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Reviewer: Prof. Robert Costanza, Crawford School of Public Policy, The Australian National University, Canberra, ACT 2600, Australia.

Introduction

This report aims to assess the monetary value of major tangible and intangible services from an indigenous owned communal property, Fish River Station (FRS), which supports local and Aboriginal communities for a range of socio-cultural and ecological benefits. Our purpose is not to imply exact \$ figures for ecosystem services (ES) but to provide an overall assessment of their total value to assist policy decisions on future planning and sustainable management over the long-term for the benefits of the local and wider Australian community.

FRS is located in the Daly river region of the Northern Territory (NT) and covers 182,500 ha (Fig. 1). It was collectively purchased by the Indigenous Land Corporation (ILC), The Nature Conservancy (TNC), the Australian Government National Reserve System, Pew Environment Group and Greening Australia in 2010 to conserve its natural and cultural values, and to provide benefits to the local Indigenous people. The purchase value of the property was AUD 13 million in 2010 whereas the unimproved capital value was AUD 3.6 million in 2012 (pers. communication with the FRS manager, S. Morrison).

The ILC has a statutory function to grant its interest in FRS to an Indigenous Corporation, with aims to provide Indigenous employment and to build people's capacity to hold and manage FRS for divestment, in 2017. The ILC proposes to divest FRS to the corporation comprised of Indigenous Advisory Group members from four language groups whose country is covered by FRS. Currently, the Traditional Owners (TOs) manage this property, with the help of an on-site manager.

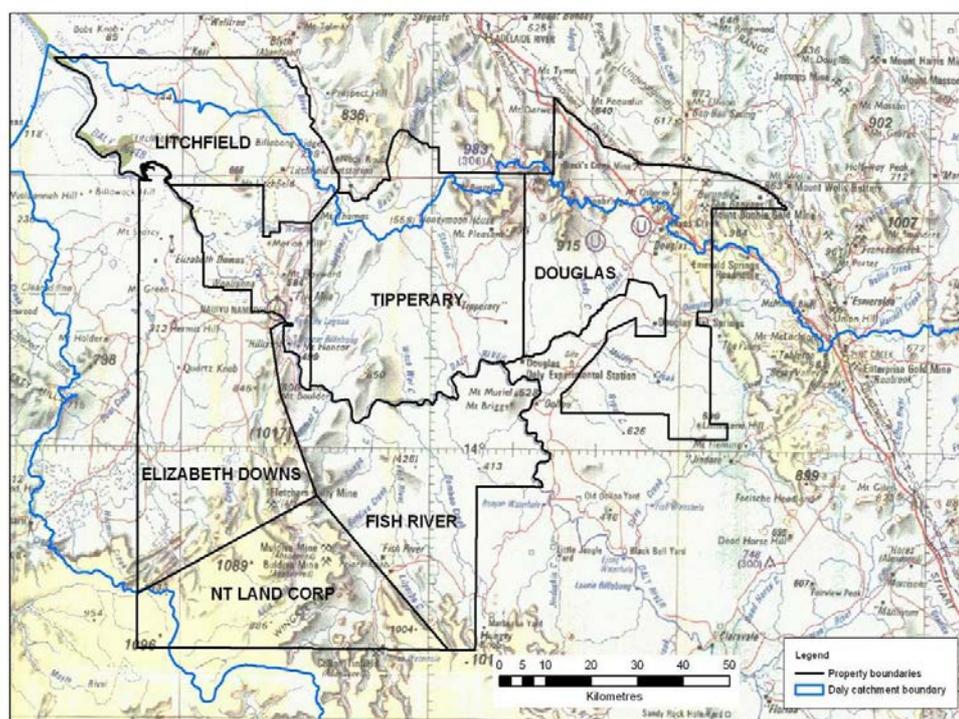


Fig 1. Map of FRS, Daly region, NT.

The identified natural, social and ecological values of FRS are discussed below, followed by their total value assessment.

Natural Values

The FRS landscape includes sandstone ranges, large tracts of intact savanna, an extensive mosaic of monsoon forest and wetlands, as well as the pristine waters of the Daly River and its tributaries. It is home to many terrestrial and aquatic species and is an important refuge site for nationally and NT listed threatened species such as the Northern Quoll, Gouldian Finch, Masked Owl and many others as highlighted in the BushBlitz report (2012), and by Mahney et al. (2011) and Choy and Fegan (2014). The BushBlitz report (2012) provides extensive information on FRS' biodiversity values. Of the FRS species complement, 60 are believed to be new to science (Tables 1 and 2), demonstrating the importance of FRS for supporting a diverse range of organisms. Apart from this, FRS land managers and TOs have recognized Black-footed Tree Rats, Northern Brown Bandicoots, Northern Brush-tail Possums, Dingos and Emus for high cultural and conservation values.

Table 1: Summary of flora and fauna records and putative new species (BushBlitz 2012)

Group	Common name	Total number of species	Species new to reserve	Species new to science
Mammalia	Mammals	33	0	0
Aves	Birds	38	0	0
Reptilia	Reptiles	64	5	0
Amphibia	Frogs and Toads	17	1	0
Pisces	Fishes	45	3	0
Lepidoptera	Butterflies and Moths	75	73	0
Coleoptera	Beetles	21	15	0

Heteroptera	True Bugs	161	161	40
Dermaptera	Earwigs	1	0	0
Odonata	Damselflies and Dragonflies	38	38	0
Arachnida	Spiders	33	33	18
Gastropoda	Snails and Slugs	21	21	0
Flowering Plants	Flowering Plants	691	317	2
Conifers	Conifers	1	0	0
Cycads	Cycads	4	0	0
Ferns	Ferns	5	4	0
Bryophytes	Liverworts	8	8	0
Bryophytes	Hornworts	1	1	0
Bryophytes	Mosses	13	13	0
Fungi	Fungi	5	5	0
Green Algae	Green Algae	3	3	0
Total		1,278	701	60

Table 2: Putative new species by group (BushBlitz 2012)

Group	Total number of species	Species new to science
True Bugs	161	40
Spiders	33	18
Flowering Plants	691	2

Overall, FRS supports four major ecosystems: woodlands (175,600 ha), grasslands (1260 ha), monsoon rainforests (700 ha) and inland wetlands (290 ha) (Fig. 2). There are different types of savanna woodlands such as mixed, eucalypt (open and mixed), non-eucalypt, or sandstone woodlands, but for the purpose of valuation in this report, all woodlands are placed in one category.

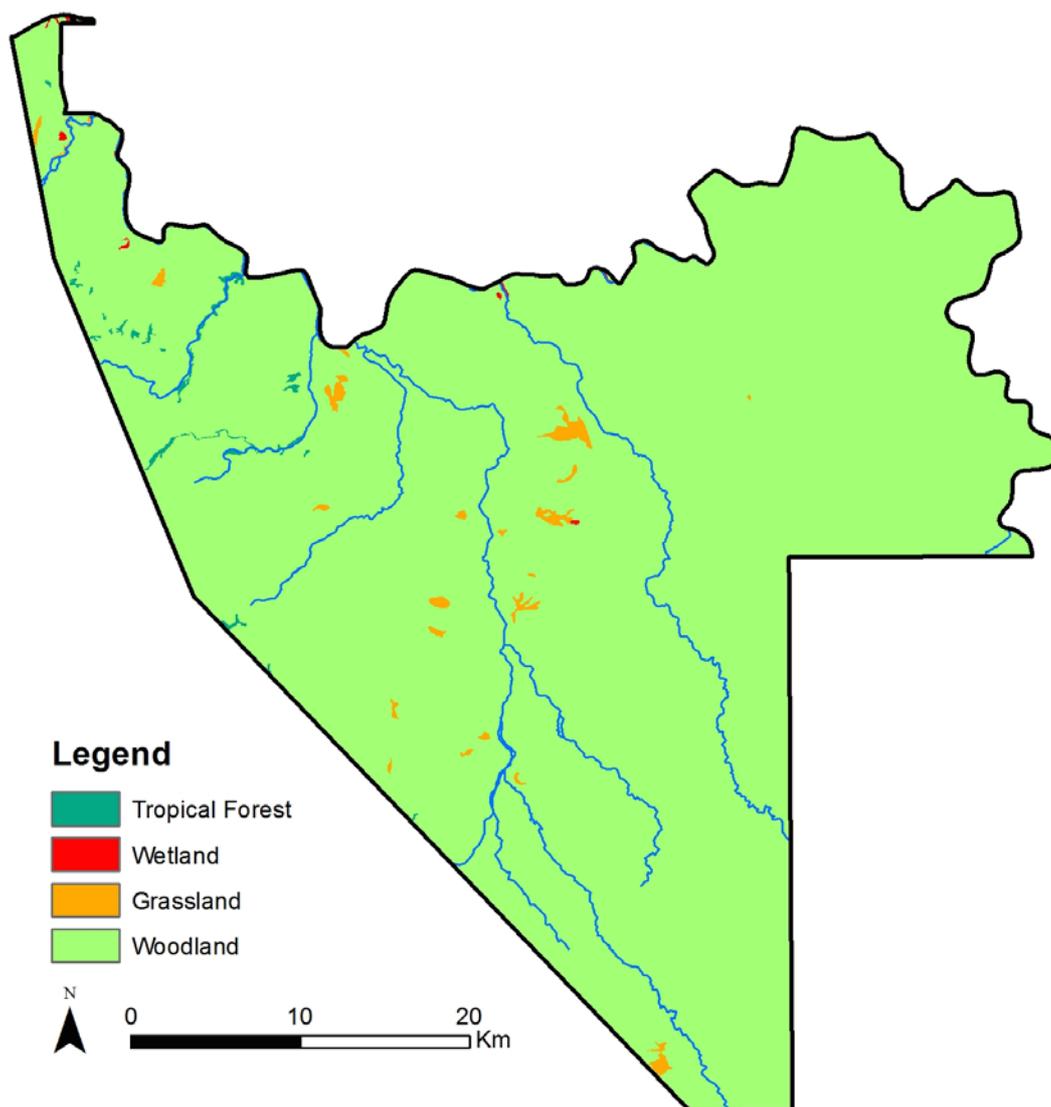


Fig. 2. Main vegetation types on FRS.

Cultural values

FRS is a culturally significant landscape for the Ngan'giwumirri (Labarganyin), Wagiman, Malak Malak and Kamu people who are Indigenous landowners of the property. It is rich in enduring cultural values (ILC 2012; Fig. 3). There are numerous sacred sites and named places, burial places and other areas known, used and managed for their resources (North Australian Indigenous Land and Sea Management Alliance (NAILSMA) 2014). The Aboriginal Areas Protection Authority (the Northern Territory Aboriginal Sacred Sites Act 1989) reported 22 sites as 'restricted works areas' on FRS.

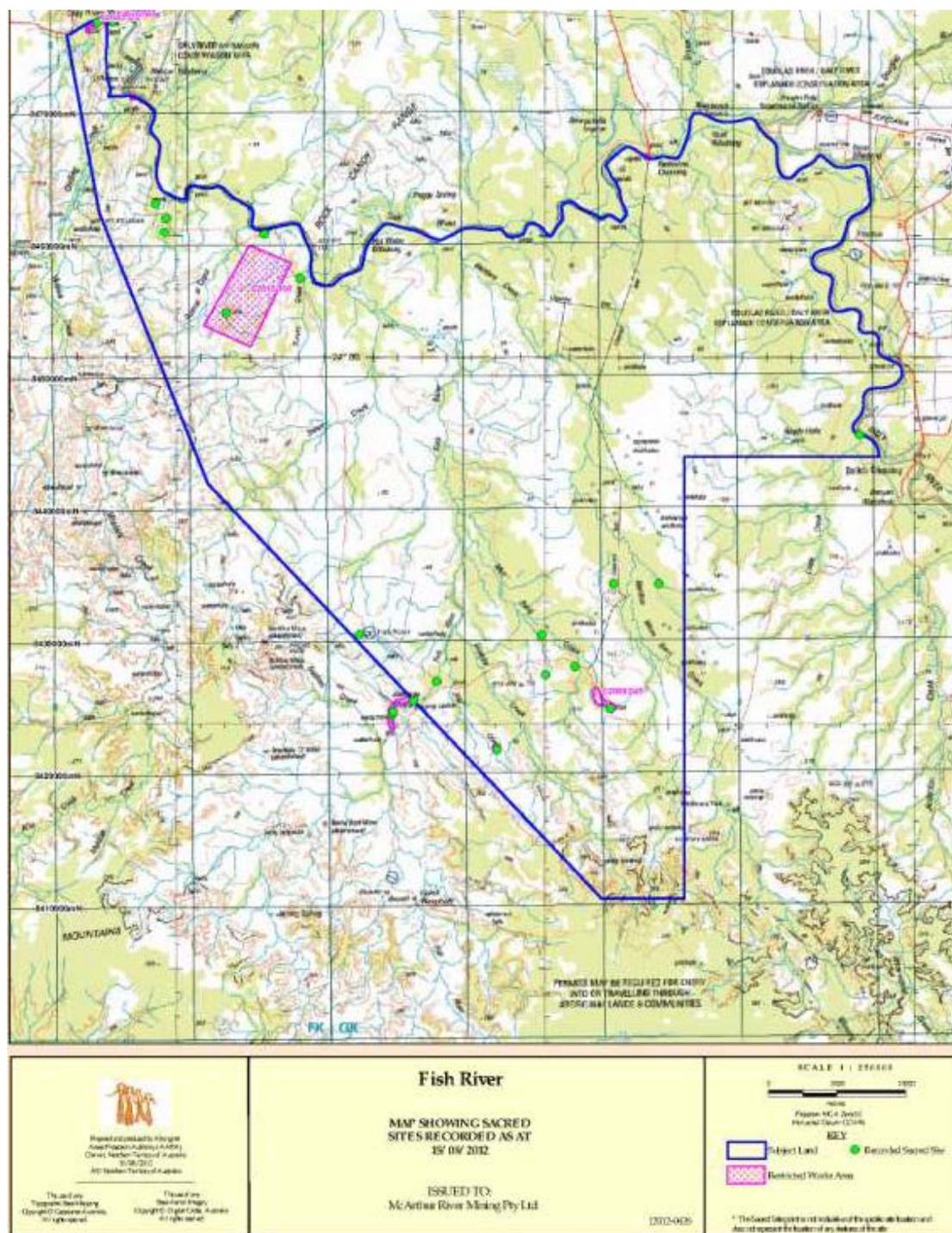


Fig. 3. Distribution of mapped cultural sites on FRS (source: ILC 2012)

Social values

There are approximately 500 Aboriginal people living in the Nauiyu (Daly River) community that is 83 km from the FRS homestead. Among these, about 80 people visited FRS in 2014 to conduct various cultural and community events or to work in related activities. Apart from these occasional visitors, nine Aboriginal people who were employed in 2014 on a part-time basis at an average wage of ~\$22,000/yr, regularly visited FRS for about 40 weeks in a year.

Overall, about 80 people consistently enjoy their socio-cultural connections with FRS landscape (pers. communication, Morrison, S. 2015). These socio-cultural connections provide opportunities to people to learn about their culture, landscape, traditional knowledge and other aspects of living on, and connecting with land. This further enables people to strengthen their cultural obligations and to build Indigenous capabilities, as discussed later.

ES from FRS

The main ES from the four main ecosystems on FRS are:

i. *Tangible ES*: These ES have a direct market (\$) value, and comprise mainly Carbon (C) benefits for sequestration of C, and mitigation of CO₂-e emissions, through improved fire management under the Emission Reduction Fund (ERF)/Carbon Farming initiative (CFI; as previously known

Eco-cultural tourism at FRS may have potential in the future, but has not been investigated at this stage.

ii. *Intangible or non-monetary ES*: FRS provides various socio-cultural and ecological services that have no market price tag, such as bush food and medicine, biodiversity, protection and regulation of water resources, recreation, traditional ecological knowledge (TEK), cultural, sacred and identity places, and provision of art and craft materials.

Based upon available information (Altman 2009, and Altman et al. 2011; ILC 2012-13 and other annual reports, Russell-Smith et al. 2009, 2013 and 2015; Whitehead et al. 2009; Woinarski et al. 2006; and others), we propose an ES framework (Fig. 4) as below:

FRS: Ecosystems, ES and Economy

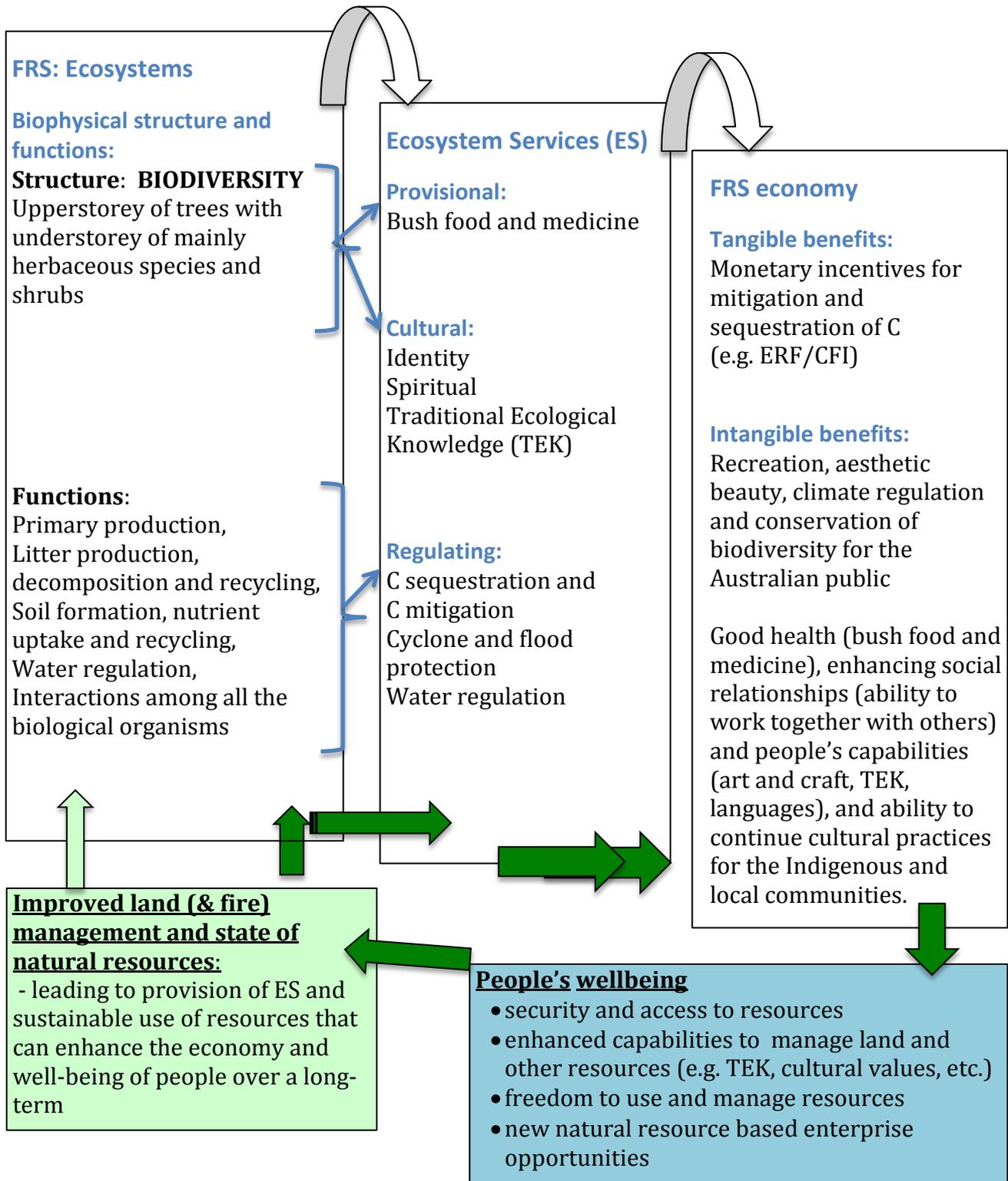


Fig. 4. ES from FRS and their contribution in the local economy, including people's wellbeing.

ES, as described in Fig. 4, benefit the local and regional communities for numerous gains out of which only two are tangible 'marketable' benefits, while several others are intangible 'non-marketable'. Particularly, there is a significant proportion of cultural, natural and social services from various ecosystems of FRS that benefit local indigenous communities in several different ways for enhancing traditional knowledge, social relationships, providing freedom to practice their culture etc., that leads to people's improved wellbeing (Fig. 4). However, most of these services are not accounted for their 'importance' in current policy decisions. Until now, only C abatement, among many other ES, is valued in monetary (\$) terms, mainly because of national Government initiatives to reduce Greenhouse Gases (GHG) to meet international GHG emissions targets and our understanding that climate change seriously compromises agricultural production and other gains. Usually, we start valuing an ES only when it's in scarcity or implies devastating impacts. The rationale for valuing ES is discussed by Costanza et al. (1997), Costanza and Daly (1987) and recently by Costanza et al. (2014) amongst others.

For intangible ES, since we lack understanding of their \$ value using the current economic mechanisms, they usually do not account in policy decision making. This lack of value leads to misinterpretation or under-estimation of the role of these services in development-related decisions. For this reason, we attempt here to assess the monetary value of both tangible and intangible ES from FRS. The methods applied to assess their monetary value are outlined below.

Methods to assess monetary value of various ES (all values in Australian dollars (AUD) except where stated otherwise)

1. Monetary value of tangible ES:

C benefits: Monetary value for mitigation of GHG emissions was assessed from the average number of Australian Carbon Credit Units (ACCU) over 2011-2014 (unpublished report, ILC 2015). Improved fire management plays a vital role in mitigating GHGs that is well recognized by the Australian Government through the Savanna Burning Methodology (SBM) for ERF projects. Apart from C mitigation, we also consider C sequestration by tree vegetation and coarse woody debris (calculated using SBMs that are currently under consideration by the Australian Government; Murphy et al. 2015). An average price of AUD 13.95/ACCU is applied based upon the current C market (Government auctions on the 16-17 of April 2015). We believe that C sequestration, along with mitigation, is most likely to be included in the SBM by the end of 2015.

2. Monetary value of intangible/non-monetary ES:

The value of various intangible ES listed above is collectively assessed applying two different methods:

i. Basic value transfer method: The value of biodiversity and other non-monetary ES was assessed applying the basic value transfer method where values are taken from relevant studies and transferred to the study of interest. This is a common method applied in many valuation studies (e.g. see Costanza et al. 1998, 2014). We used valuation data from a global study conducted by deGroot et al. (2012). In this study, the median value of per unit area for rangeland, grassland, tropical forest and

wetlands (inland) was estimated as \$1522, \$2698, \$2355 and \$16,534/ha/yr (\$ represents the USD) respectively, for a range of ES from each ecosystem. We converted the total value from USD into AUD, using conversion rate on May 4, 2015. The range of ES includes various provisional (food, medicine, raw materials, genetic resources etc.), regulating (air quality, climate and water regulation, nutrient cycling etc.), habitat (nursery service, genetic diversity) and cultural services (recreation, spiritual, aesthetic etc.).

We also applied the most relevant values from an Australian context using deGroot et al's (2012) global valuation database (from TEEB – The Economics of Ecosystems and Biodiversity, for 1310 studies on ES, developed by Van der Ploeg and deGroot 2010). We used the average values for the selected ecosystems from two main studies conducted in northern Australia (Blackwell 2006, and Curtis 2004). According to these latter studies, the total value of ES from rangeland, grassland, tropical forest and wetlands was \$398, \$199, \$1851 and \$925/ha/yr, respectively (\$ here represents the USD, that were converted into AUD).

deGroot et al. (2012) estimated ES values using a range of approaches, including direct market prices, cost-based approaches, stated preference methods, revealed preference methods, and production function approaches. They suggested that these values generally represent marginal values for a specific ES provided by an individual ecosystem. However, the main drawback of this method is the applicability of values that were applied to our study—but given that the Australian economy is at par with the economies of many developed countries from where these values have been estimated, we could expect minimum discrepancy. Moreover, we also provided estimates using the relevant Australian values from the same global database to provide a more appropriate assessment. We believe that our estimate of ES using figures from deGroot et al. (2012) is marginal, given the conservative estimate applied by those authors.

ii. Tradeoff of weed and pest expenditure

Fire, feral animal and weed management are the other major saved costs that Aboriginal management of FRS provides for on-site as well as off-site benefits. For this assessment, however, we do not include fire management costs because (a) by contrast with feral and weed management, there are no accepted Northern territory savanna-wide published costings available, and (b) by default, we have already included some part of those costs in our estimation of carbon benefits derived from enhanced fire management.

The NT Government spends AUD 100-250/ha/yr to manage one prominent weed species in the Top End (i.e. Mimosa (*Mimosa pigra*): Natural Resources Division, Department of Natural Resources, Environment, the Arts and Sport, 2010). BushBlitz (2012) reported six main weed species at FRS, i.e. Gamba grass (*Andropogon gaynus*), hyptis (*Hyptis suaveolens*), arsenic weed (*Senna obtusifolia*), coffee senna (*Senna occidentalis*), spinyhead sida (*Sida acuta*) and flannel weed (*Sida cordifolia*). Whereas, on-ground surveys by FRS staff indicate that Mimosa, Gamba grass, Grader grass (*Themeda quadrivalvis*) and *Cenchrus* species (annual and perennial) are four serious weeds, apart from 22 other roadside species. From a management-cost perspective, the TOs managing FRS help to conserve AUD 100-250/ha/yr for managing any one species of weeds. Applying a lowest cost of management, i.e. AUD 100/ha/species/yr,

the total cost for managing four main weeds only is AUD 400/ha/yr. It is important to note that there are about 20 other weed species that need to be managed as well. Thus, the overall cost of management will be much greater than the conservative estimates considered here. We acknowledge that controlling and managing one weed species also contributes to manage other weeds, but given that the actual number of weed species is much greater than the four considered here for costing, the overall cost would be greater than estimated here.

Similarly, the feral animal management program costs about AUD 46/ha/yr per species (Murray et al. 2013). There are five major pest species in the area, i.e. water buffalo (*Bubalus bubalis*), donkeys (*Equus asinus*), brumbies (*Equus caballus*), cats (*Felis catus*) and pigs (*Sus scrofa*), apart from cane toads (*Rhinella marina*), European bees (*Apis* species), cattle and 16 other invertebrate pest species. The total cost of management for these main five species is estimated as AUD 230/ha/yr (keeping in mind that there are other ~20 pest species as well).

A total cost of AUD 630/ha/yr was applied for the whole area given that many feral animals are mobile and the weeds are widespread throughout FRS— nonetheless there will be uneven distribution.

Proposed minimum premium for maintaining ES from FRS

FRS is managed as a Category II Protected Area under the International Union for the Conservation of Nature (IUCN) definition; ie. defined as large natural, or near natural area set aside to protect large-scale ecological processes along with the complement of species and ecosystems characteristic of the area. The primary objective of this category is to '*protect natural biodiversity along with its underlying ecological structure and supporting environmental processes and to promote education and recreation*'. Other congruent objectives include the management of visitor use, taking into account the needs of Indigenous people and local communities, including subsistence resource use and to contribute to local economies through tourism (Commonwealth of Australia 2012).

We evaluate the baseline premium applying two approaches:

i. Actual expenditure on weed and fire management for maintaining the flow of ES

As FRS is entirely managed for the purpose of conservation, we assume that the total amount of money spent each year on managing this property indicates the minimum cost of maintaining ES that ensures biodiversity values into the future. If this money was not spent on managing FRS, there would be huge costs for loss of ES through a strong possibility of intense, wide spread late season fires, potential spread of weeds and pests, and for degradation of soil, water and biodiversity. So, we used the current management costs, including salaries of the employees who manage FRS (ILC expenditure report 2014, unpublished) to assess the minimum premium required for maintaining ES. The average salaries (2011-2014) of a manager and rangers (i.e. AUD 390,000 per year), and the costs of fire, weed and pest management (i.e. AUD 100,000 for weeds and pests, and AUD 110,761 for fire management per year), were applied to calculate a potential premium baseline. This minimum premium represents only a pre-emptive suggestion for establishing management or stewardship payments for ES in the future. We believe the actual value of ES is much greater, given the cultural

connections of Indigenous people and numerous offsite benefits to the wider Australian public.

ii. Assessment of ES premium from the tradeoff of current Government expenditure through providing access to land for provisioning various ES to the local Aboriginal people:

Another way to evaluate the premium is to consider the economic perspective of benefits that people obtain living on their country, applying a tradeoff of current Government expenditure, as discussed below:

We contend that the provision of land, or better termed as ‘country’ in cultural context, at FRS provides many intangible services that enhance wellbeing of Aboriginal people who visit the property; ~80 people regularly visited FRS in 2014 for various cultural and ceremonial activities. The main benefits that people accrue from such visits and/or from knowing the country are: good health, traditional ecological knowledge (TEK), the fulfilment of cultural obligations, social relationships, inspiration for art and craft, cultural activities, and provision of bush food and medicine. It is important to note that these are long-term benefits although people may visit the station for a short period only. FRS further contributes to people’s wellbeing for providing security and access to land and other resources, and for enhancing people’s capabilities and providing them with cultural opportunities. This kind of direct or indirect contribution of ES (from country/land) to enhance people’s wellbeing is well acknowledged in various studies (Burgess et al. 2009; Garnet et al. 2008; Grieves 2007 and 2009; Russell-Smith et al. 2009; Sangha et al. 2011; Taylor 2008). We assume that, having security and access to FRS, Nauiyu people benefit in terms of building their capabilities and enhancing wellbeing.

The Economics Nobel Laureate, Prof. Amartya Sen, proposed a Capability Approach to welfare economics and argued that ‘development’ is about enabling people to lead their healthy and creative lives while providing them with an appropriate environment (Sen 1999). We apply Sen’s capability approach here. The provision of ES from FRS enables Aboriginal people to learn, practice and to pass-on their cultural ways that help them to lead healthy and creative lives. The various ES from FRS that enhance people’s capabilities directly or indirectly is presented in Table 3.

Table 3. Importance of country in building capabilities of Aboriginal people.

Country/homeland	Materials/items	Capability
Food/medicine	Bush food and medicine	Knowledge of native plants and animals on what, where, how, and when, to eat, ultimately contributes to good health.
Art & craft	Material objects, ochre, paint, etc.	Knowledge and ability to use different plant/stone/earth materials, and to develop ideas for painting/dancing based upon their

		ritual/ceremonies/observations in relation to country. This enables people to lead creative lives.
Songlines	Represent the invisible pathways on land, and the footprints of ancestors that describe the rules and responsibilities of a particular country.	Knowledge of songlines enables people to take care of their country in a customary way. It enables people to pass-on their rituals and culture.

Given that the Australian Government spends about AUD 43,449/yr/person (Steering Committee for the Review of Government Service Provision (SCRGSP), 2014) on the main socio-economic sectors (i.e. safe and supportive environment, economic participation, healthy lives and on early childhood development), we assume that these sectors will benefit equally from Indigenous connections with land for enhancing Indigenous wellbeing. That value (AUD 43,449/person/year) can be used to reflect the premium value of ES, especially for providing the similar required environment that contributes towards long-term well-being benefits. We apply a tradeoff analysis of Government expenditure using two scenarios: 100% suggesting that the total expenditure can be applied to evaluate the ES- premium that enables people to lead healthy and safe lives, and 50% – applying 50% of the total expenditure for the same purpose (given that Indigenous per head welfare expenditure is double that for non-Indigenous i.e. AUD 20,900 (SCRGSP 2014)). FRS can provide equivalent benefits as for Government welfare that could be used to set up ES-premium, for example:

1. The natural and cultural landscape at FRS provides a safe and supportive environment for the Aboriginal people to live/visit the property.
2. Fire management by Aboriginal people on FRS provides culturally appropriate economic opportunities to work as well as to live on country.
3. The cultural, spiritual and identity connections with FRS for Aboriginal people from four language groups enable them to lead healthy lives. There is significant literature available on the connections between healthy country and healthy people (Garnett et al. 2008 and others).
4. Knowledge of identity and culture fosters self-esteem, providing a supportive and safe environment for early childhood development.

We acknowledge that our tradeoff analysis requires further in-depth study and we recommend conducting focus group meetings to explore each dimension of Aboriginal wellbeing in relation to people’s connections with country in the future to estimate the appropriate ES-premium for FRS.

Overall, in our valuation approach, we applied the commonly used methods such as the basic value transfer technique, and tradeoff analyses of weed and pest management costs. We acknowledge that for the amount of minimum premium required to maintain ES, our technique may provide very conservative estimates; this value would increase if we included the long-term benefits of maintaining ES flows from FRS for local and regional communities.

Results

Monetary value of main ES from FRS

Main ES from FRS and their monetary values are:

1. Monetary/tangible ES: C benefits for mitigation of GHG and sequestration of C are the only ES that had direct monetary value. On average (2011-14), FRS mitigates about 13,130 t of CO₂-e emissions (unpublished report, ILC 2015). In addition, tree vegetation and coarse woody debris sequester about 27,067 t/yr—based on methodologies as set out in Murphy et al. (2015). Thus, the total amount of C benefits equates to 40,067 t of ACCUs that are tradable. Applying a moderate price of \$13.95/ACCU (based upon the current C market as per Government auctions in April 2015), the total value of C benefits can be estimated as \$560,748/yr (\$183,163 for mitigation and \$377,584 for sequestration).
2. Non-monetary or Intangible ES: the major intangible services from FRS that are collectively considered for monetary values are biodiversity, recreation, TEK, cultural, sacred and identity places, bush food and medicine, art and craft materials, apart from other provisional and regulating services. In the absence of a monetary tag for these ES, different evaluation methods/scenarios were applied, as presented in Table 4.

Table 4. Potential monetary value of intangible ES from FRS.

Various methods/scenarios to value intangible ES	Monetary value of intangible ES (AUD)/year
i a. Using basic value transfer method (deGroot et al. (2012)- applying a median value for each ecosystem type)	355,755,086 (@ 1 AUD=0.78USD as on 4/5/2015)
i b. Using basic value transfer method (deGroot et al. (2012)- applying most relevant values from Australian studies)	92, 777,155 (~ 93 million)
ii. Tradeoff of weed and fire management for the value of ES	113,400,000 (~113 million)
Total value range (including direct value of C benefits 560,748/yr)	~ 93 million – 355 million per year

The various assessment methods/scenarios to evaluate intangible ES are discussed below:

- i. Basic value transfer method: In the absence of any local valuation study in the region, we applied the median value for tropical forests, woodlands, wetlands and grasslands from an international study by deGroot, et al. (2012). This method suggested a value of AUD 355 million per year for various provisional, regulating, cultural, and social services. We also applied the relevant Australian values from the same global database used by deGroot et al. (2012) and the total value of ES from FRS was estimated at about AUD 93 million per year. A main limitation of this method was that the median or relevant values used from the global study might not reflect the real value that local Aboriginal people may have for FRS. This

requires a detailed study in participation with Aboriginal and local communities that depend on FRS.

- ii. Tradeoff of weed and pest expenditure: This method was based upon the amount of money that the Government (potentially) spends on fire, weed and pest management, that account to about 133 million per year. In other words, the ES benefits of managing land for fire, weed and pest management equates to ~113 million per year.

Minimum premium required to maintain the flow of ES from FRS

- i. Using the current fire, pest, weed and land management expenditure:

The current management costs of AUD 600,761/yr for the provision of ES suggest the minimum premium that is actually required for maintaining the ES, given that FRS is managed solely for conservation values.

- ii. Using tradeoff of Government welfare expenditure

This ES-premium estimate was based upon the amount of money that the Government spends on providing a safe and supportive environment, enhancing economic participation, to enhance healthy lives and early childhood development, especially for Indigenous people (80) who visit regularly visit FRS. We assume that people visiting, working and living close to FRS obtain these services that enhance their wellbeing over the long-term. So, the ES-premium equates to the amount of money that otherwise the Government spends on welfare services.

- scenario a – a 100% of welfare expenditure could be traded for provision of social and cultural ES from FRS that equates to AUD 3.5 million for 80 people in the region who regularly visit FRS.
- Scenario b – a 50% of the total expenditure could be saved (as Indigenous per person welfare expenditure is double the amount than that for a non-Indigenous person). Thus, a conservative estimate of AUD 1.75 million represents the value of ES.

Without doubt, the estimated premium value here is constrained by available funding on fire, weed and pest management (i) but this provides us a minimum realistic figure that the Government, ILC and other parties are currently expending to maintain FRS for its natural and cultural values. Alternatively, a 50% tradeoff of welfare expenditure (AUD 1.75 million/yr) suggests another applicable estimate for minimum premium, given that >50% of the government expenditure on welfare is on safe communities, health and economic participation as these welfare components will greatly benefit from indigenous connections with FRS. Thus, minimum ES premium can vary from 0.6 M-1.75M/yr. These estimates only provide a baseline for discussion on the premium required for ES flows from FRS, and need to be explored in consultation with the local Aboriginal community, FRS manager, TOs and other stakeholders.

Overall, we acknowledge that the actual value of ES varied from AUD 93 million to AUD 355 millions per year depending upon the valuation methods, which further requires appropriate human judgment. However, it is important to highlight that in addition to on-site benefits, there are many off-site benefits for other people in the region as well as for the wider Australian public. So, we expect that the actual value of benefits for maintaining ecological assets (ecosystems as stocks) and the flows of ES from such assets will be much greater over time than the values mentioned in here.

Discussion

A valuation assessment of ES, especially where traditional, cultural, spiritual and identity values play a significant part, is a complex task given that many ES are beyond any conventional monetary price tag. According to the use and importance of ES, these could be classified into provisional, cultural and regulating services (Fig. 4) following the Millennium Assessment framework (MA 2003 and later reports in 2005). However, assessing the monetary value of intangible ES largely depends on the state of the ecosystem and local knowledge, people's value systems, and on the cultural and geographical landscape of a place. The context of valuing ES is well discussed by Costanza et al. (1998) and many others.

Many of the ES from FRS are easily identified given the available literature (Bushblitz report 2012, ILC 2012, 2014, Mahney et al. 2011, NAILSMA 2014, Russell-Smith et al. 2009, 2013 and 2015, Altman et al. 2011, and Woinarski et al. 2006). Estimating a monetary value of identified intangible services is challenging. However, for policy decision purposes and to explore the minimum management premium, we were asked to assess an overall monetary value of these ES applying a few different but accepted methods. The monetary value of C benefits for mitigating GHGs and sequestering C is a direct market value (subject to fluctuating prices at any one point in time), whereas the monetary value of other ES was indirect—assessed using the basic benefit transfer method, or in terms of their role in people's wellbeing, and/or from the fire, weed and pest management costs for FRS, as presented in Table 4. We accounted for the tradeoff benefits only for 80 Aboriginal people who visited the property in 2014 for cultural, ceremonial or social activities, based upon the belief that people derived long-term benefits from such visits. Those benefits could readily be considered in terms of the broader local and Indigenous community, and more generally for society at large.

The basic value transfer method realised a total value of ES for ~93–355 million per year (ia and ib; Table 4) which was relatively close the values derived from the tradeoff analyses of weed and pest management (ii, Table 4). The basic value transfer method includes a number of different valuation techniques such as avoided costs, replacement costs, eco-tourism/travel costs, direct market value of timber and other products, contingent valuation, benefit transfer and others (deGroot et al. 2012). Its relevance largely depends upon the overall state economy, status of ecosystems, people's freedom and access to use and value their cultural and natural landscape, apart from the associated socio-political environment. The basic value transfer method transfers the values from one study to another by updating values (using current conversion rates etc.). For example, Blackwell (2006) used the values from Costanza et al. (1997). Thus, it may not reflect the values for ES from FRS because it does not include the local socio-economic context of an ecosystem and how people use and value a particular service.

A tradeoff of the potential Government expenditure on weed and pest management at the Northern Territory scale suggests the potential costs that the Australian community could incur if not managing the landscape in the future, thus indirectly suggest the value of ES for its current management. Based on information provided, we suggest that the current actual costs to manage weeds and pests are insufficient to eradicate all the weeds and feral species. As noted above, however, we have not included any fire management tradeoff given, primarily, that NT savanna-wide fire

cost data are not readily available. It follows that if the total costs to manage fire, weeds and pests were considered at a landscape scale, the total value of ES would be substantially greater. The values in Table 4 provide us an indication of the value of ES that requires accurate judgment to consider for future policy–decision–making.

According to our best value judgment, FRS may provide ES worth AUD 93-113 million per year for intangible benefits. We also contend that the actual value of these benefits will be much greater over time, particularly for including off-site benefits. In that context, our best value only represents about 30% of the total value estimated using the deGroot et al. (2012) median value approach. The main advantages and disadvantages of methods applied in this assessment are outlined in Table 5.

Table 5. Advantages and disadvantages of valuation methods used in FRS assessment to value intangible ES, and related precautionary measures.

Valuation methods	Advantages	Disadvantages	Precautionary measure
Basic Value Transfer	Cost-effective, Easy to apply, Quick and simple.	It could involve: Inappropriateness, Low accuracy, Over-estimation, Over use of same values in various studies without updating according to local conditions (as in Blackwell 2006).	A thorough examination of the database for relevant values, Seek experts and local opinions, Complement with other valuation methods and/or by seeking locals' opinions (focus group meetings etc.).
Tradeoff analysis	Rational assessment, Requires broader understanding of different natural systems and human values.	Includes associated factors/values for trade-in/out of any given costs/benefits, Limited application.	Requires a holistic and rational understanding of the role of ES.

It is important to note that apart from various on-site benefits for local Aboriginal people, FRS also provides many ES for the wider public, thus delivers many offsite benefits. These offsite benefits may include maintaining the diversity of flora and fauna, soil conservation, educational, recreational and heritage values, apart from various regulating and supporting services. For these offsite benefits, some people may have option values (valuing a service for knowing its existence at the present time) or bequest values (valuing a service for the future), or more broadly use and non-use values depending upon directly using or not using a service (following a Total Economic Value framework). There is an extensive literature available to explore these values (various journals: Ecological Economics, Ambio, Ecosystem Services, and websites such as TEEB–<http://www.teebweb.org>). If the value of these offsite benefits is accounted for, then the total value of ES from FRS would be significantly higher, given the higher willingness to pay for these services among the Australian public (Zander et al. 2013). Moreover, it is expected that the wider Indigenous population would substantially value the preservation of 22 heritage places on this property.

Our minimum premium estimates (0.6-3.5 M/yr) are meant to provide a rough estimate of the funds that may be required to maintain the flow of ES from FRS, although, as indicated above, the actual value of ES from FRS is realistically much greater. A tradeoff of the Government expenditure against Indigenous welfare services, especially for providing safe and supporting environment, enhancing healthy lives and early childhood development (SCRGSP 2014) for provision of ES, provides a novel approach that relates to people's benefits, particularly from Indigenous perspectives. We believe that providing access to, and security and freedom from, country enables people to develop their capabilities and to lead healthy and creative lives; e.g. applying Sen's capability approach (Sen, 1999). The capability approach has been widely considered in many development efforts; e.g. the United Nations has considered education and health as two important attributes to measure human development for Human Development Reports (HDR reports 1990, and onwards). Similarly, indigenous capabilities could be targeted for improvement through the enabling environment that FRS provides. Our tradeoff analysis realised a ES-premium of AUD 1.7-3.5 million per year for enabling people to lead creative and healthy lives. We estimated this value for 80 people only, although, as noted above, there are many others in the region who may benefit for knowing the existence of FRS.

We acknowledge that for the purposes of this initial assessment, we have focused on the basic value transfer method and the current fire, weed and pest management costs. However for premium estimate, we assessed tradeoff benefits for 80 people only that could be expanded for other people who may visit/value FRS.

In conclusion, we recommend conducting focus group meetings with the local communities to evaluate the role of various intangible ES in their various aspects of wellbeing as well as applying modeling tools (e.g. Stella, Similie etc.) to accurately assess the total value of ES from FRS and the role of these ES in people's lives. We suggest that it would be useful to hold a workshop or focus group meeting with the local community, and other stakeholders to explore this. This would involve discussing in detail the various ecosystems, fire, weed and pest spread, people's values, mapping the ES values according to the status of different ecosystems, to provide a much more accurate assessment. This should involve a spatially explicit valuation, including different options for fire, and weed and pest management, that may help to target the highly valuable locations to maintain the ecological assets and the flow of ES. Such a valuation study would be useful in planning and managing the resources on a local and regional scale, and in understanding the role of ES in people's wellbeing as well as the role of TOs in managing natural resources for the policy decision makers as well as for the wider Australian public.

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