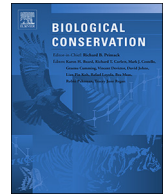




ELSEVIER

Contents lists available at ScienceDirect

Biological Conservation

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

Perspective

Engaging multiple stakeholders to reconcile climate, conservation and development objectives in tropical landscapes

James Reed^{a,b,*}, Jos Barlow^c, Rachel Carmenta^d, Josh van Vianen^a, Terry Sunderland^{a,e}^a Center for International Forestry Research, Indonesia^b Visiting Scholar, University of Cambridge Conservation Research Institute, United Kingdom of Great Britain and Northern Ireland^c Lancaster Environment Centre, Lancaster University, United Kingdom of Great Britain and Northern Ireland^d University of Cambridge Conservation Research Institute, United Kingdom of Great Britain and Northern Ireland^e Faculty of Forestry, University of British Columbia, Canada

ARTICLE INFO

Keywords:

Landscape governance
Multi-stakeholder dialogue
Conservation and development trade-offs
Landscape approach
Sustainable development goals

ABSTRACT

Achieving equitable and sustainable development that supports climate change mitigation targets and avoids biodiversity loss remains a leading, and intractable challenge in many tropical countries. Sectorial thinking – focusing on just one aspect of the problem or system – is increasingly understood to be inadequate to address linked social-ecological challenges. Holistic approaches that incorporate diverse stakeholders across scales, sectors, and knowledge systems are gaining prominence for addressing complex problems. Such ‘integrated landscape approaches’ have received renewed momentum and interest from the research, donor and practitioner communities, and have been subsumed in international conventions related to climate, biodiversity, and sustainable development. However, implementation efforts and tangible evaluation of progress continues to lag behind conceptual development. Failure of landscape approaches to adequately engage diverse stakeholders—in design, implementation and evaluation—is a contributing factor to their poor performance. Here we draw on consultation workshops, advances in the literature, and our collective experience to identify key constraints and opportunities to better engage stakeholders in tropical landscape decision-making processes. Specifically, we ask: (1) what are the key challenges related to effectively engaging multiple stakeholders in integrated landscape approaches and (2) what lessons can be learned from practitioners, and how can these lessons serve as opportunities to avoid duplicating future research efforts or repeating past perceptions of underperformance. We present our findings within three broad categories: (i) navigating complexity, (ii) overcoming siloed thinking, and (iii) incentivizing behavioral change; thus providing a useful starting point for overcoming inherent challenges associated with engaging stakeholders in landscape approaches.

1. Introduction

The persistent global challenges of poverty, food insecurity, climate change and biodiversity loss must be tackled with global commitments (Koomen et al., 2012). However, implementation strategies for conservation and development agendas are often nationally formulated (Forman, 1995; Ling et al., 2009) and are typically realized, and influenced, by sectorial approaches and individual-level actions, while long-term success will be largely dependent on landscape scale processes and interactions. As such, contemporary efforts to reconcile conservation and development at the landscape scale have gained renewed interest and momentum (Berkes et al., 2003; Olsson et al., 2006; Sayer et al., 2013; Fischer et al., 2015).

Recent research suggests that proper implementation of landscape

approaches must acknowledge the bio-physical, political, socio-economic and cultural processes that comprise social-ecological systems (Pliening et al., 2013), consider the significance of cross-scale interlinkages (Folke et al., 2005) and the unique challenges and opportunities therein. Transformational shifts seeking to move away from the ‘business as usual’ approach to agricultural production, forest conservation and rural development of recent decades should avoid sectorial focus. As often is the case, multiple stakeholders, and their represented agencies within the landscape, support and lobby conflicting mandates—often resulting in strategies that are at cross-purposes (Carmenta and Vira, 2018). However, while a more integrated approach is conceptually appealing, the application on the ground is not without challenges—whether addressing peatland management and fire in Indonesia (Carmenta et al., 2017), bush-meat extraction in Cameroon

* Corresponding author at: Center for International Forestry Research, Indonesia.
E-mail address: j.reed@cgiar.org (J. Reed).

<https://doi.org/10.1016/j.biocon.2019.108229>

Received 28 March 2019; Received in revised form 1 August 2019; Accepted 28 August 2019

Available online 05 September 2019

0006-3207/© 2019 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

(Sandker et al., 2009), or rates of deforestation in the Amazon (Aguiar et al., 2016)—evidence from across the tropics shows that tensions between multiple stakeholders with disparate conservation or development objectives at the landscape scale remain pervasive.

In recent decades, both natural and social scientists have considered how to better integrate conservation and development through a variety of—often overlapping—analytical lenses, such as: systems dynamics (Meadows, 1998), political economy (Lemos and Agrawal, 2006; Ostrom, 1990), political ecology (Blaikie, 1999; Robbins, 2011; Zimmerer and Bassett, 2003), landscape ecology (Forman and Godron, 1986; Wu and Hobbs, 2002), sustainability science (Kates et al., 2000), resilience science (Berkes et al., 2003; Folke, 2006) and conservation social science (Bennett et al., 2017). Such inter- and trans-disciplinary research has led to the development of numerous conceptual frameworks and guiding principles designed to deliver positive outcomes for both society and environment—and more recently climate change mitigation—by embedding development objectives within pro-environmental agendas, or vice versa. Various associated concepts have gained—and lost—appeal with the research and practitioner communities, particularly post-Rio Earth Summit 1992 (see for example Reed et al., 2016). However, while the theorized best practice for integrating conservation and development, and the associated nomenclature, have evolved, the objectives have remained largely consistent. Implementation efforts have typically attempted to align multiple objectives to either deliver win-win outcomes (Christensen, 2004; Muradian et al., 2013), or to optimise so that desirable outcomes for climate mitigation, conservation or development comes at a minimum cost to the other objectives (Estrada-Carmona et al., 2014; Ferreira et al., 2018).

Here we use the term ‘integrated landscape approaches’ as an umbrella term for the many initiatives that represent recent attempts to reconcile challenges facing climate mitigation, conservation and development strategies (Reed et al., 2016). Although variably defined (Erbaugh and Agrawal, 2017; Reed et al., 2017; Scherr et al., 2013), a landscape approach is essentially a governance strategy that brings together multiple stakeholders to identify land-use synergies (e.g. engaging local community members in sustainable supply chain initiatives) and balance trade-offs (e.g. land for food or for conservation) that manifest across scales and sectorial boundaries. Such integrated landscape approaches have recently been embraced by the research, donor and practitioner communities, and have been subsumed in international conventions related to climate (e.g. UNFCCC), biodiversity (e.g. CBD), and development (e.g. SDGs). However, despite the burgeoning conceptual support, there is thus far limited empirical evidence of the performance or process related to the operationalization and outcomes of landscape approaches in practice (Estrada-Carmona et al., 2014; Reed et al., 2017; Sayer et al., 2016a, 2016b). Therefore, the question: “why are attempts to integrate conservation and development so often unsuccessful?” (Brown, 2003 p. 479) remains largely unanswered as very few assessments have explored the specific challenges facing these initiatives. Arguably, the question remains even more relevant today, given the growing recognition of the vital role that ecosystems can play in mitigating climate change and the rapid rate of land use change across the tropics (Barlow et al., 2016; Griscom et al., 2017).

We address this policy challenge by offering a synthesis of our experiences—from a comprehensive systematic review (Reed et al., 2016), consultation workshops (Cairns, Australia May 2012, Lake Eacham, Australia, June 2015, Bogor, Indonesia, July 2018 amongst others), practical experience in leading multi-scale social and ecological research networks in the Amazon (Gardner et al., 2013) and Mekong delta (Sunderland et al., 2012) amongst others and the evolving literature on social-ecological systems and landscape approaches—to contribute towards the knowledge on integrating climate, conservation and development, and to better understand why the integration of multiple stakeholders remains problematic. Specifically, we ask: (1) what are the key challenges related to effective engagement of multiple stakeholders in integrated landscape approaches for climate,

conservation and development and (2) what lessons can be learned from landscape practitioners for better engagement, and how can these insights serve as opportunities to avoid duplicating future research effort or repeating past underperformance. We identified a number of constraints and opportunities facing attempts to engage multiple stakeholders in tropical landscapes that broadly relate to issues of temporality and willingness to adapt, power dynamics and inclusion, and potential to stimulate institutional and behavioral change, which we have categorized below.

2. Navigating complexity

Landscapes are often highly complex social-ecological systems: they hold poorly understood ecological interactions responding to both fast and slow drivers of change (Fischer et al., 2015), and the impacts of multiple—and often contradictory—socio-economic institutions (Carmenta and Vira, 2018). Political, environmental, social, and commercial interactions at the landscape scale serve to further amplify system complexity and therefore the degree of difficulty for investigation, management and disentanglement (Demek, 1978; Mollinga, 2010). This complexity is exacerbated by the expanding spatial scales at which contemporary socio-economic interactions take place, due to the accelerating processes of urbanization, globalization and teleconnections, which generate telecoupled landscapes (Carrasco et al., 2017; Hull and Liu, 2018; Liu et al., 2013). The recognition of social-ecological system complexity in the scientific literature is a relatively recent development (Cash et al., 2006; Cox and Arnold, 2010), however we identify a growing number of conceptual framings and governance and management responses.

One approach to managing complexity is framing it as a “wicked problem” (Balint et al., 2011; Defries and Nagendra, 2017), within which proposed solutions will neither be perfect nor imperfect. Wicked problems invariably mean a satisfactory conclusion is unattainable for all as any given “solution” will generate new challenges (Rittel and Webber, 1973). This should not however discourage current research and scholarship that attempts to provide solutions that are “better” than those that existed previously – although “better” is subjective and, as such, will be open to (mis)interpretation (Carmenta et al., 2017); what is good for one set of stakeholders will not necessarily be positively perceived by others. Disentangling natural resource decision-making at local or landscape scales need not necessarily be a state-driven initiative due to local communities’ capacity to self-organize and recognize thresholds of use and the growing role of the private sector and civil society organizations in increasingly polycentric governance arenas (Agrawal and Gibson, 1999; Ostrom, 1990, Jefferson et al. submitted). As such, centralized management is increasingly considered a poor fit for complex systems where issues need to be addressed simultaneously at various scales (Berkes, 2004; Hodge, 2007; Kremen et al., 2000) and hybrid governance approaches are increasingly common (Kozar et al., 2014; Viana et al., 2016). Researchers and practitioners must thus not only ask at which scale should land-use decision-making, policies and management structures be conceived and implemented but also, and importantly, consider how institutions, sectors and policies intersect, interact and integrate across the system, and determine the processes that will enhance recognition, understanding and adequate amelioration of conflicted aspirations and preferences. This is perhaps particularly salient in landscapes of rapid change and transformation – such as the agricultural forest frontiers of the global south.

The need for a systemic approach to dealing with complexity suggests that navigating—as opposed to strictly managing or planning for—complexity will be both more appropriate and preferable (Armitage et al., 2009; Sayer et al., 2016a, 2016b). Indeed, Olsson et al.’s (2006) suggestion that transitions within social-ecological systems “can only be navigated, not planned” has been supported by a number of scholars (Berkes et al., 2003; Folke et al., 2005; Sayer et al., 2008). The inherent complexity of landscapes renders formal

management and planning problematic and therefore an element of “muddling through” will always be necessary (Chazdon et al., 2017; Lindblom, 1959; Sayer et al., 2008). Such discourse calls for moving beyond disciplinary confinement and in to “transdisciplinary modes of inquiry” (Brown et al., 2010 p.4) that encourage adaptive co-governance and polycentric structures. Nevertheless, developing institutions that can accommodate diverse stakeholders with conflicting interests is challenging and hints at what Brown (2003) termed a case of institutional misfit. Multi-stakeholder interactions across scales implies institutional linkages horizontally (across space), vertically (across levels of organizations) (Berkes, 2002) and also diagonally (combining vertical and horizontal linkages) (Torfing, 2012). Developing greater fluidity of actors and institutional interplay across sectors and scales, in many contexts, may require changes to both top-down and bottom-up governance structures in order to minimize scale conflicts (Foli et al., 2017; Olsson et al., 2006; Young, 2002).

Transforming to alternative governance arrangements is, however, far from straightforward: entrenched power structures, institutional stickiness and socio-political inertia are hard to breakdown, requiring significant investment of time and labour (Brockhaus and Angelsen, 2012). Governance transformations will often require enhanced political will and a political “window of opportunity” (Folke et al., 2005). Such a window may be opened by a pressing environmental concern (problem-driven) or an administration that seeks a problem to justify change (politically-driven) (Kingdon and Thurber, 1984). Olsson et al. (2006) suggest that “key leaders and shadow networks can prepare a system for change by exploring alternative system configurations and developing strategies for choosing from among possible futures” (Olsson et al., 2006). This is somewhat consistent with the views of Elinor Ostrom and colleagues who recommended deliberate institution building to facilitate the emergence of adaptive co-management of social-ecological systems (Ostrom, 1990; Ostrom et al., 1999; Barrett et al., 2001). Moreover, all these scholars are proponents of building networks that integrate expert and community experiences to “increase the knowledge pool for decision-making” (Olsson et al., 2006 p.21) therefore averting an over-reliance on, or suppression of, either scientific or traditional knowledge. Effective network building that integrates actors from across disciplines and sectors can improve our understanding of system wide dynamics and enhance our “ability to exploit economies of scale in shared resources and technical expertise” (Barlow et al., 2011 p.4). Despite this broad endorsement, the ability of researchers to effectively bridge disciplinary divides and link science with action has, at best, been only partially successful (Brown, 2003; Clark et al., 2011). One strategy to bridge disciplinary divides is to build networks with a shared thematic or geographic focus (Gardner et al., 2013), however, overcoming entrenched philosophical and ideological differences requires careful, dedicated facilitation and long-term engagement, and may only be possible within a favorable political economy.

A potentially powerful—though by no means novel (Star and Griesemer, 1989)—approach to facilitate dialogue, enhance links between disciplines and navigate the ‘space’ between science and policy (c.f. Toomey et al., 2016) involves the incorporation of boundary, or bridging, organizations (Cash et al., 2006; Cash and Moser, 2000; Clark et al., 2011; Guston, 2001). Boundary organizations fulfill the complex task of considering the objectives of, and being accountable to, actors from across social-ecological system boundaries, while attempting to remain impartial to other influencing forces (Guston, 2001), therefore facilitating co-production of knowledge and social order (Jasonoff, 1996a, 1996b). Boundary organizations can link global research and environmental objectives with national commitments and local socio-economic and cultural realities. They support dialogue between experts and decision-makers through facilitating open communication, aiding mutual comprehension of problems and proposed solutions, and mediating conflicts (Cash et al., 2003). The value of boundary organizations therefore depends upon the production of salient, credible and

legitimate ‘boundary objects’ (i.e. maps, reports, protocols) that are sufficiently adaptable (to different viewpoints) and robust (to maintain identity) to satisfy the intentions of multiple parties (Cash et al., 2003; Star and Griesemer, 1989). Recent evidence has demonstrated the incorporation of boundary organizations across a range of countries and contexts (Clark et al., 2011; Mollinga, 2010; Pohl et al., 2010; Polsky and Cash, 2005; Reyers et al., 2015). However, ascertaining effectiveness of such incorporation remains challenging (Clark et al., 2011) and the inclusion of boundary organizations will not automatically lead to positive change if they themselves lack the necessary credibility or legitimacy or are embedded in unfavorable political economy contexts (Graham and Mitchell, 2016). Further, much is needed to be known about how the work at the boundary can generate policy change, i.e. how the knowledge generated can cross the boundary and result in policy uptake (Clark et al., 2011).

3. Overcoming siloed thinking

Many of the efforts to improve conservation and development outcomes highlight the critical importance of meaningful and long-term local stakeholder engagement (Bürgi et al., 2017; Sayer et al., 2013), and there is growing evidence to support this. For example, recent reviews of landscape approaches found community engagement in decision-making, and inclusion of people-based strategies, to be the most significant contributing factor to successful outcomes (Reed et al., 2017, Carmenta et al. forthcoming). Similarly, despite mixed results—in terms of reconciling conservation and development—an assessment of a long-term landscape approach in the Sangha Tri-National landscape found that the participants recognized the value of multi-stakeholder processes which were considered “vital” to enhance capacity to share and comprehend complex challenges (Sayer et al., 2016 p.137). These examples are further supported by assertions from the commons and social-ecological systems literature, which stress the value of community engagement and empowerment to the long-term sustainability of joint conservation and development interventions (Ostrom, 1990; Persha et al., 2011).

However, despite the conceptual recognition and growing evidence on the importance of bridging sectoral and disciplinary divides in decision-making dialogue, practical progress remains slow (Agrawal and Gibson, 1999; Lund, 2015; Ribot et al., 2010; Carmenta and Vira, 2018) and reporting on the means of implementation—or methods for evaluation—remains scarce (Stenseke, 2009; Bixler et al., 2016). We identify the following key constraints that hinder thinking beyond silos and complicate practical implementation of integrated approaches.

First, attempts to balance the objectives of multiple stakeholders are often hindered due to “the political process of decision-making, differing values and norms, and power imbalances” (Defries and Nagendra, 2017) which lack incentives for real change and result in “elite capture” or the further marginalization of some of the most vulnerable people (Viana et al., 2016). Second, practical advances have failed as stakeholder engagement is often being delivered as only a box-ticking exercise to satisfy project or donor demands (Enengel et al., 2011; German et al., 2007; Castella et al., 2012). Participatory forest management (PFM) programs in Kenya epitomize this challenge— a recent assessment of which found that in practice, the ‘P’, from the PFM acronym, for participation was all too often lacking (Mutune and Lund, 2016). Participation can also fail due to the reluctance of local stakeholders themselves to engage in what may be perceived as a divisive, threatening, or burdensome intervention (Cheng et al., 2006; Green et al., 2018). Finally, multi-stakeholder engagement processes have high transaction costs (Enengel et al., 2011) and these costs will, of course, also be borne by local stakeholders. As such, effective—and sustainable—engagement is only likely to occur if the long-term rewards are perceived as having potential to outweigh the initial short-term gains, or cost associated with investments/compliance – whether that be monetary or otherwise.

Overcoming these issues will require recognizing that multiple stakeholder engagement is much more than a function to simply support or empower local communities. When confronting land-use challenges that cross disciplines and sectors, adequately engaging stakeholders from across scales and levels is likely to influence outcome pathways, build consensus and enhance sustainability potential. Increasingly, the concept of knowledge co-production—that integrates communities of knowledge with communities of action—is recognized to have significant potential for confronting the kinds of “wicked problems” presented by social-ecological systems (Cash et al., 2003). Further, the effectiveness of engagement should not be measured in terms of numbers of people with increased attendance an insufficient proxy for meaningful engagement if the discussion is consistently dominated by a specific group or individual (German et al., 2007), and attendance must therefore not be understood as an outcome (Savedoff et al., 2005). Engagement platforms need to consider ways to confront issues of inequity, elite capture avoidance and encourage a more democratic form of co-governance. However, the importance of context merits attention; although it is often considered that imbalances of power are detrimental to multi-stakeholder dialogue, there may be instances when asymmetrical power relationships could facilitate the promotion of the agendas of marginalized groups (Hendriks, 2009; Moeliono et al., 2014). However, ethically, and to maintain accordance with UN declarations (e.g. Declaration on Human Rights and Declaration on the Rights of Indigenous People) attempts should be made to dissolve power asymmetries such that power be evenly distributed with decisions negotiated fairly in order to encourage co-productive governance arrangements.

Working effectively across disciplinary and sectoral divides is fraught with difficulty (Sandbrook et al., 2013), but previous experiences have provided valuable lessons. One key insight is that interdisciplinarity can be enhanced via multiple pathways. For example, multi-stakeholder fora can be incentivized through triple loop learning (i.e. not only questioning if we are doing things right but also understanding if we are doing the right things and how to know what is the right thing to do) (Biggs et al., 2011) and seeking consensus on problem definition, objectives, and solutions (Blackstock, 2007). Developing a robust theory of change in a participatory manner can be useful in this regard (Qiu et al., 2018; Sayer et al., 2016) as generating a shared understanding amongst stakeholders of their respective requirements or objectives and the implications of actions can help to highlight potential areas of synergy and also enhance empathy and trust amongst participants. Diverse collectives can then potentially form that are built upon an acknowledgement of the interdependency of actions (i.e. that the actions of one group will likely influence the outcomes of another group and therefore in order to achieve goals it is desirable to take in to account the needs of others) and collectively steward towards an agreed outcome/end state (Steyaert and Jiggins, 2007).

Previous attempts of cross-discipline or sector working have also shown the importance of issues such as: ensuring venues for public consultation are accessible to all stakeholders (or legitimate representatives) and that those stakeholders are duly well informed (Sessin-dilascio et al., 2016), negotiation processes are conducted in a common language (Bennett and Dearden, 2014), strategies are developed to enable equitable participation of all concerned stakeholders, such as by including women and marginalized groups (Ling et al., 2009) and there is genuine potential for the collective development of alternative pathways. Independent facilitation and support from external agencies—whether political, technical, or financial—has been demonstrated to inspire more effective stakeholder engagement processes (Balint and Mashinya, 2006; Sayer et al., 2016). Commitments need to be long-term, as capacity building can be a lengthy process, at times requiring external support for up to 20 years before fruition^{1,2}

Furthermore, a recent study illustrated that external support does not guarantee enhanced equity; in this case internal capacity for cohesive collective action towards sustainable development already existed and externally induced programs disrupted rather than accelerated equitable stakeholder engagement (Guillaume, 2017). A robust baseline or pilot study to determine contextual nuance and social norms and behaviors can therefore be valuable. Encouragingly, some donors have recently recognized this need and are now offering seed money for such initiatives.

Effective engagement will require the ability to facilitate dialogue and decision making between the diverse range of stakeholders that represent a variety of sectors, in order to influence or assist a range of systems (Clark et al., 2016). Engagement processes should therefore be encouraged that are adapted to specific contexts, structured in a manner that is commonly accessible and are cognizant of historic or potential conflict and power hierarchies. Furthermore, the dynamism of complex ecosystems and the associated stakeholders means that system shocks and fluctuations will inevitably occur, increasing the susceptibility to uncertainty and risk over time (Cooke and Kothari, 2001; Smith, 2008). As such, engagement structures need to be an iterative process of periodically informing, evaluating and updating knowledge and objectives to stimulate feedbacks for principles of adaptive governance (Carpenter and Gunderson, 2001; Folke et al., 2005; Gunderson et al., 2001) with methods to assess both the satisfaction of participants (Engel et al., 2011) and the effectiveness of governance platforms (Bixler et al., 2016; Hassenforder et al., 2016; Kusters et al., 2017).

4. Incentivizing behavioral and institutional change at the local level

Effectively engaging stakeholders to integrate climate, conservation and development goals will be influenced by the application of appropriate incentive structures designed to reduce the overexploitation of natural resources (Fischer et al., 2012). As previously commented, “there is little debate over whether incentives for conservation are important – they are” (Berkes, 2004 p.626; Wunder et al., 2018). However, determining the “right” or “best” incentives in complex landscapes with multiple stakeholders operating locally and remotely is far from easy, and requires consideration of a number of issues. Transitions to sustainability necessitates interventions across scales and sectors, including off-site interventions (e.g. changing the diet preferences, redistribution, reducing consumption of processed foods and waste in GDP rich countries) (Martin et al., 2018; Tilman and Clark, 2014), yet site level interventions are also part of the solution.

Incentive effectiveness is highly dependent on the socio-economic, cultural and political context, and an adequate incentive in one landscape – or for one group – may be considered inappropriate or insufficient elsewhere or for other groups (Luttrell et al., 2013; Newton et al., 2013). Incentive structures targeted at either the individual (e.g. direct cash payments) or community level (e.g. investment in health services or education) will generate variable responses depending on context specificities (e.g. the degree to which they crowd-in or crowd-out motivations for behavioral change) (Muradian et al., 2013). This raises questions over the equitable distribution and appropriateness of incentive structures (Dietz et al., 2003; Ostrom et al., 1999). Consequently, questions must be posed not just at, but also below, the scale of landscape – is the proposed incentive and means of benefit sharing perceived equally across and within stakeholder groups? Oftentimes,

(footnote continued)

tenure-rights-devolution?fnl=en

² Jennie Barron (IWMI/SLU) presentation: Feasibility of green water management and rainwater harvesting in drylands. Falkenmark Symposium – Achieving SDG in Africa: Scaling green-blue revolution. World Water Week 2017.

¹ <https://forestsnews.cifor.org/51411/a-promising-but-uncertain-future-for->

the likely answer is no (Cooney et al., 2017; Naidoo et al., 2016).

Incentives for pro-conservation behavior can take many forms, from providing financial compensation or clarifying property or access rights to addressing issues of equity, health, infrastructure, or power asymmetries of class or gender (Carmenta et al. forthcoming). Again, context is important, for example, market-based incentives rely on market forces to incentivize behavioral change and may therefore be biased towards middle-income actors with good market access. Furthermore, even within broad classifications, there will be differences in application and perception. For example, if an objective is to engage and empower marginalized groups, there are multiple potential approaches that will have differential outcomes and even empowerment itself will be perceived variably. As “perceptions often condition behavior, compliance and engagement” (Carmenta et al., 2017), it is critical that sufficient consideration is given to the potential environmental and societal pathways that may result from a given incentive.

One approach to incentives involves providing alternative livelihood options that reduce threats to the natural resource base (Roe et al., 2015), for example, encouraging seaweed farming as an alternative to artisanal fishing (Hill et al., 2011). However, the effectiveness in delivering positive outcomes for conservation or ecosystem services remains poorly understood, largely due to the fact that the impact of such projects is rarely evaluated (Ferraro and Pattanayak, 2006; Sainsbury et al., 2015). Indeed, a recent review of alternative livelihood projects found that less than 20% of the studies sufficiently analyzed or evaluated project impacts, while fewer than 10% resulted in positive conservation outcomes (Roe et al., 2015). A similar lack of evidence of effectiveness is found when examining the impact of alternative livelihood projects on socio-economic outcomes in Ghana (Hilson and Banchirigah, 2009) and Africa more broadly (Wicander and Coad, 2015). What the available evidence does show however is that, in common with compensatory incentives, alternative livelihood strategies need to be carefully contextualized. For example, when considering livelihood options for a bush meat hunter (Chaves et al., 2017), it will often be more than simply a financial or environmental consideration as a hunter may command a certain social respect within the community that he is reluctant to relinquish (John Fa, personal communication). Nevertheless, there is evidence of well applied alternative livelihood programs being effective in empowering local communities, enhancing local agency and reducing threats to local biodiversity (Lotter and Clark, 2014; Roe, 2015).

4.1. Perverse incentives

Research has illustrated the peril of perverse incentives – that is, well-intended pro-conservation incentives that have the paradoxical effect of accelerating natural resource depletion, or crowding out intrinsic motivations (Ferraro and Kramer, 1995; Langholz, 1999; Wunder, 2001). Perverse incentives are often realized when the opportunity costs of ecosystem conservation are underappreciated and the financial returns from ecosystem conversion are greater (or even perceived as being greater) than those generated from conservation to the end users. Rudimentary cost-benefit analysis also fails to account for the broader implications resulting from the action to conserve, or convert. The challenge is to develop a more nuanced understanding of the complex interactions between people, nature and institutions and then attempt to identify which incentive structure will likely deliver optimal outcomes for the highest number of stakeholders, with the objective of achieving more winners and less losers (Sayer et al., 2014)

4.2. Modelling approaches

One strategy to facilitate forecasting is via simulation models, which have long been a feature of joint conservation and development discourse (Holling and Chambers, 1973; Sandker et al., 2010; Sayer and Campbell, 2004; Walters, 1986; Wu and Hobbs, 2002). Rather than a

predictive tool, their value is in generating potential outcomes that enable better comprehension of social-ecological system function. Using participatory modelling can make explicit the assumptions and preferences of a diversity of participants, thereby enabling more transparent decision-making processes (Holling and Chambers, 1973; Sayer et al., 2016; Wu and Hobbs, 2002). Importantly they can help to develop a better understanding of the bio-physical and socio-economic processes within the landscape, and how they interact (Musacchio, 2009; O'Farrell and Anderson, 2010). Coupled with participatory historical trend analysis—the practice of consulting inhabitants to collect historical landscape information—it can be particularly effective for identifying patterns of change. Understanding both ecological processes derived from landscape configuration and function, as well as structural hierarchies, social conflicts, and political agendas can strengthen measures for safeguarding natural resources and enhance the efficacy of collaborative decision-making (Marlier et al., 2013). The application of modelling techniques can enable stakeholders to consider the current social-ecological system and negotiate desired future alternative states (Fischer et al., 2017). Furthermore, models can be revisited and evaluated against to facilitate adaptive management.

However, there remains a number of shortfalls in many modelling approaches, with projections characterized by a high degree of uncertainty (Prestele et al., 2016), and seldom capturing real world complexity. Most models retain a large number of assumptions and the parameters are subject to modeler bias and—particularly for long-term projections—are limited to the known or anticipated variables of the time. For example, a model designed today to forecast future forest cover in Indonesia for the next 30 years would certainly include oil palm production as an independent variable – something that might not have been the case 30 years previously and would (as we now know) have represented a significant oversight. A model can never build in all complexity, but it can stimulate debate to enable finding better solutions. One of the important contributions of participatory modelling is to engage multiple stakeholders in voicing their different points of view on the complex socio-ecosystem and thus create a collective understanding. Indeed, participatory modelling has been shown to be extremely effective in enhancing stakeholder discussion, helping to illustrate potential synergies or trade-offs and stimulating the development of innovative solutions. For example, Castella et al. (2014) describe the use of a boundary object (in the form of a 3D model representing a Laotian village landscape) to encourage local stakeholder participation in land use planning. The model enabled those stakeholders lacking the capacity to adequately convey landscape features or interpret GIS maps to maintain an active role in scenario visualizing. Model outputs (as GIS maps) were then coupled with simple cost-benefit analyses (with locally determined parameters) so that community members could iteratively negotiate potential outcomes and ultimately influence decision-making processes (Sayer et al., 2007).

Modelling and scenario building has developed rapidly in recent years and now take various forms (Enfors et al., 2008; Palomo et al., 2011; Watts and Colfer, 2011). While not all outcomes can be anticipated, planned, or predicted (Folke et al., 2005), it is increasingly acknowledged that the process of developing models and alternative future scenarios—particularly when performed in a participatory manner—can help engage stakeholders to recognize and respond to social and biophysical fluctuations, trade-offs and synergies; thus enhancing the potential to develop integrated strategies to enhance resilience to future environmental and social disturbance (Trospen, 2003) and provide important decision-making support for policy development.

Final considerations: enhancing engagement to address complex challenges.

The ability to fulfill internationally agreed commitments to climate, conservation and development will be influenced not only by the actions of national governments and international trading companies but also the local land use decision making of tropical communities and

smallholders. Such decision-making for landscape scale land-use management is inherently complex (Furst et al., 2010; Game et al., 2014). The evidence presented here suggests that governance that seeks to reconcile climate, conservation and development agendas must first reconcile disconnects across scales, sectors, and disciplines such that the grand theories of international policy and academia more closely align with messier local realities (Barlow et al., 2018; Boedihartono et al., 2018). While there are challenges to achieving such reconciliation, we have identified important opportunities for future research and practice.

Firstly, a greater recognition and acceptance of the need to navigate complex challenges as opposed to applying rigid management and log frame approaches should be encouraged. Careful construction of multi-stakeholder dialogue fora enlisting the support of boundary organizations and independent facilitation that applies established principles (Brouwer et al., 2016) offers potential in this regard (Larsen et al., 2018). With the right approach, the interaction 'space' between stakeholders can be seen as an opportunity and not just a challenge (Toomey et al., 2016).

Second, the sustainability of multi-stakeholder engagement will be enhanced through the development of inclusive and transparent theories of change that identify desired outcomes and measurable process indicators (Qiu et al., 2018). Including local communities and policy makers in the design and subsequent implementation and monitoring can bring to light trade-offs and synergies early in the process and iteratively inform adaptive co-governance. Recent encouraging signs have been demonstrated as academia, donors and scientific journals increasingly recognize the value and potential impact of incorporating citizen science, indigenous knowledge and other non-traditional Western science approaches in social-ecological system research design and application (Ban et al., 2018; Mistry and Berardi, 2016).

Thirdly, greater effort needs to be made in evaluating the process and impact of multi-stakeholder engagement. This means rather than solely focusing monitoring on social and biophysical indicators of significance, attention also needs to be paid to the functioning and contribution of the governance platform itself (Bixler et al., 2016; Kusters et al., 2017).

Finally, considerate planning of incentives that reward pro-conservation behavior must be encouraged. Incentives are often fundamental to influencing perceptions, actions and outcomes and can therefore lead to both positive and negative or perverse changes. Engaging stakeholders in forecasting exercises and role-playing games can position actors in unfamiliar roles and decision-making environments, simultaneously building knowledge, capacity and empathy.

While the challenges and opportunities identified here may have independent and collective value in terms of moving towards operationalizing landscape approaches and closing knowledge-practice gaps, obstacles to progress remain and new challenges will undoubtedly arise. Innovations in theory, new—and further development of existing—tools, and greater understanding of the precise functioning of landscape approaches must be encouraged. Crucially, the evidence base must continue to be developed with robust monitoring of the biophysical, social and governance processes within the landscape; this is vital to keep pace with unprecedented global environmental change, and ensure multiple stakeholder engagement remains effective.

Complexity, engagement, and incentivizing behavioral change are significant challenges to progress, yet these need not be insurmountable challenges and we have shown that opportunities exist. This article hopefully provides a resource for actors operating across the spectrum of research, policy and practice as we continue to develop the means by which to fulfill such globally conceived commitments as the New York declaration on forests, the Aichi biodiversity targets, the Bonn challenge, and the goals of the climate and development agendas. The suggestions of this article provide a useful starting point for overcoming implementation and stakeholder engagement challenges, identifies where further research is required and can also serve to focus research

effort around these emerging themes. As such, this paper can be considered a "toolkit" for engaging multiple stakeholders. We hope that it is of practical use to researchers and practitioners involved in landscape decision-making – and that those involved in complex landscape management continue to record and share their experiences to improve the evidence about what does and does not work.

Acknowledgements

This study is part of the CGIAR Research Program on Forests, Trees and Agroforestry (CRP-FTA). This collaborative programme aims to enhance the management and use of forests, agroforestry and tree genetic resources across the landscape from forests to farms. CIFOR leads CRP-FTA in partnership with Bioversity International, CATIE, CIRAD and the International Center for Tropical Agriculture and the World Agroforestry Centre. Funding for this study was provided by the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) grant 18_IV_084 and the United States Agency for International Development (USAID) Forest and Biodiversity Office. JB was supported by National Environment Research Council grant NE/K016431/1. RC was supported by the Frank Jackson Foundation.

Declaration of competing interest

The authors declare no conflict of interest.

References

- Agrawal, A., Gibson, C.C., 1999. Enchantment and disenchantment: the role of community in natural resource conservation. *World Dev.* 27 (4), 629–649. [https://doi.org/10.1016/S0305-750X\(98\)00161-2](https://doi.org/10.1016/S0305-750X(98)00161-2).
- Aguiar, A.P.D., Vieira, I.C.G., Assis, T.O., Dalla-Nora, E.L., Toledo, P.M., Oliveira Santos-Junior, R.A., Ometto, J.P.H., 2016. Land use change emission scenarios: anticipating a forest transition process in the Brazilian Amazon. *Glob. Chang. Biol.* 22 (5), 1821–1840. <https://doi.org/10.1111/gcb.13134>.
- Armitage, D.R., Plummer, R., Berkes, F., Arthur, R.L., Charles, A.T., Davidson-Hunt, I.J., McConney, P., 2009. Adaptive co-management for social – ecological complexity. *Front. Ecol. Environ.* 7 (2), 95–102. <https://doi.org/10.1890/070089>.
- Balint, Peter J., Mashinya, J., 2006. The Decline of a Model Community-based Conservation Project: Governance, Capacity, and Devolution in Mahenye, Zimbabwe. vol. 37. pp. 805–815. <https://doi.org/10.1016/j.geoforum.2005.01.011>.
- Balint, P.J., Stewart, R.E., Desai, A., Walters, L.C., 2011. *Wicked Environmental Problems: Managing Uncertainty and Conflict*. Island Press, Washington, DC.
- Ban, N.C., Frid, A., Reid, M., Edgar, B., Shaw, D., Siwallace, P., 2018. Incorporate indigenous perspectives for impactful research and effective management. *Nature Ecology & Evolution* 2 (11), 1680. <https://doi.org/10.1038/s41559-018-0706-0>.
- Barlow, J., Ewers, R.M., Anderson, L., Aragao, L.E.O.C., Baker, T.R., Boyd, E., Gardner, T.A., 2011. Using learning networks to understand complex systems: a case study of biological, geophysical and social research in the Amazon. *Biol. Rev.* 86 (2), 457–474. <https://doi.org/10.1111/j.1469-185X.2010.00155.x>.
- Barlow, Jos, Lennox, G.D., Ferreira, J., Berenguer, E., Lees, A.C., Nally, R. Mac, Gardner, T.A., 2016. Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation. *Nature* 535 (7610), 144–147. <https://doi.org/10.1038/nature18326>.
- Barlow, Jos, França, F., Gardner, T., Hicks, C., Lennox, G., Berenguer, E., Graham, N., 2018. The future of tropical hyperdiverse ecosystems. *Nature* 559, 517.
- Barrett, C.B., Brandon, K., Gibson, C., Gjertsen, H., 2001. Conserving tropical biodiversity amid weak institutions. *AIBS Bull.* 51 (6), 497–502.
- Bennett, N., Dearden, P., 2014. Why local people do not support conservation: community perceptions of marine protected area livelihood impacts, governance and management in Thailand. *Mar. Policy* 44, 107–116. <https://doi.org/10.1016/j.marpol.2013.08.017>.
- Bennett, N.J., Roth, R., Klain, S.C., Chan, K., Christie, P., Clark, D.A., Wyborn, C., 2017. Conservation social science: understanding and integrating human dimensions to improve conservation. *BIOC* 205, 93–108. <https://doi.org/10.1016/j.biocon.2016.10.006>.
- Berkes, F., 2002. Cross-scale institutional linkages: Perspectives from the bottom up. In: *The Drama of the Commons*, pp. 293–321.
- Berkes, Fikret, 2004. Rethinking community-based conservation. *Conserv. Biol.* 18 (3), 621–630. <https://doi.org/10.1111/j.1523-1739.2004.00077.x>.
- Berkes, F., Colding, J., Folke, C., 2003. *Navigating Social-ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press.
- Biggs, D., Abel, N., Knight, A.T., Leitch, A., Langston, A., Ban, N.C., 2011. The implementation crisis in conservation planning: could "mental models" help? *Conserv. Lett.* 4, 169–183. <https://doi.org/10.1111/j.1755-263X.2011.00170.x>.
- Bixler, R.P., Johnson, S., Emerson, K., Nabatchi, T., Reuling, M., Curtin, C., Grove, J.M.,

2016. Networks and landscapes: a framework for setting goals and evaluating performance at the large landscape scale. *Front. Ecol. Environ.* 14 (3), 145–153. <https://doi.org/10.1002/fee.1250>.
- Blackstock, K.L., 2007. Operationalising Sustainability Science for a Sustainability Directive? Reflecting on Three Pilot Projects. 173(4). pp. 343–357.
- Blaikie, P., 1999. A review of political ecology. *Zeitschrift Für Wirtschaftsgeographie* 43 (1), 131–147.
- Boedihartono, A.K., Bongers, F., Boot, R.G.A., 2018. Conservation science and practice must engage with the realities of complex tropical landscapes. *Tropical Conservation Science* 11 (January), 1–7. <https://doi.org/10.1177/1940082918779571>.
- Brockhaus, M., Angelsen, A., 2012. Seeing REDD+ through 4Is: a political economy framework. *Analysing REDD+: challenges and choices*. Center for International Forestry Research, Bogor, Indonesia, pp. 15–30.
- Brouwer, H., Woodhill, A., Hemmati, M., Verhoosel, K., 2016. *The MSP Guide - How to Design and Facilitate Multi-stakeholder Partnerships*. Practical Action Publishing.
- Brown, K., 2003. *Integrating Conservation and Development: A Case of Institutional Misfit in a Nutshell*.
- Brown, V.A., Harris, J.A., Russell, J.Y., 2010. *Tackling Wicked Problems Through the Transdisciplinary Imagination*. Earthscan.
- Bürgi, M., Ali, P., Chowdhury, A., Heinimann, A., Hett, C., Kienast, F., ... Verbürg, P.H., 2017. *Integrated Landscape Approach: Closing the Gap between Theory and Application*. 1–13. <https://doi.org/10.3390/su9081371>.
- Carmenta, R., Vira, B., 2018. Integration for restoration: Reflecting on lessons learned from the silos of the past. In: *Forest Landscape Restoration*. Routledge, pp. 16–36.
- Carmenta, R., Zabala, A., Daeli, W., Phelps, J., 2017. Perceptions across scales of governance and the Indonesian peatland fires. *Glob. Environ. Chang.* 46 (November 2016), 50–59. <https://doi.org/10.1016/j.gloenvcha.2017.08.001>.
- Carpenter, S.R., Gunderson, L.H., 2001. Coping With Collapse: Ecological and Social Dynamics in Ecosystem Management. 51(6). pp. 451–457.
- Carrasco, L.R., Chan, J., Mcgrath, F.L., Nghiem, L.T.P., 2017. Biodiversity conservation in a telecoupled world. *Ecol. Soc.* 22 (3).
- Cash, D.W., Moser, S.C., 2000. *Linking Global and Local Scales: Designing Dynamic Assessment and Management Processes*. 10. pp. 109–120.
- Cash, D.W., Clark, W.C., Alcock, F., Dickson, N.M., Eckley, N., Guston, D.H., ... Mitchell, R.B., 2003. *Knowledge Systems for Sustainable Development*.
- Cash, D.W., Adger, W.N., Berkes, F., Garden, P., Lebel, L., Olsson, P., 2006. Scale and Cross-scale Dynamics: Governance and Information in a Multilevel World. 11(2).
- Castella, J.C., Bourgoin, J., Lestrelin, G., Bouahom, B., 2014. A model of the science-practice-policy interface in participatory land-use planning: lessons from Laos. *Landscape Ecol.* 29 (6), 1095–1107. <https://doi.org/10.1007/s10980-014-0043-x>.
- Chaves, W.A., Valle, D.R., Monroe, M.C., Wilkie, D.S., Sieving, K.E., Sadowsky, B., 2017. Changing wild meat consumption: an experiment in the Central Amazon. Brazil. *Conservation Letters* 00 (July), 1–10. <https://doi.org/10.1111/conl.12391>.
- Chazdon, R.L., Brancalion, P.H.S., Lamb, D., Laestadius, L., Calmon, M., Kumar, C., 2017. POLICY PERSPECTIVE A Policy-Driven Knowledge Agenda for Global Forest and Landscape Restoration. 10. pp. 125–132. <https://doi.org/10.1111/conl.12220>. (February).
- Cheng, A.S., Mattor, K.M., Cheng, A.S., Mattor, A.K.M., 2006. Why Won't They Come? Stakeholder Perspectives on Collaborative National Forest Planning by Participation Level Why Won't They Come? Stakeholder Perspectives on Collaborative National Forest Planning by Participation Level (November). <https://doi.org/10.1007/s00267-005-0124-3>.
- Christensen, J., 2004. Win-win illusions. *Conservation in Practice* 5 (1), 12–19.
- Clark, W.C., Tomich, T.P., van Noordwijk, M., Guston, D., Catacutan, D., Dickson, N.M., McNie, E., 2011. Inaugural Article: Knowledge Systems for Sustainable Development Special Feature Sackler Colloquium: Boundary Work for sustainable development: Natural resource management at the Consultative Group on International Agricultural Research (CGIAR). In: *Proceedings of the National Academy of Sciences*, <https://doi.org/10.1073/pnas.0900231108>.
- Clark, William C., van Kerkhoff, L., Lebel, L., Gallopin, G.C., 2016. Crafting usable knowledge for sustainable development. *Proc. Natl. Acad. Sci.* 113 (17), 4570–4578.
- Cooke, B., Kothari, U., 2001. *Participation: The New Tyranny?* Zed Books.
- Cooney, R., Roe, D., Dublin, H., Phelps, J., Wilkie, D., Keane, A., Travers, H., 2017. From Poachers to Protectors: Engaging Local Communities in Solutions to Illegal Wildlife Trade. 10. pp. 367–374. <https://doi.org/10.1111/conl.12294>. (May).
- Cox, M., Arnold, G., 2010. *A Review of Design Principles for Community-based Natural Resource*. vol. 15. pp. 4.
- Defries, R., Nagendra, H., 2017. Ecosystem Management as a Wicked Problem. 270. pp. 265–270 (April).
- Demek, J., 1978. The landscape as a geosystem. *Geoforum* 9 (1), 29–34.
- Dietz, T., Ostrom, E., Stern, P.C., 2003. The struggle to govern the commons. *Science* 302 (5652), 1907–1912.
- Enengel, B., Penker, M., Muhar, A., Williams, R., 2011. Benefits, efforts and risks of participants in landscape co-management: an analytical framework and results from two case studies in Austria. *J. Environ. Manag.* 92 (4), 1256–1267. <https://doi.org/10.1016/j.jenvman.2010.12.005>.
- Enfors, E., Gordon, L., Peterson, G., Bossio, D., 2008. Making investments in dryland development work: participatory scenario planning in the Makanya catchment, Tanzania. *Ecol. Soc.* 13 (2).
- Erbrough, J.T., Agrawal, A., 2017. Clarifying the landscape approach: a Letter to the Editor on "Integrated landscape approaches to managing social and environmental issues in the tropics". *Glob. Chang. Biol.* 0–2. <https://doi.org/10.1111/jgh.12426>.
- Estrada-Carmona, N., Hart, A.K., DeClerck, F.A.J., Harvey, C.A., Milder, J.C., 2014. Integrated landscape management for agriculture, rural livelihoods, and ecosystem conservation: an assessment of experience from Latin America and the Caribbean. *Landscape Urban Plan.* 129, 1–11.
- Ferraro, P.J., Kramer, R.A., 1995. *A Framework for Affecting Household Behavior to Promote Biodiversity Conservation*.
- Ferraro, P.J., Pattanayak, S.K., 2006. Money for nothing? A call for empirical evaluation of biodiversity conservation investments. *PLoS Biol.* 4 (4), e105. <https://doi.org/10.1371/journal.pbio.0040105>.
- Ferreira, J., Lennox, G.D., Gardner, T.A., Thomson, J.R., Berenguer, E., Lees, A.C., Barlow, J., 2018. Carbon-focused conservation may fail to protect the most biodiverse tropical forests. *Nat. Clim. Chang.* 8 (8), 744–749. <https://doi.org/10.1038/s41558-018-0225-7>.
- Fischer, Joern, Dyball, R., Fazey, I., Gross, C., Dovers, S., Ehrlich, R., Borden, R.J., 2012. Human behavior and sustainability. *Frontiers in Ecology and Environment* 10, 153–160. <https://doi.org/10.1890/110079>.
- Fischer, J., Gardner, T.A., Bennett, E.M., Balvanera, P., Biggs, R., Carpenter, S., Tenhunen, J., 2015. Advancing sustainability through mainstreaming a social-ecological systems perspective. *Curr. Opin. Environ. Sustain.* 14, 144–149. <https://doi.org/10.1016/j.cosust.2015.06.002>.
- Fischer, Joern, Abson, D.J., Bergsten, A., Collier, N.F., Dorresteyn, I., Hanspach, J., ... Senbeta, F., 2017. Reframing the food – biodiversity challenge. *Trends Ecol. Evol.* 1–11. <https://doi.org/10.1016/j.tree.2017.02.009>. xx.
- Foli, S., James, M.A.F.R., Terry, R., Sunderland, T., 2017. Natural resource management schemes as entry points for integrated landscape approaches: evidence from Ghana and Burkina Faso. *Environ. Manag.* 0–1. <https://doi.org/10.1007/s00267-017-0866-8>.
- Folke, C., 2006. Resilience: the emergence of a perspective for social – ecological systems analyses. *Glob. Environ. Chang.* 16, 253–267. <https://doi.org/10.1016/j.gloenvcha.2006.04.002>.
- Folke, C., Hahn, T., Olsson, P., Norberg, J., 2005. Adaptive Governance of Social-ecological. <https://doi.org/10.1146/annurev.energy.30.050504.144511>.
- Forman, R.T., 1995. Some general principles of landscape and regional ecology. *Landscape Ecol.* 10 (3), 133–142. Retrieved from. <http://www.scopus.com/inward/record.url?eid=2-s2.0-0028978611&partnerID=40&md5=63e7efbf85c5d3d147afbfd6c4b0257>.
- Forman, R.T.T., Godron, M., 1986. *Landscape Ecology*. John Wiley & Sons, New York.
- Furst, C., Volk, M., Makeschin, F., 2010. Squaring the circle? Combining models, indicators, experts and end-users in integrated land-use management support tools. *Environ. Manag.* 46 (6), 829–833. <https://doi.org/10.1007/s00267-010-9574-3>.
- Game, E.T., Meijaard, E., Sheil, D., McDonald-madden, E., 2014. Conservation in a wicked complex world: challenges and solutions. *Conserv. Lett.* 7 (3), 271–277. <https://doi.org/10.1111/conl.12050>.
- Gardner, T.A., Ferreira, J., Barlow, J., Lees, A.C., Parry, L., Vieira, I.C.G., ... Cardoso, T.M., 2013. A social and ecological assessment of tropical land uses at multiple scales: The Sustainable Amazon Network. *Philos. Trans. R. Soc. Lond. Ser. B Biol. Sci.* 368 (1619), 20120166. <https://doi.org/10.1098/rstb.2012.0166>.
- German, L., Mansoor, H., Alemu, G., Mazengia, W., Amede, T., Stroud, A., 2007. Participatory integrated watershed management: evolution of concepts and methods in an ecoregional program of the eastern African highlands. *Agric. Syst.* 94 (2), 189–204. <https://doi.org/10.1016/j.jagsy.2006.08.008>.
- Graham, A., Mitchell, C.L., 2016. The role of boundary organizations in climate change adaptation from the perspective of municipal practitioners. *Clim. Chang.* 381–395. <https://doi.org/10.1007/s10584-016-1799-6>.
- Green, J.M.H., Fisher, B., Green, R.E., Makero, J., Platts, P.J., Robert, N., Balmford, A., 2018. Local costs of conservation exceed those borne by the global majority. *Global Ecology and Conservation* 14, e00385. <https://doi.org/10.1016/j.gloeco.2018.e00385>.
- Griscom, B.W., Adams, J., Ellis, P.W., Houghton, R.A., Lomax, G., Miteva, D.A., Fargione, J., 2017. Natural climate solutions. *Proc. Natl. Acad. Sci.* 114 (44), 11645–11650. <https://doi.org/10.1073/pnas.1710465114>.
- Guillaume, E., 2017. A Case Study on Inclusiveness in Forest Management Decision-Making Mechanisms: A Comparison of Certified and Non-certified Forests in the Republic of the Congo A Case Study on Inclusiveness in Forest Management Decision-making Mechanisms: A Comparison o. vol. 19. pp. 145–157 (2).
- Gunderson, L., Holling, C.S., Peterson, G., Pritchard, L., 2001. Resilience. In: *Encyclopedia of Global Environmental Change*. vol. 2.
- Guston, D.H., 2001. *Boundary Organizations in Environmental Policy and Science: An Introduction*. 26(4). pp. 399–408.
- Hassenforder, E., Pittock, J., Barreteau, O., Daniell, K.A., Ferrand, N., 2016. The MEPPP framework: a framework for monitoring and evaluating participatory planning processes. *Environ. Manag.* 57 (1), 79–96. <https://doi.org/10.1007/s00267-015-0599-5>.
- Hendriks, C.M., 2009. Deliberative governance in the context of power deliberative governance in the context of power. *Polic. Soc.* 28 (3), 173–184. <https://doi.org/10.1016/j.polsoc.2009.08.004>.
- Hill, N.A.O., Rowcliffe, J.M., Koldewey, H.J., 2011. The interaction between seaweed farming as an alternative occupation and fisher numbers in the Central Philippines. *Conserv. Biol.* 26 (2), 324–334. <https://doi.org/10.1111/j.1523-1739.2011.01796.x>.
- Hilson, G., Banchirigah, S.M., 2009. Are alternative livelihood projects alleviating poverty in mining communities? Experiences from Ghana are alternative livelihood projects alleviating poverty in mining communities? Experiences from Ghana. *J. Dev. Stud.* 45 (2), 172–196. <https://doi.org/10.1080/00220380802553057>.
- Hodge, I.D., 2007. The governance of rural land in a liberalised world. *J. Agric. Econ.* 58 (3), 409–432.
- Holling, C.S., Chambers, R., 1973. Resource science: the nurture of an infant. *BioScience* 13–20.
- Hull, V., & Liu, J. (2018). Telecoupling: a new frontier for global sustainability. *Ecol. Soc.*, 23(4), art41. doi:<https://doi.org/10.5751/ES-10494-230441>.
- Jasonoff, S., 1996a. Is science socially constructed—and can it still inform public policy? *Sci. Eng. Ethics* 2 (3), 263–276.

- Jasonoff, S., 1996b. Beyond epistemology-relativism and engagement in the politics of science. *Soc. Stud. Sci.* 26 (2), 393–418.
- Kates, R., Clark, W. C., Hall, J. M., Jaeger, C., Lowe, I., McCarthy, J. J., ... et al. (2000). *Sustain. Sci.*
- Kingdon, J.W., Thurber, J.A., 1984. *Agendas, Alternatives and Public Policies*. Little, Brown, Boston.
- Koomen, E., Opdam, P., Steingröver, E., 2012. Adapting complex multi-level landscape systems to climate change. In: *Deltas in Times of Climate Change Conference*, Rotterdam, Netherlands, September 2010. 27. pp. 469–527. <https://doi.org/10.1007/s10980-012-9721-8>.
- Kozar, R., Buck, L.E., Barrow, E.G., Sunderland, T.C.H., Catacutan, D.E., Planicka, C., ... Willemen, L., 2014. *Toward Viable Landscape Governance Systems: What Works*.
- Kremen, C., Niles, J., Dalton, M., Daily, G.C., Ehrlich, P.R., Fay, J., ... Guillery, R., 2000. *Economic Incentives for Rain Forest Conservation Across*. vol. 288. pp. 1828–1833 (June).
- Kusters, K., Buck, L., Graaf, M. De, Minang, P., Oosten, C. Van, Zagt, R., 2017. Participatory planning, monitoring and evaluation of multi-stakeholder platforms in integrated landscape initiatives. *Environ. Manag.* 0–1. <https://doi.org/10.1007/s00267-017-0847-y>.
- Langholz, J., 1999. Exploring the effects of alternative income opportunities on rainforest use: insights from Guatemala's Maya biosphere reserve exploring the E V ects of alternative income opportunities on rainforest use: insights from Guatemala's Maya biosphere rese. *Soc. Nat. Resour.* 12 (2), 139–149. <https://doi.org/10.1080/089419299279803>.
- Larsen, Rasmus, K., Osbeck, M., Dawkins, E., Tuhkanen, H., Nguyen, H., Nugroho, A., ... Wolvekamp, P. (2018). Hybrid governance and evaluation of agricultural commodity chains: insights from implementation of 'No Deforestation, No Peat, No Exploitation' (NDPE) policies in the oil palm industry. *J. Clean. Prod.*, 183, 544–554. doi:<https://doi.org/10.1016/j.jclepro.2018.02.125>.
- Lemos, M.C., Agrawal, A., 2006. Environmental governance. *Annu. Rev. Environ. Resour.* 31 (1), 297–325. <https://doi.org/10.1146/annurev.energy.31.042605.135621>.
- Lindblom, C.E., 1959. The science of "muddling through." *Public Adm. Rev.* 79–88.
- Ling, C., Hanna, A.K., Dale, A.E., 2009. A Template for Integrated Community Sustainability Planning. pp. 228–242. <https://doi.org/10.1007/s00267-009-9315-7>.
- Liu, J., Hull, V., Batistella, M., Defries, R., Dietz, T., Fu, F., Naylor, R., 2013. Framing sustainability in a telecoupled world. *Ecol. Soc.* 18 (2).
- Lotter, W., Clark, K., 2014. Community involvement and joint operations aid effective anti-poaching in Tanzania. *Parks* 20 (March), 19–28.
- Lund, J.F., 2015. Paradoxes of participation: the logic of professionalization in participatory forestry. *Forest Policy Econ.* 60, 1–6. <https://doi.org/10.1016/j.forpol.2015.07.009>.
- Luttrell, C., Loft, L., Gebara, M.F., Kweka, D., Brockhaus, M., Angelsen, A., 2013. Who should benefit from REDD + ? Rationales and realities. *Ecol. Soc.* 18 (4).
- Marlier, M.E., Defries, R.S., Voulgarakis, A., Kinney, P.L., Randerson, T., Shindell, D.T., ... Faluvegi, G., 2013. El Niño and health risks from landscape fire emissions in southeast Asia. *Nat. Clim. Chang.* 3, 131–136. <https://doi.org/10.1038/nclimate1658>.
- Martin, A., Coolsaet, B., Corbera, E., Dawson, N.M., 2018. Land use intensification: The promise of sustainability and the reality of trade-offs. In: Schreckenberg, K., Mace, G., Poudyal, M. (Eds.), *Ecosystem Services and Poverty Alleviation: Trade-offs and Governance*. Taylor & Francis Group.
- Meadows, D., 1998. *Indicators and Information Systems for Sustainable*. 78.
- Mistry, B.J., Berardi, A., 2016. Bridging indigenous and scientific knowledge. *Science* 352 (6291), 1274–1276.
- Moeliono, M., Gallemore, C., Santoso, L., Brockhaus, M., Di Gregorio, M., 2014. Information networks and power: confronting the "wicked problem" of REDD + in Indonesia. *Ecol. Soc.* 19 (2).
- Mollinga, P.P., 2010. Boundary Work and the Complexity of Natural Resources Management (April). <https://doi.org/10.2135/cropsci2009.10.0570>.
- Muradian, R., Arsel, M., Pellegrini, L., Adaman, F., Aguilar, B., Agarwal, B., Urama, K., 2013. Payments for ecosystem services and the fatal attraction of win-win solutions. *Conserv. Lett.* 6 (4), 274–279. <https://doi.org/10.1111/j.1755-263X.2012.00309.x>.
- Musacchio, L.R., 2009. The scientific basis for the design of landscape sustainability: a conceptual framework for translational landscape research and practice of designed landscapes and the six Es of landscape sustainability. *Landsc. Ecol.* 24 (8), 993–1013. <https://doi.org/10.1007/s10980-009-9396-y>.
- Mutune, J., Lund, J., 2016. Unpacking the impacts of 'participatory' forestry policies: evidence from Kenya. *Forest Policy Econ.* 69, 45–47.
- Naidoo, R., Weaver, L.C., Diggle, R.W., Matongo, G., Stuart-hill, G., Thouless, C., 2016. Complementary Benefits of Tourism and Hunting to Communal Conservancies in Namibia. vol. 30. pp. 628–638. <https://doi.org/10.1111/cobi.12643>.
- Newton, P., Agrawal, A., Wollenberg, L., 2013. Enhancing the sustainability of commodity supply chains in tropical forest and agricultural landscapes. *Global Environmental Change-Human and Policy Dimensions* 23 (6), 1761–1772. <https://doi.org/10.1016/j.gloenvcha.2013.08.004>.
- O'Farrell, P.J., Anderson, P.M.L., 2010. Sustainable multifunctional landscapes: a review to implementation. *Curr. Opin. Environ. Sustain.* 2 (1–2), 59–65. <https://doi.org/10.1016/j.cosust.2010.02.005>.
- Olsson, P., Gunderson, L.H., Carpenter, S.R., Ryan, P., Lebel, L., Folke, C., Holling, C.S., 2006. *Shooting the Rapids: Navigating Transitions to Adaptive Governance of Social-Ecological Systems*. 11 (1).
- Ostrom, E., 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge university press.
- Ostrom, E., Burger, J., Field, C.B., Norgaard, R.B., Policansky, D., 1999. Revisiting the commons: local lessons, global challenges. *Science* 284 (5412), 278–282.
- Palomo, I., Martín-López, B., López-Santiago, C., Montes, C., 2011. Participatory scenario planning for protected areas management under the ecosystem services framework: the Doñana social-ecological system in southwestern Spain. *Ecol. Soc.* 16 (1).
- Persha, L., Agrawal, A., Chhatre, A., 2011. Social and ecological synergy: local rule-making, forest livelihoods, and biodiversity conservation. *Science* 331 (6024), 1606–1608. <https://doi.org/10.1126/science.1199343>.
- Plieninger, T., Göttingen, G., Oteros-rozas, E., Olavide, U.P. De, Bieling, C., 2013. Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy* 33 (July), 118–129. <https://doi.org/10.1016/j.landusepol.2012.12.013>.
- Pohl, C., Rist, S., Zimmermann, A., Fry, P., Schneider, F., Speranza, C.I., ... Wiesmann, U., 2010. Researchers' Roles in Knowledge Co-production: Experience From Sustainability Research in Kenya, Switzerland, Bolivia and Nepal. 37. pp. 267–281. <https://doi.org/10.3152/030234210X496628>. (May).
- Polsky, C., Cash, D., 2005. Drought, climate change, and vulnerability: The role of science and technology in a multi-scale, multi-stressor world. In: *Drought and Water Crises: Science, Technology, and Management Issues*. Marcel Dekker, New York, New York, USA, pp. 215–245.
- Prestele, R., Alexander, P., Rounsevell, M.D.A., Calvin, K., Doelman, J., Eitelberg, D.A., 2016. Hotspots of Uncertainty in Land-use and Land-cover Change Projections: A Global-scale Model Comparison (April). pp. 3967–3983. <https://doi.org/10.1111/gcb.13337>.
- Qiu, J., Game, E.T., Tallis, H., Olander, L.P., Glew, L., Kagan, J.S., Weaver, S.K., 2018. Evidence-based causal chains for linking health, development, and conservation actions. *BioScience* 68 (3). <https://doi.org/10.1093/biosci/bix167>.
- Reed, J., Van Vianen, J., Deakin, E.L., Barlow, J., Sunderland, T., 2016. Integrated landscape approaches to managing social and environmental issues in the tropics: learning from the past to guide the future. *Glob. Chang. Biol.* 22 (7). <https://doi.org/10.1111/gcb.13284>.
- Reed, James, Vianen, J. Van, Barlow, J., Sunderland, T., 2017. Land Use Policy Have integrated landscape approaches reconciled societal and environmental issues in the tropics? *Land Use Policy* 63, 481–492. <https://doi.org/10.1016/j.landusepol.2017.02.021>.
- Reyers, B., Nel, J.L., Farrell, P.J.O., Sitas, N., Nel, D.C., 2015. Navigating Complexity Through Knowledge Coproduction: Mainstreaming Ecosystem Services Into Disaster Risk Reduction. 112. <https://doi.org/10.1073/pnas.1414374112>. (24).
- Ribot, J.C., Lund, J.F., Treue, T., 2010. Democratic decentralization in sub-Saharan Africa: its contribution to forest management, livelihoods. *Environmental Conservat* 37 (1), 35–44. <https://doi.org/10.1017/S0376892910000329>.
- Rittel, H., Webber, M., 1973. Rittel and Webber 1973 - dilemmas in a general theory of planning.pdf. *Policy. Sci.* 4, 155–169.
- Robbins, P., 2011. *Political Ecology: A Critical Introduction*. vol. 16 John Wiley & Sons.
- Roe, D. (Ed.), 2015. *Conservation, Crime and Communities*. IIED, London.
- Roe, D., Booker, F., Day, M., Zhou, W., Allebone-Webb, S., Hill, N. A. O., ... Sunderland, T. C. H. (2015). Are alternative livelihood projects effective at reducing local threats to specified elements of biodiversity and/or improving or maintaining the conservation status of those elements? *Environmental Evidence*, 4(1), 1–22. doi:<https://doi.org/10.1186/s13750-015-0048-1>.
- Sainsbury, K., Burgess, N.D., Sabuni, F., Howe, C., Puis, E., Killenga, R., Milner-gulland, E.J., 2015. Exploring stakeholder perceptions of conservation outcomes from alternative income generating activities in Tanzanian villages adjacent to Eastern Arc Mountain forests. *Biol. Conserv.* 191, 20–28. <https://doi.org/10.1016/j.biocon.2015.06.001>.
- Sandbrook, C., Adams, W.M., Buscher, B., Vira, B., 2013. Social research and biodiversity conservation. *Conserv. Biol.* 27 (6), 1487–1490. <https://doi.org/10.1111/cobi.12141>.
- Sandker, M., Campbell, B.M., Nzooh, Z., Sunderland, T., Amougou, V., Defo, L., Sayer, J., 2009. Exploring the effectiveness of integrated conservation and development interventions in a Central African forest landscape. *Biodivers. Conserv.* 18 (11), 2875–2892.
- Sandker, M., Campbell, B.M., Ruiz-Pérez, M., Sayer, J.A., Cowling, R., Kassa, H., Knight, A.T., 2010. The role of participatory modeling in landscape approaches to reconcile conservation and development. *Ecol. Soc.* 15 (2), 13.
- Savedoff, W., Levine, R., Birdsall, N., 2005. *When Will We Ever Learn? Recommendations to Improve Social Development Through Enhanced Impact Evaluation*. 15 Centre for Global Development, Washington DC.
- Sayer, J.A., Campbell, B.M., 2004. *The Science of Sustainable Development: Local Livelihoods and the Global Environment*. Cambridge University Press.
- Sayer, J., Bull, G., Elliott, C., 2008. *Mediating Forest Transitions: 'Grand Design' or 'Muddling Through'?* 6. pp. 320–327 (4).
- Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J.L., Sheil, D., Meijaard, E., ... Buck, L.E., 2013. Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proc. Natl. Acad. Sci. U. S. A.* 110 (21), 8349–8356.
- Sayer, Jeffrey, Margules, C., Boedihartono, A.K., Dale, A., Sunderland, T., Supriatna, J., Saryanthi, R., 2014. Landscape approaches: what are the pre-conditions for success? *Sustain. Sci.* 10 (2), 345–355.
- Sayer, J., Endamana, D., Boedihartono, A.K., Breuer, T., 2016a. *Learning From Change in the Sangha Tri-National Landscape*. 18. pp. 130–139.
- Sayer, J.A., Margules, C., Boedihartono, A.K., Sunderland, T., Langston, J.D., Reed, J., Sayer, J.A., 2016b. Measuring the effectiveness of landscape approaches to conservation and development. *Sustain. Sci.* <https://doi.org/10.1007/s11625-016-0415-z>.
- Scherr, S.J., Shames, S., Friedman, R., 2013. *Defining Integrated Landscape Management for Policy Makers*.
- Sessin-dilascio, K., Centro, I., Irvine, K.N., 2016. *The Dynamics of Co-Management and Social Capital in Protected Area Management—The Cardoso Island State Park in Brazil The Dynamics of co-Management and Social Capital in Protected Area*

- Management—The Cardoso Island State Park in Brazil (February). <https://doi.org/10.1016/j.worlddev.2014.11.004>.
- Smith, J., 2008. A critical appreciation of the “bottom-up” approach to sustainable water management: embracing complexity rather than desirability. *Local Environ.* 13 (4), 353–366.
- Star, S.L., Griesemer, J.R., 1989. Institutional ecology, translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Soc. Stud. Sci.* 19 (3), 387–420.
- Stenseke, M., 2009. Local Participation in Cultural Landscape Maintenance: Lessons from Sweden Local Participation in Cultural Landscape Maintenance: Lessons from Sweden. (April 2009). <https://doi.org/10.1016/j.landusepol.2008.01.005>.
- Steyaert, P., Jiggins, J., 2007. Governance of Complex Environmental Situations Through Social Learning: A Synthesis of SLIM's Lessons for Research, Policy and Practice. vol. 10. pp. 575–586. <https://doi.org/10.1016/j.envsci.2007.01.011>.
- Sunderland, T.C.H., Sayer, J., Hoang, M.-H., 2012. *Evidence-based Conservation: Lessons From the Lower Mekong*. Routledge.
- Tilman, D., Clark, M., 2014. Global diets link environmental sustainability and human health. *Nature* 515 (7528), 518–522. <https://doi.org/10.1038/nature13959>.
- Toomey, A.H., Knight, A.T., Barlow, J., 2016. Navigating the Space between Research and Implementation in Conservation. 00(October). pp. 1–7. <https://doi.org/10.1111/conl.12315>.
- Torring, J., 2012. *Interactive Governance: Advancing the Paradigm*. Oxford University Press on Demand.
- Trosper, R.L., 2003. Resilience in pre-contact Pacific Northwest social ecological systems. *Conserv. Ecol.* 7 (3), 6. [online] URL. <http://www.consecol.org/vol7/iss3/art6/>.
- Viana, C., Coudel, E., Barlow, J., Ferreira, J., Gardner, T., Parry, L., 2016. How Does Hybrid Governance Emerge? Role of the Elite in Building a Green Municipality in the Eastern Brazilian Amazon. vol. 350. pp. 337–350. <https://doi.org/10.1002/eet.1720>. (August).
- Walters, C., 1986. Adaptive management of renewable resources. In: *Biological Resource Management*.
- Watts, J.D., Colfer, C.J.P., 2011. The governance of tropical landscapes. In: Colfer, C.J.P., Pfund, J. (Eds.), *Collaborative Governance of Tropical Landscapes*. Earthscan, London, pp. 35–54.
- Wicander, S., Coad, L., 2015. *Learning our Lessons: A Review of Alternative Livelihood Projects in Central Africa*. IUCN.
- Wu, J., Hobbs, R., 2002. Key issues and research priorities in landscape ecology: an idiosyncratic synthesis. *Landsc. Ecol.* 17 (4), 355–365. Retrieved from. <http://www.scopus.com/inward/record.url?eid=2-s2.0-0036033445&partnerID=40&md5=4194751fad4ef5e8c6dfb2731fbc89c>.
- Wunder, Sven, 2001. Poverty alleviation and tropical forests—what scope for synergies? *World Dev.* 29 (11), 1817–1833. [https://doi.org/10.1016/S0305-750X\(01\)00070-5](https://doi.org/10.1016/S0305-750X(01)00070-5).
- Wunder, S., Brouwer, R., Engel, S., Muradian, R., Pascual, U., Pinto, R., 2018. From principles to practice in paying for nature's services. *Nature Sustainability* 1 (March), 145–150. <https://doi.org/10.1038/s41893-018-0036-x>.
- Young, O.R., 2002. Institutional interplay: The environmental consequences of cross-scale interactions. In: *The Drama of the Commons*, pp. 263–291.
- Zimmerer, K.S., Bassett, T.J., 2003. *Political Ecology: An Integrative Approach to Geography and Environment-development Studies*. Guildford Press.