CARBON IN THE NORTHERN TERRITORY

Territory Natural Resource Management

VISION

"Territorians working together to manage our environment's natural, cultural and economic values for the benefit of all."

FOR MORE INFORMATION

This publication is available on request through contacting info@territorynrm.org.au

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Enquiries should be made to:
Territory Natural Resource Management
Level 1, 16 Bennett Street Darwin NT 0800
GPO Box 2775 Darwin NT 0801
T 08 8942 8300 | F 08 8999 4100
info@territory.nrm.org.au

Territory Natural Resource Management

Australian Government

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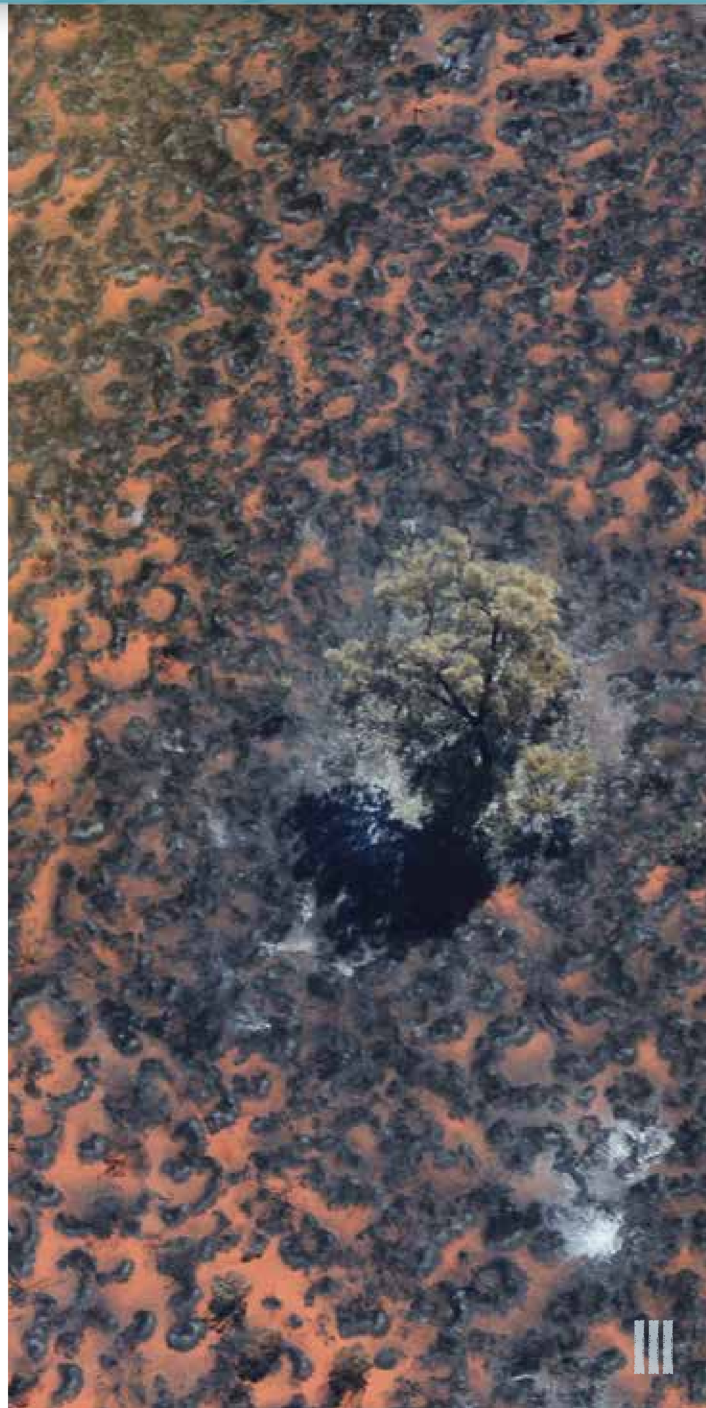


CARBON IN THE NORTHERN TERRITORY

The increase in concentration of greenhouse gasses (GHG) in our atmosphere is threatening both human and ecological systems. Reducing global emissions has been the topic of ongoing international debate, agreement and action. A number of gasses are responsible for global warming with water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) being the most prevalent. Each of these gasses occur naturally in our atmosphere but at elevated levels can cause extreme changes to the Earth's climate. The last century has seen a dramatic increase in GHG levels in our atmosphere, driven primarily by an increasing use and dependence on fossil fuels, and exacerbated by large scale habitat clearing. The consequences of increasing GHG include rising oceans, a warming planet, species extinction and an increase in extreme weather events such as severe storms, droughts and widespread flooding.

In a bid to manage and potentially mitigate the worst of these expected outcomes, a number of global strategies (such as the Kyoto Protocol) have been proposed to reduce GHG output. Governments around the world have undertaken both individual and collective action to reduce GHG emissions. Most recently this has led to the development of the Paris Agreement. In late 2015, 195 countries operating under the United Nations Framework Convention on Climate Change (UNFCCC), reached agreement on the international commitments to GHG emissions mitigation, adaptation and finance.

Under the Kyoto protocol and the Paris Agreement, Australia has made commitments to progressively reduce GHG emissions. This led to the creation of the Carbon Farming Initiative (CFI), which enabled farmers and land managers to generate Australian Carbon Credit Units (ACCUs) for sale into the carbon market. More recently, changes in policy to the Emissions Reduction Fund (ERF), means that the ability to generate ACCUs has been expanded to cover all sectors of the economy, providing much greater competition for land managers looking to benefit through participation in carbon markets. The commitments, legislation and regulation of the generation and sale of carbon credits collectively establish the carbon market.

The purpose of this booklet is to advise Territory land managers about the potential for and suitability of land management activities across different land-use sectors and regions, to generate an ACCU for sale into the carbon market.

Generating an Australian Carbon Credit Unit

Greenhouse gasses occur naturally in our atmosphere and ecological systems, playing an important role in sustaining life. We know that many activities are able to change the amounts of GHG's and their elements, for example through storage in plants, soil and water (known as sequestration), or emitted through processes such as fire and animal digestion (known as emissions). Carbon dioxide is mainly released through burning fossil fuels, plant decay and insect and microbial activity in soils. Nitrous oxide is mainly released through soil disturbance, nitrogen fertilisers, urine and dung. Methane is mainly released from animals following digestion of plant matter.

It is possible to alter the amounts of GHG's that are either sequestered or emitted, however not all activities are eligible to generate an Australian Carbon Credit Unit (ACCU). The ability to generate an ACCU through undertaking an activity to increase GHG sequestration or reduce GHG emissions is determined by a set of rules called a project method. The Australian Government has approved a number of methods to generate an ACCU and regularly releases new and improved methods for use. From a natural resources management perspective, the relevant methods can be separated into the following categories:

- Vegetation
- Farming
- Livestock
- Grazing land management
- Fire

MAIN PROJECT ACTIVITIES

EMISSIONS REDUCTIONS

- Savanna Fire Management
- Reducing Livestock Methane Emissions
- Manure Management

SEQUESTRATION

- Reforestation
- Revegetation
- Avoided Deforestation
- Soil Carbon
- Grazing Land Soil Carbon

POTENTIAL FUTURE OPPORTUNITIES

- Blue Carbon
- Restoring Rangelands

THE TERRITORY CONTEXT

Covering an area of about 1,365,000 km², the NT is comprised of wet-dry tropics, savanna and desert environments. Features of the NT landscape include:

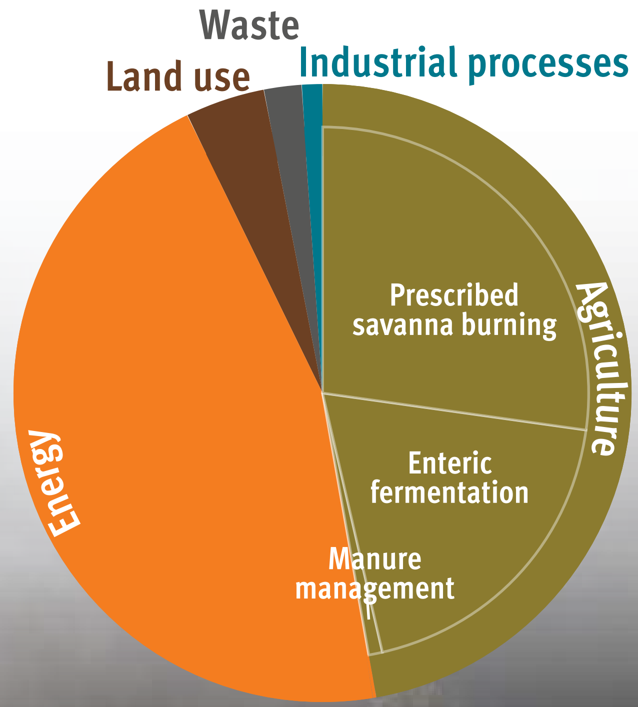
- High biodiversity
- Largely intact native vegetation
- Low rates of clearing
- Under threat from weeds, feral animals and destructive fire regimes.

The main GHG emissions from natural resources come from:

- Fire in savanna woodlands (over 1/3 of all Territory emissions).
- Livestock (about 17% of emissions, especially methane from enteric fermentation).
- Fertiliser (nitrous oxide).

Agriculture and the land sector generate over half (52%) of all Territory emissions, a much higher proportion than nationally, and Territory agriculture accounts for around 1.2 % of all Australian GHG emissions. There are around 300 cattle stations across the Territory raising approximately 2 million cattle and most are managed as extensive, large-scale, low cost operations. Cattle exports constitute the NT's most important agricultural industry, both by value and by land use. Cropping and horticultural industries are primarily restricted to small areas of the Top End and around the Katherine-Daly and though limited in extent, these industries have grown rapidly in recent years.

NORTHERN TERRITORY'S EMISSIONS

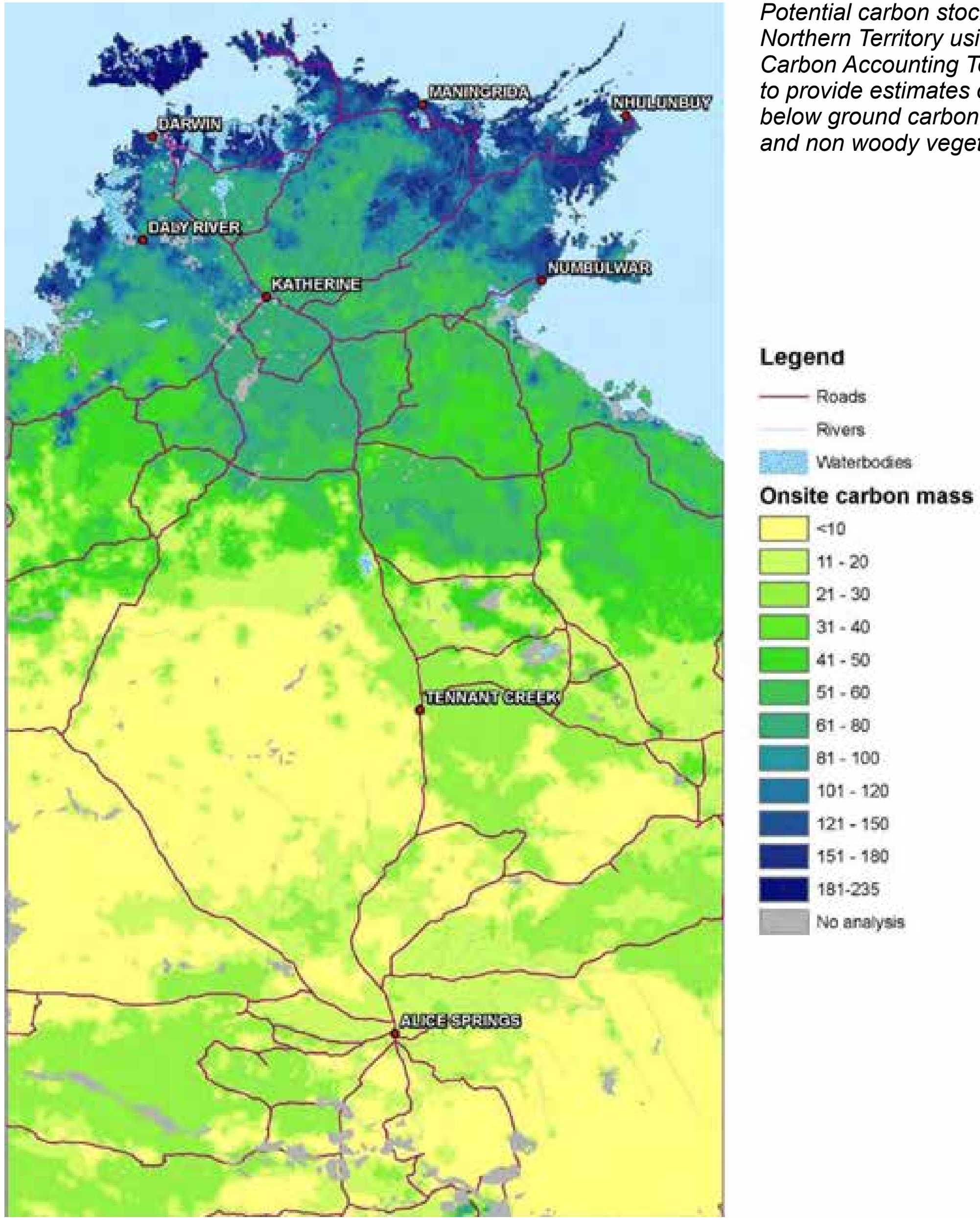


CARBON FARMING - OPPORTUNITIES AND LIMITATIONS

While the information presented here is intended as a general guide for landowners interested in taking part in an emissions reduction strategy, the extreme variation in the character of Territory landscapes (local climate, soil and vegetation types) means that these strategies are not a one size fits all approach. Opportunities for abatement and incentives for participation within the carbon market differ between areas, with some better suited to generate an ACCU, than others. Depending on the location of individual land areas and activities conducted, landowners may derive more benefit from alternative land management, livestock management or conservation initiatives.

Many Territory soils have relatively low carbon content and a limited potential for any increase. Soil carbon and carbon storage in vegetation and vegetal debris is generally highest in the northern Eucalyptus woodlands, monsoon forests, islands, coastal and riparian areas of the Top End. Lower levels of carbon are stored across the Gulf and Victoria River districts, while very little carbon is sequestered in the sandy soils and Spinifex grasslands of central Australia. In Top End tropical savannas, the largest proportion of this carbon is stored below ground in soil. Despite storing relatively small quantities of carbon per unit area, the vast extent of tropical savanna across the monsoon-influenced areas of the Territory has been characterised as a significant carbon 'sink'.

As emissions reduction methods are a new field of research, the current methodologies for many of the following activity areas are still under development. As the application of on-ground actions is a relatively specialised field, it is likely that many land managers would need to employ the services of a project manager to implement a project in the context of the Emissions Reduction Fund and would therefore need to factor this cost into planning decisions.



Potential carbon stocks in the Northern Territory using the National Carbon Accounting Tool (NCAT) to provide estimates of above and below ground carbon stores in woody and non woody vegetation.

SAVANNA FIRE MANAGEMENT

Tropical savannas extend across a 1.9 million km^2 area of northern Australia and correlate with the region influenced by seasonal monsoon. They are complex systems influenced by the interactions of many factors including rainfall, grazing and fire. Consisting of woodland habitat with a grassy understory, their soils are highly weathered, leached and contain low levels of nutrients, and are generally unsuited for broad-acre agriculture. They are mainly used for livestock grazing, although extensive areas of Indigenous lands and conservation reserves means the landscape has remained largely intact.

FIRE AND GHG

Low intensity fires are an integral part of the savanna nutrient cycle as well as the life cycle of many plants. Fire occurrence is related to seasonal accumulation of organic matter and can be brought about by human or natural causes. GHG emissions from higher intensity late dry season fires are much greater than those from low intensity early dry season fires. Changing land management practices over recent decades has led to increasingly severe fires that release levels of CO_2, methane and nitrous oxide equal to approximately 3% of national GHG emissions, and over a third of Territory emissions. The proportion of emissions increases with fire intensity and is influenced by fuel type.

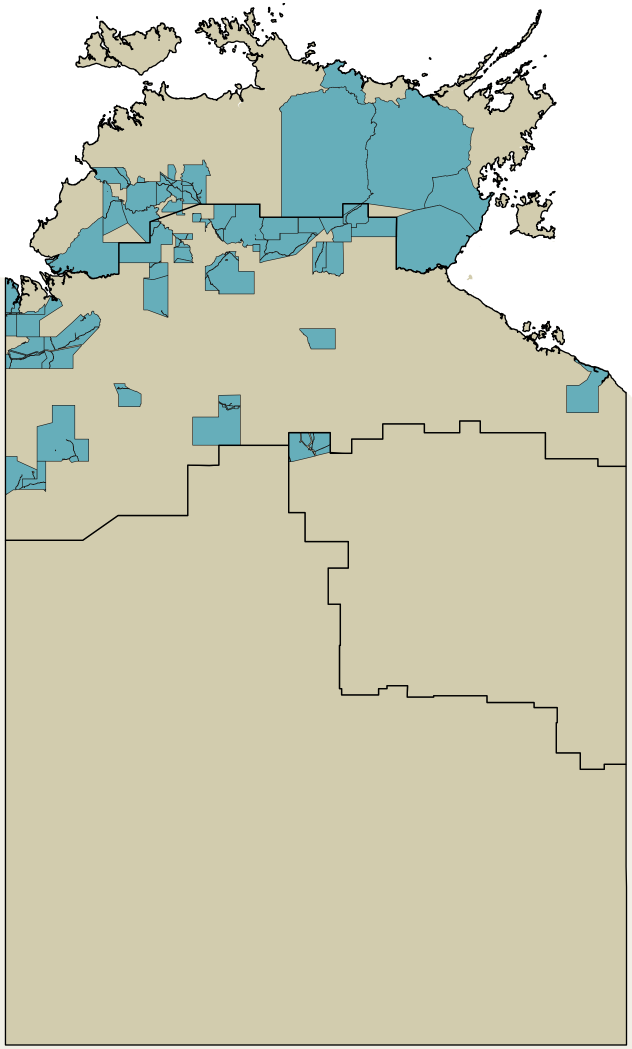
CURRENT ACTIVITY

Activities to reduce emissions through managing savanna fires are by far and away the most common projects currently being undertaken in the NT. A number of methods have been developed and refined over the preceding years. The current method for generating Australian Carbon Credit Units through a savanna burning project is the Emissions Abatement through Savanna Fire Management method.

Under this method, land managers will need to consider some or all of the following strategies to reduce fire intensity so that less area is burnt by late dry season fires. Land managers can do this by:

- implementing an early dry season fire regime to reduce fuel loads
- reducing the total area of land burnt
- establishing firebreaks or reinforcing natural barriers to contain the spread of severe fires.

Registered savanna burning carbon projects in NT as of 17 May 2016



REQUIRED ACTIONS

1. Develop detailed vegetation maps of proposed project areas, identifying vegetation types and distributions
2. Calculate baseline emissions from historical fire activities using satellite imagery of fire scars in combination with data on fuel loads and burning efficiency over a 10 year period for the high rainfall zone and a 15 year period for the low rainfall zone
3. Begin fire management activities, the resulting impacts of which are calculated and compared with baseline emissions
4. Record fuel used to deliver the project activities
5. Make a declaration that stock numbers are maintained (not increased) in the project area after the project activities.

The specific detail of fire plans including the location, timing and logistics of burning activities will need to be carefully designed, taking account of landscape attributes and vegetation types as well as local weather conditions. Reducing the area of land burnt annually and implementing long term protection of some key sites from fire (patching the landscape with burnt and unburnt areas) probably constitute the most ecologically benign management strategy.

International GHG accounting guidelines assume that CO_2 produced by dry season savanna burning is re-absorbed by plant growth the following wet season therefore only nitrous oxide and methane emissions are accountable in GHG inventories. The emissions reductions resulting from undertaking a project can be calculated manually or determined using the Australian Government's Cabon Farming Initiative (SavBAT 2). Calculations account for variations in vegetation fuel types, fire seasons, fuel loads and regional rainfall with project areas classified as either a low rainfall zone (between 600mm and 1000mm) or a high rainfall zone (greater than 1000mm).

BENEFITS

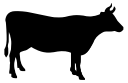
Research has shown the potential for northern savanna fire management to achieve significant emissions reductions, thereby creating economic benefits through the production and sale of carbon credits as well as biodiversity and cultural benefits.

The restoration of managed fire regimes across sparsely populated regions will generate livelihood opportunities on traditional Indigenous lands and assist in the economic revival of the outstations. Indigenous communities are well-placed to participate in and benefit from savanna burning, notably through their ownership of lands, ecological knowledge and demographic distribution across the Top End. Economic opportunities around fire management align well with Indigenous cultural responsibilities to care for country, and will lead to traditional ecological knowledge and other aspects of culture being more highly valued.

RISKS AND LIMITATIONS

Although fire is an important tool in maintaining savanna health, adverse fire regimes can significantly damage savanna biodiversity. Outcomes other than emissions reductions need to be considered in project design to prevent adverse impacts on ecological, economic and cultural values. High burning frequencies can cause a change in the structure and composition of savanna vegetation, with consequential changes in fauna. Also, the current savanna burning methodology is only applicable to areas receiving over 600mm annual precipitation.

REDUCING LIVESTOCK METHANE EMISSIONS



Livestock is the Territory's most valuable primary industry and the NT beef herd has gradually grown over recent decades in response to strong demand from local and international markets as well as productivity improvements. Latest figures put the Territory herd at over 2 million which constitutes about 7% of the total Australian herd, and nearly half of all Territory cattle are concentrated in the Victoria River District

LIVESTOCK AND GHG

Like all ruminants, cattle produce methane through a digestive process known as enteric fermentation. They also produce small amounts of nitrous oxide (N_2O) through manure and urine. The amount of methane produced is related to the quality and digestibility of their forage diet. As tropical pastures provide a poorly digestible food source, northern beef cattle under extensive grazing produce higher per animal emissions than from southern grazing or feedlot systems. Annually, the NT beef herd produces an approximate average of 1.8 t/CO_2-e per Animal Equivalent. These methane emissions have steadily increased since 1990 and now constitute the third largest source of GHG in the Territory, with the northern beef industry accounting for approximately 4.5% of Australia's total GHG emissions.

CURRENT ACTIVITY

As yet, there are no projects registered in the NT exclusively, however there are projects registered nationally that include parts of the NT beef herd. The most immediate potential comes from increasing production efficiency by modifying herd management and stocking rates, as well as enhancing health and nutrition with options like selective breeding becoming more important in the medium term. Many strategies to enhance productive efficiency will invariably raise production costs, requiring investment in new technologies, training and an intensification of management, though these costs may be offset by improved efficiencies. Two methods are currently approved for use with cattle herd management:

- Beef cattle herd management.
- Reducing greenhouse gas emissions by feeding nitrate containing supplements to beef cattle.

REQUIRED ACTIONS

Beef Cattle Herd Management

Under the beef cattle herd management method, producers can undertake a range of activities that reduce emissions from a herd of cattle that are ordinarily grazed together by:

- Increasing the ratio of weight to age of the herd
- Reducing the average age of the herd
- Reducing the proportion of unproductive animals in the herd or
- Changing the ratio of livestock classes within the herd to increase total annual liveweight gain of the herd.

Research indicates that Central Australian producers are achieving lower emissions than those further north, suggesting an opportunity to reduce GHG in the latter region. Across the NT each animal in the paddock produces about 200 grams of methane daily although this amount varies by region. By growing a steer and turning it off for market more quickly, or by increasing the calving frequency of cows, more kilograms of beef may be produced per kilogram of methane emitted. However, selling animals at lower liveweight necessitates a larger herd and possibly increased emissions, to produce the same quantity of beef. It is therefore important to calculate the optimum turnoff age, herd size and structure to minimise overall herd emissions. These factors will vary according to regional production conditions, systems and markets.

Improving weaning rates through feed supplementation, improved animal health and removal of unproductive cows from the herd would also reduce emissions. It has been estimated that a 10% increase in weaning rates in low performance cattle grazing systems would reduce CO_2-e emissions by 2kg for every kg of live weight gain. Improving breeder herd performance may also improve enterprise profitability.

Reducing greenhouse gas emissions by feeding nitrates to beef cattle

Diet directly influences methane emissions of cattle and often, particularly in the northern beef herd, our pastures are low in protein and digestibility. This means that some cattle, particularly those raised on northern pastures, have higher emissions due to a low quality diet. Using feed supplementation to increase digestibility may be an option especially as some feed supplements are known to directly inhibit the production of methane (e.g. oilseeds or legumes). From a logistical and economic point of view, this solution would not always be practical considering the extent of many NT pastoral properties, but there may be opportunities for providing supplements to cattle through water supplies or lick blocks and in some cases pastoralists already use urea lick blocks to increase the amount of nitrogen that stomach bacteria can convert to protein, therefore improving weight gain and productivity.

Under this method, land managers have the opportunity to replace the urea lick blocks with nitrate blocks which will reduce the amount of enteric methane produced by the cattle for the same feed intake, and therefore reduce greenhouse gas emissions.

BENEFITS

Improvements to production efficiency may also lead to increased enterprise profitability, with the opportunity to generate and sell ACCUs providing an additional mechanism for covering the costs of achieving increased productivity.

RISKS AND LIMITATIONS

The size of the herd will impact on the number of ACCUs that may be generated and therefore the cost effectiveness of undertaking a project of this type. The cost of undertaking the management changes required (such as purchase of supplements) may mean that the method is only applicable to large herd sizes. Additionally, the cost of undertaking some changes may outweigh the return from the sale of ACCUs. Both methods rely on baselines being set on existing management regimes and information, so good record keeping is necessary. This means there is limited applicability in situations where people are already undertaking intensive or advanced herd management practices, and the use of nitrate supplements requires that land managers were previously using urea based supplements (at least once in the last 5 years).

MANURE MANAGEMENT

Intensive animal production industries such as dairy operations and commercial piggeries, often lead to the need for waste evaporation basins or ponds to dispose of excess manure. Traditionally these ponds break down releasing methane into the atmosphere. There are a number of methods available for dealing with this waste in a way that reduces greenhouse gas emissions. The most common technique is to cover the manure ponds with an impermeable membrane, trapping the methane so it can be piped and used for electricity generation, heat production or simply burnt or 'flared off'.

REQUIRED ACTIONS

The required actions are different for each of the three methods that currently target piggeries or dairy operations, however all methods involve the capture of methane (through the installation of bio digesters, new ponds or covers on existing ponds) before converting it to CO_2 by using flares or burning it for heat or energy production.

BENEFITS

Methane has a global warming potential of 21 times that of carbon dioxide, so the conversion of methane to carbon dioxide provides a significant reduction on GHG emissions. The energy or heat provided can be used to replace on-grid consumption and reduce power bills throughout the operation, therefore reducing input costs for intensive practices.

RISKS AND LIMITATIONS

While this opportunity is available it has not yet been applied in the NT due to there being very little intensive animal husbandry such as dairy or commercial pig production.

FOREST MANAGEMENT

Around 23% of the Territory land area is designated as native forest and includes rainforests, vine thickets, closed forests, woodlands and coastal mangroves. In addition to other ecological functions, these areas are thought to constitute a net carbon sink. A relatively intact habitat, Territory forests and savanna woodlands have been subject to minimal widespread clearing, and it is mostly concentrated in select areas (namely the Katherine-Daly region). It is important to note that a forest is defined as an area of land greater than 0.2Ha, with vegetation able to achieve greater than 2m in height with a canopy cover of greater than 20%.

The NT's plantation history is relatively short and is mainly confined to developments on Melville Island (Acacia mangium) and Douglas Daly (African mahogany). However, there has been little change in the area under pine plantation.

FORESTRY AND GHG

Land clearing and deforestation emits GHG through burning, decomposition of unburnt vegetation and soil disturbance. Native savanna woodland clearing in the Top End emits between about 50-240 tonnes CO_2-e per hectare, depending on the location of the area cleared and the vegetation type. As of 2013 land use, land use change and forestry contributed about 7.5 % of total Territory GHG emissions. Reforestation of cleared native savanna woodlands results in very slow recovery of the emitted carbon. Therefore, from an abatement perspective, it is far better to retain mature savanna woodlands than to reforest an equal area.

CURRENT ACTIVITY

There are currently no vegetation or forest projects registered in the NT, however this segment is by far the largest generator of credits across Australia. There are 8 vegetation / forest methods available for use to generate credits, however not all are applicable for use in the NT. Prospective project developers can utilise an Australian Government 'decision tree' to assist in determining the suitability of the individual method and project types. Broadly speaking these methods cover activities across four main areas:

- Afforestation (establishing a forest on land where a forest did not previously exist)
- Reforestation (establishing a forest on cleared land)
- Revegetation, or
- Protecting native forest or vegetation that is at imminent risk of clearing

REQUIRED ACTIONS

The specific activities required are dependent on the project type and the method being used to generate the ACCU. Within the range of methods, a number of possible strategies could be employed:

- Integrating livestock enterprise and forestry
- Establishing plantations on previously cleared pastoral or agricultural properties in small blocks, alleys or windbreaks complementary to more usual land management
- Integrating trees in northern pasture or crop lands to improve water and soil function and enhance pasture production and sustainability.

Territory landholders undertaking a forestry project must first define which methodology will be used by checking that they meet the project eligibility criteria and can address any special conditions required. Once the project type and methodology has been identified, the process includes the following stages; site mapping and evaluation to establish a baseline scenario, identifying possible risk factors and developing a project plan including a site management plan. After any relevant land preparations such as exclusion fencing or weed management, activities such as tree planting or protection will occur. Ongoing land management may be required, including post-planting management, pest control, irrigation, management of competing vegetation, monitoring forest health, managing fire risks and collecting data.

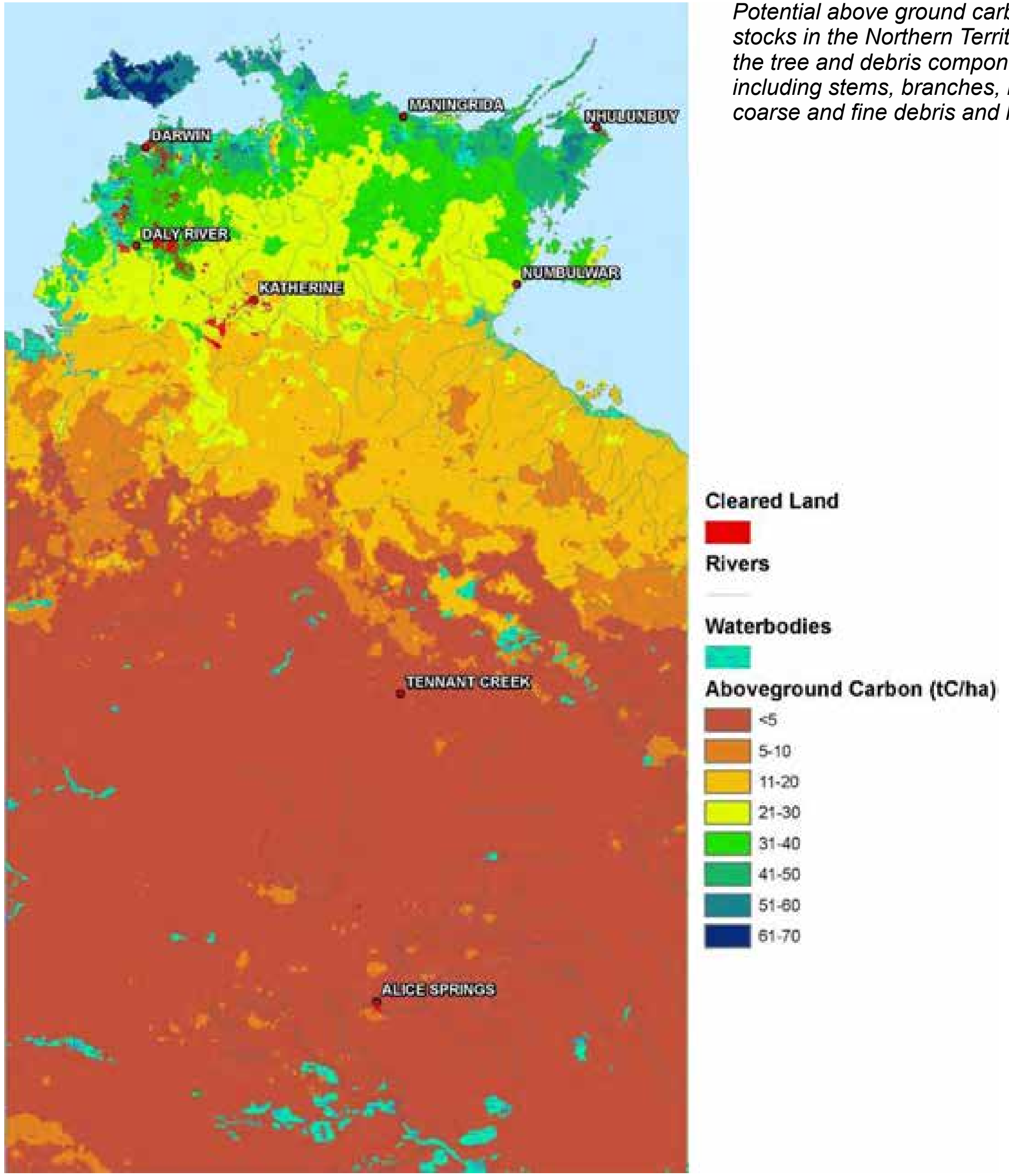
Overall, more productive land systems in high rainfall zones will have greater carbon forestry potential than arid lands, and more intensive plantation forestry will achieve higher offsets than environmental plantings.

BENEFITS

New plantings – notably of native species - and the re-establishment of forests and woodlands offer one of the easiest ways for land managers to offset GHG emissions as the amount of carbon sequestered is measurable and verifiable. The establishment of forest plantations and retention of regrowth, (especially environmental plantings of native species) also offers important biodiversity benefits. Stands of vegetation, even non-native, may provide habitat to wildlife as well as improving connectivity between other areas of native woodlands and habitat.

RISKS AND LIMITATIONS

Depending on the character of the region and the history of land use, certain methods will have limited application. The risk of losing forested areas to bushfire or drought could diminish returns over the long term. The 'Avoided Deforestation' approach also has limitations as it may be difficult for Territory landholders to demonstrate eligibility under the current permit system for land clearing.



Potential above ground carbon stocks in the Northern Territory of the tree and debris components, including stems, branches, leaves, coarse and fine debris and leaf litter.

SEQUESTERING CARBON IN SOIL GRAZING SYSTEMS

Soil is both a 'sink' and a 'source' of carbon. Sequestration occurs as plants capture CO_2 through photosynthesis, die and decay and deposit captured carbon onto or into the soil. This process is the key to increasing soil organic carbon, however while this occurs continuously, there is also a simultaneous process of decomposition and mineralisation which emits carbon back into the atmosphere. The amount of carbon stored in soil therefore reflects the balance between sequestration and emission rates and changing land management activities can therefore alter the rates of sequestration and emissions.

CARBON STORAGE AND GHG

There is a considerable body of scientific evidence and testing regarding soil carbon. It has been recognised as a major component of soil health for a long time and is known to have multiple productivity benefits. As a key soil nutrient there are many ways in which the level of soil carbon can be altered and the extent to which this occurs is dependent on the individual soil characteristics, climate and management actions undertaken, therefore it is difficult to outline specific activities that build soil carbon reliably across a range of environments. Multiple factors will vary from property to property and it is important for the land manager to choose the activities that best work for their business activities and natural resources. The land can be managed using a range of activities to build soil carbon including, but not limited to, converting cropland to permanent pasture, rejuvenating pastures or changing grazing patterns.

REQUIRED ACTIONS

To generate an ACCU through managing grazing land a project must meet the specific requirements of the Australian Government Method, Soil Carbon in Grazing Systems project. This method only applies to land that has been under permanent pasture or continuously cropped for at least the previous five years. The land manager can use a range of activities to increase the carbon store or reduce emissions including:

- converting from continuous cropping to pasture
- undertaking pasture cropping
- managing pasture by implementing or changing pasture irrigation, applying organic or synthetic fertiliser to pastures, or rejuvenating pastures, including by seeding
- managing grazing by changing stocking rates or altering the timing, duration, and intensity of grazing.

This list is not prescriptive and since the actual change in carbon needs to be measured directly, there is considerable scope for a variety of actions to be undertaken. The land manager must carefully consider what activities they wish to undertake and how they will fit within their current or desired cropping and grazing enterprises. A good understanding of their soils and how they may react to different management regimes will assist in implementing actions that lead to increases in soil carbon.

BENEFITS

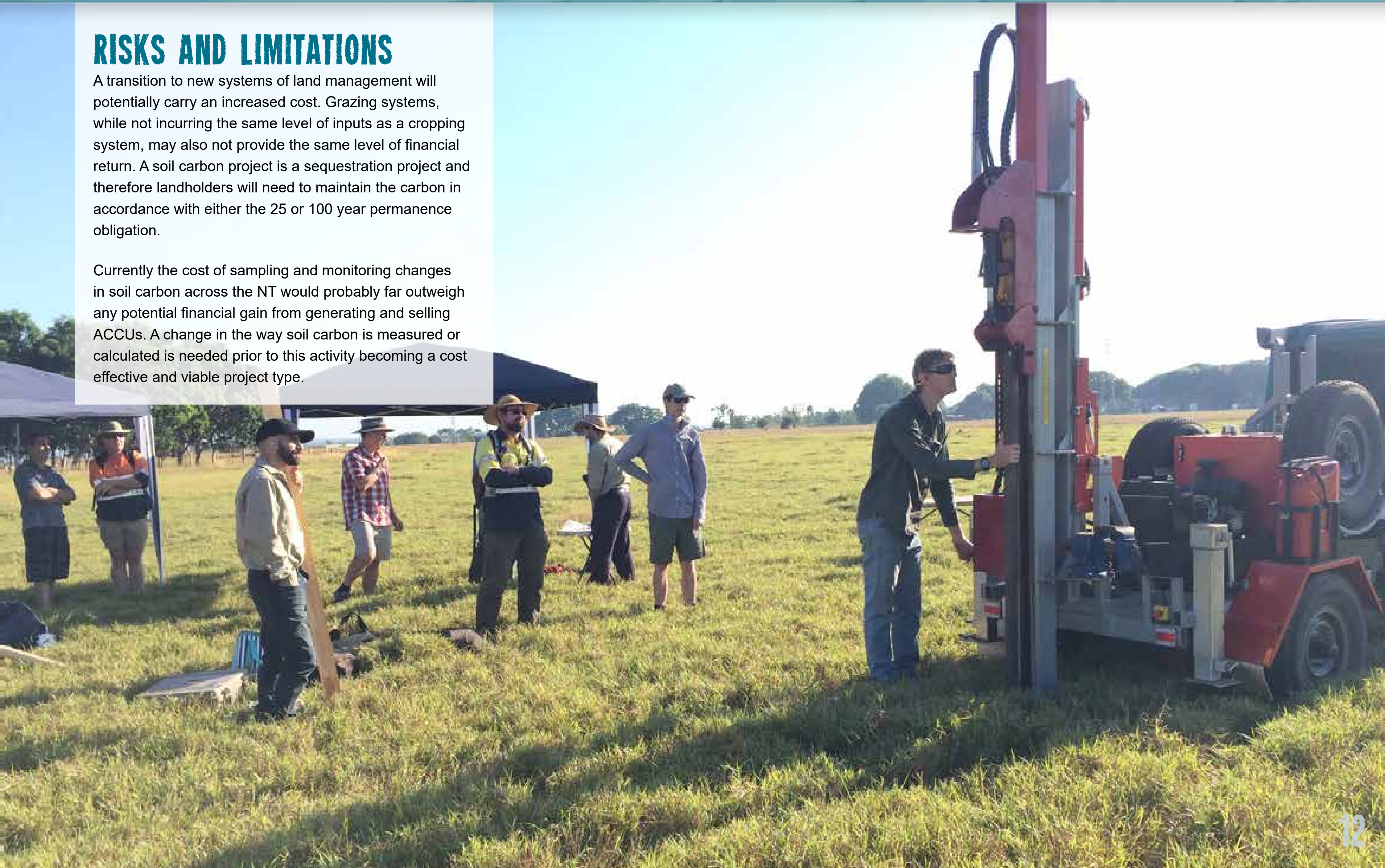
Australian soils are generally very low in organic carbon and there are multiple benefits available through increased soil organic carbon regardless of the capacity to generate an ACCU. The ability to generate ACCUs for sale may provide an income source that will enable land managers to make changes to their operations that make them more sustainable in the long term.

Soil organic carbon is important for the chemical, physical and biological components of soil and is the basis of soil fertility. Increased soil carbon increases the availability of nutrients for plant growth including nitrogen and phosphorus. It improves soil structure by holding the soil particles together as stable aggregates, which in turn improves soil physical properties such as water holding capacity, water infiltration, gaseous exchange and root growth. Soil organic carbon is a food source for soil fauna and flora and plays an important role in the soil food web by controlling the number and types of soil inhabitants which serve important functions, such as nutrient cycling and availability, assisting root growth and plant nutrient uptake, creating burrows and even suppressing crop diseases.

RISKS AND LIMITATIONS

A transition to new systems of land management will potentially carry an increased cost. Grazing systems, while not incurring the same level of inputs as a cropping system, may also not provide the same level of financial return. A soil carbon project is a sequestration project and therefore landholders will need to maintain the carbon in accordance with either the 25 or 100 year permanence obligation.

Currently the cost of sampling and monitoring changes in soil carbon across the NT would probably far outweigh any potential financial gain from generating and selling ACCUs. A change in the way soil carbon is measured or calculated is needed prior to this activity becoming a cost effective and viable project type.



SOIL CARBON SEQUESTRATION

As outlined previously, soil provides an important carbon storage, however under some management, it can act as a source of emissions. In crop agriculture, carbon accumulating in plant matter is harvested and removed from the soil and in 2013, emissions from agricultural soils accounted for approximately 1% of Territory GHG emissions.

CARBON STORAGE AND GHG

There has been growing interest around Australia in strategies to offset GHG emissions by increasing soil carbon storage on cropped lands and across the rangelands. Converting pristine lands to cropping tends to reduce the amount of soil organic carbon stored as well as depleting nitrogen. While many Australian soils have inherently low soil organic carbon, Territory soils have particularly low carbon content, with relatively low potential for increasing carbon content.

The most suitable soils for agriculture are in the Douglas-Katherine area as they have amongst the highest levels of carbon content in the Territory. Much of the Territory's cleared agricultural land is under improved pastures. Cropping occurs on a very small scale (36,664 ha) and is dominated by forage crops and hay production although some coarse grains and broad acre crops such as peanuts and mung beans are also grown. Horticulture is concentrated on small holdings in the Katherine and Darwin rural areas and main crops include mango, citrus, other irrigated orchard crops and Asian vegetables.

In many respects, field cropping is still in its infancy in the NT; most cropped lands have only recently been cleared for cultivation and in some cases the soil is still stabilising. There are no defined farming systems as yet and producers are still establishing the best farming techniques and crop combinations. Land managers face problems maintaining soil as they are of a poor quality and vulnerable to nutrient leaching during the monsoon season. Consequently, agricultural and horticultural production is heavily reliant on the application of artificial fertilisers - especially nitrogen based fertilisers. These fertiliser regimes may be highly inefficient and over 50% of urea and potassium nitrate can be lost as N_20 in warm, wet soil conditions.

Farming techniques intended to better conserve soil organic material and nutrients are generally labelled as 'conservation farming' and encompass a range of actions applicable to the NT. These could deliver a distinct range of benefits to Territory growers; reducing the loss of Top End soil through water erosion, increasing soil fertility and moisture retention and reducing some farm labour and machinery costs.

REQUIRED ACTIONS

A number of activities are known to increase soil carbon. These include utilising conservation farming techniques through implementing minimum or zero tillage. This is a farming system in which crops are established without disturbing the soil through ploughing. However, sandy soils in drier regions appear less responsive to changes in tillage and residue management, so the technique would have less application in Central Australia. 'No till' agriculture utilises heavy mulch cover to suppress weed growth and help insulate and protect the soil, retaining nutrients and carbon. Rates of about 3 tonnes/hectare have been recommended for the Top End environment.

A second underlying principle of conservation farming is to enhance soil carbon through cover crops and rotation. Crops which typically produce little biomass (e.g. sesame, mung bean, peanuts), should ideally be rotated with high mulch crops (e.g. sorghum) to increase surface cover. The practice of fallowing land to restore soil moisture, nitrogen and reduce weeds can exacerbate soil carbon losses as leaving land bare creates favourable conditions for decomposition and soil erosion. Conversely, ensuring that land always remains under crop reduces erosion risks and continues sequestration of atmospheric carbon into the soil. 'Cover crops' are grown quickly, specifically for the purpose of protecting the soil and providing mulch.

To be eligible to use the current Australian Government approved method 'Estimating sequestration of carbon in soil using default values (model-based soil carbon)', a land manager can undertake activities for:

- Sustainable intensification of cropping systems (including nutrient management, soil acidity management, new irrigation and/or pasture renovation)
- Stubble retention
- Conversion of cropping land to permanent pasture.

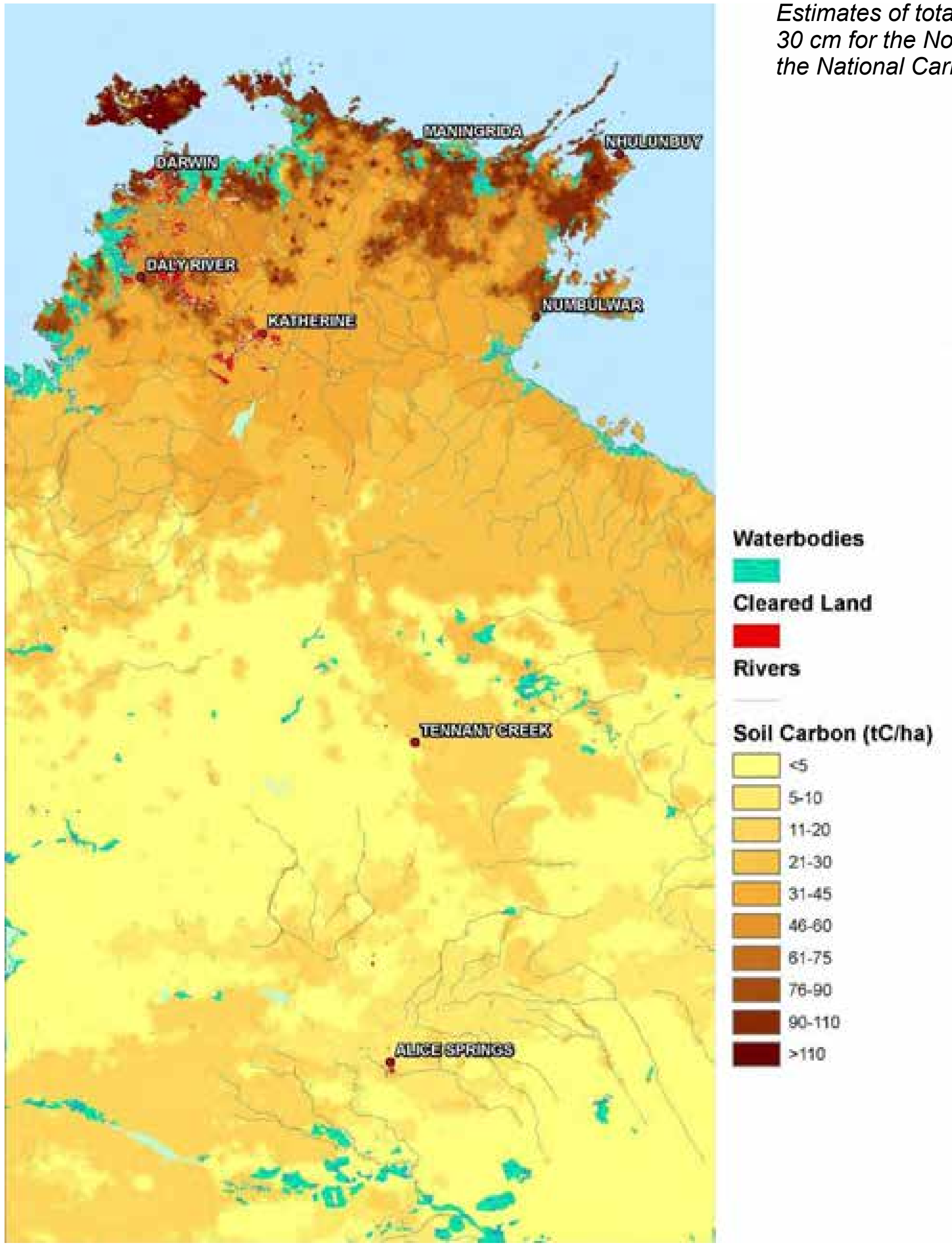
BENEFITS

Crop rotation can improve soil structure and fertility. In rotations, substituting legume pastures for field crops has a high potential to fix nitrogen and restore soil nutrients, reducing the need for nitrogenous fertilisers and avoiding N_2O emissions. Seasonal erosion and soil loss from monsoonal rains can be mitigated through physical structures such as contour banking to reduce runoff. These can be vegetated with hedgerows to help bind soil and contribute to sequestration of carbon. Conservation agriculture also requires managing land for fire or grazing as these factors can strip soils of protective mulch, exposing it to erosion.

New soil management techniques may substantially improve fertiliser use efficiency. Incorporating legumes into a crop rotation can reduce the quantity of additional fertilisers required and enhanced efficiency fertilisers can reduce GHG emissions by up to 65%. New fertiliser management regimes are expected to deliver healthier root systems and improved crop yields but would cost more than current methods, requiring greater investment and additional management. Adopting a conservation farming method in combination with improved fertiliser management can deliver a more efficient, sustainable and productive farming system along with carbon abatement.

RISKS AND LIMITATIONS

A transition to new systems of land management will invariably carry additional costs and increased labour inputs, at least initially until the benefits of the new system are achieved. In the southern part of the Territory, soils are generally sandy, carbon and nutrient deficient, and subject to erosion. Rainfall is low, vegetation is sparse and degraded soils have limited capacity to retain moisture. Soils are more heterogeneous across the Top End and Gulf Savanna regions. However, most of them are highly erodible and subject to leaching and weathering. Like desert soils, these have relatively low natural fertility.



Estimates of total soil carbon down to 30 cm for the Northern Territory using the National Carbon Accounting Tool

BLUE CARBON

'Blue Carbon' refers to carbon sequestered and stored in coastal habitats including wetlands, tidal salt marshes, seagrass meadows, mangroves, kelp forests and coral reefs. These highly productive ecosystems serve a range of important ecological functions; supporting marine and terrestrial species, retaining shorelines and enhancing water quality. The potential for carbon sequestration and storage in coastal environments may be greater than the most productive of terrestrial environments. This is of particular note in northern Australia where terrestrial landscapes hold relatively poor sequestration potential.

BLUE CARBON AND GHG

Coastal ecosystems store carbon in living biomass and soil carbon. As intact coastal ecosystems have largely mature vegetation that maintains a steady biomass, most sequestered carbon finds its way into the soil carbon pool. Although the total area of coastal habitats is comparatively small, carbon storage per hectare is typically three to five times more than that stored in tropical forests. Saltmarsh and mangrove habitats sequester between 6-8 tonnes CO_2-e per hectare per year, while seagrass habitat sequesters around 4 tonnes CO_2-e per hectare per year. An estimated 440,000 ha of mangroves extend along approximately 4,600 km of Territory coastline. Due to low population density the vast majority of this has been little impacted by human development and NT mangroves are considered among the most pristine in Australia and possibly the world. The majority of the NT coastline is under the ownership and active management of Aboriginal Traditional Owners.

BENEFITS

While coastal mangrove forests could be protected through the international United Nations' Reducing Emissions from Deforestation and forest Degradation (REDD) initiative, it is presently unclear whether other types of coastal habitat could be included. There is a growing international interest in developing market-based mechanisms to support blue carbon management projects and finance the protection of high value coastal habitats. One future opportunity may be to create economic incentives for the sustainable management and protection of coastal carbon stocks.

In northern Australia this opportunity would be available primarily to Indigenous communities, and income from offsets achieved could be utilised to provide livelihood support as well as to build local capacity for ongoing coastal management.

RISKS AND LIMITATIONS

There is currently no method in Australia for achieving carbon offsets through management and protection of blue carbon resources. One critical obstacle to developing a method is the underlying premise that in the absence of a project, carbon stocks would otherwise be lost through some form of change in land use or condition. The current situation in the Territory is that there is little imminent threat of coastal habitat being disturbed or lost. For Aboriginal and pastoral landholders who have stewardship over large tracts of terrestrial savanna which constitute major stores of carbon, there is no basis for a claim for offsets. Any future blue carbon stewardship program in Australia would probably need to be developed on a different basis that may include the concept of biodiversity crediting. Many people have been looking at establishing a 'biodiversity market' to recognise the value of providing ecosystem services beyond greenhouse gasses.

POTENTIAL FUTURE ACTIVITIES

CARBON GRAZING ON SEMI-ARID RANGELANDS

Territory rangelands are diverse and extend from the arid Central Australian ranges to the northern tropical savannas. More than half of the Territory land area is utilised primarily for grazing and in arid and semi-arid areas, the condition of rangeland vegetation varies according to environmental conditions, its palatability to livestock and land management history.

GRAZING AND GHG

Many Territory rangelands have been degraded by overgrazing and require restoration. Evidence shows that improved rangeland management can increase carbon sequestration and storage in soil and vegetation while abating GHG emissions from other sources. While there may only be marginal capacity to sequester carbon in rangelands, the low opportunity costs (in some areas) and vast expanses, together with the potential for significant co-benefits has stimulated considerable research interest.

REQUIRED ACTIONS

There has been considerable work to develop a rangelands method in the past, however this has not been able to deliver a method that provides significant opportunity for land managers with the scientific certainty that real abatement is being delivered. Considerable further work is required prior to this becoming an effective way to generate ACCUs.

Although the methods needed to implement and measure emissions reductions have not been developed, the underlying premise of rangelands abatement is simple: the amount of carbon in rangelands soil and vegetation - and the rate of its release- can potentially be modified through land management actions (e.g. grazing and burning). Due to the variable nature of arid and semi-arid environments, as well as the different ways that factors such as rainfall, soil type and vegetation interact, it is likely that a multi-faceted approach will be most effective in reducing GHG emissions. This could potentially involve a range of strategies such as:

- Carbon sequestration through woody regrowth
- Land rehabilitation to increase soil carbon
- Improving water capture and storage on rangelands
- Reducing fire emissions through controlled burning and weed management
- Reduce methane emissions through livestock and forage management
- Stock management (changing stocking rates and managing grazing pressure)
- Improving herd production efficiency
- Management of invasive species (weeds and feral animals)

Mapping a project area and the resource conditions existing within it (vegetation, soils etc...) is a crucial first step in creating a methodology. It will then be necessary to establish a ‘baseline’ which sets out the course of events likely to occur within this defined area, were the project not to be implemented. Satellite imagery for vegetation mapping supported with field data collection, fire scar maps, corporate records or other evidence of land use practices will be used to populate a model and predict a baseline scenario for the duration of the project (100 years). Predictions would regularly be compared against data from field measurements.

Optimal economic outcomes may be achieved by fully destocking some parts of a property, moderate or light destocking of other parts and potentially no change in management elsewhere. Managing fire regimes -even in arid Central Australia- can also enhance storage in carbon pools. Other management interventions may include land rehabilitation such as rills, banks and dams to enhance water retention and primary productivity on rangelands while retention of regrowth or even limited reforestation may be appropriate in some areas.

BENEFITS

The potential to achieve offsets appears to be linked to landscape attributes; soils, vegetation types, rainfall and land condition. Managing land for carbon offsets may be a valuable opportunity for property managers who have unused and degraded areas on their properties which they wish to restore - particularly as the most degraded lands may be those with the best potential for restoration and sequestration of carbon. An informed abatement strategy would only focus management interventions (such as reducing stocking rates) on land systems of the highest potential, while maintaining productivity elsewhere on the property. Overall, intensified rangelands management combining stock and fire components has the potential to restore land condition, improve soil condition and increase the sustainability of pastoral operations. Careful monitoring is required however, as there is a risk of woody thickening negatively affecting the grassy understorey under a full destocking regime.

RISKS AND LIMITATIONS

While abatement through bio-sequestration on rangelands may appear attractive to Territory landholders - at least on some areas of their properties- there exist very high levels of uncertainty regarding the development and applicability of this activity. There is currently no formally approved methodology.

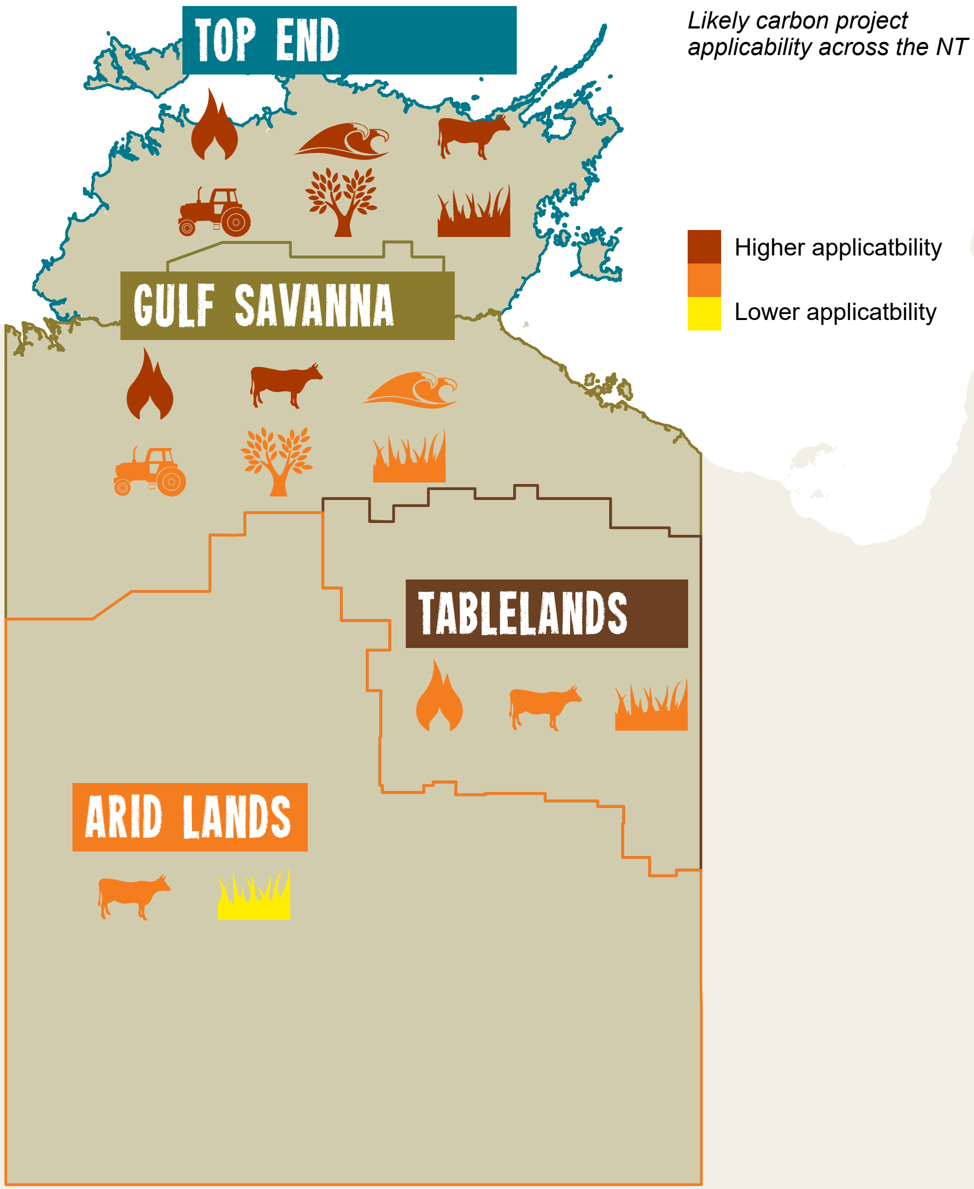
SUMMARY

The emerging carbon economy is a complicated and sometimes contentious area of NRM policy. The ability to generate an Australian Carbon Credit Unit (since the implementation of the Carbon Farming Initiative in September 2011) is of particular significance to the Northern Territory, where land and natural resource management activities predominate in many aspects of economic social and cultural life.

An overall review of the various carbon farming opportunities suggests that, in contrast to sequestration, emissions reductions do not require land managers to commit to 100 or 25 year standards for permanence and thus gives them greater flexibility in year-by-year decision making.

This summary booklet is intended to provide a succinct overview about GHG abatement opportunities across the Territory within the context of the Australian Government's carbon economy framework. The information provided here is a condensed version of a much broader analysis of available research and anyone seeking additional information about research or points of contact should contact Territory NRM. Additional information can also be found at the following web addresses;

- http://www.cleanenergyregulator.gov.au/ERF/Pages/default.aspx
- https://www.environment.gov.au/climate-change/emissions-reduction-fund/methods
- http://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register



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