



Culturally appropriate nature-based solutions policy settings supporting Indigenous Peoples in Australia—International lessons and applications

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ARTICLE INFO

Keywords:

Payment for ecosystem services
Nature-based Solutions
Indigenous Peoples and Local Communities
Incentivising mechanisms
Common assets trust
Biodiversity

ABSTRACT

Nature-based Solutions (NbS) are fast emerging as action-based approaches to address climate change, biodiversity decline, land degradation, conservation and socio-economic issues. Among a wide range of NbS approaches, Payment for Ecosystem Services (PES) is one of the famous and tried approaches that have been developed and implemented in several countries to date, offering lessons to be learnt for developing innovative NbS-PES 'systems' which are beyond the typical market approach and related policy settings, particularly to benefit Indigenous perspectives. To develop such Indigenous-specific PES or more appropriately incentivising schemes for Indigenous Peoples and Local Communities (IPLCs), we analyse and draw lessons from three famous PES schemes from Costa Rica, Mexico, and the Biodiversity Conservation Trust (BCT) from New South Wales (NSW), Australia. We examine their operational policy infrastructure and mechanisms for governing, monitoring, and payments/incentives for Ecosystem Services (ES). One common feature of the selected schemes is the pivotal role of national (Costa Rica and Mexico) and state (NSW) governments in developing specific legislation and regulatory guidelines to mediate these programmes, establish a national/state fund and authority to monitor the contracted conservation sites—offering a standardised and credible arrangement for ES providers and beneficiaries while reducing transactional costs for all parties. Other key learnings include applying a simple, input-based approach and paying land managers on a per-hectare basis for ES as a bundle, using simple indicators such as the state of the forest/ecosystem as a proxy for ES—offering insights for developing nature-based markets for Indigenous peoples in Australia and IPLCs globally. While planning Indigenous-specific schemes, we emphasise that it is critical to consider sociocultural and economic settings in which locals operate to develop equitable and sustainable mechanisms, given that many IPLCs' value systems are societal and their relationships with nature often lie outside the typical market regimes. Applying IPLCs' perspectives, we explore a Common Assets Trust model at a state/national scale as an alternative to the market approaches that can afford a common platform for stakeholders to exchange, govern, and monitor ES while also promoting the development of equitable, sustainable, and culturally appropriate incentivizing mechanisms involving low transactional and monitoring costs for IPLCs globally.

1. Introduction

Nature-based Solutions (NbS) are fast emerging as action-based approaches to address the modern climate change, biodiversity decline, land degradation, and conservation crisis among private and public sectors including state governments, corporations, conservation organizations, and others. For the transformation from traditional to

sustainable approaches for development, after much over-exploitation and degradation of nature, the need for NbS is highlighted by several international organisations including the United Nations Intergovernmental Panel on Climate Change (IPCC)[1], the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)[2,3], World Economic Forum[4], and by eminent scientists and scholars across the globe. In addition, the recent Finance for Nature report by the United

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<https://doi.org/10.1016/j.nbsj.2025.100258>

Received 11 April 2025; Received in revised form 4 July 2025; Accepted 10 July 2025

Available online 11 July 2025

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Nations Environment Programme (UNEP)[5] suggests that a US\$542 billion investment in NbS is required by 2030 to address the current natural crisis, which is nearly triple that of the present investment of US \$200 billion per year. NbS offer diverse, sustainable, and unique opportunities, with multiple environmental and socio-economic outcomes, that are critical for sustainable economic development—often a focus for State governments.

The International Union for Conservation of Nature (IUCN) defines NbS as the actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits[6]. NbS are currently underfunded and underutilized but offer a great means for investing in and managing both natural and social capital. NbS offer, in many places, both environmental and social benefits. In 2021, both the IPCC and IPBES agreed on the NbS approach to address the climate change and biodiversity crisis[7], and that NbS link with the Kunming-Montreal Global Biodiversity Framework (GBF) from the Convention on Biological Diversity (CBD) to protect biodiversity and nature by conserving 30 % of land and 30 % of water (inland, coastal and marine areas) by 2030 (30 × 30 target by the GBF during COP 15 [<https://www.cbd.int/article/cop15-final-text-kunming-montreal-gbf-221222>]).

NbS involve a range of approaches—from restoration and protection of ecosystems to land and water resource management, disaster risk reduction, and green infrastructure—to address societal and environmental problems[6,8]. NbS are based on the notion that when ecosystems are healthy and well-managed, they provide essential benefits and services to people[8,9]. To support NbS activities, Payment for Ecosystem Services schemes (PES)—typically perceived as a pathway to exchange resources among natural resource users (beneficiaries) and managers (providers)—offer rational solutions to address biodiversity and climate crises as well as socio-economic issues concerning many Indigenous Peoples and Local Communities (IPLCs), if developed and implemented appropriately[10–15].

From the IPLCs' perspective, NbS and specifically PES, or what we more appropriately call Incentivising Indigenous Natural Resource Management (or Caring for *Country* from an Australian perspective), can contribute to supporting people's well-being and conservation efforts for astutely managing their lands, seas and coastal areas. Currently, IPLCs manage and/or own almost 32 % of the total global land area through customary and community-based tenure arrangements[17,18]. Recognition is growing that IPLCs' managed lands/resources are typically managed sustainably[2,3,19,20]. However, in terms of experiencing ecological and humanitarian crises, the IPLCs are at the forefront and bear the brunt of climate change impacts, including floods, droughts, and wildfires, among others [17,21]. NbS can offer potential solutions to tackle these issues by supporting IPLCs in their efforts to restore, repair, and sustainably manage their lands and other resources to offset environmental impacts, and conserve nature while also enhancing their well-being. Concerning the UN Sustainable Development Goals (SDGs) [22], NbS can help address at least nine SDGs: 1- no poverty; 2- zero hunger; 3- good health and well-being; 6- clean water; 8- decent work and economic growth; 10- reduced inequalities; 13- climate action; 14- life below water; and 15- life on land.

In this paper, we analyse and present well-established international models of PES schemes and propose key principles for co-designing NbS-PES approaches holistically beyond the market mechanisms to support the development of transparent, credible, and sustainable 'PES systems' with low transactional costs while addressing the principles of equity, ecosystem integrity and societal well-being. In doing so, we follow a broader definition of PES than just a market mechanism, as typically perceived, involving monetary transactions between ES sellers and buyers[13,15]. Following Muradian et al. [16], PES is a mechanism to help transfer resources between social actors, with the aim of creating incentives to align individual and/or collective land use decisions with social interests in the management of natural resources. Advancing that,

we postulate PES as a 'system' for delivering effective NbS, beyond the market mechanisms, to address global environmental crises as well as socio-economic issues (following Costanza et al. [13]), while co-designing with locals, concerned actors, and encompassing their diverse values, needs and aspirations (for details see Sangha et al. [15]).

In Australia, to capture these emerging NbS opportunities, the momentum has been growing fast in recent years. The success of the existing Carbon Farming Act (2011) in initiating a carbon market in the country also confers to exploring the potential of nature-based economies for wider benefits. As a result, a Nature Repair Bill was passed by the Australian Government in December 2023 to create a national framework for establishing a voluntary national biodiversity market [23]. Under this bill, the proponents will register their biodiversity projects with a Regulator which will be responsible for the approval of the project under a given methodology. This work is being managed by the Department of Climate Change, Environment and Water (DCCEW) and various methodologies are expected to be ready for the market as early as the end of 2025. It is important to note that Indigenous perspectives on managing their lands differ significantly from mainstream land managers[24–26]; thus, a deeper understanding and integration of Indigenous perspectives into these emerging economic frameworks is essential.

To inform the imminent Nature Repair Market in Australia and elsewhere, particularly from an Indigenous context, this paper is timely for analysing selected, well-known, existing global and Australian nature-based policy frameworks, assessing their suitability from IPLC perspectives, and recommending key principles for designing Indigenous-specific PES systems. It builds upon our earlier work^{15,67} which describes and analyses various PES mechanisms operating globally and nationally in Australia. Selecting key successful examples from that research involving PES in Costa Rica, Mexico and the Biodiversity Conservation Trust (BCT) in Australia, we delve deeper into key policy design features of the selected models. This paper first describes the Australian context for nature-based markets, especially the carbon market and associated Savanna Fire Management Methodology, which has proven successful for Indigenous land managers across northern Australia. The next section describes selected case studies of PES schemes from Costa Rica, Mexico and Australia, and underlines key lessons drawn from each. The last section discusses how current PES schemes can inform the development of future Indigenous PES systems/incentivising schemes and related policy settings, including the application of an innovative Common Assets Trust model.

2. Background — Australian context

In Australia, since 2000 several PES-like schemes have been implemented mainly by the government, with >90 % funding from public sources[15]. These schemes include private land conservation for protecting threatened species and habitats through Conservation Agreements, Water Buyback in the Murray-Darling Basin, Reef Credits, and Carbon Farming. In particular, the Carbon Farming Initiative (under the Carbon Farming Act 2011) through the Emissions Reduction Fund (with initial funds of AU\$2.5 billion in 2012 and an additional AU\$2 billion in 2019) has been popular involving >35 approved methods such as savanna fire management, landfill, and land-based activities[27–32].

Among the 35 Carbon Farming methods, the Savanna Fire Management (SFM) method has been particularly successful for Indigenous land managers in northern Australia, where they manage over 34 projects covering >24 million ha, and abate 1.2 million tons of greenhouse gas (GHG) emissions per year[29,30,32–34]. This method has a long history of development where researchers and Indigenous land managers and elders worked together to manage wildfires which leads to reduced GHG emissions[29,30]. Due to the on-ground involvement of Indigenous land managers from the beginning in incorporating Indigenous aspirations and cultural responsibilities towards land, this method has proven a great success to date. It also delivers socio-economic and cultural

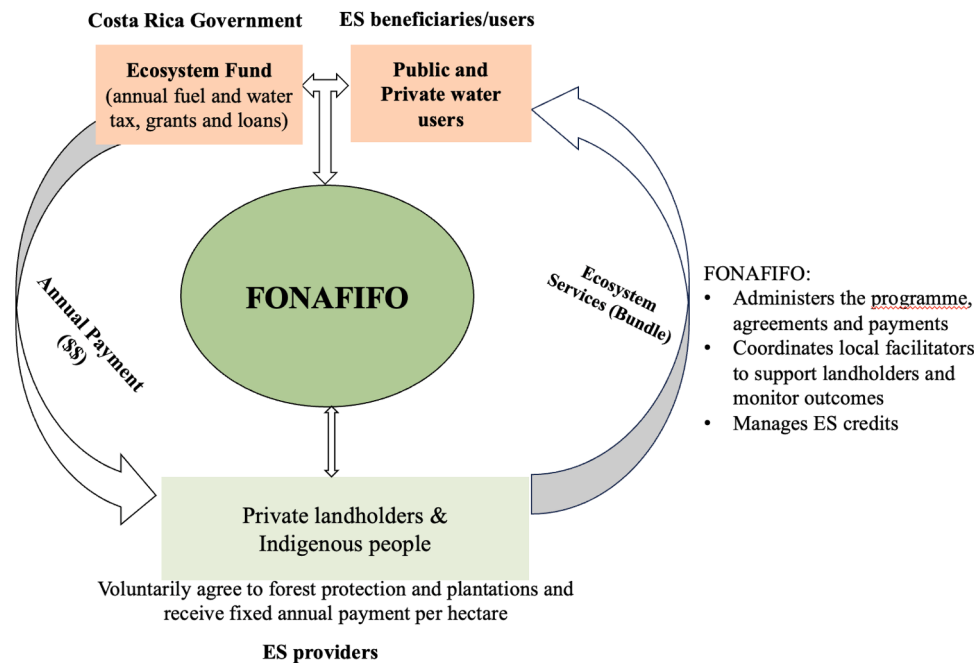


Fig. 1. Costa Rica's PES model.

benefits for local people and other ES to the public across northern Australia[35], while supporting a regional economy of >AU\$59 million per year (conservative estimate) in the north[36]. The SFM process offers several lessons that can help design the upcoming Nature Repair framework, as discussed later in this paper.

There is a clear need to expand the current carbon economy to a broader ecosystem services (ES) economy for including biodiversity, land and water management, weed and pest management, etc., to meet Australia's commitment to the Global Biodiversity Framework for protecting 30 % of the land, freshwater and oceans by 2030 (<https://www.dceew.gov.au/environment/biodiversity/international/un-convention-biological-diversity/global-biodiversity-framework>). These nature-based opportunities will help realize such targets. The recent Nature Repair Market Bill[23] offers the policy infrastructure to support such markets, with an expectation that the private market will contribute its share for investment in NbS. Currently, only <10 % of conservation projects in Australia are privately funded[15], whereas the total required amount to restore nature is estimated at AU\$2 billion per annum[37]. To attract more private investment, the Bill aims to create an independent, transparent, and regulatory market framework allowing landholders (private individuals, Indigenous peoples, conservation groups, farmers) to trade/exchange biodiversity credits to interested businesses, organisations, governments and individuals in voluntary markets.

From Indigenous perspectives, the Bill and related Nature Repair market framework affords economic opportunities to protect biodiversity, and manage weeds and pests, on Indigenous clan lands (often called 'Country'). Where they have access to their traditional lands, many Indigenous groups in northern Australia have developed their own Healthy Country Plans (HCP) to guide the management of Country (for example, the HCP by Aboriginal Organizations ASRAC[38] and MIMAL[39]). The Nature-Repair or NbS investment should enable Indigenous land managers to holistically look after their clan lands, in line with their cultural aspirations and responsibilities[40].

To establish a successful Nature Repair market/NbS scheme, existing PES models can inform on what kind of mechanisms exist, how the overall scheme works i.e. operational policy arrangements, what kind of administrative organizations/structures are required to effectively administer programmes, and possible challenges involved. We

anticipate that the knowledge of PES schemes in Costa Rica, Mexico and Australia (based on our PES review[15]) can offer useful insights to develop an effective, transparent and robust system for future nature-based economic opportunities in Australia.

3. Examples of selected PES schemes from Costa Rica, Mexico and Australia

We analyse three PES case studies from Costa Rica, Mexico, and the Biodiversity Conservation Trust (BCT) in NSW, Australia, to understand overall operational policy and administrative arrangements, and learn key lessons to inform the development of emerging incentivizing schemes in Australia and elsewhere. Details as below.

3.1. PES scheme in Costa Rica

Costa Rica had one of the highest deforestation rates on the planet during the second half of the last century due to agriculture and cattle ranching, mainly for export commodities. By 1983, the country's forest cover had fallen to just 26 %, severely impacting biodiversity, water resources, and the livelihoods of rural communities[41]. To halt and reverse a further loss of Costa Rica's green natural capital, in 1996, the country updated its Forest Law, which among other key improvements, such as banning land use change, established a nationwide PES programme called "Programa de Pago por Servicios Ambientales (PPSA)". This programme targets a variety of ecosystems, including tropical rainforests, cloud forests, and dry forests. Stakeholders include private landowners, indigenous groups, environmental NGOs, and international donors.

Costa Rica's PES programme compensates landowners who conserve forest ecosystems or reforest degraded land. Payments are designed to reflect the cost of supplying ecosystem services, incentivising sustainable land management. The programme covers four key ecosystem services: (1) greenhouse gases mitigation (i.e., carbon fixation, reduction, sequestration, storage and absorption); (2) water provision for urban, rural or hydroelectrical use; (3) biodiversity protection for its conservation and sustainable use, scientific and pharmaceutical use, research and genetic improvement, ecosystem protection and life forms; and (4) natural scenic beauty for tourist and scientific purposes.

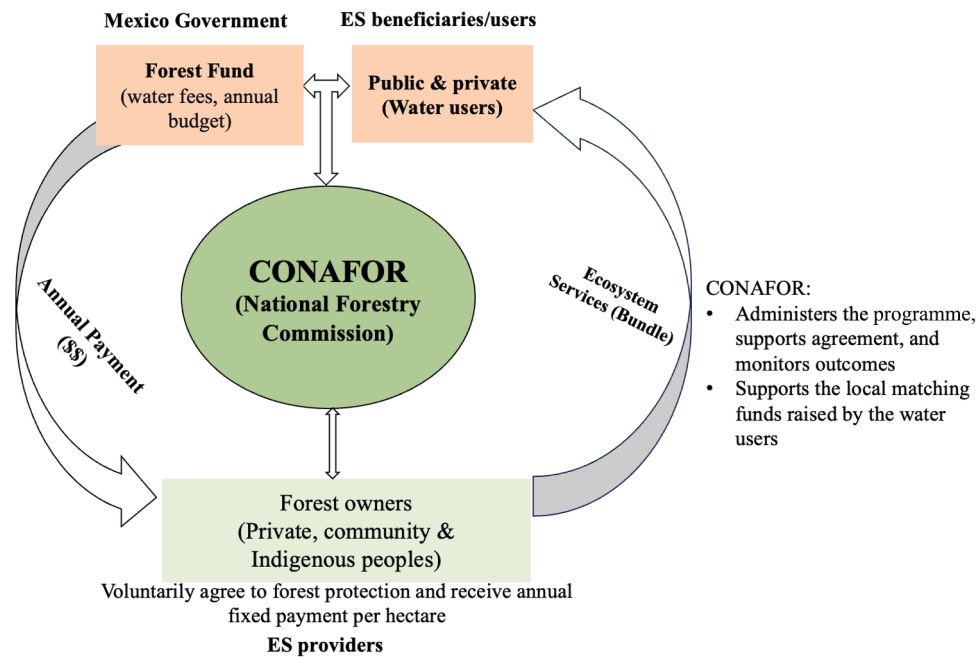


Fig. 2. Mexico's PES model.

The Forest Law also created the National Fund for Forest Finance (FONAFIFO) to manage the PES programme. FONAFIFO works as an intermediary between the beneficiaries and private landowners. Landowners submit applications detailing the area they wish to conserve or reforest, and FONAFIFO evaluates eligibility based on environmental priorities, such as proximity to protected areas or watersheds, among others. Contracts typically last five years, during which participants must adhere to conservation commitments, such as refraining from logging or farming. To some extent, forest landowners transfer their ES rights to FONAFIFO for ES credits for carbon sequestration, biodiversity, watershed services, and landscape beauty, with all four ES treated as a bundle (Fig. 1).

The PES programme is financed through a combination of innovative and diverse funding sources, including (1) a fossil fuel tax that allocates 3.5 % of revenues to the scheme; (2) 25 % of the revenues collected from a water fee that every person or institution with a water concession must pay; (3) funds from other services related to ES, such as the sale of carbon credits that are produced through forest plantations under the PES scheme to people and organizations that seek to offset their carbon footprint; (4) a 3 % tax on wood /timber in logs, of which 40 % of this tax is administered by FONAFIFO; and (5) international donors such as The World Bank, the Global Environment Facility (GEF), and bilateral agreements have also provided financial support. In the period between 2015–2019, the fuel tax contributed to 88 % of the total income of FONAFIFO, the water fee 9 % and the wood tax 1 %. The remaining 2 % comes from agreements (0.55 %), the sale of Costa Rican Carbon Units (0.94 %), the Clean Flight programme for offsetting greenhouse gas emissions (0.04 %) and from income generated by non-compliance with PES contracts (0.46 %)[42].

FONAFIFO invests its funds in two general activities on privately owned farms: (1) forest cover maintenance and (2) recovery of forest cover, each having sub-activities (e.g. protection of water resources, post-harvest protection, natural regeneration, agroforestry systems and reforestation with endangered species, among others). A third category is mixed systems, for small farms with an area of ten hectares or less where a maximum of three activities of PES can be considered. For the period 2015–2019, activities dedicated strictly to forest protection received on average 83 % of all finance[42]. Overall, 10 % of FONAFIFO funding is directed to reforestation activities, especially to the category

of “reforestation with medium-growth species” (5 %) and to the general category of “reforestation” (4 %). Finally, other activities that receive a significant number of resources, but a much smaller percentage than those mentioned before, are pasture regeneration (2 %) and agroforestry systems (2 %). The remaining 4 % of the funds for the PES are distributed among various reforestation, regeneration and agroforestry systems sub-activities.

The programme offers a fixed annual payment on per hectare basis, with a variable rate depending on the activities and contract period between 5 and 10 years. Currently, farmers get paid US\$64 per hectare as a base, and in some cases, bonuses are added according to the prioritisation criteria that FONAFIFO has established. This payment is based on the opportunity cost of dual-purpose livestock activity. FONAFIFO works as an intermediary in these transactions (Fig. 1).

Over the years, the programme has resulted in moderate ecological and social outcomes[43,44]. Small and medium-sized landholders owning between 1 and 300 hectares of land, socially disadvantaged people, and Indigenous communities (around 100,000 people) constitute the main service providers[43]. Comparatively greater ES payments go to wealthier households due to their large land size and secured land title, making them eligible for forest protection which constitutes over 90 % of payment contracts. There has been an increase in Indigenous peoples' agreement for forest protection, which provides significant economic benefits to the communities. In addition, the programme now intends to apply a landscape approach to complement the protected areas by targeting underrepresented areas with the potential for establishing biological corridors through the protection and regeneration of secondary forests.

Overall, the Costa Rican PES scheme is an input-based programme largely based on area (i.e., area of conservation and restoration) and in bulk (i.e., area for several ES) without clear biophysical measurement of ES or differentiation of the quality of ES[45] that are being conserved or restored through the activities that are financed. The scheme does not assume a direct and exhaustive measurement of each of the services on each farm (which is how an output-based and layered approach works). This can be helpful to be able to justify in a more specific way, beyond forest cover, however, involves its complexities. Particularly, there is currently insufficient funding and the scheme is highly dependent on public resources[46]. Although the prioritisation of high conservation

value areas that FONAFIFO has introduced in recent years is an important step to address the challenge of increasing the effectiveness of the programme[46], the current scheme tends to attract participants who have a low or negative opportunity cost[47,48]. Therefore, the programme could be attracting land users (i.e., farmers and foresters) who would have adopted conservation and restoration practices anyway without the payments from FONAFIFO[10], which causes a low level of additionality of the programme and a high inefficiency in the resources invested. The adaptability of the programme is necessary to cope with global advances.

3.2. PES programme in Mexico

In Mexico, the first payment programme for environmental services was implemented in 2002 by the municipality of Coatepec Veracruz, which is still operating, and a national PES programme has been operating since 2003. Some of its earliest schemes include incentivising carbon sequestration and water regulation activities through watershed payment and water user fees at specific localities[49]. First, the PES programme was designed just for hydrological services, and a year later, it included biodiversity conservation, agro-forestry systems and carbon sequestration. Currently, the Mexican National Forestry Commission (CONAFOR) implements the following initiatives: the Hydrological Ecosystem Services Programme (PSAH) in 2003, the Programme to develop PES for Carbon Sequestration and Biodiversity (PSA-CABSA) in 2004, the Local Payment Mechanisms for Environmental Services through Matching Funds (MLPSA-FC) in 2008 and the Biodiversity Heritage Fund in 2011. Since 2006, the first two programmes have been merged under a single concept called the PES National Programme[50]. Each of the programmes has its own funding sources, areas of focus, and timelines, enabling diverse stakeholders to engage through various collaborative and financial mechanisms that link ES users with providers [51].

The PES concept was incorporated within the General Law for Sustainable Forest Development in 2003 and the Federal Rights Law (Article 223, paragraph A) was amended to raise water funds and set aside an annual fund under “the Forest Fund” from the fiscal revenue for incentivising forest owners in hydrological priority areas[54]. The Forest Fund (Fondo Forestal Mexicano Trust Fund) secures finance for PES and other environmental programmes by collecting revenues from water tax, annual budget allocations from national, state and local governments, and the private sector (Fig. 2). Local governments also provide matching funds within specific watersheds, but the federal government provides the maximum allocation of funds. The maximum amount paid by CONAFOR per hectare per year for PES is 1100 pesos (US\$54.5) (by the MLPSA-CF 600 pesos (US\$29.70) and the Biodiversity Heritage Fund ~522 pesos (US\$26)) [52,53]. By 2023, a total of 12,728 projects had been awarded under the PES National Programme; 3326 through Matching Funds (MLPSA-FC); and 110 through the Biodiversity Heritage Fund, corresponding to a land area of 8347,152 ha; 1250,302 ha; and 98,303 ha, respectively[53].

The National Forestry Commission (CONAFOR) administers the PES programme, arranges contracts for services with forest owners, and monitors the outcomes of avoided deforestation (Fig. 2). The programme works on an agreement (contract) basis where CONAFOR contracts the landowners for five years to pay for water services while landowners perform sustainable management activities to deliver those services (in addition to biodiversity, carbon capture and storage, etc.). CONAFOR also contributes to local matching funds developed by water users to pay landowners in collaboration with state or municipality agencies, or non-government organisations.

Prioritised PES include locations with cloud forests and mangroves, deforestation risks, overexploited aquifers, protected areas, areas at risk of natural disasters, areas that in the face of a climate change scenario project potential changes in climatic variables that negatively affect the provision of ES, and poor municipalities with major Indigenous

communities in the priority areas, particularly involving female and young applicants. Notably, the national PES scheme has explicitly adopted an Ecosystem-based Adaptation (EbA) approach as a strategy for adaptation to the adverse effects of climate change. A scoring of social and environmental criteria such as vegetation cover (mangroves, cloud forests), poverty, water and land use, and social characteristics is used for the final selection of the areas within the targeted locations[54].

The PES programme in Mexico offers incentives to landowners to maintain certain ecosystem conditions as a proxy for ES. Private or communal landholders receive annual payments for the agreed term of up to five years as compensation for not changing land use and undertaking surveillance for preventing illegal logging or land conversion, hunting, and firebreak to avoid wildfire and other activities according to the Best Management Practices Guide published by CONAFOR (<https://snif.cnf.gob.mx/conservacion/>). CONAFOR conducts annual visits to sites and remote sensing analysis to verify the outcomes before any payment is made to landowners. The current payment approach considers the types of ecosystems and economic pressures on deforestation to realise the opportunity costs to the landowners adopting the conservation measure.

Within the PES implementation criteria, beneficiaries must invest at least 50 % of the total amount allocated in activities in accordance with the Best Management Practices Guide. For example, in the Ejido San Ignacio de Arareco, located in the Sierra Tarahumara, 1931 ha of oak-pine forest were supported through PES, including 367 ejidatarios people, mainly belonging to the Tarahumara Indigenous tribe. Following the Guide, the community decided to invest PES resources to achieve various social and environmental benefits mainly: a) boosting local organisation and economy by investing in inclusive productive projects that generate >200 jobs; b) executing activities for the conservation and sustainable use of biodiversity and silviculture; c) strengthening the leadership and governance of the Tarahumara Indigenous community; and d) developing infrastructure to promote ecotourism (<https://snif.cnf.gob.mx/conservacion/>).

Overall, the social outcomes of Mexico's PES scheme have been positive, as two-thirds of the payment recipients are poor forest owners, including Indigenous peoples. The programme has successfully involved IPLCs, with Common Property Ownership over 60 % of forests. However, the environmental outcomes in terms of lowering the deforestation rate have been moderate as the scheme covers only half of the high or very high deforestation risk areas[55]. There is still little work on the social perception of PES in Mexico. However, Saenz et al. [56]. found that although the payment has little influence on the improvement of people's income, it has caused changes in the use of the forest for more sustainable management. They also suggested that the political and organisational traditions of the communities play a crucial role in understanding their adoption of various mechanisms that promote the conservation of their forest resources. Indigenous participants in the PES programme perceive that they obtain more provisioning, regulating, and cultural services which would have been missing if they had not been part of the programme[57].

3.3. PES in Australia

For the past 2–3 decades, conservation schemes have been operating in Australia involving Private Land Conservation Agreements, Reef Credits, and the Murray-Darling Basin water trading[15]. Here we examine a Biodiversity Conservation Trust (BCT) established by the New South Wales State Government in 2016, with its focus on a systems approach including biodiversity and related conservation activities, which align with the emerging Nature Repair market opportunities.

The NSW BCT is a statutory not-for-profit body established under a robust legal and institutional framework, the Biodiversity Conservation Act 2016, to deliver private land conservation programmes[58]. The BCT manages private land conservation agreements where a landholder voluntarily enters into an agreement (perpetual or term-based) with the

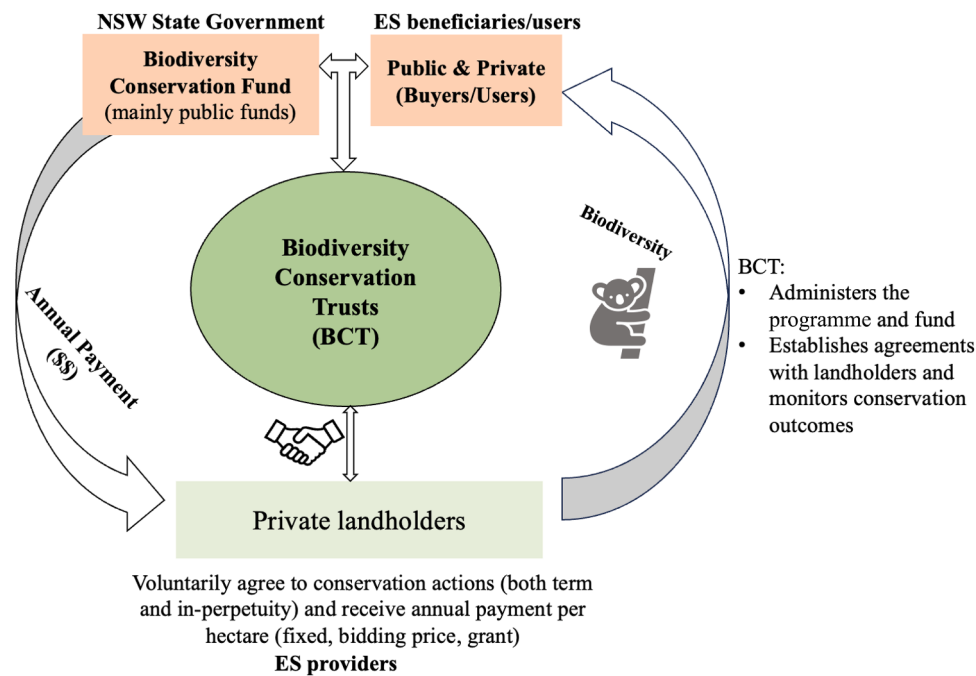


Fig. 3. NSW state's private land conservation (BCT) model.

BCT to undertake agreed conservation activities[59]. The permanent conservation agreement adds a legally binding commitment to present and future owners of the land to undertake agreed actions in meeting the international conservation standards required for protected areas. Other than the NSW government, landholders have options to engage with other schemes from non-government organisations (e.g. Land for Wildlife, Wildlife Land Trust).

The BCT manages the conservation programme on behalf of the State government to involve landholders managing some or all of their land for biodiversity, nature or wildlife conservation purposes (Fig. 3). Incentives are provided under three broad programme modalities: wildlife refuge agreements; conservation agreements; and in-perpetuity biodiversity stewardship agreements[60]. The BCT has established and managed agreements with landholders in conservation programmes, voluntary options for developers to offset their impacts, and involved investors in co-investments. Critical elements of the BCT include the diversity of schemes, delivery mechanisms and conservation agreements, all of which suit the contexts of voluntary landholders. The programme also aligns with the State's existing Biodiversity Conservation Investment Strategy in selecting priority investment areas or conservation assets on private lands[61].

In delivering the programme, the BCT applies a variety of incentive/payment delivery mechanisms: 1. fixed price offers; 2. conservation tenders; 3. co-investment partnerships; and 4. a revolving fund[60]. Under the Conservation Management programme, the BCT offers a fixed price with annual payment per hectare of land or payment to landholders through conservation tenders for management costs within the priority investment areas. While a perpetual conservation agreement is considered with a fixed payment or a tender process, the latter sets payment on a term basis for at least 15-year agreement. Under the revolving fund, the BCT can purchase properties of conservation assets or biodiversity value and sell them to interested buyers with a permanent conservation agreement affixed to the land title along with a fixed grant amount.

This programme complements the existing Biodiversity Offsets Scheme which allows developers to buy biodiversity credits from private landholders to offset unavoidable impacts of development activities on biodiversity loss. The BCT acts as a market intermediary to receive payment from developers for credit obligation and ensures a like-for-like

biodiversity gain from landholders through a biodiversity stewardship agreement. The BCT buys the credits from the landholders using credit purchase methods (e.g. tenders, open and target fixed price offers, revolving funds), to meet developers' offset obligations.

The BCT has delivered significant positive conservation outcomes through private land conservation agreements with an increase in the number of private protected areas to 100 agreements covering 45,000 ha per annum during 2018–2023⁵⁹. The scheme complements the National Reserve System, which represents a network of public, Indigenous and private protected areas. The BCT model provides a dedicated, board-governed, and adequately funded statutory trust (with AU\$240 million initial investment over five years from the NSW Government) to deliver conservation programmes. A notable aspect of the programme is a strategic investment in perpetuity payments and institutional arrangements to foster effective governance, trust and transparency for a targeted and faster programme delivery. Recently, the BCT offered a "Cultural Biodiversity Conservation" scheme targeting Indigenous landholders to receive a fixed payment (AU\$/hectare/year basis) for land management actions and cultural activities (e.g. cultural burning, planting considering cultural values, cultural monitoring) to protect biodiversity on their lands [62].

3.4. A comparative analysis of the selected PES schemes

One of the fundamental aspects of the selected PES schemes is specific legislation and policy frameworks that support market-like incentives for conservation programmes. Each scheme has an operational national or State legal entity to perform functions on behalf of the government for administering, managing funds, and involving service providers and beneficiaries (Table 1). FONAFIFO in Costa Rica, CONAFOR in Mexico, and the BCT in NSW implement the government's strategic plans and meet the commitments to invest in conservation (Table 1). Each of these entities relies on specific funds earmarked from annual revenues (i.e., sourced from service users and taxation) or private investors to pay landholders. In all the selected schemes, to date, the funds are supported largely by the public and regulated by legal entities; however, with the expansion of such schemes the need for more funds requires considering broader collaborative or private investment arrangements in the future.

Table 1

Summary of salient features of PES programmes in Costa Rica, Mexico and Australia [54,59,60,65].

Programmes	PES institutions	Incentive mechanism	ES beneficiaries & providers	Advantages	Disadvantages
PES - Costa Rica (1997- current)	A specific legislation, the Forest Law 7575, underpinned the formation of the Ecosystem Fund, setting the conservation priority and an entity, FONAFIFO, to implement the PES scheme. FONAFIFO administers, mediates and manages the programme. A significant source of PES finance from the annual revenue collected mainly through a fossil fuel tax and water use fees. FONAFIFO monitors the forest extent and condition as a proxy for the desired ES bundles.	Landholders receive a fixed annual payment per hectare of land under a 5–10-year contract. Contracted landholders manage the forest to deliver a bundle of ES, and FONAFIFO holds rights of ES credits for sale. Payment differs with conservation and restoration measures.	ES beneficiaries: Public, Water users (hydroelectric and beverage companies), businesses (tourisms). ES providers: Private landholders, Indigenous communities.	Input-based, ES-bundled approach and fixed annual payment afford a simple transactional method. Easy to monitor and regulate by the national authority. Forest extent and condition serves as a proxy for the bundle services. Increased economic opportunity for Indigenous peoples.	No explicit ecological indicators to measure additionality and specific ES outcomes. No social indicators to measure social or equity outcomes. No conservation agreement in perpetuity because of fund shortage. Fixed payment does not reveal true information on opportunity costs.
PES - Mexico (2003-current)	Mexico's Federal Rights Law (Article 223, paragraph A) mandated depositing a specific share of annual water fee into the national forest fund to pay landowners for different services that they provide by changing land use. CONAFOR implements the programme, sets the criteria, coordinates with the local administration and supports capacity building to voluntary landholders. CONAFOR monitors the outcomes by using satellite images of the enrolled properties.	Fixed annual payment per hectare of lands for a 5-year contract to deliver different services. Landholders with cloud forests receive a higher payment than other ecosystems.	ES beneficiaries: Public. ES providers: Forest owners (private and communities including Indigenous peoples).	Input-based and fixed annual payment afford a simple transactional method. Flexibility in delivering local PES mechanisms. Cost-effective monitoring with remote sensing imagery analysis of ecosystem conditions. Strengthens community ownership of forests with conservation actions.	No explicit indicators to measure additionality and specific ES outcomes. Fixed payment does not reveal true information on opportunity costs that the ES providers may experience.
Private land conservation in NSW, Australia (2017- current)	The NSW Biodiversity Conservation Act 2016 sets a specific goal to establish a market-based conservation mechanism at the state level. BCT constituted under this act establishes, manages and monitors all new and existing private land conservation agreements across the state. BCT enters into Conservation Agreements and Biodiversity Stewardship Agreements with voluntarily interested private landowners for permanent and specific term contracts. A state level Biodiversity Conservation Fund is established and managed by the BCT. With the approval of the State's Minister, BCT acts as a fund manager for Biodiversity Stewardship Payment Funds. Main sources of Biodiversity Conservation Fund are government, developers (offsetting their development impacts), philanthropic funds i.e. donations and private investment (corporate social responsibility), etc.	Annual payment to eligible landholders using fixed price or determined through conservation tenders. Landholders engaged in funded conservation agreements receive fixed or tender prices in perpetuity or long-term agreements (minimum 15 years). Landholders with a biodiversity stewardship agreement receive annual stewardship payments in perpetuity. Landholders generate and sell biodiversity credits through a fixed price and tender process. BCT maintains a revolving fund to buy and sell property of conservation values in permanent agreements.	ES beneficiaries: Public, Private businesses, Individual philanthropist. ES providers: Private landholders including farmers and graziers.	Fixed annual and tender-based payment options to match the opportunity costs for landholders. Flexible agreement options for time period —79 percent of the contracts in perpetuity conservation or stewardship agreement or term based. State government's commitment to annual investment. In-perpetuity conservation or stewardship agreement. Diversity of programmes targeting private sectors.	No explicit ecological indicators to measure additionality and specific ES outcomes. No social indicators to measure social or equity outcomes. Complexity in handling agreement assets and revenues in a single Biodiversity Conservation Fund.

The input-based payment is a common approach in the selected schemes to deliver ES and biodiversity benefits. The reason may be it is faster, simpler, and easier to account for the input/management costs for a set of conservation actions to deliver required services than monitoring and measuring outcomes[63]. It involves less complexity for the users and providers of the services in the transaction and monitoring processes. Payments only require measuring the ecosystem extent and condition as a proxy for required ES. For instance, Costa Rica and

Mexico heavily rely on spatial analysis of forest and land cover change for the agreed conservation areas to track the progress of ES. However, in Australia, standard plot-based monitoring for vegetation and soil functions, and targeted monitoring of threatened species (i.e., species credits) using appropriate methods (e.g. remote camera, trapping), are required as surrogates of biodiversity values[64].

The BCT's approach, with options for fixed and tender-based payment, benefits landholders to choose and enter into a suitable

agreement, contrasts with the FONAFIFO and CONAFOR approach, which uses just one input-based option. The BCT, with sufficient funds from State investment, focuses on in-perpetuity agreements on private land for conservation actions that pertain to the protected area principles. In contrast, fixed payment options in Costa Rica and Mexico do not allow the landholders to participate in other initiatives. Additionally, long-term conservation agreements are rare; especially in Costa Rica which has targeted payments largely for forests under strict protection, without proclaiming any permanent conservation[65].

In Costa Rica, the PPSA (PES programme) considers various land management activities that would deliver the desired ES as a bundle. Likewise in Mexico, management activities focus on disaster reduction, climate change mitigation and delivering hydrological and biodiversity services. In the BCT approach, the focus is on biodiversity, mainly through considering native vegetation, threatened species, habitat restoration, and wetland conservation. A single management action like restoring vegetation generates a bundle of services but the BCT considers only one ES. Recently, the BCT invited co-investors from the private sector to buy carbon credits from biodiversity-focused sites, somewhat similar to a stacked or bundled approach.

4. Lessons for developing Indigenous-specific PES systems

Based on our analysis of the PES from Costa Rica and Mexico, and the BCT from NSW and, more broadly, the SFM methodology that supports the carbon economy in northern Australia, and the authors' experience of working in the field over >15–20 years, we suggest the following key elements be considered when designing PES systems for IPLCs:

- **Genuine engagement with IPLCs from the beginning of the initiative/programme:**

A genuine, passionate, and trustworthy engagement with IPLCs is important right from the conception of the programme. This involves creating a safe and secure place as a first step for people to feel comfortable and talk. Such an approach helps them to understand the programme and contribute their knowledge to shape it in a collective manner. As mentioned in Section 2, Australia's SFM methodology, in particular, was developed from the very beginning, in collaboration with Indigenous peoples, over >8–10 years. One of the co-authors (3rd) worked with a team of Indigenous and non-Indigenous researchers out on land (*Country*) in Indigenous cultural settings, listening to people's concerns and aspirations. Due to such a bottom-up, collective effort, today, the methodology is well adopted by the Indigenous stakeholders from across northern Australia, delivering >AU\$59 million per year to people living in remote locations where there are negligible economic opportunities, if any[66]. However, this was not the case for PES programmes in Costa Rica, Mexico or the BCT in NSW, where a top-down approach from the State governments was followed to address deforestation and land use change-related issues in the former two and biodiversity in the case of NSW. The success of those schemes rested on the due consideration given to the feasibility, transparency, and applicability of the scheme for landholders.

- **Work collectively with IPLCs to establish a shared vision and related targets/goals:**

Typically, external/funding parties approach the communities with their established goals and a vision to achieve the project targets over their pre-defined time period. However, many IPLCs hold their own worldviews and operate on a circular timeframe where events are seen as recurring in cycles following cosmological patterns. For example, many Indigenous Australians consider time circular and hold imbued relationships with nature. Recognising and respecting IPLCs' worldviews and knowledge systems, particularly in relation to land and sea management, where many of them have a deep understanding, is

essential. Such a recognition was not evident in any of the selected case studies. However, each of those studies offered flexibility to the project proponents to practice their knowledge and skills to manage land. The BCT, based on Indigenous partnership, has recently developed an Aboriginal Empowerment Policy (2024–2027; <https://www.bct.nsw.gov.au/sites/default/files/2024-07/aboriginal-empowerment-strategy.pdf>) providing a culturally informed path forward for the conservation of lands that have both cultural and biodiversity values.

- **Develop simple, transparent and robust PES mechanisms along with culturally appropriate state/national level policy settings:**

The Costa Rica and Mexican PES programmes apply relatively simple and robust PES mechanisms, contributing to a rapid national-level uptake of the programme. In both cases, the land managers are paid on a per-hectare basis for the delivery of specific ES, using simple monitoring tools such as GIS. Whereas the BCT offers a slightly complex approach with in-depth, on-site (plot-level) monitoring of conservation targets but flexible and robust payment methods such as tenders, fixed prices, etc., applicable at the state level.

From Australian perspectives, we suggest developing state/territory-level culturally appropriate policy frameworks (similar to FONAFIFO/CONAFOR), applying top-down and bottom-up approaches. The latter is especially important when considering the methods to assess and monitor ES delivery (see Sangha et al. [67].), which can substantially reduce the transactional costs and make the project affordable for land managers when supported by culturally appropriate policy settings.

- **Consider developing long-term programmes focusing on societal/communal perspectives and applicable at landscape scales:**

To date, many of the PES programmes are designed to operate at the individual/private property scale[15]. In contrast, nature and IPLCs' systems operate mostly at a landscape or communal scale, and over the long term. All the selected case studies programmes target private properties, not particularly designed for a landscape scale. The new PES systems need to consider the landscape scale, along with societal and long-term perspectives, to better achieve long-lasting positive changes both in conservation and people's well-being.

5. Discussion

With increasing focus on NbS for investment from State governments and private organisations, it is imperative to develop suitable NbS mechanisms, policy instruments, and support structures that are culturally appropriate for practitioners, particularly IPLC land managers. With at least 32 % of global land and related inland areas being managed by the IPLCs under customary, common or private legal rights, and 80 % of those lands being in good or moderate condition[17], many global organisations such as WWF suggest that investment in IPLCs to manage their lands more efficiently is a feasible and economic option to achieve biodiversity, climate change, socio-economic outcomes and SDGs[18]. To support such initiatives, this paper offers insights into the policy design of NbS using three case studies of well-established NbS-PES systems and the Indigenous carbon economy in Australia.

Common features among the studied NbS mechanisms include establishing regulatory infrastructure, relevant governing structures and authorities for monitoring and evaluation of ES, developing policy instruments, and a dedicated fund or trust—the necessary elements for the success of a PES scheme[68,69]. However, such principles are typically ignored as most PES schemes, applying mainstream market regimes, operate as one-to-one exchange between one ES provider and beneficiary (as described in the best practice guide by Smith et al. [70]. and others). However, over time, PES has evolved with an increasing focus

on national/State-scale initiatives such as in Costa Rica and Mexico, using sophisticated GIS/Remote Sensing tools, and simple input-based models with minimum monitoring requirements. With the growing need for NbS, there is a need to establish collective policy frameworks at the State/national level including governance, monitoring and regulatory systems so that individual parties (land managers and investors) can trust the system and minimise transactional costs. In addition, if these markets are going to expand to attract private investment, then outcome-based models and detailed monitoring of deliverable ES may be necessary due to the nature of the private market[71].

In northern Australia, the Savanna Fire Management (SFM) related carbon economy offers a good example of an output-based economy where land managers manage fire early in the dry season applying low intensity, small and mosaic burns to abate GHG emissions from late dry season wildfires, and sell carbon credits either to the Australian Government (price revealed following a blind auction) or the private market [24,29,30,33,72]. The Clean Energy Regulator is the authoritative agency within the government to monitor and regulate fire management outcomes, and issues carbon credits applying standardised models (SavBAT or FullCAM- <https://www.dccew.gov.au/climate-change/publications/full-carbon-accounting-model-fullcam>). The Emissions Reduction Fund (now called the Climate Solutions Fund) is the main funding body to buy credits using a fixed price (<https://www.dccew.gov.au/climate-change/emissions-reduction/emissions-reduction-fund>). In parallel, a voluntary private market (that has tripled since 2018 generating 1.5 million Australian Carbon Credit Units [ACCUs] in 2022), operates complementarily[73]. This mixed arrangement has attracted both private and public investment. However, the sole focus of the SFM scheme is to incentivise the reduction of GHG emissions and/or sequestration of carbon, not other ES. This is unlike Costa Rica, Mexico or NSW where the input-based model delivers a range of ES and affords other advantages such as flexibility and reduced risk for land managers. We acknowledge that there is an increasing focus on including biodiversity credits under Australia's recent Nature Repair Bill[23].

To integrate Indigenous perspectives in the development of appropriate NbS-PES systems, an understanding of the socio-economic arrangements in which IPLCs operate is essential. It is well appreciated that IPLCs' socio-economic value systems are communal, based on clans not individuals [17,74–76]; hence collective, community-based initiatives are much more in line with people's values than individualistically focused private enterprises that follows typical market regimes. Therefore, the policy settings need to be framed in culturally appropriate ways to support Indigenous land managers, which may include establishing a collective platform to reduce transactional costs, support local governance structures, as well as to offer authentic information on PES mechanisms. In northern Australia, most of the fire management-related carbon economy operates at a community scale where Indigenous land managers from different clan groups collectively manage fire on their clan lands—*Country*[77].

Another major concern of a majority of the PES schemes is that these are typically designed to 'pay the polluter to fix a problem' or 'prevent degradation of nature' (which can be perceived as a right, especially if private property) rather than 'rewarding the stewards' of nature[15,63,78,79]. Throughout the world, IPLCs are regarded as stewards or custodians of land and their lands are often relatively less exploited compared to mainstream land usages[17]. Hence for Indigenous-specific PES in Australia, there is a need to reward stewardship (or Incentives for Caring for *Country* (ICC)), not just environmental mitigation, under emerging nature-based opportunities.

Globally, Chan et al. [63], analysed PES systems from operational aspects for meeting sustainability and socio-economic goals. Their study raises seven main concerns about existing PES schemes: (1) new externalities, (2) misplacement of rights and responsibilities, (3) crowding out existing motivations, (4) efficiency-equity tradeoffs, (5) monitoring costs, (6) limited applicability, and (7) top-down prescription/alienating agency. Of these, monitoring costs and top-down prescription are highly

relevant to the northern Australian context. Addressing those concerns, the authors further suggest incentivising/paying for management actions, i.e., an input-based model, not output, which will help eliminate high monitoring costs and new externalities as stewards will focus on holistic management, encourage rewarding behaviour (thus managing rights and intrinsic motivations), and reduce the risk and offer flexibility to land managers (also see Costanza et al. [13]). Carefully designed 'policy mixes' with shared public, private and government responsibilities can help distribute the rights and responsibilities to relevant land managers. From the IPLCs' perspective, high monitoring costs and top-down prescription of methods for what and how to manage land, if merely for monetary gains, could lead to failures in the long term. It follows that an evolving PES system co-developed in consultation with Indigenous peoples is required[15].

For the nature-based market in Australia, we reimagine Indigenous PES — 'ICC' as a system of socio-ecological and economic approaches that require significantly different policy arrangements (institutions, value systems, structures) than those used for simple, marketed goods, to achieve sustainable environmental and socio-economic goals[13,15]. Currently, the Australian Government is following a typical market approach with upcoming nature-repair methodologies—even different payment schemes for different components of an ecosystem (e.g. feral animal management, carbon sequestration, biodiversity), each with its expected outcomes (<https://www.dccew.gov.au/environment/environmental-markets/nature-repair-market/how-the-market-will-operate>). Moreover, respective methodologies will have specific performance outcomes measured in terms of certificates or credits. To illustrate this point, we use an example of a land manager already operating a SFM carbon abatement project. That land parcel also has pockets of high biodiversity value (e.g. rainforest) and significant feral animal (e.g. Asian water buffalo) impact issues. Under current arrangements, the project can be eligible for three different types of credits (emissions abatement, biodiversity, and feral animals), each requiring specific legal procedures and contractual arrangements, despite all components being interrelated. On-ground application of separate payments for different ES is already questioned by many, especially as ecosystems operate as one system[13,63]. Additionally, it complicates procedures for land managers, making projects economically marginal or non-viable.

The key characteristics to consider when designing PES systems, based on our analysis of global and local PES schemes, particularly targeted at IPLCs include:

1. Due consideration of socio-ecological values which are largely non-monetary, thus requiring sophisticated and sensitive institutional arrangements
2. Need to develop innovative ES exchange mechanisms that are beyond the typical market regimes
3. Preference for input-based models as one activity can deliver several ES, allowing for enhanced integrated planning to address multiple ES issues
4. Preference for a bundled ES approach which aligns with the Indigenous concept of a 'whole of *Country* or systems' approach
5. Low monitoring and transactional costs, so the projects are economically viable
6. Flexible and low-risk contractual arrangements
7. Implementing a common policy framework, such as a Common Assets Trust, as a robust, transactionally efficient mechanism for ES providers and beneficiaries.

For upcoming nature-based markets in Australia, State and national government authorities have an opportunity to play important roles along with local agencies/stakeholders in designing PES arrangements where responsibilities are shared, and markets are not left alone for private corporations/companies to set the standards for ES exchange. In our three case studies, it is the State or National level Trust model that has proven a key factor towards the programme's success. Chan et al.

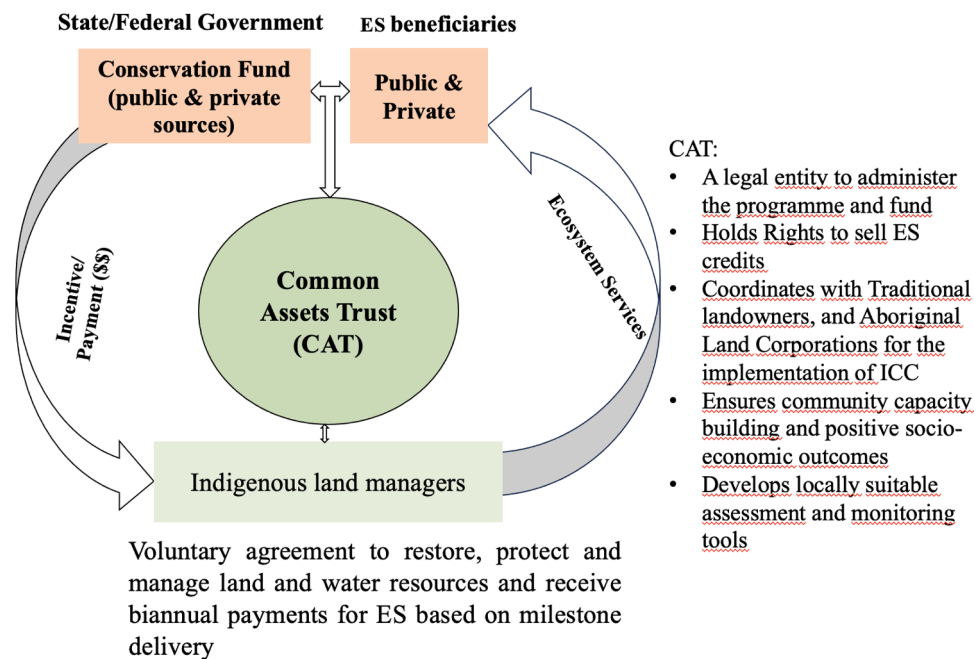


Fig. 4. Proposed Common Assets Trust model for efficient exchange of ES.

[63]. suggest that PES programmes are successful over the long term when social values are given due importance. As advocated by Costanza et al. [13], the NSW BCT demonstrates the practical advantages of establishing Common Assets Trust model(s) supported by the State, which offers a central platform for efficient contracting of land managers, private and public investors, and IPLCs to address required public good ES outcomes (Fig. 4). The respective experiences of NbS schemes as implemented in Costa Rica, Mexico, and in NSW, Australia, illustrates that, with creative aforethought and right policy settings, community-based ES approaches are readily achievable.

CRediT authorship contribution statement

Kamaljit K Sangha: Writing – review & editing, Writing – original draft, Supervision, Resources, Funding acquisition, Formal analysis. **Ronju Ahammad:** Writing – original draft, Investigation, Formal analysis, Data curation. **Jeremy Russell-Smith:** Writing – review & editing, Supervision. **Marcello Hernández-Blanco:** Writing – original draft, Conceptualization. **Octavio Pérez-Maqueo:** Writing – original draft, Conceptualization. **Robert Costanza:** Writing – review & editing, Conceptualization.

Declaration of competing interest

The authors declare that they have no conflict of interest.

Acknowledgements

This research funded by the Australian Research Council under the Discovery Programme and WWF-Australia under a project “Developing Ecosystem Services economies for northern Australia”. The project aims to co-design and co-develop PES systems in consultation with Indigenous peoples.

NbS impacts

Our paper on NbS PES design, entitled - Towards designing culturally appropriate Nature-based Solutions for Indigenous peoples in Australia – is particularly build upon analysing some successful models that work

for Indigenous peoples and local communities and our experience of working in the field for >10–20 years.

In Australia, we have witnessed a very successful Indigenous fire management practice that delivers GHG emissions abatement — a carbon economy worth >\$ 100 million per year— for Indigenous people living in remote communities. This proposed work builds upon this earlier work with the communities, papers listed below, to advance the carbon economy to broader Payment for Ecosystem Services (PES) economies.

- Sangha, K.K., Ahammad, R., Russell-Smith, J., Woolley, L.-A., 2025. A nature-based solutions assessment framework integrating indigenous biocultural and ecosystem services perspectives: An Australian example. *Ecological Indicators* 172 113230. doi: <https://www.doi.org/https://www.doi.org/10.1016/j.ecolind.2025.113230>
- Sangha, K.K., Ahammad, R., Russell-Smith, J., Costanza, R., 2024. Payments for Ecosystem Services opportunities for emerging Nature-based Solutions: Integrating Indigenous perspectives from Australia. *Ecosystem Services* 66 101600. doi: <https://www.doi.org/10.1016/j.ecoser.2024.101600>
- Russell-Smith, J., Holmes, J., Lewis, B., Brisbin, J., Sangha, K.K., 2024. Evolving nature-based solutions for Australia’s Indigenous estate in 2024 – opportunities and challenges. *The Rangeland Journal* 46 (4), -. doi: <https://www.doi.org/10.1071/RJ24019>
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We believe the impact of this work, reported in the paper, will be local, regional and global for proposing a NbS -PES model that can be culturally appropriate and viable for IPLCs across the globe.

We’ll be able to describe this more concretely once we know the purpose of this mandatory document.

Data availability

This paper presents authors' analysis based on their experience in the field and case studies, hence most of the data is already cited and referred to in the paper. In need of any particular information, the corresponding author will make it available on reasonable request.

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