





detailed REPORT

SOUTH AFRICAN NATIONAL TERRESTRIAL CARBON SINKS ASSESSMENT

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

Research Synopsis Report prepared by Cirrus Group Consortium

MAY 2015

Acknowledgements:

National Terrestrial Carbon Sinks Steering Committee

Mr Barney Kgope – DEA (Chair)
Mr Itchell Guiney – DEA (Co-Chair)
Dr Andrew Venter – Wildlands Conservation Trust
Dr Wayne Truter – University of Pretoria
Dr Oscar Mokotedi – Department of Environmental Affairs
Dr Sebataolo Rahlao – South African National Biodiversity Institute
Prof Robin Barnard – Agricultural Research Council
Mr Johan Bester – Department of Agriculture Forestry and Fisheries
Mr Matiga Motsepe – Department of Agriculture Forestry and Fisheries
Mr Peter Janoska – National Treasury
Ms Wadzi Mandivenyi – Department of Environmental Affairs

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Photos courtesy of Itchell Guiney.

Foreword

Global change through land use and cover change, climate change and the increase in atmospheric carbon dioxide has modified the structure and function of many ecosystems throughout the world. Such changes across the globe have over the years altered the relationship between the natural sources and sinks of carbon dioxide. Similarly, in South Africa, land use change and land degradation as a result of conversion to croplands, urban areas, mines and roads has modified the original geographical extent of vegetation biomes. However, the impact and the magnitude of these changes are not well understood, prompting the current research.

The National Terrestrial Carbon Sinks Assessment (NTCSA) is a first of its kind for South Africa and was commissioned following a directive from the National Climate Change Response Policy (NCCRP). Given this, the aim was to assess the national carbon sinks in relation to afforestation, forest restoration, wetlands, agricultural practices and urban greening. Furthermore, to assess all significant land use change and quantify the potential future carbon stocks under varying climate change and land use scenarios. Taken together, these variables will assist in the understanding of emissions generated from land use and in identifying land based mitigation opportunities.

Although the independent research and findings contained in this report do not necessarily represent the views, opinions and/or position of Government, the department believes that this research is critical to enhance our understanding of the global change dynamics in South Africa's Agriculture, Forestry and Other Land Use (AFOLU) sector. Hence, the department is happy to make this work publicly available and accessible.

Barney Kgope and Itchell Guiney
Chief Directorate: Climate Change Mitigation
Directorate: Carbon Sinks Mitigation
Department of Environmental Affairs

Report submitted to:

Department of Environmental Affairs

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Contributing Authors

Synopsis	*Tony Knowles, Zelda Burchell*
Sections 1.1, 1.2	*Bob Scholes, Graham Von Maltitz, Sally Archibald, Konrad Wessels, Terence van Zyl, Derick Swanepoel, Karen Steenkamp*
Section 1.3	*Tony Knowles*
Section 1.4	*Mark Thompson*
Section 2	*Tony Knowles, Phoebe Boardman, Worship Mugido, James Blignaut*
Section 3.1	*Phoebe Boardman, Zelda Burchell, Tony Knowles*
Section 3.2	*Phoebe Boardman, Amanda Dinan, Tony Knowles*

Affiliations

Cirrus Group	*Tony Knowles, Phoebe Boardman, Zelda Burchell, Amanda Dinan*
CSIR	*Bob Scholes, Graham Von Maltitz, Sally Archibald, Konrad Wessels, Terence van Zyl, Derick Swanepoel, Karen Steenkamp*
Beatus	*James Blignaut, Worship Mugido*
GeoTerraImage	*Mark Thompson*

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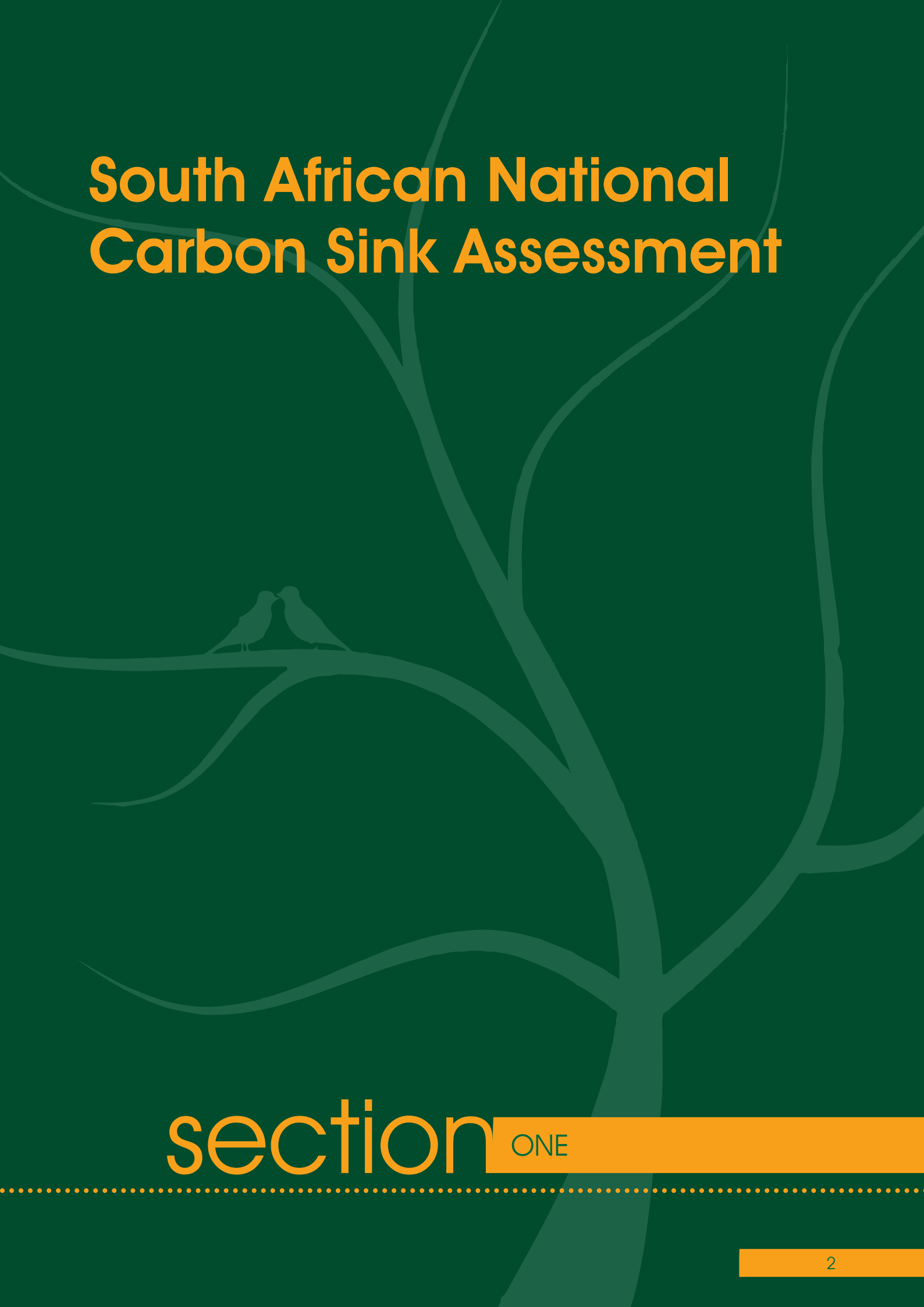
South African National Carbon Sink Assessment



section ONE

Contents

Introducing Section 1 of the National Carbon Sink Assessment

Rationale

To better understand the nature of terrestrial carbon stocks across South Africa and associated mitigation opportunities[1], the Department of Environmental Affairs commissioned the National Carbon Sinks Assessment. The Assessment forms part of a larger suite of activities implemented under the National Climate Change Response Policy with the purpose of:

> "*…assessing the current national carbon sinks related to afforestation, forest restoration, wetlands, agricultural practice, bio-fuels, urban greening and all significant changes in land use and to quantify the potential future carbon sinks under varying climate change scenarios and land use change.*"

Three themes emerged within the broad set of aims listed in the project's initial Terms of Reference:

1. The need to understand the nature of carbon stocks and fluxes at a national scale
2. The potential for mitigation activities, including the type and extent of initiatives, potential implementing models and associated agents, monitoring and reporting aspects, the finances thereof, employment implications and the need for institutional and extension service support.
3. The relationship between policy and terrestrial carbon stocks in terms of both the influence of existing policy on land-use, and the need to create an enabling policy environment for mitigation activities.

This Section 1 report focuses primarily on the first theme. Prior to commissioning this scope of work there was little understanding of the nature of carbon stocks and fluxes at a national scale. Substantial work on the subject had occurred in particular locations (e.g the Skukuza, Baviaanskloof and eThekwini areas) but there was very little in terms of a national map of carbon stocks and associated fluxes. Furthermore, there was little understanding of how such stocks and fluxes may vary in the future due to either changes in land-use or climate itself.

The initial proposal by the Cirrus Group, CSIR and GeoTerraImage suggested a three-step process to address the scope of work:

1. To first map terrestrial carbon stocks and fluxes across the entire country. This component was undertaken by the CSIR and the full report is located in Module 1[2].
2. To model the potential effect of predicted changes in climate and atmospheric carbon dioxide on terrestrial carbon stocks and sequestration rates. The Cirrus Group principally undertook the modelling exercise with support from the CSIR's Climate Studies, Modelling and Environmental Health unit on the provision of downscaled global circulation model data (Module 2).
3. To map historical land-use change within South Africa over the 2000-2010 period and to model predicted changes in land-use over the next 10-15 years - to "2020". GeoTerraImage performed this analysis (Module 3).

1 To improve readability, for the remainder of the document "land-use based climate change mitigation activity" has been abbreviated to "mitigation activity"

2 The full written reports for Section 1.1, 1.2 and 1.4 are included within the Modules. However, there is a substantial amount of spatial data (maps) generated during the course of the analysis which can be obtain from the CSIR or GeoTerraImage independently.

In terms of the value of the analysis and its application, the outcomes of these components provide much needed data for national reporting, carbon accounting and land-use planning purposes. They have formed the foundation for the analysis undertaken in Section 2 and 3 of this National Carbon Sink Assessment and provide a crucial source of data for local planning and project development. Already, during the course of the extended stakeholder engagement undertaken in Section 2, several provincial administrations and conservation authorities as well as several District Municipalities requested access to the maps and other outcomes of this analysis for urgent planning and development needs.

An additional consideration noted in the initial project description is the need to assess the potential shift in the distribution of species (and associated vegetation types) due to predicted changes in climate. However, this subject was recently given substantial consideration during the course of the Long Term Adaption Scenario (LTAS) work that is been lead by SANBI on behalf of Department of Environmental Affairs.

Module 1 (Section 1.1 and 1.2) – SECTION 1

National Carbon Sink Assessment for South Africa – first estimate of terrestrial stocks and fluxes

Background and purpose

The report describes the scheme by which the stocks and fluxes are estimated in detail, along with the sources of data, and validation details. The models have been set up in the VisiTrails environment (an open-source software for organising complex calculations). The updating of the models as improved algorithms or datasets become available is likely to be an ongoing activity since the stocks and sinks will need to be recalculated on a periodic basis, taking into account new scientific developments and changing land use and land cover.

A continuous-variable, 'wall-to-wall' approach to mapping the stocks and fluxes in South Africa has been adopted for this study, rather than a more conventional stratified-random sampling approach. A stratified-random approach would proceed by first classifying the land area of South Africa into different vegetation- or land-use types (stratification), and then estimating of the average carbon stock in each, based on a large number of randomly-located field samples. Our approach uses geostatistical methods, models and remote sensing (satellite imagery) to extrapolate a large set (several thousand) of unevenly-distributed set field measurements to the whole country. From those continuous coverages, the mean stocks and fluxes for any area can be calculated, along with an uncertainty estimate. The reasons for this choice of approach were:

South Africa is so large and ecologically diverse that using a stratified sampling approach would require a minimum of 20 strata. Existing data is too sparse and non-randomly distributed to adequately fulfill the needs of a stratification method. For instance, some land types have no existing data. Based on the observed variability within strata, the number of samples needed to constrain the uncertainty to reasonable levels would be about 100. The cost and time required to undertake new, random sampling of about 2000 sites would be excessive.

If the strata are subdivided sufficiently finely to achieve 'near-homogeneous patches' each requiring only a modest number of samples, the number of such locations becomes very large, and a stratified approach begins to resemble a continuous field approach. Fortunately, recent advances in remote sensing make it possible to estimate aboveground woody biomass stocks (i.e., trees and shrubs) for thousands of locations that are systematically distributed over large areas, at required levels of accuracy but at low cost. Similarly, new extrapolation approaches to soil profile data, and models of herbaceous and litter biomass, allow robust but inexpensive estimates over large areas. This meant that a continuous variable approach was both more feasible and more accurate for the available resources than a stratified approach. The methods applied here are similar to those being developed for use in REDD+ projects, which have come to similar conclusions regarding sample-based versus continuous approaches.

The estimated coverages of carbon stocks and fluxes can be post-stratified in many different ways – for instance, by biome, climate class or political jurisdiction – and have a spatial resolution (1 km^2) adequate to look at quite fine-scale features, such as large regional carbon storage projects. During the course of the National Climate Change Response Stakeholder Workshop hosted by the Department of Environmental Affairs in June, several participants noted applicability of the data at a provincial and municipal scale where carbon stock maps are required to develop local-scale mitigation interventions. Adequate local maps of carbon stocks and fluxes are not currently available and can quite easily be 'cookie-cut' from this data set.

The purpose of this document is to record the procedure and to familiarise stakeholders, including the South African Department of Environment Affairs, with the approach adopted and the intended products of the project. The maps allow a general reality check on the calculations. The results and the associated error calculations allow realistic planning of future steps. The post-review, final version of this report can be used as an input to the national communications to the United Nations Framework Convention on Climate Change. It remains highly unlikely that the difference between successive stock assessments, at national scale and a few years apart, will ever be precise enough to determine absolute changes in stock in a scientifically rigorous way. The trend in the national terrestrial C stock is likely to be less than 1% per year - but even with the best technology (regardless of whether a continuous variable or stratified approach is adopted) the stock cannot be estimated with an absolute precision of less than about 10%. Furthermore, the natural inter-annual variation in the fluxes may be as high as 30%. It may be feasible to observe changes in the stocks, through measurement, over a period of a decade or more. Shorter-interval changes can be inferred from land cover changes, with a reduced level of certainty.

The scientifically valid use of this information is to understand the magnitude and distribution of the various stocks and fluxes, in order that their potential contribution to a South African climate change mitigation effort can be evaluated. These results will help to evaluate the realism of project-level claims and will improve the estimates of emissions and uptakes from the Agriculture, Forestry and Other Land Use (AFOLU) sectors in the national greenhouse gas assessment. In addition, it provides a foundation for the development of national- or provincial-scale carbon sequestration and avoided deforestation (REDD) activities.

Terrestrial ecosystem carbon stocks in South Africa

Total ecosystem organic carbon

Table 5. Terrestrial total ecosystem carbon stocks in South Africa by land cover class. SD stands for standard deviation, which is a measure of the spatial variability of the stock, which would need to be dealt with by collecting a large number of samples using a stratified-random approach. A continuous, total coverage approach as applied in this project has no sampling error, only an estimation error due to uncertainties in the models used. This estimation error is reflected on the right hand side of the table as a lower (10%) and upper (90%) confidence limit in the totals for the entire class. These limits have been calculated using a rigorous error accumulation approach. Note that stratified sampling approaches also contain estimation errors of the same magnitude (in addition to sampling errors), but these are almost never accounted for.

Land cover class	Mean	SD (spatial)	Area	Best estimate	Lower confidence limit	Upper confidence limit
	gC/m²		km²	Tg C		
Savanna	5834	3513	358473	2091	1961	5214
Grassland	10660	4725	224377	2392	2213	5736
Nama and succulent karoo	1769	1799	334812	593	587	862
Fynbos	6773	4100	61490	416	372	1140
Thicket	10101	5347	27402	277	236	785
Indigenous forest	18198	6172	857	16	12	42
Desert	799	113	7017	6	6	6
Cultivated	5980	1731	143948	860	840	1788
Plantation forestry	17559	4320	16952	298	252	769
Settlement, mines, industry	6793	2448	23119	157	152	276
Other, waterbodies etc	3167	1536	19967	64	62	97
Total South Africa			1218414	7170	6693	16715

See Appendix A on page 213 for a detailed technical approach.

Soil organic carbon

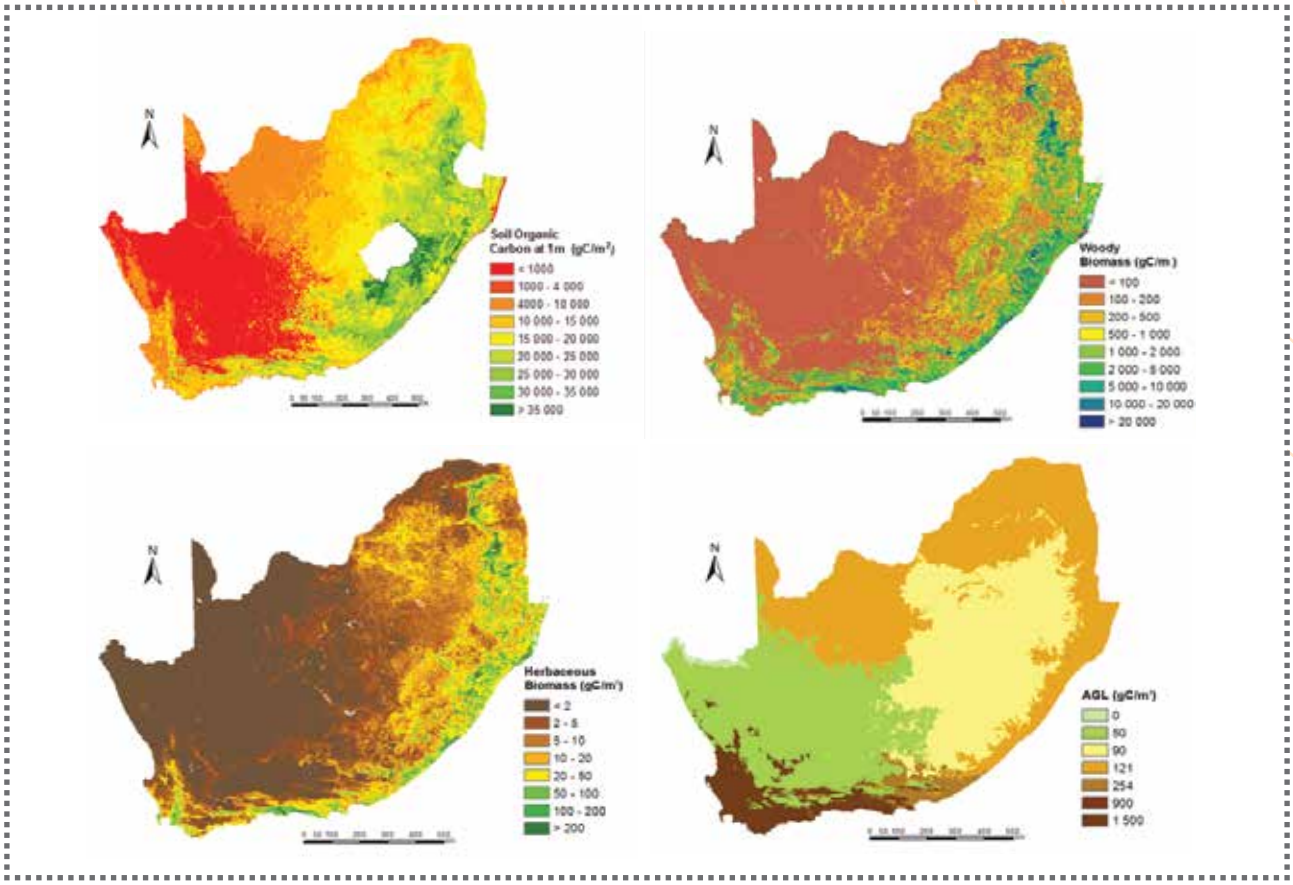
Table 6. Soil organic carbon stocks in South Africa to a depth of 1 m, by land cover class. Soil organic carbon is the largest part of the ecosystem stock in all South African ecosystems, and the most stable. The AfSIS data extrapolation procedure did not extend into the driest, hottest third of the country, which have relatively low carbon stocks. We assumed a total soil carbon content to 1 m of 700 g/m² for these areas. The notes regarding the measures of spatial variability (standard deviation, SD) and estimation uncertainty (lower and higher confidence limits) apply to this table as well.

Land cover class	Mean	SD (spatial)	Area	Best estimate	Lower confidence limit	Upper confidence limit
	gC/m²		km²	Tg C		
Savanna	5422	3078	358473	1943	1779	7138
Grassland	10149	4427	224377	2277	2008	7671
Nama and succulent karoo	1700	1744	334812	569	339	1872
Fynbos	5658	3854	61490	348	305	1301
Thicket	7737	3298	27402	212	189	772
Indigenous forest	11057	3497	857	9	8	30
Desert	833	112	7017	6	1	12
Cultivated	5785	1704	143948	835	774	2547
Plantation forestry	12961	3553	16952	220	193	663
Settlement, mines, industry	6375	2379	23119	148	136	414
Other, waterbodies etc	2819	1375	19967	57	50	135
Total South Africa			1218414	6624	5781	22555

Biomass carbon: woody, herbaceous and litter

Table 7. Terrestrial biomass carbon stocks in South Africa, by land cover class. This category includes both above and belowground parts of both woody and herbaceous plants, as well as standing dead material and organic litter. In forests, savannas, fynbos and thickets the value is dominated by the woody plant biomass, whereas herbaceous biomass dominates in grasslands, karoo and deserts.

Land cover class	Mean	SD (spatial)	Area	Best estimate	Lower confidence limit	Upper confidence limit
	gC/m²		km²	Tg C		
Savanna	418	756	358473	150	123	342
Grassland	532	748	224377	119	109	279
Nama and succulent karoo	70	159	334812	24	30	54
Fynbos	1119	626	61490	69	51	140
Thicket	2370	3159	27402	65	41	152
Indigenous forest	7186	3423	857	6	3	13
Desert	1	17	7017	0	0	0
Cultivated	186	50	138269	26	41	56
Plantation forestry	4603	969	16952	78	56	148
Settlement, mines, industry	421	345	28798	12	12	19
Total South Africa			1169649	548	466	1203



***Map 2**. The components of the terrestrial carbon stock of South Africa. Top left: soil organic carbon to 1m in depth. Top right: the above- and below-ground woody-plant biomass pool Lower left: above- and below-ground herbaceous biomass pool. Lower right: above-ground litter*

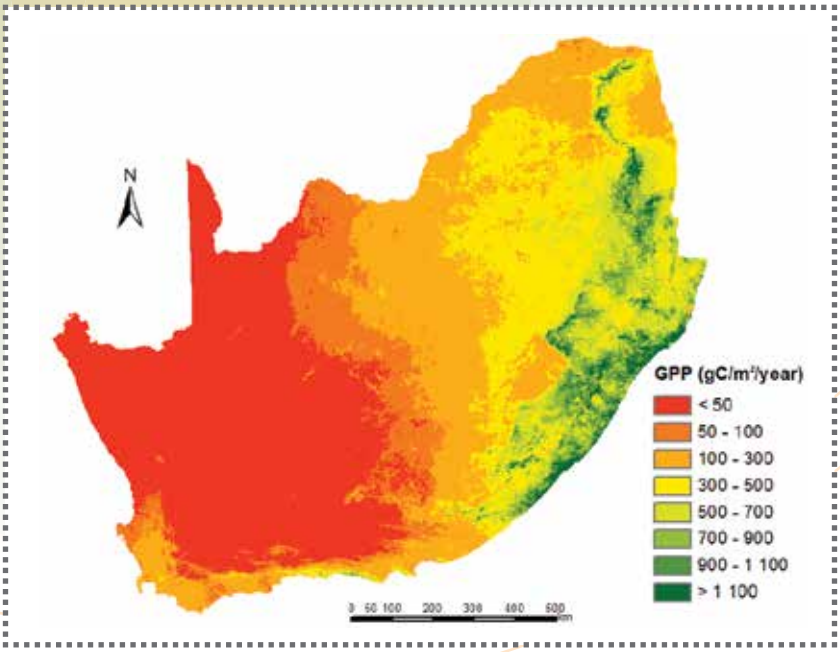
See Appendix A on page 213 for a detailed technical approach.

Terrestrial ecosystem carbon fluxes in South Africa

Gross primary production

At a large scale, and over the long term, Gross Primary Production must equal ecosystem respiration (Reco + Fire); thus Net Ecosystem Exchange (NEE) is zero. This is probably close to true for South Africa, since the regional inversion analyses suggest that the net southern African flux is small to zero (eg Valentini 2013, under review). However, the global carbon cycle is currently not at equilibrium – with rising atmospheric CO_2 and a changing climate, the global terrestrial land surface is currently a sink of about 1 PgC/y. A small part of this sink is probably in South Africa – less than the South Africa fraction of the global land area (1%) because South Africa is both more arid and hotter than the global average – perhaps 1-10 TgC/y is a likely order of magnitude (ie ~1-10 gC/m²/y, which would be very hard to detect over a short accumulation period). Given the uncertainty in all the parameters, our approach at this stage is to force GPP= 1.01*(Re+fire) at the climatological (>10 year) time scale and national spatial scale, by adjusting the respiration parameter values until this is true. The value of 1.01 is derived from the observation that the current global terrestrial net sink of carbon is around 2 PgC, and the current GPP is around 200 PgC; ie 1%.

This assumption prevents an evaluation of the national NEE initially, but means that the parameter values are forced to be approximately right; and the sub-annual and spatial patterns will be realistic. Going forward, this will allow relative changes in NEE to be assessed. Absolute changes in national scale NEE will require the implementation of a national inverse modelling and measurement capability, such is currently under experimental development at the CSIR.



Map 3. *Distribution of Gross Primary Productivity (GPP) in terrestrial ecosystems in South Africa. GPP is the carbon which is taken out of the atmosphere into plant biomass through the process of photosynthesis. About half of this returns to the atmosphere within hours to months through respiration by the plant. What remains is Net Primary Production (NPP), which is the basis of production-based ecosystem services such as timber and crop yield, firewood and grazing. NPP is not equivalent to carbon storage, since most of the NPP is also ultimately respired, burned or exported. NPP does establish an upper limit to the short-term carbon sequestration rate in carbon storage projects. It is clear from this map that the potential for such projects is greatest in the wetter parts of the country, where they also come into conflict with land needs for agriculture, settlement and water provision.*

Table 8. *Gross Primary Production (GPP) of terrestrial ecosystems in South Africa. GPP is the carbon taken up by the vegetated surface from the atmosphere. It is about twice the Net Primary Production, which is what is retained as biomass growth after the plant has respired part of the uptake to support its own metabolism. Estimation error calculations are in progress. Validation of these fluxes using direct measurement is only possible for a few sites in the country. They are bradly consistent with global-scale model-based estimates, but probably an underestimate due to incertainties in selecting a value for epsilon, the light use efficiency.*

Land cover class	Mean	SD spatial	Area	Best estimate	Lower confidence limit	Upper confidence limit
	gC/m²/y		km²		TgC/y	
Savanna	415	320	358473	149	54	351
Grassland	645	304	224377	145	72	361
Karoo	44	46	334812	15	5	34
Fynbos	142	134	61490	9	2	19
Thicket	381	264	27402	10	2	23
Desert	977	281	857	1	0	2
Forests	1	0	7017	0	0	0
Total, natural ecosystems			1014428	329	135	790

Lateral fluxes

The analysis of lateral fluxes is included for completeness, rather than because they are significant in South Africa relative to the vertical fluxes between the land surface and the atmosphere. The lateral flux analysis does not include 'virtual carbon', ie the 'embodied' carbon (as opposed to actual carbon) in exports of goods with a high energy cost of manufacture, such as metallurgical products like aluminium, steel, gold and platinum. Nor does it include the lateral flux of carbon in the form of coal exports or oil and gas imports – these are reported in the national greenhouse gas inventories.

Export flux in rivers

Carbon is exported from South Africa's land mass into the adjacent ocean in the form of Dissolved Organic Carbon and Particulate Organic Carbon. Most of this flux is believed to be trapped on the coastal shelf (the exact fraction is unknown) and therefore remains within the extended South African economic zone. The annual flux is estimated as 2.29 TgC/y, equally split between DOC and POC – ie about 1% of GPP. This value was estimated by downscaling the estimate for Africa (48 TgC/y) in Seitsinger et al (2001) by the fraction of the land area of Africa contributed by South Africa.

Export flux in trade items

Agriculture has both a large export flux and a large import flux. The result is a small net flux, which is inward in most years but outward is some: the average is about -1 TgC/y. Paper, pulp and wood is a net export of 0.4 TgC/y

Export flux as organic compound in smoke

It is estimated that about a third of the particulate carbon flux in smoke resulting from fires in South Africa leaves the subcontinent. This comes to about 10.5 TgC/y; which compares well with the van der Werf et al (2010) estimate of 10TgC/y.

Independent validation data

Biomass validation

The aboveground biomass mapped by the study has been validated against an exhaustive search of published biomass values from South Africa (Table 9). The criteria for inclusion in this database are that the studies (although variable in their approach) are methodologically sound in terms of the area of the sample relative to the spatial heterogeneity of the vegetation, method of estimation biomass and representation of the most important biomass categories for the biome. In almost all cases, some biomass categories are *not* reported (eg roots or litter are not estimated, or herbaceous biomass is not separated from woody biomass). Some assumptions have therefore to be made to get total biomass for all studies. These assumptions match those in the modelling study. The principle ones are:

- for herbaceous biomass the root:shoot = 1 (ie root biomass is equal to herbaceous aboveground biomass);
- for woody plants, the root:shoot is a function is dependent on rainfall, ranging from 0.25 in mesic ecosystems (> 800 mm) to 2 in arid ecosystems (<300 mm).

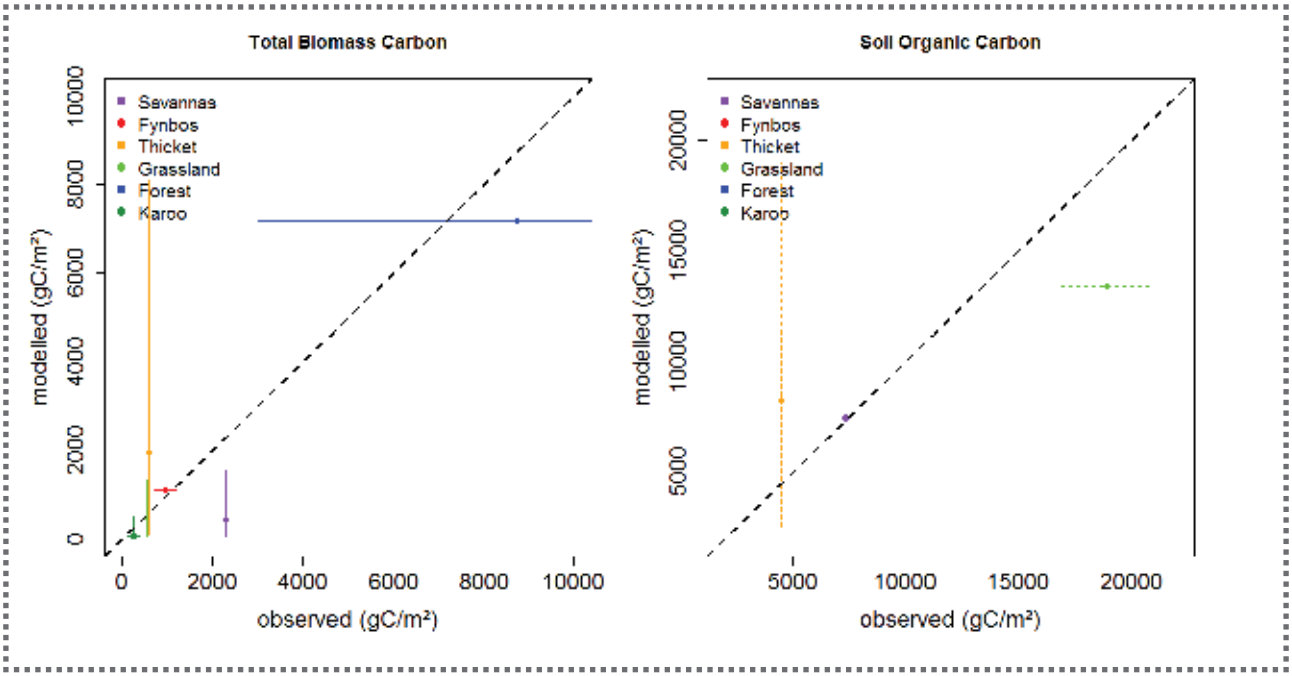
The biomass studies were conducted up to 50 years ago, and their exact geographical location is often not known. A point-by-point validation is therefore not possible. Even if it were, there is a problem of spatial mismatch between the scale of the measurements (often only a few tens of square meters) and the spatial resolution of the estimate made in this study (1 km^2, or 1 million m^2). Therefore the studies have been classified into biomes, and the comparison is done at the whole biome scale, or in some cases (where the validation sample is only from a part of the biome) for a portion of the biome. Each biome 'measured' value contains many studies, and this is reflected in the standard deviation bar in Figure 4. The 'measured' values cannot automatically be considered to be the truth: they contain measurement and plot-scale sampling errors, are not a random sample, and contain spatial variation. They cannot therefore be assumed to be an unbiased and precise representation of the biome, despite containing all known suitable estimates. They are just the best available reality check.

Table 9. Sources of data used in the biomass validation study

Study reference	Samples	Comments
Savanna		
Shackleton, CM PhD thesis, University of the Witwatersrand; and Shackleton, C.M and Scholes, R.J. 2011. Above ground woody community attributes, biomass and carbon stocks along a rainfall gradient in the savannas of the central lowveld, South Africa. South African Journal of Botany. 77 (2011), 184-192	61	Primary source for woody biomass in savannas. Well distributed throughout the biome. An expansion factor of 35% was applied to the aboveground woody biomass to include leaves and roots.
Shea, RW, Shea BW and Kauffman JB 1996. Fuel biomass and combustion factors associated with fires in avannah ecosystems of South Africa and Zambia. JGR 101 (D19) 23551-23568	12	Primary source for grass aboveground and litter mass mass in savannas. Sample from southern KNP only.
Grassland		
O'Connor, TG 2009 Influence of land use on phytomass accumulation in Highveld Sourveld grassland in the southern Drakensberg, South Africa. Af J Range and Forage Science 25, 17-27	9	Mesic grassland near Underberg. 3 sites each on commercial, communal and conservation land. High root estimate due to inclusion of dead roots, which are technically belowground litter.
O'Connor, TG, LM Haines and HA Snyman 2001 Influence of precipitation and species composition on phytomass of a semi-arid African grassland. J Ecology 89, 850-860	57	Semi-arid grassland near Bloemfontein. 19 years of data from 3 trials: good, medium and poor condition veld. No root biomass.
Gerber, L 2000 Development of a ground truthing method for determination of rangeland biomass using canopy reflectance properties. Af J Range Forage Science 17, 93-100	6	Kalahari, Karakul research station 28° 21S 24° 14 E. One experiment, six years. Mostly grass, 6-8% shrub. No root biomass.
Karoo		
Gerber, L 2000 Development of a ground truthing method for determination of rangeland biomass using canopy reflectance properties. Af J Range Forage Science 17, 93-100	6	Grootfontein research station, Middelburg. Estimated visually read off figure 1. Two grazing trials, each with 3 camps.
Mills, AJ et al 2005 Ecosystem carbon storage under different land uses in three semi-arid shrublands and a mesic grassland in South Africa. SA J plant and Soil 22, 183-190.	2	Two succulent karoo sites, near 32° 15 S 22° 50 E; 31° 20 S 19° 10 E. Estimated from fig 5. Root data included.
Fynbos		
Kruger, FJ 1977 A preliminary account of aerial plant biomass in funbos communities of the Mediterranean-type climate zone of the Cape province. Bothalia 12, 301-307	24	Jonkershoek, Zachariashoek and Jakkalsrivier catchments. No litter values or roots.
Van Wilgen BW and FJ Kruger 1985 The physiography and fynbos vegetation communities of the Zachariashoek catchments, south-western Cape province SAJBot 51, 379-399	4	Only total live biomass given.
Van Wilgen BW, KB Higgins and DU Bellstedt 1990 The role of vegetation structure and fuel chemistry in excluding fire from forest patches in the fire-prone fynbos shrublands of South Africa J Ecol 78, 210-22	1	Only used the fynbos site.
Van Wilgen BW 1982 Some effects of post-fire age on the aboveground plant biomass of fynbos (Macchia) vegetation in South Africa J Ecology 70, 217-225.	4	Jonkershoek. No roots.
Rutherford, MC 1978 Karoo-fynbos biomass along an elevational gradient in the western Cape. Bothalia 12, 555-560	3	Restionaceous, Proteaceous and Renosterbos. No root mass.

Study reference	Samples	Comments
Higgins, KB, AJ Lamb and BW van Wilgen 1987 Root systems of selected plant species in mesic mountain fynbos in the Jonkershoek Valley, south-western Cape province. SA J Botany 53, 249-257	N/A, only used for R:S	Primary source for root:shoot ratios in fynbos.
Thicket		
Mills, AJ and RM Cowling 2010 Belowground carbon stocks in intact and transformed subtropical thicket landscapes. Journal of Arid Environments 74,93-100	123	Source for soil data. 49 intact thicket (18% of landscape), 49 degraded (35%), 25 old fields (47%). Values weighted to reflect biome as a whole.
Powell MJ 2009 restoration of degraded subtropical thickets in the Baviaanskloof Megareserve, South Africa. MSc, Rhodes University, Grahamstown.	160	Primary source for thicket biomass data. Includes the sites cited by Mills and Cowling 2010 and more. 2/3 used for validation, 1/3 held aside for calibration of $BCF_{thicket}$
Indigenous forest		
Glenday, J 2007 Carbon Storage and Sequestration Analysis for the eThekwini Environmental Services Management Plan Open Space System. eTthekwini Municipality	40	Used biomass data only. Soil data uses unrealiable bulk density approach, and is at too fine a resolution for validation.
Seydack AHW1995 An unconventional approach to forest yield regulation for multi—aged multispecies forests. For Ecol Management 77, 139-153 (pers comm G Durrheim)	1 (but large area)	Mean standing volume 150 m^3/ha for large stems, doubled for all stems. Assume wood density of 0.8, and root expansion factor of 1.28.

Figure 4. *Observed biomass (Left panel) and soil carbon (right panel) means and 5-95% confidence limits for South African biomes, plotted against the means and confidence limits estimated in this study.*



Validating soil carbon stocks

The overwhelming majority of samples in the South African databases on soil profiles were apparently used in the creation of the AfSIS maps used by this study, and could therefore not be used in its validation. We relied on completely independent datasets, mostly collected for the purpose of soil carbon inventory at local scale, and therefore satisfying the following onerous criteria: measured to rock or 1 m depth; bulk density and stone fraction measured and recorded; soil carbon analysed by an accurate method. The studies used are listed in table 10. Most of the data were obtained directly from the investigators, since it is generally not given in disaggregated form in papers or reports. Although most of the profiles in these studies have exact GPS locations, for similar reasons to those given above (scale miss-match) we did not attempt to do a point-by-point validation. We did restrict the domain of the validation to the area of the biome where the profiles were located.

Table 10. *Studies used for soil carbon validation.*

Source	N	Comments
Savannas		
Lesogo Kgomo, University of Cape Town. lesogok@gmail.com	62	Granite landscapes of Kruger National Park
Grasslands		
Graham von Maltitz, CSIR gvmalt@csir.co.za	16	Mesic grasslands, Ukhalamba (Drakensberg)
Thickets		
Mills, AJ and RM Cowling 2010 Belowground carbon stocks in intact and transformed subtropical thicket landscapes. Journal of Arid Environments 74,93-100	120	49 intact thicket (18% of landscape), 49 degraded (35%), 25 old fields (47%). Values weighted to reflect biome as a whole.
Mike Powell, Rhodes University, Grahamstown m.powell@ru.ac.za	160	The primary source for the data reported above, and further sites. A random third of the dataset was reserved for calibration purposes if necessary.

Validating GPP

Eddy covariance flux data measures Net Ecosystem Exchange (NEE, but usually misses R_{fire}). After making a number of assumptions, GPP and Re can be calculated from NEE. Flux data is scarce in South Africa – only two sites (Skukuza and Malopeni) are available, with one in Potchefstroom (a grassland with scattered *Acacia* trees) possibly available in future. The site at Skukuza has operated for 12 years at the ecotone between a *Combretum* and *Acacia* savanna (Archibald et al 2009). Meaurements over a 5 year period, extrapolated using a 25-year climate record 1981-2005 give a NEE of 75 gC/m^2/y (with a SD of 105 and an annual range from -138 to +155 gC/m^2/y). The micrometeorological convention is followed in this instance, with positive numbers meaning fluxes from the land to atmosphere – thus this site is on average a moderately strong source of carbon, rather than a sink. In wetter-than average years it is a sink. The herbivory flux for this site is estimated at 9.5 gC/m^2/y and the fire flux at 40 gC/m^2/y (interannual SD 17.5). The site at Malopeni, in a hot, dry *Colphospermum mopane* savanna, has operated for 3 years (Nickless et al, in prep). Preliminary NEE estimates are 1.36 and 1.28 gC/m^2 in 2009 and 2011 respectively, a small source.

An inter-comparison (rather than true validation, since these products are themselves highly uncertain) can be made with other spatial models of GPP. Most of these are continental or global in scale, and have a spatial resolution of >20km. Recent models (those included in the Climate Model intercomparison Project CMIP 4 and CMIP 5) are presented by Beer et al 2010 and Jung et al 2009 and have been reviewed by Valentini et al (2013) for Africa. The GPP of South Africa ranges from near 0 gC/m^2/y in the west, in the hyperarid desert areas, to around 1500 gC/m^2/y in the wettest parts of the east. This pattern and range is the same as that estimated by the SA carbon sinks study.

Validating NPP

A validation can be made against NPP estimates made using traditional cut-and-weigh techniques, for a few locations. This technique typically underestimates NPP (by up to 50%), because it misses important components such as those belowground, those which decay rapidly (such as root exudates) or are in gaseous form (such as Volatile Organic Carbon). There is a long-term dataset for grasslands near Bloemfontein by O'Connor et al (2001), another for a fertilizer experiment in grassland at Towoomba near Bela Bela, and a grassland mowing experiment at Ukalinga. These suggest a grassland range of about 100 to 500 gC/m^2/y. There is a savanna estimate for Nylsvley by Scholes and Walker (1993) of 950 g DM/m^2/y (ie~460 gC/m^2/y. Doubling these numbers to get GPP suggests that the GPP estimates in the SA national C sinks study are somewhat too low.

Implications of this study for policy and implementation

This assessment is the first to generate a map of terrestrial carbon stocks and fluxes at national scale, with fine resolution. It results in a better understanding of how carbon stocks and fluxes vary across the country, and thus which particular biomes or areas are most and least important in terms of developing land-use based Greenhouse Gas (GHG) emission reduction activities. For example, whereas the forest biome has significant carbon stocks per hectare, due to its limited spatial extent, the total carbon stock located in forests is amongst the lowest when comparing vegetation classes (Table ES1). In comparison, the grassland and savanna biomes together contain approximately three-quarters of South Africa's terrestrial carbon stock and account for over 90% of Gross Primary Production occurring within the country (Table ES3). If land-use based climate change mitigation activities are to be created that contribute significantly to the national greenhouse gas budget, the emphasis should therefore be on developing implementation models that work within these biomes. Projects in smaller, but nevertheless high-stock potential and high-sequestration rate vegetation types, such as forests and thickets, may be viable at project scale, but can only make a limited national contribution. The potential in the arid biomes for projects which are both viable and nationally meaningful is very small.

The bulk of carbon is stored in the soil, which currently does not count towards many carbon storage projects. Woody biomass is the next largest store. The stores in herbaceous biomass and litter are too small, and too ephemeral, to matter very much. The lateral fluxes as forestry and agricultural exports, carbon in rivers and smoke from fires are small relative to the gross vertical fluxes and the national anthropogenic inventory, but are significant relative to the net natural fluxes and would need to be considered.

The annual flux in and out of natural ecosystems, at about 1100 $TgCO_2/y$, is over twice the emissions from South Africa from anthropogenic sources. Only about one hundredth of this is the 'net ecosystem production' retained in ecosystems as a carbon store. This will be very hard to measure and prove at national scale on a year-by-year basis, but may be detectable on a decadal basis.

National greenhouse gas inventories are periodically required from South Africa as a party to the UN Framework Convention on Climate Change. One category of emissions (or uptakes) is from the Agriculture, Forestry and Other Land Use (AFOLU) sector. The AFOLU sector estimates thus far have had the highest uncertainty associated with them, partly because there was no reliable map of the distribution of soil or biomass carbon in the country, with the fine resolution required to calculate the impacts of land use change. This project satisfies that need.

Proposed future work

This analysis provides a good foundation for national terrestrial carbon accounting and reporting as well as associated policy and mitigation activity development. In terms of next steps:

- First, each element of Section 1 can be further developed. The models developed in Module 1 and 2 can be developed substantially and the Century modelling exercise can be extended in terms of the number of sites and vegetation types modelled or even into a spatially explicit form. An initial pertinent analysis, would be to 're-run' the model develop in Section 1.1. and 1.2 with the outcomes of the land-use change modelling undertaken in Section 1.4 and the potential impact of changes in climate and atmospheric carbon dioxide. This analysis would provide a better understanding of how the nature of the national terrestrial carbon stock may change in the future.
- Second, the manner in which the outcomes are presented could be developed into a "South African Carbon Atlas" that allows practitioners to not only access the report, but the underlying data and maps in an easy and efficient manner. As stated, several stakeholders within national and local Government, research institutions and the private sector have indicated the access to the data would be an immense help to their work.
- Thirdly, the development of the set of mitigation activities and measures identified in Section 2 will require carbon mapping and accounting services during their planning, development and execution. The outcome of Section 1.1 and 1.2 (Module 1 attached), form a good foundation for planning, but there is room to develop such models further and incorporate them further into the planning and monitoring of a national land-use based climate change mitigation program.

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Module 2 (Section 1.3) – SECTION 1

Modelling the effect of predicted climate change and elevated atmospheric CO_2 on terrestrial carbon stocks in important South African biomes

Introduction

This analysis aims to answer two of the principle questions requirements raised in the South African National Carbon Sink Assessment's Terms of Reference:

1. The need to understand the potential effect of projected climate change and elevated [CO2] on terrestrial carbon stocks in important South African biomes
2. The need to understand the potential effect of projected climate change and elevated [CO2] on the outcome of land-use based climate change mitigation activities located in South Africa

These elements were included in the Terms of Reference due to a growing body of evidence which predicts that changes in climate and atmospheric carbon dioxide ([CO2]) may lead to substantial changes in the rate of plant growth, litter decay rates and other ecological variables that determine observed above- and below- ground carbon stocks. In the context of the project, assessing this potential is important to first understand how the terrestrial carbon stocks and fluxes reported in Section 1.1 may change in the future, and second, to understand how the outcome of land-based climate change mitigation activities[3] identified in Section 2 may be influenced by changes in climate and elevated [CO2].

An extensive body of published work indicates that predicted changes in climate are likely to affect terrestrial ecosystems through changes in primary productivity, litter accumulation and decay rates, fire occurrence and intensity, and several other mechanisms that influence terrestrial carbon stocks and associated fluxes (Ojima et al. 1996, Peng and Apps 1999, van der Werf et al. 2008, Rosenzweig et al. 2008, Doherty et al. 2010). Consideration of this effect of climate change is particularly pertinent in southern Africa where the climate is predicted to change substantially and to a larger extent than the global norm over the next 50 to 100 years (Boko et al. 2007, Engelbrecht et al. 2011).

In addition to the potential influence of changes in climate itself, is the related impact of predicted increases in atmospheric carbon dioxide. Principally through the

3 To improve readability, for the remainder of the document "land-use based climate change mitigation activity" has been abbreviated to "mitigation activity"

"CO2 fertilization effect", several published empirical and modelling assessments have indicated that elevated [CO2] may have a substantial influence on plant growth, observed vegetation types and carbon stocks, (Bond and Midgley 2000, Doherty et al. 2010, Kgope et al. 2010).

Due to pure time and cost practicalities, a modelling approach is typically used to assess the potential influence of changes in climate and elevated [CO2] on carbon dynamics in terrestrial ecosystems. Guided by the results of Section 1 and 2 of the National Carbon Sink Assessment, the modelling exercise focused on vegetation types that are important in terms of their contribution to the national carbon stock and opportunities for mitigation activities - grassland, savanna, woodland, sub-tropical thicket and closed canopy forest ecosystems.

Two principle scenarios were modelled:

- The effect of climate change and elevated [CO2] on existing carbon stocks in each vegetation type
- And, the effect of climate change and elevated [CO2] on the rate of carbon sequestration during the restoration of degraded ecosystems.

The first scenario will allow one to understand the potential impact of climate change on the national terrestrial carbon stock and activities that reduce emissions from deforestation and forest degradation (REDD). The second will provide an estimate of the influence of climate change on afforestation, reforestation and grassland management activities as well as the rate of biomass accumulation in the context of Biomass to Energy initiatives.

Methods

The modeling process

Each of the sites in Appendix 1 was modeled using the Century Ecosystem Program[4] that has been successfully used in numerous past studies to model carbon, nitrogen and phosphorus dynamics (e.g. Parton et al. 1993, Song and Woodcock 2003, Mooney et al. 2004, Luo et al. 2008).

Figure. 1 is an example of a typical Century simulation. The model is initially run for approximately 2000 simulated years using a historical climate dataset allowing the program to reach an equilibrium state (section 'a', Fig.1). In the example below, a disturbance event ('b', Fig.1) was then introduced that reduces the carbon in the system (point 'c', Fig. 1). The disturbance event could be an ecological disturbance (e.g. fire), or a management intervention (e.g. unsustainable harvesting or browsing) that leads to a loss of carbon. The pre-2000 simulation routine is then reintroduced from point 'c' onwards and the system is allowed to regenerate.

For each vegetation type, a typical degradation event was simulated followed by a potential carbon sequestration, rehabilitation initiative. For the mopane, broad-leaf and fine-leafed savanna sites that are situated in the Kruger National Park, the degradation scenarios were based on the studies of Shackleton et al. (1994), Shackleton (1997) and Scholes (1987) on degraded land in rural communal areas adjacent to the Park. In such communal

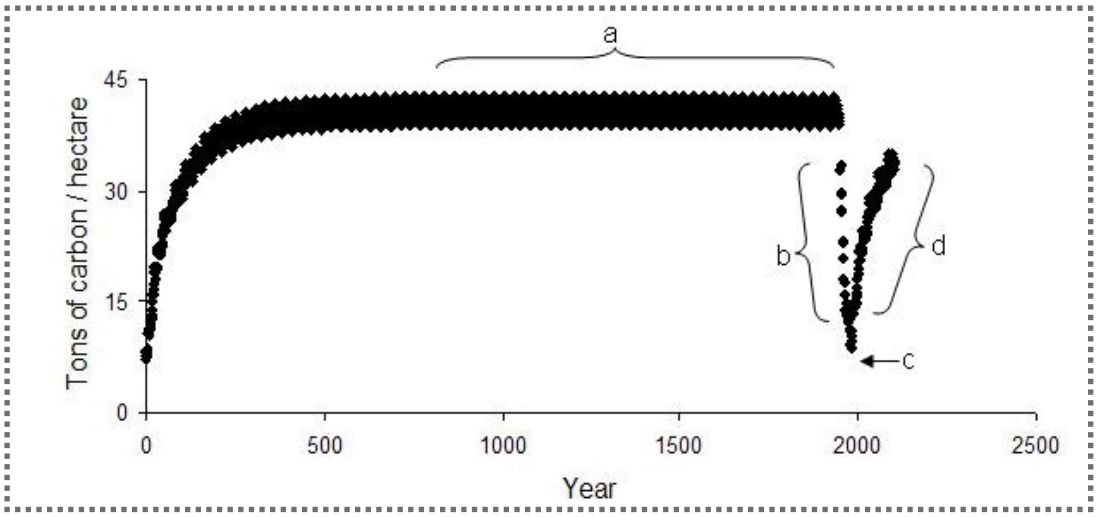

Figure 1. *An example of the results of a typical Century Ecosystem Program simulation run for sub-tropical thicket. 'a' is the 'equilibrium' intact state, 'b' is the period in which the carbon stocks are reduced to a 'degraded state' through substantial increases in herbivory or the harvesting of wood. From point 'c', the additional harvesting of wood is removed and the system is allowed to recover (section 'd').*

4 The model is freely available at www.nrel.colostate.edu/projects/century

areas, degradation is due to overgrazing and unsustainable fuelwood collection that reduces the standing biomass to ~ 10-15% of its intact state. The scenario for sub-tropical thicket was based on studies by Lechmere-Oertel et al. (2005) and Mills et al. (2005), that describe the rehabilitation of degraded thicket following unsustainable goat farming in the 1960's and '70's. The grassland scenarios were based on the observations of Snyman and Fouche (1991) in degraded grasslands.

Each of the degradation scenarios cited above were simulated in Century by introducing additional grazing, cropping or fire events during phase 'b' in Figure 2. These additional degrading events were then halted at point 'c', and the system was allowed to regenerate (phase 'd' in Figure. 2.).

For the REDD activity simulation, the model was allowed to reach an equilibrium state. Thereafter changes in [CO2], temperature and rainfall were ramped in over a period of 50 years depending on the particular GCM and scenario simulated.

Sources of data:

Table 2 lists the sites modelled during this exercise. Whereas one would optimally seek 20-30 sites strategically positioned to adequately sample variation across each vegetation type, due to time and especially budgetary constraints, this analysis is based on available data in published papers and reports as well as in published and personal datasets.

To adequately parameterize the Century model for a particular site, a substantial set of data is required. At a minimum:

- A 20-30 year record of monthly rainfall and minimum and maximum temperature
- Soil texture - sand / silt / clay context
- Soil carbon content
- Soil nitrogen content
- Soil bulk density
- Leaf lignin content
- Biomass or phytomass

These requirements have constrained the number of potential sites to those listed in Table 2. Whereas there are a vast number of sites in South Africa where particular metrics have been recorded e.g. aboveground biomass or soil carbon, there are few where the full set of required parameters has been recorded. This is especially true for the more arid areas of the country and the fynbos biome. The results should therefore be viewed as a good indicator of typical carbon sequestration rates expected in each biome and the effect of predicted climate change on carbon stocks and accumulation, but not a comprehensive analysis of the potential range within each biome.

Modelling the effect of predicted climate change and elevated [CO^2]

Choice of climate models

The projections of six coupled global circulation models (CGCMs) were used to estimate the potential effect of future climate change on each of the modelled vegetation types (Table 1). The six CGCMs contributed to the Coupled Model Intercomparison Project (CMIP3) and Assessment Report 4 (AR4) of the Intergovernmental Panel on Climate Change (IPCC). All six simulations are for the A2 scenario as described in the Special Report on Emission Scenarios (SRES, Nakicenovic et al. 2000) over the period 1961-2100. The data was obtained from the CSIR's Climate Studies and Modelling and Environmental Health Research Group that downscaled the CGCMs using a conformal-cubic atmospheric model (CCAM). As noted by Engelbrecht et al. (2012) and Malherbe et al. (2012), the CCAM has been shown to successfully downscale this set of CGCMs for southern Africa.

Adjusting climate data for each site to a global climate change model

For each CGCM, the projected monthly minimum and maximum temperatures, and precipitation for baseline (2000) and 2050 were extracted for each site location. As the CGCM baseline projection for the baseline in the year 2000 differs from true observed data, the GCM projected change in climatic variables is applied to observed data.

Calculating the change in climatic variables between the baseline and 2050 GCM projections does this. For minimum and maximum temperatures, the change is the absolute difference in temperature between the two projections. In

Table 1. *Coupled Global Change Models used to simulate the effect of projected climate change on terrestrial carbon stocks and associated sequestration rates.*

CGCM	Source
CSIRO Mark 3.5.	Ver 3.5. Commonwealth Scientific and Industrial Research Organisation
GFDL-CM2.0	Ver. 2.0 Geophysical Fluid Dynamics Laboratory, NOAA, United States
GFDL-CM2.1	Ver. 2.1 Geophysical Fluid Dynamics Laboratory, NOAA, United States
ECHAM/MPI-Ocean Model	Max Plank Institut, Germany
MIRO3.2-medres	Japanese Agency for Marine-Earth Science and Technology

the case of precipitation, the change is calculated as a multiplier as to avoid negative rainfall data been calculated. The change in climatic variables between the baseline and 2050, whether in the form of an absolute value or a multiplier, is then applied to the observed baseline data using a sliding linear scale.

The observed baseline (2000) data is calculated by averaging the minimum and maximum monthly temperatures, and monthly precipitation of observed data for at least the past 30 years. For the majority of study sites, this data was obtained from the South African Weather Bureau.

Calibrating to century parameter files to model climate change

The changes to the parameters in Century have been done as per recommended for "Enriched CO2 Effects" in the Century 5 User Guide and Reference.

- An additional weather file for each site is created that includes the GCM projected climate changes for 2000 – 2050.
- The transpiration and production rate variables (CO2itr and CO2ipr), the carbon/nitrogen and carbon/potassium ratio variables (CO2ICE(*,*,*)), and the root : shoot ratio (CO2IRS(2)), in the tree and crop parameter files are adjusted to simulate the presence of additional atmospheric carbon dioxide.
- The baseline and projected atmospheric carbon dioxide concentrations are entered into the .fix file by adjusting the CO2ppm parameter and the ramp function is chosen using CO2rmp. These changes to the .fix file are 'switched on' during the simulation by adjusting the CO2 systems variable in the schedule file using event.100.

Table 2. *The principle set of input variables used to calibrate the Century Model for each location.*

Vegetation type	Location	Geog. co-ords decimal degrees		Elevation	Mean Annual Rainfall	Above-ground carbon stock
		South	East	Meters	mm	tC.ha-1
Coastal Lowland Forest	eThekwini	29,82542	31,01564	74	800	75
Coastal Scarp Forest	eThekwini	29,80402	30,33656	380	800	65
Sub-tropical thicket	Baviaanskloof	33,63857	24,45454	450	413	41
Savanna - Combretum	Skukuza	24,99244	31,59774	264	572	9,5
Woodland - Mopane	Letaba	23,85367	31,57554	234	506	11,5
Dry grassland	Bloemfontein	29,10000	26,95000	1350	560	0,3
Moist temperate grassland	Cathedral Peak	28,92680	29,12730	2565	1324	2,3

Vegetation type	Soil texture (fraction 0-1)			Bulk Density	Source
	Sand	Silt	Clay	g/cm3	
Coastal Lowland Forest	0,89	0,03	0,08	1,39	Glenday, 2007
Coastal Scarp Forest	0,76	0,08	0,16	1,19	Glenday, 2007
Sub-tropical thicket	0,83	0,09	0,08	-	Mills et al. 2005, Lechmere-Oertel et al. 2005, Powell 2009
Savanna - Combretum	0,69	0,05	0,26	1,74	Shackleton 1997.
Woodland - Mopane	0,80	0,10	0,10	1,35	Scholes 1987, Shackleton 1997, Paterson and Steenkamp 2003
Dry grassland	0,87	0,03	0,1	1,48	du Preez and Snyman 1993, Snyman 2004, Snyman 2009
Moist temperate grassland	0,23	0,24	0,53	0,80	Everson 1985, Everson et al. 1998

Results and discussion

The results of the modelling exercise indicate that the impact of projected climate change and elevated [CO2] is likely to vary between vegetation types and locations, both in terms of the direction and the magnitude of the effect. Whereas both carbon stocks and sequestration rates are likely to increase in the modelled woodland, savanna and grasslands ecosystems, the change in coastal lowland and scarp forest is anticipated to be neutral to negative in direction (Fig. 2,3).

A 20 year and 30 year period were modelled as these are the project periods typically adopted for land-use based climate change mitigation activities, as well as time-frame often used by Government and commercial entities for land-use planning activities. The observed effect over 20 years is generally extended in magnitude over the 30-year period, although not in a linear manner or a consistent manner between CGCMs (Fig. 2,3). For example, over a 20-year period in Mopane Woodlands, the adoption of the GFDL-CM2.0 CGCM lead to largest change in carbon stocks of the five models used (Fig. 2). However, over a 30 year period, the adoption of the model only leads to marginal additional increase in carbon stocks, whereas the use of the GFDL-CM2.1 model has lead to a substantially larger increase in carbon stocks in the 20-30 year period.

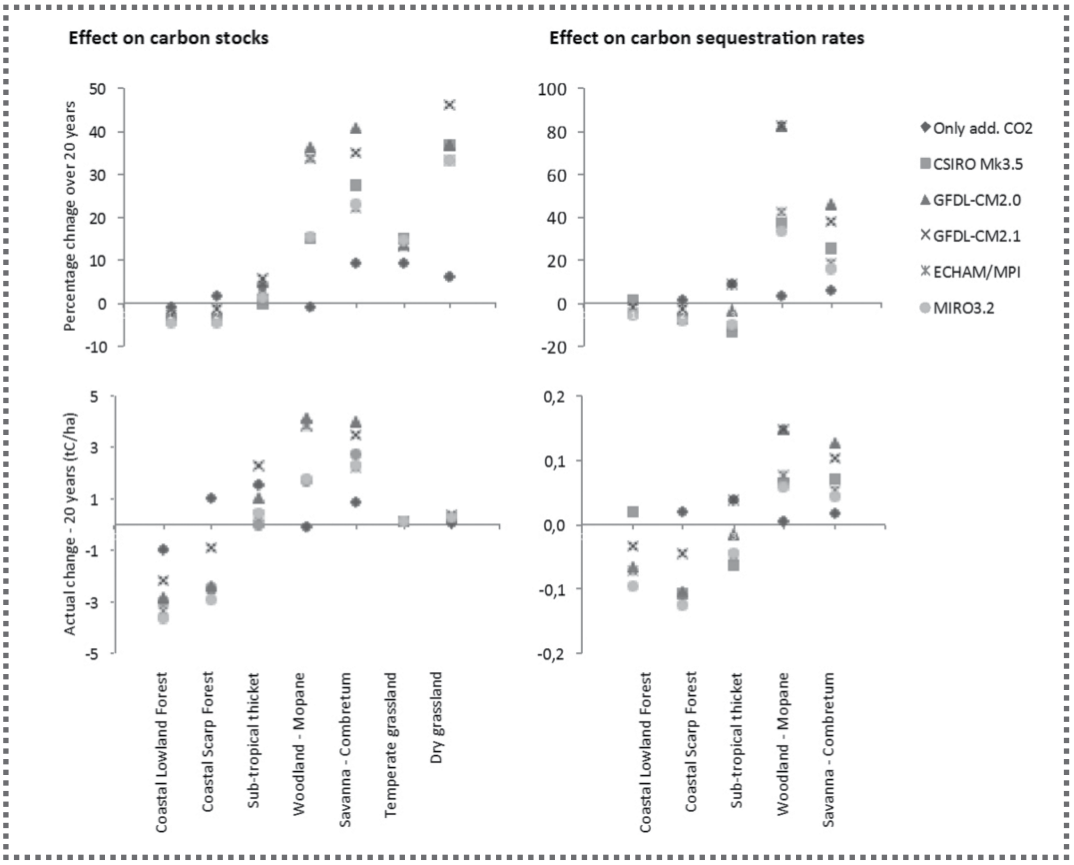

Figure 2. *The modeled effect of predicted climate change and elevated [CO2] on aboveground carbon stocks and carbon sequestration rates (during restoration or reforestation activities) over the next* **20 years**.

An interesting observation is the range of outcomes predicted by different CGCMs in particular locations (Fig 2,3). For example, the modelled percentage change in aboveground carbon stocks in coastal lowland forest systems ranges from -1 to -4 percent (depending on the particular CGCM used), whereas the results for Combretum savanna site range from 9 to 40 percent.

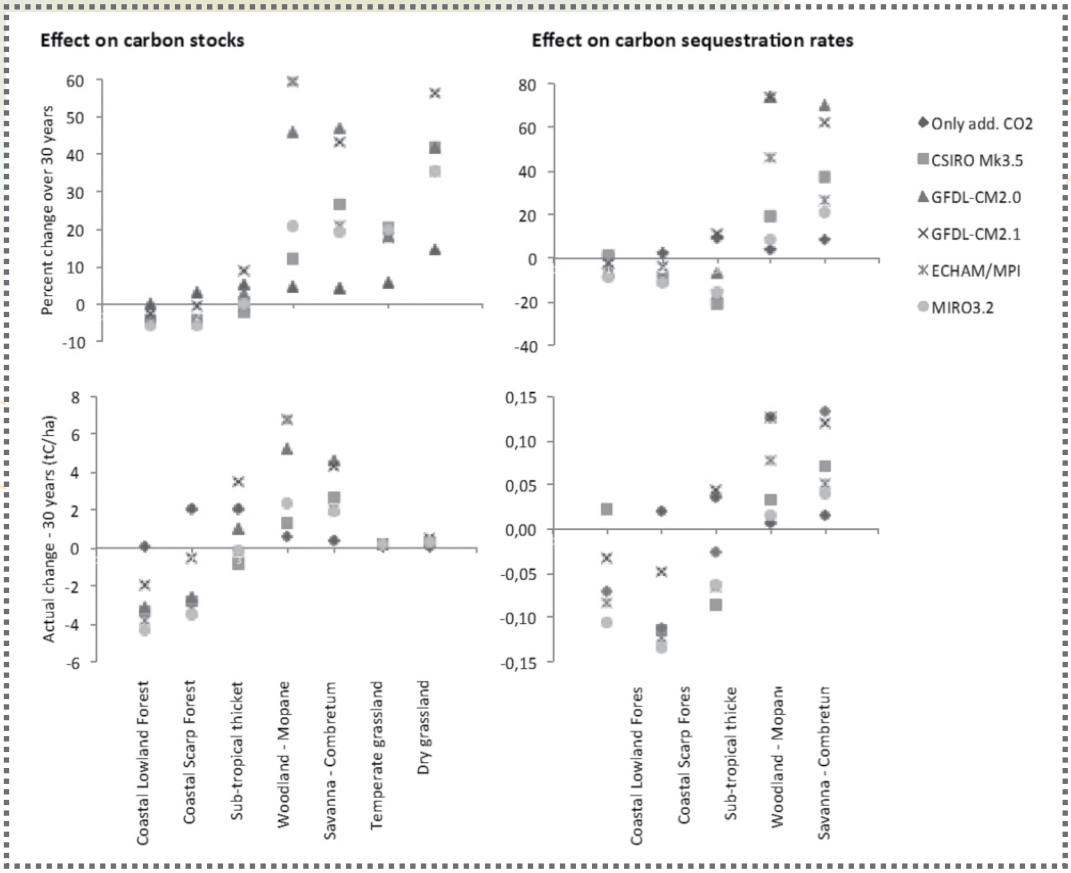

Figure 3. *The modeled effect of predicted climate change and elevated [CO2] on aboveground carbon stocks and carbon sequestration rates (during restoration or reforestation activities) over the next* **30 years**.

This range of responses is both due to the particular CGCM modelled as well as factors governing, and especially limiting, plant growth and litter and nutrient turnover in particular locations. The changes in carbon stocks and sequestration rates observed in Fig 2 and 3 are broadly related to the changes in minimum and maximum temperature and especially rainfall predicted by each CGCM (Fig 4). However, the response is also substantially influenced by limiting constraints to plant growth in certain systems. For example, plant available moisture may be a clear constraint to carbon sequestration in dry woodland and savanna ecosystems. In this context, an increase in rainfall leads to a clear increase in biomass accumulation. Yet in other ecosystems, for example coastal lowland and scarp forest, a similar change in rainfall leads to a negligible change in carbon stocks. In these ecosystems, plant growth may be more limited by soil nutrient availability rather than climatic factors.

Elevated atmospheric CO2 alone (modelled with a continuation of historical climate) is predicted to lead to a positive change in carbon sequestration rates ranging from 1-8 percent, depending on the particular vegetation type modelled (Fig 2, 3). The effect of [CO2] on standing carbon stocks is less consistent. In certain systems, for example, coastal lowland forest, the effect may be negligible to marginally negative (<1%). However, for most of the ecosystems modelled, elevated [CO2] is anticipated to lead to a 2-10% increase in aboveground carbon stocks over period of 20-30 years.

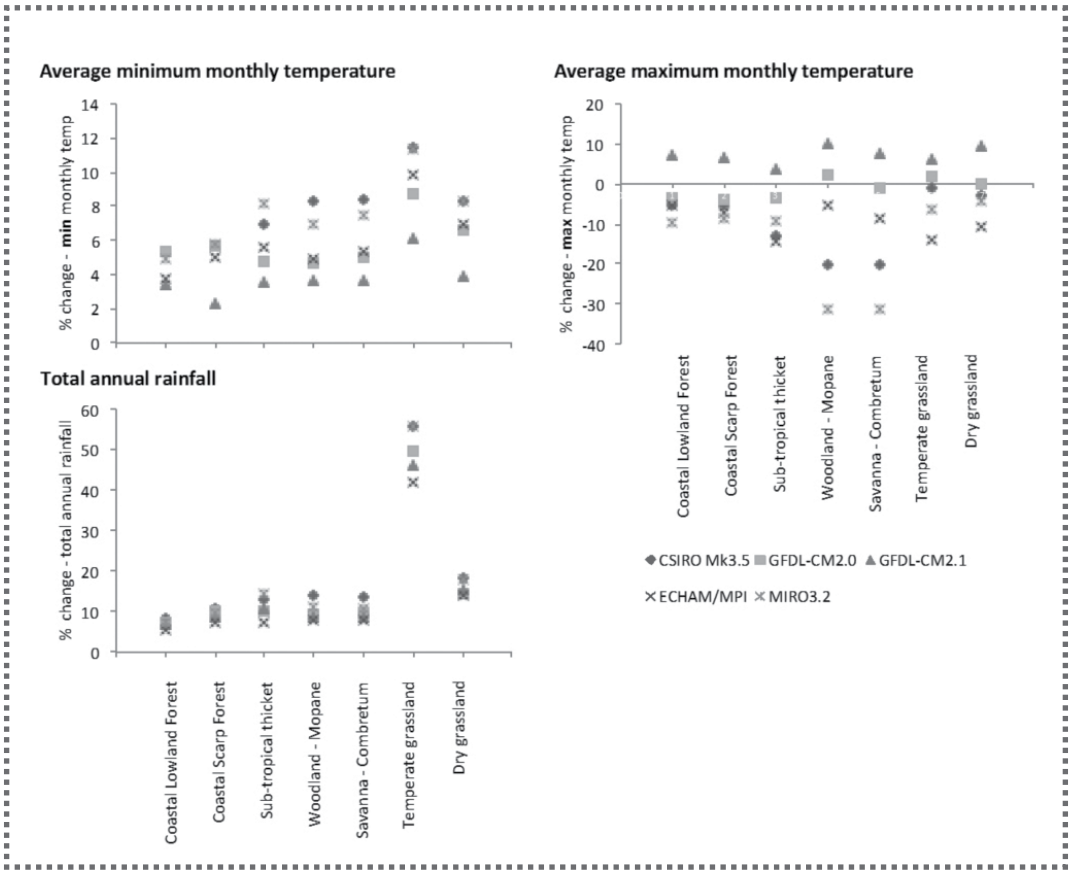

Figure 4. *The change in precipitation and minimum and maximum temperature predicted by each Couple Global Circulation Model adopted for the analysis*

Relative compared to actual changes

The relative changes in carbon stocks and sequestration rates reported Fig 2a,b and Figure 3a,b, should also be viewed in terms of the actual change in carbon stocks and sequestration rates (Fig. 2c,d and 3c,d). This is especially true when seeking to understand the impact of climate change on the outcome of land-use based mitigation activities and magnitude of the national terrestrial carbon stock. For example, although the relative change in carbon stocks in grassland systems is predicted to be considerable (up to 40%), the actual change equates to less than 0.2tC. ha-1 over 20 years. In comparison, a similar relative change in woodland and savanna systems results in an increase of 3-5tC/ha-1 over the same period.

This is particularly pertinent when considering predicted changes in carbon sequestration rates. Although the relative change is considerable (over 40% in woodland and savanna systems), the actual change equates to an increase of less than 0.1tC.ha-1.yr-1.

Does climate change present a considerable risk to mitigation activities in South Africa?

One of the principle reasons why this analysis was included in the scope of the South African National Carbon Sink Assessment was to understand if climate change and elevated [CO2] will have a considerable effect on national terrestrial carbon stocks as well as the outcomes of land-use based climate change mitigation activities. Does climate change present a significant risk to the climate change mitigation projects identified in Section II of the assessment (reforestation, afforestation, grassland restoration, biomass to energy)?

The results of this modelling exercise indicate that climate change is likely to have a negligible effect on the outcome of mitigation activities in the majority of vegetation types, if not slightly increasing carbon stocks and sequestration rates in the future. An initial area of concern may be the predicted decrease in carbon stocks and sequestration rates in coastal forest (Fig 2,3), but the magnitude of the predicted change is anticipated to be less than 5 percent over 20 years. These results should be seen relative to other determining factors and in the context of mitigation activities, in the perspective of the initiative's greater risk profile.

A number of forms of risk can affect the outcome of a mitigation activity. Typical risk classes considered include operations, technological and financial risk. For land-use based mitigation activities, an additional class of risk in the form of 'biophysical' risk is considered which includes factors that may effect the permanence of carbon stocks over an activities lifetime, for example, fire, pests and climate change.

Due to these forms of risk, the majority of standards created to verify land-use based mitigation activities (for example, the Verified Carbon Standard (VCS) and Gold Standard), include a compulsory "buffer mechanism" that is a form of risk management through which a Standard provides insurance against permanence and delivery risk over a project's lifetime. At present, the VCS and emerging Gold Standard rules and regulations stipulate a 20-30 percent "buffer", where the volume of issued emission reduction units ('carbon offsets') is discounted by this amount. The withheld units from each project are essentially held in a joint account that allows a Standard to ensure a particular project in case of default.

Considering the risk that climate change presents in this context, the results of the modelling exercise indicate that changes in climate and elevated [CO2] are generally likely to lead to an increase in carbon stocks -'upside risk'. Where a decrease in carbon stocks is predicted (in the case of coastal forests), the magnitude of the potential change is less than five percent and well within the 20-30 percent discount typically applied to land-use based mitigation projects in a near compulsory manner.

The effect of climate change relative to other drivers

The predicted effect of changes in climate and [CO2] reported here needs be seen in perspective and especially in the context of a greater set of ecosystem drivers that may also change over time. For example, fire, grazing and utilization regimes may well change in the future as land-use priorities shift and management changes accordingly. Changes in the occurrence or intensity of these drivers may even have a larger effect on carbon stocks than predicted in the above analysis. This point is raised not to discount the need to consider climate change but to caution against viewing its predicted effect in isolation. Rather a true systems ecology approach is required.

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Module 3 (Section 1.4) – SECTION 1

Modelling of Land-Cover change in South Africa (2001–2010) in support of green house gas emissions reporting

Acronyms

ARC	Agricultural Research Council
CDNGI	Chief Directorate National Geospatial Information
CGS	Council for GeoScience
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DFID	Department for International Development
DRDLR	Department of Rural Development and Land Affairs
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EWT	Endangered Wildlife Trust
FEPA	Freshwater Ecosystem Priority Areas
GHG	Greenhouse Gas emissions
GIS	Geographic Information System
GTI	GeoTerraImage
INR	Institute of Natural Resources
KZN	Kwa-Zulu Natal
MODIS	Moderate Resolution Imaging Spectroradiometer
NCCRP	National Climate Change Response Policy
NDP	National Development Plan
NFEPA	National Freshwater Ecosystem Priority Areas
NPAES	National Protected Area Expansion Policy
SA	South Africa
SANBI	South African National Biodiversity Institute
SIP	Strategic Infrastructure Plan
SKA	Square Kilometre Array
UNFCCC	United Nations Framework Convention on Climate Change
WRC	Water Research Commission

1. Background

The Department of Environment Affairs (DEA) requires the determination of land-cover change between the years 2000, 2005 and 2010 in support of their determination of Green House Gas Emissions reporting to the international community. The datasets described below were generated in response to this need. The data modelling approaches and final product content and format were all conceived to be in-line with DEA's urgent need for such data, which imposed significant constraints in terms of overall production time. The data collected for the GHG emissions project was found to be relevant for the NTCSA since it gave insight on the change in land cover over time.

Due to satellite data archival limitations associated with the proposed methodology, it is not possible to access suitable historical imagery for the year 2000, simply because the data does not exist. Hence the final set of land-cover data is based on the use of satellite time series data from 2001 – 2010 instead.

2. Objective

To create three standardised land-cover datasets for the whole of South Africa, representing conditions in 2001, 2005 and 2010; and to provide quantitative estimates of land-cover change between these three assessment dates. The methodology used was practical (i.e. time, cost, available input data), scientifically defensible (i.e. transparent and rigorous), repeatable in the future (except for loss of satellite systems etc out of our control etc), and has produced usable, standardised, wall-to-wall land-cover data for the required assessment periods.

3. Deliverables

Three (3) separate land-cover data coverages have been provided, representing landscape characteristics across the full extent of South Africa in 2001, 2005 and 2010. The datasets are based on a 500 x 500 m (25 ha) raster grid framework, within which the dominant (by area) land-cover within each cell has been defined. This is the same cell-based format and resolution as the MODIS satellite imagery used as the primary modelling dataset. All final data products have been delivered in digital (raster) format suitable for use and incorporation within GIS data modelling and analysis systems.

Table 1 lists the land-cover classes which have been modelled for each assessment year, which are in accordance with IPCC land-cover information reporting requirements:

In addition to the three digital, raster format land-cover datasets, three summary tables have been provided (in Excel spreadsheet format) that document the calculated changes in land-cover between the assessment years. These tables represent non-spatially, the changes between each cover class in both percentage and area values.

Table 1. *Land-cover classes included in the national land-cover datasets for 2001, 2005 and 2010.*

No.	IPCC Primary Class	Sub No.	DEA GHC Sub-Classes 500m
1	Forest lands	1	Indigenous Forest
		2	Thicket (remaining untransformed biome)
		3	Woodland / Savanna (remaining untransformed biome)
		4	Plantations (*incl clearfelled*)
2	Crop lands	5	Annual commercial crops (non-pivot), incl other non-pivot irrigation
		6	Annual commercial crops (pivot)
		7	Permanent crops (orchard)
		8	Permanent crops (viticulture)
		9	Annual semi-commercial / subsistence crops
		10	Permanent crops (sugarcane, irrig & dry)
3	Settlements	11	Settlements
4	Wetlands	12	Wetlands
5	Grasslands	13	Grasslands (remaining untransformed biome)
6	Other lands	14	Mines
		15	Water Bodies
		16	Bare Ground
		17	Other
		18	Fynbos (remaining untransformed biome)
		19	Nama Karoo (remaining untransformed biome)
		20	Succulent Karoo (remaining untransformed biome)

4. Methodology: general overview

Coarse resolution MODIS time series satellite data has been used to model the various land-cover classes in each assessment year, in conjunction with high resolution geographic masks of specific land-cover types. The MODIS dataset was sourced from the Remote Sensing Research Unit, Meraka Institute, CSIR. Note that the MODIS time-series dataset does not form part of the final deliverables, and is supplied under a restrictive license specifically for use in only the analysis and preparation of the 2001, 2005 and 2010 SA land-cover datasets. A full description of the MODIS data is supplied in the Appendices.

The MODIS time series imagery represents summarised biomass data for each 32-day period within the period 2001 – 2010. Biomass is represented by the Enhanced Vegetation Index (EVI) dataset. Using the EVI time series dataset it was possible to model and therefore identify on a cell-by-cell basis, for example areas that show continuously or periodically high or low vegetation cover, either in all years and all seasons, or in specific years or seasons.

The high resolution geographic masks were used to define *known* areas of specific land-cover types as mapped in independent provincial (and other) land-cover mapping projects. These high resolution reference land-cover datasets cover the full extent of the country, but not in terms of a single standardised time-frame, having been compiled through unrelated, independent projects undertaken between 2000 and 2010. In some cases these datasets are available as public-access data (with permission), whilst others are proprietary products, generated, owned and sold under license by GeoTerraImage. None of these datasets form part of the final deliverables, and have only been used during the analysis and preparation of the 2001, 2005 and 2010 SA land-cover datasets. A summary list of the source image data used to generate the geographic masks is supplied in the Appendices, listed by image date and image type per province.

Using the MODIS time-series vegetation data in combination with the higher resolution cover class geographic masks, it was thus possible to model the extent of a particular cover class in each of the three assessment years, using standardised assumptions about how such a cover class is represented by the MODIS vegetation profiles.

Note however that the physical extent of each geographical mask was not used to define the *exact* boundary of that specific cover class, but rather the results of the associated (MODIS EVI) modelling process *within that geographic mask* were used to define which cells were finally representative of that cover class. This approach ensured that standardised modelling assumptions could be applied independently and repeatedly to each MODIS dataset, for each assessment year.

For example, for the "cultivated annual commercial crops" (# 5), the following modelling rules and assumptions were applied:

- All national field boundary vector data circa 2006 – 2010 (available from the Department of Agriculture, Forestry and Fisheries, DAFF) were amalgamated into a single dataset representative of the maximum extent of cultivated lands across SA in approximately the last 10 years.
- The amalgamated field vector dataset thus represented the maximum potential area of cultivated lands in each of the assessment years.
- To define the actual extent of cultivated land (w.r.t. an annual crop cover) in each assessment year, the MODIS data cell must (a) be located within the potential cultivated land mask area, and (b), exhibit a period of low / non-vegetation at some time during the (crop) growth cycle, representative of the soil preparation / planting period,
- Any MODIS cell unit not exhibiting such a pattern is not classified as an active (annual) crop cover in that assessment window.

Thus the final extent of annual commercial crops defined for each assessment period will be represented by the output from the MODIS EVI-based vegetation modelling process and *not* the original field boundary geographic mask.

Full descriptions of all the modelling rules and assumptions for each land-cover class are supplied in later sections of this report, as well as indications of the time frames for the reference datasets used as for the sources of the different geographic masks.

Note that each land-cover type is modelled separately and the outputs are then merged into a final multi-class land-cover for that specific assessment year, using prescribed orders of dominance. The order in which each of the land-cover classes is merged (i.e. overlaid) with the other land-cover types is defined below in Table 2.

4.1 Limitations of modelling approach: area estimations

It is important to realise that the MODIS EVI modelling is based on 500 x 500 m pixels where as the geographic masks are based on 30m resolution pixels (derived independently from either Landsat or SPOT imagery). It is quite feasible that spatial misrepresentations have been introduced within the final land-cover outputs since the area for the single cover class allocated to each 500 x 500 km cell is rounded up to the nearest 0,5 km^2 regardless of the actual extent of that cover type (i.e. geographic mask) within the

500 x 500 m cell. This may be further exacerbated by the sequence in which the individual cover classes are overlaid / merged during compilation of the final land-cover product (see Table 2). For example, plantation forestry always over-writes (i.e. dominates within a cell) all cover types listed below it in the sequence presented in Table 2, regardless of the actual area of plantation forestry in that cell.

Table 2. *Hierarchical Overlay Sequence for Land-Cover Classes*

Overlay sequence	Land-Cover Class
this cover always overwrote classes below …	Settlements
this cover always overwrote classes below …	Indigenous Forest
this cover always overwrote classes below …	Plantations (*incl clearfelled*)
this cover always overwrote classes below …	Permanent crops (sugarcane, irrig & dry)
this cover always overwrote classes below …	Permanent crops (viticulture)
this cover always overwrote classes below …	Permanent crops (orchard)
this cover always overwrote classes below …	Annual commercial crops (pivot)
this cover always overwrote classes below …	Annual semi-commercial / subsistence crops
this cover always overwrote classes below …	Annual commercial crops (non-pivot), incl other non-pivot irrigation
this cover always overwrote classes below …	Mines
this cover always overwrote classes below …	Water Bodies
this cover always overwrote classes below …	Wetlands
this cover always overwrote classes below …	Bare Ground
	Other (biomes)
Other (biomes)	Thicket (remaining untransformed biome)
Other (biomes)	Woodland / Savanna (remaining untransformed biome)
Other (biomes)	Grasslands (remaining untransformed biome)
Other (biomes)	Fynbos (remaining untransformed biome)
Other (biomes)	Nama Karoo (remaining untransformed biome)
Other (biomes)	Succulent Karoo (remaining untransformed biome)

4.2 Limitations of modelling approach: accuracy and validation

It is important for end users to be aware that this has been a desk-top only modelling exercise, the results of which are directly dependent on the validity and accuracy of the modelling data inputs, theoretical assumptions and associated modelling rules. As such no statistical verification of final land-cover change detection accuracy can or has been be provided. Full transparency in terms of the MODIS data modelling rules and assumptions has however been provided should future users and / or analysts wish to re-calculate components of the land-cover data.

4.3 Limitations of modelling approach: data application

Due to the modelling processes and data inputs described, it should be clearly understood and communication to all end-users that the land-cover and land-cover change products have been developed ***specifically*** in support of the DEA-WITS GHG / IPCC reporting requirements, and that the products should ***not*** be considered new national land-cover datasets for wider application without full knowledge and understanding of the manner and process with which they have been generated.

5. MODIS modelling: detailed

Cover-class specific upper and / or lower EVI data thresholds were determined from the MODIS data for each land-cover type using appropriate Landsat and/ or high resolution thematic land-cover classifications for reference. Class specific modelling was restricted to specific geographic areas using digital masks extracted from a range of pre-existing land-cover classifications. A single reference mask was created for each cover class. The masks were created to represent the maximum geographical area of that particular cover class in all three assessment years. EVI modelling rules and assumptions were first developed on a year by year basis.

Since the geographic masks were generated from several independent reference sources, the geographical extent of each mask was not necessarily mutually exclusive, and masks could overlap. A specific sequence of priority overlaps was therefore established in order to compile the final SA land-cover datasets from each of the individual cover classes (see Table 2). For example modelled water pixels over-wrote all modelled natural vegetation pixels.

The results of the individual year modelling outputs were then tested for logical sequence across all three assessment years, and adjusted as and where deemed necessary. For example, if a cell was classified as "Water" in both 2001 and 2010, but "Plantation" in 2005, then the assumption will be that a modelling / rule error has occurred and that the logical sequence should be "Water" in all three assessment years. Only after this Quality Check has been completed was the final land-cover change assessments undertaken between the assessment years.

5.1 MODIS modelling: cover-class modelling rules

5.1.1Indigenous forests

EVI modelling assumptions

Indigenous forests were defined as pixels which consistently exhibited EVI values representing forest during every month of a year, within the pre-defined forest geographical mask.

EVI modelling thresholds

A pixel was defined as representing forests if the EVI values exceeded a minimum threshold of 0.21 during every month of a single year. This threshold value was taken to be representative of a closed canopy tree cover. Thresholds were determined visually using comparison to equivalent seasonal and year date Landsat imagery and existing small scale land-cover classifications.

Source of geographic mask

The forest geographic mask was created by merging indigenous forest classes from previously mapped land-cover datasets and the 2006 SANBI biomes vector data (see appendix).

Land-cover class modelling assumptions

Unlike plantations, indigenous forests are never cleared and replanted therefore it was assumed that pixels must contain forestry equivalent EVI values for every month of a year for that pixel to be classified as indigenous forests. If a pixel contained EVI values less than the indigenous forest threshold for one or more months of a year then it was assumed that the area had been cleared and was no longer indigenous forest.

Final logic test

A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 indigenous forest datasets. It was assumed that if a pixel was defined as forest in 2010 then the same pixel also had to be forest in 2005 because indigenous forests are not replanted if cleared and therefore the forest needed to have existed prior to the assessed date. Similarly, if a pixel was defined as forest in 2005 then the same pixel also had to be forest in 2001. It was therefore also assumed that if an EVI pixel value showed forests for 2010, but not for 2001 and 2005 then the 2010 forest is incorrect and had been removed from the class. Similarly if a pixel was defined as forest in 2005 and 2010 then that pixel had to have been forest in 2001.

5.1.2 Thicket

The thicket class boundary was extracted from the 2006 SANBI vector biome dataset, since it was outside the scope of the project and the available data to derive a MODIS EVI generated thicket boundary. Therefore the extent of thicket within the final land-cover datasets represents the biome boundary rather than the actual vegetation cover extent.

5.1.3 Woodland/Savanna

The **woodland / savanna** class boundary was extracted from the 2006 SANBI vector biome dataset, since it was outside the scope of the project and the available data to derive a MODIS EVI generated **woodland / savanna** boundary. Therefore the extent of **woodland / savanna** within the final land-cover datasets represents the biome boundary rather than the actual vegetation cover extent.

5.1.4 Plantations

EVI modelling assumptions

Plantations were defined as pixels which consistently exhibited EVI values representing forest plantations during every month of a year, within the pre-defined plantation geographical mask.

EVI modelling thresholds

A pixel was defined as representing plantations if the EVI value exceeded a minimum threshold of 0.21 during every month of a year. This threshold value was taken to be representative of closed canopy tree cover (mature stands).

Thresholds were determined visually using comparison to equivalent seasonal and year date Landsat imagery and existing small scale land-cover classifications.

Source of geographic mask

The plantation geographic mask was created by merging plantation classes from previously mapped land-cover datasets (see appendix).

Land-cover class modelling assumptions

To separate temporary clear-felled stands from permanent, non-tree covered areas, a maximum period of 4 years of undetectable tree cover was allowed, before which plantation re-growth had to become evident in terms of the EVI threshold. The 4 year period was defined from the first month of detectable non-tree cover on the EVI data, for pixels which previously contained a detectable tree cover. This 4 year period was deemed sufficient to represent a 40% canopy closure for the slowest plantation growth curves. Pixel EVI values exhibiting a lack of detectable tree re-growth after 4 years were assumed to no longer be representative of the plantation class (i.e. no re-planting).

Final logic test

A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 plantation datasets. It was assumed that if a pixel was defined as plantation in 2001 and 2010 then the same pixel also had to be plantation

in 2005. Similarly, if no plantation was defined in a pixel during 2001 and 2010, then that pixel could not contain plantations during 2005 because of tree growth rates.

5.1.5 Annual commercial crops (non pivot)

EVI modelling assumptions

Annual crops were defined as pixels which exhibited EVI values representing both bare ground and mature crops within a 12 month crop cycle, within the pre-defined annual crop geographical mask.

EVI modelling thresholds

A pixel was defined as representing annual commercial crops (non pivot) if the EVI dataset met both the bare field threshold and the mature crop threshold during a single growth year. Bare field status (i.e. bare ground prior to planting) was defined as a pixel having an EVI value below a maximum threshold of 0.148 (excluding zero as this represented "no data") during at least one month of a year. The mature crop condition was defined as a pixel with an EVI value exceeding a minimum threshold of 0.362 during at least one month of a year. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask

The annual crop geographic mask was created by merging annual crop classes from previously mapped land-cover datasets and previously mapped field boundary datasets (see appendix).

Land-cover class modelling assumptions

Annual commercial crops (non pivot) were determined by analysing the 12 month crop cycle within the annual crop mask. For a pixel to be considered as cultivated annual crop fields the EVI data had to exhibit both the bare field minimum threshold and the mature crop maximum threshold within the annual crop geographical mask, within that crop cycle.

Final logic test

A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 annual crops (non pivot) dataset. It was assumed that if a pixel was defined as annual crops in 2001 and in 2010 then the same pixel was also likely to be an annual crops in 2005 due to crop rotation cycling. Similarly, if a pixel was defined as not being annual crops in 2001 and 2010 then that same pixel was unlikely to be cultivated in 2005. Note that the 2001 EVI dataset contained several areas of "no data" values during the rain months in the Western Cape, over areas of likely annual crops. In these no data value areas, if a pixel was defined as annual crops in 2005, then it was assumed that the same pixel was annual crops in 2001, in order to maintain a logical sequence.

5.1.6 Annual commercial crops (pivots)

EVI modelling assumptions

Pivots were defined as pixels which exhibited EVI values representing both bare ground and mature crops during a 12 month crop cycle, within the pre-defined pivot geographical mask.

EVI modelling thresholds

A pixel was defined as representing pivots if the EVI dataset met both the bare field threshold and the mature crop threshold requirements during a single growth year. Bare field status (i.e. bare ground prior to planting) was defined as a pixel having an EVI value below a maximum threshold of 0.148 (excluding zero as this represented "no data") during at least one month of a year. The mature pivot crop condition was defined as a pixel representing a maturely grown crop if the EVI value exceeded a minimum threshold of 0.362 during at least one month of a year.

Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask

The pivot geographic mask was created by merging pivot classes from previously mapped land-cover datasets and previously mapped field boundary datasets (see appendix).

Land-cover class modelling assumptions

Pivots were determined by analysing the 12 month crop cycle within the pivot mask. For a pixel to be considered as a cultivated pivot the EVI data had to exhibit both the bare field minimum threshold and the mature crop maximum threshold within the pivot mask, within that crop cycle.

Final logic test

There was no logic test because the logic is covered by the initial EVI modelling and the geographic masks were spatially explicit.

5.1.7 Permanent crops (orchards)

EVI modelling assumptions

Orchards were defined as pixels which consistently exhibited EVI values representing orchard trees during every month of a year, within the pre-defined horticulture geographical mask.

EVI modelling thresholds

A pixel was defined as representing orchards if the EVI values were between a minimum threshold of 0.35 and a maximum 0.45 during every month of a year. This threshold value was taken to be representative of a canopy cover for mature orchard trees. Deciduous orchard crops were included on the basis of achieving the EVI threshold in at least one month as explained in the modelling assumptions. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask

The horticulture geographic mask was created by merging horticulture classes from previously mapped land-cover

datasets and previously mapped field boundary datasets (see appendix).

Land-cover class modelling assumptions
Orchards were determined by analysing the 12 month crop cycle within the horticulture geographic mask. For a pixel to be considered as cultivated orchards the EVI data had to exhibit at least one month when EVI values were in the designated range.

Final logic test
A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 orchard dataset. It was assumed that if a pixel was defined as orchards in 2001 and 2010 then the same pixel also likely to be orchards in 2005 due to tree growth rates. Similarly, if no orchards were defined in the same pixel during 2001 and 2010, then that pixel would not likely contain orchards in 2005. It was also was assumed that horticulture only disappears if replaced by another manmade land-cover. Therefore orchards would either remain the same in all years based on the 2001 extent or, increase in extent in subsequent years, but only reduce in area if replaced by another man-made (rather than natural) cover class. Thus the 2001 orchard extent was automatically carried through to 2005 and 2010 and similarly an expanded 2005 extent was carried through to 2010, unless replaced in any year by another man-made cover class.

5.1.8 Permanent crops (viticulture)

EVI modelling assumptions
Viticulture was defined as pixels which consistently exhibited EVI values representing vineyards during every month of a year, within the pre-defined viticulture geographical mask.

EVI modelling thresholds
A pixel had to display both EVI values representing the leaf off period and the mature, leaf on period within one growth year for it to be considered to represent a viticulture crop. The leaf off period representing bare ground was based on a EVI threshold range between 0.17 and 0.4, which must occur during at least one month of a year. The mature, leaf on crop period was defined as an EVI value range between 0.2 and 0.45, during at least one month during a year. The leaf on EVI data range was capped at 0.45 in order to exclude any surrounding areas of dense vegetation that exceeded the biomass of the viticulture crop. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask
The viticulture geographic mask was created by merging viticulture classes from previously mapped land-cover datasets and previously mapped field boundary datasets (see appendix).

Land-cover class modelling assumptions
Viticulture was determined by analysing the 12 month vine cycle within the viticulture mask. For a pixel to be considered as cultivated viticulture land the EVI data had to exhibit at least one month of bare vine (leaf off) cover and at least one month of leaf on cover within the viticulture mask.

Final logic test
A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 viticulture dataset. It was assumed that if a pixel was defined as viticulture in 2001 and 2010 then the same pixel also had to be viticulture in 2005 due to vine growth rates. Similarly, if no viticulture was defined in a pixel during 2001 and 2010, then that pixel could not contain viticulture during 2005. It was also was assumed that viticulture only disappears if replaced by another manmade land cover using the same assumptions as orchards.

5.1.9 Annual semi-commercial/subsistence crops

EVI modelling assumptions
Subsistence crops were defined as pixels which exhibited EVI values representing both bare ground and mature crops characteristics within a 12 month crop cycle, within the pre-defined subsistence crop geographical mask.

EVI modelling thresholds
A pixel was defined as representing subsistence crops if the EVI dataset met both the bare field threshold and the mature crop threshold during a single growth year. Bare field status (i.e. bare ground prior to planting) was defined as a pixel having an EVI value below a maximum threshold of 0.148 (excluding zero as this represented “no data”) during at least one month of a year. The mature crop condition was defined as a pixel with an EVI value exceeding a minimum threshold of 0.362 during at least one month of a year. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask
The subsistence crop geographic mask was created by merging subsistence crop classes from previously mapped land-cover datasets and previously mapped field boundary datasets (see appendix).

Land-cover class modelling assumptions
Subsistence crops were determined by analysing the 12 month crop cycle within the subsistence crop mask. For a pixel to be considered as cultivated annual crop fields the EVI data had to exhibit both the bare field minimum threshold and the mature crop maximum threshold within the subsistence crop geographical mask, within that crop cycle.

Final logic test
A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 subsistence crops dataset. It was assumed that if a pixel was defined as subsistence crops in 2001 and in 2010 then the same pixel was also likely to be subsistence crops in 2005 due to crop rotation

cycling. Similarly, if a pixel was defined as not being subsistence crops in 2001 and 2010 then that same pixel was unlikely to be cultivated in 2005. Note that the 2001 EVI dataset contained several areas of "no data" values during the rain months in the Western Cape, over areas of likely annual crops. In these no data value areas, if a pixel was defined as annual crops in 2005, then it was assumed that the same pixel was subsistence crops in 2001, in order to maintain a logical sequence.

5.1.10 Sugarcane

EVI modelling assumptions

Sugarcane was defined as pixels which exhibited EVI values representing mature sugarcane during at least one month in an 18 month crop cycle, within the pre-defined sugarcane geographical mask.

EVI modelling thresholds

A pixel was defined as representing sugarcane if the EVI value exceeded a minimum threshold of 0.55 during at least one month in the 18 month crop cycle. This threshold value was taken to be representative of mature sugarcane. For 2001 the 18 month period was defined from the first 2001 EVI monthly dataset forward. For the 2005 dataset it was defined as from July 2004 to December 2005. For the 2010 dataset it was defined as from July 2009 to December 2010. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask

The sugarcane geographic mask was created by merging sugarcane classes from previously mapped land-cover datasets and previously mapped field boundary datasets (see appendix).

Land-cover class modelling assumptions

Sugarcane was determined by analysing the 18 month crop cycle within the geographic sugarcane mask. The mature crop threshold had to be present within this cycle for the area to be classified as sugarcane from the EVI data.

Final logic test

A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 sugarcane dataset. It was assumed that sugarcane fields only disappear if replaced by another manmade land cover. Therefore if a pixel was defined as sugarcane in 2001 then that pixel was also defined as sugarcane in 2005 and 2010. Similarly, if a pixel defined as sugarcane in 2005 then it would also contain sugarcane in 2010.

5.1.11 Residential (modelled sub-component of settlement)

EVI modelling assumptions

Residential areas were defined as pixels which consistently exhibited EVI values representing high reflectance bare ground characteristics during every month of a year, within the pre-defined urban geographical mask.

EVI modelling thresholds

A pixel was defined as representing residential areas if the EVI values were below a maximum threshold of 0.5 during every month of a year. This threshold value was taken to be representative of residential buildings and man-made, artificial surfaces and structures within the geographic mask. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask

The residential geographic mask was extracted from land-use datasets (see appendix).

Land-cover class modelling assumptions

Residential areas were determined by analyzing the sequence and pattern of bare ground areas within the urban geographical mask for each assessment year by analysing the data across the full 10 year period. Urban areas were modelled, within the geographical residential mask, on the basis of the following assumptions:

(a) the maximum geographical extent of the residential area in one assessment year can not exceed the maximum extent in the following assessment year,
(b) all bare ground within the residential geographic mask is representative of residential areas irrespective of land use ,
(c) areas exhibiting a new phase of bare ground (after being previously vegetated) are assumed to be new development residential areas,
(d) vegetated areas occurring prior to a new phase of bare ground are representative of previously un-developed areas,
(e) areas that are consistently vegetated from 2001 through to 2010 (within the urban geographical mask) are considered established residential areas with mature garden foliage, and
(f), areas that are residential in 2010 were never previously industrial or commercial in previous years (although modelled industrial and commercial areas were allowed to over write residential areas on the assumption that these were new developments).

Final logic test

A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 residential datasets. It was assumed that a residential area could expand in size or remain static from 2001 to 2010, but it could not decrease in size. Therefore if a pixel was defined as residential in 2001, that same pixel had to be defined as residential in both 2005 and 2010. Similarly, a pixel defined as residential in 2005, had to be residential in 2010, unless reclassified as industrial or commercial.

5.1.12 Commercial and industrial (modelled sub-component of settlement)

EVI modelling assumptions

Commercial and industrial areas were defined as pixels which consistently exhibited EVI values representing high reflectance bare ground during every month of a year, within the pre-defined commercial and industrial geographical mask.

EVI modelling thresholds

A pixel was defined as representing commercial and industrial areas if the EVI value was below a maximum threshold of 0.28 during every month of a year. This threshold value was taken to be representative of commercial and industrial buildings and man-made, artificial surfaces. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask

The commercial and industrial geographic mask was extracted from land-use datasets (see appendix).

Land-cover class modelling assumptions

Modelling assumptions were that (a) all bare ground areas represented only commercial or industrial areas within the mask, and (b) commercial or industrial areas never reverted to residential once classified as commercial or industrial.

Final logic test

A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 commercial and industrial areas. It was assumed that a commercial or industrial area could expand in size or remain static from 2001 to 2010, but it could not decrease in size. Therefore if a pixel was defined as commercial or industrial in 2001 then that same pixel had to be defined as commercial or industrial in 2005 and 2010 as well. Similarly, if a pixel was defined as commercial and industrial in 2005, then it was also defined as commercial and industrial in 2010.

5.1.13 Creation of final settlement class

The final SA land-cover datasets for 2001, 2005 and 2010 do not contain separate categories for residential and commercial/industrial classes. A single “settlement” class is defined which represents the combined spatial extent of both the residential and commercial/industrial classes.

5.1.14 Wetlands

EVI modelling assumptions

For initial modelling purposes, the wetland class was split into dry, wet and vegetated wetlands. Dry wetlands were defined as pixels which consistently exhibited EVI values representing bare ground during every month of a year, within the pre-defined wetlands geographical mask. Wet wetlands were defined as pixels which exhibited EVI values representing water for a minimum of one month of a year within the pre-defined wetlands geographical mask. Vegetated wetlands were defines as pixels which did not exhibit EVI values representing bare ground or water within the pre-defined wetlands geographical mask.

EVI modelling thresholds

The EVI modelling thresholds vary depending on the nature of the wetland. A dry wetland threshold was defined as pixels with EVI values below a maximum threshold of 0.14 during every month of the year. A wet wetland threshold was defined as pixels representing water if the EVI values were below a maximum threshold of 0.18 during at least one month during a year. The vegetated wetlands threshold was defined as pixels with EVI values exceeding a threshold of 0.14, but which had not been previously classified as wet during any month of a year. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask

The wetland geographic mask was created by merging wetland classes from previously mapped land-cover datasets (see appendix).

Land-cover class modelling assumptions

Since wetlands can become drier or wetter through out different seasons, it is assumed that if a wetland is defined by the water threshold for at least one month within a year, then that wetland is classified as wet. The dry wetland is defined by a pixel representing bare ground for every month of the year. Vegetated wetlands are defined as pixels that correspond to the vegetation threshold for at least one month in a year, but are never represented by water within the same year.

Final logic test

The vegetated and dry wetlands were collapsed into a single wetland class for use in the final SA land-cover datasets. The wet wetlands were recoded as water pixels.

5.1.15 Grasslands

The grassland class boundary was extracted from the 2006 SANBI vector biome dataset, since it was outside the scope of the project and the available data to derive a MODIS EVI generated grassland boundary. Therefore the extent of grassland within the final land-cover datasets represents the biome boundary rather than the actual vegetation cover extent.

5.1.16 Mines

EVI modelling assumptions

Mines were defined as pixels which consistently exhibited EVI values representing bare ground during every month of a year, within the pre-defined mine geographical mask.

EVI modelling thresholds
A pixel was defined as mines if the EVI values were below a maximum threshold of 0.24 during every month of a year. This threshold value was taken to be representative of bare ground characteristics that are found within a mining environment. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask
The mine geographic mask was created by merging mine classes from previously mapped land-cover datasets and topographic vector data (see appendix). This included tailings, dumps and extraction sites.

Land-cover class modelling assumptions
The modelling process for mines did not identify flooded mine pits or surface water on tailings, although this was identified within the water modelling process and was incorporated into the final land-cover data compilations. It was assumed that mines contained bare surfaces throughout every month of the year for 2001, 2005 and 2010. Mine dumps/tailings containing a large covering of algae during the rainy season may have been misidentified.

Final logic test
A final logic test was used to check and edit (if required) the modelled 2001, 2005 and 2010 mine datasets. It was assumed that if a pixel was defined as mines in 2001 and 2010 then the same pixel also had to be mines in 2005, due to the semi-permanent nature of most mines. Similarly, if no mines were defined in a pixel during 2001 and 2010, then that pixel could not contain mines during 2005. However pixels representing mines could disappear (rehabilitation) if the disappearance was permanent within the assessment year range. This included acceptance that a mine pixel could be evident in 2001 and 2005, but not evident in 2010.

5.1.17 Water bodies

EVI modelling assumptions
Water bodies were defined as pixels which exhibited EVI values representing all types of open water (i.e. man-made and natural) within the pre-defined water geographical mask.

EVI modelling thresholds
A pixel representing water was defined as EVI values which were below a maximum threshold of 0.18 during any month of the year. This threshold value was taken to be representative of a body of water. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Source of geographic mask
The water geographic mask was created by merging water classes from previously mapped land-cover datasets and Chief Directorate: National Geospatial Information topographic vector data (see appendix). The dry river beds were excluded from the water geographic mask since the water threshold and bare ground thresholds overlap, which would have resulted in dry, bare river beds appearing as permanently flooded.

Land-cover class modelling assumptions
The water bodies were modelled on the basis of a candidate pixel containing at least one month in the assessment year having an EVI data value equivalent to the threshold defined for water. Therefore the modelled water output always represented the maximum geographic area of water occurrence in any of the assessment years. Note that there may be an over estimation of water pixels since the water threshold is similar to the bare ground threshold and there was no way of separating these two classes with only EVI data.

Final logic test
There was no logic test because the logic is covered by the initial EVI modelling and the geographic masks were spatially explicit.

5.1.18 Bare ground

EVI modelling assumptions
Bare ground was defined as pixels which consistently exhibited EVI values representing bare ground during every month of a year. This was modelled across the entire country without geographical masks and formed a backdrop upon which all other modelled cover classes were over laid. The final extent of bare ground in the national datasets thus represented very sparse vegetation covers and desert areas not covered by other cover classes.

EVI modelling thresholds
A pixel was defined as bare ground if EVI values were below a maximum threshold of 0.14 during every month of a year. This threshold value was taken to be representative of bare ground. Thresholds were determined visually using comparison to equivalent date Landsat imagery and the existing small scale land-cover classifications.

Land-cover class modelling assumptions
The bare ground was defined as pixels that exhibited non-vegetated / bare ground EVI characteristics for all months consistently in any assessment year. There may be an under estimation of bare ground that occur within the geographic water masks as the water and bare ground EVI thresholds are similar.

Final logic test
There was no logic test because the logic is covered by the initial EVI modelling.

5.1.19 Fynbos

The fynbos class boundary was extracted solely from the 2006 SANBI vector biome dataset, as an additional request outside the scope of the original ToR. Therefore the extent of fynbos within the final land-cover datasets represents the un-transformed extent of the potential biome boundary

rather than the actual vegetation cover extent (which may or may not contain local areas of non-fynbos vegetation cover).

5.1.20 Nama-karoo

The nama-karoo class boundary was extracted solely from the 2006 SANBI vector biome dataset, as an additional request outside the scope of the original ToR. Therefore the extent of nama karoo within the final land-cover datasets represents the un-transformed extent of the potential biome boundary rather than the actual vegetation cover extent (which may or may not contain local areas of non-karoo vegetation cover).

5.1.21 Succulent karoo

The succulent karoo class boundary was extracted solely from the 2006 SANBI vector biome dataset, as an additional request outside the scope of the original ToR. Therefore the extent of succulent karoo within the final land-cover datasets represents the un-transformed extent of the potential biome boundary rather than the actual vegetation cover extent (which may or may not contain local areas of non-karoo vegetation cover).

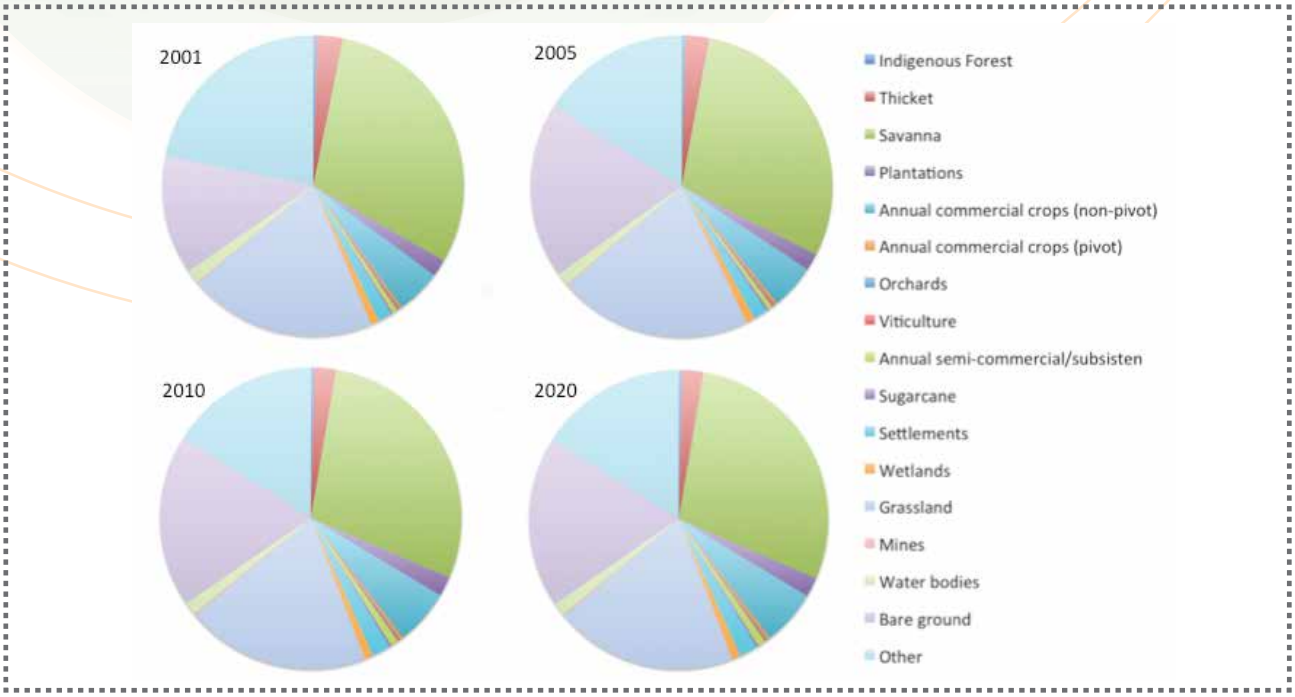

Figure 2. *Comparison of modelled 2001, 2005 2010 and 2020 SA land-cover datasets.*

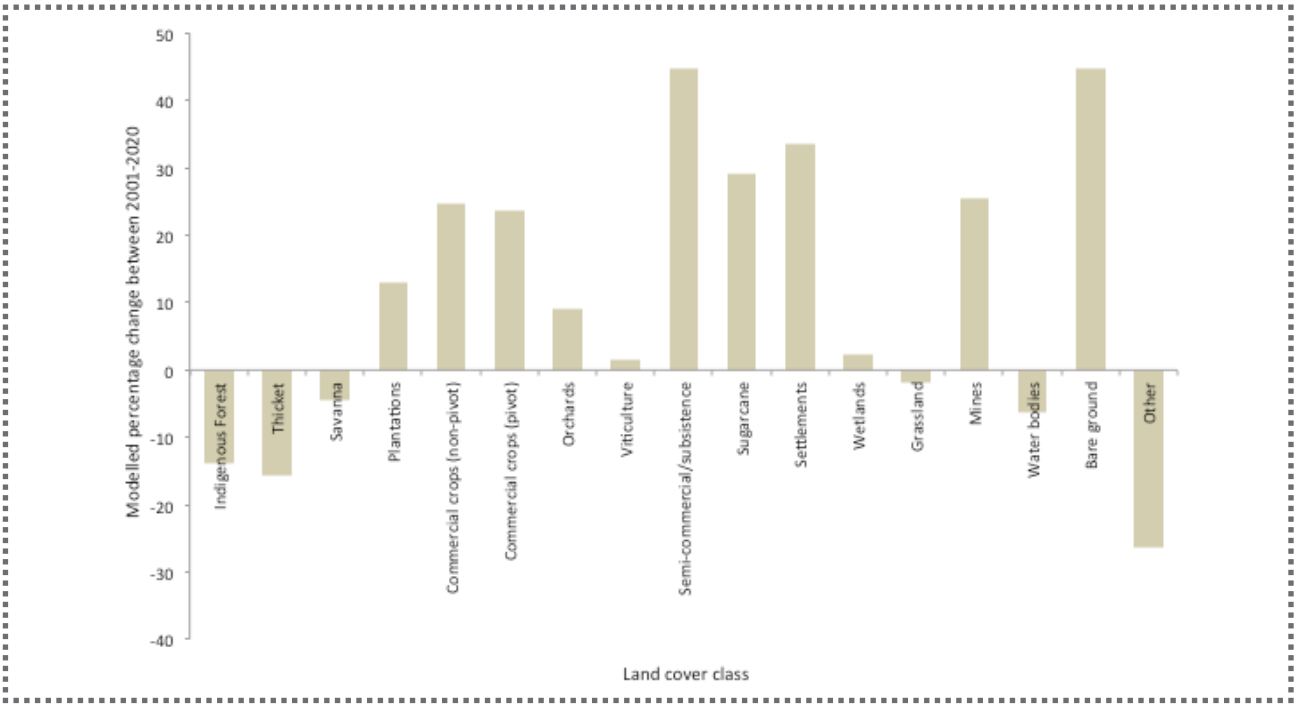

Figure 3. *Modelled percentage change in each land-cover class between* **2001 – 2020**

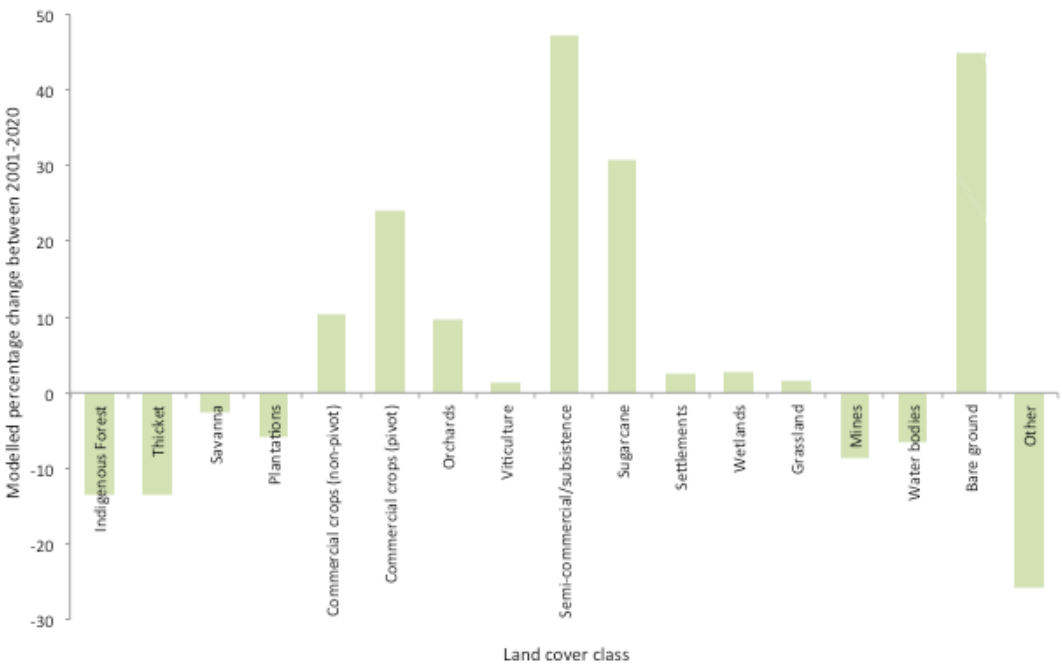

Figure 4. *Modelled percentage change in each land-cover class between* **2001 – 2010**

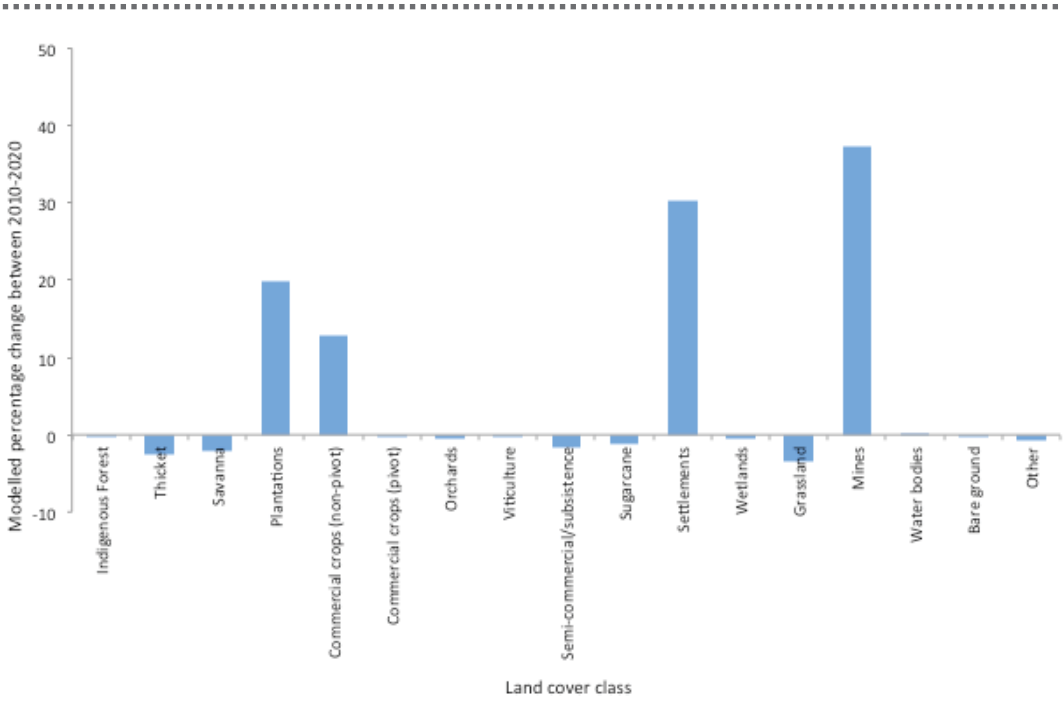

Figure 5. *Modelled percentage change in each land-cover class between* **2010 – 2020**

Land-cover change results

Overall, the comparison of all modelled land-cover results show an expected general increase in the area of transformed land-cover classes (i.e. mines, settlements, plantations, and cultivation), and a comparable loss in natural / semi-natural vegetation types between 2001 and 2020. The rate and extent of change however varies significantly with cover type (Figure 2 & 3).

During the period 2001 – 2010 the expansion of all cultivated lands, especially semi-commercial subsistence-level activity and sugarcane represent the main drivers of landscape change in terms of percent change in area (Fig. 2 & 4). Furthermore, there is a substantial increase in the area of 'bare ground' on private, communal and Government land. The increase in 'bare ground' may be both due to the degradation of indigenous vegetation classes (forests, thickets, savannas and grasslands) as well as short-term decreases in primary productivity in rangelands. One should not therefore solely interpret the increase in bare ground as due to the long-term conversion of intact indigenous ecosystems, but rather a combination of short-term decreases in vegetation cover (linked to primary productivity) as well as some longer-term changes in land-use.

During the modelled period from 2010 – 2020, this pattern changes with both sugarcane and subsistence cultivation decreasing in spatial extent, while commercial agriculture continues to expand (note that this excludes pivot irrigated cultivation since this was not a modelled class for 2020 since it was impossible to predict where an individual farmer would place new structures). Mines, settlements and plantation areas all show potential expansion with a corresponding decrease in indigenous thicket, savannas and grasslands (Fig. 2 & 5). The change in area covered by bare ground is marginal in this period compared to the previous ten years.

The variable changes indicated for water bodies across all years, representing both increases and decreases can be attributed to the wetter conditions under which the earlier 2001 MODIS imagery was acquired compared to drier subsequent years, despite the counterbalancing effect of increasing the number of major water dams included in the 2020 landscape scenario.

The greatest potential percentage area losses in natural vegetation are associated with thickets and indigenous forest, mainly as a result of the cell-based modelled agricultural expansion in the Eastern Cape and the creation of new dams. However this does not necessarily equate with the largest areas of actual physical transformation, since whilst the percentage change is high for indigenous forests (13.9%), the forest class represents less than 0.4 % of the total area of S. Africa; compared to a 2.0% loss for grasslands, which cover ± 20 % of S. Africa.

Potential terrestrial carbon stock and flux implications

To fully understand the impact of historical and predicted future land-cover changes on the size of the national terrestrial carbon stock and associated fluxes, the GIS surfaces generated in this analysis need to be integrated into a spatially explicit carbon stock and flux model (for example, the model created by the CSIR in Section 1.1 and 1.2 of the National Carbon Sink Assessment). Such a model would allow the carbon stock and flux implications of changes in land-use to be assessed in detail and would provide valuable data for Government planning and UNFCCC reporting purposes.

In the interim, it is reasonable to assume that the observed historical change in land-use in South Africa (the general conversion of indigenous landscapes into built environments and commercial and subsistence agriculture) has led to a net decrease in the size of the national terrestrial carbon stock. As indigenous ecosystems are cleared and ploughed (in the case of cultivation), the carbon sequestered in above-ground biomass and soils is released into the atmosphere.

The predicted expansion of exotic plantations over the next 10 years may lead to an increase in woody carbon stocks in particular forestry areas, but overall, the size of the national terrestrial carbon stock is expected to decrease in size due to the anticipated expansion of settlements, mines and areas under commercial cultivation.

See Appendix B on page 224 for modelling data sources, modelling data inputs and data modelling.

South African National Carbon Sink Assessment:

Phase II: understanding potential climate change mitigation opportunities

section TWO

Contents

Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
CARA	Conservation of Agricultural Resources Act
CCBA	Climate, Community and Biodiversity Alliance Standard
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CO2	Carbon dioxide
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DFID	Department for International Development
DRDLR	Department of Rural Development and Land Reform
EIA	Environmental Impact Assessment
EPWP	Expanded Public Works Program
ha	Hectare
IAP	Invasive Alien Plants
IDP	Integrated Development Plan
IRP	Integrated Resource Plan
MRV	Monitoring, Reporting and Verification
MWe	Megawatt electrical
MWh	Megawatt hour
NAMA	Nationally Appropriate Mitigation Actions
NCCRP	National Climate Change Response White Paper
NEMA	National Environmental Management Act
NFA	National Forests Act
NFU	National Facilitation Unit

NGO	Non-Governmental Organization
NPV	Net Present Value
PoA	Program of Activities
REDD	Reduced emissions from deforestation and forest degradation (through planning and regulation)
REDD+	Reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RRG	Rhodes Research Restoration Group
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SMEs	Small and medium enterprises
SPLUMA	The Spatial Planning and Land-Use Act
tC	ton of carbon
tCER	Temporary Certified Emission Reduction
tCO2e	Ton of carbon dioxide equivalent
TOR	Terms of Reference
UMDM	uMgungundlovu District Municipality
UNFCCC	United Nations Framework Convention on Climate Change
UNREDD	United Nations program aimed at REDD
VCS	Verified Carbon Standard
VCU	Verified Carbon Units
WESSA	Wildlife and Environment Society of South Africa

Introduction

Research objective

The approach for this section was to conduct an assessment of the size and nature of the land based climate change mitigation. Consequently the following objectives were pursued.

Section 2 has five objectives:

- To identify the principal land-use based climate change mitigation opportunities in South Africa
- To understand the nature of implementation in terms of required capacity and the institutional and financial context of potential implementing agents
- To better understand the magnitude and structure of implementation costs
- To understand the co-benefits and trade-offs and co-benefits implementation, particularly employment opportunities and the effect of implementation on ecosystem services
- To identify clear roadblocks to implementation that could be addressed by Government in the near term Understanding the dynamics of field-based practitioners and their ability to implement projects, the economic contribution of land-use based climate change mitigation opportunities, and the potential for job creation, trade-offs, benefits and challenges particular to each of the principal implementation opportunities identified over the course of the team's research.

The Assessment stems from needs identified in the *National Climate Change Response White Paper* (NCCRP), particularly the identification of climate change mitigation activities that increase the size of the national terrestrial carbon sink and deliver sustainable benefits as captured in section six of the National Climate Change Response Policy (NCCRP).

The approach to the analysis

The study was designed to move beyond a broad general overview of implementation options, to a specific consideration of the magnitude and nature of all land-use based mitigation activities in South Africa. The rationale for this approach is driven by Government's mandate to implement appropriate mitigation activities at scale across the country. The first step towards meeting this mandate is an explicit exploration of each potential land-use based mitigation activity (beyond only afforestation and REDD+), including careful consideration of the nature of implementation – the context of implementing agents, required management, field and monitoring capacity, required institutional support, payment and incentive mechanisms, necessary supporting policy, and implication of different implementation models on job creation, permanence and sustainability over the long-term.

The concept of land-use based climate change mitigation is certainly not new in South Africa. Several parties located in the public and private sectors have extensive experience in implementing climate change mitigation and adaptation options. Moreover, substantial expertise exists in the development of related ecosystem service and ecological infrastructure activities. In addition to populating the analysis with data from published datasets, publications and established models, the team attempted to leverage the rich body of established expertise and experience in South Africa through a number of structure interviews with leading parties.

Eighteen interviews, typically lasting 3-4 hours, were held with the individuals listed in the table below. Individuals were primarily chosen based on robust experience in implementing or designing climate change mitigation in South Africa. In addition to prominent field practitioners, members of Treasury and the national monitoring, reporting and verification (MRV) group where interviewed to better understand how to align suggested implementation measures and structures with existing Government programs.

The Cirrus Group, Beatus and Mr. Barney Kgope and Mr. Itchell Guiney of the Department of Environmental Affairs conducted the interviews. Where in-person meetings were not feasible, interviews were conducted telephonically.

Participant	Entity	Location
National Government		
Peter Lukey	Department of Environmental Affairs	Pretoria
Sebataolo Rahlao, Oscar Mokotedi	Department of Environmental Affairs	Pretoria
Peter Janoska	National Treasury	Pretoria
Guy Midgley, Mandy Barnett, Mandy Driver and Jeff Manual	SANBI	Cape Town
Field practitioners (in Government, private and NGO sectors)		
Mike Powell	Subtropical Thicket Restoration Research Group at Rhodes University	Grahamstown
Bruce Taplin	SANParks	Addo National Park
Sarshen Scorgie	Conservation South Africa	Cape Town
Andrew Venter, Andrew Whitley and the Wildlands team	Wildlands Conservation Trust	Hilton
Ian Rushworth and Steve McKean	KZN Wildlife	Howick
Marilyn Govender	South African Sugar Association	Pietermartizburg
David Everard, Nico Hattingh, and Dutliff Smith	SAPPI	Pietermartizburg
Alan Manson and Cobus Botha	CEDARA	Hilton
Riaz Jogiat	uMgungundlovu District Municipality	Pietermartizburg
Christo Marais and Ahmed Khan	Expanded Public Works Program	Cape Town
Errol Douwes, Sean O'Donoghue	eThekwini Municipality	eThekwini

The interviews focused on understanding:

- The full suite of potential land-use based climate change mitigation activities in South Africa
- The true opportunity for implementation – why have certain initiatives succeeded and others failed?
- Existing implementation models – organizational structures, required capacity, skill-sets and logistics
- Human-resource requirements, in particular the opportunity to create employment and skill-development opportunity in rural areas
- The context of implementation – the land-tenure, social, educational and economic context
- Inhibitory factors limiting initial implementation or roll-out at scale
- The opportunity for partnerships between the public, private and non-profit sectors to facilitate implementation
- Monitoring, reporting and verification requirements and the potential to reduce MRV costs through national scale support and innovative monitoring techniques
- The magnitude and structure of development, implementation and monitoring costs
- The nature of existing funding and finance, incentive mechanisms and payment structures
- Required institutional support and other forms of assistance required to scale-up implementation
- Potential alignment between government programs focusing on climate change mitigation and adaptation as well as ecosystem services and ecological infrastructure more broadly

Report structure

The report is composed of six sections. First we broadly introduce South Africa land-use domain and the eight principal climate change mitigation opportunities that were identified during the course of the stakeholder engagement and supporting analyses. in South Africa. Thereafter, the eight options are compared in terms of their magnitude, readiness to implement, and their potential contribution to national social welfare and ecological infrastructure goals. Thereafter, the nature of each activity is considered in detail. The report is concluded with a potential strategy going forward, that includes the development of a potential National Facilitation Unit (NFU).

2. The nature of terrestrial carbon stocks in South Africa

The set of climate change mitigation activities in Section 5 were informed by the particular nature of the land-use sector in South Africa. In comparison to other countries in sub-Saharan Africa, where the emphasis is on avoiding deforestation (i.e. REDD+), South Africa has limited forest cover and the main conversion of indigenous landscapes has already occurred during the 1960s and 70s. Whereas there is certainly still scope for activities that avoid deforestation and landscape degradation, there is significant opportunity to sequestrate carbon through the restoration of grasslands and thicket, as well as to reduce emissions through energy related projects in the established agricultural sector. Here, we briefly introduce the biophysical, socio-economic and historical nature of land-use in the country.

The biophysical template – the nature of terrestrial carbon stocks

South Africa is a relatively dry country where most areas receive less than 650mm of rainfall per year. Certain pockets along the eastern seaboard may receive over 1000mm annual but in general, South Africa is a fairly arid country. This is reflected in magnitude and distribution of carbon stocks across the country, which is principally determined by annual rainfall, soil type and temperature (Fig 1).

Phase 1 of the National Carbon Sink Assessment focused on understanding the distribution of carbon stocks across the country and provided the first maps of terrestrial carbon stocks at a national scale. As expected, the areas with the highest carbon stocks per hectare are the coastal forests, followed by moist savanna and thicket systems, and then the drier areas of the northern Cape, western Free State

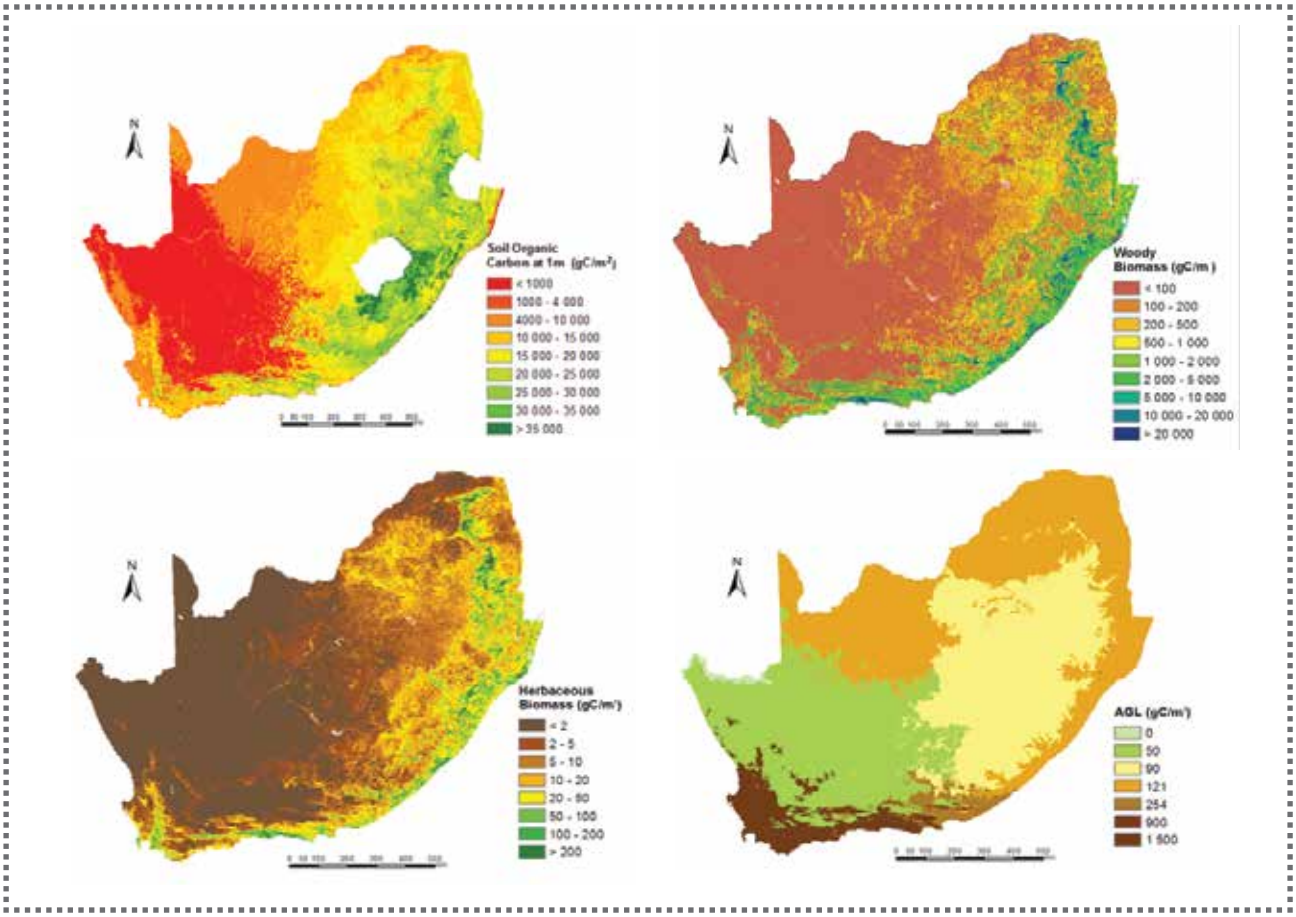

Figure 1. *The components of the terrestrial carbon stock of South Africa. Top left: soil organic carbon to 1m in depth. Top right: the above- and below-ground woody-plant biomass pool Lower left: above- and below-ground herbaceous biomass pool. Lower right: aboveground litter - AGL (Scholes et al. 2013)*

and North-West Province (Fig 1). Less expected were the estimates of the proportion of the national terrestrial carbon stock that is located in each biome or land-cover type (Fig 2).

Approximately 30% of the national terrestrial carbon stock is located in grassland ecosystems and a slightly lower amount in the savanna biome (Scholes et al. 2013). In comparison, less than 5% of the national carbon stock is located in indigenous forest and sub-tropical thicket. This result is primarily due to the spatial extent of each land-cover type (Fig 2).

Furthermore, of particular interest in terms of developing national implementation options, is that over 90% of carbon stocks within the grassland and savanna biomes are located in the belowground soil organic carbon pool. Although this is largest terrestrial pool of carbon in the country, little priority has been placed on it, due to the historical emphasis on forests and REDD+. These results suggest that a better balance of effort is required between grassland, savanna and forest ecosystems. Whereas, restoration efforts and current progress with sub-thicket and forest biomes should not be curtailed, equal effort should be placed on maintaining belowground carbon stocks in grassland and savanna ecosystems.

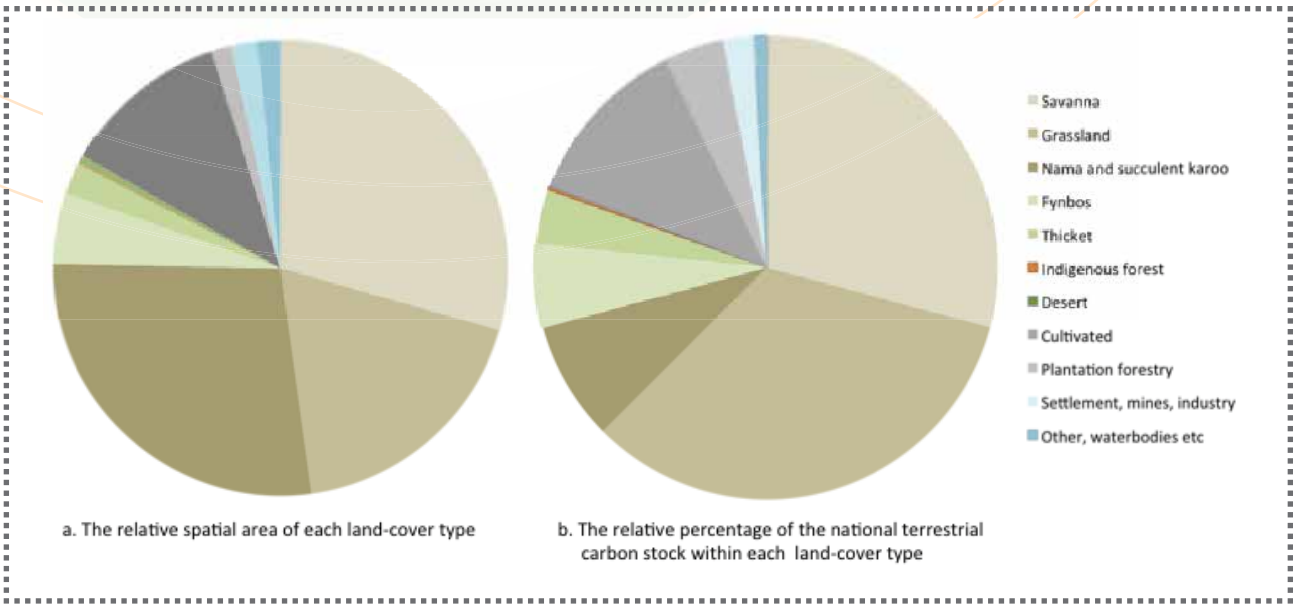

Figure 2. *The relative contribution of each of the principle land-cover types in South Africa in terms of (a) spatial area and (b) terrestrial carbon stocks (input data from Scholes et al. 2013)*

Socio-economic template – the need for broader inclusivity

Starting with the 1913 Land Act, successive laws and legislation determined that black South Africans were relegated to racially segregated "Bantustans", "homelands" or "native reserves". In these areas, land was communally owned and due to immense population pressures, was soon marked by overgrazing, soil erosion and poor soil fertility. During apartheid, these conditions were exacerbated by various "Betterment" schemes, which concentrated residence and centralized grazing- with disastrous ecological consequences (Bundy 1989).

While a democratically elected government started overturning racialised land legislation in 1994, South Africa still struggles with the legacies of land-use policies initiated during the colonial and apartheid eras. The country is marked by deep inequalities that still need to be addressed. In particular, a substantial section of the country's poor, rural population still live on the most degraded land and have little access to capital, information or the carbon market.

Whereas comprehensive and robust project development, monitoring and reporting frameworks have been created under the Clean Development Mechanism (CDM) and Verified Carbon Standard (VCS), they inherently assume that the implementing agent is well resourced and has access to capital and markets. If implementation is to occur in degraded areas within homelands and other area communal land-tenure, alternative implementation and monitoring models need to be created. While opportunities within the established commercial sector need to be realized, they should be balanced with a national program that facilitates projects in communal areas at the same time. This is particularly pertinent in a period when previously disadvantaged communities are obtaining access to land and where clear incentives for climate change mitigation and broader ecosystem management could ensure the sustainable management of ecological infrastructure over the long term.

3. What are the principle land-use based opportunities in South Africa?

The type and magnitude of climate change mitigation opportunities

Eight prominent land-use based climate change mitigation activities were identified (Table 1, Fig. 3, 4). These include both activities that increase and sustain the size of the national terrestrial carbon stock (reducing tillage, applying biochar, and the restoration and management of grasslands, subtropical thicket, woodlands and forests) as well as activities that lead to a net decrease in GHG emissions (biomass to energy and anaerobic biogas digesters). *Each is described in detail in the 'Considering each activity' section below.*

Two estimations of each activity's contribution to reducing atmospheric GHGs are provided. The first "minimum" estimate is a robust, conservative estimate of the potential scope of the activity. However, certain stakeholders thought that these estimates may be too low and therefore an additional 20% has been added to this initial estimate in separate column to provide a range for planning purposes.

A total mitigation potential of between 14,1 and 16,9 million tCO_2e can be expected from the activities combined. Biogas has the largest potential (considering farm manure only, i.e. excluding household biogas digesters), followed by sub-tropical thicket and forest restoration, and then the restoration and management of grassland systems. In addition, the generation of energy through the combustion of bagasse and wood sourced from invasive alien species can also form a significant contribution. The activities' contribution in both absolute and relative terms is indicated in Figure 3 and 4.

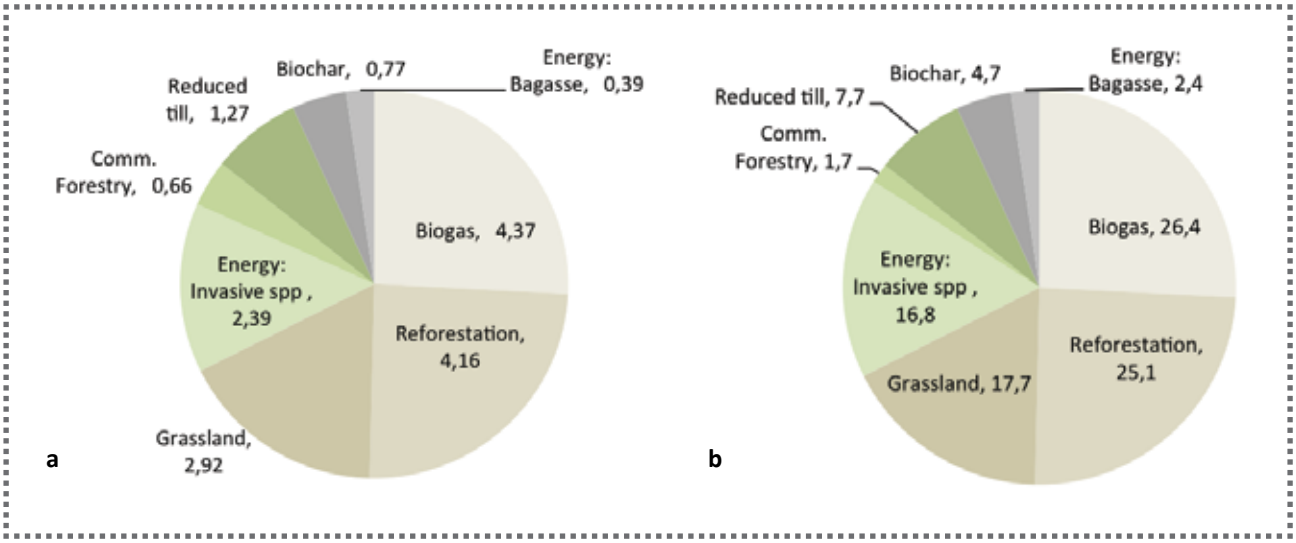

Figure 3. *Individual contribution of the various terrestrial activities towards carbon sequestration and mitigation in million tonnes of CO_2e (panel a) and in percentage contribution (panel b)*

The combined potential of all the activities are shown in Figure 4. A non-linear ramp-up or implementation period for each of the activities is assumed over various terms and indicated in the notes to Table 1. This implementation period explains the shape of Figure 4. It should be noted that different implementation periods are assumed varying from 5 years (for commercial plantation forestry), to 20 years (for the energy options). The assumed implementation period for restoration-related activities varies between 10 and 15 years.

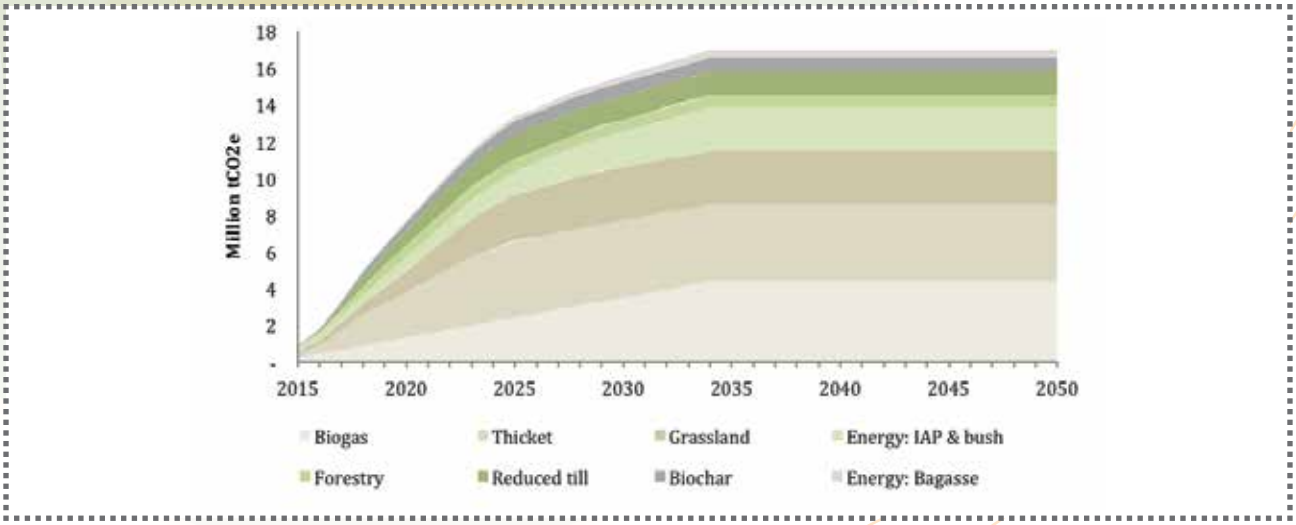

Figure 4. The total terrestrial carbon sink potential by activity over time

Table 1. Contribution of terrestrial carbon sequestration and mitigation activities

Activity	Sub-class	Spatial extent (ha)[1]	Reduction per unit area per yr (tC)	Emission reduction per yr (tCO2e) (min)	Emission reduction per yr (tCO2e) (+20%)	Reduction in emissions over 20yr (tCO2e) (min)	Percent contribution
Restoration of sub-tropical thicket, forests and woodlands	Sub-tropical thicket[2]	500 000	1,2	2 200 000	2 640 000	44 000 000	25,1
	Coastal and scarp forests[3]	8 570	1,8	56 562	67 874	1 131 240	
	Broadleaf woodland[4]	300 000	1,1	1 210 000	1 452 000	24 200 000	
Restoration and management of grasslands	Restoration - Erosion Mesic[5,6]	270 000	0,7	693 000	831 600	13 860 000	17,7
	Restoration - Erosion Dry[7]	320 000	0,5	586 667	704 000	11 733 333	
	Restoration - Grasslands Mesic[8]	600 000	0,5	1 100 000	1 320 000	22 000 000	
	Avoided degradation mesic[9]	15 000	1,0	55 000	66 000	1 100 000	
Commercial small-grower afforestation	Eastern Cape[10]	60 000	1,5	330 000	396 000	2 750 000	1,7
	KwaZulu-Natal[11]	40 000	1,5	220 000	264 000	1 833 333	
Biomass energy (IAPs & bush encroachment)	Country-wide[12]			1 990 316	2 388 379	39 806 316	14,4
Biomass energy (bagasse)	Country-wide[13]			328 955	394 746	6 579 099	2,4
Anaerobic biogas digesters	Country-wide[14]			3 642 408	4 370 890	72 848 160	26,4
Biochar*****	Country-wide[15]	700 000	0,3	641 667	770 000	12 833 333	4,7
Reduced tillage******	Country-wide[16]	2 878 960	0,1	1 055 619	1 266 742	21 112 373	7,7
Reducing deforestation and degradation	Through planning[17] Through regulation[17]						
Total				**14 110 193**	**16 932 231**	**275 787 189**	**100,0**

Notes and references associated with the table above:

1. The spatial extent estimate should be viewed as a conservative estimate based on existing publications and expert opinion. A dedicated assessment of the potential spatial extent of each activity is still required that should not only assesses the ecological potential but economic constraints and social acceptance as well.
2. **Spatial extent:** Powell pers comm (based on Lloyd *et al*. 2002). Range depending on land-owner participation; **Reduction per unit area per year (tC):** Mills and Cowling 2006 (Great Fish River Reserve site) Ramp-up or roll-out period: 10 years
3. **Spatial extent:** Conservative est. of 10% of total forest area; **Reduction per unit area per year (tC):** Glenday 2007; Ramp-up or roll-out period: 10 years
4. **Spatial extent:** Conservative est. of 10% of savanna area, 10% of which is assumed to be degraded; **Reduction per unit area per year (tC)** Glenday 2007 and Knowles 2011; Ramp-up or roll-out period: 10 years
5. The national-scale assessment of gully erosion undertaken by Mararakanye and Le Roux (2011) provides an initial (conservative) estimate of degraded bare land that could be restored. It is reasonable to assume that the majority of soil carbon pool has been lost through the degradation process. In addition, the assessment is useful for identifying the location of 'degradation hotspots' across the country. It is however not a comprehensive assessment of grassland degradation. This analysis remains to be done.
6. **Spatial extent:** Mararakanye and Le Roux 2011; **Reduction per unit area per year (tC):** Watson *et al*. 2000, Conant and Paustian, 2002; Ramp-up or roll-out period: 15 years
7. **Spatial extent:** Mararakanye and Le Roux 2011; **Reduction per unit area per year (tC):** Watson *et al.* 2000, Conant and Paustian, 2002; Ramp-up or roll-out period: 15 years
8. **Spatial extent:** The mesic grasslands occupy a total extent of about 6 000 000 ha. It is conservatively estimated that 10% of this area is degraded; **Reduction per unit area per year (tC)** Watson *et al.* 2000, Conant and Paustian, 2002, Ramp-up or roll-out period: 15 years
9. **Spatial extent:** Conservatively, 5% of the mesic grasslands is at risk of degradation over the next two decades; **Reduction per unit area per year (tC)** Inferred from Knowles *et al.* 2007 (average over 20 yrs) Ramp-up or roll-out period: 15 years
10. **Spatial extent:** SAPPI pers comm (2013); **Reduction per unit area per year (tC):** SA Forestry Annual Statistics (E. grandis pulp on 8 yr cycle, 50t dry matter at end of cycle), Ramp-up or roll-out period: 5 years
11. **Spatial extent:** SAPPI pers comm (2013); **Reduction per unit area per year (tC):** SA Forestry Annual Statistics (E. grandis pulp on 8 yr cycle, 50t dry matter at end of cycle), Ramp-up or roll-out period: 5 years
12. Potential: Blignaut (2009); Emission reduction based on: Load factor = 75%; Emission factor = 85% of Eskom grid factor; Ramp-up or roll-out period: 20 years. It should be noted that at least three estimates of the potential of invasive alien plants and bush encroachment exist, all with different assumptions and constructed for different purposes. In this study we used the mid-estimate of Blignaut (2009). The estimates are:

IRP2010(rev2)				Blignaut et al. (2008)				Blignaut (2009)			
MW	MWh	tCO2/MWh	tCO2	MW	MWh	tCO2/MWh	tCO2	MW	MWh	tCO2/MWh	tCO2
25	164 250	0.8415	138 216	720	4 730 400	0.8415	3 980 632	360	2 365 200	0.8415	1 990 316

13. Potential: IRP2010(rev2); Emission reduction based on: Load factor = 85%; Emission factor = 85% of Eskom grid factor Ramp-up or implementation period: 20 years
14. Potential: 75% of the potential estimated in Blignaut (2009), supported by a conservative estimate by Burton et al. (2009); Emission reduction based on: Load factor = 75%; Emission factor = 70% of Eskom grid factor; Ramp-up or implementation period: 20 years
15. **Spatial extent:** The cultivated area is 14,394,800 ha and penetration rate is assumed to be 5%. **Reduction per unit area per year** 0.25 tC/y for 20 years.; Ramp-up or implementation period: 10 years
16. **Spatial extent:** Adoption is assumed to be 20% of the potential cultivated area. **Reduction per unit area per year** $0.1tC.ha^{-1}.yr^{-1}$ following the adoption of no-tillage practices based on study by Farage et al. (2007). Ramp-up or roll-out: 10 years
17. Although numerous stakeholders noted this opportunity, the spatial extent thereof is currently unknown. Please see a discussion focused on this activity in Chapter 3 of this report.

The contribution of activities to national GHG emission, social and ecological infrastructure objectives

Contribution to the national GHG emission goals

One of the objectives of investing in terrestrial carbon sink and mitigation activities is to reduce South Africa's overall GHG emission profile. The Long Term Mitigation Strategy differentiates between an emissions profile under a "Growth Without Constraints" scenario and a scenario entitled "Required by Science". This latter scenario is based on South Africa making a proportionate contribution to the global effort to reduce GHG emissions. This latter scenario forms the basis of South Africa's Peak-Plateau-Decline mitigation strategy. The strategy aims to stabilize emissions between 2025 and 2035 at an upper limit of 614 million tCO_2e per annum. Between 2035 and 2050 emissions are then expected to decline to reach a range between 428 and 212 million tCO_2 per annum in 2050. This enables an estimate of required annual emissions savings. Such an estimate is done by considering the difference between the mid-range of the "Growth Without Constraints" scenario and the maximum allowable emissions as per the "Required by Science" scenario. The estimates implies a saving of approximately 1,210 million tCO_2e per annum by 2050. The terrestrial carbon sink capacity to reduce atmospheric carbon emissions is estimated to be between 14,1 and 16,9 million tCO_2e, or about 1,4% of the required savings. This is illustrated in Figure 5.

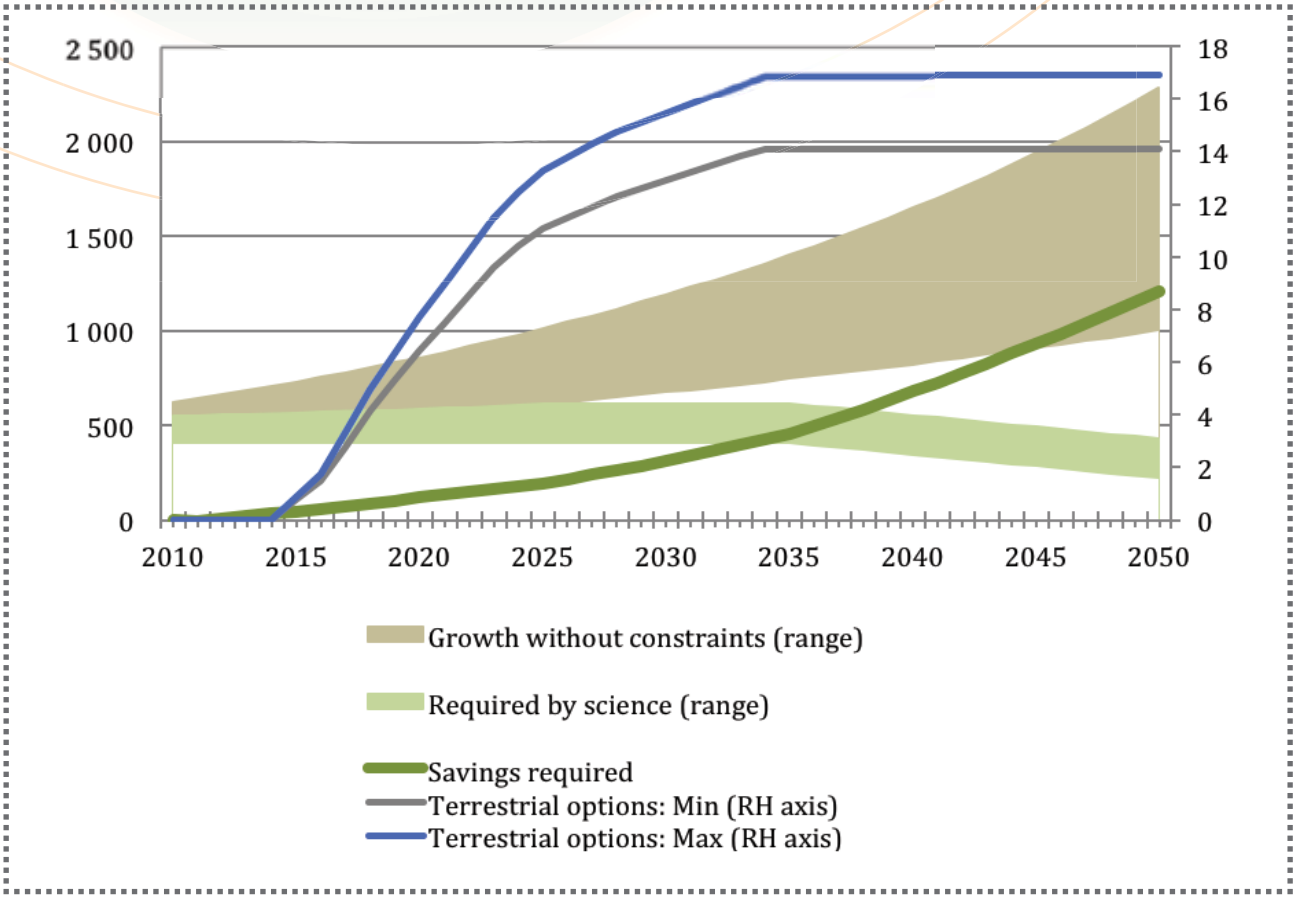

Figure 5: *Terrestrial carbon sink activities' contribution to South Africa's reduction in CO_2*

The crucial social, ecological infrastructure and climate change adaptation benefits of implementation

Casual observation of the contribution that terrestrial activities can play in reducing South Africa's overall Greenhouse gas emissions profile and the required savings would suggest that its contribution is minimal. Such an assessment would be erroneous for various reasons, namely:

1. Each sector, irrespective of which sector it is and how small its contribution in absolute terms might be, has to make a contribution towards reducing the country's carbon footprint. Since no single policy and/or intervention will achieve the total reduction, the achievement of the overall required savings will be a packaged deal. Furthermore, since the country's carbon profile is a matter of national strategic importance, all sectors and activities have to make a concerted effort in contributing to this goal.
2. By not being mindful of the contribution any activity can make, and/or to waive an activity's contribution under the pretense of it "being small and insignificant" will generate a national psyche of laissez faire pertaining to the issue of reducing the country's carbon profile. Not only will such an attitude fail to contribute to the required savings, it will propel the emissions growth under the "Growth Without Constraints" scenario.
3. Each of the activities listed offers multiple benefits. These include:

- job creation,
- opportunities for small business development,
- environmental awareness in general,
- water treatment,
- a contribution to water retention and base flows,
- water security in general, especially in periods of low flow and water scarcity, i.e. the times of high water necessity and hence an increase in the value of water,
- enhanced soil stability,
- the protection and enhancement of (endemic/natural) biodiversity,
- improved fire management and the reduction in fire hazards by reducing the biomass/fuel load, reducing the risk of damage to people, infrastructure and the environment,
- energy security by differentiating the energy mix,
- improved waste management, reducing not only the cost of waste management, but also reducing the load on the environment to assimilate and treat waste,
- food security by enhancing the productive capacity of the land
- contributes to the broader goal of sustainable development

1. Embarking on an effort to implement terrestrial carbon sink activities, see section 6, will therefore contribute far beyond carbon only. Making carbon a rallying point will assist in implementing the activities, while the activities will contribute to national welfare and development far beyond the scope of carbon only.

The cost of land-use based climate change mitigation activities

Cost is invariable a consideration when the implementation of terrestrial carbon mitigation and sequestration activities are considered. Here we performed a cost-effectiveness analysis comparing a selection of carbon mitigation activities. When considering this analysis, please note:

- This is a high-level assessment and the cost at local and/or at the level of implementation is likely to vary considerably given circumstances;
- Activities have been excluded from the analysis where some uncertainty exists pertaining to the scale of implementation and the degree and/or appetite for uptake;
- For the restoration-related activities and biogas, a time horizon of 30 years and a discount rate of 4% have been assumed in conjunction with the ramp-up period stipulated under Table 3.1. Costs were derived from stakeholder interviews;
- For the non-biogas energy-related options, the levelised costs as per the IRP (2011) have been used.

The results are provided in Table 2. The restoration-related options are considerably cheaper, by a factor of 10 or more than the energy options. The restoration-related options cost between R54 and R112 per tCO_2e whereas the energy options are between R926 and R1,054 per tCO_2e. This is mainly due to the capital intensity of the energy-related options.

Table 2. Cost of CO_2 reduction: Terrestrial mitigation and sequestration options

Project Activity	Cost (R)		NPV over 30 years (Rmill)	Mill tCO2 over 30 years	R/tCO2
	CapEx/ha	OpEx/ha			
Restoration of sub-tropical thicket and forests[1]	6 000	500	9 215	87,5	105
Restoration and management of grasslands[2]	250	200	3 081	57,2	54
Commercial small-grower afforestation[3]	10 000	550	1 681	15,0	112
	Levelised R/ MWh	MWh	Annualised Rmill	Mill tCO2/a	R/tCO2
Biomass energy (IAPs & bush encroachment)[4]	779	2 365 200	1 842	1,99	926
Biomass energy (Bagasse)[4]	869	390 915	340	0,33	1 033
Biogas (farm manures)[5]	730	5 256 000	3 838	3,64	1 054

4. Comparing the key characteristics of each activity

This section includes a comparative analysis of the key characteristics of implementation option. It seeks to describe the differences and similarities and the drawbacks and benefits of each individual implementation option. A second purpose of this section is to highlight the ways in which barriers to implementation might be addressed. Characteristics are assessed along three main criteria:

- Carbon market, governance and implementation measures;
- Social and ecological infrastructure measures; and
- Climate change potential.

Eight sub-criteria have been used to assess and compare each principle implementation option. The criteria were divided into a quintile ranking system, moving from *unfavorable* to *favorable* based on information gathered from stakeholder interviews and the project team's prior experience.

Description of the sub-criteria

Carbon market, governance and implementation measures

1. *Market acceptance:* Market acceptance is assessed according to several issues, namely the presence of a recognized legal counterparty, the ability to raise traditional forms of finance, the application of known and successful technologies, the ability to generate revenues, and the probability of receiving early government support.
2. *Readiness to implement*: A number of activities have a well-documented track record of success in South Africa – examples include small-scale commercial forestry and restoration of sub-topical thicket. Several other activities have already been subject to pre-feasibility, feasibility and costing assessments. These types of activities are deemed more favorable due to their readiness for implementation compared to those that lack this preparatory work, especially where further extensive primary research is required
3. *Capital intensity:* The extent to which large sums of capital will have to be deployed, notably at project inception. For example, biomass–to-energy and anaerobic biogas digesters, require intensive injections of capital for upfront construction and early operational costs. In comparison, grassland rehabilitation and reforestation demand less upfront capital.
4. *Government support:* It is believed that government support is more likely for projects that are self-sufficient over time, and which adopt proven, known

1 Costs provided by Powell (personal comm - 2013) and SANParks – the mid estimates were used;
2 Costs provided by Ezemvelo KZN Wildlife (personal comm - 2013);
3 Cost provided by SAPPI (personal comm - 2013);
4 Based on IRP(2011);
5 Own estimates

technologies. In addition, activities that can raise external sources of finance and deliver local jobs and potential equity opportunities for previously disadvantaged persons are likely to be prioritized

Ecological and social characteristics

1. *Ecological risk:* The extent to which a project might be exposed to forms of ecological risk, for example, fire, pests and changes in climate.
2. *Ecological infrastructure:* The extent to which a project is expected to contribute to ecosystem services at landscape or catchment spatial scales.
3. *Contribution to social welfare and quality of life:* This rating aligns with the World Bank's Environment Strategy, where improving the quality of life is assessed by the contribution to: a) enhancing livelihoods b) reducing health risks and c) reducing vulnerability to natural hazards.

Contribution to carbon sequestration potential

1. *Potential to store carbon:* The potential to store carbon or reduce GHG emissions based on the results listed in Table 3.1.

Ranking results

Figure 6 illustrates the ranking of the eight proposed implementation opportunities on a five-tiered scale from unfavorable to favorable. The relative rating for each criteria, was determined based on stakeholder input and the team's own expert knowledge. It is important to stress that these are ***relative*** ratings of each activity as compared to the other activities considered, not absolute evaluations. Such analysis would need to be undertaken during the comprehensive assessment of each activity in a subsequent stage of the national carbon sink assessment. Figure 7 provides an illustrative example of the relative ratings of each activity in each of the three principle categories. The closer an activity is to the top-right quadrant (Q1), the better its climatic, ecological and social benefits as well as market-readiness, governance structures and implementation capacity. The size of the colored bubble represents the magnitude of the GHG benefit that could be realized through the implementation of activity – the larger the bubble, the larger the opportunity for sequestering or avoiding the release of greenhouse gas emissions.

Reforestation of thicket and forests is one of the only activities located firmly in the upper right quadrant (Q1), due to reasonable per hectare costs, substantial climatic, social welfare and ecological infrastructure benefits, and the substantial amount of research and development work that has been undertaken to date. To achieve a shift along the vertical axis will require additional government support focused on a more structured, bottom-up approach to identifying and working with landowners to restore and maintain thicket and forests over the long-term. Development of a Programme of Activities (PoA) approach modeled on the CDM guidelines and supported by government may increase the visibility of thicket and forest reforestation in the proposed domestic offset market and provide more certainty to project developers.

The **restoration and management of grasslands** provides substantial opportunity to reduce GHG emissions and sequestrate additional atmospheric carbon dioxide. In addition, it offers opportunities to increase social welfare and improve ecosystem services, especially water services to key economic hubs in the country. However, despite the climatic, social and environmental benefit, this opportunity has a low carbon markets, governance and implementation criteria ranking. This opportunity is not likely to scale independently without a high level of government or institutional support. A pioneering approach outside of the CDM and VCS standards may be required to realize grasslands projects.

Although **commercial small-grower forestry** ranks favorably in both the main categories, it will deliver only minimal increases in the size of the terrestrial carbon sink. This is due to the restricted area in which is can occur – only 60,000ha in the Eastern Cape and 40,000 hectares KwaZulu-Natal.

	Relative rating:	Unfavorable →				Favorable
C. market, implementation and governance measures	**Market Acceptance** Low → High	Biochar Grassland	REDD-plan Agric		Reforestation CommForest	Biomass – Energy Biogas
	Readiness to implement Long-term option → immediate	REDD-plan	Biochar Agric	Grassland	Biogas	Reforestation Biomass-Energy CommForest
	Capital intensity High → Low	Biomass-Energy Biogas Biochar	Agric	CommForest	Reforestation Grasslands	REDD-plan
	Required Government support High → Low	Reforestation Grassland REDD-plan	Agric		CommForest	Biomass-Energy Biogas Biochar
Social and ecological infrastructure measures	**Ecological delivery risk** High → Low		Reforestation	CommForest Biochar Agric	Grassland REDD-plan	Biomass-Energy Biogas
	Contribution to social welfare and quality of life Low → High	Biochar	Biomass-Energy* Biogas* Agric		Reforestation CommForest	REDD-plan Grassland
	Ecological infrastructure Low → High	Biomass-Energy	CommForest Biogas		Biochar Agric	Reforestation Grassland REDD-plan
Climate change	**Impact on national scale sink** Low → High	CommForest	Agric** Biochar**		Grassland Biomass REDD-plan	Reforestation Biogas

*Both biomass to energy and anaerobic biogas digesters have the potential to improve in terms of social benefits if generated electricity serves rural communities and economies directly

**As carbon accumulation rates remain inconclusive for low-tillage systems and biochar use, this estimate is based on the opinion of experts interviewed during the engagement process

KEY

Reforestation: Reforestation of thicket and forests
Grassland: Restoration and management of grasslands
CommForest: Commercial small-grower forestry
Biomass-Energy: Electricity generation using biomass
Biogas: Anaerobic biogas digesters
Biochar: Biochar production and distribution
REDD-plan: REDD+ through planning and regulation
Agric: Improved agricultural practices (principally low till)

Figure 6. *Ranking of principal opportunities: broken down by sub-criteria and ranked from unfavorable to favorable*

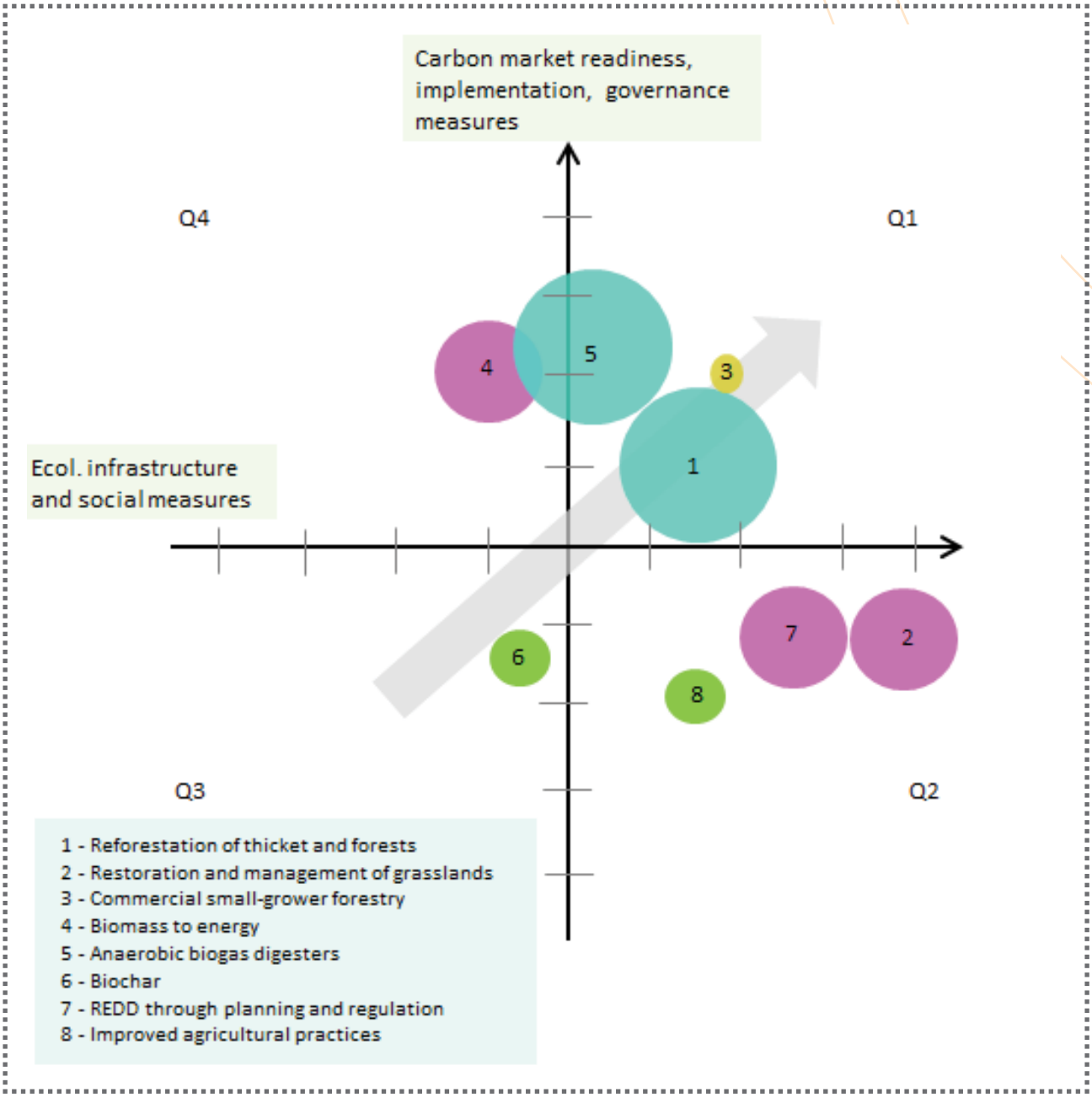

Figure 7. *The relative favorability of each land use based climate change mitigation activity*

Combined, biomass-to-energy and anaerobic biogas digesters could deliver approximately 40% of the total reduction in GHG emissions achievable in the land-use sector (Table 1). In addition, they rank high in the carbon markets, governance and implementation measures, although their social and ecological infrastructure contributions are considered to be limited. These energy projects are considered to have a high level of market readiness and appeal to investors, as they are proven technologies capable of delivering financial return under favorable electricity procurement prices, and would be managed by legally recognized entities. CDM and VCS methodologies exist for these types of initiatives, and there has been strong success in applying them internationally.

To move this opportunity up the vertical axis (markets and governance), government would need to ensure that viable and qualified biomass energy and anaerobic biogas digester projects would be prioritized for inclusion on the national grid. A shift along the horizontal axis (improving ecosystem services and social welfare) could be realized through alignment with the Working for Energy Programme. The creation of local jobs to assist in alien invasive removal would also deliver important contributions to rural economies.

Biochar receives one of the least favorable rankings of the project activities assessed. There are a number of unknowns around the application and climate change mitigation benefits of biochar. Due to the lack of clear understanding of biochar's contribution to carbon sequestration at scale in South Africa, it is unlikely to interest investors. An additional challenge is the current lack of methodologies available for its application through either the VCS or CDM standards. Furthermore, the cost of production, distribution and the potential provenance of the raw materials remain unclear. This casts considerable doubt on this activity's near-term viability. Considerable government support would have to be allocated to biochar to move it up the vertical axis (markets and governance).

During the stakeholder interview process, several individuals from government, the non-profit sector and private sector noted that comprehensive planning, regulation and enforcement could reduce degradation of natural landscapes and deforestation and deliver considerable environmental and social benefits. It is also one of the most cost effective approaches. Like the restoration of grasslands, REDD+ through planning may rate unfavorably under carbon markets, governance and implementation. Part of this is due to the lack of knowledge around the extent of the opportunity. To move REDD Planning and Regulation up the vertical axis would require significant government support.

In a similar manner to biochar, improved tillage systems on a large scale are an untested carbon sequestration approach in South Africa. Comparable to models in the United States and South America, where no-till is commonly used, local farmers have adopted it as a means for reducing soil degradation trends, as well as for its water retention benefits. In this sense it is a purely economic decision, focused on maintaining or enhancing soil productivity. It is assumed that the rollout of a reduced/no till programme would have a moderate adoption rate (20%), covering some 2.9 million hectares. This assumption is supported by a study by Bolliger (2007) on the adoption rates of no-till agricultural systems by smallholder farmers in South Africa, which indicated limited to no uptake of no-till practices despite many public claims to the contrary (Giller et al. 2009).

5. Important insights obtained through the stakeholder engagement process

Over the course of the stakeholder engagement process, a number of themes repeatedly emerged:

1. **The need to balance current top-down approaches with a bottom-up project development.** Stakeholders observed that the current top-down initiatives to land-use management should be complemented by bottom-up development if they are to be sustainable over the long-term. Typical interventions (e.g. tree planting, erosion control), need to be nested within 10-20 year business and land-use management plans if the measures are to permanent over the long-term.
2. **Maintain flexibility in model development and delivery:** Flexibility in the initial design of an implementation is crucial. The land-use domain is spatially diverse in terms of the ecology, systems of tenure, and socio-economic conditions. It is unlikely that a one-size-fits-all, pre-determined implementation model for national rollout will be successful. This is

especially true in areas under communal tenure where implementation models can only be developed once the priorities and preferences of local communities and traditional authorities are understood.

3. **A cost-efficient monitoring, reporting and verification (MRV) system is required.** High monitoring and verification costs were widely identified as a key roadblock to implementation. Further to reporting required by the carbon market, several stakeholders suggested an expanded monitoring program that would include a broader set of biophysical metrics (biomass, water, biodiversity, soil), social welfare measures, as well as operational metrics that would allow Government to improve implementation models over time.
4. **A progressive approach to auditing standards and processes is required.** Linked to the theme above, few of the eight identified activities can be realized at scale within the current constraints of the CDM and VCS standards. A progressive, cost efficient, national scale approach to auditing and incentive mechanisms is required if implementation is to occur at scale.
5. **Expand the focus beyond carbon to consider water, biodiversity, soil and other relevant ecosystem services.** While the development of a national programme focused on land-restoration may initially be based on carbon, stakeholders strongly encouraged the team to focus beyond only the climate benefit to a broader ecological infrastructure approach. For example, the climate change benefit of adopting reduced tillage practices may be marginal but the water, erosion and adaptation benefit is substantial and therefore the opportunity should not be overlooked.
6. **Creation of a clear incentive mechanism for investment in ecological infrastructure.** During the interviews, land-users ranging from municipal staff to private landowners stated that they are unable to commit to land-use activities based on current carbon market conditions. Given the vagaries of the international carbon offsets market, an alternative form of financial incentive is required to support activities, especially implementation at scale over the long-term. Stakeholders within Government indicated that there might be an emerging opportunity linked to the national carbon tax. It is vital that opportunities such as these are explore further to create a clear, long-term financial incentive for appropriate land-use management in South Africa.
7. **Development of primary ecological and economic research.** The majority of stakeholders noted that further primary research is required to support appropriate implementation. Sufficient knowledge exists to initiate activities, but dedicated applied research programs should complement this.

6. Considering each activity in more depth

6.1. Restoring sub-tropical thicket and forests

The opportunity to sequester carbon through the restoration of sub-tropical thicket and coastal forests is relatively well known and understood. To date, a considerable amount of work has been done on the science, implementation and financial aspects of sub-tropical thicket and forest restoration:

- *Sub-tropical thicket:* e.g. Aucamp 1979, Lechmere-Oertel et al. 2005, Marias et al. 2009, Powell 2009, Mills and Cowling 2010, Cowling and Mills 2011.
- *Coastal and scarp forests:* e.g. Wassenaar et al. 2005, Glenday 2007, Geldenhuys 2009, van Rooyen et al. 2012, Adie et al. 2013

Several entities are in the process of attempting to register projects through the VCS or CCBA. The carbon accounting, legislation and methodological issues are therefore relatively well understood. Due to the substantial amount of groundwork that has been done, the restoring of sub-tropical thicket and forests may be one of easiest mitigation activities to rollout in the near term.

Baseline without-activity scenario -

Approximately 4 million hectares of sub-tropical thicket located in the Eastern and Western Cape has been degraded to a certain degree through unsustainable pastoralism over the past century (Lloyd et al 2002). Of this degraded area, approximately 500,000-1,000,000 ha has been identified as suitable for restoration in the near term (Powell *pers comm*).

Additional with-activity scenario -

As sub-tropical thicket does not generally rehabilitate naturally, dedicated planting and long-term management programs are required to re-establish indigenous vegetation. The restoration process and accumulation of biomass and soil organic matter result in carbon sequestration rates of between 1.2-2.4 $tC.ha^{-1}.yr^{-1}$ (Powell 2009). If 500,000-1,000,000ha is suitable for restoration in the near term, assuming a conservative 1.2 $tC.ha^{-1}.yr^{-1}$, restoration would result in an average sequestration rate of 2,200,000-4,400,000tCO_{2e} per year.

Ecological infrastructure and ecosystem services

In addition to rural employment and skill-development opportunities created through the restoration and

management process, local benefits include the restoration of livestock forage and farming industries, nature-based tourism, and the supply of wood, fruit and medicines to local communities for consumption and sale. One of the key benefits is the effect of thicket restoration on water services. Initial research indicates that degraded land results in nearly double the amount of runoff and almost a six-fold increase in sediment load compared to intact thicket.

Implementation Model 1: Private, commercial land: Emerging and established farmers

Typical example – Private land within the sub-tropical thicket biome that was previously heavily degraded through unsustainable livestock management practices.

Long-term planning elements – A 20-30 year business and land-use management plan needs to be created for each farm that includes ecological, financial, livestock management, and capacity requirements.

Implementing agencies – Existing extension officer systems or a new set of extension officers employed by a national implementation agency (Section 6) may need to assist farmers during the planning phase to compile long-term business and land-use management plans. During the initial 1-2 year land restoration phase, national programs, such as the Expanded Public Works Program would play an important role in providing required capacity and expertise.

Implementation Model 2: Government and communal land managed by local municipalities

- *Typical example* - Restoration of forest areas within the eThekwini Municipality through partnerships with local NGOs that specialize in community-based approaches to ecological infrastructure management.
- *Long-term planning elements* – Activities need to be nested within the ecological infrastructure and spatial planning components of local Integrated Development Plans (IDPs). This will ensure that reforestation activities are included in long-term spatial planning and capacity allocations, thereby increasing their permanence over the long-term.
- *Implementing agencies* - Stakeholders noted that if a particular land-use type is to remain in place for at least 20-30 years, it should be included in local long-term planning (IDPs) and at least be overseen and managed by a rural municipality. Implementation on the ground may well happen through local NGOs, which may be the preferred option in the short-term.

Implementation Model 3: Government land managed by conservation authorities

- *Typical example* **-** The restoration of sub-tropical thicket within the Addo Elephant National Park. In this case, the restoration activities form part of the "Working on Land" under the auspices of DEA's Natural Resource Management Program. SANParks is the implementing agency on the ground, ands recruits, trains and supports locally recruited teams to replant thicket.
- *Implementing agencies* - the primary agency is SANParks or the respective provincial conservation authority. In accordance with the "Working on Land" model, implementation on the ground occurs through locally recruited and trained teams.

Monitoring, reporting and verification

Within the sub-tropical thicket biome there are several entities in the advanced stages of validating projects through the VCS. Monitoring, reporting and verification (MRV) methodologies for reforestation activities are therefore well established. The limiting factor is the cost of verification and awareness of the process. For many landowners, emerging and established, the process is often viewed as too uncertain and expensive. A national facility could form an essential role in unlocking the expanded rollout of implementation across the biome.

Employment and skill development

The restoration of ecological infrastructure is proven to be an efficient vehicle through which to create job opportunities in remote rural areas. The EPWP, internal municipal programs and NGOs within the sector (e.g. the Wildlands Conservation Trust) employ a significant number of previously unemployed people. For this reason, many of these initiatives are noted in the President's annual State of the Nation Address and receive growing support from government.

Potential demonstration projects

- *Subtropical-thicket:* The greater Addo and Fish River area in the Eastern Cape. There are several early initiatives already underway in the Eastern Cape, which should be expanded and built upon. Researchers based at Rhodes University have undertaken the identification and mapping of an initial set of sites.
- *Woodland:* The EPWP has initial projects in the Bushbuck Ridge and Sekhukhuneland areas. These could be built upon and form good demonstration sites.

ACTIVITY SUMMARY

Key Positives	• High annual carbon sequestration potential per hectare • Combats soil erosion through improved root systems • Substantial rural employment and livelihood benefits • A relatively low risk carbon sequestration option • Availability of approved methodologies to support early roll-out
Key Trade-Offs and Concerns	• Implementation in communal areas may require a new, progressive approach to incentives and disbursements

6.2. Restoration and management of grasslands

Due to the international focus on REDD+ and forests, the opportunity for climate change mitigation within the grassland biome is often underestimated. Yet in South Africa, appropriate grassland management may be one of the principle climate change mitigation and adaptation activities within the land-use sector (Table 3.1, Figure 4.2). Grassland and rangeland ecosystems are often overlooked due to the majority of the carbon being located belowground (95% of total carbon pool).

Two primary mitigation activities are considered within the grassland biome:
Carbon sequestration through grassland restoration and long-term management
Reducing the degradation of grasslands and release of soil carbon into the atmosphere

Baseline without-activity scenario

- *Grassland restoration and long-term management:* The ploughing and turnover of soil leads to the release of soil organic carbon into the atmosphere. Overgrazing and the degradation of the herbaceous layer can also lead to a substantial loss of carbon, but over a longer period of time.
- *Reducing the degradation of grasslands:* Interviewed experts within academia, government and NGOs noted clear increases in the spatial extent of degraded grassland and erosion gullies in their focus areas. It was further noted that unless new measures are introduced, the trend would continue over time and may even increase in speed as drivers of degradation become more widespread and intense.

Additional with-activity scenario

- *Grassland restoration and long-term management:* The restoration of grassland requires a comprehensive set of complimentary measures that may include a reduction in grazing pressure, physical replanting and rehabilitation, together with erosion control measures.
- In dry grasslands, a conservative carbon sequestration rate of 0.5tC.ha^{-1}.yr^{-1} can be assumed. Sequestration in moister, mesic grasslands is more rapid due to higher productivity and cooler temperatures (0.7-1.0tC.ha^{-1}.yr). If restoration were to be rolled out across the 1.2 Million hectares, it would lead to the sequestration of approximately 2.3 Million tC per year.
- *Reducing the degradation of grasslands:* Depending on the driver of degradation (ploughing, overgrazing, erosion), the rate of release can either be rapid, over the period of a few years, or a gradual decrease through leaching over a much longer period. For planning purposes a conservative release rate of 1.0tC.ha^{-1}.yr^{-1} can be assumed (Table 3.1).

Ecological infrastructure and ecosystem services

The grasslands of South Africa provide a wealth of ecosystem services to both local communities as well as regional urban and industrial centers. For this reason, the restoration and long-term appropriate management of grasslands is highlighted as a key intervention in the proposed 19th Strategic Integrated Project (SIP 19) focused on ecological infrastructure for water security. At a local scale, grasslands are the second most biodiversity rich biome in the country (after the Fynbos biomes) and provide local communities and commercial farmers with water services, productive grazing land and support an active tourism industry. At a national scale, intact ecological infrastructure within the grassland biome is viewed as an integral part of long-term national development and resilience to climate change (LTAS, DEA 2013).

Implementation Model 1: Private, commercial land: Emerging and established farmers

- *Typical example* – Either a private farm that has been heavily degraded and needs to be restored or a farm that is ecologically intact where the intention is to incentivize the landowner to maintain ecological infrastructure.
- *Long-term planning elements* - There is a substantial number of established and emerging farmers who require assistance in developing 20-30 year land management plans that focus both on veld condition and ecological infrastructure as well as commercial viability. There is considerable scope to entrench the maintenance of ecological infrastructure as part of long-term planning, with associated incentives providing a baseline source of revenue that is independent for customary agriculture commodity markets.
- *Implementing agencies* – The primary implementer is the landowner and associated staff. In certain circumstances, especially during an initial 1-2 year land restoration phase, a farmer may need additional capacity that could be provided by EPWP or provincial conservation authorities.

Implementation Model 2: Government and communal land managed by local municipalities and conservation authorities

- *Typical example* – Areas under communal land-tenure within the greater Drakensburg area or municipal land within the eThekwini Metropolitan and Umgungundlovu District Municipalities. Within these areas there is a broad diversity of land-use types and governance structures that requires flexibility in implementation models and incentive mechanisms.
- *Long-term planning elements* – Interviewed stakeholders were quick to highlight the need for expanded land-use planning in each municipal and communal area prior to implementation. It was

strongly emphasized that a more 'bottom-up' approach is required, where long-term land-use plans are developed through a truly participatory manner, prior to roll-out of activities.

- *Implementing agencies* – Implementation on the ground could potentially occur through municipal capacity, provincial conservation organizations, the Expanded Public Works Program, community organizations, NGOs or the private sector. For example, eThekwini Municipality currently implements grassland and forest management measures through their own internal capacity as well as through Working on Fire (EPWP), Working for Ecosystems (WESSA -NGO) and the Wildlands Conservation Trust (NGO). Contracting external entities allows the municipality to use existing capacity and expertise, and allows for more flexibility over time as implementation needs may change. This approach should not, however, undermine the need for a core of expertise within municipalities and regional Government that coordinates matters.

Monitoring, reporting and verification

The high cost of quantifying changes in soil carbon stocks using the methods stipulated by the CDM or VCS, is one of the key reasons why the rollout of activities has been inhibited to date. If grassland management is to be pursued as a mitigation option within a national program, particular attention will need to be paid to developing a progressive monitoring, reporting and verification system.

Employment and skill development

The restoration of ecological infrastructure is an efficient vehicle through which to create employment and skill development opportunities in rural areas. This is particularly important in the remote areas of the Eastern Cape, KwaZulu-Natal, Free State and Northern Cape where additional grassland management measures are urgently required.

Risk considerations

As 95% of the terrestrial carbon stock in grasslands is located in the belowground soil carbon pool, there is little exposure to fire and many risk factors traditionally associated with land-use based climate change mitigation activities.

ACTIVITY SUMMARY

Key Positives	• The opportunity to restore 1.2 Million hectares of potentially productive grazing land • The provision of water services to key economic hubs in a cost-effective manner • Cost-effective adaptation to predicted climate change • Substantial rural employment and livelihood benefits • A relatively low risk carbon sequestration option
Key Trade-Offs and Concerns	• Implementation in communal areas may require substantial time to develop • A new form of monitoring, reporting and verification system will need to be pioneered.

6.3. Commercial small-grower afforestation

In the interests of creating rural jobs and economic activity, Government has proposed the expansion of small-grower forestry in areas of the Eastern Cape and KwaZulu-Natal, where there is sufficient water within catchments to accommodate plantations without significantly affecting base flows. Furthermore, if this is undertaken in areas that have been previously degraded, ploughed or have limited biodiversity, commercial small-grower forestry can be a long-term viable vehicle for providing rural jobs and income streams.

Implementation model: form and agencies

A review of existing literature and interviews with industry, have indicated that is approximately 60,000ha in the Eastern Cape and 40,000ha in KwaZulu-Natal that is suitable for afforestation activities. Since much of the proposed expansion of forestry in South Africa is on communal land under local tribal authority or on private farms that have recently been redistributed to emerging farmers, commercial forestry companies have proposed a community partnership model. In this model, ownership of the forest continues to reside with the community, while the forestry company initially provides seedlings, and then advisory and fire management services over the rotation period of the forest.

Extent and potential to scale-up

The availability of suitable land that meets required water and biodiversity regulations is a clear constraint on the potential to expand this activity. Although government policy has proposed expansion across 100,000 ha in the Eastern Cape, forestry companies engaged during the stakeholder engagement process objected that this goal might be too optimistic. The amount of land that meets required water regulation, biodiversity, and EIA requirements may only amount to 60,000 ha in the Eastern Cape and 40,000 ha in KwaZulu-Natal (Chamberlain et al. 2005). An additional 100,000 ha nationally should therefore be seen as the upper-bound of the scaling up potential.

Cost of implementation

Eucalyptus plantations, grown for pulp, are typically turned over on a 7-8 year cycle. At the start of the cycle, it costs ZAR 2,500ha^{-1} for seedlings, and ZAR 1,500 ha^{-1} for land preparation and weeding. Together with fire and forest management costs over eight years (which is undertaken

by the community), the typical cost at rotation age is ZAR 9,000-12,000 ha^{-1}.

Incentive mechanisms and disbursements

At the end of a Eucalyptus rotation, the community is paid between ZAR 220 and 250 per ton of pulpwood, which equates to approximately ZAR 28,000 per hectare. However, upfront costs and accrued interest on those costs need to be subtracted from this amount. The industry highlighted this as a key area where government could provide catalytic support by assisting communities with favorable terms on these loan amounts. For emerging farmers and communities, this model provides an opportunity to produce a commodity and generate income at relatively low-risk and capital outlay, while leveraging the capacity and expertise of established industry.

Monitoring, reporting and verification

There are a significant number of established afforestation/ reforestation projects around the world that have been validated and verified either through the CDM or VCS standards. There are thus a rich set of MRV methodologies in existence, with associated protocols and processes. At the same time, the commercial forestry companies concerned have extensive internal reporting structures that can be leveraged to supply operational, biophysical and spatial data.

Employment and skill development

The implementation of a community-based pulp production model provides employment and revenue streams not only to rural communities and emerging farmers who have recently acquired land, but to other individuals within the logistics, milling and delivery functions of the value chain.

Ecological infrastructure and ecosystem services

There are well-founded concerns regarding the water, biodiversity and soil impacts of commercial plantations, including the spread of exotic trees from the initial site of the plantation. For this reason, forestry companies must clearly document the net effect of a plantation on base water flow (in order to obtain a water license) and are required to undertake a full EIA for each plantation.

Risk considerations

The entire project process, from the choice of species and planting regimes, to the day to day management of the forest, to the harvesting, transporting, processing and sale of the pulp is well known and understood. However, there are particular risk elements, such as the establishment of a plantation in grassland systems marked by high rates of fire. Engagement with industry indicated that fire risk is actively managed, is within acceptable levels, and should not be viewed as an inhibitory factor to implementation.

Potential demonstration projects

Industry has identified 60,000 ha of potential land for commercial plantation use in the Eastern Cape and 40,000 ha in KwaZulu- Natal. Industry identified three potential bottlenecks for the realization of these demonstration projects. The first is the high interest rates on loan amounts to communities, which reduce the attractiveness of forestry projects. Road infrastructure was identified as a second impediment, the provision of which would not only facilitate transport of pulpwood, but also for development of the region generally. A third obstacle noted by stakeholders was the long time lags between application for EIA and water permits, and delivery of final approvals.

ACTIVITY SUMMARY

Key Positives	• A tested model that allows communities and emerging farmers to leverage the capacity and expertise of the commercial forestry industry, while fundamentally owning the project • Provision of a fairly low-risk income stream to communities and emerging farmers • Provision of jobs and skill development opportunities in remote areas of South Africa,
Key Trade-Offs and Concerns	• The impact of commercial forestry on water and biodiversity is a well-founded concern and it needs to be ensured that established guidelines are adhered to throughout the implementation process. • There is clear concern that exotic trees may spread from the initial plantation sites. • High retail interest rates will have an inhibitory impact on the financial viability of the plantation opportunity. A key catalytic intervention would be the provision of favorable loans to the smallholder industry.

6.4. Anaerobic biogas digesters

Anaerobic biogas digesters are fermentation tanks or sealed ponds in which biodegradable material ferments anaerobically, generating a composite gas of which methane is the most abundant. Methane is a greenhouse gas with a global warming potential 23 times that of CO_2. There are thus considerable benefits in reducing the release of gasses from biodegradable fermentation processes into the atmosphere. The benefits are at least three-fold:

- Biodegradable material suitable for biogas digesters, such as cow manure, will ferment aerobically unless they are placed in a digester. This means that valuable methane is lost to the atmosphere. A digester on the other hand would capture methane and reduce the uncontrolled release of methane into the atmosphere;
- Methane is combustible and when captured in a digester can be used either to power a biogas generator generating electricity, or for thermal applications like cooking, reducing the need for fossil fuel-based power; and

- When methane is combusted it emits CO_2 with a global heating potential 23 times less than if emitted otherwise.

Implementation model

Biogas digesters can be installed by:

- Virtually anybody as it is a relatively simple, do-it-yourself- type technology, or
- By small contractors who specializes in the construction of digesters, or
- By large engineering firms/outlets.

The level of technical capacity required is determined by the scale or size of the digester. Household-level units can be constructed either by the owners themselves or by small contractors. Large industrial and/or agriculture applications require special design features that makes engineering firms or the like better suited for the task.

Extent and potential to scale-up

In 2008, a national feasibility assessment of biogas in South Africa (Austin and Blignaut 2008) estimated that 310,000 rural households are eligible for biogas digesters by virtue of not having access to grid-based electricity, but having access to grey water and manure. Austin and Blignaut (2008) estimated the potential of agriculture-based biogas digesters based on the published number of cattle, sheep, pigs and poultry in the country, producing more than 156,000 tonnes of manure a day. The total power generation capacity of the methane gas, if between 25% and 50% of this manure is captured, is 280MW (for communal areas), and about 1,100MW for all animal-based agriculture operations.

Cost of implementation

Biogas digesters are capital and labour intensive to establish, but their operation and maintenance cost is insignificant as it essentially comprises the collection/ removal of manure and the feeding of the digesters. In areas where people depend on fuel wood for cooking, lighting and heating and where their waste is not managed by municipalities, digesters save time and energy. Household digesters can cost between R15,000 and R35,000 for a $6m^3$ unit, depending on whether it is self-built or installed by a professional. Large-scale digesters cost between R2million for a $500m^3$ fixed-dome digester and R5million for a $1000m^3$ continuous stirred-tank reactor digester.

Monitoring, reporting and verification

Calculation of baseline emissions and the determination of additionality as a result of the implementation of the technology are relatively straightforward. Both the CDM and VCS provide methodologies that project developers could adopt.

Employment and skill development

There is significant scope for the development of an entirely new economic activity in the construction sector as this technology is in its infancy and there are only a few applications of it to date in South Africa.

Ecological infrastructure and ecosystem services

In addition to the obvious carbon mitigation benefits, the introduction of biogas digesters will assist greatly in the management of waste. If designed appropriately, digesters will improve water quality by reducing the pollutants from dispersed sources into water bodies as digesters reduce the biological oxygen demand loads in effluent by up to 90%.

Risk considerations

In urban areas, the water effluent from digesters could contaminate and/or mix with the sewer system. This should be avoided. While human waste can be used in digesters to generate methane gas, it is not advisable to use the resultant effluent as fertilizer on vegetables. Since digesters operate at about 40^oC and blood and traces thereof are only sterilized at approximately 80^0C, such fertilizer could increase the risk of human-to-human disease transfer.

Potential demonstration projects

There are several digesters in operation in South Africa, such as in villages near Giyani, a few in Pretoria and its outskirts, Johannesburg, Richmond near Durban, and Cape Town, as well as on farms. During the stakeholder engagement process in KwaZulu-Natal, the uMgungundlovu District Municipality highlighted a substantial source of livestock manure and food waste in Estcourt, Midmar, Thornville, Albert Falls, Kamberg and the District Municipalities' urban centre. These six opportunities for anaerobic biogas production included piggeries, poultry farms, cattle feedlots/ abattoirs, and urban food waste streams. The Municipality noted that, if adopted in full, their digesters would produce 43.3 MWe.

ACTIVITY SUMMARY

Key Positives	• Easy to implement and to maintain with direct benefits to people and the environment • Easy to monitor and well-established and relatively simple CO_2 baseline methodologies • Significant employment creation potential
Key Trade-Offs and Concerns	• Capital intensive • Potential skepticism of the use and/or introduction of a new technology

6.5. Biochar production and application

Biochar is a partially combusted form of charcoal, produced through the process of pyrolysis using organic materials such as vegetation waste, crop residues and woody biomass such as timber harvest wastes or alien invasive species. It is a carbon-rich material that can be mixed into the soils of agricultural or other lands for the purpose of increasing soil-carbon; it may also improve crop yields in previously degraded or sandy soils. Due to its strong binding effects, it is believed that biochar reduces fertilizer run-off, decreasing the net total farm needs for fertilizer, a significant cost-savings to farmers.

There are avid proponents and numerous skeptics of biochar. During the engagement phase, several stakeholders noted their concern over the enthusiasm and support it receives, despite the lack of clear scientific evidence demonstrating its carbon sequestration potential in South Africa. This absence of scientific analysis makes it very difficult to determine the extent to which this is a locally viable opportunity.

Baseline compared to with-project scenarios

Under a "without project scenario" it is assumed that the rate of carbon loss from soils will continue unabated. Under the "additional, with project scenario" it is possible that the rate of soil carbon loss would be reduced, abated or reversed with biochar amendment to soils. Added to this is the "avoided decomposition" of biomass stocks used in the pyrolysis process, which are assumed to otherwise release emissions as they break down through normal organic processes. No in-depth analysis of the spatial extent and carbon sequestration capacity of biochar amendment in South Africa currently exists. However, in the interest of providing an initial, rough estimate, it is reasonable to assume that biochar use could conservatively apply to approximately 700,000 ha (penetration fraction of 5% of agricultural lands), with an annual carbon sequestration rate of approximately 0.3 $tC.ha^{-1}.yr^{-1}$ or 641, 667 $tCO2e.yr^{-1}$ across the 700,000ha. A concern is the GHG emissions generated through the biochar production and distribution processes. Both the supply chain and pyrolysis methods need to be assessed carefully in a South African context.

Implementation model: form and agencies

Stakeholders identified two potential approaches. In the first approach, independent, commercial producers would manufacture biochar and oversee its delivery to interested end-users, such as commercial and small-scale farmers, or persons responsible for mine rehabilitation. In a second model, the EPWP would establish teams to remove alien invasives. The vegetation waste could either be transported to a central depot for biochar production, or combusted through the use of a mobile technology. The biochar could be sold at cost or subsidized for distribution amongst local, rural households practicing subsistence agriculture.

Cost of implementation

The cost of implementation is not well known. Since a moderately sophisticated supply chain is required – the collection of waste material, the combustion of waste in a controlled environment, the packaging, distribution and application of biochar in appropriate landscapes and soil types – it is assumed that this will not be one of the more affordable implementation activities. Sparrevik et al. (2013) note that advanced kiln technologies are the preferred pyrolysis device but these come at a higher cost. More crude, inexpensive kilns can be used for pyrolysis, such as earth-mound kilns traditionally employed across Africa for charcoal production (Sparrevik et al. 2013). However, the relative inefficiency of these kilns and associated GHG emissions, the quantity of greenhouse gases, particulate matter, and volatile organic compounds they release are not suitable for a national-level climate change mitigation initiative (Sparrevick et al. 2013). The costs of transportation are one of the most important factors in assessing the viability of a project.

Monitoring, reporting and verification

Directly monitoring changes in soil carbon stocks, especially at large scales, can be prohibitively expensive. This is one of the principle reasons for the limited uptake of activities that sequester soil carbon through the CDM or VCS, as the costs of quantifying changes in the soil carbon stocks is potentially more expensive than revenues that can be derived from the sale of offsets. However, if one were to step back from the CDM or VCS frameworks, a new approach can be taken, for example activity-based monitoring could be adopted instead of a carbon-stock based approach.

Employment and skill development

Employment could be generated from the harvesting of alien invasive species or the collection of other biomass waste resources required for pyrolysis (could be linked to the EPWP programme). Moreover, jobs at kiln production sites to manage the sorting and drying of biomass materials, to oversee the pyrolysis process, to maintain inventory and prepare shipments, and to oversee sales would be required. The biochar production and distribution network would likely lend itself to the establishment of small and medium enterprises (SMEs), many of which could be based in rural areas.

Ecological Infrastructure and Ecosystem Services

The removal of alien invasive species to supply biochar production will provide a significant ecological infrastructure benefit, notably in protecting important water catchments. The application of biochar, if proven effective in improving carbon absorption rates, should lead to improved soil nutrient density, water retention capacity, and limits to fertilizer run-off.

Risk Considerations

The unsustainable collection of feedstocks, through improper land-clearing practices or the allocation of high-production agricultural lands for the production of feedstocks, represents a risk in pursuing a national-level biochar programme.

ACTIVITY SUMMARY	
Key Positives	• Potential to contribute to climate change adaptation and mitigation through improved soil water retention, fertility and carbon sequestration • Potential improvements to subsistence farmer crop yields and rural food security • Means for adding further value to the alien invasives removal programme • Potential means of rehabilitating degraded soils
Key Trade-Offs and Concerns	• Limited understanding of the carbon mitigation benefits under South African conditions • Potentially prohibitive costs structure, which would have to be subsidized by government • Unclear level of potential uptake by commercial, emerging and subsistence farmers • Expensive, sophisticated biochar production technologies deliver the best health and greenhouse gas reduction outcomes, but require greater upfront capital cost

6.6. Reduced Emissions from Degradation and Deforestation (REDD) through Planning and Regulation

Conventionally, activities aimed at Reducing Emissions from Degradation and Deforestation (REDD) are primarily limited to forest ecosystems. For instance, UNREDD programmes in the Democratic Republic of Congo, Tanzania and elsewhere typically focus on halting the deforestation of large tracts of tropical forest or tall miombo woodlands. In a South African context, there is limited opportunity for this classical interpretation of REDD since most deforestation happened decades ago. In the context of the National Carbon Sinks Assessment, we have adopted a broader approach to REDD by including the reduction in degradation of all terrestrial ecosystems, be it grasslands, savannas, woodlands, fynbos, thicket and so forth.

During the course of the stakeholder engagement, numerous implementers – agricultural extension officers, academia, NGOs, municipalities and government – noted that landscape degradation of certain biomes in South Africa is still continuing due to a lack of local and regional planning and questionable regulatory practices. In terms of the potential climatic benefit, assuming a minimum degradation rate of 0.1% per year, a mean national carbon stock of 58 $tC.ha^{-1}$ and a 50% loss of above and below-ground carbon stocks in a degraded state, it is possible to avoid the release of 13 million tonnes of C02e per annum across the country.

Under the "**without project scenario**" it is expected that unchecked degradation of natural landscapes will continue in South Africa. For the purpose of describing the baseline, it is assumed that degradation is taking place, and that this degradation is not officially mandated but is rather the consequence of limited enforcement and local government oversight of the use of natural resources. Under the "**additional with-project scenario**", the degradation of critical above and below-ground carbon stocks would be avoided through rigorous application of environmental planning and regulations.

Implementation model: form and agencies

The planning and regulatory function needs to originate from government. At the local level, municipalities have a significant role to play in land-use planning functions through the annual release of an IDP. IDPs are to align with national level, binding policies, such as NEMA, and require that an environmental analysis be undertaken. This represents a critical opportunity for assessing current natural resource use at the municipal level, identifying thresholds for exploitation, and capacitating staff to enforce planning principles and objectives. These can align with Bioregional Plans and Environmental Management Frameworks, and can help inform the approval of EIAs, water permits, agricultural licenses and other activities impacting on the land-use sector.

Cost of implementation

Due to the progressive nature of this opportunity, there are no empirical examples on which to base a cost estimate. REDD planning and regulation would be implemented through existing institutions, and could leverage current budgets. But pursuing REDD Planning and Regulation would require a marginal increase in budget allocation in order to improve environmental planning functions at the local, provincial and national scales. Further funds likely need to be devoted to increasing the number of staff dedicated to ensuring legal compliance with policy and associated monitoring needs.

Monitoring, reporting and verification

As this is a progressive, blue-sky opportunity, a new MPV system would need to be created that adequately identifies a business-as-usual and additionality scenarios. An adequate MRV system would need to quantify the net effect of the planning process on carbon stock and associated GHG emissions.

Employment and skill development

It is anticipated that capacity within local and rural municipalities would need to be increased marginally. This will provide long-term job opportunities for skilled individuals in government. Compared to other mitigation

activities that require active restoration and field activities, required capacity for the implication of REDD planning and regulation is expected to be far less.

Ecological Infrastructure and Ecosystem Services

REDD Planning and Regulation could form the broad planning foundation for ecological infrastructure management at a national scale, with the potential to deliver a substantial set of ecosystem goods and services over the long-term. This set would include: climate regulation, soil erosion prevention, habitat protection, medicinal plant protection, water catchment improvements and maintenance, stream flow improvements, soil nutrient and health improvements, biodiversity conservation, pollination services, and feedstock and fodder provision.

Risk Considerations

In terms of risk, a key consideration is the concept of reversibility. In order to manage this, one needs long-term, consistent planning priorities to ensure that the protection of ecological infrastructure is firmly entrenched in planning-related policies.

Potential Demonstration Projects

The intention would be to identify 2-3 rural municipalities in the country that cover a variety of land-use types, land-use drivers, land tenure systems, and biomes that will provide valuable lessons that are indicative and useful for the remainder of the country.

ACTIVITY SUMMARY

Key Positives	• Relatively cost-effective implementation with substantial ecosystem benefits and alignment with climate change adaptation priorities. • Potential to be one of the principle land-based climate change mitigation activities in the country. • Opportunity to create a framework for national ecological infrastructure planning across the entire country.
Key Trade-Offs and Concerns	• Improved planning and application of regulations for the protection of ecosystems is not currently compatible with CDM / VCS standards. • While potentially the most significant activity, it is a longer-term option, which requires new investment. In particular, considerable skills-development, training, and oversight would be required to ensure that government employees are properly capacitated to undertake enhanced planning and regulatory functions. • This is a novel concept, which requires the development of an entire concept from base principles, including implementation, an MRV system, and disbursements. While there are lessons that can be learned from related initiatives abroad, the MRV component would notably have to be developed afresh.

6.7. Reduced Tillage

As reported in the first phase of the National Carbon Sink Assessment, over 95% of the terrestrial carbon stock in grassland and savanna systems is located belowground, in the form of soil organic carbon – essentially the dark, organic matter in soil. Being below-ground, it forms a long-term, stable pool that contributes significantly to soil quality. It can, however, be rapidly released into the atmosphere through the process of ploughing, as soils are turned over and the carbon is exposed to the atmosphere. Together with this substantial release of carbon from the top 30 centimeters, there is also the loss of additional benefits that organic matter provides, in terms of soil nutrient, water retention and so forth. For this reason, much global attention has been paid to the possibility of reducing tillage, more as an exercise to protect soil fertility and health than a pure climate change mitigation activity.

Conservation or reduced tillage can generally be defined as any tillage technique (no-tillage, direct drilling, minimum tillage and/or ridge tillage) that leaves sufficient biomass residue in place to cover a minimum of 30% of the soil surface after planting. The net carbon sequestration benefit of reduced tillage may have initially been overestimated, and several recent studies (e.g. Loke et al. 2012, Baker et al. 2007) suggest that the net effect throughout the soil profile, down to 1 meter, may be lower than first anticipated. For this study, we have therefore taken a conservative approach, and estimated the net sequestration rate to be 0.1 $tC.ha^{-1}.yr^{-1}$ (Table 3.1). In terms of the potential future spatial extent of implementation in South Africa, it is conservatively assumed that reduced tillage practices could be adopted on 20% of South Africa's arable land in future.

Implementation model: form and agencies

Reduced tillage requires farmers to halt current ploughing, fertilization and planting practices, and to adopt a new suite of planting and pest control measures. The concept is relatively well-known in South Africa, to the extent that there are no-till "clubs" in certain provinces. The majority of the winter wheat area in the South Western Cape has also already adopted reduced tillage practices. A National Facilitation Unit could expand such measures, providing additional outreach and awareness services to farmers. It should be noted that substantial additional research is required into the net climate regulation impact of reduced tillage across the full range of South African soils and commodity types.

Cost of implementation

Interviewed stakeholders noted that the overall costs of reduced tilling, adjusting for initial changes in fertilizer, tractor and herbicide usage, should remain roughly the same as traditional farming practices over the course of several years. While labour and fuel costs are expected to decline as tillage is reduced, there is likely to be an equal increase in herbicide and equipment costs.

Monitoring, reporting and verification

Monitoring changes in soil carbon stocks across diverse landscapes can be prohibitively expensive. One of the reasons why there has been a subdued roll-out of climate change mitigation activities that focus on soil carbon stocks is due to the cost of implementation exceeding revenue from carbon offset sales. For this reason, an innovative, progressive monitoring approach will need to be pioneered for South Africa in which activity-based monitoring instead of carbon stock-based monitoring could be used.

Employment and skill development

Reduced/no tillage improves farming skills as farmers need to adopt various new pest and weed management strategies, including biological, physical and chemical measures to reduce the use of herbicides. The net impact on employment is unlikely to change.

Ecological infrastructure and ecosystem services

Reduced/no tillage systems can improve water infiltration, increase soil moisture and reduce runoff and water contamination as well as improve soil quality, reduce erosion and compaction, and increase surface soil organic matter. The water and soil quality and erosion benefits are often the primary reason for the adoption of reduced tillage systems, with carbon sequestration viewed as a marginal side benefit.

Risk considerations

As noted, an intact below-ground carbon pool is not exposed to typical risks associated with the land-use sector, such as fire and pests, being relatively stable over the long-term. The key risk is that the farmer may decide to return to or adopt traditional ploughing techniques.

Potential demonstration projects

As noted, there are substantial areas in certain provinces that are already under no till. Interviewed stakeholders advise that these be used as demonstration projects, on which to expand research and develop concepts for enhanced roll-out and adoption.

ACTIVITY SUMMARY

Key Positives	• A climate change adaptation measure; • Energy and labour across the total production process can be reduced; • Less amounts of fertilisers used and lower production costs; • Increases crop productivity; • Maintenance or increase in soil organic matter content (enhanced soil quality); • Soil improvement (chemical, physical and biological characteristics); no-tilled soils tend to be cooler than others, partly because a surface layer of plant residues is present. Carbon is sequestered in the soil enhancing its quality, reducing the threat of global warming; • Reduction in wind and water erosion; • Increased water infiltration into the soil and increased soil moisture.
Key Trade-Offs and Concerns	• Herbicides must be used often, but risks being overexploited and used in excessive volumes. Application of herbicides is critical in cases where the farmer does not plough or till to control weeds and grasses.

7. Providing required support for implementation

During the stakeholder engagement process, participants were asked what barriers exist to implementation, what is required to unlock projects, what capacity is needed and so forth. An almost universal response is that there is a clear need for a “national facilitation unit” (NFU) that would facilitate and support implementation. Its role would range from the initial creation of awareness of opportunities, to extension and support services, to the cost-efficient monitoring, reporting and verification of generated emission reductions, as well as the creation of cost-effective and dependable incentive mechanisms.

Stakeholders were also asked what principles should inform a national scale programme and associated strategy. The initial set included efficiency, robustness, and transparency, which are fairly common principles in the general global discourse relating to climate change mitigation frameworks. In addition to these more general principles, a set of more South African specific principles and concerns were raised. These focused on the need

for the principle of inclusivity, where including emerging farmers and communal areas would be a priority regardless of immediate cost efficiencies. Another principle raised by South African stakeholders was the need to focus beyond the carbon benefit, to greater set of socio-economic and environmental benefits. In this case, while some activities may not deliver a substantial carbon dividend, it may still be appropriate to pursue them if the ecological infrastructure (water) and social benefits (employment) are substantial.

Key elements of required support

Informed by this set of principles, stakeholders suggested a set of elements that need to be undertaken to realize the full opportunity at a national scale. These included the typical components of a carbon project supply chain:

- Implementation on the ground
- Monitoring, reporting and verification
- Marketing and buyer-engagement, and disbursement of payments for qualified offsets

Stakeholders also included a broader suite of elements, which ensures that the programme is inclusive and that the full opportunity is realized at a national scale. These elements include:

- Awareness and support services
- A cost efficient national MRV system
- Research and strategy development
- Funds and disbursement management
- Integration with policy and regional planning
- The need for a champion and substantial operational capacity
- Third party accreditation

A potential institutional structure for a national programme

(Our intention here is to describe the roles and functions of potential national framework, but not to identify where the entity should be located in government or a parastatal).

Following a comprehensive review of required tasks and roles, as well as consideration of the guiding principles proposed by stakeholders, a two-tier structure is suggested (Fig. 8). The first is the "national facilitation unit", which would provide overriding strategic direction, support and governance at a national scale. At an elementary level, it is anticipated that the NFU would include a Chief Director and Operating Officer as well as directors of procurement, accounting and scientific services. The second is the establishment of a "Centre of Development" for each of the principal climate change mitigation opportunities that would focus solely on supporting the roll-out of a particular activity in terms of local planning support, awareness creation, extension services to communities and farmers, as well as research needs particular to the activity.

As there is understandable caution about starting new institutions, the intention would be to start with a small 4-6 person team that would initiate the NFU and focus on removing the key barriers-to-entry that are currently inhibiting the top 3-4 most promising land-use based mitigation opportunities. Thereafter, the intention would be to gradually increase the size of the unit based on needs and full comprehensive assessments of the remaining climate change mitigation activities.

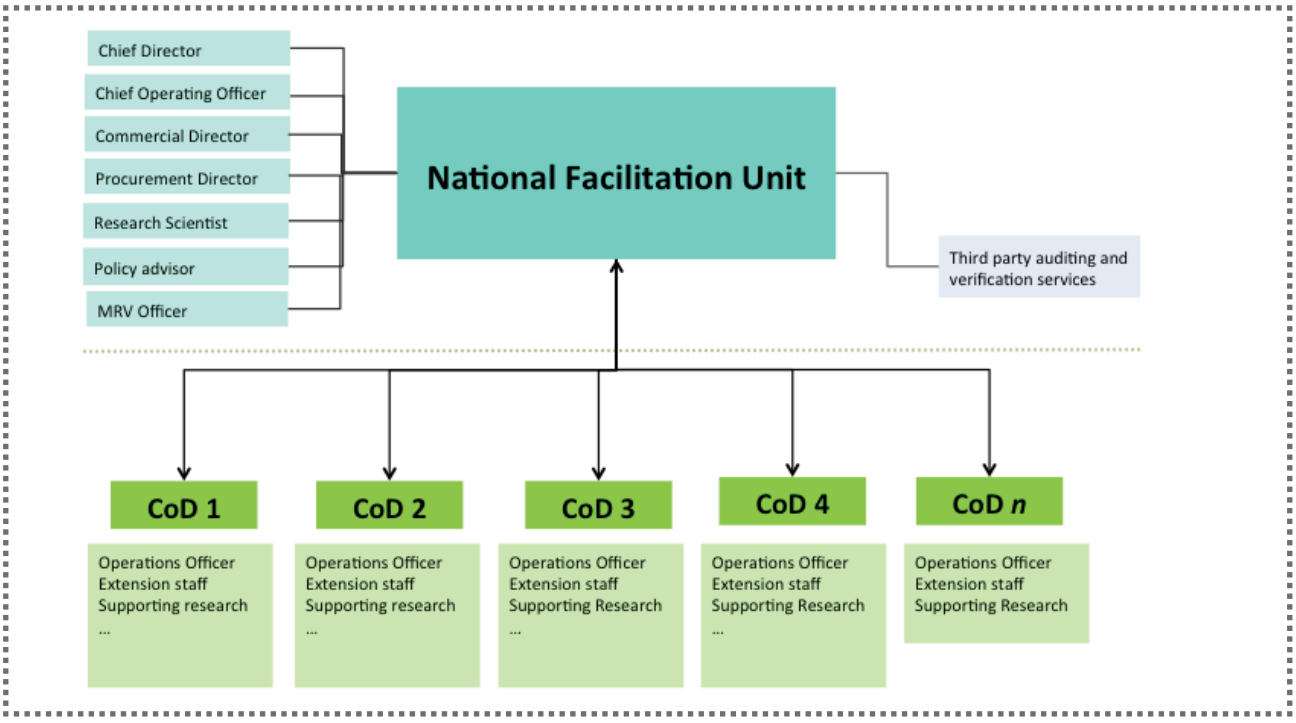

Figure 8. *Suggested organizational structure for a National Facilitation Unit and its Centres of Development*

Required functions and the suggested location thereof

- ***Awareness and support services**:* A pervasive issue continually raised by almost all practitioners, is that there is currently very little awareness of the opportunity on the ground. In addition, there is an important need to take a more balanced bottom-up approach through the development of long-term, comprehensive land-use and business plans that enable communities and land-owners to manage an area of land in a financially feasible manner over 20-30 years. It is anticipated that each CoD will provide a form of extension and support service.
- ***A cost efficient national MRV system:*** One of the main obstacles to the roll-out of projects to date has been the high transaction costs incurred associated with MRV through international standards. To address this, a robust, transparent and affordable MRV system will need to be created for each of the identified implementation options. These MRV structures should dovetail with the national MRV programme currently being developed by DEA, and support existing capacity where possible.
- ***Research development:*** Practitioners noted that despite early successes, there is a crucial need for further research into the ecological, operational and monitoring elements of implementation.
- ***Strategy development:*** It is anticipated that two broad levels of strategy development are required. The first level focuses on the long-term vision of the programme and roll-out, and strategic alignment with other government programmes, ecological infrastructure and development efforts, and government policies and priorities. The second level of strategy development focuses on the realization of this vision, and how to strategically entrench that vision in a long-term roll-out plan.
- ***Income creation and management:*** An entity is required to manage the trade of generated emissions reductions that are generated from the entire programme, as well as to secure additional, alternative sources of revenue, for example payment for other ecosystem services (water), bilateral funding, disbursements from the national fiscus, accessing new international payment systems for climate change mitigation (Nationally Appropriate Mitigation Action - NAMAs), and government grants.
- ***Incentive mechanisms and disbursements:*** Once income is secured, an effective, cost-efficient, yet flexible disbursement and incentive mechanism is required. An entity is required to manage the cost-efficient and effective disbursement of generated income to implementation agents on the ground and to cover the operational costs of each of the Centres of Development.
- ***Integration with policy and regional planning:*** As noted in section 3's review of REDD through planning and regulation, integration with policy and regional planning needs to be addressed at two levels. At one level, the programme needs to be aligned with national policies and planning, to ensure that envisioned activities do not conflict with national land-use priorities in particular areas, and so that implementation can support broader national development goals. At the second level, Centres of Development should focus on activities that reduce emissions from deforestation and degradation through planning.
- ***The need for a champion and substantial operational capacity:*** In addition to this suite of functions and associated experts listed above, there is a clear need for core operational staff that, at a national scale, will take care of the day-to-day accounting, carbon offset registry and other operational issues. At the national office, it is anticipated that 2-3 individuals, led by a Chief Operating Officer, could undertake this work. An Operations Officer would manage each Centre of Development with supporting staff depending on the magnitude of the activity.
- ***Third-party accreditation:*** In line with the guiding principles, the program needs to be audited by a third party. The scope for auditing would include both the validation of activities on the ground, in a similar manner to the CDM or VCS validation/verification processes, as well as auditing of the internal registry and sale, transfer and retirement of generated emissions reductions.

This should be seen as an initial exploration of the functions required at a national scale. In the next phase of the national carbon sink program, it is anticipated that a dedicated assessment of both the NFU and each CoD will be made, including potential structure, capacity, roles, responsibilities, and governance.

Recommended next steps

We recommend that three principle elements be considered in terms of next steps:

The creation of long-term incentives for climate change mitigation activities

The realization of a national program as well as private and NGO sector activities relies on the creation of secure, long-term financial incentives for implementation. This is especially pertinent following the collapse of international carbon offset markets. The creation of a dependable, incentive mechanism within South Africa, for example, related to the National Carbon Tax, is vital to a national

program and to encourage implementation within the private and NGO sectors.

It is suggested that a focused scoping analysis is undertaken that explores all potential sources of revenue for climate change mitigation activities in South Africa, including broader payment for ecological infrastructure, ecosystem services and climate change adaptation.

The development of a "National Facilitation Unit"

A "National Facilitation Unit" has been proposed as a solution to the needs and requirements raised by interviewed members of Government as well as field practitioners. Whereas this analysis provides good justification for the unit and suggests an initial structure, a more comprehensive assessment is required of its scope of activities, governance, location within Government or a parastatal, required capacity and how capacity would be increased over time in a financial sensible manner. An initial assessment is suggested that would be built upon over time as each of the implementation options are developed.

A comprehensive analysis of each climate change mitigation opportunity

This report includes an initial exploration of the eight principle land-use based climate change mitigation activities located in South Africa. The analysis provides a good foundation but a dedicated, comprehensive analysis of each opportunity is required as a next step. In terms of prioritization, it is suggested that Government focus on the first five activities in Table 1:

- Restoration of sub-tropical thicket and forests
- Restoration and management of grasslands
- Commercial small-grower afforestation
- Biomass energy
- Anaerobic biogas digesters

A substantial amount of work has been undertaken on each of these activities to date, with field practitioners ready to start implementation in the short to medium term (1-3 years). In certain cases, initial implementation has already begun.

The remaining three activities provide good opportunity but may require further research prior to their realization. One should not discount their potential value and especially over time, REDD through planning may form one of the leading mitigation opportunities in the country. At present, however, they are not as well known or as developed as the five activities listed above.

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South African National Carbon Sink Assessment:

Review of existing policy

section THREE

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Acronyms

AFOLU	Agriculture, forestry and other land-use
ANC	African National Congress
AQA	Air Quality Act
CARA	Conservation of Agricultural Resources Act
CDM	Clean Development Mechanism
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DOE	Department of Energy
DPW	Department of Public Works
DRDLR	Department of Rural Development and Land Reform
DTI	Department of Trade and Industry
EIA	Environmental Impact Assessment
ERU	Emissions Reduction Unit
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
ha	Hectare
IDP	Integrated Development Plan
IPAP	Industrial Policy and Action Plan
LTMS	Long-term mitigation scenarios
MTSF	Medium Term Strategic Framework
NBF	National Biodiversity Framework
NCCRP	National Climate Change Response Policy
NDP	National Development Plan
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
NGP	New Growth Path
NPAES	National Protected Area Expansion Strategy
NSSD	National Strategy for Sustainable Development and Action Plan
REDD+	Reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
SA	South Africa
SPLUMA	Spatial Planning and Land Use Management Act
tC	ton of carbon
tCO2e	ton of carbon dioxide equivalent
TOR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
yr	Year

Introduction

The context of this section

This report addresses Section 5.3 of the Terms of Reference - *Policy Recommendations.* In particular, it *maps existing policies and measures that directly and indirectly affect GHG emissions and removals from the AFOLU sector*. The report is based on an extensive qualitative analysis of 116 national-level policies that may have an impact on terrestrial carbon stocks and GHG emissions from the AFOLU sector. In the second phase of the policy analysis, to be undertaken in the first quarter of 2014, Cirrus will propose new measures and policies that are required to limit GHG emission from the sector and to encourage the implementation of land-use based climate change mitigation activities identified in Section 2 of the National Carbon Sink Assessment.

More broadly, the DEA seeks to contribute to and align with the *National Climate Change Response White Paper's* (NCCRP) mitigation efforts. The *White Paper* (also referred to as the *National Climate Change Response Policy*) proposes measures for achieving South Africa's GHG reduction targets, aiming to decrease emissions by 34% by 2020 and 42% by 2025 compared to a "business as usual" GHG emission trajectory. These targets complement the country's Long Term Mitigation Scenario (LTMS) planning, which aims to follow a "peak, plateau, decline" trajectory, with the level of emissions peaking by 2025, plateauing through to 2035, and declining thereafter. By mapping out policies that are likely to have an impact on national terrestrial carbon stocks and fluxes, this report aims to provide DEA with an understanding of the potential impact of existing policies on GHG emissions from the AFOLU sector and their contribution to national emissions reduction targets.

Results and findings

The analysis highlights the existence of two broad categories of policies that will impact terrestrial carbon stocks: those policies that promote sustainable environmental management and those that call for greater economic growth. With regards the former, South Africa has created strong legislation for environmental protection. This legal framework includes powers to protect natural landscapes, direct and rapid interventions to rehabilitate and restore degraded ecosystems and the enforcement of improved agricultural practices. This body of legislation protects the environment in line with section 24 of the Constitution:

Environment. – Everyone has the right –

1. to an environment that is not harmful to their health or well-being; and
2. to have an environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –

- prevent pollution and ecological degradation;
- promote conservation; and
- secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

The National Environmental Management Act (NEMA) family of policies take a conservative approach to land-use, adopting the precautionary principle, calling for assessments to be undertaken before developments are approved and applying restrictions on the exploitation of forests, woodlands, and sensitive, threatened or vulnerable ecosystems. These values and priorities are captured in legally binding legislation, and are included in frameworks and strategic plans focused on the protected areas network, biodiversity and air quality. The *National Environmental Management Act* (NEMA) and its *Biodiversity Act, Protected Areas Act* and *Air Quality Act* and related frameworks and strategies, are world-class, wide-ranging policies that can provide for significant protection to ecosystems and associated carbon stocks.

Equally, there is a strong drive towards economic growth, job creation and development. This drive has given rise to a number of vision statements and long-term planning documents. In these documents, the "green economy" is largely defined by pursuit of technological solutions to development challenges. Examples of this include cleaner energy production, manufacturing, installations and supply chain development. Land-use is passingly referred to with regards to bio-fuel production to alleviate GHG emissions from traditional fuel use. Environmental objectives are not as clearly articulated as economic priorities in this family of policies.

A key concern noted in this analysis is that NEMA's framework is not widely referenced by or its principles integrated within policies that aim to develop the economy, create jobs and drive infrastructure development. The most influential policies in this regard are the triad of the

New Growth Path, the *National Development Plan* and the *Medium Term Strategic Framework* that prioritize job creation. Policies and plans aimed at economic development will not necessarily lead to environmental degradation. However, when considering the effect of NEMA policies on carbon stocks and GHG emissions, one needs to make careful consideration of other policies that may take precedence due to South Africa's particular socio-economic priorities.

The research demonstrates the extent to which these two overarching objectives, sometimes seemingly at odds with one another, converge in a single policy environment, a domain that is evolving with the introduction of new strategies, plans, bills and amendments that could influence the land-use sector. From this, it becomes evident that there are multiple future paths for land-use change. It was not possible to determine which policies trump others in terms of resources, institutional support and political buy-in. Even if possible, an analysis including institutional support would likely be of use for only a limited time as the policy environment shifts due to the emergence of new priorities, policies and personnel. But what the policies reveal is that many land-use trajectories are possible.

Policies influencing agricultural landscapes

The policies that are most likely to drive agricultural expansion originate from the Presidency, and collectively seek to create agricultural opportunities for over three million individuals. Agricultural expansion is viewed as means of achieving rapid job growth and economic development. If implemented, this could lead to a substantial increase in land under cultivation – potentially increasing total land under production by 20-30%. Policies originating from the Department of Agriculture, Forestry and Fisheries (DAFF) and the Department of Rural Development and Land Reform (DRDLR) have integrated targets and strategic directions that align with these Presidential policies. This demonstrates that the Presidency has successfully originated a strategic direction adopted by these departments.

There is limited legislation that focuses specifically on the impacts of agriculture on natural resources. This could be due to silo behaviours between DAFF, DRDLR and the Minister of Water and Environmental Affairs. Only one Act attempts to incorporate improved cropping techniques into cultivation methods and approaches: the *Conservation of Agricultural Resources Act* (CARA), 1983. Whereas the *National Water Resource Act* and the *Disaster Management White Paper* and attendant legislation provide some opportunity for controlling agricultural practices, greater attention to and application of CARA may result in reduced GHG emissions from agricultural activities that negatively impact on above and below-ground carbon stocks.

A significant body of legislation exists for managing impacts on the natural environment, from land degradation to air pollution. These almost exclusively originate from the *National Environmental Management Act* and its related Acts and Regulations. They make provisions for the oversight and control of listed activities, the conservation of biodiversity, the creation of protected areas, and the long-term, sustainable management of the country's natural resources. In particular, the *Protected Areas Act* and the *Biodiversity Act* both trump all other national legislation when increasing or managing protected areas and biodiversity is concerned. The precedence of these two acts is important to note as a new generation of policy mandates, which privilege the integration of differing policy objectives, will wield their influence in aligning policies across many departments and ministries.

Biofuel production has received considerable policy attention for two principle reasons. It is seen as important component of the green economy and it is perceived as a means for reducing GHG emissions through the substitution of fossil fuels. However, the *Strategic Plan for Biofuel Production* only suggests a pilot-phase of production covering 300,000 hectares over five years. As this is a small fraction of South Africa's land area and will most probably occur on previously ploughed land, it is likely to have a limited effect on the country's terrestrial carbon stocks. Similarly, despite planned expansion of commercial plantation forestry through community-based schemes in the Eastern Cape and KwaZulu-Natal totalling 100,000ha, the net impact on South Africa's terrestrial carbon stock is expected to be limited (100,000ha is 0.08% of the countries surface area). Compared to the grassland systems that contain 33% of the country's national carbon stock (Scholes et al. 2013), this is comparatively limited. Policies promoting plantation forestry are thus considered to have a limited impact on the country's terrestrial carbon stocks.

Policies influencing natural and semi-natural landscapes

In contrast to the agricultural sector, the legal framework governing natural and semi-natural landscapes displays a more robust methodology in its development, allowing for its effective application. The NEMA family of policies has been developed using a traditional policy approach, originating in Green and White Papers, formulated into Acts and Regulations, and in each phase of development, passing Parliamentary approvals. This approach offers the benefits of rigorous oversight and democratic legitimacy. It also seems to have resulted in an internally logical set of policies that work together to achieve shared aims. The *National Environmental Management Act* (NEMA) family including Acts, Regulations, frameworks and strategic plans are key policies that govern natural and semi-natural landscapes.

However, the land-use space is crowded with competing objectives. Despite NEMA's strong legislative precedence, only expansion of the protected areas network appears

to have won broad support across departmental and Presidential plans. The *National Protected Areas Expansion Strategy* (NPAES 2008) seeks to introduce an additional 2.7 million hectares of land into the network by 2013, a quarter of the strategy's 20-year goals. The protected areas network has the potential, if enacted, to be one of the largest contributors to avoiding GHG emissions from land conversion.

Outside of the geographic area encompassed by this network, ecosystem conservation is encouraged rather than enforced through various policy measures, such as tax rebates, conservation agreements, and carbon offsets through the proposed Carbon Tax. This approach may prove insufficient for the protection of terrestrial carbon stocks. For example, savannah covers some 35.8 million hectares of land and is the second most abundant source of terrestrial carbon stocks (Scholes et a. 2013). Despite their scale and importance, they receive less stringent policy attention and protections, which could lead to their continued degradation and attendant losses of terrestrial carbon stocks. Compensation for this loss, through restoration of degraded landscapes, has not benefited from the same development of and adherence to targets such as those found in NPAES.

Aside from this alignment around the *National Protected Areas Expansion Strategy*, proposed infrastructure development, agricultural expansion and housing developments may compete for the same areas of land. One possible approach to mediating between these conflicting goals could be through using land-use plans, mapping and spatial analysis tools. This could result in reductions of terrestrial carbon stocks as compared to a "business-as-usual" scenario.

The review of policies impacting on natural and semi-natural landscapes demonstrates that the legislative approach adopted by the NEMA family of policies has led to the development of a more practicable set of policies. Two key issues emerge; the need for inter-departmental cooperation in setting land-use goals and targets, and the need for policies within a department to be both internally consistent and follow the correct processes for becoming legislation.

Policies that influence the built environment

Policy makers have long viewed an adequate supply of infrastructure services as a basic ingredient for economic development (Calderon et.al 2008). They also expect that the supply of infrastructure would generate employment directly through the actual construction, operation and maintenance requirements but also through indirect multiplier effects across the economy (Kumo 2012). These indirect effects may include, for example, the building of roads leading to an increased connection of people to markets. This in turn can promote agriculture production, leading to increased land conversion.

According to the *National Development Plan*, the South African government's mandate is to create decent work, reduce inequality and eradicate poverty. To achieve this, the government aims to revamp the economy and improve employment rates. It seeks to shift the ways in which economic growth is achieved through support to new industries and technological developments. The NDP, along with other Presidential policy initiatives, outline a medium and long-term vision for achieving this growth, which is heavily reliant on the delivery of new infrastructure.
Although references are made to "sustainable development" in these policies, the term is not clearly defined, and its application to expansion of the built environment remains unclear. Only the *National Development Plan* makes references to existing environmental legislation, which is otherwise largely omitted from the other documents. A key observation is that these policies are expected to result in significant changes in land-use. Due to the broad nature of policy, it is difficult to identify the casual link and impact of built environment expansion on terrestrial carbon stocks. It is, however, reasonable to assume that an expansion of agriculture, industry, mining, roads, urban areas and supporting infrastructure will lead to direct changes in above- and below-ground carbon stocks as well as indirect impacts through increases in natural resource consumption in areas that had not been densely inhabited before.

30 Key policies that may have the largest impact on carbon stocks

The top 30 policies that are likely to have considerable impacts on the release, conservation or sequestration of terrestrial carbon stocks and associated GHG emissions are listed in Table E2 below. These policies demonstrate that in many geographic areas and ecosystems, ministries and departments have their own policy priorities. Some of these promote growth and seek to increase employment, whereas others strive to preserve the natural environment. In some instances, there appears to be limited alignment between pre-existing environmental legislation and the strategic plans and national visions that may result in extensive land-use changes. Because there is no clear hierarchy between policy objectives, policy precedence is difficult to determine. This represents an opportunity to further integrate and adapt policy, notably through approaches highlighted in newly adopted pieces such as the NCCRP.

Table E2. 30 policies perceived to have a relatively greater impact on the maintenance and increase, or decrease of terrestrial carbon stocks and fluxes, if implemented to their full potential

Policy Type	Policy
White Papers	• White Paper on Disaster Management • National Climate Change Response White Paper
Acts	• Conservation of Agricultural Resources Act, 1983 • National Forests Act, 1998 • National Environmental Management Act, 1998 • National Environmental Management: Protected Areas Act, 2003 • National Environmental Management: Air Quality Act, 2004 • National Environmental Management: Biodiversity Act, 2004 • Spatial Planning and Land-Use Management Act, 2013
Regulations	• National Environmental Management: EIA Regulations • National Environmental Management: Environmental Management Framework Regulations
Strategies, Plans and Frameworks	• National Development Plan • Medium Term Strategic Framework • New Growth Path • Strategic Plan for Smallholder Producers • The Strategic Plan for South African Agriculture • Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries • Integrated Growth and Development Plan: Agriculture, Forestry and Fisheries • National Strategy for Sustainable Development and Action Plan (NSSD1) - 2011 -2014 • Strategic Plan for Environment Sector: 2009 - 2014 • National Biodiversity Framework • National Air Quality Management Framework • National Protected Areas Expansion Strategy for South Africa 2008 • Integrated Resource Plan • Industrial Policy Action Plan: 2012/2013 - 2014/15 • Department of Rural Development and Land Reform, Strategic Plan 2011-2014 (amended 2013) • Carbon Tax Policy Paper • National Disaster Management Framework • A Woodland Strategy Framework for the Department of Water Affairs and Forestry 10
Other	• Guidelines Regarding the Determination of Bioregions and the Preparation of and Publication of Bioregional Plans

Broadly, these policies fit into several categories:

- **Policies focused on environmental management:** Acts and Regulations originating from the NEMA cluster, or related Acts that aim to reduce negative impacts on ecosystems, such as the *National Forests Act* and the *Conservation of Agricultural Resources Act*. These are complemented by the *Disaster Management* family of policies – the *White Paper, Act* and *Framework* – which provide for undertaking prevention and mitigation actions for single disaster events or longer-term trends that could lead to a disaster.
- **Presidential policies focused on economic growth:** These include the NDP, NGP and MTSF, supported by IPAP. These promote infrastructure development, expansion of the built environment and view agriculture as a key means to reducing poverty.
- **Departmental strategic plans:** Those from DAFF, which tend to align with mandates from Presidential policies, but that make passing references to the adoption of improved agricultural techniques, restoration or afforestation. By and large, DAFF's plans propose agricultural expansion, notably at the smallholder level.
- **Planning policies:** These policies are focused on providing planning guidelines for land-use change, namely through the use of mapping, land functionality, spatial equity, sustainability and other considerations. This suite of policies is required to mediate between competing land-use objectives.
- **Outlier documents:** These include documents such as the *Strategic Plan for the Environmental Sector* or the *National Sustainable Development Strategy and Action Plan* that originate from the office of the Minister of Water and Environmental Affairs. These policies are intended to impact a broad range of sectors and activities through streamlining sustainability and environmental management.

Several observations can be made about these policies that may have a substantial impact on carbon stocks and GHG emissions from the AFOLU sector. The first is that there is a strong legislative framework favouring a conservative approach to environmental management, land use, and conservation. The legal precedent is strong, rooted in Acts and Regulations. However, policies that promote rapid job growth in the agricultural sector and support significant infrastructure build appear to have been more widely adopted in current departmental and ministerial strategies, particularly that of DRDLR and DAFF. These two departments have considerable influence on the land-use sector, and their alignment with rapid agricultural expansion could lead to conversion of rangelands and grasslands and net increases in GHG emissions due to the turnover of soils, the removal of vegetation and fertilizer usage.

Prominent Gaps in Policy

Limited protections for woodlands

Although woodlands contain a significant fraction of South Africa's terrestrial carbon stock (28%, Scholes et al. 2013), they have not received significant protections. Two factors seem to contribute to this state of affairs. Firstly, the lack of clarity on how to classify woodlands appears to have hampered progress towards more official commitments to the oversight and management of woodlands. *A Woodland Strategy Framework* notes, "The classification system for woodlands forms the basis of much of the other work that needs to be done and it is therefore a very important first step towards progress" (2004). A definition of woodlands is overdue in the sector. Secondly, the *National Forests Act* calls for the Minister rather than a devoted department to determine the area of woodlands to protect. These policy conditions are perhaps exacerbated by the land ownership status of woodlands, which typically fall under communal and private ownership. Unlike many intact forests that benefit from either state ownership or strict land-use provisions, woodlands management will require effective partnership between government entities and landowners and users.

In addition, there appears to be limited attention devoted to understanding the role of woodlands in local, rural energy security. In South Africa, fuel wood extraction, along with fencing and building material collection, represents the largest annual off take of biomass (Lawes et al. 2004). Fuel wood extraction rates range considerably from household to household, from 0.27 to 1.12 tonnes annually, accounting for some 51% of domestic energy use (Lawes et al. 2004). Despite this high level of dependence, the sustainability of supply is not addressed by the Department of Energy (DOE) in its *Revised Strategic Plan 2011/12 – 2015/16*. Neither does it propose interventions to shift fuel wood and charcoal consumption to other sources. This suggests that consumption of indigenous wood sources for heating and cooking may continue unabated.

Limited detail on how improved agricultural techniques will be incorporated in practice

A range of agricultural interventions was referred to in several of the documents reviewed, from climate smart and agro-ecological practices to sustainable agricultural production. Perhaps due to a historical lack of credible research outcomes and conclusions on these interventions to guide policy development, these policies do not provide clear targets or commitments to these practices. This is prevalent in the case of policies promoting agricultural expansion, which do not articulate how expansion will align with proposed improvement to agricultural practices. Moreover, there are few Regulations specifically controlling fertiliser application and use.

Limited reference to the role of AFOLU in mitigating climate change

Emissions reductions from the AFOLU sector could be very important for South Africa to achieve its GHG emissions reduction target of 34% decline as compared to a business-as-usual trajectory by 2020. The AFOLU sector contributes 6% of South Africa's greenhouse gas emissions (Rahlao et al. 2012). Our policy analysis showed that while South Africa has an abundance of legislation on agriculture, no policies explicitly address the reduction of emissions from AFOLU. However, current laws and policies could be used as a legal basis for reducing AFOLU-related GHG emissions.

Limited commitment for protection and improvements of natural and semi-natural landscapes

There are only two policies that set specific targets for improving natural landscapes. They are the *National Sustainable Development Strategy and Action Plan (NSSD1)* and the *Strategic Plan for the Department of Agriculture, Forestry and Fisheries 2012/12 – 2016/17*. These targeted interventions are not substantiated by further details – notably location or detailed biome type. This lack of detail makes it difficult to assess the GHG emissions reduction potential of the proposed interventions. This lack of targets and processes supports the need for a more coordinated policy response.

Policy trade-offs

The policy analysis demonstrates the extent to which many potential land-use futures exist, as policy objectives compete for limited resources and in some cases even the same lands. The resolution of these conflicts likely lies in practical compromises between departments and national, provincial and local governments, notably through thorough application of policies that call for the integration of departmental and ministerial plans. But this process requires trade-offs between policy aims and social, economic and environmental objectives. Several potentially high-impact conflicts or "grey areas" between various policy objectives and principles were identified. These highlight the trade-offs government faces when attempting to

address major social challenges simultaneously. Poverty, marginalisation of rural households, food security, long-term sustainable economic growth and climate change – all compete for policy support and resources. This has important implications for national terrestrial carbon stocks maintenance and increases, as some policies may lead to the release of emissions to achieve social and economic aims.

The analysis highlights three major trade-offs, although there are undoubtedly many others that exist. These include:

Rapid job creation in agriculture versus the sustainable use of ecological infrastructure

One of the South African government's core aims is to address entrenched poverty. Several policies issuing from the Presidency view agricultural expansion as a means of rapid social upliftment and job creation. In the policies reviewed, the rapid creation of employment is an overriding priority. Yet agricultural expansion can lead to the degradation of carbon stocks when pursued in intact ecosystems and when employing ploughing techniques that can lead to soil carbon losses. Several key environmental constraints are not addressed in the *National Growth Plan*, the *New Growth Path* and the *Medium Term Strategic Framework*. Productive agriculture relies on intact ecosystems. The NGP and NDP both recognize that balancing trade-offs will be necessary to achieve their objectives, but do not describe the ways in which they will be mediated and managed. Means for addressing these impacts, notably through improved spatial and land-use planning, is explored in the section 3.2 policy recommendations report

Biofuel production to limit reliance on fossil fuels versus land conversion

Biofuel production has received significant policy support. Although it is not expected that biofuel production will expand significantly over the next five years, government incentives and continued rising oil prices may contribute to growth in the sector. The expansion of biofuels production responds to three government objectives:

- Job creation
- Achievement of the voluntary "peak, plateau, decline" commitments under the United Nations Framework Convention on Climate Change
- Shifting dependencies on oil as price volatility represents a threat to energy security

The *Green Economy Accord* and the *Biofuel Industrial Strategy of the Republic of South Africa* confirm that biofuel production will happen on "fallow land" or "underutilized arable land" respectively. The *Long-Term Mitigation Scenario* further substantiates this by stating that "Biofuels are extended as far as limits of arable land, water, and concerns about biodiversity and food security allow" (2007). Each of these policies state that biofuel production should only take place on lands not intended for agricultural production. This is to avoid diversion of food production or manipulation of food prices. Despite the provisions relating to food security none of the documents takes into account the inherent ecological value of fallow or unproductive lands. The conversion of underutilized land is likely to lead to a net increase of GHG emissions from the disturbance of soil stocks, fertilizer use and removal of pre-existing vegetation cover. Thus the production of biofuels may lead to a net increase of AFOLU-based GHG emissions. The impacts on fossil-fuel displacement have been the subject of much scientific debate, as discussed in Module 8, and will require further scrutiny in the South African context, with a focus on production and supply-chain emissions. A full life-cycle analysis of biofuel production on different land-use types, employing a variety of production techniques, as well as assessing a number of supply-chain opportunities will be necessary to determine the full GHG reduction benefits, if any, and to what sector they should be attributed (AFOLU, energy, etc).

Short-term food security versus ecologically sustainable production

Food security is a priority regularly cited in both Presidential policies and those originating from DAFF and DRDLA. Typically, the issue of food security is presented as one that must be rapidly addressed. The most highly promoted means for achieving this is through the expansion of land under agricultural production, which is viewed as a means for reducing household-level food insecurity. The rapid expansion of agricultural production without the adoption of improved agricultural techniques could damage ecosystem services, not least of all terrestrial carbon stocks. Thus a trade-off between the future resilience of ecosystem services and shorter-term food security may exist.

Conclusions

Several themes emerge from this analysis of policy:

- The NEMA cluster of policies has strong potential to guide improved land-use management, including through control of GHG emissions, provision of principles to guide land-use practices and the establishment of spatial planning tools. However, the positive GHG impacts of the NEMA cluster of policies, as well as the *National Forests Act* and the *National Disaster Management Acts* are reliant on interpretation rather than providing clear guidelines. Their impacts could be limited or substantial depending on the types of regulations, frameworks and strategies that are formulated from them. For example, NEM: Biodiversity Act provides the Minister with the power to create and approve bioregional plans, but the content and process by which they are developed relies on the Minister developing guidelines and regulations. To-date, a number of regulations, guidelines and other supporting policy elements have not been developed to give full effect to NEMA and its subsidiary Acts.
- The analysis demonstrated that the approach used in formulating policy can have important ramifications for the consistency, long-term viability and practical application of objectives. The approach used by the Minister of Water and Environmental Affairs in formulating the NEMA family of policies is a positive example of this. It followed the process of Green Paper to White Paper to Acts and then to frameworks and strategic plans over a number of years and is internally coherent. On the other hand, more ad-hoc policies tend to receive less visibility and traction, perhaps due to their less structured process for development.
- Interdepartmental co-ordination is vital to ensure the successful resolution of conflicting goals and objectives, and should form part of future policy development impacting on the land-use sector. The DEA, DAFF and DRDLR should have a shared vision informed by the Constitution, articulating the ways in which to pursue both environmental and economic growth objectives. Increasing co-operation and alignment can act as a force multiplier enabling the successful application and practical achievement of policy aims. This type of collaboration and integration of strategies and plans is required as part of the *Intergovernmental Relations Framework Act*, and is similarly imbedded in NEMA, providing the legislative mandate for such an approach.
- As a consensus grows around the need for urgent climate change action, and emerging research demonstrates the benefits of land-based climate change mitigation activities, the South African government is presented with the unique opportunity to align and update its policies to more broadly reflect a commitment to preserving and enhancing the nation's terrestrial carbon stocks. To this effect, the second phase of policy analysis provides a series of recommendations, partially based on the findings of this report but also informed by the results from sections 1 and 2.

Module 1 – SECTION 3

Methodology and research framework

1.1 Research mandate

This analysis responds to the Department of Environmental Affairs' Terms of Reference (TOR) for the SA National Carbon Sinks Assessment, section 5.3 Policy Recommendations. Here, the mandate is to Map existing policies and measures that directly and indirectly affect greenhouse gas (GHG) emissions and removals from the agriculture, forestry and land use (AFOLU) sector. This report provides an analysis of over 110 policy documents, which include white and green papers, acts, regulations, as well as national plans, frameworks and strategies that fit within the policy domain. The set of reviewed policies were chosen based on the assumption that they may directly or indirectly influence the size of the national terrestrial carbon stock (with a knock on effect on other related ecosystem services), associated fluxes and the general GHG emission profile of South Africa's AFOLU sector (see Module 2 for a detailed description of the sector).

1.2 Background and rationale to the method of analysis

Two aspects of policy analysis have informed Cirrus's research methodology. Firstly, we identify complexities inherent in the national policy environment, i.e. inter-policy discord and poor alignment, competing aims, misaligned timeframes or important material gaps. Secondly, we adopt an analytical framework that structures the reviewed policy documentation such that each policy element is isolated, clarified and compared to a wider policy environment.

The land-use sector and associated GHG emissions are characterized by their complexity. To understand current carbon stocks and fluxes as well as future potential changes, a broad scope of drivers and determinants need to be considered simultaneously. This is because the country's biophysical template, which determines the general vegetation type observed (rainfall, temperature, soil type, fire regime etc.), has been affected by a range of human related drivers. These drivers range from subtle changes in fire or grazing regimes, to the complete clearing of land for built settlements and infrastructure. This broad set of determinants and drivers means that a vast suite of policies may directly or indirectly affect land-use and associated GHG emissions. Very few of these actually consider climate change per se; but are instead, for example, focused on issues of economic growth, job creation and rural development. For this reason, Cirrus included over 110 policies in its analysis to ensure that potentially high-impact policies - which on the surface may appear unrelated to terrestrial carbon stocks and fluxes – were not excluded from the process.

1.3 Description of methodology

A structured framework approach was adopted for two key reasons. Firstly, it systemises the extraction and organisation of policy information from complex, abundant and multiple sources, helping to distil themes, patterns and important findings (Anderson 2006, Musso et al. 1999, Guess & Farnham 2000, Ritchie & Lewis 2003). The framework approach utilises an index, which allows the researcher to tabulate, order and make sense of large quantities of textual information using different analytical categories. Since Cirrus's analysis encompassed over 110 lengthy policy documents, the framework approach was particularly pertinent. Secondly, the structured framework approach is transparent and repeatable because end users can interrogate findings through the index and references back to original texts. By building traceability and transparency into the research design, objections about the supposed anecdotal or imprecise methodologies of qualitative research (Attride-Stirling 2001) are addressed.

Our analytical process included a number of phases (adapted from Attride-Stirling 2001 and Ritchie & Lewis 2003):

- **Familiarisation:** An initial scoping of policy documents to develop a basic understanding of the themes and ideas that regularly emerge from various texts included in this study.
- **Defining a thematic framework:** The identification of categories for an index or catalogue against which each document is assessed. For this analysis, our categories were shaped by the need to understand the direct and indirect effects of policies on terrestrial carbon stocks and fluxes (see catalogue in attached spreadsheet).

- **Cataloguing:** Thoroughly review each policy document, noting core points and entering them into the catalogue framework. This indexing process creates a "viewing framework" from which the research can begin to identify emerging patterns, similarities or points of discord between different texts. During this stage, new themes may emerge and can be included in the index. This becomes an iterative process, where some documents will be returned to as necessary.
- **Charting:** Once the initial index is complete, the full catalogue is further reviewed for relevance and accuracy.
- **Mapping and interpretation:** After the more laborious parts of the process, the full set of policies entered into the catalogue are assessed for emerging patterns and associations as well as gaps and conflicts between policies relative to their potential impact on GHG emissions. This is the true mapping stage of the process where one further explores the relationships and potential interactions between policies.

1.4 Framework preparation

For this analysis, we developed a working definition of policy with a clear definition of the scope and boundaries of the policy review. Thereafter, an initial list of policy documents was compiled, which was sent to the Department of Environmental Affairs (DEA) for consideration. The set of reviewed policy documents was finalised following the DEA's feedback and are listed in the attached spreadsheet catalogue. The catalogue at once serves as an index in the framework approach, as well as a detailed reference tool for the DEA.

A clear definition of policy aids in guiding decisions about which documents are suitable for inclusion in the catalogue. As Tyler (2009) notes, there is no universally agreed meaning of policy, which may cover the ideas and philosophies that influence the policy development process and the actual concrete decisions taken by governments. Policy may thus include "intentions" and "directions" as well as institutional capacity (Tyler 2009). A broad definition of policy has been adopted that focuses on published documents rather than on speeches, proceedings from conferences, press releases or other types of communications that may relay "intentions" or "directions."

Brooks' (1989) definition of public policy was therefore adopted: "Public policy is the broad framework of ideas and values within which decisions are taken and actions, or inaction, is pursued by governments in relation to some issue or problem." This definition includes the review of strategies and frameworks, green papers and departmental plans as a way to understand the country's policy environment beyond the realm of approved measures such as Acts and Regulations or official government policy described in White Papers.

The boundaries of document collection were defined by two criteria. The first was the decision to limit the analysis to national policy documents. This was determined by the amount of time allocated to the study, and Cirrus's decision to focus largely on a horizontal analysis of policy – that is, across ministries and departments operating at the national level. A key point raised in the TOR and during engagements with stakeholders is the intersection, gaps and conflicts between policies from all relevant departments and ministries. The second was to use informed judgment in determining the relevance of the aspects of a particular policy with regards to its potential impacts, either directly or indirectly, on greenhouse gas emissions and removals from the AFOLU sector. For example, this has resulted in the exclusion of policy related to education. Although an increase in environmental education at the primary or secondary school level might lead to indirect impacts on GHG emissions or sequestration in the AFOLU sector, it was decided that the time horizons for which impacts would be realized were too distant and the relationship too vague, making judgments of causality too risky.

Some definitions of policy include programmes that government may implement that directly derive from policy. At this stage of analysis, however, it was determined that the inclusion of programmes was beyond the scope of the TOR. Nevertheless, Cirrus has generated a non-exhaustive list of programmes that may be part of the analysis of implementation options at a later stage of the SA National Sinks Project.

1.5 Research process

Familiarisation Phase

As part of the methodology's "familiarisation phase", desk-based research was undertaken with a focus on identifying relevant policy in the Parliamentary register of bills and acts, the Government Gazette, and various ministerial and departmental websites. The search spanned multiple ministerial and departmental websites, to ensure that a comprehensive set of policies that could have substantial impacts on greenhouse gas emissions from the AFOLU sector were identified.

A comprehensive approach was adopted - if it appeared that a policy document might impact on greenhouse gas emissions in the AFOLU sector, it was recorded in the catalogue. Initially, Cirrus included 108 policies in the catalogue. It requested that the DEA review and circulate the catalogue to potential interested stakeholders, to determine if any key policies were missing and to obtain general feedback and guidance on the compiled set. Following circulation, no new policies were recommended for inclusion in the catalogue. During the course of analysis, several changes to the catalogue took place:

- Seven policies were considered to have no impact on GHG emissions or reductions from the AFOLU sector.

These were amendments to Acts or Regulations that provided no relevant change to the original legislation. There were several pieces of legislation that are likely to be rescinded if some bills lodged with Parliament are passed; others have been deemed unconstitutional.

- Several additional policies that had originally been identified through the familiarisation phase are not yet available to the public.
- All of the analysis and reports commissioned by the Minister of Environment and Water Affairs to support the drafting of the National Climate Change Response Paper (NCCRP) were deemed irrelevant, given that their core findings had already been integrated into the NCCRP. In addition, they do not meet the working definition of policy adopted for this analysis.
- Eight new policies were added, under a new heading "Additions" at the bottom of the catalogue

Creating a Structured Framework

The catalogue contains thirteen analytical categories. The categories reflect different aspects of the research mandate – "to map policies that directly or indirectly impact greenhouse gas emissions or reductions from the AFOLU sector". For most of these, a narrative description is provided. Each policy logged into the catalogue was analysed against pre-determined categories, detailed below in Table 1.

Table 1. *Analytic Categories used in the Policy Catalogue*

	Description
Principle AFOLU sector impacted by the policy	Based on the nature of carbon stocks and GHG emission in each land-use type, the AFOLU sector was divided into a) Coastal, berg and scarp forests b) grasslands c) woodlands / savannah / thicket d) mosaic small scale farming e) commercial crop agriculture f) plantation forestry g) commercial livestock agriculture, and h) urban / peri-urban development (see Module 2). First, the potential influence of a policy on carbon stocks and GHG emissions in each of these land-use types was noted, followed by a broad, general indication of the influence: P (for preservation of the existing area covered by the land-use type), C (for conversion to an alternative land-use type) or E (for expansion of the land-use type). For example, a policy seeking to support smallholder agricultural production would have checked "C" in both the grasslands and woodlands/savannah/thicket categories, as these would be likely converted to croplands under the policy and "E" under mosaic small-scale farming
Land-Use Activity	Potential land-use activities promoted by the policy are noted. These range from woodland conservation to ploughing, and fire management. Each policy was assessed to determine which, if any, of the activities it promoted.
Policy type	The policy type describes broad policy categories: Acts, Regulations, Strategic Plans, Frameworks, etc.
Purpose of the document	Many policies, notably Acts, explicitly state their purpose. This was either quoted directly, or a summary of the purpose provided in instances when it was less clearly presented.
Key dependencies	Policies may depend on the delivery of future regulations, frameworks, or plans to be effectively realised. Their success may rely on the cooperation of particular departments, the establishment of committees or forums and the delivery of new research. This category seeks contextualise each policy, demonstrating the ways in which policies may rely on further interventions to be fully realised.
Direct emissions	Practically no policy included accurate calculations of GHG emissions or removals. Instead, this is a descriptive review of the types of emissions and removals that could be expected if the policy was implemented. The potential types of GHG emissions or removals as well as the activities that would lead to them are described.
Indirect emissions	Most policies, if implemented, will result in "leakage" or unintended, indirect emissions. This might be, for example, the displacement of fuel wood collection sites from one area to another following the institution of new conservation practices. It could be the use of vehicles and reliance on electricity to run an agricultural operation. However, this category will allow the DEA to consider the full range of potential emissions and reductions associated with a given policy.
Direct effect	The primary intention(s) of policies that impact on terrestrial carbon stocks is discussed. This includes a summary of the types of activities and interventions proposed by the policy. It covers "what can be expected" if the policy is implemented.

	Description
Indirect consequences	The indirect consequences of policies are reviewed, detailing the potential unexpected or unplanned outcomes that may stem from policy implementation. As it is not feasible to assess every potential outcome of a policy within the time constraints of the study, this provides a broad view of the potential indirect effects of policy adoption.
Reference to climate change	This provides insight into the extent to which a given policy clearly refers to "climate change".
Reference to GHG emissions	This provides insight into the extent to which a given policy clearly refers to "GHG emissions".
Are there clear policy targets?	The provision of clear targets, notably in departmental strategic plans, helps to assess the potential impact of a policy; it is also a sound indication of the amount of planning that may accompany certain commitments. In many instances, Acts and Regulations will not be accompanied by targets; this category is more relevant to strategic plans that seek to align with Acts, Regulations and White Papers, and to assess the extent to which adequate planning has been undertaken.
Description of the potential magnitude	The magnitude of a policy is a broad categorization of its potential impact on terrestrial carbon stocks and fluxes. The magnitude is assigned a certain qualitative designation: limited, moderate, substantial, or a range of these (moderate to substantial, for example). The magnitude category is discussed in more depth in this module.

The catalogue includes each step of the policy development framework: moving from the green and white paper drafting phase, to the development of acts, regulations and bills, and the creation of strategies, frameworks and plans to support the implementation of policy aims. Within each category of policy document, the material has been organised in chronological order.

A note on assessing the potential magnitude of a policy

The catalogue's category "Description of the Potential Magnitude of impact" proved to be one of the more difficult categories against which to assess policies. For this reason, the approach to assessing the magnitude of the effect of a particular policy is described more in-depth here, to demonstrate both the complexity of the undertaking and to provide more transparency in how the descriptors were assigned.

The aim of the magnitude category is to provide an estimate of the impact that a particular policy will have on terrestrial carbon stocks as well as GHG emissions from the AFOLU sector. In keeping with the study's qualitative approach, the potential impact magnitude was described as a relative measure, which was described as limited, moderate, or substantial.

In the catalogue, a policy is assigned one of these descriptors or a range in certain cases (for example, "minimal to moderate"). This is complemented by a short written explanation supporting the magnitude description assigned to the policy. The approach allows the reader to gauge a policy's impact relative to other policies and to understand the factors influencing the rating. The use of a range recognizes that a variety of policy outcomes are possible where policies are likely to interact, overlap, contradict or strengthen one another in reality. In this sense, the broad three-point scale recognizes that policies do not exist in isolation, but rather in a system of competing policies, priorities and mandates.

Qualitative descriptions were chosen for a number of reasons. Few policies have narrowly defined targets but rather broad goals such as "the rehabilitation of natural ecosystems." Generally, the lack of detail makes it practically impossible to precisely calculate the impact of each policy. Using the example above, a policy will typically state its broad aims – "the rehabilitation of natural ecosystems" but it will not go so far as stipulating the location and spatial extent of rehabilitation or the land-use type or methodology under concern. These finer details are generally defined as the policy is implemented at a local or provincial scale.

In the literature, our approach to describing the magnitude of a policy's impact is often preferred. As Manski (2013) notes "…the point predictions produced by [quantitative] analysts are achieved by imposing strong assumptions that rarely have foundation. Analysis with more credible assumptions typically yields intervals rather than point predictions." Furthermore, it was noted that intricate models used to predict policy outcomes have often not produced more accurate or robust results than sound expert judgement. For these reasons, a qualitative range or interval approach was adopted, supported by a descriptive explanation.

It is important to note that in this analysis, the estimated magnitude of the effect of a policy assumes that the

policy will be implemented and that there are sufficient resources and capacity for each policy to be implemented. In practice, this assumption will not necessarily hold. A full comprehensive assessment of the impact of policy would include an analysis of required resources and associated allocations and existing capacity. Unfortunately, this analysis is beyond the scope of the current review.

Our impact assessments were based on a broad estimate of the spatial area affected by the policy and the change in carbon stocks or GHG emissions per unit area. The change per unit area is based on the anticipated actions due to the policy and the particular land-use and vegetation type under concern. For example, the *Strategic Plan for the Department of Agriculture, Forestry and Fisheries* aims to rehabilitate 9,500 ha of agricultural land as part of Strategic Goal 2: *Sustained Management of Natural Resources*. This area presents a small fraction of South Africa's total land area (< 0.01%) and the sequestration rates per unit area are likely to be low (<0.1tC.ha^{-1}.yr^{-1}. Farage et al. 2007). Although this policy is certainly laudable, its impact on national terrestrial carbon stocks and fluxes would be estimated to be 'limited'. In comparison, the *National Development Plan* seeks to create over 600,000 new jobs in agricultural production, potentially converting several hundred thousand hectares of previously unploughed grassland into cropland. The turnover of 'virgin grasslands' results in a significant decrease in soil carbon stocks, especially in the cooler, temperate grasslands of KwaZulu-Natal and the Eastern Cape (>40tC.ha^{-1}, Knowles et al. 2007). This would be categorized as a policy with a 'substantial' potential effect.

Charting

As a first step in analysis, charts were used to further distil key data, relationships, differences, discord and misalignment of policies. Some aspects of policies that were charted include:

- Policies with the greatest impact on terrestrial carbon stocks and associated GHG emissions
- Those that would impact agricultural expansion
- Those that influence conservation and restoration activities
- Those promoting expansion of the built environment
- Those that focus on environmental licensing and regulation, land-use and spatial planning
- Clusters of policies
- Major gaps and trade-offs noted in the analysis stage

Mapping and Interpretation

In the final phase, charts, along with a close review of the catalogue's contents, were used to interpret the data and distil findings. The analysis is presented in written, explanatory accounts that provide insights into both individual policies and the broader policy environment.

1.6 What the analysis does not do

The analysis process has resulted in the development of important data, structured in such a way as to ease comparisons between policies, and provide a snapshot of a policy's key contributions to terrestrial GHG emissions and removals. The analysis, however, has its limitations:

- **Due to the nature of some policies, it is difficult to accurately estimate their impact on terrestrial carbon stocks:** The majority of reviewed policies advocate broad changes in land-use practices and provide few clearly defined targets, location-specific objectives or area estimates or maps. In addition, by nature, few policies accurately describe how and when policy objectives will be achieved. In practice, these details are addressed when the policy is implemented. It does, however, mean that the magnitude of the impact of each policy is difficult to estimate with accuracy. A qualitative range-based approach was therefore used to estimate the relative impact of policies on carbon stocks and associated GHG emissions.
- **The scope and impact of many policies, principally Acts, are subject to Ministerial discretion and interpretation:** A number of policies allow for broad ministerial discretion. Ministers are often tasked with the development of standards, regulations, interdictions and are responsible for defining the scope of an Act's application. The magnitude of a policy's impact is therefore contingent on a Minister's approach. If the appointed Minister was to change, the manner in which Acts or Regulations are implemented can be revisited.
- **Policy precedence is not always clear.** The catalogue presents a range of policies with different levels of legal standing. White Papers, Acts and Regulations are legislated measures, approved by Parliament and supported by legal recourse. They often stipulate the development of frameworks for their realisation, as well as strategic plans at a Department level. The orderly flow of policy creation – from Green and White papers to Acts, Regulations and frameworks, down to five year-strategic plans – can be interrupted by the emergence of new policies that fall outside of the typical development process. For example, there are Presidential vision documents such as the National Development Plan as well as cross-sectoral documents such as the National Strategy for Sustainable Development and Action Plan. These will have received approval from Cabinet, but not necessarily from Parliament. Their legal standing is less clear. Some policies will have greater political support than others, backed by more financial, human or technical resources. Some may be a direct reflection of an electoral platform, and therefore are perceived to have strong buy-in from constituents. This complex interplay between legal standing, buy-in, political backing and resources is particularly important when considering the effect of policies on land-use

and associated carbon stocks and fluxes.

- **Some policies are only applicable when certain land-uses are present:** A number of policies are applicable across the entire country, but may only be activated under certain circumstances. For example, The *National Environmental Management Act*'s Environmental Impact Assessment (EIA) Regulations are only relevant in the context that a listed activity requiring an EIA is proposed and requires an audit. It is, however, difficult to predict which activities may be listed or delisted in the future. Neither can one predict the geographic location or extent of changes in land-use (e.g. mining, infrastructure or housing developments). In the EIA example, it is only clear that the regulations present the opportunity to oversee different types of development, and potentially limit their impact or require the implementation of ecological restoration activities. The effect of these measures on carbon stocks or fluxes is unknown.
- **Indirect impacts of policies were considered, but within reason:** Once implemented, policies may lead to unintended consequences and unforeseen outcomes. For example, the construction of a new road running through arable but yet undisturbed grasslands, may lead to an increase in agricultural production due to improved market access. This in turn is likely to lead to a release of soil carbon due to commercial ploughing. Potential first and second order indirect consequences have been noted in the catalogue, but an in-depth scenario modelling exercise is beyond the scope of this analysis.

Module 2 – SECTION 3

The nature of the South African land-use sector

In comparison to other countries in sub-Saharan Africa, where the emphasis is on reducing emissions from deforestation and forest degradation (REDD+), South Africa has limited forest cover because the main conversion of indigenous landscapes had occurred during the 1960s and 70s. Whereas there is certainly still scope for activities that avoid deforestation and landscape degradation, there is significant opportunity to sequestrate carbon through the restoration of grasslands and thicket, as well as to reduce emissions through energy related projects in the established agricultural sector. Here, we briefly introduce the biophysical, socio-economic and historical nature of land-use in the country.

2.1 Biophysical template – the nature of terrestrial carbon stocks

South Africa is a relatively dry country where most areas receive less than 650mm of rainfall per year. Certain pockets along the eastern seaboard may receive over 1000mm rain annually but in general, South Africa is a fairly arid country. This is reflected in the magnitude and distribution of carbon stocks across the country, which is principally determined by annual rainfall, soil type and temperature (Fig 3).

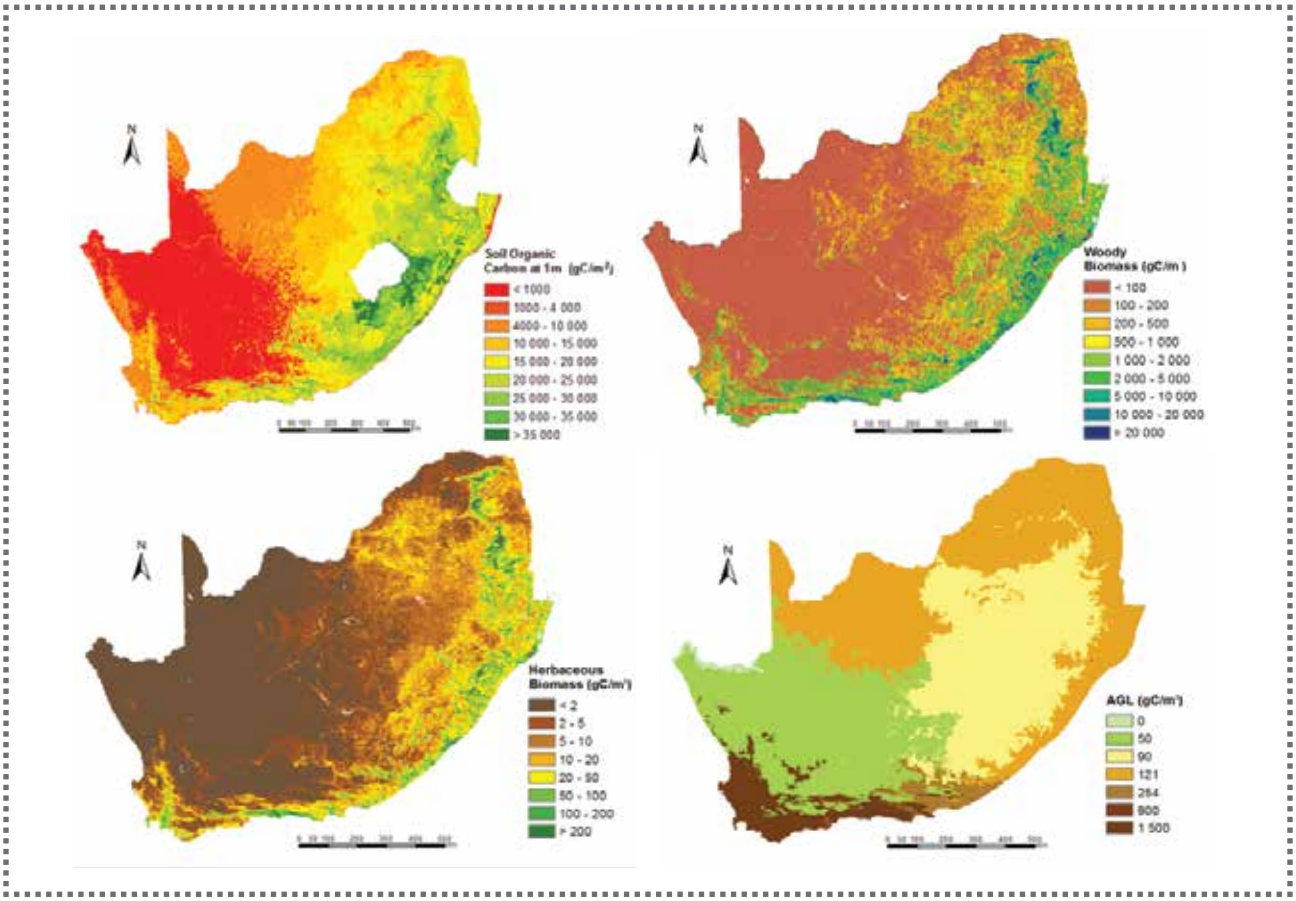

Figure 1. *The components of the terrestrial carbon stock of South Africa. Top left: soil organic carbon to 1m in depth. Top right: the above- and below-ground woody-plant biomass pool. Lower left: above- and below-ground herbaceous biomass pool. Lower right: above-ground litter (Scholes et al. 2013)*

Phase 1 of the National Carbon Sink Assessment focused on understanding the distribution of carbon stocks across the country and provided the first maps of terrestrial carbon stocks at a national scale. As expected, the areas with the highest carbon stocks per hectare are the coastal forests, followed by moist savanna and thicket systems, and then the drier areas of the Northern Cape, western Free State and North-West Province (Fig 3, Scholes et al 2013). Less expected were the estimates of the proportion of the national terrestrial carbon stock that is located in each biome or land-cover type (Fig 4, Scholes et al 2013).

Approximately 30% of the national terrestrial carbon stock is located in grassland ecosystems and a slightly lower amount in the savanna biome (Scholes et al. 2013). In comparison, less than 5% of the national carbon stock is located in indigenous forest and sub-tropical thicket. This result is primarily due to the spatial extent of each vegetation type (Fig 4).

Furthermore, of particular interest in terms of developing national implementation options, is that over 90% of carbon stocks within the grassland and savanna biomes are located in the belowground soil organic carbon pool. Although this is the largest terrestrial pool of carbon in the country, little priority has been placed on it, due to the historical emphasis on forests and REDD+. These results suggest that a better balance of effort is required between grassland, savanna and forest ecosystems. Whereas restoration efforts and current progress with sub-thicket and forest biomes should not be curtailed, equal effort should be placed on maintaining belowground carbon stocks in grassland and savanna ecosystems.

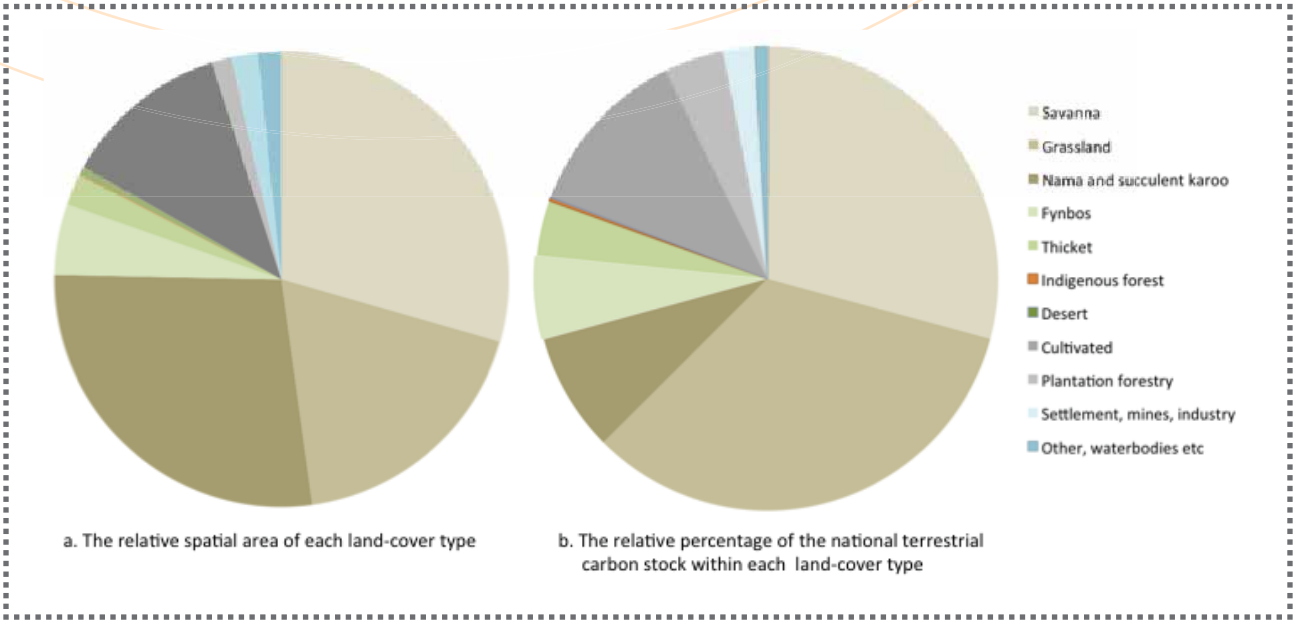

Figure 2. *The relative contribution of each of the principle land-cover types in South Africa in terms of (a) spatial area and (b) terrestrial carbon stocks (input data from Scholes et al. 2013)*

2.2 Socio-economic template – the need for broader inclusivity

Starting with the 1913 Land Act, successive laws and legislation determined that black South Africans were relegated to racially segregated "Bantustans", "homelands" or "native reserves". In these areas, land was communally owned and due to immense population pressures, was soon marked by overgrazing, soil erosion and poor soil fertility. During apartheid, these conditions were exacerbated by various "Betterment" schemes, which concentrated residence and centralised grazing- with disastrous ecological consequences (Bundy 1989).

While a democratically elected government started overturning racialised land legislation in 1994, South Africa still struggles with the legacies of land-use policies initiated during the colonial and apartheid eras. The country is marked by deep inequalities that still need to be addressed. In particular, substantial sections of the country's poor, rural population still live on the most degraded land and have little access to capital, information or the carbon market.

Whereas comprehensive and robust project development, monitoring and reporting frameworks have been created under the Clean Development Mechanism (CDM) and Verified Carbon Standard (VCS), they assume that the implementing agent is well resourced and has access to capital and markets. If implementation is to occur in degraded areas within former homelands and other areas of communal land-tenure, alternative, but just as scientifically robust options need to be created. While opportunities with the established commercial sector need to be realized, they

should simultaneously be balanced with a national program that facilitates projects in communal areas.

2.3 Defining the "AFOLU sector"

As per the TOR provided by DEA, the definition of the agriculture, forestry and other land-use sectors used in this analysis was informed by the UNFCCC paper on Agriculture (2008) and the IPCC AR4 report (2007)[5]. These definitions are broad in the sense that they not only include activities that lead to a change in terrestrial carbon stocks and fluxes in the majority of vegetation and land-use types (e.g. reforestation, afforestation, reducing emissions from forest degradation and deforestation (REDD+), reducing emissions from grassland and soil degradation, reduced tillage and conservation farming), but also refer to land-use related activities that reduce emissions through fossil fuel substitution (e.g. the use of biogas digesters, fuelled by biomass and livestock manure, to generate electricity, or the generation of electricity through biomass-energy units).

The reviewed set of policies is therefore extensive and goes beyond the traditional restricted focus of land-use based climate change mitigation activities that only recognized afforestation, reforestation and REDD+ activities located in forest ecosystems.

5 http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html

Module 3 – SECTION 3

Policies affecting natural and semi-natural landscapes

For the purposes of this policy review, we have used the term "natural and semi-natural landscapes" to refer to three broadly indigenous land-cover types - grasslands, woodlands (including sub-tropical thicket), and indigenous forests. As most policy does not differentiate between grasslands and open-savanna ecosystems, we collectively refer to these ecosystems as *rangelands*[6]. Plantations have been considered as an agricultural land-use type for the purposes of this review and are considered in the Agriculture Module. Desert ecosystems are not considered in this review due to their small contribution to terrestrial carbon stocks and fluxes (<0.01%, CSIR 2013 - Section 1 Report).

Indigenous forests cover a relatively small area in South Africa of 857km^2 (CSIR 2013 - Section 1 Report)). This is less than 0.1% of South Africa's land area. Almost three quarters of these forests are conserved either as declared state forests or within formal protected areas. Although the *National Forests Act* includes "woodlands" in its overarching definition of "forests", they are considered as a separate land-cover category in this review due to the distinctly different carbon stocks and fluxes in woodlands compared to forests (see CSIR 2013). Furthermore, woodlands are typically affected by a different set of land-use drivers and agents compared to indigenous coastal and scarp forests.

Natural and semi-natural rangelands cover 582,000km^2 or approximately half of South Africa's total land area. Importantly for this review, they contain over 75% of the country's terrestrial carbon stock (CSIR 2013, Module 2) and yet, are one of the most heavily utilised landscapes in terms of commercial and smallholder livestock production, conservation and tourism (Second National Communication to the UNFCCC). The expansion of commercial and small-holder crop agriculture over the last century has principally occurred within the grassland and savanna biomes due to the suitable climatic and soil conditions for crop production, and it is also the principle biome in which expansion is likely to occur in the future. Policies focussed on expanding small-holder and commercial crop agriculture are therefore likely to affect the present carbon stocks (and fluxes) within existing rangeland systems to some degree.

- The case for restoring and maintaining South Africa's rangeland systems is robust and clear. Rangelands cover a significant fraction of the country's surface and are home to the majority of the population due to their suitability for agriculture and pleasant climatic conditions. As most of South Africa's commercial- and smallholder agriculture is located in rangelands, much of the rural economy and associated jobs and livelihood opportunities are dependent on functioning, intact, productive rangeland systems.
- Despite this dependence (and probably due to it), rangeland systems have been heavily degraded through inappropriate management that leads to desertification or bush-encroachment. Depending on the method of calculation, it is estimated that up to 60% of South Africa's rangelands are degraded, with up to 90% vulnerable to desertification[7]. In addition to observed decreases in biodiversity, ground cover and soil health, degradation depletes the productive capacity of rangelands, which has a direct effect on rural employment and livelihoods as well as downstream economies that are dependent on such areas for cost-efficiently managing water flow and sedimentation. As noted in South Africa's Second National Communication to the United Nations Framework Convention on Climate Change "Overgrazing, desertification, natural climate variability, and bush encroachment are among the most serious problems facing rangelands".

6 "Rangelands" is a collective term for open, productive landscapes ranging from sparse grassland on the drier end of the continuum, to tall grassland and open savanna systems on the wetter end (dense woodland and forest falls outside of the definition

7 Hoffman et al. (1999) Land degradation in South Africa. Plant Conservation Unit, University of Cape Town, Cape Town; Gibson D. J. D. (2006) Land degradation in the Limpopo Province, South Africa. University of the Witwatersrand, Johannesburg.

- The South African government has been proactive in responding to such environmental degradation. It has pioneered several initiatives, such as the Expanded Public Works Program, that address the spread of alien invasive plants, control fire and restore wetland and woodland systems. In addition to restoring ecosystem health and services, these activities provide meaningful employment and skill development opportunities to previously unemployed citizens in rural areas - the Program is often cited in the President's State of the Nation Address due to its success and the considerable impact it has had on employment.

Thirty-nine policies from the catalogue were identified as potentially having an impact on carbon stocks and associated GHG emissions in intact natural and semi-natural landscapes (policies that focus on the potential expansion of commercial or small holder agriculture into areas that are presently natural or semi-natural landscapes are considered in Module 4. Policies that have limited to moderate impacts do not feature prominently in the written analysis. These categories include:

- Legally sanctioned protection of natural and semi-natural landscapes and associated maintenance of current above- and below-ground carbon stocks.
- Fiscal or other incentives to promote participation of private landowners in conservation and the avoided degradation and loss of terrestrial carbon stocks.
- Changes in terrestrial carbon stocks through water and fire management.
- Increases in terrestrial carbon stocks through restoration and rehabilitation interventions.
- Energy policies that may influence the rate at which fuel wood is harvested and the long-term sustainability of forest resources and associated carbon stocks.

Key findings

- The NEMA body of policies provide the legislative framework by which the conservation and sustainable use of natural resources is prioritized, and which adheres to a conservative approach to development in natural landscapes. Close adherence to these policies would lead to substantial protections over and cautious exploitation of the national terrestrial carbon stocks.
- The *National Protected Areas Expansion Strategy* (NPAES) provides ambitious and detailed conservation targets, and enjoys a high level of recognition in other policies. However, there are limited commitments from government regarding the conservation of areas outside of the Protected Areas Network.
- There are few national-scale initiatives that identify which particular areas or landscapes are likely to be impacted by planned expansions of commercial and small grower crop farming and other planned economic activities. Neither is it clear the extent to which planned expansion of the built environment and agriculture in particular will be influenced and mediated by the NEMA body of policies. This suggests that national terrestrial carbon stocks may be reduced due to expansion of economic activity.
- While the protection of rangelands and woodlands receive some attention in policy, the scope and location of interventions are not well defined outside of the NPAES.
- Voluntary contract agreements or biodiversity stewardship programmes hold advantages for landowners through fiscal incentives, and provides a cost effective means for protection and conservation of natural and semi-natural landscapes and associated terrestrial carbon stocks. However, these programmes have not been rolled out across a significant area of land.
- Only two policies have set specific targets relating to the improvements of natural landscapes, and there is very limited information on degraded areas requiring urgent rehabilitation and reclamation. These policies remain very broad and do not specify targeted interventions, making it difficult to quantify the potential carbon sequestration and conservation benefits.
- There is a lack of policies that refer to the unsustainable harvesting of fuel wood as a source of renewable energy, as well as a clear lack of policy addressing this issue.

Each category is considered in a separate section below (4.1-4.4)

3.1 Legally sanctioned protection of natural and semi-natural landscapes

Table 2. Policies Regulating and Controlling Protected Areas

Policy	Activity	Magnitude of impact
National Environmental Management: Protected Areas Act 2003	Protection and conservation of declared protected areas	Substantial
National Environmental Management: Biodiversity Act 2004	Protection and conservation of biodiversity that may fall outside protected areas	Substantial
National Biodiversity Framework 2009	Declaration and establishment of bioregions	Substantial
National Protected Areas Expansion Strategy 2008	Expansion of Protected Areas	Substantial
Guidelines Regarding the Determination of Bioregions and the Preparation of and Publication of Bioregional Plans	Identification and designation of critical biodiversity areas	Substantial
Land-Use Planning and Management Act	Future spatial planning makes provision for ecologically sensitive areas	Substantial
National Environmental Management Act 1998	Protection of ecologically sensitive areas (outside protected areas)	Substantial
National Environmental Management EIA Regulations 2006	Protection of ecologically sensitive areas (outside protected areas)	Substantial
National Environmental Management: Environmental Management Framework Regulations 2010	Protection of ecologically sensitive areas (outside protected areas)	Substantial
NEM: Biodiversity Act Threatened or Protected Species Regulations 2012	Regulating controlled activities to protect threatened or protected species	Substantial
Biodiversity Strategy and Action Plan	Promotion coordination of conservation network	Substantial
Conservation of Agriculture Resources Act 1983	Conservation of degraded land and soils	Substantial
National Parks Act 1967	Protection and conservation within national parks	Substantial
Regulations on the National Forests Act 2009	Regulating activities in forests and plantations	Moderate to Substantial
National Forests Act 1998	Protection of state forests and woodlands	Limited to Substantial

Table 3 Additional policies discussed in promotion of expansion of protected areas

Policy	Activity	Magnitude of impact
National Protected Area Expansion Strategy 2008	Expansion of Protected Areas	Substantial
Woodlands Strategy Framework for the Department of Water Affairs and Forestry 2005	Protection and Rehabilitation of Woodlands	Substantial

There are sixteen national policies that provide statutes for national protected areas as well as protecting species or sensitive ecosystems that may fall outside protected areas. Protected areas are generally subject to strict regulation with provision made for designation of protected areas, appointment of management authorities, preparation of management plans and strict regulation of activities within them. They include a range of designations: special nature reserves, nature reserves, protected environments, specially protected forest areas, forest nature reserves, forest wilderness reserves, mountain catchments and world heritage sites. The majority of protected areas are managed by government conservation authorities.

Less formally protected areas may include private nature reserves, national heritage sites and mountain catchment

areas or conservancies. These areas are regulated in order to conserve biodiversity as well as conserving ecosystem services. These areas are considered less formal as the management of these areas falls under private landowners.

Only a resolution of the National Assembly can exclude a portion of land from a special nature reserve; any declaration of a special nature reserve cannot be withdrawn once approved (Part 2, 19). Nature reserves are bound by less strict de-gazetting principles; on privately owned lands, it suffices for the Minister or MEC, or either of them by order of the owner, to withdraw the listing (Section 3, 24.1). Similarly, for a protected environment, the Minister or MEC can simply withdraw the listing through a declaration in the Gazette (Section 4, 29.a).

It is therefore most likely that above- and below-ground carbon stocks will be maintained in formally protected areas over the long-term. There may be some changes in carbon stocks due to, for example, a potential change in fire management in a particular conservation, but current policy will not directly or indirectly lead to a significant change in terrestrial carbon stocks located in conservation areas.

Conservation Legislation

The *National Environmental Management: Protected Areas Act 2003* is the central piece of legislation for the establishment and management of the protected area network. The *National Environmental Management: Biodiversity Act 2003,* which essentially contains the same underlying objectives as the *Protected Areas Act*, provides a suite of new legal tools for conserving many biodiversity priority areas that may lie outside the protected area network and are likely to remain so. These tools include bioregional plans, biodiversity management plans, as well as the listing of threatened or protected species regulations and regulations on alien invasive species.

The *National Biodiversity Act* provides for the adoption of the National Biodiversity Framework that provides for an integrated, co-ordinated and uniform approach to biodiversity management by all spheres of government, non-governmental organisations, private sector, local communities, other stakeholders and the public (Section 39). It also identifies priority areas for conservation action and the establishment of protected areas provide for regional cooperation and may determine norms and standards for provincial and municipal environmental conservation plans. The Framework identifies thirty-three actions to be undertaken in the next five years in order to implement its strategic objectives, highlighted in the *National Biodiversity Strategy and Action Plan*. It therefore provides an important framework to promote, inform and co-ordinate the short-term efforts of many organisations and individuals involved in conserving and managing South Africa's biodiversity.

The Minister of Water and Environmental Affairs has published the *Guidelines for the Determination of Bioregions,* which contains detailed information determining the boundaries of bioregions, the content to be included in a bioregional plan, the process to be followed in determining a bioregion and publishing a bioregional plan. Furthermore, it states that any such plan must identify a portfolio of critical biodiversity areas required to meet biodiversity pattern and ecological process targets and that these areas should include spatially explicit ecological corridors that need to be managed to ensure connectivity of natural habitat in the landscape.

The *National Biodiversity Act* also provides for the development of biodiversity management plans which may be called by a 'biodiversity management agreement'; the Minister may enter into such an agreement with stipulated bodies 'regarding the implementation of a biodiversity management plan, or any aspect of it' (Section 44). These bodies feasibly include government authorities, organisations and private landowners. In order to encourage persons to enter into such agreements, various income tax benefits have recently been introduced in respect of expenditure incurred in implementing them (see section 4.4 below).

The application and realisation of this set of Acts and associated planning and other mechanisms, provide good opportunity to both maintain large areas of intact natural landscapes that are under clear threat of degradation, as well as provide legal support for the restoration of important biodiversity and ecosystem service areas that have been degraded in the past. As such, these Acts and associated planning mechanisms, provide opportunity to maintain or increase the size of terrestrial carbon stocks above a business-as-usual scenario. It is however difficult to assess the magnitude of their effect on terrestrial carbon stocks and associated fluxes to date without a clear understanding of each case in which they have been exercised.

Further to more recent conservation legislation that provides the overarching legal framework for the protection of natural and semi-natural landscapes, the *Conservation of Agriculture Resources Act 1983 (CARA)* may also indirectly affect carbon stocks in agricultural landscapes. The regulatory tools inherent in this Act include the imposition of directives and control measures to control alien invasive species, prevent soil erosion, protect wetlands, regulate grazing capacity and prevent veld fires. Throughout our analysis of policies, CARA has rarely been cited by government departments. The most prominent citation of this Act has only been by the Department of Water Affairs for the reliance of protection of ecosystem services through the control of alien invasive species.

Land-Use Planning

Future land-use planning is entrenched in several national policies, for example, the *Land-Use Planning and Management Act,* 2013. When municipalities prepare integrated development plans, municipalities have to ensure they are aligned with a broad array of biodiversity plans prepared by conservation authorities, such as the *National Biodiversity Framework*, bioregional plans, biodiversity management plans and environmental frameworks.

Restrictions and Control Legislation

The *National Environmental Management Act* and associated *Environmental Impact Assessment (EIA)* framework aim to regulate and limit environmentally harmful activities. Environmental Impact Assessments are used to evaluate and constrain the potential harmful effects of land development activities - housing developments, industrial areas, agricultural activities, exotic plantations, road construction and so forth. Together, the *Environmental Management Act* and the *EIA* for the *Environmental Management Framework,* which enables authorities to assess all the possible impacts a potential development may have on any area's environmental attributes (sensitivity, extent, significance and interrelations) before approving such developments. This set of legislation and mechanisms can restrain the conversion of land and the potential release of biomass and soil carbon into the atmosphere, although it is principally focused on the conservation of biodiversity and rare and endangered ecosystems.

Key Findings

Although a substantial set of policies exist, there are few clear commitments on the expansion of formal conservations areas beyond the current network. Likewise, there are few clear references to which particular areas would be targeted by policy aimed at expanding the economy. It is however, reasonable to assume that many of the proposed activities (expansion of commercial and smallholder agriculture, expansion of mining, expansion of urban and peri-urban areas) may occur in what are presently natural and semi-natural rangelands.

Although the *National Forests Act* calls for the protection of woodlands, a target for protection must be defined by the Minister. In addition, the Minister may declare certain threatened or endangered woodlands as protected areas, as per section 12(1)(C) of the NFA, though this provision has not enjoyed widespread application. Beyond the legislative framework provided by the NFA only two policies that actively promote the protection of woodlands and grasslands –the *Woodlands Strategy Framework* for the Department of Water Affairs and Forestry (2005) and the *National Protected Areas Expansion Strategy* (2008). The *Woodlands Strategy* articulates the importance of prioritising woodlands due to their contribution to rural households and ecosystem services. The *National Protected Areas Expansion Strategy* (2008) identifies Lowveld savanna, Highveld grasslands, and grassland and woodland ecosystems in general to be the least protected biomes. These latter two policy documents are however only framework and strategy documents, and do not legally enforce the regulation and management of these biomes. The review noted that few policies include clear references or targets focussed on the protection of 'woodlands' and 'rangelands'.

3.2 Incentives promoting the participation of private landowners and communities in conservation

Table 4. *Policies incentivising the conservation of natural and semi-natural landscapes outside of formally protected areas.*

Policy	Activity	Magnitude of impact
White Paper National Climate Change Response	Offset Agreement	Substantial
National Protected Area Expansion Strategy 2008	Contractual Agreements	Substantial
Carbon Tax Policy Paper 2013	Offset Agreements	Substantial
Municipal Property Rates Act 2004	Property Tax Reductions	Limited to Substantial
Revenue Laws Amendment Act 2008	Income Tax Reductions	Limited
National Forests Act 1998	Community Forestry Participation	Limited
The Policy and Strategic Framework for Participatory Forest Management	Community Forestry Participation	Limited

There are seven policies that promote the participation of private landowners in protecting and conserving natural and semi-natural landscapes through fiscal incentives.

The NCCRP includes the potential development of a GHG offset trading platform as well as payment for ecosystem services. This platform is supported by the *Carbon Tax Policy Paper (2013),* which details how carbon taxes will be introduced and phased in as a greater low-carbon economy strategy. The Paper notes the exclusion of the AFOLU sector from carbon tax requirements for the first phase 2015 – 2019; however the sector may potentially be included in the tax's proposed offset scheme. Emissions reduction units (ERUs) could be generated through a number of land-use activities, ranging from restoring rangeland, woodland and forest ecosystems, to the avoided degradation of these same types of ecosystems. Prior experience in the development of such projects for validation through the Clean Development Mechanism (CDM), Verified Carbon Standard (VCS) or Gold Standard (GS), has shown that high transaction costs, general awareness and perceived risk have limited the roll-out to date. If these issues could be addressed in a new proposed offset scheme, it could strongly encourage such activities in the sector.

Voluntary contractual agreements with private landowners is a mechanism through which the total area under appropriate conservation management practices can be expanded in cost-efficient manner without purchasing additional land or expanding the country's formal protected area network. They often form part of biodiversity stewardship programmes that aim to conserve important biodiversity areas and rare ecosystems through providing financial incentives to land-owners to manage land in a manner that ensures conservation goals are met (NPAES, 2008). They have the potential to create a win-win scenario in that the country is able to realize its conservation goals in a more cost-efficient manner while landowners are able to increase and diversify their revenue streams.

The *Municipal Property Rates Act (2004)* states that no property tax can be levied on special nature reserves, national parks or nature reserves which are not developed or used for commercial, business or agricultural or residential purposes (Section 17). The property tax exclusion encourages private and communal landowners to convert land of high conservation value into forms of protected areas in order to avoid escalating property tax liabilities.

The *Revenue Laws Amendment Act (2008)*[8] makes provision for income tax incentives granted to landowners who agree to manage their land in a manner that leads to long-term conservation of biodiversity. Landowners are incentivised to conserve landholdings through both tax incentives and its associated penalties; if found in violation of the biodiversity management agreement, a fine equal to the tax deduction from the previous year is levied (Section 57.1d). In a similar manner to the *Municipal Property Rates Act*, further tax provisions are afforded to those that convert land into a protected area status for a minimum of thirty years, or land declared a national park or nature reserve (Section 37C, 4 and 5).

Further to this, an additional mechanism for the conservation of forests is provided through the development of community forestry, which is highlighted in the *National Forests Act (1998)* as well as the *Policy and Strategic Framework for Participatory Forest Management*.

Each of these policies and associated mechanisms has the potential to improve the management of natural and semi-natural landscapes across the county and in turn lead to the additional sequestration of carbon in soils and biomass, as well as halt the release of stored carbon into the atmosphere that may have occurred during the degradation of these ecosystems. The realisation of these mechanisms will be further explored during Sections 2 and 3 of the National Carbon Sinks Assessment when implementation models are considered.

3.3 The potential impact of water and fire management on carbon stocks and fluxes

Table 5. *Water and fire management policies*

Policy	Activity	Magnitude of impact
White Paper on Disaster Management 1999	Fire Management and Prevention	Substantial
Conservation of Agriculture Resources Act 1983	Clearing of Alien Species	Substantial
National Disaster Management Framework 2005	Fire Management and Prevention	Limited to Substantial
National Veld and Forest Fire 1998	Fire Management and Prevention	Limited to Moderate

8 The Revenue Laws Amendment Act 2008 seeks to amend the 1962 Income Tax Act in order to make provisions for environmental conservation and maintenance.

Policy	Activity	Magnitude of impact
Disaster Management Act 2002	Fire Management and Prevention	Limited to Moderate
The National Water Act 1998	Protection of ecosystems near water resources	Limited
Policy on Exemptions from the Duty to Prepare and Maintain Firebreaks	Fire Management	Limited

Policies aimed at promoting fire management include a cluster of disaster management policies (*White Paper on Disaster Management, Disaster Management Act, National Disaster Management Framework*), the *National Veld and Forest Fire Act* (1998) as well as the *Conservation of Agriculture Resources Act* (CARA) (1983). The *National Veld and Forest Fire Act* is closely linked with CARA, which contains specific provisions for the prevention and control of veld fires.

CARA has the potential to play a significant role in the conservation of natural and semi natural landscapes as it outlines controls and regulations of alien invasive species. While some alien invasive species provide commercial opportunities (e.g. black-wattle plantations), the generally prescribed management intervention is one of permanent removal of alien invasive plant species. This is principally due to the detrimental affect of alien invasive trees on water services. In terms of a demarcation of area for commercial ventures of alien invasive species, water use licenses must be issued for stream flow reduction activity under the *National Water Act (1998)*. The inter-relationship between the *National Water Act* and CARA are therefore important for the appropriate management of natural and semi-natural landscapes.

The net effect of these policies on terrestrial carbon stocks and fluxes is not necessarily clear. The clearing of alien invasive trees will lead to a release of sequestered carbon stocks into the atmosphere. However, the restoration of degraded and previously ploughed land as well as efforts to halt erosion, will likely lead to the sequestration of carbon in soils and biomass. Without a clear understanding of the spatial areas concerned, understanding the net effect of the policies on South Africa's terrestrial carbon stocks is difficult.

3.4 Increasing terrestrial carbon stocks through land restoration activities

Here, we focus on policies that may lead to the restoration of indigenous forests and woodlands. The expansion of commercial exotic plantations is considered elsewhere in the agricultural module.

Of particular note, the *National Strategy for Sustainable Development and Action Plan* (NSSD1) has set a target to rehabilitate 3.2 million hectares of land affected by degradation by 2014. However, the policy does not go as far as identifying particular areas or programs through which the rehabilitation would be realised. There is, however, a clear mandate to "strengthen land care, woodlands conservation, habitat rehabilitation, ecosystem rehabilitation, reforestation and other conservation farming programmes.", which in turn is likely to increase the size of both below- and above-ground carbon stocks (P.22)

In a similar manner, the *Strategic Plan 2012/2013-2016/2017* for DAFF has set a target of rehabilitating 32,280 hectares of degraded rangeland and areas that have been infested by alien invasive species. In addition, the Plan calls for the rehabilitation of 9,500 hectares of agriculture land (P. 77). Although the plan does not stipulate where the particular location of restoration efforts will be, it can be reasonably assumed that much of the area is likely to be in what is considered natural and semi-natural rangeland ecosystems.

Table 6. *Policies that promote the restoration of land*

Policy	Activity	Magnitude of impact
National Strategy for Sustainable Development and Action Plan (NSSD1) - 2011 -2014	Rehabilitation of degraded Land	Substantial
National Development Plan 2030	Restoration of the thicket biome	Substantial
A Woodland Strategy Framework for the Department of Water Affairs and Forestry	Rehabilitation of woodlands	Substantial
National Biodiversity Framework 2009	Reducing degradation	Substantial

Policy	Activity	Magnitude of impact
Integrated Growth and Development Plan for Agriculture, Forestry and Fisheries 2012	Forest restoration programmes	Substantial
Strategic Plan 2012/13-2016/17 for DAFF 2012	Indigenous forest rehabilitation	Substantial
National Environmental Management Act 1998		Substantial
NEM: EIA Regulations		Substantial
Conservation of Agriculture Resources Act 1983	Restoration and reclamation of eroded land	Limited to Substantial
National Forest Act	Rehabilitation and reforestation and sustainable forest management	Limited
National Disaster Management Framework 2005	Rehabilitation of degraded land	Limited
Human Capital Development Strategy: Environmental Sector 2009-2014	Improvement of conservation management	Limited
Draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries	Promotes efficient forestry practices	Limited
Draft National Water Resource Strategy II	Conservation and rehabilitation of lands supporting catchments, wetlands and river system health	Limited

In instances where land has been degraded by environmental incidences, the *National Environmental Management Act* (1998) makes provision for the remedy and rehabilitation of land. Such a remedial or rehabilitation event may trigger certain EIA regulation requirements (P.32), for example, a rehabilitation action plan. The impact of such requirements on terrestrial carbon stocks may, however, be limited due to their limited spatial scope.

The Conservation of Agriculture Resources Act stipulates that the Minister may undertake control measures to restore or reclaim eroded land as well as clearing invasive or alien plant species. The Act does not however contain restrictions on land types in which control measures may be applied. Again, it is reasonable to assume that much of the rehabilitation would occur in natural and semi-natural landscapes.

The recommendations from the *Woodland Strategy Framework* may lead to improved woodland management systems across the country's woodland systems. Rehabilitation and maintenance activities, potentially carried out through a partnership between LandCare, Working for Woodlands and the Expanded Public Works Program could increase woodland cover and associated carbon stocks. *The Woodland Strategy Framework* is therefore considered an important policy in terms of first sequestering additional carbon during the restoration process and then maintaining terrestrial carbon stocks over the long-term.

There are numerous policies that make a passing reference to rehabilitation; these include the *National Development Plan*, the *National Biodiversity Framework,* the *National Forests Act*, *Human Capital Development Strategy* and the *Draft National Water Resource Strategy II*. However, they provide little detail or discussion about potential land rehabilitation activities and are therefore not considered as important as the policies described above.

3.5 Renewable energy policy

Table 7. *Policies relating to renewable energy*

Policy	Activity	Magnitude of impact
White Paper on Energy Policy 1998	Increase of Renewable Energy from Biomass	Substantial
Integrated Resource Plan 2010	Increase of Renewable Energy from Biomass	Substantial

Policy	Activity	Magnitude of impact
White Paper on Renewable Energy 2003	Increase of Renewable Energy from Biomass	Moderate to Substantial
Department of Energy Revised Strategic Plan: 2011/12 - 2015/16	Increase of Renewable Energy from Biomass	Limited to Substantial
Green Economy Accord	Dissemination of Improved Cook Stoves	Limited

A key goal of government is to diversify South Africa's energy supply. This goal is conveyed in a number of policies, which stipulate government's intention to introduce 10,000 GWh of renewable energy into the national grid by 2014. At present, 9% of South Africa's energy mix is renewable energy, largely in the form of fuel wood where 65% of poor households rely on open fires for heating and cooking (*White Paper on Energy Policy*). This source of energy is however not necessarily sustainable due to potential over-harvesting.

Government acknowledges the degradation of woodlands caused by unsustainable harvesting practices in the *White Paper on Renewable Energy*. The White Paper includes the intention to conserve woodlands through the provision of alternative forms of energy to rural communities including paraffin, liquid petroleum gas (LPG) and other renewable energy alternatives such as mini-grid systems, gel fuel, solar cookers and solar water heaters.

The *Integrated Resource Plan,* which was published in 2010 (a later date relative to the initial communication of government's intentions regarding renewable energy targets), makes little reference to rural communities' reliance on fuel wood. The same applies for the *Department of Energy's Revised Strategic Plan 2011/2012 – 2015/2016*. The *Green Economy Accord (2011)* however aims to roll out improved cook stoves, which may indirectly relieve pressure on woodlands. An analysis of the policies listed above indicates that the significant reliance of rural communities on fuel wood is not included in many recent important policies. As the policies generally aim at uplifting the rural poor through the provision of services, they could provide substitutes for fuel wood collection, reducing pressure on woodlands, but there are few direct references to direct sustainable woodland management interventions.

Module 4 – SECTION 3

Policies affecting agricultural landscapes

Land under agricultural production represents the fourth largest land-cover type in South Africa covering approximately 144,000km^2 (Scholes at al. 2013, see Module 3). Historically, the expansion of commercial agriculture has been a significant driver of changes in the terrestrial carbon stock through both the removal and combustion of above-ground biomass as well as the release of soil carbon stocks into the atmosphere following the ploughing and turn-over of soils.

In this module, we review the potential influence of policy on terrestrial carbon stock in four different types of agricultural landscapes:

- Commercial crop farming
- Commercial livestock farming
- Commercial exotic plantation forestry
- Small-scale agriculture – The term 'small holder' is not used consistently in policy. The Department of Agriculture, Forestry and Fisheries' *Strategic Plan for Smallholder Support* defines a smallholder in terms of his/her linkages to a market economy. It promotes the definition of smallholders as individuals who "produce food for home consumption, as well as sell surplus produce to the market" (1). In comparison, the *National Development Plan* adopts a definition linked to the size of land under cultivation. It classifies farmers according to the size of their land holdings. Subsistence farmers are those that own 0.5 ha or less. Small-scale holders are split into two categories: those with over 0.5 ha to 5 hectares of land, and those that have more than 5 hectares. For the purposes of this review, we have adopted the term 'small-scale agriculture' to refer to all small-holder and subsistence farms i.e. those that are not large commercial concerns.

Fifty-two policies were identified as potentially having a direct or indirect influence on terrestrial carbon stocks and associated GHG emissions in agricultural landscapes (Appendix 1). Grouped by the overarching measures presented in each policy, some policies figure in multiple categories. The policies are listed in order of the perceived magnitude of their influence on carbon stocks and associated emissions. It should be noted that this is a relative magnitude measure of each policy when compared to others, not in relation to the country's national carbon stock. Policies that have limited impacts do not feature prominently in the written analysis. Emerging categories include policies that:

- Promote an increase in the area under commercial agriculture (excl. plantation forestry)
- Promote plantation forestry
- Support sustainable agricultural production
- Are focused on Land Reform and facilitating an increase in the expansion of agriculture
- Establish controls and restrictions on land-use and support improvements in spatial planning
- Promote alternative land-use options that may convert or displace agricultural land

4.1 Key findings

- Many of the priority Presidential policies promote substantial agricultural expansion. Due to the nature of broad policies, there are limited specifics on the type of agriculture and whether it will follow 'conservation tillage' practices when implemented. Agricultural expansion without improved cropping techniques could result in substantial decrease in soil carbon stocks.
- Only one of the Acts reviewed, the *Conservation of Agricultural Resources Act (1983)*, attempts to introduce cultivation techniques that may reduce soil turnover (conservation tillage) and the associated release of existing soil carbon stocks into the atmosphere. It is however not regularly referenced in strategic plans promoting agricultural expansion, and thus has limited visibility. A lack of enforceable legislation governing cultivation practices may be an issue if reducing GHG emissions from the agricultural sector is a priority (especially during the anticipated expansion of the area under agriculture in the next 10-20 years).
- Many policies call for improved spatial planning and controls on activities that impact ecosystems and the environment. Properly implemented, these may limit areas under which agriculture can expand or the types of agriculture that can be practiced. This would likely

yield net-positive benefits for conservation of national terrestrial carbon stocks.

- Poorly managed farms, leading to land degradation, soil nutrient depletion and irreversible losses of critical ecosystem services, could qualify as contributing to natural disasters; thus the *Disaster Management White Paper* and attendant legislation provide a legal basis for potentially monitoring these farms.
- Most policies that promote improved agricultural techniques or enforce spatial planning discipline tend not to originate from the Department of Agriculture, Forestry and Fisheries (DAFF). Improved agricultural practices seem secondary to other objectives and not necessarily complementary to this department's expansion targets. This may have implications for terrestrial carbon stocks, which may be reduced under DAFF's current agricultural expansion proposals.
- In a number of cases, similar geographic areas are targeted by policies that promote the expansion of the area under cultivation and a significant body of existing legislated policies that aim to manage impacts on the natural environment and protect natural resources. In these instances, it is not possible to assess impacts on national terrestrial carbon stocks, due to conflicting land-use objectives. However, this does highlight the opportunity for Government to promote further integration and alignment of departmental and ministerial plans and strategies.
- The *Protected Areas Act* and the *Biodiversity Act* appear to have precedence over all other national legislation when increasing or managing protected areas and biodiversity is concerned. The precedence of these two acts may be crucially important when potential conflict between agricultural growth and the protection of biodiversity is considered.
- Although biofuel production is promoted in numerous policies, its expansion is only likely to affect a small part of the national area that is currently under cultivation and should only have a limited impact on the loss of national terrestrial carbon stocks.

4.2 Policies promoting increases in commercial and small-scale agriculture

Table 8. *Policies promoting increases in the area under commercial and small-scale agriculture (excluding plantation forestry)*

Policy	Activity	Magnitude of impact
New Growth Path	Increase the area under agricultural production; support the land reform process; support plantation forestry	Substantial
National Development Plan	Promotion of the expanded protected areas strategy, increase land under agricultural production; improve spatial planning; improve agricultural techniques such as composting; support the land reform process	Substantial
Industrial Policy Action Plan: 2012/2013 – 2014/15	Increase agricultural production, including biofuels and commercial forestry	Substantial
Medium Term Strategic Framework: 2009 – 2014	Increase land under agricultural production and plantation forestry, and growth of the agro-processing industry	Substantial
The Strategic Plan for South African Agriculture	Rapid expansion of land under agricultural production	Substantial
Strategic Plan for Smallholder Producers	Support new smallholder producers by 2020, including in the former homelands. Limited to marginal commitment to agro-ecological agriculture	Substantial
Department of Rural Development and Land Reform, Strategic Plan 2011-2014 (amended 2013)	Expansion of small-scale agricultural production	Substantial
Integrated Growth and Development Plan: Agriculture, Forestry and Fisheries	Agricultural expansion, mediated by improved farming techniques, including conservation agriculture, soil rehabilitation	Moderate to Substantial
Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries	Agricultural expansion, notably of small-scale farmers, complemented by conservation of agricultural lands, limited rehabilitation of rangeland and soils, and support of climate-smart agriculture	Substantial
White Paper on Renewable Energy	Production of biofuels	Moderate to Substantial
Department of Energy Revised Strategic Plan: 2011/12 - 2015/16	Increase in biofuel production	Limited to Substantial

Policy	Activity	Magnitude of impact
Draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries	Support expansion of biofuel production; promotes adoption of "climate smart" agricultural techniques; improved spatial planning	Limited to Moderate
Integrated Strategy on the Promotion of Entrepreneurs and Small Enterprises	Expansion of small-scale agriculture and of agro-processing capacity,	Limited to Moderate
Biofuels Industrial Strategy of the Republic of South Africa	Expansion of the biofuels industry	Limited to Moderate
Long-term Mitigation Scenarios	Increase in biofuel production	Limited
Green Economy Accord	Increase in biofuel production	Limited
National Climate Change Policy Response White Paper	Increase in biofuel production	Limited (with regards to biofuel production)

The seventeen policies in Table 8 promote the expansion of agriculture. While is it is difficult to predict the reality of future implementation of this set of policies, the first eight in Table 8 are anticipated to have a significant impact on expanding the area under agricultural production. From these seventeen policies, important themes emerge.

The Presidency has developed the most prominent policies promoting agricultural expansion:

- The New Growth Path (NGP)
- Of which the Industrial Policy Action Plan (IPAP) is an enabling policy
- The National Development Plan (NDP)
- The Medium Term Strategic Framework (MTSF)

These policies focus on improving economic growth, rural development, food security and job creation. Agriculture is viewed as a means of achieving these objectives. Other than an overarching focus on promoting smallholder production, there is limited detail to these plans, both in terms of their location and the crops that will be grown. The policies do not identify what farming practices should be promoted as part of the expansion, and do not articulate how their objectives align with existing environmental or spatial planning policies.

The MTSF is a planning reference for all spheres of government, including national departments. Its vision and objectives are to be integrated into various departmental strategic plans (MTSF, 1). Critically, the MTSF is concerned with job creation and economic growth, following the 2008 economic crisis (MTSF, 2). A major focus area is growth in the agricultural sector, downstream food processing and the timber value chain (MTSF, 3). Small-scale agricultural production is promoted, notably as a means of reducing food insecurity. It seeks to provide 140,000 households per annum with agricultural starter packs, and limit non-agricultural developments on prime arable lands. This would theoretically impact some 700,000 households over five years. The Plan states a commitment to "supporting local and sustainable food production" (MTSF, 38).

In a similar manner, the NGP includes broad figures for job creation in the agricultural sector but limited reference to the particular type of agriculture. It seeks to create 300,000 job opportunities for small-scale farmers by 2020, and supports commercial agricultural expansion, as well as development of local food gardens. The *Strategic Plan for Smallholder Producers* aligns with the NGP. In this document, it appears that "sustainable" refers to the financial sustainability of a farm and not soil health or other environmental considerations - water supply, soil erosion, land degradation or ecosystem services.

The *Industrial Policy Action Plan* is firmly focused on the creation of agro-processing jobs and industries, supporting soybean production, the rooibos and honeybush tea industries, fruit and vegetable canning, general food processing and maize milling. Only its objective of promoting the organic food sector indicates the possibility of adopting cultivation processes that may improve soil organic material and associated soil carbon stocks.

Of the set of reviewed policies, only the NDP integrates considerations of natural resource management, improved cropping techniques and promotion of the *National Protected Areas Expansion Strategy*. Although it seeks to improve spatial planning approaches, it does not directly address the ways in which agricultural growth balances with the expansion of protected areas and conservation zones. It seeks to create some 643,000 jobs in agricultural production and includes provisions for the expansion of woody crops (avocado, grapes and citrus farms) over some 21,000 hectares as well as plans to irrigate some 500,000 ha of agricultural land.

These plans are complemented by three key policies developed by DAFF and one from the Department of Rural Affairs and Land Reform. These are:

- The Strategic Plan for South African Agriculture
- Strategic Plan for Smallholder Producers
- Strategic Plan for the Department of Agriculture, Forestry and Fisheries
- Strategic Plan for the Department of Rural Affairs and Land Reform

All four of these policies call for the rapid growth of the land area under agricultural production. *The Strategic Plan for the Department of Rural Affairs and Land Reform* seeks to create 500,000 rural farming jobs over 10 years, redistribute over 1.1 million hectares of land as part of its land reform commitments, and further survey and register 300,000 hectares of state land. This is complemented by the creation of 67,929 food gardens and 39 agri-parks.

Both the *Strategic Plan for South African Agriculture* and the *Strategic Plan for the Department of Agriculture, Forestry and Fisheries* seek to encourage sustainable agricultural practices, including soil conservation and rehabilitation, composting, improved crop rotations, and conservation agriculture. Similarly, the *Strategic Plan for Smallholder Support* notes these types of interventions – but only devotes two lines of text to "conservation agriculture" and "eco-agriculture" production support. It relegates the advancement and promotion of these activities to future policy development. In the absence of further details on timing and mechanisms, it is difficult to understand the extent to which these practices would be implemented across both commercial and small-scale production. Part of the difficulty in interpreting the scope and applicability of the various strategic plans is a lack of targets by which to assess the impact of the interventions. Among the abundance of policies dedicated to biofuel production, only the *Biofuels Industrial Strategy of the Republic of South Africa* provides any clear targets; with an expected 300,000 hectares under cultivation for its pilot phase.

Collectively, these policies seek to create agricultural opportunities for over three million individuals. If implemented, this could lead to increases in land under cultivation well into the millions of hectares – potentially increasing total land under production by some 20 – 30%.

In terms of identifying gaps and conflicts in land-use policy, there appears to be substantial overlap or 'conflicts' both between policies and within the existing legislative framework. For example, several policies promote different types of land-use in the same areas (expanding agriculture, mining, urban and conservation areas). This may well be addressed during implementation when a balance between goals and priorities in a number of policies could be struck, but as is, the text in standing policies shows considerable opportunity for improved policy integration.

The potential effect on terrestrial carbon stocks and associated GHG emissions

The establishment of new cultivated land in areas that were previously natural or semi-natural landscapes, typically leads to a release of sequestered carbon into the atmosphere. Existing vegetation cover is usually cleared, releasing the carbon stored in biomass. Cultivation also eliminates the possibility of further long-term biomass accumulation of herbaceous and woody cover. In a similar manner, ploughing and the turnover of soils allows sequestered soil carbon to be released into the atmosphere. As the soil is re-tilled every year or second year, there is little chance for carbon stocks to reach the same levels after the first ploughing event. In general, about 50% of organic carbon from the top 0-30cm of soil is released into the atmosphere following ploughing in dry land cropping systems. For irrigated crops, orchards and vineyards, and sugar cane it is generally less (20%, 20% and 40% respectively). These percentage carbon loss figures should be seen as a general estimate that will change depending on the particular soil and climatic factors as well as agronomy techniques employed.

The policies considered above promote the expansion of areas under agriculture, but provide few details on the agricultural methods or principles that should guide expansion. Although it is reasonable to assume that the realization of this set of policies will result in a net release of soil carbon stocks into the atmosphere, it is difficult to estimate the magnitude of the net effect on the national terrestrial carbon stock. If implementation occurs in areas that have been previously ploughed or degraded, the magnitude of the effect is likely to be low and even neutral. If, however, implementation occurs in intact natural ecosystems, for example the higher, altitude temperate grasslands of KwaZulu-Natal, the Eastern Cape and the eastern Free State, ploughing of virgin soils will result in a significant initial decrease in soil carbon. In light of emerging research and the Government's increased focus on climate change, this presents DAFF with the opportunity re-articulate its commitment to the legislated agricultural production principles found in CARA. The department may want to consider reviewing and updating its policies, with a focus on promoting planning and technologies that will reduce soil carbon losses and promote soil health by means that still meet employment and food security goals. More detailed recommendations for this are found in the section 3.2 Policy Recommendations Report.

4.3 Policies promoting increases in plantation forestry

Table 9. Policies promoting an increase in the area under plantation forestry

Policy	Activity	Magnitude of impact
Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries	Agricultural expansion, notably of small-scale farmers, complemented by conservation of agricultural lands, limited rehabilitation of rangeland and soils, and support of climate-smart agriculture	Substantial
Draft Strategy Framework for Forestry Enterprise Development	Support of small-scale commercial forestry	Moderate to Substantial
Forest Sector Transformation Charter	Support of plantation forestry	Limited to Moderate
Policy and Strategic Framework for Participatory Forest Management	Improved inclusion of communities in forest management	Limited to moderate
Framework for the National Forestry Programme	Expansion of plantation forestry activities	Limited
Forestry 2030 Roadmap	Afforestation of 100,000 ha of land, support of rehabilitation and conservation, improved mapping and land use planning to facilitate woodland / forest conservation	Limited

Plantation forestry in South Africa covers an area of 17,000km^2 and contains approximately 4% of the national terrestrial carbon stock (Scholes et al. 2013, Module 2). It receives extensive policy attention likely due to the industry's contribution to the economy (1.2%) and job creation in rural areas where few other employment opportunities exist (170,000 people currently employed nationally).[9] An overarching theme is the inclusion of previously disadvantaged persons and communities in the sector. Guiding principles are inclusion, improved levels of participation and a more equitable distribution of economic benefits. Means of achieving this include provision of extension services, insurance, inputs, pest and disease management, fast-tracking afforestation licensing, small-grower certification and training. These types of interventions are found in varying degrees across all policies.

Six policies promoting the development of plantation forestry were identified. These make reference to large-scale commercial concerns as well to smaller-scale undertakings in the form of woodlots or community-managed forestry efforts. The policies are reasonably aligned with one another – some of the targets vary considerably, but there is frequent cross-referencing in the policies' texts.

The establishment of plantations (afforestation) typically leads to a significant increase in both above- and below-ground biomass (tree root) carbon stocks. The influence of afforestation on organic carbon stocks is less clear. A study by Berthrong et al. (2012) in a part of South America with a similar rainfall regime to South Africa indicated that the influence of afforestation on soil carbon stocks is significantly affected by rainfall (mean annual precipitation). The afforestation of dry grasslands tends to lead to a net increase in soil organic carbon stocks, whereas the establishment of plantation in wet grasslands tends to lead to a decrease in soil carbon stocks.

There are further considerations when estimating the net effect of afforestation on carbon stocks. First, is an assessment of the type of land-cover being replaced – the establishment of plantations on degraded or previously cultivated land will significantly increase carbon stocks whereas the replacement of indigenous forests, woodlands or temperate grasslands, will result in a lower net increase. Second, as a plantation is harvested in a cyclical manner, the net increase in carbon stocks should be calculated as the average stock over the growing period, not the stock at the end of the growing period.

9 Integrated Development Plan

The realisation of the policy goal of expanding plantations and woodlots by 50,000 to 200,000 hectares (a 3-12% increase on current area of plantations) will lead to a net increase in the size of terrestrial carbon stocks but as highlighted above, the net effect may not be as high as first presumed and may need to be assessed at a site-specific scale to understand the effect of the factors highlighted above.

4.4 Policies focused on land reform

Table 10. *Policies focused on Land Reform, facilitating increases in agriculture*

Policy	Activity	Magnitude of impact
National Development Plan	Promotion of the expanded protected areas strategy, increase land under agricultural production; improve spatial planning; improve agricultural techniques such as composting; support the land reform process	Substantial
Medium Term Strategic Framework: 2009 – 2014	Increase land under agricultural production and plantation forestry, and growth of the agro-processing industry	Substantial
Integrated Growth Plan for Agriculture, Forestry and Fisheries	Supports the NDP, MTSF and Green paper on Land Reform	Substantial
Land Reform: Provision of Land and Assistance Act, no 126 of 1993 (including its amendments up to 2008)	Land reform and distribution, potentially leading to increases in agricultural production	Moderate to Substantial
Department of Rural Development and Land Reform, Strategic Plan 2011-2014 (amended 2013)	Expansion of small-scale agricultural production	Substantial
Green Paper on Land Reform	Land redistribution, potentially leading to increases in agricultural production	Limited to Moderate

The State generally views land redistribution, restitution and tenure reform as critical to unlocking the agricultural potential of South Africa. Land reform is viewed as central to encouraging agricultural expansion among previously disenfranchised persons. This is achieved both through the redistribution and restitution of land and improving security of tenure. The major drivers of land reform are the NDP and the *Medium Term Strategic Framework (MSTF)*. The *Green Paper on Land Reform* is regarded as having limited to moderate impact as it is likely to be revised prior to being released as a White Paper; it is difficult to predict what these changes might be. Nonetheless there is strong alignment and coherence between the leading land reform policies.

The MTSF asserts that it aims to "…ensure land reform (redistribution and restitution) is more coherently linked to the creation of livelihoods for the poor and that strategically located land is released for the most appropriate use without delay." (19). This objective is also affirmed in the NDP, which views land reform, job creation and increased agricultural production as key drivers in improving the rate of rural development (44). Opening up communal lands will allow for the expansion of lands under cultivation. The *Integrated Growth Plan* aligns with the MTSF and NDP; the Department of Rural Development and Land Reform views land reform as underpinning a sustainable transformation of the rural economy.

The *Land Reform: Provision of Land and Assistance Act*, supports the state's land reform objectives. Through a trading entity, it oversees the acquisition, redistribution, and leasing process, and allows for the provision of funding and support to cover the costs of acquisition and distribution. The Act seeks to ensure improvements on land, which can include agricultural production. Through the disbursal of grants, subsidies or other financial incentives, the Minister can encourage activities on that land, including for "acquisition, maintenance planning, development or improvement of property…" (10.b.iii of 2008 Amendment).

The overriding principle of land reform and redistribution is the improvement of rural livelihoods. Strengthening land tenure and security is expected to lead to increased cultivation practiced by a wide range of farming actors, including subsistence, small-scale, and commercial farmers. The NDP confirms that "As long as these farmers [black farmers in communal areas] (especially women farmers) do not have secure tenure they will not invest in the land and agricultural production will not grow at the rate and pattern required for growth in employment" (225).

As described in the MTSF, the land reform process will be targeted at the most "suitable" lands, likely grasslands for their crop yield potential and location in favourable climatic conditions. This change in land-use would lead to significant

releases of soil carbon stocks and further removal of woody biomass in grassland systems. Depending on the pace, scale, location and uptake of agriculture during the reform process, this could lead to the emission of very high amounts of greenhouse gases.

4.5 Policies promoting sustainable landscapes and associated agricultural production

Table 5.6. *Policies Promoting Sustainable Agricultural Production*

Policy	Activity	Magnitude of impact
National Climate Change Response White Paper	Supports conservation efforts; improvements in agricultural production, notably for protecting soil health	Substantial
National Biodiversity Framework	Improved conservation efforts and soil rehabilitation; improved spatial and land-use planning; improved grazing regimes	Substantial
National Development Plan	Promotion of the expanded protected areas, increase land under agricultural production; improve spatial planning; improve agricultural techniques such as composting; support the land reform process	Substantial
Conservation of Agricultural Resources Act (CARA), 1983	Improved agricultural practices	Substantial
Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries	Agricultural expansion, notably of small-scale farmers, complemented by conservation of agricultural lands, rehabilitation of rangeland and soils, and support of climate-smart agriculture	Substantial
National Strategy for Sustainable Development and Action Plan (NSSD1) – 2011 -2014	Promotion of improved agricultural techniques: conservation agriculture, composting, permaculture ; but also promote expansion of land under conservation ; promotion of biofuels	Substantial
Integrated Growth Plan for Agriculture, Forestry and Fisheries	Supports the NDP, MTSF and Green paper on Land Reform	Substantial
Policy on Agriculture in Sustainable Development	Improved agricultural techniques, including composting, reduced fertilizer use, conservation tillage, soil rehabilitation, and improved spatial planning	Limited

Eight policies within the reviewed catalogue broadly support various forms of 'sustainable' agricultural production, called "conservation agriculture", "climate smart agriculture" and "sustainable agriculture". More detailed definitions and descriptions of what these terms refer to is limited. However, most of the policies proposed a broad common set of activities:

- Protection of soil health, including the use of conservation tillage
- Rehabilitation of rangelands and soils
- An increase in organic composting
- Reduced dependence on chemical fertilizers
- Improved cropping techniques, broadly called conservation agriculture, sustainable agriculture or climate smart agriculture
- Improved grazing regimes

For some policies, improved agricultural techniques are not an overriding priority. For others, it is a critical means for achieving the policy's core objectives. The *National Climate Change Response White Paper*, the *Conservation of Agricultural Resource Act*, the *Policy on Agriculture in Sustainable Development*, the *National Biodiversity Framework*, and the *National Strategy for Sustainable Development II* all prioritise conservation and responsible natural resource use. Improved management of landscapes, including land under cultivation, is key to their vision. However, each of these documents has its limitations:

- *Policy on Agriculture in Sustainable Development:* This is a discussion document that is over a decade old. It provides an outline of what a policy might look like, but remains in its early inception phase. It has not been updated since its first drafts. It may have lost buy-in due to its inactivity.
- *Conservation of Agricultural Resources Act (CARA):* Despite its potentially substantial impact, the DAFF's strategic and integrated plans only makes passing reference to CARA. This is a legislated policy. By law, its provisions are binding and must be adhered to. However, it appears to have limited influence in guiding departmental strategic plans.

- *The National Climate Change Response White Paper (NCCRP):* The White Paper seeks to integrate its objectives into existing programmes and policies. But its priorities for supporting agricultural techniques as a strong climate change adaptation strategy do not feature strongly in departmental strategies and objectives. To date, this has not been prioritized in the Department of Agriculture's planning. This may merely be an issue of timing and the required period required to visit policies following the publication of the NCCRP.
- *The National Biodiversity Framework (NBF):* The Framework seeks to partner with the private sector actors involved in agricultural production to try to reduce degradation of natural ecosystems. Similarly, it seeks to ensure that DAFF adopts measures to reduce alien invasive vegetation. Neither of these commitments is accompanied by spatial or temporal targets.
- *The National Strategy for Sustainable Development II (NSSD):* The strategy notes in its Action Plan that it intends "Reforming agricultural legislation to support sustainable farming practices" (p. 24). It recognises that there is a significant gap in legislation in promoting improved farming practices. Despite being published in advance of either the *Integrated Plan* or *Strategic Plan*, it is not cited in either of these documents.

The Integrated Growth and Development Plan: Agriculture, Forestry and Fisheries (Integrated Plan), the *Strategic Plan 2012/13-2016/17 for DAFF* (Strategic Plan), and the *Strategic Plan for Smallholder Support* all make provisions for improved agricultural techniques, for example:

- The *Strategic Plan* calls for the rehabilitation of 9,500 hectares of agricultural land in its annual performance plan; this is complemented by the goal of launching one natural agricultural resource management strategy in one municipality. Introductory statements from both the Minister and Deputy Minister for the Department support improving agricultural techniques to respond to climate change; however there is limited discussion around this in the strategic plan itself.
- The *Integrated Plan* promotes an intervention that will fund and implement "Soil rehabilitation and forest restoration programmes…" (p. 56). Similarly, it commits to "Implement production efficiency models in line with conservation agriculture." and "Greater awareness and use of sustainable practices".
- The *Strategic Plan for Smallholder Support* simply notes that "…government will increasingly seek to build…a coherent focus on conservation agriculture and agro-ecological agriculture. "

Although these policies address improved agricultural techniques, there is limited alignment between these policies. The legislation in the field is limited to CARA, which appears to not have influenced DAFF's current strategies. Plans that call for wide-sweeping changes in agricultural policy – the NCCRP, the NDF and the NSSD – rely on the cooperation of DAFF; but in turn, these aims have not fully integrated into DAFF's plans as yet. It is worth noting that CARA, the *National Biodiversity Framework* and the *National Sustainable Development Strategy* are not mentioned in DAFF's strategic and integrated plans. In contrast, policies promoting agricultural expansion – the NGP, the *Medium Term Strategic Framework*, and the *Industrial Policy Action Plan* feature prominently in DAFF's plans.

The promotion of conservation agriculture, climate smart agriculture and sustainable agriculture, will most likely lead reduced negative impact on the size of the national terrestrial carbon stock in a number ways:

- An increase in soil carbon stocks of cultivated land following an increase in composting and conservation tillage practices.
- An increase in above and below ground carbon stocks following the restoration of rangeland systems used for commercial and small-scale livestock production.
- The avoided degradation of rangeland systems, and associated release of sequestered carbon into the atmosphere. This would be done through the adoption of appropriate grazing and burning regimes. It should be noted that the over 65% of South Africa's terrestrial carbon stock is located in natural and semi-natural grassland, savanna and thicket ecosystems (CSIR 2013, Module 2). Within these ecosystems, over 90% of the total carbon stock is located in soils.
- The restoration and sustainable management of rangeland systems may be one of the principle ways in which South Africa's national terrestrial carbon stock can be maintained over the long-term.

However, for these benefits to be realized, and the potential of rangelands to contribute to the management of South African terrestrial carbon stocks, future amendments to policies or new policies should improve clarity on spatial and temporal targets.

4.6 Policies that control certain land-use practices and promote improvements in spatial planning

Table 11. Policies that promote spatial planning and control certain land-use practices

Policy	Activity	Magnitude of impact
Spatial Planning and Land-Use Management Act	Improvements in spatial planning and land-use management	Substantial
Strategic Plan for the Environment Sector: 2009-2014	Increase land under conservation; improve spatial planning, improve agricultural techniques	Substantial
National Environmental Management Act	Potential control and restrictions on the location, extent and type of agriculture practiced, including offset or remediation efforts	Substantial
National Environmental Management Act: EIA Regulations	Potential control and oversight of the types, location and intensity of agricultural production permitted. Including limiting production within areas targeted by environmental management frameworks	Substantial
National Biodiversity Framework	Improved conservation efforts and soil rehabilitation; improved spatial and land-use planning; improved grazing regimes	Substantial
Guidelines Regarding the Determination of Bioregions and the Preparation of and Publication of Bioregional Plans – NEMA: Biodiversity Act of 2004	Improved land-use and spatial planning that address natural resource conservation and biodiversity preservation, could limit the scope, location and intensity of agricultural production	Substantial
NEMA: Air Quality Act	Potential control of and restrictions on land-use activities that release GHG emissions	Substantial
National Development Plan	Efforts to expand the protected areas strategy, as well as increase land under agricultural production; improved spatial planning; improved agricultural techniques such as composting; support to the land reform process	Substantial
National Environmental Management Act: Environmental Management Framework Regulations	Spatial Planning improvements, leading to development of Environmental Management Frameworks may restrict methods, intensity and location of agricultural production	Moderate to Substantial
Disaster Management White Paper	Potential to limit land degradation trends, which may impact on location, type and intensity of agricultural production	Limited to Substantial
Disaster Management Act	Potential to limit land degradation trends, which may impact on location, type and intensity of agricultural production	Limited to Substantial
National Disaster Management Framework	Potential to limit land degradation trends, which may impact on location, type and intensity of agricultural production	Limited to Substantial
Draft National Water Resource Strategy II	Potential reduction in amount of land made available for plantation forestry activities	Limited to Moderate

This body of policy seeks to limit inappropriate land-use practices and promote more comprehensive land-use planning. Comprised of fourteen policies, they provide for improved spatial planning discipline, propose frameworks through which to analyse, manage and restrict adverse land-use impacts, and take into consideration the impacts of various activities on ecosystem services and downstream users. The majority of them are legislated Acts, Regulations and Frameworks and therefore are legally enforceable.

The cluster of *National Environmental Management Act* policies (NEMA) is particularly significant:

- The National Environmental Management Act
- The National Environmental Management Air Quality Act (NEMA:AQA)
- The National Environmental Management Environmental Impact Assessment Regulations (NEMA:EIA)
- National Biodiversity Framework (NBF), mandated by the Biodiversity Act (NEMA:BA)
- Guidelines Regarding the Determination of Bioregions and the Preparation of and Publication of Bioregional Plans (Guidelines, mandated by NEMA: BA).
- National Environmental Management Act: Environmental Management Framework Regulations

They make provisions for controls, oversight, licensing, the issuing of permits and environmental auditing. Published listings detail activities requiring permissions prior to being undertaken. NEMA and its sub-Acts focus on a core principle, namely that the degradation of ecosystems and the attendant harm to biodiversity should be avoided, and where they cannot be, be minimised or remedied (2.4.a.i). Sustainable development and conservation of biodiversity and ecosystem services are paramount.

NEMA calls for the use of environmental management tools to achieve its objectives. These include the use of Environmental Impact Assessments, Environmental Management Frameworks, and Bioregional Plans. In all instances, the purpose is to provide opportunity for pro-active integrated environmental management – assessing projects against predefined criteria, assessing risks, evaluating alternatives and providing for remedial activities where required. The "duty of care" is placed on the individual or entity responsible for natural resource degradation. In some instances, activities will not be authorized until provisions for remedial or restoration activities are agreed to.

The implications of the NEMA family of legislation are significant. Depending on their interpretation and application, they could lead to increased controls and oversight of agricultural production. For example, under NEMA:AQA, greenhouse gases may be regulated – agricultural practices such as excessive fertilizer use, ploughing and unrestricted grazing that lead to additional GHG emissions, may be restricted or subject to licensing. Bioregional Plans as well as Environmental Frameworks are used to balance development priorities (e.g. the need to expand areas under cultivation - Section 5.3) with ensuring ecosystem health and associated ecosystem services are maintained.

This family of policies is supported by other policies that also seek to improve spatial planning discipline. The *Spatial Planning and Land-Use Management Act* seeks to establish improved planning processes, bringing more uniformity to land-use activity applications, assessment, approval and authorization. It also seeks to "…provide a framework for policies, principles, norms and standards for spatial development planning and land use management." The conservation of biodiversity and ecosystem services is considered a viable land-use activity under the Act. The Act dovetails with the NEMA family of policies, and may rely on their environmental provisions quite substantially.

Moreover, the cluster of disaster management policies may additionally influence the location, scope and intensity of agricultural practices. These include the *White Paper on Disaster Management*, the *Disaster Management Act*, and the *National Disaster Management Framework*. This cluster of policies stresses the importance of practicing pro-active risk assessments and implementing early risk mitigation measures. This applies not only to preparing emergency response measures for high-profile disasters, such as fatal mudslides, flash floods or fires, but also in addressing disasters that have the potential to gradually build in significance. In the *Disaster Management Act*, a disaster is deemed:

According to the *National Disaster Management Framework*, under Key Performance Area 2, environmental hazards such as land degradation, deforestation and loss of biodiversity are included in risk assessments as per international best practice for hazard classification (2.1.7). Climate change could be designated as a risk, linked to severe instances of land degradation, soil nutrient depletion and erosion or loss of critical biomes that support ecosystem services. The results of risk assessments could lead to updates of national, provincial and local disaster management plans. These updates could include provisions for limiting soil erosion, land degradation and natural resource exploitation trends. This legislation could be used to limit the location, scope, intensity and types of proposed changes in land-use, for example the conversion of intact natural and semi-natural landscapes to cultivated lands or built environments.

These types of interventions are reiterated in national level presidential and departmental plans. The NDP promotes the development of a national spatial framework –already encapsulated in the *Spatial Planning and Land-Use Management Act* to a certain extent. It recognizes the need to take natural resource depletion into consideration when planning human settlements – including biodiversity and water catchment threats, and areas disproportionately impacted by climate change.

The *Strategic Plan for the Environment Sector: 2009 – 2014* prioritizes the development of six provincial level bioregional plans, as well as environmental management frameworks. This requires that 66% of provinces adopt bioregional plans. These plans are a practical first step in developing an improved understanding of the location of important biological resources. These "templates" will enable effective decision-making when determining whether the location, intensity, and type of development are suitable to a region. They could also influence the types of agricultural and other land-use practices that may be enforced.

In addition, the set of water policies have broad implications for agricultural production, notably plantation forestry. The *White Paper on a National Water Policy for South Africa* seeks to ensure that sectors that use substantial amounts of water need to apply for water use permits. Enforcement measures may be undertaken in instances when users exceed permit limits. It is expected that users pay for the full economic cost of water, which will vary from area to

area and include a levy over and above operating costs. In some areas these costs are likely to act as a disincentive to the expansion of agriculture. The benefits of supplying water to alternative land-uses will be considered, to the potential disadvantage of agricultural producers.

The broad principles outlined in the *White Paper* were translated into the *National Water Act*, which requires that agricultural producers report water usage. Afforestation is classified as a Stream Flow Reduction Activity, and is thus required to apply for a water use license and subject to additional regulation. This is further affirmed in the *Draft National Water Resource Strategy II*, which describes efforts to regulate the location of afforestation activities.

The NEMA and Disaster Management family of policies could be used to improve responses to potential land degradation and exploitation. This could be achieved through spatial planning, risk assessments, environmental authorizations, permitting and licensing. The extent to which they have been effectively adopted is, however, beyond the scope of this policy mapping exercise.

The NEMA family of policies presents extraordinary potential to avoid the degradation of intact ecosystems and the associated release of biomass and soil carbon into the atmosphere – essentially 'REDD++' which includes both forest and non-forest ecosystems. This set of policies may not necessarily increase the size of terrestrial carbon stocks but may be fundamental in limiting the further release of greenhouse gases into the atmosphere.

Many of the policies are already Acts or Regulations, with an established legal status. These policies present an opportunity to regulate the use of land and natural resources across South Africa, with associated benefits to terrestrial carbon stocks. It should be noted though, that this set of policies does not seek to limit the expansion of agriculture but rather intends to ensure that development is undertaken in an efficient and appropriate manner that does not lead to environmental degradation.

4.7 Policies supporting land-use options that could compete for arable land

Table 12. *Policies promoting land-use options that could compete for arable land*

Policy	Activity	Magnitude of impact
National Environmental Management Act: Protected Areas Act, 2003	Increase areas under protection, leading to potential reduction of arable areas available for agricultural expansion	Substantial
National Environmental Management Act: Biodiversity Act, 2004	I Increase of areas under protection, leading to potential reduction of arable areas available for agricultural expansion	Substantial
National Climate Change Response White Paper	Supports conservation efforts; improvements in agricultural production, notably for protecting soil structures	Substantial
A Woodland Strategy Framework for the Department of Water Affairs and Forestry	Could lead to restrictions on agricultural activities in certain woodland areas	Substantial
Strategic Plan for the Environment Sector: 2009-2014	Increased land under conservation; improved spatial planning, improved agricultural techniques	Substantial
National Biodiversity Framework	Improved conservation efforts and soil rehabilitation; improved spatial and land-use planning; improved grazing regimes	Substantial
Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries	Agricultural expansion, notably of small-scale farmers, complemented by conservation of agricultural lands, limited rehabilitation of rangeland and soils, and support of climate-smart agriculture	Substantial
Integrated Growth Plan for Agriculture, Forestry and Fisheries	Supports the NDP, MTSF and Green paper on Land Reform	Substantial
National Protected Areas Expansion Strategy	Expansion of the protected areas network, including into arable lands	Substantial
Regulations on the National Forests Act, 2009	Potential restrictions on woodland conversion in areas suitable for agricultural production	Limited to Substantial
National Forests Act	Potential restrictions on woodland conversion in areas suitable for agricultural production	Limited to Substantial

Policy	Activity	Magnitude of impact
Forestry Roadmap	Afforestation of 100,000 ha of land ,support to rehabilitation and conservation, improved mapping and land use planning to support woodland / forest conservation	Limited

This section covers the nine most prominent policies of the reviewed set that, if fully implemented, would mediate and inform the expansion of agriculture, particularly in ploughed areas in South Africa, by applying sustainable development principles. Protection of biodiversity and conservation of important biomes and ecosystem services is prominent in national policy. The NEMA family of policies and the *National Forests Act* have historically formed the legislative foundation from which all frameworks, strategies and plans around environmental conservation have originated. More recently, the *National Climate Change Response White Paper* and the *National Development Plan* align with this legislative base, promoting advances in biodiversity protection and conservation efforts. In addition, the *Strategic Plan for the Environment Sector*, the *Integrated Growth and Development Plan: Agriculture, Forestry and Fisheries*, and the *Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries* each integrate conservation to some degree into their objectives.

The legislative context:

- The Protected Areas Act
- National Protected Areas Expansion Strategy
- The Biodiversity Act
- National Biodiversity Framework
- The National Forests Act
- Regulations on the National Forests Act
- A Woodland Strategy Framework

The *Protected Areas Act* and associated *Expansion Strategy* are focused on increasing the amount of land under formal conservation. There are strict safeguards around the authority of the Act; the *Protected Areas Act*'s provisions for the management *or development* of protected areas prevails if found to be in conflict with any other national legislation (7.1.a). Amongst other guiding principles, the Act requires that a representative sample of South Africa's naturally occurring ecosystems, habitats and species be protected (17.e).

In the *Expansion Strategy*, 42 biodiversity focus areas for expansion have been targeted. According to the *Strategy*, "These are large, intact and unfragmented areas suitable for the creation of or expansion of large protected areas." Under the *Expansion Strategy*, several substantial grassland areas are targeted for protection. These include:

- Vaal Grassland covering Gauteng and the North West
- Mpumalanga Mesic Grasslands
- Northeast Escarpment in Limpopo
- The Southern Berg Griqualand
- Free State Highland Grasslands
- Drakensburg and Midlands
- Thukela
- Tankwa Cederberg Roggeveld
- Boland Koggelberg
- Vrolijkheid

The *Expansion Strategy* seeks to include 2.7 million hectares into new protected areas in its first five-year phase, ending in 2014. This is one quarter of its total protected areas target, to be reached by 2029. Of this, grasslands account for slightly over 1 million hectares of the five-year expansion target, and 4 million hectares in the 20-year target. This may have important consequences for the proposed expansion of cultivated land in these areas.

The *Biodiversity Act* aligns with the *Protected Areas Expansion Strategy*. It provides for "the management and conservation of biological diversity within the Republic…" (2.a.i). Like the *Protected Areas Act*, the *Act* supersedes other national legislation with regards to the management of biodiversity (8.1.a). The South African National Biodiversity Institute (SANBI) is responsible for advising the Minister on the location and content of bioregional plans (see section 5.7 above). As described in the *National Biodiversity Framework*, resources will be dedicated to supporting delivery of the *Protected Areas Expansion Strategy*.

Similarly, the *National Forests Act* poses limits on the location of cultivation activities, including grazing. Natural forests receive strong protection, but due to their limited range are unlikely to limit agricultural expansion significantly. However, the *Act* allows for the Minister to determine a "minimum area of each woodland type to be conserved."(Chapter 2, 3.4). The *National Forests Act* provides a definition of woodland: "a group of indigenous trees which are not a natural forest, but whose crowns cover more than five per cent of the area bounded by the trees forming the perimeter of the group." (Chapter 1). This has sweeping implications for woodland conservation, notably in Combretum and Terminalia woodlands in the Limpopo Province, Acacia Woodlands on the southern KwaZulu-Natal and Trachonanthus woodlands in the Northern Cape and Northwest Province.

The question of woodland conservation is taken up in a *Woodland Strategy Framework* including management practices that reduce woodland degradation. It calls for the Minister to declare the areas of woodland to be conserved and proposes that this be streamlined with efforts to expand

the protected areas network. Furthermore, it calls for the rehabilitation of woodlands, community-based woodland management, and promotion of sustainable forest use systems.

The NCCRP, the *Strategic Plan for the Environment Sector* and the NDP integrate aspects of these legislative mandates into their objectives. There are three focus areas where NEMA and the cluster of Forestry Acts overlap, namely on the Protected Areas network, ecosystem restoration and conservation outside of protected areas. If a policy promotes these activities, it is likely to have implications for agricultural expansion. This alignment is detailed Table 13 below.

Table 13. *Policy alignment with NEMA and Forest Act policy groups*

Policy	Does it support the Protected Areas Network?	Does it support Ecosystem Restoration?	Notable gaps and targets
National Climate Change Response White Paper	No. There is no mention of the network.	Yes. Notably the thicket biome – though this is unlikely to influence agricultural production. No targets.	Yes. But no targets.
Strategic Plan for the Environment Sector	Yes.	Yes. But no specific biome mentioned. No targets.	
National Development Plan	Yes.	Yes. Notably the thicket biome – though this is unlikely to influence agricultural production. No targets.	No.
Integrated Growth and Development Plan: Agriculture, Forestry and Fisheries,	No. There is no mention of the network.	Supports forest restoration, but no targets.	Promotes research into woodland and forest cover to support conservation planning efforts.
The Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries	No. There is no mention of the network.	Yes. Rehabilitation of 50,000 ha of forest, woodlands and agricultural lands over 5 years.	
Forestry Roadmap	Yes.	Yes. Rehabilitation of forests and woodlands. No target.	Promotes research into woodland and forest cover to support conservation planning efforts.
National Strategy for Sustainable Development and Action Plan	Yes.	Yes. It seeks to restore some 3.2 million hectares of degraded land by 2014.	Yes. It promotes expansion of conservation activities outside of the formal network, with both the formal and informal conservation areas to cover some 9% of total land mass by 2014.

The extent to which these policies commit to the *National Protected Areas Expansion Strategy (NPAES)* is an indicator of the extent to which the policy has political support. However, as there are currently limited targets for ecosystem restoration *outside* of the protected areas network, there is opportunity to set clear targets that can be integrated into greater governmental planning and MRV requirements, such as the President's Outcomes Approach. Similarly, multi-sectoral policies such as the NCCRP present the opportunity to integrate policy objectives and targets to deliver on conservation and restoration opportunities outside of the national protected areas network.

The set of policies that aim to expand areas under formal conservation are likely to lead to the long-term maintenance of above- and below-ground carbon stocks – essentially avoiding emissions through degradation and conversion to cultivated land. As the policies expressly aim to conserve large, continuous areas of intact land, it is unlikely that the policies will lead to the restoration of degraded or ploughed land and an associated increase in carbon stocks either in soils or biomass. If implemented effectively, these policies are most likely to reduce land conversion due to agricultural expansion. This will lead to avoided land-use transformation, and retain existing terrestrial carbon stocks in both soils and above and below ground vegetation cover.

Module 5 – SECTION 3

Policies influencing built environments

For the purposes of this review, "built environments' are considered as areas that are predominantly covered by buildings, roads and other permanent structures created by human beings. This includes areas covered by provincial and municipal roads, bridges, electrical grids, telecommunication, buildings, water reticulation, dams, sanitation plants, built storm water systems and pavement. This module outlines policies that are focussed on changing the area covered by built environments. Such a change will result in a proportional decrease in the area covered by an alternative land-use type and possibly result in a change in terrestrial carbon stocks.

Twenty-three policies from the catalogue were identified as potentially resulting in an expansion in the area currently covered by built environments. The order in which policies are listed is determined by the perceived spatial area that the policy is likely to affect. This measure of 'relative magnitude' needs to be seen in context of the influence of one policy relative to other polices in the set, not relative to the size of the national carbon stock. Any policy alone is likely to have a very small impact on the size of the national terrestrial carbon stock.

Key findings

- There is a significant emphasis in policy to expand the economy and infrastructure. These expansions are anticipated to result in the expansion of the built environment and the conversion of land in general, leading to the release of emissions from terrestrial carbon stocks.
- The policies that promote expansion of the economy and infrastructure provide little clarity on the sustainable development aspects of potential built environment expansion. The term 'sustainable' is often used, but is not defined or expanded upon.
- Aside from the NDP, the policies do not cite a significant body of existing legislation that requires adherence to sustainable development principles.
- Some policies, particularly focused on the protection of natural landscapes, include exception clauses that allow for the expansion of built environment projects that are of national or provincial strategic importance in previously protected areas, which could lead to a net-release of terrestrial carbon stocks.
- Land reform policy includes the possibility of prospecting for mining, which could result in the conversion of natural, semi-natural and agricultural landscapes to mining operations.

5.1 Policies that may lead to expansion of the built environment

Although built environments only cover 2% of South Africa's surface area (CSIR 2013), they are home to approximately 49 million South Africans. Although urban areas offer advantages in terms of providing dwellers with basic services in a more cost-efficient manner, they do have a clear impact on land-use through demand for water, food, energy and other goods and services.

Urban sprawl is furthermore linked to the loss of biodiversity and the pollution of land, water and air. Limited services in overcrowded areas are associated with negative health outcomes and accelerated environmental degradation, mostly as a consequence of the collection of local resources for energy and localised pollution. It is estimated that up to half of all informal dwellings in South Africa can be classified as vulnerable to environmental factors (National Climate Change Response).

Table 14. *Policies promoting [affecting] expansion of the built environment*

Policy	Activity	Magnitude of impact
National Development Plan 2030	Development of Transport Corridors, Development in Rural Areas	Substantial
Medium-Term Strategic Framework 2009 – 2014	Massive build of economic infrastructure	Substantial
The New Growth Path: The Framework	Development of Improved Infrastructure	Substantial

Policy	Activity	Magnitude of impact
Industrial Policy Action Plan: 2012/2013 - 2014/15	Up scaling of Industrial Development	Substantial
White Paper: National Climate Change Response Strategy	Responsible expansion of the Built Environment	Substantial
National Strategy for Sustainable Development and Action Plan (NSSD1) - 2011 -2014	Upliftment of communities	Substantial
National Environmental Management Act 1998	Providing authorisations for development of industrial activities	Substantial
National Biodiversity Framework	Escape clause which in special circumstances may lead to construction of capital projects	Substantial
Strategic Plan for South African Agriculture 2001	Development of Rural Infrastructure	Substantial
Strategic Plan for the Department of Rural Affairs and Land Reform	Development of Rural Infrastructure	Substantial
Policy on Agriculture in Sustainable Development 2002	Development of Rural Infrastructure	Substantial
Mineral and Petroleum Resources Development Act 2002	Promoting economic growth and mineral and petroleum resources development	Substantial
Integrated Resource Plan 2010	Expansion of grid electricity	Moderate to Substantial
Land Reform: Provision of Land and Assistance Act 1993	Development of low income housing estates	Moderate to Substantial
Municipal Property Rates Act, 2004	Industrial expansion in support of housing developments	Limited to Substantial
National Disaster Management Framework 2005	Storm water management	Limited to Substantial
Department of Energy Revised Strategic Plan 2011/12-2015/16	Expansion of grid electricity	Limited to Substantial
Integrated Strategy on the Promotion of Entrepreneurs and Small Enterprises 2005	Developments of small business (agro-processing sectors)	Limited to Moderate
Water Services Act 1997	Development of services (sanitation)	Limited
National Forests Act 1998	Escape clause which in special circumstances may lead to construction of capital projects	Limited
National Parks Act 1967	Escape clause which in special circumstances may lead to construction of capital projects	Limited
Transformation of Certain Rural Areas 1998	Potential for prospecting of mines and minerals	Limited
Policy Principles and Guidelines for Control of Development Affecting Forests	Escape clauses for capital projects of provincial strategic importance	Limited
Long-Term Mitigation Scenario	Greening of Cities	Limited

Infrastructure has long been viewed as vital to economic development by both academics and policy makers (Calderon et.al, 2008). It is also expected to generate employment directly through the actual construction, operation and maintenance requirements but also through indirect multiplier effects across the economy (Kumo, 2012). These indirect multiplier effects may include for example, the building of roads or the expansion of land under crop agriculture that may in turn affect terrestrial carbon stocks in various ways.

The Presidency has developed the most prominent, broad and potentially high-impact policies promoting the expansion of the built environment, notably, the *New*

Growth Path, *The National Development Plan* 2030, and the *Medium-Term Strategic Framework* (*MTSF*), and the *Industrial Policy Action Plan (IPAP)* which acts as a policy supportive of the *New Growth Path*. These policies largely respond to the need to promote economic growth, rural development, food security and employment creation.

The *MTSF* is a planning reference for all spheres of government, including national departments. Its vision and objectives are to be integrated into various departmental strategic plans. The MTSF is concerned with job creation and economic growth following the 2008 economic crisis. A major focus area is outlined in the Strategic Priority 2 "Massive Programme to build economic and social infrastructure". This includes programmes to:

- Strengthen manufacturing, mining, clothing and textile, automobile and components sectors;
- Further growth of agricultural, mining, tourism and other services
- Revamp electricity infrastructure
- Expand pipelines for liquid fuels
- Expand public transport infrastructure (including Bus Rapid Transit systems)
- Expand water infrastructure
- Provide low cost and affordable housing
- Deliver universal access to basic services by 2014
- Provide physical infrastructure in rural areas (agriculture and production services in association with land redistribution and restitution, schools, health, water, energy and recreational), and
- Maintain existing infrastructure

The IPAP is aimed at mobilising the required support for strengthening the growth of the industrial sectors identified in the MTSF. The *New Growth Path* plans to implement improved infrastructure for rural market access, and investments in spatial development, notably the rural economy. It also plans to establish transport corridors for road, rail and ports which will open up rural areas to improved trade routes. This may have a multiplier effect on agricultural growth and natural resource demands, leading to further pressures on land. The *New Growth Path* regularly refers to "sustainable" growth and employment, though this is not qualified with references to the concept of either sustainable development or well-known policy documents such as the *National Framework for Sustainable Development.*

The *National Development Plan 2030* promotes the expansion of the built environment, infrastructure development and growth of businesses. The opening up of the Waterberg for mining, expanding the line to Richard's Bay, and exploring drilling for coal, seam and shale gas reserves, and upgrades to freight corridors is anticipated to result in the conversion of virgin or fallow land for industrial purposes. The Investment in public infrastructure will be equal to 10% of national GDP.

Furthermore the *Department of Energy's Revised Strategic Plan* states that it aims to establish 150,000 new grid connections and 10,000 off grid connections per year in an aim to provide access to energy in rural communities. The *Integrated Resource Plan* also aims to provide greater access to electricity through renewable sources, however both these policies lead to the expansion of the grid electricity which will require the development of support and infrastructure to provide energy to consumers.

The *Long Term Mitigation Scenario*, which is a key component of the development of the NCCRP also refers to the greening of cities, however there is very limited information regarding the targeted intervention of this project.

The *Mineral and Petroleum Resources Development Act 2002*, promotes economic growth and mineral and petroleum resources development in the Republic. The objectives of this act may be achieved through possible conversion of woodlands, savannah and thicket for mining exploration and development. The Act requires these developments to be undertaken in accordance with NEMA regulations and the Act also provides for the provision of remediation of the environmental degradation caused by the development of mining operations. However the overall effect is that the development of mining operations places significant pressures on land and generally has an overall negative impact on the environment, even though these mines are required to drive the economy. There are also other policies that allow for this inclusion, as well as, for example, policies related to land reform. The *Transformation of Certain Rural Areas (1998)*, for example, allows for the prospecting of mining and minerals once land has been transferred to the state. This may also lead to further pressures on land.

A key observation is that all these policies are expected to result in significant changes in land-use. Due to the broad nature of these policies, it is difficult to identify the causal link and impact of built environment expansion on terrestrial carbon stocks. It is however, reasonable to assume that an expansion of agriculture, industry, mining, roads, urban areas and supporting infrastructure will lead to direct changes in above- and below-ground carbon stocks as well as indirect impacts through increases in natural resource consumption in areas that had not been densely inhabited before.

Many policies clearly include planning elements (e.g. bioregional planning) but in general, these have not been exercised as yet. Once such planning is complete, a more accurate estimate of the impact of built environment related policies could be made. As an initial indicator of the potential effect in the interim, Section 1.4 of the National Carbon Sink Assessment does map current anticipated land-use change in the agriculture, mining and built environment

sectors. This analysis is not based on policy directives but on planning already taking place within government, parastatals and the private sector focusing on the next 10-15 years.

Another key observation arising from the analysis of the policies above is the 'exception clauses' associated with policies protecting and conserving natural landscapes. The *National Forests Act (1998)* for example includes a clause that states "...natural forests may not be destroyed except in exceptional circumstances where, in the opinion of the Minister, a proposed new land use is preferable in terms of its economic, social and environmental benefits." It refers to infrastructure projects of national and provincial strategic importance. Where forests are affected by such projects, it must be proven beyond doubt that these are in the strategic national or provincial interest and proven beyond doubt that no feasible alternative is available. An off-set agreement must also be established thereafter to offset the loss of biomass associated with the expansion. Similar exception clauses can also be found in the *National Parks Act*, the *National Biodiversity Framework* as well as the *National Environmental Management Act*.

Module 6 – SECTION 3

The most influential policies

Thirty policies were identified that have the potential to have *substantial impacts* on the release and reduction of emissions from the AFOLU sector. These were chosen according to their magnitude, which was assigned based on their geographic scope and the AFOLU sectors they impact. These have been discussed in modules 3, 4 and 5. With thirty policies that potentially could have very significant impacts by increasing or reducing GHG emissions, there is a high level of complexity involved in mapping impacts. The sheer number of policies, many of them accompanied by limited targets or planning, further illustrates the extent to which a wide array of land-use trajectories and rates of land-use change are possible.

The policy environment around land-use is a contested space. This module demonstrates the following:

- In many biomes there is a tension between policies originating from different ministries and departments. Often these tensions are rooted in silo approaches, which lead to different land-use trajectories. These different visions stem from two major objectives: to promote growth and increase employment, and to preserve the natural environment.
- Reconciling environmental and economic objectives is another set of policies – those mediating land-use change through improved controls, planning and oversight. This third space of policy is soon to be overwhelmed by new legislative frameworks and planning measures as discussed in section 7.3.
- Alignment between pre-existing legislation and the strategic plans and national visions that are most likely to result in extensive land-use change is not always clear.
- There is no clear hierarchy between policy objectives, and thus policy precedence is difficult to determine.

Through graphical representation, this module maps critical elements and dynamics between these policies. Table 15 lists the policies, broken down by policy type.

Table 15. *The 30 policies with potentially the greatest impact on removals and reductions of greenhouse gas emissions from the AFOLU sector*

Policy Type	Policy
White Papers	• White Paper on Disaster Management • National Climate Change Response White Paper
Acts	• Conservation of Agricultural Resources Act, 1983 • National Forests Act, 1998 • National Environmental Management Act, 1998 • National Environmental Management: Protected Areas Act, 2003 • National Environmental Management: Air Quality Act, 2004 • National Environmental Management: Biodiversity Act, 2004 • Spatial Planning and Land-Use Management Act, 2013
Regulations	• National Environmental Management: EIA Regulations • National Environmental Management: Environmental Management Framework Regulations

Policy Type	Policy
Strategies, Plans and Frameworks	• National Development Plan • Medium Term Strategic Framework • New Growth Path • Strategic Plan for Smallholder Producers • The Strategic Plan for South African Agriculture • Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries • Integrated Growth and Development Plan: Agriculture, Forestry and Fisheries • National Strategy for Sustainable Development and Action Plan (NSSD1) - 2011 -2014 • Strategic Plan for Environment Sector: 2009 - 2014 • National Biodiversity Framework • National Air Quality Management Framework • National Protected Areas Expansion Strategy for South Africa 2008 • Integrated Resource Plan • Industrial Policy Action Plan: 2012/2013 - 2014/15 • Department of Rural Development and Land Reform, Strategic Plan 2011-2014 (amended 2013) • Carbon Tax Policy Paper • National Disaster Management Framework • A Woodland Strategy Framework for the Department of Water Affairs and Forestry 10
Other	• Guidelines Regarding the Determination of Bioregions and the Preparation of and Publication of Bioregional Plans Development control guidelines • National Forest Conservation Planning

Key points:

- The policies fit into several broad categories: NEMA family policies (10 total), Presidential "vision" policies (4), agricultural policies namely from DAFF and DRDLR (6), Disaster Management Policies (2), natural forest protection policies (2) climate change and environmental protection policies originating from the Minister of Water and Environmental Affairs (3) and other (3).
- Of the most influential policies, eight are Acts. All but two originate from the NEMA family of policies, which are supported by two regulations: The NEMA: EIA Regulations and the NEMA: Environmental Framework Regulations.
- Outside of the NEMA family, the Ministry of Water and Environmental Affairs has the most forward thinking land management policies, but they are not successfully streamlined or integrated into the sectors from which cooperation is greatly needed, notably the Department of Agriculture, Forestry and Fisheries and the Department of Rural Development and Land Reform. This gap is most notable as the policies correctly observe that cooperation across multiple government departments will be critical for effective implementation.
- DAFF largely supports the expansion of agriculture backed by broad commitments to agro-ecological cropping, climate-smart agriculture, sustainable agriculture or other similar techniques.
- Three major Presidential policies focus on improving economic conditions in South Africa, reducing poverty, establishing jobs and harnessing agriculture as one of several means to achieve this. The texts show a weak to moderate commitment to ensuring that environmental considerations are applied to these interventions.
- Seven policies show strong potential to be tools for mediating between land-use expansion and natural resource conservation aims. They provide a platform from which improved spatial and land-use planning can be realized. These present a strong legislative framework with a powerful though perhaps underutilized legal status.
- Multiple policies compete for arable lands. Should government prioritize streamlining policy objectives through, say, application of mandates in the NCCRP, it could greatly reduce these potential conflicts between agricultural expansion, conservation, and land-use planning functions. Individual departments are currently advocating for their own spatial-planning functions, policies and mapping expertise. If these functions are replicated across different departments, this may further entrench silo behaviour.
- Given the strong focus on agricultural expansion as a solution to rural poverty, food security and job creation, it is likely that the country will experience a net increase in emissions associated with crop production. These emissions would stem from soil disturbance and biomass removals.
- Within the limitations of this study, it is very difficult to predict how these policies will interact. A particular difficulty is predicting which policies will most influence land-use and land-use change in South Africa.

6.1 Policy dynamics

Competition for spatial and land use planning control

Figure 3 below is a simple overview of the "push and pull" dynamics between the most influential policies – those that advocate for rapid land-use change and those that actively promote conservation and responsible natural resource management. The figure also illustrates the third cluster of policies that attempt to mediate these objectives.

Policies that are meant to "mediate land-use change trends through improved planning and controls" do not feature prominently in policies leading to accelerated land-use change. Instead, the major policies promoting agricultural and industrial expansion have their own proposed measures and propose new spatial planning tools to support their core objectives. This may serve to hamper and even override the six pre-existing policies that require improved controls and environmental management (see Figure 3 below). A number of policies advocating for accelerated land-use change have identified gaps in spatial planning and ways in which to respond to these gaps. These are illustrated in Table 16.

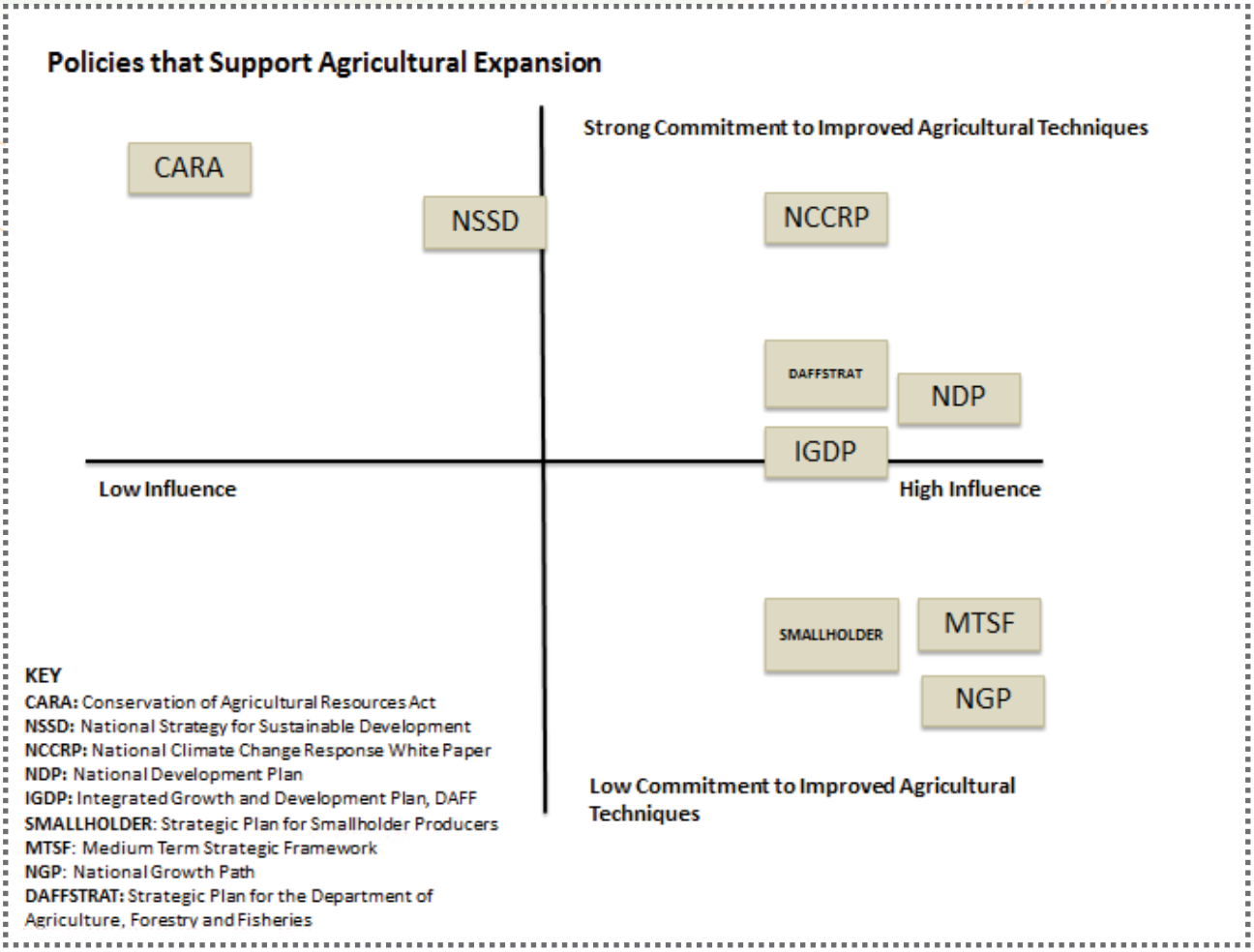

Figure 3. Dynamics between policies impacting on land-use and land-use change

Table 16. Perceived gaps and proposed responses to spatial planning and land-use management

Policy	Reference to spatial planning	Types of gaps and response measures identified
NDP	Gaps	• Spatial divides only serve to increase inequalities and hamper inclusive growth • Opportunities in agricultural production are not fully realized due to weak infrastructure support • Land-reform has not adequately harnessed agricultural potential • Mechanisms for mediating land-use competition are weak and the tensions around this issue "…are becoming increasingly acute as natural resources are depleted" (p. 265) • It is unclear in the Constitution which sphere of government is responsible for spatial planning • Private-sector investment drives spatial planning • The Spatial Planning and Land Use Management Act does not adequately address all planning issues
	Response	• Develop new spatial norms and standards, as well as a national spatial framework and vision • Streamline funds into one fund for spatial restructuring • Update the planning systems, which are fragmented and disjointed, so as to improve coherence and coordination • Include communities in spatial planning exercises • Create a national observatory responsible for tracking spatial data and analysing it • Improve effectiveness of land markets in support of the rural poor • Reform land-use management • Develop binding spatial contracts to provincial and municipal levels
MTSF	Gaps	• Spatial development is not sensitive to locally-specific conditions and needs
	Response	• Spatially reference all massive programmes that promote the development of economic and social infrastructure • Review the National Spatial Development Perspective • Service delivery will be spatially targeted • Use a spatial development framework to coordinate planning efforts across spheres of government
NGP	Gaps	• It is Imperative to overcome the apartheid-era spatial planning inequalities and injustices • Spatial disparities undercut rural development
	Response	• Develop a spatial perspective that improves economic growth through improved housing, infrastructure and job growth planning • Develop a spatial economic strategy
Strategic Plan for DRDLR	Gaps	• Need to improve land administration system • Insufficient spatial equity
	Response	• Develop ten rural development and land reform policies and twelve pieces of legislation by 2014 • Promote the development of an integrated land and planning administration system • Improve delivery of the Chief Director: National Geo-Spatial Information, including provision of annual maps charting land-use change due to development • Facilitating rural access to land and development of spatial-planning policies through its Chief Directorate: National Land-Use Management, Spatial Planning and Spatial Information Systems

Policy	Reference to spatial planning	Types of gaps and response measures identified
IGP for DAFF	Gaps	• Mentions the need for spatial analysis, notably to provide information about the location of arable lands • Notes that "the lack of integrated spatial planning is hampering the growth of the Agriculture, Forestry and Fisheries Sector as well as the effectiveness and success of support programmes and interventions by government"
	Response	• Develop a spatial, commodity-specific production plan • Include a spatial economic development plan • Develop a Spatial Decision Support System • Develop an IGDP Spatial Implementation Plan
Strategic Plan for DAFF	Gaps	• Develop a Spatial Analysis of Agriculture, Forestry and Fisheries
	Response	• Requires improved maps to better understand where key interventions and programmes should take place
Strategic Plan for Smallholder Development	Gaps	• Must improve land-use planning practices, so as to better identify and subdivide productive land and allocate this to farmers
	Response	• Improve area-based district and sub-district level planning to improve agricultural output • Undertake district-level planning for agricultural expansion in support of smallholders

What becomes apparent by comparing the response measures proposed by these policies is that there is a strong awareness of the need to introduce greater spatial planning vision, principles and controls into land-use decision-making. But only the NDP makes clear reference to existing policies; it states that the *Spatial Planning and Land Use Management Act* by itself, is insufficient for dealing with all types of potential land-use change. It seeks to develop a national level framework for spatial planning. Similarly, no other policy considers pre-existing environmental measures that significantly contribute to coordinated, pre-project analysis of land-use planning. Instead, most proposed responses for dealing with various perceived gaps, is the creation of departmental level spatial-planning functions to support local-level planning ventures, decision-support tools and mapping expertise. The Department of Rural Development and Land Reform proposes to singlehandedly introduce 10 new policies and 12 pieces of legislation by 2014, all dealing with land reform and planning issues. The abundance of proposed fragmented measures – all undertaken in a vacuum of existing environmental legislation – threatens to add new complexities, redundancies and uncertainties into land-use planning and change.

Moreover, these omissions raise important questions about the adoption rate of existing policies that aim to mediate the types, scope and intensity of land-use change. For example, the *National Environmental Management Act* is premised on several core principles, one of which is that the degradation of ecosystems and the attendant harm to biodiversity should be avoided, and where they cannot be, be minimised or remedied (2.4.a.i). This is all in the interest of promoting sustainable development, including the promotion of conservation and the sustainable use of natural resources (preamble). NEM: EIA and NEM: BA propose the use of environmental management frameworks and bioregional plans respectively. These frameworks were developed with the intention of identifying the sorts of activities that are acceptable in pre-defined areas, regardless of the department from which the proposed interventions originate. They were not created *for* the Ministry of Water and Environment Affairs, but rather to provide guidelines and oversight measures for all developments significantly impacting land. These frameworks, if applied rigorously, have the potential to block the implementation or meaningfully amend the conditions under which development will be allowed. This governs all activities that are judged to have a long-term detrimental impact on the environment. Irrespective of the level of priority assigned to the activity by a given department or Ministry, these frameworks should be able to curb or influence land-use.

Perhaps the major shortcoming of the NEMA family is that the burden of responsibility falls on the Minister of Water and Environmental Affairs to voluntarily initiate bioregional plans and environmental frameworks. In the absence of these frameworks and plans, business-as-usual is likely to take place, with little consideration given to the emissions associated with land-conversion and soil disturbances. Although the NEMA legislation provides for pro-active land-use management oversight, it remains at the discretion of the Minister to actively employ these two tools. Unlike EIAs for example, which *must* be undertaken for listed activities, the Minister is not obligated to create bioregional plans or environmental frameworks.

6.2 Limited policy integration

The dynamics presented in Figure 3 are particularly interesting when considering how policies "leading to accelerated land-use change" are informed by "policies promoting responsible natural resource management." In an integrated policy environment, the development of new strategies and plans would likely be informed by pre-existing policies, contextualized in the larger legislative environment. Instead, what we find in the land-use change space is an absence of planning that adequately acknowledges historical legislative precedence.

Table 17 illustrates this point. All major policies that cluster around the objective of transforming land to meet economic growth demands have minimal to no reference to the rich legislative framework promoting sustainable development. This suggests that the policies pushing for land conversion have not taken adequate account of the potential legislative restrictions, norms and controls to which they may need to adhere. So while certain key concepts emerge in some of these texts - addressing climate change, agro-ecological cropping, sustainable development – the legislative instruments promoting them are excluded. These omissions are not due to the absence of a convention of cross-referencing relevant pieces of legislation. Rather, it is due to a perceived legislative preference for growth-promoting policies and a bias towards referencing the most current policies. All of the following: *The* Strategic *Plan for the Department of Rural Development and Land Reform*, the *IGDP,* the *Strategic Plan for Smallholder Producers*, and the *Strategic Plan for the Department of Agriculture, Forestry and Fisheries* make reference to at least one of the following documents: *The National Development Plan 2030, the Medium Term Strategic Plan, the New Growth Path* or *The Industrial Policy Action Plan*. But only 3 of 10 policies that are likely to lead to accelerated land-use change make reference to policies such as the *NEM: Protected Areas Act* and its subordinate strategy or the *NEM: Biodiversity Act* and its framework.

Policies leading to accelerated land-use change were reviewed to determine which, if any policies supporting responsible natural resource use and conservation they referenced in their own text. These references are marked by an "X". Below, it becomes clear that only 3 of 10 policies leading to land-use change make reference to the policies regarding environmental management.

Table 17. *Reference to leading natural resource use legislation in policies that promote land-use change.*

		POLICIES SUPPORTING RESPONSIBLE NATURAL RESOURCE USE AND CONSERVATION								
		NEM: BA	NEMA: PAA	NEM: AQA	NSSD	WOODS	DISMAN	NCCRP	CARA	NFA
POLICIES LEADING TO ACCEDELRATED LAND-USE CHANGE	NDP		X					X		
	MTSF				X			X		
	NGP									
	DRDLR									
	IGDP									
	SMALLHOLDER									
	IPAP									
	IRP									
	STRATAGRI									
	STRATDAFF								X	X

Key: ***NEM: BA*** *National Environmental Management: Biodiversity Act.* ***NEM: PAA*** *National Environment Management: Protected Areas Act.* ***NEM: AQA*** *National Environment Management: Air Quality Act.* ***NSSD:*** *National Strategy for Sustainable Development.* ***WOODS:*** *Woodlands Strategy Framework.* ***DISMAN:*** *Disaster Management Framework.* ***NCCRP:*** *National Climate Change Response White Paper.* ***CARA****: Conservation of Agricultural Resources Act.* ***NFA:*** *National Forestry Act.* ***NDP:*** *National Development Plan.* ***MTSF:*** *Medium Term Strategic Framework.* ***NGP:*** *New Growth Path.* ***DRDLR:*** *Strategic Plan for the Department of Rural Development and Land Reform.* ***IGDP:*** *Integrated Growth and Development Plan, DAFF.* ***SMALLHOLDER:*** *Strategic Plan for Smallholder Producers.* ***IPAP:*** *Industrial Policy Action Plan.* ***STRATAGRI:*** *The Strategic Plan for South African Agriculture.* ***STRATDAFF****: Strategic Plan for the Department of Agriculture, Forestry and Fisheries.*

6.3 Policy precedence

It is unclear which policies take precedence in contested land areas. An Act may have a strong legislative mandate, but a lack of buy-in from the policies and strategies that in theory devolve from it. Whilst measures like Bioregional Plans and Environmental Management Frameworks could act as strong mediating forces, it is unclear the extent to which these tools are *drivers* of land-use planning as opposed to *options* that have been underutilized to date. Nothing illustrates this better than policies intended to expand agricultural production, Figure 4.

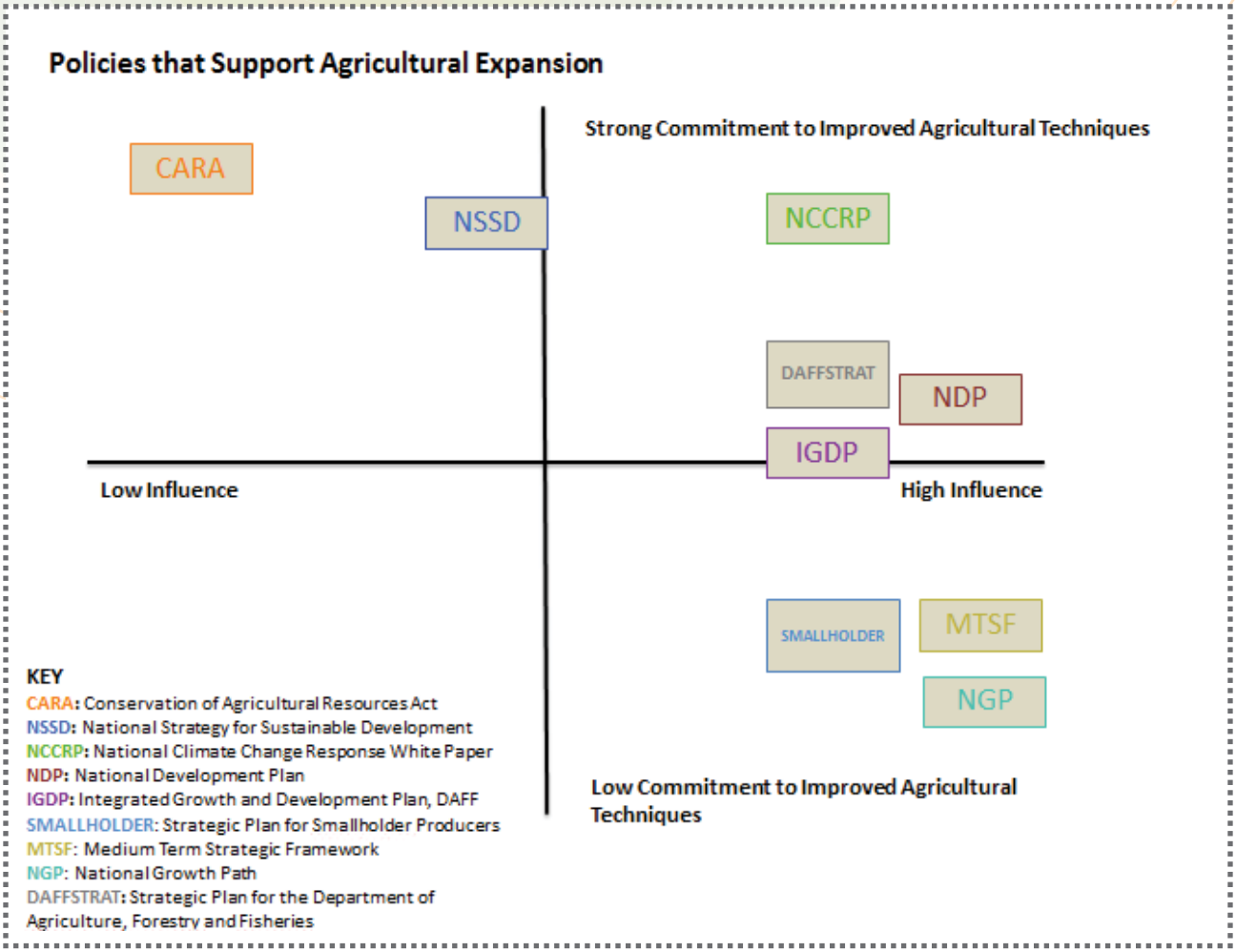

Figure 4. *The level of political buy-in and commitment to improved agricultural techniques demonstrated by multiple policies that impact on the expansion of agriculture*

Figure 4 shows that the only Act that promotes environmentally friendly agricultural techniques – CARA – has both the lowest influence and the highest commitment to improved agriculture. Similarly the *National Sustainable Development Strategy (NSSD)*, approved in 2008, receives little attention in major policies promoting agricultural expansion. Three presidential policies – the NDP, MTSF and NGP – have significant political buy-in, but no firm legislative underpinning in the form of Acts or Regulations. This brings into focus the some underlying elements of the current policy environment: Government vision policies inform many of the objectives and principles presented in agricultural and rural development strategic plans. In turn, these strategic plans have limited visible alignment to pre-existing environmental legislation.

Module 7 – SECTION 3

Conflicts and trade-offs between policies

The policy analysis presented in module three to six identifies several potential conflicts or "grey areas" between policy objectives and principles. In some cases, contradictory aims are found within a single policy paper. These contradictions highlight the types of trade-offs government faces when attempting to address several social and environmental challenges simultaneously e.g. rural poverty, food security, long-term sustainable economic growth, ecological sustainability and climate change. In terms of understanding the impact of policy on terrestrial carbon stocks and associated GHG emissions, it is important to be aware of these contradictions and trade-offs, for if one was to advocate a particular policy, the outcome may differ from that initially anticipated.

The most prominent set of trade-offs relevant to this study are between environmental preservation and sustainability and the push for social and economic well-being. While there is a growing understanding that long-term social and economic well-being is dependent on the sustainable use of ecological infrastructure, most present policies see these as conflicting goals where economic well-being should be prioritized over ecological sustainability if need be. Greater application of and reference to the planning and strategy integration requirements outlined in both NEMA and the NCCRP could provide an immediate pathway for resolution of these potentially competing objectives.

The NEMA group of policies underpin the environmental management framework and aim to adhere to the precautionary principle. Within NEMA there are contradicting aims of the preservation of natural resources and economic development. For example under NEMA, the environmental, social and cultural impacts of a proposed development must be assessed, with the purpose of "maximizing benefits" and mitigating or proposing alternatives for perceived negative impacts (23.1.b). Similar provisions are made for the *NEM: Air Quality Act* concerning provisional licenses where the licensing authority can amend a license "if it is necessary or desirable to accommodate demands brought about by impacts on socio-economic circumstances and it is in the public interest to meet those demands (46.1.c)". Yet in both clauses, restrictions are waived when social and economic development is perceived to outweigh environmental preservation.

These compromises are well known in most countries, but the *National Biodiversity Framework* clearly articulates the ways in which these tensions are exposed to marginal guidance:

"…in some cases, trade-offs have to be made when a development application is approved or not approved. There is currently no framework to guide decision-makers about how to weigh up biodiversity considerations against more immediate socio-economic considerations. The framework for trade-offs should take threatened ecosystems and critical biodiversity areas into account. (45)"

This module presents three prominent, frequent trade-offs that emerged during the review of policies that may affect terrestrial carbon stocks and fluxes. It is not an exhaustive list but focuses on issues pertinent to changes in land-use practices and associated carbon stocks and GHG emissions.

Trade-off 1: rapid job creation in the agriculture sector versus sustainable development

One of the South African government's central aims is to overcome entrenched poverty. Several Presidential policies view agricultural expansion as a means of rapid social upliftment and job creation in rural areas. This is highlighted in several key guiding documents:

Table 18. Policies that focus on rural job creation and economic development

Document	Environmental considerations	Indications that economic growth is a priority
Strategic Plan for the Department of Rural Development and Land Reform	• Ensure environmental sustainability (this is not contextualized)	• By 2014, increase rural job access • Reduction of poverty through increased access to land • By 2014, increase infrastructure build in rural areas to support sustainable livelihoods • Recapitalization and technical support to rural farmers to drive agricultural growth • Resolution of outstanding land tenure issues to incentivize agricultural production
Medium Term Strategic Framework	• Environmental sustainability will be considered with regards to delivery of Strategic Priority 2: Massive programme to build economic and social infrastructure • Natural resource management is considered a priority area • Makes reference to implementing the National Framework for Sustainable Development, supporting water conservation and a response to climate change impacts	• Strategic Priority 1: "Speed up economic growth and transform the economy to create decent work and sustainable livelihoods" (author's emphasis) • Halve poverty and unemployment by 2014 relative to 2004 statistics • "Fast track" programmes such as government infrastructure build that deliver quick employment opportunities • Accelerating the implementation of IPAP • As part of its Strategic priority 3, promote an "Aggressive implementation of land reform policies"
New Growth Path	• "Environmental outcomes" tagged as an indicator of the success of the policy generally, but outcomes are not qualified • It seeks to create a new green economy	• Employment creation is the policy's "top priority" • "Very short run" and "short to medium term" opportunities to create jobs are presented, including in direct employment programmes and the agricultural value chain • More than double the number of jobs by 2020 • 250,000 new jobs a year in various infrastructure opportunities through to 2015 • Rural development achieved through tourism and agriculture
National Development Plan	• Support of the National Protected Areas Expansion Strategy • Support of sub-tropical thicket and other biome restoration interventions • Improved farming methods • Support of preserving critical ecosystem services	• In its efforts to eliminate poverty by 2030, employ 1 million people in public works by 2015 • Strengthen policies that promote active labour markets • "In the short term, the economy needs to grow jobs." • Rapid expansion of freight and road corridors to drive economic growth
Biofuels Industrial Strategy	• The use of biodiesel itself is considered an environmental benefit	• Biofuel production acts as a "bridge from the first economy to the second economy" • Production to be focused on former homelands • "Biofuels production in South Africa is about rural development and provision of opportunities to the rural poor."

The list of policy documents in Table 18 illustrates the potential conflicts and trade-offs between promoting job creation and ecological sustainability. The policies assume that projections for job creation and economic growth are in fact compatible with responsible natural resource use and generally superficially acknowledge environmental concerns. It does not appear that the targets have been "tested" against certain important factors, for example, the impact of rapid agricultural expansion on water resources, soil erosion and soil health. Whereas these issues may well be addressed during the implementation of the policies, at present they are not addressed in the standing text. In the main, environmental resource management appears to stand "outside" the economic sphere, as a separate consideration. The necessity of healthy ecosystem services in an economic context receives little to no attention in the policies presented in Table 18. The manner in which job creation will impact on the South Africa's natural resource base is one worth future consideration, notably given the opportunity to create and maintain jobs that help sustain the environment.

However, the concept of trade-offs is brought up in both the NGP and the NDP. The NGP notes two relevant trade-offs that must be balanced in order to achieve its aims:

- Between present consumption and future growth, since that [future growth] requires higher investment and savings in the present"
- Between the present costs and future benefits of a green economy"

Despite mentioning these trade-offs, the NGP does not detail how to prioritize between present consumption and investment into a greener future. Similarly, the NDP recognises the need to negotiate these trade-offs to achieve its 2030 vision. It gives responsibility to "strong leadership" and "individual behaviour change" to navigate the trade-offs, affirming that "strategic planning" should be employed to identify and manage them.

Trade-off 2: biofuel production to limit reliance on fossil fuels versus land conversion

Biofuel production receives significant policy support. As detailed in Module 4 – Agriculture, there are seven policies promoting the expansion of the biofuels industry. Although the initial impact of biofuel production on GHG emissions from the AFOLU sector is considered moderate due to a proposed pilot phase being limited to some 300,000 hectares, this should not exclude the possibility that biofuel production could expand over the long term.

The expansion of biofuels production responds to three key government objectives:

- Job creation
- Achievement of the voluntary "peak, plateau, decline" commitments under the United Nations Framework Convention on Climate Change (UNFCCC)
- Shifting dependencies on fossil fuels as price volatility represents a threat to energy security

The *Green Economy Accord* and the *Biofuel Industrial Strategy* restrict production to areas of "fallow land" or "underutilized arable land". The Long-Term Mitigation Scenario (LTMS) further supports this approach by affirming that "Biofuels are extended as far as limits of arable land, water, and concerns about biodiversity and food security allow" (p. 19). Whereas this demonstrates common agreement that biofuel production should not impact food production or influence food prices, it does not consider the impact of biofuel production on the conversion of indigenous rangeland systems for biofuel production or the impact on ecological infrastructure and associated ecosystem services. Nor does the policy explore the use of second and third generation biofuels.

The trade-off presented in this scenario is the following: National GHG emissions from fuel use are reduced through the adoption of biofuels, which may result in an increase in GHG emissions following the ploughing of underutilized lands. The conversion of underutilized land is likely to lead to an increase of GHG emissions from the turnover of soils and removal of pre-existing vegetation cover. It is recognized that many studies fail to take into consideration the additional GHG emissions caused by land-use change when considering the net GHG emissions of biofuel production (Searchinger et al 2008). In a study of US biofuel production systems, Searchinger et al. (2008) noted that even if the corn-ethanol production cycle is assumed not to emit GHGs, the conversion of land alone results in a net increase of GHG emissions over 30 years. It is therefore important that the calculation of the net reduction in GHG emissions due to biofuel use take a full life-cycle approach, looking across the entire supply chain, and including GHG emissions associated with land use conversion.

Trade-off 3: short-term food security versus the sustainable use of ecological infrastructure and biodiversity conservation

Many policies in South Africa address food security as a principle objective. The priority here is of the rapid resolution of household level food insecurity and hunger. The most popular proposed measure for overcoming food insecurity is the expansion of land under agricultural production. This is achieved through support of both commercial and smallholder production. Partially, this may be due to the notion that even if South Africa generates a surplus of food, this does not guarantee that households are food secure. Therefore, much of the focus is on ensuring the affordability and accessibility of nutrient-rich food supplies to poor households. There is some acknowledgement of the fact that environmental service provision and proper natural resource management are important contributors

to sustained food production levels and security over time. However, the policies listed in Table 19 below demonstrate that:

- DAFF recognizes that efforts to date aimed at improving cropping techniques have been "successful but not sufficient." It has requested support from the FAO in the development of a comprehensive response to conservation agriculture. The department proposes several types of interventions – from promoting drought resistant crop types to agro-ecological practices – but few accurate figures, targets or planning accompany these.
- Few policies that promote a strong response to food insecurity describe how this may be undertaken through improved conservation agriculture techniques.
- Adoption of sustainable, agro-ecological or climate-smart agriculture or further research into climate change impacts on agriculture is often articulated as a side activity to promote at some point in the future.
- The *Policy on Agriculture in Sustainable Development* is over a decade old. Due to its age and its lack of progression towards becoming a white paper, the policy is unlikely to have a meaningful impact. Therefore only the *Environment Sector Strategic Plan* (ESSP) outlines a credible response to integrating climate change adaptation and ecosystem management into food production. The ESSP does however rely on other government departments for implementation due to their food security mandates (DAFF and DRDLR).

The major trade-off presented is one where rapid expansion of agricultural production is pursued in the near term as a "quick fix" to food security but whereby the farming methods promoted are likely to lead to soil nutrient depletion, soil erosion, and land degradation. This scenario exposes households to greater risks of food insecurity in the long-term, as important ecosystem services are eroded. Transitioning towards a combination of ecologically sustainable agriculture will require substantial resources to train small-growers in new agricultural techniques and to ensure a high rate of adoption. The viability of this transition in terms of costs and required capacity versus available resources are not discussed in these documents.

Table 19. *Policies that promote food security and their support of improved agricultural techniques*

Document	Food Security Support	Eco-Agricultural, Climate Smart or other "environmentally friendly" agricultural production techniques
Medium Term Strategic Framework	• Protecting agricultural land from "encroachment by other developments" • Provision of inputs, tools and extension services to farmers • Intensification of food security programmes	• Supports "sustainable" food production • Mentions the National Sustainable Development Strategy, but no clear alignment with it • Improved irrigation
New Growth Path	• Food security promoted by expansion of commercial agriculture and managing price volatility of major food commodities	• None
National Development Plan	• Food security considered an "enabling milestone" to achievement of the 2030 vision • Committed to the launch of a food security campaign • Food production and expansion levels a key component of security, but also social grants, nutritional services and access to jobs through the expanded public works programmes	• The role of climate change in food security needs further attention • Improvements in sustainable agriculture required, notably as commercial agriculture expands. • Soil conservation, improved tillage promoted • Improved irrigation
Strategic Plan for the DRDLR	• Increase food production, equitable access to land and tenure reform to reduce food insecurity • Promotion of home gardens and agri-parks to promote food security	• Ensure environmental sustainability (this is not contextualized)

Document	Food Security Support	Eco-Agricultural, Climate Smart or other "environmentally friendly" agricultural production techniques
Environment Sector Strategic Plan	• Food security can contribute to development of a Green Economy • Food security listed as responsibilities of DAFF and DRDLA	• Improve soil conditions, support biome restoration and manage water as critical components of food security • Promote sustainable development consideration into food production • Shift focus to the role that healthy ecosystems play in promoting climate change adaptation • Managing air pollution to support food security • Food security closely linked to environmental health • Improved agricultural techniques: composting
Strategic Plan for the Department of Agriculture, Forestry and Fisheries	• Eradicate food insecurity • Improved distribution of food and access to poor families • Improved production systems at the household level • Proposed publication of national food security policy, supported by a strategy • Improved extension services and support to smallholder farmers	• Improved irrigation • Rehabilitation of forest and agricultural land • Recognizes that a "challenge" is introducing climate-smart and conservation agriculture into farming practices • Committed to developing a comprehensive approach to agro-ecological production • 1 pilot study in 1 municipality to be undertaken targeting conservation agriculture
Integrated Growth and Development Plan for the Department of Agriculture, Forestry and Fisheries	• Agricultural sector's role includes addressing food security • Support both commercial farmers and smallholders in increasing food production, including provision of inputs and support services	• Promotes conservation agriculture as a means to reducing stresses on ecosystem services • Climate change recognised as a threat to food security • Recognizes that its efforts to promote protection of environmental services has been "successful but insufficient" • Diversification into climate resilient crops • Rainwater harvesting • Improved grazing regimes
Policy on Agriculture in Sustainable Development	• Food security is an overarching objective of the plan • It should be integrated into national policies and plans • Expansion of agricultural production can provide a rapid response to hunger and poverty • Promote rapid delivery of new technologies to support agricultural production	• Communities should be empowered to meet basic food needs in ways that are compatible with natural resource management • Biodiversity must be protected to ensure long-term food security • Production methods should sustain ecosystem services
Strategic Plan for Smallholder Support	• Aligned with Outcome 7, the policy seeks to promote food security for all • Increase number of smallholders producing food • Provide technical and financial support to smallholder producers • Promote market access and infrastructure development	• Committed to building a focus on conservation and agro-ecological farming practices

Module 8 – SECTION 3

Prominent gaps in policy

South Africa is a dynamic country with many competing demands compounded by silo approaches to addressing these demands. It is also currently experiencing a rapid phase of policy development. Although this rapidly evolving policy environment has led to some conflicts, policies like the NCCRP strongly advocate for mainstreaming and alignment of policies to mediate and resolve such conflicts.

During the development of the catalogue and consequent analysis, Cirrus identified several prominent gaps in policy relating to the AFOLU sector greenhouse gas emissions and removals. These gaps demonstrate key considerations that have received limited attention or are missing entirely from inclusion in policy. On the one hand, there exists an abundance of legislation that can play a significant role in protecting and conserving national terrestrial carbon stocks. The *GLOBE Climate Legislation Study 2011* praises South Africa for taking a lead in its comprehensive legislation dealing with climate change[10]. On the other hand, the role of AFOLU in both contributing to and potentially helping to mitigate and adapt to climate change has not featured as prominently as it could

This module therefore specifically aims to describe gaps that were identified during the policy review and analysis. These gaps do not identify shortcomings in terms of the successful implementation of the policy but merely any gaps pertaining to the limited reference to or integration of the AFOLU sector generally. Means for addressing these gaps are discussed in detail in the 3.2 policy recommendations report.

As a note, Cirrus takes cognisance of the fact that existing legislation central to the protection and conservation of South Africa's natural landscapes and biodiversity were promulgated in the 1990's and early 2000's. It was at this time that a first consensus on climate change was reached in South Africa. Therefore, a limited reference to climate change may simply be due to the short time period in which it has been brought onto the government's agenda.

One of the key action plans identified in the *National Climate Change Response Policy* is the need to review existing legislation in order to align it with the outcomes of the NCCRP in order to meet our international climate change commitments. The Government is finalizing this process, and results are intended for publication in the second quarter of 2014.

Key findings

There were a significant number of gaps identified, grouped under the following broad themes and with the following key findings. Approaches for addressing these gaps are discussed at length in the 3.2 policy report focused on recommendations. The gaps include the following:

- Limited specific content around woodlands:
- There is a lack of a clear definition for the classification of woodlands
- There is also a lack of clear targeted interventions for the protection of woodlands,
- There is a lack of reference to the reliance on fuel wood by rural communities in energy policies
- Limited reference to 'climate-smart' agriculture, 'Agro-ecological' or other improved agricultural practices:
- There is a general lack of reference to these terms or explanation of what they entail
- There is a lack of tangible plans and targets to implement improved agricultural practices
- There is very limited reference to inclusion of 'climate-smart' or 'agro-ecological' practices in the massive scale up of agriculture production envisaged for the country in the near term
- There is very limited reference to the impact of fertilisers, especially in a greenhouse gas context
- Limited commitments from government for protection and improvements of natural and semi-natural landscapes:
- There is very limited commitments for the protection of areas that fall outside the Protected Areas Network
- There is a lack of commitment to implementing rehabilitation efforts to benefit degraded natural and semi-natural landscapes
- Lack of inclusion of the AFOLU sector's contribution to climate change in policy
- There is limited reference to the emissions from the AFOLU sector
- There is limited reference to the role of the AFOLU sector in mitigating climate change
- There is limited consideration of the Costs of including AFOLU in an offset mechanism

10 Kemantha Govender, 6 December 2011, www.SANews.gov.za accessed 28 July 2011.

8.1 Limited specific content around woodlands

Lack of Definition

There is a significant lack of specific content around woodlands despite their strong contribution to the national terrestrial carbon stocks. The first example is the *National Forests Act (1998),* which is the central piece of legislation providing for the protection of woodlands. Its definition of woodlands is unrefined and not in keeping with international best practice. It makes provisions for the Minister to declare a certain area of woodlands to be protected, but it is not a legally binding mandate. Moreover, it fails to present clear targeted interventions to protect woodlands. Another example is the *Forestry Roadmap 2030*, which states that "Woodlands cover the bulk of forest land in the country covering 29 – 42 million hectares, depending on the classification system used." Although the *Forestry Roadmap2030* includes this statement, it does not provide the definition of woodlands or a commitment to a particular classification system. *A Woodland Strategy Framework* correctly observes that "The classification system for woodlands forms the basis of much of the other work that needs to be done and it is therefore a very important first step towards progress" (p. 15). That this progress is flagging 15 years after the promulgation of the NFA 1998 is indicative of the limited political attention assigned to woodland management, conservation and sustainable resource exploitation.

Lack of Reference to the Reliance of Rural Communities on Fuel wood

In South Africa, fuel wood extraction, along with fencing and building material collection, represents the largest annual off take of biomass (Lawes, Obiri, Eeley, 238). Fuel wood extraction rates range considerably from household to household, from 0.27 to 1.12 tonnes annually, accounting for some 51% of domestic energy use (Lawes et al 239).

The *National Forests Act (1998)* is the central piece of legislation providing for the protection of woodlands. However, both its lack of a credible definition and of clear targeted interventions to protect woodlands may potentially result in further deforestation of these landscapes.

It has been outlined in module 3 (Natural and semi-natural landscapes) that important energy policies originating from the Department of Energy that address renewable energy do not sufficiently address the reliance of rural communities on fuel wood for energy[11]. This could lead to both deforestation and land degradation and the concomitant release of greenhouse gas emissions. The *White Paper on Energy Policy (1998)* and the *White Paper on Renewable Energy (2003)* highlight the issue of unsustainable harvesting of fuel wood. According to the *White Paper on Energy Policy*, 65% of South African households consume fuel wood for energy. It already raises the issue that woodlands are depleted as it further states "Increasing amounts of coal, paraffin and LPG are used in areas where fuel wood has become scarce" (p. 30). The *White Paper on Renewable Energy* states that "although presently 9% of SA's energy mix is renewable energy, largely in the form of fuel wood, this is harvested in an unsustainable manner." Although these policies reference the dependencies on fuel wood, neither of these policies provides any functional reference to targeted interventions to address this problem.

Policies originating from Presidency, such as *The New Growth Path*, *the National Development Plan 2030*, *The Medium-Term Strategic Framework* and the *Industrial Policy Action Plan* aim to address this issue through the provision of access to basic energy services and through the upliftment of rural communities. None of these policies however discuss or consider the potential impacts that this may have in terms of a shift in fuel wood harvesting practices and charcoal production .The *White Paper on Energy Policy (1998)* states that the provisions of access to basic energy services may not necessarily alleviate reliance on fuel wood for energy, especially cooking and cultural related purposes. It further states that behavioural changes cannot be expected through the provision of one energy alternative, but possibly through a diverse variety of alternatives (p. 23).

It further states that "Government will facilitate the production and management of woodlands through a national social forestry programme for the benefit of rural households, where appropriate" (p. 80). There is however not much detail provided as to how this may provide protection for woodlands, and this may not guarantee behavioural changes in deforestation as communities may continue relying on fuel wood for traditional cooking practices.

Therefore, numerous policies exist that have the potential to protect woodlands. However, they largely fail to do so in two ways:

- Not addressing the issue of rural community reliance on fuel wood for heating, cooking and construction purposes
- Not providing credible, time-bound commitments and associated targets for the management and protection of woodlands.

These policies, as well as prominent gaps identified are listed in the table below.

11 The Integrated Resource Plan 2010, Department of Energy Revised Strategic Plan 2011/12-2015/16 and the Green Economy Accord

Table 20. Policies with Limited References to Content around Woodlands

Policy	Prominent Gap Identified
Forest Sector Transformation Charter	• No oversight of charcoal production methods and extraction rates • No oversight on whether wood / charcoal is harvested / produced locally or across border in neighbouring countries
National Climate Change Response Paper 2011	• No analysis of how fuel wood or charcoal extraction and production rates contribute to climate change • No mention of National Forests Act or Woodland Protection • No clear commitment to halting woodland degradation
Integrated Resource Plan	• Distinct lack of reference to reliance on fuel wood and charcoal as primary source of energy in rural communities
Regulations on the National Forests Act 2009	• There are no regulations concerning woodlands access or use, although they may be able to protect them through S17 and S18.
Policy and Strategic Framework for Participatory Forest Management	• Allocation of state land may miss the opportunity to integrate natural forest and woodland management on communal lands
Draft Strategy on Forest Enterprise Development	• No provisions foreseeing charcoal and fuel wood extraction rates and impacts
Department of Energy Strategic Plan	• Distinct lack of reference to reliance on fuel wood and charcoal as primary source of energy in rural communities
National Framework for Sustainable Development	• Lack of reference to charcoal use, only brief references to substitutions of LPG and other fuel types for fuel wood
Forest Criteria	• Lack of reference to degradation of land associated with basic, rural needs notably for fuel wood, building materials or charcoal production.
White Paper on Renewable Energy 2003	• References the unsustainable harvesting of fuel wood, but no targeted interventions to manage deforestation of woodlands
Department of Energy Revised Strategic Plan: 2011/12 - 2015/16	• Limited reference to reliance on fuel wood for energy by rural communities
Green Economy Accord	• Limited reference to reliance on fuel wood for energy by rural communities

8.2 Limited reference to planning around climate-smart or agro-ecological practices

Three agriculture-focused themes were identified as lacking in clear policy provisions. These include:

- The limited reference to 'climate-smart' or 'agro-ecological' practices
- Very limited reference to the inclusion of 'climate-smart' or 'agro-ecological' practices in the large scale up of agriculture production envisaged for the country in the near term
- Very limited reference to the impact of fertilisers, especially in a greenhouse gas context

Policies Lacking Tangible Plans and Targets

Several policies identified in module 4 (agriculture) support improvements in agriculture production; these include the Integrated Growth and Development Plan for Agriculture, Forestry and Fisheries, Strategic Plan 2012/13-2016/17 for the Department of Agriculture Forestry and Fisheries, The Strategic Plan for Smallholder Support and the Climate Change Sector Plan for Agriculture, Forestry and Fisheries.

Improvements of agriculture fall under the broad terms of conservation agriculture, climate smart agriculture, sustainable agriculture and agro-ecological practices. The proposed activities associated under these terms may potentially lead to substantial emission reductions through protection of soil structures, rehabilitation of soils, and composting, reduced dependence on fertilisers, improved cropping techniques and improved grazing intensities. The intentions of these policies were, however, not supported by concrete targets. Neither were any of the improved agricultural practices defined; it remains unclear what these techniques entail, whether they have been tested for suitability under South African conditions, and what it would require to roll them out across the country. No single policy details the ways in which agricultural expansion plans will successfully integrate improved cropping techniques, or if that is even an expectation. The limited scope of targets

or lack thereof indicates shortcomings in credible planning around improved agricultural techniques. Furthermore, these policies made limited reference to the *Conservation for Agriculture Resources Act (CARA) 1983*. Despite its potentially high impact, CARA is only made passing reference to in the Department of Agriculture, Fisheries and Forestry's strategic and integrated plans. This is a legislated policy. By law, its provisions are binding and must be adhered to. However, it appears to have limited influence in guiding departmental strategic plans.

Lack of Integration of 'Climate-Smart' Agriculture Practices in Future Planning

The policies listed above also articulate the government's intention to expand agriculture production in order to achieve economic growth. The *Rural Development and Land Reform Strategic Plan*, as well as the *New Growth Path*, *The Medium Term Strategic Plan* and *The New Growth Path* all articulate this vision for agriculture expansion; however few of these policies truly consider how the scale-up of agriculture production will be implemented. Unfortunately, few of these policies are adequately integrated into existing legislative frameworks. This could pose some interesting problems around prioritizing conflicting land-use objectives. Additionally, there is limited discussion of the ways in which more sustainable agricultural practices – from soil conservation to organic methods – will feature in expansion trends. Regardless, it is unclear whether or not Presidential mandates are intended to supersede existing legislation.

Lack of Reference to Fertiliser Use Impacts

The analysis of policy from the agriculture sector highlighted a significant gap regarding information on fertiliser use in general. Few of the policies address the significant global warming potential associated with fertiliser use as well as their impact on the environment. The *National Water Resource Plan* does not provide enough details on how fertiliser use will be regulated. The *National Fertiliser and Feeds Bill* makes provision for the regulation of the importation, sales and registration of fertiliser products, but no details are provided as to its environmental impacts in a climate change context. Cirrus was unable to find a policy that provides guidelines on the amounts of fertilisers allowed or controls on its application in agricultural fields.

Climate-smart agriculture techniques have the potential to reduce the reliance on harmful fertilisers and can play a significant role in the reduction of greenhouse gas emissions from the AFOLU sector. The limited reference to the impacts of fertilisers in general demonstrates that policy still requires substantial revisions for sustainable cropping practices to become a leading agricultural priority.

A summary of prominent gaps identified in policies regarding the limited reference to 'climate-smart' agriculture practices is listed in the table below.

Table 21. *Prominent Gaps Identified in Policies relating to Climate-Smart Agriculture*

Policy	Prominent Gaps Identified
Rural Development and Land Reform Strategic Plan	• There are no clear references to adopting ecologically friendly, sustainable food production systems, or committing to conservation and biodiversity protection. • This is interesting as these activities could add considerable new jobs to the rural economy. • There are no figures or targets qualifying what are meant by improved agricultural production.
New Growth Path 2010	• No review of what "sustainable" means, how this might apply to agricultural production
National Climate Change Response 2011	• No real discussion around improved fertilizer use and only passing reference to the adoption of improved agricultural techniques
National Water Resource Plan	• There is not enough detail around the ways in which fertilizer use will be regulated, controlled or monitored
National Fertiliser and Feeds Bill 2012	• No information regarding the environmental impacts of fertiliser use or guidance on allowable quantities per given area of land or crop type

8.3 Limited commitment for protection and improvements of natural and semi-natural landscapes

South Africa's policy and legislative framework for biodiversity is well developed, providing a strong basis for conservation and sustainable use of biodiversity. The central piece of legislation for the establishment of the protected areas network is the *National Environmental Management Protected Areas Act (2003)*. The *National Environmental Management Biodiversity Act (2004),* which essentially contains the same underlying objectives, provides for the protection of biodiversity outside the protected areas network.

The *Biodiversity Act* provides a suite of new legal tools for conserving biodiversity that may fall outside the protected areas network and is likely to remain outside it. These tools include the *National Biodiversity Framework*, *National Biodiversity Strategy and Action Plan, Guidelines for Bioregional Planning*, *Biodiversity Management Plans* and the *Threatened or Protected Species Regulations*. Whilst all these new legal tools provide an important framework to promote, inform and co-ordinate efforts for conservation, these policies provide no other references to conservation areas which may fall outside protected area networks. Therefore it may be very difficult to gauge which landscapes could possibly be impacted by future expansion of the economy.

The improvement of natural and semi-natural landscapes may potentially refer to, for example, the rehabilitation and reclamation of degraded soils or areas, reforestation, restoration of biomass and vegetation and removal of alien invasive species. The policy analysis presented in module 3 highlighted that there were numerous policies which intend to undertake improvements of natural and semi-natural landscapes, however many of these policies were not substantiated by concrete targets or clear targeted interventions. These policies include the *National Development Plan*, *A Woodland Strategy Framework for the Department of Water Affairs and Forestry*, *National Biodiversity Framework*, the *Integrated Growth and Development Plan for the Department of Agriculture Forestry and Fisheries*, the *Strategic Plan for the Department of Agriculture, Forestry and Fisheries 2012/13-2016/17* and the *Climate Change Sector Plan for the Department of Agriculture, Forestry and Fisheries*. There are only two policies that have set specific targets relating to the improvements of natural landscapes; the *National Sustainable Development Strategy and Action Plan (NSSD1)* and the *Strategic Plan for the Department of Agriculture, Forestry and Fisheries 2012/12 – 2016/17*. Regrettably, these targets are however not substantiated by any further details pertaining to the targeted interventions – notably location or detailed biome type. This lack of detail makes it impossible to assess the greenhouse gas emissions reduction potential of these proposed interventions.

The lack of concrete targets and plans for the improvement of natural and semi-natural landscapes demonstrates the need for the revision of these policies in order to include improved action plans and targets.

8.4 Lack of reference to land-use sector in policy

The policy analysis presented a limited reference to the potential sources of emissions that originate from the land-use sector and its associated activities. Greenhouse gas emissions associated with land-use activities are a major source of global greenhouse gas emissions, of which deforestation forms a large part. The most significant of these include plantation forestry and land clearing, especially for agricultural expansion. These are some of the most important anthropogenic activities that lead to deforestation (Rahlao, et. al., 2012).

As highlighted in section 11.3 above, the policies that focus on agricultural expansion do not consider the potential impacts this may have on greenhouse gas emissions from the sector. The *National Development Plan 2030* for example, makes reference to the 'sustainable' expansion of the agriculture sector, but does not provide a definition for sustainability. The same applies for the *Integrated Development Plan* and the *Strategic Plan for the Department of Agriculture, Forestry and Fisheries*. Both these policies introduce the fact that the agriculture sector may be particularly vulnerable to the impacts of climate change, yet there is no discussion about the agriculture sector's potential negative impact or contribution to the effects of climate change. Measuring the emissions from this sector may therefore be particularly important in future.

The expansion of the agriculture sector may therefore potentially lead to a significant release of greenhouse gas emissions. A selection of gaps identified in policies in this regard is listed in the table below.

Table 22. Prominent gaps identified in policies pertaining to the emissions from the land-use sector

Policy	Prominent Gaps Identified
Strategic Plan for the Environmental Sector	• There are no provisions made to establish the GHG emissions profile of projects that impact on the land-use sector • No reference to assessing the land-use emissions associated with the EIA / EIM evaluation process, or expanding the protected areas into parts of the country where concentrations of greenhouse gas in vegetation is high
National Development Plan	• There is a lack of references to the environmental impacts of the strategy, the ways in which these would be managed and monitored over time what "sustainable" growth means and how the targets for job creation may or may not be impacted by climate change
National Framework on Sustainable Development	• There is no direct mention of emissions from land-use change and how this could impact climate change vulnerability and adaptation responses. This appears to be a prominent gap in a document focused on sustainable development.
Integrated Growth and Development Plan for the Department of Agriculture Forestry and Fisheries	• This policy mentions that agriculture is particularly threatened by Climate change, but there are no details provided as to how agriculture may potentially contribute to climate change or how measuring emissions from the sector may become particularly important
Strategic Plan for the Department of Agriculture, Forestry and Fisheries	• This policy mentions that agriculture is particularly threatened by Climate change, but there are no details provided as to how agriculture may potentially contribute to climate change or how measuring emissions from the sector may become particularly important

Land-use based emission reductions may potentially be important for South Africa to achieve its relative greenhouse gas emission reduction target of 34% by 2020. The AFOLU sector contributes 6% to the national greenhouse gas emissions, with forests as a marginal stock (Rahlao, et. al., 2012). From the policy analysis, it was found that South Africa has an abundance of legislation on agricultural land use but that it does not necessarily provide for the inclusion of climate change mitigation. Nevertheless, these policies can play a significant role in mitigating the impacts of climate change from the AFOLU sector.

An example of this is the family of disaster management policies. According to the Framework, under key performance area 2, environmental hazards such as land degradation, deforestation and loss of biodiversity are included in risk assessments as per international best practice for hazard classification (2.1.7). Therefore, climate change could be designated as a risk, linked to severe instances of land degradation, soil nutrient depletion and erosion or loss of critical biomes that support ecosystem services. However, although there is some reference to the issues of drought and impacts on agriculture, it does not provide information on the various ways in which loss of biomass resources (and associated release of greenhouse gases) may aggravate climate change trends. It also does not consider the ways in which the loss of ecosystem integrity may engender further natural disaster risks. Addressing these gaps, the disaster management cluster of policies could potentially be used to improve responses to land degradation and exploitation.

Furthermore, there is very limited reference to ecosystem-based adaptation. For example, the *Guidelines on Bioregional Planning* makes no reference to ecosystem based adaptation, or more generally to the ways in which biodiversity conservation supports efforts to mitigate and adapt to the effects of climate change. Land reform policy also lacks reference to the potential impacts presented by climate change, which is an important consideration for intended land-use changes. The *Strategic Plan for the Department of Rural Development and Land Reform*, for example, lacks reference to climate change, which may potentially have a significant impact on food security and production potential.

Policies that have limited reference to AFOLU sector in mitigating climate change are listed in the table below.

Table 23. Policies that have limited reference to AFOLU sector in mitigating climate change

Policy	Prominent Gaps Identified
White Paper on Disaster Management	Lack of reference to various ways in which the loss of biomass resources (and associated release of greenhouse gases), may aggravate climate change trends. It also does not consider the ways in which the loss of ecosystem integrity may engender further natural disaster risks. Climate change is not explicitly considered a risk, and potential mitigation and adaptation programmes in the land-use sector are not discussed
National Parks Act 1967	The lack of references to climate change misses the opportunity to highlight the importance of the park network in acting as a net carbon sink and providing an important environmental service.
Land Reform: Provisions of Land	The sale of State land does not seem conditional on an environmental assessment of the conservation land in question, its importance as a biome or other considerations which would reflect important characteristics of the land.
Disaster Management Act	The definition of "disaster" is quite vague, and it's difficult to ascertain the extent to which progressive, constant environmental degradation qualifies as a disaster.
New Growth Path	There is no reference to the ways in which climate change might impact on rural, small scale agricultural production, or how improved agriculture techniques could help farmers adapt to climate change, or how the strategy might aggravate land degradation trends
Guideline on Bioregional Plans	There is no reference to ecosystem based adaptation, or generally to the ways in which biodiversity conservation supports efforts to mitigate and adapt to the effects of climate change.
Strategic Plan for the Department of Rural Development and Land Reform	Lack of reference to climate change or to the potential impact this would have on food security and production potential.

The *National Climate Change Response White Paper* and the *Carbon Tax Policy Paper* do not analyse the cost of developing offsets in different sectors, and the ways in which this may work to the detriment of the land-use sector. Due to the complexities in project development auditing that land-based carbon offset projects face, the costs of development may be significantly higher than more traditional, energy-based projects. This could limit the contribution of land-use projects to the proposed offset mechanism. This should be considered in greater depth, given the AFOLU sector's potential contribution to both mitigation and adaptation.

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South African National Carbon Sink Assessment:

Assessment: suggested future amendments to policy

section FOUR

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Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
ARC	Agricultural Research Council
CARA	Conservation of Agricultural Resources Act
CDM	Clean Development Mechanism
COP	Conferences of the Parties
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DFID	Department for International Development
DME	Department of Minerals and Energy
DMOSS	Durban Metropolitan Open Space System
DNA	Designated National Authority
DTI	Department of Trade and Industry
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
GHG	Greenhouse Gas Emissions
IPAP	Industrial Policy and Action Plan
IPCC	Intergovernmental Panel on Climate Change
LUPO	Land use planning ordinance
MTSF	Medium-term Strategic Framework
NAMA	Nationally Appropriate Mitigation Actions
NCCRP	National Climate Change Response Policy
NDP	National Development Plan
NEMA	National Environmental Management Act
NERSA	National Energy Regulator of South Africa
NFA	National Forests Act
NFU	National Facilitation Unit
NGO	Non-governmental organization
NGP	National Growth Path
NPAES	National Protected Areas Expansion Strategy
REDD	Reduced Emissions from Deforestation and Degradation (through planning and regulation)
REDD+	Reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SANBI	South African National Biodiversity Institute
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
SIP	Strategic Infrastructure Projects
SPLUMA	Spatial Planning and Land Use Act
UNESCO	United National Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard

Introduction

Building on the previous section, this analysis focuses on creating a policy environment that enables and encourages a reduction in emissions from the land-use sector and stimulates activities that lead to an increase in the size of the national terrestrial carbon stock.

In terms of the scope of the analysis and its boundaries, the aim is to provide Government with an understanding of potential changes that may need to be made to policy to create an enabling environment for the rollout of climate change mitigation activities. The decision to include the changes or how they may be incorporated into a specific policy document is beyond the scope of this analysis.

Two broad areas in which policy may need to be reviewed, were identified during the development of the two initial components and extensive stakeholder engagement:

- The first focuses on creating an enabling environment for the eight principal land-use based climate change mitigation activities identified in the second section of the project.
- The second aims at guiding current and future land-use decisions in a manner that reduces release of carbon into the atmosphere and maintains and increases the size of the national carbon pool over the long-term.

The distinction between these two broad areas is due to the nature of required activities. The first focus area is driven by the outcomes of the mitigation option analysis in Section 2 of the National Carbon Sink Assessment (NCSA). It is more immediate and specifically focuses on creating an enabling environment for the eight identified implementation options as well as creation of a National Facilitation Unit (NFU) and National Payment Facility. The second focus area is far broader in scope, considering the management of carbon stocks and land-use based GHG emissions in all landscapes, beyond the boundaries of formal mitigation activities. Stakeholders repeatedly identified this area as a missing element and therefore it has been give clear separate consideration below.

Section 1 – SECTION 4

Creating an enabling environment for formal climate change mitigation activities

Phase 2 of the NCSA focused not only on identifying the principle land-use based climate change mitigation activities, but also on understanding the costs thereof and how to create an enabling environment for the expanded rollout of activities across the country. The analysis was informed by the outcomes of Section 1 and an extensive stakeholder engagement process where the project team met with members of local and national Government as well as parties based in the private and NGO sectors.

The outcome was the identification of eight principal mitigation options (Table 1) as well as the need to create a National Facilitation Unit (NFU). The rationale for the NFU is based on the need to address a similar set of barriers that were repeatedly identified by several practitioners and are often common across a number of different types of mitigation activities - for example, the need for a cost-efficient monitoring, reporting and verification mechanism.

Table 1. *The eight principle land-use based climate change mitigation activities in South Africa*

Activity	Sub-class	Spatial extent (ha)	Reduction per ha per yr (tC)	Emission reduction per yr (tCO2e)
Restoration of sub-tropical thicket, forests and woodlands	Sub-tropical thicket	500 000	1,2	2 200 000
	Coastal and scarp forests	8 570	1,8	56 562
	Broadleaf woodland	300 000	1,1	1 210 000
Restoration and management of grasslands	Restoration - Erosion Mesic	270 000	0,7	693 000
	Restoration - Erosion Dry	320 000	0,5	586 667
	Restoration - Grasslands	600 000	0,5	1 100 000
	Avoided degradation mesic	15 000	1,0	55 000
Commercial small-grower afforestation	Eastern Cape	60 000	1,5	330 000
	KwaZulu-Natal	40 000	1,5	220 000
Biomass energy	Country-wide			1 990 316
	Bagasse - Country-wide			328 955
Anaerobic biogas digesters	Country-wide			3 642 408
Biochar		700 000	0,3	641 667
Reduced tillage		2 878 960	0,1	1 055 619
Reducing deforestation and degradation	Through planning	unknown		
	Through regulation	unknown		
Total				**14 110 193**

Please see the Section 2 report for a detailed description on how the activities were identified and assessed.

In addition to the need for a NFU, field practitioners and entities within local and national Government listed a broader set of issues and barriers to implementation that they had either experienced or observed (Table 2). On further consideration of the list, two important findings become apparent.

The **first** finding is that the eight identified mitigation opportunities (Table 1) exist on a 'continuum of readiness', from those that could be realized in the near-term, to those that require substantial additional research and development prior to implementation:

- **Short-term options –** Biomass energy, anaerobic biogas digesters and commercial afforestation are well positioned for implementation and expanded rollout in the near term. Each opportunity has been thoroughly researched, is well known and in certain cases, implementation has already started (e.g. for internal electricity generation needs). As discussed in detail in Section 1.3, a small number of important obstacles need to be addressed and then implementation could occur at scale.
- **Short to medium term options** – The opportunity to restore sub-tropical thicket, forests and woodland as well as the restore and manage of grasslands is relatively well known, with substantial research already undertaken on the biophysical and financial feasibility of ventures as well as the design of appropriate models. Although these activities may not rollout as quickly as the short-term options above, if a number of key barriers were addressed, significant implementation could occur in the short- to medium- term.
- **Medium to long-term options** – Opportunities for Biochar, reduced tillage and REDD (through planning and regulation) are less well advanced than the activities listed above. This should not discount their value and importance. It would be prudent to initiate research into the biophysical, financial and implementation aspects of these activities to ensure that they are brought on line as soon as possible.

The **second** finding is that there are two important barriers that are common across nearly the full set of projects: (i) a lack of long-term sustainable financial incentives for land-use based climate change mitigation activities, and (ii) the absence of a national or provincial facilitation unit that addresses crucial capacity, awareness and efficiency issues. From stakeholder discussions, it was noted, if these two common barriers were adequately addressed and resolved, that especially the first five activities could be rolled out relatively quickly in the near term.[12]

Table 2. *Barriers shared amongst the Top 8 implementation opportunities*

Activities Barriers	REFOR	GRASS	COMMFOR	BIOMASS	BIOGAS	BIOCHAR	AGRIC	REDD
Lack of consistent, sustainable financial incentives	X	X	X			X	X	X
High cost of monitoring, evaluation and certification	X	X	X			X	X	X
Difficulty in accessing capital / prohibitive interests rates			X	X	X			
Extent or existence of carbon benefits unclear						X	X	
Land tenure challenges		X						X
Limited understanding of key carbon sequestration metrics						X	X	
Limited technical knowledge and training support		X				X	X	

12 The challenges presented by these barriers have also been raised in other forums, recently, for example, by the African Group's submission to the UNFCCC's Subsidiary Body for Scientific and Technological Advice 38th session held in June 2013 (UNFCCC 2013).

In the policy analysis below, we first consider these two more predominant common issues (the need to create a National Facilitation Unit as well as long-term sustainable financing) and then focuses on policy considerations specific to each form of mitigation activity. Whereas the two common issues dominate, there are a number of particular, but vital barriers that need to be addressed for certain mitigation options to be realized.

1.1 Addressing common barriers: support for a NFU and long-term finance

Lack of consistent, sustainable financial incentives

Stakeholders consistently stressed the extent to which a lack of clear and consistent financial incentives for land-based climate change mitigation activities inhibited their ability to implement large-scale initiatives. Due to the opacity of the carbon markets both in terms of demand and pricing, perceived risk inhibited greater project development.

The first risk involves financial commitments to a cost-heavy certification process. Secondly, stakeholders were concerned about their ability to successfully enter into and negotiate a favorable carbon offsets purchase agreement. In recent years, international carbon markets have declined steeply with regard to both total volume demanded and price. A recent study by the Interim Forest Finance Project, forecast that demand for REDD carbon credits between 2015 and 2020 would only absorb 3% of the total expected supply. Stakeholder statements corroborate anecdotal evidence, which suggests that certification of a well-designed project is no guarantee of market access, sales or favorable pricing which would justify upfront development costs and long-term management.

Carbon markets aside, stakeholders noted that short-term grants, subsidies, and donor or corporate support was not sufficient to ensure long-term project viability. Land-based climate change mitigation interventions (biogas and biomass energy aside) require long-term management and upkeep of substantial areas of land to ensure permanence. Short-term financial support is insufficient to meet this need, and subjects a project to the threat of potential abandonment and consequent land conversion.

High cost burdens of monitoring, evaluation and certification

Stakeholders voiced concerns over the monitoring, reporting and verification expectations, and questioned the efficacy of such obligations. They shared experiences of attempting to develop carbon projects using internationally recognized methodologies, citing the extensive research timelines and the slow certification process. One group, not short on manpower or technical expertise, noted that even after two years the certification process remained on going. Stakeholders noted that such burdens made it near impossible to rely on the carbon offsets income stream, despite the original, commonly held belief that the sale of generated emission reduction units (carbon offsets), represented a safe and sure form of finance.

Unlike energy or industrial carbon offset projects, projects originating from the land-use sector tend to have higher monitoring, reporting, and verification burdens. Methodologies approved by the CDM and the VCS for REDD+ and afforestation/reforestation activities typically require in-depth, field-based measurements and assessments, multi-temporal satellite imagery analysis at numerous intervals over a historic time-period and the development of spatial statistical models to illustrate before and after project scenarios. This usually requires project developers to rely on outside, technical service providers, further driving up development costs. These methodological requirements differentiate the land-use sector from other carbon-offset types, which tend to rely on pre-determined conversion factors and have fewer complicated variables to monitor. Validation costs, before the roll-out of the actual project, can be inhibitory.

The burdens on the land-use sector in the carbon offsets space is clearly illustrated in the penetration of the asset class into the market. Of the 7,448 registered projects under the CDM (February 2014), only 52 are land-use projects (0,6%). Fifty-one of these are reforestation/afforestation projects, while the remaining one is a soil conservation initiative. Thirteen projects are based in Africa, primarily in Uganda and Kenya. Under the VCS, 83 land-based projects have been registered, or 0,7% of the total 1,153 projects that have been validated to the standard. Thirteen of these projects were developed in Africa, and only one small-scale project is based in South Africa, though it has yet to verify any emission reductions for sale. Considering that only one of 135 total registered land-based projects across both the CDM and VCS is based in South Africa, and that it has yet to sell credits through either of these standards, it is not surprising that project developers in South Africa question the validity of the approach in driving wide-scale implementation of land-based climate change mitigation projects.

Difficulties in accessing upfront capital / prohibitive interest rates

Practitioners developing biomass to energy, biogas and smallholder commercial forestry stressed that these interventions require high upfront capital investments. Without privileged access to favorable interest rates, grants or subsidies, developers were concerned that projects may have difficulty in moving beyond the feasibility stage. It was noted that smallholder commercial forestry groups, in particular, face challenges in securing favorable interest rates, as banks have historically viewed these groups as

a high credit risk. Similarly, biogas and biomass to energy projects, whilst dependent on well-tested technologies typically imported from Europe, have had little large-scale uptake in South Africa and thus remain relatively unknown to local finance institutions. The novelty of the technology has resulted in difficulties in securing capital.

It should be noted though, that access to capital at favorable interest rates was noted as the only significant barrier to implementation noted for smallholder commercial forestry. If this issue could be addressed, significant implementation could occur at scale in the near term.

1.1.1 Addressing common barriers through policy reform

Three overarching policy reforms were identified that once implemented, will fast track the rollout of land-based climate change mitigation activities. These policy reforms address the common barriers discussed above as well as the capacity, efficiency and awareness issues raised in the Section 2 report focused on the feasibility and potential structure of implementation models. By addressing these barriers, the top five principal implementation opportunities (reforestation of forests and thicket, grassland rehabilitation, small-scale commercial forestry, biomass to energy and biogas) could rollout in the short to medium term, reaching scale within 10-15 years. The recommendations are detailed below.

Development of a National Facilitation Unit

As noted, the majority of stakeholders voiced the need for an overarching facilitation unit that could provide awareness, extension and research support, create and deploy an efficient national monitoring, reporting and verification system, and facilitate efficient and sustainable financial incentives for climate change mitigation activities. Given the specific complexities and challenges of land-based climate change mitigation activities, it is foreseen that an entity dedicated to their support, development and integrity is essential to their realization.

An Act of Parliament would be required to establish the National Facilitation Unit, its objectives, governance, financial structure, legal standing, staffing and so forth. The location of the unit in Government would be determined following the appropriate stakeholder consultation procedures.

The concept of a National Facilitation Unit, its rationale and potential initial structure is described at length in Section 2 report on implementation options and models. It should be noted that the intention would be to start small. In light of the government's commitment to decrease inefficiencies in departments it is envisaged that the NFU would start as a lean organization, staffed with only the most essential posts. An initial focused team of 4-6 individuals could address many of the identified obstacles facing the Top 5 implementation opportunities and commission dedicated research programmes on the remain three. Once there is good 'proof of concept', the unit would be gradually increased in size. Discrete and replicable pilot-projects would be undertaken with the support of the NFU as a means for establishing proof of concept.

Establishment of a Payment Mechanism Facility

Practitioners within Government and private sector noted that a centralised national-level payment mechanism should be established to streamline payments for compliant activities, provide financial management oversight, explore new potential sources of funding and finance for climate change mitigation activities and ensure the appropriate disbursement of incentives. This is especially important for smaller projects and emerging landowners who have little access to international funding and carbon revenues.

The adoption of a national-level approach to mitigating climate change through land-based activities will necessarily require an institutional structure to ensure that payments (incentives) are processed and distributed in a timeous manner. It will also help avoid duplication in funding efforts, which are currently fragmented and inefficient, and have different application requirements and standards.

It is envisaged that through an Act of Parliament, the legal basis for establishment of a payment mechanism facility will be authorized. The Act should cover, but is not limited to considerations such as primary objectives, functions and duties, governance and management, the types of revenue streams the mechanism can accept, and financing of the mechanism. The primary roles of the payment mechanism would be to:

- Manage payments to individuals or entities that have successfully undertaken land-use based climate change mitigation activities, based on a net reduction in Greenhouse Gas emissions, and based on a schedule that will encourage the continued participation of implementers.
- Identify and develop new income streams from which payments can be made (see next section below for more detail)
- Facilitate strategic forms of financial support to new progressive implementation options that may have greater strategic national value (e.g. the restoration of high-altitude grassland catchments in line with the proposed SIP 19 focused on ecological infrastructure, sustainable water services and job creation in remote rural areas).

A considerable stakeholder engagement process would be required within government to determine where the payment mechanism would be located, and what department or Ministry will be responsible for its management. Such an exercise is beyond the scope of this particular piece of

work, and should be given considerable attention in future phases of the project.

Creation of demand for implementation activities

A recurrent shortcoming in a number of national-level efforts to develop land-based carbon offset programmes, REDD+ in particular, is the primary focus on the architecture of assessing, approving, monitoring, certifying and reporting on emissions reductions. Whilst critical to the success of a program, these efforts have not been complemented by the equally important exercise of determining a source of long-term demand to fund project implementation. For this reason, it will be important for the Payment Mechanism Facility, once established, to focus its efforts first and foremost on the identification of potential income streams, and the types of policies that may need to be established to promote their access. Without this necessary demand identified and secured, a national-scale initiative will risk losing the confidence and buy-in of its potential participants.

Understandably, this approach presents a conundrum. On one hand, there is significant legislative effort and resource allocation required to establish an Act to create a Payment Mechanism Facility. Once established, it may be discovered that demand for land-based climate change mitigation activities is minimal to non-existent. On the other hand, a Payment Mechanism Facility presents a unique opportunity to explore demand and income stream diversification through an established institutional entity embedded in government. It may be that an interim Payment Mechanism Facility is created, with an agreed timeline for establishing an early revenue stream from which pilot projects can be undertaken. Dissolution of the entity could be a measure of last resort in the event that demand cannot be established.

It is envisaged that a number of income streams would flow into the facility, diversifying revenue outlets and reducing reliance on a single source of finance. Both market and non-market sources for payments should be considered. These would be streamlined into one account, from which payments to project developers would be based on adherence to a single set of validation, monitoring and reporting protocols. Amongst the revenue streams that the Payment Mechanism Facility could consider, it is recommended that the following be analyzed, both in terms of potential uptake of carbon offsets and for favorable pricing.

South African Carbon Tax Policy:

In early discussions with members of Treasury, the possibility of recognizing land-use sector activities in a carbon offset mechanism and the recycling of carbon tax revenues were considered. The roll-out of land-use based climate change mitigation activities aligns with South Africa's greater climate change mandate, which is to reduce GHG emissions, reduce exposure of the rural poor to climate change, and promote ecosystem-based adaptation. In the next phase of development, it is recommended that the DEA work closely with Treasury to explore the ways in which the eight implementation activities can benefit from the tax – through offsets, revenue recycling or a combination of both. Potential means for structuring the offsets approach to best promote land-based projects is discussed below in "Development of a National Facilitation Unit."

International demand for carbon offsets:

Although current demand for land-based carbon offsets is low, as are prices, there is growing international interest in and consensus around the need to finalize finance mechanisms for REDD+. To-date, the majority of REDD finance has been directed towards "readiness" and capacity building, but not towards long-term payment mechanisms for certified emissions reductions. During the UNFCCC annual meeting (COP), held in Warsaw in 2013, it was agreed that REDD financing is critical to development of the activity, and should come from international groups such as the Green Climate Fund. As a new international climate agreement should be reached in 2015, it is envisaged that a single set of rules will facilitate project developers' access to REDD-specific funds during the 2015-2020 "interim" period. This "interim" period covers the five years during which an international compliance market, which will include REDD+, is to be negotiated. It is also a period during which access to REDD+ finance has been highlighted as a critical gap. It is provisionally expected that a UNFCCC-regulated international compliance market would come into effect in 2020. In addition, there are on-going discussions around the land sector post 2020.

It is recommended that the Payment Mechanism Facility work with the relevant government authorities to ensure that South African policies are aligned with both the interim period and that South Africa plays a pro-active role in forming international REDD+ policy so that it is aligned with South Africa's (and Africa's) context and needs. Of particular importance, is the growing consensus that REDD+ activities should include the broader landscape surrounding forests, so as to include agriculture, soil management, and grazing activities into a REDD accounting framework. As there is a large opportunity for such interventions in South Africa, it is recommended that the Payment Mechanisms Facility team participate in international climate negotiations and preparation, and contribute to the architecture of these agreements and funding mechanisms relating to the AFOLU sector. Although these payments have been difficult to access in the past, the focus appears to be shifting away from "readiness" to payments for results-based REDD+ efforts, and could signal a new and progressive era in REDD+ funding. Work has already begun on the finance architecture for the results-based payments of REDD+ activities (UNFCCC decision 10/CP.19). It is envisaged that the GCF will play a key role in the results-based funding of REDD+ (UNFCCC decision 9/CP.19). The country REDD+ national entity or focal point that will be designated in terms

of UNFCCC decision 10/CP.19, should also work closely with the PMF on issues relating to international support for implementation of REDD+ activities.

Funds associated with Nationally Appropriate Mitigation Actions (NAMAs):
Nationally Appropriate Mitigation Actions (NAMAs) are "concrete projects, policies, and/or programmes that shift a technology or sector in a country onto a low-carbon development trajectory" (UNDP 2014). NAMAs allow countries to undertake large-scale sectorial initiatives that at once reduce GHG emissions and meet local development needs. The institutional framework for (NAMAs was established at the Bali United Nations Climate Change Convention (UNFCCC) Conference of the Parties (COP) in 2007. During the Copenhagen COP (2009), a number of countries submitted the first reports on their NAMA efforts. In 2010, at the Cancun COP, it was determined that developing countries would undertake "nationally appropriate mitigation actions in the context of sustainable development, supported and enabled by technology, financing and capacity-building, aimed at achieving a deviation in emissions relative to 'business as usual' emissions in 2020" (UNFCCC, 2010). At this time, it was determined that both domestic and internationally financed NAMAs could be developed.

To-date, 95 NAMAs have been developed, as well as a number of feasibility studies across 35 countries. NAMAs have had a consistent focus on energy supply, transport and energy efficiency while only 6% have been devoted to forestry and agriculture (Ecofys NAMA database 2014, Center for Clean Air Policy 2013). Over half of the NAMAs remain in the concept and planning phase, with only two reportedly in the implementation stage (Center for Clean Air Policy 2013). Of these, 44 NAMAs have been entered into the UNFCCC reporting database (Center for Clean Air Policy 2013).

NAMAs can either be funded by the host country (the SA Green Fund, for example), or through bi-lateral agreements, overseas development assistance and climate funds (for example, the Green Climate Fund, the Global Environment Facility's new NAMA support portfolio). No particular policy changes appear to need to be made in South Africa to submit a NAMA to the UNFCCC and seek finance both domestically and abroad. The Payment Mechanism Facility should play a role in preparing funding documentation, managing engagement with potential funders, and negotiating contracts and finance windows. It should lobby for the inclusion of land-based mitigation activities in the roster of South African NAMAs, to ensure that the sector is not sidelined in favor of more traditional NAMA activities in the energy, transport and building sectors.

Government subsidies and grants:
The Payment Mechanism Facility team should collaborate with the Minister of Finance and Treasury to consider the ways in which the government fiscus can support payments to land-based climate change mitigation actions. Budget allocation to the eight principle mitigation opportunities will support a number of government priorities – from job creation, ecological infrastructure development and management, to climate change adaptation, clean energy production and food security. Careful alignment with programmes with pre-existing earmarked budgets are likely to unlock specific grants and subsidies, ensuring an optimal deployment of financial resources.

1.2 The policy environment of the top 8 activities and potential barriers

The analysis in this section aims to understand the extent to which relevant policies support the rollout of land-based climate change mitigation opportunities at a national scale, and which, if any, changes may be required in policy to create a more favorable implementation environment. In all instances it was found that there are no policies that explicitly prohibit the implementation of any of the eight proposed activities.

Policy support for each climate change mitigation activity is reviewed in three phases:

1. An assessment of whether a mandate for undertaking the activity exists within the Top 30 policies identified in the initial policy review (see Section 3.1 report: "Review of Existing Pertinent Policies"), or other relevant policies as deemed appropriate:
- By determining whether there is a broad level of support for the mitigation activity.
- By determining whether there is a clear, articulated focus on the activity
- By identifying which, if any targets, exist to guide implementation of the activity

1. A review of particular barriers that may currently impede the national-scale rollout of the activity
2. Discussion of the types of changes to policy that would strengthen the mandate for each activity. This phase also includes identifying the ways in which policy might address the project specific barriers discussed in point (2).

For further reference, Annex A provides an extensive list of each of the policies described in this section that broadly support the 8 implementation activities.

1.2.1 Restoration of sub-tropical thicket, woodlands and forests

Pertinent policies

Table 3 provides a summary of the policies that either broadly support, make direct reference to or provide targets for the reforestation of forest and thicket biomes in South Africa. The list demonstrates that although there is broad-level support for restoration efforts generally, fewer policies provide a clear focus on the activity. Targets for restoration of forests and thickets are limited. This could also be attributed to the lack of concrete and accurate nationally quantified deforestation and degradation rates.

Is there broad support?

There is recognition across the 13 policies listed in Table 3 that the restoration of degraded ecosystems is an important contribution to management of the country's environmental resources. Across the 13 policies, there is broad level support for the restoration of forests and thicket biomes. The policies cover the following considerations:

- A commitment to restoring natural ecosystems, not only for climate change purposes but also for the variety of ecosystem services e.g. water regulation and soil fertility
- Recognition of the contribution that natural ecosystems make to sequestering carbon, and how sustainable management of these ecosystems can contribute to a comprehensive national climate change mitigation and adaptation response
- The legal basis from which "duty of care" is attributed to the individual or entity responsible for environmental harm and to undertake remediation of the site in question
- A commitment to the development of financial instruments to incentivize ecosystem rehabilitation activities
- The legal basis by which areas impacted by disasters may require active rehabilitation and restoration efforts

Table 3. *Overview of policies supporting restoration of forests and thicket biomes*

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
National Climate Change Response Policy	X	X	
National Forests Act	X	X	
National Environmental Management Act	X		
NEM: Biodiversity Act	X		
Disaster Management White Paper, Act and Framework	X		
National Development Plan	X	X	
Carbon Tax Paper	X		
Guidelines regarding the determination of Bioregions and the preparation of and publication of Bioregional Plans	X		
Environmental Sector Plan	X		
National Strategy for Sustainable Development and Action Plan 2011-2014	X		X
Integrated Growth and Development Plan		X	
Woodlands Strategy	X	X	
Strategic Plan 2012/13-2016/17 for DAFF	X	X	X

Is there a clear focus on the activity or biome?

Both the *National Climate Change Response Paper* (NCCRP) and the *National Development Plan* (NDP) highlight the need to restore the thicket biome. The NCCRP calls for the restoration of sub-tropical thicket in the Eastern Cape as part of its Climate Change Response Public Works Flagship Programme. Furthermore, it notes that South Africa has legally binding, international commitments to enhance the carbon stock of its forests. The *National Development Plan* seeks to restore vegetation cover in biomes, including the thicket biome. In addition, *The Integrated Growth and Development Plan* seeks to provide funding to ensure the implementation of forest restoration plans. The most explicit directive for the restoration of forests is found in the *National Forests Act*, which provides the Minister with the "powers to intervene urgently to prevent deforestation

and to rehabilitate deforested areas (Chapter 3, part 4)" and lays out the procedures through which this should be undertaken.

Are there clear targets?

Two policies present targets for the restoration of forests and thicket. The *National Strategy for Sustainable Development and Action Plan* commits to restoring 3.2 million hectares of land affected by degradation by 2014. This target does not explicitly state if thicket or forests will be restored, although it is likely that some percentage of the 3.2 million would be allocated to these biomes. The *Strategic Plan 2012/13-2016/27 for DAFF* commits to coordinating the rehabilitation of 50,000 hectares of indigenous forests, woodlands and agricultural land. It is not clear what fraction of the total hectares is allocated to each of the three land types.

Although there is mention of both thicket and forest restoration, these do not form integral, expanded parts of any policy. Commitments do not appear to be backed by detailed plans, resource allocation, and clear roles and responsibilities as yet.

What are the unique barriers to implementation?

The most important barrier to implementation noted by practitioners is the absence of a long-term payment mechanism. This has been noted in section focused on common barriers above. In addition, this barrier combined with a lack of clear targets to support the rollout of sub-tropical thicket and coastal forest restoration provides little clear direction to either responsible government departments or potential project implementers on the required pace and extent of restoration efforts. Clear government signals on its perceived restoration needs would assist in facilitating project implementation by the private and non-profit sectors.

Important areas for consideration

Thirteen of the Top 30 policies in the initial policy review include text supportive of ecosystem restoration. The mention of both thickets and forests in the *National Development Plan* and the *National Climate Change Response Policy*, both recent documents, demonstrate a growing awareness of the importance of long-term maintenance and rehabilitation of these biomes in the context of climate change mitigation. However, the lack of distinct targets for these two biomes may need to be addressed. Clear targets do not support the recognition of the importance of restoration efforts.

Further areas for consideration:

- A key area may be enhanced interdepartmental planning and coordination. For example, the Department of Environmental Affairs (DEA) and the Department of Agriculture, Forestry and Fisheries (DAFF) could jointly agree to particular thicket and forest restoration targets. The minimum baseline opportunity presented in the Phase II Implementation report, of 500,000 hectares of thicket, 8,570 hectares of coastal forests and 300,000 of broadleaf woodlands could be used as a guide for the allocation of resources and capacity.
- Determination of the target can be further substantiated by a national forestry mapping and inventory process, whereby the areas most affected by degradation and deforestation are identified, as well as the location of areas best suited to short- and near-term interventions. This exercise is required under the *National Forests Act*.
- Once a target is agreed, it should be integrated into the next iteration of the *Strategic Plan for the Environmental Sector Plan 2009-2014*, the *Integrated Growth and Development Plan* (DAFF), the *Strategic Plan 2012/13-2016/17 for DAFF*, and other relevant departmental or cross-departmental plans and strategies.
- Assuming that a *National Framework Response on Climate Change Mitigation and Adaptation* is adopted to support the NCCRP, the adoption of clear targets by the Minister may be a key driver to implementation.
- The NCCRP requires that the Ministry responsible for each Near-term Priority Flagship Programme, including thicket restoration, develop a framework that directs implementation, details expected mitigation and adaptation outcomes, plans sustainable development benefits and monitors and evaluates progress. The framework could consider and commit to the targets for thicket and forest restoration.
- The implementation of UNFCCC REDD+ in SA can assist greatly in up scaling this mitigation option. However, this will have to be pro-actively driven by the responsible department.

1.2.2 The restoration and management of indigenous grasslands

Pertinent policies

Table 4 provides a summary of the policies that broadly support, make direct reference to or provide targets for the restoration of grasslands. The results demonstrate that although there is broad-level support for restoration and conservation efforts generally, fewer policies provide a clear focus on the activity. Only the *National Protected Areas Expansion Strategy* sets a clear target for conservation of grasslands, although no policy directly states the area of grassland that may benefit from restoration efforts.

Table 4. Overview of policies supporting restoration and management of grasslands

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
National Climate Change Response Policy	X		
Presidential Delivery Agreement No 10	X	X	
National Environmental Management Act	X		
NEM: Biodiversity Act	X		
NEM: Protected Areas Act	X		
National Protected Areas Expansion Strategy	X	X	X
Disaster Management White Paper, Act and Framework	X		
National Development Plan	X		
Carbon Tax Paper	X		
Guidelines regarding the determination of Bioregions and the preparation of and publication of Bioregional Plans	X		
Environmental Sector Plan	X		
National Strategy for Sustainable Development and Action Plan 2011-2014	X		
Integrated Growth and Development Plan			
Conservation of Agricultural Resources Act	X		
Strategic Plan 2012/13-2016/17 for DAFF	X	X	
The Grasslands Programme (launched in 2008)	X	X	

Is there broad support?

The *National Climate Change Response Paper* (NCCRP) commits South Africa to explore, develop and implement various incentive measures that could indirectly lead to reductions in land-use based GHG emissions, including biodiversity and conservation management property tax exemptions (10.7). The White Paper focuses on the realization of ecosystem-based adaptation opportunities, aiming to promote the conservation, rehabilitation and restoration of ecosystems with high potential to improve climate resilience. Although grasslands are not specified as priority areas in this context, the principles held in the NCCRP apply particularly to this important biome.

Given the importance of the biome to national carbon stocks and water resources, many of the principles held in the policies and noted below apply to the biome, although specific programmes that address the restoration and management of the grassland biome are not specifically identified,

There is recognition across the policies presented in Table 4 that the restoration of degraded ecosystems is an important contribution to management of the country's environmental resources. The following principles are recognized within legislation, plans, strategies, guidelines and programmes:

- A commitment to restoring natural ecosystems, not only for climate change purposes but for the variety of ecosystem services (e.g. water regulation, food and fodder production)
- Recognition of the contribution that natural ecosystems make to national carbon stocks, and how sustainable management of these ecosystems can continue to contribute to a sound national climate change mitigation and adaptation response
- Recognizing that intact biodiversity is vital for sustainable economic growth and development
- A commitment to the development of financial instruments to incentivize ecosystem rehabilitation efforts
- The legal basis by which areas impacted by disasters may require active rehabilitation and restoration efforts
- A recognition that grasslands are subject to degradation pressures requiring urgent conservation action

Is there a clear focus on the activity and biome?

The grassland biome is the focus of a specific South African Biodiversity Institute (SANBI) Programme that works jointly with relevant government departments at the national and provincial level. The programme maintains several practical strategies with the sectors whose activities bear consequence for the grassland biome, including the agriculture and mining sector. Agriculture

takes place on approximately 65% of the biome, and while mining occupies considerably less land area, the consequences for land, soil structure and soil carbon and water can be considerable and frequently extend beyond the site of the mining activity. In addition, the *National Protected Areas Expansion Strategy* (NPAES) seeks to conserve a certain portion of the country's ecosystems. It notes that grasslands in particular are under clear threat of conversion from various land development pressures and seeks to integrate more grassland areas into the country's protected areas network.

Are there clear targets?

Only the *National Protected Areas Expansion Strategy* provides clear, time-bound and region specific targets for grassland conservation. It seeks to integrate an additional 4.2 million hectares of grasslands into the country's protected areas network over a 20-year period, thereby securing 14% of the country's grasslands.

Presidential Agreement No 10 commits in Output no 4 to protecting biodiversity through the following (though specific grassland targets are not mentioned):

- Expansion of the conservation estate from 12% to 14% of total area of South Africa
- Developing climate change adaption frameworks for major biomes and aquatic systems (including grasslands)
- Protection of agricultural land – setting a target to protect 81% of high potential agricultural land

The *National Strategy for Sustainable Development and Action Plan* commits to restoring 3.2 million hectares of land affected by degradation by 2014. However, the percentage allocated to grassland conservation is not specified. The *Strategic Plan 2012/13-2016/27 for DAFF* commits to coordinating rehabilitation of 50,000 hectares of indigenous forests, woodlands and agricultural land. A percentage of the agricultural land may fall within the grassland biome.

Aside from the NPAES, the policies providing targets are often not complimented by commitments in the form of detailed plans, resource allocation, clear roles and responsibilities. Targets are limited and tend not to be site or time-period specific.

What are the unique barriers to implementation?

As reported in Phase 1 of the project, over 60% of South Africa's terrestrial carbon stocks are located in grassland and open savanna ecosystems. Within these open systems, over 95% of carbon stocks are located in the belowground soil carbon pool that is relatively stable, unless the area is ploughed or subject to heavy degradation through overgrazing. In this context the following key challenges are noted with respect to agricultural policy and regulation as it applies to activities impacting on grasslands.

- Many national policies promote the expansion and diversification of the sector, but tend not to promote improved agricultural techniques (cultivation or rangeland). In other words, promotion of conservation farming techniques does not often complement expansion targets.
- While the *Conservation of Agricultural Resource Act* (1983) asserts the mandate to practice soil conservation techniques, this aspect (or the Act) is not a core strategic component of strategies and plans promoting agricultural expansion.

Due to the high impact of its nature, mining also presents a threat in terms of maintaining and improving this biome for carbon stock and ecosystem service purposes. Large parts of the biome cover significant coal reserves, for which exploration license have been granted. Although regulations are in place to assess and consider mining applications in the context of the environmental impact, in both the *Mining and Petroleum Resources Development Act* (MPRDA) and NEMA, the tendency in South Africa is for the mining license to supersede existing land uses and land rights except where the latter falls within Special Nature Reserves, National Parks or Nature Reserves declared in terms of the National Environmental Management: Protected Areas Act, 2003.

Areas for consideration

A potential SIP19 focussed on Ecological Infrastructure for Water Security"

Many of the top policies include text supportive of maintaining biodiversity and conserving or rehabilitating ecosystem services. For example, *The Presidential Agreement No 10* commits to climate change adaptation frameworks within all biomes, and makes specific reference to ecosystem services, and environmental management for water resource protection amongst other objectives. Essentially many of these policies recognize the importance of maintaining and enhancing ecosystem service infrastructure, including water function and carbon storage services. Thus ecosystem services are recognized and reiterated at national level as a key component of infrastructure vital for the country's functioning.

As part of the *National Infrastructure Plan* Government identified 18 Strategic Integrated Projects (SIPs). Since the initial identification and publication of the SIPs in 2012, a further strategically important area has gained more serious recognition, notably the need to secure a long-term, resilient and sustainable source of water for South Africa in a cost-efficient manner. It has therefore proposed that an additional Strategic Integrated Project is developed that focuses on securing the provision of water services through the restoration and appropriate management of catchments. A large body of good local and international

research has shown that it is far more cost effective and sustainable to restore catchments and associated water services (ecological infrastructure) than rely on built solutions in the form of dams and filtration plants.

In addition to the provision of water services (the regulation of water quality, sedimentation, stream flow and flood and drought events), the restoration and management of intact ecological infrastructure restores the productive capacity of the land (for crop production and grazing), secures terrestrial carbon stocks, and provides extensive employment and skill development opportunities in remote rural areas.

It is therefore suggested that an additional Strategic Integrated Project is added in the form of "SIP19: Ecological Infrastructure for Water Security". From national terrestrial carbon management point of view, on first inspection, it may form one of the principle vehicles through which to restore and maintain carbon stocks at landscape and regional scales in the country.

Expanded land use planning within municipal and communal areas

Within the grassland biome there is a broad diversity of land use types, land ownership regimes and governance structures. For example within the greater Drakensberg area catchment, land use may include communal farming, commercial farming, different municipal entities, conservation areas, forestry and mining. In the context of the diverse uses and governance, there is a need for expanded land use planning that has a strong participatory component. Municipalities could be the primary agencies to co-ordinate such an activity (for example, the Umgeni Ecological Infrastructure Partnership has brought together several municipalities with the collective purpose of land use planning for managing the greater catchment.) This model has good application within the greater grassland biome.

Restoration and management of degraded lands

Different farming practices take place within the biome. Whereas many farmers have benefited from long-term veld management programmes, there is a substantial population of both commercial and emerging farmers who require more targeted assistance. Such plans focus on existing veld condition, improvements to veld condition and ecological conditions and well as commercial viability. To establish these plans and during initial implementation, the farmer may need additional capacity and assistance.

Implementation of these land management approaches could take place through municipal capacity, provincial conservation organization, the Expanded Public Works Programme, NGOs, community organizations and the private sector. As an example, eThekwini Municipality currently implements grassland and forest management measures together with Working on Fire, Working for Ecosystems, and the Wildlife Conservation Trust. This approach should however not undermine the need for core expertise within local and regional government.

It is recommended that these types of programmes be mandated and earmarked for resources through municipal level land use management schemes, required under SPLUMA. This policy vehicle presents an important opportunity to influence municipal-level decision-making. As SPLUMA has only recently been adopted, there is ample opportunity to influence the development and content of land use management schemes, which themselves devolve from SPLUMA's mandated national spatial development framework.

Setting national targets and objectives for the biome

Given the strategic importance of this biome for water resource supply, ecological services and carbon stocks, national objectives and targets should be set with respect to the management and rehabilitation of grasslands. The SA Carbon Sinks Assessment Phase II report conservatively estimates that 1.19 million hectares of grasslands could be restored.

Refinement of the target should be pursued through the identification and mapping of the location of areas best suited to short- and near-term interventions. Once a target is agreed, it should be integrated into the next iterations of the *Strategic Plan for the Environmental Sector Plan 2009-2014*, the *Integrated Growth and Development Plan* (DAFF), the *Strategic Plan 2012/13-2016/17 for DAFF*, the *National Strategy for Sustainable Development and Action Plan* and any other relevant departmental or cross-departmental plans and strategies.

Assuming that a *National Framework Response on Climate Change Mitigation and Adaptation* is adopted to support the NCCRP, this should clearly request the relevant Minister(s) to adopt clear, time-bound targets for restoration and management of grasslands.

1.2.3 Community-based commercial afforestation

Applicable policies

There is a supportive policy environment for the development of the commercial small-scale afforestation sector (Table 5). The contribution of the sector to local job creation, the opportunity to empower emerging communities, and the GHG emission reduction potential has lent itself to regular inclusion in policy. The broad support across nine policies extends into a clear focus on the activity, where there is rich and informed discussion of the challenges facing the sector. Two policies present targets for the expansion of the sector by 100,000 ha. This target extends primarily to communities, as they often own land best suited to expansion of the activity. The potential to afforest 100,000 hectares has been extensively researched and is widely acknowledged as practicable.

Table 5. Overview of policies supporting commercial small-scale afforestation

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
National Climate Change Response Policy	X	X	
National Forests Act	X	X	
Industrial Policy and Action Plan	X	X	X
Carbon Tax Paper	X		
Integrated Growth and Development Plan	X	X	
Strategic Plan 2012/13-2016/17 for DAFF	X	X	
Framework for the National Forestry Programme	X	X	
Forest Sector Transformation Charter	X	X	X
Forestry 2030 Roadmap	X	X	

Is there broad support?

Nine policies provide broad support for commercial small-scale afforestation, including a strong legislative framework presented in the *National Forests Act*. Support covers a number of considerations and demonstrates that there is substantial political will to see the activity develop to its full capacity:

- Recognition of the value of commercial forestry to the economy and to job creation
- Provision of the legislative backdrop which allows for the delivery of technical, material and financial support to community forestry activities
- Affirmation that carbon offsets can originate from projects that support rural development
- Commitments to facilitating the access of commercial small-scale farmers to forestry activities, through extension support, partnerships with private-sector actors, favorable financial packages that reduce interest burdens, and land reform assistance
- Pledges to improve the contribution of emerging farmers and introduce principles of transformation into the sector
- A commitment to growing the sector, notably with support to the licensing process to fast-track development and by developing spatially appropriate transport corridors to improve market access

Is there a clear focus on the activity or biome?

Almost all policies provide a clear focus on expanding and improving participation rates in commercial small-scale forestry. The NFA provides the legislative foundation for promoting the activity, which authorizes the Minister to provide assistance to community forestry, ranging from technical, managerial and extension interventions, to financial and material assistance. In addition, the Minister may develop nurseries or other relevant facilities, managed for the purpose of providing plants and seedlings to community forestry groups.

Following this, the *Forest Sector Transformation Charter* is the most focused plan, directed specifically at improving the participation rate of previously disadvantaged persons in the forestry sector. The Charter envisages facilitating collaboration amongst relevant government departments and private sector actors to provide technical and financial assistance to emerging farmers, and to facilitating the negotiation and resolution of land claims and outstanding land tenure issues. In addition, it recognizes the broader structural challenges facing emerging farmers, and calls for government-led investments into targeted road developments to drive market access. In each instance, the Charter provides detailed accounts of how these issues might be addressed, and notes the departments or organizations that should be partnered with to provide rapid transformation in the sector.

Generally, the policies recognize a gap in skills development and extension services, and promote a combination of government-led and private-sector partnerships to address this issue, including the revival of agricultural colleges. There is a recognition of the role that the private-sector has played to-date in encouraging the participation of communities in forestry programmes led by Mondi, Sappi and the SA Wattle Growers Union, and a commitment to continuing to foster and encourage these relationships. Moreover, there is an appreciation for the difficulties that community forestry groups encounter in raising funds to undertake forestry, in no small part due to investor's unwillingness to commit funds to the long time horizons required to establish and grow plantations to maturity. From a practical perspective, there is also a commitment to speeding up the afforestation licensing process – be it positive or negative decisions of the process – to reduce both delays and speed up delivery of product to an undersupplied market.

The nine policies clearly identify the challenges facing emerging farmers and community groups interested in pursuing commercial forestry. However, the Charter

aside, there are very few practical solutions provided to address these types of issues. Commitments to address the challenges remain quite broad, supported by limited to no detail on the practical efforts required to manage them.

Are there clear targets?

Both IPAP and the Charter provide clear afforestation targets. IPAP calculates that upwards of 145,000 hectares of new plantation forest could be established, predominately in the Eastern Cape (100,000 ha), but also in Mpumalanga, Limpopo and KwaZulu-Natal. It highlights the opportunity to create 15,000 jobs through the establishment of 100,000 hectares. In alignment with IPAP, the Charter intends to support the establishment of 10,000 ha per annum, over a 10-year period, achieving a total addition to the plantation forestry estate of 100,000 ha. Moreover, it intends to facilitate securing land tenure rights for 50% of new plantation developments in Eastern Cape, where it believes there is substantial opportunity for the sector. The targets for 100,000 ha of establishment align with those proposed in the SA Sinks Phase II Implementation Report.

What are the unique barriers to implementation?

The barriers to implementation for commercial small-scale afforestation are well documented across policy. Stakeholders further confirmed these challenges. The most commonly cited barriers for the industry included:

- Lack of forest-sector specific technical skills and knowledge amongst smallholder participants
- A slow and inefficient afforestation licensing process, notably with regards the release of water permits
- Difficulties in accessing finance at interest rates that could justify long-term investments into forestry

Stakeholders in the established commercial forestry industry noted that they had encountered success in partnering with local communities to undertake plantation forestry activities. The forestry company provided technical training, seedlings, and transport support, in exchange for a pre-established off take agreement, which granted them privileged access to timber stocks at maturation. The partnership model had yielded considerable benefits for both parties. Communities benefited from the creation of local jobs, technical forestry and business skills, and the flow of substantial revenues into local communities.

It was recognized, however, that continuing to expand that support was dependent on the ability of communities to secure afforestation licenses within a reasonable timeframe, dependent on both an EIA and water license approvals. Stakeholders confirmed that the opportunity to include an additional 100,000 hectares into the country's commercial forestry estate was based on multiple, extensive analyses. These analyses demonstrated that these areas, from an ecological perspective, were fit for establishment – not posing unacceptable threats to either biodiversity or water flow. It was noted that there is a backlog for water licensing applications through the Department of Water Affairs, for areas covering several thousand hectares of land. More importantly, however, it was noted that continued development of the smallholder sector would also be dependent on improving coordination amongst the various departments involved in the forestry licensing process – Department of Agriculture, Forestry and Fisheries, Department of Environmental Affairs and the Department of Water Affairs, as well as the Licensing Advisory Committee (LAC) that gives the final recommendation to the Department or responsible authority. Otherwise, stakeholders warned that it's difficult to maintain communities' interest in commercial forestry, as the long lag time in licensing presents an important opportunity cost.

In addition to the slow afforestation licensing process, stakeholders noted that smallholder forestry participants struggled to access bank funding. Aside from perception that community members presented a credit risk due to limited exposure to forestry management, banks were concerned by the lack of securitization emerging farmers could offer. In the instances where loans have been accessed, sometimes as a package from a forestry company in partnership with the Industrial Development Corporation, the interest rates can still limit profits considerably, putting into question the viability of the operation in the long-term. Stakeholders confirmed that the upfront establishment costs are approximately ZAR 5,000 per hectare, requiring significant capital outlays by communities for even moderate sized interventions (500 – 1,000 ha).

Areas for consideration

Currently, the delays in afforestation licensing are contributing to limitations in growth of the commercial smallholder forestry sector. The opportunity costs associated with the long delay in water licensing for afforestation may lead some communities to utilize land-holdings for potentially less profitable activities, and certainly ones that are unlikely to yield similar carbon sequestration benefits. Alternative activities may also not be accompanied by the same technical and financial skills development support afforded by the commercial forestry sector. In all, this suggests a potential net loss in community revenues, job creation, skills enhancement, and carbon sequestration gains. The following policy related actions could be considered:

- The *National Water Act* does not specify timelines for the water license decision-making process. The lack of clarity on timelines may contribute to the slow turnaround of applications. The Department of Water Affairs (DWA) states that the licensing process could take anywhere between three to twelve months, although during DWA's annual report to Parliament suggested far longer delays; it was noted that there

was a backlog of 1,420 applications, of which 18% had been pending since 2010 (Parliamentary Monitoring Group, 2013). Currently, a *Water Act Amendment Bill* has been tabled for review in Parliament. The proposed amendment to section four "water use" states "The Minister must align and integrate the process for consideration of a water use license with the timeframes and process applications for…." This alignment and integration extends to both the mining sector and any environmental authorizations considered under NEMA. It is recommended that the inclusion of afforestation in this amendment be clarified. In addition, and assuming the amendment bill covers afforestation, DAFF should collaborate with DWA to establish standards for optimal afforestation licensing timelines, considering the EIA requirements, as well as community needs. This will provide greater clarity to DWA on the required licensing timelines for afforestation, taking into consideration a number of important factors and processes, and reducing the risk that licensing processes will meet with delays.

- During DWA's annual report to Parliament in April 2013, the department was asked to provide more specific information on the breakdown of licensing issues – if the backlog was due to either incomplete or poorly conceived applications, which was delaying the team, or rather in departmental inefficiencies. DWA confirmed that in the forestry sector, 80 applications in the Eastern Cape had been put on hold, due to the provision of unverifiable information, delaying delivery of licenses in the sector. It was suggested that for forestry in particular, the fault fell not with DWA in application delays, but rather in the quality of applications submitted. It is recommended that the Minister of Agriculture, Forestry and Fisheries draw on his/her powers established in chapter four, part three of the *National Forests Act* to provide support to community forestry. In particular, the provision of technical support to prepare complete applications based on sound scientific evidence will facilitate the licensing process. In 2013, DWA has confirmed that it has established a new unit focused exclusively on water licensing. It is expected, then, that improvements in the licensing applications should be met with greater efficiencies in DWA and lead to a quicker turn-around in afforestation licensing.

Licensing aside, communities have faced significant hurdles in accessing finance on terms that favor the long-term commitments required to undertake forestry. For this reason, the following policy intervention should be considered:

- *The National Forests Act* provides the Minister with wide-sweeping powers to support community forestry. This includes the provision of financial and material assistance, which is left open to broad interpretation of what form that assistance might take. Given the high upfront capital costs required to undertake a commercial forestry venture, it is recommended that innovative financial mechanisms to support emerging farmers be developed. This might include, for example, a guarantee facility to attract private sector investment, improving the risk-adjusted return for potential funders and leading to reductions in interest rates. The Industrial Development Corporation or the Development Bank of South Africa might consider a moderate equity investment in community forestry (~25%), aggregated across a portfolio of small-scale forestry projects to encourage an increase in private sector investment. In all instances, the Department should promote and foster the continued participation of the established commercial forestry industry, to provide technical expertise and training. This will provide assurance to financial institutions that emerging farmers have the proper skills and knowledge required to undertake successful silviculture operations.

1.2.4 Biogas energy production

Pertinent policies

Table 6 provides a summary of the policies that broadly support, make direct reference to, or provide targets for biogas based energy generation in South Africa. The list of policies demonstrates that although there is a national level directive and impetus to provide an enabling environment for alternative energy generation, a specific focus on biogas energy is limited.

Table 6. *Overview of policies supporting implementation of biogas digesters*

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
National Climate Change Response Policy	X		
White Paper on Renewable Energy	X		
Strategic Plan 2011/12 – 2015/16, Department of Energy			
Integrated Resource Plan for Energy (2010 & 2013)	X	X	X
Industrial Policy Action Plan: 2012/2013 - 2014/15	X	X	

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
National Development Plan	X		
The Energy Act	X		
The DTI's Manufacturing Competitiveness Enhancement Programme	X	X	
Presidential Strategic Infrastructure Plan No 8	X	X	

Is there broad support?

The White Paper on Renewable Energy (2003) provides the basis for renewable energy promotion and generation in South Africa. It sets clear targets to achieve a diversified energy mix, with a specific target commitment of 10 000GWh of South Africa's energy requirement to be delivered through renewable energy sources (biomass, wind, solar and small scale hydro) by 2013.

The need to support diversified energy is taken up nationally in a number of policies and implementation plans. The *Presidential Infrastructure Plan* addresses this within SIP 8, which aims to support sustainable green energy initiatives on a national scale through a diverse range of clean energy options as envisaged in the *Integrated Resource Plan*. The *2010 Presidential Delivery Agreements* include a plan to improve infrastructure (No 6: Infrastructure) and undertakes to ensure the "reliable generation, distribution and transmission of electricity" (Output 2). The Agreement aims to ensure a "Conducive Environment for Independent Power Producers" and to address the regulatory framework that favors Eskom through the introduction of an Independent System Operator. Addressing regulatory constraint includes ensuring an open and non-discriminatory access to the transmission grid.

In recent years a number of developments have taken place that give impetus to the emerging alternative energy sector. The National Energy Regulator of South Africa (NERSA) published a feed-in tariff scheme and criteria for renewable energy providers. In addition, the procurement round reached financial close in the latter part of 2012 according to the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). With respect to promoting opportunities for the biogas industry, REIPPPP has had limited offering, as it is underpinned by a long-term off take by ESKOM. The economics of biogas energy dictate that the more significant potential for biogas energy generation lies in situations where there is limited access to the grid, and is typically undertaken at small scale stand-alone (off-grid) schemes in domestic, small holding, intensive commercial farm environments and for wastes generated from industrial processes[13].

Of significance though, is one of the Flagship Programmes that has its origins in the *National Climate Change Response Strategy* viz. The Waste Management Flagship Programme. This Programme commits to investigating and implementing waste-to-energy opportunities available within solid-, semi-solid and liquid-waste management sectors, especially the generation, capture, conversion and/or use of methane gas. This Flagship Programme is championed by the Department of Minerals and Energy (DME) and has been initiated with the intention of rolling out a programmatic approach for waste-to-energy at municipal waste sites.

The policy environment demonstrates that the industry is gaining exposure and interest, with the focus primarily on providing energy solutions at a local government level.

Is there a clear focus on the activity?

While there is a clear focus on promoting and facilitating the implementation of renewable energy on a national level, the regulatory response and incentives to support and stimulate biogas generation have been slow to develop since most of the potential lies in providing stand-alone (off grid) solutions.

The following initiatives give clear support for biogas energy generation:

- The Waste Management Flagship Programme: The DME intends to roll out this initiative on a programmatic level at municipal waste sites. The DME and local government focus in this sector is ideal, as municipal waste sites are challenging for the private sector development, with uncertain outcomes (and additional hurdles with respect to local government requirements for procurement tenders[14]).
- Biogas digesters are capital intensive to establish, with large-scale digesters costing R2 million (fixed dome) and R5 million (stirred tank reactor generator).

13 Although the technological is well applied elsewhere in the world for municipal waste sites, South Africa has a poor waste management history and the diverse unsorted nature of the waste gives challenges to gas reserve estimates and reliable off take. This implies high risk for private sector investors to develop in this area.

14 There may be potential here for programmatic CDM registration to boost revenues for this programme – CDM registration has been obtained for the Durban Landfill gas to energy project.

The following two incentive schemes can materially reduce the payback period on capital and substantially increase the return on biogas investment

- Rebates under ESKOM's standard offer, at R1.20 per kWh for units generating between 10kwp to 1MWp in 2012 serves as an incentivizing boost to the implementation of biogas generators offsetting some of the capital outlay barriers.
- Industry's Manufacturing Competitiveness Enhancement Programme, implemented by the Department of Trade and Industry (DTI), offers grants and incentives for green technology and resource efficiency improvements, including biogas technology

Are there clear targets? What are they?

The Integrated Resource Plan (2010 and updated 2013) makes provision for supply from biogas into the national energy mix as follows: biogas at 12.5 MW and 12.5 for Landfill Gas.

What are the unique barriers to implementation?

With respect to large scale biogas projects utilizing municipal waste streams, the *Procurement and Municipal Finance Management Act* and the *Public Finance Management Act* present significant obstacles. This legislation requires that any bid to provide a service to the public sector be put out to public tender. This implies that, for any private sector developer, the initial technical and feasibility assessments (on gas reserves for example) are done on risk, as this IP is placed in the public domain to a tender process that considers a range of criteria, not necessarily restricted to technical expertise. There is thus no first mover advantage to develop biogas infrastructure for municipal sites in this context.

Areas for consideration

Biogas energy generation has significant scope to be taken up and championed by programmes beyond the energy sector frameworks since this technology offers solutions for waste and water management as well as for rural development.

The benefits associated with implementation of biogas generators falls within a number of different ambits of national and local government, as this activity offers solutions both for waste and water management, within agricultural, municipal and industrial sectors. Thus there are a number of areas in government where this activity could be actively promoted (Department of Water Affairs Catchment Management Strategies, Municipal Integrated Development Frameworks etc.).

The issue of procurement legislation note above (relating to the *Procurement and Municipal Finance Management Act* and the *Public Finance Management Act*) presents a significant barrier that needs to be considered further.

With respect to biogas energy generation and the agricultural sector and the industrial sector[15], several interviewed practitioners noted that while they have explored carbon revenues in detail (with several even going to the lengths of compiling CDM and VCS Project Design Documents), there is little demand for carbon offsets both locally and internationally. Furthermore, if a buyer can be identified, the price offered, generally does not substantiate the high costs of validation.

As noted in the analysis of common barriers above, clear demand for carbon offsets at a reasonable price, either from international markets or through an emerging South African carbon offset program, may significant improve the financial viability of biogas based electricity generation.

1.2.5 Biomass energy generation

Pertinent polices

Table 7 provides a summary of the policies that either broadly support or make direct reference to biomass energy generation in South Africa. The list of policies demonstrates that although there is a national level directive and impetus to provide an enabling environment for alternative energy generation, the specific focus on biomass energy remains limited. Similarly, targets for biomass energy generation are limited.

15 For example, CDM registration was obtained (2006) for a scheme at PetroSA, where biogas from anaerobic wastewater was previously flared. An Independent Power Producer was established on site by an independent 3rd party and 4.2 MW of electricity is now generated and sold onwards to PetroSA, decreasing the dependence of PetroSA on the grid

Table 7. Overview of policies supporting implementation of biomass to energy

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
National Climate Change Response Policy	X		
White Paper on Renewable Energy	X		
Strategic Plan 2011/12 – 2015/16, Department of Energy	X		
Integrated Resource Plan for Energy (2010 & 2013)	X	X	X
Industrial Policy Action Plan: 2012/2013 - 2014/15	X	X	
National Development Plan	X		
The Energy Act	X		
The DTI's Manufacturing Competitiveness Enhancement Programme	X	X	
Presidential Strategic Infrastructure Plan No 8	X	X	

Is there broad support?

The *White Paper on Renewable Energy* (2003) sets clear targets to achieve a diversified energy mix. While this and earlier policy iterations confirmed South Africa's commitment to a cleaner energy mix, the frameworks to support the development of the industry have been slow to develop. Specifically the support for the sector was delayed by a process of prolonged uncertainty relating to the National Energy Regulator of South Africa ("NERSA") Renewable Energy Feed-in Tariff Scheme ("REFIT"), which was finally published in 2007, but after much consultation, never made it into law. This was followed by the subsequent implementation of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP or colloquially, REBID), which was released in 2011. The first REIPPPP procurement round reached financial close in the latter part of 2012. REIPPPP is a well-structured programme that has successfully facilitated two rounds of competitive bids, with the third currently nearing financial closure.

REIPPP is a competitive bidding system that includes significant requirement for local socio-economic development component, specifically localized production facilities and job creation. These criteria favor biomass energy projects, as by their nature they demand a higher labour component than energy generation through technologies such as wind and solar, and local sourcing is achievable.

There are several logistical and technical challenges with large scale biomass energy production (maintaining quality uniform fuel free of dust and moisture, transport logistics of fuel source to plant etc.), but the formal sugar and paper and pulp industry is ideally placed to operate in this space, as this sector tends to have more control and influence over fuel sources and transport logistics. The viability of electricity generation in this sector relies on leveraging existing capacity and these industries already have internal generation capacity based on this fuel source, and are well positioned to generate additional energy and supply to the grid from this potential. The sugar industry, for example, estimates that it could generate an additional 780MW of electricity in the near term.

Is there a clear focus on the activity?

Biomass energy generation has been largely undertaken by the private sector viz. the forestry and sugar industries with the purpose of meeting internal electricity and power requirements with limited opportunity for expansion without a clear framework for power purchasing agreements. The frameworks now accommodate the inclusion of independent power producers, including biomass technology.

To date, one biomass energy project has been awarded through REIPPPP; this is a 17.5MW plant located at Mkuze in KwaZulu-Natal that will be fuelled through the combustion of sugar cane tops. Construction is set to begin in June 2014.

Are there clear targets? What are they?

The Minister has allocated 12.5 MW of the total energy mix to be generated from biomass technology.

What are the unique barriers to implementation?

There are no specific regulatory barriers to entry now that the procurement programme for power producers is in place (REIPPPP), however there are cases where historically biomass energy projects have been shelved due to the unwillingness from NERSA to facilitate uptake by the national grid.

Generation of energy using sustainable biomass fuel is capital intensive – operating costs are also high and relatively labor intensive. For this reason the application is best suited to existing commercial operators within the forestry and sugar production sectors that can leverage existing transport, processing facilities and head-office capacity. Costs and logistics present serious challenges for the rollout of biomass energy generation using alien plans as the biomass fuel stock, especially for new 'greenfield' operations. Significant investments would be required to finance harvesting, chipping and transport, and proactive government support would be required to develop viable solutions in this area.

Areas for consideration

In terms of potential policy considerations, biomass energy generation shares many of the concerns noted for biogas energy generation. Barriers to the supply of electricity to the national grid or to local municipalities need to be addressed. Moreover, clear, long-term sustainable demand for generated carbon offsets would significantly improve the viability of ventures.

As noted above, entry into the sector by new, emerging operators that don't have the opportunity to leverage existing transport and processing infrastructure will be difficult. Here, privileged financial packages that reduce capital cost burdens and associated debt may be required to allow the entry of emerging operators. This is especially for projects that utilize biomass from harvest alien invasive plants that may require extensive field operations.

1.2.6 The roll-out of biochar

Pertinent policies

There are a number of policies that broadly support efforts that could include biochar production (Table 8). However, no policy explicitly references or supports biochar, and there are no national-level targets in place that could drive the uptake of the technology.

Table 8 *Overview of policies supporting the implementation of biochar*

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
Conservation of Agricultural Resources Act	X		
National Climate Change Response Policy	X		
National Development Plan	X		
National Strategy for Sustainable Development	X		
Biodiversity Act and Framework	X		
Environmental Sector Plan	X		
Integrated Growth and Development Plan	X		
Strategic Plan DAFF	X		
National Biodiversity Framework	X		
Strategic Plan for South African Agriculture	X		

Is there broad support?

A number of policies could be interpreted as being supportive of biochar implementation. With its suggested potential to increase soil carbon, retain moisture in soils, reduce fertilizer needs and increase crop yields, its use would be consistent with a number of broad policy objectives:

- Recognition of the agricultural sector's contribution to GHG emissions, and the need to reduce those emissions
- Acknowledgement of the need to fund further research to explore soil conservation practices and disseminate that knowledge to farmers
- A recognition of soil degradation trends in South Africa and the threats to food security it poses
- An overarching commitment to improved farming practices, notably as they relate to soil conservation
- An imperative to remove alien invasive species, which could provide a source of biomass for biochar production

Is there a clear focus on the activity?

There is no mention of biochar amendment in the Top 30 policies or any of the other policies reviewed during the course of the initial policy analysis. It is possible that a policy or policies currently exist to support biochar application, but none were identified in the extensive catalogue development phase.

Are there clear targets?

There are no targets for biochar activities listed in any of the policies reviewed.

What are the barriers to implementation?

The major barriers for the implementation of biochar, as disclosed during the stakeholder engagement meetings, included a lack of understanding of the net GHG reduction benefits in a South African context and limited awareness of the concept amongst potential users. Concerns over the need for upfront capital and the potential structure of biochar production and transportation costs are also viewed as an inhibiting factor.

Areas for consideration

- Prior to the development and commitment to targets for biochar amendment, it is highly recommended that further analysis be undertaken to review biochar's ability to reduce GHG emissions in a variety of South African crop and soil types. In addition, a study analyzing different approaches and technologies for pyrolysis is advised, in light of the potential increase of GHG emissions that the production phase can generate. This study should be complimented by an analysis of the available feedstock and production and transportation costs, to assess the financial viability of pursuing a national-level implementation initiative.
- As part of its various commitments to "sustainable agriculture" as highlighted in a number of its more recent strategies and plans, DAFF should include policy commitments to undertaking and exploring this research. This may not necessarily be linked to DAFF's agricultural research budget but should be integrated into the proposed National Facilitation Unit, and could, in the interim, be committed to the Agricultural Research Council's research programme.
- At this stage it is not believed that direct reference to biochar amendment in documents such as the *National Climate Change Response Paper* or the *National Development Plan* is merited until a clear scientific consensus on the benefit and practicalities of biochar use is reached.
- Should its practicalities be proven, the *Conservation of Agricultural Resources Act* could be used to launch a biochar amendment scheme (see the section below for more information on the legal basis for CARA schemes).
- In the event that biochar is viewed as a viable, national-scale mitigation activity, then a regulation should be passed to ensure integrity of the biomass supply-chain. No biochar originating from degraded or deforested landscapes should be permitted for use in nationally approved programmes.

1.2.7 The adoption of reduced tillage practices

Pertinent policies

Table 9 provides a summary of the policy environment supporting the adoption of reduced tillage (conservation agriculture). It demonstrates that there is broad support across sixteen policies, of which half have a clear focus on the activity. Two policies provide targets for adoption of the activity, though these targets are considered inadequate in responding to the potential of the activity, even at conservative estimates.

Table 9 *A list of policies supporting reduced tillage practices*

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
Conservation of Agricultural Resources Act	X		
National Climate Change Response Policy	X		
National Environmental Management Act	X		
Disaster Management White Paper, Act and Framework	X		
Air Quality Act and Framework	X		
Industrial Policy Action Plan		X	X
National Development Plan	X	X	
Carbon Tax	X		
Guidance on Bioregional Plans	X		
Environmental Sector Plan	X	X	
National Strategy for Sustainable Development	X		
Integrated Growth and Development Plan	X	X	
Strategic Plan 2012/13-2016/2108 DAFF	X	X	X

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
Strategic Plan for Smallholder Producers	X	X	
National Biodiversity Framework	X	X	X
Strategic Plan for South African Agriculture	X	X	

Is there broad support?

Reduced tillage benefits from the highest level of broad policy support. The basis for supporting and pursuing conservation agriculture is found within a number of cross-sectorial policies. In particular, policies highlight the following considerations, which provide a supportive environment for conservation agriculture:

- The legal foundation from which the relevant Minister can introduce legally enforceable measures to limit agricultural practices deemed to be harmful to the environment
- The legal foundation from which harmful practices may be considered a disaster risk that must be managed
- A recognition of the contribution of agriculture to global GHG emissions and a commitment to reducing these emissions in South Africa
- An appreciation for the role that improved agriculture can play in sustainable natural resource management
- A recognition of soil degradation trends currently observed in the agricultural sector, and the threats this poses to the continued delivery of environmental services
- A commitment to undertaking improved agricultural practices, such as conservation agriculture, organic agricultural production, climate-friendly agriculture, and so forth.
- The potential inclusion of activities that reduce land degradation into the proposed Carbon Tax offsets mechanism
- A commitment to improving the agricultural policy environment to increase adoption rates of conservation agriculture and other forms of agricultural practices that deliver environmental benefits
- A commitment to supporting subsistence and small-scale farmers to adopt improved agricultural practices
- Acknowledgement of the on-going need to pursue focused research on improved farming practices and technologies

Is there a clear focus on the activity?

Eight of the policies specifically discuss the benefits of- or commitments to sustainable farming practices, organic farming, conservation farming, agro-ecological farming, minimum tillage or climate-smart agriculture. Unfortunately, these terms are often used interchangeably and with few clear definitions or descriptions of actual implementation. For this reason, the exact potential impact of these activities on soil carbon and decreasing GHG emissions remains uncertain. This is an area of policy that would benefit from more precise definitions. The following commitments and support were noted in the eight relevant policies:

- *The Environment Sector Plan* supports the practice of organic food production through the use of agro-ecological models
- *The Industrial Policy and Action Plan* supports the growth of the organic agriculture industry
- *The National Strategy for Sustainable Development and Action Plan* supports conservation agriculture, organic farming and permaculture, and notes that programmes that support conservation agriculture must be reinforced
- *The National Development Plan* recognizes the need to refine research in the agricultural sector so as to focus on ways in which to improve sustainable agriculture outcomes, notably in the commercial sector. Additionally, the NDP mentions its commitment to rolling out new technologies that align with sustainable agricultural strategies, especially those that benefit subsistence and small-scale farmers
- *The Integrated Growth and Development Plan* notes the need to adopt conservation agriculture, particularly in ecologically sensitive areas. It commits to improving production efficiency in alignment with conservation agriculture principles
- *The Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries* commits to developing policies that support agro-ecological practices. It also recognizes the need to adopt climate-smart agriculture, through the practice of introducing conservation methods into farming systems
- *The Strategic Plan for Smallholders* pledges to support the adoption of conservation and agro-ecological agricultural practices
- *The Strategic Plan for South African Agriculture* commits to helping new farming entrants undertake soil conservation work and seeks to implement soil conservation programmes. It also commits to developing infrastructure and services that support sustainable land-use, and promote organic and environmentally friendly production

Are there clear targets?

Despite broad policy support for reduced tillage practices, there are few defined targets in place. The Department of Agriculture, Forestry and Fisheries in its *Strategic Plan 2012/13-2016/17*, pledges support to 15,000 smallholder

producers as part of its food security and increased food production strategy; it is not clear that these targets align with conservation agriculture practices. It also supports the rehabilitation of 9,500 hectares of agricultural land, but how that land might be farmed in the future is not clear. The *National Biodiversity Framework* commits to working with three "production sectors," of which agriculture may be an early target, to reduce impacts on biodiversity. Again, the extent to which this may result in efforts to introduce reduced tillage remain unclear.

These targets suggest that while Government is committed to growing the subsistence, small-scale and commercial agricultural sectors, there is no compulsory need for the adoption of reduced tillage practices.

What are the unique barriers to implementation?

Several researchers and practitioners note that while the general principles of reduced tillage are well known, specific knowledge of the relationship between each form of reduced tillage and carbon sequestration in South African conditions is lacking. In addition, future research is required into the net GHG benefit of implementation, cost and production implications as well as the effect on other ecosystem services (e.g. water regulation, soil fertility). This lack of specific knowledge should not halt initial implementation. Rather initial implementation should be strategically designed to explore important research questions pertinent to potential national-scale roll out.

Areas for consideration

The policy environment already provides measures and means by which both research and implementation can be undertaken. Accordingly, it is not deemed necessary to update any national-level policies required to overcome the barrier discussed above. Instead, the discussion in this section covers some initial measures that can be pursued.

The mandate for research into conservation agriculture may originate from the Minister. As proposed in the draft amendment bill for the Agricultural Research Act (2013 proposed changes to the original 1990 Act), the Minister has the authority to specify research programmes for the Council to undertake. Given that the Act is likely to be approved by Parliament sometime within the coming year, this is an important opportunity to ensure that the conservation agriculture opportunity receives considered scientific attention by inclusion in the research portfolio.

Should the research outcomes prove favorable to national-scale adoption of the activity, the *Conservation of Agricultural Resources Act* provides the basis from which the Minister can undertake either a scheme or introduce control measures into farming systems. This would allow the agricultural activities to remain under the control and oversight of the Minister, whilst still supporting land-based climate change mitigation activities. Under a "scheme" the Minister, with approval of the Minister of Finance, can instruct that subsidies are provided to farmers for undertaking conservation agriculture activities, as these would support the principles of the Act. This scheme could easily dovetail with any pre-existing offset programmes, and would have the added benefit of aligning with the Minister's own and potentially broader objectives for the agriculture sector.

Alternatively, the Minister has the power to establish control measures as they pertain to the cultivation of virgin soil, the use of agricultural land that has already been cultivated, and the restoration of previously degraded land (amongst other potential measures). Recognizing that such control measures may be both impractical to regulate in the subsistence and smallholder farmer sector, as well as potentially impose prohibitive cost burdens, it remains at the Minister's discretion to determine which types of land-users may have to adhere to various control measures. A scheme, providing financial support, could be introduced at the same time to reduce potential cost burdens.

As described in the Phase II Implementation report, the minimum opportunity for conservation tillage interventions is expected to cover some 2.88 million hectares of land, assuming an adoption rate of 20% of total agricultural lands. Taking the size of the opportunity into consideration, the Minister or other mandated authority will need to ensure that a scheme or similar intervention cater to this potential. Department plans and strategies will need to take cognizance of the total size of the opportunity into consideration when developing targets.

1.2.8 Reducing Emissions from Deforestation and Degradation (REDD+)

Applicable policies

Like conservation agriculture, REDD+ enjoys strong policy support, both with regard to broad mandates, clear focus, and targets. Table 10 lists twelve policies establish broad support for the activity. Whereas eight policies support it explicitly, four policies provide targets that are related to REDD+.

Table 10. A list of policies supporting REDD+ activities

Policy	Broad support?	Clear focus on the activity or biome?	Targets?
National Climate Change Response Policy	X	X	
National Forestry Act (1998)	X	X	
Disaster Management White Paper, Act and Framework	X		
National Environmental Management Act	X		
NEMA: Biodiversity Act and National Biodiversity Framework	X		X
Carbon Tax	X		
NEMA: Protected Areas Act	X	X	
Guidance on Bioregional Plans	X		
Protected Areas Expansion Strategy	X	X	X
Environmental Sector Plan	X		
A Woodlands Strategy Framework	X	X	X
National Development Plan	X	X	
Integrated Growth and Development Plan		X	
Strategic Plan – DAFF		X	X

Is there broad support?

REDD+ activities benefit from broad support, notably in regards to strong, explicit legislative mandates. There is strict conservation oversight of indigenous forests in South Africa. Although woodlands, in principle, are also meant to receive some measure of protection, this may not be realized to a similar extent. The support for the woodlands and forest biomes covers the following principles:

- A recognition that deforestation is a significant contributor to global GHG emissions, but that in turn, intact forests are valuable stores of carbon and play an important role in climate change adaptation strategies
- An acknowledgement of the rate of degradation of natural habitat in South Africa, forests and woodlands in particular, and the threats to ecological infrastructure that this poses
- A view that the conservation of indigenous forests in South Africa is critical, accompanied by clear targets for conservation in both natural forest and savannah landscapes
- An understanding of the important socio-economic benefits that forests and woodlands provide, notably to rural households
- A legislative mandate by which the relevant Minister can intervene to protect natural forests - individuals or entities found to be in violation of Ministerial edicts can be fined or penalized
- The legislative mandate by which forests can be declared as protected forest areas or a declared forest area
- The legislative principle that forbids the unwarranted, unsupervised destruction of natural forests and which allows the Minister to intervene urgently to halt deforestation
- The legislative framework for which a percentage of woodlands must be set aside for conservation purposes, and that all woodlands require classification
- The legislative mandate by which government can actively conserve a representative sample of the country's biodiversity and natural landscapes
- The provision by which destruction of natural forests and woodlands may qualify as a disaster, requiring immediate intervention and mitigation
- Commitments to developing fiscal instruments, such as carbon offsets or tax deductions, that will facilitate protection of critical biodiversity, such as forests and woodlands
- The provision of several important tools that allow government, individuals or entities to work to protect or sustainably manage ecosystems (Bioregional plans, Provincial Stewardship Agreements, Biodiversity Stewardship Agreements)
- A recognition of the role that research and development play in woodland and forest management, the need to develop norms and standards for overseeing the sustainable use of- and access to woodlands and forests, and the follow-up monitoring and reporting required to ensure long-term viability of these resources

Is there a clear focus on the activity or biome?

Both forests and woodland preservation benefit not only from a clear focus in departmental strategies and plans, but also in legislation, making them some of the few biomes in the country to benefit from such clear statutory emphasis. The basis for woodland and forest conservation flows from the *National Forests Act,* which considers that any destruction of natural forests should be avoided save under "exceptional circumstances" and then only with the approval of the Minister. The Minister can intervene to protect forests believed to be subject to degradation, or declare, through a mandated stakeholder process, that forests qualify as protected forest areas. Offenses and penalties are meant to deter inappropriate forest use, exploitation or access. Measures for woodland conservation are also provided: the Minister must determine what percentage of woodland to conserve, which should be based on a classification of the resource and research where required. *The National Climate Change Response Policy* situates the importance of forests in the larger climate change challenge, noting their contribution to the national terrestrial carbon stocks and the need to support conservation efforts through the use of carbon offsets.

The *National Protected Areas Expansion Strategy* (NPAES), devolving from the *NEM: Protected Areas Act,* aims to integrate both forests and savanna ecosystems (including woodlands) into the country's protected areas network. The *National Development Plan* supports NPAES. Moreover, *The National Development Plan*, *the Integrated Growth and Development Plan* (DAFF), and DAFF's *Strategic Plan* all acknowledge the important ecosystem service benefits provided by forests, not least of all carbon sequestration and storage.

A Woodlands Strategy Framework for the Department of Water Affairs and Forestry (2005) provides the most focused assessment of the current state of woodlands management. It notes that the lack of identified target for woodland conservation, as mandated by the NFA, has acted as a deterrent for ensuring the integrity of the national woodland asset. It details a number of interventions that could improve the overall sustainable management of woodlands, including the development of a Woodlands Extension Service and an Advisory Support Programme, which would assist communities in undertaking management of communal woodland resources. It notes that challenges in woodland management due to lack of secure land tenure, leading to overexploitation of the resource. It proposes that a budget be developed specifically for woodlands research, notably into what comprises a sustainable forest use system.

Are there clear targets?

There are two distinct regimes governing potential REDD+ activities in South Africa. There are those that fall under NPAES, with clear, specified, measurable targets for conservation of woodlands and forests. Outside of the existing and proposed protected areas network as designated in NPAES there is less clarity and limited detail on proposed management policies and targets.

The most ambitious targets are found in the *National Protected Areas Expansion Strategy*. It seeks to integrate a portion of the country's natural forests and its savannah systems into the protected areas network, leading to a total protected area of 23% and 10% of each biome respectively. Although this is an important contribution, it does not, however, provide insight into how the remaining 77% and 90% respectively of these two resources will be managed. Conversely, in its *Strategic Plan 2012/13-2016/17*, DAFF intends to conduct an assessment of forests and woodland forest patches in one province, monitor 20 of these patches, and develop "systematic conservation planning for forests and woodlands" in three forests of the designated province. Although this exercise will provide important learning, and perhaps provide an efficient means for replication, it will need to be scaled up considerably into adequate national-level response. It is important to note that DAFF is tasked with ensuring that no natural forest be destroyed "Save under exceptional circumstances" (NFA) and is obligated by the policy to identify a percentage of woodlands to protect.

Targets in the *National Biodiversity Framework* complement these efforts. Although the Framework requires updating in 2014, having expired in 2013, its targets over the 2009-2013 period included the development of seven bioregional plans, the establishment of two new biosphere reserves (designated by UNESCO), six spatial provincial biodiversity plans, and the implementation of six stewardship programmes aligned with NPAES and based on the development of contractual relationships with landowners. The commitment to creating two fiscal or market instruments that would incentivize participation in biodiversity conservation was also made. These targets align with efforts to conserve forests and woodlands, and could result in improved conditions by which conservation of these biomes can be realized.

What are the unique barriers to implementation?

A barrier for implementation noted by several stakeholders within Government and the NGO sector, is a lack of information on the location of the country's natural forests, the current status of its woodland assets, as well as the nature of predominant deforestation drivers within South Africa. Furthermore, clear woodland conservation goals were also highlighted as a hurdle to implementation by provinces, municipalities, and their implementation partners. Concerning woodlands in particular, stakeholders noted that the communal nature of landholdings can complicate commitment to biodiversity stewardship or similar agreements and may act as a disincentive for the development of sustainable woodland management practices.

Areas for consideration

By and large, the policy environment for REDD+ activities is well established and is not in need of substantive restructuring or alignment. The value of forest and woodland conservation, from a socio-economic and ecological perspective, is consistently cited across policy. The view that fiscal instruments, including offsets, should be established to encourage conservation is commonly held, and efforts are already under way to develop these. A clear pathway to conserve moderate percentages of these two resources is well articulated as part of the protected areas network process. A strong legislative framework supports these strategies, requiring that natural forests as well as woodlands receive protection, and that research, development and monitoring must be undertaken to ensure their integrity over time.

The following policy considerations would encourage REDD+ rollout, above and beyond removal of common barriers discussed in Section 1.1 above:

- It has been suggested that the challenge of sustainable forest and woodland management in areas under communal land-tenure, requires the development of sound, innovative implementation models that allow active community participation. Stakeholders anticipate that such models will require substantial policy support to address the issue of long-term permanence and associated viability.
- As noted above, an area target for woodland conservation needs be articulated to support implementation at provisional and local municipality scales. As noted in the *Woodlands Strategy Framework*, these targets need to be based on research that remains to be undertaken. This will allow the Minister to adhere to his/her legislative mandate with the support of robust scientific evidence.
- Development of REDD+ strategy/action plan and all the other elements as defined and required under the UNFCCC decision 1/CP.16 paragraphs 70,71, and 73 to leverage international support and generate carbon and non-carbon benefits from the implementation of REDD+ activities.

Section 2 – SECTION 4

Guiding current and future land-use beyond the scope of targeted mitigation activities

The stakeholder engagement process undertaken during the course of Section 2 was primarily aimed at identifying and understanding the nature of land-use based climate change mitigation activities in South Africa. Extended interviews were conducted to understand the nuanced details of implementation – the logistics thereof, required human resources, cost structures and so forth.

Towards the end of each interview, the party was asked to take a step-back and think beyond the strictures of the CDM, VCS and other predefined mechanisms[16]. Are there opportunities to mitigate climate change through land-use that we are missing because historically we have focused on neatly delineated project-scale initiatives? They were asked the questions: "If one could take a completely 'blue-sky' approach to land-use based climate change mitigation, what would you do?" "Which substantial opportunities are not being considered?"

Among the many great ideas put forward, two prominent areas for considerations were repeatedly identified. The first is the need to guide current land-use practices on private and communal land. The second is the need for appropriate and improved spatial and land-use planning.

The first area of consideration is based on Government and private-sector practitioners experience in the field. Many noted that while they are attempting to roll-out land restoration projects in particular areas, activities such as the deep ploughing of indigenous grasslands and the clearing of sub-tropical thicket and woodlands continue unabated. This may be understandable if the conversion of land is part of long-term development plan, but the area is often only farmed for 1-2 years before abandonment. In addition, the financial income generated in the short period is often marginal. Practitioners therefore noted that there is good scope for new forms of incentive mechanisms that would facilitate the long-term sustainable management of land.

The second area of consideration – the need for appropriate and improved spatial land-use planning – was raised by field practitioners as well as local and national Government entities. It is based on a growing awareness of the importance of ecological infrastructure and services, and the need to plan and manage such infrastructure at landscape or even regional scales. Small project-scale land restoration activities may not deliver substantial climate regulation benefits, but especially the water services that are required by local communities and downstream urban economic hubs. Although "bioregional" and other forms of spatial planning are been undertaken in particular areas, stakeholders suggested that these efforts need to be extended significantly, in terms of geographic scope, intensity and follow-up.

Guidance has been taken from the results of Section 1 of the project to first, focus the analysis on the regions or biomes with substantial carbon stocks, and secondly, on areas in which land-use and associated carbon stocks are likely to change in the near future.

The analysis illustrated that although the highest carbon stocks per hectare are found in coastal forests, followed by moist savanna and thicket ecosystems (Fig 1), when the spatial extent of the land-cover type is considered, the majority of South Africa's terrestrial carbon stock is located in grassland and open savanna systems (Fig. 2).

16 CDM – Clean Development Mechanism, VCS – Verified Carbon Standard

Approximately 30% of the national terrestrial carbon stock is located in grassland ecosystems and a slightly lower amount in the savanna biome (Scholes et al. 2013). In comparison, less than 5% of the national carbon stock is located in indigenous forest and sub-tropical thicket.

Furthermore, of particular interest in terms of developing implementation options and policy responses, is that over 90% of carbon stocks within the grassland and savanna biomes are located in the belowground soil organic carbon pool. Although this is largest terrestrial pool of carbon in the country, little priority has been placed on it, due to the historical emphasis on forests and REDD+. These results suggest that a better balance of effort is required between grassland, savanna and forest ecosystems. Whereas, restoration efforts and current progress with sub-tropical thicket and forest biomes should not be curtailed, equal effort should be placed on maintaining belowground carbon stocks in grassland and savanna ecosystems.

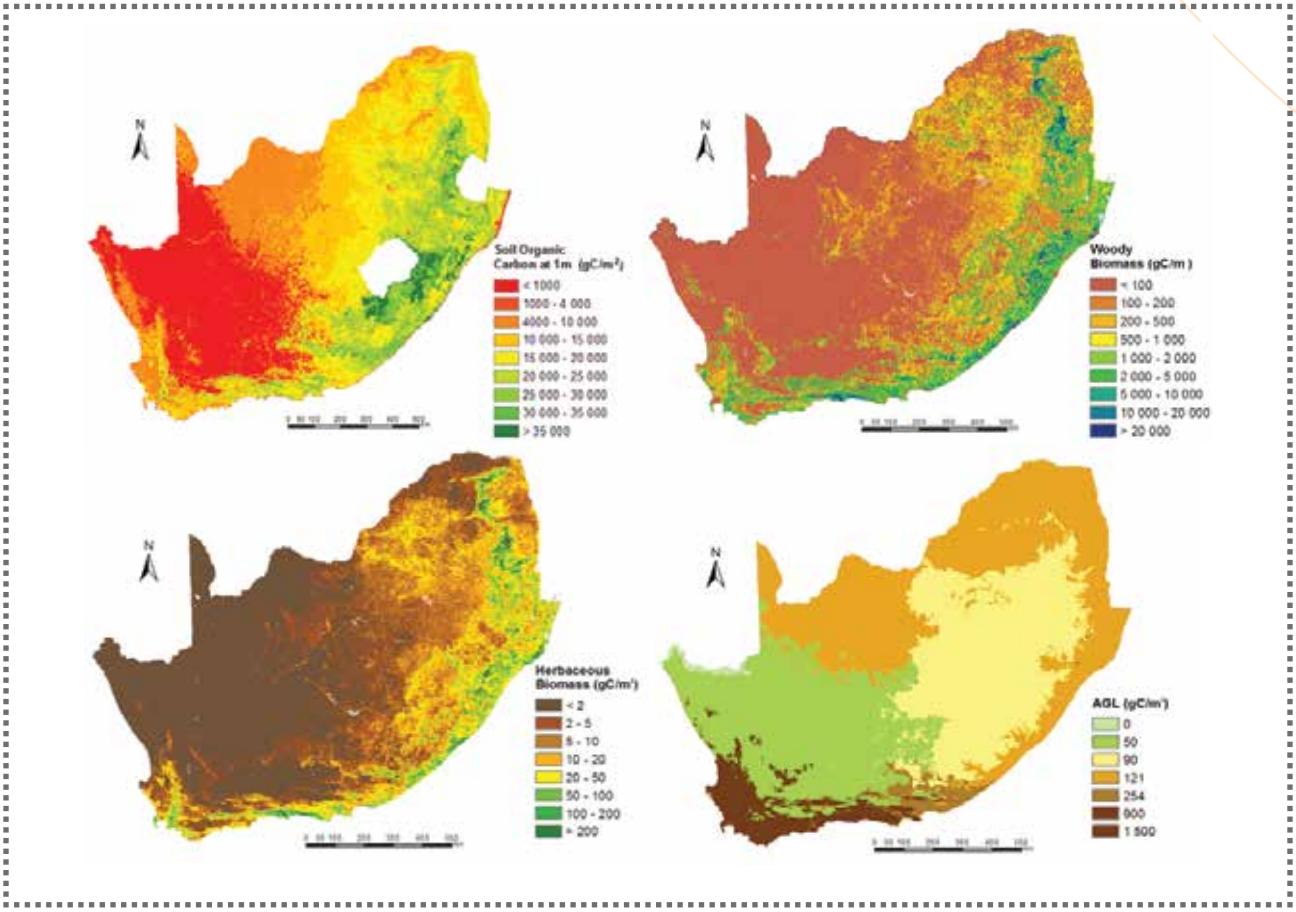

Figure 1. *The components of the terrestrial carbon stock of South Africa. Top left: soil organic carbon to 1m in depth. Top right: the above- and below-ground woody-plant biomass pool Lower left: above- and below-ground herbaceous biomass pool. Lower right: aboveground litter (Scholes et al. 2013)*

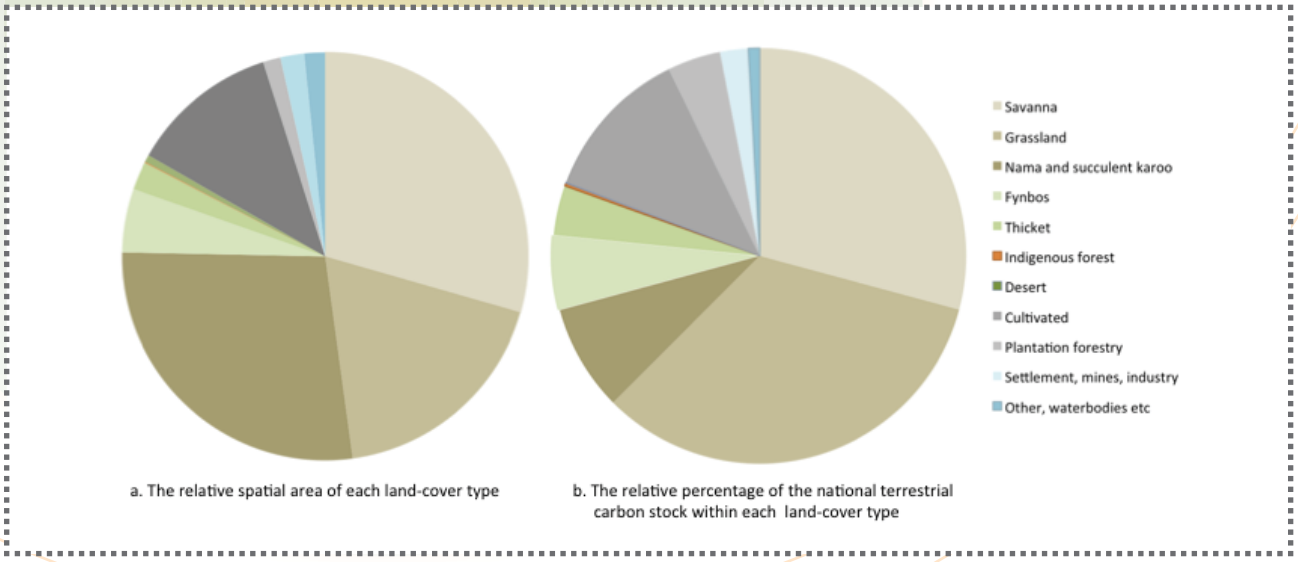

Figure 2. *The relative contribution of each of the principle land-cover types in South Africa in terms of (a) spatial area and (b) terrestrial carbon stocks (input data from Scholes et al. 2013)*

In terms of potential changes in land-cover, the analysis undertaken by GTI (2013) indicated that there is likely to be a considerable increase in the spatial extent of commercial crops, built environments and commercial forestry by 2020. The area affected by mining is also predicted to increase but to a far smaller extent (Fig 3). The majority of the expansion is likely to occur in areas that are currently indigenous grassland and savanna. There may therefore be good opportunity, not to halt the expansion of commercial crop and built environment, but to provide guidance through policy that ensures that expansion occurs with the lowest impact, and possibly positive consequences for terrestrial carbon stocks, associated GHG emissions as well as a broader suite of ecosystem services.

In the review below, we focus on policies pertinent to the expansion of the built environment, mining areas, and commercial and small-scale; and their potential affect on terrestrial carbon stocks and associated ecosystem services.

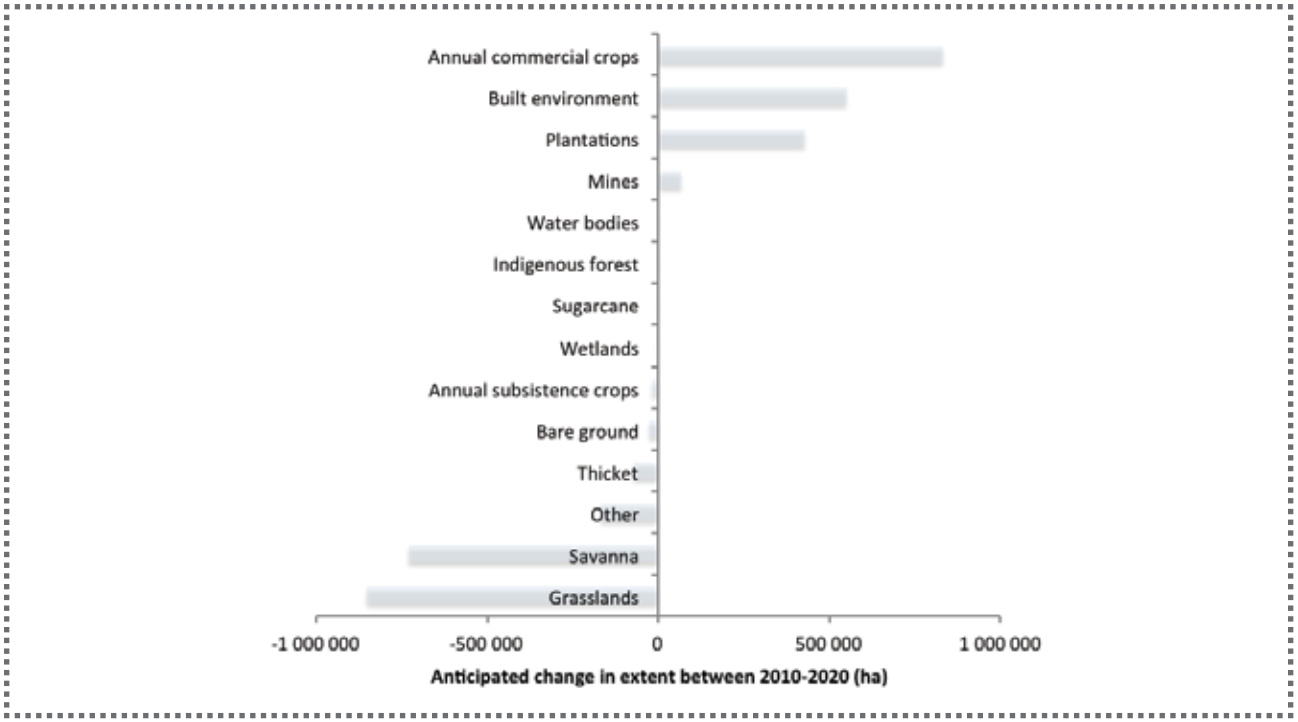

Figure 3. *The anticipated change in the extent of each land-cover type in South Africa during the period 2010-2020. For further explanation and assessed changes for the 2000-2010 period, please see GTI (2013 pp 7-10).*

2.1 Policies influencing the expansion of built environments

The built environment covers a substantial range of land-use types, including but not limited to service delivery infrastructure such as water, energy, telecommunications and health facilities, settlements in both urban and rural settings, and transport corridors, both road and rail. As part of its mandate, the Government has pledged to rapidly expand service delivery, to provide housing for its citizens, and to boost economic growth and trade through strategic delivery of road, rail and port infrastructure. This pledge has been articulated in a number of policies such as the *National Development Plan,* the *Medium Term Strategic Framework,* the *National Infrastructure Plan* and the *New Growth Path*. A coordinated response to expansion of the built environment should lead to a considered, responsible environmental approach, whereby NEMA's principles are adhered to and impacts on the environment are avoided, minimized or mitigated.

However, as illustrated in Section 1.4 of the SA National Carbon Sink Assessment focused future land-use scenarios (GIT 2013), there are cases where such development competes with other forms of land-use (e.g. mining, agriculture and conservation). This suggests that some policy interventions may be required to improve inter-governmental coordination and planning efforts.[17]

There are a number of acts, regulations and guidelines that already provide considerable direction, control and management over the spatial planning and land use development activities in South Africa (listed below). In-depth accounts of these policies can be found in the policy catalogue as well as in the policy analysis report (Section 3.1 of SA National Carbon Sink Assessment). What the following recommendation sections suggest is that policy efforts should not be focused on *amendments* to this legislation, but rather on realizing Ministerial authorizations to establish norms and standard, regulations and guidance.

Reinforcing legislation

- Local Government Municipal Systems Act
- Spatial Planning and Land Use Management Act
- Guidelines for development of spatial development frameworks, DRDLR
- National Environmental Management Act
- NEM: Environmental Management Framework Regulations
- NEM: National Biodiversity Act and National Framework
- Guidelines regarding the determination of Bioregions and the preparation of and publication of Bioregional Plans

Required suggested omissions / deletions to existing policy

This analysis suggested that no omissions or deletions are required in the existing body of policy.

Suggested new inclusions to policy

Within existing policy: Drivers

In a similar manner to strategies and plans influencing the growth of the agriculture and mining sectors, it is not clear whether the strategies and plans committed to expansion of infrastructure, settlements and transport corridors have adequately taken their potential impacts on the environment and other forms of land-use into consideration. Whereas it is understood that large infrastructure projects, housing developments and other built environment initiatives would be subject to an EIA, the EIA approval process does not extend into the domain of appropriate and adequate spatial planning. The cumulative effects on the environment of many projects that have passed an EIA, but without the context of a larger planning framework may not be desirable or meet the State's environmental obligations under section 24 of the Constitution. The newly adopted *Spatial Planning and Land Use Management Act* requires that the national government establish a spatial planning framework, which guides the content of both the provincial and municipal level frameworks, as well as the municipal level land use schemes. The Act provides spatial planning principles, and requires the Minister to develop norms and criteria to guide the planning processes across all spheres of government.

In view of the extensive built environment activities and expansion proposed in the policies and strategies, it is recommended that these strategies and plans be reviewed and potentially revised, to ensure that they adhere both to SPLUMA's (forthcoming) norms and standards, as well as against NEMA's principles. This will ensure consistency in deployment of the national spatial planning framework, as all national level policies driving expansion of the built environment will adhere to the same body of norms, standards and principles.

Within existing policy: Legislation

There is a strong legislative environment that guides land-use spatial planning and development. All of the policies listed above under "reinforcing legislation" require that the environmental impacts of land-use activities be

17 As detailed in the Section 3.1 report of the South African National Carbon Sink Assessment, a number of policies may lead to an acceleration of land-use change, partially attributable to expansion of the built environment, whereas others encourage responsible natural resource use; a third group of policies advocate for improved management, control and planning processes to inform responsible land-use change (see Module 6 of the report)

taken into consideration in planning processes, and that appropriate measures be taken to avoid, minimize or mitigate those impacts in adherence with environmental legislation. NEMA provides the Minister with powers to restrict, investigate and monitor the environmental impacts of certain activities and in certain geographic regions. The *Local Government Municipal Systems Act* requires that each municipality develop an Integrated Development Plan, inclusive of a spatial development framework (SDF). With the recent introduction of the *Spatial Planning and Land Use Management Act*, the reinforcement of local and provincial level spatial development frameworks is provided. Municipal-level spatial development frameworks are meant to adhere to any locally relevant bioregional plans, and in the absence of those plans, refer to the provincial spatial biodiversity plan or any biodiversity sector plans. They are also intended to use the outputs of from a local strategic environmental assessment (SEA). Amongst other of elements reviewed and analyzed, the SEAs review vegetation types, soils, climate risks and biodiversity within a given region. Threats to vegetation cover must be assessed (such as agriculture) and the status of ecosystems is also reviewed. This important information feeds into the SDF development process.

The frameworks are complimented by municipal level land-use schemes, which must comply with prevailing environmental legislation. SPLUMA also provides the legal basis for the administration of land use schemes, which "have the force of law" and requires that no land use activities be undertaken if not provided for in the scheme. NEMA as well as the *NEM: Environmental Management Framework Regulations* provides the legislative backdrop that is meant to guide, inform and moderate spatial planning and land use development at all levels of government.

Through NEMA, a number of listed departments and Ministries are required to submit environmental management and environmental implementation plans, depending on whether they are listed in Schedule one or two of the Act. The purpose of the plans is to ensure harmonization of environmental policies plans and programmes across national departments. Each department is required to detail the ways in which each policy, plan and programme that may impact the environment and over which it has control adheres to the Act's principles, and any other relevant norms and standards. At present, the departments covered include:

- Department of Environmental Affairs and Tourism
- Department of Land Affairs
- Department of Agriculture
- Department of Housing
- Department of Trade and Industry
- Department of Water Affairs and Forestry
- Department of Transport
- Department of Defense
- Department of Minerals and Energy
- Department of Health
- Department of Labour

This list broadly captures the national-level departments that are involved in creating policies, plans and programmes that identify and direct expansion of the built environment (notably the Land Affairs, Housing, Trade and Industry, and Transport departments). However, as observed in the 13 policies that currently drive land-use change, a number of these originate from the Presidency (the MTSF, NDP and NGP in particular). These "presidential" plans wield considerable influence over the planning processes within departments, and are regularly cited in their own policies, plans and programmes. They provide direction to many of the government's activities and efforts.

The influence of policies such as the MTSF, NDP and NGP may also resonate in the implementation of SPLUMA. SPLUMA requires that national spatial planning framework be informed by norms and standards. These norms and standards, amongst other criterion, should "reflect the national policy, national policy priorities and programmes relating to land use management and land development." It is highly likely that the national spatial planning framework will be influenced and guided to some degree by policies, plans and programmes originating from the Presidency.

Suggested new policies

Many of the proposed built environment initiatives are state run and to be paid through the fiscus (roads, energy infrastructure, low-income housing settlements, and so forth). In addition, given the extent to which spatial planning and land-use development is a government function, which is meant to dictate the rules, norms and practices by which the built environment expands, it was not considered appropriate to introduce incentives for the built environment sector. Similarly, SPLUMA already provides for penalties in its sections referring to contravention of municipal level land use schemes, so further introduction of fines, sentences or other types of measures was considered redundant. Instead, this section describes several actions that the relevant Ministers can take to improve the interpretation of, adherence to and clarity of certain Acts.

The following recommendations are intended to provide organs of state and development actors with more transparent, succinct information on the conditions under which expansion of the built environment should be pursued:

- Under SPLUMA, the Minister is requested to develop norms and standards. There are seven broad elements that they must give effect to, including the promotion of sustainable development and provision of a framework for desired land use patterns. These have yet to be published, and remain critical to the realization of the

Act's principles and stated objectives. These norms and standards could be developed with a view to ensuring the integrity of the country's ecological infrastructure, to recognizing the value of national terrestrial carbon stocks, and to ensuring that development activities are undertaken in a manner consistent with NEMA. Norms and standards could address, amongst other opportunities:

- **Means of measuring, defining, implementing and monitoring urban and peri-urban densification efforts to support improved decision-making for town and city planners.** Norms and standards could extend beyond criteria for maintaining or constructing individual buildings to encompass entire areas targeted for development. This should yield not only environmental benefits through measured reductions to urban sprawl, but also socio-economic returns and more efficient use and management of infrastructure and transportation systems.
- **Means of undertaking valuable mapping exercises that accurately capture landscape level ecological characteristics, including a carbon storage layer, other ecosystem services and land use types.** Avoiding disturbance to intact ecosystems, notably those with high carbon stocks, will be greatly facilitated through the use appropriate spatial scenario analysis. For example, the eThekwini Municipality makes use of such analysis, linked to its Durban Metropolitan Open Space System (DMOSS). As part of SPLUMAs norms and standards, notably 8.2.d.iv, which addresses the need for coherence across mapping systems, it is recommended that norms and standards for mapping requirements at the local level be specified. This should be at scale that will provide detailed, complete information on local ecosystems. This will lay the foundation for responsible development planning based on a complete, exhaustive understanding of municipal landscapes. It should lead to improved management of municipalities' terrestrial carbon stocks.
- **Means of enforcing NEMA's "polluter pays" principle**. Although the use of biodiversity offsets to address the residual impacts of development whilst helping the Government achieve conservation goals remains a contentious mechanism, it is recommended that application of this concept and approach at the national level be explored in more depth. There is legal precedence for biodiversity offset use in NEMA, and the National Biodiversity Framework. It is critical that an offset measure only be activated as a measure of last resort, in the event that the impact of a development on intact ecosystems cannot be avoided through application of SPLUMA, NEMA, and the EIA process. In all instances, the carbon offsets principles of *additionality* and *permanence* should be adhered to, to ensure that conservation (or potentially restoration) efforts target areas under threat of exploitation and will remain under conservation for a pre-defined period of years, if not in perpetuity. Currently, KZN Wildlife is piloting an "offsets banking" scheme, supported by its *Norms and Standards for Biodiversity Offsets.* National government may wish to study and track the success of this pilot initiative as a preliminary step in determining the efficacy and suitability of this approach across the country. If offsets were considered a viable approach, then development of norms and standards through SPLUMA would ensure their adoption at the national, provincial and local levels.
- It is not clear the extent to which national departments listed in schedules one and two of NEMA have in fact regularly developed and reported on their environmental implementation plans and environmental management plans. This potentially limited participation may be linked to a lack of both clear guidance as well as regulatory measures to add more clarity to the process generally. Under chapter three of NEMA, section 11(8), the Minister is authorized to publish guidelines that help national and provincial departments prepare plans that meet the standards implicit in NEMA. In addition, the Department can prepare and issue regulations which would provide clarity on the contents of environmental implementation plans, specifically: how policies, plans and programmes comply with NEMA's principles, and how departments will manage their functions in compliance with NEMA and other relevant legislation. It is recommended that the Department draft both the guidelines and regulations and submit them to the review and approval procedures described in the Act.

2.2 Policy considerations relevant to the mining sector

Mining is a key sector in the South African economy, delivering significant economic growth potential in areas of prospecting, mining and beneficiation. However the growth of the sector has slowed in recent years due to depressed global commodity prices, rising energy costs and in the domestic sphere increasing input price pressure, falling domestic productivity and increasingly protracted labour disputes.

At a policy level, the intention to support and grow the sector is reiterated in the *National Growth Path*, the *National Development Plan*, and the *Economic Development Department Strategic Plan: 2012/13-2016/2017*. This is taken up with practical implementation in the *National Infrastructure Plan*, where specific Strategic Infrastructure Plans (SIPs) are intended to direct development of infrastructure corridors to enable mining intensification. The targeted areas of extraction are the Waterberg - Platinum belt area (specifically coal), and the iron ore and manganese operations in the Northern Cape. The government's legislative support for the sector focuses

on enabling diversification of the sector to accommodate new license holders, with Black Economic Empowerment (BEE) an imperative, as established in the Mining Charter[18] (2010).

Mining activities tend to have long term and frequently irreversible impacts on the environment (soil structure, geological stability, water resources, aquatic and terrestrial biodiversity and air quality). Thus, with respect to mining expansion, land use and the question of terrestrial carbon stocks, a number of issues apply:

- **The extent of mineral resources:** South Africa is endowed with a wide range of mineral resources located throughout the country. Existing knowledge or reserves is based on conventional exploration, but the country still has significant potential for additional discoveries, using new exploration techniques. Thus the issues pertaining to mining and its relationship to other land uses including ecological infrastructure services and carbon stocks applies at a national scale.
- **The question of the right to mine, versus existing land use and other land use options**: Historically, the national and regional spatial and land use management systems did not have the ability to integrate mineral development, with the result that the question of mining rights versus other land use rights have tended to be arbitrated by the courts. This created a situation where legal precedence is frequently based on court verdicts relating to planning legislation.[19] This is a process that is under continued under legal revision. The Constitutional Court ruling in 2012 on the matter of Maccsand vs City of Cape Town implies that land use zoning rights are required for land holdings for which mining rights have been granted in terms of the MPRDA. The process of addressing this is now underway in national, provincial and local planning initiatives that fall under *The Spatial and Land Use Management Act, 2013* (SPLUMA).
- **The regional impacts of mining activity and its impacts on other land uses bioregional services:** This is an extensive topic beyond the scope of this analysis. Mining impacts are very often not limited to a single piece of land, but can also be carried by air or water. This issue is most clearly illustrated with respect to acid mine water[20] quality issues that affect both groundwater and surface water. This is particularly problematic in the Witwatersrand area, where acid water has been decanting into surrounding river catchments, with increasing impacts on river systems in Mpumalanga, Free State, Limpopo and the North West.
- **A regulatory environment in a state of flux and uncertainty:** The laws governing mining and petroleum exploration and production in South Africa are in a state of flux and have been for some time[21]. The laws changed fundamentally in 2004 with the entry into force of the *Mineral and Petroleum Resources Development Act, 2002 (Act no. 28 of 2002)*, which places all minerals under state custodianship, with the Minister of Mineral Resources authorized to grant rights to prospect and mine for mineral and petroleum in consultation with relevant departments. In a more recent development The Amendment Bill to the *MPRDA* was approved by the Parliamentary Minerals Portfolio Committee early in March 2014, again making changes to the underlying legal tenets pertaining to exploration and mining rights[21]. The Bill is likely to come under challenge in the Constitutional Court, with the result that the sector faces regulatory uncertainly in the near term.

18 The Mining Charter of 2010 aims to ensure black ownership of 26% of the country's mining assets by 2014, and introduces sustainable development principles, premised on the understanding that licence to operate includes environmental, health and safety performance.

19 The Constitutional Court ruled, in the matter of Maccsand (Pty) ltd and Others v City of Cape Town and Others (2012) that the matter of granting a mining right or permit by DMR was unconstitutional, as the required land use authorization had not been granted in terms of the Land Use Planning Ordinance (LUPO). Thus the ruling determined that the granting of a mining right in terms of the MPRDA does not obviate the need to also obtain the relevant land use zoning. In arriving at its decision the Constitutional Court held that the issues in the appeal were not confined to the Western Cape Province, but to the provinces to which LUPPO applies, viz. parts of the Eastern Cape and parts of the North-West Province. However, as all other provinces have planning ordinances and, in some instances planning laws, this may also apply generally across the country.

20 Acid mine water is characterised by a low pH, and a high salt and heavy metal content. Acid mine water can be released anywhere on a mine where sulphides are exposed to air and water including waste rock piles, tailings, open pits, mine shafts. Acid mine drainage has severe impacts on aquatic life, animals and plants and renders water unsuitable for irrigation and human consumption.

21 In 2008 an Amendment Bill to the MPRDA was introduced into Parliament, which proposed a number of changes, including the requirement that mining operations be subject to provisions of the country's environmental legislation, viz. NEMA. This Bill was delayed in coming into force, but was followed by the 2012 Amendment Bill. Before this latter bill was enacted, certain components of the 2008 Amendment Bill came into force which led to a situation where many of the MPRDA provisions relating to the environment were actually been repealed, while NEMA provisions relating to mining have not come into force.

22 The 2013 Amendment Bill, makes substantial changes to the underlying legal tenets pertaining to exploration and mining rights. To facilitate diversification and new entrants into the sector, the amendment leaves more discretionary power to the Minister (for example the Minster has the power to refuse to grant a prospecting right if the grant of such a right will "result in the concentration of mineral resources under question under the control of the applicant and their associated companies with the possible limitation of equitable access to mineral resources"). Discretionary provisions for the Minister to decide on levels of minerals to be set aside for beneficiation, the preferred pricing regime for local beneficiation and to limit the export of certain "designated" minerals are also likely to be challenged. These provisions could also run contrary to international trade agreements to which South Africa is a party.

- **Remediation legacies:** Nationally there are currently more than 6000 closed mine sites requiring rehabilitation (Financial Mail, 2012). Priority is given to asbestos sites, which pose the greatest human risk, but there are currently more than 100 sites in the Northern Cape alone requiring remediation. If handled within strict health and safety norms, remediation efforts could offer the opportunity to employ a substantial number of local, rural residents.

Thus, there are significant land use related questions pertaining to the sector, both in terms of rights and in terms of long term impacts on the human and biophysical environment. There is also is a level of uncertainty in the sector with a concern being that the longer term effects of the MPRDA Amendment Bill will be to dampen growth and investment in the sector, as the discretionary powers granted to the Minister leave some uncertainty for new investment.

Reinforcing Legislation

The *Mineral and Petroleum Resources Development Act* (Act no. 28 of 2002, the MPRDA Amendment Act of 2008, and MPRDA Amendment Bill of 2013) stipulate the environmental requirements, which must be approved by the Department of Mineral Resources prior to issuance of a mining permit. In addition, and according to MPRDA, all mining and prospecting must adhere to NEMA (section 37). Regulations listed below are some of those that govern environmental and land use aspects relevant to mining.[23]

- *The National Water Act*, Act 36 of 1998 (both a Water Use License is required and compliance with the Regulations on Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources - DWAF
- *Atmospheric Pollution Prevention*, Act 45 of 1965) (an Air Quality Certificate is required) - DEAT: Air Pollution Control
- Clearance is required from the South African Heritage Resources Agency (SAHRA)
- The *Income Tax Act*, No 58 of 1962 (the Act regulates mining rehabilitation funds, requiring that the assets of rehabilitation funds be strictly utilized according to their objects) – South African Revenue Services
- *National Environmental Management Act* (including requirements for a waste permit in terms of Act 59 of 2008 (Waste Act) – DEAT.

Regulations promulgated under the MPRDA address requirements for Scoping and Environmental Assessment Reports required for consideration of application for a mining license. Thus an environmental assessment is required according to specific guidelines of the MPRDA and in addition all mining and prospecting must adhere to NEMA (Section 17). However, ancillary infrastructure, which may be "identified activities" (roads, water pipelines etc.) may require a separate Environmental Impact Assessment, which requires approval under NEMA. Thus a situation prevails of joint responsibility for environmental authorization for mining approvals, with DME and DEAT jointly responsible for the decision on the EIA. The 2008 Amendment to the MPRDA provided for the authority on EIA to rest entirely with the DME, but this did not come about.

While the Amendment Bill to the MPRDA has sought to address the streamlining of applications between departments, some of the proposed changes have come under criticism from civil society, as the bill provides for a separate environmental authorization regime for mining-related environmental impacts, with the DMR holding ultimate responsibility for authorization. This could present an inherent conflict of interest as the DMR is the designated agency responsible for promoting the interests of mining, albeit with sustainable development principles in mind.

However the MPRDA grants the Minister discretionary powers that, if used, could favour decisions based on proactive environmental planning. According to the MPRDA, the Minister may by notice make regulations regarding the conservation of the environment at or in the vicinity of any mine works, management of the impact of mining operations on the environment in the vicinity of mining operations, rehabilitation of disturbances, and prevention of pollution of air, land, sea or other water (Section 107).

Environmental Management Programmes and post closure liability

Effective rehabilitation has scope to limit the net-negative impacts of mine expansion on local vegetation and soil carbon stocks.

While regulatory requirements for environmental management and post closure rehabilitation have been in place for several decades, the rehabilitation objectives

23 Obtaining the relevant authorisations is not a streamlined process, and is managed by several departments. There are reportedly more than 100 operators who are working without or with outdated Water Licenses, and due to delays with DWA there is a practice for mining licenses to be issued ahead of water licenses (Reichardt, pers. com). The process of obtaining approvals can take up to three years (Reichardt, pers com).

and procedures and specific legal requirements of mining companies have changed considerably over the past 25 years. The introduction of the MPRDA brought improvements to the requirements for mine closure planning, requiring that a functional end land use be reinstated, which can positively contribute to the future biophysical and societal demands of people and animals living in proximity to the disturbed environment.

Section 38(1) (d) of the MRRDA and Government Notice of NEMA both state that mining operations should "as far as reasonably practicable, rehabilitate the environment affected by the prospecting and mining operations to its natural or predetermined state, or to a land use which conforms to the generally accepted principle of sustainable development." Section 61 (b) of the MPRDA also requires that the environmental management planning needs to "… provide broad future land use objective(s) for a site" and the provision of a plan describing the final and future land use and arrangements for the site, in accordance with Section 62(i), as part of the mine's closure planning.

The MPRDA sets out requirements for closure plans and establishment of a rehabilitation fund to ensure adherence to the "polluter pays" principle outlined in NEMA.

Broader policy frameworks:
Additional regulatory frameworks apply although their legal application to determine the outcomes of mining authorization is currently limited:

- Guidelines regarding the determination of Bioregions and the preparation and publication of bioregional plans
- The National Environmental Management: Biodiversity Act
- Disaster Management Act and Framework
- Spatial Planning and Land-Use Management Act
- The National Framework on Sustainable Development
- The Sustainable Development through Mining Programme (SDM).

The Sustainable Development through Mining Programme (SDM) falls under the NFSD umbrella and aims to promote the management of human, socio economic and environmental components affected by mining. Specifically the programme has a practical implementation component, and is engaged in identifying and prioritising abandoned mines for closure which still require rehabilitation. It is also developing a strategy to ensure that current mining operations do not generate these liabilities. Reportedly one of the biggest challenges at closed mining sites stems from the soil erosion that tends to take place several years from closure.

Required suggested omissions / deletions to existing policy
It was not considered necessary to either omit or delete any content in the existing body of policies.

Suggested new inclusions to policy
There is a body of well thought out legislation with respect to the question of issuance of prospecting and mining licenses and the environmental requirements for consideration and management of mining related activities. However, there are many ambiguities around mining license applications, and lack of clarity as to the overriding regulations and responsible level of government that ultimately determine authorisation on mining applications. The result is that stakeholders frequently take disputed mining authorisations decisions to court for arbitration, notably in regards application of the *National Water Act.* This situation is not ideal for those who bear the legal costs and capacity required for court arbitration, including local and national government. It is also not ideal for a sector that is characterized by high environmental risks and potential for irreversible impacts on ecosystem service functioning, including water supply and the terrestrial carbon storage capacity of landscapes.

Policy recommendations are made for the development of more strategic frameworks related to the question of mining expansion, and for streamlining and clarifying processes for environmental authorisation.

Presidential Commitments: Outcome 10 Delivery Agreement
The Outcome 10 Delivery Agreement was launched in September 2010. This "negotiated charter" records the following key challenge with respect to mining: "*The inability of current spatial planning and land use management systems to integrate mineral development has resulted in the latter occupying areas where it permanently sterilized areas of high agricultural potential or impacted severely on sensitive and prioritised ecosystems. Mineral development priority areas should with equal standing "compete" in a spatial planning and land use management system with other policy imperatives such as biodiversity protection, food security, water security etc. The inclusion of mineral*

development in spatial planning and land use systems and identified agreed "mining restriction areas" is accordingly an important step in doing things differently towards achieving the desired outcome."

The process of addressing this is now underway with the drafting of legislation for provincial acts that fall under *The Spatial and Land Use Management Act, 2013* (SPLUMA). SPLUMA lists mining amongst 14 other land use purposes (schedule 2) for zoning. This is an opportunity for mining to be effectively integrated with spatial planning. However there is an important need to develop comprehensive frameworks that address the principals that are addressed in the presidential outcome listed above.

Many of the national policies guiding future development recognise the importance of maintaining and enhancing ecosystem service infrastructure, including maintenance of water resources and terrestrial carbon storage functions. An integrated approach is advised, whereby provincial planning frameworks are developed taking cognizance of mining land use in relation to these priorities.

Developing an Environmental Management Framework to evaluate mining applications

The location of mining activities is obviously determined by the location of identified mineral resources. As the situation stands the DMR is obliged to accept all applications for prospecting, except for certain areas defined in the MPRDA, including residential areas, public roads and railways and cemeteries (Section. 48 (2)). Acceptance does not imply granting of the prospecting license – but the application must be considered according to established processes. If minerals are located through prospecting, the DMR is then obliged to consider and process all applications for mining –subject to the environmental management principles listed in Section 2 of NEMA. Thus, in consultation with other relevant departments, including the DEA, the DMR can refuse to grant a license.

Ideally, a first level screening should take place, so that certain no-go areas are identified proactively, and contained within a planning framework, so that applications for prospecting and associated mining targeted at certain areas will not be considered in the first place. Such a framework should hold statutory legal standing, which the MPRDA provides for. Section 49(1) gives specific discretion to the Minister to "*after inviting representatives from relevant stakeholders, from time to time by notice of in the Gazette, having regard for national interest and the need to promote sustainable development of the national mineral resources, prohibit or restrict the granting of any reconnaissance permission, prospecting right, mining right or mining permit in respect of such land identified by the Minister for such period and on such terms and conditions as the Minister may determine*". Thus, for example, the destruction of the headwaters of a catchment area has an opportunity cost for South Africa with national consequence. If it is agreed that certain strategic areas should be avoided on the basis of their supply of natural resources (such as potable water) the MPRDA provides the avenue for declaring the prohibition of prospecting and mining in within these strategic areas.

In addition NEMA sets out very clear spatial planning guidelines to all organs of the state and other authorities responsible for the implementation of legislation regulating the use and development of land through Environmental Management Frameworks for spatial planning (Section6. (1)). This includes the preparation, adoption and implementation of any spatial development framework, policy or by-law concerning spatial planning and the development or use of land.

Thus both NEMA and the MPRDA could be used to develop a statutory framework. This framework should ideally fall under SPLUMA and inform the provincial planning legislation, which is now under development. Such a framework would exclude all areas that have been identified within other relevant legislation as areas where no commercial prospecting and mining are allowed. These include the following:

- World Heritage Areas (World Heritage Convention Act, (Act 49 of 1999),
- Special Nature Reserves, National Parks or Nature Reserves declared in terms of the National Environmental Management: Protected Areas Act, 2003.
- Marine Protected Areas declared under The Marine Living Resources Act of 1998
- Specially protected forest areas declared in terms of the National Forests Act of 1998

The exclusion of these areas may seem unnecessary if they are protected by law, but there are instances where prospecting and mining rights have not only been considered in these areas, but granted. This places a burden on civil society, which invariably applies to court for the reversal of such decisions. This situation could be addressed through improved verification and screening, and spatial development frameworks.

- Mountain Catchment Areas declared in terms of the Mountain Catchment Areas Act, 1970 (Act 63 of 1970)
- Ramsar Sites, or sites recognized under the Ramsar Convention on Wetlands 1971 (and this would include identifying key no-go areas within the Ramsar site catchment.)
- Recognized endangered and critically endangered ecosystems, and areas with high ecosystem services function, including provision of high-density terrestrial carbon stocks.
- Recognized important food production agricultural areas

- Areas where mining will have a negative impact on established settlements and human health

Ideally such a framework would evolve through consultation with a range of stakeholders, and not be limited to relevant government ministries. Input from the Department of Agriculture, Forestry and Fisheries is essential, as is that of established agricultural organizations and environmental agencies. Such frameworks should integrate ecosystem service infrastructure consideration, such as water resources and terrestrial carbon storage.

Rehabilitation, Post-closure planning and end use planning

This aspect of mining is adequately addressed in the MPRDA and NEMA. The Chamber of Mines has also developed clear guidelines according to international best practice and local environmental conditions. The DMR also considers mine closure very seriously owing to improved understanding of costs associated with the regional impacts of these long-term liabilities (such as the Witwatersrand AMD issue). This area is well regulated, and holders of the prospecting and mining license can be held criminally liable and remain so until the DMR has issued a closure certificate (Section 43 (1) MPRDA).

In spite of this supportive legislative environment, substantial issues regarding rehabilitation persist, with serious consequences for national resources, particularly water. In particular is the practice of selling mining assets that hold potential environmental liability[24]. Subsequent insolvency of smaller mines that purchase marginal assets (with liability) becomes problematic: competing laws mean that, when a mine goes into liquidation, the *Insolvency Act* and the *Companies Act* take over and rehabilitation funds are theoretically left unprotected. In addition, the *Companies Act* allows a company to deregister without having to obtain a closure certificate.

Further issues in this area arise due to incompatibilities between the *Income Tax Act* (the Act that regulates trust funds for rehabilitation purposes), the *National Water Act*, NEMA and the MPRDA. An in depth review of the incompatibilities is not undertaken here, but for instance, there are differing applications of time periods for which responsibility is held. The *National Water Act* holds to a 30-year liability period, MPRDA holds to a 3 to 5 year period and the ITA can only provide for tangible liability, so the water pollution issues with longer time horizons are problematic. The ITA actively prevents funding for longer-term liability, as it requires all funding to be for specific known eventuality.

On the matter of closure certificates, the DMR is responsible agency. However given the complex and specialized nature of environmental rehabilitation, and range of issues at hand, the DMR may not in all instances have the necessary capacity to evaluate rehabilitation efforts and issue closure certificates. The issue is one of national importance; the DMR and therefore the taxpayer carry the cost of mine closure and regional remediation initiatives. In addition, the impacts result in issues of national consequence in the form if sterilized land, loss of ecosystem functioning, loss of water resources, threats to a healthy living environment and so on. Rural communities are the ones who bear the brunt of this situation, and many in these communities do not have access to municipal services and are more reliant on natural resources for their direct livelihood.

The following recommendations are made:

- Positive incentives be incorporated for mines that undertake rehabilitation concurrently with mining activities, and in such a way as to reinstate functional ecosystems, with attributes that deliver ecosystem services such as flood attenuation, carbon sequestration, and water filtration and purification,
- A review is undertaken on the way that financial provisions are estimated and regulated, ensuring that the relevant legislation is aligned with the purpose at hand and relevant to current costs and future inflation.
- That the DMR's guidelines for closure-related provisioning are reviewed in the following way:
- Consultation with mining stakeholders,
- Incorporation of other relevant resources such as the DWA2008 *Best Practice Guidelines Series for Water Resource Protection* and the 2007 Chamber of Mines & Coal's *Guidelines on Rehabilitation of Mines*
- Clarification of links between the EMP guidelines and the DMR financial provision calculation guidelines to enable better quantified rehabilitation plans

It is recommended that structures be established whereby the function of evaluating rehabilitation efforts and issuance of mine closure certificates is delegated to a multidisciplinary task force, including independent experts.

2.3 Agriculture – commercial, smallholder and subsistence

At present, there is a strong focus on the expansion and growth of the agricultural sector in South Africa. Considered an important driver of job creation and a means for reducing

24 The sale of a mine requires approval from the Minister, and closure liabilities are required to be evaluated at this stage, but in practice this aspect is often not properly addressed. For example, Harmony Gold is currently seeking a Constitutional Court order declaring that a government directive in November 2005 became invalid when Harmony sold assets to which the order applied to Pamodzi Gold in 2007.

food insecurity, agriculture is an important component of both rural and urban economies.

Two prominent findings emerged following a review of the considerable body of policy governing the extent and nature of agriculture in South Africa. The first is that while the expansion of agriculture is strongly advocated for in a number of key policies, there is little reference to standards or technologies, such as reduced tillage, that may limit the impact of the roll-out on terrestrial carbon stocks and associated ecosystem services. Although there is some support for technologies such as reduced tillage in certain supporting policies, these activities are generally not referred to in leading policies directing growth within the sector.

The second finding is that while the potential impact of agricultural expansion is not explicitly included in policies driving expansion, there is a substantial body of "reinforcing legislation" (listed below), which provide a number of important tools to municipalities, provinces and national government to guide land use planning and decisions on the manner in which agriculture should be implemented. These include:

- The Conservation of Agricultural Resources Act
- National Environmental Management Act
- National Environmental Management: Biodiversity Act
- Guidelines regarding the determination of Bioregions and the preparation of and publication of Bioregional Plans
- Disaster Management Act and Framework
- Spatial Planning and Land-Use Management Act

Detailed accounts of each policy are provided in the "policy catalogue" located in the Section 3.1 Policy Review report

The majority of suggested policy considerations within the agricultural domain therefore focus on including clearer reference to the manner in which expansion may occurs. The intention of this document is not to advocate for a reduction in the expansion of agriculture but rather to advocate for clearer guidelines about expansion that reduces potential negative impacts and assists in its own long-term sustainability.

Required suggested omissions/deletions to existing policy

It was not considered necessary to either omit or delete any content in the existing body of policies.

Suggested new inclusions to policy

Within existing policies that drive the expansion of agriculture

While the *National Development Plan* and the *Medium Term Strategic Framework* make reference to responsible natural resource use and conservation, the explicit link to agricultural practices is not made. The *Integrated Growth and Development Plan* (DAFF) is the only 'driver' policy that makes reference to the need to ensure that the expansion of agricultural production be guided by a commitment to ensuring the integrity of natural ecosystems and biodiversity.

A number of these policies expire in 2014/2015, with the entry into a new election cycle.[25] This presents a good opportunity to revise and update these policies, taking into consideration the impacts on terrestrial carbon stocks as well as other ecosystem services. It is recommended that each of the policies that promote growth in the subsistence, smallholder and commercial agricultural sectors be reviewed and potentially updated, with a near-term emphasis on those policies that are set to expire and which will require updating. Proposed commitments include:

- That where possible, agricultural expansion will take place on previously ploughed or degraded lands, in an attempt to avoid the transformation of natural habitat.
- That expansion of agriculture – subsistence, smallholder and commercial – will only be undertaken once explicitly assessed against provisions in NEMA and CARA, in particular:
- The necessity to avoid disturbances and degradation to ecosystems, and where this is not feasible, to minimize and remedy disturbances (NEMA)
- The application of the precautionary principle, taking into consideration current limitations to knowledge
- The commitment to conservation of the country's natural agricultural resources, including soils and vegetation cover
- That improved agricultural practices, which through scientific, peer-reviewed research are proven to increase soil carbon stocks, are promoted as part of the overall agricultural growth strategy
- That provisions are made for training and extension services, notably to vulnerable and low-income households, to ensure uptake of improved agricultural practices

Within existing policy: Legislation

The current body of legislation governing land-use and agriculture has been drafted in such a way as to allow for the development of regulations, frameworks and norms and standards over time, which will respond to new government objectives and visions, whilst retaining their core integrity and purpose. For this reason, it is not believed that changes should be made to existing legislation, but that rather from them, new regulations, frameworks, or norms and standards can be developed which address the impacts of agriculture on national terrestrial carbon stocks. These are described in the section below.

25 The MTSF, IPAP, the Strategic Plan for the Department of Rural Affairs and Land Reform: 2011-2014.

Suggested new policies

The actors driving the expansion of agriculture are not comprised of a single, homogenous group but rather a range of subsistence and smallholder farmers, market-adept commercial farmers, large agricultural corporations and others. When formulating policy and associated legislation, the context of each of these actors needs to be carefully considered. This is particularly important when formulating legislative responses, which may include either punitive or incentive-based measures. As such, it is proposed that policy responses be adopted that take these differences into account.

Whilst punitive measures and controls at times are necessary and may be included within NEMA, the use of incentives to drive the adoption of improved practices and to reward both small-holder and commercial farmers for the avoidance of degradation of intact natural habitat, will be important means of realizing participation during agricultural expansion. The following incentive-based measures could be considered and integrated into both legislation and departmental level plans and strategies. It is advised, however, that substantive research into the soil carbon benefits of improved agricultural techniques and associated planning be undertaken in advance of promoting and rolling out a national-scale incentive programme:

- Payments for the adoption of conservation tillage practices, or other types of practices that are deemed to be consistent with the preservation of soil carbon. This directly aligns with the proposed mitigation action 7 – conservation tillage – and the policy proposals discussed in Section 1 of this report.
- Consistent, sustainable technical and extension service support to vulnerable and low-income farmers, to guide the adoption of improved agricultural practices that conserve soil resources and provide for improved crop yields.
- Privileged access to agricultural financial packages for subsistence and smallholder farmers who adopt and consistently employ improved agricultural techniques
- Fiscal incentives for farmers who undertake expansion of agricultural holdings onto recently degraded or ploughed lands, essentially rewarding the avoided release of emissions from intact natural landscapes. Recently, for example, rooibos tea producers have undertaken successful cultivation of the crop on marginal lands in Elim.

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Appendix A (Section 1)

Technical procedure

The stocks and fluxes as defined in this project are schematically represented in Figure 1.

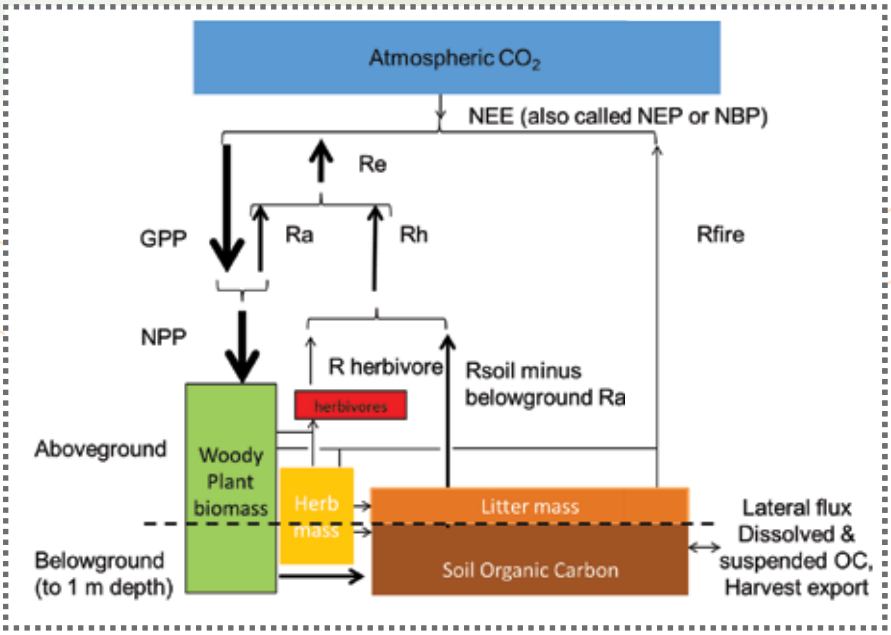


Figure 1. Components of a generalised terrestrial carbon cycle. The size of the boxes and the arrows, which represent stocks and fluxes respectively, is roughly indicative of their relative size. The herbivore stock is relatively small (<10^{12}gC nationally) , and neither it nor the corresponding herbivory flux is directly evaluated. Terminology: NEE – Net Ecosystem Exchange, NEP – Net Ecosystem Productivity, NBP – Net Biome Productivity, GPP – Gross Primary Production, NPP – Net Primary Production, Ra – autotrophic respiration (respiration by plants) , Rh – heterotophic respiration (herbivores, carnivores and microbes), Re – ecosystem respiration (the combined respiration from all sources), Rfire – fire emissions.

Error propagation

The top-level products of this study are accompanied by error estimates, defined as the likely range for a given level of confidence (such as 80%). They take into account the error of estimation associated with uncertainty in the measurements and models. Since the whole country is measured there is no statistical sampling error. The inherent spatial and temporal variability of carbon stocks and fluxes is reflected separately in the tables, as the spatial standard deviation (SD). This should not be confused with sampling error that is usually reported in carbon stock assessments that have taken a stratification approach.

In order to estimate the top-level error, the underlying errors in each of the variables that went into the calculation must be known or estimated. Where possible, and especially for values that make a large contribution to the overall error, these are statistically-rigorous, data-based derivatives of the variance. For factors where the data are sparse (n<5) or where the factor makes a small contributions to the overall error (<5%), an expert-based assessment of the variance (σ^2) has been made.

The propagation of error in the equations used in this study are mostly covered by the two rules outlined below, used alone or in combination.

For the sum (or subtraction) of statistically-independent, normally distributed variables with a variance denoted σ^2, the overall error is given by:

$$\text{Error} = \text{sqrt}\ (\sigma_1^2 + \sigma_2^2 + \sigma_3^2 + \ldots + \sigma_n^2)$$

For the product of n statistically-independent, normally-distributed variables each with a variance denoted σ^2 and an expected value of q, where the overall expected value is Q, the overall error is given by

$$\text{Error}/|Q| = \text{sqrt}\ ((\sigma_1/q_1)^2 + (\sigma_2/q_2)^2 + (\sigma_3/q_3)^2 + \ldots + (\sigma_4/q_4)^2)$$

Basis for calculating stocks

The working units for stock estimates are gC/m^2 (1 g/m^2 = 0.01 t/ha, where t is a metric tonne = 10^6g, which is properly denoted Mg). For national sums we use TgC (10^{12}g), which is a million tonnes (teragrams).

Natural and semi-natural vegetation covers

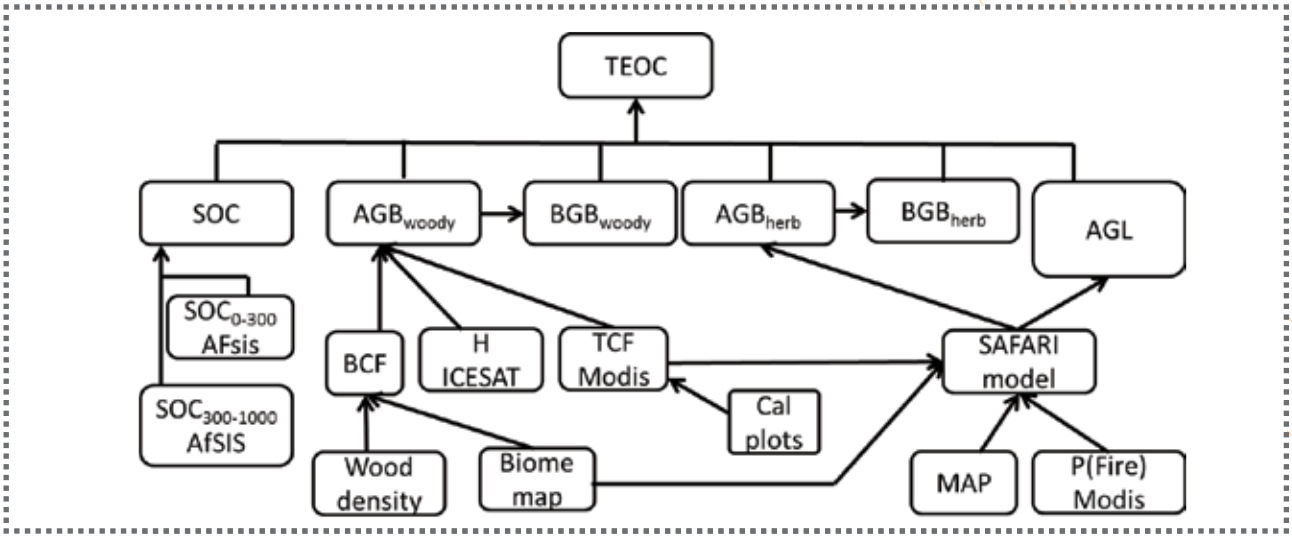


Figure 2 *The workflow for calculating terrestrial carbon stocks.*

- TEOC = SOC + (AGB_{woody} +BGB_{woody} + AGB_{herb} +BGB_{herb} + AGL)*CF
- TEOC= total ecosystem organic carbon
- SOC=Soil Organic carbon to a depth of 1 m
- AGB_{woody}=Aboveground biomass in woody plants (leaf+stem biomass of perennial, lignified plants, regardless of height – trees, bushes and shrubs)
- BGB_{woody}=Belowground biomass in woody plants (fine+coarse roots of perennial, lignified plants)
- AGB_{herb}=mean annual maximum aboveground biomass of herbaceous plants (predominantly grasses, but also forbs, restios, sedges etc)
- BGB_{herb}=mean annual maximum belowground biomass of herbaceous plants.
- AGL = Aboveground litter
- CF = carbon fraction ie C=CF*DM ; = 0.42 (references: Safari 2000, Parton et al)

The error in TEOC is determined from the error in its parts, using a combination of additive and multiplicative rules. Note that BGB is in both cases derived from AGB, they are not independent.

Soil organic carbon (SOC) is derived from the AfSIS system (http://www.africasoils.net/data/digital-soil-mapping Markus Walsh). AfSIS uses a Bayesian prediction model, based on 12000 African pedons (about 3600 of which are from South Africa) driven by many covariates (among others, climate, soil texture, and topographic position) to estimate the SOC to any given depth (0-0.3 m is the standard for 'topsoil', while 0.3-0.7 m is used for subsoil) at a given location. These are integrated spatially at a ground resolution of 1 km to provide a national surface. The SOC surfaces are accompanied by a surface representing the estimation error, defined as the 10 to 90 percentile confidence limits at each point. The lower and upper confidence ranges are assymetric – there is a long 'tail' of possible SOC values much higher than the best estimate. Since SOC dominates the TEOC, this uncertainty and its assymetry propagates through, and has forced us to adopt the 10-90 range for the uncertainty estimates of other components as well. The confidence range cannot be easily reduced by increased sampling effort, since it depends rather on the measurement and extrapolation technology. Note that the lower (more conservative) limit is much closer to the 'best estimate', and it is the one which matters more.

The SOC data comes in the form of %SOC, which is converted to absolute gC/m^2 using the following formulae for the topsoil and subsoil respectively.

$SOC_{0\text{-}300mm} = \rho_{0\text{-}300mm}$ *0.3*%SOC/100*1 000 000
$SOC_{300\text{-}1000mm} = \rho_{300\text{-}1000mm}$ *0.7*%SOC/100*1 000 000
$SOC_{to\ 1\ m} = SOC_{0\text{-}300}+SOC_{300\text{-}1000}$

ρ is the soil bulk density (Mg/m^3). The AfSIS data does not currently include a correction for stone content, which will lead to overestimation of the profile SOC in stony soils. AGB_{woody} is estimated using the product of tree cover and height as a proxy for the volume of the tree or shrub, which is in turn linearly related (using the constant BCF_{biome}) to aboveground biomass:

$AGB_{woody} = (H_{veg} * TCF) * BCF_{biome}$

H_{veg} is the mean maximum height of the vegetation at a location (m) interpolated from ICESAT-GLAS point records, obtained from the NASA Jet Propulsion Lab (Simard et al 2011, Sassan Saatchi pers com) and from the Woods Hole

Institute (Buccini et al 2008). The ICESAT-GLAS data, which represents a laser 'spot' about 80 m in diameter, is unlikely to be reliable for small vegetation patches, or in steep topography. It may also be unreliable for closed canopy. The high-slope areas were masked out and then patched-in from the national vegetation map, with an estimate of their AGB based on adjacent level areas, or published studies. For fynbos a completely different approach was used, based on modelling the biomass accumulation since the last fire, given the rainfall.

TCF = tree cover fraction (dimensionless 0 to 1: the values are given as a percentage and are divided by 100 before use) from the MODIS satellite based sensor.

BCF is the Biomass Calibration Factor, which in principle varies by biome or sub-biome. For the savanna biome, where it varies between different savanna types from 1100 to 1900 gC/m^3 (erroneously given as 29.6 to 44.4 MgDM/ha in original Colgan et al (2012) reference). Much of this variation can be accounted for by wood density and form factor which can be related to the VegMap savanna classes. We use 1100 gC/m^3 since it corresponds to the combined savanna dataset, and has an error of about ±20%. For the thicket biome the BCF is calibrated against a reserved set of intact thicket data from (Powell 2009), and came to 2029 gC/m^3. For karoo, the savanna relation was used, since the height multiplied by cover numbers are small, so any error will also be small. Grasslands also used the savanna number for BCF (1100 gC/m^3), in the absence of any calibration data.

BGB_{woody} = root:$shoot_{woody}$ * AGB_{woody}

Root:$shoot_{woody}$ is a function of mean annual rainfall (MAP).
For MAP>800 root:$shoot_{woody}$=0.25
300< MAP<800 root:shoot = -0.0035MAP+3.05
MAP<300 root:shoot=2.0

AGB_{herb} is a relatively small number, but is included for completeness. It is based on published relationships between rainfall and yearly grass production (Scholes 2003, whose units are in gDM/m^2/y), reduced proportionately to take into account competition by trees. AGB_{herb} varies greatly through the year – reaching a peak near the end of the growing and declining to near zero by the beginning of spring, especially in the presence of fire and/or herbivory. An 'annual average' is about half the peak value. It also varies greatly from year to year, which we ignore by using the mean annual precipitation (MAP) as the driver.

AGB_{herb} = 0.5*0.42*a*(MAP-c)*(1-TCF/0.65) for TCF<0.65; AGB_{herb}=0 if TCF>0.65

Constant a is often referred to as the 'Rain Use Efficiency', and c is the amount of rain needed to have production. Constants a and c are both related to the topsoil sand content.

a=-0.0376*sand%+3.442; a=0.1 if Sand%>92; a=1.1 if Sand%<64

c=328-142/a

In the absence of topsoil texture data, we assume a sandy loam (75% sand), with a=0.622 and b=99.7.

We assumed BGB_{herb}=AGB_{herb} in all biomes, ie a root:shoot for herbaceous plants of 1.

AGL consists of downed wood, leaves and dung on the soil surface. It is generally a relatively small number, included for completeness. AGL is calculated per biome (or sub-biome, where the biome covers a wide climate range) based on a simple model including litterfall and decay rates as a function of rainfall, and validated against fuel load datasets (Shea et al 1996, and Powell 2009).

AGL = 90 ± 22 gC/m2 for grasslands (from Powell (2009), old lands)
AGL = 121 ± 49 gC/m2 for savannas (from Shea et al 1996)
AGL= 900 ± 50 gC/m2 for forests (Weider and Wright 1995)
AGL= 254 ±52 gC/m2 for thickets (Powell 2009, assuming the thicket landscape is 50% degraded)
AGL = 50 ± 10 gC/m2 for karoo (no data source, expert judgement)
AGL= 1500 ± 150 gC/m2 for fynbos (van Wilgen et al 1990)
AGL= 0 for desert (expert judgement)

Transformed land

Annually-cropped cultivated lands

For calculating soil organic carbon in croplands a simplified version of the EU recommended methodology is used (Box 1). In essence the management and input factors have been assumed to be one. This is appropriate since no data on these factors is available. However, including these factors in the future would enable calculations of the contributions that could occur by moving to different management techniques such as no-till agriculture, return of residuals to the soil, adding of manure or adding biochar. A value is assigned per crop type, regardless of where it occurs in the country, consisting of

$SOC_{cultivated}$= F_{lu}*SOC_{0-30} + SOC_{30-100}

Where F_{lu} is a Land use factor reflecting the proportion of soil carbon retained in a given land use.
F_{lu} = 0.5 for dryland crops
F_{lu} = 0.8 for irrigated crops
F_{lu} = 0.8 for Horticulture tree crops
F_{lu} = 0.6 for sugar cane
F_{lu} = 0.5 for dryland crops

EU methodology (EU 2010) for calculating soil organic carbon in agriculture

$SOC = SOC_{ST} \times F_{LU} \times F_{MG} \times F_{I}$

where:

SOC = soil organic carbon (measured as mass of carbon per hectare);

SOC_{ST} = standard soil organic carbon in the 0-30 centimetre topsoil layer (measured as mass of carbon per hectare);

F_{LU} = land use factor reflecting the difference in soil organic carbon associated with the type of land use compared to the standard soil organic carbon;

F_{MG} = management factor reflecting the difference in soil organic carbon associated with the principle management practice compared to the standard soil organic carbon;

F_{I} = input factor reflecting the difference in soil organic carbon associated with different levels of carbon input to soil compared to the standard soil organic carbon.

AGB_{crop} was computed as a function of the at-harvest aboveground biomass ($AGB_{harvest}$) and the year-round residue mass left in stalks ($AGB_{residue}$). Crop duration is the average period between planting and harvest for that crop, in days.

$AGB_{crop} = AGB_{harvest}$*0.5* crop duration/365+ $AGB_{residue}$

The Harvest index (HI) was used to determine $AGB_{harvest}$ per hectare

$AGB_{harvest} = Y$ (t/ha) / HI

Where:

Y = yield * (1 – fraction moisture)

Yield (in gC/m^2) was quantified at municipal level for each crop group and used the 2002 agricultural census data (STATS SA 2002) to determine the proportional distribution of crop types and local yields. The carbon fraction was assumed the be 0.47 (EU 2010) for all agricultural vegetation. We had no error information on this term so we had to assume no error. Fraction moisture was estimated for each crop type from the literature.

$AGB_{residual} = (AGB_{harvest} - Y) * R_{AGB}$

Where R_{AGB} is the residual aboveground biomass expressed as a proportion of the non-yield biomass

$BGB_{crop} = 0.2\ AGB_{crop}$

except for root crops, where BGB_{crop} is the root dry matter (DM) yield.

Table 1. Calibration factors used for agricultural crops

Crop group	HI[1]	Moisture	Below ground fraction[2]	Carbon fraction	Residual fraction AGB	Residual fraction BGB	Crop duration[3]
					R_{AGB}	R_{BGB}	
Summer cereals [4]	0.5	0.13	0.2	0.47	0.2 (dry) 0.1 (irr)	0.8 (dry) 0.6 (irr)	0.66
Winter cereals[5]	0.4	0.11	0.2	0.47	0.2 (dry) 0.1 (irr)	0.8 (dry) 0.6 (irr)	0.5
Oil seeds	0.39	0.15	0.2	0.47	0.2 (dry) 0.1 (irr)	0.8 (dry) 0.6 (irr)	0.66
Legumes	0.85	0.15	0.2	0.47	0.2 (dry) 0.1 (irr)	0.8 (dry) 0.6 (irr)	0.5
Fodder crops	1	0.5	0.2	0.47	0.2 (dry) 0.0 (irr)	0.2 (dry) 0.0 (irr)	1

[1] HI = Harvest Index: the ratio of harvested yield to total aboveground biomass

[2] as proportion of AGB

[3] as proportion of year

[4] based on Maize which accounts for over 94% of this group

[5] based on wheat which accounts for over 85% of this group

For tree crops two categories of trees where used. Grape vines and all other trees (see table 2). An area and tree category weighted average was derived per municipality. It was assumed that tree biomass is the same in all locations.

Below ground biomass was assumed as a proportion of above ground biomass. A non-tree biomass of 1 t/ha was assumed for other (non-tree) biomass in the orchard.

Table 2. Calibration factor for tree crops

	t/ha above ground (dry)	Belowground fraction	Residual biomass (non tree) t/ha
Vines	14	0.4	1
Other trees	38	0.4	1

An area and crop weighted average of carbon density of agriculture was calculated per municipality for the following categories of agricultural land use:

- Dryland agriculture (this includes fallow land)
- Horticulture (agricultural tree crops)
- Sugar cane

Plantation forests and tree crops

Estimates are provided per plantation type, based on biomass measures from the forestry industry (http://www.forestry.co.za/statistical-data). SOC is derived unchanged `from the AFSIS product.

Urban areas

AGB_{urban} = $FAPAR_{annual\ mean}$ * 5000 [gC/m^2] (Based on an IPCC 2006 value for closed urban forests. The multiplier can be adjusted to match estimates for the urban areas which have been surveyed, eg Johannesburg and eThikweni.)

BGB_{urban} = 0.5 AGB_{urban} (assumes a mix of trees and herbaceous)

SOC_{urban} = 0.8 $SOC_{0\text{-}1000}$ (from AFSIS)

AGL_{urban} = 0. This could be used to reflect an estimate of carbon as timber in buildings and their furniture, plus the carbon in landfills from the National Communication.

Basis for calculating fluxes

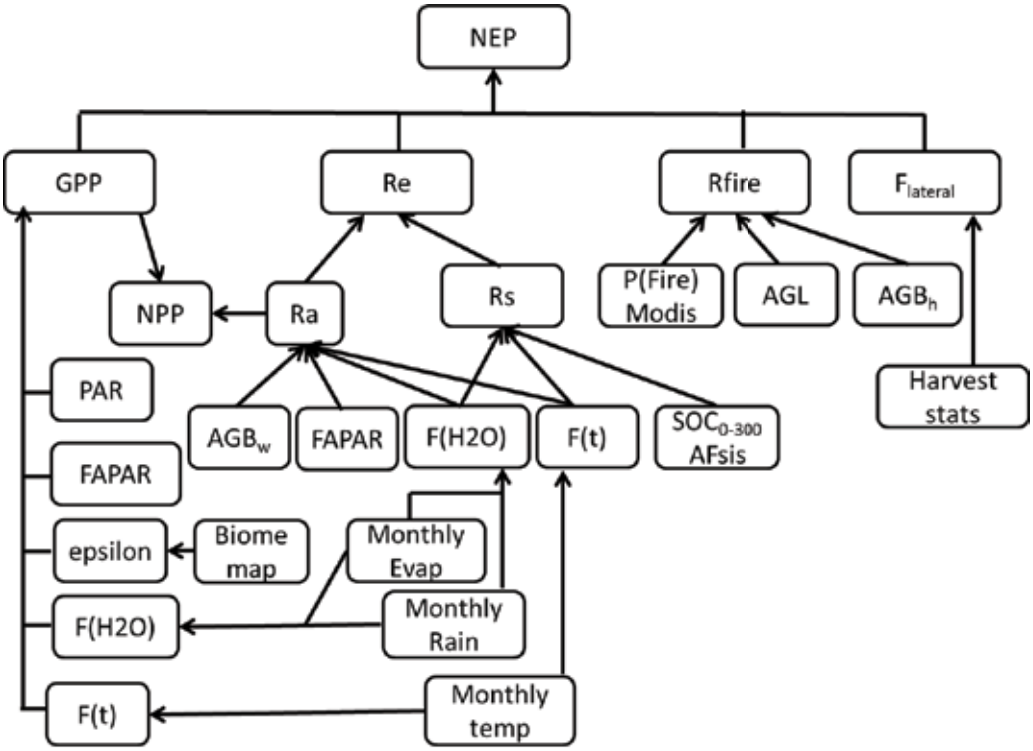


Figure 3: *The workflow for calculating terrestrial carbon fluxes*

Note that in the following the micrometeorology convention of downward fluxes (eg GPP) having negative signs and upward fluxes (eg R_{eco}) having positive signs has not been used. The equations are more intuitive when all values are expressed as positive numbers, which are then added or subtracted according to their direction. The units are gC/m^2/y. To get to $gCO_2/m^2/y$, used for instance in the National Communications, multiply by 44/12. To express the flux in dry matter terms per hectare (tDM/ha/y), divide $gC/m^2/y$ by 0.0045. National flux sums are expressed in TgC/y (1 $Tg=10^{12}g$, or a million tonnes)

NEP = GPP – Re – Rf – Flateral

NEP = net ecosystem production (also called NEE, net ecosystem exchange, or if measured at large scale and over long times, as Net Biome Production)
GPP = Gross Primary Production
Re = Ecosystem respiration
Rf = fire flux

Flateral = export and import fluxes at the scale of the whole country. Particularly harvest and trade-related fluxes, but also water and wind transport. In principle these could be import fluxes (-ve) or export fluxes (+ve), but in practice are all export fluxes (except locally, in the case of accumulation of carbon in cities, which we do not calculate).

The gross primary production (GPP) is solved for periods of time corresponding to the input data, and summed to the year. In the absence of interpolated surfaces of daily weather, or month-by-month weather, we used a climatology of monthly weather for the period 1960 to 1990, and therefore match it to a climatology of mean monthly fraction of absorbed photosynthetically active radiation (FAPAR) and mean monthly photosynthetically active radiation (PAR). There are thus 12 input files for each term, corresponding to the twelve months. The climatology averaging periods for climate and satellite data are different. For FAPAR, the MERIS dataset covers the period 2000 to 2012, and the PAR dataset is also for this period. In the future it may be possible to do these calculations in near-real time, on a monthly or 8-daily basis. The current constraint is the availability of climate data, interpolated nationally, at this time resolution.

$$GPP = \epsilon_{biome}\ PAR*FAPAR * \int(H_2O)*\int(t)*\int(CO_2)$$

ϵ_{biome} is also known as the Light Use Efficiency (epsilon). It is taken as a constant per biome, and is calculated as the weighted sum of the ϵ for each of the main plant functional types in the biome, in proportion to their contribution to the time-integrated leaf area of the biome. Note that almost all of the literature reports ϵ in its constrained form – ie, as effective ϵ *after* the effects of temperature and water have been taken into account. We are using the potential ϵ, *before* it is constrained, since the constraints are then explicitly applied.

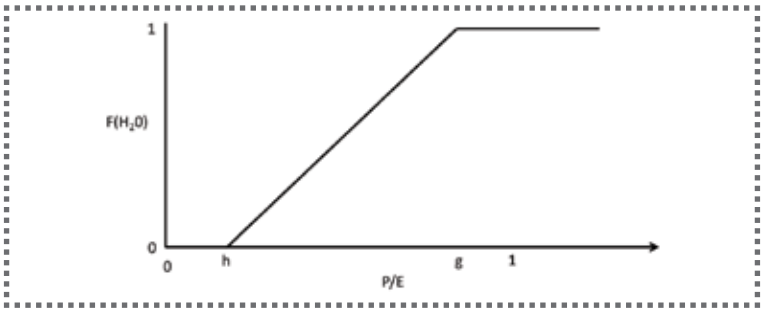
Table 3. *The unconstrained light use efficiency, per plant functional type and per biome. Data sourced from Abel et al 1996, Gower et al 1999, Hunt et al 1994, Landsberg 1986, Landsberg and Waring 1997, Neilson et al 1992, Potter et al 1993, Turner et al 2003, Prince 1995, Running et al 1999, Raich et al 1991, Ruimy et al 1999, Verostaete et al 2002.*

Plant functional type	ε unconstrained (± SD)
	gC/MJ
C3 (Trees, shrubs, temperate grasses)	1.8 (±0.5)
C4 (Tropical grasses)	2.34 (±0.6)
CAM	1.08 (±0.4)

Biome	Fraction C3	Fraction C4	Fraction CAM	Weighted ε
				gC/MJ
Savanna	0.5	0.5	0.0	2.07
Grassland	0.1	0.9	0.0	2.29
Karoo	0.3	0.4	0.3	1.80
Desert	0.3	0.4	0.3	1.80
Fynbos	1.0	0.0	0.0	1.80
Forest	1.0	0.0	0.0	1.80
Thicket	0.4	0.1	0.5	1.49

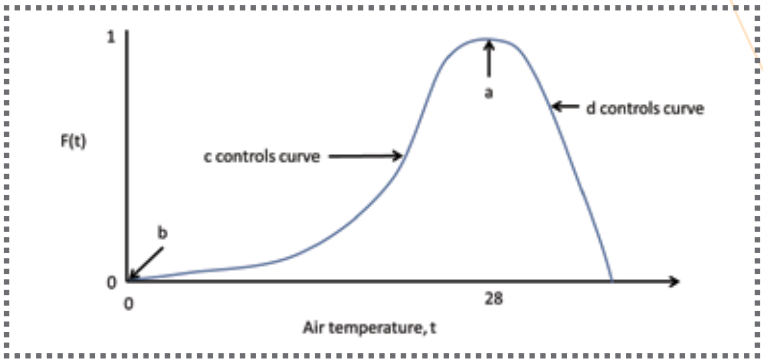
ʃ(H_2O) is the fractional constraint applied due to the closure of stomata. At the monthly mean temporal scale we apply here, where P=mean monthly rainfall in millimeters and E is the monthly open-water potential evaporation (units?)

ʃ(H_2O) = 1.0 if P/E >g
ʃ(H_2O) = (P/E-h)/(g-h) if h<P/E <g
ʃ(H_2O) = 0.0 if P/E<h



The point on the P/E axis where f(H_2O) reaches 1 (no water constraint) is given by g, which is in principle a biome-specific constant (based on the mix of functional types in the biome). Initially, g has been set to 1.0 for all biomes, and can be tuned to match known data. The point on the P/E axis at which f(H_2O) reaches 0 is given by h. Initially it has been set to 0.
ʃ (t) is a hump-shaped function of temperature. The following empirical function has a temperature optimum (a) ~28 , no-growth temperature (b)=0.0; curvature below the optimum (c) =3 and curvature above the optimum (d)= 4.

$\int(t)_{photosynthesis} = \exp(c*(1.0-f^d)/d)*f^c$ where f:= (b-t)/(b-a)

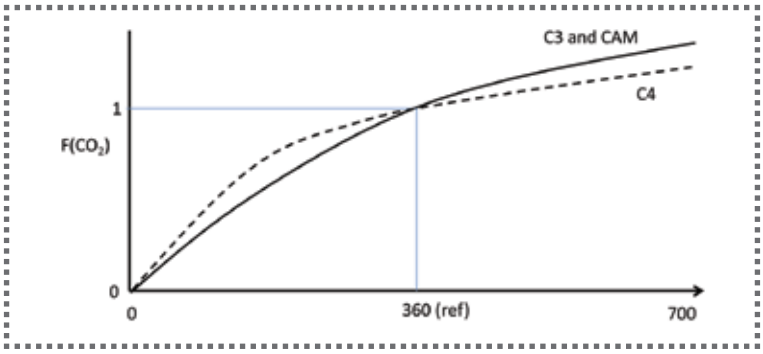


The temperature (t) used in the case of the temperature sensitivity of photosynthesis is the mean daytime temperature, approximated by

$t_{daytime} = 0.75*(t_{max}-t_{min})+t_{min}$

$\int(CO2)$ is a saturating function of increasing atmospheric CO2 concentration. It is included to allow future production to be calculated – the present effect of elevated CO2 relative to the 1990's is very small and can be ignored. We use a Michaelis-Menten enzyme kinetics equation, normalised to equal 1.0 for a reference [CO_2] of 360 ppm, which corresponds to the ~1990 era when the concern over rising CO_2 began, and adjusted to reflect the observed 11% increase in productivity for C4 plants and 15% increase for C3 plants from 'double CO_2' experiments (ie ~700 ppm).

$\int(CO2) = ([CO_2]/([CO_2]+125)) /(360/(360+125))$ for C3 plants and CAM
$\int(CO2) = ([CO_2]/([CO_2]+87)) /(360/(360+87))$ for C4 plants



The same proportions of C3 to C4 can be used per biome as described for the light use efficiency (epsilon) above.
The NPP is required by the project terms of reference, and is more intuitive for most users than the somewhat theoretical GPP. This requires disaggregating Re into its autotropic (Ra, by plants) and heterotrophic (Rh) parts (Rh = Re-Ra). NPP will be solved on a grid-cell by grid-cell basis

NPP = GPP – Ra

A widely-used assumption is that Ra~0.5 GPP. We calculate Ra as a function of temperature, AGB, BGB and FAPAR. The assumption is that the woody parts of the plant have one respiration rate and the more active tissues, indexed by FAPAR, have another.

$Ra = \int(t)_{resp} * (k_1*(AGB_{tree}+BGB_{tree}) + k_2*(FAPAR))$

$\int(t)_{resp}$ follows the same empirical form as given above, with a=28 (Archibald et al 2009). The value for k1 is about 0.01 and k2 is about 8. The temperature used in the function is the mean daily temperature $t_{mean} = (t_{max}+t_{min})/2$

In order to calculate Re,

Re = Ra + Rh

Where Rh is the soil respiration by microbes. The total soil respiration Rs, which includes Ra_{roots}, is given by Makhado and Scholes (2011) for Skukuza as

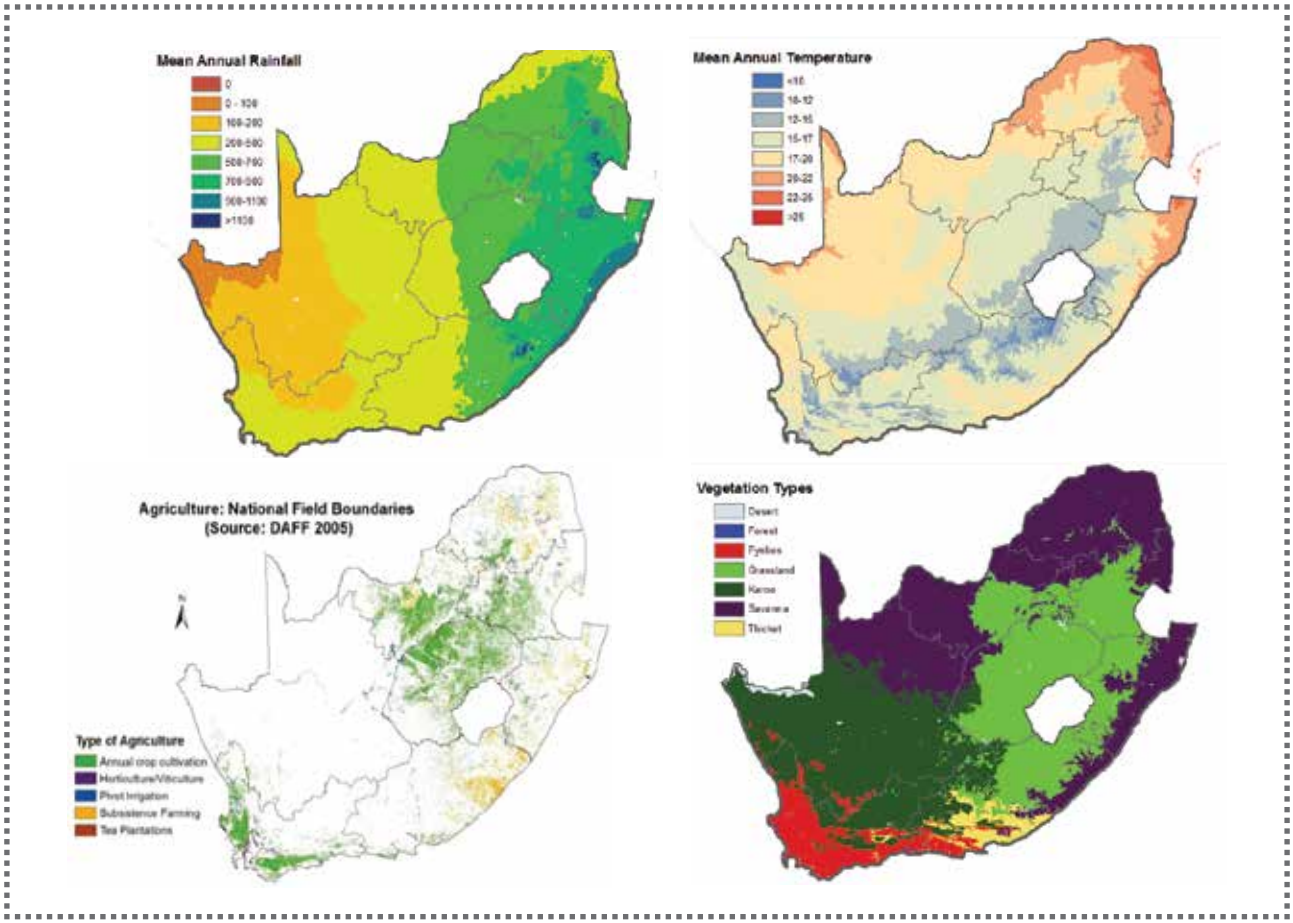
$Rs = k_3 * (SOC_{0-300} + AGL) * \int (H_2O) * \int (t)_{resp}$

where k_3 is a constant, tuned to reflect the measured Rs. From Makhado and Scholes (2011), for the Skukuza upland soils with 1.9% SOC to 300mm and a bulk density of 1.71 Mg/m^3, apparent k_3 (including roots) is about 0.0005 day^{-1}. About half of this is due to roots, so for Rh rather than Rs, the real k_3 is about 0.00025 day^{-1} The below-seepline soils have SOC ~4% and bulk density 1.68 Mg/m^3, apparent k_3 is 0.0025 day^{-1}, a difference probably due to the smectitic nature of the clay in the latter. The k_3 for the part due to the soil microbes is about 0.000125 day^{-1}

The fire flux F is given by

$F = p(fire) * AGB_{herb} + AGL * $ combustion completeness

Where p(fire) is the annual probability of a give point burning in a year, derived from the burned area fraction maps from MODIS. For areas of low burned area fraction (where there are many locations recording no fires in the 10-year observation period, but an expectation that fires could occur), an averaging window should be used. The size of this window should adjust to be larger when the fire probability is low, and smaller where it is high. Combustion completeness is taken as 0.8 (Safari 2000 data). Only a small part of this fire-emitted carbon is exported as a lateral flux from the territory of South Africa.



***Map 1**: a) climatic moisture, indexed by mean annual rainfall; b) the mean annual temperature c) National Field Boundaries d) the vegetation cover, as biomes.*

Input datasets

The four main determinants of terrestrial carbon stocks in South Africa (and elsewhere in similar environments) are moisture, temperature, soil conditions and vegetation cover. The geographical distribution of these factors is shown in Map 1. There is a general increase in plant productivity with increasing moisture (west to east), and with it, increasing soil carbon stocks and biomass. Note that even the 'wet' parts of South Africa are comparatively arid by global standards. The highest soil carbon stacks are in flooded soils (wetlands), which are small in extent in South Africa, but will be explicitly considered in future iterations of this study. There is a decrease in soil carbon with increasing temperature (south to north). Most of South Africa is warm-to-hot by global standards. There is an increase in soil carbon as the silt+clay content of the soil increases, and the carbon content of soils where the clay is of the smectitic type is higher than that of soils with kaolinitic clays. Overall the soils of South Africa tend to be sandy, but there are some important areas of clayey smectitic soils where the parent materials are basalts or dolerites. The biomass carbon varies greatly between vegetation types, in the order desert<karoo<grassland<fynbos < thicket<savanna<forest, and is largely controlled by the proportion of woody plants in the vegetation.

Table 4. Input datasets and their provenance

Input dataset	Source	Resolution	Error	Comments	Reference/ Custodian/ URL
Monthly mean of tmax,tmin	WRC Report 1489/1/06	1.7km	Assumed none	1950-1999	Schulze, R.E. (Ed). 2007. South African Atlas of Climatology and Agrohydrology. Water Research Commission, Pretoria, RSA, WRC Report 1489/1/06
Monthly mean rainfall	WRC Report 1489/1/06	1.7km	Assumed none	2004	Schulze, R.E. (Ed). 2007. South African Atlas of Climatology and Agrohydrology. Water Research Commission, Pretoria, RSA, WRC Report 1489/1/06
Monthly mean reference evaporation	WRC Report 1489/1/06	1.7km	Assumed none	1997	Schulze, R.E. (Ed). 2007. South African Atlas of Climatology and Agrohydrology. Water Research Commission, Pretoria, RSA, WRC Report 1489/1/06
Soil Organic Carbon (SOC)	Africa Soil Information Service (AFSIS)	1km	10th and 90th percentiles	2013	ISRIC – World Soil Information, 2013. Soil property maps of Africa at 1 km http://www.isric.org/data/soil-property-maps-africa-1-km
Canopy Height	NASA (JPL)	1 km	Error map provided	2011	Simard, M., N. Pinto, J. B. Fisher, and A. Baccini (2011), Mapping forest canopy height globally with spaceborne lidar, J. Geophys. Res., 116, G04021, doi:10.1029/2011JG001708 http://lidarradar.jpl.nasa.gov/
Percentage Tree cover	MODIS MOD44B	250m	Standard error by cover class provided	2010	USGS LPDAAC Vegetation Continuous Fields Yearly L3 Global 250m https://lpdaac.usgs.gov/products/modis_products_table/mod44b
SANBI 2009 Land Cover	SANBI	30m	Assumed none	2009	South African National Biodiversity Institute (SANBI), Pretoria, Report 13/10/2009 http://bgis.sanbi.org/mapsearch.asp
National Field Boundaries database	SPOT 5	2.5m	Assumed none	2007, 2011, 2012	Department of Agriculture, Forestry and Fisheries (DAFF)

Input dataset	Source	Resolution	Error	Comments	Reference/ Custodian/ URL
Agriculture statistics	Census of commercial agriculture	N/A	Assumed none	2002	Statistics South Africa (StatsSA)
PAR	MODIS and SeaWiffs JAXA	3km	Validated against flux tower	2000-2010	Earth Observation Research and application Center, Japan Aerospace Exploration Agency
FAPAR	MERIS (JRC-GEM)	1km	Estimated at 10%	10-daily composites 2000-2012	Gobron (2011)
Fire return period	MODIS MCD45A1	500m	5th and 95th quantiles provided		USGS LPDAAC Burn area product

Appendix B (Section 1)

Modelling data sources

The following organisations were contacted either telephonically, by email, internet and/or physical meetings to source potential information and spatial datasets in support of the future land-cover modelling:

- Department of Rural Development and Land Affairs (DRDLR), Chief Directorate National GeoSpatial Information (CDNGI),
- Department of Rural Development and Land Affairs (DRDLR), Spatial Planning and Information (SPI)
- Endangered Wildlife Trust (EWT)
- i@consult (commercial Town and Country Planners, Pretoria)
- CSIR Built Environment (CSIR-BE), (Pretoria)
- CSIR Natural Resources and Environment (CSIR-NRE), (Stellenbosch)
- SA National Biodiversity Institute (SANBI) (via BGIS website)
- Gauteng City-Region Observatory (GCRO)
- NW Provincial Government (NWPG), Dept of Economic Development, Environment, Conservation and Tourism (DEDECT)
- Department of Water Affairs (DWA), Directorate of Planning
- Department of Environmental Affairs (DEA),
- Directorate of Planning
- Department of Environmental Affairs (DEA), Atmospheric Carbon Mitigation
- Department of Environmental Affairs (DEA), EIM Systems and Tools
- Department of Agriculture, Forestry and Fisheries (DAFF), Directorate Land Use and Soil Management
- Department of Agriculture, Forestry and Fisheries (DAFF), Directorate: Forestry Regulation and Oversight
- MetroGIS (commercial GIS-Environmental Planning company)
- Council for GeoScience (CGS)
- STATS SA
- ESKOM (GIS Techonology, Midrand).

Modelling data inputs

The following datasets were used as the inputs into the future SA land-cover modelling, based on minimising duplication of (comparable) information from different sources, suitability and relevance of data content, geographical coverage, (perceived) information reliability and age.

Land-cover change restrictor (i.e. "protectionist") data:

- ***DEA Formal Protected Areas***: Formally (i.e. legally) protected national and provincial conservation areas (vs 2013), (source: DEA)
- ***SANBI Protected Areas***: Informal (i.e. no legal protection) conservation areas, (i.e. areas defined by formal administrative boundaries such as ownership, but not formally (i.e. legally) protected in terms of natural resource content, e.g. private game reserves, conservancies etc, but which could expect a significant level of developmental protection from EIA processes, public pressure etc (souce: SANBI)
- ***SANBI "National Protected Area Expansion Policy" 2008 (NPAES):*** future national and regional areas likely to become legally protected (source: SANBI BGIS)
- ***SANBI Threatened Ecosystems*** dataset: areas not defined by biodiversity / natural resources rather than administrative boundaries, which could expect a significant level of developmental protection from EIA processes, public pressure etc (source: SANBI BGIS)
- ***Water Research Commission's (WRC) "National Freshwater Ecosystem Priority Areas for South Africa" (NFEPA)*** Atlas, sub-quaternary River FEPA dataset (source WRC Atlas of Freshwater Ecosystem Priority Areas data CD); which could expect a significant level of developmental protection from EIA processes, public pressure etc (source: WRC Atlas data CD).

Land-cover change driver (i.e. "transformer") data:

- ***Agricultural Research Council (ARC) national (agricultural) Land-Capability Dataset***, which defines 8 x agricultural potential land-capability classes, based primarily on climate (rainfall), terrain and soils. A digital (vector) version of this was sourced from DAFF.
- ***DAFF Potential Forestry Expansion Datasets***, based on climate, terrain and soil suitability. The data for the E Cape was originally supplied to DAFF as part of a Strategic Environmental Assessment (SEA) for the Zone of Afforestation Potential in the E. Cape (Coastal and Environmental Services (CES) May, 2006). The data for Kwa-Zulu Natal was sourced from a DWA commissioned report by the Institute of Natural Resources (INR): Afforestation Potential Study in KZN and Mpumalanga: Environmental Assessment Report (March 2009).
- ***DWA New Dams***: Location of planned and/or proposed new major water storage dams, as described by DWA. In the majority of cases the geographical extent of the proposed new dam (maximum water level) was manually interpreted from pdf (or equivalent)

engineering map diagrams onto relevant base (satellite) imagery before inclusion in the future land-cover modelling. The following dams were included: De Hoop (Olifants, Mpumalanga), Foxwood (Adelaide, E.Cape), Springrove (Durban), Nwamita (Levhuvhu, Letaba), and Zalu (Lusikisiki, E Cape).

- ***CGS Coal Reserves & Mining Rights***: Approximate boundary of all major coal reserves, and associated exploration and current and future extraction licences, based on farm and sub-farm units (as granted by Department of Minerals and Energy up to 2012), as sourced from the Council for GeoScience.
- ***CGS Iron / Manganese Reserves & Mining Rights***: Approximate boundary of all major iron and manganese reserves, and associated exploration and current and future extraction licences, based on farm and sub-farm units (as granted by Department of Minerals and Energy up to 2012), and sourced from Council for GeoScience.
- ***ESKOM Future Power Stations***: Point coordinate data for future planned and/or proposed ESKOM power stations (all fuel types), major regional sub-stations, wind and solar farms. These datasets were sourced independently from DEA and ESKOM. Any duplication of information (based on coinciding locations) was eliminated before modelling commenced.
- ***CDNGI CRDP's***: Geographic boundaries of administrative districts / municipalities defined as priority development regions within the DRDLR's Comprehensive Rural Development Programme. These were sourced from the CDNGI.
- ***NDP / SIP Mega Build Projects***: significant urban-build and / or construction projects as defined in the National Development Plan (NDP) / Strategic Infrastructure Plan (SIP), excluding those already defined separately (i.e. ESKOM capital expansion projects). These were sourced from CSIR Built-Environment as a (point-based approximate location only) digital GIS dataset.
- SKA: Approximate geographic footprint of the Square Kilometer Array (SKA) telescope project. This was sourced from information available on the internet (www.ska, www.wikipedia)

Data modelling

The following section describes the actual modelling rules used to create the "2020" SA future land-cover:

Protected areas

Protected areas were defined on 5 levels, based on the level of existing legal protection, possible future legal protection, and likely protection from processes such as EIA's etc, especially if found in a pre-defined environmentally sensitive or threatened area.

Level	Protection		Dataset
0	least	All other undefined areas in S.A	n/a
1		All "Level 1" FEPA threatened sub-quaternary river catchments (defined on catchment boundaries).	SANBI / WRC
2		All "critically" threatened ecosystems (not defined on any formal administrative and/or ownership boundaries.	SANBI
3		All future Protected Areas Expansion Plan sites	SANBI
4		All existing informal conservation areas, i.e. no legal status, other than defined within formal administrative and/or ownership boundary, e.g. private game parks, conservancies etc)	SANBI
5	maximum	All existing formal conservation areas protected by legal status.	DEA

Agricultural expansion

According to DAFF, there is a need to develop ± 1 M ha of compensatory new agricultural land to replace cultivated land expected to be lost to mining in the near future. The regional priorities for this replacement land are likely to be E.Cape,, KZN, NW and then Limpopo. Very little expansion is expected within the Free State since this already at near maximum cultivation capacity. Note that modelled future cultivation *expansion* was limited to only the commercial cultivation class, and did not include any changes to subsistence, orchard, viticulture or sugarcane classes, since these are not considered as primary food security classes, and (b) no national-level data was identified to support future modelling of these specific crop-types. Potential new cultivated expansion areas were modelled thus:

- high agricultural potential land (as defined by ARC land capability classes 1- 4), re-weighted according to provincial location:

		DAFF land capability rating			
Provincial weights		1	2	3	4
E.Cape	1	1	1	2	3
KZN	2	1	1	2	3
NW	3	1	2	3	4
LPP	4	1	2	3	4

where 1 = most likely to be new cultivation

- that is currently classified as natural vegetation (excluding indigenous forests) in 2010, or
- classified as coal mines in 2010, and thus rehabilitation of high potential agricultural land could be possible by 2020, and
- on slopes <20° (as defined using the SRTM terrain dataset, re-scaled to the same cell resolution as the SA modelling exercise), which is the CARA (Conservation of Agricultural Resources, Act 4 / 1983) defined threshold for conventional cultivation, and
- with priority weightings applied to targeted provinces (EC = 1st, KZN = 2nd, NW = 3rd and Limpopo = 4th, or lowest weighting), and
- not identified as future 2020 mining sites, and
- not identified as future 2020 major dam / reservoir inundation sites, and
- not within protected areas (classes 4 and 5).

OR

- as above, but inclusive of forestry potential classes 2 if the potential land falls within a CRDP defined district boundary (to allow for expanded rural development).

Forestry expansion

According to DAFF, future expansion of commercial forestry is most likely to occur in either E.Cape or KZN, since Mpumalanga is at near maximum capacity. Potential new cultivated expansion areas were modelled thus:

- high forestry potential land (classes 1 for both E.Cape and KZN data),
- that is currently classified as natural vegetation (excluding indigenous forests) in 2010, and
- that is not targeted for future cultivation expansion, and
- not within protected areas (levels 3, 4 or 5), and
- not identified as future 2020 mining sites, and
- not identified as future 2020 major dam / reservoir inundation sites, and
- on 2010 existing coal mines that could be re-habilitated

OR

- as above, but inclusive of forestry potential classes 2 if the potential land falls within a CRDP defined district boundary (to allow for expanded rural development).

Dam expansion

All major DWA defined future dam developments were incorporated into the 2020 SA land-cover based on the best available interpretation of maximum flood level. All existing 2010 land-covers were over-written with the new dam extent, except for settlement-classified data cells, regardless of any future planned land-cover, use or protection status. Note this possibility of new dam extent overlapping existing urban codes is possible due to the single majority cover-code allocation to each pixel and the coarse resolution of the data modelling.

Future coal mines

Potential 2020 coal mines were defined as all land-cover pixels:

- located within a 500 km buffer (i.e. 1 km diameter) radius of the centroid point of each farm portion within which a future coal exploration and/or extraction licence has been granted, and
- which are located within defined national coal reserve areas; and
- which had not been previously identified as mining in either 2000, 2005 and/or 2010 land-cover datasets, or settlements, and

- were not within level 4 or 5 protected areas, or a 40km buffer exclusion zone around the SKA telescope development.
- Future coal mines were given priority over future cultivation and forestry expansion areas.

Future iron/manganese (non-coal) mines

Potential 2020 iron and manganese mines (i.e. minerals with large open-cast mining footprints) mines were defined as all land-cover pixels:

- located within a 500 km buffer (i.e. 1 km diameter) radius of the centroid point of each farm portion within which a future iron / manganese exploration and/or extraction licence has been granted, and
- which are located within defined national iron and manganese reserve areas; and
- which had not been previously identified as mining in either 2000, 2005 and/or 2010 land-cover datasets, or settlements, and
- were not within level 4 or 5 protected areas, or a 40km buffer exclusion zone around the SKA telescope development.
- Future coal mines were given priority over future cultivation and forestry expansion areas.

Future infrastructure build

Transformation foot-prints from potential future large infrastructure build projects were all incorporated into the "settlements" class, regardless of the type of infrastructure development. The potential expansion areas were defined as a 1km buffer (i.e. 2 km radius) around the defined central location point for all ESKOM future power stations (regardless of fuel type), and the NDA/SIP defined Durban Bridge Development project. Future ESKOM power sub-stations and DEA/ESKOM defined potential wind and solar power farms were allocated a single 500x500m pixel footprint. Solar and wind farm locations were defined as were the ESKOM sourced SEA phase 1 (solar/wind) potential areas intersected with the centroid points (of each farm unit) for which there was an associated DEA sourced EIA application for a wind or solar park. The SKA telescope development footprint was defined as a 10km buffer around the core location of the SKA development.

It is however acknowledged that the SKA development is a low impact development (within a large area) and this modelling approach may have created an over-emphasis of actual land-cover change.

Future urban expansion

Future urban expansion areas were modelled using a 3x3 moving window majority filter over all existing 2010 "settlement" pixels, and re-coding all adjacent non-urban pixels to "settlements" if the majority of surrounding pixels were classified as "settlements" in 2010, and the targeted new "settlement" cell was:

- Within 10km of any of the 2020 defined new infrastructure build cells (based on ESKOM and other mega projects), or
- Within a 2010 defined metropolitan or (selected) municipalities deemed to have development / expansion potential (i.e. Ekhurhuleni, eThekwini, City of JHB, Buffalo City, City of Cape Town, Mangaung, Emalahleni, Mbombela, The Msunduzi, uMhlathuze, Nelso Mandela Bay, City of Tshwane, Rustenberg and Mafikeng), or

But *not*:

- Within a protected area of level 4 or 5, or
- Within potential agricultural lands defined by land-capability classes 1 and 2, or
- On 2010 cells as cultivated land (except for sugar-cane, which was allowed, as a non-food security crop to be "lost"), or
- On 2020 or 2010 cells containing mines, plantations, wetlands, or water; or
- On slopes > 20°;
- Within the 40km SKA exclusion area buffer.

Note that no settlement expansion was modelled within CDRP's, unless as a result of other influencing factors as define above, since the aim of the CRDP's is to stabilise existing populations with employment opportunities rather than attract new migration.

Appendix A (Section 3)

Policy creation and development in South Africa

One of the deliverables set out in the terms of reference for the National Carbon Sinks Assessment is a *mapping* exercise of existing policies and measures that directly and indirectly affect GHG emissions and removals from the AFOLU sector. To this end, we have analysed a broad range of policy and measurement documents including Green and White Papers, Acts, Regulations, Bills, Strategies, Plans, Frameworks, Assessments and Others that may have a direct or indirect impact on GHG emissions and removals from the AFOLU sector.

In this module, we describe how policies in South Africa are developed, with specific focus on environmental and climate policy. We also explore the legal processes policies undergo in order to come into effect in South Africa.

Policy: working definitions

There is no universally agreed definition of what constitutes 'policy'. Policy could encompass the set of decisions taken by government, but it could also include the influences that determine both the way in which these decisions are interpreted and which decisions end up being implemented. Further, it may include the initial context that determines the types of issues considered for decision and the kinds of contestation that accompany specific policies. Harvey Brooks (1989), for instance, defined public policy as "the broad framework of ideas and values within which decisions are taken and actions, or inaction, are pursued by governments in relation to some issue or problem." An analysis of policy could thus comprise a range of written policy documents (white papers and regulations), statements by policymakers, intentions and directions as included in green papers and strategic documents, institutional capacity and orientation, and actualised policy (Tyler, 2009).

For the purposes of this analysis, however, we only reviewed written policy documents. Beyond the realm of legislated acts, regulations and official government policy laid out in White Papers, we have also included departmental, ministerial and presidential strategies and frameworks as laid out in various green papers, plans, strategies and visions. This inclusion contributes to a better understanding of the country's policy priorities and general policy environment.

Additional definitions referred to in this module include the following:

- The difference between a ***policy*** and a ***law*** can be defined as follows:
- A ***policy*** outlines what a government ministry or department hopes to achieve and the methods and principles it will use to achieve them. It's a public statement of intent, principles and goals. A policy document is not law, but it will often identify new laws needed to achieve goals.
- ***Laws*** set out standards, procedures and principles that must be followed. If a law is not followed, those responsible for breaking them can be prosecuted in court.
- The term ***measures*** can be thought of as referring to legislative, administrative or other means through which a predetermined course of action may be implemented. For the purposes of this study, Cirrus has included the following measures into its catalogue: Acts, Bills, Regulations, ministerial listings, guidelines and standards.

Mapping is understood to be a graphical representation depicting arrangement and relationships among different policies and its different components, tracing any synergies or conflicts where possible. Cirrus has used a catalogue as the initial mapping tool. This is supported by textual analysis, simplified tables and charts.

How is policy created in South Africa?

In South Africa, the process of formulating policy can be elaborate, taking time for policies to be, gazetted and implemented. The process of finalising official government policy or laws generally involves five stages during which key issues are debated and negotiated. It can thus take years before the impact of new laws or policies are felt on the ground. This section briefly outlines the policy development stages and processes in the country.

Stage One: Ruling Party Conference

The first stage involves the discussion and debate of particular issues at a major conference of the ruling party. At this stage, the ruling party decides its overall vision, goals and direction on a specific issue (Education and Training Unit, 2013).

Stage Two: Executive Ministry Draws up a Policy on an Issue

The second stage takes place at a national level where the ruling party will attempt to convert all its policy decisions

into official government policy or law, prescribed by the Constitution. The Executive Ministry, who may draw up the policy, is vested in the Presidency while all national, provincial and local levels of government have legislative and executive authorities within their spheres.

National Government is composed of three inter-connected branches:

- Legislative: Parliament, consisting of the National Assembly and the National Council of Provinces
- Executive: The President, who is the Head of State
- Judicial: The Constitutional Court, the Supreme Court of Appeal and the High Court

It is the responsibility of Parliament to approve policies and pass new laws in order to give legal standing to new policies. This process may take time as policies and laws are debated and negotiated with various stakeholders, such as opposition parties, the public and non-government organisations.

The government will draft discussion documents, called **Green and White Papers** on the policy or law to allow for debate or comment. Stakeholders can use different opportunities for input, such as attending parliamentary committee hearings, setting up meetings with department heads or the Minister, or using the media to persuade government (Education and Training Unit, 2013). Examples of policies such as these used in our analysis includes the *National Development Plan 2030*, *Medium-Term Strategic Framework 2009-2014* and the *National Growth Path: The Framework 2010*. Green and White Papers identify possible courses of action in terms of policy and legislation on specific issues that need to be addressed. These policies are therefore particularly important and form the foundation of future laws to be passed.

Stage Three: Finalise a Policy

Once a policy has undergone full scrutiny and it had been debated, the relevant Department and Ministry draw up a final policy which is published as a **White Paper**. The White Paper is a statement of intent and a detailed policy plan which often forms the basis of legislation. It is debated and adopted by Parliament and approved by Cabinet (Education and Training Unit, 2013).

Stage Four: Passing a Law

If the Ministry decides that a new law is necessary to achieve the White Paper's objectives and to implement its policy, the relevant Department will draft a new law. In its early stages before a new law has been tabled in Parliament, it is called a **draft Bill**. Once tabled in Parliament, it is called a **Bill**.

Before the draft Bill is tabled, the Bill goes to Cabinet for approval. It is then released for public comment. Once comments have been received, relevant changes are made. Cabinet then undertakes an assessment to ensure the draft Bill does not contradict any other policies or the Constitution. It is then sent to legal advisors for legal approval, and then is tabled by the Minister in Parliament.

Once a bill has been tabled, it will be issued with a number and released as a Bill and go through the process of becoming a law. The process is summarised as follows:

- The Bill is sent to National Assembly who refer it to a Portfolio Committee
- The Portfolio Committee reviews the Bill and requests public comment. Whilst the Portfolio Committee reviews the Bill, it is considered the best time to lobby for changes or protest the principles of the Bill. Once the Committee has made changes and requested clarity on any issues, a report of the findings is sent to the National Assembly.
- The National Assembly then considers the Bill and votes on the changes the Portfolio Committee may have recommended.
- The Bill then goes to the National Council of Provinces where the appropriate Select Committee considers the Bill. The Bill then goes through a different process depending on whether the Bill contains issues affecting the provinces or not.

Once both houses of Parliament have agreed to a final version of the Bill, it will be sent to the President. The President then signs the Bill and it becomes an **Act** and law in South Africa (Education and Training Unit, 2013).
There are two other types of Bills which have not been discussed in as much detail; these are the **Money Bills** (Section 77 of the Constitution) and **Constitutional Amendments** (Section 74 of the Constitution). These follow a slightly different process and are briefly described as follows:

- Money Bills allocate public money for a particular purpose or impose taxes, levies or duties. They can only be introduced by the Minister of Finance and they must be introduced in the National Assembly. They follow the same procedure as Bills that do not affect the provinces (Section 75) (Parliamentary Monitoring Group, 2013).
- There are special requirements and procedures in order to amend the Constitution, especially since the Constitution is the highest law in the land. Special requirements include, for example, requiring special majorities of votes of the National Assembly so that changes cannot be made by a minority (Parliamentary Monitoring Group, 2013). For the purposes of this briefing, the details of constitutional amendments will not be discussed in further detail.

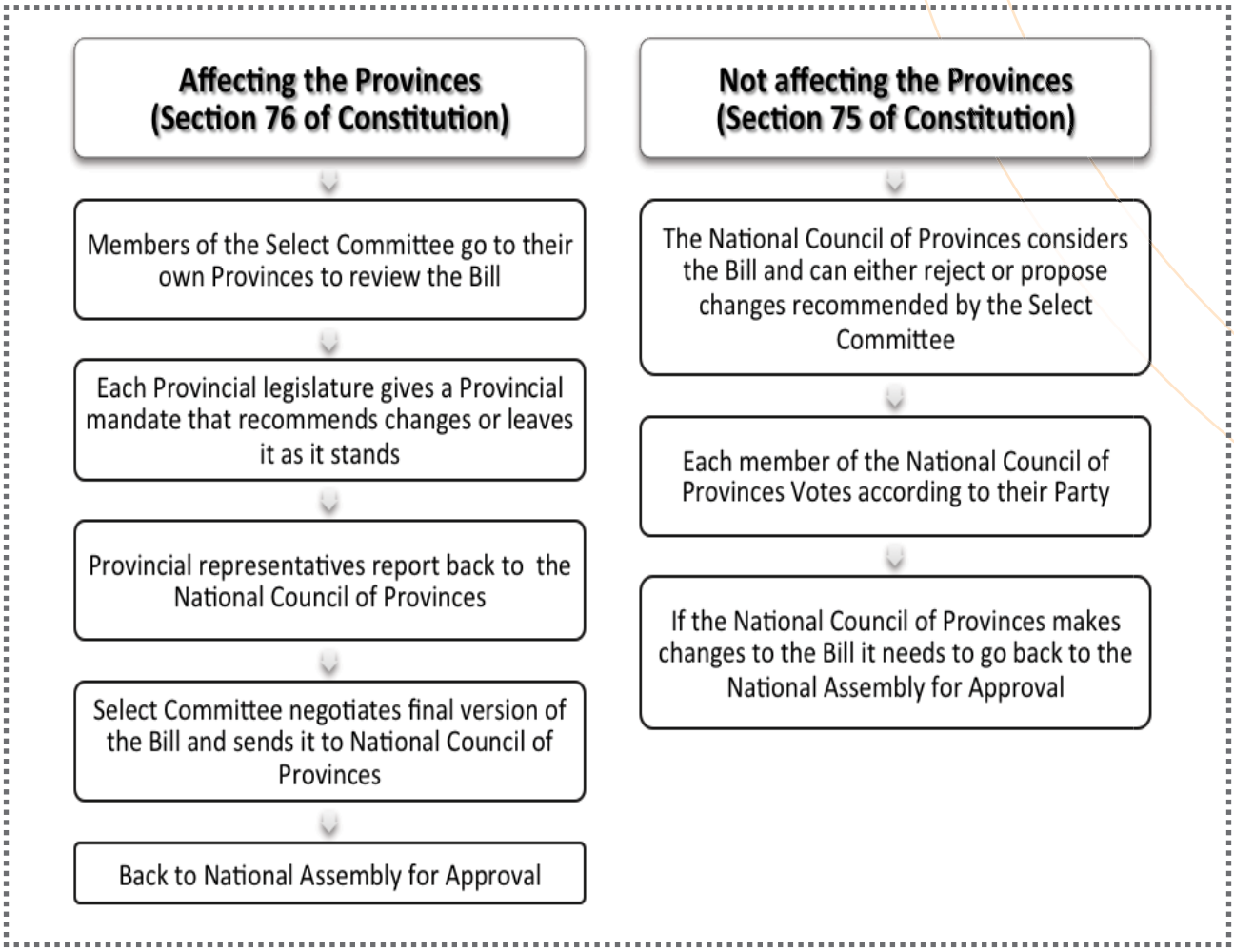


Figure 5. *Approval Process for Different Types of Bills (adapted from Education Training Unit)*

Stage Five: Subordinate legislation and implementation of Law and Policy

Once National Parliament has passed a law or a policy has been published, it is up to national and provincial ministries and departments to implement it. Provincial legislature can also make its own laws on areas defined in the Constitution. These laws will only apply to the province in which it was made. Apart from national and provincial laws, local governments can also pass ordinances that have the same legal force as national and provincial parliaments.

While some laws merely require enforcement, others need to be promoted. Frameworks and Strategic Plans, for example, generally originate from passed laws. In order to achieve the objectives prepared in an act, the legislation may require that a national department or committee (usually created as a requirement of the Act) develop a framework or strategic plans which set out the institutional frameworks, mechanisms for implementation of the act, as well as assigning key roles and responsibilities to responsible authorities. In some instances frameworks and strategic plans may include targets and timeframes within which the targeted interventions need to be implemented. Therefore, frameworks and strategic plans are often an interpretation and implementation of legislation.

National Environmental Policy Framework in South Africa

The following section aims to describe the overall context of the national environmental legal framework for South Africa.

South Africa's constitutional structure divides the powers and functions of government into three parts – national, provincial and local. The national government usually formulates broad policy parameters for the country as a whole, while provincial and local governments are mandated to formulate their own specific policies and programmes and to implement them within national policy parameters.

The area of environmental policy falls within the group 'concurrent functions' allocated by the Constitution to be shared between national and provincial spheres of government. The overall framework is outlined below.

- The Constitution is the supreme law of the country and enshrines a Bill of Rights which in turn introduces an "environmental right". Section 7(2) of the Constitution provides that the state must respect, protect and fulfil the Bill of Rights. Section 24 (b) has been interpreted

as mandating government to enact legislation which must achieve goals of environmental protection, the prevention of pollution and ecological degradation and the promotion of conservation and sustainable development (Warburton et. al., 2007).

- In order to comply with Section 24, the South African Government recently initiated an environmental law reform process overhauling important general environmental legislation and introducing new environmental legislation and policy documents concerning important aspects relevant to environmental management (Warburton et. al., 2007).
- The most important environmental statute to emerge is the *National Environmental Management Act No 107 of 1998* (NEMA), which came into operation in 1999. NEMA contains a multi-faceted definition of "sustainable development" and provides an overarching framework for integrating sound environmental management into all development activities, including those that might result in greenhouse gas emissions, and for promoting co-operative environmental governance (Warburton et. al., 2007).
- Recent legislative activity has seen the promulgation of a number of statutes under NEMA's support. The names of these "new" environmental statutes typically include the prefix "National Environmental Management". Thus the *National Environmental Management: Protected Areas Act No. 31 of 2004* and the *National Environmental Management: Biodiversity Act No. 10 of 2004*, have been promulgated to deal with a very broad range of conservation and biodiversity issues. The most recent addition to the list of NEMA-derived legislation is the *National Environmental Management: Air Quality Act No. 39 of 2004 (the Air Quality Act)* (Warburton et. al., 2007).

The figure below provides a list of some of the key sectoral, national, and global policy instruments and other regulatory frameworks underpinning environmental protection and climate change governance processes in South Africa. Although the list is not exhaustive, it does represent an ensemble of various instruments that are critical for government and other key role players in South Africa to use to address the key challenges posed by climate change.

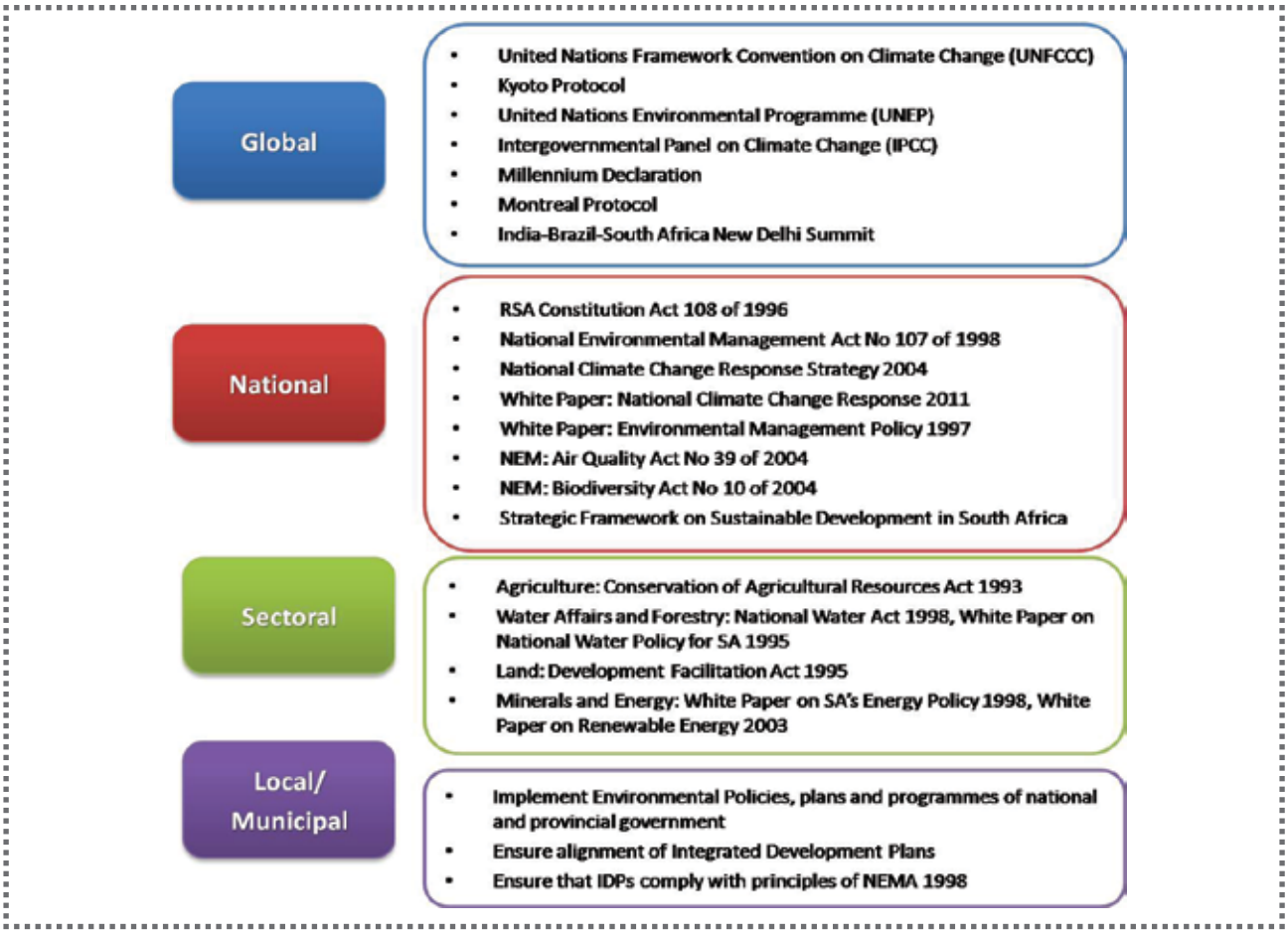


Figure 6. *Revision of existing environmental and climate policy (adaptation from Mokwena, 2009)*

National Climate Change Policy Development Process in South Africa

South Africa formed the **National Climate Change Committee** (NCCC) in 1994 which is a multi-stakeholder platform aligning government, business, industry, academia, non-governmental organisations and organised labour. By 2001, climate change had become an area of research in South Africa and became more prominent on the political agenda in 2002 when Heads of State of over 180 counties met for a world summit on Sustainable Development in Johannesburg. In 2002 and 2005, South Africa ratified the Kyoto Protocol and by June 2005 the Departments of Environment and Science started organising a unique climate change conference consisting of two components; a science conference attended by top regional scientists preceded by a policy conference. The policy discussion was focussed by input from scientists.

Two commitments were outlined at the 2005 conference; the first was the agreement to initiate a detailed scenario-building process to map how South Africa could meet its commitment to greenhouse gas stabilisation. This process was called the **Long Term Mitigation Scenarios** (LTMS). The second commitment was to initiate a participatory climate change policy development process.

The LTMS process began in March 2006 and concluded that a great deal could be done to reduce South Africa's GHG emissions. The process was run by a multi-stakeholder scenario-building team and included many representatives from government, business and civil society. In October 2007, three documents on the various scenarios were produced.
Following a long process of round table discussions to co-ordinate the diverse stakeholder and Departmental inputs, a Draft **Green Paper** was published in November 2010. Workshops were held in every province and a website was set up to create a forum for contributions. After further focus workshops and further research, Parliament hosted public hearings. After Committee reviews, the **White Paper** was approved by Cabinet on 12 October 2011 and published in the Government Gazette on 19 October 2011.

In terms of strategic priorities, the White Paper sets out South Africa's climate change response strategy to achieve the National Climate Change Response Objective. Other climate policy documents which are currently under development include the:

- Carbon Tax Policy Document
- Suite of Near Term Priority Flagship Programmes

Appendix B (Section 3)

Policy clusters

The second module of this policy review describes the policy development process. Briefly summarized, this process includes the following steps:

- Green and White policy papers are created to table an emerging policy issue in a structured manner for further discussion and debate. The objective of the initial policy papers is to communicate government's objectives and vision on the issue as well as strategic objectives.
- This set of initial papers typically undergoes a series of revisions following input from stakeholders.
- Thereafter, a bill may be drafted that may undergo further revisions based on feedback from stakeholders.
- Finally, a law is enacted based on the bill and approved by Parliament.

When drafting an Act, government is required to make the necessary provisions for the Act to be successfully implemented. An Act cannot adequately address specific issues unless the necessary institutional capacity has been established to fulfil the objectives of the Act. An Act may therefore lead to the establishment of a responsible authority that is required to co-ordinate all matters relating to the Act and may lead to the development of further supporting policy documents in the form of frameworks, strategies, action plans, regulations and guidelines (that may not necessarily be legally binding).

The creation and adoption of an overarching White Paper may therefore lead to a number of Acts and associated policy documents. To convey the potential relationship between policy documents, we have grouped documents that relate to a similar issue in "clusters". The purpose of this module is to illustrate the clusters of policies encountered in our analysis and to describe the links or cross-overs between clusters. In addition, we note key policies that may fall outside clusters or the hierarchy of policy and how this may affect their level of influence.

Summary of clusters

Policies Originating from Presidency

The following policies originating from Presidency were included in the policy analysis:

- Medium-Term Strategic Framework 2009-2014 and Industrial Policy Action Plan II
- New Growth Path: The Framework 2010
- White Paper: National Planning Commission
- The National Development Plan 2030
- Industrial Policy Action Plan which is integral to the New Growth Path

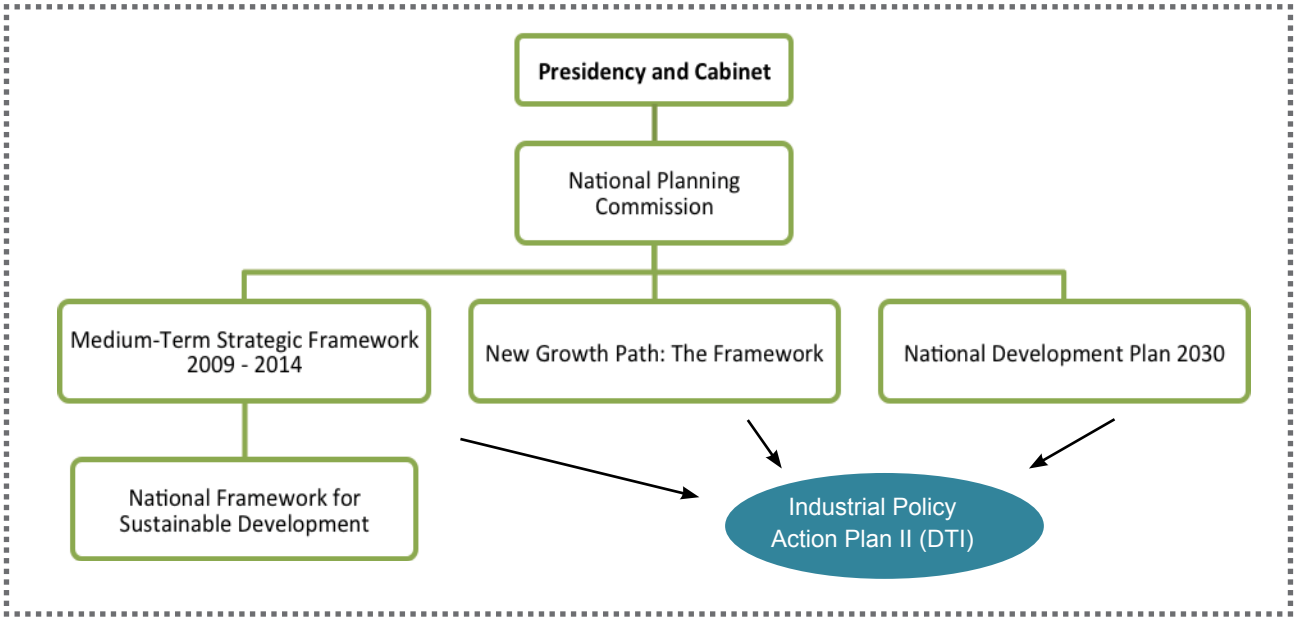


Figure 7. *Policies originating from Presidency*

The National Environmental Management Act Cluster

The family of National Environmental Management Act policies (NEMA) include:

- The National Environmental Management Act 1998
- The NEM: Environmental Impact Assessment Regulations (NEMA:EIA)
- The NEM: Environmental Management Framework Regulations
- The NEM: Protected Areas Act (Act 57 of 2003) and the National Protected Area Expansion Strategy (NPAES) (2008)
- The NEM: Biodiversity Act (Act 10 of 2004) and the SANBI Strategic Plan 2011-2015, the National Biodiversity Framework (NBF) (2008) and the Guidelines Regarding the Determination of Bioregions and the Preparation of Bioregional Plans (Guidelines, mandated by NEMA: BA).
- The National Environmental Management Air Quality Act (NEMA:AQA) and the Air Quality Management Framework

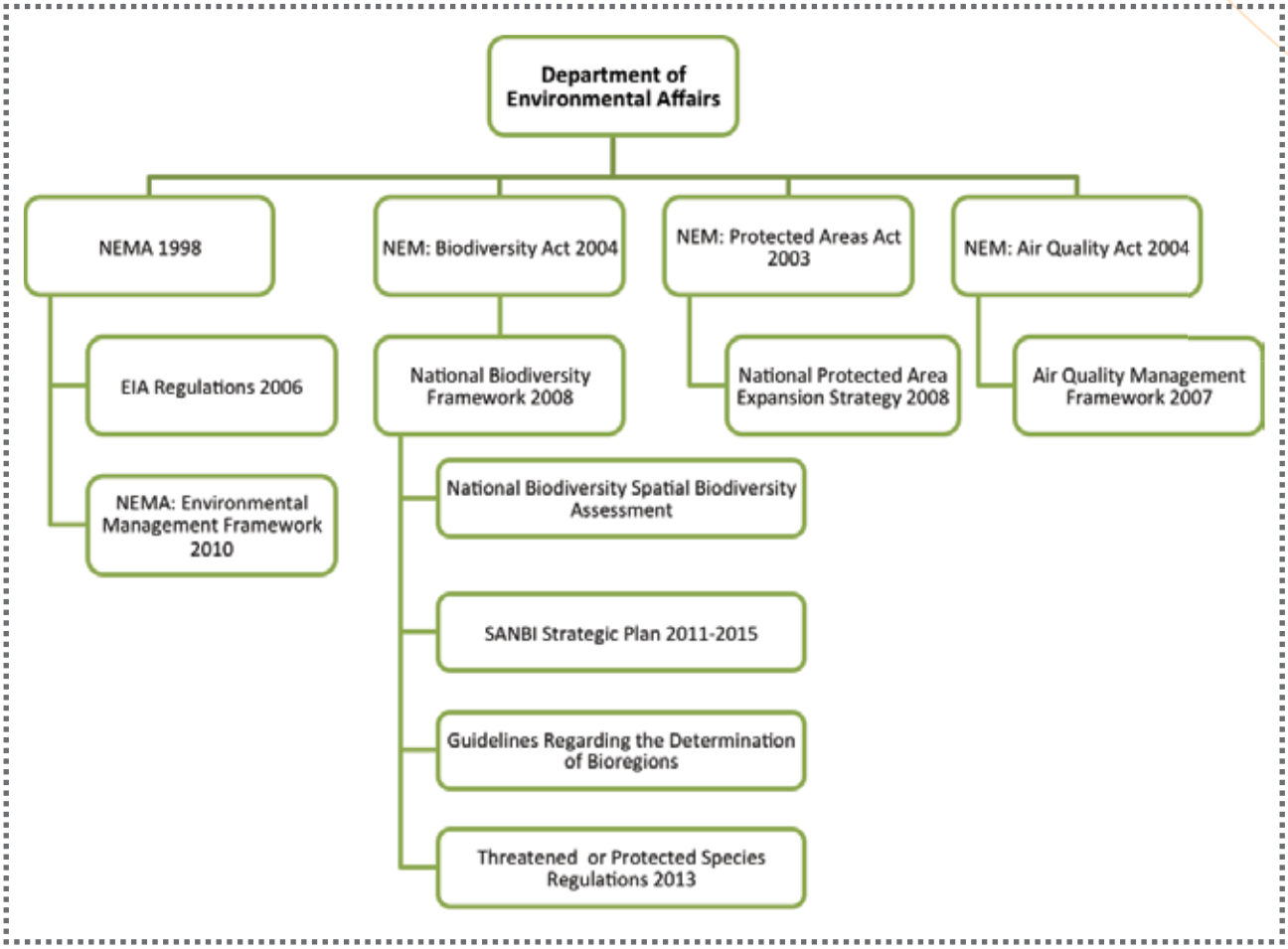


Figure 11. *The National Environmental Management Act Cluster*

Department of Agriculture, Forestry and Fisheries: Legislative Policies

Legislative policies originating from the Department of Agriculture, Forestry and Fisheries that may affect land-use and associated terrestrial carbon stocks include:

- Conservation for Agriculture Resources Act 1983
- Fertiliser, Farm Feeds, Agricultural Remedies and Stock Remedies 1947
- Forest Sector Transformation Charter
- National Forests Act 1998
- National Parks Act 1976
- National Forest and Veld Fire Act 1998
- Policy and Framework for Smallholder Development

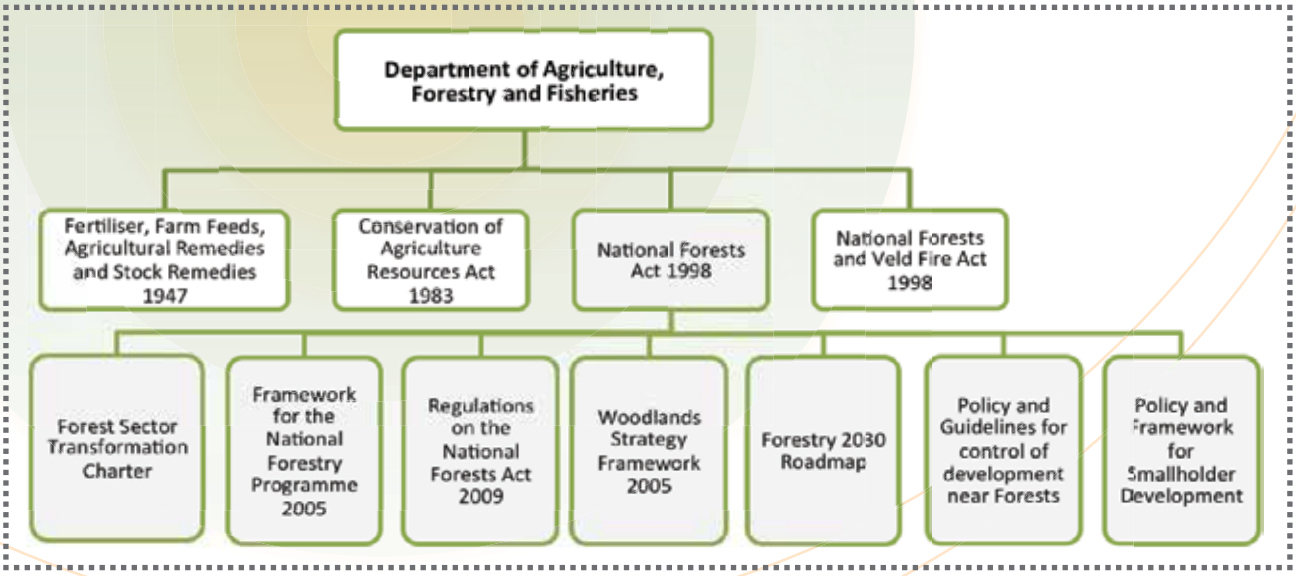


Figure 12. Pertinent policies within the Department of Agriculture, Forestry and Fisheries

Department of Agriculture, Forestry and Fisheries: Planning documents

Integrated and strategic plans developed by the Department of Agriculture, Forestry and Fisheries include:

- The Integrated Growth and Development Plan: Agriculture, Forestry and Fisheries ,
- The Strategic Plan 2012/13-2016/17 for the Department of Agriculture, Forestry and Fisheries
- The Strategic Plan for Smallholder Support
- The Climate Change Sector Plan for Agriculture, Forestry and Fisheries

It should be noted that all of these policies are closely linked to the *Medium-Term Strategic Framework*, *New Growth Path* and *National Development Plan*.

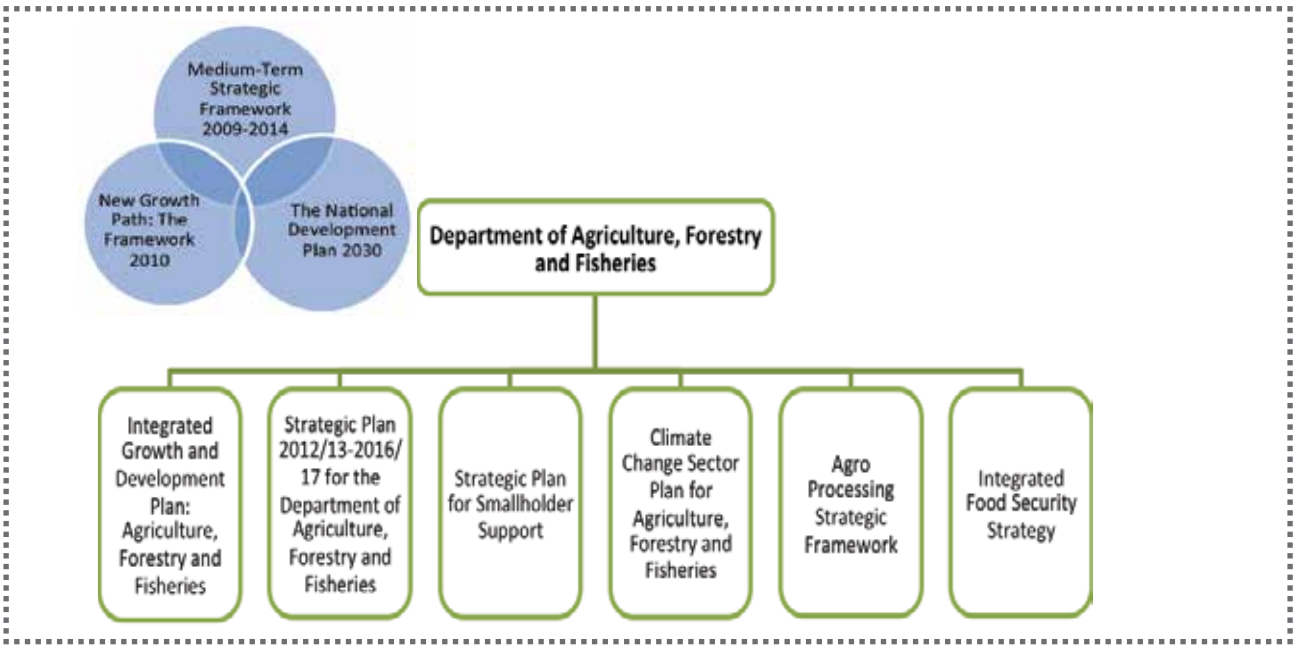


Figure 13. Integrated and strategic plans within DAFFF that may have a direct effect on land-use and associated carbon stocks and emissions.

Land Reform Policy

Land Reform policies include the following:

- Green Paper on Land Reform 2011
- Department of Rural Development and Land Reform Strategic Plan 2011-2014
- Land Reform: Provision of Land and Assistance Act 1993
- The recent passing of the restitution of land rights amendment bill, which sets a new deadline for land claims to 31 December 2018, will also have an impact on terrestrial carbon stocks.

The hierarchy of these policies are illustrated in the diagram below:

Figure 14. *Hierarchy of Land Reform Policies*

Energy Legislation Cluster

Reviewed energy sector policies that may have an effect on terrestrial carbon stocks and associated GHG emissions:

- Mineral and Petroleum Resources Act 2002
- White Paper on Energy Policy 1998
- White Paper on Renewable Energy 2003
- Integrated Resource Plan 2010
- Green Economy Accord

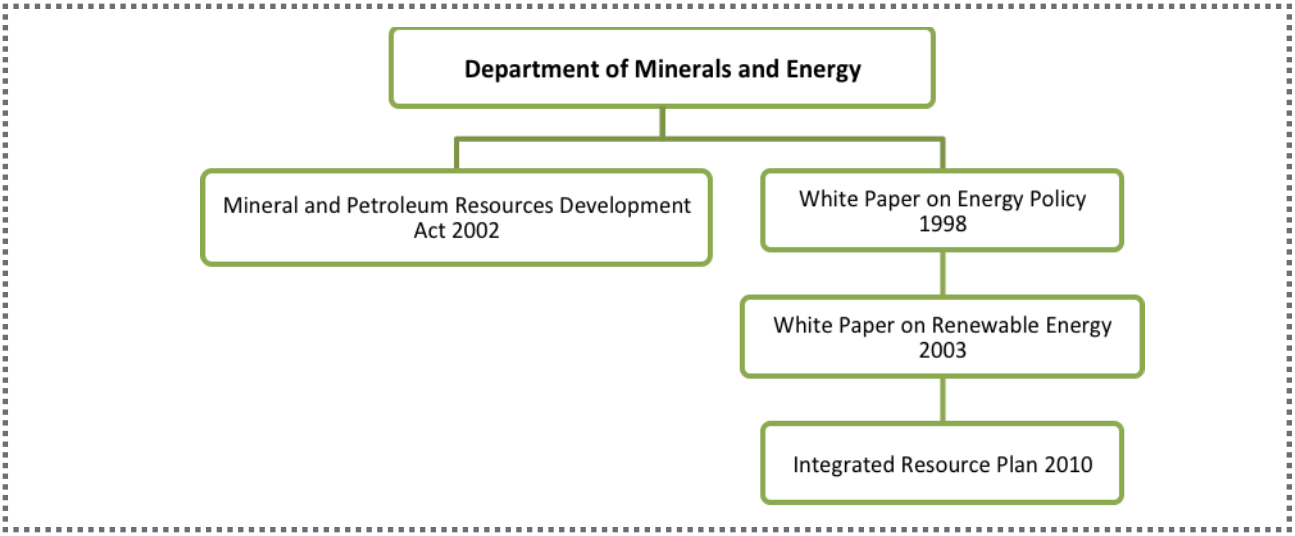


Figure 15. *Pertinent energy policies to land-use and associated carbon stocks in South Africa*

Water Legislation

Water Legislation considered in the policy review includes the following:

- White Paper on Water Policy 1997
- National Water Act 1998
- Water Services Act 1997

The hierarchy of these policies are illustrated in the diagram below:

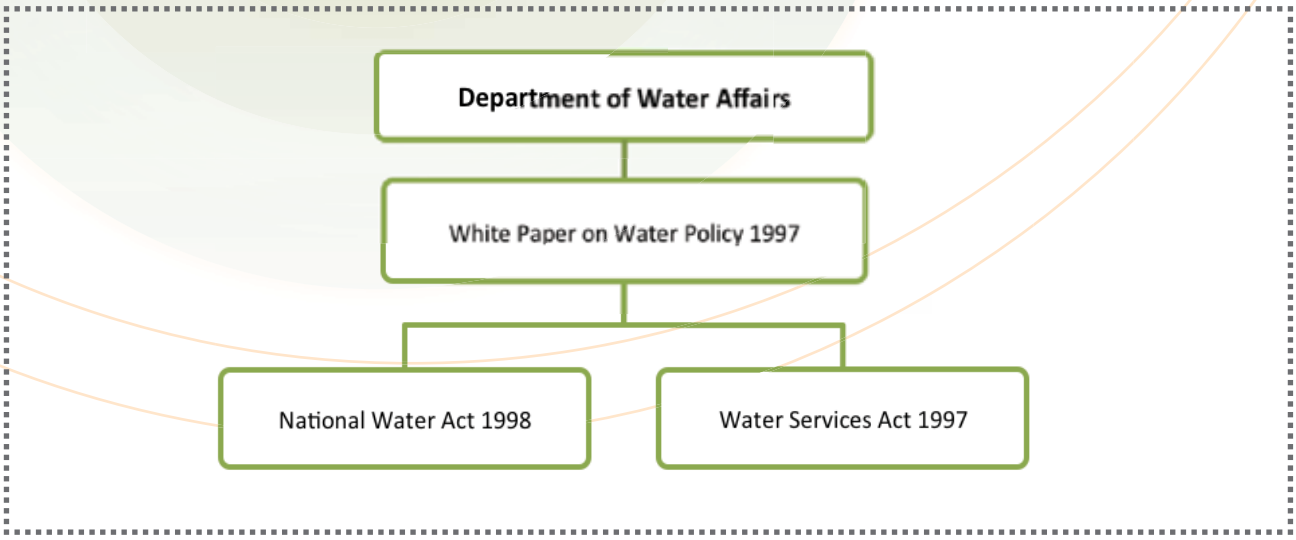


Figure 16. *Water legislation that is relevant to land-use change and associated carbon stocks and GHG emissions.*

Appendix A (Section 4)

Policies providing broad support for Top 8 mitigation opportunities

Table A.1. *Evidence of broad support for reforestation of forests and thicket biomes in national-level policy*

Policy	Evidence of broad support
National Climate Change Response Policy	• Recognizes the need to enhance the national terrestrial carbon sinks, including in biomass and forest resources • Affirms that ecosystems play a critical role in the country's adaptation response to climate change • Notes the importance of rehabilitation and restoration of ecosystem services as part of the country's management response to climate change • Notes the value that the Expanded Public Works Programme has delivered in regards to ecosystem restoration
National Forests Act (1998)	• The Act has a broad commitment to the "Promotion and enforcement of sustainable forest management," which could be interpreted as including reforestation of degraded forests
National Environmental Management Act	• As part of its core principles, recognizes the need to minimise impacts on the use and development of natural resources where and when feasible, and to not overexploit natural resources and the ecosystems on which they depend to the extent that their integrity is jeopardized • That a risk-averse approach be used in regards to exploitation of the environment, taking into consideration the current potential limitations to our knowledge of how our actions impact the environment • Sensitive, vulnerable, highly dynamic or stressed ecosystems are to receive privileged management attention, notably in instances where degradation and exploitation present threats to ecosystem integrity
NEM: Biodiversity Act	• Provides for the management and conservation of biological diversity in South Africa and is guided by the core principles outlined in NEMA • Authorizes the Minister to develop norms and standards to achieve the objectives of management and conservation of biological resources, as well as develop restrictions limiting certain activities that threaten biodiversity integrity • Requires that the Minister draft a Biodiversity Framework, which details, amongst other requirements, the location of conservation priority areas • The Minister or MEC of environmental affairs may declare and establish bioregions, with attendant management plans and which seek to manage a bioregion's biodiversity • Any person, organization, or organ of state can develop biodiversity management plans, which require approval from the Minister and can cover the management of an ecosystem • The Minister can enter into a biodiversity management agreement with the person, organization or organ of state that is authorized to implement a biodiversity management plan • SANBI may undertake programmes for the restoration of ecosystems • The Minister must promote research undertaken by SANBI, including into the conservation status of various ecosystems • The Minister may publish a list of threatened ecosystems and which require preservation (critically endangered, endangered, vulnerable, protected) and identify processes or activities that threaten that biodiversity. The protection of these ecosystems must be taken into account by organs of state responsible for developing environmental implementation or environmental management plan; relevant municipalities must also take account of these threats in their IDPs

Policy	Evidence of broad support
Disaster Management White Paper, Act and Framework	• The White Paper affirms the government's commitment to protecting the environment • The Act considers damage to the environment a disaster • The Act calls for the development of a national disaster management framework, which will include measures for reducing vulnerability to disasters • The Act requires the development of a National Centre, which will oversee the development of disaster management plans and strategies by relevant organs of states and other institutional role players and provide support in the prevention and mitigation of disasters • The Framework requires that priority be provided to protect "fragile natural ecosystems and environmental assets that offer protective environmental services and which, if damaged or destroyed in a disaster event, would result in serious natural and economic loss." • The Framework calls for the rehabilitation of areas affected by a disaster event
National Development Plan	• Notes that agriculture, forestry and land-use can make a significant contribution to the national carbon sinks • Views regional sequestration initiatives as a means for delivering carbon sink enhancements • Affirms its "Vision 2030" commitment to ecosystem and biodiversity asset rehabilitation • Notes that Treasury should introduce incentives to promote rehabilitation of ecosystems
Carbon Tax	• Notes that carbon offsets can be developed from projects that restore landscapes
Guidelines regarding the determination of Bioregions and the preparation of and publication of Bioregional Plans	• Recommends that Bioregional Plans identity priority areas for ecological restoration in identified bioregions
Environmental Sector Plan	• Notes the need to restore landscapes to ensure provision of key ecosystem services • Recognizes the role that sustainable land-use management plays in reducing the country's "carbon balance." • Promotes the planting of indigenous plant species to enhance terrestrial carbon stocks • Affirms the role that ecosystems play in climate change adaptation
National Strategy for Sustainable Development	• Notes that a strategic goal is to restore "scarce and degraded natural resources." • Commits to restoration of 3.2 million hectares of degraded lands by 2014
Woodlands Strategy	• Recognizes the extent of woodland degradation in the country and hence supports the introduction of incentives to promote rehabilitation • States that rehabilitation could take place through a national forest rehabilitation plan, perhaps linked to the EPWP in some way • Recommends the identification of "hotspots" for rehabilitation • Notes the numerous benefits that rehabilitation would provide,
Strategic Plan 2012/13-2016/17 for DAFF	• States that natural forest and woodland rehabilitation is an opportunity to respond to the challenges of degradation and exploitation the forestry sector faces • Commits to rehabilitating 50,000 hectares of degraded indigenous forests, agricultural lands and woodlands. • See page 28 and page 56 for 50,000 rehabilitation figure and page 89

Table A.2. Broad support for restoration and management of grasslands biomes in national-level policy

Policy	Evidence of broad support
National Climate Change Response Policy	• Recognizes the need to enhance the national terrestrial carbon sinks • Affirms that ecosystems play a critical role in the country's adaptation response to climate change • Notes the importance of rehabilitation and restoration of ecosystem services as part of the country's management response to climate change • Notes the value that the Expanded Public Works Programme has delivered in regards to ecosystem restoration
Presidential Delivery Agreement: Outcome 10 (1998)	• The Presidential Delivery Agreement Outcome 10 aims to ensure that environmental assets and natural resources are well protected and continually enhanced • Various outputs are identified to protect and restore ecosystem services viz. • Output no 1 is to enhance the quality and quantity of water resources, which includes water resource protection (by inference a reference to the grassland biome where key wetlands and catchment headwater lie) • Output no 2 is to reduce greenhouse gas emissions though inter alia, restoration and rehabilitation of degraded ecosystems and sustainable land use management • Output no 4 commits to protecting biodiversity through the following • Expansion of the conservation estate from 12% to 14% of total • Developing climate change adaption frameworks for major biomes and aquatic systems (including grasslands) • Protection of agricultural land – setting a target to protect 81% of high potential agricultural land
National Environmental Management Act	• As part of its core principles, recognizes the need to minimise impacts on the use and development of natural resources where and when feasible, and to not overexploit natural resources and the ecosystems on which they depend to the extent that their integrity is jeopardized • That a risk-averse approach be used in regards to exploitation of the environment, taking into consideration the current potential limitations to our knowledge of how our actions impact the environment • Sensitive, vulnerable, highly dynamic or stressed ecosystems are to receive privileged management attention, notably in instances where degradation and exploitation present threats to ecosystem integrity

Policy	Evidence of broad support
NEM: Biodiversity Act	• Provides for the management and conservation of biological diversity in South Africa and is guided by the core principles outlined in NEMA • Authorizes the Minister to develop norms and standards to achieve the objectives of management and conservation of biological resources, as well as develop restrictions limiting certain activities that threaten biodiversity integrity • Requires that the Minister draft a Biodiversity Framework, which details, amongst other requirements, the location of conservation priority areas • The Minister or MEC of environmental affairs may declare and establish bioregions, with attendant management plans and which seek to manage a bioregion's biodiversity • Any person, organization, or organ of state can develop biodiversity management plans, which require approval from the Minister and can cover the management of an ecosystem • The Minister can enter into a biodiversity management agreement with the person, organization or organ of state that is authorized to implement a biodiversity management plan • SANBI may undertake programmes for the restoration of ecosystems • The Minister must promote research undertaken by SANBI, including into the conservation status of various ecosystems • The Minister may publish a list of threatened ecosystems and which require preservation (critically endangered, endangered, vulnerable, protected) and identify processes or activities that threaten that biodiversity. The protection of these ecosystems must be taken into account by organs of state responsible for developing environmental implementation or environmental management plan; relevant municipalities must also take account of these threats in their IDPs
Disaster Management White Paper, Act and Framework	• The White Paper affirms the government's commitment to protecting the environment • The Act considers damage to the environment a disaster • The Act calls for the development of a national disaster management framework, which will include measures for reducing vulnerability to disasters • The Act requires the development of a National Centre, which will oversee the development of disaster management plans and strategies by relevant organs of states and other institutional role players and provide support in the prevention and mitigation of disasters • The Framework requires that priority be provided to protect "fragile natural ecosystems and environmental assets that offer protective environmental services and which, if damaged or destroyed in a disaster event, would result in serious natural and economic loss." • The Framework calls for the rehabilitation of areas affected by a disaster event
National Development Plan	• Notes that agriculture, forestry and land-use can make a significant contribution to the national carbon sinks • Views regional sequestration initiatives as a means for delivering carbon sink enhancements • Affirms its "Vision 2030" commitment to ecosystem and biodiversity asset rehabilitation • Notes that Treasury should introduce incentives to promote rehabilitation of ecosystems
Carbon Tax	• Notes that carbon offsets can be developed from projects that restore landscapes
Guidelines regarding the determination of Bioregions and the preparation of and publication of Bioregional Plans	• Recommends that Bioregional Plans identity priority areas for ecological restoration in identified bioregions
Environmental Sector Plan	• Notes the need to restore landscapes to ensure provision of key ecosystem services • Recognizes the role that sustainable land-use management plays in reducing the country's "carbon balance." • Promotes the planting of indigenous plant species to enhance terrestrial carbon stocks • Affirms the role that ecosystems play in climate change adaptation

Policy	Evidence of broad support
National Strategy for Sustainable Development	• Notes that a strategic goal is to restore "scarce and degraded natural resources." • Commits to restoration of 3.2 million hectares of degraded lands by 2014
Conservation of Agricultural Resources Act	• Supports efforts to conserve agricultural resources, including the prevention of soil erosion (gully erosion is particularly problematic in the grassland biome) and allows the Minister to develop controls for the cultivation and use of agricultural lands as well as for the rehabilitation of denuded or eroded lands
Strategic Plan 2012/13-2016/17 for DAFF	• Commits to rehabilitating 50,000 hectares of degraded indigenous forests, agricultural lands and woodlands.
The Grasslands Programme (SANBI, 2008)	• Although this Programme is led by an agency outside of government, it enjoys of interdepartmental support at national and provincial levels • The programme seeks to sustain and secure the biodiversity and associated ecosystem services of the grassland biome by working on a practical level with the sectors whose activities affect the grassland biome

Table A.3. *Evidence of broad support for commercial small-scale afforestation in national-level policy*

Policy	Evidence of support
National Climate Change Response Policy	• Recognizes that commercial afforestation can lead to net increases in the country's terrestrial carbon stocks • Stresses concern over the potential impacts that commercial forestry can have on water flows and biodiversity and notes the need to ensure that economic development is weighed against water resource use required to support poverty alleviation (namely ensuring that all households have access to clean, consistent water supplies) • Notes the need to promote the activity within the broader climate change agenda, with a focus on rural development, notably local job creation, and building climate resilience • Recognizes the synergies between adaptation and mitigation in commercial forestry • States the need to ensure that spatially-appropriate monitoring of climate change impacts is undertaken, to ensure that potentially negative impacts on the commercial forestry sector, amongst others, are flagged and mitigated (fires, pest outbreaks, etc.)
National Forests Act	• Highlights the contribution that plantation forestry makes to the economy • Acknowledges the need to manage the impacts that commercial forestry can have on the environment • Recognizes the need to provide targeted support to community forestry initiatives, and allows the Minister to provide technical training and extension assistance, nursery development with privileged access to seedlings granted to community members, as well as the provision of financial or material assistance • Provides for the development and agreement of community forestry agreements, but exclusively with respect to State forests
IPAP	• Supports growth in the forestry sector, and notes that many of the new planting opportunities are on communal land, where small grower participation can grow • Estimates that planting 100,00 new hectares of commercial plantation forest could generate 15,600 jobs, and believes that further expansion onto an additional 45,000 hectares could be planted in Mpumalanga, Limpopo, KwaZulu-Natal • Highlights some of the key issues facing the sector, including: the slow afforestation license process, low skill development amongst rural communities, financial barriers to entry as it's difficult to raise funds for a long-term business model, suitable lands may still be undergoing land claim court processes, demand for raw supply exceeds supply
Carbon Tax Paper	• Notes that carbon offsets can be developed from projects that promote rural development

Policy	Evidence of support
Integrated Growth and Development Plan	• Commits to growing the commercial forestry sector • Describes plantation forest ownership, total area under production, contribution to the economy and growing supply shortfalls • Notes that the Forestry Enterprise Development Programme has received limited support, and that DAFF provides no extension service to small growers • Recognizes the impacts that plantation forestry can have on stream flow, biodiversity and the spread of alien invasive species • Commits to developing a spatial commodity production plan to promote local economic growth and assist in infrastructure planning and market linkage developments • Commits to incentivizing the development of public-private partnerships which would support smallholder access to markets, through training, capacity building, improving access to information and establishing mentor programmes • Notes intention to develop Agriculture, Forestry and Fisheries Development Services Centres, so as to reach rural producers and provide support services locally • Notes intention to improve agricultural schools and colleges • Promotes skills development and training across the forestry value chain
Strategic Plan 2012/13-2016/17 for DAFF	• Describes the forestry sector in South Africa • Provides a list of major challenges in the sector, including lack of funding to invest in the development of forestry, skills shortage and a difficult regulatory environment • Seeks to establish 12,000 new jobs through rehabilitation of category B&C plantations • Recognizes the opportunity to expand plantations in the Eastern Cape and KwaZulu-Natal • Commits to helping transfer MMM plantations to communities
Framework for the National Forestry Programme	• Supports community forestry activities, including transfer of forests to communities • Supports BEEE in the forestry sector • Is committed to expanding afforestation efforts in the Eastern Cape
Forest Sector Transformation Charter	• Commits to promoting BEEE in the forestry sector • Commits to increasing the skills of previously disadvantaged persons in the sector, improving access to funds and financial services for emerging black entrepreneurs, including seeking ways to develop a funding mechanism to fund or subsidize the interest burden for emerging farmers • Commits to providing capacity building to emerging farmers, either through private sector support or the signature of service delivery agreements with enterprise development agencies • Seeks to expedite the afforestation licensing process, to ensure that every year for 10 years, 10,000 ha of new plantation forest can be planted, for a total increase of 100,000 ha • Commits to working with all relevant departments to securing community tenure rights for 50% of afforestation projects in the Eastern Cape; it is also seeks to facilitate the resolution of restitution claims on areas currently under forestry production • Promotes the use of certification schemes for smallholder farmers to promote market access • Commits to working with the appropriate government agencies and private sector actors to identify required transport corridors to promote the forestry sector • Seeks to reduce property rate taxes on forested areas to promote growth in the sector
Forestry 2030 Roadmap	• Notes the growth in community-led plantation forestry programmes, namely supported by Mondi, Sappi and the SA Wattle Growers Union • Stresses the need to provide extension services to emerging forestry participants, notably along the entire value chain • Recognizes the challenges of land reform in the forestry industry, both for existing private commercial enterprises, and the communities that may come into ownership of those plantations • Seeks to support community-private sector partnerships

Table A.4. Evidence of support for development of anaerobic biogas digesters and biomass energy generation

Policy	Evidence of broad support
National Climate Change Response Policy	• The Waste Management Flagship Programme gives the commitment to investigate and implement waste-to –energy opportunities available within solid-, semi-solid and liquid-waste management sectors, especially the generation, capture, conversion and/or use of methane gas. This has been initiated with the intention of rolling out programmatic approach for waste-to-energy at municipal waste sites
Renewable Energy White Paper (2003)	• The White Paper on Renewable Energy (2003) commits the country to a developing a practical implementation strategy on renewable energy. • The paper sets clear targets to achieve a diversified energy mix, with a specific target commitment of 10 000 GWh of South Africa's energy requirement to be delivered through renewable energy sources (biomass, wind, solar and small scale hydro) by 2013.
The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP, 2012)	• Renewable Energy Independent Power Producer Procurement Programme ("REIPPPP" or colloquially, "REBID") that was released in 2011 with the first REIPPPP procurement round reached financial close in the latter part of 2012. • REIPPPP is a competitive bidding system for renewable energy providers, which includes significant requirement for local socio economic development component, specifically localised production facilities and job creation. It is a well-structured programme that has successfully facilitated 2 rounds of competitive bids.
Presidential Strategic Infrastructure Plan No 8 (SIP8)	• SIP 8 aims to support sustainable green energy initiatives on a national scale through a diverse range of clean energy options as envisaged in the Integrated Resource Plan
Integrated Resource Plan (IRP, 2010 & updated 2013)	• The IRP determines South Africa's long-term electricity demands and details how this demand should be met in terms of generating capacity, type and cost • The IRP is a living plan, and will be updated on an ongoing basis to reflect the changing needs of South Africa • In terms of determinations, the Minister has allocated 12.5 MW for biomass, 12.5 MW for biogas and 12.5 for Landfill Gas
National Development Plan	• The National Growth Plan makes broad references to renewable energy, and speaks in broad terms about the need for increased competition in the sector, better regulation of price and supply as well as increasing diversity of power sources. • The objectives of the IRP are reiterated in the National Development Plan • The NGP emphasizes the need for more integrated energy planning
Energy Act (2008)	• The Energy Act governs the transformation of the South African energy economy and seeks to ensure that diverse energy resources are available in sustainable quantities and at affordable prices to the South African economy in support of economic growth and poverty alleviation
Industry's Manufacturing Competitiveness Enhancement Programme (DTI)	• This programme of the Department of Trade and Industry includes grants and incentives for green technology and resource efficiency improvement
Green Energy Efficiency Fund (DTI)	• The Green Energy Efficiency Fund aims to promote sustainable energy solutions to business – through assisting with technical and financial feasibility assessments to industry and provision of capital assistance

Table A.5 Evidence of broad support for biochar amendment in South African national-level policy

Policy	Evidence of Broad Support
Conservation of Agricultural Resources Act	• Supports efforts to conserve agricultural resources, including the prevention of soil erosion and allows the Minister to develop controls for the cultivation and use of agricultural lands as well as for the rehabilitation of denuded or eroded lands • Calls for the control of weed and invader plants • Authorizes the Minister to develop "schemes", which would distribute subsidies to farmers to combat weeds and invader plants • Allows the officials of the department to destroy and remove invader plants and weeds on farms that they have inspected
National Climate Change Response Policy	• Recognizes agriculture's contribution to GHG emissions globally • Notes that commercial, intensive agriculture is associated with a number of negative social and economic externalities • Climate-resilient agriculture should provide a multitude of social and environmental benefits beyond food production • Notes the need to invest in research to improve understanding of soil conservation practices and technology • Recognizes need for financial models that support "climate-smart" agriculture, which lowers agricultural emissions • Commits to educating subsistence and smallholder farmers on the practice of conservation agriculture • Notes that reducing GHG emissions from non-energy emissions in agriculture represents a viable climate change mitigation opportunity
National Development Plan	• Recognizes the need to refocus research in the agricultural sector on ways to improve sustainable agriculture outcomes, notably in the commercial sector • Notes its commitment to rolling out new technologies that align with sustainable agricultural strategies, notably those that benefit subsistence and small-scale farmers. • Seeks to ensure that agricultural policies support sustainable development • By 2020, will have ensured that agricultural development policies are aligned with the objective of delivering "environmentally sustainable rural regeneration."
National Strategy for Sustainable Development	• Recognizes that food security is threatened by soil degradation trends in agricultural lands • Promotes conservation farming, permaculture and organic farming methods. • Ensuring that principles of sustainable land-use are integrated into the practices of land-claim beneficiaries • Supports changes to agricultural policy so as to better integrate principles of sustainable development • Notes the need to strengthen agricultural programmes that support conservation farming
Biodiversity Act and Framework	• The Act allows the Minister to identify and publish lists of invasive species • The Act controls and places restrictions on the use of invasive species • The Act requires that the control and eradication of invasive species be undertaken, and that efforts to eradicate seedlings and means of regeneration of the plant species • The Act requires that all organ of states, in their environmental management plans, detail how they will control and eradicate alien invasives on land over which they have control • The Framework recognizes the threat to biodiversity that alien invasive plants present and that it is difficult to control them • The Framework notes that it intends to publish regulations for alien and invasive species to address the challenges they present and for their prevention, containment and eradication, and to begin to implement them • The Framework that sustainable development is consistent with limiting the spread and further introduction of alien invasives • The Framework presents several mechanisms for managing alien invasives, including integration of alien invasive species removal and control with other local plans, notably those for natural resource management

Policy	Evidence of Broad Support
Environmental Sector Plan	• Notes agriculture's global contribution to GHGs • Supports the use of compost as a means for locking soil in carbon • Support organic food production through the use of agro-ecological models
Integrated Growth and Development Plan	• Recognizes the need to sustainably manage landscapes so they provide optimal ecosystem services to the agricultural sector • Notes the need to adopt conservation agriculture, in particular in sensitive areas • Commits to improving production efficiency in alignment with conservation agriculture principles
Strategic Plan 2012/13-2016/17 for DAFF	• A strategic goal is to "ensure the sustainable management and efficient use of natural resources." • Commits to reducing the carbon footprint of the agricultural industry • Commits to developing policies that support agro-ecological practices • Notes the need to adopt climate-smart agriculture, through the practice of introducing conservation methods into farming systems
Strategic Plan for South African Agriculture	• Commits to helping new farming entrants undertake soil conservation works • Seeks to implement soil conservation programmes • All interventions will be supported by an overarching commitment to sustainable management of natural resources

Table A.6. *Evidence of broad support for conservation agriculture in South African national-level policy*

Policy	Evidence of Broad Support
Conservation of Agricultural Resources Act	• Provides the Minister with the authority to provide control measures that must be adhered to by landowners. A non-exhaustive list is provided, and includes controls such as: mandates over use of virgin land, grazing capacity of veld, the protection and use of cultivated land, and the restitution or restoration of degraded, cultivated land • Notes that the Minister may devise funded "schemes" which provide finance (subsidies) to farmers who undertake activities deemed to enhance soil fertility and reduce erosion or reduce grazing intensity (amongst other types of viable activities) • The Minister may establish a Conservation Committee to oversee a certain area, and which is to provide support in regards to the conservation of natural agricultural resources in the area(s) in question
National Climate Change Response Policy	• Recognizes agriculture's contribution to GHG emissions globally • Notes that commercial, intensive agriculture is associated with a number of negative social and economic externalities • Climate-resilient agriculture should provide a multitude of social and environmental benefits beyond food production • Notes the need to invest in research to improve understanding of soil conservation practices and technology • Recognizes need for financial models that support "climate-smart" agriculture, which lowers agricultural emissions • Commits to educating subsistence and smallholder farmers on the practice of conservation agriculture • Notes that reducing GHG emissions from non-energy emissions in agriculture represents a viable climate change mitigation opportunity
National Environmental Management Act	• As part of its core principles, recognizes the need to minimise impacts on the use and development of natural resources where and when feasible, and to not overexploit natural resources and the ecosystems on which they depend to the extent that their integrity is jeopardized

Policy	Evidence of Broad Support
Disaster Management White Paper, Act and Framework	• The White Paper affirms the government's commitment to protecting the environment • The Act considers damage to the environment a disaster • The Act calls for the development of a national disaster management framework, which will include measures for reducing vulnerability to disasters • The Act requires the development of a National Centre, which will oversee the development of disaster management plans and strategies by relevant organs of states and other institutional role players and provide support in the prevention and mitigation of disasters • The Framework requires that priority be provided to protect "fragile natural ecosystems and environmental assets that offer protective environmental services and which, if damaged or destroyed in a disaster event, would result in serious natural and economic loss." • The Framework calls for the rehabilitation of areas affected by a disaster event
National Development Plan	• Recognizes the need to refocus research in the agricultural sector on ways to improve sustainable agriculture outcomes, notably in the commercial sector • Notes its commitment to rolling out new technologies that align with sustainable agricultural strategies, notably those that benefit subsistence and small-scale farmers. • Seeks to ensure that agricultural policies support sustainable development • By 2020, will have ensured that agricultural development policies are aligned with the objective of delivering "environmentally sustainable rural regeneration."
Carbon Tax	• Promotes the use of offsets that reduce land degradation
Guidance on Bioregional Plans	• Confirms that the National Department of Agriculture must take Bioregional Plans into consideration when any authorizations may impact on biodiversity (such as plowing of virgin lands) • Confirms that the Provincial Department of Agriculture must reference Bioregional Plans when developing farm or area planning
Environmental Sector Plan	• Notes agriculture's global contribution to GHGs • Supports the use of compost as a means for locking soil in carbon • Support organic food production through the use of agro-ecological models
National Strategy for Sustainable Development	• Recognizes that food security is threatened by soil degradation trends in agricultural lands • Promotes conservation farming, permaculture and organic farming methods. • Ensuring that principles of sustainable land-use are integrated into the practices of land-claim beneficiaries • Supports changes to agricultural policy so as to better integrate principles of sustainable development • Notes the need to strengthen agricultural programmes that support conservation farming
Integrated Growth and Development Plan	• Recognizes the need to sustainably manage landscapes so they provide optimal ecosystem services to the agricultural sector • Notes the need to adopt conservation agriculture, in particular in sensitive areas • Commits to improving production efficiency in alignment with conservation agriculture principles
Strategic Plan 2012/13-2016/17 for DAFF	• A strategic goal is to "ensure the sustainable management and efficient use of natural resources." • Commits to reducing the carbon footprint of the agricultural industry • Commits to developing policies that support agro-ecological practices • Notes the need to adopt climate-smart agriculture, through the practice of introducing conservation methods into farming systems

Policy	Evidence of Broad Support
Strategic Plan for Smallholder Support	• Commits to supporting the adoption of conservation and agro-ecological agricultural practices • Notes that the CASP National Mechanization Programme may not align with conservation agriculture objectives • Seeks to improve smallholder access to finance, extension services, training, research and development
National Biodiversity Framework	• Recognizes the role that intact ecosystems play in carbon storage • Commits to working with the agricultural sector to fast-track adoption of best practices to minimize habitat loss and land degradation in critical areas
Strategic Plan for South African Agriculture	• Commits to helping new farming entrants undertake soil conservation works • Seeks to implement soil conservation programmes • Commits to developing a infrastructure and services that support sustainable land-use, and promoting organic and environmentally friendly production • All interventions will be supported by an overarching commitment to sustainable management of natural resources

Table A.7. *Evidence of broad support for Reducing Emissions from Deforestation and Forest Degradation (REDD+) in South African national-level policy*

Policy	Evidence of Broad Support
National Climate Change Response Policy	• Deforestation increases GHG emissions and reduces the Earth's capacity to store carbon • Seeks to conserve forests as they play an important role in carbon storage • Aligns with the objectives of the Protected Areas Expansion Strategy, notably in areas that are critical for stemming extinction of species and which will build resilience against climate change impacts • Supports conservation efforts and seeks to support these through the use of carbon offsets
National Forestry Act (1998)	• Has the specific purpose of sustainably managing forests and providing special measures for protecting certain forests and trees • Amongst its guiding principles for sustainable forest management, includes the provision that natural forests may not be destroyed save under exceptional circumstances, a minimum area of woodland must be designated for protection, • Amongst other sustainable management objectives, forests must be managed so as to ensure their health and vitality, and to conserve biological diversity • The Minister is to identify criteria and standards by which it can be judged the extent to which forests are managed sustainably, according to the core principles • Monitoring of and research into forest management must be undertaken, with results presented to Parliament every 3 years • The destruction of indigenous trees in a natural forest can only be done with a license • The Minister may declare certain forests as protected forest areas • The Minister may urgently intervene to prevent deforestation and undertake rehabilitation activities by declaring an area a controlled forest area • Penalties and offenses apply to controlled forest areas

Policy	Evidence of Broad Support
Disaster Management White Paper, Act and Framework	• The White Paper affirms the government's commitment to protecting the environment • The Act considers damage to the environment a disaster • The Act calls for the development of a national disaster management framework, which will include measures for reducing vulnerability to disasters • The Act requires the development of a National Centre, which will oversee the development of disaster management plans and strategies by relevant organs of states and other institutional role players and provide support in the prevention and mitigation of disasters • The Framework requires that priority be provided to protect "fragile natural ecosystems and environmental assets that offer protective environmental services and which, if damaged or destroyed in a disaster event, would result in serious natural and economic loss." • The Framework calls for the rehabilitation of areas affected by a disaster event
National Environmental Management Act	• As part of its core principles, recognizes the need to minimize impacts on the use and development of natural resources where and when feasible, and to not overexploit natural resources and the ecosystems on which they depend to the extent that their integrity is jeopardized

Policy	Evidence of Broad Support
NEMA: Biodiversity Act and Framework	• The Act is guided by NEMA • Seeks to ensure the conservation of ecosystems that warrant national protection • Seeks to ensure the sustainable use of indigenous biological resources • The Minister may publish norms and standards which restrict activities that may impact on biological diversity and which ensure the conservation and management of these resources • SANBI is to coordinate and implement rehabilitation programmes, including with civil society • SANBI to advise on the conservation of biological resources and the sustainable use of indigenous biological resources • SANBI to assist in identifying the location of bioregions, which must be declared by the Minister or the MEC for environmental affairs in a province • Any individual or entity, for approval by the Minister, and which are tailored to a particular ecosystem and which seeks to ensure its long-term survival, may create Biodiversity Management Plans. • Biodiversity Management Agreements may be entered into by individuals or entities wishing to preserve ecosystems under their control • The Act promotes research and monitoring of biodiversity • The Act calls for the publication of a national list detailing which ecosystems are threatened and in need of protection and also publish a list of activities which threaten that ecosystem • The Minister has the authority to create regulations that support the principles and objectives of the Act • The Act provides for offences and penalties • The Framework recognizes that ecosystems are threatened by both climate change and the loss and degradation of natural habitats and warns of the habitat fragmentation • Amongst its five strategic objectives, the Framework seeks to ensure the sustainable use of biological resources and promote the conservation of a representative sample of biodiversity. • The Framework support implementation of the Protected Areas Expansion Strategy • The Framework seeks to highlight the role of biodiversity in achieving sustainable development • The Framework seeks to integrate biodiversity considerations into the country's fiscal framework and through environmental fiscal reform • The Framework is committed to developing strategies to enhance ecosystem adaptation to climate change • Has identified 9 broad areas of conservation concern in SA • The Framework commits to better understanding what levels of resource extraction in terrestrial landscapes qualifies as sustainable • The Framework aligns with the Protected Areas Act support for the designation and management of formal protected areas on any land, including communal or private lands and seeks to integrate this tool into Provincial Stewardship Agreements • The Framework commits to expanding the information conservation network
Carbon Tax	• Carbon offsets are promoted as a means for reducing land degradation and protecting biodiversity

Policy	Evidence of Broad Support
Guidelines regarding the determination of Bioregions and the preparation of and publication of Bioregional Plans	• Supports conservation of biodiversity outside of protected areas • Provides a means for effectively managing biodiversity in a designated area • Provides for the identification of critical biodiversity areas in a bioregion and the provision of guidelines on how to avoid the degradation of those areas • Requires the use of land-use guidelines, which will ensure the long-term ecological functioning of the bioregion • Requires an explicit description of management needs in the bioregion
NEMA: Protected Areas Act	• Seeks to conserve "ecologically viable" areas in South Africa which are representative of the country's biodiversity and its natural landscapes • Describes the means by which protected areas are established, the ways in which these areas can be used sustainably, and how they may be managed by communities • Notes that protected areas include specially protected forest areas, forest nature reserves and forest wilderness areas as declared in the National Forests Act
Protected Areas Expansion Strategy	• Recognizes the role that protected areas can play in ecological sustainability, local socio-economic development and climate change adaptation • Provides concrete targets for the protection of forests and savannah over a 20-year period (2008-2028) • Supports the use of contract agreements to encourage the participation of private landowners • Asserts that the use of innovative fiscal instruments should incentivize the participation of private landowners • Stresses the urgency with which expansion of the protected areas network should take place • Notes the vital role that protected areas play in the country's ecological infrastructure
Environmental Sector Plan	• Affirms the role that ecosystems play in climate change adaptation • Supports the efforts of NEMA: BA and NEMA:PAA • Supports sustainable land-use management • Recognizes how biologically diverse South Africa is • Acknowledges the threat to biodiversity due to climate change and natural habitat degradation • Aligns with the conservation goals of the Protected Areas Expansion Strategy

Policy	Evidence of Broad Support
Woodlands Strategy	• Recognizes the Department of Forestry's role and mandate in conserving woodlands and ensuring sustainable resource use • Notes that the Minister is responsible for determining what percentage of woodlands should be conserved • Seeks to support community forest management in communal areas • Proposes the development of a Woodlands Extension Service • Supports the use of incentives to promote woodland management • Recommends the development of woodlands certification, to provide a transparent chain of custody for woodland-derived products • Proposes the use of "energy grants" in rural areas, which would serve to reduce local reliance on unsustainable fuel wood consumption • Notes that the overexploitation of woodlands is leading to widespread degradation, soil erosion, and sedimentation of water sources and loss of biodiversity. • Woodlands can provide climate change adaptation benefits and are an important terrestrial carbon sink • Notes that tenure reform is required to ensure more responsible use of woodlands in communal lands • Recognizes the importance of woodlands to rural communities • Acknowledges the need to have a budget specifically focused on woodlands research • Proposes the development of an Advisory Support Programme, to work with local communities on woodland management • Notes that further investigation is required to better understand sustainable forest use systems
National Development Plan	• Recognizes the contribution of forests to GHG emissions, and the role they can play in acting as a carbon sink • Recognizes the role that long-term planning plays in realizing an effective conservation programme • Supports the Protected Areas Expansion Strategy's conservation targets • Supports SANBI's use of Biodiversity Stewardship Programme to establish conservation partnerships
Integrated Growth and Development Plan	• Recognizes that forests, woodlands in particular, have been subject to degradation over an extended period of years • Acknowledges the important ecosystem service benefits that forests provide, in particular its rich biodiversity environment • Notes that forest (including woodlands) resource management requires, amongst other strategies, a focus on conservation but can also extend to other management interventions • Describes the reliance of rural households on woodland resources • Affirms the need to undertake a national-scale mapping of woodlands to facilitate the development of conservation and other targets • Commits to conserving woodland and forest resources
Strategic Plan 2012/13-2016/17 for DAFF	• Notes that the management of indigenous forests and woodlands does not necessarily solely focus on conservation, but also on sustainable resource use, management, and the processing of non-timber forest products • Notes that forest degradation is a challenge, as well as lack of budget and in-depth research and development • States that conservation and rehabilitation of forests as well as development of a Working for Forests Programme are all important opportunities in the sector • Committed to improving the licensing process in indigenous forests to ensure sustainable resource extraction

Department of Environmental Affairs

Environment House
473 Steve Biko
Arcadia
Pretoria, 0083
South Africa

DEA call centre:
+27 86 111 2468