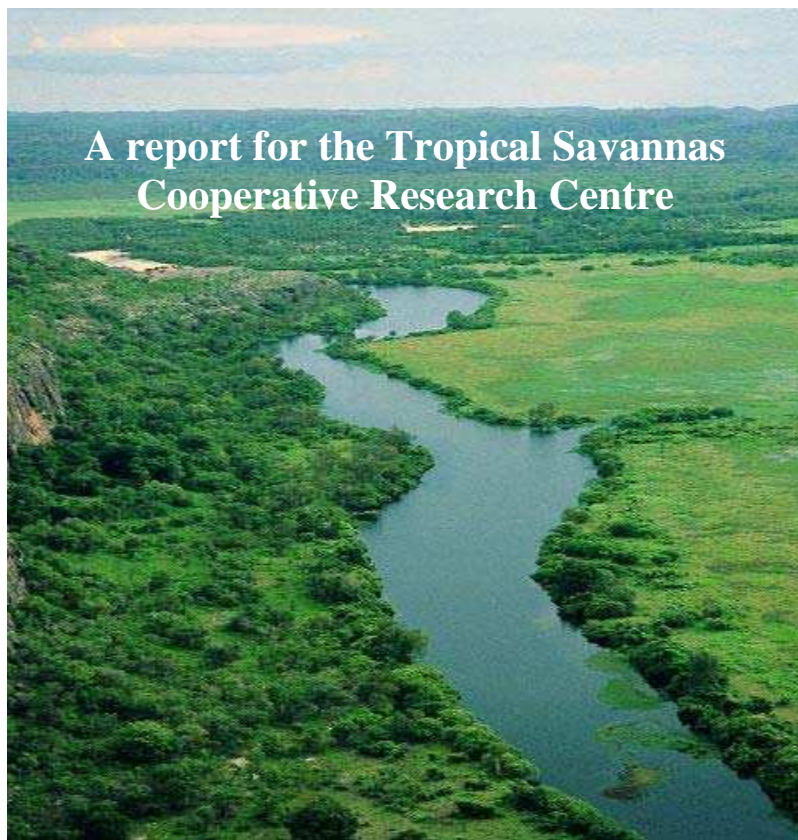


The role of ecosystem services from tropical savannas in well-being of Aboriginal people: A scoping study



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Photos in figures 1.6 and 1.14, and of Aboriginal dance in Appendix 2 are courtesy of Central Art and of Aboriginal Tourism Australia, respectively.

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Preface

This report is an outcome of a scoping study funded by the Tropical Savannas Cooperative Research Centre (TS–CRC). The aim of the study was to examine the linkages between ecosystem services and well-being of people in the tropical savannas of northern Australia. It was found that both the Aboriginal and non-Aboriginal communities of this area depend vitally upon these services. However, the roles of many of these services in well-being of people are often ignored because many services have non-monetary values. This report emphasises the importance of these ecosystem services in terms of well-being, but does not attempt to value these services.

While the non-Aboriginal communities of this region gain most benefits from ecosystem services through the market, the Aboriginal communities gain substantial benefits from non-market behaviour. These include the use of natural resources for bush food, medicine, or cultural values. Some of these values could be even more important in well-being of Aboriginal people than the commonly used materialistic/social-economic values. The standard socio-economic approaches, however, do not measure these or incorporate them in their definition of well-being.

This scoping study explores the ecosystem services available from savannas, develops links between various services and well-being of Aboriginal people, and proposes a socio-economic-ecological concept to measure well-being of Aboriginal people. The socio-economic-ecological concept used here, was adopted from the Millennium Ecosystem Assessment (MEA) (2003) which was a project initiated by the United Nations (UN) in 2001. This research applies the MEA framework at a local scale in the context of savannas, with some modifications. This study also examines the ‘Savanna health’ concept, earlier proposed by TS-CRC, that included ecosystem functions and health of people in savanna region.

Chapter 1 of the report describes savannas, land use and land management practices, various ecosystem services and their current status, and trends in human use. Chapter 2 discusses the concept of human well-being, and proposes a change from socio-economic concept of well-being to socio-economic-ecological concept of well-being. Chapter 3 discusses the existing methods and proposes a methodology that can be used to study the linkages between ecosystem services and human well-being. Chapter 4 suggests how the major businesses in savannas are linked to natural resources and how natural resource based businesses can improve well-being of Aboriginal people.

Major outcomes and directions for future research

This research found the following:

- Ecosystem services are very important to well-being, particularly for Aboriginal people for their cultural, spiritual and identity values connected to the landscape.
- Various types of ecosystem services available from savannas and their roles in various constituents of well-being of Aboriginal people, are identified and examined in detail.
- A model is developed based upon the linkages between ecosystem services and well-being of people, while applying socio-economic-ecological concept of well-being.
- The savanna health concept (proposed earlier by TS-CRC) is examined for its advantages and disadvantages.
- An understanding of the role of ecosystem services in well-being of Aboriginal people can help non-Aboriginal people to realise the non-monetary benefits of savannas.
- By understanding the role of ecosystem services in the lives of Aboriginal people, appropriate measures could be taken to improve their well-being.
- Planning of land use policies while considering non-use (cultural, identity and spiritual) values of savanna landscape, can improve human well-being at regional level and sustain the resources for future use.

Future research

In the future, in-field research needs to be conducted to test the model proposed in this study (Figure 2.3; Chapter 2) and to evaluate how changes in ecosystem services can affect well-being of Aboriginal people. These studies should be as follows:

- Case studies using properties which are either managed or owned by Aboriginal people, on ecosystem services and their importance in well-being of Aboriginal people. Focus group meetings with Aboriginal people could assist in the evaluation of the proposed list of socio-economic-ecological indicators for well-being.
- Develop data sets which can be used to analyse trends on the condition and use of ecosystem services in savannas. These trends could be further explored using secondary data from various sources (e.g. ABS, ABARE, EPA, NRM&W and other agencies).
- Current changes in land use practices could be analysed and their implications for provision of ecosystem services and hence for human well-being could be obtained. An evaluation of the positive and negative effects of any change in current land use need to be studied before implementing any change in land use practices.
- MEA style models could be developed for the changes in ecosystem system services that are considered important by the people (Aboriginal and non-Aboriginal). This will help to predict changes in the well-being of future generations which will result from the current use of resources, and will help highlight the limitations of the current land use practices.

The list of Abbreviation and Acronyms

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ATSIC	Aboriginal and Torres Strait Islander Commission
BRS	Bureau of Rural Sciences
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DNR&M	Department of Natural Resources and Mines
DPI	Department of Primary Industries
DPIFM	Department of Primary Industries, Fisheries and Mines
EPA	Environmental Protection Agency
IBA	Indigenous Businesses Australia
MEA	Millennium Ecosystem Assessment
NLWRA	National Land and Water Resources Audit
NRETA	Department of Natural Resources, Environment and the Arts
NRM&W	Department of Natural Resources, Minerals and Water
NT	Northern Territory
QLD	Queensland
TS-CRC	Tropical Savanna – Cooperative Research Centre
UN	United Nations
WA	Western Australia

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Research outreach

Research papers from this project:

Kamaljit Kaur (2006). Multiple Land Use in Tropical Savannas: Concepts and methods for valuation. **Agricultural Journal**, 1(2): 90-95.

Kamaljit Kaur and Owen Stanley (2006). Role of ecosystem services of tropical savannas in well-being of Aboriginal people of north Australia. **Conservation and Society** (revised version submitted in June, 2006).

Presentations:

1. Presented a paper on Multiple land use in tropical savannas in a workshop 'Multiple land use in Australia's outback regions: Key issues for research' organised by CSIRO, Townsville, on the 18-19th of Oct 2004.
2. Presented a paper on Multiple land use in savannas in a seminar at the School of Business, Economics programme, Oct 2004.
3. Presented a seminar on An Overview of Millennium Ecosystem Assessment Research to Hons. School students in Semester 2, 2005 (Oct 2005).
4. Presented two seminars on The role of ecosystem services from tropical savannas in well-being of Aboriginal people to Hons. School students in Semester 1 2006 (13 April 2006) and to Economics students (on the 28 of April 2006).
5. ABC north Queensland Radio Talk 16 November, 2005.
Source: <http://www.abc.net.au/northqld/stories/s1507602.htm?northqld>

Other journal papers (all with surname Sangha or Kaur) published during Post Doctoral fellowship:

1. Kamaljit Kaur, R.K. Jalota and R. K. Kohli (2006) Social acceptability and value of use and non-use ecological services of exotic *Eucalyptus tereticornis* and indigenous *Dalbergia sissoo* tree plantations in N-W India. Accepted for publication in **International Journal of Ecological Economics and Statistics**.
2. Kamaljit Kaur, Rajesh K. Jalota, David J. Midmore and Kerry Walsh (2006) Impact of tree clearing on soil respiration and soil microbial biomass in pasture systems of central Queensland, Australia (authors). **Agriculture Journal**, 1 (4): 291-302.
3. Kamaljit Kaur, John Rolfe and Owen Stanley (2006). Net benefits from clearing trees to develop pastures in central Queensland, Australia. **Agricultural Journal**, 1(2): 81-89.
4. Kamaljit Kaur, David J. Midmore, Rajesh K. Jalota and Nanjappa Ashwath (2006). Pasture composition in cleared and uncleared pastures of central Queensland. **Australian Journal of Botany**, vol 54 (5): 459-470.
5. Sangha, K., Jalota, R.K., Midmore D. (2006) Litter production, decomposition and nutrient release in cleared and uncleared pasture systems of central Queensland, Australia. **Journal of Tropical Ecology**, vol 22 (2): 177-189 (Cambridge Publication).
6. Kaur, K., Jalota, R.K., Midmore, D.J. and Rolfe, J. (2005) Pasture production in cleared and uncleared grazing systems of central Queensland. **The Rangeland Journal**, vol 27 (2): 143-149.
7. Jalota R.K., Sangha, K.K. and Kehal H.S. (2005). State of agriculture and natural resources in Punjab and methods for their improvement. In Sustainable Development in India: An Interdisciplinary Perspective (ed. Guljit K. Arora and Arunabh Talwar), pp. 223-235.
8. Sangha, K. K. and Jalota, R.K (2005). Value of ecological services of exotic *Eucalyptus tereticornis* and native *Dalbergia sissoo* tree plantations in N-W India. **Conservation and Society**, vol 3 (1): 92-108.
9. Sangha, K. K., Midmore, D.J., Rolfe, J. and Jalota, R.K., (2005) Tradeoffs between pasture production and plant diversity and soil health attributes of pasture systems of central Queensland, Australia. **Agriculture, ecosystems and environment**, 111: 93-103 (Elsevier publication).
10. Sangha, K. K., Jalota, R.K., and Midmore, D.J. (2005) Impact of tree clearing on soil pH and nutrient availability in grazing systems of central Queensland, Australia. **Australian J. Soil Research**, 43:51-60.

1. Ecosystem services

The main aim of this chapter is to:

- Identify the ecosystem services available from savannas and their use and non-use values for Aboriginal people.

The Chapter plan is:

- i. Section 1.1 provides general introduction about savannas
- ii. Section 1.2 describes major land use and land management practices in savannas
- iii. Section 1.3 describes various ecosystem services available in savannas
- iv. Section 1.4 suggests the current status and trends in human use, of ecosystem services in the past (Table 1.3).
- v. Section 1.5 concludes the use and non-use value of various ecosystem services for Aboriginal people (Table 1.4)

1.1 Introduction: Savannas

Savannas are the natural ecosystems with upper storey of scattered trees and understorey of grasses and shrubs. In the north, savanna vegetation covers the one third of Australia, approximately 1.9 m km² area.

The Australian tropical savannas are the largest and unique in the world (Fox *et al.* 2001). They provide home to hundreds of species of native plants, mammals, birds, reptiles and amphibians and invertebrates. Many species are exclusive to tropical savannas and are found nowhere else in the world. It is a very diverse ecosystem with about 22 bioregions (Fig. 1.1, according to Interim Biogeographic Regionalisation of Australia (IBRA); Fox *et al.* 2001). Each bioregion has characteristic types of plant species associated with a particular land zone. There are different species of eucalypt, corymbia and acacia, and of grasses such as spinifex, mitchell, wiregrass and bluegrass. Both, trees and grasses, perform various ecosystem functions, which complement each other and provide various services. Soils in savannas are dominated by podzols, red earths, yellow earths, heavy texture grey, brown or red, desert sandplains and siliceous sands, and are generally poor in nutrient content.

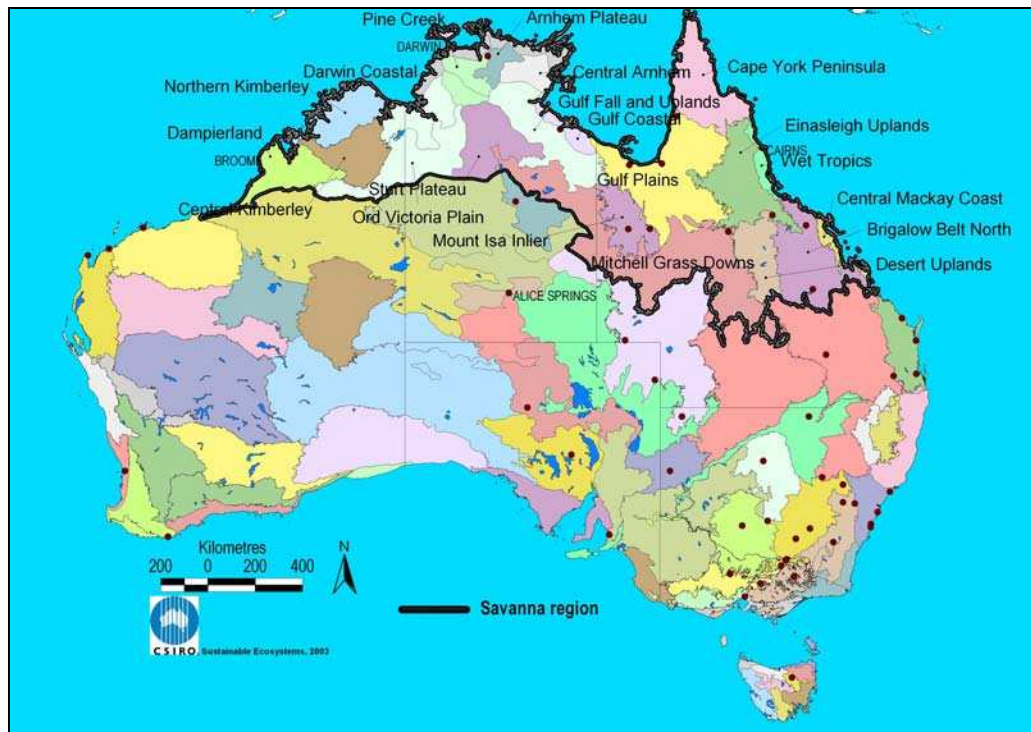


Figure 1.1 The savanna region defined by interim bioregionalisation of Australian boundaries

The savanna is divided into four regions based on rainfall distribution (Fox *et al.* 2001). The ‘top end’ north tropical zone (Cape York Peninsula) receives an annual rainfall of >1500 mm, while the areas in proximity to the coast, represent typical savanna landscape, receive 1000-1500 mm annual rainfall. The southern parts, major area in savanna region, are semi-arid with only 250-500 mm and even lesser yearly rainfall (Fig. 1.2). In the northern part, wet (December to March) and dry (May to August) seasons are very distinct, while southern part is dry with hot summers and cold winters. Average temperatures are usually ~30 °C. For in-land areas, temperature sometimes reaches the maximum of ~50 °C in summer and minimum of ~21 °C in winter.

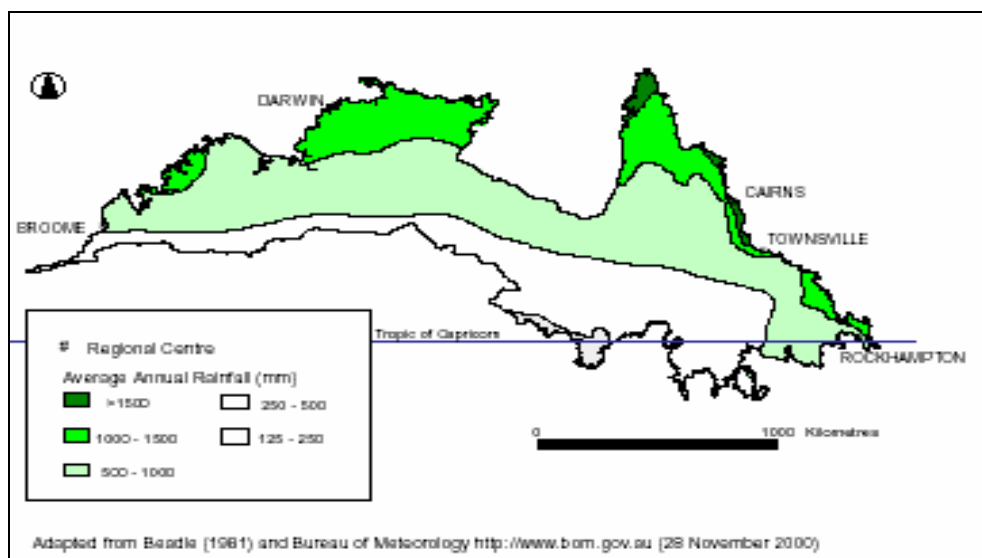


Figure 1.2 Rainfall in the savanna region (Source: Fox *et al.* 2001).

1.2 Land use

Savannas are mainly used for grazing, mining, tourism, conservation and for subsistence grazing and other activities by Aboriginal people (Fig. 1.3). Cattle and sheep grazing became the main land use only after 1900s when Europeans arrived. Some of the grazed land is sown to exotic grass species such as buffel grass (*Cenchrus ciliaris*) to develop pastures.

There is a considerable area, particularly in NT, under Aboriginal land use. However, Aboriginal activities are not only confined to the Aboriginal land, but also to other areas such as crown land or conservation parks, and to some Aboriginal owned pastoral properties.

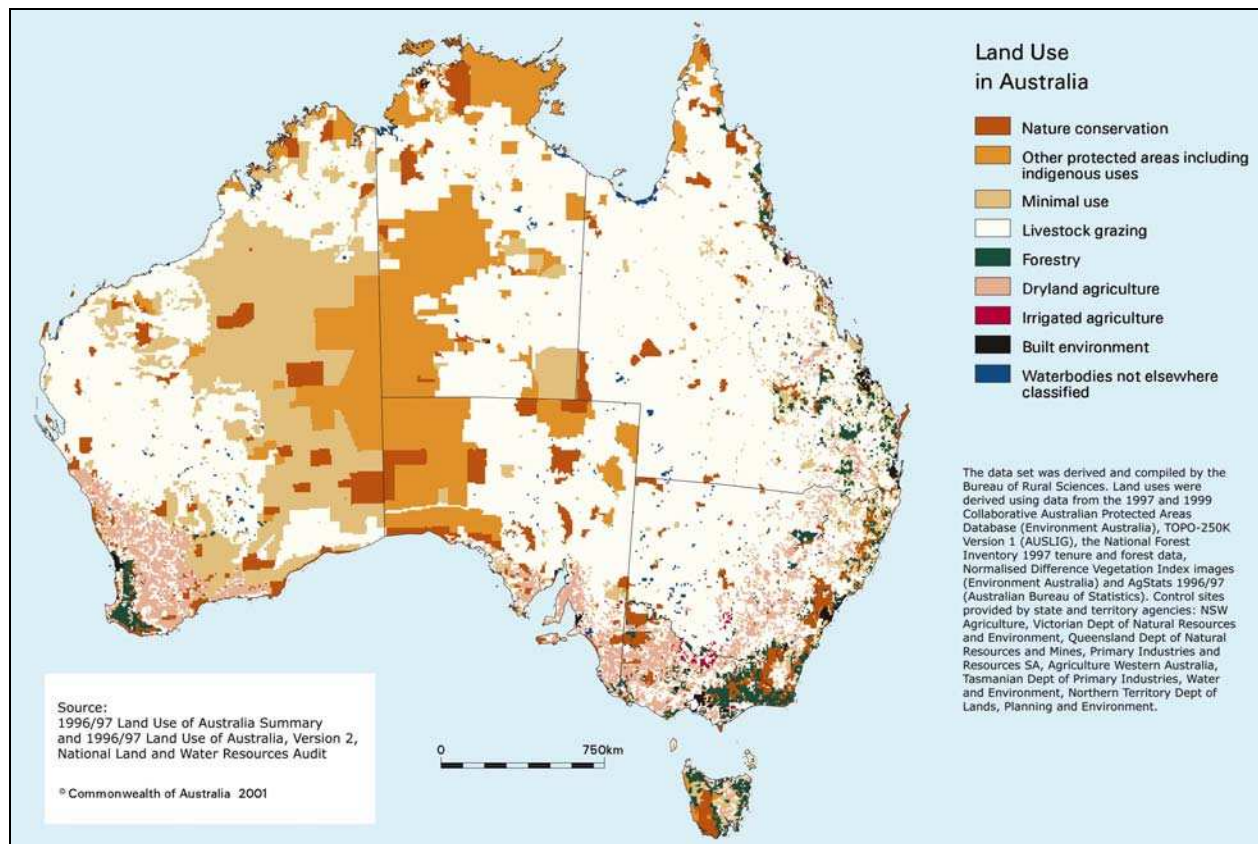


Figure 1.3 Land use in Australia (source: National Land and Water Resources Audit)

Savannas are a good source of minerals such as gold, gems, copper, bauxite, nickel and iron ore besides coal, gas and petroleum, and these contribute significantly to the state economy.

Some areas are conserved for national parks, forests and Aboriginal land. Tourism is an important activity in the region that integrates different land uses such as mining, grazing, conservation parks and Aboriginal land.

The various land uses provide a range of benefits for people, some of which are quantified and valued (monetary value), while others are non-quantifiable with non-monetary values, as presented in Fig. 1.4. However, there are interactions among different land uses, and a mosaic of different land uses actually adds to the value of savanna landscape and enhances the variety of benefits for people.

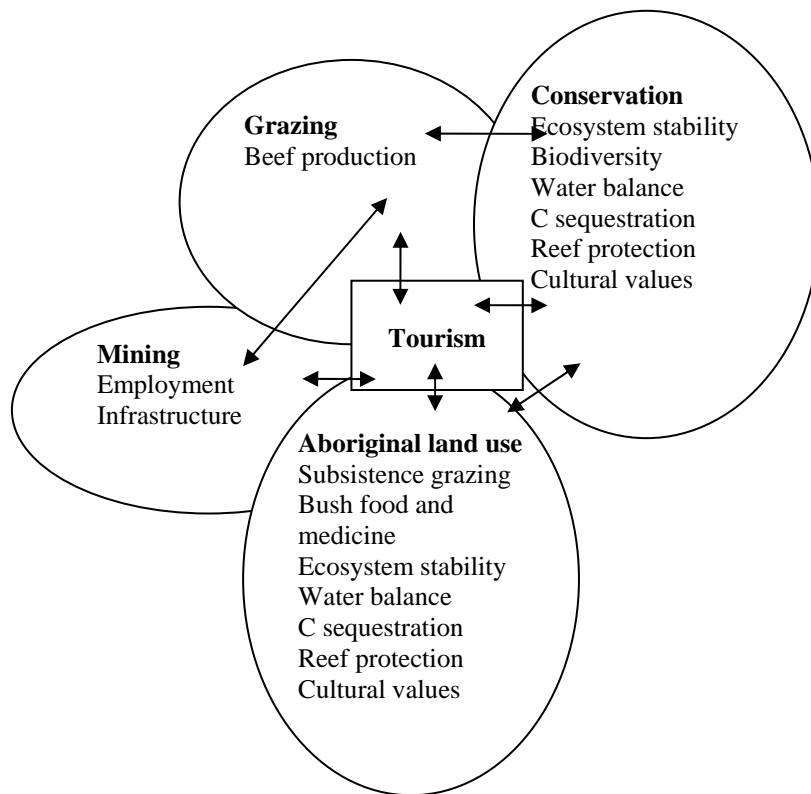


Figure 1.4 Main benefits from grazing, conservation, mining and Aboriginal land, and the interactions among various land uses (indicated by arrows) in tropical savannas.

1.2.1 Externalities of current land uses and their impact upon use and non-use value of ecosystem services

The various land uses of grazing, mining, tourism, Aboriginal land use and conservation are interlinked at a landscape scale and have both negative and positive off site effects (externalities). For example, grazing practices, in particular overstocking, leads to soil loss (Holmes 1990, Ludwig *et al.* 2000) and results in accumulation of sediments in waterways. Cultivation of exotic grasses, such as buffel, has reduced the diversity of native species in woodland pastures and in conserved areas (State of the Environment Advisory Council 1996). Mining has negative effects on soils in terms of soil degradation, on water resources and on species diversity (Integrated Natural Resource Management Plan for the Northern Territory 2005, State of the Environment Advisory Council 1996). Such external effects adversely affect the ecosystem services available for both Aboriginal and non-Aboriginal people alike.

On the other hand, some land uses, such as conservation or land under Aboriginal use, have positive effects on other land uses, and these contribute to improve hydrological balance, soil and climate stability, biodiversity, and impart aesthetic beauty to the landscape. Overall, the positive effects of various land uses leads to a synergistic effect at a landscape level.

1.2.2 Modern and traditional land management practices

Land management practices vary between Aboriginal and non-Aboriginal people. Aboriginal people perform activities for subsistence such as hunting and gathering for food and medicines, and for various spiritual and cultural ceremonies in relation to the landscape. These activities are

different to the land use and related practices (mainly grazing or mining) for non-Aboriginal people which focus on production (Edwards 1988). Aboriginal people manage land not only for production gains but also for other cultural, recreational, and spiritual values.

Current management practices for grazing or mining land are of concern for the region because these may lead to the depletion of natural resources, and because of the desire to sustain these resources for future use. Major grazing management practices include stocking rate, use of fire, sowing of exotic pasture species, spilling etc. Whereas, Aboriginal people manage resources using fire, and selective harvesting. Fire management is considered quite important for sustainable resource use. Figure 1.5 provides an illustration of how fire is used and how its use resulted in changes in savanna vegetation for adaptation to fire over the past centuries. A detailed study on Kakadu National Park compiled by Press *et al.* (1995) reported the traditional knowledge on seasons for fire, based upon changes in weather and in plant and animal life.

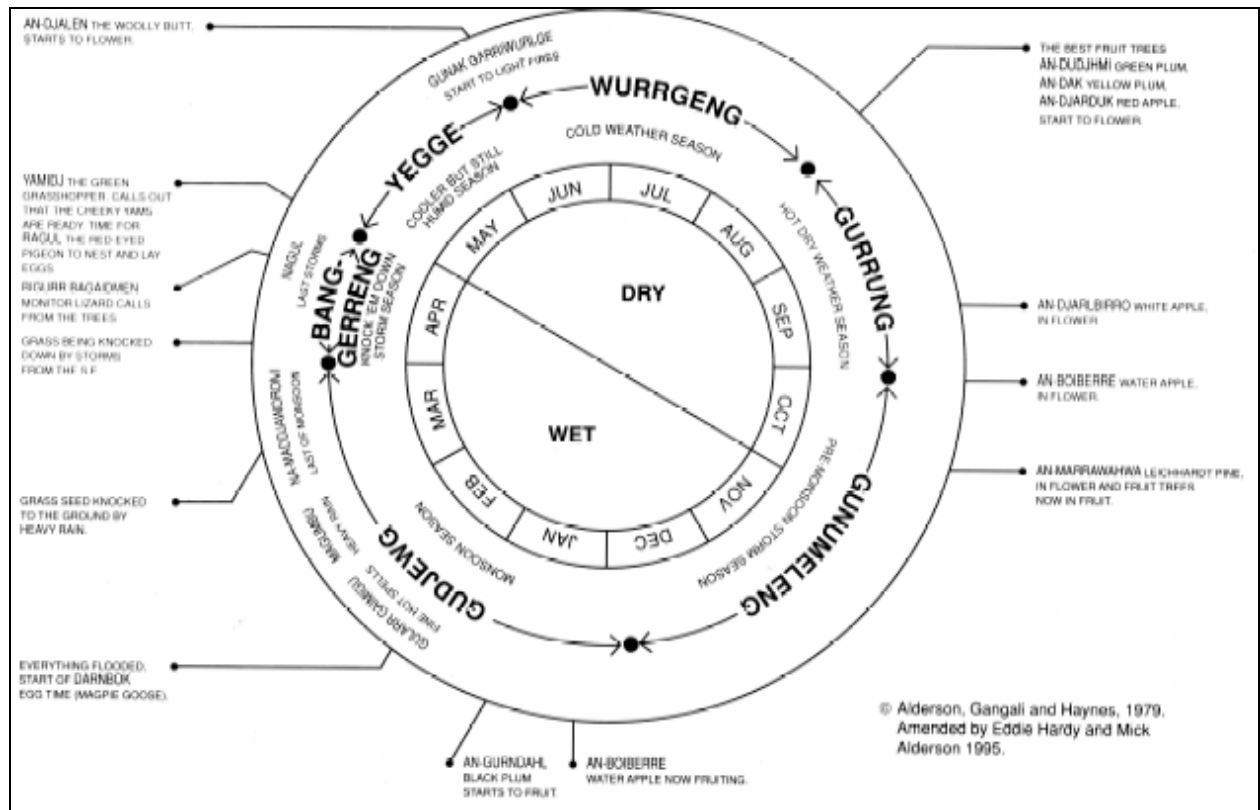


Figure 1.5 Seasonal calendar for Kakadu Region (source: Brockwell et al. 1995 cited in Press et al. 1995).

1.3 Important ecosystem services offered by savannas

Savannas provide a range of ecosystem services, described as follows:

1.3.1 Provisional services

1.3.1.1 Food

Aboriginal people use various parts of trees, shrubs, and herbs are used as food. These include fruit and seeds, the most famous ones are Kakadu plum, Illawarra plum, wattle seeds (of various *Acacia* spp.), bush tomatoes, riberry and quandong; and leaves of some herbs such as native mountain pepper or lemon myrtle. Seeds from cycads and various grasses are used to prepare flour. Table 1.1 shows the use of a range of plants for food.

Table 1.1. Food value of some plant species occurring in savannas (Isaacs 1987).

Botanical name	Common name	Use
<i>Acacia</i> spp.	Wattle	Seeds are exceptionally nutritious, with higher protein and fat contents even than wheat or rice. Gum is a good source of dietary fibre.
<i>Acmena smithii</i>	Lillypilly	Fruits (berries) are widely eaten, as these are a good source of water and minerals.
<i>Adansonia gregorii</i>	Baobab nut	Seeds and pith are eaten as raw and with honey.
<i>Alpinia</i> spp.	Wild ginger	Buds, stems and roots eaten raw, and leaves are used for flavouring.
<i>Ampelocissus acetosa</i>	Native grape	Fruit is eaten raw and thick roots are eaten after cooking.
<i>Banksia dentata</i>	Swamp banksia	Nectar from flowers is sucked or flowers are also soaked in water to prepare sweet liquid.
<i>Boerhavia diffusa</i>	Tar vine	Root are roasted in fire and considered a good source of food (for its water and carbohydrate content)
<i>Brachychiton</i> spp.	Kurrajong	Water-bearing trees, roots are tapped for water in drought. Seeds are mostly eaten.
<i>Buchanania obovata</i>	Wild plum	Fruits are a good source of vitamin C and are eaten raw.
<i>Cycas media</i>	Cycad	Nuts are dried, soaked, fermented and then roasted.
<i>Dioscorea</i> spp.	Yam	Underground tubers are a good source of water, carbohydrates, protein and some trace elements.
<i>Eucalyptus</i> spp.	Gum tree and others	Many eucalypt species are used to extract water from roots/bark, for nectar and seeds.
<i>Ficus</i> spp.	Fig	Fruit from all the species are eaten raw.
<i>Livistona australis</i>	Cabbage tree palm	Young shoots and leaves are eaten raw.
<i>Nymphaea</i> sp.	Waterlily	Seeds, bulbs and stems are eaten.
Many other species are also used by the Aboriginal people as listed in many reference books (Isaacs 1987, Cribb and Cribb 1975, 1981 and 1982, Low 1988 and Levitt 1981).		

Whitehead *et al.* (2002) studied 122 species in the Arnhem land (The Northern Territory) for their potential as various commercial products:

Plant product	Number of species
Bush food	43
Traditional food for consumption within the community	7
Live plant trade (landscaping in gardens)	38
Arts and crafts based mostly on woody plants	7
Timber extraction	8
Botanical medicines	3
Volatile oils	3

Many animals such as kangaroos, wallabies and emus graze on grass and other herbaceous/shrubby vegetation, are also an important source of food. Various water sources (small water holes, lakes and rivers) are also important for fish and mussels.

Beef

Grazing cattle for beef production is the most valuable rural industry in the Northern Australia, as ABS reports that 50% of Australia's meat cattle herd is in this region (ABS 2006).

Some areas of savannas e.g. the Daly river catchment have been identified for potential cropping or horticulture (cotton, sorghum, mangoes etc.).

1.3.1.2 Plant medicine

Bush medicine is practised by many Aboriginal people. Bark or roots of Acacias are infused or soaked to obtain a liquid drink that is used to treat cough and cold. Many species of *Eucalyptus* are used for various medicinal purposes, to cure wounds and braises, cold, snakebites, ophthalmia, headaches and toothache. Tea tree oil from *Melaleuca alternifolia* is very useful to cure many skin diseases and has become a commercial product these days. Some plants of these uses are mentioned in Table 1.2.

Table 1.2. Medicinal value of some plant species occurring in savannas (Isaacs 1987).

Botanical name	Common name	Medicinal use
<i>Acacia</i> spp. (many species)	Wattle	Bark used for decoction for skin conditions such as boils. Gum mixed with bark is used to treat wounds and sores.
<i>Acacia ligulata</i>	Wattle	Bark boiled or soaked and drunk as cough medicine. Also good for sickness ('smoking' ill people), dizziness, nerves and fits.
<i>Alphitonia excelsa</i>	Red ash	Young leaf tips chewed for upset stomach and decoction of bark and wood used as liniment for muscular pains or gargles to relieve toothache.
<i>Alstonia constricta</i>	Quinine bush	A deadly poison. Latex used to cure infectious sores, though very severe on skin.
<i>Brachychiton diversifolium</i>	Kurrajong	Inner bark crushed in water, and the liquid is used as an eye wash.
<i>Buchanania obovata</i>	Wild plum	Leaves crushed and applied to sores, boils, wounds and ringworm. Inner bark and sapwood pounded and soaked and used for toothaches. Ashes of burnt sapwood are packed around sore tooth.
<i>Capparis lasiantha</i>		Honey from flowers is used as a remedy for coughs. Plant, including roots, macerated and soaked, and water applied to swellings, snake bites, insect bites and stings.
<i>Cycas media</i>	Cycad	Used specially for spear wounds. Soft insides of the male flower stalk are combined with human urine in a paperbark container to heat liquid which is then used as an antiseptic.
<i>Erythrophleum chlorostachyum</i>	Ironwood, Cooktown poison tree	Leaves boiled in water to bathe sores and cuts. Infusion from bark and roots are used to treat sores, and stomach ache. Wood, leaves and bark used to 'smoke' person suffering from constipation. Pulverised leaves placed in nostrils to relieve diarrhoea.
<i>Eucalyptus</i> spp.	Gum tree and others	Gum is extracted from many trees to treat sores, cuts, as an astringent, and for cold and cough.
<i>Ficus opposita</i>	Sandpaper fig	Eyewash made by soaking inner bark in water. Leaves are used to treat inflammation. Infusion is drunk to treat diarrhoea.
<i>Hibiscus tiliaceus</i>	Yellow hibiscus, cottonwood	Decoction of inner bark and sapwood is used to wash wounds. Bark is used to wrap around wounds.
<i>Pandanus spiralis</i>	Screw palm	Inner core of young tree is eaten to cure diarrhoea. Upper inner core of trees is used to treat colds, toothaches and wounds.
<i>Spinifex longifolius</i>	Spinifex	Juice squeezed from new shoots is used to cure sore eyes. Decoction of young shoots is used to infected sores or burns.
<i>Terminalia ferdinandiana</i>	Billygoat/Green/Ka kadu plum	Inner bark is used to cure sores, leprosy sores, and backache.
Many other species, used by the Aboriginal people to treat many ailments, are mentioned in reference books such as Aboriginal communities of the Northern Territory of Australia 1988, Cribb and Cribb 1981 and 1982, Isaacs 1987 and Lassak and McCarthy 1983).		

However, many species that occur in savannas and used by Aboriginal people for medicinal purposes are yet to be recorded.

The importance of bush food and medicine in Aboriginal lifestyle could be deciphered from its integration in their culture, as apparent from paintings in Fig. 1.6.



Painting 1. Bush food, Artist: Shirley Mbitjara



Painting 2. Bush medicine Artist: Gloria Petyarre

Figure 1.6. Paintings demonstrating the importance of bush food and medicine.

(Source: www.aboriginalartstore.com.au/paintings)

Story

Painting 1. The painting depicts important bush tucker survival foods for Aboriginal people.

Painting 2. The painting depicts the Bush Medicine Dreaming. The leaves are of a special plant are used to aid the healing process. Women go to different places around Utopia to collect leaves from special plants. Back at the camp leaves are boiled to exact resin. Kangaroo fat is mixed in the resin creating a paste that can be stored for long periods of time in bush conditions. This medicine is used to heal cuts, wounds, bites and rashes. It also acts as a repellent.

1.3.1.3 Wood (timber, fuel wood and bark)

Many hard wood savanna tree species such as *Eucalyptus camaldulensis* (river red gum), *E. pellita* (red mahogany) or *E. argophloia* (white gum) are used to make furniture and floors by the mainstream community. Wood from some trees is still used by the Aboriginal people to make temporary shelters.

Hibiscus tiliaceous is used to make spear shafts for hunting, fishing and for carvings. Some hard wood trees are used to make digging sticks to dig for food such as yams, though most modern digging sticks are made from steel rods. Bark and wood from many trees is used to cook and store food. Different types of colours are obtained from bark and roots of different trees, and

ochre (an extract from bark/roots) and used in cultural ceremonies and artwork. Fuel wood is very important not only for fire to cook food but also in many ceremonies, for example wood from *Erythrophleum chlorostachyum* is used in certain religious ceremonies (Roberts and Stanley 1986). Fuel wood is important for fire in many Aboriginal cultural ceremonies, and to manage the country.

Many of the native trees and bushes have been used to make artefacts such as didgeridoo, boomerangs, shields, and decorative pieces for various ceremonies. Wood from many native trees is also used to make totemic sculpture, clubs or knives (Fig. 1.7).

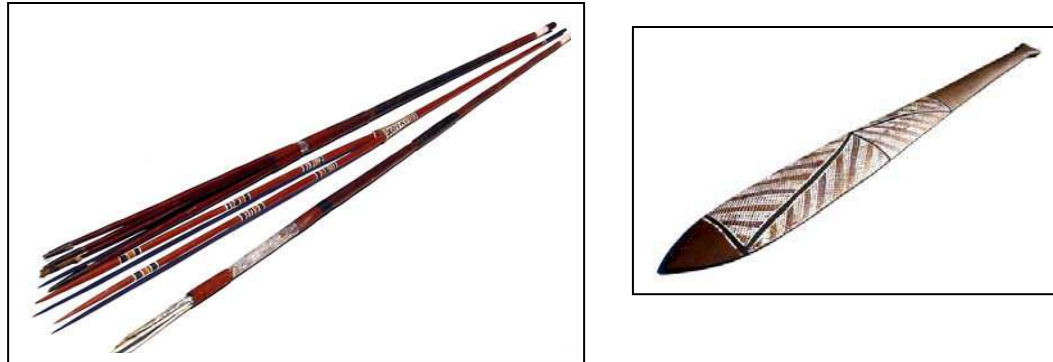


Figure 1.7 Spears and club.

1.3.1.4 Minerals

Mining is a very important source of income after grazing, all over savannas (Fig. 1.8). In Queensland, mining accounts for about 7.8% of Gross State Product (mining exports totalled almost \$11.8 billion dollars) (ABS 2005a). Approximately two third area of Queensland is under savannas, and it could be appropriate to consider at least one half of the total mining income from savanna area of the state, given that there are some important mines in the region. In the Northern Territory, the value of production (minerals and petroleum) was \$ 76.3 million in 2004-05 (ABS 2005b) (where savannas covers about one half of the state) and in WA, production from these operations is about \$ 15.9 billion annually, with very important mines in the top part (where savannas cover about one sixth of the state) (ABS 2005c).



Figure 1.8 Fig. 1.8. Australian mines and mineral deposits December 2004 (Source: Geoscience Australia)

1.3.1.5 Water

Water sources play an important role in human survival and help in maintaining diversity of flora and fauna in dry (in-land) areas of savannas. Majority of the savanna is generally dry (except coastal areas) with some rivers, lakes and water holes (Fig. 1.9 and 1.10).

Water plays a central role in some religious beliefs of Aboriginal people. There are about 26 small and large rivers, and many creeks of cultural significance. Water is more or less like a “living entity” as Yu (2000) describes the importance of water in Aboriginal culture:

‘Living water’ is an Aboriginal English expression that requires translation as it refers both to physical properties of water sources and their cultural significance.’

Aboriginal people developed skills over the past years to survive in dry areas. They dig water holes to save rain water for use in dry season. People know about trees where bark or roots store water. However, the northern savannas have relatively more water resources with higher rainfall, and people are dependent upon these resources for various types of fish, mussels and turtles.

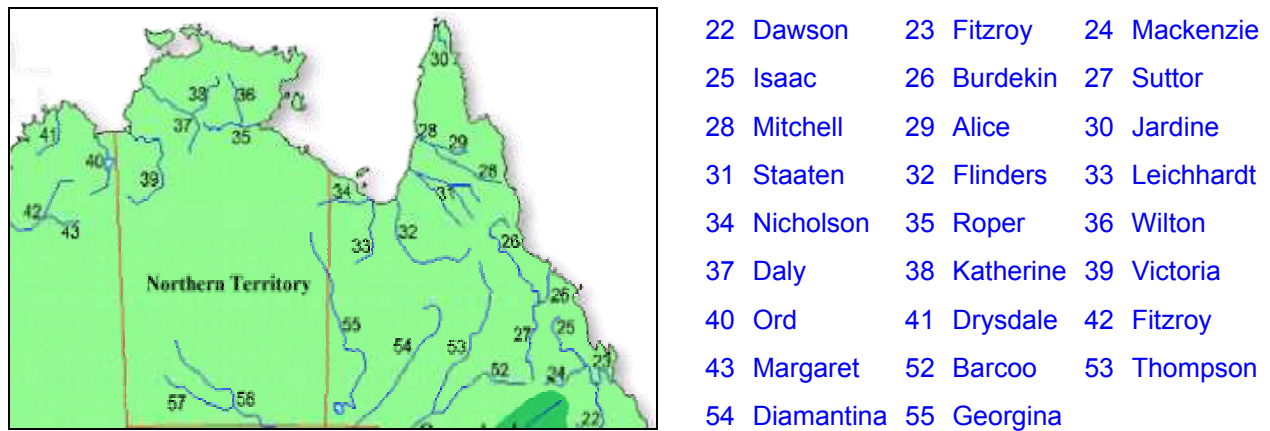


Figure 1.9 Fig. 1.9. Major rivers in the northern region.
(Source: www.cultureandrecreation.gov.au/articles/rivers/).

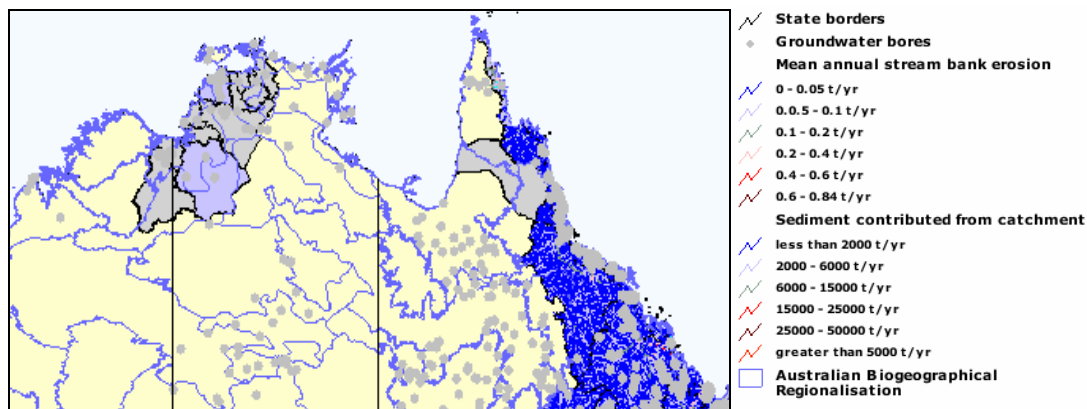


Figure 1.10 Water bodies (ground water bores) and sediment contribution from catchment (Source: NLWRA).

1.3.1.6 Recreation

People from different parts in Australia visit the region for its vast, open landscape, diverse and unique species of flora and fauna and to experience Aboriginal culture. There are also some of large cattle stations of the world which are source of interest for tourist. Many national parks and forests are internationally famous for their unique landscape, rock formations, and flora and fauna. For example, in the Kimberley region, the north west of savanna country, Purnululu National Park (area about 240 000 hectares) is listed as World Heritage site for its sandstones karst, representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, and for exceptional natural beauty and aesthetic importance. Another such site of World Heritage listing is Kakadu National park, which gained that status for both outstanding cultural and natural universal values. There are many other national parks in the region that are important for natural beauty and aesthetic value.

Aboriginal people also use the landscape for recreation, often performing various activities linked to landscape e.g. hunting, gathering food and listening stories about land and other natural features.

1.3.2 Cultural services

Savanna landscape is highly important for identity, cultural, and sacred values for Aboriginal people. There are many sites of cultural significance which are important to perform rituals and other ceremonies. Life for Aboriginal people is well connected to the landscape. Land entitled as 'Aboriginal land' is managed by Aboriginal people to preserve some cultural sites. Various activities are performed in relation to different components of the landscape i.e. plants, animals, waterholes, rocks or caves, or land. The details of cultural services of savannas are mentioned in Chapter 2.

It is interesting to note that the cultural services of savanna landscape are mentioned in the Natural Resource Management plan (NRM plan 2004 for the Southern Gulf region (area between the Cape York peninsula and Arnhem Lands)), and to much greater details in the Wet Tropics Aboriginal Cultural and NRM plan (Wet tropics Aboriginal plan project team 2005).

1.3.3 Regulating and supporting services

Savannas provide various ecological services that sustain the ecosystem, the following are considered herein:

1.3.3.1 Biodiversity:

Biodiversity maintains ecosystem functions such as nutrient recycling, soil microbial composition, hydrological balance and C sequestration that directly or indirectly contribute to supply various goods and services. Tropical savannas are rich source of diversity, with many species endemic to this landscape. The region is divided into 22 bioregions (Fox *et al.* 2001 and EPA website). The species diversity and status of each of the bioregion are presented in Appendix 1.

1.3.3.2 Soil stability

Savanna vegetation plays a significant role in recycling nutrients, in maintaining soil processes and hydrological balance at the top and bottom depth of soil for having 2-3 storey vegetation of

grasses, shrubs/bushes and trees. However, grazing (as the main land use) has led to soil erosion in many areas of savannas (Fig. 1.11) which further leads to loss of soil nutrients and pollutes water streams and reef subsequently. Cropping, in the eastern part in Queensland, has led to prominent loss of nutrients (N and P) through sediment flow (Fig. 1.12). Maintaining soil stability is very important for a productive landscape. Thus, development of land for cropping in some parts of savannas, need to be considered with cautions.

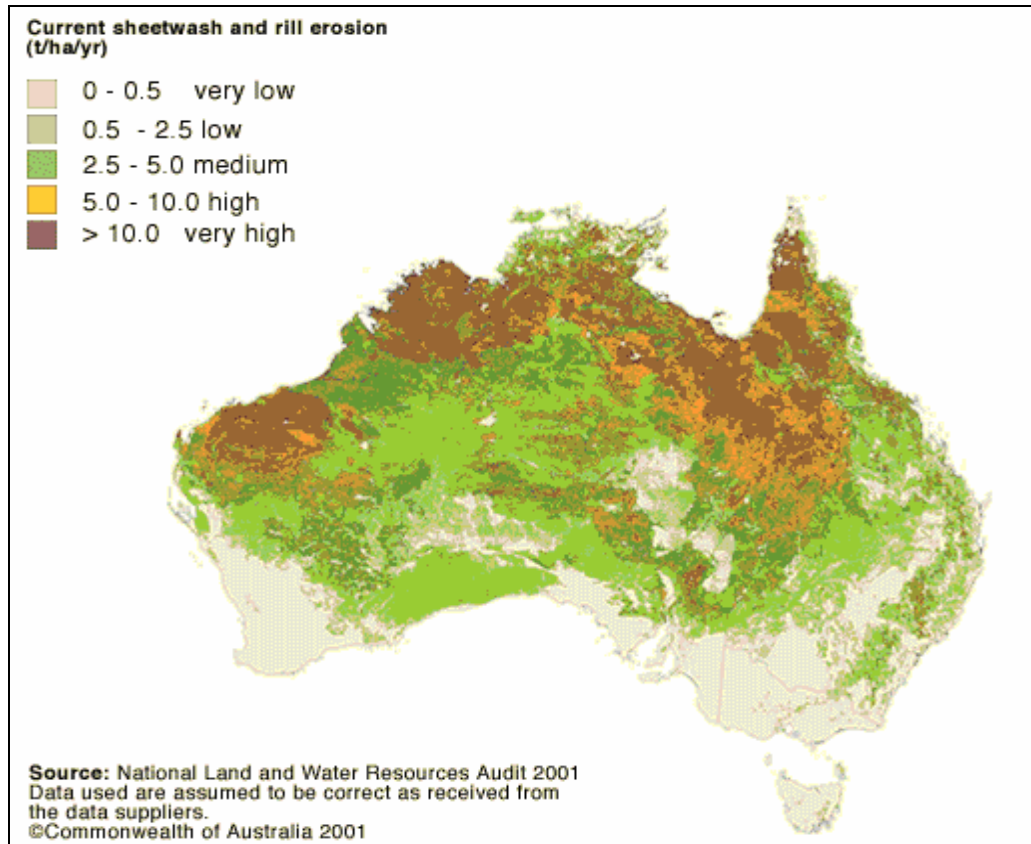


Figure 1.11 Soil erosion (sheetwash and rill).

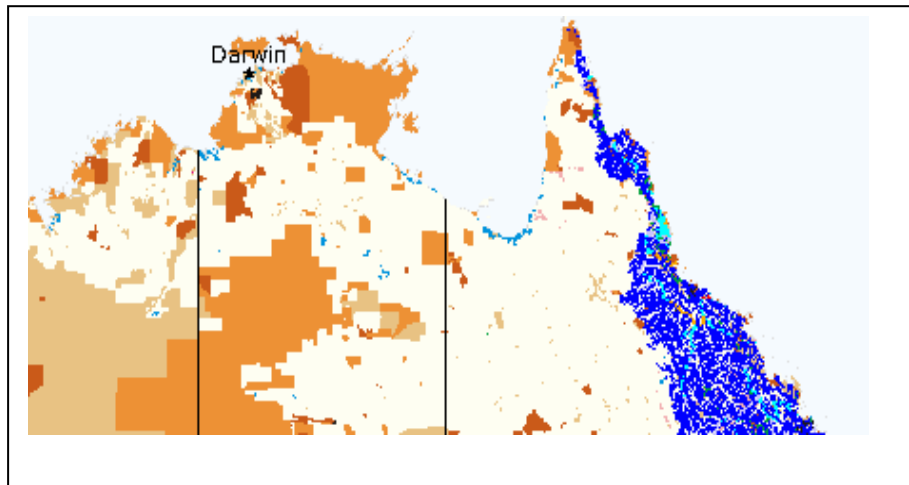


Figure 1.12 Land use and nutrient loss (N and P) through sediment flow in water ways (Source: NLWRA).

Maintaining a balance in soil nutrients and water levels is very important for ecosystem processes such as nutrient mineralisation/recycling and nutrient availability for plant growth. Savanna vegetation in its ‘natural form’ maintains this balance for production gains (from native woodland pasture systems), and other ecological services (bush food, medicine, good air, water and aesthetic value) from conservation parks or the Aboriginal land .

1.3.3.3 Reef protection

Savannas contribute to protect the Great Barrier Reef from degradation. The reef is located all along the eastern coast of savannas region. The land use practices, in particular of savanna area in Queensland, significantly affect the reef. The Australian Government funded ‘Catchment to Reef’ project in 2002 through Cooperative Research Centre for Reef which aims to assess the impact of different land use practices and river flows on reef. The natural vegetation in savannas serve the purpose by holding the soil particles together and minimising the sediment loss and the flow of chemicals in water streams which open in the Pacific Ocean, and thus helps to protect the reef.

1.3.3.4 Hydrological balance

Maintaining hydrological balance of an ecosystem is important to obtain production (pasture and crops) and other ecological benefits (bush food and medicine, and aesthetic value). Trees in the savannas help maintain salt levels by up taking water from deep soil, and prevent many other

associated problems of acidity, water logging or pollution in waterways. Consequently, a healthy landscape with native vegetation offers various ecological services for people in the region.

1.3.3.5 Climate stability (C sequestration)

Savannas contribute to climate regulation at local, national and international scale by sequestering C, mainly in trees and shrubs and soils. Savanna vegetation sequesters from 0-30 t C/ha (Fig 1.13; Raupach *et al.* 2001) depending upon the land and vegetation types. The total amount of C sequestered in savannas for the total area of 190 m ha, at the minimum rate of about 10 t/ha is 190×10^7 t, which is a significant figure to contribute in reduction of CO₂ concentration in the atmosphere.

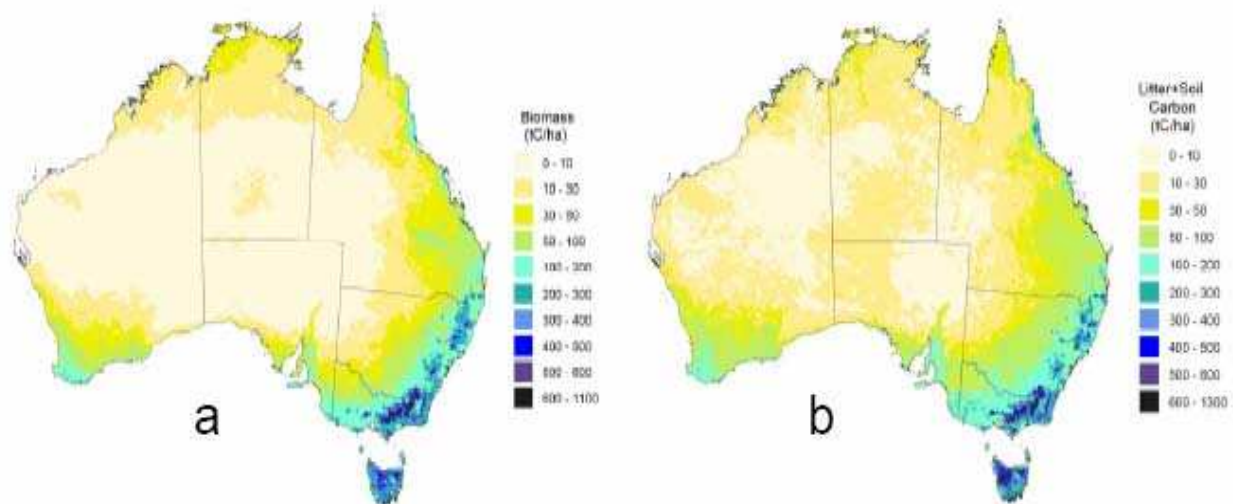


Figure 1.13 Mean biomass carbon, including leaf, wood and root pools (mostly 10-30 followed by 0-10 t C/ha in biomass and soil (including litter) in the savanna region) (Source: Raupach *et al.* 2001, CSIRO Land and Water).

1.4 The current status and human use of various ecosystem services

To summarise, the Aboriginal communities benefit from ecosystem services of savannas in ways that are different for the non-Aboriginal people. The role that various ecosystem services play in well-being of Aboriginal people may change over time with change in people's attitude and circumstances. Even so, the socio-economic approaches of ABS and others to the measurement of well-being ignore many ecological values that are important to Aboriginal people. The current approaches may well reflect well-being of non-Aboriginal people to some extent, but certainly miss the values that are related to natural resources. In future, there may be a shift in current use of ecosystem services by the Aboriginal people, either towards more economic oriented benefits such as businesses, or towards a natural resource based approach such as crocodile/bush food/medicine farming (information about various Indigenous businesses in savannas is presented in Chapter 4). People may apply a balanced approach that enhances their benefits from natural resources for financial and for cultural and spiritual values.

There has been a significant change in the ecological benefits obtained from savannas from bush food, medicine, shelter etc. to commercial production of beef or minerals, with European arrival since 1780s. As a consequence, the landscape has undergone a change from supporting a nomadic lifestyle to a contemporary life style. For the last 100-200 years, although Aboriginal people have modified their lifestyle, they still retain their connections to land, and their dependence upon various ecological services for their living. Table 1.3 presents trends (based

upon information obtained from EPA and NLWRA) in human use of ecological services from savannas, and their status over the past 100 years. The changes in land use, and in people's attitude (towards commercial benefits) has affected the availability of various services, and consequently their usage. Use of bush food and medicine has declined over the recent years, as relatively few Aboriginal communities have that traditional knowledge and many non-Aboriginal people are not aware of wild food/medicinal plants. There are hardly any bush food and medicines available in the supermarkets or alternative medicinal stores. Moreover, with land development for pastoral activities over the last 100 years, the change in native vegetation has adversely affected the availability of many resources. There are upward trends in some ecological uses such as beef production (increased over the past years; ABS 1999-2000), though the condition of grazing systems has deteriorated (National Land and Water Resources Audit 2002). Recreational use of the natural environment has increased over the past years, especially for non-Aboriginal people, with establishment of National parks, whereas the cultural use of landscape for Aboriginal people has decreased since many people have lost rights to visit most areas of their traditional country to which they belong (Hill 1995).



Artist: Minnie Pwerle

Story: The painting tells the story of the sweet bush tucker that comes from a very small bush and is only found in Antwengerrp.

Once very abundant and fruiting in the summer it is now very hard to source. Minnie Pwerle and the other women used to collect this fruit and scrape out the black seeds.

They would then eat the fruit immediately or cut in into pieces and skewer them onto a piece of wood and dry them to be eaten when bush tucker was very scarce.

Figure 1.14 A painting demonstrating food shortage.

1.5 Conclusion

Savannas provide many ecosystem services (provisional (mainly bush food and medicine, beef, timber, fuelwood, minerals, water and recreation), regulating and supporting and cultural) services for people.

Key message:

- Many ecosystem services have use and non-use values for Aboriginal people, and most of these services have non-monetary values, as presented in Table 1.4.

Table 1.4. Use of ecosystem services by Aboriginal people (based upon data presented in section 1.3).

Available ecosystem services from savannas	Aboriginal use (+) or non-use of a service (-), and the monetary value (MV) and non-monetary value (NMV)
Provisional:	
-Bush food	+ (NMV)
-Beef	+ (non-commercial)(MV)
-Bush medicine	+ (NMV)
-Timber	+ (MV)
-Fuel wood	+ (NMV)
-Tree bark	+ (NMV)
-Minerals	- (MV)
-Water	+ (NMV)
-Recreation	+ (NMV)
Cultural:	
-Sacred value	+ (NMV)
-Identity value	+ (NMV)
-Cultural value	+ (NMV)

2. Role of ecosystem services in human well-being

Aims:

- To broaden the commonly used socio-economic concept of human well-being to socio-economic-ecological concept
- To develop a model for savanna country to suggest linkages between ecosystem services and well-being of Aboriginal people

The sketch for this Chapter is:

- i. Section 2.1 defines the concept of human well-being, and explains the modern socio-economic concept from an Australian perspective. Section 2.1.2 describes the socio-economic-ecological approach of well-being as suggested in Millennium Ecosystem Assessment (MEA) framework.
- ii. Section 2.2 applies the socio-economic-ecological concept in savanna context. Section 2.2.1 provides information on socio-economic aspects of Aboriginal people and section 2.2.2 explains the linkages between people' well-being and ecosystem services.
- iii. Section 2.3 describes a model for the linkages between ecosystem services available from savannas and various constituents of well-being.
- iv. Section 2.4 provides the evidences for such linkages.
- v. Section 2.5 concludes the key points to suggest that the dimensions of human well-being may change over time for Aboriginal people, therefore, the proportional role of ecosystem services in their well-being for direct dependence may also change over time.

2.1 Concept of well-being- definition

“Human well-being” is defined as the state of being healthy, happy and prosperous (Oxford dictionary). While money helps to obtain many materials and services which feeds into well-being, but it is true that money does not provide everything for a good life. There are many other values such as culture, spirituality or identity, which could be equally or even more important in one's life than the materialistic values.

There are 3 philosophical approaches to the concept of human well-being according to Diener and Suh (1997):

1. The choice utility (economics) approach
2. Normative ideal (social science) approach
3. Subjective experience (behaviour science) approach

1. Choice utility approach

The key assumption of this approach is that people select things and activities that enhance their utility within the constraints of resources they possess (utilitarianism). This approach is widely accepted in western societies and influences the policy makers. The utility approach forms the basis of welfare economics.

2. Normative ideal approach

This approach is based upon values including cultural, religious, philosophical or other norms and ideals which are important for well-being. For this, optimal levels of health, income and other economic resources are determined and well-being is measured relative to those reference points.

3. Subjective experience approach

With this approach, different people have different value systems, so personal characteristics determine the type of attributes important to people. For example, people with low income may have low expectations and lead a satisfactory life compared to people with high income. This approach is individual specific and includes subjective feelings such as joy, pleasure, contentment and life satisfaction.

2.1.1 Modern/applied socio-economic concept

The modern concept is based upon various socio-economic attributes. It has originated from welfare economics, and therefore, selection of attributes for well-being depends mainly upon how the economists consider values to be important in human life. Since, economists view well-being as 'developing options for people to have choices by increasing utility/consumerism' (Human Development report published by The United Nations (UN) Development Programme 1990), so human well-being is mostly interpreted in terms of provision of various goods and services. For example, a person can be well off (or have a good standard of living) with good income, a good house, other household things, car etc. Most of the work reported to date on human well-being by socio-economic institutions (such as ABS, Australian Bureau of Statistics) measures well-being from utilitarian point of view. The attributes generally used are economic resources (income), household items, and availability of health services.

In the 1990s, Sen introduced a capability approach (CA) to well-being. This includes non-monetary attributes of human capability, with a focus on people's ability to lead lives which are valuable for them (Sen 1993). The CA emphasises human capabilities and functionings, freedom, inequality and rights that are important in well-being of an individual. For example, health and knowledge are people's capabilities that contribute to their well-being. From 1990 onward, health (life expectancy) and knowledge (literacy) are adopted in Human Development (HD) reports published by the UN. Apart from human capabilities, there are many other factors that play a significant role in human well-being such as freedom of speech, cultural values, or security of resources, to name a few. Most of these are acknowledged in well-being studies these days, though, not actually incorporated or measured.

Recently, human well-being is developed as a multi-dimensional concept that includes socio-economic and people's values towards life, and goes beyond income. Dasgupta (2004) states that well-being comprises two main components:

1. Constituents i.e. happiness, freedom, health and freedom of values (basic liberties)
2. Determinants i.e. commodity inputs in well-being such as food, shelter, access to knowledge, information and resources.

In practice, this concept is still much focussed on income or materialistic gains in an individual's life, with inclusion of education and life expectancy (human capabilities), crime and justice (security), or leisure time (freedom or health attribute). The reason is mainly peoples' attitude. People are more concerned for visible/materialistic achievements, particularly, in the developed

world; and the similar notion is becoming prominent in the developing world. However, it is also important to recognise that the other values such as culture, freedom or identity are difficult to measure.

2.1.1.1 Socio-economic concept implemented by the Australian Bureau of Statistics (ABS) in Australia

The Australian Bureau of Statistics applies socio-economic concept to measure well-being (ABS 2001) for both Aboriginal and non-Aboriginal people. The main indicators used to measure well-being are economic resources, work, education and training, health (life expectancy and infant mortality), housing family and community, crime and justice, and culture and leisure.

2.1.1.2 What is missing in the ABS list of indicators used to measure well-being in Australian context?

The well-being of an individual or a society depends upon its culture, geography and ecological conditions. In Australia, there is diversity in each of these three categories. The Australian community is multicultural, but could be broadly divided in to a majority group of non-Aboriginal people (dominated by Europeans) and minority group of Aboriginal people. Both of these groups have different value systems in terms of lifestyles, culture, identity and spirituality.

Aboriginal people in the savanna live close to nature and feel themselves attached to land for various reasons. These people are directly dependent upon natural resources for their daily needs. In addition, they have cultural, spiritual and religious ties with land and feel attached to the landscape (Table 2.1). Aboriginal people adapted themselves to the environment in the past and have gained vast knowledge about how, when and where to use various resources.

By comparison with Aboriginal people, non-Aboriginal people have been living in savannas for only the last about 100-150 years, still trying to understand the nature of savanna resources. Most of the non-Aboriginal people are engaged in the public sector, transport, mining and grazing. They are concerned with the production potential of land. These people do not directly depend to a great extent upon natural resources for their daily needs for food or medicine, but they indirectly rely upon natural resources for various services such as beef from grazing cattle in natural pastures. The difference in attitudes in the context of natural resources and other social values among non-Aboriginal and Aboriginal people are presented in Table 2.1.

Table 2.1. Value systems of Aboriginal and non-Aboriginal communities (Source: Edwards 1988).

	Aboriginal	Non-Aboriginal
Natural resources:		
Land	Related to, Sacred	Ownership, Secular
Environment	Adapt to	Exploit
Other social values:		
Society	Unified	Diverse
Relationships	Extensive	Limited
Basic unit	Society	Individual
Reality	Spiritual	Material
Possessions	Share, Use	Acquisitive, Accumulate

Since Aboriginal and non-Aboriginal people have different value systems, the indicators for well-being for each group will be different. The current social indicators used by ABS to measure human well-being are appropriate for non-Aboriginal people, but not for Aboriginal people since the ABS list of indicators does not include a range of non-materialistic values (such as ecological services) for Aboriginal people. Moreover, natural resources provide significant benefits in terms of good air, water, production capacity of land, climate stability, hydrological balance, aesthetic beauty, food and medicine, which are not only important for Aboriginal but also for the non-Aboriginal community. A change in the approach to measure well-being, so as to include non-materialistic values that are linked to ecosystem services, could help to understand their importance in well-being of not only the Aboriginal, but also of non-Aboriginal people. Although, the degree of importance of various ecosystem services may be different for Aboriginal and non-Aboriginal people, the estimates from Aboriginal people can help to realise the value of ecosystem services in well-being of non-Aboriginal people.

2.1.2 Socio-economic-ecological concept of human well-being

It is also important to note that human well-being is context specific and depends on gender, culture, geographic locations and ecological conditions. The latter, ecological conditions, are ignored in well-being studies. Well-being of people is well connected to various services available from the natural environment for example food, clean air and water. However, these links are normally not sought and people also differ in use and understanding the importance of natural resources in their lives.

Ecosystem services play an important role in human well-being for health, solitude, cultural, spiritual and identity values. These values are not only important for traditional societies but also for non-traditional societies. The main reasons to neglect ecological attributes in well-being studies are the existing imperfect markets that do not capture the benefits from natural resources or to consider ecosystems services as free gift of nature. However, with increasing population pressure and demand on natural resources, the role of ecosystem services in human well-being is now becoming important.

Recently, the UN started a Millennium Ecosystem Assessment (MEA) program in 2001, to develop a framework to assess the role of ecosystem services in human well-being. In 2003, the MEA study (by scientists, from various backgrounds such as economics, ecology and sociology) proposed a framework that highlighted the significance of ecosystem services in human well-

being (MEA 2003). In this framework, the different services from ecosystems i.e. provisional, cultural, regulating and supporting are considered to play a significant role in different components of well-being i.e. basic materials for life, good health, security, social relations and freedom and choice (Fig. 2.1).

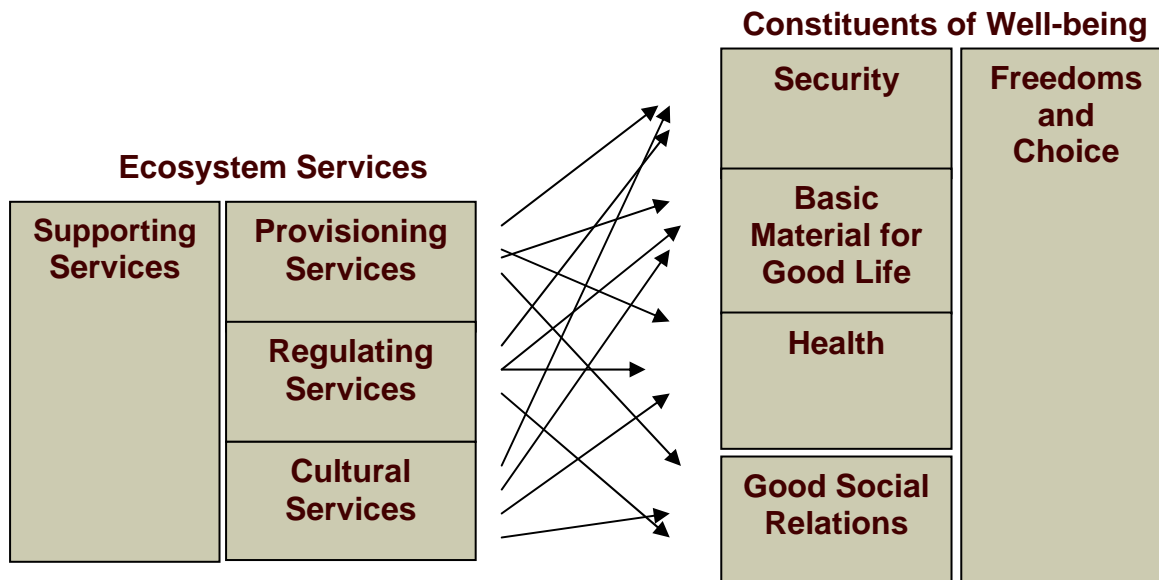


Figure 2.1 Linkages between ecosystem services and human well-being (MEA 2003).

The MEA revised the definition of well-being as “A context- and situation-dependent state, comprising basic material for a good life: freedom and choice, health and bodily well-being, good social relations, security, peace of mind, and spiritual experience.”

The MEA link between ecosystem services and human well-being is nicely framed to assess the role of following ecosystem services in various components of well-being:

1. Provisional services e.g. food, medicine, shelter, water and fibre
2. Regulating services e.g. water and air purification, climate stability and soil stability
3. Cultural services e.g. spiritual value of some sites
4. Supporting services e.g. soil formation, nutrient cycling and primary production,

The various components considered for human well-being are basic materials for life, good health, social relations, security and freedom and choice to use the resources. This framework is applicable at three scales i.e. local, regional and global, over the short and long term time frame.

However, the ecosystem services and their benefits for people will vary in relation to culture, geography and ecological conditions (climate etc.), and over time. There are difficulties in measuring the strength of relationship between ecosystem services and constituents of well-being as these relationships are difficult to evaluate and methods could differ for each of these linkages in different regions.

2.1.2.1 Advantages of socio-economic-ecological approach

The socio-economic-ecological approach has the following main advantages:

- Highlights the importance of natural resources in people' life
- Integrates human and ecosystem aspects as one constituent of a natural system
- The approach identifies some non-measurable values i.e. cultural, spiritual and identity values that are important in well-being

2.2 Adopting socio-economic-ecological concept to apply for savannas in the present study

The current research aims to assess the role of ecosystem services from savannas in well-being of Aboriginal people living in the northern Australia to demonstrate that:

1. ecological services are important in people' lives, and
2. these services could be linked to well-being so as to broaden the concept of well-being.
3. the well-measures differ for Aboriginal and non-Aboriginal people.

In the report, the term Aboriginal rather than Indigenous is used, since people who live in savannas are mainly of Aboriginal and not of Torres Strait Island background. Some socio-economic information is provided herein about the Aboriginal and non-Aboriginal communities to provide an overview, in particular from the northern part, and this information relates to differences in people' value systems.

2.2.1 Socio-economic aspects of Aboriginal and non-Aboriginal communities

2.2.1.1 Population demographics (Australia wide)

In Australia, there are 458,520 people (2.4 per cent) who identified as being of Aboriginal origin in the 2001 Census (ABS 2001) (Table 2.2). A significant number of the Aboriginal people live in the state of Queensland, Western Australia and the Northern Territory, where savannas represent the main type of vegetation (Fig. 2.2).

Table 2.2. Aboriginal population in different states (Source: ABS 2003).

	Aboriginal population number	Proportion of the total Australian Aboriginal population %	Aboriginal population as proportion of the total Australian population %
New South Wales	134,888	29.4	2.1
Victoria	27,846	6.1	0.6
Queensland	125,910	27.5	3.5
South Australia	25,544	5.6	1.7
Western Australia	65,931	14.4	3.5
Tasmania	17,384	3.8	3.7
Northern Territory	56,875	12.4	28.8
Australian Capital Territory	3,909	0.9	1.2
Australia	458,520	100.0	2.4

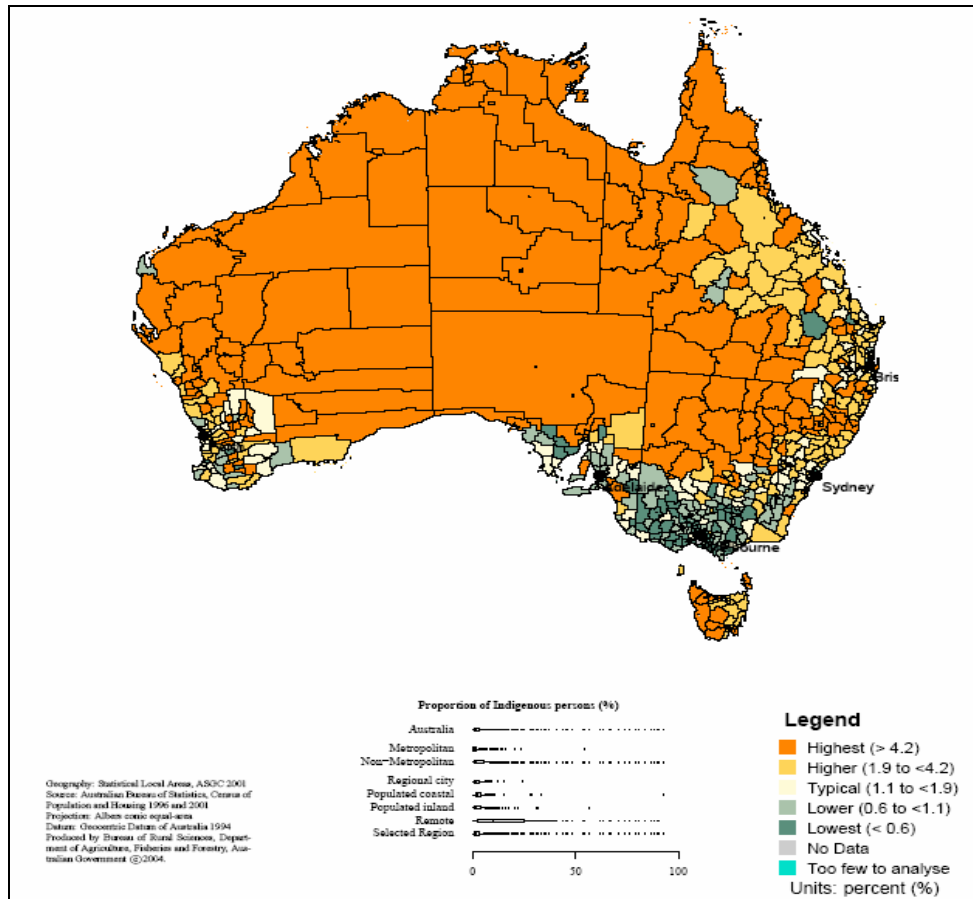


Figure 2.2 Aboriginal population as a proportion of total population (Source: BRS 2005).

Education, income, and residency – Aboriginal vs. non- Aboriginal (Australia wide)

Only nine per cent of the total Aboriginal population have completed year 12, compared to 29 per cent of non-Aboriginal population. The percentage of people working for private/government sector was relatively much less for Aboriginal than the non-Aboriginal people (Table 2.3). Weekly income from CDEP or other employment is less for Aboriginal compared to non-Aboriginal people. About 70 per cent of the Aboriginal people live in regional and remote areas compared to 30 per cent non-Aboriginal people (Table 2.3).

Table 2.3. Socio-economic indicators of Australian population (Source: ABS 2003).

		Aboriginal	Non-Aboriginal
Population		458, 520	18,954,720
Education	Year 12 or equivalent completed	41,923 (9% of total Aboriginal population)	5,529,881(29% of total non-Aboriginal population)
	Degree or higher	1.8	10.8
Employment (%)	Private	54.8	81.5
	Government	23.3	16.2
	CDEP	17.7	-
Income:			
Median annual income (\$)			
	CDEP	9620	22412
	Employee	25844	31044
	Other (a)	23088	28548
	Unemployed	8684	8476
	Not in the labour force	9412	9828
Resident population in remoteness areas (% of their population)			
	Major Cities	30.2	67.2
	Inner Regional	20.3	20.7
	Outer Regional	23.1	10.1
	Remote	8.8	1.5
	Very Remote	17.7	0.5

(a) Includes employers, own account workers and contributing family workers.

2.2.1.2 Aboriginal people in tropical savannas vs. Australia wide- a case study from Thamarrurr (Taylor 2004)

The socio-economic standards of Aboriginal people living in savannas are different to the Aboriginal people living elsewhere in Australia, because there are many remote areas in savannas with lesser opportunities for work.

To demonstrate the differences between average Australian Aboriginal people and Aboriginal people from savannas in terms of socio-economic characteristics, a sub-region of savannas i.e. Thamarrurr Collection District was selected from a study conducted by Taylor (2004). Thamarrurr is a part of Daly Statistical local Area, and represent an Aboriginal Area for Wadeye and outstations (Table 2.4).

Table 2.4. Aboriginal and non-Aboriginal ABS census counts, education, labour force status, and annual average personal income for people in Thamarrurr region, 2001 (Source: Taylor 2004).

	Aboriginal	Non-Aboriginal	Not stated
Census count (de facto)	1379	89	24
Total people	1492		
Education^a	% of adults		
Year 8 or below	56.1		
Year 9	12.1		
Year 10	11.2		
Year 11	1.2		
Year 12	2.7		
Did not go to school	16		
Labour force (no.)			
(Employment)			
Employed CDEP	88	0	
Employed Other	64	63	
Unemployed	22	0	
NILF	930	3	
Total 15+	1104	66	
Income per annum (\$)			Ratio (Aboriginal/non-Aboriginal)
Employed CDEP	8926	n/a	n/a
Employed Other (mainstream)	15127	52 240	0.28
Unemployed	8240	n/a	n/a
NILF	8170	15 600	0.52
Total earnings per adult	8632	49 143	0.17

^aBased on 2001 Census (Source: ABS, customised tables)

Education

In Thamarrurr region, only 2.7 per cent compared to the national average of nine per cent of Aboriginal people have completed year 12 (Table 2.3 and 2.4).

Employment and Income

Taylor (2004) calculated the number of people employed for Community Development Employment Project (CDEP), other employment and for people Not In Labour Force (NILF) as presented in Table 2.4, for total number of people with 15 years of age or over. There were 84 per cent people in NILF (but these people have potential to work) compared to only 4 per cent non-Aboriginal people. People working for CDEP in Thamarrurr (88 per cent) are greater than the national standards (17.7 per cent) (Table 2.3 and 2.4).

Average annual income for an Aboriginal person is about 25 per cent less than the non-Aboriginal people (Table 2.4). A large gap (of \$37113) exists between mainstream income earned by Aboriginal and non-Aboriginal people in the Thamarrurr region. However, this gap is much lesser at the national level (only \$5200) (Table 2.3 and 2.4).

Health

Death rate for Aboriginal people in Thamarrurr is 23.8 per cent, compared to six per cent for non-Aboriginal people. Life expectancy for Aboriginal people across Australia is 59.4 years for

males and 64.8 years for females, considerably low compared to average Australian (77.4 years for males, and 82.6 years for females) (Report on Government Services 2005 –Indigenous compendium). Diabetes, hypertension, renal disease, chronic lung disease, asthma, rheumatic heart and chronic liver diseases are quite common among Aboriginal people (Table 2.5).

Poor health condition of Aboriginal people may be the result of a combination of changes such as food habits, living style, crowded living conditions, and general lifestyle regimes, in association with emotional stress from the past history. This is evident from the medical records in Wadeye where 116 people suffered from hypertension (Table 2.5).

Table 2.5. Notification of chronic diseases by sex: Wadeye clinic, June 2003 (Source: Taylor 2004).

<i>Disease</i>	<i>Total</i>
Diabetes	68
IGT	12
Hypertension	116
Renal disease (early)	92
Hyperlipidemia	22
Chronic lung disease	53
Asthma	51
Rheumatic fever	14
Rheumatic heart disease	53
Chronic liver disease	23

Conclusion on socio-economic measures of Aboriginal people in Tropical Savannas (Thamarrurr)

Aboriginal people in Thamarrurr have traditional knowledge and skills to survive in natural environment, social network and relations, cultural heritage and traditions, which are often missed in well-being measures. However, they lack in capabilities such as modern education and good health. Poor health of Aboriginal people compared to non-Aboriginal people is likely due to changes in living conditions, including other socio-political factors, over the past 100-200 years.

2.2.2 Savannas: attributes of well-being and their linkage with ecosystem services

Savannas provide a diverse range of ecosystem benefits for people as discussed in Chapter 1.

Aboriginal people have attachment to savanna landscape for their culture, spiritual and identity values, apart from its provisional ecological benefits. There are many natural sites of cultural importance all over the savanna country, and many of them are yet to be recorded (personal communication, John Richter, Department of Natural Resources, Mines and Water).

Based on a literature survey (Altman 1987, Cribb and Cribb (1975 & 1981), Jean 1995, Williams 1998, Clarkson *et al.* 1992, Sen 1993, ABS 2001, World resources 2000, Norwegian Millennium Ecosystem Assessment- Pilot Study 2002, MEA 2003 and 2005, Dasgupta 2004, Keen 2004, and Integrated Natural Resource Management Plan for the Northern Territory and for the wet tropics 2005), the following attributes of savanna landscape are considered important in well-being of Aboriginal people:

1. Basic material for living: bush food and medicine, and shelter (provision of timber, fuelwood and fibre).
2. Good health: provision of good air, water and land resources for good health.
3. Security: availability of natural resources for the present and future generations, and opportunity to have recreational/cultural sites for the present and future use.
4. Social relations: cultural ceremonies linked to land and other natural features of savanna landscape, hunting and gathering food, learning techniques and listening stories from elders.
5. Freedom and choice: freedom to access the natural resources (land and water).
6. Cultural importance: sites of cultural significance, identity and spiritual values.

Each of the above-mentioned attributes links ecosystem services with well-being, are discussed below from Aboriginal perspective:

1. Basic material for living: bush food and medicine, and shelter

Over the past thousands years of use, the Aboriginal people have developed knowledge of different plants and animals. Keen (2004) described the environments and resources for the Aboriginal people from seven different communities, among these two are in the savanna country i.e. Ngarinyin (in north-east of Australia) and Yolngu people (north-Arnhem lands). Both of these communities use various plant species for vegetable food, seeds and nuts and for fruits, and have knowledge when and how to harvest plant products according to the climate.

Savannas provide a range of bush food products such as bush tomatoes, Illawarra plum, Kakadu plum, Lemon aspen, Lemon myrtle, Wattle seeds, Cycads, Quandong, and many native bushes, honey, plant oil such eucalypt oil and tea tree oil, and native wild flowers. Details of bush food and medicine are mentioned in Chapter 1. Altman (1987) reported that the household economy of an Aboriginal community of north-east Arnhem Land ‘Momega’ was based mainly on various flora and fauna, where animal meat (kangaroos, wallabies, fish, goannas etc.) provided a good source of protein while plants provided carbohydrates.

There are not many reports available on the value of wild food for Aboriginal people. However, Gray *et al.* (2005) calculated the economic value of wild resources (fish) for Aboriginal communities living in the Wallis Lake catchment in NSW about \$468-1200/adult/year. This value is only a part of the total value of the benefits that people get from the natural resources. The actual value of the landscape would be much more if the non-market and non-use services of bush food, cultural/spiritual values, and importance of Aboriginal practices in teaching young generation, are considered.

Isaacs (1987) describes the Aboriginal knowledge about flora and fauna as:

“Aboriginal people have an encyclopaedic knowledge of Australian plants and animals and of seasonal changes in the Australian environment. A batwing coral tree flowers, its orange blossoms fall and women know it is time to go and dig crabs from their hides under the mangrove mud. Their fat, too, will be orange, and the flesh good and filling. Another flower

blooms to warn that poisonous stringers are in the northern waters, while the milky white flowers known as ‘oyster flowers’ tell people to move camp to the oyster beds, for the oysters are fat and white. Every child learns the importance of such natural signs. The winds, the blooming of plants and the seeding of grasses, rather than a fixed calendar of dates and months, herald the changes of seasons.” (Isaacs 1987, pg 13).

There is a lot of potential to commercialise native plants and animals that could help to improve the regional economies, and to integrate Aboriginal knowledge with scientific knowledge to manage natural resources, however, this would involve many institutional, socio-economic and ecological issues (Whitehead 2003).

2. Good health: provision of good air, water and land resources for good health

With the depletion of natural resources and changes in climate all over the world, ecologists have concerns for the provision of good air and water for human beings in the future. Air and water are vital elements for living. The rise in global surface temperature (air temperature above land and sea surface) by 0.6°C over the past 100 years (IPCC (Intergovernmental Panel on Climate Change) 2001) is mainly due to clearing forests and industrialisation.

The presence of natural resources to fulfil the prime needs for good air and water, is the most important for human well-being. In the past, history provides us with evidence of cases where civilizations (e.g. Mesopotamia, Mayan (for water logging and water siltation)) vanished due to scarcity of water resources for human use (Redman 1999 cited in World Resources 2000).

Savannas are important as an ecosystem because they have both trees and grasses which provide monetary production gains for beef (marketable), and non-monetary gains for biodiversity, regulating CO₂ concentration and other ecosystem functions. The role of trees in maintaining C levels in soils is particularly important for climate regulation (Raich and Tufekciglu 2000).

There are important rivers in the savannas such as the East Alligator, Burdekin, Ord, and Daly rivers that supply water for people, and maintain diversity of flora and fauna. Water is an important resource for both the Aboriginal and non-Aboriginal people. Non-Aboriginal people view water as a resource for their use (drinking, cropping or grazing) whereas Aboriginal people also have spiritual and other values attached to water resources (Jackson *et al.* 2005).

3. Security to have healthy country for the present and future generations

All over the world, until the beginning of the 20th century, ecosystem services were considered abundant and humans could manipulate the ecosystems according to their needs. In the early 1950s, a lot of forests were cleared to develop land for agriculture. This led to increase in crop production, but raised many issues on nutrient balance in soils, salinity, acidity, climate change and loss of flora and fauna.

In savannas, since the early 1900s with European arrival, land has been developed for pastures to maximize the monetary benefits. This led to financial gains to some extent but compromised diversity of flora and fauna, and soil and river health (State of the Environment Advisory Council 1996). This approach focuses on physical maintenance of land. Natural resources are generally thought as a free gift for people to use and exploit. In contrast to this, the Aboriginal people have a holistic approach towards natural resources. According to their culture, land provides a medium through which all aspects of life are mediated, and they manage land for both spiritual and physical values to keep the country healthy for future generations. The past 100 years of use of

natural resources under modern practices has raised serious ecological concerns in terms of land degradation and loss of biodiversity.

For human beings, security of good air, land and water is quite important. Aboriginal people are very concerned about the security of ecosystem services (goods and services) for their cultural linkages and dependence upon natural resources. Strang (1997) says that people are integrated in the natural world, with a responsibility to care for it according to the ancestral law.

Despite the security issue for provisional services, there are issues relating to cultural services. Many cultural sites have been destroyed European settlements in the past, so the security to have existing cultural sites is of paramount importance for Aboriginal people so they can pass on their traditions to future generations.

4. Social relations (how the use and activities related to natural resources contribute to social relations e.g. celebrations at a cultural site, hunting in a group, sharing food, and managing the country together)

“Trees and animals- they’re like our brothers and sisters, we got to care for them; they are part of us too” (Colin Lawrence, Kowanyama).

“I feel with my body. Feeling all these trees, all this country. When this blow you can feel it. Same for country... you feel it, you can look, but feeling... that make you.” Big Bill Neidjie, Gagudju Elder, Kakadu (Source: www.dreamtime.net.au/indigenous/land.cfm).

The Aboriginal way of living is intricately linked with nature for cultural, spiritual and day to day activities. In Aboriginal art, foot and hand prints are quite common signs that represents that the elders walked there and had a relation with that country. Land, considered as ‘mother’, is cared for with a sense of responsibility. People go bush to hunt animals and to gather food. During these activities, the elders teach the younger generation about bush skills, pass on knowledge about plants, animals and the country, and tell stories about the land and their elders. Muir (1998) says that hunting and gathering bush tucker are the activities that serve to cement the bonds within the group. When a family group goes hunting they usually bring surplus food for distribution to other members of the clan.

The presence of various plants and animals is also important in various relationships among people, in the Dreamtime stories, and in connections with the country. Many ceremonial activities are linked to land or water, and people get together for celebrations. The presence of natural resources provides the opportunity for people to be together to perform rituals, cultural ceremonies and to keep their spiritual relationships with the country (Muir 1998).

5. Freedom to access the land and water resources

Land and sea are the most important natural resources for the Aboriginal people for their cultural, identity and spiritual values. Access to land and water for Aboriginal people is like access to their own spirits and having freedom to live their way of life that they value. Since, land and sea are considered like extensions of soul and body, so freedom to access these resources is vital for their well-being. Dhayirra Yunupingu, a member of Yolngu community says (in Williams 1998, pg 5) “we Yolngu look over and care for this land, and so it rests on our heads, it comforts us, when we think sadly about our old people, and we remember the places where they used to gather together and the places where they died.”

Freedom of culture or traditions and religion plays an important part in people's lives because it allows the advancement of their culture and tradition, and promotes diversity and understanding among people from different cultures. For non-Aboriginal people, there is much which can be learnt about natural resources from Aboriginal people. For this, Aboriginal people need access to country so that they can continue teaching young generation about valuable bush skills (Muir 1998). The importance of freedom to access land is also evident from the song by Neprrija Gumbula (1994) on "Yolngu Children":

“.....Can't you hear the Yolngu children
Crying out for freedom and rights
This land and its heritage
Has been handed back again
Yolngu children must live in the Yolngu way of life
We have fought back the land for our new generation
It's beauty and the land of ours will remain the same
For the future of Yolngu children”

(Corn and Gumbula 2001, pg 57)

The transfer of traditional ecological knowledge and its incorporation in modern practices could improve the ecosystem services for the present and future generations. This will also be useful for modern science to understand how Aborigines have managed the resources over the past 40,000 years of long history. However, for this Aboriginal people need the freedom and rights to use the land and sea. Such a freedom will also bring a sense of responsibility among Aboriginal people, as it did in the past. Freedom to use resources, in a sustainable and responsible way, could improve well-being in terms of fulfilling basic needs, cultural, health and social needs.

6. Cultural values

Aboriginal people have cultural ties with savanna landscape for their identity, spiritual or sacred values.

Identity values:

"The land owns you and you have to look after it. And that just goes on for generations. It's passed on. And it's in your heart. It's in every Aboriginal person's heart." - Mary Darkie (Source: www.loreftheland.com.au/indigenous/index.html)

Landscape has a unique identity value for Aboriginal people. Land “speaks” the stories of old people, and the relationships among people. Generally, younger people inherit land from elders and undertake the responsibility to look after it. While taking care for land, people feel related to land. Jean (1995) says:

For Aboriginal people, their lands and waters underpin who they are and the foundation of their very survival as people. Aboriginal people all over the globe insist that living things can not be separated from the land they grow on, and that people's knowledge and myriad uses of natural resources can not be separated from their culture, their survival as peoples on the land.

Land is not a separate entity for Aboriginal people but rather it is the 'oneness' between people and land. Land is an identity of people, of their elders and of their future generations, as Father Dave Passi says:

It is my father's land, my grandfather's land, my grandmother's land. I am related to it, it gives me my identity. If I don't fight for it, then I will be moved out of it and [it] will be the loss of my identity.

Father Dave Passi, Plaintiff, 'Mabo' Case in 'Land bilong Islander' 1990 (Source: www.dreamtime.net.au/indigenous/land).

The bond between people and land is also highlighted in the Aboriginal flag where black colour represents people and red colour represents earth and people's spiritual relationship with earth. A member from Yolngu community, Dhayirra Yunupingu (in Williams 1998) says "land is like our bodies, or the land represents ourselves, so for example, whenever a person will die, it will be this very land which will slowly wipe out all the traces, and this is so that we will somehow still be able to interact with that person's spirit properly". Connections to the land are central in all Aboriginal communities. Rose (1996) says "country is a living entity with a yesterday, today, and tomorrow, with a consciousness, and a will towards life".

From an ecological perspective, the feeling of 'oneness' and 'relatedness' to land among Aboriginal people, helps them follow practices that sustains land resources. This seems to be the main reason Aboriginal communities have not exploited the resources and instead integrated themselves with nature to co-exist as one entity.

Sacred value:

Savanna landscape is sacred for Aboriginal people because features such as hills, rocks, trees, waterholes have a specific meaning and importance to Aboriginal people (according to the Aboriginal Land Rights (NT) Act 1976 (hereafter Land Rights Act)). Sometimes, these sites could be rock art or other human artefacts such as ceremony grounds or traditional burial grounds. However, it is usually the natural features that are of most significance as they speak of Aboriginal tradition. For example, rocks were considered to be metamorphosed bodies of fig-men, so the spirits remain there and people remember them. Sacredness of land is mentioned many times in the Dreamtime stories for various events as Strang (2000, pg 7) says:

"the stories go along with the land, everything, must go ...so....you are talking about land and all that...our stories gotta be there to cover all our land-Kenny Jimmy)."

The sacredness of land, for people who believe in that, is invaluable and is irreplaceable. Traditions, history and relations linked with sacred sites are passed on from one generation to another, and are of paramount importance for well-being of a society. About the Aboriginal people living in the north-eastern Arnhem land (the Yolngu people), Mick Dodson (1997, cited in Williams 1998, pg 4) says "our traditional relationship to land is profoundly spiritual."

Dhayirra Yunupingu (Williams 1998, pg 5) from the same community explains about sacredness of land “.....this land of ours, it provided our ceremonial objects, sacred for people, and it wasn't the only sacred things which were given but the land also provided the sacred names, the kinship, the subsections, the homelands, and whatever language you might speak. So wherever we Yolngu people see this land, we must care for it, even as if it were our mother.”

According to the Aboriginal believe system, “sacred” is where the dreaming whispers hope for everyone. Thus certain features of the natural environment remained well preserved without any interference from mankind. Many sacred sites of Aboriginal heritage have been reported (e.g. rocks paintings, caves, stone arrangements, ceremonial sites) and registered by the Government departments, and still there are many yet to report.

2.3 A model of the relationships between human well-being and ecosystems services

As described in the earlier sections, ecosystem services play an important role in well-being of people. There are complex relationships between various ecosystem services and various components of well-being. Each of the ecosystem services contribute to more than one component of well-being (Fig. 2.3). For example, bush food and medicine contribute to provision of basic materials for life, good health, security of food and in social relations.

Some relationships are direct and obvious, for example, the provision of basic material for life and good health, whereas others are indirect. For the later, though the raw/basic material is mostly obtained from the ecosystems but its importance is not considered since people mostly focus on industrial output without realising the source of input from the natural resources.

The proposed model (Fig 2.3) for savannas contains both the ecological and the ABS socio-economic indicators, as the later are considered a part of contemporary Aboriginal well-being. It is important to note that many standard socio-economic measures also relate to ecosystems services in one or another way, and most such links are indirect.

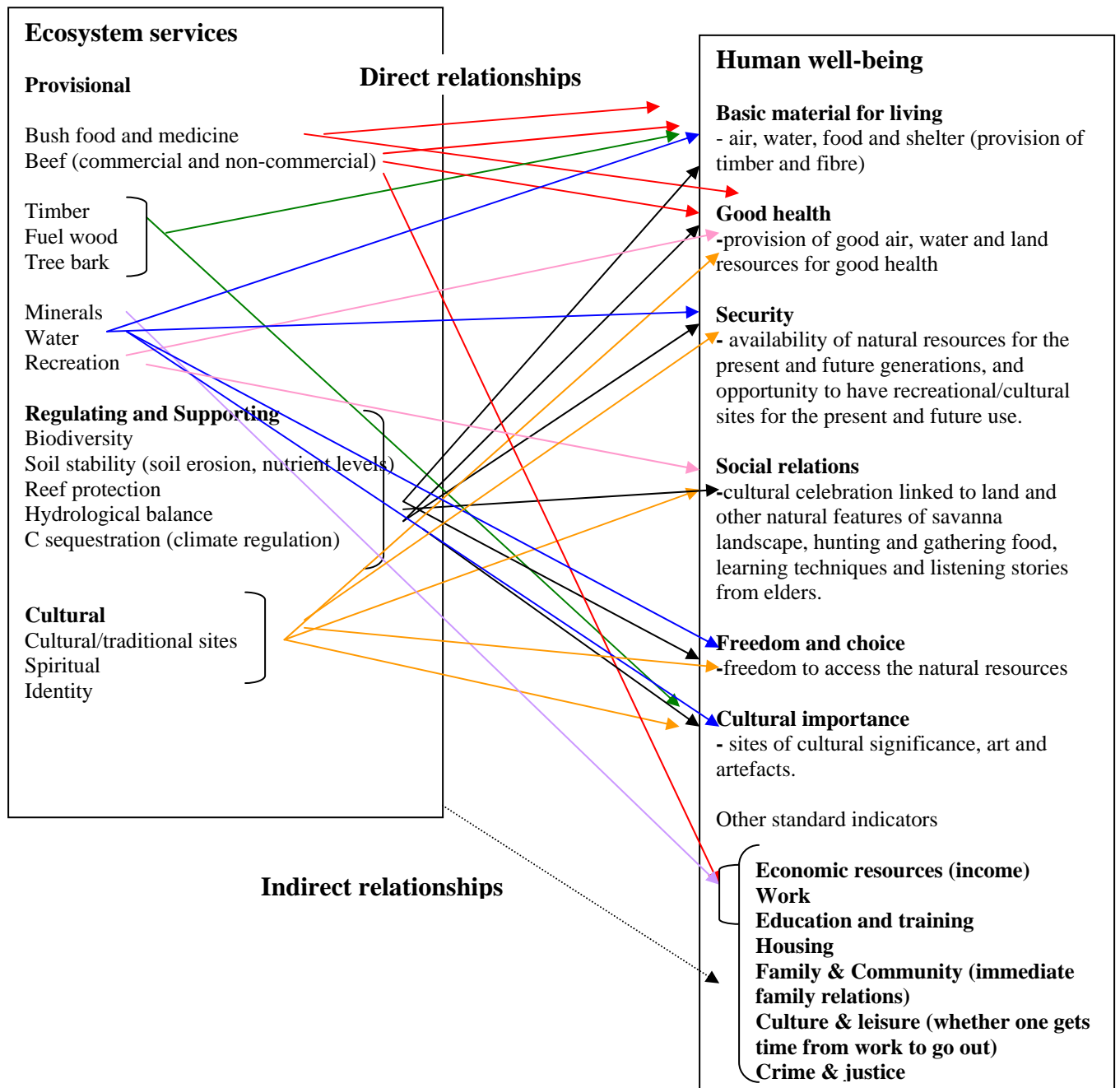


Figure 2.3 Relationships between various components of human well-being and ecosystem services.

2.4 Evidences of linkages between ecosystem services and Aboriginal well-being: An Aboriginal account of different services of savanna landscape (a case study by Roberts and Stanley (1986)).

This study presents information for a group of people living in Alawa country (top end in NT) on:

- Living style
- Social customs
- Association with land
- Association with animals, as totems
- Use of plants

Aboriginal people in Alawa country prefer to live in the outback, closer to nature. Different components of an ecosystem such as land, water, plants or animals are embedded in their way of life. People believe that children come from water. Totems, spirit ancestors, (generally plants or animals) are acquired by a child at birth, and that person is required to protect and look after the particular totem. This study describes various plants for food and medicines, cultural and sacred values of various natural features (plants, animals, rocks etc.) for Aboriginal people of Alawa country.

Most animals and important plants are totems. Many places, for example, particular hills, caves and a tree/tree grove are considered sacred. Such services of the natural landscape are directly linked to well-being of people.

The evidence for linkages between ecosystem services and various attributes of well-being of Aboriginal people are provided in Appendix 2.

2.5 Conclusion

Ecosystem services play a vital role in well-being for both Aboriginal and non-Aboriginal people. However, these communities have different value systems, and the linkages between ecosystem services and well-being are more apparent for Aboriginal people for their direct dependence and connections with land and other natural resources (Fig. 2.4).

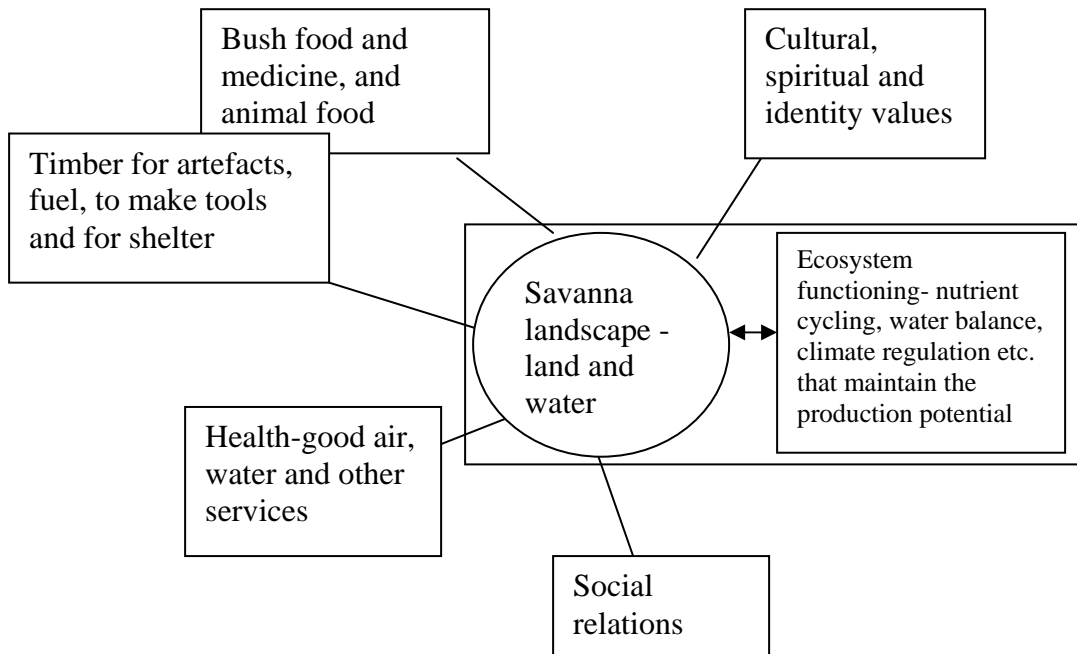


Figure 2.4 Ecosystem services from savanna landscape.

If the proportion of economic resources and ecosystem services in human well-being is considered, the ecosystem services contribute a large proportion in well-being of Aboriginal than non-Aboriginal people (Fig. 2.5). The non-Aboriginal people may have less direct dependence but more of indirect dependence upon ecosystem services. Therefore, studying the role of ecosystem services in well-being of Aboriginal people will also help understand their value for non-Aboriginal people.

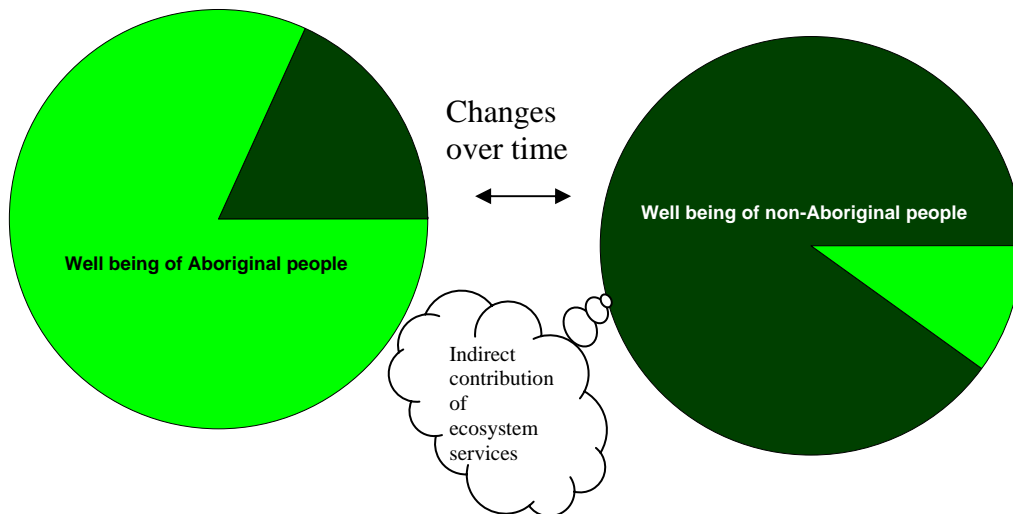


Figure 2.5 Direct (light colour) and indirect (economic resources mainly) (dark colour) contribution of ecosystem services in well-being of Aboriginal and non-Aboriginal people (hypothetical figures).

It is very important to anticipate that people's attitude may change over time, and Aboriginal people may trade off some of their values to obtain greater economic gains (Fig. 2.5) or they may evolve an integrated system that includes the ecosystem services and marketable benefits for them. In the past, before the European arrival, ecosystem services were playing a major role in the lives of Aboriginal people, however after 1920s till 1970s (welfare period) governmental policies changed people's attitude to be away from the country, and only after 1970s, people preferred to move back to their country. Thus, the role of ecosystem services in Aboriginal well-being has changed over time in the past with change in governmental policies (Fig. 2.6), and the same is expected in the future.

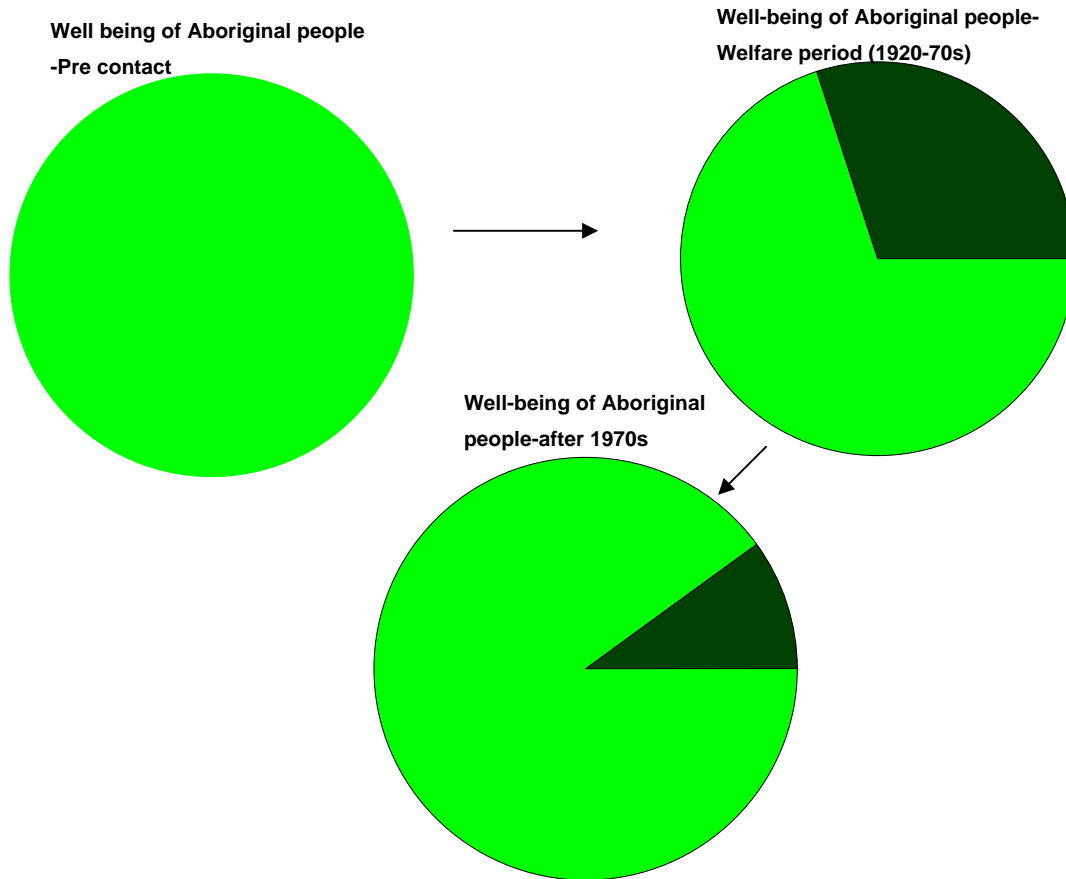


Figure 2.6 Change in role of ecosystem services-light and dark colours represent contribution of ecosystem services and of economic resources respectively, in Aboriginal well-being (author's interpretation from literature).

With changes in governmental policies/people's circumstances, the direct role of ecosystem services in well-being of Aboriginal people may change. This may result in people having increased indirect (rather than direct) dependence upon these services. For the savanna region, it is opportune to have Aboriginal communities that provide evidences for their direct dependence upon these services.

Clarkson *et al.* (1992) (from the International Institute for Sustainable Development) pointed out "we must conceptualize our ideas on the quality of life that incorporate the health of the planet as the primary goal rather than the satisfaction of the material wants that go hand in hand with accumulation of wealth and uninterrupted expansion and exploitation of the gifts of the earth." Aboriginal people, all over the world, have a lifestyle that connects them well with nature in terms of daily living, culture, identity and spiritual values. This scoping study in savannas can help understand the importance of ecosystem services not only for Aboriginal but also for non-Aboriginal people.

The various methods that could be used to test the linkages (as described in this chapter) are proposed in Chapter 3. The strength of these linkages will provide data on how Aboriginal people think and rank each of the six identified ecosystem services in terms of their role in well-being. The current uses of savannas and the related present and potential future businesses having natural resource base, are explored in Chapter 4.

Key message:

- There are strong links between ecosystem services and various constituents of well-being for Aboriginal people based upon literature survey, however these need to be tested.
- The role of ecosystem services in well-being may change over time with change in people' attitude.

3. Methods

Aim

- To study the available methods to measure well-being and their advantages and disadvantages
- To explore and propose methods to study the links of ecosystem services with well-being of Aboriginal people.

This chapter is planned as follows:

- i. Section 3.1 - introduction.
- ii. Section 3.2 describes common measures of well-being
- iii. Section 3.3 discusses limitations of common methods used to measure well-being in savannas.
- iv. Section 3.4 proposes the list of attributes to be considered to measure well-being (socio-economic-ecological measures) in savanna region.
- v. Section 3.5 presents an overall approach to measure ecosystem services and their value in people' lives. This section discusses the methods for ecosystem services as well as for well-being attributes.
- vi. Section 3.6 suggests the area to conduct this type of study
- vii. Section 3.7 proposes statistical methods to be applied for data analysis
- viii. Section 3.8 presents work outline

3.1 Introduction

The first part of the chapter explores the existing methods used to measure well-being, and provides a list of measures that includes socio-economic and some ecological attributes as suggested in a model in Chapter 2 (Fig. 2.3). The second part of this chapter describes the approach and methods applicable to study ecosystem services, and their linkages with human well-being.

3.2 Measures of well-being

3.2.1 Socio-economic indicators

The common social and economic indicators, generally applied by the socio-economic institutions to measure well-being, and their limitations are discussed below.

3.2.1.1 Economic indicators

Various indicators to measure human well-being are focused on determinants, or commodity inputs such as income and household items (car, washing machine, dryer, refrigerator etc.). Income or the Gross Domestic Product (GDP) is used as an important indicator of well-being.

3.2.1.2 Social indicators

Demography, crime rate, family relations, crowding in a house or household size and leisure time are also used along with economic indicators.

3.2.1.3 Human Developed Index (HDI)

Over time, non-monetary constituents i.e. health and knowledge have been incorporated to measure well-being. In 1990, the UN began to measure human well-being in terms of HDI based on health (life expectancy), education (literacy), and GDP for different countries (The UN Development Programme 1990). Health and education are measures of human capabilities. The HDI is calculated from individual indices for each of the 3 attributes i.e. life expectancy at birth (health), education (the combined primary, secondary and tertiary gross enrollment ratio) (knowledge) and GDP (a decent standard of living) as:

Dimension index = $\frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$

Performance of each index is expressed as a value between 0 and 1. For GDP index, logarithmic function is applied as one does not need unlimited income for respectable level of development. Overall HDI is calculated from each of the individual indices as:

$\text{HDI} = \frac{1}{3} (\text{life expectancy index}) + \frac{1}{3} (\text{education index}) + \frac{1}{3} (\text{GDP index})$

The HD reports aim to achieve development for humans by increasing options for people. These reports also mention other options as security, economic, social and political freedom for being productive and creative, enjoying personal self respect and guaranteed human rights but none of these are included in the HDI.

3.2.1.4 ABS (Australian Bureau of Statistics 2001) measures of well-being

The ABS uses the following attributes to measure well-being:

- i. Economic resources (individual and household income, expenditure and wealth (assets owned))
- ii. Work (employment, unemployment, hours worked, underemployment)
- iii. Education and training (no. of schools, universities, no. of educators (school teachers, academics), level and field of education, apprentices and trainees.
- iv. Health (life expectancy, infant mortality and age specific death rates, disability adjusted life expectancy, prevalence of specific diseases, and risk factor indicators (smoking rates))
- v. Housing (housing demand and supply, housing affordability, ratio of persons to rooms, and satisfaction with dwelling and neighbourhood conditions, housing costs and their relationship to income)
- vi. Family and community (demographics of family: no. of children, age and relationships etc.)
- vii. Crime and justice (Crime rate, public order offences, etc.)
- viii. Culture and leisure (types of businesses/industries providing goods and services for cultural and leisure activities, types of cultural activities people undertake and the role they play (e.g. player, coach), participation in activities, no. of people at cultural venues (e.g. museums, cinemas etc.), attendance at festivals (art and cultural festivals), and types of cultural, sports and recreational industries.

The organisation for economic cooperation and development (OECD) uses a similar list of social indicators (health, education and learning, employment and quality of working life, time and

leisure, command over goods and services (corresponds with economic resources, ABS), physical environment (corresponds housing in the ABS list), social environment (family and community in the ABS list) and personal safety (corresponds to crime and justice, ABS).

3.2.2 Other measures in particular for Savannas: Savanna health concept as proposed by TS-CRC

The Tropical Savanna Management Cooperative Research Centre (TSM-CRC) introduced the concept 'Savanna health' to encompass the ecosystem functions and their relations with people's health, particularly for Aboriginal people, pastoral, cropping and conservation groups. A healthy savanna is defined as (Whitehead *et al.* 2000):

- Maintains basic functions (including but not only confined to nutrient cycling, water capture, provision of food and shelter for fauna) at all spatial scales;
- Maintains viable populations of all native species of plants and animals at appropriate spatial and temporal scales, and
- Reliably meets the long-term needs (spiritual, aesthetic and material) of people with an interest in the savannas.

In ecological terms, health of an ecosystem is mainly related to its functions, however, the savanna concept was proposed to include biodiversity and people's health as well.

3.3 Limitations of socio-economic measures and savanna concept

Limitations of commonly used socio-economic measures and of savanna health concept (proposed by TS-CRC) are discussed below:

3.3.1 Limitations of socio-economic measures of human well-being

- The socio-economic measures are based on quantifiable gains or achievements of an individual or people, and exclude the non-quantifiable measures of well-being such as personal satisfaction, security of work and social relations.
- Income, considered an important indicator of well-being, is however not directly proportional to well-being. There could be a minimal level of income to meet basic necessities, and that minimum level will vary for different societies.
- These indicators will vary with people' attitude/behaviour (Aboriginal and non-Aboriginal communities).
- Knowledge as human capability is considered in terms of western system of education which ignores the knowledge of traditional societies.
- These measures ignore non-quantifiable cultural, identity or spiritual values.
- People's freedom, security and access to natural resources that they value, are not considered, particularly for traditional societies.
- The role of natural environment in people's well being is absolutely neglected.

3.3.2. Limitations of Savanna health concept, in particular for Aboriginal group

- The concept is primarily based upon biophysical functions of savanna landscape, which is correct according to ecological nomenclature, but not the same emphasis was given to well-being/health aspect of people.
- The selected indicators to measure savanna health from Aboriginal perspective such as availability of key resources to reliably meet people's needs, are misleading as a resource

may be available while there would have been changes occurring in ecosystem functions. The natural system may provide that service/resource due to its resilience. Moreover, the reliability to meet people' needs is also linked to other factors i.e. management, climate or social framework.

- The attribute of savanna health for spiritual sites 'no evidence of physical damage to the sites' is more or less linked to social/political circumstances. The presence of spiritual sites is an important characteristic of savanna landscape, however, does not necessarily mean that any change in spiritual sites will reflect as a change in savanna (vegetation) health.
- Relating ecological indicators i.e. availability of key resources and spiritual sites with human health, as was suggested for Aboriginal perspective, does not actually suggest the overall health of savannas (people and natural environment), as people's health also depends upon many others factors e.g. provision of medical facilities.

3.3.2.1 Suggestions

- In ecological studies, the interaction between living and non living components of the natural environment includes people. However, over the past years of advances in ecological sciences, the human component in the main considered exclusively.

People are related to ecosystems through their ecosystem services, and provision of various ecosystem services further depends upon ecosystem functions. The performance of ecosystem functions is generally revealed as healthy or non-healthy ecosystem. There seems to be a three step linear relationship between people and ecosystem health (Fig. 3.1):

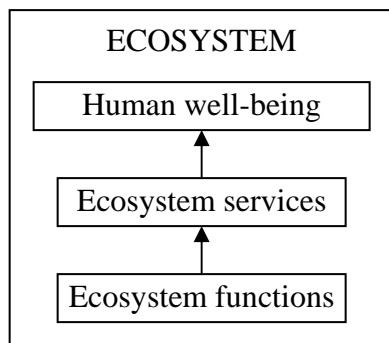


Figure 3.1 Fig. 3.1. Relationship between different components of an ecosystem.

- There is a need to expand the Savanna health concept to consider ecosystem services (not only the biophysical functions) and their linkage with human well being (rather than health only). There is an immediate connection between people and ecosystem services, whereas ecosystem functions (as considered in the savanna health concept) reflect the health of savannas from a biophysical point of view.
- The human well-being concept is more holistic as it includes other aspects of well-being such as freedom, security, social relations etc. apart from health.

The concept of savanna health was introduced to integrate health of savannas and people living there. Although, savannas contribute to human health, the direct linkages are difficult to establish. For this reason, human well-being, which is a broader concept as it includes other aspects such as cultural and spiritual values, freedom and security apart from health, is used in

the present research, and the linkages are sought between ecosystem services and human well-being for it is the closest and immediate link that people have with the natural resources.

3.3.3 Overall drawbacks of above-mentioned methods

The socio-economic concept ignores the importance of ecosystem services in human well-being, whereas the savanna health concept considered people's health and natural ecosystem together but was mainly focussed on ecosystem functions. Moreover, it is difficult to relate people's health with ecosystem functions since the later are not directly related to people and people's health, and the modern medical services play a significant role in people's health. The savanna health concept misses other attributes of ecosystem services such as security of natural resources or basic needs, which are directly linked to human well-being.

For these limitations, a socio-economic-ecological concept that includes the relationships between ecosystem services and human well-being is adopted in the present research.

3.4 Proposed list of attributes (expands the existing ABS list by adding some new measures) to reflect well-being of Aboriginal people in savannas

For Aboriginal people, the ecological attributes may be equal or even more important than the standard socio-economic attributes considered for well-being. Thus, a combined list of various socio-economic-ecological attributes is proposed in Table 3.1 based upon the linkages established in a model (Fig. 2.3 in Chapter 2).

However, the level or ranking of various attributes need to be tested, and they can vary between groups. The selected socio-economic-ecological attributes of well-being will help the Aboriginal as well as non-Aboriginal people to understand the role of ecosystem services in their lives, and will help to plan policies for land use that promote sustainable use of resources.

3.4.1 Practical issues to measure well-being for remote communities in savannas

About 70 per cent of Aboriginal people live in remote/rural areas so as to access the land and other natural resources (ABS 2003). People live at outstations, and the distances between these outstations and from the nearby towns are quite considerable. Moreover, the benefits that people obtain from natural resources are largely non-quantifiable.

The data on standard socio-economic measures of well-being are collected by ABS at the smallest unit of collection districts, which is still a large area for some parts of savannas. For ecological attributes, most of the data are available at bioregional levels which define the savanna boundary. The bioregional boundaries do not coincide with the collection districts, thus, makes it difficult to overlay socio-economic data with the ecological data.

In relation to ecological attributes of well-being, there are some obvious linkages, but not much data are available. There is no existing ecological data base on biodiversity or soils, or on use of plants for bush food and medicine in particular for savanna region, that could be used to determine trends over time. Moreover most of the information available from government/non-governmental institutions is scattered and not well connected across the region. There is need for caution while overlaying and interpreting ecological and socio-economic data for the region.

Table 3.1. Indicators of well-being for Aboriginal and non-Aboriginal communities.

* suggests the importance of an indicator in well-being however, the level/rank may vary for different indicators.

Method		Measured							Non-measured						
		Economic resources (income)	Work	Education and training	Health (health services)	Housing	Family & Community (immediate family)	Culture & leisure	Crime & justice	Basic materials for life: Bush food and medicine, and animals	Good Health: air, land and water (for present and future use)	Security to have healthy country for future generations	Social relations	Freedom to access the country and use land and other resources	Cultural importance: sacred, cultural and identity values
Importance	Measured by ABS														
	Non-Aboriginal	*	*	*	*	*	*	*	*	-	-	-	-	-	-
	Aboriginal	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Response Focus group meetings (Ordinal method)														
	Non-Aboriginal														
	Strength of linkages with ecosystem services (based on ranks, L, M, H)														
	Aboriginal people														
Strength of linkages with ecosystem services (based on ranks L, M, H)															

3.5 Overall approach to measure ecosystem services and their value in people' lives

In order to determine the linkages between ecosystem services and Aboriginal well-being, data on both these components of savannas are needed. There are some standard data available on socio-economic measures of well-being but not much on ecological services that link to well-being. To understand the strength of various linkages as shown in Fig. 2.3, Chapter 2, there is a need to have data on each of the selected attribute. Therefore, this research proposes to study the ecological and socio-economic attributes of savannas in two parts: 1. ecosystem services and 2. well-being (socio-economic-ecological) attributes.

In order to do this, a case study approach is proposed. Studying both ecological and well-being measures simultaneously at each case study area will help to test the model by providing relevant data. A minimum of three case study sites are proposed for savannas, may be one in each state.

3.5.1 Proposed methodology to measure ecosystem services applying case study approach

The various ecological attributes that need to be studied in detail (considered in the model Fig. 2.3; Chapter 2) at each case study site, are listed in Table 3.2:

Table 3.2. Various parameters and proposed methods to study ecosystem services and Aboriginal well-being.

	Parameter	Method
Ecosystem services		
Provisional services		
Bush food	Types of bush food, and number of each plant type providing a particular food	Transects in different regional ecosystems (RE)
Bush medicine	Types of bush medicine, and number of each plant type providing a particular medicine	Transects in different regional ecosystems
Beef (commercial and non-commercial)	Area, main type of grass species, total beef production/yr	Information from the land holder
Timber	Area under main REs, major tree types (no. and biomass)	Transect method
Fuel wood	Area under main REs, major tree/bush types (important for fuelwood)	Transect method
Tree bark	Area under main REs, no. of major trees/bushes	Transect method
Water	Quality (good/bad) and quantity (number and type of sources - bore/river etc.), and availability of water (less/frequent)	Information from landholders and general surveys of the property
Recreation	Availability, and number of sites to recreate on the site	General surveys
Regulating and supporting services		
Biodiversity	No. of REs, type of plants in major REs,	Transect and Quadrat methods
Soil stability (soil erosion, nutrient levels)	Presence of gullies, salt or signs of erosion	Transect method
Reef protection	Qualitative assessment of soil erosion	Transect method
Hydrological balance	Water levels (data from NLWRA), or general condition of soils	Transect method
C sequestration (climate regulation)	C estimations based upon biomass, no. and type of trees in various REs	Transect method
Cultural services		
Cultural/traditional sites	Number of cultural sites and no. of people visiting (if any)	Focus group meetings, and general observations
Spiritual	Number, frequency of visits to spiritual sites (if any)	Focus group meetings
Identity	People's value	Focus group meetings
Aboriginal well-being		
Basic materials for life: bush food and medicine, and animals	Availability of bush food/medicine, and their use by people	FG (focus group) meetings-with landholders
Good health: good air, water and land resources for the present and future use	Availability of good air, water and land resources	FG meetings-with landholders
Security to have healthy country for future generations	People' opinion to feel secure having healthy country for future generations	FG meetings-with landholders
Social relations	Contribution of natural system in maintaining social relations- activities done together such as fishing, hunting, dancing, art etc.	FG meetings-with landholders
Freedom to access the country and use land and other resources	People' attitude for freedom to access their country and to use land and other resources	FG meetings-with landholders

3.5.2 Proposed methodology to test linkages between ecosystem services and well-being of Aboriginal people applying Focus Group meetings

Focus group meetings are proposed to measure various attributes of well-being that are related to ecosystem services, at each of the case study area as presented in Table 3.2.

A focus group, involves organised discussion (Kitzinger 1994), collective activity (Powell *et al.* 1996), social events (Goss and Leinbach 1996) and interaction (Kitzinger 1995) among individuals. A key characteristic of a focus group is the insight and data produced by the interaction between participants help identify people' attitudes, experiences and their beliefs. These meetings typically elicit a multiplicity of views and emotions within a group. During the process, the moderator has to allow participants to talk to each other, ask questions and express doubts and opinions, while having sufficient control over the interaction to keep the participants focused on the topic. By its nature, focus group research is open ended and cannot be entirely predetermined.

For the present work, focus group meetings will be conducted to estimate:

1. The relative importance of various socio-economic-ecological measures of human well-being
2. To measure the importance of each attribute on an ordinal scale.

A focus group generally constitutes of 12-15 people (Babbie 1995). In the meetings, the focus of discussion is to explore the topic. The moderator starts the process with an introduction, and then puts forth the topic to initiate interaction among group members, however, the moderator is responsible to guide the members time to time to remain focus on the topic. There are 5 main advantages of focus group meetings, as the technique is:

1. flexible
2. high face validity
3. speedy results
4. low in cost
5. helps to capture real life data.

Focus group meetings also help to highlight other aspects of the topic that would have not been anticipated by the researcher. However, there are some disadvantages of this technique:

1. the research has less control over focus group members than in the case of individual interviews
2. differences between focus group members can be troublesome
3. groups are difficult to organise
4. the discussion needs to be conducted in a conducive environment and this can be difficult to organise
5. the moderator requires special skills

The focus group meetings are proposed to study the importance of the following attributes in well-being (as listed in Table 3.1):

1. Economic resources (income)
2. Work
3. Education and training
4. Health (health services)
5. Housing
6. Family and community (immediate family)
7. culture and leisure
8. Crime and justice
9. Basic materials for life: bush food and medicine, and animals
10. Good health: good air, water and land resources for the present and future use
11. Security to have healthy country for future generations
12. Social relations
13. Freedom to access the country and use land and other resources
14. Cultural importance of a landscape: sacred, cultural and identity values

**ABS
measures**

**Ecological
measures**

For these, a pilot study is proposed to pre-test the proposed attributes and their ranks, that will focus on:

1. Ordering of 14 attributes according to peoples' preferences (for relative values).
2. Ordinal ranking on a scale of 0-10 for each of the attribute.
3. Discussing about the trends in human use of ecosystem services in the past
4. How people expect a change in current use of ecosystem services for their well-being

The pilot group would be asked to rank all the 14 attributes according to their importance in well-being, and then to assign score for each of the attribute on a scale of 0-10. Probably, close ended method is preferred over open ended while ranking, for greater uniformity in response, accuracy to interpret respondents' view, and easy processing. The only problem with the closed ended method is that the questions need to be clear, with all the possible options for response.

Based upon the feedback from a pilot group discussion, the changes should be incorporated to improve the discussion for future focus group meetings. Further, from data on ranking of each of the selected **6 ecological and 8 ABS attributes (i.e. 14 indicators)** on the scale 0-10 (low-high), Borda score can be calculated (Dasgupta 2004) as explained in Table 3.3:

Table 3.3. Example: Borda score for various attributes ranked on a scale of 0-10.

	<i>Attribute 1</i>	<i>Attribute 2</i>	<i>Attribute 3</i>	<i>Attribute 4</i>	<i>Attribute 5</i>	<i>Attribute 6</i>	<i>Attribute 7</i>
Focus group 1	5	10	5	10
Focus group 2							
Focus group 3							
Average response	Low, medium or high based upon the criteria set for each attribute						
Borda score	=∑ scores for each of the attribute from 3 focus group meetings						

3.5.3 Expected outcomes from focus group discussions

The focus group discussions will help to understand people's attitude and values towards ecosystems. For example, current use/value of the savanna country, change in various ecosystem services over the past years and whether people want to shift from the current use of ecosystem services to related businesses in the future if opportunity arrives.

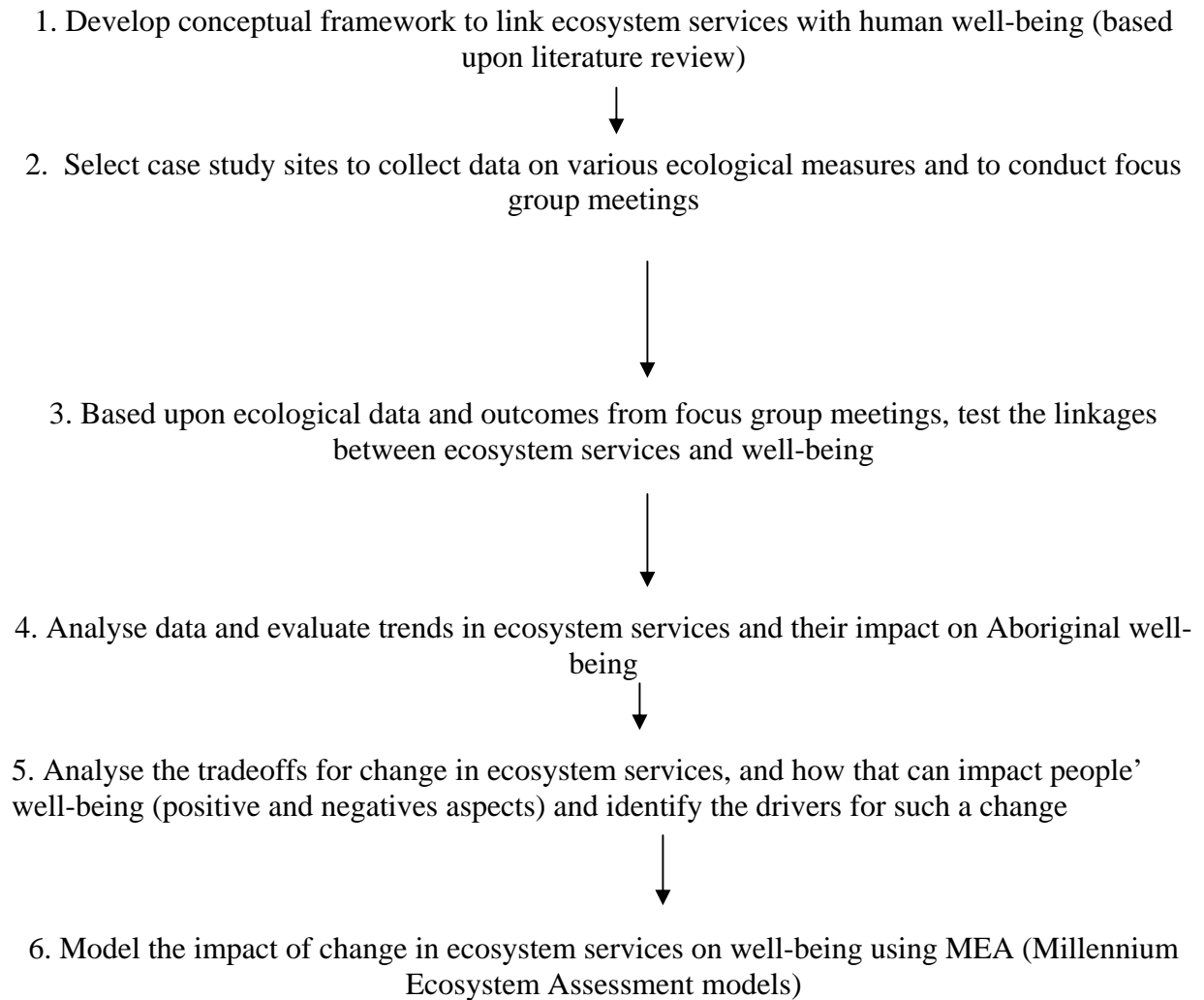
3.6 Proposed areas of study

The case study areas such as Kowanyama (located in the North-west of Queensland) are very appropriate for this type of research where Aboriginal people run a pastoral property and perform their traditional activities. Both the ecological data and focus group information need to be collected from the same site. Similar case studies can be selected across savanna region in the NT and WA where Aboriginal people either manage/own the property or are directly involved in management.

3.7 Statistical analysis

The ecological data and results from focus groups meetings will be analysed mainly using Neural Networks to understand the multiplicity of interactions among various components of ecosystem and well-being. The analysis will be done for individual case study areas as well as overall for all the case studies. The data will also be tested using correlation and multivariate analyses to determine the strength of various linkages described in Fig. 2.3, Chapter 2. The Neural Networks analysis will help to predict how the change in ecosystem services can impact on well-being of people.

3.8 Work outline



4. Dynamic Savannas: Indigenous businesses and their relationship to natural resources

Aim of this Chapter is to:

- Identify the major natural resource based Indigenous businesses (established and potential) in savanna region.
- Examine the effects of change in current natural resource based businesses/industries on human well-being.

The Chapter plan is:

Section 4.1 Existing Indigenous businesses in tropical savannas.

Section 4.2 Linkages between various businesses/industries and natural resources

Section 4.3 The positive and negative effects of businesses/industries on Aboriginal well-being

Section 4.4 Benefits of natural resource based businesses in terms of well-being of Aboriginal people (hybrid economy model)

4.1 Existing Indigenous businesses/industries in tropical savannas

In savannas, beef is a major industry, followed by mining and tourism, and some minor industries such as fisheries, horticulture, arts and crafts, and mixed farming. In the absence of information on these industries for savannas (comprises the northern regions of three states- Qld, NT and WA), an overview of various industries in each of the state is mentioned as follows:

Queensland

The Department of Primary Industries (DPI) reports various established industries. The DPI central (Brisbane) and regional (Townsville) offices provided information for Queensland, not in particular to savanna region, according to this the main industries are:

- Beef
- Dairy
- Sheep
- Pig
- Fisheries
- Forestry
- Horticulture
- Sugarcane
- Cotton
- Grain
- Mining
- Tourism

The percentage financial contribution of different industries in the overall state economy is shown in Fig 4.1.

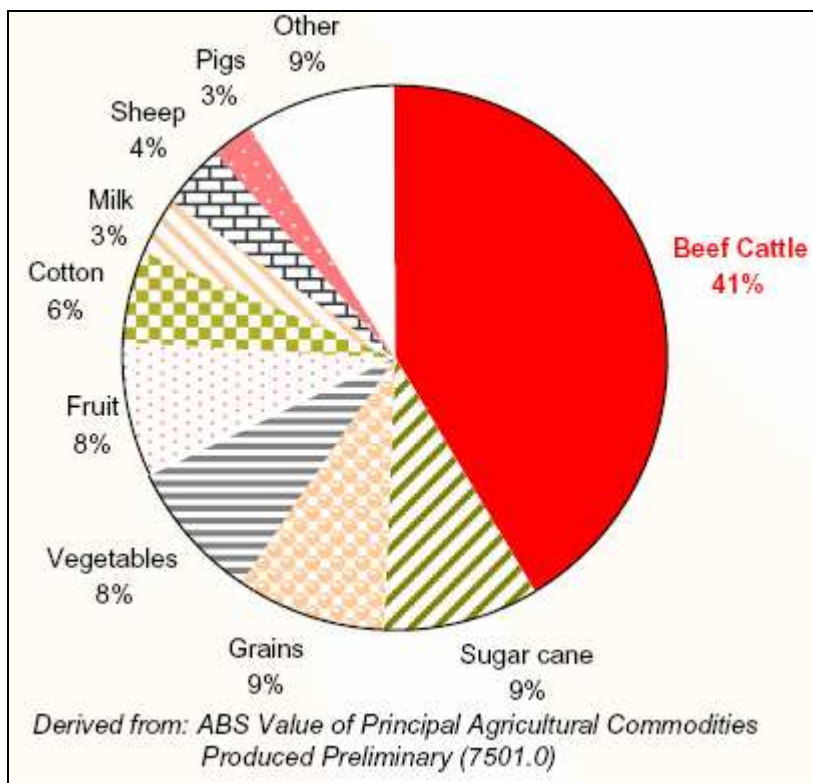


Figure 4.1. Contribution of different industries in Gross Value Product in Queensland (2000-2001) (Source: DPI fact sheets for various industries- www.dpi.qld.gov.au/business/10071.html).

The Northern Territory

The Department of Primary Industries, Fisheries and Mines (DPIFM) listed the following industries operating in the NT (Source: www.primaryindustry.nt.gov.au/):

- Pastoral
- Agro-forestry
- Horticulture
- Mixed farming
- Fisheries
- Minerals and Energy

The Indigenous Businesses Australia (IBA) in the NT provides support for the following industries (Indigenous Businesses Australia, Annual Report 2004-5):

- Commercial property
- Mining
- Manufacturing, retail and services
- Agriculture
- Fisheries
- Tourism
- Financial services

WA

The Department of Industry and Resources has established a special branch, Aboriginal Economic Development, to promote various businesses among Aboriginal people. However, tourism is the major industry that has been emphasised in the region. There are other minor industries, as mentioned above in Queensland and in the NT.

The Aboriginal and Torres Strait Islander Commission (ATSIC) also provided funds to Indigenous people for some businesses. The list of businesses funded by ATSIC in 1997-98, are presented by Arthur (1999; Table 1):

Table 1. Industry of indigenous self-employment from 1996 Census, applications to ATSIC in 1997-98 and business loans made since the 1970s

Industry	ATSIC loan		
	Census ^a 1996 Per cent	applications ^b 1997-98 Per cent	Loans made 1970s-1998 Per cent
Agriculture/forest/fishing	10	18	18
Mining	1	2	0.2
Manufacturing	5	7	7
Electricity, gas, water	0.2	0.1	0
Construction	13	9	22
Wholesale	3	3	2
Retail trade	12	15	22
Accommodation, cafes, restaurants	3	7	0
Transport and storage	4	6	8
Communication services	1	0.5	0
Finance and insurance	0.3	0	0
Property and business	8	7	18
Govt. admin. and defence	5	0	0
Education	3	0.8	0
Health and community services	8	1	0
Cultural, recreation, personal	3	16	4
Personal services	5	4	0
Non classifiable	3	3	0.5
Not stated	13	0.8	0
Total	100	100	100

Notes: a. Refers to those who identified as employers or self-employed.

b. From the Commonwealth indigenous agencies including ATSIC but excluding the CDC.

Sources: 1996 Census; ATSIC (1998a: 197, 1998d); supplementary data provided by DCTWA.

The abovementioned list of various businesses suggest that many of these businesses in savanna region are not according to the needs and capabilities of the Aboriginal people. To explore the opportunities and to involve Aboriginal people in businesses, the Northern Territory Government hosted the Indigenous Economic Development Summit in November 2001. Later, the first Indigenous Economic Development (IED) Forum was held in Alice Springs in March 2003, and addressed the requirement for four key areas:

1. Employment, education and training
2. Financial capacity and governance
3. Sustainable economic use of country
4. Tourism and arts

The second IED Forum was held in Darwin in May 2005. This forum helped people to share a range of success stories of Indigenous business activities, in particular in the key sectors of Horticulture and Bush Food, Tourism and Parks, Mining, Arts, Knowledge and Media, Retail and Service, Natural Resource Management, Pastoral and Aquaculture.

For the NT, Indigenous forum development strategy (2005) have identified several areas for development such as:

- Aquaculture and fisheries
- Arts
- Community services
- Construction

- Forestry and business
- Government
- Horticulture
- Knowledge and culture
- Mining and production
- Natural resource management
- Pastoral
- Retail and services
- Tourism

The current state of some of these industries in the NT as presented in IED strategy (2005), is as follows:

Among various sectors, aquaculture and fisheries is a promising industry with increasing demand of sea food. IED strategy has laid a significant emphasis on research related to mud crabs, sponges, trepangs and wildlife harvest. The research includes searching for methods, brood stock/ spawns, sites for cultivation and sustainable practices for harvest.

Arts is an important sector, it includes visual arts, performance arts, films, new media and literature. About 5000 Indigenous visual artists are living and working in the NT. The Indigenous remote centres in the NT generate approximately \$ 10 m per annum from direct sales of arts and crafts.

Forestry and agri-business are at the exploratory stage. A private forestry plantation firm 'Sylvatech' and the Tiwi people have planned a long venture to plant *Acacia mangium* for pulpwood on Tiwi Island, that can employ 200 people full time and about 150 seasonal workers. Horticulture is one of the fastest growing industries in the NT. The Centre farm Aboriginal horticulture limited started cultivation of table grapes in the Ti Tree and Alice Springs, and also promoting in Ali Curung, Pine Hill and Finke in the NT.

Indigenous people are getting involved in management of Natural Resources through various programs such as Caring for the Country. This sector employs approximately 350 people. Pastoral industry for Indigenous people is supported by Indigenous pastoral project (IPP) which is a collective effort among the Northern and Central land councils, Department of Business, Industry and Resource Development and the Indigenous Land Corporations. This program conducts pastoral training for Indigenous people to enable them to manage the pastoral land to increase the number of cattle and the Indigenous people working in this industry.

Tourism is a very important industry in the NT. In 2001-02, tourism directly or indirectly contributed about \$ 2.02 bn and 15000 jobs to the NT economy. Indigenous cultural tourism is recognised as a 'building block', which offers a significant potential in the long term.

Some other initiatives, such as:

- The Body Shop: supports young Indigenous people in businesses;
- Coles Myers: sells Indigenous food and set up a Coles Indigenous Fund and coles contribute to this fund about 25 c per product;
- Qantas: partnership in the arts (have two Boeings painted with Aboriginal art)

suggests that there are many opportunities ahead to explore and develop Indigenous businesses for the need-based services and benefits for Aboriginal people (The Allen Consulting Group 2001).

The above proposed industries are, directly or indirectly linked to the capabilities of Aboriginal people. Otherwise, a number of businesses that were addressed by IBA or regional agencies (DPI, DPIFM etc.) have focussed on economic development related to services/goods suitable for non-Indigenous living, without acknowledging the need-based services for Aboriginal people.

4.2 Linkages between businesses/industries and natural resources

To conclude, the main industries in the savanna region are:

- Pastoral
- Mining
- Tourism
- Arts and crafts

The other small scale (established/potential) industries are:

- Bush food and medicine
- Horticulture
- Agro-forestry
- Aquaculture
- Natural resource management
- Cultural tourism

It is important to note that all the major and minor businesses in savanna region are linked to natural resources, as shown in Table 4.1:

Table 4.1. Various businesses and their links to natural resources.

	Business type	Main raw materials - natural resources
Major established industries	Pastoral	Grasses, soil and water
	Mining	Minerals in earth
	Tourism	Natural and cultural landscape
Other potential industries	Arts and crafts	Bark, wood and ochre
	Bush food and medicine	Native plants and animals
	Horticulture	Plants, soil and water
	Agro-forestry	Crop plants, trees, soil and water
	Aquaculture	Fish, crabs and other sea animals

All the above-mentioned industries are based upon natural resources. It is also important to recognize that Aboriginal people have knowledge and capabilities related to natural resources and can apply their skills in these areas. To develop the businesses that can improve the Aboriginal well-being, it is very important to consider the availability of natural resources in the region and their linkages with people.

4.3 The positive and negative effects of various businesses/industries on Aboriginal well-being

There are opportunities for various businesses such as forestry, bush food or medicine. These businesses also bring a change in current use of land, mainly grazing to other forms. Some of these businesses are mentioned below:

1. Forestry
2. Wildlife harvest: Crocodile farming
3. Bush food
4. Art and Craft
5. Cultural tourism

1. Forestry: In 1960s, the Australian government established plantations of *Cyperus sp.* and *Pinus caribaea* on Tiwi Islands. In 1995, the Tiwi Land Council in association with the Great Southern Plantations (GSP, formerly Sylvatech) planted cyperus trees on a large area after clearing natural vegetation. Recently, the GSP has plans (approved from the NT and Commonwealth Governments) to clear another 26,000 ha of natural vegetation to plant an exotic *Acacia mangium* for woodchip export industry to supply Japan and other Asian countries (Source: www.ecnt.org).
2. Wildlife harvest: Harvesting wildlife such as Kangroos, Magpie Geese for food has a potential for development and to augment the state economy. In Arnhem Lands, Bawinanga Aboriginal Corporation is involved in production of Crocodile eggs. This provides some economic benefits as well as allows the Aboriginal people to live close to the nature for their social and spiritual values of the landscape (Altman and Whitehead 2003). There are opportunities for Aboriginal people to ranch magpie, geese, turtles or some other wild animals. Whitehead (2003) has discussed various options for commercial use of wildlife, the constraints that limit the related economic activity, and proposed some approaches that can help to overcome certain limitations.
3. Bush food and medicine: There are many species that Aboriginal people use and can have potential for cultivation on a commercial scale. Tea tree oil is the common commercial product produced by Thursday plantations from a native tree (*Melaleuca alternifolia*). Whitehead (2003) suggested that many native plant species have potential for use as food, however there are not proper markets. Bush Tomatoes and Kakadu Plums are among the few important foods that are becoming available in the supermarkets (Coles-Myers) (Whitehead 2003). However, poor or undeveloped markets and unawareness among non-Aboriginal people of how to use native plants are the important reasons, apart from many regulations and policy constraints, for non-commercialisation of bush food or medicine.
4. Art and Craft
This industry continues to grow over the last one decade (Hoegh-Guldberg 2002). The Indigenous remote centres in the NT generate approximately \$ 10 m per annum from the direct sales of arts and crafts (IED Strategy 2005). Wild resources play an important part in the development of this industry in the NT (Altman and Whitehead 2003).
5. Cultural tourism: Savanna country is becoming an important destination for tourists for wide, open landscape with Aboriginal cultural values. This industry integrates various land uses i.e. Aboriginal use of land, Aboriginal art and craft work, and conservation parks. Indigenous cultural tourism has been identified as the key 'point of difference' for marketing and promoting tourism in savannas region of the NT (IED Strategy 2005).

The additional options, as suggested by Whitehead (2003), to enterprise wild plants and animals are:

- Customary food – to be consumed within Aboriginal communities
- Trade in live plants
- Timber extractions
- Volatile oils
- Novelties or educational items directed at the tourist trade

The above-mentioned businesses could have the following impacts on Aboriginal well-being:

1. Forestry: Plantations of exotic trees, as had happened on the Tiwi Islands, would have the following main positive impacts on well-being of Aboriginal people:
 - Economic gains from wood production
 - People may benefit for C- credits, if exists in future
 - Employment for some people (permanent as carer, or casual when planting, managing and harvesting)

However, planting exotic trees can have long-term negative impacts:

- Loss of bush food and medicine
- Loss of native fauna (birds and other animals)
- Loss of cultural sites (if any)
- Loss of aesthetic value of the landscape

Major tradeoffs that people may face for planting exotic trees:

- Loss of cultural sites, traditional activities linked to cultural sites, bush food and medicine, and fauna for the present as well as future generations.
- Monetary gains (if locals are involved) for wood production

Aboriginal people can get more benefits if native species or a mix-culture of native/exotic species, instead of purely exotic species, having bush food and medicinal value could be promoted. This will benefit people for their customary use of the landscape and to enterprise the plant/animal products. However, this needs a much more detailed study on what type of native plant species are important to locals and can be cultivated, how these species can be used, policies and government regulations and markets related to an enterprise. It is very important to evaluate and compare the positive and negative effects of planting an exotic vs. native tree over a long term.

2. Crocodile farming: The positive effects of crocodile farming are:
 - Economic gains from commercial activity
 - Employment and creativity for people while people remain on their land

The negative impacts could be:

- Need to create a balance between commercial and local activities

3. Bush food and medicine: The positive effects of planting trees/bushes for food will be:
 - Economic gains from commercial activity
 - Employment and creativity for people while they remain on their land
 - Improvement in human health, for availability of food materials and access to bush food
 - Proper management of bush food plants can sustain the natural ecosystem functions in savanna landscape
 - Useful for regulation of ecosystem processes e.g. climate and water.

- Helpful to preserve biodiversity

There is a lot of potential to explore cultivation of native plants for food and medicine at a small/large scale industry, may be in association with forestry. However, there are some regulations, policies and other issues that restrict cultivation of bush food and medicines.

It is unlikely that there will be major negative impacts of bush food/medicine cultivation, but the main concern is:

- Sustainable use of plant resources for industrial purpose will be a necessity to maintain the natural resource base in the region.

4. Art and Craft: The positive impacts of this industry are:

- Economic gains
- Employment and creativity for people
- Promote Aboriginal culture among others
- Adding value to social esteem of the Aboriginal society

However, proper management and sustainable use of natural resources that provide raw materials (e.g. wood, bark or colour (ochre)) for Aboriginal art and craft is required.

5. Tourism benefits local people:

- For economic gains and employment
- To spread culture among wider community
- To learn about other people across the country or the globe

Concerns:

- Over-use or exploitation of resources such as fishing, reported in some studies on tourism (Greiner *et al.* 2004) and management of natural resources while promoting tourism in savanna region, are the major concerns.

It is important to study these effects in detail before implementing any policies related to use of natural resources for business purposes. There are many constraints that relegate these businesses, some of these highlighted by Whitehead (2003) are as follows:

- Poorly understood and under-developed markets: In Australia, there is not much experience in exploiting wild resources for marketing. For this, comprehensive research is required in relation to type of products, operation, and potential markets. Since non-Aboriginal people are not so dependent upon the native wild products so not much efforts been made in the past to develop markets for these products.
- Locational and structural disadvantage: Remote location and lack of skills in education/health/marketing sector, of Aboriginal people contribute to non-entrepreneurship of wild products.
- Clumsy or overzealous regulation for sustainability and of access: The government regulations do not favour Aboriginal people to sell fish or other wild products in the local market. Competition from other major firms to prevent the alternatives also restricts the use of wild products in the common market. There are also evidences where access to resources for Aboriginal

people was denied for the sake to preserve the resource, without actually considering the sustainability in provision of a resource.

- Anti-use philosophies: Human mindsets for not liking the idea of living resources being directly exploited for commercial gain, and considering ‘sustainability’, as an issue (rather than genuine concern for resource availability) prevent the development of businesses (related to wild life) in savannas.

4.4 Benefits of natural resource based Indigenous businesses for well-being

Businesses based upon wild life/resources can benefit the local as well as overall Australian community in many ways. For example, Aboriginal Arts and crafts industry is unique and is becoming famous worldwide. Similarly Tea Tree oil, helps to cure many skin illnesses, now being exported. There is potential for Aboriginal community to specialise and trade in wild/natural products. For this, there is need to provide skills to the Aboriginal people to enterprise, and to allow them to access natural resources for management and sustainable production. This will help, not only for economic gains, but also in building the capacity of Aboriginal people, improving natural resource management, and for uniqueness of the Indigenous nature of products.

Businesses related to wildlife resources and management can help build the hybrid economy that includes customary, market (private) and state (public) economy, and can further enhance well-being of Aboriginal people. Altman (2001, 2006) developed a model for Indigenous hybrid economy, based upon customary, private and public economy. The customary economy includes wild resources and skills of Aboriginal people to manage land, private (market) economy (marketing of Indigenous products) and state economy (public goods in good condition such as conservation parks).

One such example where hybrid economy operates is the engagement of Aboriginal people in natural resource management in the NT, reported by Altman and Whitehead (2003). The authors reported how “Caring for the country” program has multiple benefits. The Aboriginal communities play a role in fire regimes, control over weeds, and in harvesting of feral animals. People generate economic benefits for themselves by harvesting wildlife (customary economy), and for the market economy using natural resources in commercial enterprise such as arts and crafts. This could further benefit the state economy for diversification in state products, uniqueness (products of Aboriginal origin e.g. art) and for sustaining natural resources for public. Such an approach applies biodiversity conservation with contemporary Indigenous natural resource management on Aboriginal land, for both commercial and customary use. Moreover, there are many social benefits for Aboriginal people being involved in natural resource management for they will have a task and get the opportunity to use their skills, so less chances for them to be on a wrong path.

Natural resources, their access and management by Aboriginal people, customary practices and traditional knowledge and entrepreneurship can improve well-being of local as well as people living across the nation for providing economic-social-cultural benefits for Aboriginal people, and other ecological-cultural benefits (to have natural resources in good condition or climate regulation) for public.

Conclusion

Major current businesses (pastoral, mining and tourism) in savannas region are based upon natural resources. For Aboriginal people, developing businesses such as bush food and medicine, or crocodile farming where people can use their skills and knowledge, can benefit people to remain in touch with their country for traditional use. Natural resource based

businesses can play an important role in building the economy as well as in improving well-being of people in the savanna region.

Key message:

- There is a need to develop natural resource based businesses (bush food and medicine, cultural tourism, art and craft, animal harvesting and agro-forestry) to improve regional economy and well-being of Aboriginal people.
- Even the modern businesses (pastoral, mining and tourism) depend upon ecosystem services from savannas.

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Indigenous Business Australia (IBA):

www.nt.gov.au/business/

www.iba.gov.au/locations/westernaustralia/

www.sdi.qld.gov.au/dsdweb/

6. Appendix 1.

Main characteristics, number of wetlands of national importance, number of threatened species, general condition and factors that impact the status of various bioregions in savannas (Source: EPA, Queensland Government).

Bioregion	Characteristics	Wetlands	Threatened species	General trend	Factors
CYP	diverse ecosystem, ranging from rainforests, woodlands, shrub lands heaths, sedge lands, grasslands and mangroves	19	103 threatened 22 endangered 81 vulnerable	Declining	Altered fire regimes
EIU	Ironbark (<i>Eucalyptus spp.</i>) woodlands	9	64 threatened, 14 endangered 50 vulnerable	Declining	Grazing pressure Fire regime, Weeds Tree clearing.
BBN (Brigalow belt north)	Ironbark woodlands (<i>E. melanophloia</i> , <i>E. crebra</i>), poplar box, Brown's box (<i>E. populnea</i> , <i>E. brownii</i>) brigalow (<i>Acacia harpophylla</i>), blackwood (<i>A. argyrodendron</i>) gidgee (<i>A. cambagei</i>)	14	A number of rare and threatened species	Declining	Tree clearing
DEU (Desert Uplands)	woodlands of <i>Eucalyptus whitei</i> , <i>Eucalyptus similis</i> and <i>Corymbia trachyphloi</i> .	5 wetlands 2 freshwater lakes i.e. Buchanan and Galilee.	21 threatened 9 endangered 12 vulnerable	Declining	Grazing Tree clearing
GUP (Gulf Plains)	Grassland and tropical woodland	6	3 endangered 20 vulnerable	Declining	
Mt Isa Inlier	Low open eucalypt woodlands dominated by <i>Eucalyptus leucophloia</i> , <i>E. leucophylla</i> and <i>E. pruinose</i> . Fossil deposits Riversleigh site is of World Heritage.	2	15 threatened 3 endangered 2 vulnerable	Declining	Grazing



Bioregion	Characteristics	Wetlands	Threatened species	General trend	Factors
MGD (Mitchell Grass Downs)	<i>Acacia</i> low woodlands with understorey of <i>Astrebela</i> spp.	9	32 threatened 8 endangered 24 vulnerable	Declining	Grazing
GUC (Gulf Coastal)	The islands, and some coastal areas in the mainland subregion, are nationally significant as nesting sites for marine turtles and colonial seabirds, and as feeding sites for migratory shorebirds.	3	16 threatened 1 endangered 3 vulnerable	Good condition, destabilised to some extent	Weeds Mining Fire regimes Grazing
GFU (Gulf Fall and Uplands)	woodland dominated by <i>Eucalyptus tetradonta</i> and <i>C. dichromophloia</i> with spinifex understorey, and woodland dominated by <i>Eucalyptus tectifera</i> with tussock grass understorey.	2	10 threatened	Good condition, eroded to some extent	Feral animals Weeds
STU (Sturt Plateau)	<i>Eucalyptus dichromophloia</i> and <i>Macropteranthes keckwickii</i> woodlands with spinifex understorey, <i>Acacia shirleyi</i> thickets.	1 (Lake woods)	6 threatened	Good condition	Weeds, Feral animals Grazing Altered fire regimes
CA (Central Arnhem)	Darwin open Open forests and woodlands of woollybutt <i>Eucalyptus miniata</i> and Darwin stringybark <i>E. tetradonta</i> , with a dense grass understorey. Almost all of the bioregion is Aboriginal land.	1, part of Arafura swamp	10 threatened	Good condition	Weeds Feral animals Altered fire regimes
ARC (Arnhem Coast)	Mostly woodlands of Darwin woollybutt (<i>Eucalyptus miniata</i>) and Darwin stringybark (<i>E. tetradonta</i>), and some areas of monsoon rainforest.	1, most of the Arafura Swamp (an extensive permanent wetland)	24 threatened	Good condition	Feral animals, Weeds Altered fire regimes

Bioregion	Characteristics	Wetlands	Threatened species	General trend	Factors
ARP (Arnhem Plateau)	heathlands, rainforests dominated by the endemic tree <i>Allosyncarpia ternata</i> , hummock grasslands and eucalypt open woodlands (<i>Eucalyptus phoenicea</i> , <i>E. kombolgiensis</i> , <i>E. miniata</i> and <i>E. dichromophloia</i>).	3 wetlands. Part of Ramsar wetland of international significance.	29 threatened	Overall in good condition, but declining	Altered fire regimes, feral animals and weeds.
PCK (Pine Creek)	Tall open forests, typically dominated by <i>Eucalyptus miniata</i> and <i>E. tetradonta</i> , and woodlands dominated by <i>E. grandifolia</i> , <i>E. latifolia</i> , <i>E. tintinnans</i> , <i>E. confertiflora</i> and <i>E. tectifera</i> . Smaller areas of monsoon rainforest patches, <i>Melaleuca</i> woodlands, riparian vegetation and tussock grasslands.	2, Kakadu NP and Katherine river gorge.	23 threatened	Good condition	Mining Horticultural developments Grazing
DAB (Daly Basin)	Open forests of <i>E. miniata</i> and <i>E. tetradonta</i> with understorey of perennial and annual grasses.	1, lower part of Daly river.	11 threatened	Generally in good condition, but recently reported some decline.	Development of land for horticulture, grazing and cropping, weeds and altered fire regimes.
VB (Victoria Bonaparte)	Open savannas with high grass	5	23 threatened	Generally good condition, some declines in recent past	Grazing, weeds, feral animals and changes in fire regime.
DAC (Darwin Coastal)	Extensive and diverse coastal floodplains, eucalypt tall open forests.	7, with part of Kakadu wetlands and Cobourg Peninsula.	33 threatened	Good condition	Tree clearing for urban and horticultural development
OVP (Ord-Victoria Plains)	<i>Triodia</i> , <i>Astrebela</i> and <i>Dicanthium</i> grasses with upper storey of eucalypt and acacia species.	2	11	Declining	Grazing, weeds and fire regimes.

Bioregion	Characteristics	Wetlands	Threatened species	General trend	Factors
TIW (Tiwi)	Tall eucalypt open forests, typically dominated <i>Eucalyptus miniata</i> , <i>E. tetradonta</i> and <i>E. nesophila</i> . This is entirely Aboriginal land.	All wetlands of Cobourg are included as a Ramsar site.	44 threatened	Good condition	Feral animals
CK (Central Kimberley)	Open woodlands with understorey of <i>Triodia</i> spp. and <i>Chrysopogon</i> spp.	1	3 endangered 4 vulnerable	Good condition	Grazing Feral animals
NK (North Kimberley)	<i>E. miniata</i> , <i>E. tetradonta</i> , <i>E. tectifera</i> and <i>E. grandifolia</i> woodlands with understorey of shorgum.	4	2 endangered 12 vulnerable	Good condition	Fire Grazing
DL (Dampierland)	<i>Eucalyptus microtheca</i> and <i>Lysiphyllum cunninghamii</i> with <i>Chrysopogon-Dichanthium</i> understorey, or <i>Eucalyptus</i> spp. with understorey of <i>Sporobolus</i> , <i>Spinifex</i> or <i>Triodia</i> spp.	10	5 endangered 9 vulnerable	Declining	Grazing pressure Altered fire regimes

7. Appendix 2.

The linkages between ecosystem services and human well-being in savanna region.

Ecosystem Services	Benefits for Aboriginal people
Provisional	
<i>Bush foods and medicinal</i>	 <p data-bbox="762 1014 1102 1043">Eating tip of pandanus shoot</p>  <p data-bbox="762 1375 1278 1440">Illawara plum (<i>Podocarpus elatus</i>) (Source: www.cse.csiro.au/research/nativefoods)</p>

Ecosystem Services

Benefits for Aboriginal people

Provisional

Bush foods and medicinal



Quandong (*Santalum acuminatum*) Source: www.cse.csiro.au/research/nativefoods

Beef commercial and non-commercial^a

Subsistence cattle grazing for beef.

Fuel wood

Commonly used to cook food



Making fire using wooden sticks

Ecosystem services

Benefits for Aboriginal people

Fuel wood



Preparing for food (damper). Source: images.google.com)



Timber





To make tools (spears, shafts, woomeras) and artefacts which are part of Aboriginal culture



Making a basket to store food. Source: images.google.com

Ecosystem services	Benefits for Aboriginal people
<p>Timber</p>	 <p>Boomerangs used in hunting and dancing Source: www.didjshop.com/</p>
<p>Tree bark</p>	 <p>Commonly used to wrap food, make strings, to store water and to prepare medicinal decoctions. Above: Stripping under bark from a tree to make string</p>
<p>Minerals^b</p>	<p>Not much</p>
<p>Water</p>	<p>Rivers: 26 rivers flow in savanna country The main ones: Daly, Ord, Katherine, Victoria rivers in the top north west, and Burdekin, Fitzroy, Mackenzie in the south, and Flinders, Leichhardt and Mitchell in the north. Values: water for living, food (fish, mussels etc.), cultural, sacred and religious. Rivers were used by people for transport, and recreation, and river banks to make campsites. Water is considered as a living entity, like land.</p>

Ecosystem services	Benefits for Aboriginal people
<p>Recreation</p>	 <p>Hunting and gathering food, listening stories from elders, and learning about traditional knowledge that is linked to landscape.</p>
<p>Regulating and Supporting Biodiversity</p> <p><i>Soil stability (soil erosion, nutrient levels)</i></p> <p><i>Reef protection</i></p> <p><i>Hydrological balance</i></p> <p><i>C sequester</i></p>	<p>Help to provide various provisional services</p>
<p>Cultural</p> <p><i>Cultural/traditional sites</i></p> <p><i>Spiritual</i></p> <p><i>Identity</i></p>	<p>Values: Corroboree (Aboriginal dance), burial sites, birth sites, scarred trees, ochre (colour obtained from plants), paintings (rock, cave etc.), traditional sites that belong to elders, and stones sites.</p>  <p>Aboriginal dance using boomerangs and ochre; materials obtained from plants/earth. Source: www.aboriginaltouroperators.com.au/gallery.htm</p>

Ecosystem services**Benefits for Aboriginal people**

Cave paintings (colours obtained from plant/earth extracts). (Source: images.google.com)

^aBeef production in savanna region (a major benefit for non-Aboriginal people): Approximate total value worth of \$ 1902 m + crop production (\$500 m) (conservative estimate). {Livestock production (slaughterings) for \$ 3.3 b (\$3357 m) in 2002-2003 in Qld (ABS 2005), \$238.5 m in NT (ABS 2005), and \$626.1m in WA (ABS 2005). The total figure represent conservative estimate of livestock production for savannas (2/3 of Qld, 1/2 of NT, and 1/6 of WA)}.

^bMining (a significant benefit mainly for non-Aboriginal people): Approximate value of minerals for savanna region: \$ 9 b (conservative estimates, a considerable amount of mining takes place in Savannas, mostly for coal, gold, diamonds, bauxite, copper, gas and petroleum). {Total value of minerals in Qld = \$11.8 b and NT = \$ 76.3 m, the values herein were taken 1/2 of the total value (\$ 5.9 b (QLD), and \$ 38.1 m (NT)), and only 1/6th i.e. \$2.65 b (of the total value \$15.9 b in WA) (source: ABS 2005 and ABS 1998)}.