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Discussion

Common asset trusts to effectively steward natural capital and ecosystem services at multiple scales

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ABSTRACT

Ecosystems (natural capital) produce a range of benefits to humans. Natural capital is best thought of as common property since many of the ecosystem services it helps produce are non-rival and/or non-excludable. Private property regimes and markets alone are ineffective and inappropriate institutions to manage them sustainably. These systems can be better managed as commons, using more nuanced private and community property rights and Common Asset Trusts (CATs), with legal precedent in the Public Trust Doctrine. Effective CATs embody a generalized version of Elinore Ostrom's eight core design principles for sustainable commons management: (1) shared identity and purpose; (2) equitable distribution of contributions and benefits; (3) fair and inclusive decision-making; (4) monitoring agreed behaviours; (5) graduated responses; (6) fast and fair conflict resolution; (7) authority to self-govern; and (8) collaborative relations with other groups and spatial scales. Here, we describe a few existing and proposed systems that approximate effective CATs. We also suggest how Costa Rica can transform its existing payment for ecosystem services (PES) scheme into a national CAT. Finally, we describe how CATs can facilitate more fair and effective public/private partnerships (PPPs) to invest in natural capital and ecosystem services.

1. Property rights regimes

Society's most pressing challenge today is to create a sustainable and desirable future. How we manage our private and collective resources will determine the quality of the world that future generations inherit. Conventional economic markets are relatively efficient at managing simple (rival, scarce, and easily excludable) goods and services (Fig. 1), where markets determine the price such that the marginal cost of producing a good equals its marginal benefit.¹ However, the limiting factors to creating a sustainable and desirable world in today's Anthropocene epoch are natural and social capital, which are not simple goods (Beddoe et al., 2009; Daly, 2005) and yet they provide arguably the majority of support to sustainable human wellbeing (Costanza et al., 1997, 2014b). In addition, even simple goods require inputs in their supply chains from natural and social capital which are not included in the cost of production, limiting the efficiency of market pricing and allocation (Daly and Farley, 2010). Natural and social capital require significantly different institutions and management regimes than those used for

simple, marketable, assets and the goods and services they help produce (Costanza et al., 2014a; Kubiszewski et al., 2010).

The characteristics of resources are not always well defined and can change with technological advancements. Fig. 1 shows the characteristics of various resources in terms of their rivalness and their ease of exclusion. The ease of exclusion is presented on a spectrum since technology may change this characteristic. Simple goods are easily excludable and rival (i.e. clothing). Fish in the open ocean are rival as there is a limited amount, but it is very difficult to exclude someone from fishing in the open ocean. The open ocean is a non-rival and difficult to exclude capital asset, whereas fish once harvested can become rival and excludable market goods. However, this is changing as technology is making excludability easier with GPS tracking of both boats and fish. The Internet, on the other hand, is non-rival (it improves the more people that use it) and it's hard to exclude people from it. The same management schemes used for assets and goods that are rival and easily excludable, are inappropriate for the management of those that are non-rival and not easily excludable.

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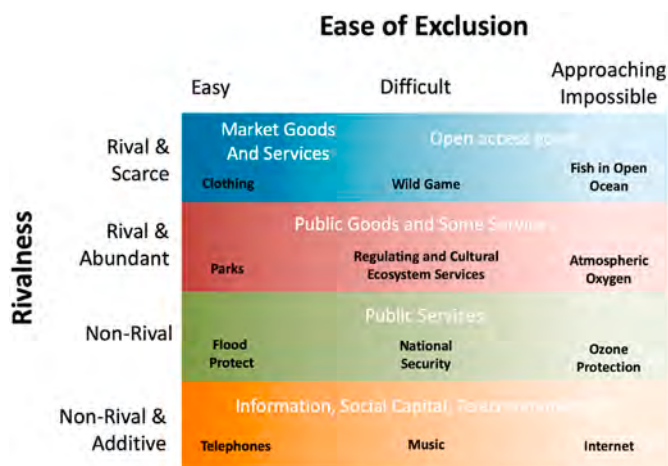


Fig. 1. Goods and services classified according to rivalness and excludability. Adapted from Kubiszewski (2010).

In this paper, we focus on the property rights regimes, institutions, and management regimes for natural capital assets. These assets supply both public and private goods and services in complex combinations.

Sustaining and enhancing human well-being requires a balanced portfolio of all of our assets—individual people, society, the built economy, and natural ecosystems. These four basic types of capital assets (human, social, built, and natural) all have distinctly different characteristics that affect how they interact to produce ecosystem services and other public and private benefits (Costanza et al., 2014c). Their characteristics and interactions can also guide what types of property rights regimes and institutions are most effective for managing them sustainably and well.

To solve our increasing challenges around environmental degradation and climate disruption, society must design and implement new institutions based on more nuanced forms of property rights (Baden and Noonan, 1998; Hanna et al., 1995). Sustainability requires inalienable rights for future generations and healthy ecosystems capable of generating continued flows of vital ecosystem goods and services. Justice requires the fair distribution of property rights over the wealth created by nature and society as a whole. Private property rights and conventional markets are a necessary institution as part of this mix, but will not on their own ensure ecological sustainability and fair distribution (Prugh et al., 2000). Common property rights and institutions can help do so. Private property rights are relatively effective for allocating rival and excludable assets, goods and services, but we cannot rely on private property and markets to allocate resources that are non-rival and/or not easily excludable (Ostrom, 2008). Creating a sustainable and desirable future requires that we find the right balance between private and community property at multiple scales in space and time.

1.1. Property rights to the commons

The basic idea behind common property regimes for natural capital is that assets created by nature or by the whole society should belong to everyone, including future generations. This idea has a long history in environmental discourse (Barnes, 2006; Bollier, 2007; Bollier and Helfrich, 2014; Bromley, 1992). A recent manifestation is the idea of granting legal rights to natural systems. For example New Zealand’s Whanganui River, and India’s Ganges River, were recently granted the legal rights of “personhood” and Ecuador’s Constitution now grants nature the “right of integral respect (Tanasescu, 2017). These initiatives are quite consistent with what we are proposing. We flesh out some ways to act on these legal precedents to create more nuanced property rights regimes to better manage the commons.

The ‘tragedy of the commons’ (Hardin, 1968), was a mislabelling of a

resource which had no ownership or rights and was an open access resource, not one with community ownership rights and shared management (Feeny et al., 1990). Resources owned in common can be effectively managed through collective institutions that assure cooperative compliance with established rules and agreements (Atkins et al., 2019; Berkes, 1989; Feeny et al., 1990; Ostrom, 1990, 2008). Ostrom articulated eight core design principles as guidelines for effective and sustainable commons management. Table 1 lists these principles and a more generalized version from Atkins et al. (2019). While incorporation of these design principles does not guarantee a successful commons management system, they have been shown to be important ways to guide and evaluate system design. For example, one analysis of the effectiveness of Ostrom’s design principles in 91 case studies of common property resource management found that “the principles are well-supported empirically” (Cox et al., 2010).

By declaring certain assets the shared property of all members of the community, the beneficiaries are clearly defined, and all members have incentives to monitor their neighbours and ensure no individual takes too much (as in the case of Territorial Use Rights for fishing (Young, 2013)). Those who do take more than their share are likely to be first rebuked by their compatriots, and if rebuke fails, reported to the law—an example of principle 5, graduated sanctions. As Wilson et al. (2013) note, when citizens have “a sense of ownership, monitoring and graduated sanctions take place spontaneously” (p. S29).

But simple rights of ownership do not ensure responsible management of a resource. Property rights usually refer merely to control over a resource, not to responsibility for its effective management. For global resources such as the atmosphere and open ocean fisheries, there must be an element of stewardship on behalf of those who cannot directly speak for their interests such as the poor, dispossessed and future generations. It is the role of government to ensure such stewardship occurs through guaranteeing that agreements to control the commons meet the needs of all involved in the system.

Governments (or in the case of global resources such as atmospheric waste absorption capacity or oceanic fisheries, a coalition of national governments) are generally required to create and enforce property rights regimes. For example, the public sector can cap resource use at rates less than or equal to renewal rates, which is compatible with inalienable property rights for future generations. Since these resources are created by nature and enforcement requires the cooperative efforts of society as a whole (but especially government), rights to the resource should also belong to society as a whole. Individuals who wish to use the

Table 1

Elinor Ostrom’s 8 core design principles for sustainable commons management, with a generalized version (Atkins et al., 2019) and a description of the basic function of each principle in the context of CATs.

Ostrom’s principle	Generalized version	Function
1. Clearly defined boundaries	Shared identity and purpose	Defines group and establishes property rights
2. Proportional equivalence between benefits and costs	Equitable distribution of contributions and benefits	Ensures effectiveness by balancing individual and collective interests
3. Collective choice arrangements	Fair and inclusive decision-making	“
4. Monitoring	Monitoring agreed behaviours	“
5. Graduated sanctions	Graduated responding to helpful or unhelpful behaviour	“
6. Conflict resolution mechanisms	Fast and fair conflict resolution	“
7. Minimal recognition of rights to organize	Authority to self-govern (according to principles 1–6)	Ensures effectiveness while supporting engagement
8. Polycentric governance	Collaborative relations with other groups (using principles 1–7)	Connects to other spatial and temporal scales

resource for private gain must compensate society for the right to do so. For example, a cap, auction, and dividend scheme, in which the revenue is equally distributed among all members of society or invested in common good infrastructure works like this (Barnes, 2006; Barnes et al., 2008). Taxes on waste emissions and resource extraction can serve the same purpose as a cap and auction system. Preventing the re-sale of the temporary use-rights would reduce the potential for speculation and private capture of rent.

Under common ownership regimes, both costs and benefits accrue to the community as a whole, and the two are more likely to be brought into balance. This satisfies Ostrom's second core design principle – that there be proportional equivalence between benefits and costs (Table 1). Cap, auction, and dividend schemes ensure that everyone who uses common assets must pay the same price, with resulting revenue spent on the common good, while taxes on rent ensure that no one captures unearned profits from common assets. Both policies ensure that principle 2, *equitable distribution of contributions and benefits*, is met.

1.2. The public trust doctrine

The *public trust doctrine* has its roots in ancient Roman law and occurs in the many legal systems derived from it. It holds that certain natural resources should be held in trust as assets for public use. It is the government's responsibility as trustee to protect these assets from harm and maintain them for the public's use. It also asserts that the government cannot sell off these public assets to private parties.

The public trust doctrine has been used in many countries in the past to protect water bodies, shorelines, fresh water, wildlife and a few other resources, but as Wood (2014) argues, the time has come to expand the reach of the doctrine to cover all of the critical natural capital and ecosystem services that support human well-being, including the atmosphere, the oceans, ecosystems, and biodiversity. Wood argues that governments have been shirking this responsibility to protect "nature's trust" and instead have retreated to a statutory and regulatory approach to the environment that has allowed the decimation of natural capital by private interests. She makes the case that, under the public trust doctrine, governments cannot legally shed their responsibility to protect the environment in trust for current and future generations and notes that "Properly understood, the public trust stands as a fundamental attribute of sovereignty—a constitutive principle that government cannot shed" (Wood, 2014)(pp.129).

The public trust doctrine implies that critical natural capital should be seen as a community asset that belongs to all and should be held in trust and managed responsibly for the benefit of current and future generations. It also implies that the public can hold governments responsible for failure to fulfil their responsibilities to protect public assets. It further implies that governments can claim natural resource damages from parties responsible for the damage in order to restore the asset and make the public "whole." For example, the US government claimed damages from BP for the Deepwater Horizon oil spill and for the Exxon Valdez oil spill. Kuwait claimed environmental damages from Iraq for the first Gulf War (Payne and Sand, 2011).

The "Nature's Trust" idea can also significantly change the whole discussion about how to deal with climate disruption. Rather than national governments negotiating with each other about emissions reductions, governments can be seen as co-trustees with a fiduciary responsibility to protect the atmospheric trust. To do this they can claim damages from the private interests that harm the public asset. As Wood (2014) notes: "Trustees have an affirmative obligation to recoup monetary damages against third parties that harm or destroy trust assets." For example, several US states, including Rhode Island, are suing oil companies for climate related damages² (pp. 185).

² <https://www.commondreams.org/news/2019/07/23/big-win-rhode-island-court-battle-make-polluters-pay-consequences-climate-crisis>.

2. Common Asset Trusts (CATs)

Trusts are widely used and well-developed legal mechanisms designed to protect and manage assets on behalf of specific beneficiaries. Extending this idea to the management and protection of natural capital, such as the atmosphere, oceans, and ecosystems more broadly, is a straightforward extension of this idea. Common Asset Trusts (CATs) are based on the integration of the public trust doctrine and community property rights as described above. In essence a CAT is a collection of agreements and poly-centrally governed institutions in support of a shared purpose, sustainable management of public goods. But how should such agreements and institutions be designed to be maximally effective in realising that purpose. Ostrom's design principles for sustainable commons management (Table 1) provide a guide to key factors to consider in the design of CATs.

For example, existing legal structures around property provide conflict resolution mechanisms that are widely perceived as fair (principles 5 and 6). Implementation of CATs should also pay close attention to two other principles: 3-collective choice arrangements and 7-minimal recognition of rights to organize, both of which relate to the unwillingness of people to accept rules imposed from above. Participatory, transparent, democratic, governance is therefore essential for CATs. Communication between the board of trustees and civil organizations should be built into the CAT. It is also essential to recognize that CATs are designed to protect the rights of future generations, which clearly cannot help formulate rules and goals. The need to respect ecological limits must therefore be non-negotiable. Finally, CATs must explicitly deal with border-crossing pollutants and other impacts (principles 7 and 8).

2.1. Examples of CATs at multiple geographic scales

Lest the reader think that the idea of CATs is idealistic or unrealistic, in this section we briefly present several existing and proposed systems that incorporate various characteristics of CATs at various scales around the world and work very effectively. Here we highlight a few of them and discuss the degree to which they incorporate Ostrom's 8 design principles in their design and operation.

2.1.1. National trusts

The National Trust for Places of Historic Interest or Natural Beauty (England, Wales, Scotland and Ireland) was the first national trust, founded in 1895. National trusts are designed to protect both historic buildings and natural landscapes. For example, the UK National Trust (Scotland now has a separate trust) is a conservation charity in England, Wales and Northern Ireland. It owns over 2500 km² of land, mostly countryside, covering nearly 1.5% of the total land area of England, Wales and Northern Ireland. There are now over 50 similar national trusts around the world.

While national trusts often focus on historic buildings, they also preserve historic landscapes and places of natural beauty. They are usually set up as non-profit, membership organizations. For example, the UK National Trust currently has over 4 million members. This provides broad community ownership, participation, and support.

National trusts embody many of the elements of Ostrom's 8 core design principles, which is one of the reasons for their success. They own or manage their assets on behalf of their community of members with a shared identity and purpose (P1). They incorporate an equitable distribution of contributions and benefits to their members (P2). For the most part they practice fair and inclusive decision making via boards and trustees answerable to the members (P3). They incorporate monitoring of behaviours on their properties (P4), graduated sanctions for rule breakers and strong reinforcement for cooperation (P5). They use the legal system for fair (and hopefully fast but this could be improved) conflict resolution (P6). They have the authority to self-govern (P7) and collaborate well with other groups (i.e. private landowners) and scales

(i.e. local, regional and national governments) (P8).

2.1.2. Costa Rican payment for ecosystem services (PES)

From 1950 to 1987, Costa Rica had one highest deforestation rates in the world, going from 72% to just 21% cover (Rodríguez Zúñiga et al., 2012; Sader and Joyce, 1988). This decrease was mainly due to a growth in cattle ranching and general agriculture (Rodríguez Zúñiga et al., 2012; Zúñiga and Mario, 2012).

In response to this deforestation, Costa Rica implemented a series of conservation policies and programs, including a National System of Conservation Areas which protects 140 wildlife areas covering 26% of its terrestrial area (Corrales Chaves, 2019). In 1996, Costa Rica instituted a landmark Forest Law, which established two keystone measures: (1) banning land use change (i.e. deforestation) and (2) creating a nation-wide payment for ecosystem services (PES) program. Together, these efforts have stopped deforestation and increased forest cover annually, reaching 52% cover by 2018 (Corrales Chaves, 2019).

In establishing the PES program, the Forest Law identified four ecosystem services generated by forests and forest plantations: 1) greenhouse gases mitigation (carbon fixation, reduction, sequestration, storage and absorption), 2) water provision for urban, rural or hydro-electrical 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 (article 3 of the Forest Law).

The Forest Law also created the Nation Fund for Forest Finance (FONAFIFO) to manage the PES program.³ The program receives its funding from a fossil fuel tax (3.5% of revenues from the tax) and a water tax (25% of the revenues from the tax on water purchases).⁴ In 2018, the fossil fuel tax represented 89% of FONAFIFO's total funding and the water tax 7.5%,⁵ and the remainder from other sources. FONAFIFO also offers other services related to ecosystem, including the sale of carbon credits that are produced through forest plantations under the PES scheme. Currently, these credits only provide approximately 1% of the total funding.

The funds collected through these mechanisms are used to fund two general activities on privately owned farms broadly described in terms of maintenance and recovery of forest cover. A third category is mixed systems, for small farms with an area of 10 ha or less, in which a maximum of 3 activities of PES can be considered (Table 2).

Another key aspect of this PES scheme is that it's an input-based program, in which payments are made based on the implementation of a particular land uses. It is not output based, in which buyers pay for the provisioning of a specific service (e.g. payments for tons of carbon

Table 2
Activities and sub-activities that are funded under the current Costa Rican PES program.

Forest cover maintenance	Recovery of forest cover
Forest protection	Reforestation
Water resources	Reforestation with endangered species
Post-harvest protection	Natural regeneration
	Agroforestry systems
	Agroforestry systems in coffee farms
	Agroforestry systems with endangered species

³ Besides the PES program, FONAFIFO also provides loans for sustainable forestry activities.

⁴ Executive Decree 32868.

⁵ Funds collected from the "canon de aguas" should be invested in private lands that are located in the watershed where the ecosystem service of water protection is produced, and in zones of hydrological importance (Article 14 of the Executive Decree 32868).

sequestered, or cubic meters of water produced or enhanced) (Engel et al., 2008). This allows for enhanced planning across multiple land-uses. This also allows for payments to be made in a bundled approach, where activities are funded to protect, enhance, or restore the forest ecosystems as a whole and the four ecosystem services in the process. This is more effective than a stacking or layering approach, where payments are made for separate ecosystem services (Lau, 2013).

On average,⁶ FONAFIFO funds 57,400 ha annually through an average of 808 contracts (Fig. 2). It is important to note that approximately 90% of the area in the program is under conservation (Corrales Chaves, 2019), which raises concerns around the additionality of the program since it already prohibits deforestation.

The Costa Rican PES scheme already functions approximately as a common asset, with FONAFIFO playing the role of trustee using economic incentives to motivate protection and restoration of natural capital assets. It receives payments from activities that harm or utilize the asset (carbon emissions and water use), and rewards private parties that protect or restore the asset via payments for contracted activities.

FONAFIFO and the PES scheme incorporate several elements of Ostrom's eight core design principles. FONAFIFO has a clear purpose of sustaining and enhancing forests in Costa Rica and it enjoys strong support as an institution, suggesting a sense of shared identity and purpose (P1). It incorporates a relatively equitable distribution of contributions to the fund and benefits to land owners (P2), although this relationship is somewhat indirect. Decision-making is answerable to the government and ultimately to the citizens (P3), but this aspect could be strengthened with greater citizen consultation and participation. Monitoring of behaviours on funded properties is part of the system, but could be improved particularly through enhancing mechanisms for peer-monitoring among buyers (P4). There are sanctions (loss of payments) for those who do not live up to their contracts and the rewards of continuing participation for those who do (P5), although monitoring to assess this is not adequate. The national legal system is used for fair conflict resolution (P6). Finally, FONAFIFO has the authority to self-govern to some extent (P7) and collaborate with the national government.

The Costa Rican PES scheme currently is limited to forests on private land. The government is considering vastly expanding the scheme to include all terrestrial and marine ecosystems and more directly envisioning the system as a National Common Asset Trust (NCAT). We elaborate on what this would look like in a following section.

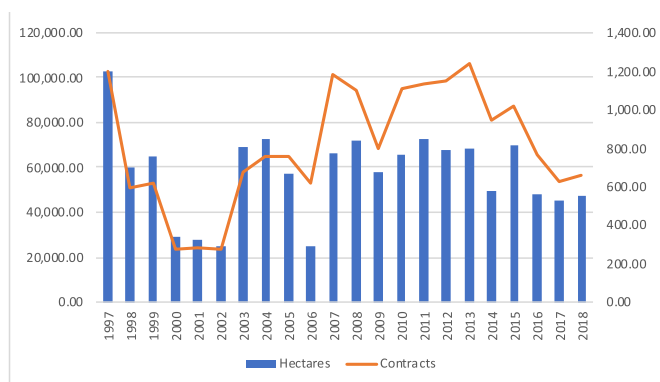


Fig. 2. Land area covered and number of contracts issued per year under the Costa Rican PES scheme from 1997 to 2018.

⁶ Period assessed: 1997–2018.

2.1.3. Vermont common asset trust (VCAT)

In January of 2007, State Senator Hinda Miller, submitted a revolutionary legislative bill to establish the Vermont Common Assets Trust Fund (S.44). This bill expanded on the public trust doctrine that is common for rivers, lakes, oceanfront, fish and game, and sometimes groundwater. It placed all the state's natural and social assets into a public trust to be managed sustainably for current and future generations (Barnes, 2006). It followed the structure of the Alaska Permanent Fund and the Norwegian Sovereign Fund in collecting rent for use of resources, and paying a dividend to residents with at least 25% of the annual revenue (Farley et al., 2015). These are two of many examples of a special case of a CAT in which users of the commons who extract private, marketable goods or services can be charged for that use, and a dividend returned to the common owners or reinvested in the commons.

The Vermont bill stated: "It is appropriate that the concept of the public trust be explicitly expanded, so that a legal institution is created whose managers, the trustees, have clear legal responsibilities to protect the common resources, to assure that the capital assets are not depleted, and to manage any assets that may arise from the common resources on behalf of the beneficiaries in a manner that includes strict fiduciary responsibilities, transparency, and accountability. The creation of such an institution is particularly important in regard to those beneficiaries who, as members of future generations or ecosystems or non-human species, are unable at present to represent their own substantial interests."

The bill did not get out of committee, but sponsors met with researchers at the Gund Institute of the University of Vermont and asked for more details on the value of the commons. A 2008 Gund Institute Report found that common assets in Vermont were worth about \$1.2 billion per year or \$1972 per capita in Vermont. Portions of the bill have been taken up in other proposals, such as fees for groundwater use by bottling companies, closing land conversion tax loopholes, pollution fees on discharge from the state's nuclear plant, and others. In 2011 the bill was reintroduced in the state House of Representatives (H.385) by representative Chris Pearson. The bill is still under consideration (Farley et al., 2015).

With town meetings, accessible state government, a viable third party and very active civil society, the proposed VCAT incorporates Ostrom's principles. As a state government initiative, it already includes a community of members (citizens of the state) with a shared identity and purpose to manage natural and social assets sustainably for current and future generations (P1). It is designed to incorporate an equitable distribution of contributions and benefits to citizens via possible annual rebates (P2). Fair and inclusive decision making via boards and trustees answerable to the voters is incorporated in the design (P3). It incorporates monitoring of behaviours on state properties (P4) and graduated sanctions for rule breakers (P5). It uses the legal system for fair (and hopefully fast but this could be improved) conflict resolution (P6). It has the authority to self-govern (P7) and collaborate well with other groups (i.e. private landowners) and scales (i.e. local, regional and national governments; P8).

2.1.4. Earth atmospheric trust (EAT)

Under the public trust doctrine, the atmosphere and the open oceans should be treated as public assets to be held in trust (Osherenko, 2006; Wood, 2014). Various types of marine protected areas and no-take zones have been proposed as one example of this approach and it could be extended to the entire global ocean and atmosphere (Barnes, 2006).

For example, a global "earth atmospheric trust" has been proposed to treat the atmosphere as a CAT (Barnes et al., 2008; Costanza, 2015). We first discuss the way in which the trust could be funded, then the structure of the trust itself.

Funding for the trust includes:

- 1) Create a global cap, auction, and trade system for greenhouse gas emissions – all greenhouse gas emissions from all sources. Although either could work, we believe a cap, auction, and trade system is superior to

a tax system for this purpose, because the major goal is to cap and reduce emissions in a predictable way. Caps set quantity and allow price to vary; taxes set price and allow quantity to vary. The European Union Emissions Trading Scheme is an example of this approach.⁷

- 2) Auction off all permits to introduce greenhouse gases into the system. Some trading among permit holders may be allowed, but the auction of permits is essential in order to send the right price signals to permit holders. The EU trading scheme initially started by giving away the permits for free, but has recently changed to auctioning most of the permits. Unlike the EU scheme and other emissions trading schemes, permits in the EAT scheme would be issued at the point of entry into the economy rather than the point of emissions to the atmosphere. Holding climate polluters accountable for their damage is more straightforward than it might seem. Approximately 90 entities globally are responsible for introducing two-thirds of the carbon emitted into the atmosphere.⁸ This means that permits could target a relatively small number of private interests rather than the entire population. If carbon intense industries internalize their negative externalities (with its associated operational cost), this will be translated in higher prices of products and services that depend on these industries and will hasten the transition to products and services that do not.
- 3) Gradually reduce the cap to stabilize concentrations of greenhouse gases in the atmosphere at a level equivalent to 450 ppm of carbon dioxide (or better) as recommended in the Paris agreement. The price of permits will go up and total revenues will increase as the cap is reduced.

The revenues from these activities would then be deposited into an Atmospheric Trust with the following features:

- 4) It would be administered by trustees serving long terms and provided with a clear mandate, appropriate governance structures and incentives to protect the asset (the climate system and atmosphere) for the benefit of current and future generations.
- 5) Return a fraction of the revenues to all people on Earth in the form of an annual per capita payment. This amount will be insignificant to the rich, and much smaller than their per capita contribution to the fund, but will be enough to lift many of the world's poor out of poverty. It is likely that the Trust's income would rise as the cap is lowered.
- 6) Use the remainder of the revenues to enhance and restore the asset, to encourage both social and technological innovations, and to run the Trust. These funds could be used to fund renewable energy projects, research and development on new energy sources, payments for ecosystem services such as carbon sequestration, etc.

The details of this global CAT would need to be worked out using the Ostrom principles as guidelines, but a system designed with these general features would directly deal with climate change, while being fair, efficient and relatively immune to political manipulation, and it would help to alleviate global poverty.

3. Costa Rican NCAT: investing in natural capital stewardship

The 24 year old Payment for Ecosystem Services (PES) scheme of Costa Rica has become its flagship conservation program and has inspired the creation of similar schemes in many parts of the world (Salzman et al., 2018). Considering the experience and success of this PES scheme, we believe it is time for Costa Rica to again take the leadership in proposing innovative ideas for natural capital management, by redesigning this program to reflect the new national and

⁷ https://ec.europa.eu/clima/policies/ets_en.

⁸ <http://www.theguardian.com/environment/2013/nov/20/90-companies-man-made-global-warming-emissions-climate-change>.

international context, as well as increasing its level of ambition (Hernández-Blanco, 2019).

The current PES is a fund, and we propose that the new PES version 2.0 be a National Common Asset Trust (NCAT) of the type described above, similar to the VCAT proposed for the state of Vermont. Although closely related, funds and trusts are different investment vehicles. A fund collects financial resources from a diverse number of investors and then invests them in a portfolio of investments. In the case of FONAFIFO, it obtains resources from the tax on gasoline and invests them in a conservation portfolio, such as reforestation and agroforestry projects.

On the other hand, a trust is an agreement between parties, in which the assets of one party (i.e. the trustor) are transferred to the other party (i.e. the trustee) that will be in charge of maintaining the assets and its use for the benefit of a third party (i.e. the beneficiary). In the case of an NCAT, the trustor is nature and the trustee is the government of Costa Rica or its delegated authority, who will conduct actions to protect and restore the natural endowment they manage for the common good of the beneficiaries, which are all national and global citizens. Specifically, the new institutional arrangement will reward citizens that enhance the common assets (via payments), and charge for use or damage.

A key step for the design of the new scheme is the selection and assessment of the natural capital that will be considered as part of the trust. Ideally, to avoid negative externalities, the trust will be the entire natural capital of the country, and perhaps the scheme should aim towards this goal in the medium term. Nevertheless, for a first phase of the NCAT, the scheme could focus on ecosystems that have a significant land cover in the country, as well as those that have been studied the most, such as all types of forests (e.g. cloud, dry, etc.) wetlands, rivers, mangroves and coral reefs. Moreover, the trust can consider human dominated systems, such as cities and agricultural lands.

The current PES scheme only deals with privately owned land. Another key step is to broaden coverage to include wetlands and coral reefs which are already public property. Currently, these public natural assets are essentially open access, free to use, as well as free to damage, by private economic actors that obtain private economic benefits from them.⁹ Expanding the scope of implementation will therefore be a key step in reimagining the current private-forest-focused scheme.

Next, key ecosystem services have to be determined. As noted earlier, the current program functions as an input-based scheme that targets 4 ecosystem services of forests under a bundled, whole of eco-system, approach, which has worked well. We therefore propose the NCAT should continue with this approach, but expand it to more ecosystem services. This could open the program to new activities or modalities and financial mechanisms, such as the creation of payments for sustainable agricultural practices that improve pollination services, among many others. Conversely, an output and stacking approach (i.e. “pay by performance”), will be impractical and prohibitively expensive, especially due to high transaction costs related to monitoring and assessment activities.

Another key step is the creation of financial mechanisms to have the financial resources needed to fund new modalities of the scheme, as well as making the scheme resilient to financial fluctuations. Interestingly, the current PES program is vulnerable to the success of one of the most ambitious sustainable development initiatives of Costa Rica, the Decarbonization Plan, launched in 2018 with the objective of having a decarbonized economy with zero net emissions by 2050 (MINAE, 2018). The plan includes a series of measures in different sectors of the economy, where transport is the key one since it represents the largest portion of the country’s carbon footprint (Instituto Meteorológico Nacional, 2015). Reducing fossil fuel consumption will mean a direct reduction of funding for FONAFIFO who depends almost entirely on the tax on fuels to operate. Therefore, the NCAT will require new funding

⁹ For example, there is not a diving fee, despite the fact that this industry depends on healthy marine ecosystems.

sources that complement decreasing fossil fuel tax income. These funding sources ideally will be designed with the goal of incorporating negative externalities into the economic system, as in the case of pollution taxes and fines if common assets are damaged. Funding from positive externalities could come from buyers of ecosystem services, such as tourism activities paying the trust to maintain healthy ecosystems for birdwatching or diving.

While we recognize the general value of Ostrom’s principles for designing CATs, we believe that a set of more specific principles are useful for considering the design of the Costa Rican NCAT (PES 2.0) and indeed any other CAT scheme (Table 3). These *guiding* principles for CATs are inspired by, and intended to complement, Ostrom’s *design* principles and Table 3 highlights where there are overlaps.

In summary, the proposed Costa Rican NCAT is designed to incorporate Ostrom’s 8 principles (Table 1). It includes a community of members (the citizens of the state) with a shared identity and purpose (P1). It is designed to incorporate an equitable distribution of contributions and benefits to citizens (P2). Fair, inclusive, and transparent decision making with participation at multiple scales is incorporated in the design (P3). It incorporates monitoring of behaviours (P4) as well as graduated sanctions for rule breakers and appropriate reinforcement for cooperative behavior (P5). It uses the legal system for conflict resolution but will require additional mechanisms for fair local dispute resolution (P6). It can be granted the authority to self-govern (P7) and must collaborate well with other groups (i.e. private landowners) and scales (i.e. local, regional and international national governments) (P8).

4. Public/private partnerships and CATs

Common property and private property are not mutually exclusive, given the complexity of ecosystems. We need more nuanced and multifaceted property rights regimes to build successful CATs. For example, the existing and proposed PES systems in Costa Rica engage private farmers that are producing public benefits on land with a mixture of property rights regimes. We can think of CATs as an institutional mechanism to manage complex assets that benefit both public and private interests.

A key piece of information in managing this partnership is assessing the relative “return on investment” to each party. Private investments in managing a forest will have a mixture of private and public returns. Likewise, public investments in managing the same forest will also have a (probably different) mixture of private and public returns. An ability to estimate the relative value of the public and private returns to these investments will enable stronger incentives for joint investments and partnerships. There is a huge amount of research underway to better measure, monitor and value natural capital and ecosystem services (Costanza, 2020; Leach et al., 2019). For example, the measurement and accounting standards being finalised in the System of Environmental-Economic Accounting (SEEA) would support CAT development and application (Dvarskas, 2019; Hein et al., 2015). The ability to better measure and monitor the relative contributions and benefits from public and private investments would greatly enhance the ability to attract and utilize those investments.

For example, Fig. 3 shows the possibilities for public and private returns to investments in natural capital in terms of the spectrum of ecosystem services they can provide. If we can estimate the total value of the ecosystem services provided by these investments, divided into their private, marketable benefits (i.e. provisioning services and some cultural services like recreation) and their non-marketable public benefits (i.e. supporting, regulating, and other cultural services) then we can optimize the relative investments for the public and private parties.

A CAT can manage and monitor these investments. For example, a CAT for coral reef management could have investments from onshore tourism operators, local commercial and sport fishers, and the government. The private returns would be better dive tourism revenues, fish harvest, and sport fishing revenues. The public benefits would be the

Table 3
Guiding principles of the Costa Rican NCAT. Ostrom’s design principles are noted (P#) where they relate to these guiding principles.

Guiding principle	General description
1. Stewardship responsibility.	The trustee has the mandate to sustainably manage the trust through conservation and restoration activities, recognizing the limits of the system, in this case the trust, to provide services and to withstand negative impacts. (P1)
2. Systems thinking.	PES modalities and its financial mechanisms should consider the socio-ecological system, with a focus on improving the ecosystem health and the wellbeing of its beneficiaries (P1). Furthermore, the NCAT should have a landscape approach for the implementation of its activities, considering the connectivity between ecosystems and cross-scale interactions (P7, P8). Finally, the scheme should acknowledge that several ecosystem services are protected or restored at the same time under the managing activities that the NCAT will propose.
3. Additionality.	The implementation of the activities of the scheme should be additional to any initiative or legal instrument already in place. Therefore, paying strictly for forest conservation in private property would stop being a priority under the NCAT, since deforestation is illegal in the Forest Law and therefore these ecosystems are theoretically already protected (P2).
4. Conditionality.	Related to additionality, the NCAT should enforce an innovative monitoring and assessment system (P4), through the use of modern technologies such as Earth Observation and drones, to ensure that activities are being implemented as they were designed and established under the contract with the supplier or implementer of the ecosystem services. Therefore, payments should be conditional to the successful implementation of the activities and fines for damages to common assets should be implemented in a graduated way (P5, P6).
5. Efficiency.	The selection of the areas to invest with conservation and restoration activities should be determined through a set of criteria that could include health, level of threat, ecosystem service provision intensity, uniqueness and biodiversity, among others, as determined by the trustees in collaboration with citizens and local governance structures. Socio-economic variables could be included as well. Consideration should also be given to local governance capabilities such that the trusts limited funds are used wisely to create the highest returns/benefits (P3, P7). Moreover, the NCAT should maintain low transaction costs, which can be achieved through the implementation of an input-based and bundled approach, as well as through the targeting strategy described before.
6. Financial sustainability.	The trust should secure a minimum amount of funding every year, through a combination of financial mechanisms that will be resilient to social-economic stressors and variability. The financial mechanisms should be adjusted as necessary, some can be eliminated and others can be created over time (P7).
7. Intersectoral participation.	The scheme should operate under a participatory approach, integrating the academy, business, non-governmental organizations, indigenous and local, communities, among others (P3). From the supply side, these sectors or stakeholders will help in designing the conservation and restoration activities, as well as with their implementation (P1, P7). From the demand side, these stakeholders will be benefit in different ways from these activities, depending on variables such as location and economic activity, but independently of this the NCAT should secure equitable and sustainable distribution of ecosystem services to them (P2).
8. Legally sound.	A set of laws, regulations and policies should be modified, created or eliminated, in order to ensure a legal framework that enables the implementation of the scheme and secure the necessary financial mechanisms that will sustain it over time (P2, P3, P4, P5, P6). Furthermore, current and new regulations should enable an equitable governance of the NCAT.

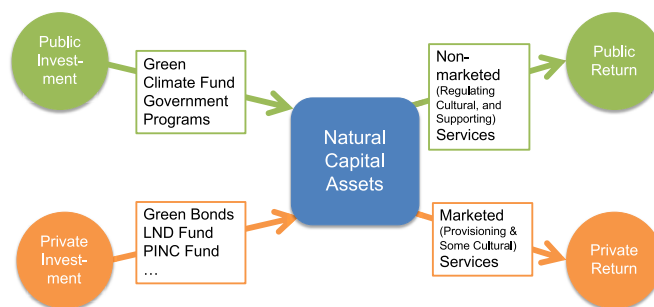


Fig. 3. Public and private investments and returns to investments in natural capital assets.

regulating services of coral reefs for protecting against storms, carbon sequestration, aesthetic, scientific, and cultural benefits.

Suppose, for example, that the private, marketable benefits from better management of the reef were estimated to be worth \$10 million/yr., while the public benefits were estimated to be worth \$15 million/yr. Suppose, also, that a total investment in the coral reef by the CAT of \$2.5 million/yr. was required to achieve these benefits. This would argue that the private interests should contribute \$1 million/yr. while public investment by the government should be around \$1.5 million/yr. Both parties would be getting a 10-1 return on their investments. Of course, it would be a bit more complicated, since investments and returns would be spread over time and would involve risk and uncertainty. But better valuation of the ecosystem services resulting from investment in natural capital assets, combined with the management and monitoring of the ecosystem via a CAT, can lead to better public-private partnerships and better, more sustainable, management of ecosystems. The new CAT for Costa Rica described above can facilitate just these kinds of investments and partnerships.

5. Conclusions

Common Asset Trusts (CATs) are effective institutional structures for managing and monitoring complex natural capital assets in ways that are consistent with Ostrom’s 8 design principles. Versions have been successfully implemented at various scales. We have proposed to expand these applications to better manage natural capital and ecosystem services as common assets and showed how, for example, Costa Rica may again lead the way by implementing a national CAT to manage all of its terrestrial and marine natural capital assets. New methods for modeling, measuring, and valuing NC and ES make these applications feasible and also facilitate better public-private partnerships.

To achieve a sustainable and desirable future, we need a more nuanced balance of private, public, and community property rights and responsibilities. CATs based on Ostrom’s 8 core principles can help design and implement this more balanced approach at a range of spatial scales.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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