Payments for ecosystem services are a policy mix

- demonstrating the Institutional Analysis and Development framework on conservation policy instruments

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Abstract

Policy mix analysis has been applied in research on energy, climate, urban and transport policy, and more recently biodiversity conservation and ecosystem services. However, policy mix analysis has thus far been employed at a high conceptual level, focusing on describing interactions between instrument types. Policy mix analysis rarely describes instrument 'structure' or functional characteristics, in a way that would answer the question "what constitutes an instrument"? We describe how the rules-in-use taxonomy of the Institutional Analysis and Development (IAD) framework, developed for research on common pool resource management, can be used to characterise conservation policy instrument interactions. We demonstrate the approach on the well-known Costa Rica's PES program and cross-compliance policies, arguing that PES is a policy mix rather than a single economic instrument. Our analysis shows how design features of payments for ecosystem services (PES) described in the economics literature maps to 'rules-in-use' in the IAD

framework. It illustrates that the framework provides a terminology for defining what constitutes institutional context, comparing economic, regulatory and information instruments, and studying their interactions. The rules-in-use taxonomy of IAD is a 'structural' diagnostic approach, which needs to be combined with other tools that analyse more the role and 'agency' of actors, as part of integrative environmental governance research.

Keywords: payment for ecosystem services (PES), economic instrument, market-based instrument (MBI), integrative environmental governance, Institutional Analysis and Development (IAD), rules-in-use, functional role, Costa Rica.

1. Introduction

Policy mix analysis has been applied by research on energy, climate, urban and transport policy, and more recently biodiversity conservation and ecosystem services. However, policy mix analysis has been employed at a high conceptual level, focusing on describing interactions between instrument types(Gunningham and Sinclair, 1998; OECD, 2007; Flanagan *et al.*, 2010; Schröter-Schlaack and Ring, 2011). Policy mix analysis rarely describes instrument 'structure' or functional characteristics, in a way that would answer the question "what constitutes an instrument"? Using Costa Rica's well known Payments for Ecosystem Services (PES) as an example, this paper aims to demonstrate how the Institutional Analysis and Development (IAD) framework (Ostrom, 2005) can contribute to policy mix analysis and the wider research field of integrative environmental governance (Visseren-Hamakers, 2015).

Ring and Barton (2015) review the development of policy mix literature. Policy mix emerged in economic policy literature in the 1960s concerning the interaction of fiscal and monetary policy (Flanagan *et al.*, 2010). Since the 90s policy mix analysis has be taken up in international research on biodiversity conservation and environmental policy (Gunningham and Young, 1997; Young, 2002), air pollution and climate change policies (Sorrell and Sijm, 2003;

Lehmann, 2012; Kivimaa and Kern, 2016), resource efficiency (Bicket and Vanner, 2016; Bontoux and Bengtsson, 2016; Ekvall *et al.*, 2016) and sustainability research (Kivimaa and Kern, 2016). In the field of biodiversity and ecosystem policies, Ring and Schröter-Schlaack (2011) define a *policy mix* as "a combination of policy instruments, which has evolved to influence the quantity and quality of biodiversity conservation and ecosystem service provision in public and private sectors".

Similar concepts to policy mix analysis exist in a diversity environmental research fields. A non-exhaustive list of examples include, 'institutional blending' of public-private ownership and contracting (Hodge and Adams, 2013), 'policy coherence'(Howlett and Rayner, 2007; Makkonen *et al.*, 2015), 'second-best theory' of multiple policy instruments (Bennear and Stavins, 2007), 'hybrid instruments' mixing price and quantity mechanisms (Hepburn, 2006), 'overlapping policy instruments' addressing the same policy objective (Lecuyer and Quirion, 2013), 'optimal mixes' in integrated conservation and development projects (Minang and van Noordwijk, 2013),'mixes of policy mechanisms' in a public-private benefit framework (Pannell, 2008), 'mix of institutional types' in governance of commons (Dietz *et al.*, 2003), environmental 'policy diversification' (Brock and Carpenter, 2007), 'policyscapes' (Barton *et al.*, 2013; Ezzine-de-Blas *et al.*, 2016), 'mix of actions and outcomes' (Derissen and Quaas, 2013), 'polycentric governance' in multifunctional landscapes (Nagendra and Ostrom, 2012), 'institutional diversity' (Ostrom, 2005), and 'hybrids' in business pooling, contracting and competition (Hagedorn, 2008).

Policy mix analysis is also an emerging area of analysis in the journal of Environmental Policy and Governance (Klassert and Möckel, 2013; Jordan *et al.*, 2014; Kivimaa and Virkamaki, 2014; dos Santos *et al.*, 2015; Mahzouni, 2015). Klassert and Möckel (2013) analyse the constraints and opportunities for introducing further market-based instruments in conjunction with existing policies under the EU Birds and Habitats Directive and Common Agricultural

Policy. Jordan et al. (2014) evaluate a federal level policy mix to overcome the barriers of small and medium-sized enterprises to resource efficiency innovation in Germany. Kivimaa and Virkamaki (2014) analyse the intended paths towards low-carbon transport systems in Finland with multiple policies. Santos et al. (2015) evaluate the mix of European agri-environmental measures directed at private landowners and ecological fiscal transfers directed at local governments for improved land-use zoning and land management practices in Portugal. Mazouni (2015) analyses the policy mix for a transition towards energy efficient buidings in a city district of Stockholm Sweden. Our reading of this substantially and conceptually broad environmental policy and governance literature is that policy mix analysis lacks a common terminology for describing what constitutes the functional characteristics of instruments.

Addressing the impacts of policy instruments, economic instruments for biodiversity conservation have been compared in terms of their legitimacy, environmental effectiveness and cost-effectiveness(OECD, 2007; Angelsen, 2009; Ring and Schröter-Schlaack, 2011; Vatn *et al.*, 2011). Yet, as the analytical approach of these studies compares economic instruments in terms of their outcomes, they pay little attention to the functional characteristics of the instruments themselves. Although these studies point out that institutional and socio-ecological context influences instrument choice and implementation, they do not offer descriptors of the institutional context factors that potentially interact with the instruments' functional characteristics. We take this analytical void in the policy mix research as our starting point.

Payment for ecosystem services - a hybrid instrument as a case study

Payments for ecosystem services (PES) is a much debated economic instrument for biodiversity conservation which serves as the empirical setting of this paper. Based on a review of different PES definitions across academic traditions Wunder (2015) defines and 'ideal type' of PES as (1) voluntary transactions, (2) between service users, (3) and service providers, (4) that are

conditional on agreed rules of natural resource management, (5) for generating offsite services. There is strong debate about whether PES should be classified as market-based in practice or neoliberal in intent. Wunder (2015) notes that the classification of PES has at times been used to argue for or against market-based instruments versus apparent alternatives in a normative fashion. Early PES research has noted that context matters for the interpretation of PES' impacts (Landell-Mills and Porras, 2002) . The growing literature on the classification of PES also emphasises the need to characterise context (Wunder, 2005; Porras *et al.*, 2008; Sommerville *et al.*, 2009; Swallow *et al.*, 2009; Muradian *et al.*, 2010; Vatn, 2010; Karsenty, 2011; Shelley, 2011; Pirard, 2012; Tacconi, 2012; van Noordwijk *et al.*, 2012; Wunder, 2015; Hausknost *et al.*, 2017; Huber-Stearns *et al.*, 2017). Syntheses of PES findings increasingly point to institutional and socio-ecological contextual factors in explaining its impacts (Wunder, 2006.; Wunder *et al.*, 2008; Angelsen, 2009; Greiber, 2009; Muradian *et al.*, 2010; Pascual *et al.*, 2010; Vatn, 2010; Ferraro, 2011; Corbera, 2015; Raes *et al.*, 2016). Impact assessments of PES have recently included administrative heterogeneity and presence of other instruments (Alix-Garcia *et al.*, 2012; Pfaff and Robalino, 2012; Robalino *et al.*, 2015). Fletcher and Buscher (2017) note that much of the recent literature (Vatn, 2010; Dempsey and Robertson, 2012; Pirard and Lapeyre, 2014; Gomez-Baggethun and Muradian, 2015; Van Hecken *et al.*, 2015) argues that PES is not a market instrument or neoliberal because of the substantial mix of public funding and regulation of PES implemention on the ground. Yet, the interaction between the institutional context factors and the design of the PES arrangements has not been thoroughly analysed (Huber-Stearns *et al.*, 2017).

The intention of this paper is not to offer another definition of PES (Wunder, 2005; Muradian *et al.*, 2010; Fletcher and Breitling, 2012; Pirard, 2012; Pirard and Lapeyre, 2014; Wunder, 2015), nor an interpretation of its ideological objectives (Dempsey and Robertson, 2012;

Matulis, 2012; Matulis, 2016; Fletcher and Buscher, 2017), we focus our attention on describing PES' institutional context and interaction with other policy instruments. Just like any successful new policy instruments, enduring PES regimes have resulted from processes of adaptation and co-evolution with the existing policy mixes(Primmer *et al.*, 2015; Ring and Barton, 2015). For example, PES may have an explicit role in a broader conservation instrument mix, making general restrictions more 'palatable', through temporary compensations for expropriated property owners in newly created protected areas, or they can provide alternative means of income generation for people displaced around protected areas (Porras et al. 2011). Rather than as compensation for strongly implemented regulatory policies, PES may complement insufficient or weakly enforced forest laws. PES may compete with subsidies for forestry and forest clearing, or be part of a cross-compliance scheme for example tied to credit (Wunder *et al.*, 2008). PES may follow a policy sequence replacing or being integrated into pre-existing conservation and development projects (Wunder, 2006.), or develop from a subsidy scheme towards a performance-based scheme (Fletcher and Breitling, 2012; Matulis, 2012). PES have also been developed as a reaction to a failed regulatory approach that has neither generated the envisioned conservation outcomes, nor gained legitimacy(Primmer *et al.*, 2013).

An analytical framework for policy mixes

Wunder (2015) makes a case for 'ideal type' definitions of PES that are consistent and precise, distinctive in function, robust to inter-temporal variations and simple enough to remember. We would add that the definition of PES should be comparable to the characteristics of other conservation instruments using a common typology. Fletcher and Bluscher (2017) call for investigation of common elements in PES design, rather than emphasising particularities of implementation. We would add that a typology identifying commonalities across economic, regulatory and information instruments is needed. Our main concern in this paper therefore is

to test a framework that identifies the functional characteristics of instruments as a basis for comparison and analysis of interaction. The decomposition of instrument characteristics is intended to support discussion of conservation policy instrument characteristics in terms of their function, without the need for normative instrument labels.

Ostrom (1990) defined institutions as "the set of working rules that are used to determine who is eligible to make decisions in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must or must not be provided, and what payoffs will be assigned to individuals dependent on their actions". Ostrom (2005) argued that a large number of different resource use situations – or 'action situations' – may be described by a limited set of rules for cooperative governance. In her Institutional Analysis and Development (IAD) framework, she proposes that the same types of rules also define cooperative institutions at different hierarchical levels. Vatn (2010) discusses the institutional characteristics of PES. Framing conservation policy instruments as institutions, Ring and Barton (2015) suggested that the 'rules-in-use' taxonomy of the IAD framework could serve as a detailed approach to classifying functional characteristics of economic instruments in a policy mix. They argued that the IAD framework allows wider comparison with regulatory and information instruments, as well as the common pool property resource management institutions that gave rise to IAD. The approach is inspired by diagnostic multilevel analysis of institutions (Ostrom, 2007; Cox *et al.*, 2010; Cox, 2011) and employing a 'grammar' of institutional analysis (Basurto *et al.*, 2010). In this paper, we aim to show how the analysis of formal rules-in-use can avoid the "instrument labelling" debate by describing the functional characteristics of instruments such as PES, and conservation instruments more widely. To our knowledge our paper is the first application of the 'rules-in-use' aspect of the IAD framework to the analysis of economic instruments in conservation, using Costa Rica's PES as a demonstration case. In our further analysis we use the Spanish abbreviation (PSA) -

pagos por servicios ambientales – to identify Costa Rica's program, and PES when referring to definitions and cases in the international literature.

The paper is laid out as follows. In Section 2 we describe the Costa Rica Forest Law and PSA program used to test IAD framework as a diagnostic tool for functional and interaction analysis. We then present the IAD analytical framework and its 'rules-in-use' as functional characteristics of PES. To get started we show how the framework maps to a simple ideal type definition of PES. We then describe how IAD can be used a generic tool for classifying functional characteristics of conservation instruments. In section 3, we demonstrate the application of IAD 'rules-in-use' classification to Costa Rica's PSA by mapping design features cited in the literature to the 'rules-in-use' classification of IAD. Our analysis illustrates how PSA could be called a policy mix of incentives, addressing different compliance and land-use situations, as well as environmental and rural development policy goals. In section 4 we discuss limitations and potential of the IAD framework for instrument analysis, and how the 'policy mix' framing of PES opens different avenues for the analysis of instrument interaction. Section 5 concludes the paper.

2. Analysis frameworks and methods

2.1 A diagnostic method for policy mix analysis – the Institutional Analysis and Development (IAD) framework

The IAD framework proposes that the functional role of rules-in-use in cooperative institutions is understood in relation to 'action situations' involving particular actors and actions (Ostrom, 2005; Poteete *et al.*, 2010). Ostrom (2005) makes a distinction between organisations and institutions. Institutions encompass 'rules-in-use' at different levels of organisation, while

organisations are made up of actors who have different roles according to rules-in-use (both formal and informal). Our framing of 'rules-in-use' as the functional characteristics of conservation instruments, suggests that they could serve both as a terminology to describe the instrument that is the focus of analysis, but also the 'wider institutional context' understood as the formal and assumed roles of actors in organisations.

The IAD framework's 'rules-in-use' taxonomy include position, boundary, information, aggregation, scope, payoff and choice rules (Table 1).

Table 1 Institutional Analysis and Development (IAD) Framework

IAD Rule	Description
Boundary rules	Who is eligible; entry rules; succession rules; exit rules. Defining holder and nonholders of positions.
Payoff rules	Assign external rewards and sanctions to particular actions or to particular readings on outcome of state variables.
Position rules	Decision-making positions that actors can fill and which are assigned action sets at particular decision-making junctures. Multiple positions are possible for individual actors.
Choice rules	Required, permitted and forbidden actions at a particular time based on conditions that have or have not been met.
Scope rules	Known outcome variable(s) that must, must not, or may be affected by action (i.e. policy goals). Define which variables are observed and their range (includes intermediate and final outcomes in the 'policy cycle').

Information rules	Affect level of information available to participants about; Overall structure of situation, current state of resource, previous and current experience of others' participation, own past moves (channels, frequency accuracy, subject of communication, official language).
Aggregation rules	Whether decision requires single or multiple participants. Lack of agreement rules.

Source: action situation 'rules' based on Ostrom (2005).

Boundary rules govern the entry, succession and exit of landusers in a particular instrument regime. *Payoff rules* identify the rewards and sanctions associated with outcomes of actions. Payoff rules encompass all incentives rather than just a narrow focus on payment conditions. *Position rules* determine decision-making positions, such as the types and roles of intermediaries. *Choice rules* define required, permitted, forbidden and guaranteed actions on particular types of land. *Scope rules* define outcome variables and their ranges, such as the maintenance of forest cover as a proxy for a bundle of ecosystem services. *Information rules* govern information access and disclosure. *Aggregation rules* refer to collective voting rules and lack of agreement rules governing an instrument regime.

The rules are inter-related with specific function, which are context specific – or in IAD language are specific to an 'action situation' (Figure 1) (Ostrom, 2005). An 'action situation' is a land-use decision to be taken for example by a landuser in a forest location. In the 'action situation' *participants* and *actions* are assigned to *positions*. *Outcomes* are linked to *actions*. *Information* is available about *action-outcome linkages.* *Control* is excercised over action-outcome linkages. *Costs* and *benefits* for actors are outcomes from acting according to sets of

rules, which make up conservation policy instruments such as a protected area regulation or PES

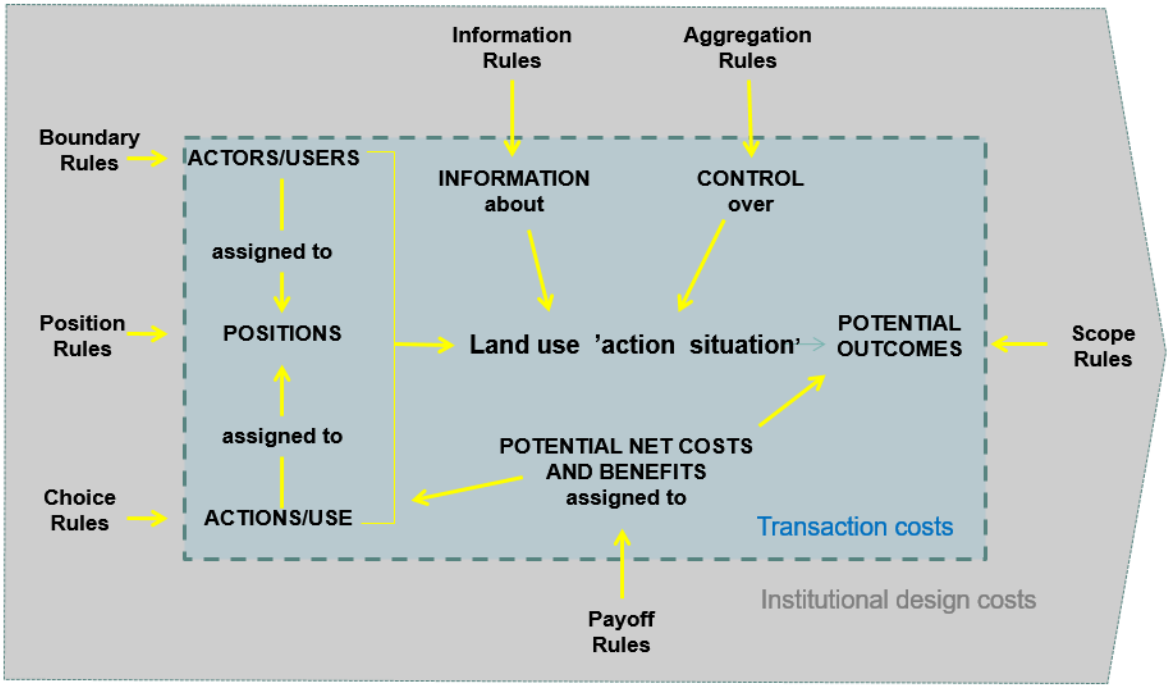

Figure 1. Action situation in the Institutional Analysis and Development(IAD) framework could be used to characterise policy instruments for biodiversity conservation. (Source: Ring and Barton (2015) adapted from Ostrom 2005). To Ostrom's original 'rules-in-use' figure we have added indications of transaction costs as distinct from institutional design

Ostrom (2005) defines a default condition with no rules, which under a common-law system presumes general freedom unless a rule specifically prohibits or mandates an act or event. Ostrom's default *rule-less* conditions have many features in common with assumptions of a perfect market (where property rights are the *sine qua non* rule). In an ideal type, performance-based instruments place emphasis on defining *scope rules* about what target to meet, and *pay-off rules* for achieving those targets. This implies that actors are left to choose how to achieve targets, rather than choice rules being specified. Regulatory or command-and-control instruments place emphasis on *choice rules* regarding how a policy target is to be met – for example which land-use practices are permitted or prohibited. Regulatory instruments also have

pay-off rules through definition of sanctions. Information-based instruments by definition place emphasis on *information rules*, with information provided to "nudge" (Hiedanpää and Bromley, 2014) any aspect of an action situation (scope, choices, payoffs, boundary rules etc.). From this discussion we see how the IAD framing can be used to distinguish between 'ideal types' of conservation instruments in general, and payment for ecosystem service in particular, as defined by Wunder (2015). Furthermore, rules-in-use are sufficiently generic to describe other instruments applied in conjunction and for cross-compliance purposes (Ring and Barton, 2015). We note that Bollman and Hardy (2012) used the transactions cost[1] and institutional performance benchmarks[2] aspects of the IAD framework to assess "Pagos por Servicios Ambientales" (PSA) in Costa Rica, but did not take advantage of the rules-in-use aspects of the framework.

2.2 Demonstration case – the Costa Rican Forest Law and PES

Costa Rica's payments for ecosystem services program is a very well-known, analysed and publicised case of PES that have been used to set and discuss PES definitions (Rojas and Aylward, 2003; Pagiola, 2008; Wunder *et al.*, 2008; Daniels *et al.*, 2010) and normative characteristics and ideologies of PES (Fletcher and Breitling, 2012; Matulis, 2012; Matulis, 2016). However, PSA case analysis has not lead to consensus on the nature of this instrument. PSA provides a rich example of research broadening over time to consider policy context (Pagiola, 2008; Daniels *et al.*, 2010; Le Coq *et al.*, 2010; Porras *et al.*, 2011; Robalino *et al.*, 2011; Fletcher and Breitling, 2012; Matulis, 2012; Le Coq *et al.*, 2013; Rosendal and Schei, 2014; Robalino *et al.*, 2015; Matulis, 2016). Thus PSA is a good case to demonstrate a framework that endeavours to go beyond ideological debate on PES instruments.

[1] Information, coordination and strategic costs
[2] economic efficiency, fiscal equivalence, redistributional equity, accountability, conformance to the value of local actors and sustainability

PSA (legal / and institutional) background were set in the Costa Rican Forest Law (No 7575, 1996) that establishes 'incentives' to monetarily compensate conservation, reforestation and regeneration actions that provide 'environmental services'. Environmental services covered by the law include mitigation of greenhouse gas emissions; hydrological services, including provision of water for human consumption, irrigation, and energy production; biodiversity conservation; and provision of scenic beauty for recreation and ecotourism. The terminology "pagos por servicios ambientales" (PSA) is not used in the text of the Forest Law, which refers to "incentivos" both regarding monetary compensation for different conservation activities, as well tax exemptions and enforcement of tenure security. The same Forest Law that establishes PSA bans landuse change in forests[3]. Exceptions can be granted for housing and infrastructure for the purpose of ecotourism, infrastructure of national interest, natural hazard mitigation and forest fire prevention. "Pago de servicios ambientales" (PSA) – payments for environmental services - was first introduced as a legal term in art. 37 of the Biodiversity Law (7788, 1998). Different payment modalities in PSA exist for different conservation actions in different parts of the landuse mosaic, including forest protection, reforestation, forest regeneration, forest management and agroforestry (Pagiola, 2008; Daniels *et al.*, 2010) . PSA modalities have been increasingly diversified to address different landuse change contexts across a landscape mosaic (Le Coq *et al.*, 2013). Most research attention has focused on the 'protection modality' as it in recent years constitutes roughly 90% of the area contracted under the program(Daniels *et al.*, 2010; Porras *et al.*, 2013). In this paper we use the characteristics of "forest protection" modality of PSA to demonstrate the IAD framework's rules-in-use as a diagnostic tool. Development of "forest protection" PSA can be divided into three major phases (Porras *et al.*, 2013);

[3] art19. Law No7575

Phase I - conservation area priority-setting (1997-2002): Spatial criteria were specific to locations within each conservation area and determined by the National System of Conservation Areas (SINAC) their local area offices individually. Revision of decrees shows a wide range of different criteria terminology applied across different conservation areas. With such a wide range of spatial criteria defined by SINAC they did not represent effective spatial targeting. In 1999 spatial priorities differentiated by PSA modality were introduced for the first time. During this period applications meeting the criteria were selected on a first-come-first-served basis.

Phase II - priority-setting at regional level (2003-2010): From 2003, the National Forest Fund of Costa Rica (FONAFIFO) assumes full management of the PSA programme including selection of PES beneficiary (Robalino *et al.*, 2011). Spatial targeting criteria were reduced to a handful of criteria. Criteria were not applied in order of importance. Contracts were selected on a first-come-first-evaluated-basis and then prioritised[4]. The first non-environmental criteria, in the form of low Human Development Index was introduced. Regional FONAFIFO offices each had their PSA area quotas to fill per modality.

Phase III - priority-setting at national level (2011-present): In 2011, the system of first-come-first evaluated was dropped. In its place, a matrix of weights per priority-setting criteria was introduced and used to select among "pre-applications". A criteria for priority to small farms is introduced to improve distributional equity. Moreover regional quotas were dropped in favour of a national level priority-setting across all "pre-applications" using weighting of criteria.

Our brief description of PSA has emphasises how the program has changed over two decades, adopting and discarding different policy objectives and mechanisms.

[4] Pers.com. Oscar Sanchez, FONAFIFO, January 2013

2.3 Materials

We made an initial identification of PES design features based on a highly cited international review of 13 PES cases that include user-financed, government financed and PES-like programs (Wunder *et al.*, 2008). As an initial test we mapped these design criteria to the rules-in-use definitions of the IAD framework. We then augmented the list of international PES characteristics with those specific to the Costa Rica PSA program, based on a review of research in Costa Rica, as documented in Porras et al. (2013) and Barton *et al.* (2014). The identification of 'rules-in-use' focused on the "forest protection" modality of PSA. It was based on a review of the Forest Law #7575 and Biodiversity Law #7788, and all Presidential Decrees on PSA from 1997-2013 (Table 1). We also carried out an analysis of the PSA Procedures Manual (FONAFIFO, 2009) to identify the integration of cross-compliance rules with PSA. This included comparing the pre-selection criteria for evaluating the property titles of PSA applicants' for their consistency with cadastre and national property registers. Cadastre criteria were tested against a case study for the Osa and Nicoya Peninsulas, Costa Rica, and discussed in a workshop with FONAFIFO regional staff, as documented by Benavides *et al.* (2014). Based on this information we constructed a draft diagnostic of the IAD framework 'rules-in-use' of the forest protection PSA. A draft diagnostic of PSA in terms of 'rules-in-use' was discussed with the director of FONAFIFO Oscar Sanchez and revised based on feedback.

3. Application and results

3.1 Simple mapping of PES 'ideal type' to the IAD framework

As a starting point we revisit Wunder's (2015) PES "ideal type" as (1) voluntary transactions, (2) between service users, (3) and service providers, (4) that are conditional on agreed rules of natural resource management, (5) for generating offsite services. The ideal type PES definition maps to the 'syntax' of the IAD rules-in-use framework as illustrated in Table 2.

Table 2 PES ideal type characterized by IAD rules-in-use

RULES-IN-USE / INSTRUMENT IDEAL TYPE:	Boundary	Pay-off	Position	Choice	Scope	Infor-mation	Aggre-gation
Market-based (PES)	voluntary	conditional transaction	service provider & user	agreed rules of natural resource management	off-site services	..	..

Source: PES definition based on Wunder (2015)

In PES ideal type definition, entry, succession and exit of landusers are voluntary (*boundary rule*). The *payoff rules* includes many types of transaction including monetary payments, compensations, rewards and also sanctions conditional on outcomes of actions. The essential *positions* are service provider and user (because PES is voluntary, actors are usually, but not necessarily private). Additional positions might include those of interpreting and assigning rules by actors who manage PES, or function as an intermediary. These positions can be held by the public sector administration or some other organisation (Vatn, 2010; Primmer *et al.*, 2013). Agreed *choice rules* of natural resource management define required, permitted, forbidden and guaranteed actions on particular types of land. *Scope rules* define off-site ecosystem services as the outcome variable of interest, although transaction costs often mean that the transaction is conditional on following agreed rules for resource management.

3.2 Detailed mapping of PSA characteristics to the IAD framework

The simple ideal type mapping (Table 2) can be expanded to consider the detailed characteristics of Costa Rica's PSA program. Table 3 maps PSA characteristics first in terms of frequently cited PES 'design features' (Wunder *et al.*, 2008) and then using the IAD framework terminology. The detailed description is based on identification of 'rules-in-use' from the Forest Law that created PSA, the annual presidential decrees determining PSA priorities and the PSA Operational Manual.

The forest conversion ban in the Forest Law 7575 is a general *choice rule* banning forest clearing with a few exceptions. Landuse change with intent is illegal and punishable by prison sentences of up to 3 years (*payoff rule*). Private forest owners 'who manage their forests' through PSA or in protected areas are exempt for property taxes (*payoff rule*)[5], which can make a significant impact on the property owner given recent re-valuation as part of property tax reform. Participation in PSA also provides a guarantee of public eviction of squatters[6], which is a non-monetary *pay-off rule* in providing additional tenure security which is not always guaranteed by the State, particular at the time the Forest Law was introduced. Other *choice rules* reinforce prohibitions through passive obligations, such as the conserving buffer zones required by the Forest Law[7]. Despite being non-action obligations, forest in buffer zones are counted as part of the PSA contracted area and subject to compensation (*pay off rule*) (FONAFIFO, 2009). Finally, PSA contracts require specific and additional actions. For example, payments in the PSA 'protection modality are conditional on establishing fire breaks, fencing, sign posting and stopping poachers from illegal hunting and logging on one's property

[5] Art. 23 Forest Law 7575
[6] Art. 36 Forest Law 7575
[7] Art. 33 Forest Law 7575. 100m around natural springs, 10-15 m along rivers and streams, 50 meters around lakes, variable distance in recharge zones.

(*pay off rule*). There is has been a trend in recent years to make contracts longer i.a. to reduce transaction costs of re-application (*boundary rules*).

Table 3 PSA characteristics in terms of PES ideal type and rules-in-use in the IAD framework

IAD Rules-in-use	Instrument characteristics as identified by PES ideal type# , review* of PES cases	Examples of rules-in-use in Costa Rican PSA "Forest protection" modality and examples of cross-compliance
Boundary rules	**1. Voluntary** 2. Spatial scale/planning area* 3. Tenure security cross-compliance * 4. Social security cross compliance 5. Pre-application ranking criteria 6. Length of contract 7. Contract renewal criteria 8. Contract cancellation criteria 9. Agglomeration bonuses or minimum contiguous area requirements for collective PES contracts […]	1. Private land-owners, previously also cooperatives 2. Previously regional, now national ranking & selection 3. PSA promotes legal property or possession 4. Social security payment of employees 5. FONAFIFO pre- application ranking criteria (Table 4) 6. Fixed term contract (10 years) 7. Same as for first time applicants 8. Land title inconsistencies; Lacking protection measures (not enforced) 9. Minimum area requirement, agglomeration encouraged by prioritizing biological corridors 10. Cooperative group contracting (until 2002)
Payoff rules	**1. Conditionality*** 2. **Transaction*** 3. Payment principle (incentive, compensation, reward, tax exemptions)* 4. Payment schedule* 5. Intermediaries' fees* 6. Administrative fees 7. Contract-to-payment delay 8. Fines, other sanctions* […]	1. Conditional on maintaining forest cover; renewal conditional on eligibility 2. Monetary payment 3. Differentiated payments for ES and biodiversity, real value less than opportunity costs; exemption from property taxes; compensation of non-expropriated properties within national parks 4. Fixed payment per year 1-5, 5. Regulated to maximum 18% of contract amount 6. FONAFIFO charges 0,6% of contract amount for registration 7. Several months 8. Contract cancellation and reimbursement. Fines and jail under Forest Law for deforestation.
Position rules	1. Instrument initiator* 2. Financing sources* 3. External donor support* 4. Priority-setting policy maker 4.1 Target, annual objectives 4.2 Priority and eligibility criteria 5. Buyers* **6. Beneficiary/Users*** **7. Participants/Sellers*** 8. Intermediaries* 8.1 Identification 8.2 Application 8.3 Negotiation 8.4. Monitoring and reporting 9. Verification (3rd party) […]	1. Forest Fund (FONAFIFO) 2. Public: Earmarked taxes, water fees; Private: CTO sale 3. External donor (GEF and World Bank). 4.1 MINAET-FONAFIFO 4.2 Multi-sectoral board of FONAFIFO 5. Forest Fund (FONAFIFO), water utilities, hydropower companies, individuals 6. State, private companies, households 7. Forest landholder; physical person; anonymous legal entity; cooperative group (previously) 8.1 Forest engineer (*regente*) & landholder self-selection 8.2 Forest engineer (regente): self-employed or NGO 8.3. N/A 8.4. Forest engineer (*regente*): self-employed or NGO 9. Conservation authorities (SINAC)
Choice rules	**1. Agreed rules of natural resource management :** 1.1 Prohibitions (cross compliance) 1.2. Permissions (land uses proxies for ES)* 1.3. Guarantees 1.4. Obligations (cross compliance)	1.1. Landuse change prohibition, timber extraction, any hunting, residence 1.2. Recreation 1.3. Squatter eviction, title enforcement, no enforced conservation on site

	[…]	1.4. Management procedures defined for conservation measures. Maintained forest cover; fire breaks, fencing, signposting, conservation of riparian buffer zones
Scope rules	1. **Externalities / Services**(property level)* 2. Baseline scenario* 3. Aggregate conservation target (national level) 4. Budget (national level) […]	1. Area-based forest cover proxies for biodiversity (on-site) and water, landscape aesthetics, carbon (off-site) 2. Forest cover evaluation every 10 yrs, no control group 3. Annual area targets for conservation, reforestation, trees in agroforestry set according to budget, determined by REDD+ carbon partnership 4. Stable earmarked tax funds; less stable donor funds, and private purchase
Information rules	1. Tenure documentation 2.Free prior informed consent (FPIC) 3. Public hearing processes. 4. Freedom of information 5. Monitoring, reporting* and verification (MRV) requirements […]	1. Grace periods for obtaining tenure documentation 2. Yes, criteria openly available, but require specialist interpretation 3. No public hearing process on contract selection criteria (determined by FONAFIFO board). 4. Applications not listed, contracts listed, but not mapped. Owners of anonymous legal entities cannot be identified. Not strict interpretation of privacy of forest owner information. 5. SINAC monitoring; FONAFIFO reporting. No third party verification.
Aggregation rules	1. Collective participation 2. Consensus or majority rules on priority setting, selection criteria etc. 3. Lack of agreement rules. 4. Complaints procedures. […]	1. Cooperatives no longer eligible. Few landowners are members of cooperatives or forest associations. 2.Criteria developed by FONAFIFO and approved by their board 3. Non-negotiable contract conditions. 4. None regarding PSA selection process

Note: types of cross-compliance & instrument integration :

fiscal: protected areas: social, tenure:

#Ideal type PES criteria by Wunder (2015) marked in **bold**. * indicates PES characteristics used in a review of PES cases by Wunder et al. (2008). Porras *et al.* (2013) and Barton *et al.* (2014) for further documentation of the detailed characteristics right hand column) of PSA. FONAFIFO – National Forestry Financing Fund

3.2 An analysis of changing rules-in-use over time

Long-standing PES programs develop and change over time (Primmer *et al.*, 2013; Raes *et al.*, 2016) . In this section, we provide an example of analysing instrument development in terms of rules-in-use. Table 4 is based on the analysis of presidential decrees since 1997 describing the year-to-year changes in the formal pre-selection criteria for PSA applicants. *Boundary rules* define eligibility of the individual application. *Boundary rules* also include other instruments of social, tenure and protected area policies in the design of PSA. By 2013, PSA *boundary rules* were based on a mixture of landowner and landuse characteristics. The development of priority-criteria over time has moved PSA forest protection from a conservation

instrument to complement protected areas, to a conservation and rural development policy mix instrument (Le Coq *et al.*, 2013). PSA spatial targeting both strengthened protection in publicly designated protected areas, as well spatially complementing protected areas and indigenous territories through targeting of biological corridors and conservation gaps.

The hierarchical nature of PSA from national to property level poses some room for interpretation in terms the rules-in-use framework. For the PSA program at the national level the annual budget and total land areas assigned to a particular modality constitute *scope rules*, which when translated into *boundary rules* at property level defines aggregate eligibility. The minimum points needed for an applications to be approved varies year on year depending on the available total budget, quality and number of competing applications. This weighting and scoring system can be interpreted as a collective choice *aggregation rule.*

Table 4 Evolution of PSA pre-application selection criteria for "forest protection" modality – interactions with other policy instruments

		Phase I: conservation area priority-setting						Phase II: regional priority-setting								Phase III: national priority-setting		
	Year:	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
	Presidential Decree #:	25828 26141	26977	27808	28610	29394	30090	31081	31767	32226	33226	33852	34371	35119	35762	36516	36935	37660
Selection criteria / boundary rules:	Conservation area specific criteria	Whole country / no spatial priorities																
	Indigenous territories													R	R	W	W	W
	Protected areas													R	R	W	W	W
	Biological corridors (GRUAS, CBM)													R	R	W	W	W
	Conservation gaps (GRUAS II)													R	R	W	W	W
	Forest protecting water resources															W	W	W
	Ecomercados#, KfWproject areas																	
	Non-priority forest															W	W	W
	Low IDS (<40%)													R	R	W	W	W
	Cooperative group contracting																	
	Property register & title																	
	Social security regularization																	
	Non-expropriated properties													R	R			
	Expiring forest mngt PSA													R	R	W		
	Expiring contract this yr.															W	W	W
	Expired PSA contract													R	R	W		
	Expired CAFMA >10yrs																	
	Contracts, properties <50 ha															W	W	W

Comments: Criteria/ Boundary rule in force. Boundary rules defined by other instruments: protected areas social, tenure

Scope rules: R – system of ranked criteria. W – system of weighted criteria and aggregate scoring; minimum score threshold to comply with PSA annual budget constraints and area targets . See Porras *et al.* (2013) for further details on criteria.

3.3 Describing instrument cross-compliance in the IAD framework

The PSA Operations Manual (FONAFIFO, 2009) specifies legal conditions that must be met regarding property titles being correctly registered in the National Register and being consistent with the national property cadastre. A number of cadastral inconsistencies can delay or disqualify PSA applications (Benavides *et al.*, 2014)[8], acting de jure as *boundary rules* although they are not all made explicit in the Operations Manual (Table S1 Supplementary Material). The national property register and cadaster is both a guarantor of tenure rights, and an information-based instrument in its own right, acting as a certification for PSA eligibility.

FONAFIFO personnel argue that PSA is an effective tool for land tenure regularisation[9]. This cross-compliance argument runs counter to a Coasian view that property rights are a necessary precondition for market-based instruments such as PSA (Pagiola, 2008). The Operations Manual provides detailed information on grace periods for obtaining necessary tenure documentation to resume the application process (*information rules*). Applicants may also qualify if they can document posessionary rights, but the process of documentation and witnesses is laborious. Smallholder applicants may choose to pay surveyor and legal services to obtain formal title, sometimes borrowing money in informal credit markets against the first PSA payment[10]. How important PSA is for tenure regularization beyond examples cited here remains to be studied.

[8] Table S1 in Supplementary material describes which cadastral inconsistencies can lead to rejection of PSA applications.
[9] Personal communication Oscar Sanchez, FONAFIFO
[10] Authors' own interviews with PES participants in the Osa Peninsula (Puerto Jimenez, December 2012).

Another example of cross-compliance *boundary rule* which has not been previously documented is the requirement that PSA participants have no outstanding debts with the national social security system (FONAFIFO, 2009). PSA applications with outstanding social security debts are rejected. Although land under PSA is exempt from property tax (*payoff rule*), a long term effect of PES-driven tenure regularisation may be an increase in the tax base once properties leave the PES scheme, hence also an example of cross-compliance. PSA applicants from expropriated properties within national parks that remain uncompensated is an example, though less frequent, of cross-compliance related to a *payoff rule.*

3.4 PES as a policy mix - combining rules-in-use from different instruments and cross-compliance

Based on the detailed analysis of the Costa Rican PSA as a mix of rules-in-use and cross-compliance mechanisms, we demonstrate an example of payments for ecosystem services as a policy mix (Table 5).

Table 5 Costa Rica's PSA as a policy mix

		RULES- IN-USE						
		Boundary	Pay-off	Position	Choice	Scope	Infor-mation	Aggre-gation
INSTRUMENT IDEAL TYPES	'Rule-less' reference (Perfect market)	property rights						
	Regulatory (Protected area)	designated public land	compensation & sanction	steward & regulator	prohibitions	on-site bio-diversity		
	Market-based (PES & REDD+)	voluntary private land	conditional transaction	service provider & user	agreed rules of natural resource management	off-site services		
	Information-based (Property Register)	cadastre map & land title					certified surveying	
		PSA AS A POLICY MIX						
ACTUAL	PSA Costa Rica	voluntary private land with title and cadaster map & some designated public land	transaction with conditional compensation payments & sanctions	providers & users with multiple over-lapping roles	agreed rules of natural resource management & cross-compliance	on-site biodiversity & off-site ecosystem services	monitoring & certified tradable offsets	

Indeed, PSA is a combination of characteristics from regulatory, market-based and information-based conservation instruments. PSA is (1) a voluntary transaction (on voluntary private land with title and cadaster maps, as well as some designated public land), (2) with conditional compensation payments & sanctions, (3) between service providers and users (with multiple overlapping roles), (4) subject to agreed rules of natural resource management and cross-compliance, (5) for generating off-site environmental services and protecting on-site biodiversity, (6) which is monitored and certified (e.g. carbon offsets as part of reductions of emissions from deforestation and forest degradation) .

4. Discussion

4.1 Does IAD offer a new perspective on instrument design?

We have demonstrated that PES and economic instruments in general can be described by the IAD framework's rules-in-use. We use the framework in an explorative fashion for 'institutional diagnostics' (Young, 2002), rather than a prescriptive search for 'optimal' design criteria for PSA (Engel *et al.*, 2008; Wunder *et al.*, 2008). However, it is difficult to propose a framework completely free of normative content (Fletcher and Buscher, 2017) and the IAD framing is no exception. The IAD framework casts instrument analysis in the light of cooperative governance theory. From this perspective PES can be discussed as an example of a (hierarchical) cooperative institution – the type of institution for which IAD was originally developed. For example, PSA has been interpreted by economists as a national political level as a *quid pro quo* or pre-condition for forest stakeholder representatives accepting the land use change ban (Pagiola, 2008; Daniels *et al.*, 2010). Le Coq and colleagues documented the surprisingly wide political support across different stakeholder interests for the ban on landuse conversion prior to introduction of the Forest Law (Le Coq *et al.*, 2010; Le Coq *et al.*, 2015). While recognising PSAs neoliberal conservation agenda at macro level (Fletcher and Buscher, 2017), the IAD framework also casts the origins of PSA in the light of cooperative governance at national level.

The IAD framework may also provide an additional perspective on Vatn (2010) or Muradian et al. (2010) discussion of trade-offs between efficiency and equity outcomes of PES. Muradian et al. (2010) has found that problems in identifying and demarcating biodiversity and ecosystem services lead PES managers in different case studies to use a combination of criteria to allocate PES. Our rules-in-use diagnostic shows that PSA

combines (i) criteria for entering the PES program (*boundary rules*), (ii) types of landuses allowed under PES contracts (*choice rules*), and (iii) habitat characteristics in approximation to conservation goals (*scope rules*).

4.3 Are rules-in-use sufficient as functional characteristics of PES?

Interactions between economic, regulatory and informational instruments in a policy mix have been defined as complementary, synergistic, path-dependent, redundant or in conflict (Ring and Barton, 2015). A diagnostic of rules-in-use provides a common language for defining functional characteristics of instruments, but does not explain the quality of the functional interactions between these characteristics. The focus in IAD is on describing institutional 'structure', while a balanced policy mix analysis must also consider 'agency' (Van Hecken *et al.*, 2015; Fletcher and Buscher, 2017). This is related to how design and transaction costs are increased/reduced by other instruments and the practices in use, which are an essential factor to be considered when evaluating institutional performance (Bollman and Hardy, 2012; Coggan *et al.*, 2013). For example, Matulis (2016) provides a detailed analysis of how the role of forester intermediaries - '*regentes forestales*' – developed over time as part of PSA. The law defined *position rules* allowing private forest contractors to administer application, contracting and monitoring of PSA. PSA Procedures Manual defines *pay-off rules* for intermediaries' fees as a fixed maximum percentage of the PSA contract. Over time this has led to *regentes* favouring large landholders because of economies of scale, illicitly charging smallholders more than the maximum fixed rates in some cases, and private contractors outcompete non-profit NGO intermediaries representing smallholders. This dynamic is a result of the interaction of position and pay-off rules, but is not explained by the rules *per se*, but additionally by more active role and agency that can be captured by the 'theory of coercive competition' (Matulis, 2016). However, rules-in-use provide

a framework for describing the institutional structure as sources of agency and transaction costs of PES.

4.4 PES as a policy mix – avoiding ideal types and ideology?

Matulis (2012, 2016) argues that PSA is in a process of neoliberalization in terms of instrument financing, moving away from tax-financing towards user financing, particularly through water user fees; largely fixed monitoring costs and competitive contracting of forest regents favouring larger over smaller forest owners (*position rules, payoff rules*); and through the decline in group contracts in favour of individual and anonymous society participation (*boundary and aggregation rules*). Analysis of PES application criteria development over time as *boundary rules* (Table 4) also reveals increased and more detailed regulation in PSA contracting, particularly since 2009. There has been more detailed use of spatial priority-setting criteria to generate ecosystem services and conservation in accordance with stated policy goals for PSA, in contrast to the initial a first-come-first-serve supply determined enrollment. Payment levels in the PSA program continue to be administratively determined, rather than demand-supply driven. For example, PSA payment levels have been maintained in nominal terms by decree, but fallen in real terms (Porras *et al.*, 2013).

There is an undeniable political tension between PSAs voluntary nature, use of competitive intermediaries and partial private funding, one the one hand, and public funding and public regulation of PSA selection criteria, on the other. We have suggested that rules-in-use terminology of IAD framework, provides a language for describing the structure of economic instruments for conservation that avoids arguments based on ideal types. Implicitly we have been arguing for policy analysis that avoids ideological starting points for policy design research. The IAD's rules-in-use focuses on instrument structure and makes descriptions of instruments more ideologically neutral. But policy

design research must also address policy objectives and the types of agency needed to support their achievement (Van Hecken *et al.*, 2015; Fletcher and Buscher, 2017). This requires a complementary set of analytical tools that address political dimensions of instruments (Vatn, 2015; Hausknost *et al.*, 2017).

5. Conclusions

We use Ostrom's Institutional Analysis and Development (IAD) framework and its 'rules-in-use' terminology to describe Costa Rica's 'pagos por servicios ambientales' (PSA) program. We demonstrate how describing payments for ecosystem services (PES) in terms of 'rules-in-use' accommodates a wide range of definitions that have been discussed in the PES literature. In the case of Costa Rica, through a detailed analysis of boundary rules, position rules, choice rules, information rules, aggregation rules and pay-off rules, we demonstrate an interpretation of PSA as a policy mix in itself, rather than a single instrument. Our analysis illustrates that the 'rules-in-use' of the IAD framework offers a terminology that can be used to compare the structure of economic, regulatory and informational instruments in terms of functional characteristics – characteristics that can explain instrument interactions. The rules-in-use terminology also offers greater precision regarding what is understood as the institutional context of PES, bridging literatures on economic instrument design and environmental governance. The rules-in-use terminology does not explain the quality of interactions - complementarity, synergy, path-dependence, redundancy or conflict - between rules and between instruments. However, the IAD framework provides a consistent terminology for the decomposition of instrument characteristics for future comparative policy research in environmental conservation.

Acknowledgements

We are grateful to Oscar Sanchez, FONAFIFO, for a number of discussions on PSAs early history. Thanks Graciela Rusch, Rui Santos, Peter May and Stuart Whitten for comments on early drafts. The authors acknowledge the POLICY MIX project (http://policy mix.nina.no) funded by the European Commission, Directorate General for Research, within the 7th Framework Programme of RTD, Theme 2 – Biotechnology, Agriculture & Food (Grant no. 244065) and the PESILA-REDD project funded by the Research Council of Norway (Grant no. 204058).

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SUPPLEMENTARY MATERIAL

Table S1 documents types of cadastral inconsistencies mapped by the IDB cadastre project in Costa Rica (BID CR0134 Regularización de Catastro y Registro). Benavides *et al.* (2014) evaluated the possible implications for PSA pre-applications if FONAFIFO have information on these cadastral inconsistencies, shown in the colour coding. The cadastre developed by the IDB Project is not currently applied systematically by FONAFIFO to assess pre-applications because the cadastre lacks complete national coverage, but is used when and where available at the time of assessing pre-applications.

Table S1 Boundary rules of an information-based instrument - cadastral inconsistencies and their implications for PSA pre-application process in Costa Rica

INCONSISTENCY	DESCRIPTION	IMPLICATIONS FOR PES APPLICATION
1	**Property without property map or national register information** Predio sin información catastral ni registral.	Cost; time to obtain property map and register may exceed PSA annual application deadlines
2	**Property defined by «posession» information** Predio definido por información posesoria	None. Follow procedure in PES Operations Manual to qualify for PES
3	**Registered property without property map** Finca sin un plano catastrado relacionado	Cost; time to obtain property map and register may exceed PSA annual application deadlines
4	**Difference due to excess area relative to register (>10%)** Diferencia por exceso de área.	Cost and time for a process of possessionary information for excess area.
5	**Discrepancies in register information** Discrepancia en el asiento registral	None. Follow simple procedure for rectification of register information
6	**Physical superposition of registered property** Sobreposición física de fincas (SOBREPOSICIÓN PARCIAL O TOTAL)	Subject to negotations between neighbours - at least one of the affected parties must make a new property map and rectify register information.
7	**Apparent physical superposition of registered property with public property** Sobreposición física aparente de finca con bienes públicos	Superposition with public roads or the Coastal Marine Zone Cost and time to make a new property map
8	**Registered properties with same property map** Fincas con el mismo plano catastrado	Simple modification of register information if another property map exists or Cost and time to make a new property map
9	**Property registered in a different district** Finca inscrita en otro distrito	None. Follow simple procedure for rectification of register information
10	**Property boundaries not identified** Finca no ubicada	Two properties registered for the same physical area, but not possible to identify boundaries
11	**Incompatibility with physical reality** Incompatibilidad con la realidad física	Property boundaries in the field different from register and property map information.

No significant implications | Entails additional costs | Stops application process

Source: Benavides *et al.* (2014)