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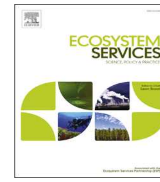

Evaluating the outcomes of payments for ecosystem services programmes using a capital asset framework

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A B S T R A C T

There is a limited understanding of the conditions under which payments for ecosystem services (PES) programmes achieve improvements in ecosystem service (ES) flows, enhance natural resource sustainability or foster sustainable livelihoods. We used a capital asset framework to evaluate PES programmes in terms of their social, environmental, economic and institutional outcomes, focusing on efficiency, effectiveness and equity trade-offs. We found that PES schemes can provide positive conservation and development outcomes with respect to livelihoods, land-use change, household and community incomes, and governance. However, programmes differ with regards to contract agreements, payment modes, and compliance, and have diverse cross-sector institutional arrangements that remain primarily state-structured and external donor-financed. There is a consistent lack of focus on evaluating and fostering human, social and institutional capital. This reflects general inattention to how PES programmes consider the causal links between ES and outcomes. To enhance ES production and PES scheme accessibility and participation, we recommend strengthening the linkages between ES production and land-use practices, boosting private and voluntary sector involvement, encouraging property rights and tenure reform, improving financial viability, and adequately accounting for the distribution of programme costs and benefits among participants.

1. Introduction

The application of market-based incentive (MBI) mechanisms to deal with the challenges of landscape and environmental protection, climate mitigation, wetland restoration and biodiversity conservation is growing (Gómez-Baggethun et al., 2010; Muradian and Rival, 2012; Pirard, 2012). This signals an underlying shift in national and international natural resource use policy (Farley and Costanza, 2010; Pokorny et al., 2012). The emergence of MBIs have been justified on the grounds that they correct market failures, reduce information asymmetry, provide price signals for decision makers, and bridge the conservation funding gap (Gomez-Baggethun and Ruíz-Perez, 2011; Pirard, 2012).

Despite these endorsements concerns remain. For some, MBIs represent a plurality of 'hybrid governance' instruments that conflate conceptually different philosophies and mechanisms (i.e., rewards, incentives, markets), often addressing social–environmental problems not externalities arising from market failures (Muradian and Gómez-Baggethun, 2013; Muradian, 2013). There are also doubts over the ability of MBIs to adequately secure the provision of public goods and common pool resources (Muradian and Rival, 2012; Van Hecken and Bastiaensen, 2010; Kinzig et al., 2011; Lockie, 2013) whilst providing cost-effective policy (Kemkes et al., 2010). Other challenges include potential misapplication of MBIs (Lockie, 2013); the propensity to commoditize nature (Kosoy and Corbera, 2010), which could lead to reductions in ecological complexity and a 'commodity fiction' (Gomez-Baggethun and Ruíz-Perez, 2011; Muradian and Rival, 2012; Robertson, 2012); and the perception that MBIs represent encroaching neo-liberalist interventions (McAfee and Shapiro, 2010; McElwee, 2012; Arsel and Büscher, 2012; McAfee, 2012; Shapiro-Garza, 2013).

Nonetheless, the MBI model has been applied in many developing countries in the form of payment for ecosystem services (PES) programmes (Shelley, 2011; van Noordwijk et al., 2012; Tacconi, 2012; Derissen and Latacz-Lohmann, 2013) as a policy tool intended to address a spectrum of land management challenges (Landen-Mills, 2002; Landell-Mills and Porras 2002; Wunder, 2006; Engel et al., 2008; Bond and Mayers, 2010). PES has been presented as an alternative to traditional command-and-control approaches, which through encouraging more decentralised management has the potential to advance both conservation

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and rural livelihood development goals (Ferraro and Kiss, 2002; van Noordwijk et al., 2007; Agrawal et al., 2008; Pokorny et al., 2012; Muradian and Rival, 2012).

However, the widespread adoption of PES masks important issues (Pirard et al., 2010). The validity and suitability of formulating PES theory on Coasean grounds has been challenged because of the complexity, uncertainty, and asset specificity involved in managing ecosystem services (Farley and Costanza, 2010; Kosoy and Corbera, 2010; Muradian et al., 2010; Vatn, 2010; Muradian, 2013). Some argue that win-win conservation and development outcomes are likely if programmes are well designed (Pokorny et al., 2012; Kinzig et al., 2011), while others regard this as too optimistic given the influence of diverse contingent factors (Redford and Adams, 2009; Muradian et al., 2013). A number of practical obstacles may also hinder PES implementation: scheme design and payment structure (e.g., Engel et al., 2008; Kelsey Jack et al., 2008; Kemkes et al., 2010; Adhikari and Boag, 2012); modes of implementation (e.g., Engel and Palmer, 2008; Zhang and Pagiola, 2011); managing trade-offs arising from the need to balance efficiency, effectiveness and equity (e.g., Borner et al., 2010; Pascual et al., 2010, Narloch et al., 2011); institutional embeddedness and propensity to cooperate (e.g. Muradian et al., 2010; Vatn, 2010); spatial targeting, monitoring, participation, and compliance (e.g. Wünscher et al., 2008; Wendland et al., 2010); the adequacy of property rights (Lockie, 2013); and social and well-being outcomes (e.g. Bulte et al., 2008; Pattanayak et al., 2010; Daw et al., 2011) (Supporting information Table S1).

What, then, do these theoretical and practical debates mean for future PES prospects? Given that PES adoption will continue (Bond and Mayers, 2010), it is necessary to jointly assess both environmental and social effects to ensure long-term PES validation and effectiveness (Kelsey Jack et al., 2008; Farley and Costanza, 2010; Brouwer et al., 2011). To this end, we conducted a systematic review of the measured environmental and socio-economic outcomes of PES programmes. Systematic reviews are used widely in medical (Popay, 2006) and ecological sciences (Sutherland et al., 2004; Pullin et al., 2009) to gather evidence and generalise findings. We structured our review using a capital asset framework (CAF). The CAF originated as a rural livelihood assessment tool emphasising the interactions between individual- and community-level assets, and how collective action could be used to maintain various assets and resource flows to nurture local empowerment and foster development (Carney, 1998; Bebbington, 1999; Rudd, 2000; Green and Haines, 2008). The CAF connects socio-ecological context, institutional structure, the effects of changes in capital asset and their resource flows, and options for economic or political interventions based on actors' or societal values (Rudd, 2004). It has been used in diverse situations to analyse the transformative ability of assets to support rural livelihoods and reduce poverty in the Andes (Bebbington, 1999), assess poverty alleviation opportunities of a compensation-reward scheme for ecosystem services (van Noordwijk et al., 2007), identify barriers to the adoption of agricultural greenhouse gas mitigation measures in rural communities (Dulal et al., 2010), and appraise capacity-building requirements for tourism development in gateway communities bordering protected areas (Bennett et al., 2012).

We assessed the extent to which PES programmes represent effective environmental management tools based on their effects on social, environmental, financial and institutional capital assets. Our goal was to provide a means of appraising PES studies (and the programmes they describe) in a manner that enables improvements in scheme design, application and implementation. We systematically collated, consolidated and analysed PES literature describing specific programmes and the 'measured outcomes' of those programmes. We also collated observed barriers to PES uptake and the potential opportunities for enhancing PES programme success. Our approach builds on work by Wunder et al. (2008), Daniels et al. (2010) and Pattanayak et al. (2010) but, by adopting a CAF approach, introduces a new means by which PES programme management interventions can be systematically appraised.

2. Materials and methods

Following various guidelines for systematic and related reviews (e.g., Petticrew and Egan, 2006; Cooper, 2010; Centre for Evidence-Based Conservation, 2013) our sequential four step process to the systematic review (Fig. 1) proceeded from evidence gathering to critical analysis.

2.1. Step 1 – search strategy

Relevant studies were located via three sources: scientific databases; internet searches and websites; and journal special issues. Databases we searched included: ISI Web of Knowledge (all databases); Science Direct (SciVerse); Scirus; and OvidSP (see Supporting information Table S2 for search details). Internet searches were performed using Google (Supporting information Table S3). Searches used combinations of keywords and the first 50 hits retrieved were checked for relevance (Davis and Pullin, 2006; Bowler et al., 2010). We searched websites of specific organisations with known MBI expertise and involvement (e.g., FAO, World Bank, Global Environment Facility, WWF, Conservation International, Ecosystem marketplace, Watershed Markets, Katoomba group, World Agroforestry Centre and Centre for International Forestry Research). Journal special issues focusing on PES included three from Ecological Economics (65 (4), 69 (7), 69(11)), and one each from Journal of Sustainable Forestry (28 (3–5)) and Environmental Conservation (38 (4)). We restricted our source documents to those written in English but made efforts to locate English translations of non-English documents whenever possible. All document types were accepted (e.g., articles, conference papers, theses, chapters and reports as long as the provenance of the texts could be verified).

2.2. Steps 2 and 3 – document screening

The preliminary screening process focused on article title and abstract relevance, and used a standardised protocol applied to all documents to generate a first cut of 'relevant' articles (Supporting information Table S4). A second, more detailed, screening was applied to those documents to obtain the final sample frame; we considered article type, theoretical content, and empirical evidence, and used a standardised protocol (Supporting information Table S5) in conjunction with additional study inclusion and exclusion criteria (Table 1).

2.3. Step 4 – critical analysis

Following Wunder et al. (2008), Pattanayak et al. (2010), and Daniels et al. (2010), we pursued three appraisal avenues to assemble our collection of studies: study appraisal (i.e., detailing the principal methodological characteristics of each study); PES programme evaluation (i.e., the application of the CAF to assess programme outcomes); and PES programme deconstruction (i.e., dissecting the operational, institutional, and financial arrangements of the specific projects identified within the collection of studies) (Fig. 2). For each aspect, standardised coding protocols were employed to extract relevant information systematically and

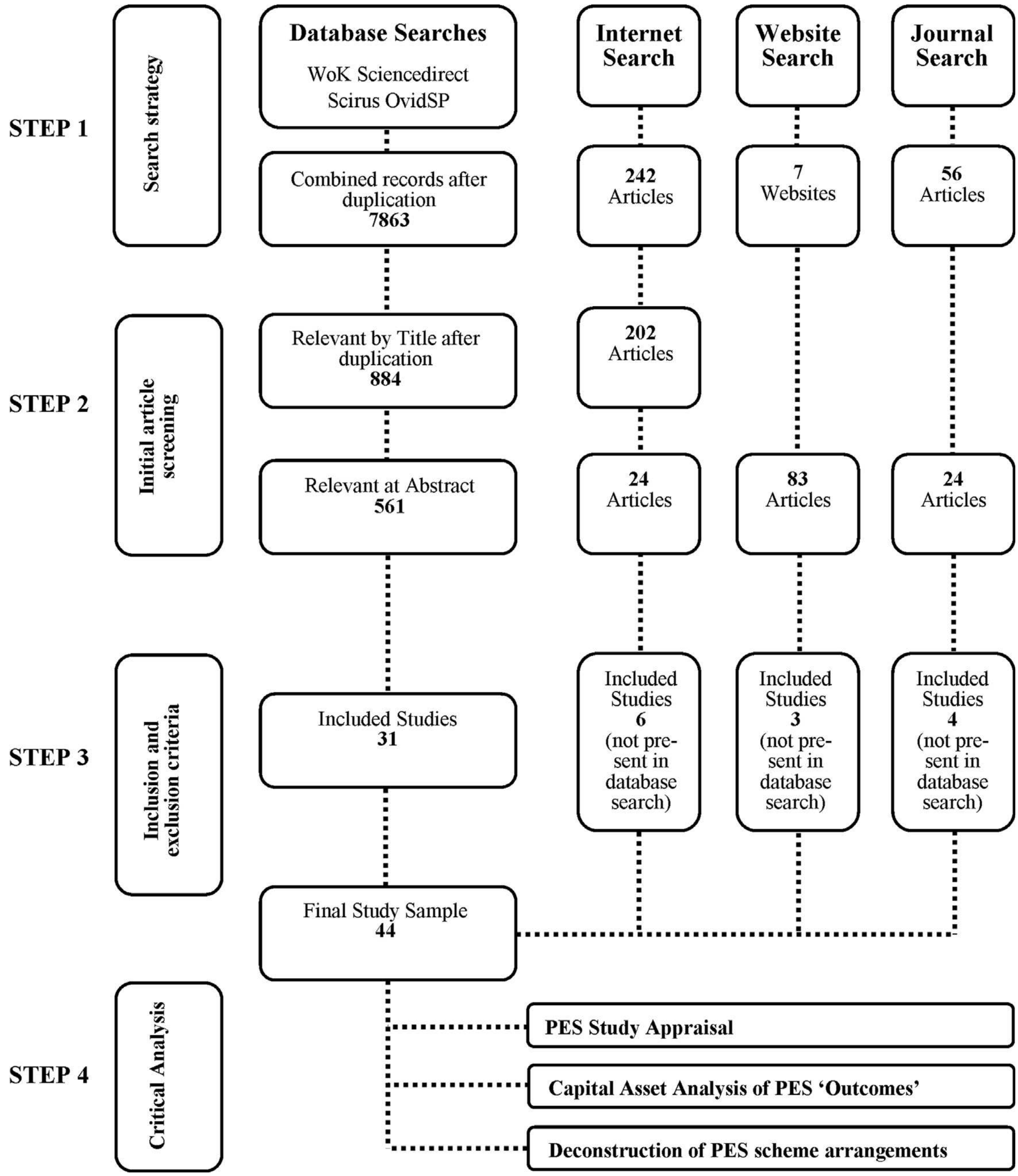

Fig. 1. Flow diagram outlining the four steps of the systematic approach.

accurately across all studies (Supporting information Tables S6–S12 [data available upon request]).

Capital asset data were of two types. First, some data reflected the interpretation of theoretically relevant attributes for various assets. Second, in situ 'measured outcomes' were detailed for individual studies. Those 'measured outcomes' we considered to represent 'effective' (i.e. beneficial or positive) programme impacts are detailed in Table 2. A number of capital asset categorisations are recognised in the literature, from natural, human, social, cultural and produced (built, physical, or manufactured) capital (Bebbington, 1999) to financial and political capital (van Noordwijk et al., 2007; Bennett et al., 2012). Our framework consisted of human and social capital as an aggregated asset, natural capital, financial capital, and institutional capital that focused on conservation-relevant and development-relevant properties, characteristics or evaluation qualities. In other words, our 'conservation-development perspective' focused on those aspects relevant to those particular contexts (e.g., social mobility, access to social resources, land-use types, changes in ecosystem services, payment distribution and equity, and institutional accountability and transparency).

Natural capital refers to the structure, function and flows of ESs to humans as well as the land management practices and changes in those practices that PES programmes may cause (Costanza and Daly, 1992; Daily, 1997, van Noordwijk et al., 2007). Financial capital relates to the wealth of households and communities, the flow of funds available for undertaking activities and payment distribution and equity (Rudd, 2004; Bennett et al., 2012). Human capital constitutes skills, knowledge, experience, and health at the individual level (Rudd, 2004; Brondizo et al., 2009; Behrman, 2011; Winters and Chiodi, 2011; Bennett et al., 2012; Moav and Neeman 2012), while social capital refers to social structure and

Table 1
Inclusion and exclusion criteria applied to select and determine the study sample.

Inclusion criteria	Exclusion criteria
(1) The intervention being assessed by a study is wholly or primarily PES focused, where an intervention is defined as An environmental externality addressed via a payment (which may or may not be performance related) received by a seller or provider of an environmental service from a private company, NGO, local or central government agency. The user is distinguishable from the seller, who is not a central government agency. The buyer *does not have complete control* over the production of the outcome, whereas the seller has *partial or total control* over the production of the outcome. Voluntary in principle on the supply side. (Based on adjustments to Wunder's (2005) definition by Porras et al. (2008) and Ferraro (2009)) (2) The influence of PES interventions on specific environmental, socio-economic and/or institutional outcomes ought to be identifiable	(1) PES intervention is not the main aspect of the study assessed (2) Articles focused on other market-based instruments, specifically: • Cap and trade schemes • Biodiversity banking (biodiversity offsetting, conservation banking and wetland banking) • North American and EU agri-environment schemes • REDD/REDD+ (3) No detailed information regarding programme environmental, social, economic or institutional outcomes (4) General PES discussion/opinion papers concerning broad themes rather than specific PES programmes and their impacts

relations that contribute to flows of norms and reputation-based trust (Bebbington, 1999; Rudd, 2000; Adler and Kwon, 2002; Brondizo et al., 2009). Finally, we use the term institutional capital to refer to aspects of resource governance and institutional transparency and accountability. Elsewhere, institutional capital has also been referred to as the structural attributes of organisations, institutional norms, and the capacity to build competencies (de los Hoyas and Antunez Diaz, 2012; Valente, 2012). While what we denote as institutional capital reflects features of human and social capital, the scope of this asset does not fit neatly within common conceptions of human or social capital. In light of this we consider it justified to include a separate asset that considers the wider institutional, organisational and governance-related perspectives of a specifically environmental management intervention.

3. Results and discussion

3.1. Critical analysis: study appraisal

We used a total of 44 studies in our analysis (Table 3). They were primarily from the peer-reviewed literature (71%) and in total considered 23 PES programmes operating at local and national scales in 13 countries (Supporting information Table S13). We found scholarly work concentrated largely on implementation and outcome evaluation, primarily in relation to natural and financial capital. The main geographic focus was Latin America, which has historically been the main testing ground for PES. However, PES initiatives were also identified in Asia (particularly China) and Africa, although these programmes were fewer in number.

Our cases employed multiple theoretical approaches to assess programme outcomes and highlight the discourses and drivers promoting the contextual development of PES. Eighty four per cent of studies were multi-modal, using one or more theoretical approaches and evaluation measures (Fig. 3). In general, studies assessed programme additionality (66%), livelihood sustainability (22%) and participation (20%). They situated programme-level developments within a predominantly historical (82%) and environmental conservation (95%) frame of reference that emphasised land-use change (98%), water protection (55%) and climate mitigation (50%) as the principal drivers of scheme introductions (Fig. 4). Similarly, in their regional analysis of payments for watershed services (PWS) in Latin America, Martin-Ortega et al. (2013) identified deforestation and loss of land cover to be a comparable driver (77%) of PWS scheme development. Poverty alleviation, surprisingly, was mentioned in only 27% of cases as a key driver of PES development despite the increasingly pro-poor rationale for PES and the recognition of the effects that poverty can have on natural capital (Bulte et al., 2008).

Various experimental designs were employed across the studies. Comparative matched-sample approaches commonly focused on qualitative assessments achieved through survey-related methodologies. However, relatively little attention was paid to assessing social and institutional factors and developing more explanatory social–ecological models (Fig. 5). Studies exhibited an array of sampling (66%), methodological (75%) and analytical (27%) limitations (Fig. 6).

3.2. Critical analysis: evaluating programme arrangements and outcomes

3.2.1. Human and social capital

Ecosystem services contribute to livelihood development at different spatial scales and through varying combinations (Willemen et al., 2013). Meeting development needs, alleviating poverty, and enhancing well-being are increasingly important roles for PES (Bulte et al., 2008; Lipper et al., 2009; Daw et al., 2011). However, only 52% of studies we assessed specifically evaluated human and social capital implications of PES programmes. The lack of focus on PES social dimensions may reflect the general division in the research community between those that view PES as a development tool (e.g., Muradian et al., 2010) and those arguing its development function is (and should be) secondary to its conservation function (e.g., Wunder, 2008). Milder et al. (2010) argue that the extent and influence of pro-poor PES have been inadequately quantified. While this is certainly the case, evidence from our study indicated that programmes can have a general, albeit conservative, positive social impact. Certainly a lack of evidence concerning the social impact of PES on non-participant households within targeted communities needs further investigation (Huang et al., 2009).

In part, the confusion regarding the social impacts of PES programmes, outlined in the preceding paragraph, arises due to the difficulties in comprehensively identifying potential ES beneficiaries and understanding how different programme strategies are likely to influence the distribution and magnitude of ES supply (Willemen et al., 2013). This suggests that PES may unrealistically promote win-win outcomes by simplistically claiming to have resolved the problems faced by earlier Integrated Conservation and Development Programmes (ICDPs) (Muradian et al., 2013). Research in Mexico, for example, has suggested that PES enhances a short-term utilitarian view of conservation (Rico García-Amado et al., 2013). In contrast, ICDPs are perceived as long-term conservation endeavours designed for specific community-level developments but may not be viable economically (Rico García-Amado et al., 2013). It is significant that the human and social

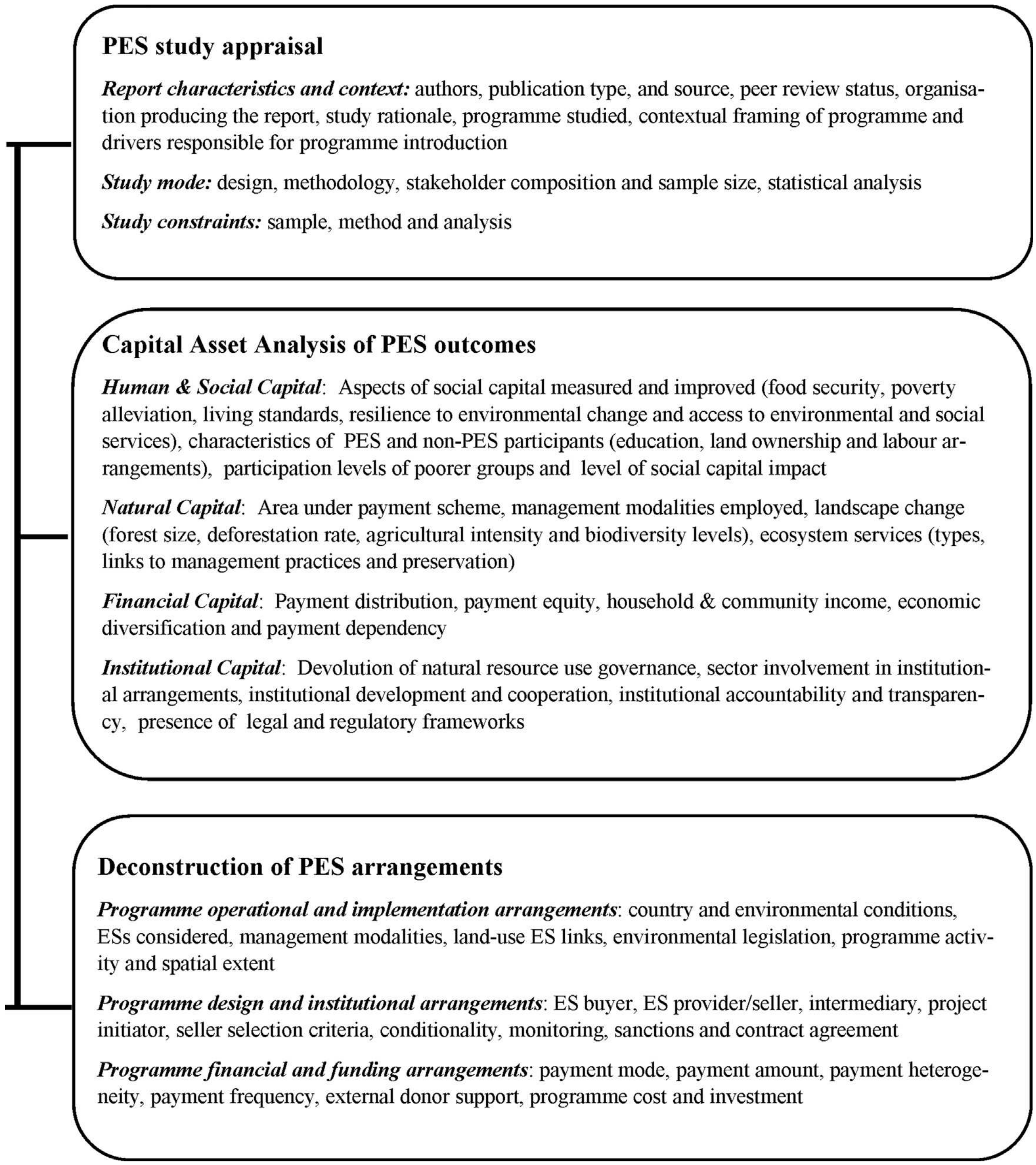

Fig. 2. Critical analysis: a three part process comprising study appraisal, capital asset evaluation of PES 'outcomes' and deconstruction of programme arrangements.

capital measured outcomes in PES have quite broad human development implications relating to living standards (26% of studies examined), better access to environmental and social services (26%), poverty alleviation (17%), food security (13%), and resilience to environmental change (11%). These outcomes bolster recent commentaries advocating a realistic approach to PES design based on achieving attainable objectives (Muradian et al., 2013) and alignment of PES and ICDP practices that captures their respective benefits (Rico García-Amado et al., 2013).

The socially transformative capacity of PES is linked to scheme access, which is underpinned by eligibility and participation (Mahanty et al., 2013). A number of investigations have evaluated the extent to which ES sellers have benefitted from programme participation. The results have been mixed, although marginal benefits have been identified at the household and community level (Milder et al., 2010). Twenty-nine per cent of studies in our review viewed the ability to access relevant scheme information as a major barrier to participation. In this respect social status and wealth may affect PES participation rates even when eligibility is not an issue (Mahanty et al., 2013). For example, where examined, those wishing to sign-up for entry into a PES programme were wealthier, better educated, owned larger tracts of land and were more socially mobile compared to non-participants. This supports the view (Mahanty et al., 2013) that skill level, education and negotiating ability are important determinants of scheme participation. Furthermore, poor economic development policies can constrain pro-poor livelihood strategies by failing to recognise the underlying characteristics of the poor (Smith, 2005; Fisher et al., 2008).

Stakeholder and community participation is vital for promoting individual and community empowerment, enabling access to resources and information, developing wider support networks and access to markets, and securing economic stability and land reform (Smith, 2005; Fisher et al., 2008). Tenure arrangements, community

Table 2
CAF categorisation of ‘effective’ PES programme ‘measured outcomes’.

Capital asset	‘Measured Outcomes’ of PES programmes judged ‘Effective’[a]
Natural capital	• Increase in forest size, protected area extent and decrease in deforestation • Reduction in agricultural intensity • Alteration in agricultural practices (e.g. adoption of programme modalities) • PES specifically acknowledged to be an effective and efficient mechanism to induce changes in land-use • PES activities undertaken in areas of poor environmental condition • Improvements in biodiversity (e.g. conservation of a specific species) • Ecosystem service(s) identified • Ecosystem service provision assessed • Link between management practice and ecosystem service production • Ecosystem service(s) preserved
Financial capital	• Small landholders receiving payments • Medium landholders receiving payments • Observed increase in household income • Diversification of household economic activities • Improved distribution of material wealth • Payments favour poorer land owners • PES participants more reliant on payments for household finances (i.e. better targeting of poorer sectors) • PES participants have more diverse income streams than non-participants (i.e. more economically resilient) • Payments are sufficient to meet household needs and/or provide a suitable alternative income stream
Institutional capital	• Community control over natural resource-use • Decentralised administration control over fund disbursement and contract awards • Greater involvement of local institutions • Improved institutional relationships and cooperation • Institutional accountability assessed • Increased institutional accountability and transparency • Increased transparency in funding chain • Providers more accountable to beneficiaries • Legal and regulatory measures in place to ensure proper resource-use
Social and human capital	• Improved food security • Reduction in poverty • Improved living standards • Resilience to environmental change • Better access to social and environmental services • Increased poorer household participation

[a] We can say that there are certain ‘measured outcomes’ that are representative of an ‘effective’ PES programme. Here, our use of the word ‘effective’ implicitly acknowledges that a ‘measured outcome’ is positive or beneficial in some way. There is no predefined exogenous objective protocol for determining what ‘measured outcome’ is deemed ‘effective’; determination is rather both normative and common sensical. These ‘measured outcomes’ derive from the coding applied to assess each individual study engaged in evaluating a PES programme.

capacity, and coherent livelihood development strategies are critical issues for stimulating participation (Brewer et al., 2014). Despite the centrality of participation to programme success, its evaluation – particularly in relation to poorer households – is largely ignored, highlighting the limited role of social embeddedness in PES evaluation (Muradian et al., 2010). This sentiment is illustrated in our analysis, where only 27% of prior studies explicitly recognised the need to improve poorer household uptake rates.

The choice of ES providers is fundamental for PES to achieve significant poverty alleviation (Muradian et al., 2010). The chosen selection model must balance efficiency, effectiveness, and equity trade-offs (Unisfera International Centre et al., 2004) with fairness (Pascual et al., 2010) while maintaining cost-effectiveness (Chen et al., 2010). Ultimately, selection should reflect participant socio-economic circumstances and biophysical properties likely to maximise ES provision. We found most service sellers were farmers (51%), communal landholders (23%) and indigenous communities (14%), with 70% of programmes targeting one seller group. The selection of those sellers was often made primarily on ecologically important criteria (e.g., priority areas, biophysical conditions, strategic service site location, land and farm characteristics, herd size and livestock and the production of a management plan). The use of multiple criteria was generally low; 78% of programmes stipulated just one or two selection criteria. Still, this suggests natural capital optimisation over social capital maximisation, as most programmes considered few, if any, social criteria in their eligibility requirements. Bolivia's Los Negros programme is a case in point: the programme's criteria automatically excluded the poorest landless immigrants living within the PES implementation zone (Aquith et al., 2008).

Even where social criteria were considered (e.g., the Social Development Index devised for Costa Rica's PSA programme), they may be fundamentally at odds with the scale at which they need to operate (Porras, 2010; Matulis, 2013). The result may be the potential exclusion of large numbers of poorer households and de-emphasising social welfare concerns in programme design and implementation (WRI, 2005). However, in some cases, particularly in relation to China's Sloped Land Conservation Programme (SLCP), evidence suggests that poorer members of society were effectively captured by PES programmes. Liu et al. (2008) suggest that 30 million farming households have benefitted directly from the SLCP. There was a strategy to target poorer marginalised households and communities to enhance SLCP impact (Yin et al., 2013).

Table 3
A summary of the final selected articles: their geographical focus, the PES schemes investigated and their scale of operation.

Geographical location	No. of studies[a]	PES programme and scale: local (L), regional (R), national (N)
Costa Rica	16	PSA[b] (N)
Mexico	7	PSAH[c] (N), PSA-CABSA[d] (N), Fidecoagua (L)
Ecuador	4	Pimampiro (L), PROFAFOR[e] (R), SocioBosque (L)
Nicaragua	4	RISEMP[f] (L), PPSA-H[g] (L), San Pedro del Norte – PASOLAC[h] (L)
Bolivia	2	Los Negros (L), NKMCAP[i] (L)
Columbia	1	RISEMP (L)
Honduras	1	Jesus de Otoro – PASOLAC (L)
Brazil	1	Bolsa Floresta (L)
Madagascar	2	Durrel Conservation Trust PES Scheme (L)
Mozambique	1	Carbon Livelihoods Project
Kenya	1	WKIEMP[j] (R)
Cambodia	1	Payments for wildlife friendly products, community-based ecotourism, bird nest scheme (L)
China	5	SLCP[k] (N), NFP[l] (N)

[a] 44 Case studies. The numbers do not sum to 44 as some studies focused on more than one PES programme.
[b] Pagos por servicios ambientales.
[c] Payments for hydrological environmental services.
[d] PES programme for carbon sequestration and biodiversity conservation.
[e] Programmea Face de Forestaciûn del Ecuador.
[f] Regional Integrated Silvopastoral Ecosystem Management Project – operates transnationally but in each area at a local level.
[g] Proyecto de Pagos Por Servicios Ambientales Hidricos.
[h] Programma para la Agricultura Sostenible en Laderas da América Central – operates transnationally but in each area at a local level.
[i] Noel Kempff Mercado Climate Action Project.
[j] Western Kenya Integrated Ecosystem Management Project.
[k] Sloping Land Conversion Programme.
[l] National Forest Programme.

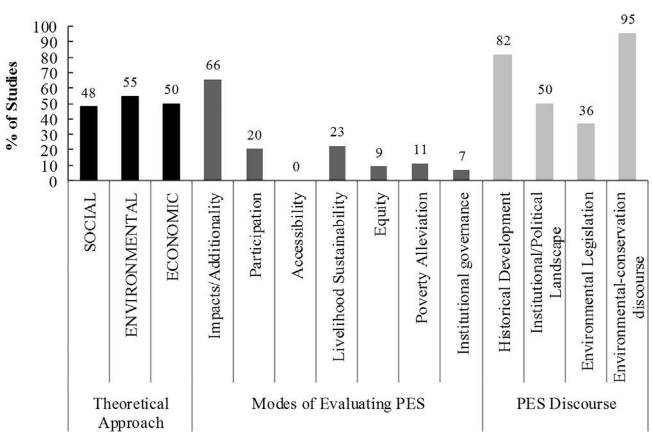

Fig. 3. Theoretical approaches applied by PES studies: emphasising the discourse in which PES development is situated.

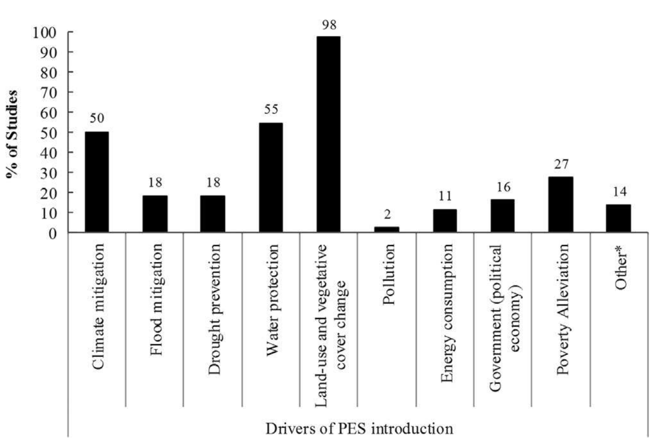

Fig. 4. Drivers motivating PES scheme development. *Other refers to: urbanisation, population expansion, food security and biodiversity threat.

3.2.2. Natural capital

We found programmes extended across multiple landscape types operating mainly in agricultural (74%) and tropical rainforest and dry forest landscapes (65%). They ranged from lowland (69%) to highland (48%) geographies and across rural areas (52%). These broad landscape configurations mask high levels of heterogeneity, even over small ranges, with most being multi-functional landscapes dominated by smallholder farmers (Tscharntke et al., 2012). Most programmes (91%) were implemented over spatial scales encompassing three or more distinct landscapes types, and focused principally on delivering hydrological/watershed (52%), carbon/forest (61%), biodiversity (56.5%), and food and fibre (22%) services.

Despite landscape multi-functionality, only a few programmes targeted ES bundles (e.g., PSA in Costa Rica, Socio Bosque in Ecuador). Our findings contrast with Martin-Ortega et al. (2013), who found 73% of PWS transactions involved bundled services. Ingram et al. (2014) recently argued that bundling and stacking ESs can reduce the risks associated with unstable markets. However, 78% of programmes we examined focused quite narrowly on one or two ESs. Similarly, with respect to the land-use practices adopted by participants, 74% of programmes relied heavily on one or two management practices to achieve ES provision. The assumption that individual or coupled land-use practices are sufficient to generate ESs at adequate rates, spatial scales, and levels of availability currently informs most PES programme design (Schomers and Matzdorf, 2013). In total, 84% of studies that we examined measured aspects of natural capital primarily through documenting land-use changes, rather than focusing on the provision of jointly-occurring ESs. Land-use change is likely a poor proxy for ES provision because change occurs, generally, as a consequence of utilising just one or two land-use practices. This is insufficient to guarantee service supply especially in the case of multiple ESs (Bennett et al., 2009; Raudsepp-Hearne et al., 2010). Further, failing to acknowledge the connections between targeted ESs in PES programmes hinders the ability to assess ES provision, distribution and trade-offs, as well as to identify adequately factors

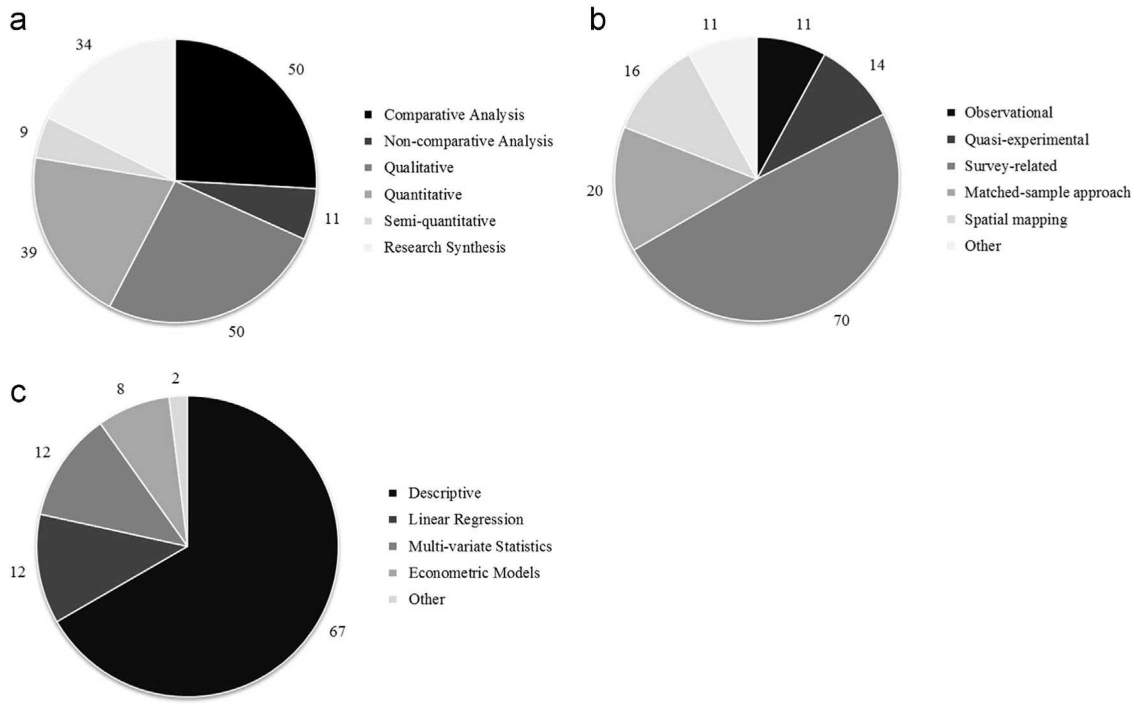

Fig. 5. (a) Study design (b) Study mode (c) Data analysis. All numbers refer to percentage of studies.

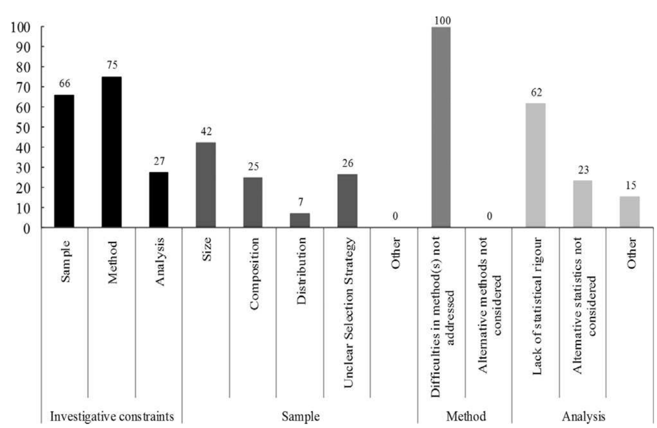

Fig. 6. Investigative constraints of reviewed studies at the sample, method and analysis stages. All numbers refer to percentage of studies.

affecting service delivery such as the extent and type of land-use practices adopted by participants (Bürkhard et al., 2010; de Groot et al., 2010). Not accounting for this information could increase transaction costs, lead to contradictory regulations, degrade market compatibility, and forfeit potential win-win opportunities (Deal et al., 2012).

Similar to other research (Landen-Mills and Porras, 2002; Wunder et al., 2008), we found land-use practices were frequently geared towards forest protection (65%), reforestation and afforestation (52%), and reductions in extractive activities (30%). However, the extent to which these land-use practices deliver ESs is dependent upon high adoption rates and consistent employment by participants (Wunder et al., 2008). Adopted land management practices were generally regarded as effective in producing the stipulated land-use changes. In Colombia's Regional Integrated Silvopastoral Ecosystem Management Programme (RISEMP), for example, significant reductions in degraded pasture (78.3–7.1 ha) and natural pasture without trees (721–239 ha) alongside increases in improved pasture with high tree density (2.2–266 ha) were observed (Pagiola et al., 2010). At the global scale, increases in forest extent and decreases in deforestation rates were fourfold more frequently identified than reductions in forest size and increases in deforestation rates. For example, China's SLCP converted 408,000 ha yr^{-1} of cropland to forest and grassland during the initial pilot phase (1998–2001), and a further 2.3 million ha yr^{-1} from 2002 to 2003 (Bennett, 2008). Furthermore, one-third of studies demonstrated a notable reduction in the degree of agricultural intensity undertaken within project areas, with almost half of those suggesting shifts away from traditional cropping activities towards the development of timber plantations and forest management or protection.

The adoption of management practices can be hampered by technical, infrastructure, and payment constraints. For instance, we observed land management practice restrictions (27% of cases) and farm area or forest size requirements if taking land out of production was required (11%). This was particularly evident for programmes with specific criteria for management practices such as minimum farm size (e.g., PROFAFOR, Ecuador) or specific management plans (e.g., Los Negros, Bolivia). Reducing the number of management practices may increase the probability that they are jointly adopted and practiced (Engel et al., 2008; Wunder et al., 2008). However, although this action may increase the overall implementation of management practices the result may still be insufficient provision of ES because of the limited number of management practices employed (Bennett et al., 2009).

Even with 84% of studies targeting particular ecosystem services, 73% lacked evidence to demonstrate programmes were providing those services. This supports the view that land-use changes are not easily translated into ES provision (e.g., Bond, 2007; Wunder et al., 2008; Bennett et al., 2009). We found that 62% of studies described the links between land management practices and ESs as assumed, with only 30% acknowledging a robust relationship between management practices and ES provision. The assessment of ES delivery is primarily associated with programmes focused on carbon management, for which clear protocols measuring carbon storage and sequestration rates exist (Wunder et al., 2008). For example, China's National Forest

Conservation Programme (NFCP) is estimated to have sequestered 21 Tg of carbon between 1998 and 2004 and reduced carbon emissions by 23 Tg over the same period (Liu et al., 2008). To compensate for the short-fall in domestic timber supply, however, China rapidly expanded imports, thereby 'exporting' its 'timber footprint' abroad (Liu et al., 2008).

In 40% of studies, there were calls to improve the assessment and monitoring of ES production and land-use linkages. The lack of data and lag-effects makes it difficult to determine ES changes in most studies. The inability to adequately define and quantify ESs has in general reduced programme effectiveness and efficiency (Engel et al., 2008; Kroeger 2013). Overall understanding of dynamics is typically rudimentary and assumes sometimes tenuous causal linkages. This highlights the need for pre-planning, baseline studies, and effective demonstration projects (Yin et al., 2013). Bennett et al. (2009: 1395) argued that "without knowledge about the relationships among ecosystem services, we are at risk of incurring unwanted trade-offs, squandering opportunities to take advantage of synergies, and possibly experiencing dramatic and unexpected changes in provision of ecosystem services", a sentiment that we would reinforce.

3.2.3. Financial capital

Not surprisingly, two thirds of studies focused on the financial capital implications of PES programmes. The potential of PES to strengthen livelihood development strategies rests upon the financial capacity of programmes to support household and community needs through the provision of payments (Wunder, 2008; Pascual et al., 2010; Narloch et al., 2011). Payments to ES providers were generally annual, ex post, on a per hectare basis, and for 'delivered' ES proxies (i.e., land-use changes) rather than ES supply. A number of schemes were sensitive to the variations in effort that different land-use practices require and paid accordingly (Wunder et al., 2008). For example, Costa Rica's PSA provided (in 2009) US\$64–80 $ha^{-1}\,yr^{-1}$ for forest protection but US\$82–98 $ha^{-1}\,yr^{-1}$ for reforestation. Ecuador's Socio Bosque programme employed a descending payment scale, reducing incremental per hectare payments as the area enroled increased. The majority of programmes (60%) implemented a single payment system rather than adopting a multiple streams approach, with payments made predominantly in the form of cash (62%) or technical assistance (21%). Just 30% of programmes opted for two payment modes (primarily cash and technical assistance), while only 9% employed three payment modes (i.e. the addition of in-kind payments) such as Ecuador's PROFAFOR and China's SLCP schemes. Consequently, the payment design of most programmes had an important effect on their capacity to aid individuals, households and communities because they fail to utilise the broadest array of available options (Wunder et al., 2008).

In some cases payments were made to families (e.g., Cambodia's payments for wildlife friendly products) or to communities (e.g., Madagascar's Durrell Conservation Trust scheme), but generally 58% of programmes allocated payments to small- (2–30 ha) and medium-sized (30–60 ha) landholders, versus 22% to large-size (60+ ha) landholders. This may reflect informed programme targeting of the poorest sectors to maximise the benefit from payments (Narloch et al., 2011). For example, due to the nature of its mandate China's SLCP preferentially targeted poorer landowners (Bennett, 2008; Liu et al., 2008). At the other extreme, Costa Rica's PSA generally benefitted wealthier landowners because larger farms acquired proportionally more money (Miranda et al., 2003). Ecuador's Socio Bosque programme was hampered by the scheme's failure to distribute and apportion individual and collective contracts in a manner that sufficiently accounted for the number of beneficiaries per contract and their poverty status (Krause and Loft, 2013). However, Narloch et al. (2013) have demonstrated that conservation auctions, in relation to distributional outlay, can minimise the 'traditional' trade-offs between fairness and effectiveness. In addition, our analysis also suggests that payment distribution may be influenced by a range of other factors, including collective land ownership (e.g., indigenous communal lands), shared needs, technical assistance, land security and property rights, proximity to protected areas, and the type of scheme in operation.

We found that household level impacts of programmes were mixed. Fifty per cent of studies suggested programmes positively increased household income, particularly in China. Many cases failed, however, to provide evaluations of income streams alongside these observations. Where such information was detailed, 29% of studies demonstrated payments contributed between 0% and 50% of household income, with just 8% showing payments contributing to more than 50% of household income. This demonstrates the highly variable nature of payment contributions to household incomes.

Household wealth, particularly for comparatively poorer households, was identified by 11% of studies as an additional barrier to participation and, by extension, to programme effectiveness. Although 50% of studies established that programmes enabled a diversification of household economic activities, only 12% described payments as sufficient to meet household needs or provide an alternative income stream. Generally, payment contributions provided insufficient income to enhance household economic productivity and diversity. Yet promoting household and community capabilities relies in part on generating adequate working capital (Smith, 2005) and stimulating wider rural economic growth (WRI, 2005). Expanding the number of revenue streams from the natural resource-base lessens the risks for families and communities relying on a single market (Ingram et al., 2014). Providing access to functioning markets and increasing household wealth is essential for generating diverse income streams, securing sustainability, and driving innovation (Smith, 2005; WRI, 2005; Wunder, 2008; Narloch et al., 2011).

Addressing the income stream shortfall as a constraint to improving living standards was mentioned by 59% of studies. Only 20% of studies demonstrated that PES schemes reduced wealth inequity. This has dual effects on poor landholders and on providers who bear opportunity costs (Wunder, 2008; Pascual et al., 2010; Narloch et al., 2011); 43% of studies highlighted opportunity costs as significant barriers to participation. A further 38% cited the low level of programme payments as responsible for reducing uptake and contract renewal rates. The studies we examined suggested that wealth distribution and equity are also influenced by factors related to payment design and broader institutional and socio-economic circumstances, in particular: sub-optimal targeting; land entitlement and formal property rights; centralisation of payment distribution; the utilisation of non-monetary payments; elite capture and under-representation of the highly marginalised; diversion of funds from the local community to project management budgets; asymmetric distribution of funds between communities and concessionaires; gender differences; community status and reductions in the extent of inequalities. Pirard et al. (2010) argued that in order to mitigate these complex and diverse issues PES (more broadly) should emulate the RISEMP agro-ecosystem business model as an example of a sustainable and self-sufficient wealth generating scheme.

Many of the issues concerning payment amounts, contributions to household incomes, wealth distribution, and equity are directly related to programme contracts. Negotiating these issues requires permanency, flexibility and compliance in contractual agreements (Ferraro, 2008). Programme permanency and contract flexibility were relatively heterogeneous, and determined by a range of factors including the adoption of specific management practices (e.g., Costa Rica's PSA scheme), service seller decision-making (e.g. Bolivia's Los Negros programme), and contractual extension (e.g., Ecuador's PROFAFOR and Pimampiro programmes). Eleven per cent of studies described the need to extend the time frame of projects and guarantee permanency. A further 13% acknowledged the need to improve contractual arrangements for the benefit of agreement holders (e.g. in terms of payment amounts), by improving programme permanency and renewal options as well as allowing more flexibility with regards to sanctioned management actions. Dealing with risk and uncertainty regarding payment cessation, adverse selection and moral hazard, and the extent to which negotiated agreements spread unfairness by embedding asymmetric power relations, is vital (Ferraro, 2008; Wunder et al., 2008; Milne and Adams, 2012).

Solving the targeting and monitoring conundrum is also important (Sommerville et al., 2011; Wünscher and Engel, 2012). The priority for targeting has to be determining an effective basis for directing payments to locations that will enhance scheme additionality at least-cost while balancing potentially competing conservation and development objectives (Wünscher and Engel, 2012). Similarly, monitoring requires attention on multiple fronts: deciding what is to be measured and meaningfully quantified across the range of capital assets; identifying who is monitoring, how frequently, and at what cost; and linking land use and ES provision with payment heterogeneity (Sommerville et al., 2011). Effective monitoring requires stability over time (Lin and Nakamura, 2012). Ensuring agreement obligations are fulfilled is thus critical but only 48% of programmes we examined had a high degree of conditionality and 36% had medium to low levels of compliance. In theory most programmes subscribe to annual monitoring by local stakeholders and/or government-related officials, with many instituting sanctions for non-compliance. In Brazil's Bolsa Floresta programme, for example, a system of penalty cards is used to determine non-compliance and designate the appropriate sanction (Pereira, 2010). However, across all programmes, applications of sanctions are relatively rare. Clearly, substantial improvements are needed to make PES programme monitoring effective (Schomers and Matzdorf, 2013).

At the global scale “there is an urgent need to mobilise substantial additional funds and develop effective mechanisms for global biodiversity conservation” (Hein et al., 2013: 91). Fauzi and Anna (2013) identified ‘fiscal constraints' as limits to long-term programme financial viability. We found that 48% of studies declared financial viability as a major barrier to PES effectiveness. Recently, a number of nascent watershed investment programmes have become inactive due to inadequate financing (Bennett et al., 2013). Programme investment levels vary widely, with national programme implementation requiring high levels of financing. China's SLCP was designed as a 10 year programme with a total budget of over US$40 billion (Bennett, 2008) and Costa Rica's PSA programme received US$175–206 million (1997–2008) (Porras, 2010). Mexico's Fidecoagua, a local programme, received only US $0.5 million annually (2003–2009). Our analysis indicates that external donor investments, loans and grants are essential sources of financial capital, guaranteeing the financial viability of many PES programmes. Seventy four per cent of programmes received some form of external donor support, with 59% supported by a single donor and 41% by two or more donors. External donors range from international conservation agencies (e.g., Conservation International – see Niesten et al., 2010) and development agencies (e.g., Swiss Development Cooperation) to major international corporations (e.g., British Petroleum Amoco, PacifiCorp). However, the most frequent external donor support organisations were the World Bank (WB) and Global Environment Facility (GEF), which in many cases provided full projecting costs or initial start-up capital. Indeed, WB and GEF have supplied 60% (approximately US$11 Billion) of global biodiversity aid over the past three decades (Hein et al., 2013).

Transaction costs impose significant constraints on programme effectiveness (59% of studies). To ensure that locally-derived sources of finance can support programmes in the long-term, which 34% of studies highlighted as necessary to secure, requires that the full range and magnitude of transaction costs are accounted for (Fauzi and Anna, 2013; Marshall, 2013; McCann, 2013). The prohibitive nature of programme transaction costs (McCann et al., 2005; McCann, 2013) may dictate that bilateral donor funding is essential to implement PES programmes. Legrand et al. (2013) argued that the securing of national and international funds by programmes ought to be viewed as an institutional triumph.

3.2.4. *Institutional capital*

Our analysis supports the view that institutional factors of PES programmes are ‘undervalued’ (Pascual et al., 2010) as only 58% of studies assessed institutional capital and context. There are typically knowledge gaps relating to direct and indirect, and short and long-term institutional performance (Legrand et al., 2013). Clearly, “PES systems are never established in an institutional vacuum” (Vatn, 2010: 1247). Programme success relies on establishing institutions and maintaining functional institutional relationships (Ostrom, 2005), and strengthening institutional frameworks and ties (Legrand et al., 2013). Forty four per cent of studies noted that programmes improved institutional capacity, cooperation between sectors and across groups, and the level of engagement with local organisations (e.g., Costa Rica's PSA scheme) (Legrand et al., 2013). Yin et al. (2013) suggest that grass-roots inclusion, through direct stakeholder inputs, improves long-term PES programme stability and reduces inefficiencies. Extolling the virtues of cooperation, 50% of studies expressed the view that developing improved institutional coordination was especially important for facilitating and enhancing capacity-building and technical assistance. Thus, for institutions, achieving lasting outcomes requires understanding and assessing the relational interactions between agents, institutions, and sectors, and their collective cultural effects (Campbell et al., 2010; Legrand et al., 2013).

Legitimacy, transparency and accountability in particular are central for successfully building institutional capacity and increasing effectiveness (Lockwood et al., 2010; Ingram et al., 2014). Eleven per cent of studies that we examined advocated the need to optimise governance, accountability, and transparency to improve programme effectiveness. Only 44% of studies addressed matters of institutional accountability. However, of these, 73% registered improvements in accountability and transparency. This refers mainly to instances where legal and regulatory mechanisms enabled appropriate resource-use (73%), as well as examples in which the funding chain was described as more transparent (27%) and the level of accountability between providers and beneficiaries was improved (36%). Notably, however, 36% of studies still indicated reduced transparency and accountability regarding institutional arrangements and operations.

The importance of property rights (i.e. their distribution, allocation, and social embeddedness) for PES effectiveness is widely acknowledged (Lin and Nakamura, 2012; Schomers and Matzdorf, 2013). Thirty two per cent of studies identified the lack of defined property rights and land tenure arrangements as a clear barrier to programme effectiveness. Clearly-defined tenure arrangements, which acknowledge local customary rights, may legitimise secure long-term resource access through the use of entitlements. Conversely, inappropriate tenure reforms could negatively affect livelihoods, and so need to be sensitive to contextual factors such as local power asymmetries, gender exclusion, or poor legal documentation of customary rights (WRI, 2005; Fisher et al., 2008). For example, consolidation of current inequalities has reinforced disparities in resource allocation and power structures with respect to water access in Ecuador's Pimampiro programme (Rodríquez de Francisco et al., 2013). Regulation of ownership and property rights needs to be open for transparent and simple fiscal mechanisms to operate in relation to payment arrangements (Fauzi and Anna, 2013). The legislative landscape is particularly important for land reforms, as government recognition provides legitimacy and legal instruments to formally institute land rights. Part of this involves access to legal remedies for PES programme damages (Kaul et al., 2003). Despite the importance of the legal landscape, the significance of the legislative framework in which PES programmes operate was mentioned in only 36% of studies.

Regarding the overall involvement of the State in PES, institutional governance programmes are considered predominantly state-centric (Schomers and Matzdorf, 2013). However, in cases where the State has the primary responsibility for being the originator and operator of programmes, only 28% of schemes we examined were of this type (e.g. China's SLCP and NFCP). In some circumstances these centralised tendencies may constrain participation options. For example, in a 2003 survey concerning SLCP operations fewer than 50% of participants thought that villages had been adequately consulted by State authorities regarding programme design and implementation, and 53% of households felt centralised control constrained their participation choice (Bennett, 2008). As Stanton et al. (2010) highlight, there can be a stark difference in the role played by the State compared to private and voluntary sectors. All sectors procured environmental services but government and related bodies represented ES buyers in 50% of our cases, while private and voluntary sectors each accounted for 18% of buyers. This observation accords with those made previously by Brouwer et al. (2011).

Programmes operated in chiefly agrarian locations meaning that most service sellers were rural and community farmers; where government or private sector service sellers played a minimal role (3% and 6% of studies, respectively). Institutionally, those responsible for connecting ES providers and ES beneficiaries, and facilitating fund disbursement are the intermediaries (Huber-Stearns et al., 2013), who were active in 96% of programmes we examined (exceeding the 82% identified by Martin-Ortega et al., 2013). This demonstrates the crucial roles played by intermediaries in delivering effective PES programmes (see also Lin and Nakamura, 2012). Intermediaries may be individuals, groups, or organisations, and operate at different scales and in different economic sectors (Huber-Stearns et al., 2013). Local and national governments represented intermediaries in 40% of cases, usually in the form of semi-autonomous bodies acting as government subsidiaries (e.g., Comisión Nacional Forestal (CONAFOR) in Mexico and Fondo Nacional de Financiamiento Forestal (FONAFIFO) in Costa Rica). NGOs acted as intermediaries in a third of programmes (e.g., Fundación para el Desarrollo de la Cordillera Volcánica (FUNDECOR) in Costa Rica, Nitlapan in Nicaragua, and Corporación para el Desarrollo de los Recursos Naturales (CEDERENA) in Ecuador). It could be argued that government is the most influential and powerful intermediary actor. Perhaps this is not surprising given the 'functional diversity' intermediaries display, for example, as mediators, information providers, arbitrators, administrators, and core network facilitators (Thuy et al., 2010; Huber-Stearns et al., 2013).

Clearly the influence of external intermediaries is substantial, particularly so in grass-roots community-driven situations, which emphasises the importance of including intermediary partners to represent the local context and stakeholder views (Thuy et al., 2010). Engagement of local intermediaries does have a decentralising effect, which we found in relation to local community oversight and fund disbursement (Thuy et al., 2010; Huber-Stearns et al., 2013). The involvement of fewer intermediary actors can reduce the negative impacts associated with organisational competition (Thuy et al., 2010; Brouwer et al., 2011). Consistent with this view, we found about 75% of programmes involved only a single intermediary partner. When well-run, intermediaries can help reduce transaction costs, and supply expertise to draw-up contracts and monitor PES-related activities. They do so via a complex combination of relationship-building, establishing reputation, and adapting to location conditions (Thuy et al., 2010). Intermediary functions and actions are not always, however, positive or allied to local sensitivities. They can legitimise and de-legitimise processes; decentralisation does not always favour beneficial outcomes if it fails to take account of elite capture and accountability issues (Thuy et al., 2010; Huber-Stearns et al., 2013).

Actors in PES may play multiple roles. One quarter of projects we examined were initiated by service buyers, higher than the 16% observed by Martin-Ortega et al. (2013). Of those, 50% were initiated by national governments. To some extent this State-centric influence was counter-balanced by significant NGO involvement (43%) in project initiation (lower in our study than the 58% of NGO project promoters identified by Martin-Ortega et al., 2013). However, NGOs may have considerable influence on national and sub-national governance and development issues, land-use policy, and advocacy linked to incentive-based mechanisms. This influence has grown alongside rapid sector expansion e.g. in Kenya, the number of NGOs (of all types) increased 15-fold between 1990 and 2008 and in Tanzania, the number of NGOs multiplied by approximately 250 times between 1990 and 2000. Growth in the number of NGOs has been witnessed worldwide (Banks and Hulme, 2012). Lane and Morrison (2006: 232), for example, referring mainly to the environmental NGO sector in Australia, noted that – "the extent of NGO involvement, both formal and informal, in environmental policy and management is so widespread […] NGOs (and other forms of civil society) now assume a dominant, even-pre-eminent role in the ascendant model of governance".

Due to their ubiquity and the niche NGOs have created for themselves between the State and Civil society, especially in developing countries, they have been cast and recast as both hero and villain: standing-up for the rights of the poor, dispossessed and marginalised; combating anti-democratic values embodied in poorly governed States and corporations and promoting environmental sustainability; yet failing to make headway in many of these areas through gradually de-politicising and re-focusing on service-delivery, up-scaling and technocratic professionalisation aligned to donor priorities and funding, media image and political connections. This series of transformations has led to increased concerns regarding their underlying accountability, credibility and capacity to actively promote and reflect civil society values (Bebbington, 2004, 2005; Holmes, 2011; Banks and Hulme, 2012; Rusca and Schwartz, 2012; AbouAssi, 2013). Nevertheless, the development of so-called 'horizontal' governance, in which PES has sometimes been contextualised, has been viewed as promoting decentralisation and benefitting grass-roots concerns (Agrawal, 2001; Barbosa, 2003; WRI, 2005). There are those that remain unconvinced and see such developments as sponsoring and implementing the priorities of an elite group of wealthy global institutions (McAfee and Shapiro, 2010; Holmes, 2011). In a number of cases, however, projects originated as multi-party programmes. Almost one-third of schemes had more than one initiator e.g. the State and a NGO or utility, indicating a relatively high degree of cross-collaboration, balance of competences and influences in relation to programme design and implementation (Martin-Ortega et al., 2013).

Collectively then, reappraising the institutional relationships between the actors facilitating programme operations is crucial (Pascual et al., 2010; Muradian et al., 2010). Our analysis indicates that government influence extends across the entire PES system, whereas the involvement of the private and voluntary sectors is more restricted. Expanding private sector participation, particularly as ES sellers and project initiators, presents new opportunities. In our review, 16% of studies recommended encouraging the private sector to pay for ESs as a means of promoting PES effectiveness. Engaging with the private sector provides a mechanism to increase direct investment, supply needed know-how and facilities, and reduce state centrism through local and national firm participation (WRI, 2005; Blackman and Woodward, 2010). Business and industry account for 7% of global investment in watershed payment schemes, so there is clearly substantial room for PES programme growth (Bennett et al., 2013). Private sector demand for PES programmes is growing as the reasons motivating participation multiply (Waage et al., 2007). National firms appear more likely to invest in multiple ecosystem services (Koellner et al., 2010). Furthering private sector integration represents a means for expanding the portfolio diversity of PES operations across scales as well as enhancing corporate social responsibility and widening sustainability (Rio+20, 2012).

4. Conclusion

PES programmes have recently been subjected to mounting scrutiny (Pirard et al., 2010; Muradian and Rival, 2012). Our CAF analytical approach in a systematic review has provided considerable insight into the workings and effectiveness of PES schemes and their 'measured outcomes' (see also Supporting information Table S14). We identified a number of important issues related to essential components (or absence thereof) needed for functional, effective PES schemes: proper protocols for assessing ES production and distribution; adequate accounting for social, human and institutional capital assets in PES design and programme outcomes; and viable long-term funding arrangements. Like Martin-Ortega et al. (2013), our analysis indicated that the theoretical underpinnings of PES, whether inclined towards Wunder's (2005) archetype or Muradian et al.'s (2010) model, are quite different to the real-world implementation of these schemes labelled with the same terminology. In this regard, there are opportunities for aligning theory and practice. We suggest three research themes that require further development if PES is to represent an effective natural resource management option in the future: connecting land-use practices and ES provision (e.g., Yin et al., 2013); ensuring programmes provide adequate socio-economic contributions to livelihood development by focusing on the poorest sectors (e.g., Ingram et al., 2014); and developing appropriate property rights regimes and building institutional capacity and institutions that are robust, inclusive, transparent and accountable (e.g., Legrand et al., 2013).

In attempting to address whether PES programmes are effective, the answer is not straightforward. A diversity of PES programmes exist, each of which produces a different set of measured outcomes when assessed through a CAF lens. Any argument calling for PES to be employed as generic solutions to natural resource management challenges requires careful scrutiny. What constitutes impacts (good or bad) worthy of action depends on societal, political, and stakeholder values (Rudd, 2004; Ostrom, 2005). It is clear that both locally-administered and nationally-governed PES programmes can be effective and have positive measured outcomes across multiple capital assets. However, important issues remain regarding how PES schemes negotiate effectiveness, efficiency, and equity trade-offs. These depend on how programmes are constructed and administered, as well as monitored and evaluated, within an appropriate context.

In designing schemes and mitigating trade-offs, we advocate a function-oriented and outcome-led approach. That is, identifying and prioritising a set of scheme outcomes (the desired end-products of a programme) and reverse engineering the structural and institutional arrangements of a programme (the underlying functional properties of a scheme) to achieve those aims. Using a CAF approach in this regard may help achieve an optimal balance between conservation and development outcomes. The precise composition of conservation and development objectives needs to account for locally-generated concerns, and not result from a one-size fits-all approach. There is potential for substantial PES expansion internationally, but these opportunities should be viewed alongside other natural resource management and poverty alleviation policy instruments. They should be subject to testing in with/without policy analyses in a way that accounts for causal linkages between intervention options, ES flows, and proxy measures for ES in the field, and programme outcomes. PES programmes should not necessarily be regarded as superior to other intervention options or a panacea to be implemented on blind faith.

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Appendix A. Supporting information

Supporting data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ecoser.2014.05.001.

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