LETTER

The impacts of REDD+ on the social-ecological resilience of community forests

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Abstract

Reducing emissions from deforestation and forest degradation (REDD+) has emerged as an important and cost-effective climate change mitigation strategy internationally. In many localities around the world, REDD+ and related interventions have been superimposed on, and overlap with, existing decentralized institutional arrangements such as community forests. These interventions often modify local institutions through new rules and practices that comply with mostly carbon-related objectives, prompting questions about the compatibility of a top-down mechanism such as REDD+ with the decentralized approaches of community forestry. Thus, we asked: are REDD+ interventions in community forests enhancing or detracting from communities’ abilities to practice adaptive management and governance—key desired components of local social-ecological resilience and the ability of communities to respond to disturbance and global change? We conducted a systematic review of studies examining REDD+ interventions in community forests. We extracted data on 59 case studies reported on in 43 articles, stemming from 14 countries, with two thirds of the cases located in two countries alone. Our meta-analysis found that REDD+ has had mixed impacts on communities’ social-ecological resilience. Increases in network ties, connectivity across scales, and increased participation in decision making are indicators of enhanced potential for local adaptability. However, we also see that, through restrictions on local forest practices, rigidity in rules, and communities’ natural capital being locked into carbon contracts, REDD+ has limited communities’ ability to manage for uncertainty. While not representative of all existing REDD+ projects, our results suggest important implications for REDD+ policymakers and forest-reliant communities engaging in REDD+. Reconciling REDD+ goals with the need for forest communities to retain adaptive capacity will be a challenge moving forward, particularly if REDD+ compromises the ability of forest-reliant communities to respond to unexpected shocks or their ability to adapt to changing environmental or economic conditions.

1. Introduction

Reducing emissions from deforestation and forest degradation (REDD+) has emerged as an important and cost-effective climate change mitigation strategy internationally (Recio 2014). There has also been considerable interest in the co-benefits that REDD+ programmes can deliver: improved livelihoods, biodiversity conservation, and socio-economic development of rural areas through monetization of standing forests (UN-REDD Programme 2009). REDD+ is currently being implemented in more than 50 countries, with myriad interventions being piloted by multiple actors, from national to local governments, NGOs, and development agencies (Wong et al 2019). While initially envisioned as a market-based instrument for carbon emissions reductions, where landowners could sell REDD+ credits on a carbon market for avoiding deforestation or enhancing carbon stocks, REDD+ has evolved to encompass various funding mechanisms promoting integrated conservation and development projects (Angelsen et al 2017). Several subnational governments have additionally developed jurisdictional approaches that...
combine carbon market-related mechanisms into broader low-emission development strategies and regulations (Wunder et al 2020). Although only about one third of REDD+ projects have sold verified carbon credits (Duchelle et al 2018), it has been estimated that USD 323 million annually has been directed to REDD+ financing (Martius et al 2018).

Shortly following the conceptualization of REDD+, there was a strong recognition that community forest management (CFM) and other forms of decentralized and localized forest governance can play an important role in REDD+ implementation and success (Agrawal and Angelsen 2009, Cronkleton et al 2011, Tomaselli and Hajjar 2011, Balooni and Lund 2014). Community forests are a promising path for retaining and enhancing forest carbon stocks (Chhatre and Agrawal 2009, Walker et al 2014), and recent calls have been made for titling Indigenous lands as a strategy to conserve tropical forests and mitigate climate change (Fa et al 2020). Community-based carbon monitoring and management can also be cheaper than professional surveys (Danielsen et al 2011, Torres and Skutsch 2015), and enhance participation and transparency in the process (Agrawal and Angelsen 2009). As such, REDD+ mechanisms are superimposed on, and overlap with, existing decentralized institutional arrangements in many localities around the world; in other locations, implementers seek to create new community forests as part of national REDD+ strategies (Hajjar and Oldekop 2018).

REDD+ interventions in community forests often modify local institutions through new rules and practices that comply with mostly carbon-related objectives (Poudel et al 2014, Bayrak and Marafa 2016, Duchelle et al 2018). Early critique of REDD+ included worries that REDD+ could reverse the progress made around the world in devolving rights to Indigenous and local communities, as central governments and technocrats seek to regain control of forest governance by limiting local uses and a community’s ability to set their own objectives (Phelps et al 2010, Chomba et al 2016, Khatri et al 2018). Further concerns have been raised around the potential for the commodification of forest carbon to detrimentally impact local, communal forest governance (Osborne 2015, Martin et al 2019). Yet, decentralized decision making and management of natural resources is a central tenet of adaptive management, where the cycle of local monitoring, decision making, and action better allows communities to adapt to changing social, economic, and ecological conditions (Folke 2004, Folke et al 2005, Kinzig et al 2006, Fischer et al 2016). Adaptive capacity is a component of social-ecological resilience that captures the ability of a system to learn, remain flexible, innovate, and respond to changes (Walker et al 2004, Berkes 2017). Should REDD+ limit communities’ adaptive capacity through substantial modifications of rules and resources, communities may face difficulties in responding to biophysical and social environments characterized by change, unpredictability, and uncertainty (Magis 2010).

Thus, questions remain about the compatibility of a top-down mechanism such as REDD+ with the decentralized approaches of CFM. Given that REDD+ will likely modify existing local institutions to comply with objectives focused on carbon emissions reductions, it is important to examine the impacts that REDD+ can have on communities’ abilities to practice adaptive management and governance. That is not to say that the decentralized approaches of CFM are not without their critique. Several studies have examined the governance challenges that community forests face in many locations, including limitations on communities’ natural resources rights (Hajjar et al 2020), unequal distributions of benefits and elite capture (Persha and Andersson 2014), and difficulties in long-term viability of CFM projects and dependence on outside sources (Humphries et al 2012). The question is, does REDD+ ameliorate some of these challenges, or does it further detract from forest communities’ social-ecological resilience?

We conducted a systematic review and meta-analysis of peer-reviewed studies that describe current or previous REDD+ interventions in community forests. Our global meta-analysis of 59 cases found that there are several key areas where REDD+ is further limiting communities’ abilities to practice adaptive management and retain resilience, whereas some changes caused by REDD+ can aid communities’ adaptive capacity. Given the global scale and scope of REDD+ implementation, this analysis highlights reforms that should be considered by REDD+ implementers to ensure that changes to local systems are not diminishing their resilience.

2. Methods

2.1. Search strategy and inclusion criteria

We performed a series of Boolean searches in four languages and three publication databases in May 2018 (see supplementary information (available online at stacks.iop.org/ERL/16/024001/mmedia) for keywords used). Each abstract and article was reviewed by at least two people using the following inclusion criteria: articles had to (a) be published peer-reviewed research; (b) present empirical research (excluding reviews); and (c) focus on specific REDD+ interventions which are currently taking place or have taken place in a forested area with some form of community management. REDD+ was broadly defined to include project-based or jurisdictional approaches, identified by the study’s authors as a REDD+ initiative, both where verified carbon emissions credits were being sold and where they were not. These criteria excluded future-focused articles, where
authors conjectured about what REDD+ could or would do in a locality; our analysis focuses on what REDD+ has done or is currently doing. Covidence, a software for evidence synthesis by groups, was used to organize and exclude papers among the team.

2.2. Data extraction and analysis
We developed an analytical framework from the social-ecological systems concept of resilience (examining a system for characteristics related to diversity, openness, tightness of feedbacks, system reserves, and modularity (Walker et al 2010)—see table 1 for definitions), combined with the community capitals framework used in vulnerability assessments (Emery and Flora 2006, Magis 2010—table 2). From these theories, we developed indicators and a protocol to extract information from the studies included in our review to document the impacts that REDD+ has had on communities’ social-ecological resilience; indicators covered community governance structures, natural and social capital, and livelihoods (figure 1; table S1). While almost none of the reviewed articles used the language of resilience, we connected changes described in the articles with characteristics of resilient systems (see supplementary information for details on development of the theoretical framework and how it has been applied to the context of community forestry and REDD+).

We extracted qualitative data on 22 indicators linked to changes in resilience of social-ecological systems (defined in table S2). We noted whether the article described a change in the chosen indicators (increased, little/no change, decrease, or mixed) after REDD+ had been implemented. For publications presenting multiple cases of CFM, we extracted data separately for each case where possible. To reduce coding bias and enhance rigor in data extraction, each article was assigned to at least two coders (authors) who first extracted data independently, then conferred with each other to justify their coding and reach consensus on the data extracted from each article and case. We use this information to describe how REDD+ has affected community resilience and adaptive capacity in community-managed forests.

Lastly, given concerns about the potential negative and marginalizing impacts of forest carbon commodification (Ribot and Larson 2012, Osborne 2015, Martin et al 2019), we sought to examine whether REDD+ projects that are selling carbon credits were impacting community resilience differently than projects that were not selling carbon credits. For each case in our sample, we searched for project names, project proponents, and keywords in two online databases: the Verra Registry (which lists projects that have received Verified Carbon Standard (VCS) or Climate, Community and Biodiversity Standards (CCB) certifications), and the International Database on REDD+ Projects and Programs (ID-RECCO). Cases that were listed as selling verified carbon credits with any certification, or cases that were listed as being in the process of verification (a sometimes multi-year process), were considered ‘certified.’ These cases were then compared to the remaining, non-certified cases to ascertain whether any trends in impacts could be related to the certification status (and thus key financing and implementation mechanism) of the REDD+ project.

3. Results
From our initial pool of 495 articles, we extracted data from 43 articles (figure S1 shows inclusion results at each filtering stage of the systematic review). From these papers, we identified 59 unique cases of implemented REDD+ projects superimposed on community forests. These cases stemmed from 14 countries, although Tanzania and Nepal accounted for 66% of cases. Sixty-eight percent of cases had some form of CFM prior to REDD+ implementation (44% formal arrangements, 29% informal, 20% unclear, 2% mixed), with 15% of the 59 cases seeing the creation of new CFM institutions with REDD+ (17% of cases were unclear as to whether CFM existed previously). Almost half of the cases (42% of 59 cases) came from studies published before 2017, with the last year of data collection for 45% of 47 reporting cases occurring in 2013 or earlier (figure S2), indicating that much of the reported cases stemmed from early REDD+ projects. Overall, 11 of the 59 cases had been certified (1 Plan Vivo certification and 10 VCS/CCB certified), and 3 were in the process of getting certified at the time of research. Twelve projects had been described in the studies as intending to seek certification, but as several years had passed since the project had been implemented and they had yet to appear in any carbon registries as certified or seeking certification, these were considered as non-certified. Thirty-three additional cases did not mention certification in the study and were not located in the carbon registries we searched.

The following results are a summary of the reported changes in resilience indicators. Notably, there were no statistically significant relationships between certification status and the resilience-related outcomes we assessed (see supplementary information)—the positive and negative changes we report on occurred independently of certification.

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Given that two thirds of our cases came from two countries, we examined whether those two countries may have been driving the patterns in the results. Except for two indicators (local participation in decision-making and flexibility to change rules), there were no statistically significant relationships (Fischer’s Exact Test \( p > 0.05 \)) between country context (whether a case was located in Tanzania, Nepal or elsewhere) and resilience-related outcomes, indicating that location and outcomes were independent for almost all indicators. Our results thus broadly held across cases regardless of whether they were located in Nepal, Tanzania or elsewhere.
Table 1. Attributes of general resilience (adapted from Walker et al 2010).

| Attribute of resilience | Definition                                                                 | Effect on resilience                              |
|-------------------------|---------------------------------------------------------------------------|---------------------------------------------------|
| Diversity               | The presence of many different components in a system, such as biodiversity or diversity in stakeholders | Little or no diversity may make the system more vulnerable to a loss of function |
| Openness                | The connection and interaction of the system with other systems           | Extremely open or extremely closed systems can reduce resilience |
| Tightness of feedbacks  | The speed at which a system recognizes and responds to a disturbance     | Tighter feedback loops lead to more resilience    |
| System reserves         | The ecological, social, and economic resources a system can draw on, such as wood, knowledge, and money | More reserves generally contribute to greater resilience |
| Modularity              | The degree to which the different components of a system are connected; modularity entails loosely connected components of a system that tightly interact | A modular system leads to more resilience, while a fully connected system may more rapidly transmit shocks |

Table 2. Forms of community capital (adapted from Emery and Flora 2006, Magis 2010).

| Type of capital | Definition                                                                 |
|----------------|---------------------------------------------------------------------------|
| Natural        | The natural resources, ecosystem services, and features connected to a community's location, such as water, weather, and geography |
| Human          | The innate and acquired attributes of the individuals in a community, including health, skills, and knowledge |
| Cultural       | Community-based values, traditions, and ways of knowing                   |
| Financial      | Monetary resources available to the community for capacity-building and development |
| Built          | A community's physical assets and infrastructure, such as roads, buildings, and equipment |
| Political      | A community's access to power and ability to impact the rules and regulations that affect it |
| Social         | The connections between people within a community that allow them to collectively take action; includes cohesion between community members (bonding), the ties between them (bridging), and their links to others with resources (linking) |

status. While certified and non-certified cases showed mostly similar patterns in outcomes, we highlight some differences here and show descriptive results differentiated by certification status in the supplementary information (figures S3–S5).

3.1. Governance
The majority of cases reported increased local participation in decision making, management, and monitoring (figure 2), although some still excluded those traditionally marginalized (Nathan and Pasgaard 2017). Twenty cases reported that new decision-making bodies had been created at the local level and 15 stated that multiple decision-making bodies had been created at various levels. The vast majority of cases reporting on procedural requirements described increased procedural requirements (32 of 34 reporting cases), especially restrictions on forest uses such as harvesting and grazing (Poudel et al 2014, Peras et al 2016, Isyaku et al 2017) or closures in restoration areas for extended periods (Poffenberger 2015). A number of cases also saw decreased flexibility to change local forest use and management rules (16 of 25 cases), such as those regulating local benefit-sharing mechanisms (Nantongo 2017) or those that ‘locked in’ forest resources for 30 years through REDD+ arrangements (Khatun et al 2017). The increase in procedural requirements was consistent across both certified and non-certified cases, but increases in governance transparency were proportionally more often reported in certified cases (figure S3), likely reflecting consultation requirements of the certification process.

3.2. Social and natural capital
Increases in social and natural capital indicators were recorded in most studies reporting on these indicators (figure 3). Increases in natural capital (71% of 38 reporting cases) were mostly due to reforestation and afforestation efforts brought by REDD+ interventions (Shrestha et al 2014, Saito-Jensen et al 2015, Khatri et al 2018), increased efforts to reduce illegal logging (Patel et al 2013, Larson et al 2018), or reduced forest losses to fire (Khatun et al 2017). However, in many cases, the increases in forest resources were accompanied by restrictions

Figure 1. Analytical framework, combining attributes of general resilience and forms of community capital, used to inform indicators assessing resilience and adaptive capacity in community forests following REDD+ implementation. See SI for details on the development of the framework, definitions of indicators, and how indicators link back to various aspects of resilience.

| Natural Capital | Governance | Social capital and knowledge | Livelihoods |
|-----------------|------------|-----------------------------|-------------|
| System Reserves | ▪ Natural capital | -- | ▪ Social networks/capital, Knowledge and human capital |
| ▪ Monetary benefits, Opportunity costs, Community development and physical capital, Distributional aspects |
| Tightness of feedbacks | ▪ Local participation in decision making | ▪ Local management, monitoring, Local decision-making bodies, Procedural requirements, Reaction to disturbance/change | ▪ Social connections, Capacity to self-organize, -- |
| Modularity | ▪ Multiple decision-making bodies, New, decentralized bodies | ▪ Dependence on outside bodies, -- |
| Diversity | ▪ Species/landscape diversity | ▪ Stakeholder diversity | ▪ Livelihood diversity |
| Openness | ▪ Flexibility to change rules/actions, Governance transparency | ▪ Outside connections, -- |

Forms of community capital
Natural Cultural Human Financial Social Built
Political

Figure 2. Changes in governance indicators following REDD+ implementation.

| recognition/reaction to a man-made/natural disturbance | transparency in governance | multiple decision-making bodies | flexibility to change rules/actions | creation of new decentralized committees/institutions | diversity of stakeholders | procedural requirements, including access restrictions | local participation in management/monitoring | local participation in decision making |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------------|----------------------------------|--------------------------|-----------------------------------|----------------------------------|---------------------------------|
| ![Graph](image-url) | ![Graph](image-url) | ![Graph](image-url) | ![Graph](image-url) | ![Graph](image-url) | ![Graph](image-url) | ![Graph](image-url) | ![Graph](image-url) | ![Graph](image-url) |

on their use, putting in question community members’ abilities to use this ‘capital’ for productive purposes (Bayrak and Marafa 2017, Scheba and Scheba 2017). In ‘mixed’ cases, communities lost agricultural lands or grazing rights (and thus livelihood) to the creation of a community forest or REDD+ area (Poudela 2014, Poudel et al 2015, Scheba and Scheba 2017), trading increases in forest resources for decreases in food production resources. Awareness raising and training activities contributed to knowledge sharing and increased human capital in some cases (Atela et al 2015, Bayrak and Marafa 2017, Nantongo 2017). However, changes to social capital and network connections were less consistently positive (50% and 36% of reporting cases described decreases or mixed results in these categories, respectively). In these cases, conflicts arose as REDD+ interventions exacerbated inequalities in power and economic status within communities (Poudela 2014, Scheba and Rakotonarivo 2016, Vatn et al 2017). Certified cases in particular showed proportionally more decreases in community social connections.
than non-certified cases (figure S4): cases in Tanzania, Cambodia, and Papua New Guinea highlighted land disputes and conflicts over required rules related to maximizing carbon benefits to different community groups, as well as reports of favouritism among management committees leading to decreases in trust (Leggett and Lovell 2012, Scheba and Rakotonarivo 2016, Nathan and Pasgaard 2017). Several non-certified cases reported that REDD+ development projects united neighbouring communities and increased social cohesion (multiple cases in Corbera et al 2020). Finally, while 13 of 17 reporting cases saw increased connections to outside bodies and resources, 6 of these cases reported increases in dependency on these outside institutions (exemplified in Blomley et al 2017).

3.3. Livelihood indicators
Fifty-seven percent of the 23 reporting cases showed increases in community physical capital and development projects (figure 4), such as investing in fish ponds (Khatri et al 2018), seed grants for pro-poor activities (Maraseni et al 2014), or purchasing cookstoves (Poffenberger 2015). Thirty-five percent (of 43 reporting cases) described increases in monetary benefits following REDD+ implementation, while 51% of the 43 reporting cases saw decreases or mixed results. In most of the mixed cases, some community members saw payments or increased incomes from carbon payments or other project activities, but others (often the more marginalized) saw decreased incomes because of the opportunity costs associated with lost revenues from forest uses that were outlawed with REDD+; this exacerbated existing community inequities (74% of 27 cases saw increases in opportunity costs because of REDD+ related conservation; e.g. Maraseni et al 2014, Nantongo 2017, Nathan and Pasgaard 2017, Khatri et al 2018). Seven of 10 certified cases reported ‘mixed’ results for monetary benefits, with 2 cases reporting increases, while 13 of 33 non-certified cases reported ‘mixed’ results and 13 reported increases (figure S5). Relative to non-certified cases, certified cases also reported a disproportionate number of cases with mixed impacts on community equity in adaptation and resilience (figure S5).

3.4. Implications for forest community resilience
Several studies have examined the performance of REDD+ as related to emissions reductions, non-carbon co-benefits, benefit sharing, and community engagement (Bos et al 2017, Duchelle et al 2018, Arts et al 2019, Wong et al 2019). Yet, few studies have explicitly examined REDD+ impacts on forest community resilience (Bayrak and Marafa 2017). Our analysis shows that REDD+ will likely have mixed impacts on communities’ resilience, for both those REDD+ projects that have been certified to sell carbon credits and projects that have not. Here we focus on five key characteristics of resilient systems (Walker and Salt 2006).

3.4.1. Diversity
A lack of diversity may make systems more vulnerable to unpredictable disturbances, whereas a diverse system has more variations of individuals, resources, or opportunities available to respond to or absorb an...
unforeseen shock (Walker and Salt 2006). Our meta-analysis finds that while many projects are including more diverse stakeholders in local decision making and forest management, decreases in livelihood diversity have occurred as many forest-based activities are outlawed by REDD+. This limits individuals’ abilities to respond to unexpected shocks, should their livelihoods be threatened by environmental or economic changes.

3.4.2. Openness
Openness can enhance a system’s resilience by increasing the ability of new information to flow through a system and being open to making changes to the system (Walker and Salt 2006). In many cases, we saw expanded social networks, where communities engaged with outside groups, enhancing their openness to new information and resources. This can increase social capital and exchange of knowledge (Folke et al. 2005, Kinzig et al. 2006). At the same time, we see an increase in externally imposed rules regarding forest management, and inflexibility in changing such rules, with contracts committing forest users to certain practices. This inflexibility may prevent communities from modifying practices should a need arise to adapt to new conditions.

3.4.3. Tightness of feedbacks
Increased local involvement in decision making, monitoring, and management, which many certified and non-certified cases reported, indicates an increased ability of communities to detect and respond to changes, as they evaluate whether desired outcomes are being achieved—a tightening of the feedback loops needed to rapidly respond to changes in the system (Walker and Salt 2006). This larger role for local decision making has come about from REDD+’s increased efforts to clarify land and forest tenure (Duchelle et al. 2018), which is key to ensuring effectiveness, efficiency, and equity in REDD+ implementation (Barbier and Tesfaw 2012; although see Resosudarmo et al. 2014). However, increased restrictions on access and use, and the above-mentioned inflexibility in rule making, also indicate that the adaptive management cycle (Rist et al. 2013) may be cut short: local monitoring can speed up observation time, but inability to change practices may limit adaptation options. Halting the local rule-making process can have negative impacts on both carbon storage and livelihood outcomes (Chhatre and Agrawal 2009).

3.4.4. System reserves
With increases in social and natural capital, and in some cases financial and built capital, REDD+ seems to be increasing system reserves that can be drawn upon in the face of adversity, although increases in social conflicts may detract from social reserves. We did not specifically address ecological resilience, but increases in forest area and species diversity reported in many studies indicate a potential trend towards healthier ecosystems. However, as demonstrated in many cases, it is questionable how accessible some of these reserves will be when they are needed as assets for production or development. In particular, we see that natural capital, while increasing, is often less accessible to communities following REDD+ implementation, and capital that is more readily convertible to productive assets (agricultural land and livestock) has decreased in many cases. This resonates with a recent meta-analysis that found CFM interventions, with or without REDD+, tend to have more positive forest-related outcomes than positive livelihood outcomes (Hajjar et al. 2020). Additional rules for forest protection and restoration might be positive for short-term conservation, but leave in question long-term sustainability when livelihoods are
not carefully integrated with conservation goals. This short-term view may counteract the gains in local decision making and stakeholder participation.

3.4.5. Modularity
In this context, we look at modularity as how connected or disconnected, and centralized or decentralized, the broader system is, with more modular systems being more resilient (Walker and Salt 2006). We found that, following REDD+ implementation, modularity of the broader system seems to increase, with multiple decision-making bodies at different scales being created to implement national REDD+ plans. Yet, not many cases saw new or strengthened decision-making bodies at the local level, and some cases were relying on outside bodies for resources (not unusual for CFM—see Hajjar et al 2011, Humphries et al 2012). This increased connectedness, centralization, and reliance on others theoretically indicates that if there were to be a shock in the system—for example, if an NGO that played a key role in setting up local REDD+ projects were to leave the network—the shock would have a more severe impact on the community than if they were part of a more modular system.

4. Conclusion
We explore how REDD+ may be contributing to, or detracting from, the resilience of community forestry. While we note that CFM interventions alone have resulted in many of the positive and negative effects on community social-ecological resilience that we report here, we found that REDD+ is bolstering some aspects of adaptive capacity while further limiting others. Local adaptability may be enhanced by increasing network ties and connectivity across scales that allow for new resources and information to reach communities, as well as by increasing participatory decision making. However, we also see that REDD+ has further limited communities’ ability to manage for uncertainty through restrictions on local forest practices, rigidity in rules, and ‘locking-in’ of communities’ natural capital through carbon contracts. These findings seem to cut across both certified and non-certified REDD+ projects, although the effect of carbon credit certification merits further investigation given the small number of certified cases in our sample.

As with any meta-analysis, we acknowledge limitations and biases associated with the use of secondary data that in many cases is subject to individual authors’ interpretations and our own interpretation of how the data related to resilience theory, as well as the necessary simplification of information presented in articles to be able to standardize data collection across papers. We further acknowledge that the geographical spread of the cases reviewed in this systematic review of the academic literature is not representative of the country distribution of REDD+ projects globally. This skewed geographical focus of REDD+ in the academic literature is reported elsewhere (Duchelle et al 2018), so we suggest that future research additionally examine the grey literature on REDD+ and CFM for information on social-ecological resilience. Many of the cases in this review were reporting results from early REDD+ projects and preparation phases, so they may not be representative of ongoing and evolving initiatives. Yet these exploratory results bring out important implications for REDD+ policymakers and forest-reliant communities engaging in REDD+, particularly during those preparatory, planning, and demonstration phases.

Reconciling REDD+ goals and policies with the need for forest communities to retain adaptive capacity will be a challenge moving forward. REDD+ is likely just one of many changes to come in these social-ecological systems—the climate will continue to change, as will social, economic and policy landscapes. Forest communities cannot afford to lose their ability to respond to what will come next. As such, interventions such as REDD+ should consider unintended consequences that can limit long-term resilience. While safeguards such as biodiversity conservation and free, prior and informed consent are already part of many REDD+ strategies (UNFCCC 2011), efforts need to be made to include additional adaptability safeguards. Here we point to key indicators, such as building or retaining local decision making, rule-making flexibility, systems reserves, and livelihood diversity, that are potentially being undermined by REDD+.

A resilience perspective recommends a variety of approaches regarding how a top-down mechanism such as REDD+ can be implemented in a decentralized CFM context so as not to further limit a community’s ability to respond effectively to change. A shift towards adaptive governance of REDD+ projects is needed, where representative stakeholder groups are involved in community resource management embedded in strong social networks, and where space is created for opportunities to self-organize while nurturing reserves (Folke et al 2005). Data beyond carbon monitoring (the focus of current monitoring efforts) can be used to determine thresholds in social-ecological systems (Walker and Salt 2006). Adaptive management of REDD+ requires enabling legislation, funds for responding to change, and information sharing that allows for collaborative learning among actors at different scales (Kinzig et al 2006). Many of these, and other, aspects of resilience thinking can be taken into account in new and existing REDD+ projects, and would allow for forest communities to retain their adaptive capacity in the face of change. We advocate the use of assessments similar to the one conducted here to examine unintended consequences of other climate-related
or conservation interventions on community resilience.

Data availability statement

The data that support the findings of this study are available upon request from the authors.

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References

Agrawal A and Angelsen A 2009 Using community forest management to achieve REDD+ goals Realising REDD+: National Strategy and Policy Options ed A Angelsen (Bogor: CIFOR)
Angelsen A, Brockhaus M, Duchelle A E, Larson A, Martius C, Sunderlin W D, Verchot L V, Wong G and Wunder S 2017 Learning from REDD+: a response to Fletcher et al Conserv. Biol. 31 718–20
Arts B, Ingram V and Brockhaus M 2019 The performance of REDD+: from global governance to local practices Forests 10 837
Atela J O, Minang P A, Quinn C H and Duguma L A 2015 Implementing REDD+ at the local level: assessing the key enablers for credible mitigation and sustainable livelihood outcomes J. Environ. Manage. 157 238–49
Balooni K and Land J F 2014 Forest rights: the hard currency of REDD+ Conserv. Lett. 7 278–84
Barbier E B and Tesfaw A T 2012 Can REDD+ save the forest? The role of payments and tenure Forests 3 881–95
Bayrak M M and Marafa L M 2016 Ten years of REDD+: a critical review of the impact of REDD+ on forest-dependent communities Sustainability 8 620
Bayrak M M and Marafa L M 2017 Livelihood implications and perceptions of large scale investment in natural resources for conservation and carbon sequestration: empirical evidence from REDD+ plus in Vietnam Sustainability 9 10
Berkes F 2017 Environmental governance for the anthropocene? Social-ecological systems, resilience, and collaborative learning Sustainability 9 7
Blomley T, Edwards K, Kingazi S, Lukumbuzya K, Mäkelä M and Vesa L 2017 When community forestry meets REDD+: has REDD+ helped address implementation barriers to participatory forest management in Tanzania? J. East. Afr. Stud. 11 549–70
Bos A B et al 2017 Comparing methods for assessing the effectiveness of subnational REDD plus initiatives Environ. Res. Lett. 12 7
Chhatre A and Agrawal A 2009 Trade-offs and synergies between carbon storage and livelihood benefits from forest commons Proc. Natl Acad. Sci. 106 17676–70
Chomba S, Kariuki J, Lund J F and Sinclair F 2016 Roots of inequity: how the implementation of REDD+ reinforces past injustices Land Use Policy 50 202–13
Corbera E, Martín A, Springlete-Baginski O and Villaseñor A 2020 Sowing the seeds of sustainable rural livelihoods? An assessment of Participatory forest management through REDD+ in Tanzania Land Use Policy 97 102962
Cronkleton P, Bray D B and Medina G 2011 Community forest management and the emergence of multi-scale governance institutions: lessons for REDD+ development from Mexico, Brazil and Bolivia Forests 2 451–73
Dahlin-Fjäll P et al 2011 At the heart of REDD+: a role for local people in monitoring forests? Conserv. Lett. 4 158–67
Duchelle A E, Simonet G, Sunderlin W D and Wunder S 2018 What is REDD+: achieving on the ground? Curr. Opin. Environ. Sustain. 32 134–40
Emery M and Flora C 2006 Spiraling-up: mapping community transformation with community capitals framework Community Dev. 37 19–35
Fa J E et al 2020 Importance of indigenous peoples’ lands for the conservation of Intact Forest Landscapes Front. Ecol. Environ. 18 1–6
Fischer A P, Vance-Borland K, Kounst J, Koury C G, Cruz E and Charney S 2016 A network approach to assessing social capacity for landscape planning: the case of fire-prone forests in Oregon, USA Landsc. Urban Plan. 147 18–27
Folke C 2004 Traditional knowledge in social-ecological systems Ecol. Soc. 9 7
Folke C, Hahn T, Olsson P and Norberg J 2005 Adaptive governance of social-ecological systems Annu. Rev. Environ. Resour. 30 441–73
Hajjar R, McGrath D G, Kozak R A and Innes J L 2011 Framing community forestry challenges with a broader lens: case studies from the Brazilian Amazon J. Environ. Manage. 92 2159–69
Hajjar R and Olden J K 2018 Research frontiers in community forest management Curr. Opin. Environ. Sustain. 32 119–35
Hajjar R, Olden J K, Cronkleton P, Newton P, Russell A J M and Zhou W 2020 A global analysis of the social and environmental outcomes of community forests Nat. Sustain. 1–9
Humphries S, Holmes T P, Kainer K, Koury C G, Cruz E and de Miranda Rocha R 2012 Are community-based forest enterprises in the tropics financially viable? Case studies from the Brazilian Amazon Econ. Ecol. 77 62–73
Isyaku U, Arhin A A and Asiyani P A 2017 Framing justice in REDD+ governance: centring transparency, equity and legitimacy in readiness implementation in West Africa Environ. Conserv. 44 212–20
Khatri D B, Marquardt K, Pain A and Olja H 2018 Shifting regimes of management and uses of forests: what might REDD+ implementation mean for community forestry? Evidence from Nepal For. Policy Econ. 92 1–10
Khattun K, Corbera E and Ball S 2017 Fire is REDD plus: offsetting carbon through early burning activities in south-eastern Tanzania Oryx 51 43–52
Kinzig A P, Ryan P, Etienne M, Allison H, Elmquist T and Walter B H 2006 Resilience and regime shifts: assessing cascading effects Ecol. Soc. 11 20
Larson A M, Solís D, Duchelle A E, Atmadja S, Resosudarmo I A P, Dokken T and Komalasari M 2018 Gender lessons for climate initiatives: A comparative study of REDD+ impacts on subjective wellbeing World Dev. 108 86–102
Leggett M and Lovell H 2012 Community perceptions of REDD+: a case study from Papua New Guinea Clim. Policy 12 115–34
Magis K 2010 Community resilience: an indicator of social sustainability Soc. Nat. Resour. 23 401–16
Maraseni T N, Neupane P R, Lopez-Casero E and Cadman T 2014 An assessment of the impacts of the REDD plus pilot project on community forests user groups (CFUGs) and their community forests in Nepal J. Environ. Manage. 136 37–46
Martin A, Kebede B, Gross-Camp N, He J, Inturias M and Rodriguez I 2019 Fair ways to share benefits from REDD+ governance: centring transparency, equity and legitimacy in readiness implementation in West Africa Environ. Conserv. 44 212–20
Martius C, Atmadja S, Siemons A, Boettcher H 2018 Assessing REDD+ Readiness to Maximize Climate Finance Impact (Bogor: CIFOR)
Nantongo M G 2017 Legitimacy of local REDD+ processes—a comparative analysis of pilot projects in Brazil and Tanzania *Environ. Sci. Policy* 78 81–88
Nathan I and Pasgaard M 2017 Is REDD+ effective, efficient, and equitable? Learning from a REDD+ project in Northern Cambodia *Geoforum* 83 26–38
Osborne T 2015 Tradeoffs in carbon commodification: a political ecology of common property forest governance *Geoforum* 67 64–77
Patel T, Dhiuaillaq A, Gritten D, Yassi Y, De Bruyn T, Paudel N S, Luintel H, Khatri D B, Silori C and Suzuki R 2013 Predicting future conflict under REDD+ implementation *Forests* 4 343–63
Peras R J, Pulhin J, Inoue M, Mohammed A J, Harada K and Sasaoa M 2016 The sustainable livelihood challenge of REDD+ implementation in the Philippines *Environ. Nat. Resour. Res.* 6 91–105
Persha L and Andersson K 2014 Elite capture risk and mitigation in decentralized forest governance regimes *Glob. Environ. Change* 24 265–76
Phelps J, Webb E L and Agrawal A 2010 Does REDD+ threaten to decentralize forest governance? *Science* 328 312–3
Poffenberger M 2015 Restoring and conserving Khari forests: a community-based REDD+ strategy from northeast India *Forests* 6 4477–94
Poudel M, Thwaites R, Race D and Dahal G R 2014 REDD+ and community forestry: implications for local communities and forest management—a case study from Nepal *Int. For. Rev.* 16 39–54
Poudel M, Thwaites R, Race D and Dahal G R 2015 Social equity and livelihood implications of REDD plus in rural communities—a case study from Nepal *Int. J. Commons* 9 177–208
Poudela D P 2014 REDD+ comes with money, not with development: an analysis of post-pilot project scenarios from the community forestry of Nepal Himalaya *Int. J. Sustain. Dev. World Ecol.* 21 552–62
Recio M E 2014 The Warsaw framework and the future of REDD+ *Yearb. Int. Environ. Law* 24 37–69
Resosudarmo I A P, Atmadja S, Ekaputri A D, Intarini D Y, Indriatmoko Y and Astri P 2014 Does tenure security lead to REDD+ project effectiveness? Reflections from five emerging sites in Indonesia *World Dev.* 55 68–83
Ribot J and Larson A M 2012 Reducing REDD risks: affirmative policy on an uneven playing field *Int. J. Commons* 6 233–54
Rist L, Felton A, Samuelsdon L, Sandström C and Rossval O 2013 A new paradigm for adaptive management *Ecol. Soc.* 18 65
Saito–Jensen M, Sikor T, Kurniawan Y, Ellenberg M, Setyawati E P and Kustini S J 2015 Policy options for effective REDD+ implementation in Indonesia: the significance of forest tenure reform *Int. For. Rev.* 17 86–97
Scheba A and Rakotobiarivo O S 2016 Territorialising REDD+: conflicts over market-based forest conservation in Lindi, Tanzania *Land Use Policy* 57 625–37
Scheba A and Scheba S 2017 REDD plus as ‘inclusive’ neoliberal conservation: the case of Lindi, Tanzania *J. East. Afr. Stud.* 11 526–48
Shrestha S, Karky B S and Karki S 2014 Case study report: REDD+ pilot project in community forests in three watersheds of Nepal *Forests* 5 2425–39
Tomaselli M F and Hajjar R 2011 Promoting community forestry enterprises in national REDD+ strategies: a business approach *Forests* 2 283–300
Torres A B and Skutsch M 2015 Special issue: the potential role for community monitoring in MRV and in benefit sharing in REDD*Forests* 6 244–51
UN-REDD Programme 2009 Operational Guidance: Engagement of Indigenous Peoples and Other Forest Dependent Communities (http://www.un-redd.org/Portals/15/documents/events/20090309Panama/Documents/UN%20REDD%20IP%20Guidelines%202009Mar09.pdf)
UNFCCC 2011 The Cancun Agreements Dec 1/COP.16 (https://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf)
Vats A, Kajembe G, Mois E, Nantongo M and Silayo D S 2017 What does it take to institute REDD+? An analysis of the Kilosa REDD+ pilot, Tanzania *For. Policy Econ.* 83 1–9
Walker B, Gunderson L, Quinlan A, Kinzig A, Cundill G, Beier C and Bodin Ö 2010 Assessing resilience in social-ecological systems: workbook for practitioners. Resilience Alliance (Stockholm: Resilience Alliance)
Walker B, Holling C, Carpenter S and Kinzig A 2004 Resilience, adaptability and transformability in social-ecological systems *Ecol. Soc.* 9 5
Walker B and Salt D 2006 *Resilience Thinking: Sustaining Ecosystems and People in a Changing World* (Washington, DC: Island Press)
Walker W et al 2014 Forest carbon in Amazonia: the unrecognized contribution of indigenous territories and protected natural areas *Carbon Manage.* 5 479–85
Wong G Y, Luttrell C, Loft L, Yang A, Pham T T, Naito D, Assembe-Mvondo S and Brockhaus M 2019 Narratives in REDD+ benefit sharing: examining evidence within and beyond the forest sector *Clim. Policy* 19 1038–51
Wunder S, Duchelle A E, de Sassi C, Sills E O, Simonet G and Sunderlin W D 2020 REDD+ in theory and practice: how lessons from local projects can inform jurisdictional approaches *Front. For. Glob. Change* 3 1–17