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CHAPTER XII

Carbon finance in extensively managed rangelands: issues in project, programmatic and sectoral approached

Abstract

Considering their vast geographic area and the documented carbon (C) sequestration effects of a variety of rangeland management practices, there is considerable interest in the potential of C finance in rangelands, where it is still very much in its early stages. Pilot projects are essential to exploring this potential in practice. *Ex ante* assessments at the project level show areas of positive potential, but have identified several areas where documentation is insufficient, and critical constraints that exist in some contexts. This chapter summarizes these potentials and constraints, and then discusses opportunities and challenges in view of the major options currently being considered for a post-Kyoto agreement that includes agricultural land use: project, programmatic and sectoral approaches (including unilateral mitigation actions, supported mitigation actions and sectoral crediting approaches). The paper describes this emerging architecture for future mitigation options, and analyses the requirements for developing project, programmatic and sectoral approaches. It concludes by highlighting key actions required to promote the development of project, programmatic and sectoral approaches to rangeland-based mitigation.

POTENTIAL FOR CARBON FINANCE IN EXTENSIVELY MANAGED RANGELANDS

Growing international interest in rangeland carbon finance

Globally there are over 120 million pastoralists who are custodians of more than 5 000 million ha of rangelands (White, Murray and Rohweder, 2000), a significant proportion of whom live in income poverty. Traditional resource management practices in many pastoralist societies enable sustainable use of rangeland resources (Barrow *et al*., 2007). Driven by inappropriate rangeland management and development policies, the breakdown of traditional resource management regimes and cessation of beneficial rangeland management practices has often been a key cause of rangeland degradation (IPCC, 2000).

Without remedial action, average global temperatures could reach 2 °C higher than pre-industrial levels by 2035–2050 (Stern, 2007). Other changes of significance for pastoralism include changes in the length and timing of the growing season, changes in the amount and seasonal pattern of precipitation, and rising atmospheric carbon dioxide (CO_2) concentration, all of which may impact on: forage and feed availability (Hall *et al.,* 1995); possible heat stress of livestock; changing availability of water resources; and changes in the epidemiology of livestock diseases (Thornton *et al.,* 2009). Although pastoralists have made minimal contributions to the current rate of global warming, many pastoral areas will be severely affected by climate change, making resource management an important priority. Rangeland-based adaptation strategies – such as seasonal grassland reserves (Angassa and Oba, 2007) or revival of traditional grazing systems and development of forage reserves (Batima, 2006) – are likely to benefit vegetation and soil C sequestration, supporting both adaptation to and mitigation of further climate change. Sustainable management and restoration of degraded rangelands can increase the land and therefore also livestock productivity. Thus, the adoption of rangeland-based greenhouse gas (GHG) mitigation measures can be integrated with the adaptation needs and livelihood development goals of pastoralist communities.

Given the large geographic extent of rangelands across the globe, and the potential benefits for pastoralists of schemes that support improved rangeland management, there has been considerable interest in the potential for C finance in rangelands (e.g. Reid *et al*., 2004; Roncoli *et al*., 2007; Mannetje *et al.,* 2008; Lipper, Dutilly-Diane and McCarthy, 2008; Smith *et al*., 2008; Tennigkeit and Wilkes, 2008; UNEP, 2008; FAO, 2009). This interest has also been stimulated by recognizing that C markets will develop more rapidly and with deeper financial backing than other regulatory approaches to rangeland management or other market mechanisms for rewarding provision of environmental services from rangelands. In 2008, the Kyoto compliance market made transactions worth USD65 billion, while the voluntary market traded at least USD397 million (Capoor and Ambrosi, 2009). Could these growing markets be accessed to support sustainable resource management in the world's rangelands while also supporting livelihood development for their pastoralist custodians?

The most extensive research on the mitigation potential of rangelands has been conducted in developed countries with significant rangeland land areas. Schuman, Janzen and Herrick (2002) estimated that rangelands (not including managed pasture) in the United States of America have a technical potential to reduce emissions by more than 157 million tonnes of CO_2eq per year, roughly equivalent to 2.6 percent of total United States net GHG emissions in 2007 (US-EPA, 2009). Ash *et al.* (1996) suggested that adoption of just one management measure (reduction of stocking rates) across Australia could sequester 38.5 million tonnes CO_2eq/year, which is equivalent to just under 7 percent of total gross Australian emissions in 2008 (AGDCC, 2009). An analysis of all mitigation options for the world's largest GHG emitting developing country, China, suggests that "with an abatement potential of 80 Mt [million tonnes] of CO_2eq, grassland management and restoration are the most important abatement opportunity in [China's] agriculture" up to 2030 (McKinsey and Company, 2009). In developing countries with significant rangeland areas but with much fewer intensive industrial and energy sectors than China, rangelands are also likely to be among the most readily available, with lower cost and larger mitigation options.

Potentials and constraints in developing rangeland carbon finance

Creating a C asset requires land managers to implement additional management practices that deliver credible increases in C stocks or decreases in C losses or GHG emissions. In grassland ecosystems, with limited above-ground biomass, as much as 98 percent of C is stored below ground (Hungate *et al.*, 1997). So when considering the potential of grassland vegetation types to sequester C, soil C sequestration is the main potential. In rangelands with significant tree and shrub components, management practices that increase above-ground biomass will also sequester C. Measures to achieve this include afforestation and other forms of vegetation management, as well as innovations in rural energy technologies that reduce dependence on biomass energy sources in rangelands. Particularly since their inclusion in the clean development mechanism (CDM), approaches for increasing sequestration in or reducing emissions from above ground-woody biomass are generally better understood than rangeland soil C management options. This chapter, therefore, focuses more on soil C sequestration in rangelands.

In general, management practices that increase C inputs to grassland soils or that decrease C losses are considered "good" practices, while actions that decrease C inputs or increase losses are considered to be "bad" practices. Table 22 presents a range of management practices that may sequester C or reduce GHG emissions in rangelands.

For many of these management practices, there is already a basis of scientific research documenting their potential C sequestration. Table 23 shows that almost all management practices may have either positive or negative impacts on grassland soil C stocks. Rather than indicating inconsistent results from scientific research ("lack of scientific consensus"), it should be understood that whether a specific practice has positive or negative C sequestration effects depends on a range of site-specific variables, such as vegetation and soil types, climate and land-use history. Rangelands in some locations may respond positively to a certain practice, while the same practice may reduce C sequestration rates elsewhere (Smith *et al.*, 2007). More detailed discussion of the sequestration potential of the management practices listed can be found in Tennigkeit and Wilkes (2008) and other contributors.

The potential of C sequestrating management practices to be adopted in the context of C finance also depends on a number of other factors, among which the economic feasibility of these practices is a crucial, but hitherto underdocumented and little understood aspect. Adoption of C sequestrating rangeland management practices will only happen if adoption provides additional net economic benefits to land users compared with current practices. There is scant documentation of current implementation costs (UNFCCC, 2007) and benefits faced by pastoralist producers across the world and, in many cases, pastoralists' household economies are not well understood at all. Two recent analyses (Smith *et al.*, 2008; McKinsey and Company, 2009) suggest that rangeland mitigation activities are cost-competitive compared with most other mitigation options, but improved documentation of the costs of implementing these activities may find that this is not necessarily the case. In addition to the direct financial costs of implementing management practices, other costs to be considered include: opportunity costs to herders of changes in management practices; transaction costs incurred by project implementation agencies and herders in project implementation (see Chaco, 2009); and costs of validation and verification required for issuing emission reduction credits. A review of existing studies of economic aspects of rangeland C sequestration (see Tennigkeit and Wilkes, 2008) found that (i) the high initial costs of implementing management practices may require subsidization; (ii) households with different capital and resource endowments will have different access to adoption of management practices and different potential to realize economic benefits; and (iii) seasonality of incomes and expenditures can also impact on economic viability for households. The benefits for livestock system productivity and incomes of different C sequestrating practices have also not been systematically documented, so there is little understanding of how incentives for adoption change over time after initial adoption of improved practices.

Globally, to date there is only a very limited number of C finance projects in rangelands. Table 24 summarizes a selection of some of the existing projects, and gives an idea of the management practices that can link with C finance. Bearing in mind, then, that the practice of rangeland carbon finance is still in its early stages and that much documentation and research remain to be done, some general conclusions on the potential, constraints and challenges to C finance in rangelands can be summarized (see Tennigkeit and Wilkes, 2008). Available evidence points to the following potentials for rangeland C finance:

- Rangelands cover a large portion of the world's surface, and are often degraded to some extent, suggesting a large total C sequestration potential;
- Rangelands are often in large contiguous areas, so there is potential for land users to aggregate large C assets;
- Several management practices have been shown to increase C sequestration in a variety of rangeland contexts across the world;
- For some rangeland ecosystems and some management practices, there is already a strong scientific basis at both site and regional levels.

The following challenges to developing C finance projects in rangeland areas have been identified:

- lack of data in many rangeland areas, particularly in developing countries, on the responses of C sequestration rates to changes in management practices;
- lack of assessments of the social, institutional and legal contexts of rangeland management, and the feasibility of multistakeholder collaboration within the framework of C finance markets;
- limited documentation and assessment of the economic feasibility of adopting improved rangeland C management practices in many rangeland contexts;

- limited understanding among potential project developers of market opportunities and limited contacts with C market actors;
- the need for approved C accounting methodologies that do not rely on detailed and long-term data sets unavailable outside developed countries.

Significant constraints to developing C finance in rangelands may exist:

- where rangeland users lack legally recognized land tenure rights (whether private or collective) or
- where herders are unable to exclude others from land use (see Roncoli *et al.*, 2007).

At present, the biggest constraint on the development of rangeland C finance is the exclusion of rangeland emission reductions from eligibility in most compliance markets, so demand remains weak. It remains to be seen whether a post-2012 international framework will create demand for a wider range of terrestrial C assets, including rangeland C. In the short term, it is more likely that charismatic rangeland C assets would be of interest to the voluntary market. Early pilot action projects and the development of necessary methodologies will also generate important experiences for the compliance market and for developing programmatic or sectoral approaches.

Clearly, there is much to be done before livestock keepers in most developing countries can benefit from the growing global C markets. Among the highest priorities is the development of operational, on-the-ground pilot projects that can provide freely available, approved methodologies to be used and adapted elsewhere, valuable experiences in project development and institutional arrangements in rangeland settings, experience in linking science with the cost constraints and verifiability requirements of the market; and that can provide policy-makers with a clearer understanding of what C finance in rangelands may mean in practice.

EVOLVING OPTIONS FOR FUTURE RANGELAND CARBON FINANCE

This section describes existing and options under discussion relevant to rangelands in the international context, structuring discussion around the potential opportunities provided by “project”, “programmatic” and “sectoral” approaches (Figure 29). One possible overarching framework for organization of these various options, nationally appropriate mitigation actions, is also discussed. Since discussions on post-2012 arrangements are still ongoing, and results are far from certain, some of the discussion below is somewhat speculative. However, as experience in the development of project approaches in rangeland C finance grows, it is important to be aware of the different options that experience in other land-use sectors and in national and international policy discussions present, so that early pilot projects can be positioned to leverage the advantages that these evolving arrangements may provide for developing rangeland C finance.

What are project approaches?

One of the flexible mechanisms of the Kyoto Protocol has been the CDM. Under the CDM, GHG mitigation activities in developing countries have been supported mostly on a project-by-project basis. Similarly, most voluntary market transactions have been based on emission reductions delivered through project mechanisms. The project-based approach to C finance structures payments for GHG emission removals resulting from defined activities within a predefined project boundary, and measured against an approved baseline methodology.

The project mechanism has given rise to the need for a range of specific skills and capacities. Carbon finance projects require:

- a methodology approved by a C standard recognized by the buyer, the methodology details the GHGs targeted, methods for calculating baseline and with project GHG emissions, and a C monitoring approach;
- a project design document detailing:
  - a baseline description to demonstrate the business-as-usual situation and the with-project scenario
  - justification of additionality to demonstrate that the project can only be implemented because of the C finance component
  - a leakage assessment to avoid the project resulting in extra new C emissions outside the project area
  - a permanence or reversibility assessment to avoid the emission of sequestered C
  - a C monitoring plan detailing the monitoring design and intervals
- an institutional setup that facilitates implementation of improved management practices, aggregation of C assets, monitoring and verification of emission reductions, and transfer of C payments to the supplier of the credits;
- many C standards also require that projects demonstrate adherence to some degree of environmental and social safeguards, and some have more stringent requirements in this regard.

Typically, individual projects in the land-use sector are relatively small to medium in size. Projects supported by the World Bank BioCarbon Fund, for example, range between 53 000 tonnes–CO_2eq and 2.2 million tonnes–CO_2eq (averaging around 700 000 tonnes–CO_2eq),[1] mostly over a 20-year period. Where aggregators are able to reach large numbers of land users, and where a discreet number of mitigation actions are defined, individual "project" activities on each land user's land can be "bundled" or "pooled"' to form a larger project. In terms of institutional arrangements, an aggregator bundles a number of individual land users' projects together, and sells the C rights to one or more investors.

At present, most rangeland management activities (with the exception of methane (CH_4) management, afforestation and renewable energy projects) are not eligible for the CDM. Voluntary markets have arisen, and play a role in transacting emission reduction credits that are not eligible under compliance markets, as well as incubating innovations for future compliance markets. In December 2008, the Voluntary Carbon Standard (VCS) announced the eligibility of improved grassland management activities (VCS, 2008), and set out basic guidelines for eligible activities and methodologies. At the time of writing, no proposed methodologies for rangeland activities had been submitted to the VCS, although a number of groups are known to be working on developing methodologies and associated projects.

What are programmatic approaches?

In addition to the better-known CDM projects, the CDM also supports programmatic approaches, in which multiple project activities, possibly at multiple sites, can be included in a suggested programme of activities.[2] As with project approaches, programmatic CDM requires characterization of a baseline, and approval of a methodology for accounting for emissions compared with the baseline scenario. But unlike CDM projects, the actual implementation of activities does not need to be specified in advance, so long as they occur during the lifetime of the programme. In order for a methodology to be specified, however, the types of activities and their GHG emission reduction impacts must be identified in advance. Compared with the bundling of projects, programmatic approaches may include a wider range of activities, such as the enactment and implementation of policies, laws

[1] http://wbcarbonfinance.org/Router.cfm?Page=BioCF&ft=Projects/

[2] For the UNFCCC definition, see http://cdmrulebook.org/452/ Figures (2006) provides a comparison between programmatic and bundling approaches.

or sectoral standards that will impact on GHG emissions compared with the baseline scenario. Additionality, permanence and management of leakage have to be only demonstrated at the programme level and not for individual activities, which reduces transactions costs compared with a bundle of projects. There has been strong interest in programmatic approaches in the energy and transport sectors where emissions are caused by the actions of a huge number of actors, and where activities resulting in emissions are impacted by a variety of factors, and can therefore be addressed through multiple actions across the sector. With bundled projects, by contrast, each subcomponent could be taken as an individual stand-alone CDM project, but bundling small projects to create a large-scale CDM project reduces the transaction costs involved.

Within the land-use mitigation sector, there is reportedly some interest in programmatic approaches (Eliasch, 2008). However, this study also found that project developers are reluctant to carry the costs and risks of pioneering the development of programmatic approaches under the CDM. In practice, the regulations governing programmatic CDM approaches have been found to be problematic, for example, allowing a wide range of activities under the programme of action but restricting the programme to the use of one methodology, and including administrative incentives against adopting programmatic approaches (Pan and Lütken, 2008). This has contributed to low uptake by both project developers and national entities responsible for the management of CDM activities, despite the widely recognized potential that programmatic approaches have for pooling multiple mitigation actions within a sector and increasing the supply of emission reduction credits from activities that would not be feasible as a stand-alone CDM project.

What are sectoral approaches?

Ongoing discussions guided by the Bali Action Plan have seen many national governments look beyond project and programmatic approaches, to consider how mitigation actions can be supported at the national sectoral level. This has been driven by a clear need to scale up investment in mitigation actions, and defining actions that would lead to emission removals at the sectoral level is seen as one way to attract C finance on a larger scale than currently under the CDM. In short, sectoral approaches define a baseline at the (regional or national) sector level, and this enables a focus on emission "hotspots" and investment in low-cost mitigation options. Nations would measure and report against this baseline, but have to design incentive or

C revenue distribution systems that reach the entity adopting emission reduction activities. As distinct from sector-wide, project or programmatic approaches, the defining characteristic of sectoral approaches is that a target is set for emission reductions within the sector. Once a sectoral target for emission reductions has been defined and agreed internationally, there is no requirement for mitigation actions to pass additionality tests, and many of the complicated rules of the CDM are no longer required (Ward *et al.*, 2008). Mitigation actions under sectoral approaches could be financed from different sources, including national funds, international (non-aid) grant funding and C finance (if the sectoral emission reductions are allowed to be credited as tradable C credits).

In general, sectoral approaches are well suited to sectors where monitoring, measurement and reporting metrics are easily definable, and where sectoral approaches will lead to significant emission reductions. Typically, discussions of such approaches have considered mainly high emission intensity sectors such as energy generation, steel and cement. Within the agriculture, forestry and land-use (AFOLU) sector, the development of mechanisms for Reducing Emissions from Deforestation and Forest Degradation (REDD), implementing mitigation actions has begun to outline the regional and national accounting methods that would underlie sectoral approaches in the AFOLU sector (Angelsen *et al*., 2009). Typically, a REDD baseline scenario defines what is predicted to happen to forest-related emissions in the business-as-usual scenario. It is suggested that a nation would be credited for emission reductions if actual emissions are below that level. Thus, the baseline scenario is analogous to the sectoral "target" suggested for other sectors.

Deforestation is often driven by demand for land from the agriculture sector, including demand for grazing lands. There is also, therefore, a strong argument that REDD approaches should be expanded to include a wider range of terrestrial C pools. This is necessary to address the drivers of deforestation and forest degradation, to account for leakage within the land-use sector, and to provide incentives for the creation of new terrestrial C assets (Terrestrial Carbon Group, 2008).

What are NAMAs?

Since the Bali meeting in December 2007, discussions on post-2012 mechanisms for supporting mitigation actions have increasingly been adopting the concept of nationally appropriate mitigation actions, or NAMAs. The United Nations Framework Convention on Climate Change

(UNFCCC) commits signatory parties to reduce GHG emissions in accordance with the principle of common but differentiated responsibilities. While an agreed international legally binding definition of NAMAs does not yet exist, NAMAs are generally understood as actions proposed by country parties that have been identified following consideration of the context of sustainable development in that country. A variety of proposals for specific mechanisms for implementation, and for monitoring, reporting and verification have been proposed.

The design of these mechanisms will depend in part on the nature of the commitment made and the source of finance and other support. If an action is voluntary and implemented using national resources, the international community will have lower requirements of the monitoring, reporting and verification (MRV) of the GHG impacts of the action (Winkler, 2008). It has been suggested (Republic of Korea, 2009) that a registry of voluntary actions can be established within the UNFCCC to provide a greater profile for the mitigation actions taken by developing countries independently of international support. Some actions may be supported by developed countries, but without the expectation of generating C credits. A key issue with these "assisted actions" is that financial support should be considered additional to overseas development assistance (ODA) that developed countries claim, otherwise the finance provided will be double counted as the developed country's ODA as well as its contribution to international mitigation activities. Some proposals also suggest that certain actions under a plan of NAMAs could generate tradable credits (e.g. New Zealand, 2009). Some formulations of NAMAs focus on defining key sectors within a nation for inclusion in the NAMA mechanism. In this case, emission reductions would be achieved within each identified sector or within the identified sectors taken together. Other formulations allow for a wider range of activities to be specified within the NAMA, and might thus include project-based actions, programmatic actions and sectoral actions. Some of these actions may be supported by C finance and eligible to generate tradable credits, while others may not.

WHEN WOULD PROJECT, PROGRAMMATIC AND SECTORAL APPROACHES BE SUITABLE IN RANGELAND MITIGATION?

Why and when a project approach?

Project approaches depend on reliable estimation of GHG emission reductions through specified actions implemented within a defined geographic boundary.

Past research has already identified a range of management practices which, if adopted, can in many contexts reduce GHG emissions (Table 23). Most of this research, however, comes from the rangelands of a small number of developed countries. Data in developing countries, especially data from long-term experiments, are very sparse. Given that responses of rangeland soil C to changes in management practice are influenced by highly context-specific factors, C sequestration rates in response to specific management practices in the rangelands of most developing countries have yet to be estimated reliably. Without reliable projections of emission reductions based on local conditions, C credit buyers would be unwilling to invest in supporting project implementation.

In previous discussions of constraints to C finance in rangelands, perceived difficulties and high costs of reliable measurement of soil C responses to change in management practice have been cited as significant obstacles (GCWG, 2009; FAO, 2009). However, there are ways to overcome these obstacles. In December 2008, the CDM Board approved a small-scale methodology for agroforestry in which changes in soil C are automatically credited 0.5 tonnes C/ha based on a default value approved by the Board (CDM AR-AMS-0004).[3] In principle, then, default values with a scientific basis can be used to substitute for expensive recurring measurement costs. Following the approach proposed in an agricultural soil C project in Kenya (Wölcke and Tennigkeit, 2009), in the absence of long-term experiments, the use of established C models (e.g. Century, RothC, etc.) in providing these estimated default values may be an acceptable approach on which to base rangeland mitigation project methodologies. Once a modeled default value has been accepted, it would only be necessary to monitor the adoption of the prescribed activities by land users. The other main perceived obstacle to acceptance of rangeland credits is the risk of non-permanence. This has been dealt with in the VCS by creating a permanence "buffer account" in which a proportion of credits generated is withheld against the risk of reversal of the emission reductions created (VCS, 2008).

In the vast majority of rangeland contexts, even though each herder household (or community) may have tenure over large areas of land, aggregation of C assets within the project boundary requires well-functioning institutions. Constraints on institutional reach and capacity may mean that some potential projects will not be able to achieve sufficient scale to offset the

[3] http://cdm.unfccc.int/UserManagement/FileStorage/LXB75FO38Z9NW1IEGH6V0TSUKD4JYM

constraints imposed by fixed transaction and project management costs. Since buyers will require legal certainty over their purchase, projects will be most feasible where households or communities have legally recognized tenure of the land in the project boundary and where they are able to exclude others from use (Roncoli *et al*., 2007), or where multistakeholder approaches have been shown to be effective in coordinating the land use of different actors (Lipper, Dutilly-Diane and McCarthy, 2008). In contexts with effective institutions for aggregating large numbers of smallholders' C assets, there is also potential for bundling individual project activities into a large-scale project, as has been done by several aggregators involved in the rangeland offsets project of the Chicago Climate Exchange (see NCOC, 2007).

Since rangeland mitigation practices other than CH_4 avoidance, energy and forestry activities are not eligible for the CDM and many other compliance standards, in the immediate short term, voluntary market standards are the only option for providing verified emission reductions from improved rangeland management. The inclusion of a wider range of land uses has been raised at several points in international discussions on post-Kyoto agreements, so there is some potential in the future for rangeland mitigation activities to become eligible for the CDM. Proposed cap and trade systems in some developed countries also allow for international offsets, and if the current voluntary standards are accredited in these emerging compliance systems, there is potential for rangeland C offsets from developing countries to be supported under such emerging offset systems. However, if these cap and trade systems only recognize emission reduction credits from international sources that are approved by the UNFCCC (EDF, 2009), then acceptance by UNFCCC agencies of the eligibility of rangeland mitigation activities and associated methodologies will be a prerequisite for expanding both the supply and demand for rangeland C finance.

In the short and medium term, then, project approaches will remain the main operational modality for C finance in rangelands. Project approaches will also be essential for developing capacities, models and monitoring, and reporting and verification systems for the programmatic and sectoral approaches discussed below.

Why and when a programmatic approach?

In practice, programmatic approaches under the CDM have been found to be hindered by restrictive regulations. In principle, however, programmatic approaches are highly relevant to rangeland mitigation activities. As with project approaches, establishing a programme of activities requires an implementation plan following an approved baseline and monitoring methodology. Emission reduction credits are issued *ex post* following verification of the emission reductions resulting from adoption of activities under the programme. Programmes do not have to target contiguous areas and can be adopted over the lifespan of the programme, and are suited, therefore, to supporting voluntary adoption by land users of a variety of mitigation activities across large rangeland areas.

However, moving from a project to a programmatic approach brings additional risks that must be addressed through the programme design. For example, the legal setup requires not only a buyer and an entity adopting the mitigation activities, but also a programme operating entity. Second, small-scale projects, methodologies that allow a certain degree of uncertainty but that reduce transaction costs of measurement and monitoring, may be acceptable. Yet as the scale of implementation increases, the uncertainties may increase and, unless these uncertainties are addressed, the programme may not generate sufficiently credible emission reductions, and thus have low demand from buyers. Third, as the scale of implementation increases, the risk of non-adoption or default on adoption by land users increases. Since it would be difficult to enforce increased adoption, this would have to be dealt with through risk management mechanisms, such as by pooling risks across individual actions within the programme, or by developing a risk management buffer from the emission reductions generated.

The critical need to develop programmatic activities is to establish a baseline for business-as-usual emissions caused by rangeland management activities across the target region or sector. Most countries have diverse rangeland vegetation types and different farming systems in different areas, so initially it is more suitable for baselines to be developed for specific regions that have been identified as having the greatest mitigation potential. Establishing a regional baseline can also aid in targeting mitigation actions to those locations and management practices that account for significant GHG emissions. Experience with developing regional baselines for forestry projects in India suggests that it also significantly reduces the transaction costs of baseline characterization (Sudha *et al.*, 2006). In areas where land conversion between rangeland and agriculture or rangeland, agriculture and forest are important drivers of GHG emissions, an integrated terrestrial C baseline would be required to prevent leakage between these subsectors (Terrestrial Carbon Group, 2008; Smith *et al.*, 2009; FAO, 2009).

In order to generate credible and verifiable emission reductions, methods for developing robust baselines will have to be developed. The examples provided by REDD baselines suggest possible options for developing baselines for rangelands. In general, two approaches have been adopted to characterize REDD baselines: (i) characterization of historical degradation trends using remote sensing, and directly extrapolating the results into the future; and (ii) modelling the probability of degradation in specific locations across the region based on indicators of the drivers of deforestation and degradation. In all cases, this baseline is developed using remote sensing techniques. When combined with on-the-ground biomass inventories, this lends additional credibility to the estimation of C stocks and subsequent changes caused by land-use change (Westholm *et al*., 2009). The application of remote sensing to characterize rangeland degradation trends has been demonstrated in a number of rangeland contexts. This may enable characterization of a business-as-usual scenario by extrapolating past trends into the future. However, in contrast to research on deforestation, there are few examples of models developed to predict rangeland degradation in response to anthropogenic drivers. A further constraint to developing probabilistic models of degradation to inform regional baselines is often the critical lack of quantified and spatially explicit data on the socio-economic drivers of rangeland degradation. Research in the agriculture sector shows that C models (e.g. Century) can be used to model past and predicted trends in soil C stocks at a regional level (Easter *et al*., 2007). However, because historical management practices can have a large impact on trends in C stocks, the lack of data on management practices can be a strong constraint to the further development of baselines against which to measure the impacts of adopting additional management activities (Milne *et al.*, 2007). Where potential for developing regional programmatic approaches exists, since monitoring project level emission reductions will involve more context-specific measurement, pilot project activities will be essential to developing and validating the regional baselines that are likely to be based more on remote sensing.

In some countries, data availability and scientific capacities for regional estimation of land degradation trends and GHG fluxes are a major constraint (Smith *et al*., 2009; Westholm *et al.,* 2009). Very little is also known about the socio-economic feasibility of adopting rangeland mitigation activities in most of the developing world. Furthermore, the implementation, monitoring and verification of mitigation actions on a large scale require significant institutional capacities. To date, there has been no assessment of institutional capacities for implementation of mitigation actions in rangelands on a large scale in developing countries. Existing documentation from international cooperation projects is mostly insufficiently transparent to provide sufficient guidance as to where large-scale rangeland management projects can deliver verifiable adoption of activities and emission reductions. Where institutional capacities for large-scale implementation are lacking, smaller-scale project approaches are likely to be the preferred option.

Why and when a sectoral approach?

Given the large, often contiguous area of rangelands in many countries, along with other terrestrial C sectors, rangeland mitigation activities might seem to be a good candidate for developing subsectoral mitigation approaches. Sectoral mitigation, assuming that agriculture is considered as one sector, covers cropland and grazing land management activities. Sectoral GHG inventory systems for a large number of non-point emission sources would have to be highly sophisticated and complex. Such systems are not available in most developing countries. Therefore, we consider defining rangelands as a subsector that is more suited to adoption of sectoral approaches.

Once a rangeland sub-sectoral baseline has been established, potential difficulties under project and programmatic approaches with leakage (except international leakage) and additionality are no longer present, since all the land in the area has been defined as within the scope of the sector, and adoption of mitigation activities has been characterized in the baseline. Development of regional, sectoral and national baselines and measurement, reporting and verification (MRV) systems is ongoing in relation to the development of REDD finance mechanisms. A phased approach has been suggested whereby subsequent to the development of REDD mechanisms, a wider range of terrestrial C can then be integrated into the national mechanisms (Terrestrial Carbon Group, 2008; FAO, 2009). The development of regional baselines for rangelands would be an intermediate step towards exploring the linkages with REDD and other land-use GHG accounting mechanisms.

The design of mechanisms for sectoral crediting has not yet been agreed. The business-as-usual baseline scenario could be used as a sectoral crediting line or any line below, depending on the common but differentiated commitment of a country. Fund mechanisms or credit trading options can be introduced to reward mitigation actions that contribute to reducing the emissions from the sector below the sectoral crediting line. However, distributing the C benefits to the provider remains a challenging task, unless the adoption of mitigation actions is monitored and quantified. Apart from performance criteria, equity issues as well as operational and transaction costs will define potential C revenue distribution mechanisms.

Draft legislation for the United States cap and trade system accepts the eligibility of non-sectoral international offsets for a certain period, after which only sectoral approaches will be eligible for the country's C market. However, the draft bill specifies that sectoral credits would only be eligible if they derive from countries and sectors (i) that would be capped if they were in the United States; and (ii) where the country adopts domestically enforceable sectoral baselines that keep sectoral emissions below the business-as-usual scenario (EDF, 2009). Rangelands are not likely to be a capped sector in the United States, and few countries are likely to have strong incentives to identify the rangeland sector as suitable for setting a sectoral target. Thus, while the draft United States bill and the international discussions regarding sectoral crediting mechanisms are far from set in stone, this gives an indication that demand for sectoral emission reduction credits from the rangeland sector is not likely to be strong.

CONCLUSIONS

Potential for carbon finance in rangelands

Interest in the potential for C finance in rangelands is growing. In addition to its mitigation potential, there is strong interest in the co-benefits of C sequestrating practices for livestock productivity and livelihood development, and also for synergies between mitigation practices and adaptation needs. Several management practices have been shown to sequester C in a variety of contexts around the world. Rangelands are often in large contiguous areas, indicating potentially large C assets per household, and providing the opportunity for aggregating C assets across large numbers of smallholders.

The critical constraint on the development of rangeland C finance as a whole is its exclusion from the CDM and most other compliance markets. In the short term, the voluntary market is the only option for developing rangeland C finance projects. Projects are most likely to be developed where:

- land users have clear legal rights over rangelands;
- there is solid scientific documentation of the C sequestration impacts of management practices;
- adoption of these practices is in line with national sustainable development priorities and adaptation plans;

- institutions involved have the capacity to develop projects in accordance with common C finance standards, are able to market the credits and support implementation.

Rangeland C finance is still in its very early stages. There are some existing pilot projects. Together with experiences in other AFOLU sectors, these can provide some guidance for further development of C finance approaches in rangelands. Pilot projects will be essential to developing approved methodologies and building capacities for further replication. Improved documentation of the costs and benefits of adopting C sequestrating management practices in rangelands will be essential to identifying potential areas and activities for early pilot action.

Project, programmatic and sectoral approaches

Project approaches are likely to be the main vehicle for supporting mitigation actions in rangeland areas in the short and medium term. In some contexts, development of early pilot projects in rangelands will provide a stepping stone towards the development of programmatic approaches at the regional (subnational) level. Pilot projects will provide essential experience and data for calibration of remote sensing-based regional accounting methods. Upscaling to regional and programmatic approaches requires strong institutional capacities and, in many countries, project approaches will probably remain the main approach in most countries in the long term. The critical gap to overcome for developing regional and programmatic approaches is the development of methods for characterizing robust regional baselines. Methods for developing regional baselines for rangelands can draw on experiences from other AFOLU sectors, especially REDD baseline methods and methods applied to estimating regional C budgets in the agriculture sector. In many countries, the lack of data on historical and current management activities will preclude the development of regional baselines, and baselines developed to account for emission reductions on a project-by-project basis will be the only option. In addition to supply-side constraints, there is not likely to be strong demand for sectoral credits from the rangeland sector in most countries.

Although their precise legal nature, forms of support and means for MRV have yet to be agreed, NAMAs provide a possible framework for integrating mitigation activities funded initially from public and – as MRV systems evolve – from private sources to provide C offsets. Domestic sources and international financial support can be integrated. As the level of international involvement in the financing of mitigation actions increases, the requirement for stringent MRV can be expected to increase.

While there is growing documentation of the C sequestration impacts of different management activities, there is very little documentation of the economic costs and socio-economic feasibility of adopting C sequestrating practices in most rangeland settings. It is quite likely that some mitigation practices will not be cost-effective in the context of mitigation programmes because of low returns, high transaction costs or high risks (FAO, 2009). Some low-return rangeland mitigation options have great rural development and adaptation benefits that justify tapping into other funding mechanisms to support their implementation.

Priorities for the foreseeable future include the following.

- Initiating pilot projects, which will be essential to understanding constraints to the execution in the rangelands, and to developing capacities for implementation.
- Increased documentation of the economics of adopting mitigation practices in rangelands, including the development of marginal abatement cost curves that cover the rangeland sector.
- Development of methods for characterizing regional baselines in the rangeland sector.
- Scientists and policy-makers concerned with rangeland C finance should pay attention to ongoing and future progress in the development of methodologies and sectoral accounting methods for REDD, and seek opportunities for linking sectoral accounting methods with methods that cover all terrestrial C pools.

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