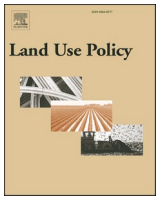
Land Use Policy 127 (2023) 106575

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol



Governance of interdependent ecosystem services and common-pool resources

Catherine M. Tucker [a], Mateja Šmid Hribar [b], Mimi Urbanc [b,*], Nevenka Bogataj [c], Alexey Gunya [d], Romina Rodela [e], Maurizia Sigura [f], Lucia Piani [f]

[a] Department of Anthropology and Center for Latin American Studies, Grinter 309, University of Florida, Gainesville, FL 32611, USA
[b] Anton Melik Geographical Institute, Research Centre of the Slovenian Academy of Sciences and Arts - ZRC SAZU, Novi trg 2, 1000 Ljubljana, Slovenia
[c] Slovenian Institute for Adult Education, Ulica Ambrožiča Novljana 5, 1000 Ljubljana, Slovenia
[d] Institute of Geography, Russian Academy of Sciences, Staromonetny per. 29, 109017 Moscow, Russia
[e] Department for Environment, Development and Sustainability Studies, Södertörn University, SE-141 89 Huddinge, Sweden
[f] Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, Via della Scienze 206, 33100 Udine, Italy

ARTICLE INFO

Keywords:
Governance challenges
Ecosystem services
Common-pool resources
Policy
Governance recommendations

ABSTRACT

Environmental governance is recognized as a key issue in many natural and social sciences. It is highly relevant for ecosystem services and common-pool resources as well. Both fields overlap yet have typically been studied separately. Therefore, this study aimed a) to examine the emerging body of literature that incorporates concepts from both fields of research and considers governance challenges, and b) to identify policy tools and recommendations presented for addressing those challenges. The analysis of thirty-nine selected peer-review papers revealed the multiplicity of interacting governance challenges with three major categories: environmental, socioeconomic, and problems of governance itself. Governance is impeded by institutional mismatches, exclusion of local actors, corruption, and perverse policies. The proposed policy recommendations most often suggest changes in institutional arrangements and increasing scientific understanding. Meeting human needs, and increasing social equity and justice were recognized broadly as integral for improving governance, yet correlations among governance problems and solutions appear elusive. These findings extend theoretical reasoning, while carrying practical implications for policy, governance and environmental stewardship. The analysis implies that policies to improve human conditions will be key for improved environmental governance, but more research is needed to learn which types of policy recommendations prove successful given diverse local contexts.

1. Introduction

We live in an era of unprecedented environmental challenges. Research addressing ecosystem services (ES) and common-pool resources (CPR) often points to governance as a central component for assuring future sustainability of natural resources that are integral to human and planetary well-being (e.g., Gatto, 2022; Greiber and Schiele, 2011; Kenward et al., 2011; Young, 2003). Some of the world's most complex challenges for sustainability occur precisely where ES and CPR systems coexist and are mutually reproduced or degraded. These interactions occur in forests, grasslands, watersheds, oceans, and other CPR systems that provide ES. Currently, many ES and CPR experience rates of overuse and transformation that pose a risk for human and planetary welfare (Millennium Ecosystem Assessment, 2005). Processes of deforestation, industrialization of agropastoral production, and urbanization are among the human-driven trends that have degraded commons and undermined ES integral to human well-being. Much of this degradation and overuse has been linked to shortcomings in current approaches to governance (Sattler et al., 2018). The overlap of ES and CPR presents governance challenges that require integrated attention. Building on early work done by Rodela et al. (2019), who mapped literature at the ES and CPR nexus, this analysis examines governance challenges at this nexus and seeks to further the academic attention to this topic.

Scientific and policy interest in the governance of natural resources has been growing with the recognition that many environmental crises originate in governance failures (Pahl-Wostl and Patterson, 2021). While CPR research has long focused on governance arrangements (e.g.,

* Corresponding author.
E-mail address: mimi.urbanc@zrc-sazu.si (M. Urbanc).

https://doi.org/10.1016/j.landusepol.2023.106575
Received 17 June 2022; Received in revised form 24 December 2022; Accepted 31 January 2023
Available online 15 February 2023

Anderson and Hill, 1983; Bromley, 1992; Gibson et al., 2000; Mckean and Cox, 1982; Netting, 1976; Ostrom, 1990), attention to governance in ES research has been emerging gradually (Winkler et al., 2021). Numerous gaps exist in our understanding of governance (Loft et al., 2015), and empirical support for any particular governance mode for ES conservation remains unclear in the literature (Primmer et al., 2015). Some suggest that questions focused on the governance of ES are lagging behind questions about ES functioning (Droste et al., 2018; Loft et al., 2015; Winkler et al., 2021). By contrast, CPR literature has accumulated extensive empirical studies on CPR governance (e.g., Andersson et al., 2020; Favero et al., 2016; Ostrom, 2005). Yet this large body of empirical data and insights have often been overlooked in implementation of programs to protect and maintain CPR systems and related ES. This is the case even though the findings have been broadly recognized, and an internationally acclaimed scholar of CPR governance, Elinor Ostrom, won the 2009 Nobel Prize in Economics for her work. Research at the intersections of ES and CPR presents opportunities to integrate knowledge gained from these separate approaches, and to overcome the weaknesses of each approach.

The purpose of the present analysis is to expand understanding of environmental governance challenges by looking closely at literature incorporating dimensions from both ES and CPR research. Examining the nascent body of literature at the intersection of these two neighboring areas of work offers opportunities to deepen the understanding of contemporary environmental governance challenges and how these are being addressed through scientific research and policy processes. Rodela et al. (2019) traced some relevant trends, but it did not explore governance challenges or recommendations. The present study aims to fill that gap and advance knowledge by examining two research questions: **(1) How does research at the intersection of ES and CPR engage with issues of governance? In particular, what challenges receive the most attention? (2) What policy tools are recognized, and what recommendations are offered to address governance challenges?** Shortcomings in environmental governance are ubiquitous and persistent despite advancing theory and policies designed to effectively conserve and maintain ES and CPR. Failures in environmental conservation programs and sustainable development initiatives have been traced to interacting economic, political, and sociocultural contexts and conflicts (e.g., Duraiappah et al., 2014; Loft et al., 2020). Social inequities, competing interests, government hubris, extractive markets and power differentials are among the factors that can undermine well-intentioned plans (Berlin and Berlin, 2004; Harnish et al., 2019; Stonich, 1989; Trana et al., 2016; Vandermeer and Perfecto, 2013). Moreover, research and policy formation on ES and CPR have typically proceeded without coordination, which may contribute to contradictory policies and institutional mismatches across scales that undermine conservation of CPR and provision of ES (e.g., Duraiappah et al., 2014). Therefore, research that examines governance issues at the intersections of these related areas of work carries practical implications for policy and environmental stewardship. It also offers opportunities to gain integrative insights and knowledge, as well as to identify areas that need further investigation.

2. Theoretical context and key concepts

While ES and CPR are ubiquitous and related, they have typically been treated as distinct academic realms. Research on ES has tended to occur from the top-down, with an emphasis on mapping, assessment, and recently ES accounting (Burkhard et al., 2018, Harrison et al., 2014; Liquete et al., 2013). Similarly, the slowly growing number of ES studies addressing governance have predominantly focused on hierarchical (top down) approaches (Winkler et al., 2021), although some recent work has recognized local and community levels (e.g., D'Amato et al., 2017; Mikusiński and Niedziałkowski, 2020). By contrast, CPR studies tend to regard top-down approaches with caution. A number of studies examine unintended consequences of outside interventions on CPR systems and the people who depend upon them (e.g., Arnold, 1998; Cordell and McKean, 1992; Ostrom et al., 2012; Thomson et al., 1992). Focusing on the local level, CPR researchers have accumulated extensive empirical data and comparative analyses of effective as well as flawed arrangements for governing and managing CPR (Agrawal, 2003; Dietz et al., 2003; McIntosh and Renard, 2009; McKean, 1992; Ostrom et al., 2002; Runge, 1986). Recent work now includes attention to multi-level and cross-scale partnerships and collaborations (e.g., Basurto, 2013; Berkes, 2007; Seixas and Berkes, 2009). Currently, some researchers have begun to examine the intersections of CPR and ES. We look to this literature to discover what insights regarding governance challenges and improvements may emerge as top-down governance approaches typical of ES research interact with bottom-up approaches favored by CPR research.

Our **definition of ES** follows the Millennium Ecosystem Assessment (2005) where ES are understood as benefits to people provided by ecosystems. The Common International Classification of Ecosystem Services (CICES) V5.1 (Haines-Young and Potshin, 2018) defines Provisioning ES (renewable resources that provide food, clothing, fuel, construction, and sustenance), Regulating and Maintenance ES (which support social-ecological systems through filtration, storage, pollination and other environmental and geochemical processes) and Cultural ES (including recreation, forms of knowledge, heritage, and much more) (Englund et al., 2017).

CPR are defined by the characteristics of subtractability and difficulty of exclusion (McKean, 2000). Thus CPR face particular governance challenges due to their vulnerability to degradation and exposure to overuse. Many natural resource systems, including forests, grasslands, rivers and lakes, among others, are CPR systems encompassing multiple resources. They cover large expanses associated with difficulty in controlling access. The expanse of CPR systems can be integral to producing their benefits (McKean, 2000). For example, the Amazon rainforest helps regulate global climate through carbon sequestration and evapotranspiration, which are endangered by deforestation and climate change (Barkhordarian et al., 2019). The Amazon rainforest produces ES and CPR as interdependent resources. Moreover, certain ES *are* CPR due to shared characteristics of subtractability and the difficulty of limiting access. As highlighted by Rodela et al. (2019) CPR and ES often coincide, because they either overlap, interact, or fit both categories. For ES that are simultaneously CPR (with vulnerability to degradation and difficulty of exclusion), the use of "ES" or "CPR" depends on who chooses the term, and their frame of reference. To illustrate, potable water in an aquifer can be viewed as an ES or a CPR, or recognized as both.

CPR may be held under any form of property rights, and those defined as commons or common property have received a great deal of attention (McKean, 2000). CPR systems may be managed, utilized or owned by individuals, communities, governments, or other entities. In some cases, ownership rights are contested or uncertain, increasing vulnerability to degradation. Yet a large body of research has documented the capacity of certain groups to collectively and effectively govern CPR over extended periods (e.g., Agrawal, 2003; Cox et al., 2010; McCay and Acheson, 1987; Ostrom, 2005; Wang et al., 2019). Typically, group size appears proportional to capacity to monitor the CPR system expanse (Varughese, 2000). Long-enduring CPR regimes survive due to effective governance arrangements that prevent overuse and develop ways to manage access (Ostrom, 1990). CPR are often understood as commons; however, commons can also be created for places, or goods, that are not intrinsically CPR through rules and practices that establish joint use (Tucker, 2010). Among the general public, commons, CPR and public goods are often equated (Šmid Hribar et al., 2018), however, CPR scholars distinguish between commons and public goods, because the latter do not face the social dilemmas associated with subtractability (McKean, 2000).

Governance involves how norms, rules, and practices are crafted, implemented, maintained and modified (Stringer et al., 2018). Also understood as the exercise of authority, governance addresses a given

domain (e.g., territory, population, formal or informal organization) and may be carried out by one or multiple entities, such as governments, networks, organizations, or various types of groups. Governance flows through power relations and language use (Bevir, 2013), and encompasses formal and informal dimensions. Thus, governance is broader than government. Formal governance includes actions of government entities at all levels including but not limited to policy-making, setting standards, creating subordinate entities, and authorizing judicial and legal procedures (McGinnis, 2011). Informal governance involves unwritten rules and decision-making processes that evolve and occur outside officially recognized channels (Helmke and Levitsky, 2004; Christiansen and Neuhold, 2012). It typically operates through webs of influence and social relationships (Harsh, 2012). Thus sociocultural groups, communities and diverse actors may participate informally in governance through the creation, modification and enforcement of unwritten agreements and rules recognized by their members and related actors. Formal and informal governance can be linked. Actors with formal governance authority may also be involved in informal governance (for example, group consensus on norms and practices underlying formal procedures). Similarly, those involved with informal governance may have formal governance roles within their purview (e.g., non-government organizations and certain authorized actors given decision-making authority in a specific area). Governance and management are related but distinct. Management comprises the operational arrangements, direct decision-making and practices applied to specific CPR or ES (Schlager and Ostrom, 1992; Sikor et al., 2017). Resource management processes and practices reflect governance arrangements; thus, challenges of management are tied to challenges encountered by governance itself. Both governance and management exist mainly to meet human needs; therefore, concern for human needs (or for certain groups) underlies informal and formal governance decisions, although it is not always made explicit.

Examining governance requires attention to policy, which constitutes a ubiquitous component of formal governance and is key for addressing CPR and ES challenges. Policies can be defined as principles established to guide decisions and attain rational outcomes. A policy constitutes an expression of intent to influence behavior and is typically developed through a governing authority's actions, such as a legislative body (Lowi, 1985).

3. Methods

This study aims to advance understanding of research at the intersection of ES and CPR with special interest for what literature says about governance challenges and related recommendations. We use knowledge synthesis methods to study what and how the selected publications report on governance challenges and related recommendations. The current work acknowledges the diverse research methodologies used across the ES and CPR literature, which include quantitative, qualitative and action-oriented research.

3.1. Sample of selected papers

The sample used for the present study includes 39 papers, identified and mapped earlier by Rodela et al. (2019), following the *Reporting Standards for Systematic Evidence Synthesis in Environmental Research* (Haddaway et al., 2017). The papers are peer-reviewed journal articles, published from January 2010 through January 2017 which use both CPR and ES or related terms in the title, abstract or keywords (Appendix A) (See Rodela et al., 2019 for details of their selection process). To be included in the final set, the papers met the key selection criterion: research that integrated both CPR and ES.

3.2. Data extraction and analysis

To answer the research questions, we first identified variables relevant to governance and defined their parameters (see the abbreviated version in Table 1 and the full version in Appendix B). Second, for each aspect of governance, papers were coded in teams of two or three co-authors who had both ES and CPR expertise. The third step consisted of verifying and resolving mismatches among team members to achieve inter-coder consistency. Where differences existed, coders reached a consensus through discussion. We had access and permission to use the Excel database developed by Rodela et al. (2019). We expanded that database by adding thirty-six new governance related variables of interest here and populated those with data extracted from the pool of 39 papers.

We worked with an Excel spreadsheet, which was transferred into SPSS to create a database for analysis. The basic patterns in the variables and relationships among them were explored by descriptive statistics.

A hierarchical cluster analysis was conducted to group the papers according to the combinations of the resource bases (general biome types) discussed. We chose this analytical method to enable discovering whether governance challenges and recommendations varied across differing combinations of resource systems, grouped as clusters. Using Ward's Method (Ward, 1963), which minimizes the total within-cluster variance, a series of groupings by the similarity of features was obtained. The cluster analysis generated five coherent groups of resource systems (Table 2, Fig. 1). The distinctions between these groups were statistically reliable and significant with a p value of 0.001. Subsequently, part of the analysis examined the governance challenges and recommendations by cluster, as discussed in the results section.

Table 1
Selected variables for data extraction (for full list see Appendix B).

Variable Groups	Selected variables
A. Bibliographic Information*	Publication Year; Authors; Title; Journal; Disciplinary Focus (e.g., Natural, Social)
B. Geographic Information*	General Location; Specific Location; Geographic Level (e.g., Local, Regional)
C. Topical Description*	Focal Topic of Study; Research Questions; Disciplinary Scope; Methodological Approach (e.g., Theoretical, In-depth case study)
D. Integration of ES and CPR*	Application of Findings (e.g., Theoretical; practical); How are CPR defined?; How are ES defined?; Reasons for integrating ES and CPR?; How do ES and CPR approaches and concepts interact?
E. Resource Base / Resource Systems*	Type of Resource (e.g., Tangible, Intangible); Resource Bases Initial Description (e.g., Forest, Savannah); Sectors (e.g., Forestry, Fishery etc.)
F. Resource Bases for Cluster Analysis ^	Resource Bases (e.g., Forest, Grassland, Freshwater); Clusters
G. Governance Regimes*	Governance Rights Regimes (e.g., Communal, Private, Public); Governance Levels (e.g., Local/community, Regional, National)
H. Actors^	Actors (e.g., individuals, local government); Types of Owners (e.g., individual, government); Beneficiaries (e.g., local people, tourists)
I. Policy Tools^	How many types of policy tools are identified?; What policy tools?
J. Governance Challenges^	Types (e.g., Environmental Degradation, Biodiversity Conservation/Loss); Human Needs Focus (e.g., Weak, Strong); Description of Human Needs, Problems of Governance Itself; Conflict; Conflict Types (e.g., Competing goals, Social inequality); Conflict Resolution Proposal; Corruption
K. Recommendations to Address Governance Challenges^	Description of Recommendations; Recommendations (categories) (e.g., Institutional changes, increase of equity and justice); Number of recommendations

* indicates variables from the Rodela et al. (2019) database; ^ indicates variables identified and coded for this study

Table 2
Description and frequency of resource system clusters in the sample.

Resource system clusters	Description	Frequency (%)
Group 1: Coastal-Marine-Fisheries	Island and coastal resource bases with marine or freshwater fisheries	6 (15.4)
Group 2: Forest & Grassland	Combined forest and grassland resources	8 (20.5)
Group 3: Grassland, Air & Arable Land	Grasslands, meadows or savannahs, some cases with arable land or coastal edges, or global scale resources such as air	9 (23.1)
Group 4: Freshwater & Forest	Freshwater, aquifers, or wetlands with forests and related resource bases	10 (25.6)
Group 5: Multiple resource bases	Interactions among multiple resource bases in regional scope	6 (15.4)
Total		39 (100)

4. Results

4.1. Overview of results

This study found that all 39 papers mention aspects of governance, discuss challenges, and make recommendations, although few presented research questions focused primarily on governance. The sample encompassed a wide range of governance levels and actors. Nearly all papers discuss multiple levels of governance. The local or community level received the greatest attention (79.5%), while the international level was least common (28.2%). Papers identified diverse actors shaping ES-CPR governance, ranging from governmental entities, non-governmental organizations, local groups, or others according to the research foci. Over half of papers (56%) recognized multiple types of ES-CPR beneficiaries, defined by use of ES-CPR but not necessarily involved with governance (e.g., tourists). ES-CPR rights were held under various types of formal arrangements, including communal (28%), private (23%), and public (13%), or informal (*de facto*) rights (23%); multiple arrangements often co-existed in a given study site. Twelve studies (31%) did not discuss rights to resources, instead addressing broad ES-CPR governance issues or approaches. These general results provide context for findings related to our research questions, which we present in two parts, one for each research question: **Challenges for governance**, and **Policies and recommendations to address governance challenges.**

4.2. Challenges for governance

Major challenges fell into three broad categories: environmental, socioeconomic, and problems of governance itself (Table 3). Twenty-six papers (66.7% of the sample) mentioned all three categories of challenges. Seven papers discussed both environmental and socioeconomic problems for governance, and four papers focused on socioeconomic problems and problems of governance itself. Two papers discussed a single category of governance challenges – one focused on environmental dimensions, and the other on problems of governance itself.

4.2.1. Environmental challenges

Environmental challenges encompassed four types: environmental degradation, biodiversity loss, climate change, and intensification-urbanization. Thirty-four (87%) of the papers discussed one or more environmental challenges. In addition, 29 of these papers also discussed socioeconomic challenges, and 23 mentioned problems of governance itself.

Environmental degradation was the most frequent – and broadest – type of environmental challenge, recognizing anthropogenic processes impacting the availability and conservation of CPR and ES (Table 3). Degradation included deforestation and forest degradation (e.g., Hausner et al., 2015; Kitamura and Clapp, 2013; Neitzel et al., 2014), degradation of land or pasture (e.g., Baumgärtner et al., 2010; Shimada, 2015; Ulgiati et al., 2011), land use change and resource fragmentation (e.g., Kaye-Zwiebel and King, 2014; Reid et al., 2014; Šmid Hribar et al., 2015), soil erosion (e.g., Dixon and Carrie, 2016; Kolinjivadi et al., 2014; Polman et al., 2016), decreasing water quality (Magner et al., 2011; Mulatu et al., 2014); pollution (e.g., Everard et al., 2013; Hoffmann, 2011; Molnar et al., 2015), fisheries decline (e.g., Ban et al., 2015; Martin et al., 2016; Polman et al., 2016), coral reef degradation (Dunning, 2015) and general decline or overuse of ecosystem services or natural resources (e.g., Castilla, 2016; Duraiappah et al., 2014; Kininmonth et al., 2015). Overall the studies recognized that the challenges facing ES and CPR governance were multiple, interconnected, and nontrivial.

Table 3
Frequency of papers mentioning environmental challenges and conjunctions with socioeconomic challenges and problems of governance itself.

Environmental challenges (N = 34)	# of papers (% of N = 34)	In conjunction with problems of governance itself # (%)	In conjunction with socioeconomic challenges # (%)
Environmental degradation	29 (74.4%)	23 (79.3%)	29 (100%)
Biodiversity loss/ conservation	10 (25.6%)	10 (100%)	10 (100%)
Climate change	5 (10.3%)	4 (80.0%)	5 (100%)
Intensification /urbanization	6 (15.4%)	5 (83.3%)	5 (83.3%)

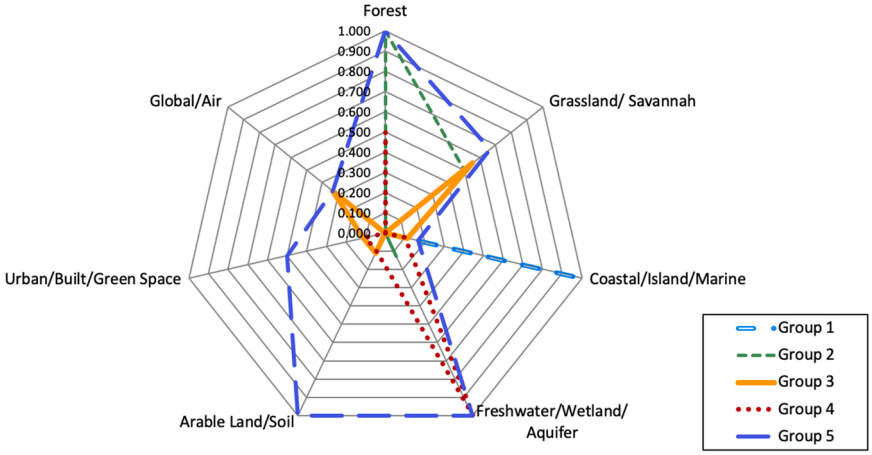


Fig. 1. Radio graph of clusters by component resource bases.

Of the ten papers that examined Biodiversity Loss/Conservation, nine (90%) also discussed at least one other type of environmental degradation, such as deforestation or fisheries decline. All of the papers discussing biodiversity loss or conservation noted problems related to governance itself. Of the five papers that discussed climate change, three recognized environmental degradation, including desertification (i.e. Reid et al., 2014), fisheries decline (i.e. Martin et al., 2016), or deforestation (i.e. Kitamura and Clapp, 2013). Intensification of land use and urbanization received attention in six papers, and four of these pointed to related environmental degradation processes (i.e. Fisher et al., 2010; Martin et al., 2016; Neitzel et al., 2014; Unnikrishnan and Nagendra, 2015).

All clusters included papers that discussed environmental degradation in some form. Half of the papers in the Forest & Grassland cluster mention biodiversity as an issue, but it was not identified as a challenge in the Freshwater with Forest cluster, and only one paper in the Coastal-Marine-Fisheries cluster discussed it. Intensification–Urbanization included land use intensification and conversion, and expansion of urban, suburban or peri-urban areas. Only six of the papers addressed urbanization and intensification (referring to increased intensity of land use and technification), but for these, it was a central concern and was prominent in the Freshwater with Forest cluster (Table 4).

4.2.2. Socioeconomic challenges

Socioeconomic challenges for governance appeared in 37 papers (94.9%) of the sample, and fell into three broad categories: meeting human needs, conflicts, and socioeconomic disparities. Meeting human needs emerged as the most prevalent socioeconomic challenge (Table 5).

4.2.2.1. Meeting human needs. Human needs were explored in a variety of ways. Twenty-six papers (66.67%) explored human needs with a strong focus (two or more mentions throughout the paper), while two papers mentioned needs vaguely (with a single mention). A concern for human needs occurred across all clusters, but was especially prominent in the Coastal-Marine-Fisheries and Freshwater with Forest clusters, where 83% and 80% of papers, respectively, revealed a strong focus on human needs (Table 6).

Examples of human needs included livelihoods dependent on the availability of provisioning ES, such as fodder grass, edible plants, and grazing livestock (Unnikrishnan and Nagendra, 2015; Reid et al., 2014).

Table 4
Type and frequency of environmental challenges by cluster*.

Resource System Clusters (Cluster Size)	Environmental degradation (% of cluster)	Biodiversity loss (% of cluster)	Climate change (% of cluster)	Intensification-urbanization (% of cluster)
Coastal-Marine-Fisheries (6)	4 (66.7%)	1 (16.7%)	1 (16.7%)	1 (16.7%)
Forest & Grassland (8)	5 (62.5%)	4 (50%)	2 (25%)	1 (12.5%)
Grassland, Air & Arable Land	6 (66.7%)	4 (44.4%)	2 (22.2%)	1 (11.1%)
Freshwater & Forest (10)	8 (80%)	0 (0%)	0 (0%)	3 (30%)
Multiple resource bases (6)	6 (100%)	2 (33.3%)	0 (0%)	0 (0%)
Total (% of sample)	29 (74.4%)	10 (25.6%)	5 (12.8%)	6 (15.4%)

* Clusters included multiple types of environmental challenges.

Table 5
Frequency of papers mentioning socioeconomic challenges and conjunctions with environmental challenges and problems of governance itself.

Socioeconomic challenges (37 of 39 papers)	# of papers (%)	In conjunction with problems of governance itself # (%)	In conjunction with environmental challenges # (%)
Meeting human needs	28 (71.8%)	24 (85.7%)	24 (85.7%)
Conflicts	19 (48.7%)	17 (89.5%)	17 (89.5%)
Socioeconomic disparities	18 (46.2%)	14 (87.5%)	17 (94.4%)

Table 6
Focus on human needs by resource system cluster.

Resource system clusters	No focus on human needs	Weak focus on human needs	Strong focus on human needs	Total N (% of cluster)
Coastal-Marine-Fisheries	1	0	5	6 (83%)
Forest & Grassland	2	1	5	8 (62.5%)
Grassland, Air & Arable Land	4	1	4	9 (44.4%)
Freshwater with Forest	2	0	8	10 (80%)
Multiple resource bases	2	0	4	6 (66.6%)
Total (% of all papers)	11 (28.2%)	2 (0.51%)	26 (66.67%)	39 (100%)

Polman et al. (2016) examined conch fisheries and goat grazing, which depended on access to commons. Studies of Payment for Ecosystem Services (PES) Programs notably considered implications for human needs. Neitzel et al. (2014) noted that community members with lower incomes viewed PES as a threat to their subsistence activities based on resource extraction. Several discussed subsistence pastoral economies dependent on the production of meat, milk or dung (Baumgärtner et al., 2010; Kaye-Zwiebel and King, 2014).

Other papers mention human needs in relation to site conditions. Mulatu et al., (2014, p. 26), for instance, observed that in their Kenyan case study, agricultural resources were inadequate to meet basic needs. Working in rural Mexico, Monroy-Sais et al. (2016) found that conditions of communal forests, including topography, biodiversity (number of useful plants), and provision of ES, influenced subsistence activities and collective action for conservation.

Thirteen papers discuss freshwater: eight in the Freshwater with Forest cluster, four in the Multiple Resources cluster and one in the Forest & Grassland cluster. Water availability and quality can affect diverse actors. For example, Mongruel et al. (2011) discussed farmers, fishers, and inhabitants' needs for drinking water. Goods produced by grasslands received attention in ten papers; the remaining three papers emphasized other resources.

4.2.2.2. Conflicts. Nineteen papers (49%) discussed conflicts with implications for ES-CPR governance. We identified five types of conflict (Table 7).

When examined across the five clusters, the lowest frequency of conflict appears in the Coastal-Marine-Fisheries cluster (33% of the cluster), while the highest frequency is found in the Forest & Grassland cluster (63% of the cluster reported conflict). Horizontal conflicts, the most common type (6 papers), were distributed evenly across three clusters: Forest & Grassland, Freshwater with Forest, and Multiple Resource Bases.

Five articles explored two or more kinds of conflicts. For example, Jupiter et al. (2014) described conflicting development potentials,

Table 7
Types of conflict.

Types of conflicts (19 papers)	Definition	Examples
Horizontal (6 papers)	Conflicts over access to scarce resources among local actors, such as different ethnic groups	Baumgärtner et al. (2010);Mongruel et al. (2011)
Vertical (4 papers)	Conflicts between local and higher-level actors, as between the state and local communities over top-down interventions	Hansen et al. (2015); Reid et al. (2014)
Competing goals (4 papers)	Conflicts related to contrasting development goals, such as traditional land use vs. tourism	Kitamura and Clapp (2013);Polman et al. (2016)
Social inequity (3 papers)	Conflicts resulting from unequal rights to use resources	Lakerveld et al. (2015); Shimada (2015)
World view contradictions (2 papers)	Conflicts arising from conflicting strategies and convictions that pose barriers to effective governance	Duraiappah et al. (2014);Šmid Hribar et al. (2015)

which were associated with conflicts over access to limited resources on the island study site. Conflicts were often related to scarce resources, unequal distribution, or lack of consensus on development goals. Few papers explicitly described the actors involved in conflicts. Ownership of the given ES/CPR varied from a single owner (government, NGO) to multiple types of owners or communities / collectives with joint rights. Most of these articles pointed to underlying issues that informed conflicts. These included poorly defined property rights, contradictory institutions and regulations, demographic changes, and a decline in arrangements associated with effective governance, such as reciprocity, active management, and local, participatory institutions (e.g., Monroy-Sais et al., 2016).

4.2.2.3. Socioeconomic disparities. Eighteen papers (46.2%) discussed a range of socioeconomic disparities that posed challenges for governance. These encompassed inequities and problems related to poverty, injustice, power differentials, contrasting access to ES, and social status (e.g., social class, caste, gender, ethnicity, religion). Social change processes linked to societal inequities can destabilize effective, traditional ES-CPR governance (Šmid Hribar et al., 2015), such as unmanaged tourism (Polman et al., 2016), market failures (Kallis et al., 2013) and outmigration (Shimada, 2015). Socioeconomic disparities were represented in all of the resource base clusters, and often interacted with problems inherent in governance itself.

4.2.3. Problems of governance itself

Appearing in 79.5% of the papers, problems of governance itself occurred in association with other challenges that can impede or undermine efforts to address environmental, socioeconomic and development challenges. Problems of governance itself were diverse. They included corruption, management issues, institutional mismatches across scales, lack of institutional fit (e.g., inappropriate policies and rules that did not fit the local circumstances), and policies that create disincentives or otherwise lead to undesirable outcomes for ES-CPR and human conditions. For example, Polman et al. (2016) found certain PES measures intended to improve ES that distributed benefits inequitably, which resulted in a loss of community support and a decline in ES-CPR conditions. This study also noted that poor leadership and unstable governments could inhibit constructive governance and management of ES.

Inappropriate or poorly fit policy tools and unintended governance consequences appeared prominently in the papers assessing PES programs. Seven papers recognized risks or shortcomings of PES (Fisher et al., 2010, Handberg and Angelsen, 2015; Kallis et al., 2013; Kitamura and Clapp, 2013; Monroy-Sais et al., 2016; Mulatu et al., 2014; Neitzel et al., 2014). Kallis et al. (2013) and Monroy-Sais et al. (2016) noted that PES only included participants with secure land rights. Similarly, Handberg and Angelson (2015) found that PES contributed to elite capture. Thus certain PES projects excluded the poorest (the landless and disenfranchised) and exacerbated local inequalities to the detriment of ES-CPR conservation.

Management challenges, identified in association with the term "management" or "manage" appeared in 29 of the 31 papers that identified problems of governance itself. Only a few papers distinguished between governance and management (e.g., Ban et al., 2015; Dunning, 2015; Monroy-Sais et al., 2016). Where specified, management was discussed in terms of operational procedures and activities (e.g. monitoring, delimitations, specific practices), while governance was recognized implicitly as the exercise of authority. In general, ES-CPR management challenges interact with policy contexts and governance arrangements as well as broader socioeconomic, spatial, and environmental contexts. As examples, Chand et al. (2015) found better forest management outcomes among those closer to government offices, which provided access to information, recommended practices and technical support; Monroy-Sais et al. (2016) discussed management discrepancies and government incentives that risked exacerbating degradation.

Corruption was identified as a problem for governance in three papers (Duraiappah et al., 2014; Dunning, 2015; Neitzel et al., 2014). Two papers explored institutional mismatches across scales for access, production, delivery and use of ES (Duraiappah et al., 2014; Gómez-Baggethun et al., 2013). Gomez-Baggethun et al. (2013) studied southwestern Spain, where increasing regulatory control by national-level governments has progressively eroded local institutions for managing communal lands, thus impacting ES. Hoffman (2011) critiqued perverse incentives, in particular those that privilege provisioning services with negative implications for other ES.

4.2.4. Combinations of governance challenges

Linkages between environmental and socioeconomic challenges are well established. Twenty-six papers recognized multiple governance challenges that covered all categories: environmental, socioeconomic, and governance itself. This combination of challenges represented a majority of papers in four resource system clusters: Forest & Grassland, Grassland, Air & Arable Land, and Freshwater with Forest. Notably, 37 papers that identified socioeconomic problems for ES-CPR governance discussed them in relationship with environmental problems or problems of governance itself, or both.

4.3. Policies and recommendations to address governance challenges

Approaches to address governance challenges encompassed discussion of existing, historical, or proposed policies relevant to the paper topic. Examination of policy dimensions included recognition of past interventions and their outcomes, and critical assessments of current policies and programs. Papers tended to conclude with recommendations that frequently transcended policy options. First, we discuss the identified policy tools, then move on to the recommendations that emerged.

4.3.1. Policy tools

All of the papers discussed policy tools as means to address ES-CPR governance challenges. Thirty-five papers (89.7%) identified multiple policy tools. The most frequently discussed policy instruments fell in the IPBES (2018) category of rights-based and customary norms (84.6%), and with one exception, these were recognized in combination with other policy approaches (Table 8). Twelve papers (30.7%) discussed three of the four categories of policy instruments, and seven papers encompassed all four types of policy instruments. Socioeconomic and information-based policies appeared the fewest times (21 papers, 53.8%). Each broad category contains multiple instruments. For example, Economic & Financial Tools include subsidies, taxes, and market-based tools. PES, discussed in eight papers, was the most

Table 8
Policy tools identified in papers.

Type of policy tool (IPBES 2018)	Number of papers (% of sample)	In conjunction with other policy instruments [# papers (%)]*
Legal & Regulatory	31 (79.5%)	30 (96.7%)
Economic & Financial	23 (58.9%)	23 (100.0%)
Social & Information-based	21 (53.8%)	19 (90.5%)
Customary & Rights-based	33 (84.6%)	32 (96.9%)

* 34 papers recognized multiple policy tools.

prevalent of the market-based interventions.

Policy tools convey different degrees of formality; from highly formal Legal & Regulatory to less formal or informal Customary & Rights-based tools. The pool of investigated papers recognized redistribution patterns, such as sharing (Boafo et al., 2016; Lakerveld et al., 2015), and other informal cultural practices that support effective ES-CPR management. These fit the category of Customary Norms and Rights-based tools. For these cases, close social relationships, internal cohesion and social networks play crucial roles. Such customary arrangements merit attention because numerous CPR studies identify customary norms as integral to long-enduring CPR regimes (Ostrom, 2005, 1990). Recognizing customary norms within formal policy tools (or at least allowing persistence of local norms) may enhance applied efforts and outcomes for ES-CPR governance as well as cultural survival.

Papers presented policies in several ways: as creating or exacerbating governance challenges (e.g., Gómez-Baggethun et al., 2013; Hansen et al., 2015; Jupiter et al., 2014; Magner, 2011; Neitzel et al., 2014), as legal frameworks for governing ES-CPR (e.g., Ban et al., 2015; Chand et al., 2015; Farley et al., 2015; Kitamura and Clapp, 2013), or as components of effective (ostensibly sustainable) governance (Molnar et al., 2015).

4.3.2. Recommendations

Recommendations cover a wide range of topics, which we structured in broad categories and subcategories (Table 9). All of the papers offered at least one recommendation to address governance challenges. Thirty papers (76.9%) offered two to five recommendations, with a mode of two recommendations (43.6%). Recommendations were distributed across diverse combinations of governance challenges (Table 8). Calls for institutional changes (24 papers; 62%) occurred most frequently. Recommendations often identified communities as key actors. Recommendations to improve ecosystem management tended to occur in association with recommendations to support communities' participation in governing their own natural resources and benefitting from the CPR and associated ES. Nearly half (49%) of the sample identifies a need for more research to clarify certain findings or explore gaps in knowledge. It is followed closely by recommendations for increased understanding by incorporating existing knowledge and broadening perspectives (18 papers, 46%). As noted by Martin et al. (2016), research gaps limit our understanding of linkages among ES. They recommend further research to comprehend better how changes in one type of ES impact others.

The categories of recommendations generally apply to more than one type of governance challenge. The exception is the category of "Recommendations Towards Improvement of Ecosystems and Their Management," which focuses on solving environmental challenges for ES-CPR governance. The other categories pose recommendations appropriate for a range of environmental and socioeconomic challenges, as well as problems of governance itself. Certain recommendations appear as an umbrella approach for multiple and linked challenges. Clearest examples exist with "Avoid One Size Fits All Approaches (Avoid panaceas)" and "More Research Needed," which often appeared with nearly these same phrases. The majority of the recommendations (68%) are

Table 9
Synthesis of recommendations to improve governance.

GENERAL RECOMMENDATIONS (8 papers)
- Use practical tools
- Develop effective and holistic governance measures for both social and ecological factors
- Transform the current economic system to find alternative ways of integrating nature and economics (to counteract unsustainable processes, commodification, extractive markets, and inequity).

RECOMMENDATIONS TOWARDS IMPROVEMENT OF ECOSYSTEMS AND THEIR MANAGEMENT (6 papers)
- Strengthen the multifunctionality of the resource system
- Limit waste emissions
- Raise public awareness on necessity of particular resource management
- Create new demand for local renewable resources
- Protect the environment
- Remove perverse incentives and provide positive incentives

RECOMMENDATIONS TOWARDS INSTITUTIONAL CHANGES (24 papers)
- Strengthen existing or create new institutions and processes (including adaptive governance and management, or PES)
- Call for soft institutional change towards empowering local communities, collective action and participative approaches
- Strengthen government leadership and improve legislation
- Fit interventions to local circumstances and values (limit top-down regulation)

RECOMMENDATIONS TOWARDS INCREASING UNDERSTANDING (18 papers)
- Recognize linkages between resources, benefits and actors
- Improve/enhance understanding of specific challenges and learning for adaptation
- Include local/traditional knowledge
- Learn from other contexts and concepts (e.g. from ES)
- Gather data/do an assessment
- Include field experiments

RECOMMENDATIONS TOWARDS INCREASING EQUITY AND JUSTICE (6 papers)
- Distribute resources more equitably across various actors (social, institutional and policy approaches)

AVOID ONE-SIZE-FITS-ALL APPROACHES (Avoid panaceas) (7 papers)

MORE RESEARCH NEEDED (19 papers)

associated with the 26 papers (67% of the total sample) that address all three categories of challenges: environmental and socioeconomic challenges as well as problems of governance itself. This group covered all of the synthetic categories of recommendations, as did the group of seven papers that addressed both environmental and socioeconomic challenges.

The three most prevalent recommendations (suggesting institutional change, increasing understanding, and the need for more research) appear in all the clusters (Fig. 2). Curiously, the Coastal-Marine-Fisheries cluster lacked papers that made general recommendations, neither did they offer recommendations for improving ecosystems and their management, nor for increasing equity and justice.

Focus on conflict resolution: Although every category of recommendation appeared in the group of 19 papers discussing conflict, the vast majority (63.2%) of Conflict Resolution Mechanisms (CRM) fell in the category of recommendations towards institutional change. In some cases, researchers identified effective local CRM arrangements (Boafo et al., 2016; Molnar et al., 2015), and presented them as examples to follow. Other instances received recommendations to improve local CRM arrangements, typically through informal CRM using *soft institutional change* (9 papers). The latter refers to modes of governance that prioritize local collective agreements, in contrast to the imposition of legalistic, top-down decision-making that characterizes hard institutional change. According to Mongruel et al. (2011), soft institutional changes that involve greater participation can be more effective than the external imposition of restrictive rules. By contrast, four cases of conflict recommended formal, external CRM. In Tanzania, Fisher et al. (2010) reported numerous actors in conflicts over water and recommended a PES program. However, other studies found that PES spurred conflict (e.g., Neitzel et al., 2014, Monroy-Sais et al., 2016). Another case explored conflict over customary rights to land and marine resources on Pacific islands (Jupiter et al., 2014), and suggested an Integrated Island Management approach to foster adaptive management and sustainable resource use. These CRM occurred in conjunction with

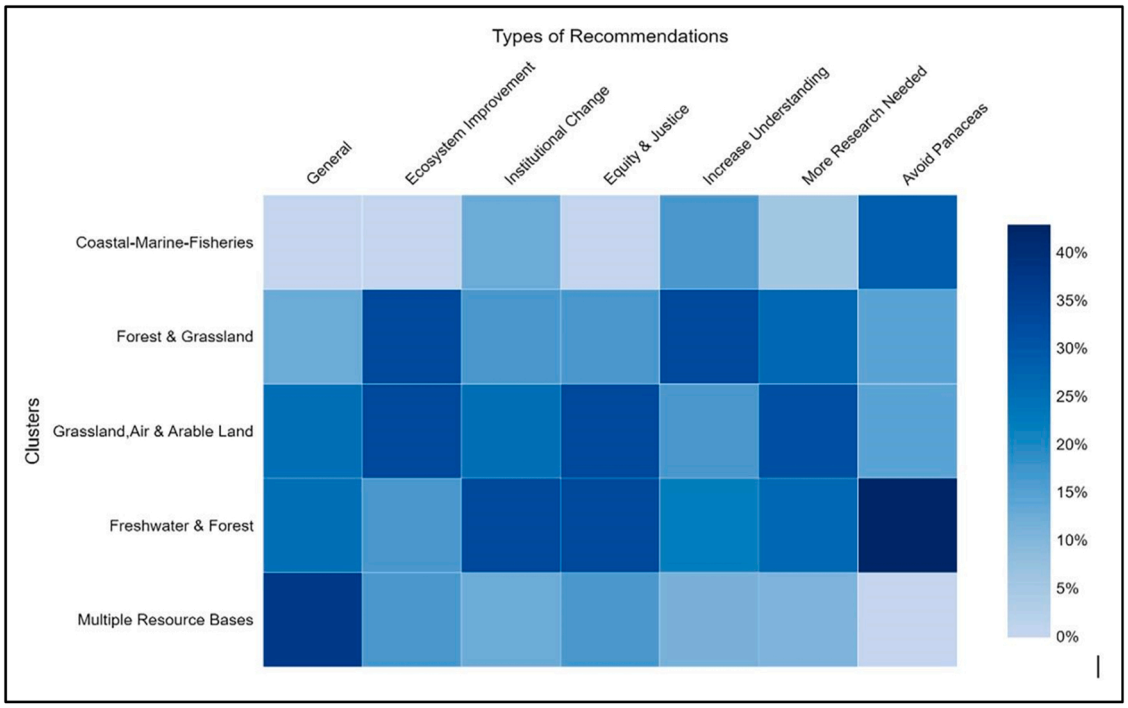


Fig. 2. Heat map indicating types of recommendations by cluster.

recommendations to increase understanding and to conduct more research of CRM (9 papers). Four papers considered only theoretical or conceptual CRM approaches, fitting with general recommendations or recommendations for equity and justice.

5. Discussion and synthesis

Overall, we identified seven main findings related to aspects of governance that emerged from the data extracted from the 39 papers at the nexus of ES-CPR research. We also point to knowledge gaps. These are discussed below.

5.1. Local actors matter in governance

CPR literature generally pays attention to local actors and how they govern their resource base, while the majority of the ES literature looks more broadly at the ecosystem scale. The sample points to the importance of local actors in effective governance and management, consistent with a focus on CPR and attention to local ES-CPR uses. To varying degrees, these papers recognize customary rights, traditional knowledge, and potential for community-based governance in which informal arrangements foster equitable access to and sustainability of ES and CPR. Further, the sample broadly recommends institutional changes that empower local actors, encourage participatory processes, and support informal approaches to improve understanding and foster innovation for improved governance of ES and CPR. In general, the papers recognize that customary norms may better support ES-CPR governance than externally imposed regulations, and contribute to cultural survival where indigenous groups and their CPR are involved.

5.2. Institutional mismatches exist across governance levels

A number of papers mentioned inappropriate policies and unanticipated consequences of interventions, as found in the PES examples. High-level governing bodies often lack knowledge of the local ES-CPR and socioeconomic contexts, which can lead to perverse incentives. At the same time, local populations and organizations may benefit from information from alternative perspectives and knowledge (e.g., from scientists). Better communication and knowledge sharing could prevent inappropriate policies. Policies would be more likely to achieve intended ES-CPR gains if higher-level regulatory agencies and governance bodies were to develop greater appreciation, recognition and support of local capacity for governance. In complementary findings, Gatto (2022) uses case studies of water governance to propose a commons framework in which interplay among public, private and civil society actors generates multiple governance solutions for resilient communities and sustainable development.

5.3. Conflicts can emerge over rights of access and ownership

This analysis suggests that complexity or uncertainty about use rights or ownership contributes to or exacerbates conflicts, and indicates governance shortcomings. A large body of literature points to the importance of clear property rights for effective resource management, thus poorly defined property and use rights, or struggles among overlapping or competing owners, are likely to be the cause of governance failure. It was unclear whether this was accidental or intentional (e.g. in undemocratic states?). It is possible that internal conflicts arise due to free riders or difficulties related to changes in property rights systems. Conflicts also emerged when external powers threatened local arrangements, compelling affected actors and communities to resist.

5.4. Contradictory governance arrangements may lead to conflicts

A conflict has diverse origins, and this sample revealed cases in which contradictions among institutional arrangements and regulations led to a conflict (e.g., Monroy-Sais et al., 2016). Furthermore, institutional arrangements and their distributive consequences can be challenged and contested for actors, social groups and different strata of society. More broadly, the relationships between conflicts and governance are apparent but inconsistent. A conflict can disrupt established governance and fragment society; simultaneously, it may connect social units and enable dynamic societal adaptation. Thus conflicts can be seen as a motor of social change (e.g. Elias, 1970; Dahrendorf, 1986) and

collective actions (e.g. (Goluža et al., 2021)).

5.5. Soft institutional change can support conflict resolution

Considering the diverse types of conflict and their resolution mechanisms, soft institutional change is apparently viewed as an effective mechanism for addressing horizontal conflicts and clashes over socioeconomic and institutional development, as well as for addressing conflicts over inequitable access to resources. It is noteworthy that soft institutional change, with its focus on local-level collective engagement, is not proposed for top-down conflict resolution, but for wide participation of local actors and institutions in problem solving. More recent work also offers support for soft institutional changes in community-based collective action (Nguyen et al., 2022).

5.6. Correlations among governance challenges are elusive

The papers overwhelmingly recognized multiple challenges for governance, and offered multiple recommendations. As a result, challenges and recommendations created "multiple to multiple" combinations that confounded identification of correlations. Thus the analysis reveals a shared recognition of complexity and interrelationships among governance challenges, for which there are neither simple nor singular policy remedies. Moreover, a lack of data and gaps in understanding are widely acknowledged, as evidenced by the widespread recommendation for more research, and advice against one-size-fits-all solutions (panaceas). In addition, recommendations point to incorporating traditional knowledge and local perspectives to improve understanding. These recommendations recognize the potential for tailoring governance interventions to specific local conditions and recognizing customary rules, in keeping with evidence that successful CPR governance correlates with institutional arrangements appropriate for the locale (Ostrom, 2005; Cox et al., 2010).

5.7. Recommendations focus on socioeconomic challenges and problems of governance itself

Most of the studies (85%) involved collaboration among natural and social scientists and sometimes practitioners (Rodela et al., 2019), and focused on questions regarding human misuse of natural resources. In this context, a majority of the recommendations address socioeconomic challenges and problems of governance itself that often underlie natural resource degradation. This implies a recognition that meeting human needs, resolving conflicts, and mitigating societal inequities and governance shortcomings are foundations for improving ecological conditions and ES-CPR governance. The prevalence of recommendations favoring Customary and Rights-based tools suggest that research on governance at ES-CPR has been oriented toward local levels, incorporating a trend toward soft institutional approaches rather than external interventions. Most papers present multiple policy recommendations, some of which have synergistic and overlapping aspects. For example, calls for increased local participation and soft institutional changes have synergies with recommendations for improving equity and justice, which are recognized as part of effective governance (cf. Loft, 2020). At the same time, most of the papers seem to assume that recommendations would be mutually reinforcing. Few papers (e.g., Duraiappah et al., 2014) recognize the potential for contradictions, mismatches, and trade-offs among various policy instruments. It is hard to find policies that do not involve trade-offs across environmental and socioeconomic priorities. As the papers on PES reveal, it can be difficult to foresee whether policies will result in unintended consequences for equity or sustainability.

Only a few papers recognized that internal conflicts, unstable governments, corruption, or other governance failures can undermine even well-designed projects (e.g., Monroy-Sais et al., 2016; Polman et al., 2016). Underlying conflicts and systemic problems may also be difficult for researchers to detect, especially if people find it risky to share their understanding, or if researchers unwittingly align themselves with a certain side or entity in a conflictive situation.

5.8. Knowledge gaps in ES-CPR research

In part, the gaps and oversights discovered in this sample reflect adherence of researchers to well-focused questions and observations, which may limit analyses to proximate factors and exclude underlying drivers. Although most papers acknowledge the interconnectedness of socioeconomic, environmental and governance issues, it remains rare to find analyses that approach problems systemically, and with respect to an inequitable global system. This gap merits research prioritization. By inadequately examining the interconnections and feedbacks among various dimensions in an ES-CPR system, and impacts of global processes (e.g., international markets, climate change), researchers and decision-makers may propose inadequate or inappropriate remedies. They also risk underestimating or overlooking unintended consequences resulting from programs and policies, leading to governance tragedies instead of remedies.

Issues of equity and justice underlie many of the social dilemmas related to interdependent ES and CPR governance. Only six papers offered recommendations to improve equity and justice, an integral dimension of sustainability, indicating further attention needed in this area. Similarly, ethical dimensions of CPR and ES governance – which resonate with equity and justice – receive little mention in this data set. An exception is Castilla (2016), who discusses the need for practical environmental ethics and personal ethical responsibility as integral to transitioning to sustainability. Recently, researchers studying commons governance and policy making (e.g., Peredo et al., 2020) and ecosystems services conservation and policies (e.g., Jax et al., 2013) have focused on ethical issues, suggesting that the area may be gaining recognition but merits more attention at the intersections of ES and CPR.

Underlying these gaps exists an obscure challenge: it can be difficult to conduct research that critically examines societal and political structures which perpetuate ineffective governance and incentivize processes associated with ES and CPR degradation. In certain situations, powerful interests impede research that could reveal governance failures, unvarnished facts or corruption. Three papers expressly discussed systemic problems for environmental governance. Kallis et al. (2013) critiqued the commodification of nature, and recommended distributive justice and equality among their criteria for improved governance. Lopes et al. (2015) examined distributive issues, and argued that the "straightjacket of neoclassical theory" would have to be broken to open paths to alternative ways of integrating nature and economics. Baumgärtner et al. (2010) noted that adaptive governance ultimately requires transformations in the global economic system.

6. Conclusions

The analysis highlights both the need and the challenges of crafting better governance arrangements and institutions (formal and informal rules) to sustain CPR and ES. Indeed, concern for sustainability appears to underlie and inform many of the recommendations that appeared in the dataset. This review indicates that research at the intersections of ES and CPR is merging the strengths of both fields. The sample included many diverse authorship teams, and those that were most diverse (natural scientists, social scientists and practitioners representing expertise in ES, CPR and applied work) were more likely to recognize strong interactions among ES and CPR (Rodela et al., 2019). More broadly, this review conveys that the challenges affecting CPR and ES governance are multidimensional and multilevel issues. This outcome highlights the conundrums of improving governance of interdependent ES and CPR, where diverse actors struggle for access and control under conditions of inequitable power relations across disparate spheres of knowledge and scales of influence. While these struggles complicate

efforts to achieve sustainable management and governance, the research recognizes the potential utility of practical approaches and concrete steps. Specifically, the review suggests the emergence of a consensus that ES-CPR governance outcomes would improve through institutional changes that empower local actors, support collective action, increase participation of diverse actors in governance, and achieve better alignment of legislation with local conditions. Recommendations to improve understanding point to incorporating local and traditional knowledge, learning across different contexts, and paying attention to linkages among different actors and resources. These recommendations resonate with other research calling for engaged science with society (Steger et al., 2021). While we have limited comprehension of how current ES-CPR governance failures can be transformed to achieve sustainability, justice and equity (e.g., Pahl-Wostl and Patterson, 2021), it is clear that innovative and inclusive approaches must be found. Given the multidimensionality and urgency of ES and CPR governance challenges, it appears that collaborations and knowledge exchanges among ES and CPR researchers, practitioners, local actors, and other involved actors can offer a promising approach for building better understanding and transformation toward improved governance for sustainability of interdependent ES and CPR. Given the diversity of local contexts and of ES and CPR interactions, more research will be crucial to identify and implement effective, locally appropriate governance approaches that foster ES and CPR sustainability.

Declaration of Competing Interest

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

Data Availability

Data will be made available on request.

Acknowledgements

We acknowledge support from the Slovenian Research Agency for organizing a workshop that laid the foundations for this study (Project J6-6854). Mateja Šmid Hribar and Mimi Urbanc acknowledge financial support from the Slovenian Research Agency for core funding Geography of Slovenia (P6-0101). Romina Rodela acknowledges funds from The Foundation for Baltic and East European Studies (Grant ID 3044601). Catherine Tucker expresses appreciation to the Anton Melik Geographical Institute of the Research Centre of the Slovenian Academy of Sciences and Arts for a visiting scholar invitation that advanced this collaborative work.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2023.106575.

References

Agrawal, A., 2003. Sustainable governance of common-pool resources: context, methods, and politics. Annu. Rev. Anthropol. 32, 243–262.
Anderson, T., Hill, P.J., 1983. Privatizing the commons: an improvement? South. Econ. J. 50, 438–351.
Andersson, K.P., Chang, K., Molina-Garzón, A., 2020. Voluntary leadership and the emergence of institutions for self-governance. PNAS 117 (44), 27292 https://10.1073/pnas.2007230117.
Arnold, J.E.M., 1998. Managing forests as common property. FAO Forestry Paper 136. Food and Agriculture Organization of the United Nations, Rome.
Ban, N.C., Evans, L.S., Nenadovic, M., Schoon, M., 2015. Interplay of multiple goods, ecosystem services, and property rights in large social-ecological marine protected areas. Ecol. Soc. 20, 15 https://doi.org/10.5751/es-07857-200402.
Barkhordarian, A., Saatchi, S.S., Behrangi, A., Loikith, P.C., Mechoso, C.R., 2019. A recent systematic increase in vapor pressure deficit over tropical South America. Sci. Rep. 9, 1–12 https://doi.org/10.1038/s41598-019-51857-8.
Basurto, X., 2013. Linking multi-level governance to local common-pool resource theory using fuzzy-set qualitative comparative analysis: Insights from twenty years of biodiversity conservation in Costa Rica. Glob. Environ. Chang 23, 573–587 https://doi.org/10.1016/j.gloenvcha.2013.02.011.
Baumgärtner, J., Tikubet, G., Gilioli, G., 2010. Towards adaptive governance of common-pool mountainous agropastoral systems. Sustainability 2, 1448–1471 https://doi.org/10.3390/su2061448.
Berkes, F., 2007. Community-based conservation in a globalized world. Proc. Natl. Acad. Sci. USA 104, 15188–15193. https://doi.org/10.1073/pnas.0702098104.
Berlin, B., Berlin, E.A., 2004. Community Autonomy and the Maya ICBG Project in Chiapas. In: Hum. Organ, 63. How a Bioprospecting Project that Should Have Succeeded Failed, Mexico, pp. 472–486.
Bevir, M., 2013. Governance: A Very Short Introduction. Oxford University Press, Oxford, UK.
Boafo, Y.A., Saito, O., Jasaw, G.S., Otsuki, K., Takeuchi, K., 2016. Provisioning ecosystem services-sharing as a coping and adaptation strategy among rural communities in Ghana's semi-arid ecosystem. Ecosyst. Serv. 19, 92–102 https://doi.org/10.1016/j.ecoser.2016.05.002.
Bromley, D., 1992. Making the Commons Work: Theory, Practice, and Policy. Institute for Contemporary. Studies (ICS). Press, San Francisco https://doi.org/10.2307/1243610.
Burkhard, B., Maes, J., Potschin-Young, M., Santos-Martín, F., Geneletti, D., Stoev, P., Kopperoinen, L., Adamescu, C.M., Adem Esmail, B., Arany, I., Arnell, A., Balzan, M., Barton, D.N., Van Beukering, P., Bicking, S., Borges, P.A.V., Borisova, B., Braat, L., Brander, L.M., Bratanova-Doncheva, S., Broekx, S., Brown, C., Cazacu, C., Crossman, N., Czúcz, B., Daněk, J., de Groot, R., Depellegrin, D., Dimopoulos, P., Elvinger, N., Erhard, M., Fagerholm, N., Frélichová, J., Grêt-Regamey, A., Grudova, M., Haines-Young, R., Inghe, O., Kallay, T.K., Kirin, T., Klug, H., Kokkoris, I.P., Konovska, I., Kruse, M., Kuzmova, I., Lange, M., Liekens, I., Lotan, A., Lowicki, D., Luque, S., Marta-Pedroso, C., Mizgajski, A., Mononen, L., Mulder, S., Müller, F., Nedkov, S., Nikolova, M., Östergård, H., Penev, L., Pereira, P., Pitkänen, K., Plieninger, T., Rabe, S.-E., Reichel, S., Roche, P.K., Rusch, G., Ruskule, A., Sapundzhieva, A., Sepp, K., Sieber, I.M., Šmid Hribar, M., Stašová, S., Steinhoff-Knopp, B., Stępniewska, M., Teller, A., Vackar, D., Van Weelden, M., Veidemane, K., Vejre, H., Vihervaara, P., Viinikka, A., Villoslada, M., Weibel, B., Zulian, G., 2018. Mapping and assessing ecosystem services in the EU-Lessons learned from the ESMERALDA approach of integration. One Ecosyst. 3. https://doi.org/10.3897/oneeco.3.e291.
Castilla, J.C., 2016. View points of an ecologist on practical environmental ethic: socioecology, common-pool resources and conservation. Cuad. Bioet. 27, 403–414.
Chand, N., Kerr, G.N., Bigsby, H., 2015. Production efficiency of community forest management in Nepal. Policy Econ. 50, 172–179 https://doi.org/10.1016/j.forpol.2014.09.001.
Christiansen, T., Neuhold, C., 2012. Introduction. In: Chistiansen, T., Neuhold, C. (Eds.), International Handbook on Informal Governance. E. Elgar Publishing Ltd, Cheltenham, UK, pp. 1–15.
Cordell, J., McKean, M.A., 1992. Sea tenure in Bahia, Brazil, Making the commons work: Theory, Practice and Policy. International Center of Self-Governance, San Francisco.
Cox, Michael, Gwen Arnold, Sergio Villamayor Tomás, 2010. A review of design principles for community-based natural resource management. Ecol. Soc. 15 (4), 38.
D'Amato, D., Rekola, M., Wan, M., Cai, D., Toppinen, A., 2017. Effects of industrial plantations on ecosystem services and livelihoods: perspectives of rural communities in China. Land Use Policy 63, 266–278 https://doi.org/10.1016/j.landusepol.2017.01.044.
Dahrendorf, R., 1986. Pfade aus Utopia: Zur Theorie Und Methode Der Sociologie. Verlag Serie Piper, München.
Dietz, T., Ostrom, E., Stern, P.C., 2003. The struggle to govern the commons. Science 302 (5652), 1907–1912 https://doi.org/10.1126/science.1091015.
Dixon, A., Carrie, R., 2016. Creating local institutional arrangements for sustainable wetland socio-ecological systems: lessons from the 'Striking a Balance' project in Malawi. Int. J. Sustain. Dev. World Ecol. 23, 40–52 https://doi.org/10.1080/13504509.2015.1107861.
Droste, N., D'Amato, D., Goddard, J.J., 2018. Where communities intermingle, diversity grows – the evolution of topics in ecosystem service research. PLoS One 13 https://doi.org/10.1371/journal.pone.0204749.
Dunning, K.H., 2015. Ecosystem services and community based coral reef management institutions in post blast-fishing Indonesia. Ecosyst. Serv. 16, 319–332 https://doi.org/10.1016/j.ecoser.2014.11.010.
Duraiappah, A.K., Asah, S.T., Brondizio, E.S., Kosoy, N., O'Farrell, P.J., Prieur-Richard, A.H., Subramanian, S.M., Takeuchi, K., 2014. Managing the mismatches to provide ecosystem services for human well-being: a conceptual framework for understanding the new commons. Curr. Opin. Environ. Sustain 7, 94–100 https://doi.org/10.1016/j.cosust.2013.11.031.
Elias, N., 1970. Was ist Soziologie?. Juventa-Verlag, München.
Englund, O., Berndes, G., Cederberg, C., 2017. How to analyze ecosystem services in landscapes—a systematic review. Ecol. Indic. 73, 492–504 https://doi.org/10.1016/j.ecolind.2016.10.009.
Everard, M., Pontin, B., Appleby, T., Staddon, C., Hayes, E.T., Barnes, J.H., Longhurst, J.W.S., 2013. Air as a common good. Environ. Sci. Policy 33, 354–368 https://doi.org/10.1016/j.envsci.2012.04.008.
Farley, J., Costanza, R., Flomenhoft, G., Kirk, D., 2015. The vermont common assets trust: an institution for sustainable, just and efficient resource allocation. Ecol. Econ. 109, 71–79 https://doi.org/10.1016/j.ecolecon.2014.10.016.

Fisher, B., Kulindwa, K., Mwanyoka, I., Turner, R.K., Burgess, N.D., 2010. Common pool resource management and PES: lessons and constraints for water PES in Tanzania. Ecol. Econ. 69, 1253–1261 https://doi.org/10.1016/j.ecolecon.2009.11.008.
Gatto, A., 2022. Polycentric and resilient perspectives for governing the commons: Strategic and law and economics insights for sustainable development. Ambio 51, 1921–1932 https://doi:10.1007/s13280-022-01719-x.
Gibson, C., McKean, M.A., Ostrom, E., 2000. People and Forests: Communities. Institutions and Governance. MIT Press, Cambridge, MA.
Goluža, M., Šubic-Kovač, M., Kos, D., Bole, D., 2021. How the state legitimizes national development projects: The Third Development Axis case study, Slovenia. Acta Geogr. Slov. 61 (2), 109–121. https://doi.org/10.3986/AGS.9572.
Gómez-Baggethun, E., Kelemen, E., Martín-López, B., Palomo, I., Montes, C., 2013. Scale misfit in ecosystem service governance as a source of environmental conflict. Soc. Nat. Resour. 26, 1202–1216. https://doi.org/10.1080/08941920.2013.820817.
Greiber, T., Schiele, S., eds., 2011. Governance of Ecosystem Services: Lessons learned from Cameroon, China, Costa Rica and Ecuador. IUCN Environmental Policy and Law Paper. Medienhaus Plump, Rheinbreitbach, Germany.
Haddaway, N.R., Macura, B., Whaley, P., Pullin, A.S., 2017. ROSES for systematic review protocols. Version 1, 0. https://doi.org/10.6084/m9.figshare.5897269.v4.
Haines-Young, R. & Potshin, M., 2018. Common International Classification of Ecosystem Services (CICES), V5.1: and Guidance on the Application of the Revised Structure. CICES, European Union.
Handberg, O.N., Angelsen, A., 2015. Experimental tests of tropical forest conservation measures. J. Econ. Behav. Organ 118, 346–359 https://doi.org/10.1016/j.jebo.2015.03.007.
Hansen, M., Islar, M., Krause, T., 2015. The politics of natural resource enclosure in South Africa and Ecuador. Conserv. Soc. 13, 287–298 https://doi.org/10.4103/0972-4923.170406.
Harnish, A., Cliggett, L., Scudder, T., 2019. Rivers and roads: a political ecology of displacement, development, and chronic liminality in Zambia's Gwembe Valley. Econ. Anthr. 6, 250–263 https://doi.org/10.1002/sea2.12151.
Harrison, P.A., Berry, P.M., Simpson, G., Haslett, J.R., Blicharska, M., Bucur, M., Dunford, R., Egoh, B., Garcia-Llorente, M., Geamănă, N., Geertsema, W., Lommelen, E., Meiresonne, L., Turkelboom, F., 2014. Linkages between biodiversity attributes and ecosystem services: a systematic review. Ecosyst. Serv. 9, 191–203 https://doi.org/10.1016/j.ecoser.2014.05.006.
Harsh, M., 2012. Informal governance of emerging technologies in Africa. In International Handbook on Informal Governance, Christensen, T. Neuhold, C. (Eds.). E. Elgar Publishing, Ltd., Cheltenham, UK, pp. 481–500.
Hausner, V.H., Brown, G., Laegreid, E., 2015. Effects of land tenure and protected areas on ecosystem services and land use preferences in Norway. Land Use Policy 49, 446–461. https://doi.org/10.1016/j.landusepol.2015.08.018.
Helmke, G., Levitsky, S., 2004. Informal institutions and comparative politics: a research agenda. Perspect. Polit. 2, 725–740.
Hoffmann, I., 2011. Livestock biodiversity and sustainability. Livest. Sci. 139, 69–79. https://doi.org/10.1016/j.livsci.2011.03.016.
Jax, K., Barton, D.N., Chan, K.M.A., de Groot, R., Doyle, U., Eser, U., Görg, C., Gómez-Baggethun, E., Griewald, Y., Haber, W., Haines-Young, R., Heink, U., Jahn, T., Joosten, H., Kerschbaumer, L., Korn, H., Luck, G.W., Matzdorf, B., Muraca, B., Neßhöver, C., Norton, B., Ott, K., Potschin, M., Rauschmayer, F., von Haaren, C., Wichmann, S., 2013. Ecosystem services and ethics. Ecol. Econ. 93, 260–268. https://doi.org/10.1016/j.ecolecon.2013.06.008.
Jupiter, S.D., Jenkins, A.P., Lee, L., W, J., Maxwell, S.L., Carruthers, T.J.B., Hodge, K.B., Govan, H., Tamelander, J., Watson, J.E.M., 2014. Principles for integrated island management in the tropical Pacific. Pacific. Conserv. Biol. 20, 193–205.
Kallis, G., Gomez-Baggethun, E., Zografos, C., 2013. To value or not to value? That is not the Question. Ecol. Econ. 94, 97–105. https://doi.org/10.1016/j.ecolecon.2013.07.002.
Kaye-Zwiebel, E., King, E., 2014. Kenyan pastoralist societies in transition: varying perceptions of the value of ecosystem services. Ecol. Soc. 19, 19 https://doi.org/10.5751/es-06753-190317.
Kenward, R.E., Whittingham, M.J., Arampatzis, S., Manos, B.D., Hahn, T., Terry, A., Simoncini, R., Alcorn, J., Bastian, O., Donlan, M., Elowe, K., Franzen, F., Karacsonyi, Z., Larsson, M., Manou, D., Navodaru, I., Papadopoulou, O., Papathanasiou, J., von, R., Sharp, R.J.A., Soderqvist, T., Soutukorva, A., Vavrova, L., Aebischer, N.J., Leader-Williams, N., Rutz, C., 2011. Identifying governance strategies that effectively support ecosystem services, resource sustainability, and biodiversity. Proc. Natl. Acad. Sci. U. S. A. 108, 5308–5312. https://doi.org/10.1073/pnas.1007933108.
Kininmonth, S., Bergsten, A., Bodin, Ö., 2015. Closing the collaborative gap: aligning social and ecological connectivity for better management of interconnected wetlands. Ambio 44, 138–148 https://doi.org/10.1007/s13280-014-0605-9.
Kitamura, K., Clapp, R.A., 2013. Common property protected areas: community control in forest conservation. Land Use Policy 34, 204–212 https://doi.org/10.1016/j.landusepol.2013.03.008.
Kolinjivadi, V., Adamowski, J., Kosoy, N., 2014. Recasting payments for ecosystem services (PES) in water resource management: a novel institutional approach. Ecosyst. Serv. 10, 144–154 https://doi.org/10.1016/j.ecoser.2014.08.008.
Lakerveld, R.P., Lele, S., Crane, T.A., Fortuin, K.P.J., Springate-Baginski, O., 2015. The social distribution of provisioning forest ecosystem services: evidence and insights from Odisha. India Ecosyst. Serv. 14, 56–66 https://doi.org/10.1016/j.ecoser.2015.04.001.
Liquete, C., Piroddi, C., Drakou, E.G., Gurney, L., Katsanevakis, S., Charef, A., Egoh, B., 2013. Current status and future prospects for the assessment of marine and coastal ecosystem services: a systematic review. PLoS One 8 https://doi.org/10.1371/journal.pone.0067737.
Loft, L., Mann, C., Hansjürgens, B., 2015. Challenges in ecosystem services governance: Multi-levels, multi-actors, multi-rationalities. Ecosyst. Serv. 16, 150–157 https://doi.org/10.1016/j.ecoser.2015.11.002.
Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, D. C https://doi.org/10.3897/zookeys.715.13865.
Loft, L., Gehrig, S., Salk, C., Rommel, J., 2020. Fair payments for effective conservation. PNAS 117, 14094–14101.
Lopes, L.F.G., Bento, J., Cristovao, A., Baptista, F.O., 2015. Exploring the effect of land use on ecosystem services: the distributive issues. Land Use Policy 45, 141–149 https://doi.org/10.1016/j.landusepol.2014.12.008.
Lowi, T., 1985. The state in politics: the relation between policy and administration. In: Noll, R. (Ed.), Regulatory Policy and the Social Sciences. University of California Press, London, pp. 67–104.
Magner, J., 2011. Tailored watershed assessment and integrated management (TWAIM): a systems thinking approach. Water 3, 590–603 https://doi.org/10.3390/w3020590.
Martin, S.L., Ballance, L.T., Groves, T., 2016. An ecosystem services perspective for the oceanic eastern tropical pacific: commercial fisheries, carbon storage, recreational fishing, and biodiversity. Front. Mar. Sci. 3 https://doi.org/10.3389/fmars.2016.00050.
McCay, B.J., Acheson, J.M., 1987. Human Ecology of the Commons. In: McCay, B.J., Acheson, J.M. (Eds.), The Question of the Commons: The culture and ecology of communal resources. University of Arizona Press, Tucson, pp. 1–36.
McGinnis, M.D., 2011. An Introduction to IAD and the Language of the Ostrom Workshop: A Simple Guide to a Complex Framework. Policy Stud. J. 29, 169–183.
McIntosh, S., Renard, Y., 2009. Placing the commons at the heart of community development: three case studies of community enterprise in Caribbean islands. Int. J. Commons 4, 160 https://doi.org/10.18352/ijc.135.
Mckean, M.A., Cox, T.R., 1982. The Japanese experience with scarcity: management of traditional common lands. Environ. Rev. 6, 63–91.
McKean, M.A., 2000. Common Property: What Is It, What Is It Good For, and What Makes It Work? In: Gibson, C.C., McKean, M.A., Ostrom, E. (Eds.), People and Forests: Communities, Institutions and Governance. MIT Press, Cambridge, MA, pp. 27–56.
Mikusiński, G., Niedziałkowski, K., 2020. Perceived importance of ecosystem services in the Białowieża Forest for local communities – does proximity matter? Land Use Policy 97 https://doi.org/10.1016/j.landusepol.2020.104667.
Molnar, Z., Gelleny, K., Margoczi, K., Biro, M., 2015. Landscape ethnoecological knowledge base and management of ecosystem services in a Szekely-Hungarian pre-capitalistic village system (Transylvania, Romania). J. Ethnobiol. Ethnomed. 11, 22 https://doi.org/10.1186/1746-4269-11-3.
Mongruel, R., Prou, J., Balle-Beganton, J., Lample, M., Vanhoutte-Brunier, A., Rethoret, H., Agundez, J. a P., Vernier, F., Bordenave, P., Bacher, C., 2011. Modeling Soft Institutional Change and the Improvement of Freshwater Governance in the Coastal Zone. Ecol. Soc. 16, 13 https://doi.org/10.5751/es-04294-160415.
Monroy-Sais, S., Castillo, A., Garcia-Frapolli, E., Ibarra-Manriquez, G., 2016. Ecological variability and rule-making processes for forest management institutions: a social-ecological case study in the Jalisco coast. Mex. Int. J. Commons 10, 1144–1171 https://doi.org/10.18352/ijc.672.
Mulatu, D.W., van der, V., van, O., P, R., 2014. Farm households' preferences for collective and individual actions to improve water-related ecosystem services: The Lake Naivasha basin, Kenya. Ecosyst. Serv. 7, 22–33. https://doi.org/10.1016/j.ecoser.2013.12.001.
Neitzel, K.C., Caro-Borrero, A.P., Revollo-Fernandez, D., Aguilar-Ibarra, A., Ramos, A., Almeida-Lenero, L., 2014. Paying for environmental services: Determining recognized participation under common property in a peri-urban context. Policy Econ. 38, 46–55 https://doi.org/10.1016/j.forpol.2013.04.002.
Netting, R.M., 1976. What alpine peasants have in common: Observations on communal tenure in a Swiss village. Hum. Ecol. 4, 135–146. https://doi.org/10.1007/BF01531217.
Nguyen, V.T.H., McElwee, P., Van, Le, H.T., Nghiem, T., Dieu, Vu, H.T., 2022. The challenges of collective PES: Insights from three community-based models in Vietnam. Ecosyst. Serv. Volume 56 https://doi.org/10.1016/j.ecoser.2022.101438.
Ostrom, E., 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, United Kingdom.
Ostrom, E., 2005. Understanding Institutional Diversity. Princeton University Press, Princeton, New Jersey.
Ostrom, E., Chang, C., Pennington, M., Tarko, V., 2012. The Future of the Commons. Institute of Economic Affairs, London.
Ostrom, E., Dietz, T., Dolšak, N., Stern, P.C., Stonich, S., Weber, E.U. (Eds.), 2002. The Drama of the Commons. National Academy Press, Washington, DC.
Pahl-Wostl, C., Patterson, J., 2021. Transformative change in governance systems: Commentary on: a conceptual framework for analyzing adaptive capacity and multi-level learning processes in resource governance regimes. Glob. Environ. Chang, 102405. https://doi.org/10.1016/j.gloenvcha.2021.102405.
Peredo, A.M., Haugh, H.M., Hudon, M., Meyer, C., 2020. Mapping Concepts and Issues in the Ethics of the Commons: Introduction to the Special Issue. J. Bus. Ethics 166, 659–672. https://doi.org/10.1007/s10551-020-04584-4.
Polman, N., Reinhard, S., van, B., L, K.J., Kuhlman, T., 2016. Governance of ecosystem services on small islands: three contrasting cases for St. Eustatius in the Dutch Caribbean. Isl. Stud. J. 11, 265–284.
Primmer, E., Jokinen, P., Blicharska, M., Barton, D.N., Bugter, R., Potschin, M., 2015. Governance of ecosystem services: a framework for empirical analysis. Ecosyst. Serv. 16, 158–166. https://doi.org/10.1016/j.ecoser.2015.05.002.
Reid, R.S., Fernández-Giménez, M.E., Galvin, K.A., 2014. Dynamics and resilience of rangelands and pastoral peoples around the globe. Annu. Rev. Environ. Resour. 39, 217–242. https://doi.org/10.1146/annurev-environ-020713-163329.

Rodela, R., Tucker, C.M., Šmid Hribar, M., Sigura, M., Bogataj, N., Urbanc, M., Gunya, A., 2019. Intersections of ecosystem services and common-pool resources literature: an interdisciplinary encounter. Environ. Sci. Policy 94, 72–81 https://doi.org/https://doi.org/10.1016/j.envsci.2018.12.021.

Runge, C.F., 1986. Common property and collective action in economic development. World Dev. 14, 623–635 https://doi.org/10.1016/0305-750X(86)90128-2.

Sattler, C., Loft, L., Mann, C., Meyer, C., 2018. Methods in ecosystem services governance analysis: an introduction. Ecosyst. Serv. 34, 155–168 https://doi.org/https://doi.org/10.1016/j.ecoser.2018.11.007.

Schlager, E., Ostrom, E., 1992. Property-rights regimes and natural resources: a conceptual analysis. Land Econ. 68, 249–262.

Seixas, C.S., Berkes, F., 2009. Community-based enterprises: the significance of partnerships and institutional linkages. Int. J. Commons 4, 183 https://doi.org/10.18352/ijc.133.

Shimada, D., 2015. Multi-level natural resources governance based on local community: a case study of semi-natural grassland in Taroji, Nara, Japan. Int. J. Commons 9, 486–509 http://doi.org/10.18352/ijc.510.

Sikor, T., He, J., Lestrelin, G., 2017. Property rights regimes and natural resources: a conceptual analysis revisited. World Dev. 93, 337–349 https://doi.org/10.1016/j.worlddev.2016.12.032.

Šmid Hribar, M., Bole, D., Urbanc, M., 2015. Public and common goods in the cultural landscape. Geogr. Vestn. 87, 43–57. https://doi.org/10.3986/GV87203.

Šmid Hribar, M., Kozina, J., Bole, D., Urbanc, M., 2018. Public goods, common-pool resources, and the commons: the influence of historical legacy on modern perceptions in Slovenia as a transitional society. Urban. izziv 29 (1), 96–109 https://doi.org/10.5379/urbani-izziv-en-2018-29-01-004.

Steger, C., Klein, J.A., Reid, R.S., Lavorel, S., Tucker, C.M., Hopping, K.A., Marchant, R., Teel, T., Cuni-Sanchez, A., Dorji, T., Greenwood, G., Huber, R., Kassam, K.-A., Kreuer, D., Nolin, A., Russell, A., Sharp, J.L., Šmid Hribar, M., Thorn, J.P.R., Grant, G., Mahdi, M., Moreno, M., Waiswa, D., 2021. "Science with society: Evidence-based guidance for best practices in environmental transdisciplinary work.". Glob. Environ. Chang 68, 102240. https://doi.org/10.1016/j.gloenvcha.2021.102240.

Stonich, S.C., 1989. The dynamics of social processes and environmental destruction: A Central American case study. Popul. Dev. Rev. 15, 269–296. https://doi.org/10.2307/1973705.

Stringer, L.C., Osman-Elasha, B., DeClerck, F., Ayuke, F.O., Gebremikael, M.B., Barau, A. S., Denboba, M.A., Diallo, M., Molua, E.L., Ngenda, G., Pereira, L., Rahlao, S.J., Kalemba, M.M., Ojino, J.A., Belhabib, D., Sitas, N., Strauß, L., Ward, C., 2018. Options for Governance and Decision-Making Across Scales and Sectors. In: Archer, E., Dziba, L., Mulongoy, K.J., Maoela, M.A., Walters, M. (Eds.), The IPBES regional assessment report on biodiversity and ecosystem services for Africa. Secretariat of the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany, pp. 353–414.

Thomson, J., Feeny, D., Oakerson, R.J., 1992. Institutional Dynamics: The Evolution and Dissolution of Common-Property Resource Management, in: Bromley, D. (Ed.), Making the Commons Work: Theory, Practice and Policy. Institute for Contemporary Studies (ICS) Press, San Francisco.

Trana, T.T.H., Zeller, M., Suhardiman, D., 2016. Payments for ecosystem services in Hoa Binh province, Vietnam: An institutional analysis. Ecosyst. Serv. 22, 83–93 https://doi.org/10.1016/j.ecoser.2016.10.001.

Tucker, Catherine M., 2010. Private goods and common property: pottery production in a Honduran Lenca community. Hum. Org. 69 (1), 43–53. https://doi.org/10.17730/humo.69.1.8581463255p28526.

Ulgiati, S., Zucaro, A., Franzese, P.P., 2011. Shared wealth or nobody's land? The worth of natural capital and ecosystem services. Ecol. Econ. 70, 778–787 https://doi.org/10.1016/j.ecolecon.2010.11.015.

Unnikrishnan, H., Nagendra, H., 2015. Privatizing the commons: impact on ecosystem services in Bangalore's lakes. Urban Ecosyst. 18, 613–632 https://doi.org/10.1007/s11252-014-0401-0.

Vandermeer, J.H., Perfecto, I., 2013. Breakfast of biodiversity the political ecology of rain forest destruction. Food First Books, Oakland, CA.

Varughese, G., 2000. Population and Forest Dynamics in the Hills of Nepal: Institutional Remedies by Rural Communities, in: Gibson, C., McKean, M.A., Ostrom, E. (Eds.), People and Forests: Communities, Institutions, and Governance. MIT Press, Cambridge, MA, pp. 193–226.

Wang, Y., Zhang, M., Kang, J., 2019. How does context affect self-governance? Examining Ostrom's design principles in China. Int. J. Commons 13 (1), 660–704 http://doi.org/10.18352/ijc.916.

Ward, J.H., 1963. Hierarchical grouping to optimize an objective function. J. Am. Stat. Assoc. 5, 236–244.

Winkler, K.J., Rodrigues, Garcia, Albrecht, J., Crockett, E.T.H, E., 2021. Governance of ecosystem services: a review of empirical literature. Ecosyst. People 17, 306–319 https://doi.org/10.1080/26395916.2021.1938235.

Young, O.R., 2003. Environmental governance: the role of institutions in causing and confronting environmental problems. Int. Environ. Agreem. Polit. Law Econ. 3, 377–393 https://doi.org/10.1023/b:inea.0000005802.86439.39.