research REPORT

Development of potential verification standards and methodologies for carbon offset projects in the AFOLU sector in South Africa

environmental affairs
Department:
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Carbon Offset Standards and Methodologies Project Steering Committee

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Carbon Offset Standards and Methodologies Steering Committee

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Photos courtesy of Itchell Guiney and Barney Kgope.

detailed REPORT

Foreword

The National Terrestrial Carbon Sinks Assessment (NTCSA) for South Africa was primarily undertaken to improve our understanding of the distribution of carbon stocks and fluxes, equally important to identify land-based mitigation opportunities that can avoid or decrease emissions from the agriculture, forestry and other land use (AFOLU) sector. Land-based mitigation opportunities include the restoration and management of grasslands, rehabilitation of the thicket and REDD+ through planning and regulation, to mention a few. The challenge is that the current international standards and methodologies (e.g. the Clean Development Mechanism, Verified Carbon Standard, Gold Standard and Climate and Community Biodiversity Alliance) for carbon offsetting in the AFOLU sector are biased towards forest systems, making it difficult to include other land-based mitigation options, such as grasslands and soil systems.

The current project was undertaken to assess the applicability of the current international standards and methodologies for carbon offsetting on both forest and non-forest (grassland) systems in South Africa. The timing of this project is impeccable in that some of the international standards for carbon offsetting are undergoing review to cater for non-forest systems as well. However, if these standards and methodologies are not applicable, then the aim was to put together a framework from which a South African Carbon Offsetting Standard can be developed. This makes this project very important since the eight land-based mitigation opportunities identified in the NTCSA have also been considered as potential projects in the imminent carbon offsetting platform developed by National Treasury of South Africa.

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 applicability of the international verification standards and methodologies for carbon offset projects in the AFOLU sector in South Africa. Hence, the Department is happy to make this work publicly available and accessible.

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Acronyms and abbreviations

ACoGS	Avoided conversion of grasslands and shrublands
AFOLU	Agriculture, forestry and other land use
AfSIS	Africa Soil Information Service
A/R	Afforestation and reforestation
ANR	Assisted natural regeneration
BioCF	BioCarbon Fund
CBG	Compressed biogas
CAR	Climate Action Reserve
CCBA	Climate, Community and Biodiversity Alliance
CDM	Clean Development Mechanism
CER	Certified emission reductions
CFC	Chlorofluorocarbons
CFE	Cook stove and fuel efficiency
CIFOR	Centre for International Forestry Research
CNG	Compressed natural gas
CO_2	Carbon dioxide
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEFRA	Department for the Environment, Food and Rural Affairs, United Kingdom
DFID	Department for International Development
DNA	Designated National Authority
DOE	Designated Operating Entity
DWAF	Department of Water Affairs and Forestry
EPA	Environmental Protection Agency
EPWP	Expanded Public Works Programme
ERU	Emission Reduction Unit
FPIC	Free, prior and informed consent
FRL	Forest reference level
FREL	Forest reference emission level
GFOI	Global Forest Observation Initiative
GHG	Greenhouse gas
GGP	Gross Primary Production
GPS	Global Positioning System
GS	Gold Standard
ha	Hectare
IAP	Invasive alien plants
ICM	Improved cropland management
ICRAF	International Centre for Research in Agroforestry
IET	International Emissions Trading
IGM	Improved grassland management
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
ISFL	Initiative for Sustainable Forest Landscapes
ISO	International Organisation for Standards
JI	Joint implementation
LULUCF	Land use, land-use change and forestry
MRV	Measuring, reporting and verification
MW	Megawatt
MWe	Megawatt electrical
MWh	Megawatt hour
NCCRP	National Climate Change Response White Paper
NEE	Net Ecosystem Exchange
NEP	Net Ecosystem Productivity
NGO	Non-governmental organisation
NPO	Non-profit organisation
NTCSA	National Terrestrial Carbon SInk Assessment
NPP	Net Primary Production
NPV	Net present value
PDD	Project design document
PoA	Programme of activities
PV	Plan Vivo
Ra	Autotrophic respiration (respiration by plants)
Re	Ecosystem respiration (the combined respiration from all sources)
Rfire	Fire emissions
Rh	Heterotophic respiration (herbivores, carnivores and microbes)
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
RothC	Rothamsted Carbon Model
SA	South Africa
SAEON	South African Environmental Observation Network
Sappi	South African Pulp and Paper Industries
SBSTA	Subsidiary Body for Scientific and Technological Advice
SGM	Sustainable grasslands management
SO_2	Sulphur dioxide
SOP	Standard operating procedure
tC	Ton of carbon
tCER	Temporary certified emission reduction
tCO_2e	Ton of carbon dioxide equivalent
TIST	The International Small Group Tree Planting
ToR	Terms of Reference
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNREDD	United Nations programme aimed at REDD
VCS	Verified Carbon Standard
VCU	Verified carbon units
VER	Verified Emission Reductions
WESSA	Wildlife and Environment Society of South Africa
WWF	World Wide Fund for Nature
ZAR	South African Rand




Executive summary

Rationale for the scope of work

Published in early 2015, South Africa's National Terrestrial Carbon Sink Assessment (NTCSA) identified eight climate change mitigation activities within the country's agriculture, forestry and other land-use (AFOLU) sector that are appropriate to South African conditions and could result in substantial climatic, social and ecological infrastructure benefits (Table 1). Part of the assessment was the identification of important inhibitory factors that need to be addressed if implementation is to be realised on a national scale.

One of the more prominent issues identified by most field practitioners is the process of verifying activities through international carbon standards. Many stakeholders reported that the process is a source of considerable uncertainty and often too complicated to consider further. In cases where parties had pursued verification, proponents reported that the process was often too expensive, especially due to the high costs associated with compiling project documentation, composing the required methodologies and the expense of the field assessments of biomass and soil carbon stocks that were required.

During the course of the assessment, it became clear that, unless these inhibitory factors are addressed, it is unlikely that implementation will occur at scale in its current form. The intention of this scope of work is to review international carbon standards and associated methodologies, as well as monitoring requirements, to assess whether there is a more efficient and user-friendly way of validating climate change mitigation projects, without compromising scientific robustness and transparency.

Table 1: The eight principles of land use-based mitigation opportunities identified in the NTCSA

Activity	Subclass	Spatial extent (ha)*	Reduction over 20 years (tCO_2e)	Percentage contribution
Restoration of subtropical thicket, forests and woodlands	Subtropical thicket	500 000	44 000 000	16.0
	Coastal and scarp forests	8 570	1 131 240	0.4
	Broadleaf woodland	300 000	24 200 000	8.8
Restoration and management of grasslands	Restoration – erosion mesic	270 000	13 860 000	5.0
	Restoration – erosion dry	320 000	11 733 333	4.3
	Restoration – grasslands mesic	600 000	22 000 000	8.0
	Avoided degradation mesic	15 000	1 100 000	0.4
Commercial small-grower afforestation	Eastern Cape	60 000	2 750 000	1.0
	KwaZulu-Natal	40 000	1 833 333	0.7
Biomass energy (woody biomass)	Countrywide		39 806 316	14.4
Biomass energy (bagasse)	Countrywide		6 579 099	2.4
Anaerobic biogas digesters	Countrywide		72 848 160	26.4
Biochar		700 000	12 833 333	4.7
Reduced tillage		2 878 960	21 112 373	7.7
Reducing deforestation and degradation	Through planning			
	Through regulation			
Total			**275 787 189**	**100.0**

Defining the goal of the analysis

South Africa's National Climate Change Response White Paper (NCCRP, 2012) provides a clear directive to identify, develop and implement all climate change mitigation opportunities that result in a reduction in greenhouse gas (GHG) emissions, while providing social, economic and environmental benefits. Interviewed officials within government substantiated this policy mandate further, reiterating that land use-based climate change mitigation activities should be realised in all landscapes where they result in robust climatic, social and ecological infrastructure benefits. Beyond the immediate focus on GHG emissions, it is well known that the restoration of degraded ecosystems leads to significant ecosystem services benefits and employment opportunities in remote rural areas. This forms the basis for the Expanded Public Works Programme (EPWP).

The initial Terms of Reference (ToR) identified the following four distinct, but related sections of analysis:

- A review of existing carbon standards and methodologies pertinent to South African activities
- An assessment of monitoring requirements and opportunities to improve cost efficiencies
- An analysis of investment risks relevant to each activity
- An assessment of governance and structural elements of a future South African carbon offsets system

If the ToR are strictly conformed to in terms of *only* considering existing, validated methodologies, it may limit this study to well-known activity types, such as reforestation or biomass-to-energy initiatives. The study does not consider progressive emerging approaches to programmes located in grasslands, especially in landscapes under communal land tenure, which are often the prime target areas for implementation by government.

Therefore, the assessment starts with a structured analysis of methodologies that have been formally validated through the Clean Development Mechanism (CDM) and Verified Carbon Standard (VCS). Thereafter, the assessment explores emerging approaches that are being pioneered through other national or state programmes (such as in Australia or California), the World Bank's Initiative for Sustainable Forest Landscapes (ISFL) and regional research institutions. The intention would be to use established CDM and VCS methodologies where appropriate (e.g. for reforestation activities in subtropical thickets) and to explore progressive approaches where risk and cost profiles limit their application (e.g. in mixed-use landscapes under communal land tenure). Such an approach increases the potential for implementation to occur in a broader range of landscapes, assisting government to meet its climate change goals, as well as social and ecological infrastructure objectives.

Note on Section 4:
Following commencement of the scope of work, members of the project's steering committee noted that Section 4, which is aimed at the governance and structural elements of a future carbon offsets system, is largely being undertaken by other parties in government. The majority of the time allocation for that section has therefore been reallocated to the first three sections. However, a brief that covers considerations for a future carbon offsets system, drawing on valuable input from interviewed stakeholders and field practitioners, has been included.

Summary and recommendations per activity

The primary climate change mitigation opportunities within the South African AFOLU sector are briefly summarised below. Monitoring considerations and an assessment of costs for landscape-orientated activities are considered jointly in a single section to avoid unnecessary duplication (reforestation, 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 (REDD+), grassland restoration and conservation agriculture). Please see the full report for an in-depth analysis of each element.

Reforestation activities

South African context
The following three broad types of reforestation activities were identified in the NTCSA:

- The **restoration of subtropical thickets** is expected to take place on land predominantly owned by private individuals and government. Private landowners or contractors would undertake implementation under the auspices of the EPWP.
- **Commercial small-grower afforestation** would occur on communal land through a partnership between commercial forestry and local residents. The model allows the substantial expertise, human, transport and processing capacity of established commercial operators to be leveraged, while providing rural communities with an additional source of income.
- **Small-scale reforestation on communal or municipal land** typically occurs on land that was previously degraded or used for crop production. Municipalities, the EPWP or non-profit organisations (NPOs) would undertake implementation, with an emphasis on creating local employment and skills development opportunities.

Methodology summary
Following a substantial number of earlier versions, two consolidated CDM afforestation and reforestation (A/R) methodologies have emerged over time. One focused on small-scale projects and the other on large-scale

initiatives. Although the small-scale methodology (AR-AMS0007) has successfully been applied to South African projects, limitations in terms of the generated GHG emission removals (<16 000 tCO_2e/year) means it has not been permitted to aggregate individual projects in a programmatic manner. This limits the applicability of this methodology to a national programme.

It is recommended that the large-scale CDM methodology (AR-ACM0003) be used as the basis for a national programme. It has successfully been used by a South African project (the Kuzuko Lodge Private Game Reserve in the subtropical thicket biome) and has been adopted by the VCS and other standards as the basis for their reforestation methodologies – the emerging Gold Standard (GS) A/R methodology utilises many of the CDM's established tools.

Grassland: avoided degradation and restoration

South African context

The NTCSA reported that approximately 62% of the country's terrestrial carbon stock is located in grassland and open savanna ecosystems, where over 90% of the total carbon stock is located below ground in the soil organic carbon pool. Although comprehensive maps of the status of national soil carbon degradation may not be available, robust maps of gully erosion with the grassland biome indicate that at least 600 000 ha could initially be restored. Experts noted that the total area of degraded grassland could be double this estimate or more.

Several different forms of land tenure are found within the grassland biome. Stakeholders noted that the majority of degradation is likely to have occurred in areas under communal land tenure and that these areas should be the initial of focus of implementation efforts. This determination is not only due to potential climatic benefits, but also social and ecological infrastructure outcomes.

A number of clear messages emerged regarding the structure of implementation during the course of engagement with established South African field practitioners:

- A context-specific, bottom-up, participatory approach is required to identify and develop additional activities. Predefined top-down approaches have proven problematic to date.
- A range of potential implementing agencies may be required, depending on the activities developed in a bottom-up manner. Agencies may include the EPWP, local government, community organisations, NPOs or commercial farmers.
- A landscape approach to implementation may be required to address risk and cost-efficiency issues, as well as bundle grassland, conservation agriculture and other potential climate change mitigation activities.

Methodology summary

Two existing VCS methodologies are applicable to activities located within grassland ecosystems. However, there are limitations to their adoption by South African initiatives:

- Methodology VM00026, which focuses on sustainable grassland management, does not present significant issues in terms of eligibility criteria, but strongly relies on the application of a predictive biogeochemical model, which remains to be calibrated to South African conditions to achieve the required levels of accuracy. This is likely to take considerable resources, which are often beyond the capacity of individual project developers.
- Methodology VM0009, which focuses on the avoided conversion of grasslands and shrublands (ACoGS), includes a useful method for estimating future degradation, but is constrained by eligible activity types (only avoided degradation, not restoration) and reference area requirements may limit its applicability in a South African context.

Due to methodological requirements, as well as the risks associated with implementation in areas under communal land tenure, it is suggested that a new, progressive landscape approach is taken to developing and validating activities located in South African grasslands. The ISFL is currently pioneering such an approach internationally. A version focused on grasslands could address many of the issues inhibiting roll-out in the grassland biome.

Reducing deforestation and forest degradation

South African context

In comparison to clear frontier-type deforestation observed within the Tropics, deforestation in South Africa tends to occur in a disaggregated manner where parties are degrading numerous forest patches, often in a mosaic-like manner. Furthermore, stakeholders noted that significant forest degradation may be occurring without the complete clearance of the canopy layer. Where deforestation and forest degradation are occurring, it is generally due to unsustainable use by neighbouring residents, rather than by large-scale commercial companies.

There are only a few REDD+ activities in South Africa on which to base the expansion of successful pilot programmes. It is, however, envisaged that the implementation of REDD+ at scale would follow a similar structure to that suggested for a grassland-based programme, where a bottom-up approach would be taken to the identification and development of additional activities that adequately address the underlying drivers of deforestation in each area. Additional activities may include direct interventions, e.g. forest and fire management, as well as initiatives that address indirect drivers of deforestation and provide alternative livelihoods to local residents.

Methodology summary
Two established VCS methodologies are broadly applicable to the type and pattern of deforestation observed in South Africa:

- Methodology VM0009 was initially developed for a project located in woodland and savanna ecosystems in Kenya that have recently been updated to consider ACoGS activities. Whereas the methodology uses an innovative, non-spatially explicit model to estimate future deforestation rates that are applicable to the type and nature of deforestation observed in South Africa, existing stipulations regarding the location, size of reference and proxy areas limit its application. While the methodology holds good promise, it would need to be updated to adequately address reference area requirements.
- Methodology VM0006, which was initially developed for a project located in central Malawi, may be more applicable to South African project contexts. It is simpler and less demanding in terms of required field and technical data to populate baseline models and is less restrictive regarding suitable reference areas. It could form the basis for a national programme located in South Africa, but may need to be updated to include ACoGS activities as well.

Conservation agriculture

South African context
The concept of conservation agriculture is based on three principles: minimal soil disturbance, permanent soil cover and an increase in the diversity of crop and cover species. The implementation of the principles may in theory lead to an increase in the size of the soil organic carbon pool through an increase in inflows of organic matter, an increase in soil structure, microbial activity and associated biological processes, but the concept remains to be tested across a range of South African locations. In addition to an increase in soil organic carbon stocks, an initial study in the Western Cape has shown that the adoption of no-till or low-till practices may lead to a 66% reduction in diesel usage during ploughing operations.

To date, the implementation has mainly occurred within the commercial farming sector and predominantly in the Western Cape where up to 60% of farmers have adopted certain of the principles. Adoption is expected to gradually increase within both the commercial and small-grower sectors, although the cost of additional machinery and capacity may hinder the complete roll-out of the activity at scale across the country.

Methodology summary
Two principal VCS methodologies were identified that, while technically applicable, may be difficult to adopt due to research and cost issues similar to those raised for the reforestation and grassland methodologies described above. VM0017, which focuses on the adoption of sustainable agricultural land management, used a biogeochemical model – the Rothamsted Carbon Model (RothC) – to estimate changes in soil organic carbon over time. Although RothC is internationally recognised, it would need to be adequately calibrated to South African conditions. In addition, although the methodology does not stipulate it, soil carbon may need to be empirically measured at certain intervals in time to avoid the potential perverse issue of emission reduction units and associated reputational risk.

The second methodology, VM00021, focuses solely on the quantification of soil carbon. It is technically sound, but the cost of stipulated field sampling and laboratory procedures is likely to be inhibitory.

Summary of monitoring considerations for landscape activities

The set of four landscape-orientated activities described above share common monitoring requirements in terms of the need to assess and report changes in terrestrial carbon stocks in a cost-efficient manner. To avoid repetition, all four are jointly considered here.

The process of estimating terrestrial carbon stocks following conventional techniques is well known. The CDM, VCS and leading institutions provide a substantial set of modules and guidance that have been successfully applied to projects in South Africa and elsewhere. The cost of achieving the required levels of accuracy following prescribed procedures is an inhibitory issue raised by nearly all interviewed practitioners. This is especially relevant to the assessment of soil organic carbon and above-ground carbon pools within the subtropical thicket biome.

Assessing soil organic carbon stocks at landscape scales
To address cost constraints, international carbon standards have adopted the use of predictive models (e.g. RothC) and default values to estimate soil carbon stocks. Although this approach may reduce costs, both predictive models and default values need to be calibrated to local conditions.

Interviewed field extension staff, research officers and academics voiced concern that both predictive models and default values may not be adequately calibrated to South African biophysical conditions and require substantial development and calibration. South Africa is not unique in this situation, with many countries in Eastern and Southern Africa exploring progressive field sampling and predictive modelling techniques to assess soil carbon stocks in mixed-use landscapes in a cost-efficient manner

(e.g. for field techniques, see Vagen et al. (2010) and Aynekulu, Vågen, Shepherd and Winowiecki (2011), and for predictive models, see the work done by the Africa Soil Information Service (AfSIS)[1]).

It is suggested that such approaches are explored for both the mapping of soil carbon stocks and estimating potential loss and sequestration rates following implementation. This may be a significant step to unlocking mitigation activities within grasslands and the agricultural sector, and is likely to significantly improve the financial attractiveness of reforestation and REDD+ opportunities.

Estimating above-ground carbon stocks in subtropical thickets

Whereas there are reforestation activities within the subtropical thicket biome that have been successfully validated through the VCS, project proponents noted that scaling up implementation may be limited by high monitoring costs. This is mainly the result of limited access and relatively impenetrable vegetation that leads to high transportation, staffing and time requirements.

To resolve these issues, it is proposed that landscape-scale allometry and predictive carbon pool models be developed. Both these techniques have been tested elsewhere and could provide a means of reducing monitoring costs considerably. Landscape-scale allometry would be used to provide an estimate of the amount of carbon located in the above-ground woody biomass pool. The soil, litter and deadwood carbon pools could then be estimated using predictive models based on a substantial set of climatic, edaphic, topographical and land-cover input parameters.

Anaerobic biogas digesters

South African context

The generation of energy-using anaerobic biogas digesters is considered within the AFOLU sector, where feedstock is provided in a sustainable manner through land-use practices. In a South African context, feedstock would principally be in the form of cattle, pig or chicken manure. The key factor determining the viability of digesters is an adequate concentration of feedstock that is provided in a constant manner throughout the year. Collection and transportation costs and a lack of continuity throughout the year reduce the viability of digester systems where livestock is dispersed across landscapes or from sources such as fruit waste, where feedstock is only available during a particular time of the year.

Early developers of digesters in South Africa have therefore focused on large cattle feedlots, as well as dairies, piggeries and chicken farms, where a substantial amount of manure is generated in a consistent manner all year round. Initial examples include six 5 MW digester units in the uMgungundlovu District Municipality. These units are located in close proximity to feedlots, piggeries and chicken farms within the municipal area.

Methodology summary

A substantial number of potential CDM methodologies exist that may be applicable to anaerobic biogas digester initiatives in South Africa. Based on its successful adoption to date by existing projects within the country, it is suggested that AMS-I.D: Grid-connected renewable electricity generation is adopted by future digester initiatives.

Monitoring summary

With the introduction of standardised baselines and through the integration of monitoring variables into operational processes, monitoring is expected to be reasonably straightforward and affordable.

Monitoring will require three fundamental components:

- **Upstream compliance monitoring:** This requires assurance of the consistency and stability of the feedstock (typically manure), which can influence the methane content, leading to potential required adjustments to the calculation of emission reductions.
- **Baseline monitoring:** In the past, project developers were required to assess the carbon intensity of the grid into which the project feeds electricity. More recently, however, the United Nations Development Programme (UNDP) developed a standardised baseline for South Africa, which was approved by the South African designated national authority (DNA) for use by all project developers.
- **Project scenario monitoring:** Project emissions associated with flaring methane must be monitored, and equipment installed to constantly assess the flare.

Biomass to energy

South African context

In a similar manner to anaerobic biogas digesters, biomass-to-energy initiatives require a sufficient, concentrated and sustainable source of feedstock in a constant manner through the year. In a South African context, three essential sources have been identified in the form of sugar bagasse, commercial forestry waste and biomass from cleared invasive alien species.

Interviewed members of industry and government noted that, while existing biomass-to-energy initiatives within the sugar and forestry industries are typically fuelled by a single fuel source, there may be good opportunities to establish units that are fuelled by a combination of the three major sources noted above in future.

1. http://www.isric.org/data/soil-property-maps-africa-1-km

Methodology summary

In a similar manner to methodologies aimed at quantifying the GHG benefit of the installation of anaerobic biogas digesters and the supply of energy into the national grid, a number of potential methodologies could be applicable to South African conditions. To date, Tugela Mill and Lomati Biomass Power have successfully adopted methodology AMS-I.C: Thermal energy production with or without electricity. It is suggested that AMS-I.C and AMS-I.D (adopted by the Grahamstown Invasive Biomass Power Project) are principally used for future projects.

Monitoring summary

Like anaerobic biogas digestion, monitoring for biomass to energy is assumed to be relatively affordable and straightforward, assuming that standardised baselines are adopted, and that consideration is given to appropriately integrating monitoring variables into day-to-day operations.

The following will need to be monitored:

- **Upstream compliance monitoring:** The sustainability of the biomass supply must be demonstrated, using a published CDM tool, so as to ensure that the project does not adversely contribute to landscape degradation and deforestation, negating the emission reduction benefits of the intervention.
- **Baseline monitoring:** The energy value of the fuel to be replaced by the biomass energy product must be regularly assessed, to ensure that the energy value conversion between the displaced fuel and biomass is reported accurately.
- **Project scenario:** The project must regularly assess the volumes and calorific values of the biomass feedstock, typically through the installation of measurement equipment. Biomass samples will probably need to be collected and sent for laboratory analysis to ensure accurate reporting of calorific content.

Cost assessment summary

Full costs were assessed, including those incurred through the compilation of methodologies, especially through the required remote sensing, fieldwork, laboratory analysis and data management during each monitoring event. Costs were calculated based on an industry-standard 30-year project period, with inputs provided by a South African remote sensing service provider, as well as field practitioners who kindly provided estimates based on real expenditure over a substantial period of time.

The results of the analysis illustrate that the cost of monitoring carbon stocks per hectare is closely dependent on the spatial scale of the activity (Figure 1). Good support was provided for implementation at scale or for regional programmes that cover an area of at least 100 000 ha. The cost of monitoring reforestation activities located in subtropical thickets are substantially more than estimations for projects in other biomes due to the high levels of spatial variability, project access and associated staff and transportation costs.

Emerging landscape allometry and predictive modelling approaches to estimating above- and below-ground carbon stocks may potentially reduce costs considerably. Such development will cost a substantial amount and is therefore generally beyond the means of individual project developers. It is suggested that donor funding is accessed to develop these elements.

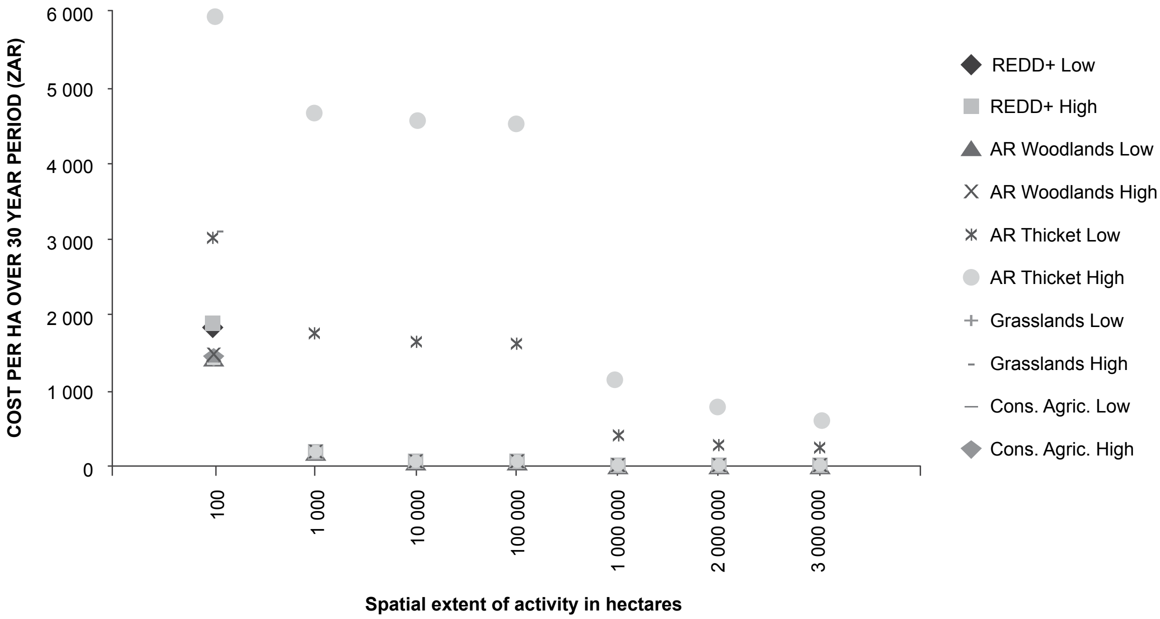


Figure 1: The relationship between remote sensing and field assessment costs, and the spatial scale of implementation for climate change mitigation projects located in South Africa.

Important risk considerations

For all validated carbon offset projects, the overarching risk is project underperformance, notably with regard to the total expected emission reductions. This potential variability in outcomes can be due to numerous potential risk factors. Unlike carbon offset projects from the industrial or energy sectors, land use-based initiatives face unique risk factors, notably as projects must typically remain in place for 20 to 30 years. In particular, these risks threaten the permanence of emission reductions, which, through numerous potential eventualities, can lead to a reversal of emission reduction.

These risks include the following:

- **Biophysical risks:** Risk of fire, drought, wildlife disturbances, below-average growth rates, and pest invasion.
- **Land-tenure risks:** Disagreements over land use, rights of use and changes in ownership can lead to project disruptions, and in severe cases, project closure. This is especially pertinent on communally owned lands, where the majority of grassland and agriculture interventions are expected to take place.
- **Land-use planning and policy risks:** Due to the long-term nature of landscape-based interventions, there is a risk that national, provincial or local land-use policy and planning efforts could lead to reversals in credits. New mandates, programmes or interventions stemming from policy and land-use planning could overturn landscape-level carbon offset interventions as government priorities and needs shift and evolve over time.

Emerging concepts

Based on research and stakeholder consultation, three predominant emerging concepts were identified. Some of these concepts were conceived several years ago, but they only gained traction and interest more recently. These concepts can assist in reducing costs and risks for project developers. Considerable benefits could be gained from adopting and applying these emerging trends in South Africa.

These benefits include the following:

- **Aggregation of activities – grouped projects and jurisdictional reduced emissions from deforestation and forest degradation (through planning and regulation) (REDD):** The leading approach to GHG emission reduction activities to date has been to develop individual project interventions. This has been met with considerable success in the energy sector, but less so in the AFOLU sector. The CDM is a pioneering programme of activities, while the VCS is a grouped project approach. This allows for the aggregation of activities with similar technologies, scales, geographic locations and objectives to be gathered under a single programme. This introduces greater efficiencies in the technical project development, reporting and monitoring processes. A single, umbrella organisation manages the overall programme, and has the flexibility to introduce more project instances as they become available. The umbrella organisation manages many key aspects of monitoring, auditing and reporting to the standards body regarding the commercialisation of emission reductions and calculating GHG emissions.

- This is especially pertinent for small-scale projects that simply cannot afford the expensive project development, auditing and long-term monitoring costs. Jurisdictional REDD uses similar approaches, including the development of standardised baselines, reducing overall mapping and field-based data collection costs for individual project participants and allowing for greater government participation.

  Aggregated approaches could deliver considerable benefits for small-scale project developers in South Africa, such as small-scale farmers, community reforestation initiatives, communal grassland restoration projects and the conservation of scattered, threatened forest patches. Existing processes available through both the CDM and VCS could be adopted and managed by a well-resourced umbrella organisation, including a government body.

- **Modules and tools:** Modules and tools are written guidance, published in conjunction with a base methodology, to provide greater insight into key methodological concepts and processes. They can cover any number of topics, from, for example, specific steps required to run additionality tests to field-based data collection procedures and leakage assessment processes. Tools and modules represent an important cost-saving and risk-reduction measure for project developers, who are no longer required to develop technically complex procedures for undertaking the development of elements of a methodology. There are drawbacks to modules and tools, however. They can be numerous, with project developers required to adopt many tools to implement a single methodology which, like most methodologies, they can be complex. The average project developer is still likely to struggle with interpreting and properly applying existing tools and modules.

  Government may want to explore developing modules and tools specific to South Africa that are described in layman's terms and that can be easily adopted by a range of project developers.

- **Non-project-based approaches to AFOLU-sector climate change mitigation:** The underlying project-based approach has remained the de facto means for generating tradable emission reductions, initially through the CDM, and now through a number of recognised standards, such as VCS, GS and the Climate, Community and Biodiversity Alliance (CCBA) Standard. However, this approach has not been as successful in the AFOLU sector as it has been in the energy sector, in part due to higher monitoring and project development costs, and unique risk burdens. To address this, organisations such as the World Bank are exploring landscape-based approaches, such as the ISFL. The approach is comprehensive, and includes integrated land-use planning, alignment with policy, and the creation of public-private partnerships for implementation, as well as supply-chain development.

  In a South African context, the ISFL approach may be suitable to certain activities, particularly the roll-out of grassland restoration and management at scale. Such an approach may be more appropriate in terms of efficiencies and risk when compared to conventional project-based methods.

Potential next steps

Four principal interventions are presented as potential next actions that should be prioritised to realise land-based climate change mitigation activities in South Africa. These include the following:

- **A programmatic, aggregated approach to each of the project activities:** It is recommended that government supports the large-scale implementation of activities using the latest published processes for following a grouped-project (such as VCS) or a programme-of-activities approach (such as CDM) . This will introduce cost and resource efficiencies, provide a more inclusive environment for under-resourced project developers and establish the conditions under which a greater number of emission reductions can be realised.

- **The establishment of predictive models and landscape allometry:** Predictive modelling is likely to be an integral part of future carbon accounting methods, as it provides a cost-effective means of estimating carbon stocks and changes in carbon stocks. The underlying research and modelling needs to be undertaken in a South African context. The development of a predictive model would need to be underpinned by a dedicated, national soil carbon research programme. Similarly, landscape allometry holds strong promise to reduce costs, notably in the subtropical thicket biome.

- **A communication platform:** The development of an easily accessible communications platform with content described in layman's terms will be of considerable benefit to project developers. Interviewed stakeholders highlighted the lack of easily accessible information pertaining to methodologies, monitoring, relevant policies, guidance and so forth. In addition, critical types of information, such as suitable areas for activities, maps of sequestration rates and land-use changes maps are difficult and costly to locate or produce.




- **Institutional capacity and support:** Interviewed stakeholders regularly stated the need for sustainable, readily accessible and comprehensive institutional support. For the elements described above (a programmatic approach, predictive modelling and a communication platform) to be realised, one needs institutional capacity and support, as these steps are unlikely to be realised through an ad-hoc approach or driven solely through private-sector intervention.

Introducing the structure of the report

The ToR require the following four deliverables to be achieved:

- A review of existing carbon standards and methodologies pertinent to South African activities
- An assessment of monitoring requirements and opportunities to improve cost efficiencies
- An analysis of investment risks relevant to each activity
- An assessment of governance and the structural elements of a future South African carbon offset system

Initially, the intention was to compile each section as a stand-alone report. However, as each element is so closely related to the others, this would result in substantial repetition in introductory and conceptualisation sections, as well as in emerging concepts and further discussion.

All four deliverables are therefore presented in a single comprehensive report.

The introduction provides background to the study and an introduction to the concept of carbon markets and methodologies. It is recognised that many readers will not have a background in climate change mitigation, so this section provides an initial exploration of important concepts, frameworks and processes, with links to pertinent web portals and further reading.

Chapter 1 provides an introductory description of the South African context against which methodologies, monitoring, risk and costs are assessed. The nature of GHG emission reductions and implementation models, land-tenure considerations and the socioeconomic context are described, as they substantially influence the applicability and appropriateness of methodologies and monitoring models. This chapter also provides readers who are unfamiliar with South African conditions with an initial introduction of how they may differ compared to other countries within the region and elsewhere.

Chapter 2 contains a review of existing methodologies that are pertinent to South African activities. These have principally been drawn from the CDM and VCS as the leading carbon offset standards used within the region to date and those highlighted in South Africa's Carbon Tax Policy paper. The GS has recently started to consider AFOLU-sector projects, but to date, only has two methodologies aimed at reforestation and reduced tillage in a "road testing" phase. Leading representatives of the GS were interviewed and methodology developers focused on the Californian and Australian programmes. Progressive concepts developing within these programmes are included in Chapter 5, which focuses on emerging concepts.

Chapter 3 focuses on monitoring requirements and opportunities to improve cost efficiencies. Much of this chapter is focused on the field assessment of the biomass and soil organic carbon pools, as interviewed stakeholders repeatedly identified this as a problematic area.

Following the review of methodologies and monitoring elements, Chapter 4 assesses the costs of undertaking each component. Based on input from field practitioners and academics, particular emphasis is placed on understanding the nature of fieldwork expenses and how they can be reduced through predictive modelling and landscape-scale allometry.

Chapter 5 briefly introduces emerging concepts that could lead to substantial reductions in the costs, risk and required specialist capacity associated with the application of methodologies and monitoring frameworks. Each concept is worthy of a full analysis. Here, the intention is to introduce each concept in a succinct manner with links provided to further reading.

An analysis of investment risks relevant to each activity is introduced in Chapter 6. Readers are encouraged to review the risk matrix provided in a spreadsheet format, which is attached to this report.

As noted in the introduction, members of the project's steering committee noted that other parties within government are currently developing the governance and structural elements of a future South African carbon offset system. In addition, their advice was to reduce the time allocated to this section considerably. Nevertheless, a brief note is included in Chapter 7, highlighting important considerations raised by interviewed stakeholders that are pertinent to introducing efficiencies and managing risk.

Chapter 8 highlights potential next steps in the process towards a cost-efficient and appropriate verification process for climate change mitigation activities in the South African AFOLU sector.

The three annexures provide further detail on the costs of remote sensing, mapping and the compilation of methodologies.

A list of interviewed specialists and stakeholders is presented below. Each interview was structured by using a common set of predefined questions, after which the discussion was left open to explore emerging ideas.

Parties were selected based their substantial hands-on experience in fieldwork, and the application of methodologies and required monitoring frameworks in a South African context, their technical knowledge of specific elements, e.g. soil carbon monitoring, or their experience in leading international carbon standards and progressive approaches to methodologies and monitoring. Furthermore, members of the South African National Treasury and the financial sector were interviewed to better understand future demand-side requirements for emission reductions in South Africa.

We wish to express our sincere thanks to all interviewed parties for making their time available and for their considered inputs.

Interviewed specialists and stakeholders

Table 2: Interviewed specialists and stakeholders

Name	Affiliation	Title	Location
Gauteng			
Peter Janoska	National Treasury	Senior Economist	Pretoria
Prof Bob Scholes	University of the Witwatersrand	Professor	Johannesburg
Duncan Able	Nedbank	Senior Transactor	Johannesburg
Tyrone Hawkes	South African Pulp and Paper Industries (Sappi)	Director: Strategy and Business Development	Johannesburg
Johan Myburgh	Sappi	Process Development Manager	Johannesburg
KwaZulu-Natal			
Andrew Whitley	Wildlands Conservation Trust	Deputy Director	Pietermaritzburg
Errol Douwes	Durban Municipality	Manager: Restoration Ecology	eThekwini
Steve McKean	Ezemvelo KZN Wildlife	Park Ecologist: Maloti Drakensberg World Heritage Site	Pietermaritzburg
Ian Rushworth	Ezemvelo KZN Wildlife	Manager: Biodiversity Research	Pietermaritzburg
Nico Hattingh	Sappi Forests	Planning Manager	Cascades
Dr David Everard	Sappi Forests	Divisional Environmental Manager	Cascades
Giovanni Sale	Sappi Forests	Land Management Programme	Cascades
Western Cape			
Dr Christo Marais	Department of Water Affairs and Forestry (DWAF), EPWP	Chief Director	Cape Town
Dr Johan Strauss	Western Cape Department of Agriculture	Scientist	Elsenburg
Dr Ailsa G Hardie	University of Stellenbosch	Senior Lecturer	Stellenbosch
Dr Anthony Mills	C4 EcoSolutions	Director	Cape Town
James Reeler	World Wide Fund for Nature (WWF) South Africa	Ecosystem Carbon Project Manager	Cape Town
Dr Catherine Traynor	Natural Justice	Advisor	Cape Town
Leon Theron	BioCarbon Partners	Carbon Accounting Manager	Cape Town
Wim Hugo	South African Environmental Observation Network (SAEON)	Chief Data and Information Officer	Paarl
Eastern Cape			
Mike Powell	Rhodes University	Researcher	Grahamstown
Cosman Bolus	Rhodes University	Senior Researcher	Grahamstown
International			
Dr Toby Jansen-Smith	VCS	Director: Sustainable Landscapes	San Francisco, USA
Moriz Vohrer	GS	Technical Director: Land Use and Forests	Zurich, Switzerland
Dr Keith Shepard	World Agroforestry Centre	Principal Scientist	Nairobi, Kenya
Dr Markus Walsh	Columbia University	Senior Research Scientist	Nairobi, Kenya
Dr Kyle Holland	EcoPartners	Managing Director	Berkeley, USA
Jonathan Sullivan	EcoPartners	Manager: Development Services	Berkeley, USA
Interview team			
Barney Kgope	Department of Environmental Affairs (DEA)		Pretoria
Itchell Guiney	DEA		Pretoria
Tony Knowles	Cirrus Group	Director	Cape Town
Phoebe Boardman	Cirrus Group	Principal	Johannesburg

Introduction

Published in October 2011, South Africa's NCCRP provides a clear mandate to identify, develop and implement all climate change mitigation opportunities that can assist the country to reduce GHG emissions, while providing social, economic and environmental benefits in a sustainable manner. To address this mandate in the context of the land-use domain, the DEA first commissioned the NTCSA to fully understand the distribution of carbon stocks, associated fluxes, and the scope and nature of all mitigation opportunities, allowing South Africa to develop a comprehensive, inclusive and efficient mitigation programme within the sector. The results of the NTCSA indicated that there are eight key mitigation opportunities within the land-use sector (see Table 3), but that a number of inhibitory factors need to be addressed before national-scale implementation of these activities can be realised.

Table 3: The eight principal land use-based mitigation opportunities identified in the NTCSA

Activity	Subclass	Spatial extent (ha)*	Reduction over 20 years (tCO_2e)	Percentage contribution
Restoration of subtropical thickets, forests and woodlands	Subtropical thickets	500 000	44 000 000	16.0
	Coastal and scarp forests	8 570	1 131 240	0.4
	Broadleaf woodlands	300 000	24 200 000	8.8
Restoration and management of grasslands	Restoration – erosion mesic	270 000	13 860 000	5.0
	Restoration – Erosion dry	320 000	11 733 333	4.3
	Restoration – grasslands mesic	600 000	22 000 000	8.0
	Avoided degradation mesic	15 000	1 100 000	0.4
Commercial small-grower afforestation	Eastern Cape	60 000	2 750 000	1.0
	KwaZulu-Natal	40 000	1 833 333	0.7
Biomass energy (invasive alien plants and bush encroachment)	Countrywide		39 806 316	14.4
Biomass energy (bagasse)	Countrywide		6 579 099	2.4
Anaerobic biogas digesters	Countrywide		72 848 160	26.4
Biochar		700 000	12 833 333	4.7
Reduced tillage		2 878 960	21 112 373	7.7
Reducing deforestation and degradation	Through planning			
	Through regulation			
Total			**275 787 189**	**100.0**

One of the prominent inhibitory issues, especially for mitigation activities that require the restoration and sustainable management of landscapes, is a lack of clarity regarding verification standards and methodologies that are appropriate to South African conditions. Where a substantial set of international carbon standards and associated methodologies, such as the CDM, VCS, GS, Plan Vivo (PV) and CCBA, already exist, South African field practitioners have noted that their application often presents a barrier to implementation due to the required technical expertise and the high transaction costs associated with the application of methodologies, monitoring, project documentation and contracting international auditors[2] (see Table 2). To date, very few land-based projects have been validated through recognised standards as a share of total projects. For example, under the CDM, over 7 500 projects had been registered by January 2015, yet only 268 of these registered projects originated from the land-use sector, of which 80% are related to the biomass-to-energy and biogas options identified in the NTCSA. Furthermore, activities aimed at reducing deforestation or forest degradation

2. For a review of current CDM projects and typical issues facing developers, please see the Designated National Authority Annual Report: http://www.energy.gov.za/files/esources/kyoto/2011/Status%20Report%20final,%2008%20November%202012.pdf

are not recognised under the CDM. The only recognised forest-related activities are A/R, and no single A/R project has yet to be registered with the CDM in South Africa. This may partly be due to the temporary crediting approach the CDM has adopted for managing permanence issues in the AFOLU sector, although even under the VCS, which has adopted a buffer stock approach, only seven projects have been registered locally. These include four registered A/R projects under the VCS (two of which are dually certified under the CCBA), two biogas energy projects that are registered under the CDM and one biomass-to-energy project that is certified to the GS.

The limited proportion of land use-based projects recognised in international carbon markets suggests that, while the methodologies may be technically robust, they are challenging to adopt. Our experience in the land-use sector in South Africa has indicated that, further to cost implications, a lack of understanding of international standards and methodologies is a source of much uncertainty to project developers, who often decide not to pursue ventures due to the perceived validation risk. The identification and formal adoption of a clear set of methodologies that are communicated in a manner appropriate to the South African context would significantly address such perceived risk. In addition to the outcomes of the NTCSA, National Treasury is seeking to identify an internationally acceptable standard and set of methodologies that will ensure that emission reduction units generated from the South African AFOLU sector are real, permanent, additional and do not have negative social or environmental consequences. Such requirements are fundamental to the legitimacy of a potential internal South African carbon offset programme.

This study is therefore structured to emphasise two main objectives:

- Ensure that an internationally acceptable standard and set of methodologies are either adopted or developed in terms of their robustness, transparency, governance and consideration of social and environmental safeguards.
- Ensure that adopted methodologies are appropriate to the financial and technical capacity context of targeted South African end users, for example an emerging farmer in the Eastern Cape.

Prior to exploring the scope of the work and the approach of the consultant (Cirrus) to the analysis, a brief introduction to carbon standards and associated methodologies is provided to ensure that readers understand the nature and scope of the analysis, important elements of the analysis, as well as its limitations.

What is a carbon standard?

A brief history of emissions trading standards

The use of environmentally focused market-based trading mechanisms was initially explored in the 1980s as a means of addressing difficult environmental pollution issues both efficiently and cost-effectively. Popularised under the Reagan administration as a counter to government-based "command and control" regulations, the approach first won widespread recognition when the United States' Environmental Protection Agency (EPA) launched its first successful sulphur dioxide (SO_2) trading platform as part of its national Clean Air Act. Following this, the Montreal Protocol on Substances that deplete the ozone layer's credit trading system was tested at an international scale in 1994, with the purpose of reducing chlorofluorocarbons (CFCs) and their threat to the ozone layer. With proof of concept demonstrated through the successful development of these programmes, the inclusion of "flexible mechanisms" as part of the ongoing international climate change negotiations was proposed. During the United Nations Framework Convention on Climate Change Conference (UNFCCC) of the parties' negotiations held in Kyoto, Japan, in 1997, 37 developed countries and the European Community (Annex I countries) agreed to a binding target for the reduction of GHG emissions, relative to a 1990 baseline.

During the Kyoto negotiations, Brazil proposed a Clean Development Fund, to which developed country signatories would contribute funds. This Fund would help leapfrog emissions-intensive technologies for cleaner technology transfer in the developing world. The idea was met with resistance, notably from the USA, which proposed and pushed through the adoption of "flexible mechanisms", one of which (the CDM) was intended to deliver similar sustainable development benefits as the discarded Clean Development Fund. Three mechanisms were written into Article 12 of the Kyoto Protocol: International Emissions Trading (IET), Joint Implementation (JI) and the CDM.

Each mechanism was intended to reduce the cost burden of reducing GHG emissions through market-based trading as follows:

- The IET, through Annex I participants, trading emission reduction units (ERUs) among themselves.
- JI through project development funded by Annex I parties in the former Soviet Union Eastern Bloc
- CDM through the development of emission reduction projects in the developing world, with credits made available to Annex I countries and their market participants.

Developing countries were concerned that the CDM represented an easy "opt out" opportunity for Annex I countries, which could continue to pollute at baseline rates by sourcing cheap credits from abroad. To ease these concerns, a capped amount of emissions could be offset through the trade of CDM credits. To retain the goodwill of developing countries' signatories, a stipulation that all CDM projects should promote sustainable development in their host countries was included in the Protocol's final text.

Purpose and elements of a standard

The primary concern of the Executive Board responsible for managing the CDM has been to build and maintain trust in the integrity of a CDM standard. To maintain confidence in the CDM, a rigorous project screening approach has been used. This screening approach must be balanced with the cost effectiveness of the process in order to increase participation. The primary goal underlying the Kyoto Protocol is to reduce the amount of GHGs released into the atmosphere. In order to contribute to this goal through market-based mechanisms, certified emission reductions (CERs) must be real, verifiable and additional to ensure that each CER traded effectively offsets a ton of carbon dioxide equivalent (tCO_2e).

While the CDM is the dominant standard, all carbon standards tend to share five similar attributes and functions.

Most standards have a governing body, such as the Executive Board of the CDM, that develops rules, processes and structures for the standard and undertakes various functions, from approving methodologies and projects and maintaining a project registry, to issuing credits and ensuring the accreditation of auditing bodies.

Most standards have subcommittees, panels or working groups that gather qualified experts and deal with specific elements, sectors or functions of a standard.

A Secretariat undertakes the day-to-day responsibilities and ongoing management of the standard, as well as the management of a registry of ERUs.

Third-party, independent auditing bodies perform the standard's validation and verification functions, ensuring that projects are designed to rigorous technical specifications, and assessing the actual emission reductions generated by each project intervention over a specified period of time. These third-party auditors must be accredited and undergo an approval process that typically involves meeting predefined technical competencies, having auditors tested to the standard's rules and regulations, and performing audit shadowing.

A structured process of ongoing stakeholder engagement with interested parties across all sectors of society is a common element of most standards. Standards seek input from the public on a number of issues, including commenting on project design and methodologies, developing new methodologies, and sharing opinions on the structure and rules of a standard on an ongoing basis. This is meant to maintain transparency and public trust in the fairness and objectivity of the standard.

A diversity of standards

Additional standards have entered the marketplace, responding to market and project developer demands. The CDM has tended to be the benchmark for other carbon standards. Its structure and approach to quantifying emission reductions on a project-by-project basis has produced a blueprint that has strongly influenced the structure of other standards.

A partial list of some of the other standards and their noteworthy divergences from the CDM is outlined below. Although there are many regional initiatives, including those in California, China, Quebec and South Korea, the following standards are reviewed due to their dominance in the market and high market share of internationally recognised and traded emission reductions:

The VCS: This is the leading voluntary market standard and was launched in 2005. It allows for over-the-counter trade of credits outside of any regulated obligation to reduce emissions. The development of the VCS was driven in part by corporate leaders wishing to offset their GHG emissions outside the obligatory framework of the Kyoto Protocol. This was particularly important in the USA, where the final ratification of the Kyoto Protocol did not take place. The VCS has several positive features. Unlike the CDM, the VCS allows for the development of REDD and other AFOLU projects other than only A/R ventures. The VCS's acceptance of land-based interventions has driven the majority of AFOLU projects across the globe.

The GS: This standard was developed in response to concerns that the CDM standard did not assess projects against strict enough sustainable development indicators. The formulators of the GS felt that by adding stricter criteria to the project development process, projects would be more environmentally and socially responsible. The GS applies a more rigorous assessment of these benefits. This has the intended advantage of creating a sustainable development market “premium” for best-practice projects.

The CCBA Standard: This standard focuses exclusively on AFOLU interventions. Much like the GS, the CCBA Standard seeks to promote projects that have distinct, verifiable and measurable biodiversity, climate and community benefits. As the CCBA does not validate, verify or issue emission reductions, it is most often coupled with an existing standard that undertakes quantification of emission reductions. This tends to make projects more costly to design and manage.

The PV Standard: This standard seeks to allow smaller carbon projects to enter the market. In particular, it aims to promote the participation of smallholders in land-based projects, creating a marketplace for projects that might otherwise have been too small for validation to more traditional standards. However, the PV has not been reviewed in detail. The standard is focused on small-scale, community-based projects where 60% of revenue is expected to accrue to community members. It is therefore not broadly applicable to large-scale interventions. Moreover, PV does not have published methodologies or related monitoring requirements, as project developers are required to develop their own technical specifications and methodological approaches.

What is a methodology?

Methodologies were initially developed to streamline the process of designing, developing and auditing. A methodology is a standardised, approved and recognised approach for quantifying emission reductions from a project activity. It allows the project developer to describe the project’s main attributes within a predetermined framework, which encompasses the following elements: the project’s boundary, baseline, additionality, leakage and monitoring approach. When a project is audited against a methodology, an auditor assesses the consistency, transparency and reproducibility of emission reduction calculations, and reviews the broad assumptions that were applied to develop results.

Upon the official launch of the CDM in 2005, numerous methodologies were developed. Well-resourced project developers drafted most of the methodologies from the bottom up. Although this led to a great number of methodologies at little to no cost for the CDM, it had two significant drawbacks. Firstly, the bulk of the methodologies that were developed focused on established sectors, like the industrial energy and later the renewable energy sectors. Lesser-known or practiced, but nonetheless important interventions, such as improved soil management, did not see the publication of pertinent methodologies. Secondly, methodologies tended to be highly project-specific and were thus too specific to be useful to similar, but not identical interventions. To address this, the CDM, VCS and GS have developed modular approaches and broader methodologies. However, methodologies in lesser-explored sectors, such as grasslands management, are still underdeveloped and have not benefited from project experience, which can be used to further refine and improve methodologies through stakeholder feedback loops.

The main cost for many AFOLU projects tends to be the measurement and monitoring of emission reduction potential. By creating rigorous and wide-ranging scientific datasets, governments and standards bodies could greatly lower the cost of developing a project. These datasets could be used as a benchmark to replace intensive field-based measurements for each project, while also generating greater confidence in the emission reductions generated by projects from the AFOLU sector. As further experience is gained in the application of methodologies, a global consensus is emerging that default methods, standardisation, and the provision of publicly available and regularly updated datasets will allow for both improved quality and reduced project development costs. This is likely to substantially increase the number of projects certified.

Currently, standards such as the CDM are also undergoing reform, with the intention to implement the changes in the third commitment period. Four work programmes (refer to UNFCCC decision 2/CMP.7) have been established to consider different elements of the CDM mechanism in order to make it more pragmatic and implementable.

These programmes include the following:

- Exploring more comprehensive accounting of anthropogenic emissions by sources and removals by sinks from land use, land-use change and forestry (LULUCF), including through a more inclusive activity-based or land-based approach.
- Considering, developing and recommending modalities and procedures for possible additional LULUCF activities.
- Considering, developing and recommending modalities and procedures for alternative approaches to addressing the risk of non-permanence under the CDM.
- Developing and recommending modalities and procedures for applying the concept of additionality (however, it is not known whether and how the reform of the CDM will affect other standards, and when such reforms might be adopted).

Approach to the analysis

The overall goal of this scope of work is to comprehensively inform the identification of a standard and set of methodologies that allows parties in the South African land-use sector to realise emission reduction units (and associated incentives for implementation) in a flexible, yet scientifically robust, cost-efficient, transparent, inclusive and low-risk manner. While each of the eight mitigation opportunities identified by the NTCSA will be given due consideration, additional emphasis will be placed on the “landscape-related” activities, especially in terms of identifying cost-efficient and low-risk certification and monitoring methodologies. The additional weighting on landscape-related opportunities is due to the nature of the activities, existing suitable methodologies, and particularly the institutional and economic context of potential implementing parties.

Our experience in the AFOLU sector to date has indicated that there are two different "classes" of activities: energy-related and landscape-related activites. Due to the inherent nature of the activities, each may require a different approach and level of emphasis (see Table 4).

Energy-related activities

The two activities that fall in this class are biomass-to-energy and anaerobic biogas digestion. These activities are well developed and at an advanced state of readiness. Recognised CDM and VCS methodologies exist and – importantly – the implementing agent is typically a large enterprise that has the financial capacity to cover upfront project development costs, employ specialist staff and undertake the full project documentation and verification process. Monitoring is limited to a point source and can be undertaken in a relatively easy manner by existing internal staff members at marginal additional costs. Methodological and monitoring issues are therefore not a significant barrier to implementation in this class to the same extent as they are in the landscape-related activities discussed below.

Our approach to this class of energy-related activities was therefore to undertake a comprehensive review of existing methodologies that have been adopted, with a view to improving efficiencies and potentially adopting a "programmatic" approach. This approach will be based on a desktop analysis, supported by structured meetings with key individuals in industry and local government. However, more emphasis will be placed on the landscape-related activities, such as methodological and monitoring issues, as this class currently presents a clear barrier to implementation and inclusion in a South African carbon offset programme.

Table 4: Energy-related and landscape-related land-use sector climate change mitigation opportunities

	Energy-related	Landscape-related
Type of activity	Biomass-to-energy Anaerobic biomass digestion	Grassland restoration and management Thicket and forest restoration and management Commercial small-grower forestry Biochar, reduced tillage and REDD+
Nature of implementer	A substantial enterprise within the forestry, sugar, dairy or livestock production sectors	Individual farmers (especially emerging and subsistence farmers), community organisations, non-governmental organisation (NGOs), local government and, potentially, the EPWP
Ability to afford the required transaction costs	High – the forestry and sugar industry have paid costs to date	Low – individual farmers, community organisations and NGOs generally do not have the resources to cover the required transaction costs
Nature of GHG emissions or carbon sequestration	Point source	Distributed across vast heterogenous landscapes
Required GHG monitoring	Limited to a point source	Extensive, including the use of remote sensing and field sampling to monitor above- and below-ground stocks across heterogenous landscapes
Required social and ecosystem services monitoring	Limited to initial impact assessments	Extensive, including extended community engagement, free, prior and informed consent (FPIC), water and biodiversity monitoring
Contribution to rural employment, emerging farmers	Limited to moderate	High potential
Level of readiness	High – implementation has already been initiated on a limited scale	Low – although a few VCS projects are in place, there are limited examples of success in South Africa, notably in REDD, grasslands and improved tillage interventions

Landscape-related activities

Aside from A/R[3], the three other activities listed in this class (grassland restoration and management, REDD+ and conservation agriculture – including the application of biochar) were initially not recognised under the CDM framework[4] as legitimate mitigation activities due to permanence and verification concerns. The adoption of even A/R activities was and continues to be very limited due to perceived risks generally associated with the permanence of land use-based activities (e.g. fire and pests). However, as the magnitude of GHG emissions from deforestation and soil degradation became better known over time, and as an understanding of the rural development, ecosystem services and climate change adaptation co-benefits (i.e. non-carbon benefits) of implementation improved, REDD+ and other landscape-related activities have been clearly recognised and prioritised as important legitimate mitigation activities.

While many of the initial permanence and risk concerns related to the land-use sector have been addressed, undertaking necessary methodology development and monitoring in a cost-efficient manner often presents a barrier to implementation. As noted in Table 4, recognised VCS and GS methodologies that are applicable to South African conditions already exist (e.g. VM0009), but the cost of the required remote sensing and fieldwork to populate baseline and additional scenario models is prohibitive. This is especially the case in the context of relatively small South African farms with low above-ground carbon stocks (relative to those observed in the Tropics where the methodologies are often developed).

Our analysis of landscape-related activities is therefore broader than the approach taken to energy-related activities. It is initiated through a comprehensive review of existing applicable methodologies in a structured manner that assesses the suitability of methodologies in terms of scope, requirements, risk and the cost of applying the methodology. Estimated costs are provided for each methodology based on at least one generic project scenario that is representative of the typical, potential South African project developer, e.g. a small or emerging farmer with a limited amount of land available for development to a standard.

The initial review will be followed by an analysis of how the cost and risk profile of suitable methodologies can be reduced, either through the adoption of emerging monitoring technologies, national standard factors, or programmatic (CDM) or jurisdictional (VCS) approaches. Furthermore, emphasis will be placed on attempting to identify local South African institutions (e.g. SAEON) that could assist in undertaking the required analysis in a more cost-effective manner.

3. Afforestation is the establishment of an indigenous forest or commercial plantation in an area where forest did not previously exist, e.g. the afforestation of grasslands in South Africa. In comparison, reforestation is the re-establishment of indigenous forest in a location where it previously occurred. For further, technical definitions, please see the definitions section of the CDM reference manual *Afforestation and reforestation projects under the Clean Development Mechanism* (Clean Development Mechanism, n.d.)

4. The following were prioritised and are being considered as possible additional LULUCF activities under CDM: revegetation, including agroforestry and silvopastoral practices where the established vegetation is not likely to reach the forest thresholds selected by the host party, cropland management and grazing land management, and wetland drainage and rewetting. Currently, there is work under the Subsidiary Body for Scientific and Technological Advice (SBSTA)/UNFCCC to consider and develop modalities and procedures for these, but with a specific focus on revegetation first.

Scope and methodology

The extensive scope of work described in the initial ToR is addressed in four related sections. It was initially proposed in the inception report to address each of the points below in separate reports. However, as the project developed, Cirrus, in conjunction with Cardno Emerging Markets and the DEA, decided to combine the reports into a single piece of work, as monitoring and methodologies are interlinked. This would therefore help reduce the repetition involved in covering all the elements in a South African context. It would also avoid reintroducing standards, key methodological components, such as baselines and leakage, and emerging concepts.

Therefore, it was decided that it would be better to structure this as one coherent, integrated document. In terms of fulfilling the ToR, as indicated below, the sections are addressed in the following separate chapters:

- A review of existing international standards and methodologies pertinent to the main mitigation opportunities listed in the NTCSA (chapters 1 and 2)
- An assessment of the monitoring requirements of each activity and opportunities to improve cost-efficiencies (chapters 3 and 4)
- A broad analysis of investment risks inherent in each mitigation activity (Chapter 6)
- Reflections on a future South African carbon offset standard (Chapter 7)

Following the initial analyses of methodologies, monitoring requirements and cost assessments, emerging concepts and next steps have been further explored (chapters 5 and 8).

It should be noted that our methodology has been calibrated to align with the indicated budget and time allowance for the project. The full development of the standard and set of methodologies, including country-specific monitoring protocols, is estimated to be sufficient work for a team of at least four professionals over a period of three to four years, and would include extensive fieldwork, remote sensing, workshops and stakeholder engagement. Our methodology has been structured to address the most important issues (in terms of realising national implementation) and will provide clear guidance on potential subsequent steps.

Chapter 1: Description of the South African context

The design of an appropriate methodology and associated monitoring framework is directly determined by the nature of the particular climate change mitigation activity, which in itself is composed of several elements. These elements include the manner in which atmospheric GHGs are reduced due to the activity and nature of the implementation model and implementing agent. In addition, in the context of activities that extend over landscapes (e.g. A/R, REDD+, grassland restoration), several further elements need to be considered, including the ecological and socioeconomic context and the nature of land tenure in which the project is located.

The intention of this section is to briefly describe the nature of each type of land use-based climate change mitigation activity in a South African context. This will inform the technical analysis that follows, as well as the risk assessment and suggested appropriate options. A "typical" context is described based on stakeholder input and the team's experience. There will certainly be variation from this typical, common context, but the goal is to broadly inform the identification (and potential development) of methodologies and monitoring frameworks that are appropriate to the majority of implementation situations in the country. Certain activities, such as reforestation, have been disaggregated into a number of "sub-activity" types, as the nature of implementation is fundamentally different for each, thereby requiring different methodological, monitoring or risk management considerations.

1.1 Reforestation: subtropical thicket restoration

Nature of GHG emission reduction or sequestration of carbon

- Additional atmospheric carbon dioxide (CO_2) is sequestered in the biomass and soil organic carbon pools during the process of restoring subtropical thickets on previously degraded farmland.
- Adverse livestock farming methods during the 1960s and 1970s led to the widespread degradation of subtropical thickets, leaving lands in an open state with depleted biomass and soil carbon stocks. All indications show that degraded or degrading lands would remain in an open state unless *Portulacaria afra* (spekboom) and other key species are replanted in dedicated rehabilitation programmes.
- The NTCSA noted that a sequestration rate of 4.3 tCO_2e/ha.yr (Mills & Cowling, 2006) could be conservatively expected or approximately 2.2 million tCO_2e a year if implementation occurs at scale across the biome.

Nature of implementation

- The restoration of subtropical thickets is expected to take place on land predominantly owned by the government and private individuals.
- Government land in this context is either land under the jurisdiction of municipalities or conservation agencies, e.g. the restoration process currently underway in the Addo Elephant National Park. In this case, local contractors, under the auspices of the EPWP, would undertake implementation. The local municipality or a conservation management agency would oversee the restoration process and manage the restored land over the long term.
- Privately owned land may either be in the form of conservation areas, established commercial farms or land that has recently been redistributed to emerging farmers. Landowners are expected to participate, as it is in their interest to restore the ecological integrity of their land and associated agricultural production and other ecosystem services. Access to a carbon-based revenue stream is likely to be a further substantial incentive for activity adoption.
- In a similar manner to government land, private landowners may require additional external capacity to undertake the initial restoration and planting process. The EPWP has provided this capacity in certain cases to date. The long-term management of the activity would remain the landowner's responsibility.
- The majority of interviewed stakeholders and project developers that are located in the biome repeatedly noted the need for a programmatic approach to implementation that would include a facility that provides support through the implementation process – from initial awareness and education, through to project identification, development and documentation, and assistance with monitoring, reporting and verification over the long term. This refers essentially to an entity that would build on the significant work that the DEA's Chief Directorate: Natural Resource Management has already undertaken in the subtropical thicket biome. In the absence of such a facilitating entity, it is unlikely that implementation will be realised at scale.

Land-tenure considerations

- In the case of both privately owned and government land, tenure can be demonstrated through title deeds. A copy of the title deed will need to be included in material presented to the auditor in order to demonstrate clear, undisputed ownership of the land. This, in turn, establishes proprietorship over the emission reductions realised over the course of the intervention.
- Importantly, these forms of tenure ensure that the landowner is an adequate legal counterparty, with rights of use to the land, which is required under any standard. Additionally, proven tenure or other demonstrable rights of use will improve a project developer's ability to attract commercial financing and associated support.

Socioeconomic context

- **Privately owned land – established entities:** Whereas the management of commercial farms and conservation areas typically has sufficient resources to initially explore the opportunity, they generally do not have the appetite to invest substantial capital in an overly expensive project development, documentation and validation process, without clear demand for carbon assets over the long term. Although farmers have indicated willingness to implement restoration measures, stakeholders noted that an established market and support system will be required if implementation is to be realised at scale. This system could leverage established farmer union networks and communication channels, rather than starting anew.

- **Privately owned land – emerging farmers:** The tenure context of emerging farmers is similar to established entities. However due to lower financial resources and a lack of established unions and networks, additional awareness, extension and support services may be required to ensure that activities are adopted and sustained over the long term.

- **Government-owned land – municipalities and conservation agencies:** In this context, agencies noted that they may be able to provide oversight and managerial support to implementation over the long term, but additional awareness, extension and support services may be required to realise implementation, monitoring and incentive mechanisms.

- **Further considerations***:* In each of the three contexts listed above, entities noted that additional capacity might be required at several stages over the lifetime of the activity. Stakeholders noted that additional capacity is required to restore and replant lands, which is often provided through the EPWP. In addition, there may be good opportunity to reduce capacity and expertise demands through the recruitment and training of "eco-rangers" to undertake monitoring and reporting tasks in an adequate and efficient manner. The "eco-rangers" may be positioned within the EPWP or a new subtropical thicket restoration programme that facilitates a programmatic approach to implementation across the biome.

Existing examples in South Africa and elsewhere

- Kuzuko Lodge Private Game Reserve, which covers 5 300 ha and is registered under the VCS. It was developed by Spekboom Trading (Pty) Ltd[5].
- Addo Elephant National Park, where approximately 7 000 ha of spekboom was planted as part of the Working on Land Programme.

There are numerous examples of reforestation initiatives in Africa, which are registered under both the CDM and VCS. Registration does not guarantee the issuance of credits, as monitoring events and associated verification audits must first be successfully undertaken.

The following projects have been registered, and the first three have issued emission reductions for sale. It has, however, not been disclosed whether sales have been made:

- Natural High Forest Rehabilitation Project on Degraded Land of Kibale National Park Project (validated to the VCS, credits issued): Over 6 200 ha of degraded forest has been rehabilitated in Uganda's Kibale National Park.
- Bukaleba Forest Project in Uganda (validated to the VCS, credits issued): Approximately 2 000 ha of degraded grassland and shrubland has been reforested.
- Humbo Ethiopia Assisted Natural Regeneration Project (validated the CDM, credits issued): This project seeks to use assisted natural regeneration techniques to reforest over 2 700 ha of land using indigenous tree species.
- Aberdare Range/Mt. Kenya Small-scale Reforestation Initiative (validated to the CDM, credits yet to be issued): This initiative has completed the reforestation of 1 649 ha of land, including land within a government forest reserve.

5 http://africanclimate.net/en/node/9268

1.2 Reforestation: commercial small-grower model

Nature of GHG emission reductions or the sequestration of carbon

- The forestry industry has indicated that approximately 60 000 ha in the Eastern Cape and 40 000 ha in KwaZulu-Natal are suitable for afforestation activities through a small-grower model.
- Under a business-as-usual without activity scenario, it is assumed that target areas would remain in an open, degraded state with marginal woody biomass carbon stocks (if anything at all).
- The activity primarily includes the establishment of Eucalyptus plantations that are grown on a seven- to eight-year cycle for wood pulp markets.
- The NTCSA reported that approximately 550 000 tCO_2e could be sequestrated in woody biomass over the project period. This estimation is based on the average increase in the woody biomass pool over time, as plantations go through growth and harvesting cycles.
- As the understory of the plantation may be cleared or burnt at intervals, the herbaceous, deadwood and litter carbon pools are not included in sequestration calculations. Due to high monitoring costs, most plantation projects have not included the soil carbon pool in reporting to date. This may change if a more cost-efficient form of monitoring soil carbon is developed or if a model or default value approach is assumed.

Nature of implementation

- Large-scale commercial forestry operators, such as Sappi or Mondi, would partner with local communities to develop small-scale commercial tree lots. It is expected that the forestry operator will extend assistance in the form of technical support, seedling provision, interest-free loans, fire protection and guaranteed off-take purchase agreements. Interested local parties will participate by providing the long-term management of biomass stocks on their lands, be they individually or communally operated.
- Smallholders are motivated to participate in this model due to the relatively limited risk of the operation and a guaranteed off-take agreement that provides predictable income.
- Large-scale forestry operators seek to participate in this model, as it increases their access to timber and reduces some of the internal risks and costs of production through the outsourcing of operations.

Land-tenure context

- Implementation under this model would occur on communal land. This may result in tenure issues in certain cases, particularly if smallholders have not acquired a title deed or have established clear user rights to the land on which implementation occurs. Similarly, in cases where a commercial venture is undertaken by several members of a community on communal land, the allocation of ownership rights over carbon will require a comprehensive legal assessment and may require negotiations to be facilitated between all contracting parties.
- A legal agreement therefore needs to be reached between the forestry operator and the smallholder(s) to clarify the nature of who owns potential carbon assets generated by the venture, as well as between any community members or community organisations that seek to jointly develop a project. Legal and financial agreements would need to be established upfront to ensure that communities and the forestry company are fully aware of the structure and magnitude of incentives. It is assumed that ownership would be transferred to the forestry company, who would include a share of carbon revenues as part of the financial incentive provided to small-growers.
- It is debatable whether the small-grower would form an adequate legal counterparty in case of default. However, due to the nature of the implementation model, a large number of small plantations (several thousand), the impact of default by a small set of small-growers may not significantly affect the feasibility of the venture. Furthermore, as part of a greater comprehensive risk assessment of the venture, typically a 20% risk discount on issued emission reduction units is imposed by the VCS and other international carbon standards.

Socioeconomic context

- The commercial small-grower model is based on a partnership between large, established, commercial forestry companies and local residents who have access to land and are keen to realise additional livelihood and income opportunities where possible.
- Although each plantation may be located on communal land and may be implemented on site by local residents, the overall activity is managed by a well-resourced commercial company that provides supporting functions throughout the implementation cycle, and a market for generated pulp wood. Supporting functions range from early planning and assessments to awareness creation, training and planting, day-to-day extension services, and assistance with harvesting and financing.
- Such an approach greatly reduces the typical risks associated with implementation on communal land

and considerably reduces capacity and cost burdens that would usually be imposed on small-scale implementers in the process of attempting to access carbon revenues.

Existing examples in South Africa and elsewhere

- Sappi currently purchases timber from 20 000 ha of outgrowers' land, comprising some 15 000 participants. However, licensing has slowed down. In 2014, licences had only been released for approximately 400 ha of smallholder timber production, less than 1% of the total opportunity. The limited uptake to date is in part related to difficulties in obtaining the requisite licences (notably water licences) and associated delays within government departments. This has negatively impacted on the ability to realise the true potential of this opportunity.

1.3 Reforestation: small-scale on communal or municipal land

Nature of GHG emission reductions or the sequestration of carbon

- Reforestation typically occurs in areas that were previously degraded or used for agricultural purposes (e.g. sugarcane and marginal subsistence agriculture) and left in an open state. In the majority of cases, the biomass carbon pool is severely depleted and soil carbon stocks may be degraded as well.
- Implementation focuses on the restoration of forests through the planting and seeding of indigenous tree species.
- The activity therefore results in an increase in the size of the biomass carbon pool (woody, herbaceous, deadwood and litter), as well as an increase in soil organic carbon.
- Due to their relative size and the impact of surface fires, the herbaceous, deadwood and litter pools are not typically monitored. In a similar manner, the change in the size of the soil organic pool has not been monitored to date, but this is primarily due to cost and capacity concerns. This may change if a more cost-efficient or default value/model approaches are adopted.
- The NTCSA noted that a conservative sequestration rate of 6.4 tCO_2e/ha.year can be expected following the restoration of coastal and scarp forests (biomass pool only (Glenday, 2007) and 4 tCO_2e/ha.year in woodland ecosystems (biomass pool only) (Knowles, 2011).

Nature of implementation

- In a South African context, reforestation activities on communal or municipal land are either implemented by municipalities, the EPWP or NPOs that are focused on the conservation of natural resources and community upliftment. In practice, these three entities may collaborate on certain ventures where NPOs are contracted by municipalities or the EPWP to undertake certain tasks.
- The implementing agent will identify sites, erect and manage local nurseries, where feasible, train local community members in silviculture and monitoring activities, oversee planting and monitoring, and generally provide managerial support. It is assumed that community members will ensure ongoing tree health, but they will receive technical support as required.
- Community members are likely to participate due to training, employment and income-generation opportunities, as well as the chance to restore degraded lands and associated ecosystem services.

Land-tenure context

- Implementation would occur on municipal/government land or on communal land.
- Land tenure may not be a significant issue in terms of risk, where implementation takes place on municipal/government land, e.g. the Buffelsdraai Community Reforestation Project.
- Tenure may be difficult to prove when planting takes place on communal land and ownership of the carbon credits generated may be disputed. A transparent, inclusive, well-documented and well-managed community engagement process should be undertaken to avoid disagreements and confusion. Legal support may be required to demonstrate land tenure, taking into account the varied land-tenure systems in South Africa, and ensuring compatibility with international carbon standards.

Socioeconomic context

- The design of small-scale reforestation activities is often strongly influenced by the acute need to generate skills development and employment opportunities in rural areas in South Africa. In addition to the restoration of carbon stocks, ecosystem services and natural capital, the primary reason for the adoption of many small-scale programmes is the creation of livelihoods where alternatives are rare.
- Within reason, implementation, monitoring and reporting frameworks should be designed to create local employment where possible by recruiting and training locals with limited education to undertake the monitoring of the required biophysical and social parameters.




Existing examples in South Africa and elsewhere

- Small-scale reforestation in South Africa has either been pioneered by a number of NPOs, in partnership with municipalities and the EPWP, or it is based on donor funding. Early entities include the following:
  - Wildlands Conservation Trust – www.wildlands.co.za
  - Wilderness Foundation – www.wildernessfoundation.co.za
  - Wildlife and Environment Society of South Africa (WESSA) – www.wessa.org.za
  - The International Small Group Tree Planting (TIST) Programme in East Africa – www.tist.org
- The CCBA has validated the Buffelsdraai Community Reforestation Project (implemented by eThekwini Municipality in partnership with the Wildlands Conservation Trust), but few other projects have been validated through international carbon standards.
- Members of municipalities and NPOs noted that the difficulty with proceeding through validation processes is due to the high transaction costs and risks associated with monitoring and validation, combined with the lack of a long-term substantial demand for generated emission reduction units.

1.4 Grasslands: avoided degradation and restoration

Nature of GHG emission reductions or the sequestration of carbon

- The NTCSA reported that approximately 62% of the country's terrestrial carbon stock is located in grassland and open savanna ecosystems. Within these systems, approximately 94% of the total carbon stock is located below ground in the soil organic carbon pool.
- The degradation of grasslands through adverse livestock management practices and accelerated erosion leads to the release of sequestered carbon into the atmosphere. Alternatively, the restoration of grasslands through erosion control and the adoption of appropriate livestock and veld management practices leads to the restoration of carbon flows and an increase in soil organic carbon over time.
- The two activities (the avoided degradation of grassland and the restoration of grasslands) would usually be considered separately in terms of methodological and monitoring requirements (in a similar manner to the way in which reforestation and REDD+ activities are considered as clearly separate activities by international carbon standards). However, in the South African context, potential implementing agents noted that both activities are liable to be combined into a single intervention at scale, e.g. the restoration and long-term management of a catchment.
- It is therefore suggested that these two activities be considered jointly in a South African context to reduce costs and improve efficiencies. The two activities will occur within the same landscape. Although degradation and restoration have traditionally been considered separately (REDD vs reforestation), the two activities will occur in the same landscape, and will require the same analysis of soil carbon and scenario development over time. Thus, a large percentage of the baseline and additionality scenarios, including laboratory fees, would need to be undertaken twice if the activities were tackled separately. Joint consideration negates this repetition and introduces greater efficiencies.

Nature of implementation

- A number of entities, in the form of the EPWP, local government, municipalities, conservation agencies, NPOs, commercial farmers and academic institutions, have pioneered the restoration of degraded grasslands in South Africa.
- In terms of the key determinants of success and adoption over the long term, interviewed officials and stakeholders noted that grassland restoration is certainly not a case of "one approach fits all", but rather that a more flexible, bottom-up approach is required to ensure that implementation measures are tailored towards the specific ecological, commercial and socioeconomic context of the area. Such an approach improves the likelihood of success and creates a sense of ownership among participating parties.
- Despite a potential variety of implementing agencies being required across the grassland biome, a number of common suggested structures and principles emerged during the engagement with officials and stakeholders:
  - A form of facilitation entity is required to promote, manage, monitor and report the activity at a provincial or biome scale – in a similar manner to the activity facilitation units described in the NTCSA. Stakeholders noted that an entity that performs this function is currently absent, leading to the non-realisation of potential opportunities. Due to the high transaction costs and risks associated with developing a new activity (and potentially a new methodology), private entities or NPOs are unlikely to have the appetite for such development.
  - The entity could initially facilitate the required feasibility assessments and research, and create awareness of the opportunity in local government, rural communities and commercial agriculture.

- Thereafter, the planning of the interventions would happen in a bottom-up manner, followed by the creation of implementation capacity within local government or through partnerships with the EPWP and established NPOs (depending on the particular needs of the project).
- Monitoring and reporting could be directed and managed by the entity, but the intention would be for field monitoring by "eco-rangers", who would assess a broad range of ecosystem services, and operational and social parameters, in addition to the main metrics required for carbon offset reporting.

Land-tenure context

- The avoided degradation and restoration of grasslands is principally expected to occur on municipal and communal land.
- On communal land, emphasis will need to be placed on creating agreements with local authorities that decrease the risk of default and non-delivery of envisaged project outcomes over the lifetime of the activity.
- Stakeholders and officials noted that these forms of risk could be further managed through thorough planning, the adoption of a bottom-up approach and the creation of a biome-scale activity that would reduce the impact of particular entities' default on the net risk profile of the entire activity.
- The creation of a provincial or biome-scale grassland restoration programme that is comprehensively supported by local and national government would further reduce risks related to tenure.
- If the intention is to develop the opportunity for validation under an internationally recognised standard, a comprehensive legal assessment of right of use should be undertaken in order to demonstrate compliance with ownership specifications.

Socioeconomic context

- Although implementation may be facilitated through district municipalities, NPOs and entities such as the EPWP, the majority of implementation is likely to occur on communal land that is presently occupied, or used to a certain extent, by low-income communities.
- Communities such as these generally have few income and employment opportunities. Therefore, activity interventions and associated monitoring and reporting should be structured in a manner that will create local jobs where reasonably possible.
- Interviewed officials and stakeholders strongly advocated the recruitment of local people as implementing officers and "eco-rangers" to undertake such tasks.

Existing examples in South Africa and elsewhere

- Although entities such as Ezemvelo KZN Wildlife and others are pioneering significant grassland management programmes in the greater Drakensberg area, there are no examples of validated projects under international carbon standards yet.

1.5 REDD+: reducing emissions from deforestation and forest degradation in developing countries and the role of conservation, the sustainable management of forests and the enhancement of forest carbon stocks

Nature of GHG emission reductions or the sequestration of carbon

- GHG emission reductions are realised through a reduction in deforestation and forest degradation, and the role of conservation, the sustainable management of forests and the enhancement of forest carbon stocks in developing countries.
- In comparison to the large-scale frontier-type deforestation observed in the Congo Guinea Belt and elsewhere in the Tropics, deforestation in South Africa tends to occur in a disaggregated manner, where parties are degrading numerous forest patches, often in a mosaic-like manner.
- As an example, Ezemvelo KZN Wildlife has observed the clear, but dispersed deforestation of a substantial fraction of the over 1 500 of the forest patches that it monitors.
- In terms of monitoring particular pools, project proponents principally assess and report changes in the biomass, deadwood and litter carbon pools, as well as the soil organic carbon pool, if it can be undertaken in a cost-effective manner or through the adoption of default values.

Nature of implementation

- The main aim of a REDD+ activity is to adequately address observed drivers of deforestation in a manner that leads to a net reduction in GHG emissions and the sustainable management of forests over the long term.
- Interviewed officials and stakeholders noted that where the deforestation of forest pockets occurs, it is not necessarily driven by large established commercial entities, but rather by local residents seeking timber, fuelwood, charcoal and associated livelihood opportunities.

- Established REDD+ projects in Kenya, Tanzania, Zambia and Zimbabwe address such drivers of deforestation through improved forest and fire management processes, together with the creation of a suite of alternative livelihood opportunities[6]. Such opportunities are typically identified in a bottom-up, participatory manner with communities, which ensures that they are applicable and acceptable over the long term, and would typically include improved fire and grassland management, as well as sustainable timber and charcoal production, nursery and reforestation activities, improved agriculture and improved agricultural output.
- Additional forest and fire management practices do not necessarily require a halt in the use of forest resources, but a shift from unsustainable to sustainable utilisation.
- Both the additional forest management and alternative livelihood opportunities are typically developed in a bottom-up manner through consultation with local residents, government and stakeholders.
- No validated REDD+ activities exist in South Africa on which to base the scaling up of existing implementation. It is, however, envisaged that the implementation of REDD+ at scale would follow a similar structure to the framework suggested by stakeholders for a grassland-based programme (described above).
- The high cost of establishing baseline scenarios and monitoring REDD+ activities lends itself to the creation of a "jurisdictional approach" that would be overseen by a facilitation entity and implemented on the ground through a range of implementation partners, including local government, national and provincial conservation agencies, NPOs and private concerns. Such an approach allows for the cost-efficiencies of implementation at scale to be realised, while allowing for a tailored approach to implementation in specific contexts. A structured approach at a landscape scale generates a substantial amount of data that is important not only to project reporting, but also to national reporting, including to the UNFCCC.

Land-tenure context

- The implementation of REDD+ activities is primarily expected to occur on government and communal land.
- Similar to the grassland-based activities above, there may be concern regarding land tenure in communal areas. However, this may be addressed to a sufficient extent through careful consideration of legal agreements, adequate support over the full project period, and a broader jurisdictional approach where default in a few cases would not substantially affect delivery by the entire programme.
- However, a comprehensive legal assessment should be undertaken to ensure compliance with international standards' specifications covering right of use with regard to land and ownership over avoided emissions. This may need to be complemented by a transparent, thorough stakeholder engagement process to ensure that benefits flow to appropriate, targeted parties and that all the required legal documentation is in place. In addition, this will assist in showing that the developed activity meets environmental and social safeguard requirements.

Socioeconomic context

- Deforestation and forest degradation in South Africa is usually the result of local entities utilising forest resources in an unsustainable manner. This is often due to marginalised communities having few other energy, resource or livelihood opportunities. If deforestation and forest degradation is to be adequately addressed, alternative resource and livelihood opportunities need to be created.
- Although the activity may be overseen by a jurisdictional facilitation entity, implementation and monitoring should be designed in a manner that leads to additional income and employment opportunities where reasonably possible.

Existing examples in South Africa and elsewhere

- No REDD+ activities located in South Africa have yet been formally validated or verified through international carbon standards.
- Interviewed stakeholders noted that this is principally due to the high transaction and monitoring costs associated with validation, relative to the size of small-scale initiatives. A broader jurisdictional or programmatic approach that bundles numerous projects together is an ideal approach to cut down on transactional costs.
- There are good examples of REDD+ projects in Kenya, Zambia and Zimbabwe that have obtained validation through the VCS, but these initiatives are considerably larger in scale than typical South African opportunities.

6. Please see further details on the project websites:
http://southpolecarbon.com/Kariba/page/projectpage.php
http://biocarbonpartners.com/lowerzambeziredd-project/
http://www.awf.org/projects/kolo-hills-redd
http://www.wildlifeworks.com/saveforests/forests_kasigau.php

1.6 Conservation farming and the application of biochar

Nature of GHG emission reductions or the sequestration of carbon

- The concept of "conservation agriculture" is based on three general principles:
  - Minimal soil disturbance
  - Permanent soil cover
  - An increase in plant diversity through crop rotations and diverse cover species
- There will be considerable variation in application depending on the particular crop, soil type, climate, capacity of farm management, etc., but, in general, the aim is to follow the three basic principles listed above.
- The implementation of the principles may in theory lead to an increase in the size of the soil organic carbon pool through an increase in inflows of organic matter, an increase in soil structure, microbial activity and associated biological processes.
- However, this assumption needs to be tested across a range of South African locations, and soil and crop types, as the influence of conservation agriculture principles on soil carbon is not necessarily universal (Govaerts, Verhulst, Castellanos-Navarrete, Sayre, Dixon and Dendooven, 2009; Palm, Blanco-Canqui, De Clerck, Gatere and Grace, 2014; Scholes et al., 2013).
- The main climatic benefit of conservation agriculture, and particularly a reduction in tillage, may be through a reduction in diesel usage compared to a conventional tillage scenario.
- Initial indications show that the adoption of no-till or low-till practices may lead to a 66% reduction in diesel usage during ploughing operations[7].

Nature of implementation

- To date, the implementation of conservation farming principles has mainly occurred within the commercial farming sector and predominantly in the Western Cape, where up to 60% of commercial farmers may have adopted certain of the principles to date.
- Adoption is expected to gradually increase within the commercial and small-grower sectors, although the cost of additional machinery and capacity may hinder the complete roll-out of the activity at scale across the country.
- Where the additional cost of machinery, capacity and expertise limits roll-out, a case for additionality may be made, which would make conservation farming potentially eligible for carbon revenues.
- It should be noted that the primary reason for the adoption of conservation tillage practices is not necessarily climate change mitigation, but rather a broad suite of benefits that include increased crop production, improved soil fertility, improved water retention and a reduction in soil erosion. Conservation agriculture is therefore often viewed as more of a climate change adaptation response than a climate change mitigation measure.

Land-tenure and socioeconomic context

- The activity is expected to occur in commercial agriculture, as well as small-grower and subsistence farming schemes.
- Commercial agriculture typically occurs on privately owned land by a relatively well-resourced entity. Importantly, commercial agriculture has established sector organisations, unions and associated communication channels and capacity, through which implementation, monitoring and incentives can be facilitated at scale.
- Implementation within the small-grower and subsistence farming sectors would typically occur on communal land where particular attention may need to be paid to ensure permanence over a 20- to 30-year period. Interviewed stakeholders suggested that implementation in this domain may take on a similar structure to the implementation of grassland and reforestation activities in areas with communal land tenure. An activity facilitation unit would be needed to plan and manage the activity at scale, but actual implementation and monitoring may be undertaken through established government structures, the EPWP, NPOs or the private sector.

Existing examples in South Africa and elsewhere

- The principles of conservation agriculture have already been adopted at scale in the Western Cape, where it is estimated that approximately 60% of farmers are following a form of this approach.
- Although there are smaller areas in KwaZulu-Natal and North West where commercial farmers are following this practice, there is substantial opportunity to scale up the implementation of the practice across the country.
- The Kenyan Agricultural Carbon Project (validated to VCS) realises carbon emission reductions through improved soil-management and tree-planting practices across a portfolio of smallholder farmers' lands.

7. Personal communication: Dr Johan Strauss, Elsenburg.




1.7 Biomass to energy

Nature of GHG emission reductions

When looking at the emission reduction dynamics of biomass-to-energy projects, two types of activities can be distinguished:

- On-site emission reductions (Scope 1)
- Off-site or indirect emission reductions (Scope 2)

The on-site emission reduction-based activities reduce emissions via the replacement of on-site fossil fuels like oil, gas and coal with sustainable biomass as the fuel. The fossil fuels in the baseline and the biomass in the project scenario are most commonly used to generate steam and, in some cases, heat as well. The off-site emission reductions result from a reduction in (fossil fuel-based) grid electricity with electricity or direct energy derived from the biomass as a fuel, although biomass can be used to generate electricity via a steam turbine.

Nature of implementation

At the moment, five biomass-to-energy projects are registered under the CDM in South Africa, of which the majority are implemented by large, integrated pulp and paper companies. In these instances, the source consists of leftover biomass from the forestry and pulping process. The production of paper requires a substantial amount of steam and heat, which is provided by a boiler or a number of boilers. Typically, the coal used for these boilers is replaced by the leftover biomass from upstream activities.

In some instances, the source of the biomass is provided as part of an invasive species removal programme, and the biomass is converted into briquettes or pellets to be used elsewhere to replace fossil fuels.

Land-tenure context

From a land ownership and continuation of use perspective, biomass-to-energy projects are not critically dependent on the source being the same during the entire crediting period. However, it is crucial that the project can demonstrate, on an ongoing basis, that the biomass used is of a sustainable nature and meets the biomass sustainability criteria as agreed in the project design documentation. For this reason, it is more practical and less risky from a verification point of view to either own or have a long-term contractual off-take agreement with one or two sources, rather than having multiple sources that change over time.

Project development and auditing risks

The technology used to utilise biomass as a fuel instead of fossil fuels is completely mature and does not pose a material project development risk. When looking at biomass-to-energy projects globally and in South Africa, it becomes apparent that the primary risk lies in the availability of a consistent and reliable source of biomass. In some instances, the biomass originally envisaged for the project meets all the sustainability requirements, but as a result of a forest fire, ceases being available. The project then has to switch to alternative sources, and this provides a substantial auditing/verification risk.

1.8 Anaerobic biogas digesters

Nature of GHG emission reductions

Anthropogenic emission reductions from anaerobic digestion can have one or two sources. Both types reduce emissions in the sense that the biogas resulting from the anaerobic digestion can replace fossil fuel as an energy source in the generation of electricity and/or heat. Depending on the source of the biomass, an anaerobic digestion project can also reduce emissions by preventing methane from escaping into the atmosphere.

If the biomass is harvested or collected with the purpose of being anaerobically digested, chances are that methane was not generated prior to harvesting, and that it went into the atmosphere. Therefore, the anaerobic digestion and biogas energy activities did not reduce these emissions. However, if the biomass was already disposed of or processed in a manner that generates methane, the project would reduce these emissions into the atmosphere. For example, if cow manure is spread out in the field, it is aerobically digested and no methane is generated in material quantities. However, if the manure is processed in a lagoon system (basically a set of open ponds filled with manure), it is anaerobically digested, and therefore results in the generation of methane into the atmosphere. Hence, emission reductions from both sources result from the replacement of fossil fuel with biogas; however, it is only in the case of the latter source that a reduced amount of methane is also emitted into the atmosphere.

Nature of implementation

In most cases, an anaerobic digestion project consists of three components: the anaerobic digester, the electricity generator and the flare. The biomass fed into the anaerobic digester is processed (digested), which results in the generation of biogas. Depending on the type of biomass and the efficiency of the digester, biogas contains between 40 and 60% methane. After cleaning the biogas, it is either fed into an electricity generator or combusted in a flare. The primary objective is to flare as little as possible of the biogas, but due to the limited volume that can be stored in relation to the fluctuation in demand, the remaining methane has to be flared.

In some very limited cases, biogas from an anaerobic digestion process is upgraded and compressed to meet compressed natural gas (CNG) standards, and it is used as compressed biogas (CBG) in transport applications.

Project development and auditing risks

After renewable energy projects like wind and solar projects, anaerobic digestion projects are the most common projects under the CDM. The methodologies applied are elaborate, but workable, as is proven by the large number of registered projects. The primary risk lies in the verification process. This is mainly caused by an interesting conundrum in that the methodologies available for these projects require that not only the biogas generated and used for the production of electricity is monitored, but also the biogas flared. The most commonly used flares are so-called open flares. However, to measure the combustion efficiency of the flare, it needs to be covered by the monitoring equipment, making it a closed flare. Hence, it is not technically possible to measure the efficiency of an open flare. To address this, the methodology sets high requirements as to the operation of the flare and the monitoring of other parameters of the flaring process (e.g. temperature.). The consistent monitoring and processing of these parameters in itself forms the primary auditing/verification risk of emission reduction projects of this type.

Chapter 2: Technical analysis of methodology elements

2.1 Introduction

Why have methodologies been created?

One of the most important elements of a project design document (PDD) is a description of the manner in which the GHG emission reductions (or carbon sequestration) due to the project activity are assessed and reported. As the legitimacy of emission reduction units and associated carbon standards are closely dependent on this element, substantial emphasis has been placed on ensuring that the process is scientifically robust, conservative and transparent.

Recognising the importance of this element, early CDM developers considered it to be a clearly discrete section within the PDD. Known as a "methodology", its independent consideration is useful for a number of reasons:

- A separate section with a predefined structure ensures that all key assumptions, parameters, calculations and reporting mechanisms are communicated in a structured, cohesive and comprehensive manner.
- A particular methodology is generally applicable to more than one project, which share a common type and scope.
- As this element is often one of the most expensive to develop, under high levels of scrutiny and open to validation risk, the creation of an approved set of methodologies reduces costs and risk, and streamlines the development and auditing of CDM activities.

In general, from a practical point of view, a substantial portion of project developers' concerns regarding project eligibility, clarity on the potential volume of carbon offsets that could be realised, and development and monitoring costs is closely dependent on the methodology adopted by the project. The creation of applicable methodologies that are already formally recognised by international carbon standards addresses these concerns, as well as validation risk to a significant extent.

What is a methodology?

A methodology is a standardised, approved and recognised approach for quantifying the GHG emission reductions and carbon sequestrated by a project activity. It allows the project developer to describe the project's main attributes within a predetermined framework, which encompasses the project's boundary, baseline, additionality, leakage and monitoring approach. Any project that wishes to be approved under a given standard must first identify a methodology, apply its various component parts to the project, have the project assessed by a third party, and submit it for final review to the standard. Deviations from a methodology are rarely granted and require the completion of additional paperwork.

When a project is audited against a methodology, an auditor assesses the consistency, transparency and reproducibility of emission reduction calculations and reviews the broad assumptions that were applied to develop results. Methodologies create a simple framework for robust projects, but their blueprint approach could also theoretically be abused by projects that are not truly additional. To combat the potential gaming of a methodology, most standards tend to err towards requiring overly rigorous, intensive methodologies and auditing. This sometimes raises project development costs to the detriment of promoting participation, but leads to greater trust in the additionality of accepted credits.

How does a methodology work?

A project developer is required to determine which existing methodology, if any, is most suitable to the emission reduction activity for which carbon credits will be claimed. A first step is to ensure that the project meets each methodology's unique applicability conditions, for which there is a dedicated section. A full feasibility assessment of potential costs, monitoring requirements and emission reduction potential should be undertaken next to ensure that the project meets the developers' expectations for financial return, and that there is appropriate expertise available. Developers can access methodologies for this purpose on a given standard's website, along with associated tools for easy access by the public. The CDM has also published a booklet that provides an overview of all its methodologies to facilitate the process of identifying an appropriate methodology[8].

The process of developing a project to a methodology is usually quite time-consuming and resource-intensive. It requires the collection of documentation about and metrics for the project: financials, historical land-use practices prior to the project start, operational

8 https://cdm.unfccc.int/methodologies/documentation/meth_booklet.pdf

processes, environmental and social impacts, stakeholder engagement(s), collecting monitoring data, satellite imagery analysis, research into relevant local, provincial and national policies, emission reduction calculations, etc. Time must be allocated to developing all written content into a PDD and managing the external audit process. In most instances, a project will require outside support from consultants, and/or technical experts in a given field to ensure the integrity and accuracy of results. Some projects are able to attract donor or loan finance to cover the initial upfront development costs, although riskier projects with less clear emission reduction potential, untested technology or limited success in reaching validation through CDM, VCS or GS processes are far less likely to receive support from the private financial sector.

A number of tools are typically developed in association with a given methodology or broad set of methodologies in a given sector, and are to be adopted when appropriate to the project context. Tools are intended to provide practical advice and direction on how to collect certain data elements, describe project characteristics, assess additionality and maintain records, to name a few.

The intention is to reduce the project developer's risk by providing clear, thorough explanations of how to implement all elements of a methodology, providing a common template of assessment for both the developer and the auditor.

Project developers use a project design template, published by a standards body, to describe the application of the methodology to the project conditions. The template includes additional information as required by the standard, such as the results of stakeholder engagement and environmental impacts. All the steps and equations required to assess the overall emission reduction potential of the intervention are captured in the methodology, supported by more descriptive, detailed tools. The template requires additional field-based research to be undertaken, above and beyond that detailed in the methodology. These standard-specific requirements and associated costs are not assessed in this analysis. The table below details the CDM PDD template requirements and where the methodology components would be addressed within the form.

Table 5: The CDM PDD template requirements and where the methodology components would be addressed within the form

CDM PDD section	Information pertaining to methodology
Section A: Description of the project activity	Project boundary
Section B: Application of selected approved baseline, monitoring methodology and standardised baseline	Scope and applicability conditions Baseline and additionality assessment GHG reductions/removals assessment Leakage Monitoring framework
Section C: Duration and crediting period	GHG reductions /removals assessment
Section D: Environmental impacts	No content specified in the methodology
Section E: Socioeconomic impacts	No content specified in the methodology
Section F: Local stakeholder consultation	No content specified in the methodology
Section G: Approval and authorisation	No content specified in the methodology

Once the template has been completed, it is sent to the standard authority for a quality check before it can be released to the independent auditing firm engaged by the project. In the case of the CDM, the local DNA, an independent government body, must also approve the project's contribution to local sustainable development as a qualification for validation. The VCS does not require government consent. The auditing firm reviews all documentation – the PDD and primary references. It also visits the project site to ensure that statements made in the PDD are a true and accurate reflection of activities and processes on the ground. Typically, the auditor will identify issues that need to be addressed, either as corrective action requests or clarifications. While technically the process of addressing these issues and finalising the review process could only take a few months, the stakeholder engagement phase and Cirrus's own experience has indicated that this process can take anywhere from six months to two years to complete – sometimes longer. Moreover, a significant number of projects are never validated to a standard, due to technical error, poor documentation, a lack of follow-through or a shortage of financial resources.

2.2 Considered methodologies for landscape-orientated activities

A substantial set of CDM and VCS methodologies has been compiled and validated to date.

A full list of approved methodologies can be found on each standard's web portal:

- CDM: https://cdm.unfccc.int/methodologies/index.html
- VCS: http://www.v-c-s.org/methodologies/find

A large fraction of list-approved methodologies are not applicable to the South African context, e.g. those aimed at the avoided conversion of peat swamp forests, but thankfully a fair number have been developed or calibrated for AFOLU-sector activities located in Eastern and Southern Africa. The set at least forms an initial pool of methodologies and tools on which South African project developers can draw. Table 6 contains a list of methodologies that have either been successfully applied to landscape-orientated projects in South Africa or that may be broadly applicable for future adoption within the country.

Afforestation and reforestation methodologies

Following an initial flourish of published methodologies (especially within the CDM), concerted efforts have been made to simplify and consolidate methodologies and associated tools and modules where reasonably possible. As noted in Section 2.3, interviewed representatives of the VCS and GS noted that this remains an important goal and that more emphasis will be placed on simplifying methodologies, tools and modules in the future.

The outcome of these efforts has resulted in two consolidated CDM methodologies for reforestation activities: one focused on large-scale initiatives (AR-ACM0003) and the other on smaller-scale projects (AR-AMS0007). To be classed as a "small-scale A/R activity", a project is permitted to sequestrate up to a maximum of 16 000 tCO_2e per year (Clean Development Mechanism, n.d.). Although small-scale A/R projects are entitled to use a set of simplified modalities and procedures, which may reduce cost and capacity burdens, the aggregation of activities into a programmatic approach is not permitted. The small-scale class of methodologies may therefore be useful to particular project contexts, but their usefulness to a provincial or national programme is limited.

REDD+ methodologies

To date, no REDD+ activities located in South Africa have been validated or verified through the VCS. However, within the suite of recognised VCS REDD+ methodologies, two are reviewed for the potential development of future REDD+ activities within the country[9]. Methodology VM0009 was initially developed for a location in Kenya that shares land-use and deforestation patterns similar to those found in South Africa. Since its approval, VM0009 has been successfully applied to REDD+ activities in Zambia and northern Zimbabwe as well.

Furthermore, Methodology VM0006 is considered, as it is focused on estimating the GHG emission reductions and removals generated through mosaic and landscape-scale REDD+ projects. It has recently been successfully applied to the Kulera Landscape Project in northern Malawi and allows for a range of baseline scenarios that may be applicable in a South African context.

The remaining VCS REDD+ methodologies have typically been developed for REDD+ programmes in Central and South America, where the scale of implementation and the nature of deforestation drivers is substantially different to the South African context.

9 Formal REDD+ methodological guidance is available as part of the proposed UNFCCC REDD+ mechanism, but as this has yet to be approved or put into practice, it is not considered in the analysis.

Table 6: A list of prominent CDM and VCS methodologies that may be applicable to land use-based climate change mitigation activities in South Africa

Methodology code*	Project locations	Comments
Afforestation/deforestation		
AR-ACM0003	South Africa and many others	A consolidated large-scale A/R methodology that should be broadly applicable to reforestation activities in South Africa. Adopted successfully for the validation of the Kuzuko Lodge Private Game Reserve thicket restoration project located in the Eastern Cape and the Renencom A/R grouped project near Magaliesberg.
AR-AMS0007	South Africa and many others	Small-scale consolidated A/R methodology that is suitable for lands other than wetlands. An initial version of this small-scale methodology (AR-AMS0002 V2) was adopted by a VCS-verified project aimed at tree planting in South African townships.
-	-	There are no unique VCS or GS afforestation/reforestation methodologies. Project developers are directed to use the existing CDM methodology under the VCS. The GS is currently developing methodologies for the AFOLU sector.
REDD+		
VM0009 v.3	Kenya, Zambia, Zimbabwe	Aimed at quantifying the net GHG emission reductions and removals from deforestation, as well as the conversion of natural shrubland and grassland into a non-native state. Different versions of the methodology have been successfully applied to projects in Eastern and Southern Africa.
VM0006	Malawi	The methodology is aimed at mosaic and landscape-scale REDD+ activities, and are applicable to a range of baseline scenarios, e.g. the conversion of forests into croplands, settlements and other practices. Importantly, it allows for REDD+ to be combined with A/R and improved forest management activities.
Grassland restoration and avoided degradation		
VM0026	Not applied as yet	Focused on estimating the net GHG emission reductions and removals due to the adoption of sustainable grasslands management (SGM) in semi-arid regions. The main eligible activity is a change in grazing regime within the project area. Although it may be appropriate for a typical South African context, it has not yet been adopted.
VM0009 v.3	Kenya	Version 3 of methodology VM0009 includes consideration of the conversion of grasslands in addition to REDD+ (which was the only activity included in previous versions).
Conservation agriculture and the application of biochar		
VM0017	Kenya	Aimed at quantifying the GHG emission reductions and removals achieved through sustainable land-management practices. Although the methodology has been successfully applied to the Kenyan Agriculture Carbon Project, the RothC model on which it is strongly based needs to be calibrated and tested for South African conditions.
VM0021	Not applied as yet	Aims to assess changes in the size of the soil carbon pool and associated GHG emissions. It is based on the Intergovernmental Panel on Climate Change (IPCC) 2003 Good Practice Guidance for LULUCF activities and leverages a large set of established VCS modules. Importantly, it does not take a predictive modelling approach to monitoring changes in soil carbon, but requires an empirical field assessment of soil carbon stocks during each monitoring event.

* For clarity and cataloguing purposes, the VCS and CDM assign a code to validated methodologies. VCS methodologies start with the letters VM, and the CDM A/R methodologies start with the letters AR.

Methodologies focused on grassland-based activities

Due to the historical international focus on REDD+ activities within the Tropics, there has been little focus on climate change mitigation opportunities within grassland ecosystems until recently. Although, two verified VCS methodologies (VM0026 and VM0009 v.3) are aimed at estimating GHG emission reductions and removals from SGM activities and may potentially be applicable to the South African context, neither has yet been successfully applied to a verified project .

Conservation agriculture and the application of biochar

Two validated VCS methodologies may be broadly applicable to the implementation of conservation agriculture in South Africa – VM0017 and VM0021. Both are well structured and clear, but an important difference between the two is that Methodology VM0021 requires a field assessment of the soil carbon stocks at each monitoring event, whereas Methodology VM0017 advocates the use of a predictive model (Roth C) to estimate changes in the soil carbon pool over time. Although the predictive model-based approach will certainly save significant costs over the lifetime of an activity, it needs to be adequately calibrated and tested for typical South African project contexts prior to its adoption.

2.3 Methodology elements

Each of the five elements of a methodology is reviewed separately below. Emphasis is placed on assessing methodology contributions or constraints that are important to their adoption in typical South African project contexts and how existing methodologies (aimed at a project-scale) may provide the basis for programmatic or national programmes.

The five key elements of a methodology are the following:

- Scope and applicability conditions
- Project boundary[10]
- Baseline and additionality assessment
- GHG emission reduction assessment, including leakage
- Monitoring framework

In addition to a review of particular technical criteria, a broad assessment of the cost of applying each methodology is made. The reason for this is that, in reality, from a practical point of view, the cost of applying a methodology dictates its acceptability to developers as much as the technical criteria. Interviewed project developers and stakeholders noted that the high cost of applying methodologies often determines their choice of international carbon standard and, in many cases, has halted further project progression.

A detailed costing requires an intimate knowledge of the particular context of the implementation as it is strongly influenced by project type, location and size. For the purposes of this report, a broad costing based on a "typical South African context" is used to determine whether established methodologies are generally affordable (relative to income generated through the trade of emission reduction units), or if a new methodology or approach may be required.

METHODOLOGY ELEMENT 1: SCOPE AND APPLICABILITY CONDITIONS

As broadly defined above, a "methodology" is a formally documented, approved and recognised approach to estimating the GHG emission reductions and/or carbon sequestration due to the implementation of a project. When developing a methodology, the writer needs to strike a balance between ensuring the scientific robustness and complexity of the approach, with the associated cost and capacity burdens.

In addition, the developer is generally focused on a particular project context and does not have the resources (or time) to compile a methodology that is universally applicable, considering all potential project contexts and forms of implementation. A methodology often takes several months of professional time to compile and may require supporting fieldwork that comes at great expense. Investor or funder appetite to finance the development of a universal methodology that is beyond immediate requirements is therefore limited, especially considering that the methodology becomes a public good on publication and that the initial developer cannot levy a fee on its future application.

The scope of applicability of established methodologies is therefore often constrained to particular project circumstances, and while applicable to other similar projects, they are not universal to all activities of a certain type, for example, a single methodology that is applicable to all reforestation activities globally. The initial scope and applicability section therefore describes the particular context in which the methodology may be applied and defines the conditions in which it is not applicable. For example, in the case of a methodology that is focused on reforestation activities, the scope and applicability section may define the type of reforestation permitted and the carbon pools that should be measured and reported. In addition, it will define conditions under

10. While not a dedicated element of every given methodology, the establishment of the project boundary and demonstration of control over the land to establish clear ownership over generated emission reduction units will be required.

which the methodology is not applicable, such as the reforestation of wetlands or where the project proponent intends to irrigate the project area. Such circumstances require the consideration of additional sources or sinks of GHG emissions that either negate the benefit of reforestation or simply bring additional complexity to monitoring and modelling requirements. If the developer of the methodology is focused on a project where such conditions do not exist, it makes sense to simply stipulate that the methodology is not applicable in those situations.

In terms of this review, the scope and applicability criteria of prominent CDM and VCS methodologies are assessed from a South African context. If either scope or applicability criteria exclude the eligibility of South African initiatives (described in Section 2.1), advice is provided on how this may be addressed, either in terms of the adoption of alternative methodologies, the amendment of an existing methodology or the creation of a new methodology where necessary.

The guidelines for CDM methodologies require the developer to define both a scope and set of applicability criteria. In the case of VCS methodologies, only a set of applicability criteria is defined, which performs the role of both elements in the CDM template. For this reason, the review of CDM methodologies for reforestation activities below includes consideration of both scope and applicability criteria, whereas the review of VCS methodologies only lists applicability criteria.

Reforestation activity methodologies

AR-ACM0003 Version 2 A/R Large-scale Consolidated Methodology

- This consolidated CDM methodology has been adopted widely by both activities validated through the CDM and VCS. As indicated in its name, it is the consolidation of a number of previous methodologies focused on A/R activities and the result of a considerable period of development and review in each of its versions.
- The methodology has two major eligibility criteria – implementation is not allowed to occur on peat land, disturbed soils or wetlands. These are not expected to be restrictive issues for typical South African project contexts.
- While there may be substantial room to reduce the costs of applying the methodology, in terms of scope and eligibility criteria, it is suitable in South African conditions.

AR-AMS0007 Version 3 A/R Small-scale Methodology

- Although Methodology AR-AMS0007 has successfully been applied to small-scale reforestation projects in South Africa, limitations in terms of the generated GHG emission removals (<16 000 tCO_2e/year) and not being allowed to aggregate individual projects limits the applicability of this methodology to a national programme.

Table 7: Reforestation activity methodologies

Methodology code		Criteria and comments
A/R		
AR-ACM0003 Version 2.0	Scope	Excludes A/R activities located in wetlands.
		Due to the limited extent of wetlands in South Africa, this constraint is unlikely to be a significant factor inhibiting roll-out.
	Applicability	In addition to the exclusion of wetland areas, the activity places restrictions on projects in which soil is disturbed. The concern here is that the turnover of soils, e.g. through ploughing or digging, may lead to the release of sequestered carbon into the atmosphere.
		This criteria can be easily managed through initial screening and should not affect the majority of South African project locations.
AR-AMS0007 Version 3.1	Scope	Only applicable to "small-scale" A/R activities that, by definition, lead to less than 16 000 tCO_2e being sequestered a year.
		The limitation of this scope and the lack of opportunity to bundle small-scale projects in a programmatic approach severely limits its application to a national programme.
	Applicability	In a similar manner to Methodology AR-ACM0003, this methodology excludes activities located on disturbed land.
		As noted, this criteria may not be a significant issue in a South African context, but the constraint of project size limits its utility to a national or provincial programme.

Methodologies aimed at REDD+ activities

VM0009: Methodology for avoided ecosystem conversion

- Originally developed for a project located in Kenya, Methodology VM0009 is focused on the type of land-use and deforestation drivers that are commonly found in South Africa. In addition, it is applicable to both REDD+ and ACoGS activites.
- The methodology uses an innovative non-spatially explicit statistic model to estimate future deforestation rates, which is suitable for the type and nature of deforestation observed in South Africa. To a large extent, the methodology is appropriate to South African conditions, except for the manner in which it considers the establishment of a baseline without-project scenario.
- Firstly, stipulations on the size and location of a suitable reference area may not be met in typical South African contexts. Secondly, the cost of required “participatory rural appraisals” and the extensive remote sensing of a reference and proxy area is likely to be prohibitive, especially the type of forest pockets described in Section 2.1.
- In summary, the methodology includes innovative elements that are applicable to the types of land-use and deforestation and degradation drivers observed in South Africa. However, the manner in which the methodology develops a baseline scenario would need to be revisited if it were to be adopted as the foundation of a nationally appropriate methodology.

Table 8: REDD+ Methodology: VM0009 Version 3

REDD+ Methodology: VM0009 Version 3	
Criteria	**Consideration from a South African activity context**
1. Nature of deforestation: Drivers and agents may be planned or unplanned, but land use must change from forest to non-forest.	This condition applies to REDD+ projects in South Africa where the aim is to reduce the conversion of forest and woodland ecosystems into an open non-forest state.
2. Historical land use: All project accounting areas must have been in an unconverted state for at least 10 years prior to the project start date.	This condition is met for South African REDD+, as well as avoided grassland degradation initiatives.
3. Threat of deforestation: For unplanned baseline types, the threat of deforestation must be imminent and within 2 km of the perimeter of the accounting area.	This condition could be reasonably met in a South African context. It would require the support of spatial data (remote sensing).
4 – 6 and 8. Distance to reference areas and nature thereof: Depending on the type of baseline type, reference areas need to be within 120 m of the project area. As stipulated in Applicability Point 9, an eligible reference area needs to meet an extensive set of criteria.	The provision that an appropriate reference area should be located within 120 m of the project area is likely to be problematic in a South African context. Firstly, an envisaged South African REDD+ project (e.g. one that is described in Section 2.1) would include numerous relatively isolated forest pockets, often more than 120 m apart. Secondly, the requirement assumes that a suitable “reference area” would continue to be deforested adjacent to the project area. If a comprehensive REDD+ programme is developed at a regional, provincial or national level, this assumption of continued deforestation may not hold, as the intention would be to systematically reduce all deforestation in the region.

REDD+ Methodology: VM0009 Version 3	
Criteria	Consideration from a South African activity context
7. The project accounting area must not contain peat soil.	The extent of peat land in South Africa is limited. This scope constraint is unlikely to limit roll-out.
9. Availability of historical imagery for reference area	Although a set of historical imagery (Landsat) is technically available for South Africa, its cost may be prohibitive. This is explored further in a separate section.
10. Permitted project activities include the provision of alternative livelihoods, sustainable forest, fire and agricultural management practices, and others (see 8.3.1)	The range of permissible activities are typical additional project activities that would be implemented in a South African context. This requirement would not inhibit adoption of the methodology.
11 and 12. Access to activity-shifting leakage areas and market data for monitoring purposes	It will be able to access leakage areas and market data would not be an inhibitory issues in a South African context.
13. The potential use of a default value for soil organic carbon in Tropical regions	As South African is not in the Tropics, this does not apply.
14 and 15. Livestock emissions and manure management. The management of manure is not permitted within the project area and additional GHG emissions associated with livestock need to be accounted for.	The management of manure is unlikely to occur in the context of South African REDD+ or ACoGS. In addition, adequate emission factors for South African livestock are already available (from enteric fermentation and manure) and are relatively straightforward to apply.

VM0006: Carbon accounting for mosaic and landscape-scale REDD projects

- The VM0006 methodology was originally developed for a project located in central Malawi and it stipulates a relatively open and straightforward set of eligibility criteria that suit typical South African project contexts.
- In comparison to VM0009, it does not include ACoGS activities, but its consideration of baselines (and associated costs and capacity requirements) is far simpler and easier to meet in a South African context.
- In terms of eligibility criteria and associated restrictions, it is suited to South African REDD+ activities, especially if efforts are made to reduce cost burdens related to remote sensing and datasets.
- If the methodology was to be adopted as the basis for a national REDD+ programme, it may be advisable to assess the possibility of updating the methodology to include ACoGS activities as well.

Table 9: REDD+ Methodology: VM0006

REDD+ Methodology: VM0006	
Criteria	**Consideration from a South African activity context**
General applicability conditions	
1. Eligible land conditions • Forest for at least 10 years prior to start • Deforestation must be mosaic in nature • Only unplanned drivers of deforestation permitted, no planned deforestation • Not permitted on peat or organic soils • Accurate remote sensing is required for historical reference period	• The set of eligibility criteria is met by REDD+ activities in a typical South African context. • Observed deforestation drivers in South Africa are unplanned in nature (e.g. unsustainable woodland usage). Classic planned deforestation drivers, e.g. large-scale commercial logging of indigenous forests, are generally absent from South Africa in modern times. • Adequate cloud-free imagery covering the extent of the country is available for historical periods.
2. Eligible project activities • The methodology lists eight primary eligible project activities that include sustainable forest and fire management, a reduction in fuelwood usage and sustainable intensification of agriculture, among others.	• The list of eligible project activities is very much the type of additional activity that would be practised in a South African context.
Applicability conditions for optional activities	
The methodology lists a number of optional activities that include: • Assisted natural regeneration (ANR) • Cook stove and fuel-efficiency activities (CFE) • Sustainable wood harvesting activities • Improved crop production • Increased rice production • Increased livestock production	• Each listed optional activity has its own set of eligibility criteria • Out of the set, ANR, CFE, sustainable wood harvesting and improved crop and livestock production are appropriate to a South African context, and the nature of implementation in the country would fulfil the eligibility criteria. • Improved rice production is not applicable to typical South African conditions.

Methodologies aimed at grassland restoration and avoided degradation

VM0026: Sustainable grassland management

- This methodology does not generally present substantial issues in terms of eligibility criteria for typical South African grassland restoration programmes.
- A key element due to cost considerations is the use of a biogeochemical model to estimate carbon sequestration over time. While the use of a model is certainly the preferred approach, substantial supporting research and development will be required to apply it in South African conditions with the required levels of accuracy.

In addition, Methodology VM0009 (listed in the REDD+ activity section above) is applicable to projects focused on ACoGS. While certain elements of the methodology are very useful to a South African context, particularly the method used to model future degradation constraints relating to eligible activity types (only avoided degradation, not restoration) and reference area requirements may limit its applicability in a South African context.

Table 10: Grassland restoration and avoided degradation: VM0026

Grassland restoration and avoided degradation: VM0026	
Criteria	**Consideration from a South African activity context**
1. Land-use eligibility • The area has to be grassland at the start of the project activity and for 10 years hence. • If degradation is present, it would continue under a baseline scenario in terms of the presence of drivers. • The area is subject to livestock grazing, burning and/or nitrogen fertilization.	• These criteria are met in a typical South African context, where pressures remain on grassland areas. • This second "presence of degradation drivers" criteria is also important from an additionality point of view.
2. Dung management Some 95% of animal dung must remain on the land and not be actively managed.	This stipulation will be met by typical South African grassland projects where livestock dung is not aggregated into biogas digesters or other forms of dung management.
3. Leaching consideration The project is to be located in a region where precipitation is less than potential evapotranspiration for most of the year.	Potential annual evapotranspiration exceeds annual rainfall across South Africa (Jovanovic, Mu, Bugan and Zhao, 2015).
4. Application of biogeochemical model The methodology allows the application of a model to estimate potential changes in soil carbon stocks under certain conditions (e.g. RothC or the Century Ecosystem Model).	- The methodology allows the use of a predictive model to estimate changes in soil carbon stocks if it is adequately calibrated to the particular project site in a robust manner. - Whereas a substantial amount of research on soil carbon in South African grasslands has been undertaken to date, a dedicated research programme may be required to calibrate a biogeochemical model to required levels of accuracy for the broad range of South African grassland ecosystems under consideration.
5. Permissible activities - Project activities may not include the seeding of perennial grasses or legumes. - Activities may not occur on wetlands or peatlands. - The project may not lead to an increase in the combustion of fossil fuels through cooking or heating.	- This set of constraints on permissible activities is unlikely to affect the eligibility of typical South African grassland restoration and avoided degradation projects.

Methodologies aimed at conservation agriculture

VM0017: Adoption of sustainable agricultural land management

- Both the land-use trend and biogeochemical model criteria may present a challenge to the widespread adoption of this methodology.
- The land-use trend criteria state that a project needs to be located in an area in which the cultivated area is increasing or remaining constant. In addition, forest cover in the region must either remain the same or decrease. Both criteria may not be met in certain parts of South Africa (e.g. Eastern Cape).
- Furthermore, the biogeochemical model validation requirements may also be an inhibitory factor for many locations.
- To address the first issue regarding land-use trends, an additional ploughed area and forest cover module may need to be added to the methodology. This revision would be relatively straightforward and dependent on remote sensing data that is readily available.
- To address the second issue, it may be possible to calibrate the RothC model for a few locations in South Africa, based on previously published research, but significant further research will be required to calibrate the model for a decent set of typical project condition across the country.

Table 11: Conservation Agriculture: VM0017

Conservation agriculture: VM0017	
Criteria	**Consideration from a South African activity context**
1. Land-type and land-use eligibility • Land is either cropland or grassland at the start of the project. • Not permitted on wetlands.	• These eligibility criteria will be met by in a typical South Africa project context.
2. Land-use trends • The area of land under cultivation in the region is constant or increasing. • The area of forest in the region is remaining the same or decreasing.	• Each of these criteria may present constraints to the adoption of the methodology and are closely dependent on the particular region of implementation in South Africa. • For example, if conservation agriculture were implemented in the wheat-growing areas of the Western Cape, these criteria may be met. • Alternatively, in the small-grower and subsistence farming landscapes in the Eastern Cape, these criteria may not be met where the area under cultivation may be decreasing, and forest cover (often through bush encroachment) may be increasing.
3. Biogeochemical model validation requirements • The methodology strongly depends on the adoption of the RothC model to estimate changes in soil carbon stocks over time. • The applicability criteria describe two options through which to demonstrate that the model is calibrated to the project area. The first is based on existing supporting research and the second describes the type of research required in its absence.	• Conservation agriculture is likely to occur in a variety of contexts and locations with significantly different edaphic, climatic, management and crop conditions. • Whereas it may be possible to adequately calibrate the RothC model for a few locations based on prior research, it is assumed that a significant amount of additional applied research will need to be undertaken to validate the model for a full set of principle implementation options across South Africa.

VM0021: Soil carbon quantification methodology

- Methodology VM0021 has no eligibility criteria that would inhibit its adoption for conservation agriculture activities in typical South African contexts.
- Whereas there may be few technical hurdles, as explored below, the cost of soil carbon assessment and monitoring in general may need further consideration.

Table 12: Conservation agriculture and grasslands: VM0021

Conservation agriculture and grasslands: VM0021	
Criteria	**Consideration from a South African activity context**
1. Eligible project activities Includes improved cropland management (ICM), improved grassland management (IGM) and cropland/grassland conversions	Typical South African conservation agriculture practices would fall within the VCS's definition of ICM and would therefore be eligible under this methodology.
2. Land-type and land-use eligibility • The project area is either cropland or grassland at the start of the project. • Not permitted on wetlands or peatlands.	These eligibility criteria will be met in a typical South Africa project context.
3. Restrictions on changes in soil water regimes The project may not change soil water regimes through flood irrigation, drainage or changes to the ground water table.	This set of restrictions is unlikely to be an issue to South African conservation agriculture activities.
4. The activity may not cause a change in termite populations.	This criterion is unlikely to be an issue in the context of South African conservation agriculture activities.

METHODOLOGY ELEMENT 2: PROJECT BOUNDARY

Goal

The intention of the project boundary is to clearly delineate where the project activity will occur by ensuring that each discrete piece of land has a unique geographical identification. It ensures that emission reduction calculations evaluate the whole opportunity, neither mistakenly adding nor eliminating portions of the project area. In the case of landscape-based initiatives, this ensures that the total area of land to be assessed is appropriately geolocated. For energy projects where there are point-source emission reductions, it ensures that each site of emission reduction is identified and reported.

General approach to date

For landscape-level projects, the preferred approach for delineating the project boundary is to geolocate the perimeter of the project using a Global Positioning System (GPS). For projects where there are several pockets of land to be included, each polygon must be mapped out in a dedicated field survey. This is usually done by a project employee or outside consultant who walks the perimeter of the project with a GPS unit, taking measurements at a given distance interval. In some instances, the entire project area will have been previously surveyed. For example, the boundaries of a state-owned forest will already have been established as part of a dedicated national land survey. Although private landowners will likely have had the boundaries previously mapped and lodged in the municipal deeds office, it is unlikely that the entirety of their landholdings will become a dedicated carbon project. A farmer in the Eastern Cape, for example, may only wish to include marginal, unproductive lands in a carbon project, requiring that those specific polygons be mapped. In other words, the boundaries of his/her farm will not be sufficient evidence of project boundaries, as they will encompass more land than included in the project activity.

Clearly missing data, tools and emerging issues

Identifying project boundaries on communal land can be a difficult undertaking. GPS surveys may be undertaken, but they will need to be complemented by social survey techniques, such as a participatory rural appraisal, community meetings and key informant interviews. As there can be disagreement about land uses, control of lands and overlapping claims to land, these will need to be carefully assessed and agreed upon across a range of stakeholders. Identifying "control", i.e. the clear owner of credits, will be a difficult task, requiring dedicated resources and expertise, notably in mediation and land-tenure assessment.

METHODOLOGY ELEMENT 3: BASELINE AND ADDITIONALITY ASSESSMENT

Goal

The purpose of the baseline and additionality is twofold. An additionality assessment is required to prove that the project would not have happened otherwise in the absence of the carbon finance incentive made accessible through participation in a standard. Demonstrating this is critical for maintaining the integrity of a standard, through rigorous screening processes that seek to bar projects that would in all probability have been implemented anyway. This ensures that there are limited "free-riders" in the system, and that the market is not flooded with false carbon credits. While it is not technically possible to prove definitively that a project would not otherwise have been pursued, a number of tests have been developed that can be used to assess various characteristics of a project.

The baseline approximates what the "business-as-usual" scenario would have been in the absence of the project. Once additionality is demonstrated, the baseline becomes the most plausible alternative land-use scenario. It is an assessment of what activity or activities would have taken place should the project never have been developed or implemented. Like additionality, it is impossible to prove with absolute certainty what would have happened, but a great deal of research and expertise has been called upon to generate credible tools to provide an acceptable approximation of alternative scenarios.

Once the baseline has been established, it provides a quantitative assessment of GHG emissions in the business-as usual scenario. For example, a reforestation project undertaken on lands that are degraded or degrading may be able to demonstrate that the baseline scenario would be continued degradation of above- and below-ground woody biomass stocks. Conservatively, the baseline could be set at zero, which requires no assessments of woody biomass during subsequent monitoring events and has no net impact on total claimable emission reductions. Under other circumstances, there could be a significant number of standing trees in the project area that face no threat of being cleared under the baseline scenario. These trees would need to be measured as part of the baseline assessment, monitored over the course of their lifetime, and their GHG emission reductions subtracted from the project's total emission reductions at each verification event.

General approach to date

There are two broad approaches to assessing additionality and fixing the baseline. The choice of tests and approach is an important one. Less stringent additionality tests will lead to greater market participation,




but will run the risk of allowing a higher number of “false” carbon credits and potentially drive down carbon offset prices. It can also result in more stringent tests, which introduce higher risks and costs for project developers, and limit the number of worthy projects that may lack financial and technical resources to undertake a detailed, time- and resource-intensive additionality test. The project-level testing approach is expensive for project developers, inefficient as developers each undertake similar assessments, and can be inconsistently assessed by auditors. A key benefit, however, is that the standards body internalises very few risks and costs.

Both the VCS and CDM have a published tool, which includes a number of discrete tests. The tests that need to be applied to a given methodology depend on the project circumstances, size and geographic location. Most methodologies simply reference the tool, instead of introducing further additionality assessment steps and criteria. Broadly, the additionality tools cover the following tests:

Identification of alternative land-use scenarios are critical for justifying the choice of baseline, which will include a review of mandatory applicable laws and regulations and a review of any barriers that would effectively limit the implementation of any of the given scenarios.

An investment analysis includes a choice of investment analysis type and is cross-checked through a sensitivity analysis. Investment analyses include an investment comparison analysis, a benchmark analysis or the calculation and comparison of key financial indicators.

A barrier analysis is conducted, in which the project developer demonstrates that significant barriers to entry exist for the project. Extensive data and research should be used to substantiate the use of barriers, although this test is sometimes considered to be too “soft.” In some instances, a barrier analysis can be used as a stand-alone test, although an investment analysis is considered more rigorous and can be requested by the auditor.

A common practice analysis, which requires a scan of the broader region in which the project is being implemented, is to be undertaken to assess the extent to which similar activities have been undertaken, and where there are multiple instances of similar projects, to indicate how the particular activity is different. Essentially, standards do not wish to allow projects with proven technologies and widespread adoption to penetrate the market, as they are unlikely to be additional.

Each of the steps is fairly research-intensive. The investment analysis, in particular, will require specific expertise in the field of accounting to ensure the reliability of results. Primary data sources must be collected, desk-based research will need to be undertaken and interviews with key informants and experts pursued to cover the range of material and information that will need to be presented and analysed. The identification of alternative land-use scenarios and common practice analyses are requisite for all projects. In some instances, just the barrier analysis can be undertaken, or just the investment analysis, although, on some occasions, an auditor will request that both be completed.

Once the baseline activity is identified through the application of either of the tools described above, a baseline monitoring assessment is typically undertaken. This is described in detail in Chapter 3.

The use of a combined additionality and baseline tool has been the most prominent approach to date. However, it is not the only means of assessing these two important project elements. Under the carbon trading system in California, for example, a “positive list” is established by the Climate Action Reserve (CAR), the standards body. A positive list identifies those activities that will be considered additional, sending a clear market signal to potential project developers as to whether their projects can be validated under the standard. The CAR establishes the positive list by undertaking detailed research into the extent to which similar activities have been undertaken through a series of performance standard assessments covering financial, economic, social and technological considerations. This is complemented by a legal requirement test. It represents an opportunity for the standard to identify projects that it believes have high market potential, and environmental, social or other benefits that it wishes to see realised at scale. Moreover, the rigorous research that is undertaken by qualified experts reduces the risk that auditors will approve projects that are underpinned by poor research, references and arguments. This ensures widespread consistency in the additionality approach.

There are clear benefits of the positive list to project developers. It eliminates the range of costs associated with undertaking the additionality assessment. In this regard, it is perhaps a more efficient approach, as countless, project-level assessments – often covering similar material – no longer need to be undertaken. Perhaps more importantly, it provides developers with surety that their project passes the additionality requirements. Under the traditional CDM and VCS approach, projects run the risk of investing heavily in full methodology development, only to fail the additionality assessment during costly third-party audits. The positive list eliminates this risk, allowing project developers to dedicate budget and time resources to other important aspects of project design. However, there are two key drawbacks to the approach. The first is that the CAR must absorb all the costs for drawing up, researching and maintaining the positive list. Secondly, truly additional project activities may not make the list, restricting their access to carbon finance opportunities.

Under the California system, standardised baselines are also pursued. Based on specific geographic regions as a means for ensuring the integrity of baseline estimates, baselines are typically restricted to predefined geographic regions. Extensive research is undertaken, looking at broad trends that cover economic, technological and regulatory sectors. In some instances, the baseline emissions are fixed for a predefined period, and under other circumstances, dynamic models can be adopted. The steps taken to develop standardised baselines are made publicly available and are open to public comment as part of CAR's commitment to transparency.

METHODOLOGY ELEMENT 4: NET GHG EMISSION REDUCTION ASSESSMENT

Goal

The purpose of the GHG emission reduction assessment is to undertake a comprehensive, complete review of the net GHG emission reductions or avoided emissions generated by the project activity, including emissions from the baseline, operational emissions and potential sources of leakage. This ensures a full, complete accounting of all sources of emissions, as well as the nature of those emissions. This detailed approach ensures that the total claimed CERs or verified carbon units (VCUs) are an accurate reflection of the project activity – including leakage and relevant operational emissions – and its impact on the baseline. Each methodology provides clear guidance on how these emission types and sources are to be measured, typically through reference to a suite of tools or modules; they also provide detailed formulae describing how to undertake all necessary calculations.

Methodologies vary in the way they present this section – occasionally the baseline assessment is grouped with project emissions or they may be stand-alone elements.

Regardless of a given methodology's organisation, the net emission reductions or avoided emissions are assessed, taking into account the following categories of emissions (see Chapter 3 for an in-depth discussion of how these emission sources are measured).

- **Baseline emissions and removals:** Baseline emissions represent the sources of emissions that would have been released or sequestered in the absence of the project. Where emissions would have been sequestered, they must be subtracted from the project activity emissions, ensuring that only emission reductions above that which would have happened in the most likely alternative land-use scenario are claimed. In some instances, baseline emissions will be accounted as zero, whereas in others, the clearance of woody biomass to make way for tree planting activities, for example, would lead to a release of emissions, which would need to be subtracted from the project's total emission reduction balance.

- **Project emissions and removals:** Project emissions include the emission reductions realised by the implementation of the activity, as well as any sources of operational emissions that are deemed significant. For example, project emissions under REDD would include avoided emissions generated through forest conservation activities, or under an improved agriculture project, the emission reductions realised through the introduction of reduced tillage practices. Whereas historically, project developers were required to complete a full account of all operational emissions, including those emanating from activities such as transportation, fertilizer use and road construction, it was widely accepted that it was resource-intensive to evaluate these sources, and they only contributed a minimal amount to the net total emission sources (typically less than 5%). For this reason, only a few methodologies continue to require these emissions to be accounted for. Tools have been developed to test the significance of emissions.

- **Leakage emissions:** When a source of emissions is shifted to lands outside the project area, and it is a direct consequence of the project intervention, it is termed "leakage" and must be accounted for. Not every project will generate leakage emissions, but those that do must undertake strict monitoring protocols to ensure that the emission sources are properly accounted for over the lifetime of the project. Sources of leakage can vary considerably from one project type to another. They might be generated from the shifting of livestock for a grasslands restoration project to adjacent lands, or can include market leakage effects under REDD where the protected forest in question, having previously been a regional source of charcoal, has reduced production, leading to charcoal producers' shift to other unprotected forests in the region. Projects can develop leakage mitigation interventions to reduce the total leakage emissions balance. In some instances, these interventions can prove to be complicated and expensive to implement. Under these circumstances, project developers will typically weigh the emission reduction benefits and associated market price for CERs or verified emission reductions (VERs) against the cost burden of implementing and monitoring the leakage mitigation activity.

- **Risk buffer:** Under the VCS, emission reductions are qualified as being permanent, allowing for fungibility across different project types, facilitating the trade of

AFOLU-sector projects. To achieve this, a risk buffer is applied and assessed considering each project's unique project circumstances. This risk buffer is deducted from total assessed project emissions and removals, and is the final step in determining the number of sellable credits from a given intervention.

- **Temporary credits:** Under the CDM, the matter of permanence is dealt with through the issuance of temporary certified emissions reductions (tCERs). These tCERs can be renewed during every CDM crediting period, assuming that carbon stocks have been left undisturbed, and have not been subject to fires or other types of removals. In turn, this means that buyers must replace tCERs on a five-yearly basis. This explains, in part, why there has been so little investment in CDM A/R projects. The tCERs are not fungible with other carbon assets, and due to the limited inclusion of A/R projects to date, price discovery has been difficult, leading to further barriers to market participation.

General approach to date

The general approach to date for assessing net total GHG emissions has been project-level, field-based data collection, mapping, desk-based research and participatory rural appraisals or similar social survey techniques, which are used to collect key data components. This is described in detail in Chapter 3. Efforts have been made to develop standardised baseline, default values, and modules and tools to reduce costs, improve efficiencies and encourage wider market participation. These are described in detail in Chapter 5.

Once all the data has been collected and cleaned, the project developer will take a stepwise approach, populating the formulae described in the methodology. Due to the sheer volume of information to be reviewed and pulled into this exercise, typically a project will need to develop detailed Excel spreadsheets (or other software) to manage data, and to build a model to hold all the formulae. Particular care must be taken with this step – typos, incorrect ordering of formulae, and errors in linking worksheets and data can lead to significant accounting errors. Auditors will assess models with scrutiny, testing links, cross-checking datasets and running duplicate, dummy worksheets to assess the integrity of the model.

Existing tools, modules and guides

The formulae used to assess GHG emission reductions are presented in the body of each methodology. However, some methodologies are also supported by a series of tools, which can be referred to in order to clarify how data is to be collected. These are listed below and are broken down by the leading, recognised methodologies applicable to the South African context.

Table 13: Methodologies and supporting tools

Methodology	Supporting tools
AR-AMS0007 – A/R activities implemented on lands other than wetlands	• Estimation of non-CO2 GHG emissions resulting from the burning of biomass attributable to an A/R CDM project activity • Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities • Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities • Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activities • Demonstrating the appropriateness of allometric equations for the estimation of above-ground tree biomass in A/R CDM project activities • Tool for estimating change in soil organic carbon stocks due to the implementation of A/R CDM project activities • Demonstrating the appropriateness of volume equations for estimating above-ground tree biomass in A/R CDM project activities • The identification of degraded or degrading lands for consideration in implementing CDM A/R project activities
REDD+: VM0006 – Mosaic and landscape-scale REDD+	• Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities • Calculation of the number of sample plots for measurements within A/R CDM project activities • Procedures to determine when accounting of the soil organic carbon pool may be conservatively neglected • Estimation of GHG emissions related to the displacement of grazing activities in A/R CDM project activities • Tool for testing the significance of GHG emissions in A/R CDM project activities • VCS tool for calculating deforestation rates using incomplete remote sensing images
REDD: VM009 – Methodology for avoided ecosystem conversion	• Tool for testing significance of GHG emissions in A/R CDM project activities • Estimation of direct and indirect (e.g. leaching and run-off) nitrous oxide emission from nitrogen fertilization
Grassland management: VM0026 – sustainable grassland management	• Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities • Identification of degraded or degrading lands for consideration in implementing CDM A/R project activities • Tool for testing the significance of GHG emissions in A/R CDM project activities • VCS AFOLU Non-permanence Risk Tool • VCS Methodology module VMD0033: Estimation of emissions from market leakage • VCS Methodology module VMD0040: Leakage from displacement of grazing activity • VCS VT0001: Tool for the demonstration and assessment of additionality in VCS AFOLU project activities
Improved agriculture – VM0017 – Adoption of sustainable agricultural land management	• Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities (Version 01) EB 41, Annex 15 • Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities • Estimation of direct nitrous oxide emission from nitrogen fertilization • Estimation of GHG emissions related to fossil fuel combustion in A/R CDM project activities

*Extensive lists of all supporting tools can be found on www.v-c-s.org and ww.cdm.unfccc.int.




2.4 Considered methodologies for energy-related activities

Currently, the CDM standard has 215 approved methodologies. Of these methodologies, 110 are for small-scale projects (i.e. for projects with an electrical capacity of less than 15 MW, less than a 60 GWh reduction or less than a 60 000 tCO_2e/year reduction), and 105 approved methodologies for large-scale projects, of which 23 are so-called consolidated methodologies[11]. In addition to these methodologies, the standard provides 18 so-called tools that are applied across most of the methodologies. These tools provide guidance on the determination of the baseline, additionality, etc. Within the biomass-to-energy and anaerobic digestion categories under the CDM standard, 1 571 projects have been registered (873 biomass-to-energy and 698 anaerobic digestion projects) globally. The tables below provide an overview of the number of registered projects per subcategory and the different methodologies used for these projects.

Table 14: Number of registered projects per subcategory and the different methodologies

Biomass-to-energy methodology/ subtype	Bagasse power	Palm oil solid waste	Agricultural residues: other kinds	Agricultural residues: rice husk	Agricultural residues: mustard crop	Agricultural residues: poultry litter	Black liquor	Forest residues: sawmill waste	Forest residues: other	Forest biomass	Industrial waste	Gasification of biomass	Switch from fossil fuel to piped biogas	Biomass briquettes or pellets	Biodiesel	Biodiesel from waste oil	Ethanol	Totals
AM25											1	1						**2**
AM36	1	2	1	1				1	2									**8**
AM39		1																**1**
AM57		1																**1**
AM69												1						**1**
AM82									1									**1**
ACM2	13	1	7	11		1	2	1	2		1							**39**
ACM3			24	3				1					1					**29**
ACM6	51	2	51	19		1	7	3	8									**142**
ACM10			1			1												**2**
ACM14		1																**1**
ACM17																1		**1**
ACM18	1	2	47	2					3									**55**
ACM22														1				**1**
AMS-I.A				1				1				1						**3**
AMS-I.C	11	20	28	56			1	17	6	3	3	1	1	14				**161**
AMS-I.D	14	13	72	50	9	5		7	9	5		6						**190**
AMS-I.F		1	1						1									**3**
AMS-II.D			1					1										**2**
AMS-III.B														1				**1**
AMS-III.D						1												**1**
AMS-III.E		10	4	6		3		14	1									**38**
AMS-III.F		2																**2**
AMS-III.G		2		1														**3**
AMS-III.H		2										1	1					**4**
AMS-III.I												1						**1**
AMS-III.AS			2								3							**5**
Registered projects	**91**	**60**	**239**	**150**	**9**	**12**	**10**	**46**	**33**	**8**	**8**	**12**	**3**	**16**	**0**	**1**	**0**	**698**

11. Source: UNEP DTU Partnership, 1 July 2015

When looking at the methodologies that are used for biomass-to-energy projects across the different subsectors, it becomes apparent that many methodologies are used across the different subtypes. ACM0006: Electricity and heat generation from biomass is the most commonly used large-scale methodology and AMS-I.D: Grid-connected renewable electricity generation is the most commonly used small-scale methodology, followed by AMS-I.C: Thermal energy production with or without electricity.

Table 15: Methodology subtypes

Anaerobic digestion methodology/ Subtype	Manure	Domestic manure	Wastewater	Industrial solid waste	Palm oil waste	Aerobic treatment of wastewater	Composting	Totals
AM25					1		2	**3**
AM39							4	**4**
AM73	2							**2**
AM80			1					**1**
ACM10	7							**7**
ACM14			25					**25**
AMS-I.A	2		11		7			**20**
AMS-I.C	7	31	66		1			**105**
AMS-I.D	70		78		9			**157**
AMS-I.E	1	15						**16**
AMS-I.F	4		19		3			**26**
AMS-III.D	177		2					**179**
AMS-III.E								**0**
AMS-III.F	2		1		7	1	34	**45**
AMS-III.H			191		41			**232**
AMS-III.I			6			1		**7**
AMS-III.M			1					**1**
AMS-III.O			1					**1**
AMS-III.R	5	29						**34**
AMS-III.Y			3					**3**
AMS-III.AO	1		3					**4**
AMS-III.AQ			1					**1**
Registered projects	**278**	**75**	**409**	**0**	**69**	**2**	**40**	**873**

Of the 873 registered CDM projects for anaerobic digestion, the most commonly used large-scale methodologies are ACM0014: Treatment of wastewater and AMS-III.H: Methane recovery in wastewater treatment.

In South Africa, there are 56 registered CDM projects, of which 15 have issued CERs. Although the proportion of registered projects in South Africa in comparison to the 8 000 projects registered globally is not that unreasonable, the limited number of projects that have managed to issue credits is concerning. Of the 56 projects registered in South Africa, eight fall within the biomass-for-energy and anaerobic digestion category. Table 16 provides an overview of the eight projects and the methodologies that were applied by the projects.

Table 16: Overview of the eight projects and their methodologies

Type	Project name	Subtype	Methodology
Biomass-to-energy	Tugela Mill Fuel Switching Project	Forest residues: other	AMS-I.C.
	Mondi Richards Bay Biomass Project	Forest residues: other	AM36
	Lomati Biomass Power Generation Project in Mpumalanga	Forest residues: sawmill waste	AMS-I.C.
	Manufacture and utilisation of biocoal briquettes in Stutterheim, South Africa	Biomass briquettes or pellets	ACM22
	Grahamstown Invasive Biomass Power Project	Forest biomass	AMS-I.D.
Anaerobic digestion	PetroSA Biogas to Energy	Waste water	AMS-I.D.
	Kanhym Farm Manure to Energy Project	Manure	AMS-III.D. and AMS-I.D.
	Dundee Biogas Power (Pty) Ltd	Manure	AMS-I.D. and AMS-III.D.

In line with global practice, AMS-I.D. and AMS-I.C. are the most commonly used methodologies across both project types. These methodologies are broadly applicable in the South African context. Globally, an additional 16% of potential projects within the two sectors are still in the pre-registration stage. This represents an additional 57% in South Africa. Out of the total of 1 571 projects registered worldwide in the two sectors, over 500 projects have successfully issued CERs, where in South Africa only two projects managed to realise CER issuance for small volumes several years ago.

These methodologies have been successfully applied in South Africa, and a substantial pipeline of projects adopting these methodologies is in place. However, when it comes to realising CER issuance from registered projects in these sectors, South African projects are substantially less successful than the global average. Two barriers lie between a registered project and an issuing project: monitoring and reporting, and verification (MRV). In the next section, we will examine the monitoring requirements of the most commonly used methodologies that are applicable in these sectors for South African projects, and the verification elements required to issue credits.

Chapter 3: Technical analysis – monitoring requirements

3.1 Introduction

Why?

The legitimacy of climate change mitigation activities is strongly dependent on the appropriate assessment and reporting of the net change in atmospheric GHGs due to each activity, as well as a broader set of operational parameters that allow investors and stakeholders to evaluate the robustness and ethics of a programme. An inadequate or inappropriate reporting system may result in the false allocation of emission reductions, which in turn would undermine the validity of flexible mechanisms and the credibility of "carbon offset" measures in general. It is therefore imperative that emerging South African climate change mitigation activities adopt assessment and reporting mechanisms that adequately ensure the integrity of underlying programmes.

Due to the close relationship between project legitimacy and robust reporting mechanisms, international carbon standards have placed considerable emphasis on developing scientifically robust and transparent frameworks and processes. While this approach has ensured the credibility of emission reductions, it has often led to the adoption of overly complicated and expensive monitoring processes, which can become a barrier to implementation due to associated high costs and specialist capacity burdens. A balance therefore needs to be achieved between the need to ensure that emission reductions are real and true, and the cost and capacity burden of monitoring procedures.

In this monitoring section, fundamental required parameters, units and processes are introduced, together with an exploration of potential costs and the required capacity. In sections 3.2 and 3.3, emerging concepts that may reduce costs, capacity and associated risk are described, followed by a recommended approach to monitoring each activity in Section 3.4.

The formal assessment and reporting of key parameters occurs during two distinctly different phases of an activity's lifetime:

- The first is during the development of a baseline scenario for a project, and is communicated in the methodology section of an initiative's PDD. In this phase, a baseline assessment of key parameters is required to populate a likely without-project scenario, and to quantify existing terrestrial carbon stocks and sources of GHG emissions at the start of the project period in the case of landscape-orientated projects.
- The second is in the form of "monitoring events" that occur at set intervals throughout the lifetime of the activity. Depending on the type of project and the particular requirements of investors or stakeholders, the interval may vary from every year to every fifth year. The scope and structure of such monitoring events is described in the monitoring section of the PDD.

In terms of strict industry-appropriate definitions, the term "monitoring" should only refer to the latter phase – the periodic monitoring events. However, as many of the parameters and associated analysis and reporting procedures are similar, both phases are considered here.

A monitoring plan for landscape-orientated climate change mitigation activities typically comprises three components: project details, the implementation status of subactivities and an assessment of the net change in GHG emissions and removals due to the project (see Table 17).

Table 17: Each component of a typical AFOLU-sector monitoring plan

Component	Elements
Project details	• Brief description of the activity • Activity type and sectoral scope • Start date, crediting period and monitoring interval • Project proponent and other contributing parties
Implementation status	• The implementation status of each intervention needs to be assessed and reported in an appropriate manner. • For example, a REDD+ project usually includes a broad suite of interventions that together result in a net decrease in deforestation – activities may include improved forest and fire management systems, sustainable charcoal production and replanting programmes, as well as the creation of alternative livelihood opportunities. • The progress of each activity is noted, including key statistics and problematic issues that may exist.
GHG emissions or removals	• The change in GHG emissions and sinks due to the activity is assessed and reported in three distinct sections. These are summed to assess the net effect of the project on atmospheric GHGs: - he change in the size of terrestrial carbon pools within the project area - GHG emissions due to operations and project activities - Leakage

The first two components (the project details and the implementation status of activities) are relatively straightforward to compile and are largely based on the parameters and activities listed in the initial PDD. In practice, each comprises a number of pages of text, with supporting tables, which can be compiled by a professional in a few days. The compilation of these two components therefore rarely presents a significant barrier to implementation or the financial viability of a project[12].

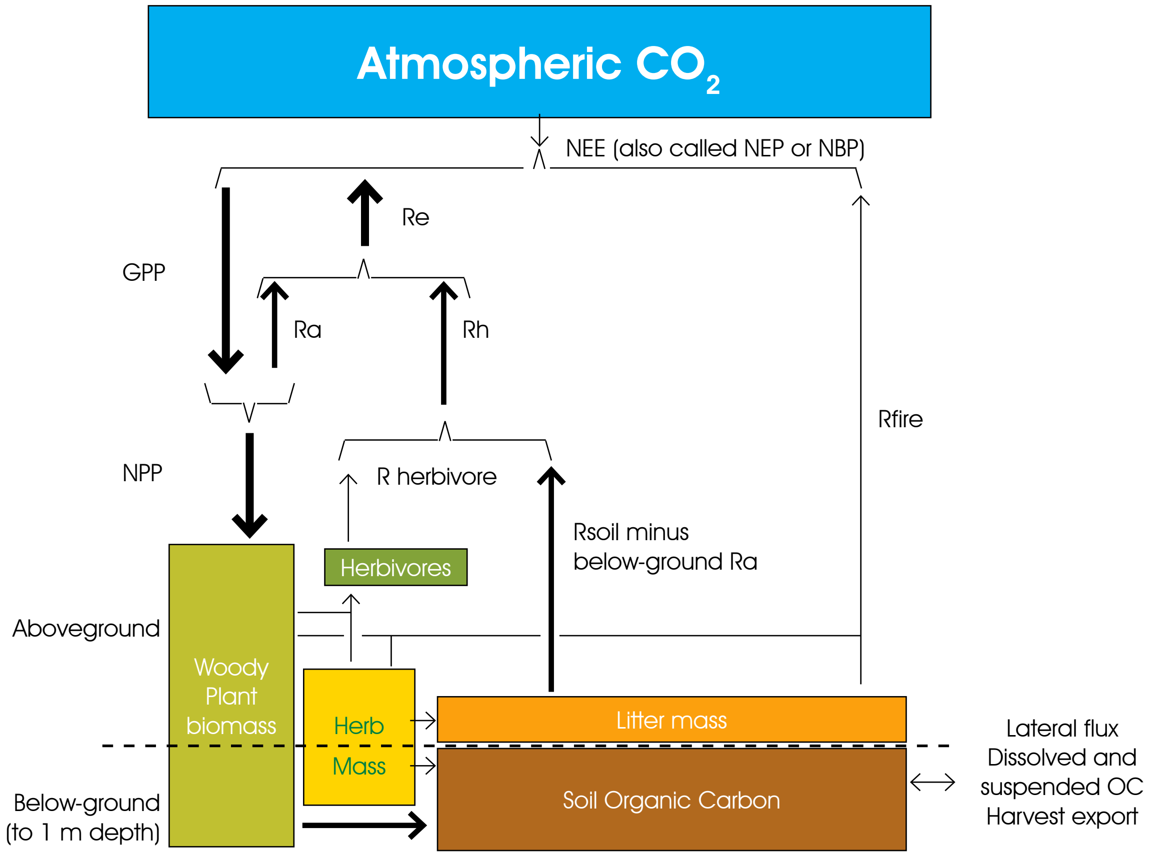
The third component, the estimation of GHG emissions or removals, is considerably different in terms of scope, nature and cost. Due to the need for extensive remote sensing, fieldwork, potential laboratory work and data analysis, the costs of this component can be considerable to the extent that they affect the financial viability of the underlying project (Cacho, Wise and MacDicken, 2004; Betemariam et al., 2011). In addition, South African project implementers and stakeholders noted that the execution of this component is often viewed as an area of risk and uncertainty due to a lack of readily available knowledge of the subject and associated field capacity.

The chief focus of this review will therefore be on the third component, with emphasis on reducing costs and developing an efficient monitoring framework that is appropriate to South African implementation in terms of ecological and socioeconomic conditions, and a context where creating rural employment is an important national priority.

12 Readers are encouraged to browse published PDDs and monitoring reports to understand the depth of required detail and reporting (http://www.vcsprojectdatabase.org/). In the review of methodologies above, we have covered elements of a methodology and monitoring in detail. However, we still encourage readers to go to the VCS website to review examples on their own. It is beyond the scope of this research to cover examples for each activity. Please also see the cover letter for the explanation as to why VCS and CDM are the only approaches reviewed.

3.2 Carbon pools and sources of GHG emissions

The mitigation of climate change caused by land use affects the concentration of atmospheric GHGs through two main mechanisms – either through a change in terrestrial carbon stocks or through a change in GHG emissions generated within the project area and associated operations.



NEE: Net Ecosystem Exchange
GPP: Gross Primary Production
Rh: Heterotophic respiration (herbivores carnivores and microbes)
NEP: Net Ecosystem Productivity
NPP: Net Primary Production
Re: Ecosystem respiration (the combined respiration from all sources)
NBP: Net Biome Productivity
Ra: Autotrophic respiration (respiration by plants)
Rfire; Fire emissions
OG: Organic carbon

Source: Scholes et al. 2013

Figure 2: Components of a generalised terrestrial carbon cycle: The size of the boxes and the arrows, which represent stocks and fluxes respectively, is only roughly indicative of their relative size.

Due to its nature, the total terrestrial carbon stock is usually separated into a number of pools for consideration and measurement (see Figure 1 and Table 18). It is not necessarily mandatory for a project proponent to monitor all carbon pools. Firstly, depending on the type of project, certain pools are not considered by default, e.g. the woody carbon pool would not be included in a crop-based conservation agriculture project. Secondly, depending on the particular context of implementation, a project developer may decide not to monitor a particular pool due to costs or pure practicalities, such as measuring the size of litter, deadwood and herbaceous carbon pools in a savanna ecosystem that burns every three to four years. Although most methodologies require an essential set of pools to be measured, they often allow for the exclusion of pools where it does not lead to an overestimation in claimed VERs.

As dry biomass is approximately 50% carbon, plant growth and the restoration of soil organic carbon leads to a net flow of carbon from the atmosphere into terrestrial organic pools (see Figure 2). In a similar manner, deforestation and the turnover of soils may lead to the release of sequestered carbon into the atmosphere. Further to changes in carbon pools, the implementation of project activities may result in changes in emissions from fire or from new project operations, e.g. through liquid fuel or fertilizer usage (see Table 18). Each change in carbon pools and sources of emissions needs to be jointly considered to understand the *net* effect of the activity on GHG emissions.

Table 18: Carbon pools that may be considered within a project's baseline assessment and monitoring protocol

Carbon pool	Climate change mitigation activities					
	REDD+ and A/R				Grassland restoration and ACoGS	Conservation agriculture
	Subtropical thickets	Woodlands	Coastal and montane forests	Commercial		
Above-ground woody biomass	Yes	Yes	Yes	Yes	No	No
Above-ground non-woody biomass	Yes	Yes	Yes	No	No	No
Below-ground biomass	Yes	Yes	Yes	Yes	No	No
Deadwood	Yes	Site-dependent*	Yes	No	No	No
Litter	Yes	Site-dependent	Yes	No	No	No
Soil organic carbon	Yes	Site-dependend	Site-dependent	No	Yes	Yes
Wood products	No	No	No	No	No	No

* The inclusion of particular carbon pools for certain activities depends on the particular implementation context. For example, the monitoring of deadwood and litter pools in woodland-based projects depends on the prevalence of fire (among other factors) that may influence the nature of the pool in the project period.

In terms of the consideration of each carbon pool in a South African context, the proponents of reforestation and REDD+ activities need to at least account for changes in the woody biomass pool. Inclusion of the other pools is less obvious and depends on the costs of monitoring the pools and other factors like fire (see Table 19). Projects located in the subtropical thicket biome have, to date, monitored the biomass, as well as deadwood, litter and soil carbon pools. This is due to expected substantial changes in the soil carbon pool (Mills, Cowling, Fey, Kerley, Donaldson, Lechmere-Oertel, Sigwela, Skowno and Rundel, 2005) and the general absence of fire in thickets that may remove litter and deadwood. In contrast, small-grower plantation projects and those located in woodlands may not elect to monitor the litter and deadwood pools due to periodic surface fires and may not assess changes in the soil carbon pool due to cost considerations. The decision to include or exclude the monitoring of these pools is often site-specific and depends on the particular edaphic and topographic conditions, as well as the financial resources of the implementing agent. Interviewed project developers noted that changes in soil organic carbon would be assessed in most project locations if the costs of traditional field assessments were more affordable relative to expected carbon revenues.

For grassland and conservation agriculture activities, monitoring principally focuses on changes in the soil organic carbon pool. Above-ground carbon pools are either likely to burn every few years or be removed to a certain degree through harvesting.

Further to monitoring changes in carbon pools, project proponents are required to monitor sources of additional GHG emissions that are generated through the implementation of the activity (see Table 19). Sources may include the combustion of liquid fuels, the application of fertilizer, fire and emissions from livestock through enteric fermentation or manure.

To avoid inefficiencies and additional cost burdens, most international carbon standards require implementing agents to only account for such sources if they are estimated to amount to more than 5% of the total net emission reductions claimed by the activity. Therefore, in practice, GHG emissions from the majority of these sources are not measured or reported (see Table 19).

If there are particular project contexts in which they would need to be monitored, the additional cost and capacity burden is typically limited to a few days of a professional's time. Input parameters are usually obtained through existing project or financial reporting (annual billing for diesel and fertilizer) and resultant GHG emissions are calculated using a set of established emission factors.

Adopted emission factors should be peer-reviewed and should be as specific to the project context as possible.

The general approach is to start with internationally accepted factors published by the IPCC or the UK Department for Environment, Food and Rural Affairs (DEFRA)[13] as a default option, and to then use more locally specific emission factors where possible.

Table 19: Sources of GHG emissions that may be considered in a baseline assessment and monitoring protocol

Source	GHG	Climate change mitigation activities					
		REDD+ and A/R					
		Subtropical thickets	Woodlands	Coastal and Montane forests	Commercial	Grassland-restoration and ACoGS	Conservation agriculture
Liquid fuel – diesel	CO_2	No*	No	No	Site-dependent	Site-dependent	Yes
Fertilizer application	N_2O	No	No	No	No	No	Site-dependent
Burning site preparation	CH_4, N_2O	No	Site-dependent**	No	Yes	Yes	Site-dependent
Burning crop residue	CH_4, N_2O	No	No	No	No	No	No
Burning forest fires	CH_4, N_2O	Yes	Yes	Yes	Yes	No	No
Enteric fermentation	CH_4	No	No	No	No	Yes	Site-dependent
Manure deposition	CH_4, N_2O	No	No	No	No	Yes	Site-dependent

* The majority of methodologies do not require the monitoring and reporting of GHG emissions generated through project operations (e.g. fuel for vehicles and machinery), if these sources add up to less than 5% of the total claimed GHG emission reduction due to the project activities.

13 IPCC :www.ipcc.ch
DEFRA: www.ukconversionfactorscarbonsmart.co.uk.

Thankfully, the Confronting Climate Change Programme has already invested a considerable amount of time in developing a suitable set of emission factors for South African agriculture. The emission factors have been reviewed by the Climate Trust and are published on the programme's web portal[14]. Furthermore, a set of four studies by Du Toit, Meissner and Van Niekerk (2013a; 2013b) and Du Toit, Van Niekerk and Meissner, (2013d; 2013d) provide appropriate GHG emission factors for a range of South African livestock and game species. Additional emission factors specific to South Africa that are pertinent to the AFOLU sector may be located in the GHG Inventory for South Africa (Department of Environmental Affairs, 2013).

3.3 The assessment and reporting of carbon pools

International carbon standards (CDM, VCS and GS) typically required project proponents to estimate the size of carbon pools with less than a 10% error at a 95% confidence level. The governing bodies of international carbon standards have stipulated this requirement on the basis that it will ensure the robustness and accuracy of carbon stock estimations and associated issued VERs. This requirement may not result in the most rational or efficient allocation of project resources (Wise, Von Maltitz, Scholes, Elphinstone & Koen, 2009), but it is the current international industry norm and a condition that South African projects may need to meet to be accepted by international standards and VER buyers at present. It should be noted that this requirement is not necessarily absolute and could be revisited in future if a party were to propose a new methodology with sufficient, sound and scientific support.

Due to variability in vegetation, soils and associated carbon stocks across vast landscapes, ecologists normally take a "stratified-random" approach to estimating the size and nature of carbon pools. The first step in the process is to stratify the landscape into homogenous units based on carbon stocks, e.g. areas of grassland, savanna, open woodland, closed woodland and taller forest. Thereafter, the carbon stock within each strata is estimated using sample plots that are distributed in a random manner. Biomass and/or soil carbon are estimated for each sample plot, from which an estimation of the carbon located within strata can be made, and from there, an estimation of carbon stocks within the entire project area.

14 www.climatefruitandwine.co.za

To assist project proponents and to remove potential uncertainty regarding how to measure each pool, a substantial number of manuals, modules and tools have been published by international carbon standards. In addition, other programmes that focus on land-use climate change mitigation, such as the United Nations programme aimed at REDD (UNREDD), as well as research and private institutions, such as the Centre for International Forestry Research (CIFOR) and Woods Hole, have created extensive documentation and tools to guide potential developers on a project- or national-scale.

Our intention is to describe the assessment and reporting process from a South African viewpoint, considering the potential adoption of recognised tools and published manuals where appropriate. Furthermore, emphasis will be placed on not only assessing the technical suitability of recognised methodologies, but the cost of their execution as well. The reason for this is that numerous interviewed practitioners noted that the cost of effecting the required monitoring frameworks is often unaffordable, resulting in expenses that exceed generated carbon revenues. Recommendations will be made on how to reduce costs where possible in a South African context.

The review is divided into three steps:

- Step 1: Mapping and stratification using remote sensing
- Step 2: Field assessment of carbon stocks
- Step 3: Analysis and reporting of data

STEP 1: MAPPING AND STRATIFICATION

General approach

The spatial data requirements of a typical project fall into three broad categories: mandatory project maps, stratification of the project area for carbon stock assessments, and, in the case of REDD+ activities, the following analysis of historical and potential future land-use trends:

- **Requisite supporting maps:** A staple component of the PDD, methodology and monitoring reports of any landscape-orientated activity is an essential set of maps illustrating its location and land use, vegetation, soils and climate within the project area. In practice, the majority of these maps are drawn from existing national or regional datasets, such as national land-cover surfaces or the AfSIS soil carbon map of Africa.

- **Stratification of the project area:** As noted above, the first step in the stratified-random approach is the stratification of the area of interest into homogenous units. The number of strata and the method used is closely dependent on the type of vegetation and land use observed within the project area. In a South African context, Landsat imagery is typically used due to its particular resolution (30 m), spectral range and the fact that it is inexpensive and easy to access. Due to the nature of South African vegetation and land cover, a supervised multi-temporal classification of Landsat imagery is generally undertaken to adequately differentiate between particular vegetation classes.

- **Stratification is often a stepwise process** – A first iteration is usually generated based on prior knowledge of the area and established maps. Following initial field sampling, the initial iteration may need to be revisited if a particular stratum is too heterogeneous or if the map falsely illustrates particular features. Furthermore, a separate stratification process for biomass and soil organic carbon pools may be required.

- **Analysis of historical and future land-use trends:** To estimate the avoided GHG emissions due to a REDD+ or ACoGS initiative, an understanding of potential deforestation and degradation under a baseline, without-project scenario, is required. This is typically achieved by mapping historical deforestation and land-use trends in a suitable "reference" area that adequately replicates what could be reasonably expected within the project area in the future.

A reference area is selected based on similar land-use patterns and trends, topography, climate, access to transport, distance to markets, etc. These parameters are generally selected after a study of local deforestation drivers and engagement with stakeholders in the landscape. Once the reference area is selected, forest/non-forest maps for four to five historical points in time (going back 20 to 30 years) are generated and used to assess the rate and nature of deforestation and degradation. Depending on the adopted methodology, this understanding of the rate and nature of change is used to model future deforestation and degradation within the project area in a spatially explicit or non-explicit manner. If an analysis of reference levels is developed on a national scale, it is commonly referred to as a forest reference level (FRL) or forest reference emission level (FREL), which is being explored by the UNFCCC REDD+ mechanism.

Existing tools, modules and guides

The guidance documentation provided by the Global Forest Observation Initiative (2014) is viewed as the standard primary resource for the remote sensing of forests, land use and parameters important to regional REDD+ activities. One of the reasons for its compilation was to ensure that common and comparable remote sensing methods are used across regions.

Whereas future activities in South Africa should adhere to such international approaches to ensure that datasets are comparable and useful, at the same time, local innovative remote sensing techniques should not be discounted and should be encouraged where possible. This is particularly important to the remote sensing of savanna and grassland degradation that is often not considered in depth by international publications that are more focused on large-scale deforestation in moist tropical forests.

Cost considerations

Please see the report on required remote sensing and the nature of associated costs in annexures A and C. GeoTerraImage compiled the report based on their significant experience in mapping land use in a South African context.

Emerging considerations and possibilities to improve efficiencies

During this analysis and interviews with practitioners and stakeholders, a number of themes emerged regarding remote sensing and spatial data in general:

- **Accessibility:** Field practitioners noted that they have very limited access to the required maps and spatial data. Furthermore, if maps are publicly available, entities seldom have the required software or skills to extract data for their particular area of interest.

- **Scale:** If AFOLU-sector activities were to be developed at scale in South Africa, e.g. a programme focused on the restoration and maintenance of the grassland biome, it is suggested that a full suite of the required maps for the particular activity are compiled and presented through an easily accessible web portal. This could be created in a similar manner to the online BioEnergy Atlas developed by SAEON and the National Carbon Sinks Atlas collaboratively built by SAEON, DEA and the Council for Scientific and Industrial Research (CSIR).

- **Repetition:** Stakeholders and potential service providers noted that there might be substantial repetition in the development of spatial datasets for different clients. For example, several parties are presently developing maps of degraded areas and farm boundaries. To improve efficiencies and ensure consistency in approach (or at least awareness of variation between approaches), it may be appropriate to develop a central portal for generated maps and spatial datasets.

- **Cost efficiencies:** The cost section above clearly illustrates that it makes sense, in terms of cost efficiencies, to implement measures at scale, or at least to aggregate individual activities in a programmatic or jurisdictional manner. If implementing agencies only need to pay the marginal cost for spatial data, it could reduce their expenses considerably. This is especially true in the context of REDD+ projects that may require the mapping of separate project, reference and proxy areas for several historical and future points in time. In our experience, these mapping costs alone have been found to inhibit the financial viability of small-scale REDD+ activities.

STEP 2: FIELD ASSESSMENT OF CARBON STOCKS

General approach

Following the stratification process, the goal of field sampling is to estimate the size of the carbon pools in each stratum with a sufficient level of accuracy. Depending on the particular vegetation or soil type under consideration within the stratum, the manner in which sampling is undertaken may vary in terms of the number, shape and size of sampling plots, measured plant and soil parameters, adopted laboratory techniques and the application of allometric equations and further data analysis.

A substantial set of published manuals, modules and tools describe each part of the sampling processes in fine detail. Leading examples of these are listed in the section below. However, here we focus on a broader, more general level to explore important elements of the field assessment process that are currently constraining or inhibiting the roll-out of activities in South African ecosystems. Important elements have been identified based on input from interviewed field practitioners, consulting firms, academics and the project team members' own experience in the field.

Sampling the woody biomass, herbaceous and litter carbon pools

Part of the stratified-random approach is the use of randomly located sample plots within each stratum to estimate the amount of woody biomass, as well as herbaceous matter and litter. The required number, shape and size of plots may differ between ecosystems and particular project needs, but in general, field practitioners aim to have at least 30 sample plots within each stratum that are often circular in shape. A circular shape is usually adopted due to the time it takes to demarcate (relative to other shapes) and the need to only geolocate the central point, rather than several corner points.

The herbaceous and litter carbon pools are estimated by harvesting a sample at each plot location. Herbaceous and litter matter is gathered from within one or more smaller quadrats (e.g. 1 x 1 m), initially placed in paper bags, and then oven-dried in a laboratory until a constant mass is reached. The matter is then weighed and the amount of carbon estimated.

While the process of collection, handling and drying is not technically difficult, substantial costs can be incurred during field operations and the drying process. Field staff wages and transportation costs can be significant. Although the drying process is straightforward, it would require a project to either purchase a laboratory oven and staff it, or transport samples to a service provider. Ways of reducing these expenses are explored in a separate section below.

The woody biomass pool is estimated in a non-destructive manner with appropriate allometric equations. As woody plants of a particular species have a common growth form, it is possible to estimate the approximate volume of biomass within a tree based on a few key measurements and the application of a suitable allometric equation. South African ecologists have historically had an interest in allometry, and therefore an extensive set of allometric equations already exists for common South African species, especially within the savanna and woodland biomes.

Due to the nature of allometry, two sets of equations are suggested for South African woody species, depending on the size of the tree and growth form:

- The analysis by Nickless, Scholes and Archibald (2011) suggests two equations for trees (fine-leafed and broad-leafed species) with a basal diameter of less than 30 cm.
- The equations published in Chave, Andalo, Brown, Cairns, Chambers, Eamus, Folster, Fromard, Higuchi, Kira, Lescure, Nelson, Ogawa, Puig, Riera and Yamakura (2005) are recommended for trees with a basal diameter greater than 30 cm.

The Nickless et al. (2011) equations are initially recommended, as they are based on an analysis of primary field data obtained through the laborious harvesting of species within South Africa. However, due to the nature of the Nickless et al. (2011) equations, they may not provide a conservative estimate of biomass for trees with a basal diameter larger than 30 cm (the analysis was not aimed at that size class). For this size class, the Chave et al. (2005) equations provide a suitable estimate of above-ground biomass. Although the equations were developed based on South American data, meta-analysis of allometric equations for African forest species (e.g. Henry, Picard, Trotta, Manlay, Valentini, Bernoux and Saint-André (2011) have identified the set of Chave et al. (2005) equations as robust and conservative.

This set of allometric equations provided by Nickless et al. (2011) and Chave et al. (2005) provide an estimate of *above-ground* woody biomass. To estimate the size of the *below-ground* root component of trees, pertinent root:shoot ratios are used. Similar to allometric equations, the relationship between above- and below-ground biomass depends on the growth form of the plants to a certain extent, but it is additionally influenced by soil and climatic conditions. For these reasons, practitioners pragmatically adopt the root:shoot ratios published in the meta-analysis, such as those by Mokany, Raison and Prokushkin (2006).

Biomass estimation remains an issue in the South African subtropical thicket biome of Eastern Cape (Powell, 2009). This is particularly important, as the biome is the focus of some of the leading reforestation programmes in the country (Mills & Cowling 2006; Marais, Cowling & Powell, 2009; Powell, 2009). Although allometric equations have been developed for prominent species, including *Portulacaria afra* (Powell, 2009), practitioners noted that the impenetrability of thicket leads to exceptionally high time and capacity requirements, which in turn increase the cost of sampling to unsustainable levels. Interviewed stakeholders within the region noted that these cost burdens are likely to inhibit large-scale adoption of reforestation activities, unless addressed in some manner.

Sampling the soil organic carbon pool

A stratified-random sampling design is also generally adopted to estimate the size of the soil organic carbon pool. The area of interest is stratified into homogenous strata based on the assumed distribution of soil carbon, and an adequate set of randomly located samples is taken within each strata to be able to estimate the size of the pool with a sufficient level of accuracy.

At each sampling point, soil samples are taken at a number of depths due the manner in which soil organic carbon is distributed with depth. Four to five samples are usually taken at depths of 0 to 5 cm, 5 to 15 cm, 15 to 30 cm, 45 to 55 cm and 90 to 100 cm. The exact depth of each sample may differ between practitioners, but the underlying aim is to estimate carbon stocks in the top 30 cm with sufficient accuracy, and to extrapolate the estimation to a depth of 1 m in a robust manner. To reduce the potential effect of small-scale spatial variation and anomalies on a particular sample, samples are generally taken from a number of sampling holes within a greater plot mixed together, and a single sample for each particular depth is then sent to the laboratory.

In addition to the soil sample extracted for organic carbon content analysis, a second set of samples needs to be taken to estimate bulk density. As variation in bulk density is typically less than variability in soil organic carbon, fewer samples may need to be taken, but it requires dedicated field sampling and laboratory time.

The laboratory analysis of soil carbon can be done in-house, but in practice, it is usually outsourced to a dedicated professional entity. Depending on the particular laboratory, soil samples may be submitted in the form in which they are extracted from the ground, or they may first need to be dried to a constant mass and the root and stone content analysed before submission.

The soil sampling process is briefly described here, as detailed consideration of each element can easily form a full report (e.g. Aynekulu et al. 2011). It is clear that the process is laborious, time-consuming and expensive. It requires trained staff, transportation to field sites, accommodation and sustenance, the transportation of samples to a lab and laboratory time. The cost of such activities and emerging mechanisms through which to reduce such expenses are explored further below.

Existing tools, modules and guides

A large body of guidance documents and tools has been published by the CDM, VCS and other institutions that focus on the estimation of above- and below-ground carbon stocks in the context of climate change mitigation activities. The CDM's web portal includes an extensive list of tools that focus on various aspects of sampling design and the estimation of each carbon pool. Furthermore, the CDM recently published a new field manual that focuses on reforestation activities in particular:

- CDM web portal: https://cdm.unfccc.int/Reference/tools/index.html
- UNFCCC (2015): http://unfccc.int/resource/docs/publications/cdm_afforestation_field-manual_web.pdf

In a similar manner, the VCS has published a broad set of modules and tools that provide guidance on each element of the sampling process:

- http://www.v-c-s.org/methodologies/modules-and-tools

In practice, field staff may view many of the CDM and VCS guidance documents as too technical. The manuals published by Wood Hole and Winrock provide further background and guidance to the sampling design and measurement process for biomass carbon stocks:

- Woods Hole RC: http://www.whrc.org/resources/fieldguides/carbon/index.html
- Winrock International: https://www.winrock.org/sites/default/files/publications

Likewise, the following soil sampling and analysis manual:

- Aynekulu et al. (2011): www.worldagroforestry.org

During the course of the stakeholder engagement, several interviewed parties noted that the sheer number of manuals, modules and tools might create uncertainty due to confusion on which is the appropriate option for a particular project context. For this reason, only the Wood Hole, Winrock and ICRAF manuals are listed here. If the decision is made to create and support the implementation of particular activities at scale, such as a national reforestation programme, it is suggested that a suitable set of manuals be adopted or drafted, and hosted on an easily accessible web portal with supporting explanation.

EMERGING CONSIDERATIONS AND POSSIBILITIES TO IMPROVE EFFICIENCIES

Landscape-scale allometry

As introduced above, the present industry norm is to estimate the woody biomass carbon pool using a stratified-random sampling design and tree-scale allometry. This approach is known for its rigour, as well as its simplicity, where field staff can undertake the required field measurements after a few weeks of training.

This application is limited in subtropical thickets, not in terms of scientific rigour, but rather in terms of the inhibitory costs of the required sampling in a landscape that is characterised by close to impenetrable vegetation and exceptional topographical, climatic and edaphic variability (Powell, 2009). This results in a large number of the required strata and associated sampling plots that each takes a protracted amount of time to access and sample. Based on several years of operational data, field specialists in the region provided cost estimates of between approximately R5 000 to R7 000 per plot, inclusive of staff, transportation and sustenance expenses.

An alternative approach is to develop allometric relationships on landscape scale rather than on the scale of a single tree. Colgan, Asner, Levick, Martin and Chadwick (2012) provide an example of the application of this approach in the Kruger National Park. It is a technique where remote sensing is initially used to estimate both the height and aerial cover of vegetation. The product of these two parameters provides a volume estimate per pixel that is multiplied by an appropriate biomass calibration factor to estimate the amount of biomass per unit area.

To date, this approach to allometry and estimating carbon stocks has not been applied to the subtropical thicket biome, but it holds good promise as an approach that may reduce costs considerably. Once developed, the technique may also be applicable to reforestation and REDD+ activities located in coastal and scarp forests.

Predictive biomass and litter models in subtropical thickets

The same access and cost issues that limit the cost-efficient assessment of biomass carbon stocks in subtropical thickets also apply to the litter and deadwood pools. Furthermore, project developers noted that there is

little understanding of how the upper bound for biomass or carbon sequestration may vary across the subtropical thicket biome, which is characterised by high levels of climatic, edaphic and topographic heterogeneity.

Both of the issues could be solved through the creation of spatially explicit predictive models based on the relationships between the woody biomass pool, and litter and deadwood components. A similar approach, either based on new model development or the adjustment of established models (e.g. the Century Ecosystem Programme), could be used to estimate the upper bound for carbon sequestration across the biome, at the spatial scales required for implementation methodological and monitoring requirements.

Predictive soil carbon stock and sequestration models

The cost of conventional approaches to estimating soil carbon has often inhibited the adoption of climate change mitigation activities within grasslands and the agricultural sector. Likewise, similar cost issues have often limited the inclusion of the soil carbon pool in reforestation and REDD+ project accounting. Although the majority of REDD+ and A/R methodologies allow for the inclusion of the soil organic carbon pool, the expense of the first assessment and repeated monitoring every two to five years often results in project developers deciding not to include the pool in reporting.

To address this constraint, international carbon standards have advocated the use of predictive models (e.g. RothC) or default values as an alternative to expensive field assessments. Whereas this approach may reduce costs, both predictive models and default values need to be calibrated to local conditions and implementation scenarios to ensure the robustness of carbon stock and sequestration rate estimates. In terms of their immediate application to activities located across South Africa, interviewed field extension services, research officers and academics voiced concern that both predictive models and default values may not be adequately calibrated to South African ecological and implementation context as yet, and required additional development and calibration. South Africa is not alone in this situation, as many countries both regionally and globally are attempting to facilitate efficient climate change mitigation measures, and in general, measure and manage the health of soils on a national scale. In response to this need, several entities are exploring progressive soil carbon monitoring and modelling systems. These generally use a combination of progressive, cost-efficient field sampling techniques (e.g. Vagen et al. 2010; Aynekulu et al. 2011) and predictive models (e.g. AfSIS[15]).

15. http://www.isric.org/data/soil-property-maps-africa-1-km

It is suggested that such an approach be explored for both the mapping of soil carbon stocks, as well as estimating potential loss and sequestration rates following implementation. This may be a significant step to unlocking mitigation activities within grasslands and the agricultural sector, and it is likely to significantly improve the financial attractiveness of reforestation and REDD+ opportunities.

STEP 3: ANALYSIS AND REPORTING OF DATA

General approach

Data is typically entered, stored and analysed following Standard Operating Procedures (SOPs[16]) that are published by the project proponent at the start of the initiative. An auditor reviews the SOPs during the initial project validation process, which includes predefined data entry and reporting templates. Although many implementing agents have adopted the use of more progressive database systems, the CDM and VCS require parties to present primary data and the analysis process in spreadsheet format. This requirement may be viewed as regressive in terms of efficiencies, but the governing bodies of the standards have been more inclined to prioritise transparency to date and the ready availability of data to those who may not have knowledge of more advanced data systems.

Existing tools, modules and guides

During the early stages of the CDM and VCS, the data analysis process was often viewed as a source of uncertainty and risk by project developers who may not have had a background in ecology or forestry sciences. For this reason, a plethora of guidance documents, tools and approved spreadsheet templates have been published to assist parties in the data entry, analysis and reporting process:

- CDM web portal: https://cdm.unfccc.int/Reference/tools/index.html
- VCS web portal: www.v-c-s.org/methodologies/modules-and-tools
- Additional sources:
  US-AID AFOLU carbon calculator: www.afolucarbon.org
  FAO (UN): www.globallometree.org
  Winrock (Walker, Pearson, Casarim, Harris, Petrova, Grais, Swails, Netzer, Goslee and Brown, 2012): www.winrock.org/ecosystems

Despite the abundance of tools and templates, many interviewed parties noted that there is still concern that the correct approach has not been followed and that the

16. Walker et al. (2012) include an example of a set of SOPs for carbon-monitoring and data-entry purposes.

project will be left lacking during validation. Furthermore, while published guidance documents usually focus on estimating and communicating the net GHG emission benefit of activities, few provide guidance on required socioeconomic survey and operational parameters.

It is therefore suggested that, if a particular activity is going to be promoted at a regional or national scale, a review of established templates is undertaken with the aim of cost-efficient implementation in a South African context.

EMERGING CONSIDERATIONS AND POSSIBILITIES TO IMPROVE EFFICIENCIES

The creation of a national data capture, housing and reporting facility

Interviewed project developers noted that, although the process is not necessarily technically demanding, they often underestimate the required data-entry capacity, and database management and support over the long term. This is especially true for larger projects, where field data from several hundred sampling plots needs to be considered, in addition to a greater suite of operational and socioeconomic survey data. Furthermore, parties voiced concern over a lack of consistency in data structures between projects and the manner in which data files are often stored in an ad-hoc manner with little consideration for consistent datasets and reporting over 20 to 30 years.

The majority of these concerns could be addressed through the creation of a national data capture, housing and reporting facility. The ultimate location of such an entity would need to be decided by government. As an example, an entity like SAEON may be well placed to provide such capacity and host pertinent atlases. Leveraging existing hardware and expertise, the network could provide a data entry, housing, analysis and reporting capacity to implementing agencies at marginal cost.

Monitoring a broader suite of ecosystem service and operational parameters

Two additional themes consistently emerged during the course of interviews with local implementing agencies and international carbon standards authorities. The first is the need to monitor an essential set of operational parameters in order to guide future implementation. Local implementing agencies noted that the absence of historical operational data, for example staff productivity, planting regimes and plant survivorship, has limited potential insight into how future programmes should be structured. Agencies strongly advocated the monitoring of key operational parameters from the inception of activities in a manner that is aligned with general assessment and reporting procedures.

A second theme that emerged with local entities, which has been in the international discourse for some time, is the need to monitor a broader set of ecosystem services and parameters that allow one to estimate improvements in landscape productivity and resilience to climate change and other forms of disturbance. For example, within South Africa, implementing parties have been asked to report on changes in water services, erosion, livestock production, fuelwood availability and biodiversity, in addition to climatic benefits. In a similar manner, in the international domain, investors and funders are asking carbon standards to expand their monitoring requirements to include broader measures of human wellbeing, landscape productivity and changes in ecosystem services.

The existing CCBA Standard focuses on the biodiversity, ecosystem service and socioeconomic impact of projects, but more from a safeguarding (do no harm) point of view, than for the empirical measurement and reporting of changes in ecosystem services and landscape production due to implementation.

It is therefore suggested that these two elements are included in future South African monitoring frameworks. A comprehensive assessment of additional cost burdens will need to be undertaken first, but as implementing agents would already be travelling to field sites, commissioning mapping, further capacity and cost burdens may be marginal.

3.4 Monitoring of energy-related activities

When looking at the monitoring requirements of the primary methodologies used within the biomass-to-energy sector and anaerobic digestion categories, the following three monitoring components can be identified:

- **Upstream compliance monitoring**: Some of the methodologies applied require the project developer to periodically demonstrate that an initial statement made in the PDD or confirmation of a requirement set in the methodology is still accurate and true. A good example of this is the methodology requirement that the biomass used in a biomass-to-energy project is from a sustainable source and that the project developer confirms that this is the case.

- **Baseline monitoring**: Some of the monitoring requirements in a methodology state that one or several of the variables that are used to determine the baseline have to be monitored. An example of this is the volume of methane generated by an anaerobic digestion project. In this case, the project itself would consist of the generation of electricity via the combustion of the methane, resulting from the anaerobic digestion




process, the generation of carbon credits from the destruction of methane and the provision of renewable electricity onto a fossil fuel-based electricity grid.

- **Project scenario monitoring**: It is self-evident that, to be able to determine the remaining emissions under the project scenario (i.e. after the implementation of the project), a set of variables that allow the calculation of the project emissions have to be monitored. However, some of the methodologies also require the project to measure the relevant activity level in relation to the baseline.

When looking at two existing CDM projects in South Africa and reviewing their monitoring operations against the abovementioned components, the following can be found.

Project 1: Tugela Mill Fuel-switching Project

- Type: Biomass-to-energy project
- Status: Issuing
- Methodology: AMS-I.C: Thermal energy production with or without electricity
- Description: The replacement of coal with sustainable biomass as boiler fuel
- Monitoring: To determine the emission reductions from the project, the total volume of steam produced by the boiler from the use of biomass has to be determined. The amount of emissions that would have occurred if the steam was made by using coal is then calculated to determine the volume of emission reductions.

When looking at the “upstream compliance monitoring” element of the monitoring plan, the most stringent requirements that have to be monitored are those that demonstrate the sustainability of the biomass used. For this project, this is demonstrated by explaining that a pulp-and-paper operation is a going concern, and therefore the biomass removed for the production process is replaced by new biomass for future production. In addition, the sustainability is demonstrated via a sustainable forest management certification such as the Programme for the Endorsement of Forest Certification.

The baseline monitoring for the project consists of the ongoing monitoring of the quality of the coal used in the baseline (and in other boilers at the same plant) to ensure that the energy value conversion between the coal and biomass remains correct. The reason for this is that, even though coal-based steam is replaced with sustainable biomass-based steam, the steam from a range of boilers goes into the same steam system before it is measured. This is a practical example of a situation where the in-operation process monitoring is used to provide the required data for the carbon component of the project at no additional costs.

On the project scenario side, the focus lies on the volume and calorific value of the biomass that goes into the boiler. To determine this additional monitoring, equipment has been installed to determine the volume via a so-called “impact plate” and biomass samples are collected to be sent to a laboratory to determine the calorific value of the biomass. The volume of coal fed into the boiler is also determined via an impact plate system, but the calorific value is only checked on a random basis, since the procurement of the coal is done on a calorific basis and is therefore predetermined.

Project 2: Dundee Biogas Power (Pty) Ltd

- Type: Anaerobic digestion
- Status: Registered
- Methodology: AMS.III.D: Methane recovery in animal manure management system and AMS-I.D: Grid-connected renewable electricity generation
- Description: The generation of grid electricity from the manure at a cattle feedlot
- Monitoring: The volume of manure provided from five different farms is measured before adding it to the digester. The total biogas flow from the digester, as well as the biogas flow to the flair and the flow to the generator, is measured. Emission reductions are derived from two components in the project: firstly the destruction of CH4 that would go into the atmosphere under baseline conditions, and secondly, the electricity from a sustainable source that is provided to the grid in relation to the carbon intensity of the grid.

The upstream compliance component of the monitoring process aims to demonstrate the consistency and stability of the manure provided from five different cattle farms to the anaerobic digester. The primary rationale for this is that when the source of manure (e.g. location and/or volume) changes, the baseline assumptions (e.g. that the CH_4 enters the atmosphere from a lagoon system at the farm) could potentially change as well. It therefore forms the basis on which emission reductions are generated.

The baseline part of the monitoring primarily consists of the determination of the carbon intensity of the grid into which the electricity generated is provided or prior consumption is displaced. For this methodology, AMS-I.D. describes the use of the “methodology tool to calculate the emission factor for an electricity system”.

Although the project applies a small-scale methodology, the method(s) and calculations used in the tool require a substantial amount of baseline data gathering. For this reason, the UNDP has developed a standardised baseline for the South African electricity system, which can be used by all project developers since it has been approved by the South African DNA.

The project scenario looks at the use of fossil fuel in the form of leakage and at the emissions resulting from the flaring of the CH_4 that is not used for the generation of electricity. For this methodology, AMS.III.D describes the use of the methodology tool to determine project emissions from flaring gases containing methane. The monitoring data required under the tool is extensive and requires additional monitoring equipment to be installed within the flair. The primary concern that is addressed in this part of the monitoring process is the flair efficiency in that not all the CH_4 is expected to be combusted when flared, and therefore some of the CH_4 resulting from the anaerobic digestion might still end up in the atmosphere.

From the above, it is interesting to see that, although it is complex and elaborate, there are ways in which the monitoring of the different parameters can be conducted within a reasonable time and with reasonable costs if concepts like "integration into the operational processes of monitoring variables" and the "application of standardised baselines" are applied. It therefore seems reasonable to conclude that the wider adoption and expansion of these concepts globally and domestically could reduce the monitoring hurdle as perceived by project developers within the CDM.

The above only provides a snapshot of the monitoring requirements, processes and tools used in two of the registered projects in South Africa. A more detailed analysis of the applicable methodologies can be found in the Excel spreadsheet provided with this report.




Chapter 4: Cost assessment

The costs of applying recognised methodologies and monitoring frameworks is considered in two sections due to the nature of expenses. The first focuses on the nature of monitoring costs, including field sampling and the spatial data required by a project proponent (e.g. the mapping of deforestation scenarios and the occurrence of fire). The second section assesses the cost of compiling the methodology section of a PDD, including the required SOPs and supporting spreadsheet models.

The costs of compiling the methodology section of a PDD, and especially fieldwork, is highly dependent on the particular project. Where possible, a range of costs is provided to provide an understanding of how costs may vary from site to site.

4.1 Cost assessment – spatial data and field assessment of carbon stocks

The assessment of terrestrial carbon stocks is undertaken in two phases:

- **Remote sensing and land-use change modelling**
  The first phase comprises an analysis of remote sensing imagery to map current land use and, in the case of REDD+ activities, historical deforestation over at least 20 years. Mapping exercises are repeated every five years at each monitoring event. (Please see Annexure A and Annexure C, which contain a list of the remote sensing products required for each activity type and the associated costs).

- **Field assessment of terrestrial carbon stocks**
  Following the mapping and stratification process, a set of sampling plots is used to estimate carbon stocks within each stratum. In terms of costs, the primary determinants are the required density of plots, distance and access to sampling plots, required capacity and time per plot, and laboratory fees to process soil and litter samples.

  Table 20 includes a range of estimated costs based on interviews with experienced field practitioners working on initiatives located in Malawi, South Africa, Tanzania and Zambia (the estimated cost per sampling plot includes the cost of soil sampling and laboratory analysis).

  Sampling costs per plot vary considerably, primarily due to the cost of access, transportation and sustenance, which make up the majority of costs. Particular ecosystems (especially subtropical thickets) are difficult to move through, and it takes substantial time to locate each plot and undertake measurements. This, in turn, increases the amount spent on wages, sustenance, accommodation, fuel and vehicle maintenance.

  The required density of sampling plots varies between ecosystems, based on heterogeneity and necessary stratification. Estimating the number of hectares per sampling plot is difficult without detailed knowledge of the particular project area. However, interviewed field practitioners noted that there is typically one plot every 10 to 20 ha in subtropical thickets and approximately one sampling plot every 200 to 400 ha in open grassland and woodland ecosystems.

The model is based on a five-year monitoring interval, as this is the standard proposed under the VCS. However, in practice, parties often elect to adopt a shorter interval of every one or two years, depending on the type of project and debt-servicing requirements. An annual discount rate of 8% was used for modelling purposes.

Table 20: The estimated cost of undertaking field sampling and the required density of plots

Location of projects	Grasslands and woodlands		Conservation agriculture		Subtropical thickets	
	Low	High	Low	High	Low	High
Costs per sampling plot	R2 500	R4 000	R1 500	R3 000	R5 000	R7 000
Density of sample plots (ha/plot)	400	200	400	200	20	10
Costs per hectare	**R6,25**	**R20,00**	**R3,75**	**R15,00**	**R250,00**	**R700,00**

The results of the analysis indicate that the costs per hectare are highly dependent on the spatial extent of the activity, ranging from R10,00 to R60 00,00 per hectare (see Figure 3 and Table 20). The magnitude of these costs is in line with international estimates by Watson, Noble, Bolin, Ravindranath, Verardo and Dokken (2000), Cacho et al. (2004) and

Pearson, Brown, Sohngen, Henman and Ohrel (2013), who provided estimates ranging from US$0,10 to US$18,00, depending on the type and extent of project activities.

Costs per hectare decrease rapidly relative to the spatial extent of the activity. The cost per hectare for projects larger than 100 000 ha is generally an order of magnitude less than projects that are 10 000 ha or smaller. This is the result of a relative reduction in remote sensing costs, and especially a reduction in the number of sampling plots required per unit area.

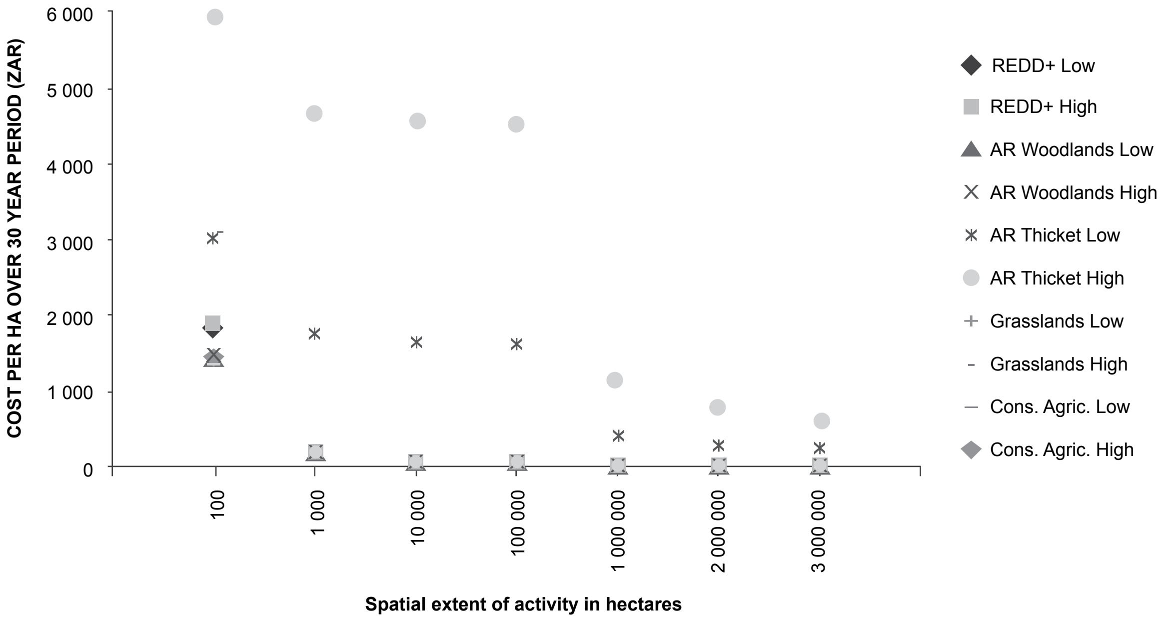


Figure 3: The relationship between remote sensing and field assessment costs, and the spatial scale of implementation for climate change mitigation projects located in South Africa

In general, the results show good support for a programmatic or jurisdictional approach to implementation at scale, and the development of predictive models that would allow small-scale project implementers to significantly reduce costs. Furthermore, the high costs associated with field sampling in subtropical thickets highlight the need for alternative approaches to estimating terrestrial carbon stocks, such as landscape-scale allometry.

Table 21: The estimated costs of required remote sensing, spatial modelling and field sampling for land use-based climate change mitigation activities located in South Africa

Activity	R per ha over 30-year project	Spatial scale (ha)						
		100	1 000	10 000	100 000	1 000 000	2 000 000	3 000 000
REDD+	Low	1 800	216	58	44	11	8	6
	High	1 889	306	147	133	33	23	18
Reforestation (woodlands)	Low	1 429	179	54	43	11	8	6
	High	1 519	269	144	132	33	23	18
Reforestation (subtropical thickets)	Low	3 009	1 759	1 634	1 622	406	284	222
	High	5 926	4 676	4 551	4 539	1 135	794	620
Grasslands	Low	3 003	337	70	44	11	8	6
	High	3 093	426	159	133	33	23	18
Conservation agriculture	Low	1 413	163	38	27	6	5	4
	High	1 486	236	111	100	25	17	14

4.2 Cost analysis – compiling methodologies

Overview

A cost estimate is undertaken for each methodological component. It is based on the costs associated with developing and drafting PDD content – essentially any activity that does not fall under the broad suite of required monitoring activities. This will include the costs of developing Excel-based models used to calculate net total GHG emission reductions or avoided emissions, desk-based and interview-based research, solving for all methodological equations, drafting monitoring plans and associated SOPs, and drafting content suitable for inclusion in a PDD. In some instances, projects will be able to internalise elements of PDD development. Whereas project developers are free to develop a methodology internally, the relative inexperience of most potential project developers in South Africa puts them at greater risk of producing a PDD that will encounter numerous problems during an audit, driving costs up and potentially leading to audit failure. For simplicity's sake, full outsourcing to South African professionals is assumed. It is also assumed that work is undertaken by a team consisting of a lead author, senior associate and junior associate with skills in the domain of carbon accounting, methodology compliance and PDD drafting. Fees are broken down by person-day and are based on Cirrus's experience working with professionals in the field (see Annexure B).

Because costs are project-specific and are influenced by project location, size, management capacity, nature of implementation, etc., costs are presented in a range of ±20% of an identified central value. The costing exercise is primarily a means for communicating the resource intensity of developing certain components of a methodology. It is not intended to be a precise budgeting exercise – this can only be done accurately when reviewing a specific project intervention, with complete knowledge of all its key characteristics.

The costing analysis assumes a perfect project scenario. On the one hand, it assumes that there is a professional team in South Africa that has had previous exposure to and a comprehensive understanding of each methodology, and has a network of professionals to turn to when further outside knowledge is required. On the other hand, it assumes that the project activity in question is undertaken by a project developer with all paperwork in order, internal capacity that can be devoted to working with the outside consulting team, and a project plan that is executed flawlessly. In reality, the overwhelming majority of these methodologies have not been applied in a South African context. Each methodology presents its own complexities, and it will take a team unfamiliar with its core premises and assumptions time to assess the full scope of work required.

Globally, only a handful of organisations have an intimate understanding of the recently approved methodologies for grasslands management and improved agriculture. Project developers who are unfamiliar with the process are unlikely to have all the requisite paperwork on hand or in order and may be susceptible to changing project development time lines and shifting or updating elements of the planned intervention. They may have limited capacity to engage timeously and constructively with consultants. The analysis does not include costs that are associated with this early process of "discovery", which will be an inevitable part of South Africa's learning during the adoption of the proposed national offsets mechanism.

One methodology for each of the four overarching landscape-based project interventions was assessed for costs:

Table 22: Methodologies assessed in the cost analysis

Activity	Methodology
A/R	AR-ACM0003 – A/R of lands except wetlands
REDD	VM009 – Methodology for avoided ecosystem conversion
Grasslands management	AR-ACM0003 – A/R of lands except wetlands
Improved agriculture	VM0026 – Sustainable grasslands management

Costs include the following:

- The development of all written content and equations for each of the core components of a methodology have to be included in the budget. This includes applicability, baseline and additionality assessment, GHG reductions and removals for the baseline, project activity, leakage and monitoring. Where it is required, desk-based research and interview costs are included.
- The costs consider the application of any tools that were cited in a methodology, covering the time required to develop equations and undertake any desk-based or interview-based research, as well as the time taken to draft PDD content for those tools.
- The development, population and testing of a comprehensive spreadsheet model that integrates all equations, default values and the activities' planned interventions also carry costs. The model ensures the accurate assessment of the project's net actual GHG emission reductions.
- Monitoring includes the development of a full monitoring plan, covering all required methodological

parameters, as well as all associated SOPs and written content for the PDD.

- During the stakeholder engagement process, a number of participants noted that, while they were able to undertake a budgeting exercise in advance of project implementation, there were often high, unexpected costs , which could not have been predicted. Often, these costs were accrued post-audit, when auditors would request, for example, that more extensive field research be undertaken to complete an allometric equation analysis. Due to the unpredictability of these costs, a 20% contingency buffer is built into the financial analysis.

The development of a carbon offset project in compliance with a standard incurs numerous types of costs. Given the focus of this section on methodologies specifically, we focus exclusively on the costs incurred to develop methodological elements. For this reason, the following costs are not included, but will need to be considered by any project developer:

- The development of a complete PDD to a given standard is not included. Only the development of the methodological components is considered. For example, under the VCS, a buffer stock analysis must be undertaken, as well as an environmental and social impact assessment. These cost components are not considered in this analysis.
- Costs associated with engaging a third-party auditor for either the validation or verification events are excluded from the analysis.
- Travel costs are not included, for example, where the consulting team is required to travel to the project site to gather key information or meet with the project developer. These costs are entirely project-specific, dependent on distances travelled, mode of transport and the management approach adopted by the project developer and consulting team.

Summary results

Detailed estimated costs of compiling methodologies for each activity type are included in Annexure B. Tables B1 to B5, provide a summary of the results.

The costing analysis demonstrates that developing a stand-alone project for any one of the identified activities will represent a significant investment for any project developer, regardless of access to financial resources. Whereas industrial and commercial companies seeking to pursue biomass-to-energy projects or anaerobic biogas digestion are likely to have established connections with potential lenders or available financial resources in-house to cover upfront development costs, non-profit, community organisations, or small-scale private actors are unlikely to be in a position to raise finance at affordable rates.

Table 23: Summary of methodology development costs per methodology

Methodology	Total cost	Cost range
AR-ACM0003 –A/R	R574 800	R459 840–R689 760
VM0009 – Mosaic REDD	R807 000	R645 600–R968 400
VM0026 – Grasslands management	R594 000	R475 200–R712 800
VM0017 – Improved tillage	R674 400	R539 520–R809 280
Multiple for biomass-to-energy and anaerobic biogas digestion	R540 000	R432 000–R648 000

Project development will be costly for any given section of methodology development, as illustrated in the costing tables. The most resource-intensive exercise is the time required to solve and draft content for the numerous equations presented in the net GHG emission calculations, such as baseline emissions, project emissions and leakage, but no single remaining section will be affordable for the average project developer in South Africa. Moreover, developing projects in isolation will only ensure that costs remain high for all participating actors, as content must be developed afresh for each new PDD. However, there are numerous ways in which to establish efficiencies through improved information-sharing and consolidation of certain research and development elements, as discussed in the recommendations given below.

4.3 Recommendations

This section explores opportunities for government to facilitate project development by reducing costs and the complexities involved in developing a project to a given standard. Costs are broken down according to broad methodological components. Monitoring costs are described in the monitoring section of this report.

Scope and applicability conditions

Validating a biogeochemical model (VM0027 and VM0017) and analysing historical and present land-use trends through satellite imagery mapping are the two most expensive cost elements for demonstrating applicability. Both these elements could act as significant barriers to entry for certain participants, both with regard to the costs and the complexity of the required analysis. Small-scale farmers and rural communities in particular – who represent

a significant majority of the target audience for project development – are likely to lack the resources required to undertake these two applicability conditions' assessments.

It is recommended that government undertakes the validation of the RothC model (VM0017) and other relevant biogeochemical models (VM0027), as described in the methodologies in a variety of ecological contexts in South Africa, notably those contexts where project interventions are most likely to happen. The publication of findings in an easily accessible web portal could provide much-needed clarity to potential project participants as to whether their project is viable.

Similarly, a broad satellite imagery stratification mapping analysis of cropland and forest cover, as well as historical land-use trends for key geographic regions, could be undertaken, and results similarly shared in a dedicated web portal or online "atlas".

Project boundary

Identifying project boundaries on communal land is likely to prove a difficult undertaking. GPS surveys may be undertaken, but they will most likely need to be complemented by social survey techniques, such as a participatory rural appraisal, community meetings and key informant interviews. A range of stakeholders needs to carefully assess and agree on land uses, control of land and overlapping claims to land, as there can be disagreement about these issues. Identifying "control" (i.e. the clear owner of credits) will be a difficult task that requires dedicated resources and expertise in mediation and land-tenure assessment. Government support may be required to assist in mediation exercises, legal analyses, and mobilising experts to undertake a participatory rural appraisal and similar work with communities.

Baseline and additionality assessment

As demonstrated in the costing analysis, developing the additionality argument is a resource-intensive exercise. There are a number of opportunities to consolidate, analyse and publish information for the benefit of project developers in South Africa, which reduce costs and risks associated with developing an additionality argument and setting the baseline. A detailed analysis of and costing for the CDM additionality tool indicated that government could intervene with positive benefits for developers in the following ways:[17]

- A broad alternative land-use scenario research exercise, which would be assessed by provincial authorities, could be undertaken for the primary mitigation activities. The desk-based and background research to assess these alternatives is the most expensive part of implementing the CDM tool and could easily be absorbed by a well-defined research programme, with findings updated on a biannual or five-year basis.
- Government could develop a list and analysis of laws and regulations that implicate AFOLU projects, and the extent to which these laws and regulations are regularly enforced. This list could be broken down according to province.
- Government could undertake an investment analysis of the most probable project land-use alternative scenarios and assess key indicators such as net present value (NPV) and internal rate of return (IRR). The analysis could be adopted by a number of project developers. As the investment analysis is one of the more complicated assessments to be undertaken in the tools, it would limit a developer's risk exposure.
- Government could provide research material and information that substantiate the existence of the most common project barriers, reducing the time project developers allocate to desk-based research and interviews, while ensuring the consistency and reliability of the analysis.
- Provincial-level common practice analyses could be undertaken for each project opportunity or a selection of AFOLU project opportunities. This would be an excellent indication to project developers of the potential additionality of their projects, improve the consistency and transparency of the analysis, and reduce redundancies in cases where project developers need to repeatedly undertake the analysis.

All information generated above could be placed on an easily accessible user-friendly web portal that is freely accessible to project developers.

While the interventions mentioned above would assist project developers, they are based on a project-level additionality and baseline-fixing approach. They provide a number of the key research elements that would be required for generating a positive list. The introduction of a positive list could be of great benefit to South African project developers. However, the positive list would not be compliant with current CDM and VCS rules and regulations, as the two standards have opted for a project-level approach. Presently, National Treasury indicates that it prefers to adopt CDM and VCS methodologies and validate projects according to its standards. It is unclear how to link a positive list to either the CDM or VCS, although either standard would perhaps be interested in exploring the concept further with the South African government. The development, publication and maintenance of a positive list will represent an important cost to government, which should be weighed against its potential to encourage greater participation in the proposed carbon offset mechanism.

17 Recommendations for adopting standardised baselines and introducing efficiencies into the baseline assessment are discussed in Chapter 3.

GHG emission reduction assessment, including leakage

The formulae presented in methodologies, while not necessarily comprised of complicated mathematical principles, are presented in scientific notation. The various symbols and assumptions are likely to be inaccessible and confusing to small-scale project developers in South Africa. There is a high likelihood of the formulae being improperly applied, leading to accounting error and delays in validation. The complexity of the GHG emission reduction assessment may present a significant deterrent to market participation.

As demonstrated by the cost analysis, one of the most costly means of developing a project according to a given methodology is undertaking the net GHG emission reduction or removal assessment. Government should commission the development of a net GHG emission reduction and removal model for each of the leading applicable methodologies in South Africa. The model would bring together all formulae into a comprehensive series of worksheets, which would be tested for errors prior to release to the general public. This model should be simple enough for a project developer to adopt and use with ease. It should also be complemented by a workbook and instructions written in colloquial language.

An example of such a model is the tool for afforestation and reforestation-approved methodologies (TARAM, v1.2) developed by the World Bank's BioCarbon Fund (BioCF) and the Tropical Agricultural Research and Higher Education Centre. It has been adopted by numerous A/R projects, notably those funded under BioCF. It greatly reduces the risk that project developers will incorrectly assess the net GHG sequestration benefits of A/R interventions. It brings together all required default values and formulae from A/R methodologies, and includes spreadsheets that capture the unique planting and management regimes of projects.

Monitoring framework

The drafting of a monitoring plan and related SOPs is one of the most expensive cost centres associated with developing PDD content. Monitoring plans must capture all key data parameters, specify how data will be collected and at what intervals, clarify roles and responsibilities, and specify levels of accuracy. A set of SOPs must accompany the monitoring plan. A particular challenge for project developers is that monitoring plans for other projects are not always published on a standard's website, and are rather guarded as proprietary to a given project developer. For inexperienced project developers, this lack of a "roadmap" to follow increases the risk that a monitoring plan fails to meet auditors' expectations, and will require further revisions.

This approach has several inefficiencies. The first is the time spent updating and revising monitoring plans and SOPs, which could be limited in part if standards published more approved monitoring plans to act as a guide. The second inefficiency is that each project must individually develop a monitoring plan and associated SOPs at great cost, despite there being enough similarities between projects for core elements of the monitoring approach to remain constant. The inefficiencies in this approach could be easily remedied through the publication of a set of standardised monitoring plans and supporting SOPs. For this reason, it is highly recommended that government develops a generic monitoring plan for each of the project activities, as well as a library of SOPs. Project developers can fine-tune and amend these to meet their unique project circumstances where required. Moreover, this reduces the risk of adopting monitoring plans and SOPs that do not meet a given methodology's data collection, validation and reporting needs. This can lead to challenges during the verification audits.

Chapter 5: Emerging concepts

5.1 Aggregation of activities – programme of activities and grouped projects

As originally conceived under the CDM, GHG emission activities would be pursued on a project-by-project basis. The development of methodologies was externalised, left to the initiative of the private and public sectors, which reduced the CDM's overall management costs. In addition, it was believed that project-level assessments would lead to rigorous screening of projects, ensuring that only truly additional credits would enter the marketplace. Although there are many advantages to pursuing the reduction of GHG emissions at a project level, in recent years, the CDM and VCS have both sought ways to offer project developers the opportunity to aggregate activities. Project-level baseline setting and additionality assessments place a high cost and resource burden on project developers, and can be exposed to "micro-cheating", when developers manipulate subjective elements of the assessment to their advantage (Muller-Pelzer, 2004). Aggregation is expected to reduce costs, improve efficiencies and estimations of total available credits when undertaken by a skilled organisation, and ensure that a greater number of GHG emission reductions are realised.

The overarching goal of a CDM Programme of Activities (PoA) or VCS grouped approach is to establish an inclusive environment that allows for a greater number of projects to reach the market. Often, the single-project approach can exclude viable initiatives, because potential projects lack funding, technical capacity, managerial oversight or knowledge of the CDM, VCS or other carbon-standard systems. An aggregated approach allows for the development of a single, overarching umbrella activity, which is responsible for managing the programme over its lifetime. This is typically managed by a well-funded, technically adept organisation or consortium. During the validation audit, the umbrella project details the attributes with which any future subactivities must comply in order to be included in the programme, and sets a standardised baseline. Subactivities can either self-select to join the umbrella group, or they may be approached by the umbrella organisation. In most instances, the umbrella organisation charges a fee for all subactivities to be included in the programme. This establishes an incentive for the umbrella organisation to recruit as many activities as possible. There is no limit to the number of subactivities that can be included in a PoA or grouped approach, and they can extend to municipal, provincial, national or multinational boundaries.

Participation in a PoA or grouped approach should yield multiple benefits for subactivity participants:

- Reduced reporting burden, as subactivities are not required to draft entire PDDs or monitoring reports. The core structure, eligibility requirements and other important information are contained in the validated PDD, which is developed by the umbrella organisation. All subactivities have abridged versions to complete, often with the assistance of the umbrella organisation.
- Only the umbrella organisation reports directly to the CDM or VCS on behalf of all subactivities, which further reduces the obligations, costs and reporting responsibilities of the subactivity.
- The umbrella organisation is responsible for developing all monitoring protocols and managing all monitoring events, reducing the risk for the subactivity member. Monitoring is aggregated across all activities using a sampling approach. The umbrella organisation typically bears the costs as part of the overall inclusion fee that is levied on each subactivity.
- Managerial support can be provided by the umbrella organisation, so that less sophisticated, understaffed and/or less well-resourced activities can access the support they require to develop documentation, plan project logistics and meet the requirements of the VCS or CDM. This is intended to allow smaller projects, which would otherwise have been excluded from registration, to participate in the carbon market.

There are also important national-level benefits to the development of an aggregated approach. Governments can use the approach to realise goals, such as the native reforestation of a certain province, the conservation of forest patches in a given area, or the extension of clean technologies to thousands of households. There are many potential applications in the South African AFOLU context. For example, this type of intervention could dovetail with government's objective to establish small-grower commercial afforestation as part of the Forest Sector Transformation Charter, which streamlines resources and establishes additional incentive mechanisms for participants.

Resources

- CDM PoA: http://cdm.unfccc.int/ProgrammeOfActivities/index.html
- VCS grouped projects: http://www.v-c-s.org/grouped-projects

5.2 Aggregation of activities – jurisdictional and nested REDD

In 2012, the VCS released its first version of the Standard's jurisdictional and nested REDD+ requirements. The purpose of the new VCS programme is to allow for the development of REDD initiatives at the jurisdictional and national levels, providing the guidance that is required to aggregate REDD initiatives. The new requirements allow for REDD projects to share baselines, which can be determined at a scale beyond the project level, covering entire provinces or nations, depending on the jurisdictional level applied. This approach allows for the improved integration of entire landscapes – not just forests – into accounting areas, and the input of a wider range of stakeholders. A distinct advantage of the approach is the development of baseline and reference scenarios, which can apply across an entire jurisdiction, and which all potential projects adopt, reducing overall costs associated with baseline identification.

Some advantages to adopting a jurisdictional and nested REDD approach are the following:

- If it is adopted on a national scale, leakage need not be accounted for. Sources of leakage across national borders still need to be identified, and measures should be taken to mitigate the leakage adopted. However, costly and complex leakage calculations are not required.
- Government objectives and priorities for responsible landscape management can be realised at scale, integrated fully with government policy and administered, where feasible, in partnership with local, regional and national government bodies.
- A single accounting framework for assessing emission reductions, including the use of a single reference level for deforestation, can be implemented. This can be applied to all forests that fall within its boundaries and helps reduce some of the accounting confusion that can emerge when numerous project-level activities begin to share overlapping reference, project zone and leakage areas.
- A landscape-level approach can be adopted, which takes activities and impacts on non-forest land into consideration.

This approach could potentially be applied in South Africa. For example, in KwaZulu-Natal, Ezemvelo KZN Wildlife has been working to identify and protect numerous threatened forest patches across the province. Adoption of the jurisdictional REDD approach at the provincial level would provide a single accounting framework that could cover all forest patches, and provide a carbon revenue stream for landowners.

Resources:

- VCS jurisdictional and nested REDD: http://www.v-c-s.org/JNR

5.3 Modules and tools

The development of modules and tools has effectively reduced risk for many project developers. Much as the development of methodologies provided a clear analytical pathway, consistent rules and surety to both project developers and auditors on the nature, scope and boundaries of GHG emission calculations, modules and tools help chart the way towards developing key elements of a given methodology.

Tools

The need for tools was first identified when there were differing interpretations and means of demonstrating additionality under the CDM. This led to confusion among project developers, auditors and the standards body. Without clear guidance, project developers were left to demonstrate additionality as they best saw fit, which exposed them to auditor bias, disagreement and, in the worst cases, rulings of non-compliance. To reduce uncertainties, risks, and highly subjective and selective additionality assessments, the CDM developed the additionality tool, which provides a stepwise approach for assessing additionality across a number of core criteria. The tool has evolved over the past decade – with new additionality tests introduced, and one developed specifically for A/R projects. Other standards bodies have released their own additionality tools.

The purpose of a tool or module is to reduce uncertainty for the project developer, while introducing more scientific rigour to elements of a methodology. In the case of the additionality tool, project developers can test their activity in advance before fully developing a methodology to assess the likelihood that their project will be validated. Moreover, a series of concrete steps to follow removes a significant number of unknowns. Since the introduction of the CDM additionality tool, other tools have been developed as addendums to methodologies. Some of these tools can be used across multiple methodologies, and some are specific to a given methodological approach. These range from tools that assess above- and below-ground biomass stocks, to those that assess the extent to which land degradation trends were present on project land before implementation. While sometimes complicated and expensive to adopt, these tools detail clear ways to undertake data collection, field-based analyses and calculations. This represents an important cost saving to project developers, who are no longer required to develop technically complex procedures for undertaking the development of elements of a methodology. Historically, a lack of tools led to project developers devising their own methods and approaches, which were more open to criticism by auditors, delaying validation approvals, and frequently requiring project developers to redo entire field-based assessments to auditor specifications.

For organisations such as the VCS and CDM, a consistent approach applied across all projects strengthens the integrity of the standard. Moreover, the top-down development of tools, led by leading experts and scientists, builds greater scientific reliability into field-based assessment processes.

Modules

Modules are typically core elements of a methodology that are broken down into their component parts. These are less prevalent than tools, and have only recently been introduced under the VCS. A modular approach is intended to provide more flexibility to project developers by allowing them to pick and choose elements of a methodology that fit their unique activity's circumstances. The full library of modules for a given methodology is intended to cover a wide range of project contexts and conditions. For example, the VCS Methodology VM0007 (REDD+ Methodology Framework v1.5) provides 22 modules from which project developers can select the modules that apply to their specific project activity. To some extent, it is difficult to distinguish between a module and a tool. The VCS has developed "modules" that perform the same functions as CDM "tools". In either instance, however, they are intended to provide guidance on how to undertake key aspects of project development.

5.4 Non-project-based approaches to AFOLU-sector climate change mitigation

The current predominantly project-based approach to climate change mitigation within the AFOLU sector emerged as a result the CDM. The VCS, GS, PV, CCBA and other carbon standards have since emerged as alternative means to verify activities, but the underlying project-based approach has remained.

Whereas this approach has been successful within certain sectors and project types, such as energy, industrial and small reforestation activities within the AFOLU sector, it has its limitations, especially when considering landscape-scale initiatives that include several different forms of land-use, land-tenure and implementing agents. In such contexts, verification through established standards is often too restrictive and expensive, and investors' willingness to invest is restrained due to land-tenure concerns and associated permanence risk.

In response, entities such as the World Bank are pioneering non-project-based approaches to landscape-scale climate mitigation activities. As an example, the ISFL[18]) focuses on implementing comprehensive and complementing suites of activities in large-scale landscapes that may include more than one type of land use (e.g. forests, commercial agriculture and small-grower subsistence agriculture). The approach is comprehensive, including integrated land-use planning, alignment with policy and the creation of public-private partnerships for implementation, as well as supply chain development.

It should be clearly stated that it is not a "soft approach" that is intended to be any less rigorous than established international standards, but rather a method that is more suitable to implementation in heterogeneous landscapes without formal land tenure. Although it is envisaged that donor funding would be used to set up the initiative, long-term financing is still clearly based on results, with carbon as the key performance metric.

In a South African context, the approach may be suitable to certain activities, particularly the roll-out of grassland restoration and management at scale. As the activity is expected to be mainly implemented in multiple-use landscapes under communal land tenure, such an approach may be more appropriate in terms of efficiencies and risk when compared to conventional project-based methods. The suggestion here is not to necessarily completely abandon existing project-based mechanisms, but to encourage the exploration of a landscape approach that is based on similar levels of rigour, and methodological and monitoring processes.

18. http://www.biocarbonfund-isfl.org/

Chapter 6: Risk assessment

When one considers the risk of a chosen course of action, it is essential to understand and assess potential variability in expected outcomes. In terms of land-based climate change mitigation activities, the overarching risk factor is the potential variability in the amount of GHG reductions, removals or avoided GHG emissions realised over the lifetime of a project. Total, expected VERs are modelled through approaches detailed in each methodology, yet even when applying conservative accounting estimates, a number of risk factors that can impact on net total VER issuance remain.

A risk assessment is an assessment of variation in expected outcomes, whether negative or positive. Most assessments emphasise the drawbacks of pursuing a particular intervention or course of action. For the purpose of this exercise, all prominent factors that may result in a deviation from expected outcomes in VER issuance will be considered.

Like any project, the implementation of a GHG mitigation project comes with a wide range of risk "classes" (see Figure 4, as well as the included spreadsheet). This assessment includes two overarching categories of risk: project development and carbon credit risks. The project development risk for a GHG mitigation project has essentially the same risk components as a non-GHG mitigation project. However, a project developer may decide to quantify the GHG mitigation component of the project with the aim of realising an additional revenue stream through the sale of certified VERs. To achieve this, the developer must formally quantify the GHG emission reductions of its project under a carbon standard. In practice, this means that a carbon credit project, in addition to its project risk, has an additional set of risks, so-called "carbon credits" risk.

Many of the project-specific risks can be mitigated or inflated by a set of contractual precautions (i.e. penalty clauses for late commissioning imposed on the construction company). The risks can also be mitigated by insurance/warranty-based precautions (i.e. insurance against unforeseen equipment failure or fire risk) or commercial precautions (i.e. long-term fixed price supply agreements or hedging of the downwards sales price risk). To some extent, this is also true for the carbon credit risk (i.e. the forward sale of carbon credits at a fixed price would take away much of the downside sales-price risk). The included spreadsheet provides a more detailed overview of the different project and carbon credit risks, and indicates some of the more common risk mitigation measures per risk category.

Irrespective of potential risk mitigation measures, the fact remains that when a project developer decides to add a carbon credit layer to the activity, the overall risk profile will increase. This, in turn, increases investment risk and may make the activity unattractive to potential financiers.

Land-based project activities face particular risk factors beyond those that a project developer in the biomass-to-energy or anaerobic biogas digestion space would have to consider. The long period of a project, typically 20 to 30 years, is a critical factor that influences the permanence of emission reductions, and the expected emission reductions that can be claimed. Over the course of this long project timeline, biophysical risks, prevailing land tenure regimes, and policy and land-use planning can all have important impacts on land-based carbon projects. Whereas the biophysical risk of fire is often cited as the primary risk factor for land-based projects, the risk of fire on the long-term VER potential of an initiative is considered minimal in South Africa (Knowles 2011). Drought could prove more problematic, as could the failure of VER modelling to adequately capture the carbon sequestration potential of various tree species, notably in the subtropical thicket biome. The potential for policy and national and provincial land-use planning to result in the reversal of GHG reductions and removals is a critical risk factor that is discussed much less often. These risk elements are discussed in more detail in the included spreadsheet, which describes all potential risk factors, broken down by project and carbon credit risk. Colour-coding is used to highlight risks specific to land-use projects, as well as energy projects.

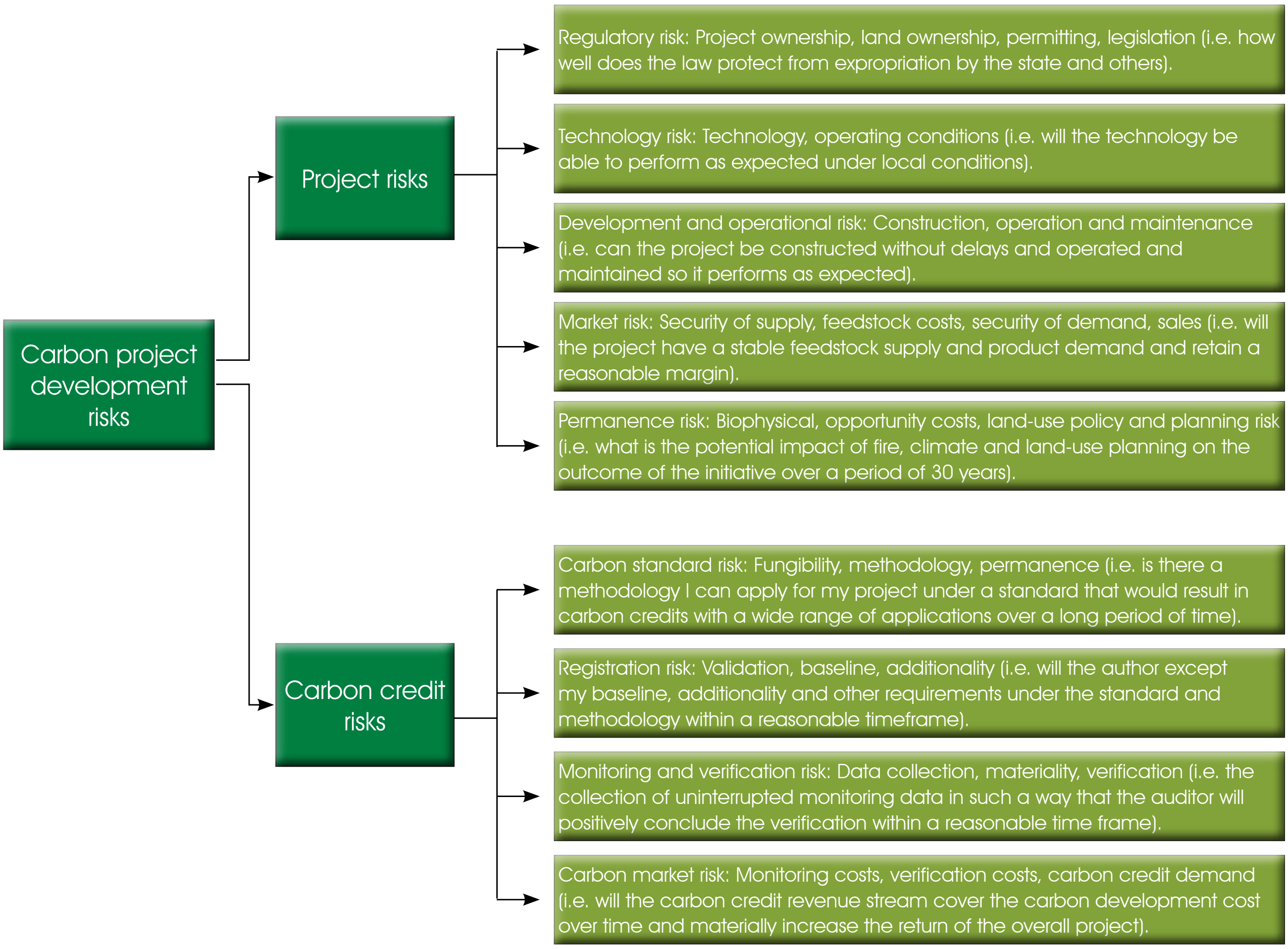


Figure 4: An outline of a typical risk assessment that was conducted for land use-based climate change mitigation activities. Please see the included spreadsheet for further exploration of this framework.

Chapter 7: Considerations for a future South African carbon offset standard for the AFOLU sector

7.1 Introduction

The primary intention of this report was to inform the development of an appropriate, cost-efficient South African carbon standard. The standard would respond to emerging trends in national-level GHG reporting, and the development of a South African carbon offset mechanism. In recent years, National Treasury has spent considerable time developing a carbon tax with an associated carbon offset mechanism. National Treasury expects local project developers to adopt published, approved methodologies developed by the CDM, VCS and GS, and to follow auditing and offset registration processes through these standards. Under this approach, there is no foreseeable need for a specific South African standard, which would be redundant and add confusion to an already complex project development process.

There are many benefits to National Treasury's decision to align with existing standards, some of which are touched on in this report. However, there are potential drawbacks for local project developers, notably with regard to the cost implications. This could have serious ramifications for the AFOLU sector's potential to access and make use of the proposed offset mechanism. This report explores ways in which alignment with and adoption of existing standards can be done in a way that can reduce risks and costs for local project developers, leading to a greater number of participating entities.

The following three recommendations emerged from our analysis of existing standards and the South African context:

- The South African government should undertake direct engagement with the three international standards to identify opportunities to tailor existing approaches to the needs of local project developers. This might include, for example, establishing specific South African consolidated baselines, default values, additionality tests or other equally important interventions.
- The launch of a South African Ombudsman for carbon offsets that can work directly with leading carbon standards to mediate audit irregularities, provide key, local expertise to auditing issues, and fast-track South African projects through the audit process.
- An in-depth review and assessment of existing capacity across the entire carbon offsets value chain would ensure a greater proportion of local expertise, with the aim of reducing costs and creating greater local ownership of the offsets mechanism.

7.2 Objective of a standard

A carbon standard provides a structure through which individuals and entities can develop, review, register and issue approved GHG carbon ton equivalents according to specified principles. Carbon standards respond to the need of government bodies, sovereign nations and corporate and non-profit entities and individuals to access certified, additional and true emission reductions that have been assessed against rigorous, quantifiable approaches. The benefit of using a standard is the development of a recognised "unit" that can be used to compare the relative effectiveness of various interventions, and can form the basis of an exchange. The intention of a standard is to establish a platform from which a diversity of interventions in numerous sectors can develop quantifiable, homogenous units that can be traded interchangeably among other, similar units. These include ERUs under the CDM and VERs under the VCS. Each unit is expressed in tonnes of carbon dioxide equivalent.

When considering the principles that underpin a standard from a GHG mitigation perspective, it is important to first identify an appropriate unit of measure for the emission of GHGs to allow for a comparative evaluation. Although there are thousands of GHGs, six groups of GHGs have been identified as the most relevant contributors to climate change. Table 24 provides an overview of these gases and their global warming potential. After each gas has been converted via its global warming potential, it is expressed in tonnes of carbon dioxide equivalent (tCO_2e).




Table 24: The global warming potential of the six gases typically included in carbon accounting schemes

Name	Composition	Global warming potential
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Perfluorocarbons	PFC	9 200
Hydrofluorocarbons	HFC	11 700
Sulphur hexafluoride	SF_6	23 900

Although carbon standards use a single ton of carbon dioxide equivalent as the basis for assessing the potential of each project, each standard has its own principles and approaches. Although these may be similar in many instances, and the calculations that underpin the assessment of an intervention's projected and actual GHG reductions or removals may be similar if not interchangeable, units are not necessarily fungible between different standards. For instance, although the VCS allows projects to use CDM methodologies, previously approved CDM projects must go through a conversion process for their emission reductions to be recognised and registered under the VCS. In other instances, there is no opportunity for conversion. The VCS, for example, will not recognise PV-generated emission reductions due to substantial differences in methodologies and GHG accounting approaches. The fungibility of carbon credits is of considerable concern in the South African context. This is an important reason why National Treasury has chosen to align with pre-existing, internationally recognised standards (VCS, CDM, GS). In this way, credits can be traded across jurisdictions and can enjoy global recognition.

7.3 The proposed South African approach to international standards

An offset mechanism has been proposed that would allow corporate entities to reduce a specified portion of their emissions burden through the purchase of tonnes of carbon dioxide equivalent under National Treasury's carbon tax. In lieu of creating a local standard, government has rather opted to adopt pre-existing standards, such as the CDM, VCS, CCBA and GS. In practice, this will require local project developers to adopt methodologies, engage accredited auditors, and attempt to validate their projects through the specified processes outlined by these standards. Government significantly saves on costs via this approach, as it effectively outsources all management and administration to the VCS, CDM, CCBA or GS, while ensuring the delivery of additional high-quality true carbon credits.

7.4 Striking an appropriate balance with a standard

The leading international carbon standards have erred on the side of technical robustness, which ensures that carbon emission reductions are real, true and additional. They enforce the adoption of conservative estimates, high confidence intervals for field-based assessments, and rigorous additionality assessments. This focus on robustness stems from a need to ensure the integrity of the standard to build market confidence in their offset products. Potential investors in credits, who seek solid returns, typically identify the most robust standards and know that end users require additional credits to comply with regulations or meet voluntary offset goals.

This approach is not without its challenges. Project developers take on considerable desk- and field-based research costs and associated risks. They are also presented with complex, challenging methodological issues and must assiduously manage difficult audit processes. The realities of implementation at ground level in South Africa, and particularly the projects considered in this report, are not matched with appropriate, tailored approaches. The result is that projects, such as grasslands restoration, REDD and improved agriculture on communal lands, are not particularly well suited to the cost and research burdens or overarching regulations presented by existing standard approaches. This can be seen in the handful of projects across all identified activities in South Africa that have been validated to any standard, despite the enormous potential for projects in a variety of landscapes highlighted in the NTCSA. The impact of these rigorous technical specifications is an overall limitation on the net total projects that are able to prepare for and pass validation and verification audits. While this reduces the number of "free riders" in the system, it can also restrict the number of potentially viable projects.

The recommendations in both this report and the Methodology and Monitoring Report aim to identify means of supporting project developers within the context of existing standards that National Treasury intends to align with as part of the proposed offset mechanism. Whereas government will need to identify means of funding the various proposed interventions, the costs and associated time lines should be considerably less than those that would be incurred by developing an entirely new, unique South African standard. It also has the added benefit of ensuring that carbon credits are generated that can be traded on global market platforms, with no risks to credit fungibility.

7.5 South African context

To properly assess the compatibility of international standards with South Africa's AFOLU opportunities, it is important to understand the nature of implementation for AFOLU carbon offset interventions. The context of project development, both with regard to implementation hurdles and developing a specified methodology, can provide important information about the viability of interventions under the VCS, CDM or GS. While the NTCSA has demonstrated that there is a significant opportunity to reduce, sequester or avoid the release of GHG emissions in the AFOLU sector, it does not mean that projects can easily or cost-effectively meet the stringent specifications of the leading standards bodies. The key elements of each of the four primary AFOLU landscape-based opportunities in South Africa are discussed below. Energy-based projects – biomass-to-energy and anaerobic biogas digesters – are not discussed, as it is considered that they will face far fewer barriers to entry than landscape-based projects.

A/R initiatives in South Africa will typically follow one of two implementation models. The first is one where reforestation occurs in the subtropical thicket biome, mainly on private land, commercial farms or land recently handed over to emerging farmers. Under this approach, land-tenure risk is unlikely to be an inhibitory issue, but a sizeable quantity (well over 10 000 ha) of land will need to be replanted in order to reach financial viability. Currently, there is a large-scale, consolidated CDM methodology that is broadly applicable to the South African context. The most significant barrier to entry is project development costs with regard to field-based monitoring requirements.

The majority of grasslands restoration and management interventions in South Africa are likely to occur on communally owned lands, leading to considerable land-tenure and associated permanence risks. Although there are two approved grasslands methodologies under the VCS (see Chapter 2), neither has been successfully adopted in South Africa, nor anywhere else in the world. These new methodologies are likely to be reworked and updated due to their limited uptake, as issues with their approaches are discovered through implementation. The risk profile of grasslands restoration, associated with land-tenure risk and untested proof of concept, means that the intervention is unlikely to attract private finance at affordable rates. Monitoring and methodological costs are high and likely to act as deterrents to widespread adoption in South Africa.

It is assumed that REDD+ projects will be primarily located on government or communal land. Due to communities' typical high dependency on forests for fuelwood, medicines, fruit, etc., and overlapping right of use claims, care must be taken to undertake comprehensive, inclusive and transparent stakeholder processes, and ensure a complete legal review of ownership considerations. Numerous REDD+ methodologies are available through the VCS, but only two of these are considered to have widespread application in South Africa, as they deal specifically with disaggregated, mosaic deforestation and degradation patterns typically observed in the country (see Chapter 2). Neither of these methodologies has been applied successfully in South Africa. Due to the presence of numerous small forest patches, notably in KwaZulu-Natal, it is recommended that a grouped or "jurisdictional" approach be adopted in order to benefit from tools such as standardised baselines, reducing the inefficient allocation of resources. The monitoring and mapping costs for REDD+ projects are likely to be prohibitive, and may limit the uptake of this activity.

Conservation agriculture is expected to occur in both commercial agriculture, as well as small-grower and subsistence farming schemes. Commercial agriculture typically occurs on private land owned by a relatively well-resourced entity. Implementation within the small-grower and subsistence farming sectors would typically occur on communal land where particular attention may need to be paid to ensure permanence over 20 to 30 years. An activity facilitation unit would be needed to plan and manage the activity at scale, but actual implementation and monitoring may be undertaken through established government structures, the EPWP, NPOs or the private sector. There is a methodology for improved agriculture under the VCS, but it has yet to be applied to any initiatives in South Africa. Although the technology and interventions are quite well known, the actual monitoring costs to assess soil carbon will be high, and there are no known individuals in the country who have practical experience in implementing the methodology.

7.6 Recommendations

Direct, collaborative engagement with existing standards

During the stakeholder engagement phase, it became clear that the presiding carbon standards organisations (CDM, VCS and GS) are dynamic, evolving bodies. They regularly review, question and revise their thinking to respond to market, end-user, government, regulatory and project developer demands and needs. They regularly engage stakeholders to improve their organisations and the quality of the services they provide. More recently, standards bodies have demonstrated their willingness to engage with national governments, seeking to better understand their unique needs to develop responsive, tailored programming and interventions.

Carbon markets continue to evolve and face uncertainties in light of international negotiations under the Conference of the Parties, and shifting corporate appetites for voluntary credits under difficult global economic circumstances. Against this backdrop, a number of new, local and regional voluntary and regulated GHG emission reduction programmes – emissions trading schemes – have been established to meet specific emission reduction targets. These include initiatives in California, Quebec, South Korea and Chile, to name a few[19]. Stakeholders from standards organisations noted that new, innovative approaches are being studied and assessed, notably ones that can align with and support the rapidly expanding national and regional interventions. There appears to be a growing consensus that such engagement and partnerships can allow for more considered, tailored emission reduction programmes that meet local needs, taking precedence over the historic one-size-fits-all approach. National Treasury has already initiated discussions with the CDM to explore, consider and possibly implement a shared vision for offsets management, recognition, registration and issuance in South Africa.

Aside from broad collaboration covering key governance issues, interview participants noted that methodological and monitoring improvements have been devised or are under consideration. These were discussed in the Methodology and Monitoring Report, and include modular approaches, standardised baselines, local and regional default values, as well as new additionality approaches, such as the “positive list”. These approaches could easily be adopted in the South African context, and could very well receive technical, organisational or financial support from the leading standards bodies.

Considering the ways in which standards bodies are examining their role in and contribution to the global, regional and national carbon markets, there is a unique opportunity for the South African government to engage directly with these organisations to discuss the country’s context, circumstances, opportunities and key constraints.

19. The World Bank will publish a detailed report on emissions trading schemes and carbon pricing at the end of 2015. It should provide a comprehensive overview of all established and emerging schemes. A brief overview is available for review at: http://documents.worldbank.org/curated/en/2015/05/24528977/carbon-pricing-watch-2015-advance-brief-state-trends-carbon-pricing-2015-report-released-late-2015.

While it may be cost, resource and time prohibitive to create a unique South African standard at this time, collaboration with existing standards could lead to the development of fit-for-purpose tools, approaches and rules that support South African conditions. These may lead to a greater proliferation of successful projects.

A South African Ombudsman

During the stakeholder engagement process, organisations across Africa that work to develop land use-based carbon offset initiatives through a variety of standards, such as the VCS, PV, CDM and CCBA , were contacted. When asked for further considerations beyond technological and monitoring requirements, each of them raised the issue of engagement with auditors. Challenges included the inconsistent application of methodologies, differing interpretations of methodological requirements, and unjustified time lags in preparing responses and final reports, all of which led to delays and new cost burdens. For example, one project developer in Zambia noted that his project was required to undertake extensive new field research to develop a more accurate allometric model for trees with a diameter at breast height wider than 30 cm. In contrast, a similar REDD project in Zambia that was audited by the same firm and used the same methodology was allowed to use existing equations. The costs were estimated to be well above R600 000 for the exercise. From our own project experience in Uganda, one well-known auditing firm took months to respond to clarifications, raised new clarifications to written responses on at least one occasion, and delayed the validation of the project by well over a year.

There are countless similar stories, and interviewed stakeholders suggested that this was one of the primary issues that led to increased risk, unplanned costs and significant delays on a project. One project developer admitted that the audit process was enough to end the initiative. A contributing factor to delays may well be auditors’ unfamiliarity with African ecology, cultural norms, land-tenure patterns and typical project circumstances. The lack of practical experience in the region can lead auditors to be more cautious in their approach. While understandable, the need for such caution may not be warranted in all situations.

There is often recourse for project developers when such issues arise. For example, under the CDM, a project developer must first work within the internal process for complaints resolution and appeals developed by the auditor in question. Where auditors have publicly disclosed their complaints process, there is typically no agreed time frame in which the complaint must be responded to. If a project developer remains dissatisfied with the process and has sought all reasonable measures for resolution, he or she can complete a Complaint against Designated Operating Entity (DOE) form, which is found on the CDM website, and submit this to the Secretariat for review. Depending on the level of detail and supporting documentation provided, the Secretariat may decide that further investigation is needed, which would be undertaken by an ad-hoc committee. The committee will also, where necessary, engage with the DOE to collect information and material. The Secretariat is not obliged to respond to complaints or seek resolution within a bound time line[20]. Engagement with a DOE or the CDM Secretariat to resolve complaints could lead to significant project delays. This is partly attributable to the fact that neither organisation has staff dedicated solely to complaints resolution, which leads to greater, protracted delays when multiple complaints are managed at a time.

A solution might be the establishment of a South African Ombudsman function, whose sole objective would be to apply local expertise to dispute resolution in a timeous manner. The Ombudsman could act as an initial screener of complaints, which reduces the burdens on the standards organisation, and provides more nuanced, informed opinions based on local knowledge. The Ombudsman would retain a list of pre-approved leading technical experts, and contact them when a complaint relating to methodological or monitoring matters was raised. Although the final decision may still lie with the standards organisation, the Ombudsman can undertake desk-based research, document reviews, conduct DOE interviews and prepare an opinion before forwarding findings to the standards body. This approach should lead to more nuanced, case-specific and timeous resolution of outstanding issues between auditors and project developers, which would drastically reduce cost burdens and lead to speedier audit outcomes. It is suggested that, as part of the discourse on carbon standards, the potential for a South African Ombudsman should be discussed, and its role and function within existing dispute resolution processes explored. The benefits to the standards organisation, auditors, and local project developers would be considerable in terms of cost savings and the improved allocation of resources, and it could pioneer an innovative means of resolving conflicts, misunderstandings, inappropriate methodological interpretations and poor time-management processes.

Capacity challenges

The NTCSA identified a significant opportunity to realise GHG emission reductions and sequestration in the AFOLU sector. However, realisation of this potential through the proposed carbon offsets mechanism is critically linked to the input and participation of knowledgeable experts.

20. For a more detailed overview of the CDM complaints resolution process, please refer to Procedure for Accrediting Operational Entities by the Executive Board of the CDM.

The successful realisation of an active carbon offsets "supply chain" requires the participation of a wide range of individuals with expertise in numerous domains. National Treasury intends to outsource the management and administration of a standard, which includes such functions as the staffing and management of numerous committees and a Secretariat, approval of methodologies' review of projects, the management of a website, the drafting and maintenance of the standard and all supporting guidance, auditor accreditation, the registration of projects, and the issuance of offsets. However, considerable capacity requirements will need to be met to deliver credible projects according to a given standard. At present, many of these functions may need to be outsourced to foreign firms due to local capacity constraints. This is likely to be cost-prohibitive for many project developers. Capacity needs can be divided into three overarching categories of work streams, as described in Table 25.

*Table 25: Work streams and related capacity needs**

Work stream	Capacity needs
Technical project development**	• Satellite imagery analysis and related mapping • Ecological expertise, covering allometry, sampling strategies, soil carbon and above- and below-ground biomass carbon measurements • Agronomy • Forestry • Technical PDD development • Carbon accounting and related model development • Software development • Social impact assessments and community engagement • Legal expertise to assess land-tenure issues and carbon ownership
Project validation	• Third-party auditing expertise, preferably in-country
Commercialisation	• Commercial negotiations • Legal assistance with emission reductions, purchase agreements and other related sales agreements • Marketing of credits to local, regional and international buyers

*Please note that this discussion does not include the capacity required to undertake the actual implementation of a given land use-based mitigation activity
**Many of these functions will be required over the course of the project's lifetime, post-validation




Technical project development

At present, only a handful of small firms are well positioned to offer consulting services to cover a number of the critical technical PDD development needs, including the required carbon accounting, model development, field-based data collection and PDD preparation. The number of qualified experts with hands-on, practical project development experience in the AFOLU sector could likely be counted on one hand. These few existing firms in South Africa have no practical exposure to the improved agriculture or grasslands methodologies, and somewhat limited project experience with the remaining REDD and reforestation methodologies. Although there are probably numerous individuals with educational credentials that would qualify them to undertake PDD development, they have not been hired in considerable numbers due to the limited project development pipeline in South Africa.

Whereas the other types of expertise, such as satellite imagery mapping and social impact assessments, can be found in South Africa, they have not been adequately exposed to AFOLU carbon methodologies, standards, or related processes and regulations. Various entities may need to attend workshops, receive training or acquire learning by other means in order to deliver satisfactory work to project development clients.

Presently, experienced technical project development capacity is inadequate to meet potential demand. It is suggested that a complete review of existing capacity be undertaken. Such a review aims to understand how quickly existing firms would respond to new market opportunities by increasing capacity, the type of training that new talent would require to successfully contribute to PDD development and over what time period, the cost of training, and the identification of innovative, strategic ways to fast-track training and firm expansion.

Project validation

Numerous foreign auditing bodies are accredited to both the CDM and VCS, and these bodies could offer services in South Africa. However, due to current exchange rates, the costs are simply too prohibitive for the majority of potential project developers. Moreover, foreign auditors are unlikely to fully understand South African ecological, economic, legal or cultural conditions and how these factors influence project development considerations. Currently, there is only one auditing firm in Africa – Carbon Check in Johannesburg – that is accredited to the CDM, VCS and CCBA. Recently, its CDM accreditation status was transferred to an Indian subsidiary based in Delhi, although the firm retains expertise in South Africa.

The development of a number of accredited auditing firms should be considered to increase price competitiveness and ensure that there is adequate capacity to meet potential demand in the AFOLU sector. While market forces may well impel private investment into new firms, or the extension of European or American firms into South Africa, the efforts required are significant. Becoming an accredited auditing body takes significant resources and time. For example, under the CDM, a potential DOE must comply with the CDM's Accreditation Standard for Operating Entities*,* a process that will require, among other things, the development of written policies, procedures and guidelines. In addition, the potential DOE must submit an application and associated fee (US$15 000), and undertake a rigorous assessment process that includes an on-site assessment, followed by periodic reviews. Each firm will require at least one lead auditor who must undergo intensive training, including training in International Organisation for Standards (ISO) standards, and participation in a number of audits. Team auditors may require less training, but would still have to pursue a predefined pathway to qualification.

It will likely take some time to develop further auditing capacity in South Africa. Priority should be given to fast-tracking this development through the following methods:

- Direct engagement with existing firms based abroad to understand their appetite for opening an office in South Africa.
- Discussions with auditing firms that provide other services in South Africa that could extend into CDM, VCS or GS auditing.
- Encouraging the development of new auditing firms in South Africa who specialise in carbon offsets through tailored incentive programmes.

Commercialisation

Several firms in South Africa offer assistance with the drafting and content of emission reduction purchase agreements. However, rates are high and may not be accessible to the majority of project developers. Furthermore, legal firms who are focused on drafting commercial agreements and contracts will likely need to better understand the rights of use, ownership considerations and carbon "supply chain" issues in more depth to ensure the integrity of contracts. This should be explored in partnership with National Treasury to ensure that contracts align effectively with the carbon offset mechanisms' modalities and underlying rules.

7.7 Next steps

This report has demonstrated that DEA can make strides in three important ways to shape and influence existing international standards to better respond to the South African context. To realise these potential benefits, the following work streams are recommended:

Work Stream 1: Immediate engagement with both National Treasury and existing standards

- Use the findings from the Methodology and Monitoring Report to engage with National Treasury to highlight South African project developers' key, primary difficulties and challenges, and the types of interventions that could address these.
- Identify the methodological and monitoring interventions that could be undertaken in partnership with existing standards to reduce financial burdens and risks for project developers. These might include standardised baselines, additionality tests, default values or predictive models.
- Develop a communications brief to share with the leading standards.
- Agree on an approach with National Treasury, including key desired outcomes, and initiate communications with the three leading standards in order to explore joint interventions that could foster the development of AFOLU-sector projects.

Work Stream 2: Develop and present a proposal for a South African Ombudsman function

- DEA should undertake a scoping assessment for a South African Ombudsman function, including staffing needs, key responsibilities, potential interaction, and compatibility with existing standards and budget requirements.
- Present findings to National Treasury, and discuss a strategy for approaching existing standards to appeal for the creation of the function.
- Approach VCS, CDM or GS and present the Ombudsman function, highlighting key benefits to standards bodies, auditing firms and local project developers.

Work Stream 3: Detailed audit of existing carbon offsets value chain capacity

- Undertake a full scoping of local capacity in the carbon offsets value chain, focusing on the pipeline of talent emerging from universities, existing firms and their ability and interest in scaling up, and foreign auditing firms' interest in expanding into South Africa.
- Identify the "go, no-go" threshold for investment in the value chain, the size of the AFOLU opportunity that would justify firms hiring new talent, training employees, and dedicating finances to project development, auditing or commercialisation functions.
- Explore cost savings to project developers associated with using local talent over foreign firms and personnel to motivate for greater support to the value chain.
- Present findings to key government departments, educational and training institutions, and the corporate sector to jointly develop a strategy for encouraging capacity development in the sector.

Chapter 8 – Potential next actions

The report presents four chief interventions as potential next actions that should be prioritised to realise land-based climate change mitigation activities in South Africa. For a number of reasons, these interventions are unlikely to be realised purely through market forces, and should rather be funded through dedicated government and donor programming. Taken together, the realisation of these four interventions should unlock a great number of AFOLU projects, notably those that have historically struggled to access carbon market opportunities.

A programmatic, aggregated approach to each of the project activities

Both the costing exercises and the stakeholder engagement process highlighted the need for a programmatic, aggregated approach to each of the most important activities[21]. In terms of methodologies and monitoring, a broad suite of supporting research tools and processes has been highlighted, including standardising additionality arguments, and producing generic monitoring plans and SOPs. If this type of support is to be extended to project developers, it makes the most sense under the auspices of a larger programmatic approach where there are sufficient projects to justify the research cost burdens. Public donors will likely need to fund the development of standardised baselines, common additionality argument content and generic monitoring approaches. The private sector is unlikely to be interested in developing an approach that will become a public good with unclear revenue potential. This is the overriding justification for the programmatic approach in general.

With regard to the specific activities themselves, it is suggested that a normal CDM PoA or VCS grouped approach be adopted for A/R, REDD, biomass-to-energy, anaerobic biogas digesters and conservation agriculture in the formal commercial sector. For the grassland programme and sustainable agriculture on communal owned land, a different approach is recommended, for example, something similar to the World Bank ISFL. However, it should be noted that the World Bank programme is focused typically on Tropical areas, and a truly South African version would need to be established following the World Bank's broad principles. The primary factors determining whether a traditional PoA or grouped project approach, or an ISFL approach should be adopted would include the prevailing land-tenure status, the capacity of implementing agents and associated risk.

21. The authors are aware that "programmatic" has a particular meaning under the CDM, but here the systematic aggregation of activities to facilitate opportunities in South Africa is meant.

The establishment of predictive models and landscape allometry

High monitoring costs, notably in the soil carbon pools, have often halted the progression of projects, especially those that are heavily dependent on soil monitoring. For these reasons, over the past few years, there has been an increase in the use of default values, tools, modules and predictive models to provide cost-efficient estimates of carbon stocks and changes in carbon stocks over time. Recently, international standards have advocated the adoption of default values and models, such as RothC, to predict carbon stocks and changes in carbon stocks. This is particularly important in a South African context, as it is likely to unlock the extensive opportunities in the grasslands biome highlighted in the NTCSA. In addition to grasslands, the soil carbon pool may also be crucially important to the viability of REDD and A/R activities. The inclusion of the GHG sequestration potential of this pool can quite easily tip the scales for a project from being unprofitable to being financially viable.

Whereas predictive modelling is likely to be an integral part of future carbon accounting methods, the underlying research and modelling need to be undertaken in a South African context. The development of a predictive model would need to be underpinned by a dedicated, national soil carbon research programme. In addition to the use of predictive models to estimate carbon stocks and changes in carbon stocks over time, the use of landscape allometry holds strong promise to reduce costs, notably in the subtropical thicket biome.

Both the creation of predictive models and landscape allometry, however, are costly, and unlikely to be developed by the private sector or project developers. As a result, these models will likely require donor funding.

A communication platform

Interviewed stakeholders noted that there is limited available information on carbon market opportunities in general. They highlighted the lack of easily accessible information pertaining to methodologies, monitoring, relevant policies, guidance, etc. In addition, critical types of information, such as suitable areas for activities, maps of sequestration rates, land-use change maps, etc. are also difficult and costly to locate or produce. The development of an easily accessible communication platform with content described in layman's terms will be of considerable benefit to project developers. By way of example, the South African Bio-energy Atlas provides a comprehensive set of information for potential bio-energy project implementers, including basic guidance and introductory reports on the opportunity, dedicated sections on regional policies and trends, a broad suite of maps and spatial development tools to measure the viability of projects, etc. If the government would like to take a programmatic approach to each activity, it is recommended that a similar web portal be developed to house critical information for each activity.

Institutional capacity and support

Interviewed stakeholders regularly stated the need for sustainable, readily accessible and comprehensive institutional support. For the elements described above – a programmatic approach, predictive modelling and a communication platform – to be realised, one needs institutional capacity and support, as these steps are unlikely to be realised through an ad-hoc approach or driven solely through private-sector intervention. Institutional support should be consistent, underpinned by a multi-year strategy. Although this particular scope of work focuses on methodological and monitoring elements, the entity would also need to look at dedicated feasibility assessments, policy elements and implementation models.

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Annexure A: An illustration of how estimated remote sensing costs change with spatial scale

Activity	Interval (when)*	Sensor	Resolution (m)	Analysis	Spatial scale (ha)** 1	10	100	1 000	10 000	100 000	1 000 000	2 000 000	3 000 000
REDD+	Start of project and every five years	Landsat	30	High-level multi-temporal	N/A	N/A	N/A	N/A	400	4 000	40 000	80 000	120 000
	Four historical time periods	Landsat	30	Forest/non-forest	N/A	N/A	N/A	N/A	1 120	2 000	20 000	40 000	60 000
				Spatial modelling	N/A	N/A	N/A	N/A	100	1 000	10 000	20 000	30 000
Reforestation	Start of project and every five years	Landsat	30	High-level multi-temporal	N/A	N/A	N/A	N/A	400	4 000	40 000	80 000	120 000
	One historical map 10 years prior	Landsat	30	Forest/non-forest	N/A	N/A	N/A	N/A	200	2 000	20 000	40 000	60 000
Grasslands	Start of project and every five years	Landsat	30	High-level multi-temporal	N/A	N/A	N/A	N/A	400	4 000	40 000	80 000	120 000
	Start of project and every five years		30	Map of current degraded/ non-degraded	N/A	N/A	N/A	N/A	200	2 000	20 000	40 000	60 000
	Four historical time periods		30	Map of historical degraded/ non-degraded	N/A	N/A	N/A	N/A	200	2 000	20 000	40 000	60 000
	Start of project and every five years	MODIS		Fire scar map on an annual basis	N/A	N/A	N/A	N/A	N/A	N/A	20 000	40 000	60 000
	Start of project and every five years			Extent of cultivated land in leakage areas	N/A	N/A	N/A	N/A	N/A	N/A	20 000	40 000	60 000
Conservation agriculture	Start of project	Landsat	30	High-level multi-temporal	N/A	N/A	N/A	N/A	400	4 000	40 000	80 000	120 000
	Start of project and every five years			Field boundaries	N/A	N/A	N/A	N/A	600	16 000	16 000	16 000	16 000
	Start of project and every five years			Extent of cultivated land in leakage areas	N/A	N/A	N/A	N/A	200	2 000	20 000	40 000	60 000

Notes:

All cost estimates are presented in South African rand (ZAR).

* Cost is per iteration that occurs once every five years, not the total cost over a 30-year project period, and excludes any inflationary factors.

** Costs are based on a conservative scenario where the project location (if small enough) is located within a single Landsat scene.

N/A refers to scenarios where the image-data resolution, scale and format are inappropriate for the area (ha) under analysis, regardless of cost.

A minimum project implementation cost of R10 000 (excluding VAT) per task, per assessment year, will normally be applied if the calculated cost is below this amount.

Annexure B: Estimated costs of compiling recognised methodologies

Table B1: Cost analysis for AR-ACM0003 – A/R of lands except wetlands

Section	**Person days**			**Rates**			**Total costs**	**Cost range (±20%)**
	Lead	**Senior**	**Junior**	**Lead**	**Senior**	**Junior**		
Applicability	-	-	0,5	-	-	R1 500	R1 500	R1 200–R1 800
*Demonstration of additionality and identification of the baseline scenario **	2,75	6	8	R22 000	R36 000	R24 000	R82 000	R65 000–R98 000
Stratification	-	6	-	-	R36 000	-	R36 000	R1 200–R1 800
*Baseline net GHG removals by sinks***	1	2	2	R8 000	R12 000	R6 000	R26 000	R20 800–R31 200
*Actual net GHG removals by sinks***	1	1	-	R8 000	R6 000	-	R14 000	R11 200–R16 800
*Leakage****	2,75	1,5	1,5	R22 000	R9 000	R4 500	R35 500	R28 400–R42 600
Spreadsheet and model creation for the calculation of net anthropogenic GHG removals by sinks	5	3	-	R40 000	R18 000	-	R58 000	R46 600–R69 600
Initial population of model	1	2	2	R8 000	R12 000	R6 000	R26 000	R20 800–R31 200
Reviewing, testing and calibrating model	2	3	3	R16 000	R18 000	R9 000	R43 000	R34 400–R51 600
Monitoring procedure	8	11,5	8	R64 000	R69 000	R24 000	R157 000	R125 600–R188 400
Contingency costs (20% of total)							R95 800	R76 640–R114 960
Total costs							**R574 800**	**R459 840–R689 760**

In undertaking overall costing for this methodology, it is assumed that a single project accounting area is used in an unplanned deforestation/degradation context.

*To meet applicability condition 3, it is assumed that satellite imagery mapping is undertaken as part of the larger project costs, and that a separate field-based survey with local residents is not required.

**Assumes that no commercial logging is taking place in the baseline, and hence no merchantable timber is included in the project area, the presence of which drives up project development costs due to additional analyses required.

***Includes the use of the CDM tool "Estimation of direct and indirect (e.g. leaching and runoff) nitrous oxide emission from nitrogen fertilization".

Table B2: Cost analysis for VM0009 – Methodology for avoided ecosystem conversion

Section	Person days			Rates			Total costs	Cost range (±20%)
	Lead	Senior	Junior	Lead	Senior	Junior		
*Applicability**	0,5	1,5	-	R4 000	R9 000	-	R13 000	R10 400–R15 600
*Project boundary***	0,5	0,5	1,5	R4 000	R3 000	R6 000	R13 000	R10 400–R15 600
Identification of the baseline scenario	5,5	9,5	7,25	R44 000	R57 000	R29 000	R130 000	R104 000–R156 000
Additionality	2,75	6	8	R22 000	R36 000	R32 000	R90 000	R72 000–R108 000
Baseline emissions	2	3	2	R16 000	R18 000	R8 000	R42 000	R33 600–R50 400
*Project emissions****	2	3	2	R16 000	R18 000	R8 000	R42 000	R33 600–R50 400
*Leakage emissions*****	1,25	2	1	R10 000	R12 000	R4 000	R26 000	R20 800–R31 200
Ex ante estimation of net emission reductions	-	0,25	0,5	-	R1 500	R2 000	R3 500	R2 800–R 4 200
Spreadsheet and model creation for the calculation of net anthropogenic GHG removals by sinks	5	3	-	R40 000	R18 000	-	R58 000	R46 400–R69 600
Initial population of model	1	2	2	R8 000	R12 000	R8 000	R28 000	R22 400–R33 600
Reviewing, testing and calibrating model	2	3	3	R16 000	R18 000	R12 000	R46 000	R36 800–R55 200
*Monitoring******	10	11,5	8	R80 000	R69 000	R32 000	R181 000	R144 800–R217 200
Contingency costs							R134 500	R107 600–R161 400
Total costs							**R807 000**	**R 645 600–R968 400**

In undertaking overall costing for this methodology, it is assumed that a single project accounting area is used in an unplanned deforestation/degradation context.

*To meet applicability condition 3, it is assumed that satellite imagery mapping is undertaken as part of the larger project costs, and that a separate field-based survey with local residents is not required.

**Assumes that no commercial logging is taking place in the baseline, and hence no merchantable timber is included in the project area, the presence of which drives up project development costs due to additional analyses required.

***Includes the use of the CDM tool "Estimation of direct and indirect (e.g. leaching and runoff) nitrous oxide emission from nitrogen fertilization".

****Assumes that the project is not subject to market leakage.

*****Assumes that no new allometric equations were developed for the project, which would require testing, using the methods described in section 9 of the methodology.

Table B3: Cost analysis for VM0026 – Sustainable grasslands management

Section	Person days			Rates			Total costs	Cost range (±20%)
	Lead	Senior	Junior	Lead	Senior	Junior		
*Applicability**	0,5	1,5	2	R4 000	R9 000	R6 000	R19 000	R15 200–R22 800
*Project boundary***	-	1	0,5	-	R6 000	R1 500	7500	R6 000–R9 000
*Demonstration of additionality and identification of the baseline scenario****	2,75	6	8	R16 500	R18 000	R24 000	R58 500	R65 000–R98 000
*Baseline emissions*****	1,5	2	3,5	R12 000	R12 000	R10 500	R34 500	R27 600–R41 400
*Project emissions******	3	4	4,5	R24 000	R24 000	R13 500	R61 500	R49 200–R73 800
*Leakage emissions*******	3	1	-	R24 000	R6 000	-	R30 000	R24 000–R36 000
Spreadsheet and model creation for the calculation of net anthropogenic GHG removals by sinks	5	3	-	R40 000	R18 000	-	R58 000	R46 600–R69 600
Initial population of model	1	2	2	R8 000	R12 000	R6 000	R26 000	R20 800– 31 200
Reviewing, testing and calibrating model	2	3	3	R16 000	R18 000	R9 000	R43 000	R34 400–R51 600
Monitoring	8	11,5	8	R64 000	R69 000	R24 000	R157 000	R125 600–R188 400
Contingency costs							R99 000	R79 200–R118 800
Total costs							**R594 000**	**R475 200–R712 800**

*Includes the costs of applying the CDM tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities. It assumes that multi-temporal satellite imagery, already commissioned by the project, will be used as a reference to demonstrate degradation, and that the only outstanding cost then for the tool is writing the PDD content.

**Includes application of the CDM tool for testing the significance of GHG emissions in A/R CDM project activities.

***Costs cover the application of the combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities.

****Costs cover writing up findings from the tool for the estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities. Assumes that the conditions under which carbon stock and change in carbon stock may be estimated as zero are met through the provision of documentary evidence.

*****Assumes that, for soil organic carbon, a field-based sampling approach is used. Costs of this type of exercise are detailed in the monitoring section. Costs cover writing up findings from the tool for the estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities.

******Assumes the use of the two VCS tools: VMD0033: Estimation of emissions from market leakage, and VMD0040: Leakage from the displacement of grazing activities. Costs are associated with running all equations in the tool in preparation for inclusion in the spreadsheet and in the net GHG reduction model, and developing written content for inclusion in a PDD.

Table B4: Cost analysis for VM0017 – Adoption of sustainable agricultural land management

Section	Person days			Rates			Total costs	Cost range (±20%)
	Lead	Senior	Junior	Lead	Senior	Junior		
*Applicability**	5	4	1,5	R40 000	R24 000	4500	R68 500	
*Demonstration of additionality and identification of the baseline scenario***	2,75	6	8	R22 000	R36 000	R24 000	R82 000	R65 000–R98 000
*Estimation of baseline GHG emissions and removals****	3	2	1,5	R24 000	R12 000	R4 500	R40 500	R32 400–R48 600
*Estimation of project GHG emissions and removals*****	5	2	2	R40 000	R12 000	R6 000	R58 000	R46 400–R69 600
Leakage	0,5	0,5	-	R4 000	R3 000	-	R7 000	R5 600–R8 400
Spreadsheet and model creation for the calculation of net anthropogenic GHG removals by sinks	5	3	-	R40 000	R18 000	-	R58 000	R46 400–R69 600
Initial population of model	1	2	2	R8 000	R12 000	R6 000	R26 000	R20 800–R31 200
Reviewing, testing and calibrating model	2	3	3	R16 000	R18 000	R9 000	R43 000	R34 400–R51 600
Monitoring	8	11,5	8	R64 000	R69 000	R24 000	R157 000	R125 600–R188 400
Uncertainty analysis	2	1	-	R16 000	R6 000	-	R22 000	R17 600–R26 400
Contingency costs							R112 400	R89 920–R134 880
Total costs							**R674 400**	**R539 520–R809 280**

*Includes the costs of applying the CDM tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities. It assumes that multi-temporal satellite imagery, already commissioned by the project, will be used as a reference to demonstrate degradation, and that the only outstanding cost then for the tool is writing the PDD content. Costs also include testing the appropriateness of the RothC model.

**Costs cover the application of the combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities.

***Costs include the adoption of tools for the estimation of direct nitrous oxide emission from nitrogen fertilization, the estimation of non-CO_2 emissions from the burning of crop residues, the estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities, and the estimation of emissions from combustion in the use of fossil fuels in agricultural management. With regard to the tool used to estimate carbon stocks in trees and shrubs, it is assumed that the conditions under which carbon stock and change in carbon stock may be estimated as zero are met.

****Assumes the use of the CDM tools for the estimation of direct nitrous oxide emission from nitrogen fertilization, the estimation of direct nitrous oxide emission from N-fixing species and crop residues, the estimation of non-CO_2 emissions from the burning of crop residues, the estimation of emissions from the use of fossil fuels in agricultural management and elements of the methodology's simplified baseline and monitoring methodologies for small-scale A/R project activities under the CDM implemented on grasslands or croplands.

Table B5: Cost analysis for a selection of methodologies applicable to biomass-to-energy and/or anaerobic biogas digestion

Methodology	Section	Total costs	Cost range (±20%)
ACM0006/AMS-I.C/AMS-I.D	*Development of PDD content*	R300 000	R240 000–R360 000
	Spreadsheet and model creation for the calculation of net anthropogenic GHG removals by sinks	R30 000	R24 000–R36 000
	Initial population of the model	R15 000	R12 000–R18 000
	Reviewing, testing and calibrating model	R30 000	R24 000–R36 000
	Monitoring	R75 000	R60 000–R90 000
	Contingency costs	R90 000	R72 000–R108 000
	Total costs	**R540 000**	**R432 000–R648 000**

Annexure C: Remote sensing and spatial analysis

Note: All prices are guidelines only and may change at the time of formal quotations. When determining optimal methods and data formats, remember to check the minimum area coverage that can be purchased for each image format.

1. REDD+ activities

a. Current land-cover classification

The current land-cover will be captured using up-to-date imagery to provide an overview of the area and will include the following high-level land-cover classification:

No	Land-cover class
1.	Forest/dense bush
2.	Woodlands/thickets
3.	Open bush/shrubland
4.	Grassland
5.	Wetlands
6.	Cultivated lands
7.	Settlements
8.	Bare/non-vegetated areas
9.	Water bodies

The land-cover will be developed using conventional per-pixel classification procedures, and, as far as possible, the most recent multi-temporal imagery. The data will indicate the extent of land use and vegetation classes and will only be developed for the project area. This level of mapping will not be conducted retrospectively. It will, however, continue into the future approximately every five years.

The different scales and resolutions are described in the table below:

Sensor	Supplier	Resolution & Format	m	operational	Approx Min Mapping Scale	Approx **Min** Mapping Unit (ha)
Ikonos	Digital Globe	Pan/P-merge	1.0	1999 - 2014	1:3000	0.003
Ikonos	Digital Globe	Colour	4.0	1999 - 2014	1:12,000	0.011
Quickbird	Digital Globe	Pan/P-merge	0.6	2001 - current	1:2,500	0.002
Quickbird	Digital Globe	Colour	2.4	2001 - current	1:7,500	0.006
GeoEye	Digital Globe	Pan/P-merge	0.5	2008 - current	1:1,500	0.001
GeoEye	Digital Globe	Colour	2.0	2008 - current	1:6,000	0.005
WorldView 1	Digital Globe	Pan/P-merge	0.5	2007 - current	1:1,500	0.001
WorldView 1	Digital Globe	Colour	n/a	2007 - current	n/a	n/a
WorldView 2	Digital Globe	Pan/P-merge	0.5	2009 - current	1:1,500	0.001
WorldView 2	Digital Globe	Colour	2.0	2009 - current	1:6,000	0.005
WorldView 3	Digital Globe	Pan/P-merge	0.4	2014 - current	1:1,200	0.001
WorldView 3	Digital Globe	Colour	1.5	2014 - current	1:7,500	0.004
Pleiades 1A/B	Airbus	Pan/P-merge	0.5	2011 - current	1:1,500	0.001
Pleiades 1A/B	Airbus	Colour	2.0	2011 - current	1:6,000	0.005
SPOT 1 - 4	Airbus	Pan/P-merge	10.0	1986 - 2013	1:30,000	0.027
SPOT 1 - 4	Airbus	Colour	20.0	1986 - 2013	1:60,000	0.054
SPOT 5	Airbus	Pan/P-merge	2.5	2002 - 2015	1:7,500	0.007
SPOT 5	Airbus	Colour	10.0	2002 - 2015	1:30,000	0.027
Spot 6 / 7	Airbus	Pan/P-merge	1.5	2012 - current	1:5000	0.004
Spot 6 / 7	Airbus	Colour	6.0	2012 - current	1:20,000	0.016
Landsat 4 / 5	USGS	Pan/P-merge	n/a	1982 - (2014)	n/a	n/a
Landsat 4 / 5	USGS	Colour	30.0	1982 - (2014)	1:100,000	0.081
Landsat 8	USGS	Pan/P-merge	15	2013 - current	1:50,000	0.041
Landsat 8	USGS	Colour	30.0	2013 - current	1:100,000	0.081

The cost of generating a standard, full land-cover classification from these different image formats is provided below. Note that the total cost of mapping is the combined total of the image-acquisition cost and the image-mapping cost. These costs are listed separately. Also note that, apart from the Landsat imagery, which is free to access, all other image types are only available as commercial products, which have associated minimum purchase volumes (i.e. per km²) and prices per km².

Standard Single Image									Guideline only
Sensor	Resolution & Format	m	Price / sq km ArchOrtho	Price / sq km TaskOrtho	Area SqKm Arch**Min**Order	Area SqKm Task**Min**Order	Image Data Cost Arch**Min**Order	Approx Rand Equivalent	Standard Land-cover Mapping Cost / sq km
Ikonos	Pan/P-merge	1.0	$10	n/a	25 sq km	n/a	$250.00	R 3 125.00	R 350.00
Ikonos	Colour	4.0	$14.50	n/a	25 sq km	n/a	$362.50	R 4 531.25	R 45.00
Quickbird	Pan/P-merge	0.6	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 100.00
Quickbird	Colour	2.4	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 60.00
GeoEye	Pan/P-merge	0.5	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 200.00
GeoEye	Colour	2.0	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 80.00
WorldView 1	Pan/P-merge	0.5	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 200.00
WorldView 1	Colour	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WorldView 2	Pan/P-merge	0.5	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 200.00
WorldView 2	Colour	2.0	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 80.00
WorldView 3	Pan/P-merge	0.4	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 300.00
WorldView 3	Colour	1.5	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 120.00
Pleiades 1A/B	Pan/P-merge	0.5	€ 10.00	€ 17.00	25 sq km	100 sq km	€250.00	R 3 125.00	R 1 200.00
Pleiades 1A/B	Colour	2.0	€ 10.00	€ 17.00	25 sq km	100 sq km	€250.00	R 3 125.00	R 80.00
SPOT 1 - 4	Pan/P-merge	10.0	€ 0.70	n/a	1000 sq km	n/a	€700.00	R 8 750.00	R 20.00
SPOT 1 - 4	Colour	20.0	€ 0.70	n/a	1000 sq km	n/a	€700.00	R 8 750.00	R 15.00
SPOT 5	Pan/P-merge	2.5	€ 1.50	n/a	1000 sq km	n/a	€1 500.00	R 18 750.00	R 60.00
SPOT 5	Colour	10.0	€ 1.50	n/a	1000 sq km	n/a	€1 500.00	R 18 750.00	R 20.00
Spot 6 / 7	Pan/P-merge	1.5	€ 3.80	€ 4.60	250 sq km	1000 sq km	€950.00	R 11 875.00	R 120.00
Spot 6 / 7	Colour	6.0	€ 3.80	€ 4.60	250 sq km	1000 sq km	€950.00	R 11 875.00	R 25.00
Landsat 4 / 5	Pan/P-merge	n/a	free	free	n/a (unlimited)	n/a	$0.00	n/a	n/a
Landsat 4 / 5	Colour	30.0	free	free	n/a (unlimited)	n/a	$0.00	R 0.00	R 2.00
Landsat 8	Pan/P-merge	15	free	free	n/a (unlimited)	n/a	$0.00	R 0.00	R 4.00
Landsat 8	Colour	30.0	free	free	n/a (unlimited)	n/a	$0.00	R 0.00	R 2.00
								US $: Rand 1:12.5	cost per single
2015 prices								Euro: Rand 1:13.5	assessment year
									(current or historical)
ALWAYS REMEMBER TO ADD IMAGE COST(S) TO MAPPING COST(S) FOR TOTAL									
MAPPING COSTS DO NOT ACCOUNT FOR ANY COMPANY SPECIFIC MINIMUM COST THRESHOLDS BASED ON ECONOMIES-OF-SCALE.									

ArchOrtho refers to the cost per km² for ortho-corrected imagery available in existing data archives. TaskOrtho refers to the cost of acquiring new ortho-corrected imagery in terms of future, project-specific requests. In both cases, there are associated minimum area coverages of data that must be purchased. The data purchase cost of the minimum data order coverage is shown as an example in both US$ or Euro and the equivalent rand value.

b. Development of land-cover datasets illustrating the change in forest cover over the last 20 years, mapped every five years.

This component will include the mapping of a simplified land-cover (forest/non-forest) for an area around and including the project area and will be developed for four periods equally spaced five years apart. The current full land-cover referred to in 1a will be included as part of these datasets.

As an example, land cover will be mapped for the following time lines:

No.	Date	Information classes
1.	Every five years into the future	**All forest classes *** **All non-forest classes ****
2.	2015	**All forest classes *** **All non-forest classes ****
3.	2010	Forest Non-forest
4.	2005	Forest Non-forest
5.	2000	Forest Non-forest
6.	1995	Forest Non-forest

* **Forest** Forest/dense bush/woodlands /thickets
** **Non-forest** Open bush/shrublands/grasslands/wetlands/cultivated lands/settlements/bare or non-vegetated areas/water bodies

These land-cover maps need to be developed for an area 10 times the size of the physical project area and will be updated every five years to reflect the extent of forest/non-forest cover, as well as the other land uses in the area.

The table below illustrates the cost of generating only a forest vs non-forest map product (as opposed to a full land-cover dataset) on a per assessment date basis. The production of a full land-cover dataset is not a prerequisite for the production of a forest/non-forest dataset.

The table also shows the cost of modelling forest change between two (or more) assessment periods, using time-stamped forest vs non-forest datasets as inputs. The ability to determine forest change over time depends on the availability of forest/non-forest datasets for each assessment date. The total cost of generating a forest change dataset is therefore a combination of the forest/non-forest mapping and forest change (plus, if applicable, image-acquisition costs).

Note that, if standard land-cover classifications have already been completed (at the indicated prices) for all the assessment years to be used in the change modelling, there is no requirement (or cost) for the generation of the simplified forest/non-forest datasets, since this can be generated by a simple class-recoding exercise. All that would need to be costed in such instances would be the cost of the change analysis between the assessment dates.

Standard Single Image			*Guideline only*	*Guideline only*
Sensor	Resolution & Format	m	Forest / Non-Forest only Mapping Cost / sq km	Forest / Non-Forest Change Model / sq km
Ikonos	Pan/P-merge	1.0	R 105.00	R 8.75
Ikonos	Colour	4.0	R 13.50	R 1.13
Quickbird	Pan/P-merge	0.6	R 330.00	R 27.50
Quickbird	Colour	2.4	R 18.00	R 1.50
GeoEye	Pan/P-merge	0.5	R 360.00	R 30.00
GeoEye	Colour	2.0	R 24.00	R 2.00
WorldView 1	Pan/P-merge	0.5	R 360.00	R 30.00
WorldView 1	Colour	n/a	n/a	n/a
WorldView 2	Pan/P-merge	0.5	R 360.00	R 30.00
WorldView 2	Colour	2.0	R 24.00	R 2.00
WorldView 3	Pan/P-merge	0.4	R 390.00	R 32.50
WorldView 3	Colour	1.5	R 36.00	R 3.00
Pleiades 1A/B	Pan/P-merge	0.5	R 360.00	R 30.00
Pleiades 1A/B	Colour	2.0	R 24.00	R 2.00
SPOT 1 - 4	Pan/P-merge	10.0	R 6.00	R 0.50
SPOT 1 - 4	Colour	20.0	R 4.50	R 0.38
SPOT 5	Pan/P-merge	2.5	R 18.00	R 1.50
SPOT 5	Colour	10.0	R 6.00	R 0.50
Spot 6 / 7	Pan/P-merge	1.5	R 36.00	R 3.00
Spot 6 / 7	Colour	6.0	R 7.50	R 0.63
Landsat 4 / 5	Pan/P-merge	n/a	n/a	n/a
Landsat 4 / 5	Colour	30.0	R 0.60	R 0.05
Landsat 8	Pan/P-merge	15	R 1.20	R 0.10
Landsat 8	Colour	30.0	R 0.60	R 0.05
			cost per single	*assumes 2 or more*
2015 prices			*assessment year*	*assmnt yrs mapping*
			(current or historical)	*already completed*
				(current & historical)
ALWAYS REMEMBER TO ADD IMAGE COST(S) TO MAPPING COST(S) FOR TOTAL				
MAPPING COSTS DO NOT ACCOUNT FOR ANY COMPANY SPECIFIC MINIMUM COST THRESHOLDS BASED ON ECONOMIES-OF-SCALE.				

c. Spatial modelling of future deforestation potential based on historical trends and external factors impacting on deforestation, such as access to roads, topography, access to markets, etc.

Using the historical trends identified in the previous mapping exercise, future deforestation potential must be projected for 30 years into the future, based on external factors such as the following:

- Slope (accessibility)
- Aspect (soil moisture)
- Distance to markets
- Access to transportation in the area
- Existing land cover and land use in the area

These factors must be used to model the deforestation potential over a 30-year period based on existing trends and knowledge.

The table below illustrates the cost of generating future deforestation estimates. Note that the guideline cost excludes the cost of any image purchases required, and the cost of producing any required forest/non-forest or land-cover maps that may be required as part of the input to the future scenario modelling.

Standard Single Image			*Guideline only*
Sensor	Resolution & Format	m	Future Deforestation Change Model / sq km
Ikonos	Pan/P-merge	1.0	R 87.50
Ikonos	Colour	4.0	R 11.25
Quickbird	Pan/P-merge	0.6	R 275.00
Quickbird	Colour	2.4	R 15.00
GeoEye	Pan/P-merge	0.5	R 300.00
GeoEye	Colour	2.0	R 20.00
WorldView 1	Pan/P-merge	0.5	R 300.00
WorldView 1	Colour	n/a	n/a
WorldView 2	Pan/P-merge	0.5	n/a
WorldView 2	Colour	2.0	R 20.00
WorldView 3	Pan/P-merge	0.4	R 325.00
WorldView 3	Colour	1.5	R 30.00
Pleiades 1A/B	Pan/P-merge	0.5	R 300.00
Pleiades 1A/B	Colour	2.0	R 20.00
SPOT 1 - 4	Pan/P-merge	10.0	R 5.00
SPOT 1 - 4	Colour	20.0	R 3.75
SPOT 5	Pan/P-merge	2.5	R 15.00
SPOT 5	Colour	10.0	R 5.00
Spot 6 / 7	Pan/P-merge	1.5	R 30.00
Spot 6 / 7	Colour	6.0	R 6.25
Landsat 4 / 5	Pan/P-merge	n/a	n/a
Landsat 4 / 5	Colour	30.0	R 0.50
Landsat 8	Pan/P-merge	15	R 1.00
Landsat 8	Colour	30.0	R 0.50
			assumes (a) 1 or more
2015 prices			*assmnt yrs mapping*
			already completed
			and (b) scale compatible
			supporting landscape
			and infrastructure data
			available (free)
ALWAYS REMEMBER TO ADD IMAGE COST(S) TO MAPPING COST(S) FOR TOTAL			

2. Afforestation activities

a. Mapping of current land cover for the project area

The current land cover will be captured using up-to-date imagery to provide an overview of the area and will include the following high-level land-cover classification:

No	Land-cover class
1.	Forest/dense bush
2.	Woodlands/thickets
3.	Open bush/shrubland
4.	Grasslands
5.	Wetlands
6.	Cultivated lands
7.	Settlements
8.	Bare/non-vegetated areas
9.	Water bodies

The land cover will be developed using conventional per-pixel-based classification procedures and, as far as possible, the most recent multi-temporal imagery. The data will indicate the extent of land use and vegetation classes, and will only be developed for the project area. This is typically a once-off exercise for the project.

The cost of this land-cover mapping is the same as that provided previously:

Standard Single Image									*Guideline only*
Sensor	Resolution & Format	m	Price / sq km ArchOrtho	TaskOrtho	Area SqKm ArchMinOrder	Area SqKm TaskMinOrder	Image Data Cost ArchMinOrder	Approx Rand Equivalent	Standard Land-cover Mapping Cost / sq km
Ikonos	Pan/P-merge	1.0	$10	n/a	25 sq km	n/a	$250.00	R 3 125.00	R 350.00
Ikonos	Colour	4.0	$14.50	n/a	25 sq km	n/a	$362.50	R 4 531.25	R 45.00
Quickbird	Pan/P-merge	0.6	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 100.00
Quickbird	Colour	2.4	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 60.00
GeoEye	Pan/P-merge	0.5	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 200.00
GeoEye	Colour	2.0	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 80.00
WorldView 1	Pan/P-merge	0.5	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 200.00
WorldView 1	Colour	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WorldView 2	Pan/P-merge	0.5	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 200.00
WorldView 2	Colour	2.0	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 80.00
WorldView 3	Pan/P-merge	0.4	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 1 300.00
WorldView 3	Colour	1.5	$14.50	$24.00	25 sq km	100 sq km	$362.50	R 4 531.25	R 120.00
Pleiades 1A/B	Pan/P-merge	0.5	€ 10.00	€ 17.00	25 sq km	100 sq km	€250.00	R 3 125.00	R 1 200.00
Pleiades 1A/B	Colour	2.0	€ 10.00	€ 17.00	25 sq km	100 sq km	€250.00	R 3 125.00	R 80.00
SPOT 1 - 4	Pan/P-merge	10.0	€ 0.70	n/a	1000 sq km	n/a	€700.00	R 8 750.00	R 20.00
SPOT 1 - 4	Colour	20.0	€ 0.70	n/a	1000 sq km	n/a	€700.00	R 8 750.00	R 15.00
SPOT 5	Pan/P-merge	2.5	€ 1.50	n/a	1000 sq km	n/a	€1 500.00	R 18 750.00	R 60.00
SPOT 5	Colour	10.0	€ 1.50	n/a	1000 sq km	n/a	€1 500.00	R 18 750.00	R 20.00
Spot 6 / 7	Pan/P-merge	1.5	€ 3.80	€ 4.60	250 sq km	1000 sq km	€950.00	R 11 875.00	R 120.00
Spot 6 / 7	Colour	6.0	€ 3.80	€ 4.60	250 sq km	1000 sq km	€950.00	R 11 875.00	R 25.00
Landsat 4 / 5	Pan/P-merge	n/a	free	free	n/a (unlimited)	n/a	$0.00	n/a	n/a
Landsat 4 / 5	Colour	30.0	free	free	n/a (unlimited)	n/a	$0.00	R 0.00	R 2.00
Landsat 8	Pan/P-merge	15	free	free	n/a (unlimited)	n/a	$0.00	R 0.00	R 4.00
Landsat 8	Colour	30.0	free	free	n/a (unlimited)	n/a	$0.00	R 0.00	R 2.00
2015 prices								*US $: Rand 1:12.5* *Euro: Rand 1:13.5*	*cost per single assessment year (current or historical)*
ALWAYS REMEMBER TO ADD IMAGE COST(S) TO MAPPING COST(S) FOR TOTAL									
MAPPING COSTS DO NOT ACCOUNT FOR ANY COMPANY SPECIFIC MINIMUM COST THRESHOLDS BASED ON ECONOMIES-OF-SCALE.									

b. Mapping of historical forest/non-forest land-cover for the project area

The current land cover will be complemented with a forest/non-forest map for a period 10 years before the current map. This basic land cover will only consist of a forest and non-forest classification and will be used to quantify the afforestation effort and its success.

The table below illustrates the cost of historical archive image acquisition and forest/non-forest mapping and, if required, associated forest change modelling.

Standard Single Image							*Guideline only*	*Guideline only*
Sensor	Resolution & Format	m	Price / sq km ArchOrtho	Area SqKm ArchMinOrder	Image Data Cost ArchMinOrder	Approx Rand Equivalent	Forest / Non-Forest only Mapping Cost / sq km	Forest / Non-Forest Change Model / sq km
Ikonos	Pan/P-merge	1.0	$10	25 sq km	$250.00	R 3 125.00	R 105.00	R 8.75
Ikonos	Colour	4.0	$14.50	25 sq km	$362.50	R 4 531.25	R 13.50	R 1.13
Quickbird	Pan/P-merge	0.6	$14.50	25 sq km	$362.50	R 4 531.25	R 330.00	R 27.50
Quickbird	Colour	2.4	$14.50	25 sq km	$362.50	R 4 531.25	R 18.00	R 1.50
GeoEye	Pan/P-merge	0.5	$14.50	25 sq km	$362.50	R 4 531.25	R 360.00	R 30.00
GeoEye	Colour	2.0	$14.50	25 sq km	$362.50	R 4 531.25	R 24.00	R 2.00
WorldView 1	Pan/P-merge	0.5	$14.50	25 sq km	$362.50	R 4 531.25	R 360.00	R 30.00
WorldView 1	Colour	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WorldView 2	Pan/P-merge	0.5	$14.50	25 sq km	$362.50	R 4 531.25	R 360.00	R 30.00
WorldView 2	Colour	2.0	$14.50	25 sq km	$362.50	R 4 531.25	R 24.00	R 2.00
WorldView 3	Pan/P-merge	0.4	$14.50	25 sq km	$362.50	R 4 531.25	R 390.00	R 32.50
WorldView 3	Colour	1.5	$14.50	25 sq km	$362.50	R 4 531.25	R 36.00	R 3.00
Pleiades 1A/B	Pan/P-merge	0.5	€ 10.00	25 sq km	€250.00	R 3 125.00	R 360.00	R 30.00
Pleiades 1A/B	Colour	2.0	€ 10.00	25 sq km	€250.00	R 3 125.00	R 24.00	R 2.00
SPOT 1 - 4	Pan/P-merge	10.0	€ 0.70	1000 sq km	€700.00	R 8 750.00	R 6.00	R 0.50
SPOT 1 - 4	Colour	20.0	€ 0.70	1000 sq km	€700.00	R 8 750.00	R 4.50	R 0.38
SPOT 5	Pan/P-merge	2.5	€ 1.50	1000 sq km	€1 500.00	R 18 750.00	R 18.00	R 1.50
SPOT 5	Colour	10.0	€ 1.50	1000 sq km	€1 500.00	R 18 750.00	R 6.00	R 0.50
Spot 6 / 7	Pan/P-merge	1.5	€ 3.80	250 sq km	€950.00	R 11 875.00	R 36.00	R 3.00
Spot 6 / 7	Colour	6.0	€ 3.80	250 sq km	€950.00	R 11 875.00	R 7.50	R 0.63
Landsat 4 / 5	Pan/P-merge	n/a	free	n/a (unlimited)	$0.00	n/a	n/a	n/a
Landsat 4 / 5	Colour	30.0	free	n/a (unlimited)	$0.00	R 0.00	R 0.60	R 0.05
Landsat 8	Pan/P-merge	15	free	n/a (unlimited)	$0.00	R 0.00	R 1.20	R 0.10
Landsat 8	Colour	30.0	free	n/a (unlimited)	$0.00	R 0.00	R 0.60	R 0.05
						US $: Rand 1:12.5	*cost per single*	*assumes 2 or more*
2015 prices						*Euro: Rand 1:13.5*	*assessment year*	*assmnt yrs mapping*
							(current or historical)	*already completed*
								(current & historical)
ALWAYS REMEMBER TO ADD IMAGE COST(S) TO MAPPING COST(S) FOR TOTAL								
MAPPING COSTS DO NOT ACCOUNT FOR ANY COMPANY SPECIFIC MINIMUM COST THRESHOLDS BASED ON ECONOMIES-OF-SCALE.								

3. Grasslands

a. Mapping of current land cover for the project area

The current land cover will be captured using up-to-date imagery to provide an overview of the area and will include the following high-level land-cover classification:

No	Land-cover class
1.	Forest/dense bush
2.	Woodlands/thickets
3.	Open bush/shrubland
4.	Grasslands
5.	Wetlands
6.	Cultivated lands
7.	Settlements
8.	Bare/non-vegetated areas
9.	Water bodies

The land cover will be developed using conventional per-pixel-based classification procedures and, as far as possible, the most recent multi-temporal imagery. The data will indicate the extent of land use and vegetation classes, and will only be developed for the project area. This is typically a once-off exercise for the project.

The cost of generating a standard, full land-cover classification from these different image formats is provided below. Note that the total cost of mapping is the combined total of the image-acquisition cost and the image-mapping cost. These costs are listed separately. Note that, apart from the Landsat imagery, which is free to access, all other image types are only available as commercial products, which have associated minimum purchase volumes (i.e. a km^2) and prices per km^2.

Sensor	Supplier	Resolution & Format	m	operational	Approx Min Mapping Scale	Approx **Min** Mapping Unit (ha)
Ikonos	Digital Globe	Pan/P-merge	1.0	1999 - 2014	1:3000	0.003
Ikonos	Digital Globe	Colour	4.0	1999 - 2014	1:12,000	0.011
Quickbird	Digital Globe	Pan/P-merge	0.6	2001 - current	1:2,500	0.002
Quickbird	Digital Globe	Colour	2.4	2001 - current	1:7,500	0.006
GeoEye	Digital Globe	Pan/P-merge	0.5	2008 - current	1:1,500	0.001
GeoEye	Digital Globe	Colour	2.0	2008 - current	1:6,000	0.005
WorldView 1	Digital Globe	Pan/P-merge	0.5	2007 - current	1:1,500	0.001
WorldView 1	Digital Globe	Colour	n/a	2007 - current	n/a	n/a
WorldView 2	Digital Globe	Pan/P-merge	0.5	2009 - current	1:1,500	0.001
WorldView 2	Digital Globe	Colour	2.0	2009 - current	1:6,000	0.005
WorldView 3	Digital Globe	Pan/P-merge	0.4	2014 - current	1:1,200	0.001
WorldView 3	Digital Globe	Colour	1.5	2014 - current	1:7,500	0.004
Pleiades 1A/B	Airbus	Pan/P-merge	0.5	2011 - current	1:1,500	0.001
Pleiades 1A/B	Airbus	Colour	2.0	2011 - current	1:6,000	0.005
SPOT 1 - 4	Airbus	Pan/P-merge	10.0	1986 - 2013	1:30,000	0.027
SPOT 1 - 4	Airbus	Colour	20.0	1986 - 2013	1:60,000	0.054
SPOT 5	Airbus	Pan/P-merge	2.5	2002 - 2015	1:7,500	0.007
SPOT 5	Airbus	Colour	10.0	2002 - 2015	1:30,000	0.027
Spot 6 / 7	Airbus	Pan/P-merge	1.5	2012 - current	1:5000	0.004
Spot 6 / 7	Airbus	Colour	6.0	2012 - current	1:20,000	0.016
Landsat 4 / 5	USGS	Pan/P-merge	n/a	1982 - (2014)	n/a	n/a
Landsat 4 / 5	USGS	Colour	30.0	1982 - (2014)	1:100,000	0.081
Landsat 8	USGS	Pan/P-merge	15	2013 - current	1:50,000	0.041
Landsat 8	USGS	Colour	30.0	2013 - current	1:100,000	0.081

b. Mapping of current degraded/non-degraded grassland areas

The current land-cover map developed in 3a must be converted into a degraded/non-degraded grassland map to indicate the current status of the grasslands in the area.

The table below illustrates the price for current degraded/non-degraded mapping. Note that the cost of acquiring the imagery must be added to the grassland mapping cost in order to calculate the total cost.

Standard Single Image			*Guideline only*
Sensor	Resolution & Format	m	Grass / Degraded Grass only Mapping Cost / sq km
Ikonos	Pan/P-merge	1.0	R 105.00
Ikonos	Colour	4.0	R 13.50
Quickbird	Pan/P-merge	0.6	R 330.00
Quickbird	Colour	2.4	R 18.00
GeoEye	Pan/P-merge	0.5	R 360.00
GeoEye	Colour	2.0	R 24.00
WorldView 1	Pan/P-merge	0.5	R 360.00
WorldView 1	Colour	n/a	n/a
WorldView 2	Pan/P-merge	0.5	R 360.00
WorldView 2	Colour	2.0	R 24.00
WorldView 3	Pan/P-merge	0.4	R 390.00
WorldView 3	Colour	1.5	R 36.00
Pleiades 1A/B	Pan/P-merge	0.5	R 360.00
Pleiades 1A/B	Colour	2.0	R 24.00
SPOT 1 - 4	Pan/P-merge	10.0	R 6.00
SPOT 1 - 4	Colour	20.0	R 4.50
SPOT 5	Pan/P-merge	2.5	R 18.00
SPOT 5	Colour	10.0	R 6.00
Spot 6 / 7	Pan/P-merge	1.5	R 36.00
Spot 6 / 7	Colour	6.0	R 7.50
Landsat 4 / 5	Pan/P-merge	n/a	n/a
Landsat 4 / 5	Colour	30.0	R 0.60
Landsat 8	Pan/P-merge	15	R 1.20
Landsat 8	Colour	30.0	R 0.60
			cost per single
2015 prices			*assessment year*
			(current or historical)

c. Mapping of historical degraded/non-degraded grassland areas

The current degraded/non-degraded grasslands dataset must be complemented by historical degraded/non-degraded grassland layers to illustrate the change over time for the project area. These datasets may need to be repeated on an annual basis retrospectively if necessary.

The cost for mapping historical degraded/non-degraded grasslands is the same as that provided for current grasslands in 3b.

The methodologies to map and quantify the degraded grassland class will still need to be developed and these costs may change based on new mapping techniques, modelling approaches or satellite imagery available.

4. Conservation agriculture

In order to quantify the agricultural practices in an area, field boundaries will need to be mapped and evaluated (classified) in terms of "close to zero till", maintenance of ground cover throughout the year and diversity of crops planted on a given piece of land.

To broadly classify these conservation agricultural practices, agricultural field boundaries will be mapped using image interpretation (heads-up digitising) to define the extent. These fields will be broadly classified into commercial or subsistence agricultural land-use practices to assist in understanding the scope and intensity of agriculture in an area. An agricultural extension officer will need to visit a sample of these fields to classify them according to conservation tillage practices.

The agricultural field boundaries will be mapped for the project area. The cost associated with this mapping and classification is linked to the level of detail required and is defined in the table below.

Standard Single Image				*Guideline only*
Sensor	Supplier	Resolution & Format	m	Field Boundary Delineation Mapping Cost / sq km (of fields)
Ikonos	Digital Globe	Pan/P-merge	1.0	R 120.00
Ikonos	Digital Globe	Colour	4.0	R 30.00
Quickbird	Digital Globe	Pan/P-merge	0.6	R 240.00
Quickbird	Digital Globe	Colour	2.4	R 50.00
GeoEye	Digital Globe	Pan/P-merge	0.5	R 240.00
GeoEye	Digital Globe	Colour	2.0	R 60.00
WorldView 1	Digital Globe	Pan/P-merge	0.5	R 240.00
WorldView 1	Digital Globe	Colour	n/a	n/a
WorldView 2	Digital Globe	Pan/P-merge	0.5	R 240.00
WorldView 2	Digital Globe	Colour	2.0	R 60.00
WorldView 3	Digital Globe	Pan/P-merge	0.4	R 240.00
WorldView 3	Digital Globe	Colour	1.5	R 90.00
Pleiades 1A/B	Airbus	Pan/P-merge	0.5	R 240.00
Pleiades 1A/B	Airbus	Colour	2.0	R 60.00
SPOT 1 - 4	Airbus	Pan/P-merge	10.0	R 12.00
SPOT 1 - 4	Airbus	Colour	20.0	R 6.00
SPOT 5	Airbus	Pan/P-merge	2.5	R 50.00
SPOT 5	Airbus	Colour	10.0	R 12.00
Spot 6 / 7	Airbus	Pan/P-merge	1.5	R 90.00
Spot 6 / 7	Airbus	Colour	6.0	R 40.00
Landsat 4 / 5	USGS	Pan/P-merge	n/a	n/a
Landsat 4 / 5	USGS	Colour	30.0	R 4.00
Landsat 8	USGS	Pan/P-merge	15	R 8.00
Landsat 8	USGS	Colour	30.0	R 4.00
				this is a manual digitisation
2015 prices				*process and cannot currently*
				be automated or based on
				digital classifications
				Note: costs are per sq km of
				field coverage, NOT image
				extent since costs will vary
				according to field densities.
ALWAYS REMEMBER TO ADD IMAGE COST(S) TO MAPPING COST(S) FOR TOTAL				

Note that field-mapping costs are based on the km² of fields to be mapped, not the km² of the total area of interest. It is therefore important to estimate the approximate area coverage of fields in order to determine mapping rates. Note that, as per previous mapping costs, the total cost for field-mapping needs to be calculated from the combined cost of the image-acquisition and the field-mapping rates.

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