ENVIRONMENTAL IMPACTS OF DIFFERENT PROPERTY REGIMES IN FORESTS, FISHERIES AND RANGELANDS
-preliminary findings from a systematic review

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Abstract

Debate over the effects of different property regimes on natural resource systems has long been controversial, incited by Hardin's (Hardin 1968) thesis that common pool resources will inevitably suffer from overexploitation and degradation. A large, diverse, and rapidly growing body of literature has investigated the links between different property rights regimes and environmental outcomes and shown that common, government, and private property rights regimes are each capable of yielding sustainable environmental outcomes. However, the existing evidence base is highly fragmented. There also exists a large body of literature reviews assessing the evidence base, but these reviews have been limited in scope, focusing on specific resource systems and specific regime comparisons without examining the links between property rights regimes and environmental outcomes across these resource systems. Also, few studies compare impacts across geographical regions.

This paper addresses this knowledge gap through a systematic review that assesses current knowledge of the impacts of property rights regimes on environmental outcomes in forests, fisheries, and rangelands in developing countries. We use a bundle of rights approach to assess environmental impacts across the three main property rights regimes—state, private, and community—as well as mixed property rights regimes that involve some combination of these three.

The review screened over 29,000 references and identified a total of 208 relevant articles, but was only able to use 106 of these articles in data analysis, as the remaining articles were unclear in their presentation of property regimes. A total of 371 case studies were extracted from these 106 articles, as many articles included more than one case study.

Preliminary results show that most of the included articles examine forests (52 articles), followed by fisheries (40 articles) and rangelands (14 articles). Geographically, most of the studies were conducted in Africa (43); with equal number of studies conducted in Asia (including Melanesia) and Latin America and the Caribbean (31 each).

In general, the quality of the evidence base is limited by the lack of data from cases prior to property regime change, and most case studies present spatial comparisons in a control-impact setting. Only 21 articles (N=106) contain data from cases prior to property regime change, while the remaining 85 articles present spatial comparisons between cases with and without property rights arrangements. As many studies address the impact of formal protection compared to adjacent areas, adequate proof for site similarity is often missing. Comparison between cases is further complicated by the wide variety of environmental indicators used for measuring environmental outcomes.

Key Words: Property rights, Tenure, Bundle of rights, Forests, Fisheries, Rangelands, Environmental impacts

Introduction

In developing countries, ownership of natural resources has long been claimed by the state, with long held paradigms emphasizing the role of government or private property as a requirement for conservation and sustainable resource use (Armstrong 2014). Within forestry, where aggregated data on ownership is more readily available than in fisheries and rangelands, estimates show that governments in lower and middle income countries claim over 60% of total forest lands, while communities hold 30% (RRI 2013).

Tenure reforms and decentralization processes, increasing demands for greater local participation in resource conservation, and increased competition over resources in globalized markets have led to the transfer of many resource-related rights during the past two decades. The devolution of property rights to community and local level actors is often deployed as an instrument that would achieve a multitude of targets, such as poverty alleviation (Besley and Burgess 2000), gender equity (Meinzen-Dick et al. 1997), sustainable resource conservation (Berkes 2009), and climate change mitigation (Sunderlin, Larson, and Cronkleton 2009). At the same time, states have also retained or claimed new property rights, or allocated them to private sector actors in the name of these same goals (Lemos and Agrawal 2006).

A large, diverse, and rapidly growing body of literature has investigated the links between different property rights regimes and environmental outcomes and has shown that state, community, and private property rights regimes are each capable of yielding sustainable environmental outcomes, challenging Hardin's (Hardin 1968) thesis that common pool resources will inevitably suffer from overexploitation and degradation. More pointedly, a large body of scholarship has demonstrated that, in some contexts, widening the breadth of property rights held by local-level actors in common property regimes can lead to more efficient and effective outcomes for resource sustainability (Ostrom 1990, Larson and Soto 2008, Ostrom and Nagendra 2006).

Within forestry, these case studies often assess recent forest decentralization policies, broadly described as forest tenure reforms, which transfer decision-making rights and authority from central to local governments or formally recognizes existing de facto rights at the local level (Jagger 2010, Larson et al. 2010, Mohammed and Inoue 2014, Sudtongkong and Webb 2008). Concurrently, there are numerous case studies assessing the outcomes of co-management and participatory management arrangements, which also appear often in fisheries research (Nuon and Gallardo 2011, Crawford et al. 2010, Unsworth et al. 2007). In the rangelands context, the emphasis is on comparisons of environmental outcomes between different management regimes, such as communal versus private rangelands (Belgacem, Tarhouni, and Louhaichi 2013, Kiguli, Palmer, and Avis 1999, Fabricius, Burger, and Hockey 2003).

With the increasing number of case studies on different property rights regimes, there have also been an increasing number of reviews summarizing and aggregating their results. However, these reviews are often resource-specific and focus solely on the performance of community regimes or co-management regimes (Pagdee, Kim, and Daugherty 2006, Evans, Cherrett, and Pemsl 2011). Another common focus is the performance of natural resource conservation regimes, such as comparing conservation outcomes between state-protected, community-protected and open access areas (Shahabuddin and Rao 2010, Porter-Bolland et al. 2012).

Thus far, the literature examining different property regimes has yielded mixed findings on resource conditions and sustainability such as biodiversity and forest cover (Dahal, Larson, and Pacheco 2010), fisheries decline (Costello, Gaines, and Lynham 2008), and rangeland degradation (Homewood 2004). Despite the expanding literature and reviews, little has been done to account for the variations in environmental impacts between regime types, which limits advances in policymaking and management interventions. Broadening the scope to examine outcomes in state and private property regimes can give us valuable theoretical and policy insights on the similarities and systematic differences within and across resource systems. Moreover, the increasing emphasis on landscape approaches and thinking beyond individual resource systems makes informing policy and practice at multiple scales of governance even more crucial (Sayer et al. 2013).

This systematic review synthesizes empirical evidence of the impacts of different property rights regimes on environmental outcomes in the three resource systems of forests, fisheries and rangelands at local to regional scales in developing countries. We have chosen these resource systems as they do not only support most of the world's biodiversity and provide most global ecosystem services, but are also crucial to the livelihoods of millions of people. These resource systems represent different levels of resource mobility and variability and capture a significant share of ecosystem types found across the globe. Although this review limits itself to the assessment of environmental outcomes, it also considers contextual and mediating factors in determining which elements matter most decisively in influencing environmental outcomes. Accounting for context is especially important since property regime transitions are not always unidirectional nor fully realized, leaving ample room for discrepancies between existing de facto and newly inscribed de jure regimes, and thus conflicts between recognized and unrecognized actors (Larson et al. 2010). Currently we are aware of only two relevant systematic reviews on the impact of payment for environmental services and decentralization, respectively, on environmental outcomes in forests and poverty (Lisiecki et al. 2014, Chavis et al. 2014). This review is broader in scope, encompassing not only forests, but also rangelands and fisheries, and goes beyond decentralization aspects to cover different property rights regimes

The review seeks to answer three main questions. 1) What are the environmental impacts of different property rights regimes in forests, fisheries, and rangelands in developing countries? 2) Which property rights regimes are associated with positive, negative or neutral environmental outcomes? 3) How do those environmental outcomes compare within and across resource systems and world regions?

Materials and methods

Systematic reviews aim to identify the best available evidence on specific questions by using transparent and pre-defined procedures to find, evaluate and synthesize the results of relevant research. Systematic reviews are established practice in fields of healthcare and medicine in contributing to evidence-based policy and decisionmaking, but are still relatively new in the field of environmental conservation and development. This review follows the guidelines set by Collaboration for Environmental Evidence (CEE 2013), and a systematic review protocol that has been published to guide the process of data collection, validation, and analysis (Ojanen et al. 2014a).

This review adopts a PICO (Population-Intervention-Comparator-Outcomes) framework to structure the analysis of these research questions (CEE 2013), summarized in Table 1.

Table 1: Research framework for Population-Intervention-Comparator-Outcomes (PICO)

POPULATION Resource systems	INTERVENTION Property regimes	COMPARATOR Study Design	OUTCOME MEASURES
Forests, fisheries and rangelands	State, private, community, and mixed regimes	Before and after intervention (temporal dimension) With and without the intervention, from similar settings, or control-impact (spatial dimension) Before and after AND control-impact (BACI)	**Forests:** Forest cover, species diversity and abundance, biomass, perceptions of forest condition, deforested area, land conversion, measures of disturbances such as number of cut stumps , etc. **Fisheries:** Abundance of fish and invertebrates, size and diversity of species, biomass, coral cover, etc. **Rangelands:** Species diversity and abundance, plant and bare ground cover, proportion of different species, soil indicators, biomass, number of supported animals etc.

Population

Population refers to the three resource systems covered by this review: forests, fisheries and rangelands. Given the diversity of definitions of these terms (forests, fisheries and rangelands) we have adopted FAO definitions of forests and fisheries (FAO 2000, 2013), and the Society for Range Management's definition of rangeland (Society for Range Management 1998) as follows:

- Forest: Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 hectares (ha). The trees should be able to reach a minimum height of 5 meters (m) at maturity. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent. (FAO 2000)

- Fishery: A geographical place, activity, or unit that is involved in raising and/or harvesting fish. As a unit, a fishery is typically defined in terms of some or all of the following: people involved, species or type of fish, area of water or seabed, method of fishing, class of boats and purpose of the activities.(FAO 2013)

- Rangeland: Land on which the indigenous vegetation is predominantly grasses, grass-like plants, forbs, or shrubs and is managed as a natural ecosystem. If plants are introduced, they are managed similarly. Rangelands included natural grasslands, savannas, shrublands, many deserts, tundras, alpine communities, marshes and meadows. (Society for Range Management 1998)

Intervention

The intervention refers to the introduction or change of a particular property rights regime, whether state, private, or community, or some combination of these (mixed regimes), where a property rights regime is defined as a system of rules governing access to and control over resources. The intervention could also be the establishment of a protected area for the explicit objective of resource conservation. The review uses a bundle of rights approach, introduced by Schlager and Ostrom (1992), to examine how the distribution of access, withdrawal, management, exclusion, and alienation rights in state, private, community, and mixed property regimes affects resource outcomes. In addition, this review considers the right to income from resource use as part of the bundle of rights that comprise a property regime.

Comparators

This review compares environmental outcomes based on the analysis of studies that:

1) Compare environmental outcomes before and after intervention (temporal comparison)
2) Compare cases with intervention to without intervention (spatial comparison)
3) Compares cases using BACI design, which combines temporal and spatial comparisons

Outcomes

The outcomes of interest in this analysis consist of qualitative and quantitative changes in environmental measures, which varied greatly by resource system. Table 1 includes illustrative outcome indicators that were found in relevant studies. We reported the environmental results and author's conclusions on results; based on this information, we also made our own assessments on environmental outcomes.

Searches

The search used terms derived from the PICO framework and was conducted in 90 online databases, including databases for academic literature (Web of Knowledge, CAB Abstracts, Agris, Agricola, Scopus, Scielo), general web search engines (Google and Google Scholar), library collections (Digital library of the commons) as well as publication websites of various research institutions, international organizations and universities (FAO, World Bank, CGIAR research centers, USAID). We also searched grey literature in NGO and other think-tank websites (WWF, Conservation International, RRI). A detailed list of databases search can be found in the systematic review protocol (Ojanen et al. 2014). Previous reviews relevant to the topic (e.g (Brooks, Waylen, and Borgerhoff Mulder 2013, Hellebrandt, Sikor, and Hooper 2011, Porter-Bolland et al. 2012) were hand-searched to identify further relevant studies. To reduce language bias that may be associated with limiting the review to English language publications, the search was also conducted in French and Spanish where meaningful results could be found.

Study inclusion and exclusion criteria

Study inclusion criteria determine what kind of studies will be accepted for the review. The inclusion criteria were applied sequentially to the titles, abstracts and full-text of articles to select the relevant articles captured by the search. Studies were included if they fulfilled the following criteria.

Type of study

Only primary empirical literature was included, such as case studies, case–control studies and cohort studies, including quantitative and qualitative research. Only studies using one of the three designs summarized in Table 1 under comparators were included.

Subjects studied

We included studies that assessed any property regime associated with forests, fisheries and rangelands. Papers reviewing environmental outcomes without a reference to a specific property regime were excluded. Studies that focused only on plantation forests, agroforestry and aquaculture were excluded. However, we included papers where agroforestry or reforestation activities took place, if the overall assessment of the paper focused on forests or grasslands. The review also excluded commentary and position papers.

Outcomes

The included studies had to quantitatively measure and/or qualitatively assess change and/or difference in environmental outcomes as illustrated in Table 1.

Regional focus

This review focused on environmental outcomes of property regimes in developing countries and only studies from Latin America and the Caribbean, Africa, and Asia and the Pacific were included. Developing countries were those defined as either low or middle income according to

the World Bank (World Bank 2013). The countries were categorized into world regions according to UNstats definitions. Our decision to focus on developing countries is for a number of reasons: the history of these property rights regime changes dates to early 1980s in most developing countries, the context of people-resource interdependencies is more similar between these countries, and the need for improving understanding on the relationship between property rights and resource outcomes is needed in these regions more than in other world regions.

Timeframe

We decided to include only articles published between 1990-present to ensure that we have sufficient data on environmental outcomes from different property rights regimes because in most developing countries, common and private property started only in the 1980s while public property goes back to the colonial era.

Based on the inclusion criteria described above, the review used a three-step process to identify articles for inclusion.

1. Articles clearly not relevant were excluded on the basis of titles only

2. Articles with potentially relevant titles were assessed using their abstracts.

3. Articles that passed steps 1 and 2 were considered for full text screening.

Study quality assessment

Quality assessment is an essential part of systematic reviews. Once all relevant articles had been identified, full text articles were reviewed to assess study quality according to the quality assessment criteria developed by the team, based on recommendations by the Cochrane Collaboration (Higgins and Green 2008) as well as previous reviews (Brooks, Waylen, and Borgerhoff Mulder 2013). The quality assessment addressed the clarity and replicability of methods, appropriateness of methods, study design, sample size and confounding factors of selected studies. In this paper we will not assess the quality of included papers, but aim to do so in the final systematic review.

Screening

Because of the timing of the search, our search covered published literature from 1990 to the first half of 2014. Because of the breadth of the review and extensive search terms, the search identified 32,648 hits. However, this number included many duplicates, following the removal of which 29,119 titles [1] remained. Following titles and abstract screening, 1497 articles were included for full text review. After full text screening, most articles were excluded due to lack of

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[1] This number also includes article identified by snowballing. As reviewers read the full text articles, other clearly relevant studies were noted and checked.

primary data, and a total of 208 relevant articles remained. However, only 106 articles were used for data analysis, as property rights regimes were unclear in the remaining studies. List of included articles is included at the end of this paper.

Data extraction strategy

Data on individual property regime interventions and their environmental outcomes (case study) was collected from the articles into a data extraction matrix using an Excel spreadsheet. Tables 2(a)-2(c) summarize the information that was collected from the case studies.

Table 2(a): Case study identification, regime characteristics and environmental outcomes information

Case study identification and research methods	• Author • Year of publication • Title of the publication • Research question • Study discipline (natural sciences, social sciences or mixed) • Study year • Data collection methods used • Location (subnational, country and world region as classified by UnStats)
Regime characteristics	• Nature of the regime -de jure: state, community, private or mixed. Mixed was considered to be any combination of the main three property regimes • Nature of the regime -de facto: state, community, private, open access or mixed. Mixed was considered to be any combination of the main three property regimes (state, community or private) • Stated objectives of the property rights regime intervention • Regime intervention year

Environmental outcomes	• Environmental measurements and indicators used in the study
	• Study results on biological outcomes
	• Study conclusions on biological outcomes
	• Review team assessment on the environmental outcomes: evaluations were made based on the study design
	  o Before-after (temporal) studies: negative or positive to before. If there was no change observed compared to before, change was neutral. If the article concluded that the environmental change could not be attributed to the regime, the outcome was classified as undetermined.
	  o Spatial comparison: better, worse or same compared to comparison regime. If the direction of the results could not be determined (e.g. both significant positive and negative changes occurred), the outcomes were noted as undetermined.

We also collected information on a set of contextual factors that may explain the nature and variation of outcomes by regime. Based on previous systematic review recommendations

(Brooks, Waylen, and Borgerhoff Mulder 2013) we limited our contextual data collection to a manageable set of environmental, socio-economic, and political variables, listed in Table 2(b). These were identified based on consultation with experts in the field of property rights and natural resource governance, as well as consultation of the empirical and theoretical literature relevant to this review.

Table 2(b): Environmental, Socio-economic and political contextual information.

Environmental context	• Ecosystem type (resource and more specific description) • Spatial extent of resource area (size of the area) • Elevation • Accessibility (e.g. proximity to roads and cities • Baseline resource condition in before-after (temporal) comparisons • Presence of previous environmental management interventions • Protection status (IUCN protected area, other protected area or not a protected area)
Socio-economic context	• Population density in study/resource area • Change in population in study/resource area • Local and external market demand on resource • Economic inequality stated in the study • Presence of education initiatives • Presence of public infrastructure (e.g. roads, ports, power supply
Political context	• Decentralization (whether decentralized or decentralizing; year decentralization process began; extent of decentralization: advanced; not advanced) • Nature of political regime (democracy, authoritarian, totalitarian) • Corruption (no corruption, low corruption, high corruption according to study; other measures of corruption, e.g. WGI, Transparency International

In addition, the following characteristics of property regime interventions were also noted. If the information was not available or unclear, the category was marked as unknown.

Table 2(c): Additional information about the case studies

Clarity of rights	▪ Clear, if the study had information on both de jure and de facto rights and no disagreements or conflicts between users were cited ▪ Unclear, if the study mentioned several right holders and presence of disagreements or conflicts over rights
Stability of rights	▪ Stable, if the study had no information on the likelihood of revocation of rights or limitation to the duration of rights. Rights limited in scope (e.g. rights only to NTFP products) were not considered as part of the stability question. ▪ Unstable, if the study mentioned conflicts and had information

		on the likelihood of revocation of rights or limitation to the duration of rights.
Level of enforcement	▪	Any information on enforcement (e.g. patrolling and monitoring) was noted here.
Legitimacy of decision-making authority over rights	▪	Any information regarding internal decision making processes was noted here, and to what extent was the decision making inclusive (not excluding certain groups).
Gender equality of property rights	▪	Any information on gender equality was noted.
External support	▪	Any information regarding support by external actors, such as NGOs, donors, or companies

Unpacking property regimes using a bundle of rights approach

Although the broad categories of property rights regimes (public, private, communal mixed) appear distinct from each other, the specifics of which rights are held by which actors differ from place to place. To ensure a systematic comparison of these property rights arrangements, we adopted the bundle of rights approach as defined by Schlager and Ostrom (1992) that identifies the individual rights held by state, community, and private actors in each property regime. These rights include access, management, exclusion and alienation rights. In addition, in our analysis we also considered the right to earn income from the resource as a specific right. We are not aware of previous research or reviews that have attempted to unpack different tenure arrangements to the extent presented in this study; moreover, previous assessments of the relationship between resource condition and tenure arrangements have been country-level (Pulhin et al. 2008) or resource specific assessments (Larson et al. 2010).

Property rights definitions:

Access: Right to enter a defined resource area

Withdrawal: Right to enter a defined resource area and obtain resource units or products of a resource system (e.g., cutting firewood or timber, harvesting fish, grazing cattle)

Management: Right to regulate internal use patterns and transform the resource by making improvements (e.g., planting seedlings, thinning trees)

Exclusion: Right to determine who will have right of withdrawal and how that right may be transferred

Alienation: Right to sell or lease withdrawal, management, and exclusion rights.

Right to income: Right to benefit from a resource even without using it directly and is derived from permitting others to use the resource (Eggertsson 1990, Honore 1961).

Property regime and open access definitions

Private regime: Individual or "legal individual" holds rights.

Community regime: Group members hold rights (e.g. community)

State regime: State holds rights

Mixed regime: A combination of any of the three above, but only when withdrawal, management or exclusion rights in the bundle are shared

Open access: No one has property rights and everyone can use the resource as they like; no effective management or regulation

The mixed category is defined only based on the holders of withdrawal, management, and exclusion rights. While alienation is crucial in determining regime type, in most cases this right is retained by the state and its use would result in the classification of nearly all regime types as mixed. We did not use access rights in determining regime type because in most cases almost all actors have certain access rights. Thus if more than one actor held the three categories of rights (withdrawal, management and exclusion), the regime was characterized as mixed.

Furthermore, we also considered tenure security by distinguishing between de jure and de facto rights. Rights were defined as de jure when their legal nature was explicitly mentioned by authors. For communities, rights were defined as de jure if the article mentioned specific rules and laws, formal state recognition for devolution of rights or decentralization policies. We also assumed that in the case of state protected areas, the state was the holder of de jure rights, such as in the case of national parks and marine reserves. For private regimes such as private wildlife ranches/farms, private forests and private conservation areas we assumed that the private actors held de jure rights. If the article referred to communal lands/areas or discussed community management, the rights were defined as de facto, unless explicitly stated as de jure rights.

Data analysis

The systematic review is ongoing, but this paper reports and discusses preliminary results from our analysis. Figure 1 shows the distribution of the 106 included articles by resource system 1(a) and geographical region (1b). Some of these articles contained more than one study case, bringing the total number of case studies to 371; their distribution is summarized in Figure 2.

Figure 1. Distribution of articles by (a) resource system and (b) geographical region
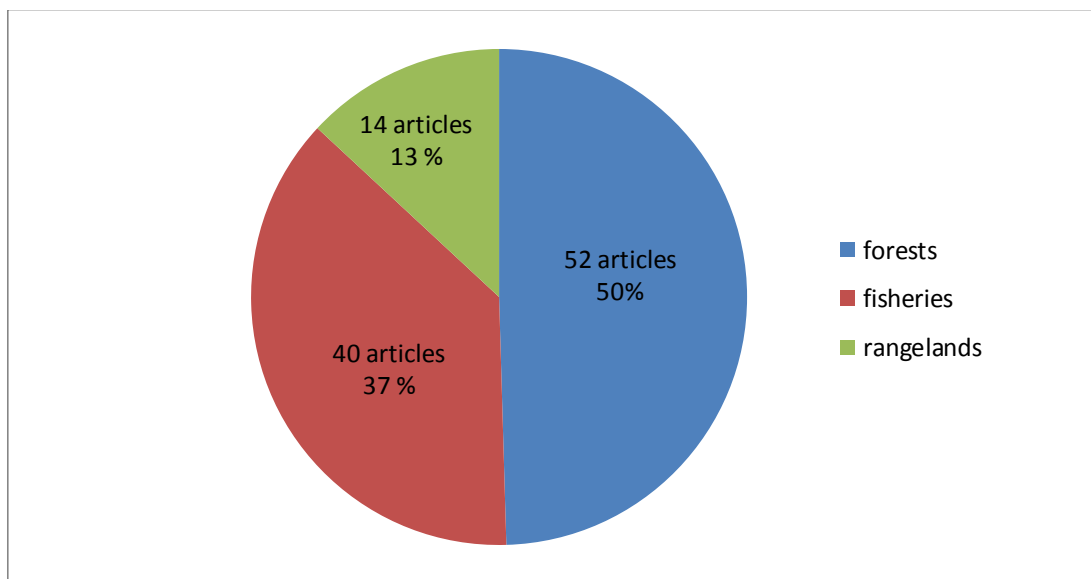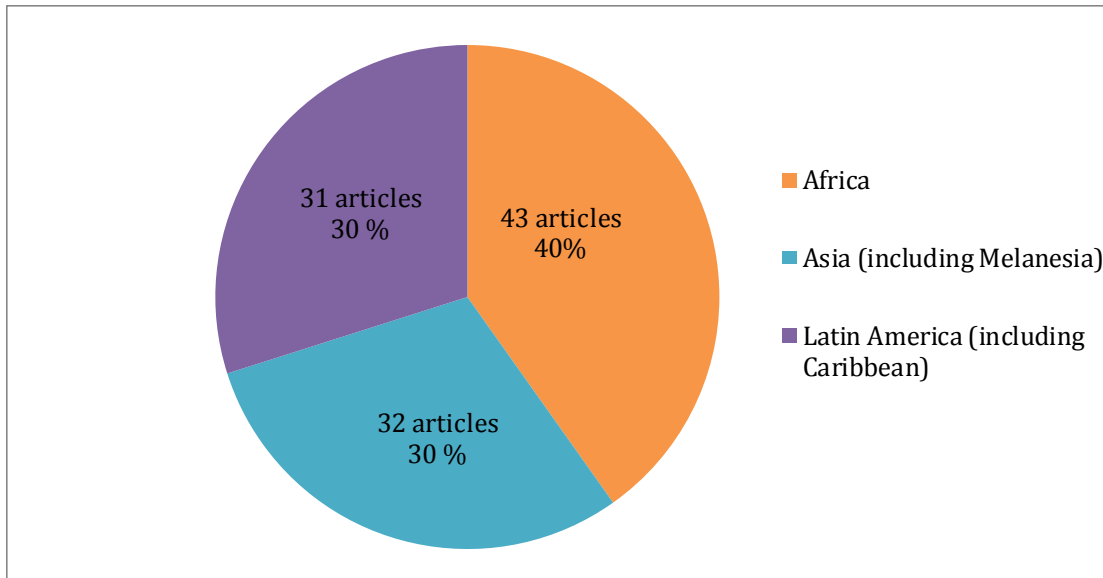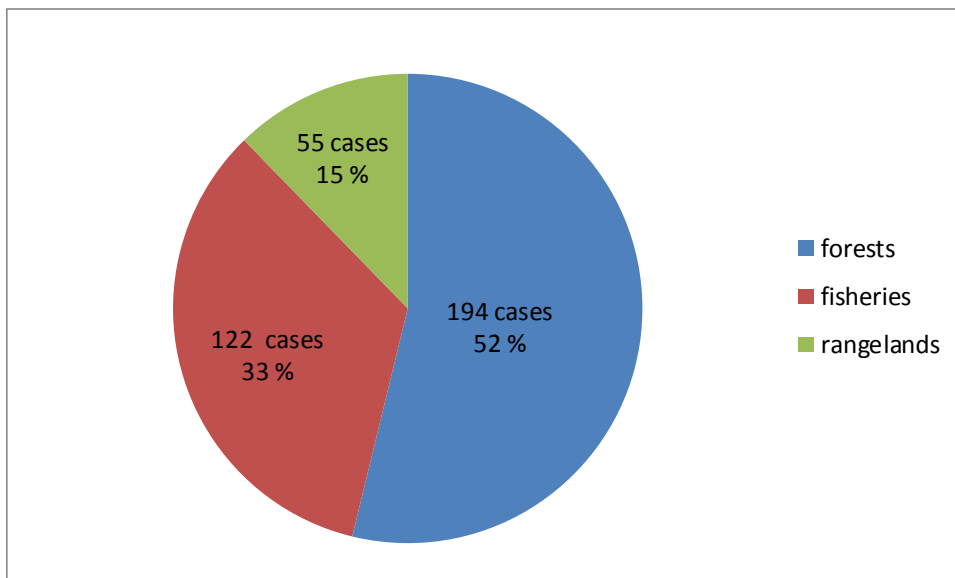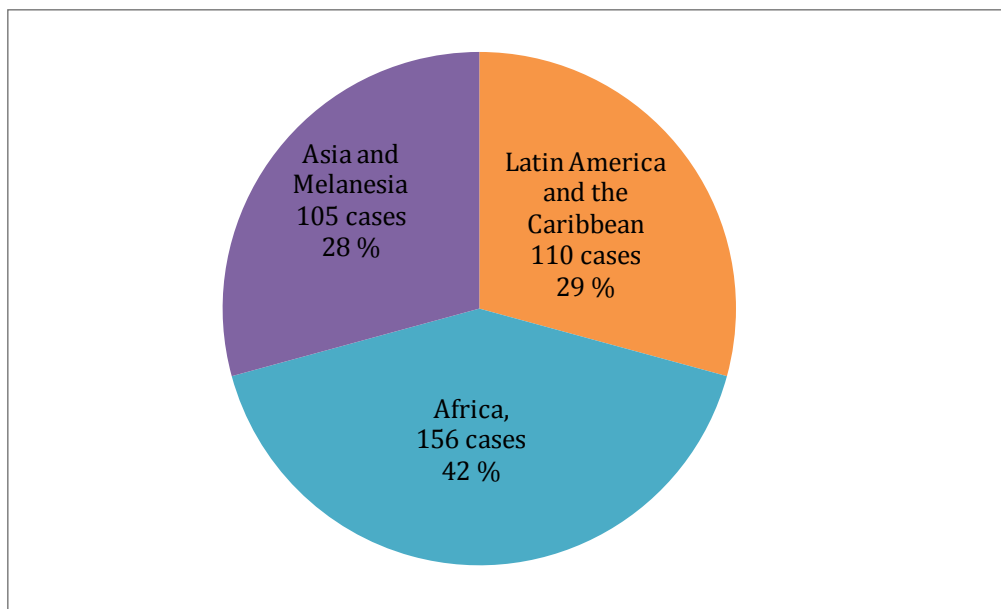

Figure 2. Distribution of case studies by resource system (a) and geographical region (b)

We also recorded information on the study design reported in each article. Our data reveals that spatial comparison assessing environmental outcomes between sites with and without property regime changes is the most common design, present in 85 articles (79%, N=106). Only 13 articles (12%) reported using the before-and-after (temporal comparison) study design, while 8 studies (8%) used the before-after-control-impact (BACI) design. Of the 371 case studies, 321 used spatial comparisons, 26 used temporal comparisons and 24 used BACI designs. While the before-and-after intervention design provides strong causal explanations between property rights regimes and environmental outcomes after controlling for confounding factors, there are few such studies in the existing literature.

Before and after studies.

A total of 13 articles used before and after study designs, with 8 articles on forests, 4 on fisheries and 1 on rangelands. Four articles discussed more than one case study, bringing the total number of case studies to 26. Table 3 lists in detail the regime changes and associated environmental outcomes in these case studies. Regime change led to positive environmental impacts in 16 case studies, neutral impacts in one case study, and negative impacts in five cases. In three cases the environmental impacts could not be linked to the regime change (undetermined).

Table 3. Regime changes and impacts in 13 before-after articles (26 case studies).

Regime Change		Resource type	Impacts				Total case studies
Before	**After**		**Positive**	**Neutral**	**Negative**	**Undeter mined**	
Open access	Mixed (State/ community)	Fisheries	1	1	0	0	2
	Community	Fisheries	5	1	0	0	6
State	Mixed (State/ community)	Forests	7	0	1	0	8
		Rangelands	0	0	1	0	1
	Community	Forests	1	0	0	0	1
Community	State	Forests	0	0	1	0	1
	Private	Forests	0	0	1	0	1
	Open access	Fisheries	0	0	1	0	1
Private	State	Forests	0	0	0	3	3
Mixed (State/ private)	Mixed (State/ Community)	Forests	2	0	0	0	2
Total			16	2	5	3	26

From Table 3 it is clear that positive impacts are reported more often than neutral or negative impacts. Although most types of regime change have small sample sizes, we do see trends in outcomes across different regime changes. Transition into community regimes (and most transitions into mixed state and community regimes) saw positive environmental impacts. We find that transition from state control to mixed regime resulted in positive environmental outcomes (7 case studies) with two exceptions. The only case study that resulted in open access saw negative impacts, while all eight cases that transitioned away from open access situations saw positive or neutral impacts. All three cases that transitioned away from community regimes led to negative environmental impacts.

Almost all fisheries studies (8 out of 9 studies) evaluated change from open access situations to community or mixed regime involving communities, leading to positive or neutral environmental impacts. The 16 forest studies present a more extensive analysis regarding the nature of regime change. Analysis of this group shows that change to community (or mixed state and community) regimes results in positive environmental impacts (10), whereas change away from community regimes to another regime led to negative outcomes (2).

These results from fisheries and forests suggest that avoiding open access situations and transferring user rights to communities usually lead to positive environmental impacts. This kind of study must be extended to rangelands, where there is a gap in research; we found only one study focusing on rangeland, evaluating a shift from state to mixed property with negative outcomes using the before-and-after design.

Spatial comparisons (with and without intervention cases)

Spatial comparisons are control-impact studies comparing cases with a particular property regime to a matched control. We identified 85 articles with such study designs, with 43 on forests, 30 on fisheries and 12 on rangelands. The articles presented a total of 289 case studies of different property regime comparisons, of 144 regimes in forests, 93 in fisheries and 52 in rangelands. There were clear differences between resource systems, as shown in the table below. Community vs. state was the most prevalent comparison made and is especially dominant in forestry studies, with 23 of 43 articles having this kind of regime comparison. In fisheries, comparisons with open–access situation are most common, with state vs. open access totalling 14 articles (out of 30) and community vs. open access totalling 13 articles. In rangelands, multiple regime comparison cases are common, and 12 articles made 52 comparisons, with the most frequent one being community vs. private (12 articles).

Figure 3. Frequency of different regime comparisons across resource systems.
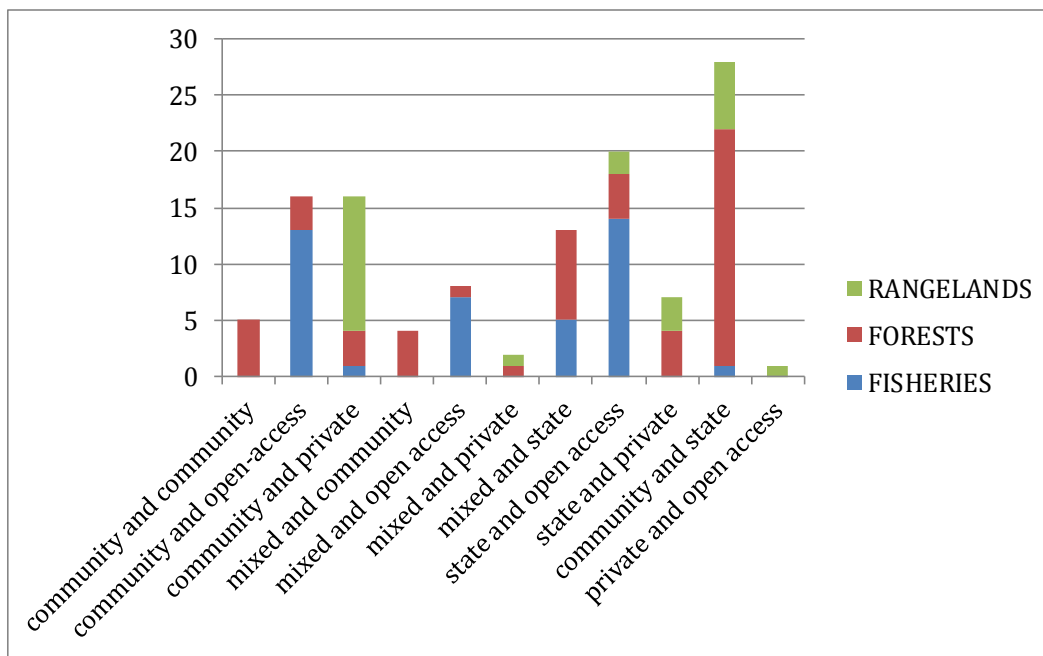
Under spatial comparisons, we assessed whether environmental outcomes were better, worse, similar or undetermined between the two regimes under comparison. Undetermined was defined as when authors did not make causal linkages between regime type and environmental outcomes. Table 4 summarizes these results.

Comparisons between regimes demonstrate community regimes to have better environmental impacts than open access regimes, but generally worse impacts than private and state regimes across the three resource systems. State regimes more often lead to better or similar results when compared with open access, private, and mixed regimes, as is the case for private and mixed regimes when compared with open access regimes. In all cases, mixed regimes refer to state and community co-management arrangements.

Table 4. Environmental outcomes of different property rights regimes.

Regime comparison	Resource system			Total
	Fisheries	**Forests**	**Rangelands**	
community versus open access				
community better than open access	22	8	0	30
community even with open access	4	0	0	4
open access better than community	2	0	0	2
undetermined	4	0	0	2
community versus private				
community better than private	0	4	6	10
community even with private	0	7	4	11
private better than community	2	1	9	12
undetermined	0	10	0	10
community versus state				
state better than community	0	32	20	52
state even with community	0	12	4	16
community better than state	0	20	0	20
undetermined	0	7	0	7
community versus mixed				
mixed better than community	0	11	0	11
mixed even with community	0	0	0	0
community better than mixed	0	0	0	0
undetermined	0	0	0	0
state versus open access				
state better than open access	21	3	1	25
state even with open access	16	0	0	16
open access better than state	0	0	0	0
undetermined	0	1	0	1
state versus private				
state better than private	0	1	4	5

state even with private	0	0	0	0
private better than state	0	6	0	6
undetermined	0	6	0	6
state versus mixed				
mixed better than state	3	7	0	10
mixed even with state	4	4	0	8
state better than mixed	3	2	0	5
undetermined	0	0	0	0
private versus open access				
private better than open access	0	0	2	2
private even with open access	0	0	0	0
Open access better than private	0	0	0	0
undetermined	0	0	0	0
mixed versus open access				
mixed better than open access	2	0	0	2
mixed is even with open access	6	0	0	6
open access is better than mixed	0	0	0	0
undetermined	4	0	0	4
mixed versus private				
mixed is better than private	0	2	0	2
mixed is even with private	0	0	0	0
private is better than mixed	0	0	2	2
undetermined	0	0	0	0

Environmental outcomes by world regions

In this section we present findings on whether and how environmental outcomes differ from one world region to another by resource type and property rights regime. Table 5, 6 and 7 summarizes these results in forests, fisheries and rangelands, respectively, for spatial comparison studies.

Overall findings

State versus community regimes: In Latin America and Africa, community regimes perform worse than state regimes, while in Asia community performs better than state regimes. 15 cases from Latin America report community performing worse than the state, compared to four cases that report community performing better than the state. All 10 cases from Africa report community performing worse than state, while in Asia 16 cases report community performing better than the state compared to seven reporting state performing better than community regimes.

Community versus private regimes: While there was no data comparing community and private property regimes from Africa and Asia, where data is available in Latin America community performs either better or similar to private property arrangements but these results equal with number of undetermined cases.

Other comparisons: State property arrangements in Africa perform better than mixed regimes, while state performs worse than private regimes. In Africa, where data is available on comparisons between community and mixed regimes, results indicate that community always performs worse than mixed regimes. All regimes perform better than open access in Africa (none reported in other regions).

Table 5. Main Forest outcomes by world region.

Regime comparison	World region			Total
	Latin America and the Caribbean	Africa	Asia and Melanesia	
between community and private				
community better than private	4	0	0	4
community similar with private	7	0	0	7
community worse than private	1	0	0	1
undetermined	10	0	0	10
between state and mixed				
state better than mixed	2	5	0	7
state similar with mixed	0	2	2	4
state worse than mixed	1	1	0	2

undetermined	0	0	0	0
between state and private				
state better than private	1	0	0	1
state similar with private	0	0	0	0
state worse than private	0	6	0	6
undetermined	4	0	2	6
between community and state				
community better than state	4	0	16	20
community similar with state	10	0	2	12
community worse than state	15	10	7	32
undetermined	0	0	7	7
between community and mixed				
community better than mixed	0	0	0	0
community similar with mixed	0	0	0	0
community worse than mixed	0	11	0	11
undetermined	0	0	0	0
between community and open access				
community better than open access	0	8	0	8
community similar with open access	0	0	0	0
community worse than open access	0	0	0	0
undetermined	0	0	0	0
between state and open access				
state better than open access	0	3	0	3
state similar with open access	0	0	0	0
state worse than open access	0	0	0	0
undetermined	0	1	0	1
Total	51	47	33	139

Table 6 summarizes fishery outcomes by world region.

In the fisheries sector, most studies compare environmental outcomes between a property rights regime and open access situation but not comparing between different property rights regime types. In Latin America and Asia, common property rights regimes almost always perform better open access (no data from Africa). In Latin America and the Caribbean, state fisheries management yield similar environmental outcomes to open access situations, while in Africa and Asia, state regimes nearly always result in better outcomes compared to open access (21 of 23 cases).

Table 6. Main Fishery outcomes by world region.

Regime comparisons	World region			Total
	Latin America and the Caribbean	Africa	Asia and Melanesia	
between community and open access				
community better than open access	5	0	17	22
community similar with open access	0	0	4	4
community worse than open access	0	0	2	2
Undetermined	4	0	0	4
between state and open access				
state better than open access	0	15	6	21
state similar with open access	14	0	2	16
state worse than open access	0	0	0	0
Undetermined	0	0	0	0
between mixed and open access				
mixed better than open access	0	1	1	2
mixed similar with open access	4	2	0	6
mixed worse than open access	0	0	0	0
Undetermined	0	0	4	4
between state and mixed				
state better than mixed	0	3	0	3
state similar with mixed	0	4	0	4
state worse than mixed	0	3	0	3
Undetermined	0	0	0	0
Total	27	28	36	91

Table 7 summarizes rangeland outcomes by world region; rangeland studies were only found in Africa. Community and private property regimes are found to be alternately better or worse in

equal measure. However, community is nearly always found to perform worse than state regimes (20 out of 24 cases).

Table 7. Main Rangeland environmental outcomes by world region. [Note: Mixed regimes refer always to state/community arrangements]

Regime comparison	World region			Total
	Latin America and the Caribbean	Africa	Asia and Melanesia	
between community and private				
community better than private	0	6	0	6
community similar with private	0	4	0	4
community worse than private	0	9	0	9
undetermined	0	0	0	0
between community and state				
community better than state	0	0	0	0
community similar with state	0	4	0	4
community worse than state	0	20	0	20
undetermined	0	0	0	0
Total	0	43	0	43

Note on contextual factors

The differences in environmental outcomes across regime types and between the three world regions indicate that contextual factors affect the performance of property rights regimes differently in each region. This raises several questions for further investigation: Why in some cases, community performs better than state but worse in others? Why do communal rangelands always perform worse than state regimes in Africa? Why does state control of fisheries result in similar environmental outcomes to open access situations in Latin America, contrary to expectations? Why do communal forestry arrangements in Africa and Latin America perform worse than the State whereas they perform better than the State in Asia? And why do mixed regimes (community and state) always perform better in managing forest resources in Africa than when communities operate on their own?

Natural resource governance encompasses a diverse set of relevant arrangements and actors, and property rights alone cannot explain the variety of outcomes within a specific regime. In order to better understand the causes of such variation, we collected context-specific data on property rights, including their clarity, stability, and legitimacy, as well as relevant socio-economic and political data to assess how specific characteristics of case study sites might influence environmental outcomes. However, despite evidence that contextual factors influence

institutional performance (Ostrom 1990, Agrawal 2001), over 60% of the articles had no information on the specific context of the regime.

Within our included articles, although some authors have discussed the relevance of context, contextual factors are largely ignored when assessing environmental outcomes of property regimes. The lack of contextual analysis is especially evident in the fisheries literature where most of our studies came from the field of natural sciences. Overall, in the cases where information on contextual factors is provided, it was inconsistent and anecdotal regarding the contextual factors interest to this study. Figure 4 below presents the number of cases that provided information on contextual variables. Market for resources is the most commonly reported contextual variable, with about 55% of the cases presenting relevant information.

The presence or absence of contextual information is also split along disciplinary lines: most articles from mixed disciplines report on contextual factors, while natural science studies do not report such information. The limited socio-economic and political context information available thus present a challenge in analyzing the role of contextual factors in mediating the effects of property rights regimes on environmental outcomes. In this preliminary analysis, however, we will consider the available data on the clarity and stability of property rights within the included case studies.

Figure 4. Availability of socio-economic and political contextual information
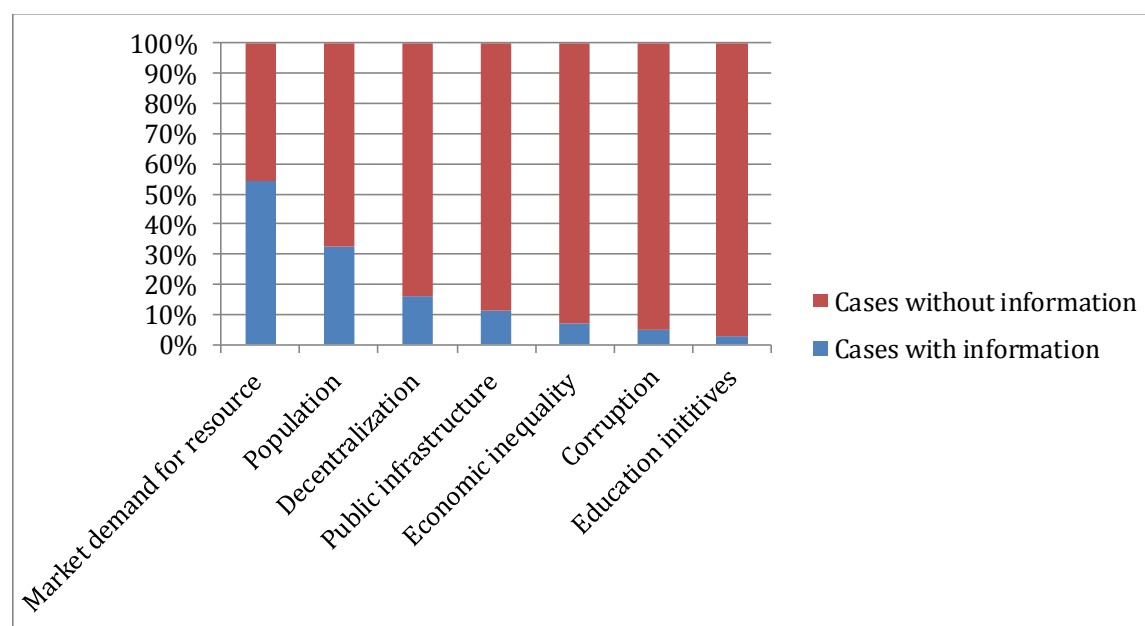
Clarity and stability of rights

With regards to the clarity and stability of rights, we considered the rights to be clear if they were explicitly mentioned by the author. For those cases that provide information on the clarity of rights, 43 (91%) cases with positive environmental outcomes (the regime performed better than its comparator) had clear rights. Additionally, of the 94 cases where rights were clearly allocated, 43 (45%) cases had positive environmental outcomes, whereas, 27 (29%) had negative outcomes, 19 (20%) had mixed outcomes and 5 cases neutral or undetermined outcomes.

Figure 5 shows the distribution of regimes where rights were clearly defined across world regions. Private regimes tend to have more clarity across regions, and unclear rights are more prevalent in state, community and open access regimes.

Figure 5. Clarity of rights by regime type and world region

a) **Asia**

b) **Africa**

c) **Latin America and the Caribbean**
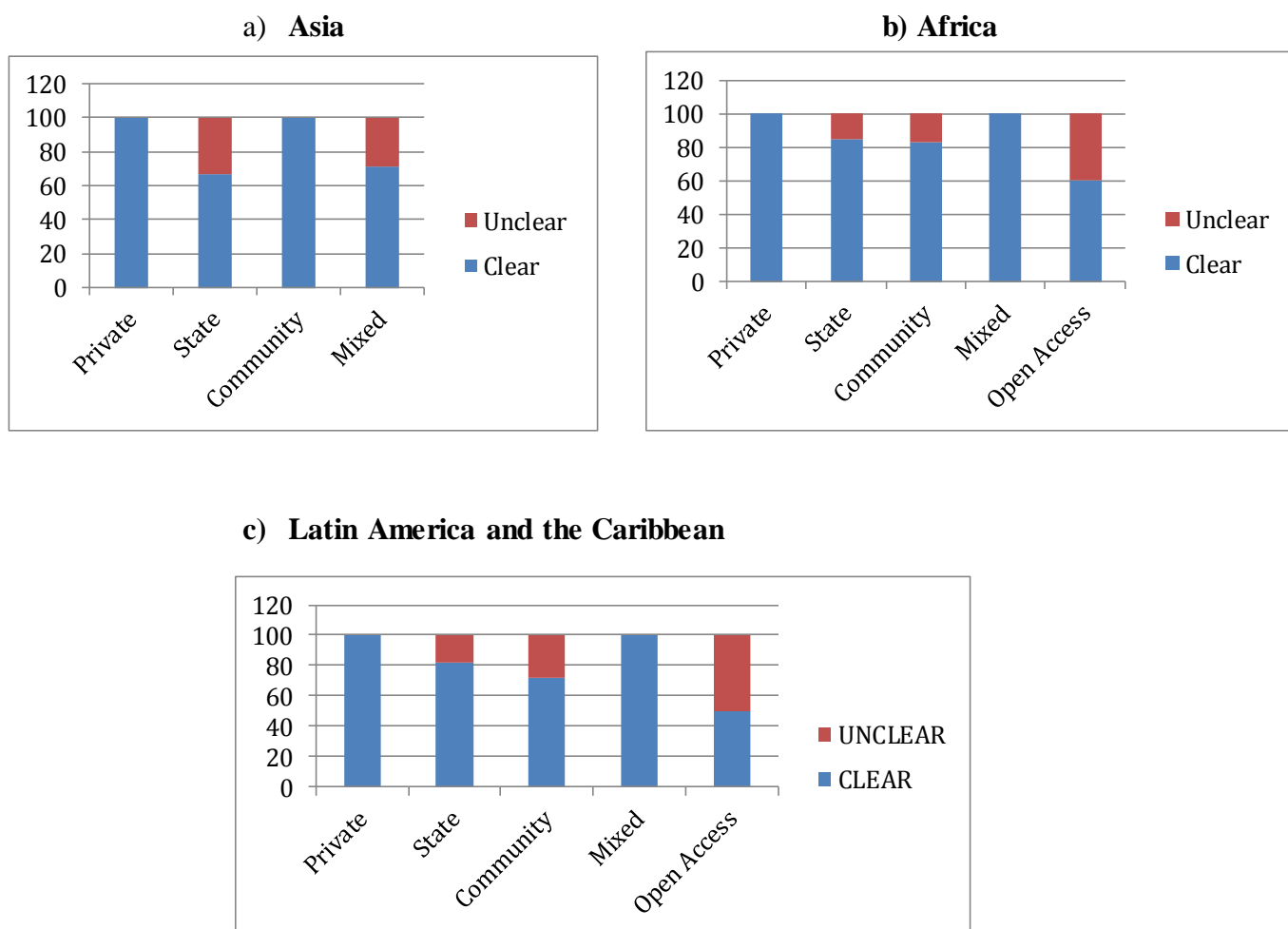
Stability of rights was related to the risk of revocation or limitation, but a regime change in itself does not necessarily mean the rights are unstable. Examples of unstable rights include multiple changes of property regime in a short period of time, multiple conflicts between de jure and de facto rights, or when rights can be revoked by the authorities for a number of reasons.

When we examined the stability of rights, 80% of the cases did not provide relevant information. There are no cases on rangelands for which there is information on stability of rights, and most cases with available information are on forests. The majority of cases with unstable rights are state (11 or 26%) and mixed regimes (12 or 29%). The instability derives from three main reasons:

1) Conflicts between de facto and de jure rights – Even though the community has de facto rights, the state refuses to recognize it legally. Additionally, conflicts between the community and local administration can undermine community's attempts to enforce their de facto rights.

2) The state reserves the right and uses the right to revoke community rights

3) Political instability

On the other hand, the majority of the cases with stable rights come from communities with historical rights that have been respected over time (15 or 53%). The main difference between the stable and unstable state regimes are that stable state regimes refer to either national parks, which would also entail additional levels of protection, or cases in which the rights of the forest user groups have been respected or have been negotiated with the community.

Figure 6 shows the stability of rights across regions, Latin America, for example, presents high instability on both open access and state regimes, which might contribute to the understanding of why in some cases, these two regimes yield similar results. There are also clear differences in stability and clarity of regimes across world regions. Further analysis is required, but the data shows correlation between specific context of the regimes, such as clarity and stability, and the direction of environmental outcomes

Figure 6. Stability of rights by regime type across world regions

a) **Asia**   b) **Africa**
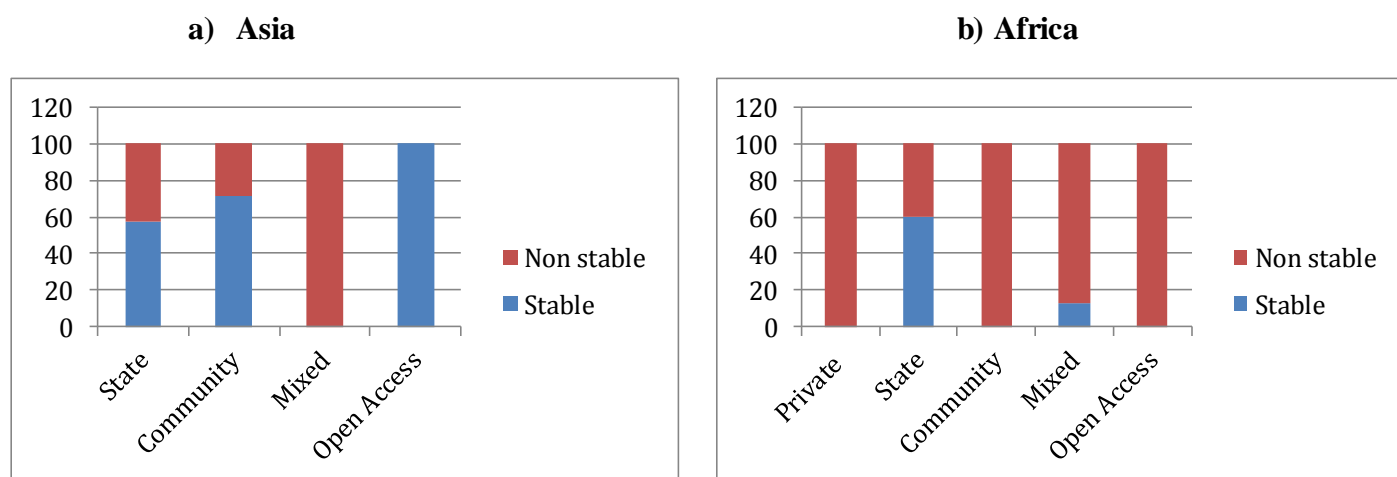
c) Latin America and the Caribbean
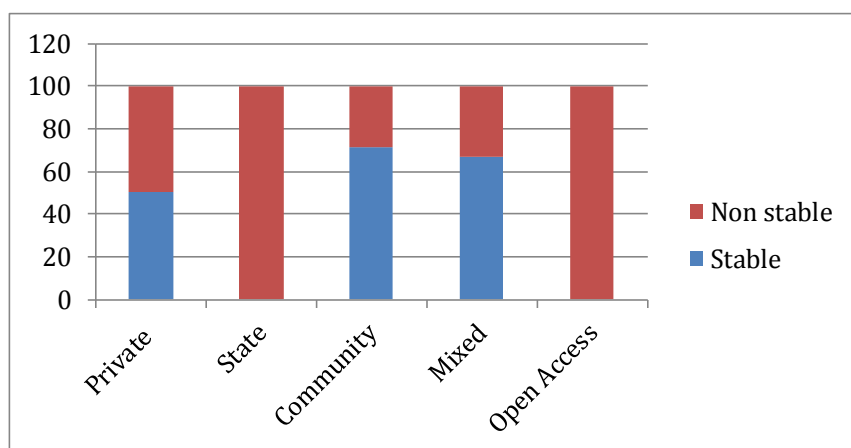
Discussion and conclusion

This systematic review provides a broad analysis of the varied relationships between different property rights regimes and their associated environmental outcomes across different resource systems in developing countries. The review improves on existing literature in three distinct ways. First, it examines different property rights regimes in comparison to each other as well as within individual regime types. Second, it examines environmental outcomes across three different resource systems to better determine the impact of similar regime types across resource particularities. Third, it dissects each property rights regime according to its component bundle of rights for more meaningful comparison across different contexts.

Several interesting results from this analysis are worth reiterating: community regime outcomes are better than open access regime outcomes across resource systems, whereas state regimes generally lead to results that are similar to those with open access regimes. State and community regimes perform alternately better and worse in comparison with each other. Mixed regimes (shared state and community) generate either similar or better outcomes than with open access, but compared with state regimes the differences are less pronounced.

Although defining regimes based on their component bundle of rights allowed for a clearer description of the relationship between specific rights and environmental outcomes, performing this data extraction and subsequent analysis presented several challenges. First, most articles did not describe regimes by their rights of access, exclusion, management, alienation and right to income. Moreover, rights were often affected or claimed by different actors: in most property rights arrangements, the government still imposes some restrictions, such as permit requirements for commercial use of resources. Whether these government restrictions imply that the state shares rights with communal and/or private actors is unclear. The classification of rights also proved to be problematic, such as whether government intervention in commercial management (i.e. requiring permits) should be classified as part of the management regime or the right to income.

The debate regarding impact of property regimes is challenged by the ambiguity of terms, as property regimes can take many different forms. The differences between regime types are often

unclear, which becomes evident when the authors address governance or tenure security issues (Pulhin et al. 2008, Ameha, Larsen, and Lemenih 2014), Our initial attempt to describe as "mixed" those regimes where rights were held by more than one actor was unsuccessful, as most of our cases would have then been considered mixed regimes. In the end, all mixed regimes were found to be combinations of state and community rights holders. Typically, the state holds some management, income generation, and alienation rights in the mixed cases (Beitl 2011, Lélé et al. 1998, Pulhin et al. 2008).

Tenure security has become the focus of many recent articles (Robinson, Holland, and Naughton-Treves 2011) but this distinction is commonly missing in rangelands literature We were able to clarify the bundles for many state-protected areas that the state holds all the de jure rights, however, for de facto rights definition of bundle was much harder, resulting in many "not available" descriptions for de facto rights (Wallgren et al. 2009, Watson and Ormond 1994).

An overwhelming majority of the studies assess environmental outcomes through a spatial comparison, such as comparing the performance of state-protected areas to outside (open access or community protected areas). The socioeconomic and environmental baselines for these comparisons can be very different, and it is important to recognize the potential impact of different management histories and objectives on environmental outcomes. When baselines are too different, there is a risk that divergent environmental results are not due to the regime intervention but to other contextual factors instead.

Although the use of multidisciplinary methods is increasing, future empirical research on property rights impacts would benefit if researchers in the natural sciences also consider property regimes and tenure security issues, as well as provide more information on contextual factors. Likewise, social scientists could contribute by providing more rigorous empirical data on environmental outcomes. These improved datasets will thus enable more rigorous statistical analysis of environmental outcomes across tenure regimes.

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