model does allow for the disaggregation of cost and benefit, as well as the multiple components of benefit to provide specific insights. It is therefore possible to discern a priority ranking that is based on benefit alone. This might apply if the WCG were not operating under budget constraints, or if it was required to solicit donor funding for the greatest impact.

5 CONCLUSIONS

A CBA has been conducted on 16 climate change responses that government in the Western Cape is either in process of undertaking or plans to undertake. The CBA method has considered the cost of implementation (and operation) of these responses, as well as the benefits that are expected to arise from each. A Human Benefit Index was used to measure non-financial benefits, including the importance of each measure in reducing risk or enhancing the well-being of people in the Western Cape Province.

The CBA results have demonstrated that the different response options assessed have very different cost-benefit ratios. The installation of PV technology on government buildings emerged as the response with the best cost-benefit ratio of the 16 options and is a response that saves money. Conservation agriculture and invasive alien plant clearing in the Berg/Breede River Catchments emerged as the second and third best scoring options. These two projects scored well owing to their low investment cost (compared with other responses that are more capital intensive) and high ability to create positive benefits for large numbers of people.

The more capital-intensive responses (such as BRT and desalination) scored lowest in the CBA. While these scored poorly in the CBA, it should be recognised that there may be other important reasons why the high costs of these projects are justified by government, and the CBA alone would not provide justification for them not to be pursued.

During the selection of climate change responses to be analysed in the CBA, it was evident that cost-effective climate change responses can be found across a range of sectors and

departments, highlighting that reducing climate change risks is a province-wide and multi-sectoral responsibility and not the domain of a single department or unit within the WCG.

At its core, the "climate change response curve" produced by the CBA model is useful in managing the real-world situation in which resources are constrained and in which these resources must be stewarded to realise the greatest benefit. Whilst the 16 responses analysed in this study do not constitute a climate change response strategy, they do reveal that the WCG has planned, or is already busy with, activities that are economically valuable in terms of reducing climate change risk. It also assists in demonstrating how this value manifests through developmental, institutional and ecological pathways, and in emphasising the need for climate change responses that turn the economic burden of climate change into an opportunity.

6 REFERENCE LIST

Cartwright, A., J. Blignaut, M. De Wit, K. Goldberg, M. Mander, S. O'Donoghue, and D. Roberts, 2013: Economics of climate change adaptation at the local scale under conditions of uncertainty and resource constraints: the case of Durban, South Africa. *Environ. Urban.*, **25**, 139–156, doi:10.1177/0956247813477814. http://journals.sagepub.com/doi/10.1177/0956247813477814 (Accessed April 9, 2017).

Cote, M., and A. J. Nightingale, 2012: Resilience thinking meets social theory Situating social change in socio-ecological systems (SES) research. *Prog. Hum. Geogr.*, **36**, 475–489, doi:10.1177/0309132511425708. http://phg.sagepub.com/content/36/4/475%5Cnhttp://phg.sagepub.com/content/36/4/475.full.pdf%5Cnhttp://phg.sagepub.com/content/36/4/475.short.

Daron, J. D., K. Sutherland, C. Jack, and B. C. Hewitson, 2014: The role of regional climate projections in managing complex socio-ecological systems. *Reg. Environ. Chang.*, 1–12, doi:10.1007/s10113-014-0631-y.

Geels, F. W., F. Kern, G. Fuchs, N. Hinderer, G. Kungl, J. Mylan, M. Neukirch, and S. Wassermann, 2016: The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990-2014). *Res. Policy*, **45**, 896–913, doi:10.1016/j.respol.2016.01.015. http://dx.doi.org/10.1016/j.respol.2016.01.015.

Stern, N., 2016: Economics: Current climate models are grossly misleading. *Nature*, **530**, 407–409.

Department of Environmental Affairs and Development Planning
Leeusig Building, 4th Floor, 1 Dorp Street, Cape Town, 8001
Private Bag X9086, Cape Town, 8000
Telephone: +27 (0)21 483 5126
Email:

Western Cape Government
Environmental Affairs and Development Planning

BETTER TOGETHER.