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Article

Towards an Indigenous Ecosystem Services Valuation Framework: A North Australian Example

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Abstract

Despite calls by various international agencies, considerable work is still required to understand and incorporate the importance of earth's ecosystems for informing public policies. Savannas comprise nearly one third of global terrestrial ecosystems and support many local and Indigenous communities, but the value of their ecosystem services (ES) is insufficiently understood. This study proposes an integrated ES valuation framework and applies it to assess ES for an Indigenous savanna estate in northern Australia, describing how capabilities along with biophysical and socio-cultural ES benefits play a vital role for peoples' wellbeing. We estimated the monetary value of ES by applying a conventional Basic Value Transfer (BVT) method for biophysical benefits (USD 84 M y^{-1}), and a wellbeing approach for valuing socio-cultural benefits and capabilities (USD 4 M y^{-1}). The latter offers a relatively nominal estimate but underscores the importance of including peoples' capabilities in order to demonstrate wellbeing benefits for Indigenous people who regularly visit and utilize their lands. We explore two scenarios, Business as Usual (pastoral land use) and ES-based economies (implying customary land use, particularly through fire management) to project plausible broader benefits for the community over a longer term. This research describes how inclusion of Indigenous peoples' capabilities and socio-cultural values are critical for ES assessments, and indicates that an integrated approach is essential for appropriately informing local, regional and global development policies.

Keywords: Ecosystem services, Savanna ecosystems, Northern Australia, Indigenous capabilities, Indigenous wellbeing, Socio-cultural services, Value of Ecosystem Services

INTRODUCTION

Globally, incorporating the value of Ecosystem Services (ES) in public policy is recognised as being essential for better management of scarce and rapidly depleting natural resources (Intergovernmental Panel on Biodiversity and Ecosystem Services (Díaz et al. 2015; IPBES 2016), Millennium Assessment (MA 2003, 2005), The Economics of Ecosystems and Biodiversity initiative (TEEB 2010a) and the World Resources Institute (WRI 2016)). However, many local and regional policies fail to consider those values due to ignorance, lack of interest and goodwill, paucity of relevant valuation studies and lack of public understanding of the importance of natural wealth (MA 2005; IPBES 2016).

Earth's natural systems and their ES are critical for supporting human wellbeing, especially our currently expanded economic systems with much increased levels of economic activity (Costanza et al. 1997, 2014; MA 2003; deGroot et al. 2012; Human Development Report 2015). Notwithstanding this recognition, our natural resources are degrading and depleting at a fast rate, for example, 30% of cropping land is experiencing

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high rates of degradation; more than 50% of the area of six biomes have been converted to agriculture since 1950s causing severe loss of forest cover; 20% loss of coral reefs and 35% of mangrove areas; coupled with more than 30% increase in atmospheric CO_2 emissions since the 1750s (MA 2005). To address these concerns, many global institutions are calling for valuing the ES of various ecosystems and integrating those values into policies as a key solution.

Savannas comprise about 30% (44 M km^2) of the total area of terrestrial ecosystems distributed across Australia, Africa, South America, South-East Asia and India, but have not been assessed for their ES. Many local and Indigenous people in those regions have deep and intricate relationships with their landscape, which are rarely measured or considered in public policies. The TEEB (2010a) global study compiled an ES valuation database. Of the total of 248 TEEB studies, only 12 covered tropical woodlands that include heaths, rangelands, scrubs and other woodlands (van der Ploeg and deGroot 2010; McVittie and Hussain 2013). Of those 12 studies only four, from Australia, Peru, South Africa and Tanzania, are truly representative of savannas. This paucity of valuation studies suggests a real need for more of this work (TEEB 2010b; Figgis et al. 2015; IPBES 2016). The ES valuations are particularly important for local and traditional societies, including Indigenous people in northern Australia, whose values for their natural systems fall outside of the modern economics framework (Archer 2015; Russell-Smith 2016; Sangha et al. 2017).

To evaluate the role of ES for wellbeing, the MA and IPBES developed ES conceptual frameworks (MA 2003, 2005; Díaz et al. 2015; IPBES 2016), which are widely known. The MA framework was the first of its kind where ES, mainly categorised as provisioning, regulating, cultural and supporting, was linked to five constituents of human wellbeing; i.e. security, basic materials for life, social relations, good health, and freedom and choice (Figure 1). Building on the MA concept, recent IPBES (2016) and related valuation frameworks (Pascual et al. 2017) have expanded ES into nature and nature benefits, linking the latter with quality of life (human wellbeing) (Figure 2) and applying simple and easy language for strengthening the science-policy interface. Unfortunately, none of these frameworks accommodate Indigenous perspectives, particularly peoples' capabilities and related wellbeing afforded through 'living on *country*'—a term commonly used by Indigenous Australians to describe social, cultural and spiritual connections to their customary lands (Queensland Studies Authority 2008; NAILSMA 2012). Following Sen (1993), capabilities refer to the freedoms to achieve various opportunities (abilities/functionings) a person may value doing or being (Sen 1993); e.g. a person's knowledge and skills enabling him/her to 'live on *country*'. This study attempts to address those perspectives as an important component of valuing ES from tropical savannas, and proposes an integrated framework incorporating peoples' capabilities and knowledge systems.

Tropical savannas in Australia comprise about one quarter of the total landmass (1.9 M sq. km) and support a diverse

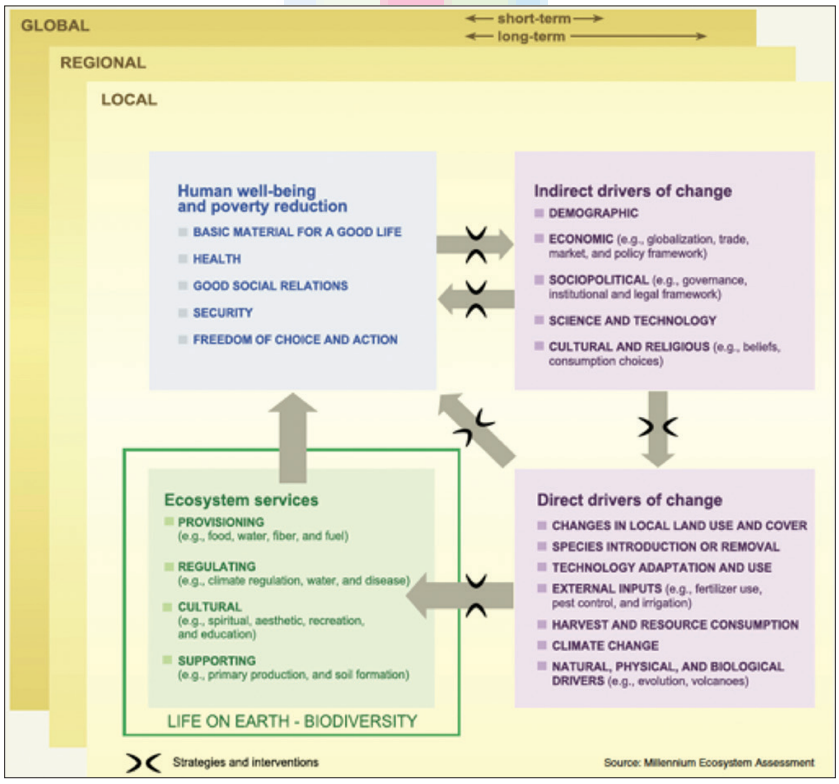

Figure 1

The MA framework linking human well-being and the ecosystem services (on the left-hand side), which are influenced through various direct and indirect drivers of change (on the right-hand side)(MA 2003; 2005)

range of habitats (Woinarski et al. 2007). Most importantly, savannas sustain the livelihoods of many Indigenous people living in about 120 discrete Indigenous communities (from 100 - 10,000 people) (ABS 2011, Figure 3), and deliver conservation benefits for more than 500,000 non-Indigenous people in the region (Russell-Smith 2016; Woinarski et al. 2007). Indigenous people comprise around 17% of the regional population, the majority living outside of major urban centres (ABS 2011). Indigenous people depend upon savanna systems for various benefits including health, economic opportunities, cultural knowledge and practices that are important contributors to peoples' wellbeing (Archer 2015; Burgess et al. 2009; Russell-Smith et al. 2013). Above all, people derive many of their capabilities from connections with their *country*'. For example, knowledge and skills to learn a language, hunt or to collect bush food or medicine from particular *country* (comprising various ecosystems), involve a specific set of capabilities which are only learned from knowing that particular place (Keen 2004). However, there is little evidence of such values, capabilities and related wellbeing benefits being incorporated into policies affecting Indigenous welfare, employment, health, education and learning, and natural resource management (Altman and Whitehead 2003; Sangha et al. 2015a).

In this paper, ES refers to 'services or goods' that are valuable to people. Firstly, we offer an integrated view of Indigenous perspectives of *country*. Secondly, we assess the monetary value of ES in terms of their contribution to shaping and maintaining peoples' values, capabilities and wellbeing (MA 2005; TEEB 2010a; Costanza et al. 2014). In this valuation context, ES align generally with benefits derived from the contemporary Australian cultural and natural resource management concept of Indigenous peoples' 'Caring for Country' (Altman and Kerins 2012), and its monetary value to Indigenous socio-cultural values, capabilities and wellbeing that *country* supports. For example, Indigenous people in northern Australia have managed fire over millennia to support their livelihoods (Russell-Smith et al. 2009). Such fire management practices now afford carbon enterprise opportunities through national market-based greenhouse gas (GHG) emission abatement and sequestration policies. In addition, such practices also deliver a variety of socio-cultural benefits important for the wellbeing of local people (Dodson 1997; Grieves 2007 and 2009; Burgess et al. 2008; Russell-Smith et al. 2009; Altman et al. 2011; Sangha et al. 2011; NAILSMA 2012; Archer 2015; Russell-Smith and Whitehead 2015; Sangha et al. 2015a).

Currently, the Australian Government seeks to develop northern Australia by promoting agriculture (cropping and beef cattle), mining, infrastructure and non-renewable energy under its 'Northern Development' agenda (Australian Government 2014, 2015a). That agenda takes no account of Indigenous peoples' values for their *country*. Currently only four ES valuation studies consider northern Australian savannas: two on woodlands that are listed in the TEEB database (Curtis 2004;Blackwell 2006); one on the monetary value of aquatic resources affecting Indigenous people in the Daly River region

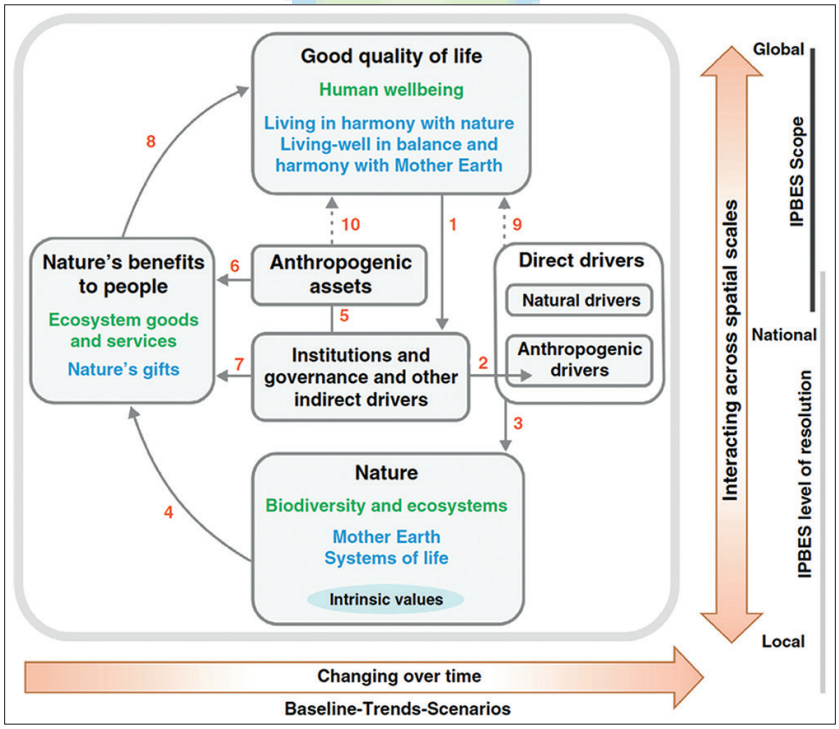

Figure 2

IPBES conceptual framework (Source: IPBES 2016 and Díaz et al. 2015). There are six main elements: Nature, Nature's benefits, Good quality of life, Anthropogenic assets, Direct drivers and Institutions and governance. The arrows denote the links between elements, along with temporal and spatial scales (side arrows)

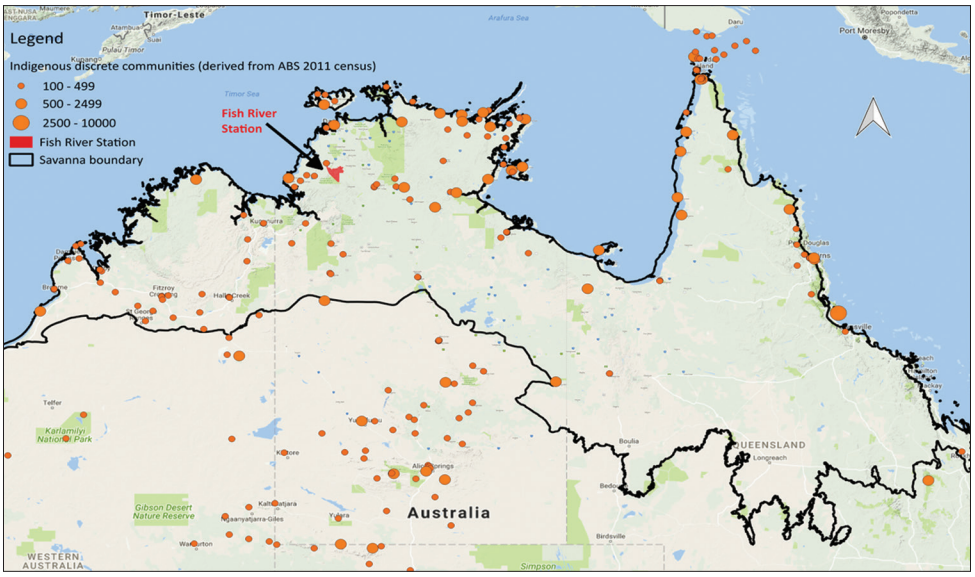

Figure 3
Location of FRS and distribution of Indigenous communities in Australian Tropical Savannas

(Jackson et al. 2014); and another on coastal and land systems in the Cape York region (Preece et al. 2016). Three of these studies (except Jackson et al. 2014) apply a global/market valuation approach, with no inclusion of the suite of benefits from Indigenous perspectives (Sangha et al. 2017). This study aims to redress this gap by illustrating how Indigenous capabilities can be utilized and valued to manage ecosystems that deliver services of national and global significance while offering many wellbeing benefits to local Indigenous communities.

This study proposes an Indigenous-specific ES valuation framework and assesses the value of ES from a specific Indigenous estate, Fish River Station (Figures 3 and 4), to address the following questions:

- How are ES typically valued from regional savannas?
- How do various ES contribute to Indigenous peoples' capabilities and wellbeing?
- What is an appropriate framework for recognising *country*-related Indigenous values for making policy decisions?
- What are the appropriate methods to measure the monetary values of those ES?

BACKGROUND

Our case study site, Fish River Station (FRS), is illustrative of Indigenous-owned or managed lands occupying more than 20% of Australia's northern savannah. This region is characterised by vegetation comprising scattered trees over under-storey grasses, mostly infertile soils, and markedly seasonal summer rainfall (October-April) with long-term mean annual rainfall of at least 600 mm per year (Figure 3). Over the past century, the major regional land use has comprised low intensity rangeland cattle production. Despite their extensive use for beef pastoralism, regional savannas are largely structurally intact and represent the largest relatively unmodified tract of savannas on earth (Woinarski et al. 2007).

Description of Fish River Station

The FRS is situated in the Northern Territory (NT), covering approximately180,000 ha and is representative of an average-sized property (around 120,000 ha) in the region (Figure 3). In 2010 the Australian Government, in partnership with conservation-based Non-Government Organisations, purchased FRS for its natural and cultural heritage values. The station is listed by Australia as meeting the criteria for recognition as an International Union for Conservation of Nature (IUCN) Category II Protected Area (Indigenous Land Corporation 2012). Previously, it was managed as an under-developed pastoral beef cattle enterprise. The current lease-holder, the Indigenous Land Corporation (ILC), has a statutory function to divest its interest in FRS to its Indigenous owners by 2017. The ILC and partners have been providing Indigenousemployment opportunities and building peoples' capacities to manage FRS.

The Indigenous traditional owners (TOs) of FRS – the Ngan'giwumirri (Labarganyin), Wagiman, Malak Malak and Kamu people - hold customary social, cultural and spiritual connections with the area. There are numerous named sacred, burial and other cultural sites including 22 'restricted works areas' (high importance Aboriginal areas) that are known, used and managed for their resources (ILC 2012; NAILSMA 2014).

Approximately 2000 Indigenous people residing in the Daly River catchment have direct or indirect cultural connections with the property. Among them, around 100 people regularly access FRS, mainly for cultural and ceremonial purposes. Most local Indigenous people reside in regional community centres such as the Daly River township. Legal recognition of theirIndigenous rights to land under Australian Government

legislation from the 1970s has helped foster re-connection with people's traditional estates. Regular visits to FRS enable local people to maintain their knowledge of the landscape, and other aspects of living on, and connecting with, '*country*'. These activities help people meet their cultural obligations and build capabilities, as discussed below.

Ecosystem services derived from Fish River Station

The region supports four main ecosystems (Figure 4) that deliver various ES (e.g. bush food and medicine, language, cultural practices, lores (customs and traditions), learning and training on *country*; Table 1). Most of these services offer socio-cultural and ecological benefits, which are largely non-marketable in the market system except for greenhouse gas (GHG) emission abatement and carbon (C) sequestration services.

Most importantly, ES from FRS offers not only benefits, but also enhances peoples' capabilities (Table 2) (Sangha et al. 2011; Archer 2015; Russell-Smith et al. 2013, 2015; Sangha and Russell-Smith 2015a). This includes enabling people to develop, maintain and pass on their knowledge and skills (Sangha et al. 2015b, 2017). We assess such values by applying a wellbeing approach.

METHODS

Value of Ecosystem Services

We develop an Indigenous-specific valuation framework that includes socio-cultural, capabilities-related and other wellbeing benefits for people '*being on country*' derived from available literature (Altman and Whitehead 2003; Grieves 2007; Sangha 2007; Russell-Smith et al. 2009, 2013; Altman et al. 2011; AIHW 2011; Sangha et al. 2011; Weir et al. 2011; ILC 2012-13, 2015; NAILSMA 2014; Whitehead et al. 2014; Archer 2015; Sangha et al. 2015b,c). This framework particularly integrates socio-economic, cultural and customary aspects of Indigenous living to address key linkages between *country* and wellbeing of Indigenous people for policy decision making. The main focus is on including Indigenous capabilities, which are essential for people to enjoy the benefits and services from their traditional lands, as explained in section 3.1.2.

For valuation purposes, we use FRS as a case study and categorize ES as marketable (tangible—C benefits) or non-marketable (intangible—biophysical, socio-cultural and capability benefits), respectively (Table 1). We assess these benefits by applying conventional Basic Value Transfer (BVT), and wellbeing approaches. The BVT method transfers values for a bundle of ES from selected studies to the one being studied. Wellbeing approaches include valuing socio-cultural and health benefits, and peoples' capabilities. Monetary values for any ES are expressed here in USD for the year 2015-2016 unless stated otherwise (the currency conversion rate 1 AUD= 0.78 USD, as on 10/08/2016, was used).

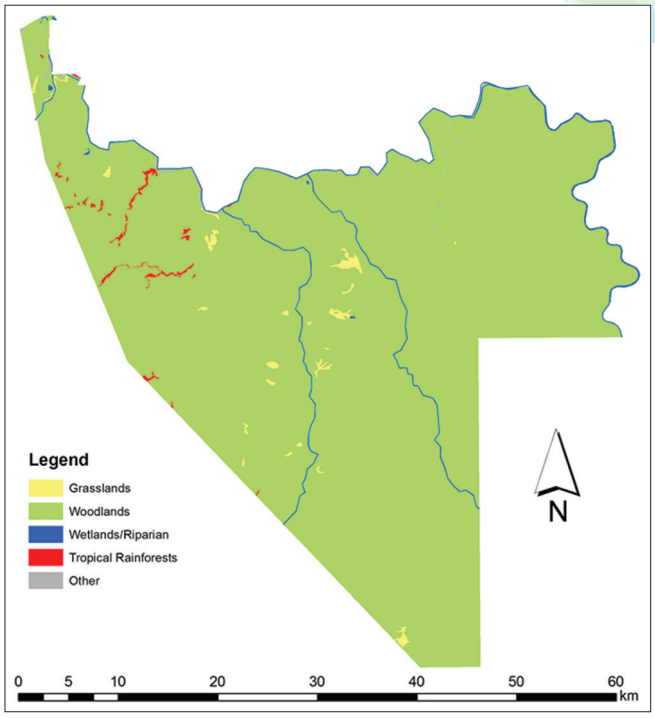

Figure 4
Main ecosystem types on Fish River Station (note: 'other' represents 150 ha of cleared land)

Non-marketable ES (mainly biophysical benefits)

The BVT approach was applied to value mainly biophysical benefits of ES using the two available regional Australian studies (Curtis 2004; Blackwell 2006) from the global TEEB valuation database (van der Ploeg and de Groot 2010) . Values were adjusted using average inflation rates from 2004-2015 (Table 3). The BVT method chiefly reflects the value of biophysical (i.e. provisioning and regulating) ES (van der Ploeg and de Groot 2010; ; TEEB 2010b; McVittie and Hussain 2013). A critique of its applicability for valuing regional Indigenous estates is given by Sangha et al. (2017). Overall, application of the BVT approach was found to have limited regional relevance, given both inadequate context-specific valuation of biophysical ES, and non-inclusion of wellbeing benefits in the source studies.

Non-marketable ES (mainly socio-cultural benefits and capabilities)

Given the important role of savanna ES for Indigenous peoples' wellbeing, we apply a Capability Approach proposed by Sen in the 1990s. Sen (1999) argued that 'development' is about enabling people to lead healthy and creative lives while providing them with an appropriate environment. In line with Sen's development paradigm, ES from FRS provides several socio-cultural benefits including opportunities to utilize and develop Indigenous capabilities and enhance wellbeing in several ways (see Table 2). For example, people collect bush food and medicine, which requires knowledge and skills for how, when and where to collect these resources, with improved health outcomes. Similarly, dance and art activities that originate from and relate to *country* enable people to lead more creative lives.

Table 1
ES from FRS and relevant valuation techniques applied in this study

Ecosystem services		Type of services	Valuation technique
Provisioning	Bush food and medicine	Non-Marketable	BVT for a bundle of services
	Water resources		
	Art and craft materials		
	Cultural sites		
	Ceremonial/camping sites		
	Teaching/story places		
Regulating	*Climate: CO_2-e emissions abatement and carbon sequestration**	*Marketable*	*C price*
	Hydrological balance	Non-marketable	BVT
	Soil stability		
	Coastal protection		
Cultural	Traditional knowledge	Non-Marketable	Wellbeing valuation
	Cultural practices and customs		
	Cultural lores and languages		
	Social connections: hunting, story telling, kinship, etc		
	Sacred sites/spiritual connections		

*Currently, CO_2-e emissions abatement is the only marketable service

Table 2
Importance of country in building capabilities of Indigenous people

ES derived from *country*/homeland	Materials/items	Capability
Climate regulation	'Cleansing the *country*' and other associated benefits for food etc	Traditional knowledge of fire management – providing economic opportunities
Food/medicine	Bush food and medicine	Knowledge of native plants and animals, what, where, how, and when to eat – ultimately contributing to good health
Language	Many words originate from knowing and being on '*country*' and are exclusive to a particular '*country*' (e.g. several language groups of a clan land)	Knowledge of a particular language and ability to pass on that knowledge contribute to the core of Indigenous cultures – enabling people to learn norms, practices and to lead creative and fulfilling lives
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 rituals/ceremonies in relation to *country* – enabling 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 – enabling people to learn and pass-on their rituals and culture

To assess the value of such complex socio-cultural benefits in monetary terms, we applied substitute values for current government welfare expenditure on four welfare-relevant services that are delivered by peoples' engagement with *country*: a safe and supportive environment, economic participation, healthy lives, and early childhood development. The Australian Government spends $36,119 per person per year (adjusted for the year 2015) on Indigenous people for these services; double the amount for non-Indigenous people (SCRGSP 2014). We applied 50% of that expenditure as a substitute to evaluate ES given that Indigenous per capita welfare expenditure is double that for non-Indigenous people, and assuming that *country* offers equivalent benefits for provisioning a safe environment and economic opportunities, and improvements in health and learning.

To estimate the value of ES derived from *country* benefits, we included the substitute value of associated welfare savings, plus associated employment opportunity costs for five full-time rangers (at the rate of $58,500 per person per year), and the travel expenses (including fuel, food and camping costs at the rate of $500 per person per year) to visit cultural sites. In 2014, 80 Indigenous people visited FRS for a week each from the neighbouring community at Daly River, and its catchment (details in Table 3). The employment benefit of $58,500 per person per year was derived as the average value of economic opportunity provided through the Australian Government's 'Working on Country' program (Social Ventures Australia (SVA) 2016). Thus, there is a total direct economic benefit of $292,500 per year for five rangers, which is a direct saving to government of welfare payments if rangers are employed.

To assess the role of *country* in peoples' capabilities, only two capabilities—to build pride and self-respect, and the ability to pass on knowledge to the next generation—are considered here. These were evaluated in a detailed Social Return on Investment Analysis report, prepared for the Australian Government (SVA 2016) for a neighbouring 1.4 M ha Indigenous savanna estate, in the Northern Territory. That report estimated the cost of building pride and sense of self

Table 3

BVT technique using TEEB database for regional ES values (i), and local wellbeing valuation approaches (ii), as applied in this study

i. Regional ES values using relevant Australian studies from TEEB database, and **ii. Local ES values for socio-cultural benefits**			
Ecosystem types	Blackwell (2006)	Curtis (2004)	i. TEEB-based ES value calculations
Woodlands (regional Australian studies in TEEB included rangelands)	BTV for a bundle of ES was AUD 417 ha^{-1} y^{-1}, calculated using values from Costanza et al. (1997) applying BVT method (ES values for rangelands were used for woodlands in our study)	NA	We applied adjusted values (using World Bank GDP deflation (inflation) rates and Purchasing Power Parity of AUD, to derive 2015 estimates) i.e., USD 469 ha^{-1} y^{-1} from values suggested by Blackwell (2006) for Australian rangelands
Grasslands	NA	NA	We derived grassland's adjusted values (i.e. USD 233 ha^{-1} y^{-1}) as 50% of the total rangeland ES values suggested by Blackwell (2006), using our best judgement and knowledge
Inland wetlands/riparian areas (included inland wetlands)	TEV for a bundle of ES was AUD 35,208 ha-1 y-1 (swamps/ floodplains), calculated using values from Costanza et al. (1997) applying BVT method	NA	We derived adjusted values i.e., USD 1088 ha^{-1} y^{-1}, as 50% of mean tropical rainforest values suggested by Blackwell (2006) and Curtis (2004), to derive conservative estimates
Tropical Rainforests (included wet tropical rainforests)	TEV for a bundle of ES was AUD 3608 ha^{-1} y^{-1}, calculated using values from Costanza et al. (1997) applying BVT method	Total value of ES from the rainforests of Wet Tropics World Heritage Area was AUD 210-236 ha^{-1} y^{-1}; calculated applying surrogate for the market value of land, multiple criteria analysis and expert opinion from a Delphi panel of experts	We applied adjusted mean ES values (i.e. 2177 ha^{-1} y^{-1}); suggested by Curtis (2004) and Blackwell (2006)
			ii. Local scale ES calculations for socio-cultural benefits
Country - Property scale value of socio-cultural benefits estimated from: i. Substitute values of welfare expenditure currently afforded by the Australian Government ii. *Country*-related peoples' capabilities and reduced domestic violence	Not included, except for the recreational/eco-tourism values that were considered in the original studies referred to by Costanza et al. (1997)	Not considered, except for the recreational and aesthetic values of the Wet Tropics World Heritage Area	Trading off additional welfare expenditure per Indigenous person (USD y^{-1}) compared that to a non-Indigenous person, on four domains of wellbeing: to provide safe and supportive environment, enhance economic participation, healthy lives and early childhood development (details in Methods section) Trading off travel expenses for 80 people to visit FRS (USD $person^{-1}$ y^{-1}) for management activities to maintain cultural values Saved costs of welfare payments by employing five rangers (USD y^{-1}) Replacement costs of Indigenous healing centres, a research professional and some saved costs of domestic violence

at $11,093 per person per year, using the replacement cost of attending Indigenous healing centres, and the ability to pass on knowledge using the cost of a research position at $29,048 per person per year. In addition, the value of *country* connections for other socio-cultural benefits in terms of reducing violence in the community was interpreted from the saved costs of domestic violence ($15,348 per person per year). We applied a 50% discount to those costs used by the SVA (2016), assuming, as applied also in that study, that *country*-related benefits contribute 50% for building confidence, passing on knowledge, and reducing violence for 80 people visiting FRS.

We acknowledge that our valuation estimates for wellbeing and capability benefits may provide only a fraction of the total value of various ES that people derive from being on and

using their *country*. To complement our valuations, and scope the contribution of ES for enhancing peoples' wellbeing and building capabilities, we outline those connections using the MA framework (MA 2005) (Table 4). Local literature (as mentioned earlier) was analysed to relate ES with peoples' capabilities.

Marketable/tangible services

Carbon (C), in the form of GHG emission abatement and sequestration, is currently marketed under Australia's climate change mitigation initiative, the Emissions Reduction Fund (ERF; http://www.environment.gov.au/climate-change/emissions-reduction-fund). Mitigation of CO_2 emissions through improved fire management delivers direct monetary benefits, either through contractual arrangements with the Australian Government or in voluntary markets. Additional market-based opportunities involving biosequestration of carbon in non-living (e.g. coarse woody debris) and living (tree) biomass pools are under advanced development (Russell-Smith et al. 2015). The ERF has led to a rapid development of a regional carbon economy, although it has only been in effect nationally since December 2012.

Scenario analyses

To envisage the implications of policy decisions and to inform the development of a sustainable vision for northern Australia, we applied two scenarios – Business As Usual (BAU) and an ES-based economy (ESE). The BAU scenario is applied to reveal the potential benefits and costs applying to pastoral land use prevailing over as much as 90% of north Australian savannas (NALaWT 2009). The ESE scenario is applied as an alternative option to current land use practices, and focuses on the rapidly emerging carbon economy in the region. These scenarios help illustrate the benefits of *country* and its services.

For each scenario, we estimated the main costs and benefits of 80 people regularly visiting FRS and trends in ecosystem and social benefits derived from main ecosystem functions.

i. Income: For the BAU scenario, we considered the annual income from a pastoral enterprise that was operational on FRS prior to its recent purchase. We estimated the foregone value of the pastoral beef enterprise for 4000 cattle available for sale at the time of purchase (ILC 2012, ILC 2012-13), using average long-term (2001-2012) gross margin values for regional pastoral businesses (McLean et al. 2014). These estimates were spread over three years to reflect the average turnover rate for beef cattle since usually one third of a herd is sold in a year (Bray et al. 2015). For the ESE scenario, income generated from GHG emission abatement and sequestration was considered
ii. Welfare expenditure (costs/savings): For the BAU scenario, welfare costs (derived from the Indigenous Expenditure Report by the SCRGSP (2014) of $36,119 (in 2015) per person per year were used for 80 people in the absence of culturally appropriate employment opportunities. For the ESE scenario, we assumed that 50% of those costs will be saved given that people will have culturally appropriate work opportunities (this is a conservative estimate which assumes there will be full/part-time opportunities in the region; Sangha et al. 2017). Employment saves government expenditure on welfare payments on the one hand and provides tax contributions on the other
iii. Fire, weed and pest management, repairs and maintenance costs: The actual on-ground management and maintenance costs were considered under the BAU scenario (for details see Sangha and Russell-Smith 2015a; Sangha et al. 2017). For the ESE scenario, 50% of total costs were considered assuming employment of rangers/TOs and that consistent management of *country* alleviates associated costs
iv. Job Training expenditure by the Remote Jobs and Community Program (RJCP, Australian Government 2015b): For the BAU scenario, these costs were derived using annual job training costs per person (averaged over 2013-2018) for remote Indigenous communities from allocated RJCP government expenditure. These costs were 50% discounted under the ESE scenario given that people can utilize their country-related management skills and so help reduce training requirements
v. Health expenditure: Under BAU, annual per capita costs for Indigenous peoples' health expenditure were applied as reported by SCRGSP (2014), and 50% discounted for the ESE scenario assuming that 'living on *country*' substantially contributes to health improvements (Burgess et al. 2009), and as applied by SVA (2016) and Sangha et al. (2017).

RESULTS

A valuation framework for Indigenous estates

Applying Indigenous peoples' perspectives concerning their values for *country* to FRS, we scope the ES contributions for enhancing peoples' capabilities and wellbeing using the MA (2005) framework through provisioning basic materials for life, enhancing good health, social relations, security of resources and affording freedom and choice for people (Table 4).

An understanding of these connections suggests that the importance of ES from Indigenous peoples' perspectives involves two key elements – people and their *country* – which are pivotal for developing an Indigenous-specific framework, as shown in Figure 5. There is a direct two-way relationship between people and their *country*; as often stated by Indigenous Australians, 'if *country* is healthy, people are healthy'. Peoples' capabilities, and cultural norms and ceremonies (rituals) are the dynamic, unique set of 'means' (drivers) through which a range of relationships are maintained between people and *country* in the form of socio-cultural and biophysical services or benefits. Peoples' knowledge and abilities to care for *country*, 'capabilities', are vital to obtain and maintain those services for their wellbeing. Cultural norms and ceremonies also enable people, in addition to supporting institutional governance systems, to help manage *country* (Figure 5).

Table 4

Main ES from FRS, related capabilities and their role in peoples' wellbeing applying MA framework

Ecosystem Services		**Capabilities**	**Wellbeing constituents**				
			Basic materials for life: food, water, air and shelter (incl. provision of timber and fibre)	**Good health: Provision of resources and services for good health**	**Social relations: Peoples' values linked to land, learning/ teaching techniques and listening stories from elders, and hunting**	**Security of resources: Availability of natural resources for the present and future generations, and opportunities for resource use**	**Freedom and choice: Freedom to access and use land/ natural resources**
Provisioning	Bush food and medicine	Knowledge of time and place of availability, and related limitations/rules for using a resource/site; Knowledge of ceremonies and ability to pass-on that knowledge; Ability to process, manage and use a resource/ material/site, etc	X*	X	X	X#	X#
	Water resources		X	X	X	X#	X#
	Art and craft materials				X	X#	X#
	Cultural sites			X	X	X#	X#
	Ceremonial/ camping sites				X	X#	X#
	Teaching/story places				X	X#	X#
Regulating	Climate		X	X			
	Hydrological balance		X	X			
	Soil stability		X				
	Coastal protection		X	X			
Cultural	Traditional knowledge	Traditional knowledge of the landscape, including when, where and how to value/apply certain specific sites/resources/practices; Ability to teach, develop and pass-on cultural practices, lores, languages; knowledge of kinship relations, hunting practices, totems, sacred and spiritual sites; ability to socialize, to practise community norms and regulations, and to pass on this knowledge; ability to manage land and water resources, and to pass-on related knowledge, etc		?	X	X#	X#
	Cultural practices and customs			?	X	X#	X#
	Cultural lores and languages			?	X	X#	X#
	Social connections: hunting, kinship, etc			?	X	X#	X#
	Sacred sites/ spiritual connections			?	X	X#	X#
Supporting services		Nutrient cycling, soil formation, primary production etc. underpin various provisional, regulating and cultural services					

* X denotes link between ES and the constituent of Indigenous wellbeing ? - unsure about a relationship # - depends upon rights to access land (in case of FRS, TOs have rights to access their land)

This framework illustrates how peoples' wellbeing, which includes appropriate work opportunities (such as fire management for carbon benefits), education ('learning on *country*'), access to bush food and medicine, security of resources, capacity and freedom to learn cultural practices and ceremonies, are linked to *country* (Figure 5). This concept is further applied here to assess ES from FRS in the following sections targeting:

i. Biophysical benefits
ii. Peoples' socio-cultural values
iii. Peoples' capabilities

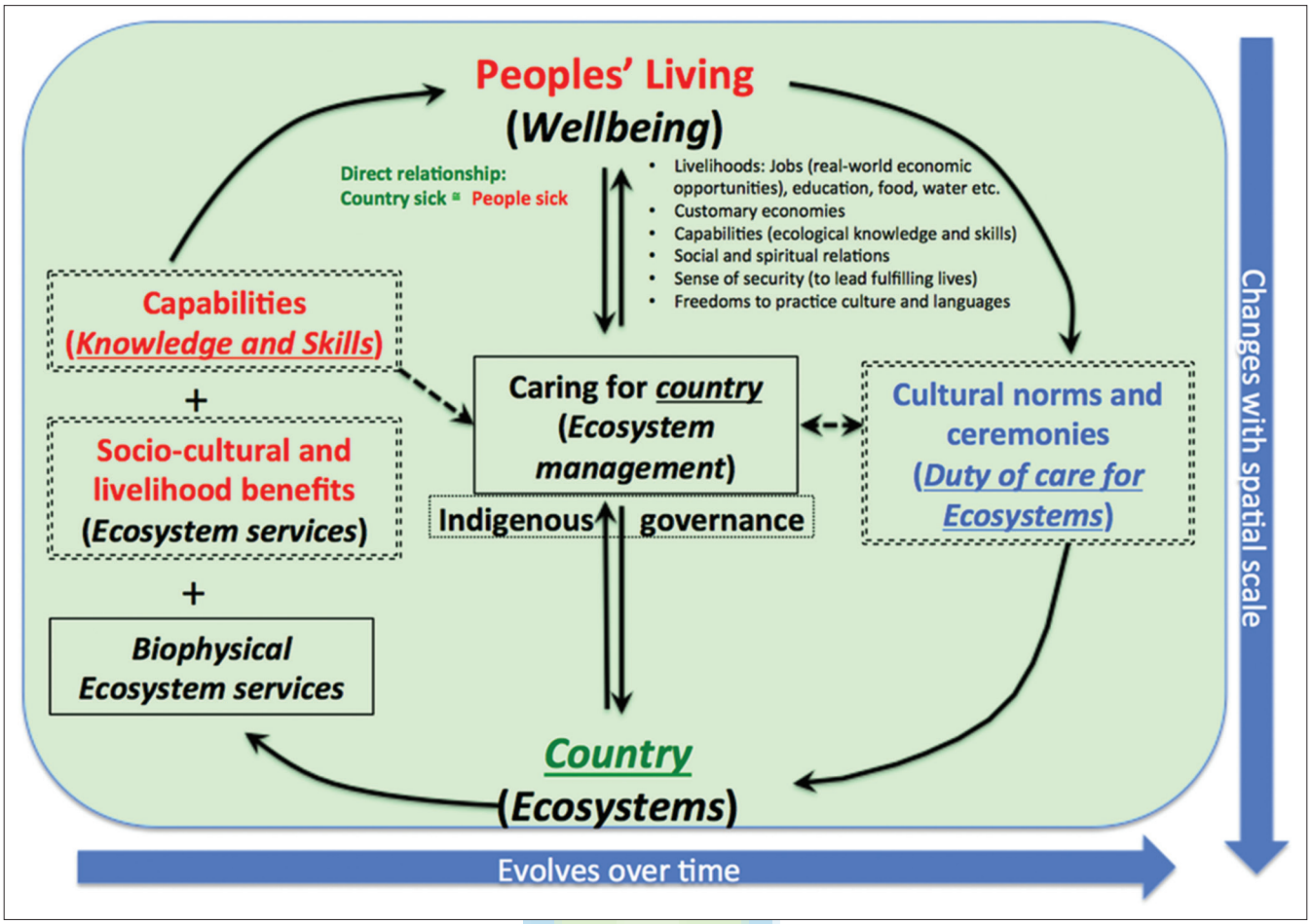

Figure 5

An Indigenous framework for valuing benefits (ES) from country. The green box denotes country of which people and their living are an integral part (thus, red and green text not enclosed in a box). In each text box, the normal font indicates Indigenous, and the italicized equivalent western, perspectives (except for country). The arrows denote the influence (benefits/knowledges) between the two systems. Red and blue text boxes indicate the key aspects lacking valuation in the current economic framework. The blue arrows at the base and on the side reflect changes in peoples-country associations over temporal and spatial scales

Value assessment of ES

Valuations of non-marketable, mainly biophysical ES from FRS at the ecosystem-scale, were estimated as $84.4 million per year using the BVT method derived from two pertinent Australian regional-scale studies (Table 5). Valuation of socio-cultural ES at the property-scale, derived from substitute values of welfare costs, employment benefits, and lost employment opportunity benefits, was estimated as $1.77 million per year (Table 5). Additionally, the substitute value of benefits for gained capabilities and reduced domestic violence was $2.21 million per year. Combined, wellbeing and capability benefits were valued at $4 million per year.

The potential marketable benefits derived from the sale of carbon credits through GHG emissions abatement and biosequestration activities were valued at $437,000 y^{-1} (Table 5). The total value of marketable carbon and non-marketable socio-cultural benefits, including opportunities to apply capabilities, was $4.434 million per year, equating to $25 per hectare per year. These estimates illustrate the importance of ES for directly supporting Indigenous wellbeing (Table 5).

Scenario analyses

At FRS, the BAU scenario costs approximately $4.1 million per year, in addition to loss of both ecological amenities (including landscape functions, biodiversity, etc.) and socio-economic benefits (Table 6). Since the FRS purchase in 2012, the property has been in transition towards an ES-based economy that has yet to realize its full potential for ensuring a suite of socio-cultural and ecological benefits. This change can deliver benefits, estimated here as worth $5.56 million per year under the ESE scenario, through saving of costs to government expenditure, as well as delivering multiple benefits to the community (Table 6). Moreover, the ESE scenario results in improved landscape functions, cultural values and practices, and empowers communities while contributing to reducing the costs of domestic violence and other associated social and health issues (Hunt 2010; SVA 2016). In contrast, over time,

Table 5
Value of non-marketable and marketable ES of FRS

Area (ha)	Unit value (USD ha^{-1} y^{-1})	Total Value (USD y^{-1})	Ecosystems-based values
Non-marketable ES:			
1. Applying BVT using regional-relevant values from TEEB database (de Groot et al. 2012)			
Woodlands	175,600	469	82,356,400
Grasslands	1,260	233	293,580
Inland wetlands/riparian areas	290	1088	315,520
Tropical rainforests	700	2177	1,523,900
Disturbed/clear land	150	0	0
Total value			$84,489,400
Property/Country' - scale values			
2. Applying tradeoff of Indigenous welfare expenditure, capability costs and domestic violence expenditure to assess the socio-cultural values of Indigenous estate for 80 people:			$1,688,108
Wellbeing benefits from *country*			1,355,608
50% tradeoff of Government expenditure for provision of cultural and social ES from FRS that can save expenditure on welfare services (safe and supportive environment, economic participation, healthy lives and early childhood development) for 80 people who regularly visit FRS			40,000
Travel expenses			292,500
Saved costs of welfare payments for employing five rangers			$1,605,677
Capability benefits			$ 613,954
Other socio-cultural benefits for reduced domestic violence			$3,907,739
Total benefits			
Marketable ES:			
C credits (mitigation and sequestration)	180,000	$437,383	

such functions/benefits are expected to decline under the BAU scenario while the management costs will increase based on a detailed literature review of several regional studies (Sangha and Russell-Smith 2015b). The ESE scenario clearly suggests that a holistic vision afforded through ES-based opportunities can deliver multiple environmental, socio-economic and cultural benefits (Table 6).

DISCUSSION

This study proposes an integrated, Indigenous people-specific ES valuation framework (Figure 5), and applies the same to highlight the monetary value of ES derived from an Indigenously owned, 'typical' tropical savanna estate in northern Australia. Our framework incorporates key aspects of Indigenous peoples' associations with natural systems – people and *country* (not in isolated compartments) – which complement socio-cultural benefits, capabilities, and cultural norms and regulations. The framework highlights how Indigenous peoples' *country*-related capabilities and cultural norms are essential for peoples' wellbeing and managing (looking after) *country*. These capabilities and values are typically ignored in conventional ES frameworks and economic assessments (Sangha et al. 2017).

Applying the proposed framework, this study highlights the monetary value of ES for peoples' wellbeing in terms of socio-cultural and biophysical benefits, along with a capability dimension. Valuation of socio-cultural and capability benefits was estimated as $4 million per year, based on utilisation of FRS by 80 Indigenous Australians. This valuation would be much greater should the benefits be considered over a longer period and for all potential beneficiaries, i.e. around 2000 people residing in neighbouring Indigenous communities.

While this monetary valuation is relatively small when considered against an ES assessment of mainly biophysical ES benefits using a conventional BVT approach, we acknowledge that there are considerable challenges remaining in developing and appropriately monetising both regionally relevant biophysical ES valuations (TEEB 2010b; Sangha et al. 2017), as well as evaluating more extensive socio-cultural benefits for policy decision making (TEEB 2010b; Chan et al. 2012; Sangha et al. 2017). Nonetheless, the broader benefits achieved by inclusion of socio-cultural perspectives are amply illustrated by the ES comparison of pastoral land use (BAU) with more sustainable biodiversity and cultural (ESE) land use practices (Table 6). The study illustrates that integration of Indigenous peoples' capabilities as part of ES valuation processes can provide valuable insights for better informing local, regional, and potentially, global development policy perspectives.

From a wellbeing perspective, the Australian Bureau of Statistics (ABS 2001) reports Indigenous and non-Indigenous people's wellbeing using a common set of socio-economic attributes (economic resources, work, education and training, health, housing, family and community, crime and justice and, culture and leisure). Although the ABS (2010) has developed an Indigenous-specific framework, it fails to recognize the

Table 6

Comparison of economic, socio-cultural and ecological gains/losses under 'typical' savanna pastoral land use – BAU and ES-based economy – ESE, scenarios

Benefits/costs	BAU (USD y^{-1}): Pastoral land use for beef cattle	ESE (USD y^{-1}): Customary land use
Economic benefits		
Income (USD y^{-1})	104,921 (using long-term regional gross margin)	437,383 (C income from abatement and sequestration)[6]
Potential Government expenditure on welfare support for 80 people[1]	-2,711,218	-1,807,478
Fire, weed and pest management, repairs and maintenance costs[2]	-751,000	-375,500
Job Training expenditure (although fails to offer appropriate work opportunities)[3]	-141,377	-70,688
Health expenditure4	-562,099	-281,050
Total estimated expenditure	-4,165,694	-2,534,716
Saved welfare payments (50% of total costs)[1,5]	-	1,807,478
Saved costs for reducing the risk of weed and pest spread (50%)[5]	-	292,890
Saved costs of job training (50% of the RJCP job training costs only)[5]	-	70,688
Saved costs of health expenditure (50%)[4,5]	-	281,050
Total value	-4,060,773	+ 2,972,099
Ecological benefits/costs[7]		
Landscape functions/processes	↓Grazing cattle at unsustainable rates degrades land causing soil erosion, sediment flow and loss of soil functions	↑Improvements in land functions with implementation of sustainable management practices
Biodiversity	Loss due to spread of weeds and pests, over-stocking↓	↑Improvement in biodiversity with sustainable management practices
Water and climate regulation	↓Disturbed and polluted water resources, and greater GHG emissions from cattle grazing	↓Improvements in water resources and reduction in GHG emissions due to sustainable management
Social benefits/costs		
Domestic violence	↑Increases, due to lack of self identity/self sense and recognition, that further leads to social problems↓	Reduces, for increased sense of identity, culture, respect and recognition↑
Revival of cultural practices	Limited opportunities	Significant improvements are expected
Community empowerment	↓Little chances for the Indigenous community to be able to lead their lives in their own ways	↑Enhanced capabilities, economic opportunities and cultural recognition, helping people to lead the lives they want

Data sources: [1]SCRGSP (2014): costs as estimated from average Indigenous welfare expenditure under the BAU scenario, and only 50% of those costs under the ESE scenario. [2]On-ground expenditure on FRS, annual average for the last 5 years (Sangha and Russell-Smith 2015a) under the BAU scenario, and 50% of those costs under the ESE scenario. [3]Remote Jobs and Communities Program (Australian Government 2015b): using annual expenditure per person specifically on remote Indigenous communities under the BAU scenario, and 50% of those costs under the ESE scenario. [4]SCRGSP (2014): total costs of health expenditure under the BAU scenario, and 50% costs under the ESE scenario. [5]Saving the costs of weed and pest expenditure/job training/health and welfare payments: a conservative estimate of saving only 50% of the estimated BAU costs is applied. It is important to note that these costs will reduce over time. [6]C income was estimated using C price AUD 13.95/t for emissions abatement and sequestration (Government auction in April 2015); mean annual GHG emissions were estimated applying well recognised Savanna Fire Management Methodology (refer Russell-Smith et al. 2013), and C sequestration i.e. achievable sequestration in non-living and in living tree biomass using methodologies suggested by Russell-Smith et al. 2015 (which are well under way for implementation by the end of 2016). [7]Based on savanna regional studies (Aubault et al. 2015; Crowley 2015; Eady et al. 2016; Hunt et al. 2014; Kutt and Woinarski 2007; Rolfe et al. 2016; Russell-Smith et al. 2009, 2013, 2015; State of the Environment Committee 2011; Woinarski et al. 2000, 2007). [8]Based on Altman et al. (2011), Dodson (1997), Grieves (2007), Hunt (2010,) NAILSMA (2012), Russell-Smith et al. (2013), and SVA (2016)

role of *country* in supporting peoples' capabilities, wellbeing and local or regional economies (Sangha et al. 2015a; 2017).

Consideration of these relationships is also not apparent in well-known frameworks such as the MA (MA 2003, 2005), IPBES (IPBES 2016) or the recent Nature's Contributions to People (NCP, by Pascual et al. 2017; based on the IPBES approach), which are developed using western knowledge system approaches. For example, the IPBES framework (Figure 2), which updates the MA framework, primarily focuses on the benefits people derive from their natural systems with a main aim of influencing policies. It does not consider or relate people's abilities to achieve outcomes (knowledge and skills) in association with their natural environment. Similarly, the NCP framework, in an attempt to clarify valuations, adds several layers of economic, ecological, social and cultural/ Indigenous valuations, without addressing/valuing people's capabilities in relation to managing their natural systems. Many social, cultural and other values are essentially economic,

if 'economics' meaning 'management of the household' is correctly applied.

Although the MA (2003, 2005) recommends studying links between ES and human wellbeing to assist decision making, most local, regional and global studies report on the status and trends of ES, with little focus on human wellbeing and none on human capabilities (Maes et al. 2013, 2014; Science for Environment Policy 2015; reports on Asia-Pacific, Africa and South America by Sub-Global Assessment Network listed in the IPBES catalogue (SGAN 2016; IPBES 2016)). We acknowledge that although the ES concept includes the component of human benefits, it does not fulfil the purpose of informing policy-decision-making (ICSU-UNESCO-UNU 2008). There has been little progress on how to explicitly integrate ecosystems with people's wellbeing (Egoh et al. 2007; Díaz et al. 2015; ICSU-UNESCO-UNU 2008; SGAN 2016) – a main motivation for establishing IPBES in 2012.

The lack of consideration for people's capabilities in the IPBES/MA frameworks and in related studies (IPBES 2016) reflects a basic difference between western and local/traditional knowledge approaches applied to understand people's connections with natural systems. People in western societies typically achieve their capabilities in formal training and learning settings; e.g. schools, universities or other technical centres. In contrast, more traditional societies, including many Indigenous communities in northern Australia, gain many capabilities by learning from elders and *being on country*. However, our current economic and ES frameworks fail to recognize the value of those *country*-related skills and knowledges, amongst many other values (Sen 1993). There is a real need to consider people's capabilities in addition to more direct measures of wellbeing benefits when evaluating ES delivered from local/Indigenous estates.

Designing a common ES framework applicable to local or Indigenous communities across the globe (such as currently underway for IPBES assessments), may not be appropriate given inherent variability in local value systems. Instead, efforts may be more constructively focused on developing region-specific frameworks in active participation with the local/Indigenous communities, to effectively communicate people's values of their cultural-natural systems and for informing development policies.

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