CHAPTER 5

Towards a Sustainable, Diversified Land Sector Economy for North Australia

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CONTENTS

5.1 INTRODUCTION

Previous chapters have set out a compelling case for developing sustainable economies across the North that are inclusive of the wellbeing and aspirations of Indigenous people. Despite being very significant components of the North's population, especially in remoter areas, and increasingly 'land rich' through ongoing acquisitions and Native Title determinations, it is widely acknowledged that Indigenous people remain severely economically and socially disadvantaged. In this chapter we address the challenge of developing a culturally, environmentally, socially, and economically sustainable regional land sector economy, focusing on alternatives to the current spatially dominant land use sector of the North, the pastoral industry.

By some estimates, beef cattle production activities occur over as much as 90% of North Australia, particularly involving extensive, as opposed to intensive grain-fed, production systems.[1] Pastoral lands include not only pastoral leases but also swathes of *country* involving Indigenously-owned Land Trust areas, such as Arnhem Land that supports large numbers of feral water buffalo, cattle, and horses. Available data indicate that there are around four million cattle in our focal area of 1.2 million km^2 of the North Australia study region (Chapter 2; Map 2.3), with a 'northern Australian' (including all of Queensland) herd of around 13.7 million, and a national herd of around 25 million.[2]

The pastoral industry in our focal area generates approximately $400 million gross value from about 650 pastoral enterprises with about 2800 direct employees, of whom, based on available 2016 census data, about 390 are Indigenous.[3–5]

Despite the vast geographic spread of this industry, all is not economically, socially, or environmentally well. For a start, a landmark North Australian industry situation report covering the period 2001–2012 found that most pastoral enterprises were neither economically viable nor sustainable.[4] Average operating profitability across the northern pastoral industry over the 12-year assessment period was just 0.2%, and 2.6% for the top 25% of business performers; average return on assets was <1%.[4] Such low levels of profitability reflect conditions across the industry of typically low fertility soils, seasonal access restrictions, limited infrastructure, high labour and input costs, limited financial management skills, and distant and volatile markets.[4,6–12] If there is one mitigating bright spot, it is the longer-term trend of exponentially increasing land values, averaging around 6% annually over 20 years for a median-priced northern pastoral property[13] – albeit subject to market fluctuations such as occurred with the 2011 collapse of the Indonesian live-export market (Box 5.1).

While the industry has enjoyed high cattle and property prices in recent seasons, over the long-term they have experienced poor financial returns, fluctuating land values, and significant debt levels extenuated by prolonged drought conditions in some regions, contributing to major

BOX 5.1 VALUING PASTORAL PROPERTIES IN NORTHERN AUSTRALIA

FRANK PEACOCKE

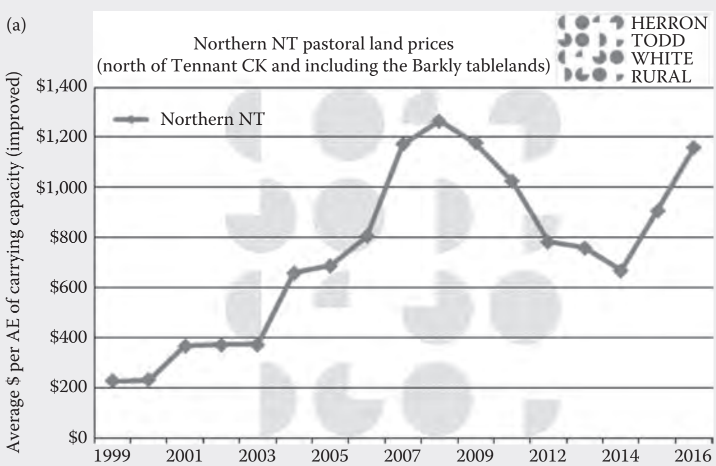
RURAL VALUATIONS, HERRON TODD WHITE (NORTHERN TERRITORY) PTY LTD, DARWIN

1. NT/KIMBERLEY PASTORAL MARKET OVERVIEW (SEE FIGURES B5.1.1)

2001–mid-2009 NT Pastoral Property Market Boom

Beef cattle properties in northern Australia in general experienced rapid value increases over a period of about eight years to around mid/late-2009. This rapid growth created a snowballing effect in cattle property demand. It appears that the market reached its peak in the Northern Territory (NT)/Kimberley in 2008/2009 (Queensland a bit earlier in 2007). Factors influencing the buoyant market conditions up until that stage included

(a)



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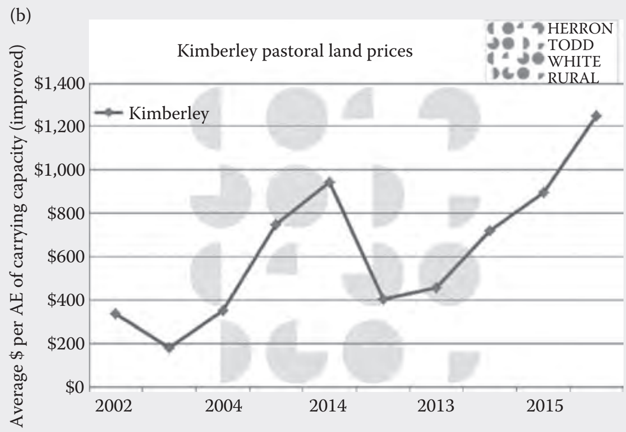
BOX 5.1 (Continued) VALUING PASTORAL PROPERTIES IN NORTHERN AUSTRALIA



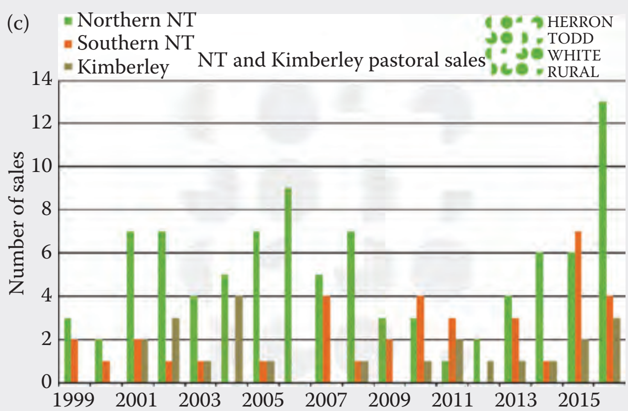


Figure B5.1.1 Pastoral property prices represented as average $per Adult Equivalent (AE) of carrying capacity (improved) over time. (a) Price changes in the NT from 1999 to 2016. (From HTW [Northern Territory] sales analysis based on HTW's own long-term carrying capacity assessments.) (b) Price changes in Kimberley from 2002 to 2016. (From HTW [Northern Territory] sales analysis based on HTW's own long-term carrying capacity assessments.) and (c) Number of sales from 1999 to 2016. (From HTW [Northern Territory] analysis of settled sales.)

- Generally strong cattle prices (particularly Indonesian live export through Darwin) and favourable seasonal conditions boosting confidence in the industry. It must be remembered that the Indonesian live export market has historically provided a second trade option for Barkly Tableland cattle stations for out of spec cattle (culls).
- Low interest rates and bank lending policies encouraging equity borrowing to fund purchases on long term interest only loans.
- Strong demand and a shortage of listings.

Mid-2009–2013: NT pastoral property market downturn

Beyond 2009 and through to the end of 2012 there were a number of features that negatively affected the values of pastoral enterprises in the northern NT region, especially

(*Continued*)

BOX 5.1 (Continued) VALUING PASTORAL PROPERTIES IN NORTHERN AUSTRALIA

- The Indonesian Government's step towards the goal of self-sufficiency in 2010, which hanged the import specifications to a cap on cattle live weights of 350 kgs and no more females.
- The June 2011 suspension of the live cattle trade to Indonesia, which had the combined effect of significantly reducing the size of the market to Indonesia and therefore the gross revenues achievable from Kimberley/Pilbara/NT Top End cattle stations.
- The suspension's impact on gross revenue decline in markets for the base product (live export cattle) meant that previously manageable debt levels held by many pastoralists became unsustainable at prevailing levels and this appears to have forced a number of northern properties onto the market.

Late 2013 can be viewed as representing the most recent low point in the pastoral property market in the Kimberley region, and 2014 in the Northern Territory Top End.

2013 to Present

Since late 2013 a combination of strengthening live export cattle prices, continuing low interest rates, and an influx of overseas investor capital into the northern pastoral market has seen value levels strengthen. Of most importance to Top End cattle properties is the live cattle export market, which has strengthened significantly since late 2013. Although as of June 2016 live cattle shipments from Australia (630,547 head) were down 12% year-on-year, it has still been the third highest on record. And while exports to Indonesia were down 14% in that year to June, exports to all other major markets were up 19% year-on year. However, keeping up with the cattle supply to south-east Asian markets is anticipated by exporters to be a problem for the rest of 2017 as pastoralists focus more on herd rebuilding.

Other positive drivers during this period have included the opening of Australian Agricultural Company's (AACo) new abattoirs at Livingstone, south of Darwin, and the NT Government's announced changes to the Pastoral Land Act, whereby pastoralists are given greater freedom to potentially utilise their property's natural attributes and diversify the potential income streams (for example, develop a groundwater resource that lies under arable *country* for the purposes of horticulture; or clear an area of appropriate land type for forestry). It is proposed that the diversification permit would run for 30 years and would be registered on title and so would run with the land in the event of a sale. Also, in 2015 the NT Government formalised (subject to consent) the use of pastoral lease property for non-pastoral uses. Although some pastoral leases have carried out activities such as tourism for some years, a formal process now exists to legitimise these activities. It is expected that the most common non-pastoral uses would be for tourism-related purposes and ancillary purposes such as haymaking for sale. It is therefore expected that the number of pastoral leases which will be able to benefit is relatively small.

2. VALUATION METHOD: PASTORAL LEASES AND CARRYING CAPACITY

In a nutshell, the use of the $/AE (Adult Equivalent) approach in Herron Todd White's (HTW) sales analysis of a pastoral lease interprets economic worth by relating land values to long-term, sustainable productivity as determined by district standards (i.e. the assessed long-term sustainable carrying capacity [CC] reflects a buyer's, vendor's, or valuer's opinion of a property's *highest and best use*). By multiplication of a property's current carrying capacity by the $/AE rate resulting from the analysis of a group of comparable property sales (i.e. their sale price excluding livestock, plant and equipment divided by current produces a value which HTW contends is a fair indicator of what the market is likely to pay.

(*Continued*)

BOX 5.1 (Continued) VALUING PASTORAL PROPERTIES IN NORTHERN AUSTRALIA

CC assessments are generally undertaken using either the utilisation method or historic method. Importantly, we note that in applying the methodology and assumptions below the valuer is also maintaining consistency with how he analyses property sales.

Utilisation Method

We consider this method the best method to gain consistency in carrying capacity (CC) assessment across the northern pastoral estate. The utilisation methodology is always based on the most recent pasture research. The long-term CC of the property is estimated using methodology outlined in Meat and Livestock Australia's Edge Network Grazing Land Management (GLM) package. The experience gained from various grazing trials on the Barkly Tablelands, Victoria River District, Katherine Region is also incorporated here.

The method requires that areas of the different *country* types (land systems or land units) within the cadastral boundaries of a pastoral lease to be mapped and calculated. This is done electronically using a GIS program such as ArcGIS. A typical land system map with 3 km grazing radii on permanent waters follows (Figure B5.1.2):

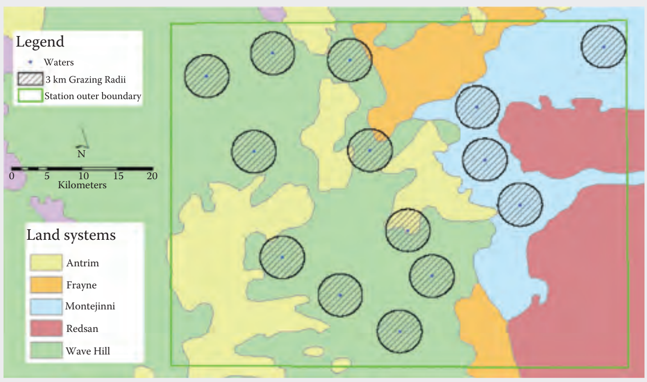


Figure B5.1.2 Land systems and water resources mapping to estimate CC of a pastoral property.

For each land system:

- The area (ha or km^2) within 3 km grazing radii of permanent water is calculated.
- The estimated expected annual growth/supply of pasture is calculated, taking into account land type, climate, and land condition. In the example in Table B5.1.2 we have adopted a land condition rating of B out of a range of A to D in accordance with the assessment parameters in Table B5.1.1.
- Apply a safe annual utilisation rate, taking into account the forage demand of the grazing animal:

$$\text{Long-term stocking rate (ha/AE/yr or AE/sqkm/yr)} = \frac{\text{Annual pasture growth (kg dry matter/ha)} \times \text{Utilisation (\%)}}{\text{Forage Demand per AE (kg/yr)}}$$

where annual (median) pasture growth is estimated using the GRASP model developed by Queensland Department of Primary Industries and calibrated to local conditions. Utilisation rates are taken from the GLM package, and forage demand is calculated as the amount of forage that an AE (again, a 450 kg dry animal) consuming a percentage of live-weight on average each day over a year (around 2,920 kg based on 8 kg per day or around 1.8%–2% of bodyweight).

(*Continued*)

BOX 5.1 (Continued) VALUING PASTORAL PROPERTIES IN NORTHERN AUSTRALIA

Table B5.1.1 Assessment of Pastoral Land Condition (A, B, C and D) Using Soil, Pasture Types, Weed and Woodland Attributes to Evaluate Pastoral Properties

Land	Soil	Pasture	Weed	Woodland
A All of these features	No erosion and good surface condition	Good coverage of 3P grasses[a], little bare ground (<30%) in most years	Few weeds and no significant infestations	No signs of woodland thickening
B (At least one or more of these features)	Some signs of previous erosion and some current signs of erosion	Some decline in the presence of 3P grasses and/or bare ground (more than 30%, but less than 50% in most years)	Small infestations of weeds	Some thickening in the density of woodland
C (One or more of these features)	Obvious signs of past erosion and/or current susceptibility to erosion	General decline in the presence of 3P species and/or bare ground (>50% in most years)	Obvious presence of weeds	General thickening in the density of woody plants
D (One or more of these features)	Severe erosion, scalding or compaction resulting in a hostile environment for plant growth	General lack of and perennial grasses or forbs	Large weed infestations covering significant areas	Thickets of woody plants that cover significant

Source: NT Government.
[a] 3P grasses = Palatable, Productive, Perennial.

- Once the long-term CC for each land type has been estimated, this is applied to the different land systems areas within 3 km grazing radii previously calculated.

Table B5.1.2 provides an example of the CC calculation on a typical area of pastoral land in the Victoria River District. Note, in Table B5.1.2:

- *Supp Util %* means the percentage of pasture utilised assuming mineral supplementation.
- *Access* means the percentage of actual physical access the animal has for pasture given the topography (e.g. steep banks on a pastured riverbank may not be fully accessible). In the following example, everything is fully accessible.
- *Intake* means an AE consumes 2,920 kg pa on average.

Historic Method

Estimates of sustainable long-term CC made using the historical approach utilises the experience and historic long-term stocking evidence of many long-term graziers and pastoralists who have managed *country* without causing significant reduction in land condition over long periods. These CC estimates are usually applied to the areas of *country* within 5 km of permanent water and are generally utilised in districts where pasture growth and utilisation modelling has not been well researched (mainly south of Tennant Creek, in the more remote districts of the NT, and in the Kimberley).

DEFINITIONS

Market value: The estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction, after proper marketing, where the parties had each acted knowledgeably, prudently, and without compulsion.

Highest and best use: The use of an asset that maximises its potential and that is physically possible, legally permissible and financially feasible.

Adult equivalent: An adult equivalent (AE) is defined as a 450 km non-lactating beast. This is a long term, year-in-year-out sustainable average level of productivity through fluctuating annual seasonal conditions.

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BOX 5.1 (Continued) VALUING PASTORAL PROPERTIES IN NORTHERN AUSTRALIA

Table B5.1.2 An Example of CC Calculations of Pastoral Land in the Victoria River District of the NT

Land System	Class Description	Land System Area within 3 km (ha)	Yield (B cond)	Supp Util %	Unsupp Util %	Access	Intake (kg pa)	AE/km²	AE
Wave Hill	Plains and rises on basalt, agglomerate and tuff, some dolerite; clayey soils with surface stone	26,489	2,425	20	15	100	2,920	16.6	4,400
Frayne	Plains and rises on basalt, agglomerate, tuff, some dolerite; clayey soils with surface stone	394	2,200	15	10	100	2,920	11.3	44
Antrim	Low hills and hills on basalt, agglomerate and tuff, some dolerite; mostly rock rock outcrop with surface stone and pockets of clayey soils	1,391	1,900	15	10	100	2,920	9.8	136
Montejinni	Plains, rises and plateaux on weathered and unweathered Cambrian limestone, dolomite, chalcedony, shale, sandstone and siltstone with associated sand	11,309	1,200	10	8	100	2,920	4.1	465
TOTAL		39,582							5,045

financial stresses on many pastoral businesses.[12,14] At the family level, such stresses have contributed to serious emotional health issues – including high rates of suicide in north Australian rural and remote communities.[15] The ongoing impacts of dispossession on Aboriginal people and communities are well documented (Chapter 3).

The industry also generates significant long-term environmental liabilities, which are not accounted for in current market pricing, including: land degradation[9,11,16–22]; gully erosion,[23–25] and associated down-stream siltation effects on maritime systems[26–28]; impacts on freshwater resources and quality, including unrestricted access to and exploitation of ecologically fragile springs and soaks[29–31]; impacts on native species biodiversity, including granivorous birds and small mammals[7,32–35]; and ruminant greenhouse gas emissions, which are estimated to contribute 4% of national emissions.[36] However, it needs to be recognised that, in many northern regions, significant weed and feral animal management issues are common to all types of land use.[11,19]

Collectively, these issues point to a pressing need for assessing the value proposition of the northern pastoral industry, and to explore novel diversified approaches for developing sustainable land use practices and broader community benefits. In this chapter we focus on the development of diversified economic opportunities that currently, and in the near future, can be derived through enhanced and sustainable management of natural ecosystems and the services these provide.

The chapter begins with a general description of what we mean by 'ecosystem services', derived from natural systems, followed by illustration of the value of such services nationally under different land use scenarios. The second part of the chapter describes and assesses the current economic and environmental condition of the pastoral industry in our focal region, and associated impacts on ecosystem services, based on available documented sources. A more localised geographic assessment is provided for the Northern Territory's gulf region as a regional case study in Chapter 7. The final section of the paper addresses opportunities for developing a diversified regional land sector economy based on sustainable ecosystem services.

Wherever possible, our intention is to provide quantitative monetized valuations of both the financial condition of the industry as well as associated cultural, social, and environmental benefits and costs. However, as might be expected, many core attributes cannot readily be expressed in monetary units (e.g. spiritual values), or insufficient data currently exist (e.g. valuing threatened species or dry season above-ground water sources). Nonetheless, using these assembled data, we show that people and communities occupying the great majority of the current North Australia pastoral region will benefit substantially from the development of a diversified ecosystem services-based land sector economy.

5.2 ECOSYSTEM SERVICES

Ecosystem services can be defined as the ecological characteristics, functions, or processes that directly or indirectly contribute to human well-being – the benefits people derive from functioning ecosystems.[37,38] Ecosystem processes and functions may contribute to ecosystem services, but they are not synonymous. Ecosystem processes and functions describe biophysical relationships and exist regardless of whether or not humans benefit.[39] Ecosystem services, on the other hand, only exist if they contribute to human well-being, and they cannot be defined independently. The following categorization of ecosystem services has been used by the Millennium Ecosystem Assessment.[38]

1. *Provisioning services*: Services that offer 'provisioning' benefits to people such as bush tucker, medicine, timber, and fibre.
2. *Regulating services*: Services that regulate different aspects of the integrated system, such as flood control, storm protection, water regulation, human disease regulation, water purification, air quality maintenance, pollination, pest control, and climate control. These services are generally not marketed but have clear value to society.
3. *Cultural services*: Services that offer recreational, aesthetic, religious, scientific, cultural identity, sense of place, or other 'cultural' benefits. For example, customary lands provide sites for Indigenous people to perform ceremonies and transmit knowledge to future generations.
4. *Supporting services*: Services that maintain basic ecosystem processes and functions such as soil formation, primary productivity, biogeochemistry, and provisioning of habitat. These services affect human well-being *indirectly* by maintaining processes necessary for provisioning, regulating, and cultural services. For example, net primary production (NPP) is an ecosystem function that supports carbon sequestration and removal from the atmosphere, which provides the benefit of climate regulation. Some would argue that these 'supporting' services should rightly be defined as ecosystem 'functions' because they may not yet have interacted with the other three forms of capital to create benefits. We agree with this in principle but recognize that supporting services/functions may sometimes be used as proxies for services in the other categories.

This categorization suggests a very broad definition of services, limited only by the requirement to contribute to human well-being. Even without any subsequent valuation, explicitly listing the services derived from an ecosystem can help ensure appropriate recognition of the full range of potential impacts of a given policy option. This can help make the analysis of ecological systems more transparent and can help inform decision makers of the relative merits of different options before them.[40]

Examples of these services include the maintenance of the composition of the atmosphere; amelioration and stability of climate, flood controls, and drinking water supply; waste assimilation; recycling of nutrients; generation of soils; pollination of crops; provision of food; maintenance of species and a vast genetic library; and also maintenance of the scenery of the landscape, recreational sites, and aesthetic and amenity values.[37,41–45] Biodiversity at genetic, species, population, and ecosystem levels all contribute in maintaining these functions and services.[46] An environmentally literate society would probably accept the assertion that most, if not all, ecosystem functions are in the long term beneficial to society[47] and should not be damaged or traded off lightly.

Many ecosystem services are public goods. This means they are non-excludable, and multiple users can simultaneously benefit from using them. This creates circumstances where individual choices are not the most appropriate approach to valuation. Furthermore, ecosystem services (being public goods) are generally not traded in markets. We therefore need to develop other methods to assess their value.

5.2.1 Valuation of Ecosystem Services

Valuation is about assessing trade-offs towards achieving a goal.[48] All decisions that involve trade-offs involve valuation, either implicitly or explicitly.[40] When assessing trade-offs, one must be clear about the goal. Ecosystem services are defined as the benefits people derive from ecosystems – the support of sustainable human well-being that ecosystems provide.[37,38] The value of ecosystem services is therefore the relative contribution of ecosystems to that goal. There are multiple ways to assess this contribution, some of which are based on individual's perceptions of the benefits they derive. But the support of sustainable human well-being is a much larger goal,[41] and individuals' perceptions are limited and often biased.[49] Therefore, we also need to include methods to assess benefits to individuals that are not well perceived, benefits to whole communities, and benefits to sustainability.[49] This is an ongoing challenge in ecosystem services valuation, but even some of the existing valuation methods like avoided and replacement cost estimates are not dependent on individual perceptions of value. For example, estimating the storm protection value of coastal wetlands requires information on historical damage, storm tracks and probability, wetland area and location, built infrastructure location, population distribution, and so on.[51]

It is also important to note that ecosystems cannot provide any benefits to people without the presence of people (human capital), their communities (social capital), and their built environment (built capital). This interaction is shown in Figure 5.1. Ecosystem services do not flow directly from natural capital to human well-being – it is only through interaction with the other three forms of capital that natural capital can provide benefits. This is also the conceptual valuation framework for the recent UK National Ecosystem Assessment (http://uknea.unep-wcmc.org) and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES; http://www.ipbes.net). The challenge in ecosystem services valuation is to assess the relative contribution of the natural capital stock in this interaction and to balance our assets to enhance sustainable human well-being. The relative contribution of ecosystem services can be expressed in multiple units – in essence any of the contributors to the production of benefits can be used as the 'denominator' and other contributors expressed in terms of it. Since built capital in the economy, expressed in monetary units, is one of the required contributors, and most people understand values expressed in monetary units, this is often a convenient denominator for expressing the relative contributions of the other forms of capital, including natural capital. But other units are certainly possible (i.e. land, energy, time, etc.) – the choice is largely about which units communicate best to different audiences in a given decision-making context.

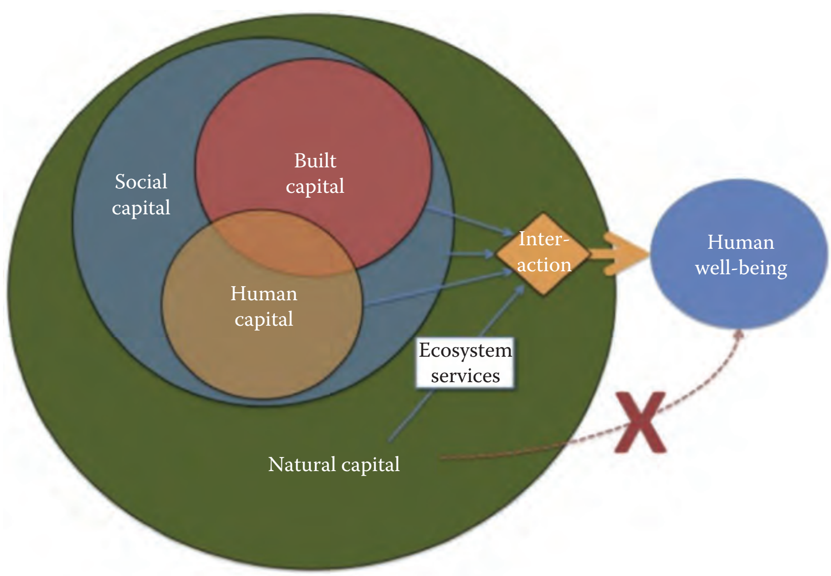


Figure 5.1 Interaction between built, social, human, and natural capital required to produce human well-being. Built and human capital (the economy) are embedded in society which is embedded in the rest of nature. Ecosystem services are the relative contribution of natural capital to human well-being; they do not flow directly. It is therefore essential to adopt a broad, trans-disciplinary perspective in order to address ecosystem services. (From Costanza, R. et al., *Glob. Environ. Change*, 26, 152–158, 2014.)

5.2.2 Ecosystem Services of North Australian Savannas

North Australian Savannas have not been extensively studied in terms of their ecosystem services contributions. Table 5.1 shows a summary of the estimates that have been assembled as part of the Ecosystem Services Value Database (ESVD) (http://www.fsd.nl/esp/80763/5/0/50) for 17 ecosystem services for various ecosystems as of 2012. For woodlands, 21 estimates have been included with a mean value of $1,600/ha/year and a range from $1,300 to 2200/ha/year. For grasslands, 32 estimates have been included with a mean value of $2,900/ha/year, but a broader range of from $125 to 6,000/ha/year. Of these only one study was performed in North Australia, but 20 were performed in similar ecosystems in Africa, the Americas, and Asia. But based on this, we can estimate that North Australian savannas contribute about $1,000–2,000/ha/yr.

5.2.3 Possible Futures under Different Scenarios

As part of a recent global study,[49] the value of ecosystem services was estimated for four future scenarios (Figures 5.2 and 5.3) to the year 2050 built around the four great transition initiative archetypes: (1) market forces (MF); (2) fortress world (FW); (3) policy reform (PR); and (4) great transition (GT).[52–54] Two of these scenarios (market forces and great transition) are similar to those described elsewhere in this chapter. The market forces scenario is well captured in the government white paper on northern Australia development,[55] despite continued public subsidies of some industries. The great transition scenario is consistent with our vision for sustainable and desirable development.

Detailed great transition initiative (GTI) scenarios exist for both the global system and several regions. Brief narrative descriptions of each scenario, extracted directly from the GTI website (www.greattransition.org/explore/scenarios), are reproduced here:

Market forces (MF): The market forces scenario is a story of a market-driven world in the twenty-first century in which demographic, economic, environmental, and technological trends unfold without major surprises relative to unfolding trends. Continuity, globalization, and convergence are key characteristics of world development – institutions gradually adjust without major ruptures, international economic integration proceeds apace and the socioeconomic patterns of poor regions converge slowly towards the development

Table 5.1 Summary of the Number of Estimates, Mean, Standard Deviation, Median, Minimum and Maximum Values from the ES Value Database. Values Are in International $/ha/yr

	No. of Estimates	Total of Service Mean Values	Total of St. Dev. of Means	Total of Median Values	Total of Minimum Values	Total of Maximum Values
Open oceans	14	491	762	135	85	1,664
Coral reefs	94	352,915	668,639	197,900	36,794	2,129,122
Coastal systems	28	28,917	5045	26,760	26,167	42,063
Coastal wetlands	139	193,845	384,192	12,163	300	887,828
Inland wetlands	168	25,682	36,585	16,534	3018	104,924
Rivers and lakes	15	4267	2771	3938	1446	7757
Tropical forest	96	5264	6526	2355	1581	20,851
Temperate forest	58	3013	5437	1127	278	16,406
Woodlands	21	1588	317	1522	1373	2188
Grasslands	32	2871	3860	2698	124	5930

Source: de van der Ploeg S, de Groot R (2010) The TEEB Valuation Database – A searchable database of 1310 estimates of monetary values of ecosystem services. Foundation for Sustainable Development, Wageningen, the Netherlands.

Figure 5.2 Four development scenarios about the future of ES.[52] (From Kubiszewski, I. et al., *Ecosys. Ser.*, 26, 289-301, 2017.)

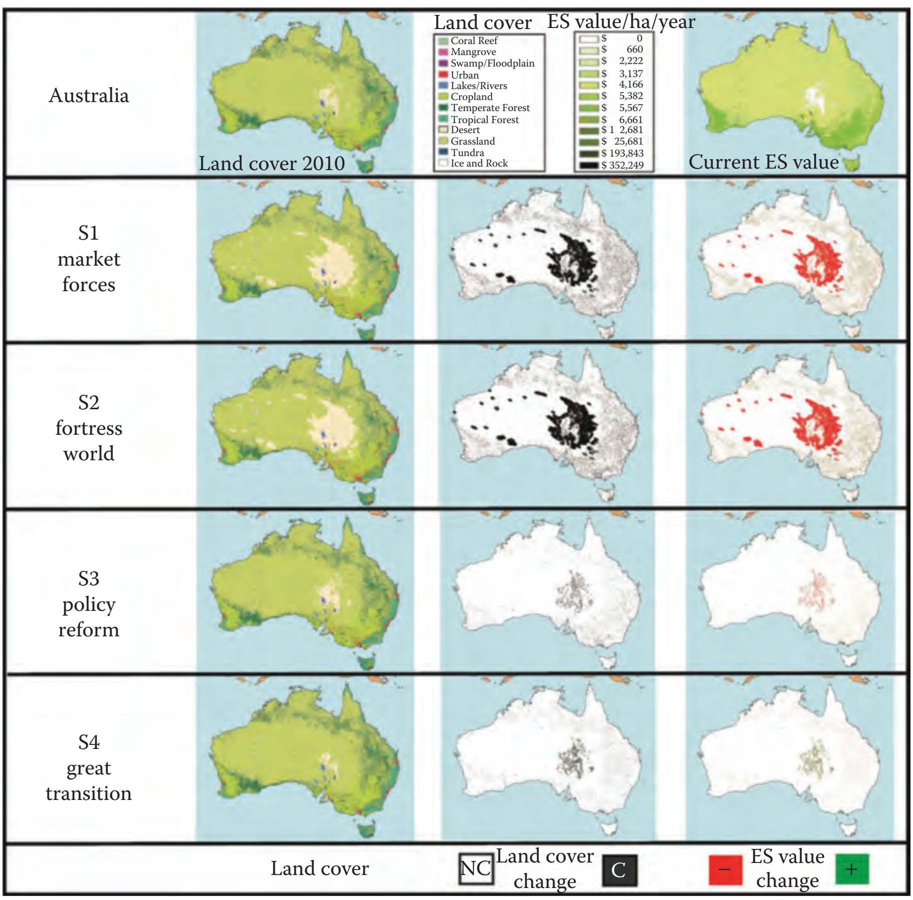


Figure 5.3 Land cover and ecosystem service values for Australia in 2010, and for four future scenarios to 2050.[52] (From Kubiszewski, I. et al., *Ecosyst. Ser.*, 26, 289-301, 2017.)

model of the rich regions. Despite economic growth, extreme income disparity between rich and poor countries, and between the rich and poor within countries, remains a critical social trend. Environmental transformation and degradation are a progressively more significant factor in global affairs.

Policy reform (PR): The policy reform scenario envisions the emergence of strong political will for taking harmonized and rapid action to ensure a successful transition to a more equitable and environmentally resilient future. Policy Reform is designed to achieve a set of future sustainability goals. The analytical task is to identify plausible development pathways for reaching that end-point. Thus, the policy reform scenario explores the requirements for simultaneously achieving social and environmental sustainability goals under high economic growth conditions similar to those of market forces.

Fortress world (FW): The fortress world scenario is a variant of a broader class of Barbarization scenarios, in the hierarchy of the global scenario group.[52] Fortress world features an authoritarian response to the threat of social breakdown brought about by growing inequality. Ensconced in protected enclaves, elites safeguard their privilege by controlling an impoverished majority and managing critical natural resources, while outside the fortress there is repression, environmental destruction, and misery.

Great transition (GT): The great transition scenario explores visionary solutions to the sustainability challenge, including new socioeconomic arrangements and fundamental changes in values. This scenario depicts a transition to a society that preserves natural systems, provides high levels of welfare through material sufficiency and equitable distribution, and enjoys a strong sense of local solidarity.

Each of these scenarios has been produced and vetted by a large network of scholars and have been used as archetypes for a range of other scenario planning studies.[52–54,56] They incorporate a range of world views and policies, and the impacts of these on the entire, integrated system, including population, energy use, equity, environmental change, and climate change. The GTI scenarios also include impacts on land use and management. The interactive web tool Futures in Motion, on the GTI website, was used to derive estimates of land use change (urban, cropland, forest, grassland, desert), population, GDP, and other variables such as inequality and GDP for these four future scenarios to the year 2050 (see www.tellus.org/results/results_World.html).

Based on earlier methodological approaches, Figure 5.3 shows maps of land cover for each biome for the base map and the four scenarios, changes in the land cover between 2011 and each of the four scenarios in 2050 (shown as those pixels that changed or did not change), and the change in ecosystem services value from the 2011 values to each of the four scenarios within that *country* or region.[56] Regions in the vicinity of deserts will experience a greater desertification rate than those regions further away from existing desert. This assessment indicates that the great transition scenario, similar to the scenario we describe later in this chapter, significantly restores ecosystem services in North Australia.

5.3 ASSESSING THE ECONOMIC CONDITION AND ENVIRONMENTAL IMPACT OF THE NORTH AUSTRALIA PASTORAL INDUSTRY

The focal area for this assessment comprises 1.2 million km,[2] including all savannas receiving at least 600 mm and as much as ~2000 mm rainfall/year (Map 2.4). Over this vast region rainfall is highly seasonal, with 90% falling in 4–5 wet season months (generally November–March) (Map 2.4). Soils are mostly infertile,[57] dominated by rudosols, kandosols, and tenosols over 69% of the region, and smaller areas of fertile vertosols covering 15% (Map 2.6).

As noted earlier, extensive beef cattle pastoralism comprises by far the dominant land use in this region (Map 2.7). Pastoral lands in North Australia are recognised generally as supporting much lower levels of pastoral production than in south-eastern Australia, mainly due to low fertility soils and poor-quality pastures, seasonal access restrictions, limited infrastructure (e.g. roads, fencing water points), relatively high labour and input costs, and distant and volatile markets.[4,5,11,36]

The region includes large pastoral properties varying in median size from 100,000 to 200,000 ha in the Top End (NT), Cape York (QLD), and Kimberley (WA), and from 15,000 to 70,000 ha in the rest of QLD. Most properties are under either freehold, or long-term perpetual (99 year) pastoral lease, tenure arrangements depending upon respective state or territory legislation. Annual rental lease payments are low (0.75–1.5% of the land value, depending upon 'term' or 'perpetual lease' arrangements). Average stocking rates vary from <1 to 15 head/km^2, depending upon soil potential, pasture species and infrastructure.[4] The industry's northern beef situational analysis report for the period, 2001–2012, determined that the average gross margin for a median sized beef property in different regions varied from $200,000 to $950,000 per year, with relatively greater returns from Barkly, Kimberley, and QLD Mitchell grass regions.[4]

Pasture types over the study region are dominated by spinifex (*Triodia, Plectrachne* spp.) 19.8%; annual sorghum (*Sorghum* spp.) 16.1%; *Aristida-Bothriochloa* 13.1%; *Shizachyrium* 9.4%; and black spear grass (*H. contortus*) 8.8% (Table 5.2, Figure 5.4a). In terms of pasture capability, 81% of the total area is considered as having low potential, with 4% having moderate and 15% high pasture capability.[58] Following validation of these observations with contemporary understanding of regional pastoral scientists, two revised pasture capability ratings are included here: Queensland black spear grass communities are re-rated from high to moderate; and ribbon grass communities in

Table 5.2 Pasture Species and Area under High, Moderate or Low Pasture Production Potential, Where Total Area = 1.2 million km^2

Pasture Communities Categorised under High, Moderate, and Low Pasture Potential	Area (km^2)	Proportion of Study Area (%)
High	**36,670**	3
Bluegrass-browntop (*Dichanthium fecundum – Eulalia fulva*)	24,831	
Ricegrass (*Xerochloa* sp.)	7,563	
Shortgrass grassland (*Triodia* spp., *Eragrostis* sp.)	4,277	
Moderate	**455,673**	39
Aristida-Bothriochloa spp.	68,377	
Black speargrass (*Heteropogon contortus*)	104,096	
Blady grass (*Imperata cylindrica*)	1,658	
Bluebush/saltbush (*Maireana astrotricha/Atriplex vesicaria*)	59	
Bluegrass-browntop (*Dichanthium fecundum*)	26,627	
Heathland pastures (*Schoenus sparteus*, *Digitaria* sp. etc.)	4,045	
Mitchell grass (*Astrebla* spp.)	32,067	
Plume sorghum (*Sorghum plumosum*)	10,330	
Ribbongrass (*Chrysopogon fallax*)	103,238	
Ricegrass (*Xerochloa* sp.)	131	
Saltwater couch (*Sporobolus virginicus*)	3,184	
Schizachyrium spp.	6,737	
Shortgrass grassland (various species)	12,401	
Spinifex (*Triodia* and *Plectrachne* spp.)	82,206	
Wanderrie grass (*Eriachne* spp.)	516	
Low	**691,596**	58
Annual sorghum (*Sorghum intrans, S. stipoideum, S. australiense*)	190,307	
Aristida-Bothriochloa spp.	85,751	
Blady grass (*Imperata cylindrica* spp.)	11,243	
Heathland pastures	15,262	
Rainforest derived pastures	2,329	
Saltwater couch (*Sporobolus virginicus*)	30,556	
Schizachyrium spp.	103,708	
Spinifex (*Triodia* and *Plectrachne* spp.)	234,071	
Wanderrie grass (*Eriachne* spp.)	18,370	

Source: Adapted from a Regional Report.[58]

WA/NT are re-rated from low to moderate. Accordingly, it is considered that 58% of the focal area is of low, 39% moderate, and only 3% has high pastoral potential (Table 5.2; Figure 5.4b).

We assessed the carrying capacity of regional pastures by integrating data from a number of published sources,[4,5,59,60] and expert opinion (Figure 5.4c). Almost 70% of the total area is considered to support <4 head/km^2, 20% supports 5–9 head/km^2, and just 10% supports ≥10 head/km^2 (Figure 5.4c).

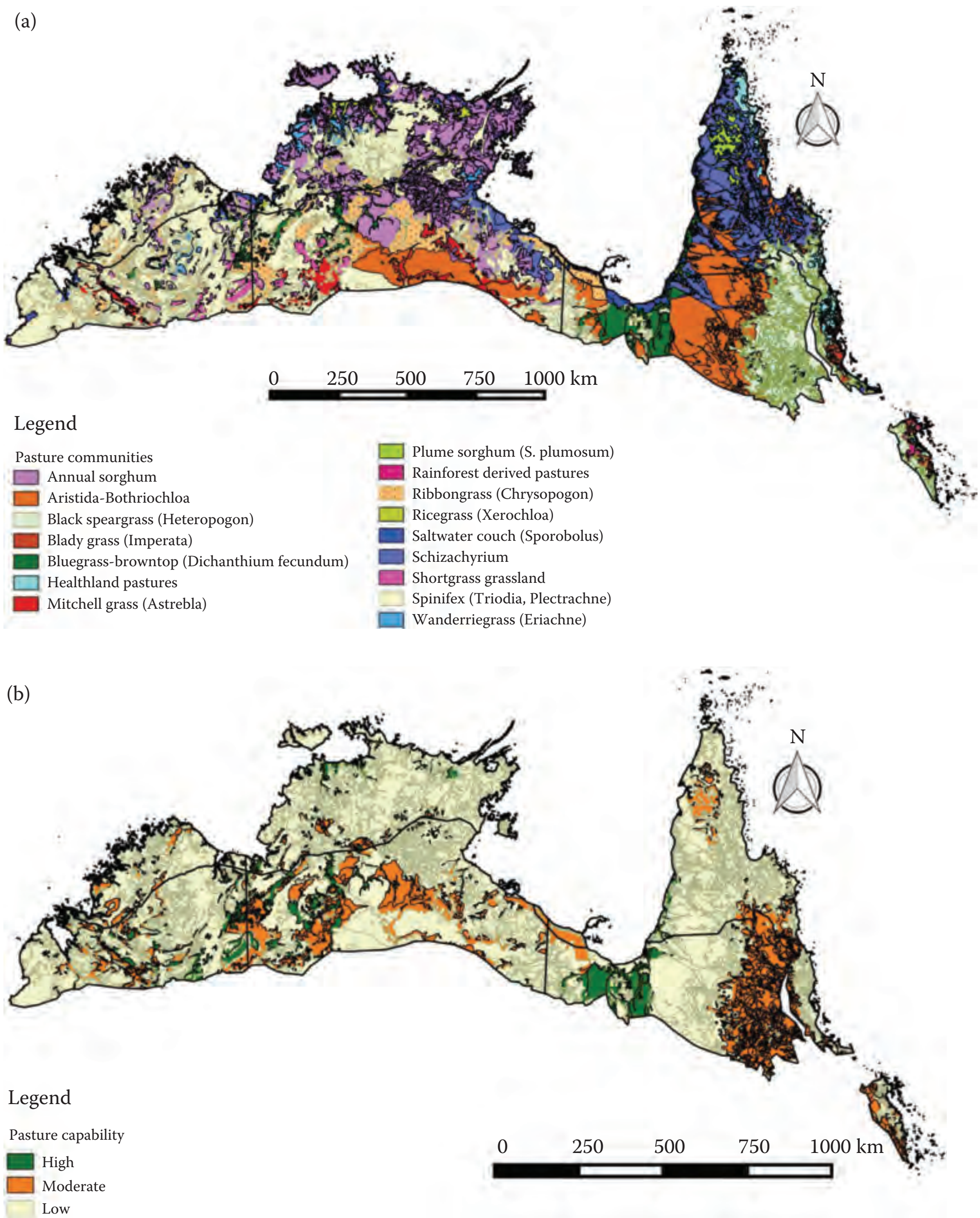


Figure 5.4 Pasture attributes for the study region: (a) pasture communities, (b) pasture capability (the image has been updated with minor modifications for categorising ribbongrass and black spear grass as moderate, following an expert opinion). (*Continued*)

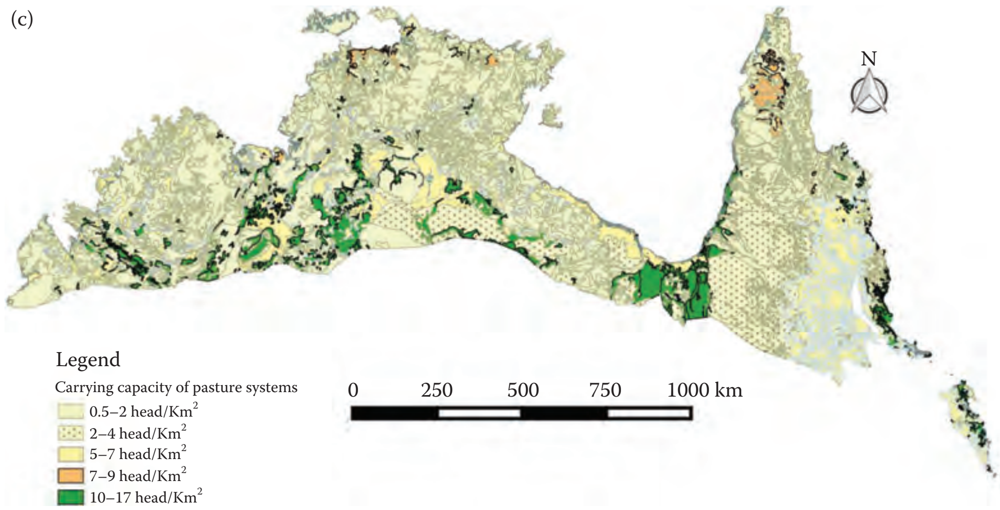


Figure 5.4 (Continued) Pasture attributes for the study region: (c) pasture carrying capacity including current expert opinion. (From Tothill, J. C. and Gillies, C., *The Pasture Lands of northern Australia: their condition, productivity, and sustainability*. Tropical Grassland Society of Australia, on behalf of Meat Research Corporation, Brisbane, Australia, 1992.)

Locations supporting high carrying capacity in our focal region occur mainly in lower rainfall parts of the QLD Gulf, central NT, and Fitzroy plains in WA (Figure 5.4c). In general, this assessment conforms with a recent pastoral industry productivity assessment identifying areas of low, moderate, and high productivity in NT and QLD.[5]

5.3.1 Economic Assessment

We conducted a detailed assessment of the economic condition of a typical regional beef cattle producing enterprise integrating available published data mostly from Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) farm survey data[60] (http://www.agriculture.gov.au/abares/surveys) and regional sources.[4,5] For this assessment (except where noted below), we used eight regions as identified by Bray et al. (2015) based on their productivity potential, amalgamated from 18 Australian Bureau of Statistics SA2 sub-regions. All values cited are given in 2016 AUS$.

Financial returns from cattle production were assessed in terms of annual earnings before interest and taxes (EBIT) following the northern beef situational analysis report.[4] For each region, we applied long-term (2001–2012) EBIT estimates for a median-sized property operating as a ‘typical’ pastoral business. Considering the North Australia focal region as a whole, as defined in that report, a ‘typical’ pastoral business is representative of roughly 70% of all regional pastoral enterprises, with an average herd size of 3200 adult equivalents, and collectively contributing 42% of total beef production in North Australia. Our assessment thus does not include a relatively smaller number of larger, generally corporately owned properties.

Our EBIT financial analysis shows that most northern sub-regions return <$100,000/year/property except for the Barkly and central-west QLD regions (Figure 5.5a). For our focal area, EBIT returns were just $20,000–$50,000/year/median-sized property in north Queensland and the Kimberley, and $50,000–$99,000/year for a median-sized property in the Top End of the NT. The average annual long-term (2001–2012) EBIT for a typical pastoral business in northern Australia is $136,000/year, or $6.16 per adult equivalent (AE), indicating very low financial returns for a majority of pastoral businesses.[4] In reviewing these results, it was noted, however, that 'the calculated EBIT figure includes an imputed value on owner wages. In reality this wage is rarely paid so the businesses may achieve a small cash surplus, even though it is reported as a loss'.*

However, 'exceptional performers' comprise about 27% of total beef production in northern Australia.[4] Financial performance of those pastoral businesses is better (an average EBIT of $348,000/year, or $61.96/AE) than the typical businesses reported here, mainly due to better herd management (especially maintaining stocking rates relative to seasonal carrying capacity), herd productivity, lower operating costs, and better financial management.[4]

Apart from low levels of financial return, most northern pastoral properties are operating with high levels of long-term debt (Figure 5.5b). Using available ABARES debt liability data reported in the northern beef situational analysis report,[4] we estimated earnings after interest but before taxes (EAIBT) by calculating annual interest repayments per median-sized property at a conservative 5% annual rate of interest. When taking debt into account, the EAIBT assessment indicates that almost 80% of pastoral properties in the northern region have been operating at loss, except for high productivity areas in QLD and the NT Barkly (Figure 5.5c). In our focal area, almost all median-sized pastoral businesses have been operating at an average annual loss of $5,000–$21,000 per property. A long-term negative EAIBT for a typical business is also highlighted in the situational analysis report[4] (Figure 5.6).

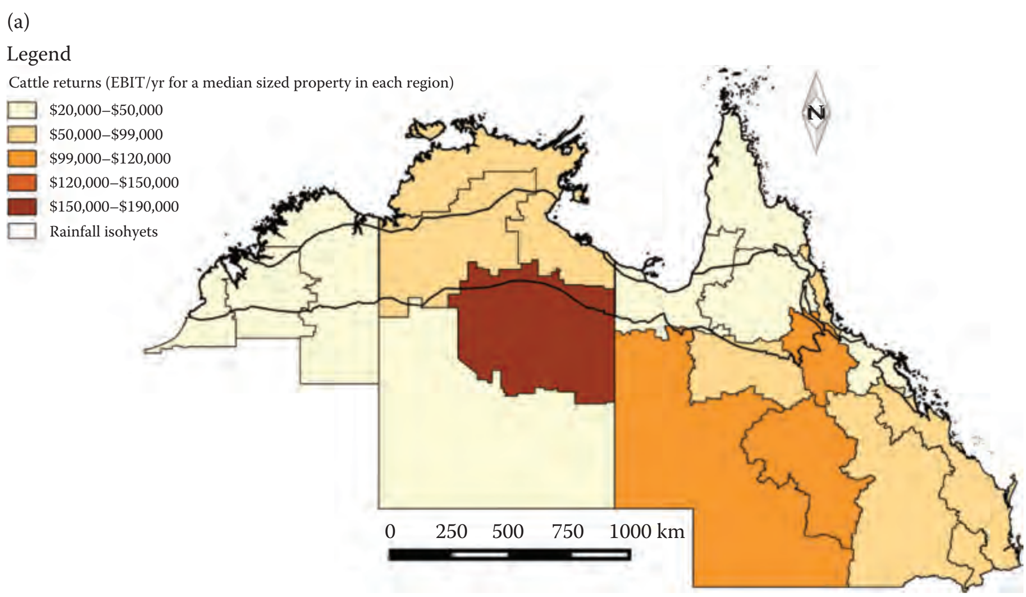
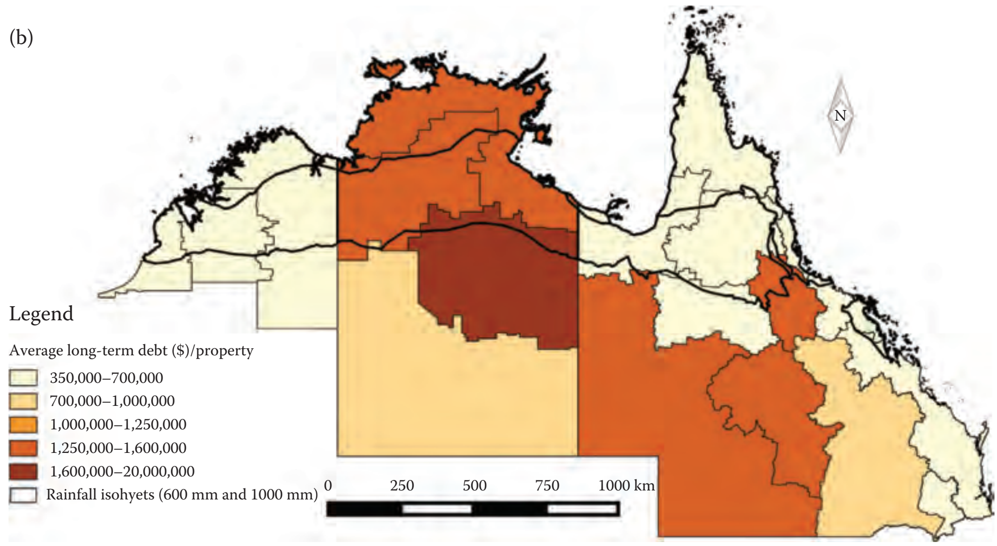


Figure 5.5 Annual long-term (2001–2012) economic returns from a typical, median-sized pastoral business in the north: (a) Earnings before interest and tax (EBIT)/year. (From McLean, I. et al., *The Northern Beef Report – 2013 Northern Beef Situation Analysis*. Meat & Livestock Australia Ltd., North Sydney, NSW, 2059, 2014; Bray, S. et al., 'Desktop research project to provide data on liveweight and liveweight gain in the beef cattle sector in Queensland and the Northern Territory'. *Final report, 2015*. Department of Agriculture and Fisheries, State of Queensland, Rockhampton, Australia, 2015 based upon ABARES (Australian Bureau of Agricultural and Resource Economics and Sciences), Customised data extracted from AAGIS dataset. ABARES. http://www.agriculture.gov.au/abares/surveys frequently accessed from May–December 2016, 2013.) (*Continued*)

* Ian McLean, personal communication, June 2016.

(b)



(c)

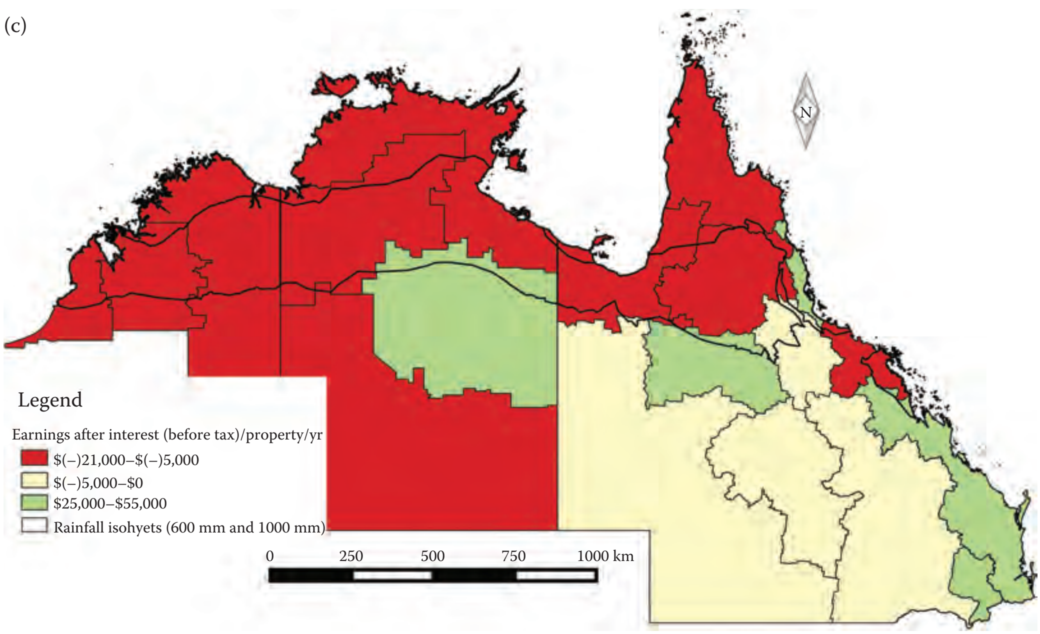


Figure 5.5 (Continued) Annual long-term (2001–2012) economic returns from a typical, median-sized pastoral business in the north: (b) long-term debt (2001–2012). (From ABARE 2001–2012 data [McLean, I. et al., *The Northern Beef Report – 2013 Northern Beef Situation Analysis*. Meat & Livestock Australia Ltd., North Sydney, NSW, 2059, 2014]) and (c) earnings after interest but before tax (EAIBT)/yr. (From McLean, I. et al., *The Northern Beef Report – 2013 Northern Beef Situation Analysis*. Meat & Livestock Australia Ltd., North Sydney, NSW, 2059, 2014; Bray, S. et al., 'Desktop research project to provide data on liveweight and liveweight gain in the beef cattle sector in Queensland and the Northern Territory'. *Final report, 2015*. Department of Agriculture and Fisheries, State of Queensland, Rockhampton, Australia, 2015; ABARES, Regional farm debt: Northern Queensland gulf, south west Queensland, and north west New South Wales. ABARES, Canberra, Australia, December. CC BY 3.0, 2014.)

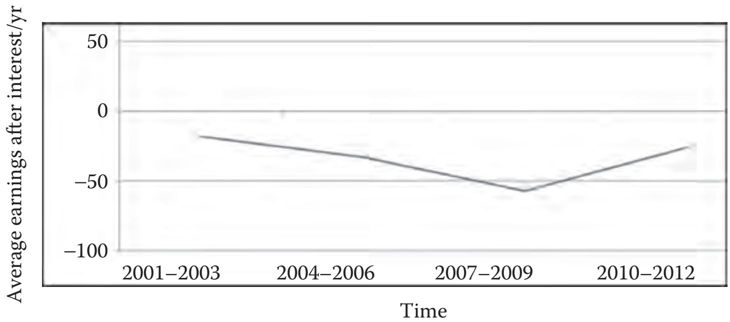


Figure 5.6 'Average annual long-term earnings after interest (EAIBT) for a typical pastoral business in northern Australia'. (From McLean, I. et al., *The Northern Beef Report – 2013 Northern Beef Situation Analysis*. Meat & Livestock Australia, North Sydney, NSW, 2059, 2014.)

Levels of farm business debt across the north are substantial, with 44% of businesses owing more than $0.5 million in the QLD-Gulf region, and 37% owing more than $1 million in the NT.[61] These amounts are much higher than the rest of beef producing regions in Australia. Since 2008, northern pastoralists have taken on obligations to service higher debt levels while farm income has been declining; the ratio of interest payments to total cash receipts for serving debt is 20%, well above the national average (8%).[61] Others have highlighted that many northern beef businesses are in dire financial situation given high debt levels and low productivity.[5,12] Clearly, a majority of the northern pastoral businesses are operating much below the break-even level, with <1% return on assets over the period 2001–2012.[4]

The recurring pattern of long-term poor financial returns from typical, as opposed to 'exceptionally performing' northern Australian pastoral enterprises raises the obvious question why people might want to invest time, effort, and financial resources in this industry. Apart from being an active, if challenging, life-style choice for many participants,[9,11,12,62] a part answer might be that, despite significant inter-annual variability, over the long term property prices have continued to escalate[13] (Box 5.1). However, even where the debt to equity ratio may be relatively small, rising land values in themselves do not provide an annual return sufficient to service associated debt. In economically marginal situations 'it reduces profitability and can force new entrants (who pay the high prices) to run their *country* harder in an effort to achieve a return, thus compromising the environment'.* Rising land values also clearly cannot substitute for losses on communally held Aboriginal lands that will never be sold.

A recent industry report concluded: 'at the individual beef business scale, productivity growth and returns on investment in the northern Australian beef industry is generally static or declining and, together with high debt levels and increasing input costs, many northern grazing businesses are in a dire financial situation'.[5]

5.3.2 Ecological and Environmental Assessment

While recognizing that well-managed pastoral enterprises can provide many positive ecosystem services (e.g. reducing weed, feral animal, fire impacts), heavy grazing by cattle (and associated livestock and feral animals such as horses and Asian water buffalo) incurs well-known impacts on savanna systems which typically are not accounted for in conventional financial assessments, nor taken into account in establishing the real long-term costs (and benefits) of the pastoral industry and its products. Such environmental impacts can be exacerbated by financial imperatives of poorly performing and managed pastoral enterprises to overstock in an endeavour to meet crippling debt.[4]

The character and magnitude of various of these landscape-scale impacts is immense, contributing to land degradation resulting in reduced landscape function and consequent lost pastoral

* Ian McLean, personal communication, June 2016.

production, through losses of topsoil, soil organic matter, nutrients, and surface water retention, and, in severe cases, surface deflation and associated gully erosion; downstream effects of sedimentation on coastal and marine ecosystems; impacts on the quality and quantity of ecologically precious perennial and seasonal surface water resources; greenhouse gas emissions directly associated with cattle rumination and dung; spreading of weeds and facilitating undesirable woody thickening; and significant impacts on vulnerable flora, fauna, and critical habitats (Table 5.3). Effects are ubiquitous but vary in intensity across the landscape.

To illustrate the magnitude of such impacts, in this assessment we consider the environmental costs associated with aspects of pasture condition and greenhouse gas emissions from cattle given ready availability of accepted environmental accounting procedures (Tables 5.4 and 5.5). Costing of other environmental impacts listed in Table 5.3, while feasible to do, has either not

Table 5.3 Effects of Unsustainable Grazing Land Use on Soils (Including Landscape Functions), Biodiversity, GHG Emissions, Woody Thickening, Weeds, and Water Resources

Ecological Effects	Study Areas	References
Loss of Soil, Landscape Health, and Landscape Function		
Effects of over-grazing on land can result in very significant soil erosion, gully erosion, top soil run-off, sediment loss, decline in soil fertility, and loss of landscape functions and processes which further results in loss of future production potential of land.	Northern Australia, including: NT regions – (Daly basin, Arnhem Land, Gulf); QLD – Northern Gulf, Burdekin catchment, GBR catchments; WA – Kimberley.	6, 11, 16, 18, 23, 24, 25, 27, 63–68
Biodiversity Impacts		
Effects of grazing typically result in significant impacts on flora and fauna, including declines in bird and mammal assemblages and diversity, and associated plant and habitat resources	Northern Australia	22, 32–35, 76, 97, 102, 109
GHG Emissions and Climate Change		
GHG from cattle contributing 2–4% of national emissions, estimated at 10.5–25 kg CO_2-e/kg of Live Weight sold, or 1.78–1.83 tCO_2-e/yr per adult equivalent in northern Australia	Australia wide and northern Australia	336, 68, 77, 102, – also see the Australian GHG Emissions Information System (AGEIS) calculator @ (http://ageis.climatechange.gov.au)
Woody Thickening		
Over-grazing, often combined with reduced fire frequency, can result in woodland thickening (involving both native and exotic species) with significant impacts on pasture growth and pastoral productivity. Conversely, C sequestration is promoted through woody thickening	Northern Australia	75, 77–85, 125, 126, 132
Weeds		
Heavy grazing often results in weed infestations. Benefits associated with introduced pasture species (including grasses) typically are far outweighed by long-term environmental costs	Northern Australia	86–93
Impacts on Freshwater and Perennial Water Resources		
Grazing can have significant impacts on quality and quantity of freshwater water resources, downstream ecological communities, and the cultural needs of local indigenous communities	The NT Gulf, GBR, and its catchments on the eastern coast of Queensland	16, 24, 25–28, 30, 64, 94, 95, 113, 118

Table 5.4 Cattle Numbers, Recommended Carrying Capacity, and Long-Term Stocking Rates in North Australia Sub-Regions

Sub-Regions[a]	Proportion of Sub-Region in North Australia (%)	Proportion of Sub-Region with Pastoral Land Use (%)	Pasture Land Use Area ($km^2 \times 1000$)	Beef Cattle Numbers[b] ($\times$ 1000)	Recommended Average Carrying Capacity (CC)[c] (hd/km^2)	Long-term Average Stocking Rate (SR), 2001–2012[d] (hd/km^2)	SR/CC	Proportion of degraded land (B-Deteriorating/ C-Degraded)[e] (%)
NT–DTE (M)	100	45[f]	91	187	2	1	1	0.6/0.3
NT–VRD (M)	95	80	158	719	6	6	1	0.5/0
Qld–Gulf (M–H)	97	95	199	1,224	4	7	1.75	0.42/0.13
Qld–CYP (L)	100	85	92	125	4	4	1	0.39/0.15
Qld–Coast (L+H)	65	95	44	573	4	17	4.86	0.4/0.15
WA–East Kimberley (L)	65	75	197	992	2	3	1.5	0.35/0.1
WA–Central Kimberley (L)	72	80	76	344	2	3	1.5	0.19/0.07

[a] L, M, M–H, H denotes low, moderate or moderate-high, or high areas of pasture production potential, respectively.

[b] Bray S, et al. 'Desktop research project to provide data on liveweight and liveweight gain in the beef cattle sector in Queensland and the Northern Territory'. Final report, 2015. Department of Agriculture and Fisheries, State of Queensland, Rockhampton, Australia, 2015.

[c] Tothill JC, and Gillies C (1992). *The pasture lands of northern Australia: their condition, productivity and sustainability*. Published by the Tropical Grassland Society of Australia Inc. on behalf of Meat Research Corporation, Brisbane, Australia and expert opinion; note that these average values mask significant productivity variability.

[d] McLean I, et al. 'The Northern beef report – 2013 northern beef situation analysis'. Meat & Livestock Australia, North Sydney, NSW, 2059, 2014; note that these average values mask significant productivity variability.

[e] Tothill JC, and Gillies C (1992). *The pasture lands of northern Australia: their condition, productivity, and sustainability'*. Published by the Tropical Grassland Society of Australia, on behalf of Meat Research Corporation, Brisbane, Australia.[58]

[f] Includes only area under operational cattle enterprises; additional area, especially Arnhem Land, supports large feral stock numbers including very environmentally destructive Asian water buffalo.

Table 5.5 Net Sustainable Economic Benefits (EBIT Less Costs Associated with GHG Emissions from Cattle and Degraded lands) in North Australia Sub-Regions

Sub-Regions	Total Potential Returns from Pasture Enterprise (EBIT) ($/yr × 1000)	Cost of GHG (@$10/ tCO_2–e)/yr) ($/yr × 1000)	Loss of Production from Degraded Land (Accounting 25% for B (Deteriorating) and 50% for C (Degraded) Land Condition) ($/yr × 1000)	Total Costs – GHG Emissions and Loss of Production from Degraded Land ($/yr × 1000)	Net Sustainable Benefits (excl. Cost of Loss of ES from Degraded Land) ($/yr × 1000)	Loss of ES Due to Land Degradation in 'B' and 'C' Land Condition (Based on Tothill and Gillies 1992)[a] ($/yr × 1000)
NT–DTE (M)	1,567	–1,239	–47	–1,286	281	–85,134
NT–VRD (M)	10,972	–4,814	–137	–4,951	6,021	–61,608
Qld–Gulf (M–H)	20,019	–8,132	–3,403	–11,535	8,484	–1,056,591
Qld–CYP (L)	3,152	–1,768	–544	–2,311	841	–497,110
Qld–Coast (L+H)	8,171	–2,999	–1,430	–4,429	3,742	–240,443
WA–East Kimberley (L)	5,143	–3,282	–707	–3,989	1,154	–846,199
WA–Kimberley (L)	2,833	–1,526	–234	–1,760	1,074	–194,654
Total costs/benefits ($)/yr × 1000)	**51,857**	**–23,759**	**–6,502**	**–30,261**	**21,596**	**–2,981,740**

[a] Land degradation estimate assumed to be $156/ha/yr for lands in C condition, and $78/ha/yr for lands in B, following ELD initiative (2015). (From The Economics of Land Degradation (ELD) initiative, *The Value of Land: Prosperous Lands and Positive Rewards through Sustainable Land Management*, ELD Secretariat, Bonn, Germany, 2015. Retrieved from www.eld-initiative.org.).

yet been undertaken for North Australia savanna conditions or poses significant challenges – for example how to put monetary values on biodiversity components and ecologically critical surface and groundwater resources (see Boxes 5.2 and 5.3).

BOX 5.2 WATER, WETLANDS AND ECOSYSTEM SERVICES

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Wetland ecosystems (including lakes, rivers, marshes, estuaries, and near-shore coastal regions to a depth of 6 meters at low tide) contribute a large range of ecosystem services to human well-being.[1] Provisioning services include supplying water directly for human consumption, as well as water for the production of food, fibre, and fuel. Regulating services provided by wetlands include water purification, climate regulation, flood regulation, and coastal protection. Cultural services include the recreational and tourism opportunities associated with inland freshwaters, estuarine, and near-shore marine regions.[1] Although it is universally accepted that the provision of water is essential to human well-being, it is often not recognised that basic water infrastructure is provided by rivers, lakes, soil, plants, and trees. Investing in and maintaining the land around surface water sources and protecting groundwater resources (particularly aquifer recharge zones) will create a more water-secure future for cities and communities, in addition to generating other benefits, including conservation and protection of biodiversity.[2]

One of the most striking examples of the value of maintaining ecosystem services to support the provision of water is that of the New York City water supply and the restoration of the Catskill/Delaware watersheds.[3] In the late 1990s the quality of drinking water in New York City had declined below acceptable US Environmental Protection Agency (EPA) standards. The cause was found to be watershed (catchment) pollution from various developments, including runoff from agricultural lands and impervious urban surfaces, and discharges from wastewater treatment plants. Pollutants had reduced the ability of the watersheds to provide the ecosystem service of water purification.[3] Restoration of the watershed was estimated to cost $1 to $1.5 billion, while construction of a water filtration plant would cost $6–$8 billion with a further $300 million per year to run the plant. The city of New York saved billions of dollars by choosing the restoration option. The watershed protection program implemented to preserve and restore natural filtration services was clearly a more cost-effective means of providing good quality water than building a water treatment plant.

The major categories of source water protection activities for cities[2] can also be usefully applied to the wetland ecosystems of northern Australia (Table B5.2.1). It is also recognised that the value of source water protection goes well beyond the issue of providing water security for communities. The benefits of investing in water source protection include reduction of our carbon footprint, conserving biodiversity and maintaining critical ecological processes, climate change mitigation, and adaptation and building healthier and more resilient communities.[2]

Protecting and restoring the vegetated fringing zones of tropical wetlands and the riparian zones of tropical rivers is also of critical importance in maintaining the ecosystem services provided by the freshwater ecosystems of Australia's north. These land-water interfaces

(*Continued*)

BOX 5.2 (Continued) WATER, WETLANDS AND ECOSYSTEM SERVICES

Table B5.2.1 Major Categories of Source Water Protection

Source Water Protection Activity	Description
	*Targeted land protection*: Protecting targeted ecosystems, such as savannas, grasslands, or wetlands
	*Revegetation*: Restoring natural savannas, grasslands, or other habitat through planting (direct seeding) or by enabling natural regeneration
	*Riparian restoration*: Restoring natural habitat that is at the interface between land and water along the banks of a river or stream. These strips are sometimes referred to as riparian buffers.
	*Agricultural and pastoral best management practices (BMPs)*: Changing agricultural/pastoral land management to achieve multiple positive environmental outcomes
	*Fire risk management*: Applying prescribed burning early in the season to reduce grass-fuel and reduce the risk of wildfires
	*Wetland restoration and creation*: Re-establishing the hydrology, plants, and soils of former or degraded wetlands that have been drained or modified
	*Road management*: Deploying a range of avoidance and mitigation techniques that aim to reduce the environmental impacts of roads, and other development activities

Source: Abell, R. et al. (2017). *Beyond the Source: The environmental, economic, and community benefits of source water protection*, Arlington, VA: The Nature Conservancy.

influence and regulate a range of processes, including nutrient and sediment fluxes, water temperatures (shading), and organic matter (leaf litter) inputs. They also influence terrestrial biodiversity through the provision of habitats and food for many faunal species.[4] Land-water interfaces are ecotones, which share elements of both adjoining aquatic and terrestrial ecosystems and are vulnerable to threats from both directions They are especially prone to invasion by exotic species. Invasive plants can reduce plant diversity by smothering and destroying natural vegetation and reduce the availability of riparian habitats for birds and other fauna. Grazing and trampling of fringing and riparian vegetation by cattle and other introduced herbivores also degrades these habitats and reduces water quality through the associated influx of sediments and nutrients.

In the wet-dry tropics perennial river pools play an important role in sustaining populations of aquatic species. The perennial pools that persist within dry river channels after

(*Continued*)

BOX 5.2 (Continued) WATER, WETLANDS AND ECOSYSTEM SERVICES

monsoonal rains cease, provide important ecological refuges for many species that require permanent water.[4] These pools enable aquatic species to persist until wet season rains, and associated river flows, return. Ensuring that perennial pools are not depleted by over-extraction of groundwater or surface water resources is a major management issue. Accordingly, the determination of environmentally sustainable levels of water extraction is currently a key area of research focus in northern Australia.

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BOX 5.3 A SOCIAL, ECONOMIC, AND ENVIRONMENTAL ASSESSMENT OF WATER RESOURCE DEVELOPMENT IN NORTHERN AUSTRALIA

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UNIVERSITY OF ADELAIDE, ADELAIDE

Developing water resources to increase the value of agriculture is a long-held ambition for northern Australia. Agriculture in northern Australia is characterised by relatively low value beef production with scattered examples of irrigation development to produce higher value crops and feedstock for cattle (e.g. the Ord in WA and the Burdekin in QLD). The June 2015 Australian Government White Paper, *Developing Northern Australia*, outlines a series of federal government investments and reforms to encourage land and water resource development in the north. Any development will come with environmental and social trade-offs from the changes to terrestrial and freshwater ecosystems, and assessing these trade-offs is essential for determining the full range of benefits and costs from water resource development.

In 2013 the Commonwealth Scientific and Industrial Research Organisation (CSIRO) completed an assessment of water resource development opportunities in two catchments of North Queensland, the Flinders and Gilbert rivers, to add to the information base for developing northern Australia. The Flinders and Gilbert Agricultural Resource Assessment identified the soil and water resources available for new irrigated agriculture, the economic viability of irrigated agriculture and documented the ecological systems, industries, infrastructure and values associated with irrigation development. The Flinders and Gilbert Assessment estimated the utility of irrigation development based on the economic, environmental and social costs and benefits of potential irrigation development. The triple bottom line (TBL) assessment includes monetary indicators describing environment and economy as well as broader social considerations.

(*Continued*)

BOX 5.3 (Continued) A SOCIAL, ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF WATER RESOURCE DEVELOPMENT IN NORTHERN AUSTRALIA

The TBL assessment used a Bayesian decision network (BDN) to estimate the utility of irrigation development in the Flinders and Gilbert catchments. The BDN has many properties that make it useful for performing a TBL assessment, in particular their ease of construction; their ability to handle quantitative and qualitative data types; their preservation of system knowledge and; their ease of use in aiding decision making. The ecosystem services framework was used to structure the BDN and estimate the utility of water resource development.

The TBL assessment:

1. Captured expert knowledge estimating potential impacts to aquatic and terrestrial ecosystems from water resource development.
2. Surveyed regional stakeholders on their values associated with ecosystem services, their priorities for managing ecosystem services, and their preferences for water resource development more broadly (i.e. social values).
3. Reviewed and summarised the unit economic values of ecosystem services supplied by land and water ecosystems in the region.
4. Built a BDN to integrate results from one to three above to estimate the utility of water resource development based on social, environmental and economic benefits and costs.
5. Investigated scenarios that could increase the utility of water resource development.
6. Discussed the institutional and natural resource management options that minimise tradeoffs between irrigation development and ecosystem service impacts.

From the perspective of the TBL, the total utility of water resource development is negative in both the Flinders and Gilbert catchments. The explanation for the negative utility is that the negative impact to ecosystem service values is not balanced by the positive benefits of water resource development. Water resource development, if fully realised, will result in large areas of land use change, impacting on the supply of ecosystem services from the terrestrial land system. The benefit to ecosystem services supplied by the land system will be largely neutral to negative following development.

Diversion of water for irrigation and the subsequent alterations to hydrology and freshwater and riverine ecosystems, while not necessary large overall, will impact on the crucial dry-season pool refugia, as well as potentially impacting on riparian zones and estuarine environments. Results of the ecosystem services social surveys demonstrate that the 'food production' and 'habitat for species' ecosystem services were highly valued by respondents. The estuarine (prawns and fish) and in-stream fish food-based ecosystem services and the freshwater and terrestrial habitat ecosystem services are important components of the BDN model and the medium-to-high impact to them from development, plus their high social and economic value, contribute to the negative utility.

The negative utility is further explained by the low economic value at farm scale of water resource development as demonstrated in the rigorous economic analysis of irrigation costs and benefits completed for the Flinders and Gilbert Assessment, and the high frequency of locations of relatively low land suitability for many irrigated crops. The irrigated agriculture potential estimated in the BDN model is therefore most likely to be low and the benefit for food production (crops and beef) is therefore neutral.

The overall utility of water resource development in both the Flinders and Gilbert catchments could enter positive territory in a number of scenarios: (1) water resource development

(*Continued*)

BOX 5.3 (Continued) A SOCIAL, ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF WATER RESOURCE DEVELOPMENT IN NORTHERN AUSTRALIA

Table B5.3.1 Utility Value of Water Resource Development in the Flinders and Gilbert Catchments under Different Scenarios

	Flinders Catchment	Gilbert Catchment
Baseline	–296	–378
Scenario 1	2	–54
Scenario 2	53	32
Scenario 3	314	314

Note: Baseline: Plausible scenarios of water resource development; Scenario 1: Water resource development with high economic benefits but ecosystem impacts as per baseline; Scenario 2: No ecosystem impact from irrigation development, but economic benefits as per the baseline; Scenario 3: The economic benefits are high and no ecosystem impact.

is highly sensitive to the environment and there are no or very low environmental impacts, or (2) given an absence of environmental impacts, much higher net economic returns to irrigators eventuate, possibly through higher commodity prices, lower capital costs of water resource development or some combination of both (Table B5.3.1).

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1. Crossman ND, Bark RH (2013). 'Socioeconomics: triple bottom line accounting'. Technical report to the Australian Government from the CSIRO Flinders and Gilbert Agricultural Resource Assessment, part of the North Queensland Irrigated Agriculture Strategy. CSIRO Water for a Healthy *Country* and Sustainable Agriculture flagships, Australia.

For pasture condition, the total area of degraded pastoral land was assessed using data from a regional study published in 1992,[58] classifying northern pastoral lands as being in A (good), B (deteriorating), and C (degraded) states. Although somewhat dated, expert advice suggests that this condition assessment is still broadly representative – if conservative. For example, whereas the report[58] considered only small areas of the NT's VRD pastoral district to be in a degraded state (Table 5.4), more recent assessments document some areas of improvement, and continuing degradation in localised areas of the VRD[96] particularly in association with critical riparian habitat.[97]

Given established relationships that pastures in B and C condition result in reduced productivity,[4,6,16,98,99] we first estimated losses in pasture production and consequent cattle returns for both B and C areas (EBIT/year). As suggested by pastoral scientists,[5,99] we assumed that pastoral lands in B condition reduced pastoral productivity by 25% and by 50% when in C condition. Overall, losses in cattle production from pasture degradation were $1,000–$26,725 per median-sized property/year, with an average of $10,500/property/year. It is notable that land condition in our focal region is generally much better than for the broader northern Australia pastoral estate.[4,17,58]

Costs associated with greenhouse gas (GHG) emissions from cattle were determined using regional cattle numbers,[4] and region-specific cattle GHG emissions ranging from 0.023 to 0.311 tonnes of $CO_{2\text{-equivalent}}$/year/ha (t. CO_2-e/year/ha).[100] The average annual costs for most properties in QLD and the NT ranged between $100,000 and $150,000/median-sized property, and $173,000/property in the Western Australia (WA) Kimberley region.

Taking into account environmental costs associated with lost pastoral production from pasture degradation, and GHG emissions, we can derive a conservative, indicative estimate of the net economic returns of typical pastoral properties in our focal region (Figure 5.7). For the period 2001–2012,

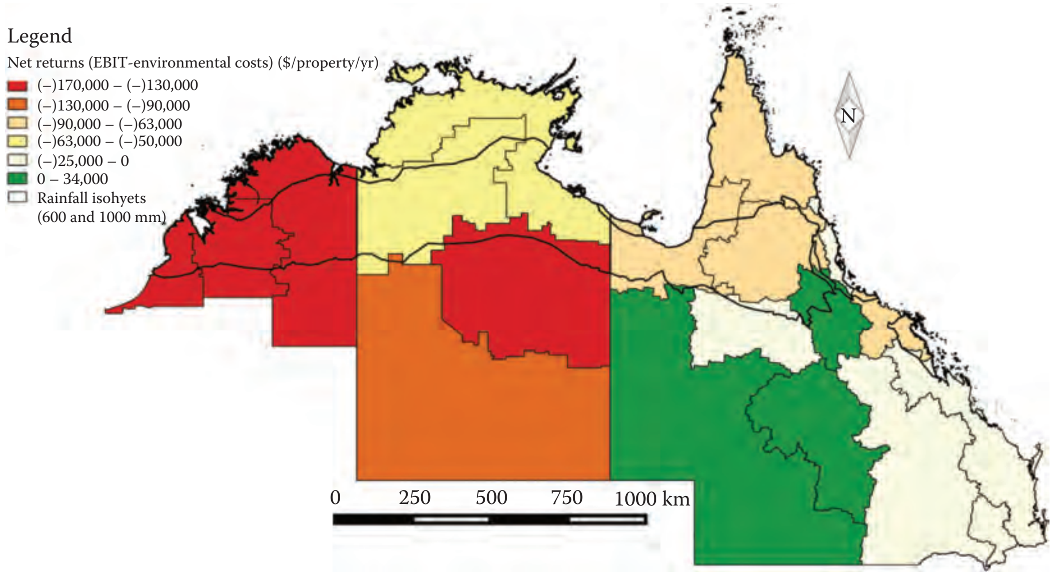

Figure 5.7 'Net annual returns (EBIT) per median-sized North Australia property, adjusted for costs of losses in production due to land degradation and GHG emissions'. (From McLean, I. et al., *The Northern Beef Report – 2013 Northern Beef Situation Analysis*. Meat & Livestock Australia Ltd., North Sydney, NSW, 2059, 2014; Bray, S. et al., 'Desktop research project to provide data on liveweight and liveweight gain in the beef cattle sector in Queensland and the Northern Territory'. *Final report, 2015*. Department of Agriculture and Fisheries, State of Queensland, Rockhampton, Australia, 2015; Eady, S. J. et al., 'Down scaling to regional assessment of greenhouse gas emissions to enable consistency in accounting for emissions reduction projects and national inventory accounts for northern beef production in Australia', *Rangeland J.,* 38, 219–28, 2016 and others.)

net returns for median-sized properties were highly negative both for EBIT (and especially EAIBT), for example: −$70,000/year for Top End NT, −$89,000/year for Cape York, −$133,000 for Kimberley (WA).

Applying a similar approach to that described earlier, we present a complementary assessment of net pastoral enterprise sustainability for seven sub-regions (principally following ABARES statistical boundaries) within our focal region, based on identified areas of low, moderate, and moderate-high carrying capacity (Figure 5.4c). Stocking rates (SR) in five sub-regions were observed to exceed recommended carrying capacity (CC; Table 5.4). Considering only areas of B and C land condition,[56] net benefits (EBIT less environmental costs) for our entire North Australia focal region based on available data for the period 2001–2012 are estimated to amount to just $21 million/year (Table 5.5), before any consideration of interest repayments (EABIT). Although there is no simple robust measure linking overstocking (high SR relative to CC) with land condition class, we can anticipate that associated environmental costs will continue to accumulate with time.

Land degradation also results in significant loss of ecosystem services (Tables 5.3 and 5.5), in addition to those we have costed conservatively above. A recent international assessment of the loss of ecosystem services from degraded lands estimated an average annual indicative cost of $156/ha/year.[101] When applied at a full rate to degraded (land condition C) lands, and a 50% discount to partly degraded (land condition B) lands, in our focal region, annual losses of associated ecosystem services amount to $3 billion/year (Table 5.5).

By any measure, under the current market forces scenario, the North Australia pastoral industry is generally unsustainable. However, as demonstrated by 'exceptionally performing' pastoral enterprises, and especially those which can and have implemented adaptive, seasonally conservative herd management practices,[102–105] enhanced sustainability is attainable.

5.4 TOWARDS THE DEVELOPMENT OF A SUSTAINABLE LAND SECTOR ECONOMY IN NORTH AUSTRALIA

The previous analyses reinforce a number of recent informed assessments concerning the poor financial and environmental performance and sustainability of much of the northern beef industry.[5,11,12,106] These conditions are reinforced further by the most recent authoritative industry assessment for the years 2004–2016, which only came available after the analyses presented here were completed.[*] Policy imperatives which flow from this assessment include: firstly, recognition that fundamental land sector change is required (in stark contrast with the 'business-as-usual' mantra of current north Australia development policy[52]); and consequently, recognition that more culturally, economically, and environmentally sustainable regional options need to be supported and developed. In practical terms, a key regional sustainable development challenge is to embrace a great transition pathway to a more diversified ecosystem services-based land sector economy.

A first issue to appreciate is that North Australia, far from being a landscape endowed with extensive high pastoral potential (unlike the Barkly and Queensland's Mitchell grasslands), instead supports very significant cultural (Chapter 2), biodiversity conservation,[107] and global carbon stock values[108] which contribute significantly to the socioeconomic well-being of local and regional communities. The North is dominated by lands of international conservation significance[107] (Figure 5.8a): 76% of 0.5°cells ($n = 573$) encompass lands where at least half the cell area is either managed currently for conservation purposes (e.g. National Parks, Indigenous Protected Areas (IPAs), savanna burning project areas), or comprise high conservation value riparian areas (Box 5.2) and biodiversity-rich, topographically rough, hilly terrain[109–111]).

The relatively little structurally modified (by global standards) North Australia landscape resource supports a thriving nature-based tourism industry, anticipated to be worth $2.8 billion in 2018.[112] That industry is based particularly on maintaining intact freshwater systems and associated recreational fishing opportunities.[112,113] Maintaining the integrity and quality of flow regimes is vital also for the productivity of the northern commercial fishing industry,[112] the multibillion dollar tourism industry based on the Great Barrier Reef resource,[27,114–117] and very significant cultural, livelihood, and economic dependencies and aspirations of Indigenous people.[118,119]

In the North Australia focal region, the formal conservation estate (e.g. National Parks, IPAs) occupies 400,000 km^2 and savanna burning projects separately 331,000 km^2 (as at January 2017) (Figure 5.8 a, b), with a combined net area of 595,030 km^2, or 50% of the total region. Both these estates deliver many economic, social, and cultural values to local people. For example, it is estimated that at least 650 Indigenous FTE (full-time equivalent) positions currently are available (mostly through Commonwealth commitments to Working on *Country* and IPA funding programs) to service the North Australia conservation land sector economy (Box 4.5); contrasting with about 390 Indigenous positions currently available through the pastoral industry.[*] Market-based ecosystem services enterprises offer significant opportunities for growing Indigenous employment opportunities, and concomitantly reducing public expenditures,[120–123] in a diversified North Australia land sector economy (Chapter 4). As addressed also in the following, a key challenge is to reframe current government Indigenous conservation and employment program expenditures as investments for building local Indigenous land sector-based enterprises.

The rapid expansion in market-based savanna burning GHG emissions abatement projects since the introduction of the Australian Government's Carbon Farming Initiative in 2012, and its current iteration as the publicly funded emissions reduction fund, points to the potential both for ongoing expansion in savanna burning projects and the ecosystem services sector generally. Notably, the distribution of current (Figure 5.8b) and prospective (Figure 5.8c) savanna burning projects overlaps markedly with areas identified as having high conservation significance (Figure 5.8a) but has limited overlap with areas identified as supporting (relatively) high pastoral carrying capacity (Figure 5.4c). Savanna burning projects

[*] See Holmes P, McLean I, Banks, R (2017). *The Australian Beef Report*. (Bush AgriBusiness Pty Ltd: Brisbane.)

can be undertaken profitably also on pastoral properties with eligible fuel types (Figure 5.8d), especially in more fire-prone, pastorally marginal situations,[124] whereas there are genuine concerns about the application of prescribed, relatively low intensity, early dry season fires on pastorally productive grasslands which can, in combination with grazing, result in undesirable woody invasion and thickening.[125–127]

Using the Savanna Burning Abatement Tool (SavBAT),[128] we estimate that an annual average of 7.5 million tonnes (Mt) CO_2-e of accountable GHGs were emitted from savanna fires over the decadal period 2000–2009. Assuming that well-implemented savanna burning projects typically can reduce GHG emissions by at least one third,[129,130] collectively such projects could realize $20–30 million/year based on a currently conservative average carbon price of $10–15 t. CO_2-e. Over the next few years it is likely that additional carbon sequestration opportunities will become available for savanna burning projects through development of methodologies accounting for storage of carbon in woody debris and in living trees. Initial estimates suggest that, for every carbon credit (1 t. CO_2-e) generated by savanna burning emissions abatement projects, complementary sequestration methods could provide an additional three credits for woody debris sequestration,[131] and at least another five credits for sequestration in living trees.[132]

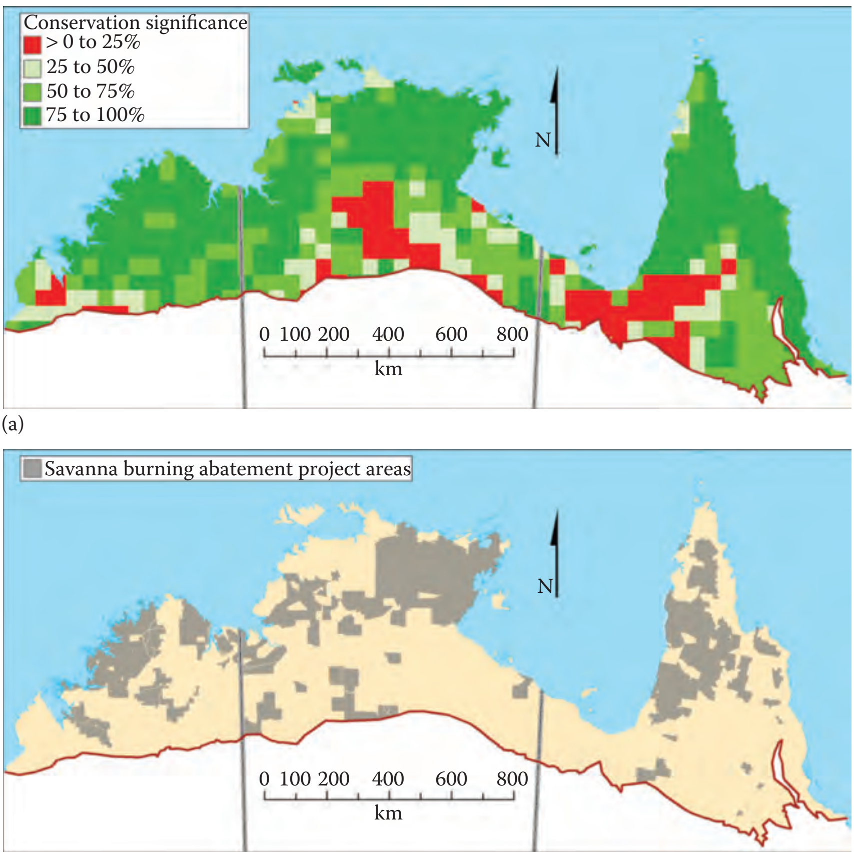

Figure 5.8 Towards a more sustainable land sector economy: (a) Conservation significance, mapped as proportion of 0.5° cells comprising all lands managed for conservation purposes, buffered riparian areas, high topographic roughness – refer Chapter 2 for details; (b) registered 79 savanna burning GHG emissions abatement projects (total area 331,000 km²), as at January 2017. (http://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/carbon-abatement-contract-register.)

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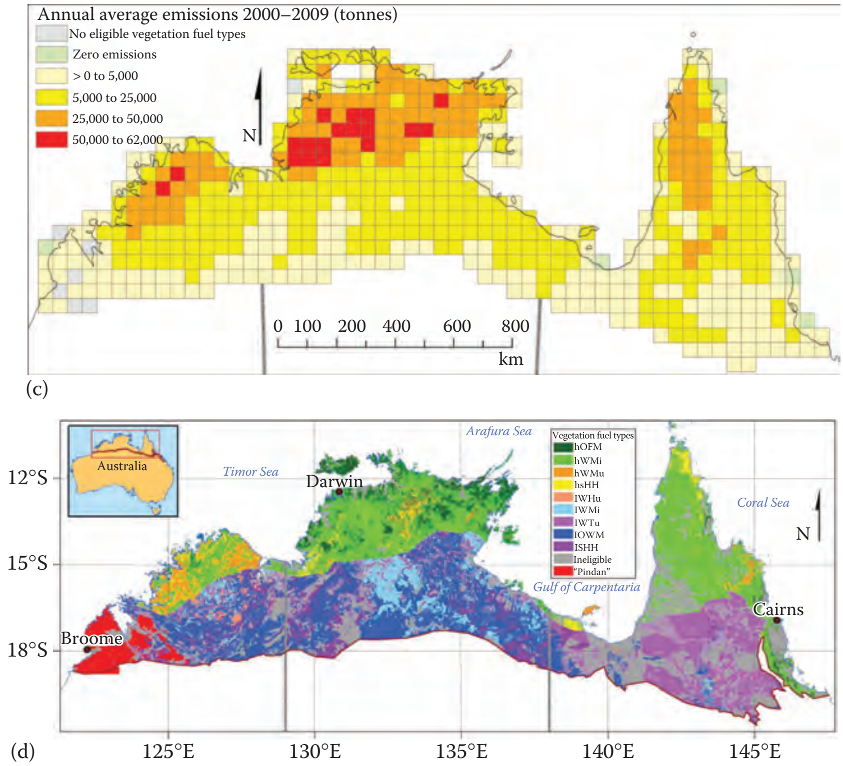

Figure 5.8 (Continued) Towards a more sustainable land sector economy: (c) mean accountable greenhouse gas (GHG) emissions (methane, nitrous oxide) from savanna fires, 2000–2009, summarized per 0.5°cells – based on methodology as at 10 April 2015 (http://www.comlaw.gov.au/Details/F2015L00344.), and following calculation procedures as given in Russell-Smith et al. (2015: Chapter 10[129]); (d) vegetation fuel types: hOFM – open forest with mixed grass, hWMi – Woodland with mixed grass, hWHu/lWHu – Woodland with hummock grass, hSHH – Shrubland (heath) with hummock grass, lWMi – Woodland with mixed tussock/hummock grass, lWTu – Woodland with tussock grass, lOWM – Open Woodland with mixed grass, and lSHH – Shrubland with hummock grass. (From https://data.qld.gov.au/dataset/the-vegetation-of-the-australian-tropical-savannas.)

One evident risk to this scenario is the potential spread of highly flammable, high fuel-load exotic pasture grasses, which are relatively difficult to manage and contain (Box 5.4).

The emergence of the savanna burning industry highlights opportunities for developing further innovative ecosystem services markets and activities based on North Australia's natural and cultural assets. For the pastoral industry, already we are seeing a rapid expansion of carbon market opportunities, including reducing livestock emissions; increasing efficiency of fertiliser use; enhancing carbon in agricultural soils; and sequestering carbon through revegetation and reforestation.[133] It has been suggested also that carbon markets could assist with developing more sustainable grazing practices through incentivising both the restoration and maintenance of productive pastures*. These sorts of affirmative ideas sit at the heart of progressive thinking in the northern pastoral industry (for example, auditable grazing best management practice standards as established by the Fitzroy Basin Association's market chain accreditation scheme[134]). However, the market potential of such systems still has to be developed.

Given the international conservation significance of North Australia, practical incentives are needed for sustainable land management practices on public (typically pastoral leasehold) and

* Steven Bray, personal communication, 2016.

BOX 5.4 HIGH BIOMASS GRASSES THREATEN THE SAVANNA LANDSCAPE

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The biodiversity and function of Australia's tropical savannas and wetlands are under threat from a range of high biomass, invasive tropical grasses. Significant areas of invasion occur across northern Australia, particularly in the Top End region of the Northern Territory and Cape York Peninsula, Queensland. Species of particularly high threat are gamba grass (*Andropogon gayanus*), annual mission grass (*Cenchrus pedicellatum*), perennial mission grass (*Cenchrus polystachion*), grader grass (*Themeda quadrivalvis*), and Guinea grass (*Megathyrsus maxim*us). These species were introduced primarily for assessment and/or use for pastoral production. They were selected for their persistence under harsh conditions and their higher growth rates and nutritional value compared to native grasses. However, the characteristics were selected to try and find successful pasture plants resulted in making them successful weeds.

Of the suite of invasive grasses, gamba grass poses the greatest threat to northern Australia's savannas. Two varieties of *A. gayanus* were introduced in the 1930 and '40s, subsequently cultivated into the cultivar 'kent' with commercial seed supply available in 1983.[1] Large-scale plantings commenced in the 1980s, but the rate of invasion has been explosive,[2] and it now covers 15,000 km^2 of the NT, with the potential to invade 380,000 km^2 in the NT alone in addition to other large areas in Queensland and Western Australia.[1] The rapid invasion and the significant threat for conservation, aboriginal, pastoral, mining, and defence land users is reflected by its status as one of Australia's weeds of national significance and a key threatening process under the Commonwealth's Environment Protection and Biodiversity Conservation Act.

Gamba grass invasion is considered very high risk across northern Australia because of the resultant changes to fuel beds and fire behaviour.[3] Invasion results in a tall (~4 m), dense fuel bed of up to 25–30 t ha^{-2} that replaces the shorter (<0.5 m) native grass fuel bed (up to 6 t ha^{-2}) savanna communities.[3–5] As a result, fire intensity (the product of the available heat of combustion per unit of ground area and the forward spread of the fire, measured in kilo or megawatts per metre) increases significantly, from typically 1–3 MW m^{-2} in native grass fires to 16 MW m^{-2} in gamba fuelled fires in the early dry season (Figures B5.4.1 through B5.4.3).[5]

The flame height is greater in the invaded sites resulting in more fire damage to the tree and shrub layers.[5,6] If invaded sites are not burnt in one fire season, the fire fuel load increases resulting in more intense, high combustion fires in the following year.[3,5] Plant species diversity is substantially reduced after only a few gamba fuelled fires, and at some sites where we have undertaken repeated vegetation surveys over the past decade, we have followed the vegetation decline from healthy savanna to having only a few unhealthy woody plants remaining (Figure B5.4.4). This represents a major reduction in above-ground savanna carbon store, and therefore a financial risk to landholders engaging in savanna burning projects.[7] This is particularly important given that 75% of the eligible area for savanna burning is spatially coincident with the high suitability range for gamba grass.

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BOX 5.4 (Continued) HIGH BIOMASS GRASSES THREATEN THE SAVANNA LANDSCAPE

Figure B5.4.1 Dense stands of gamba grass in the Northern Territory. The grass now poses a serious risk to savanna vegetation as it transforms key elements of the ecosystem. (Courtesy of Samantha Setterfield.)

Figure B5.4.2 Dense stands of gamba grass in the Northern Territory. The grass now poses a serious risk to savanna vegetation as it transforms key elements of the ecosystem. (Courtesy of Michael Douglas.)

(*Continued*)

BOX 5.4 (Continued) HIGH BIOMASS GRASSES THREATEN THE SAVANNA LANDSCAPE

Figure B5.4.3 Gamba grass invasion leads to much hotter fires in the savannas. (Courtesy of Samantha Setterfield.)

Figure B5.4.4 Gamba grass invasion can lead to dramatic declines in tree canopy. (Courtesy of Samantha Setterfield.)

High intensity gamba grass fires have substantial impact on fire management practices and costs. Historically fires were low intensity native grass fires, which occurred in sparsely populated areas, and which could be managed using minimal firefighting equipment. Gamba grass invasion has resulted in hotter fires occurring in residential areas, requiring helicopters and water bombing planes to effectively protect people's lives and properties. Fire management costs have increased

(Continued)

BOX 5.4 (Continued) HIGH BIOMASS GRASSES THREATEN THE SAVANNA LANDSCAPE

none-fold in 10 years in a region of the NT due primarily to gamba grass invasion.[3] Further economic impacts of gamba grass fires are evident each year with damage to dwellings and infrastructure, and the cost of weed management activities to the landholders and government.

Gamba grass presents a long-term threat to Australia's savannas and its biodiversity. Carbon abatement programmes are also at risk. However, many of the infestations on properties are currently small and not financially onerous to eradicate. In addition, current gamba infestations total only 2% of the current potential range. Therefore, immediate containment of the existing gamba infestations would be a significant step in mitigating the risk posed by gamba grass to Australia's iconic savanna region.

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Indigenous lands, especially the maintenance and restoration of critical aquatic systems.[29] While regulatory requirements and approaches evidently need to be better and more forcefully applied by relevant administering institutions, equally, incentivized approaches need to be encouraged (for example, subsidies for riparian fencing and alternative watering point infrastructure; active promotion of market-based sustainable pastoral enterprise accreditation schemes). A land stewardship case for enhancing biodiversity conservation outcomes has been suggested through the application of carbon market-based fire and grazing management.[135]

For regional Indigenous communities and organisations, land sector enterprise opportunities include a variety of contractual services besides the undertaking of current government-funded land and sea natural resource management activities – for example, assuming prime responsibility for remote community emergency management, from prevention to response capabilities[136]; cultural site management; infrastructure maintenance; road works management; degraded land and mine site rehabilitation (Box 4.3); quarantine and surveillance activities; commercial harvest activities; culture-based ecotourism; and industry-funded environmental offset projects that are compatible with community values and needs.[137] In short, any activity that helps develop independent business capability, social capital (Box 5.5), and an extensive

BOX 5.5 SOCIAL CAPITAL AND THE CREATION OF AN INNOVATIVE ENVIRONMENTAL AND CULTURAL ENTERPRISE IN ARNHEM LAND

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It takes more than one kind of capital to establish an innovative and successful not-for-profit enterprise on Aboriginal land. The genesis of the West Arnhem Land Fire Abatement (WALFA) project demonstrates this point.

For all enterprises, start-up financial capital is needed to pay the bills until an adequate income stream flows. But for WALFA, the first and most critical step was creating social capital to underpin a vigorous collaboration between Aboriginal rangers, communities of traditional owners and governments, industry, and the science community.

It took almost ten years of project development to reach the point in 2006 where a deal brokered by the Northern Territory Government with the operators of the Darwin Liquefied Natural Gas (DLNG) plant provided funds to allow WALFA to go fully operational. In 2006 the DNLG plant owners, energy giant Conoco Phillips, signed up to provide 22 years of funding contingent on WALFA abating a minimum of 100,000 tonnes of CO_2-e emissions annually from an area of 28,000 km^2 in western and central Arnhem Land.

Funding started with $1.3 million per year (subject to annual indexing) supporting fire abatement work by five Aboriginal ranger groups – Manwurrk (later Warddeken), Djelk, Adjumarlarl, Mimal, and Jawoyn. Since 2013, WALFA has expanded to include most of Arnhem Land under an Aboriginal-owned umbrella entity. With additional income generated from access to the Australian Government's Emissions Reduction Fund, this entity confidently expects a minimum turnover for the 2016 calendar year of ~$10 million.

But without implementation of a considered and strategic approach to raising social capital, this social and environmental success would not have happened.

Social capital is defined by theoreticians in various ways but the concise description from an Organisation for Economic Co-operation and Development (OECD) publication will suffice in telling the WALFA story: 'Social capital provides the glue which facilitates co-operation, exchange, and innovation'.[1]

In 1997, the fire regime prevailing in western and central Arnhem Land was both a serious local problem and a contributor to the global problems of increasing greenhouse gas (GHG) emissions. During times of assimilation policies, most Aboriginal land managing groups, who for millennia had maintained fire regimes typified by many small and cool fires in the early dry season, had been drawn into government settlements and missions and further afield away from their clan estates. Without this very effective management approach, fire regimes changed to being dominated by late dry season fires, often massive in extent, fierce in intensity and increasingly frequent. Managed fire became feral fire.

Increasing late dry season fires were pushing a fire sensitive cohort within plant communities towards local extinctions and creating big changes in the composition of those plant communities, with negative flow-on effects to animal species.

Much of this was happening out of sight of human observation in a very depopulated, large landscape. Following plant surveys relying on helicopters to access remote, rugged, and trackless areas in the 1980s, alarm bells began to toll amongst conservation scientists. A leadership of emerging Aboriginal ranger groups employing 'two-toolbox' management focused on reinvigorating

(*Continued*)

BOX 5.5 (Continued) SOCIAL CAPITAL AND THE CREATION OF AN INNOVATIVE ENVIRONMENTAL AND CULTURAL ENTERPRISE IN ARNHEM LAND

customary management and indigenous knowledge but open to using non-Aboriginal management tools, also began to notice the effects of bad fire (for example, declining emu numbers).

These two groups began to talk together and build shared concerns through the cross-sectoral interactions of the Cooperative Research Centre for Tropical Savannas. The CRC's focus on the objective of sustainably healthy landscapes resonated with the aspirations of the ranger group leadership, and the recognition within the CRC of the Aboriginal domain as a sector to be treated equally with mainstream sectors of pastoralism, mining, conservation and tourism began to increase dignity and respect in cross-cultural conversations.

The individuals involved comprised a core group looking for solutions to the commonly perceived problems. But each faced cultural problems in extending engagement sufficiently broadly in Aboriginal and non-Aboriginal society to create the critical collaborative mass needed for effective action.

Bringing a collaboration home to Arnhem Land posed a cultural credibility problem for Ranger leaders. As in many colonised societies around the world, being seen to be 'acting like a white man', or joining a non-Aboriginal agenda, was regarded as conduct unbecoming. In central Arnhem Land the effects of a government-sponsored forestry project that tried to suppress Aboriginal traditional burning was still remembered somewhat bitterly. In south-central Arnhem Land roadside signs erected by the Bushfires Council threatened $1000 fines or six months gaol for fire lighting. The ill-conceived forestry project policies and the manifest non-Aboriginal view that fire was an enemy, expressed in authoritarian signage, were in fact significant drivers of the rise of the catastrophic late dry season fire regimes.

Aboriginal fire management was widely viewed by non-Aborigines as anarchic pyromania, contrasting with the Aboriginal view expressed by Aboriginal Ranger leader Dean Yibarbuk, who said: 'The secret of fire in our traditional knowledge is that it is a thing that brings the land alive again. When we do burning the whole land comes alive again – it is reborn'.[2]

Thus in 1997 the inchoate cross-cultural collaboration focused on bringing back good fire management faced a severe constraint of being overdrawn at the social capital bank.

With funding from the Natural Heritage Trust, the ranger leadership and their non-Aboriginal friends set out to engage with the most respected elders of the region – not necessarily the community councillors or public figures, but ceremonial and cultural leaders mostly of a generation who were born in the bush, swaddled in paperbark, and who grew up in times before fire management was broken down by colonisation.

The middle-aged Ranger leaders brokered friendships and intellectual relationships between Aboriginal and non-Aboriginal 'experts'. They assisted Elders to understand what the scientists' fire history maps were saying – confirming the truth that unfriendly fire was killing *country*. Understanding and trust was being built effectively at large regional meetings over years.

Black and white worked together in the 'big laboratory' of Arnhem Land to create the science of fire, fuel loads, and vegetation communities that led to the accepted savanna burning methodologies (Figure B5.5.1).

Science colleagues worked to create an understanding amongst politicians, bureaucrats and broader science community that Aboriginal customary burning was good for *country* and could tame runaway greenhouse gas emissions. The strength of this collaboration and the evident social

(*Continued*)

BOX 5.5 (Continued) SOCIAL CAPITAL AND THE CREATION OF AN INNOVATIVE ENVIRONMENTAL AND CULTURAL ENTERPRISE IN ARNHEM LAND

Figure B5.5.1 Fire management planning in WALFA with the aid of satellite-derived fire maps.

Figure B5.5.2 Annual Arnhem Land fire planning meeting 2016, Barrapunta.

capital attendant with it brought on board the federal and Northern Territory environment departments. With their help the DNLG/Conoco Phillips deal was struck in 2006, enabling WALFA to go fully operational. WALFA quickly began to demonstrate emissions abatements well in excess of the 100,000 tonne CO_2-e minimum requirement. WALFA's success has enabled expansion of further viable emissions projects through Arnhem Land, the collaboratively developed science informs emissions accounting nationally and internationally, and importantly real jobs have been created that make for healthy landscapes and healthy people (Figure B5.5.2).

(Continued)

BOX 5.5 (Continued) SOCIAL CAPITAL AND THE CREATION OF AN INNOVATIVE ENVIRONMENTAL AND CULTURAL ENTERPRISE IN ARNHEM LAND

Developing Aboriginal governance capacity has put corporate control firmly in Aboriginal hands; the directors of the umbrella public company ALFA NT Ltd are all elected Aboriginal men and women, as are the directors of the corporations in which the ranger groups are embedded.

CONCLUDING REMARKS

The WALFA story is not a 'model' for development – all development situations must be addressed according to their particular circumstances. But WALFA's success does point to what can be achieved by incorporating the creation and maintenance of social capital as a key element in participatory processes to develop Aboriginal enterprises that resonate with a dynamic Aboriginal culture. Some important elements of social capital,[3] and evident from the WALFA story, are highlighted in the following.

From WALFA 'new networks' have been created – across communities and across cultures and knowledge systems. Many people have been motivated to participate proactively in these networks. Ranger groups' use of indigenous and non-Indigenous 'toolboxes' to manage land has become a new norm. A default Indigenous reluctance to collaborate with the dominant colonising culture has been diminished when benefits of doing so can be demonstrated and trust has been established. Aboriginal land management systems, which have been rightly termed an 'enduring commons', have been renewed, strengthened, and modified to respond to changing social and environmental circumstance.

But more remains to be done. The WALFA experience also points to the need for more attention to be given to the Northern Territory's Aboriginal Land Rights Act (ALRA) so that it can be made more appropriately responsive to and supportive of community-based enterprises like WALFA. Community-driven not-for-profit enterprises are not well served by the formal systems for approvals under the ALRA. Many Aboriginal people and their advocates believe that land council processes favour non-Indigenous enterprise proposals over local not-for-profit proposals. They believe the bar for securing landowner approvals is set higher and made more onerous for local initiatives than for outside interests. Projects suffer long waiting times to be processed.

Without stepping outside the requirements of the ALRA, there is much that can be done by land councils to be a more supportive force for local Aboriginal development initiatives. This is a critical next step in adding value to and expanding the benefits of sustainable enterprise development underpinned by a valuing of social capital.

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range of broader health, education, well-being benefits that, in turn, can substantially reduce the reliance of remote communities on state expenditures.[120–123] In this regard, it is self-evident that current government resource management funding arrangements need to be expanded from sole or primary dependence on public 'green welfare' funding to help build social capital and business capability in local Indigenous organisations. As discussed at length in other chapters, such capability building requires necessary development of typically challenging, culturally appropriate, robust governance arrangements.

So where to for the North Australian pastoral industry, and, given the context of this book, Indigenous interests in land? First, it is evident that there are examples of profitable, adaptive northern pastoral enterprises,[4,102] including those under Indigenous ownership (Box 5.6). In general, however, the industry faces significant sustainability, economic viability, and credibility challenges. Given the poor pasture capability and associated business conditions confronting most of the North, to be

BOX 5.6 INDIGENOUS PASTORAL CASE STUDIES, NORTH QUEENSLAND

RICKY ARCHER

NORTH AUSTRALIAN LAND & SEA MANAGEMENT ALLIANCE LTD. DARWIN

DELTA DOWNS STATION

Delta Downs in a successful Aboriginal owned and managed cattle property in the Gulf of Carpentaria. It is situated on the traditional lands of the Kurtijar people. The property is managed along with two adjoining properties, Maggieville Station and Karumba Downs. The total area of these properties is approximately 390,000 ha, running a herd of 40,000–45,000 Brahman cattle.

Governance: The Kurtijar people have developed a unique governance framework which enables the business to achieve its outcomes (Figure B5.6.1). The framework consists of three components as outlined in the following.

NORMANBY STATION

The Balnggarrawarra Rangers are a newly established Indigenous Ranger group based at Normanby Station, west of Cooktown. Purchased in 1995, Normanby Station is a long-standing pastoral lease held by Normanby Aboriginal Corporation. The cattle station was purchased for the traditional owners of the area with the intention of increasing economic development opportunities and employment.

Fast forward 22 years: the cattle property has not provided sufficient economic return to meet the aspirations of traditional owners. An opportunity was then identified to establish an Indigenous Ranger group, which would better meet aspirational targets and support core values of countrymen (Figure B5.6.2).

The Balnggarrawarra Rangers were established in 2016 and are funded under the Queensland Government's Indigenous Land & Sea Management Program. Through strategic partnerships, Balnggarrawarra manage invasive species, fire, water, and cultural heritage. As a result of these activities they have been able to improve infrastructure on *country*, and planning to redevelop the cattle business in a bid towards self-sustainability. This also enables future environmental and cultural targets to be achieved.

(*Continued*)

BOX 5.6 (Continued) INDIGENOUS PASTORAL CASE STUDIES, NORTH QUEENSLAND

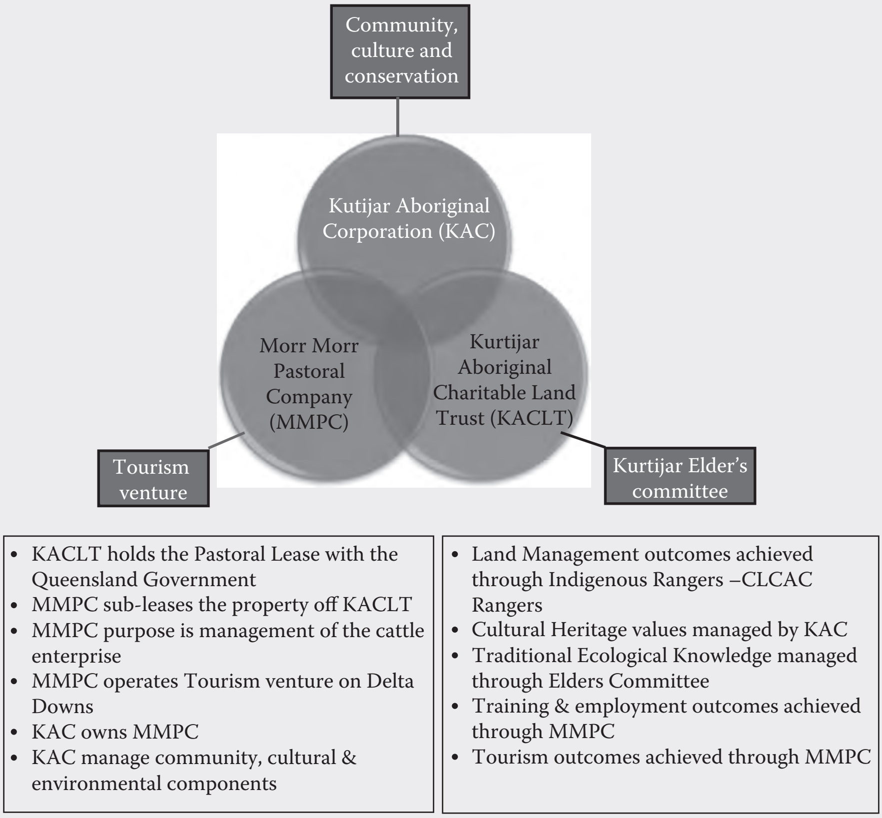

Figure B5.6.1 Concept by Joseph Rainbow, traditional owner and Morr Morr Pastoral Company Board member.

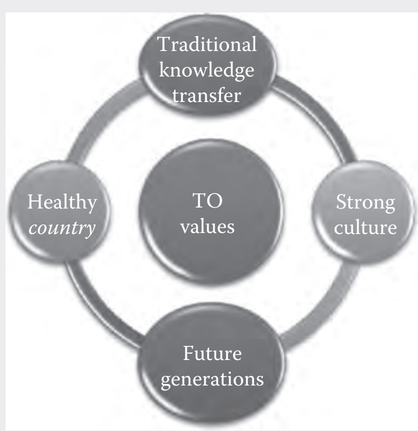

Figure B5.6.2 Concept by Vincent Harrigan, Coordinator, Balnggarrawarra Rangers.

viable and sustainable the industry evidently needs to either substantially improve core business efficiency and productivity where financial resources permit, or adapt and transition to embrace diversified opportunities including, where appropriate, carbon, biodiversity conservation, and culture- and nature-based tourism markets. For Indigenous people, sustainability also includes ensuring cultural responsibilities and obligations for looking after *country*. These are not small undertakings and able and resolute assistance will be required to inform these transitional processes in the years ahead.

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