LDD Land Degradation & Development

Putting the Pieces Together: Integration for Forest Landscape Restoration Implementation

Journal:	*Land Degradation & Development*
Manuscript ID	LDD-19-0051.R2
Wiley - Manuscript type:	Review Article
Date Submitted by the Author:	n/a
Complete List of Authors:	Mansourian, S; University of Geneva, Geography; Mansourian.org, Parrotta, John; USFS, Research & Development Balaji, Poorna; Ashoka Trust for Research in Ecology and the Environment, -; Manipal University, - Bellwood-Howard, Imogen; Institute of Development Studies, - Bhasme, Suhas; Ashoka Trust for Research in Ecology and the Environment, - Bixler, Patrick; University of Texas at Austin, - Boedhihartono, Agni; University of British Columbia Department of Forest and Conservation Sciences, - Carmenta, Rachel; University of Cambridge, - Jedd, Theresa; University of Nebraska, - de Jong, Wil; Kyoto University, - Lake, Frank; US Department of Agriculture Forest Service, - Latawiec, Agnieszka; Pontifical Catholic University of Rio de Janeiro, Department of Geography and the Environment; University of Agriculture in Kraków, Institute of Agricultural Engineering and Informatics Lippe, Melvin; Thünen Institute of International Forestry and Forest Economics , - Rai, Nitin; Ashoka Trust for Research in Ecology and the Environment, - Sayer, Jeffrey; University of British Columbia, - van Dexter, Kristina; George Mason University, - Vira, Bhaskar; Cambridge University, - Visseren-Hamakers, Ingrid; George Mason University, -; Radboud Universiteit, School of Management Wyborn, Carina; Luc Hoffmann Institute, - Yang, Anastasia; University of Edinburgh, School of Geosciences
Keywords:	Forest landscape restoration, Integration of natural resource management, Multi-functional landscapes, Traditional knowledge, Drivers of deforestation

PUTTING THE PIECES TOGETHER: INTEGRATION FOR FOREST LANDSCAPE RESTORATION IMPLEMENTATION

RUNNING TITLE: INTEGRATION FOR FOREST LANDSCAPE RESTORATION

Authors: Stephanie Mansourian[1,2], John Parrotta[3,4], Poorna Balaji[5,6], Imogen Belwood-Howard[7], Suhas Bhasme[5], R. Patrick Bixler[8], Agni Klintuni Boedhihartono[9], Rachel Carmenta[10], Theresa Jedd[11], Wil de Jong[12], Frank K. Lake[3], Agnieszka Latawiec[13,14], Melvin Lippe[15], Nitin D. Rai[5], Jeffrey Sayer[9], Kristina Van Dexter[16], Bhaskar Vira[10], Ingrid Visseren-Hamakers[16,17], Carina Wyborn[18], Anastasia Yang[19]

Affiliations:

1. University of Geneva, 2. Mansourian.org, 3. USDA Forest Service, 4. IUFRO, 5. Ashoka Trust for Research in Ecology and the Environment, 6. Manipal Academy of Higher Education, 7. Institute of Development Studies, 8. University of Texas, 9. University of British Columbia, 10. University of Cambridge, 11. University of Nebraska, 12. Kyoto University, 13. Pontifical Catholic University of Rio de Janeiro, 14. University of Agriculture in Kraków, 15. Thünen Institute of International Forestry and Forest Economics , 16. George Mason University, 17. Radboud University, 18. Luc Hofmann Institute, 19. University of Edinburgh.

Corresponding author: Stephanie Mansourian, 36 Mont d'Eau du Milieu, 1276 Gingins, Switzerland, tel: +41796338839, e-mail: stephanie@mansourian.org

Putting the Pieces Together: Integration for Forest Landscape Restoration Implementation

RUNNING TITLE: INTEGRATION FOR FOREST LANDSCAPE RESTORATION

Abstract

The concept of forest landscape restoration (FLR) is being widely adopted around the globe by governmental and non-governmental agencies, and the private sector, all of whom see FLR as an approach that contributes to multiple global sustainability goals. Originally, FLR was designed with a clearly integrative dimension, across sectors, stakeholders, space and time, and in particular across the natural and social sciences. Yet, in practice this integration remains a challenge in many FLR efforts. Reflecting this lack of integration are the continued narrow sectoral and disciplinary approaches taken by forest restoration projects, often leading to marginalisation of the most vulnerable populations, including through land dispossessions. This article aims to assess what lessons can be learned from other associated fields of practice for FLR implementation. To do this, 35 scientists came together to review the key literature on these concepts to suggest relevant lessons and guidance for FLR. We explored the following large-scale land use frameworks or approaches: land sparing/land sharing, the landscape approach, agroecology and socio-ecological systems. Also, to explore enabling conditions to promote integrated decision-making we reviewed the literature on: understanding stakeholders and their motivations; tenure and property rights; polycentric governance; and integration of traditional and western knowledge. We propose lessons and guidance for practitioners and policymakers on ways to improve integration in FLR planning and implementation. Our findings highlight the need for: a change in decision-making processes for FLR; better understanding of stakeholder motivations and objectives for FLR; and balancing planning with flexibility to enhance social-ecological resilience.

1. Introduction

Globally many forest landscapes remain central to the cultures and economies of indigenous and local communities and their loss, degradation and transformation can have deleterious impacts on livelihoods. Despite growing recognition of the importance of forests and forested landscapes for multiple goods and services, we continue to lose forests, with up to 230 million ha of forest lost over the 2000-2012 period (Hansen et al., 2013). Equally alarming, forest degradation (i.e., reduction in forests' capacity to deliver ecosystem services as a result of anthropogenic and environmental changes) remains pervasive in many parts of the world (Hosonuma et al., 2012; Kissinger et al., 2012, IPBES, 2018). Tree-planting programmes of various sorts have transformed 80 million ha of land (of various condition and land use) between 2000 and 2012 (Hansen et al., 2013). Figures from the Food and Agriculture Organization of the United Nations (FAO) ~~FAO figures~~ suggest that between 2010 and 2015, annual forest cover increased 4.3 million ha in some regions (FAO, 2016), much of it occurring in China through its large scale (and often controversial) afforestation and reforestation programmes. Despite these gains in forest cover in some regions, the quality of these forests and the programme objectives are not always aligned to the needs of those most dependent on forests or to long-term landscape resilience and sustainability (Adams et al., 2016; Mansourian et al., 2017). Forest landscape restoration (FLR) has emerged as an approach to address forest loss and degradation in the last two decades (Mansourian et al., 2005; Rietbergen-McCracken et al., 2007; Maginnis & Jackson, 2005). The 2011 Bonn Challenge on forest landscape restoration epitomises the global restoration movement with its target to "bring into restoration" 150 million ha by 2020 and 350 million ha by 2030 (Aronson and Alexander, 2013). Programmes with similar objectives exist at all scales: the United Nations' "Billion Trees Campaign" launched in 2006; the African restoration initiative AFR 100 aims to bring 100 million hectares of land in Africa into restoration by 2030; and

Brazil's Atlantic Forest Restoration Pact aims to enable the recovery of 15 million hectares by the year 2050; and so on. Laudable as these commitments are, restoration of landscapes capable of delivering multiple benefits for diverse stakeholders and addressing the full range of ecological, human, political and economic dimensions that underlie deforestation and forest degradation requires more than just planting trees (Mansourian et al., 2005; Aronson et al., 2010).

The term FLR was defined in 2000 as "a planned process that aims to regain ecological integrity and enhance human wellbeing in deforested or degraded landscapes" (WWF and IUCN, 2000; Mansourian et al., 2005). Integration and interdisciplinarity are implicit through the two objectives of FLR: regaining ecological integrity and enhancing human wellbeing. We interpret 'interdisciplinarity' as a means of bringing together diverse perspectives from various fields of study and different knowledge systems and management practices in order to solve a common problem (adapted from McNeill et al., 2001) and 'integration' as the broader umbrella term that covers different forms of collaboration across disciplines or sectors (adapted from Tress et al., 2005).

The challenge of integrating the human and ecological dimensions of FLR remains significant and presents an obstacle to widescale application. However, limited research exists to date on these aspects. To address some of these integration challenges, it is useful to understand how related knowledge and research beyond the forest landscape restoration community can be applied to FLR (Mansourian & Parrotta, 2018).

Our hypothesis is that through their experience of integrative and interdisciplinary approaches, other fields of practice and analysis related to land use may offer lessons for FLR in terms of improving diagnosis of restoration challenges, definition of objectives and targets, planning and implementation. ~~Our hypothesis is that other fields of practice and analysis related to land use may offer lessons for FLR in terms of improving diagnosis, planning and implementation through their experience of integrative and interdisciplinary approaches.~~ This contribution explores frameworks, approaches and conceptual frames (hereafter referred to as "approaches" for short) in related fields of practice, through an FLR lens to identify useful lessons related to integration that could improve FLR implementation.

2. Methodology

Between 2016 and 2018, 35 scientists working in a variety of disciplines from around the world joined forces to produce an edited volume on integration for FLR. The justification for the volume was twofold: our premise was that drivers of forest loss and degradation are predominantly anthropogenic, often crossing scales (e.g., contradictions between livelihood needs at the local level and economic, financial and political forces operating at national or international scales) and sectors (e.g., infrastructure construction contributing to forest loss and degradation) (IPBES, 2018). Additionally, FLR implementation is often criticized as being too uni-dimensional and that more could be done to promote integration and interdisciplinarity in FLR implementation (Reinecke & Blum, 2018; Caughlin et al., 2019). To begin to respond to these challenges we sought to explore and bring together integration lessons from other related and topical land use challenges that could be applied to FLR.

A review of the literature and prevalent discourses in international science/policy forums related to land management, allowed us to identify four approaches related to the people-nature nexus, which can be used to explore integration in FLR implementation:

1. Social-ecological systems (defined by Anderies et al. (2004) as an ecological system intricately linked with and affected by one or more social systems),

2. Integrated landscape approaches (with landscapes defined by Sayer and Boedhihartono (2012) as "a mosaic of different land-cover types that have properties that differ from the simple sum of the properties of the individual cells of the mosaic."),
3. Land sparing-sharing (with land sharing defined by Phalan et al. (2011) as integrating "both objectives on the same land"; and land sparing defined by them as combining "high-yield farming (..) with protecting natural habitats from conversion to agriculture."), and
4. Food security through agroecology (defined "as the science of ecology applied to the design, development, and management of agriculture" van Dexter and Visseren-Hamakers, 2018).

In addition, to explore enabling conditions to promote integrated decision-making we reviewed the literature on: understanding stakeholders and their motivations; tenure and property rights; polycentric governance (presenting multiple centres of authority - Ostrom, 1999); and integration of traditional and western knowledge.

Chapter teams explored their topic through an FLR lens to identify relevant integration lessons to support FLR implementation. The book's co-editors identified emerging trends across the chapters. The following three questions were specifically explored across the entire body of work:

1. What are some of the integration challenges for FLR?
2. What can we learn from other large scale land use initiatives, frameworks or approaches?
3. How can integrated approaches improve FLR decision-making processes?

Our collaborative research highlighted several areas that can be useful for FLR decision-makers, policymakers, resource managers and practitioners. The next section distils the main findings from this work responding to the above three questions.

3. Integration challenges for FLR

Analysing, understanding, addressing and reversing drivers of forest loss is the first step to any successful, long term and sustainable restoration programme (Mansourian et al., 2017; IPBES, 2018). Drivers of forest loss can nearly always be traced back to human pressures, notably population growth, land scarcity, urbanization and market forces, including rising global demand for specific products such as palm oil (Lambin & Meyfroidt, 2011; Kissinger et al., 2012). In turn these are associated with governance challenges, inadequate policies, poor or inadequate cross-sectoral coordination, perverse incentives and illegal activities (Kissinger et al., 2012; Riggs et al., 2018). Despite the complexity of factors that contribute to forest loss and degradation, narrow sectoral or disciplinary approaches to address this issue continue to abound in restoration interventions (Perring et al., 2018; Caughlin et al., 2019). Such 'silo-based' approaches often create negative externalities and cannot adequately address the diversity of issues that contribute to deforestation and land degradation (IPBES, 2018). For instance, an emphasis on carbon sequestration in afforestation/reforestation fails to acknowledge the multiple benefits (e.g. food, soil stabilisation, biodiversity, etc.) that a more integrated approach to reverse land degradation could achieve.

An understanding of what comprises land and forest degradation, and preferences for management scenarios, can depend on individuals' backgrounds and value systems: a social scientist may perceive the landscape differently than an ecologist, or an industrial business person's view may differ from that of a small-scale subsistence farmer (Carmenta et al., 2017; Mansourian, 2018). The multiplicity of interests in forests - as an object of exploitation, a basis for local livelihoods, as biodiversity-rich ecosystems, as places for climate change mitigation and adaptation, and a global resource to protect, manage and restore - spans many disciplines, sectors and actors (Baker et al., 2014; Mansourian, 2018). For example, forest scientists and ecologists have sought to understand the dynamics of forest ecosystems to restore ecosystem functions on degraded forest lands and improve

habitat quality for key species (Hobbs & Norton, 1996; Higgs, 1997; Lamb et al., 2005; Palmer et al., 2006), while development organizations have seen restoration as a tool to reverse land degradation and enhance rural livelihoods, supply communities with fuelwood and other forest products, improve water and soil quality, and protect agricultural fields and coastlines (MEA, 2005). Forest transition theorists have made significant progress in understanding the factors that drive forest decline and a subsequent return of tree cover in landscapes. Social-ecological systems (SES) theorists have suggested that resilience - a concept developed in ecosystem theory and defined as the ability to withstand or maintain integrity in the face of a shock and a switch to another state (Folke et al., 2002) - can apply to forest landscapes.

Yet, there is surprisingly little collaboration among scientists, FLR planners, practitioners, and policy-makers (Mansourian, 2018; Riggs et al., 2018). There is also little cross-disciplinary use of knowledge from relevant forestry and non-forestry disciplines. More generally, there is limited knowledge sharing and awareness of different values, and collaboration has rarely transcended disciplines, sectors or even geographical scales in efforts related to FLR (Reinecke & Blum, 2018; Mansourian, 2018; Caughlin et al., 2019). Such collaboration is important to ensure that multiple environmental, economic and social objectives encompassing a range of values for forest restoration can be fulfilled, reconciled and mainstreamed through policies (Reinecke & Blum, 2018).

To date, expertise in restoration ecology has been applied to the restoration of relatively small-scale sites, focusing on reproducing ecological processes with limited attention to the social dimensions of restoration (e.g. McDonald et al., 2016). Restoration ecologists have emphasised recreating systems that are similar to those prior to the degradation event, focusing exclusively on biophysical criteria, i.e., authenticity, naturalness, structure, composition, function, dynamics (Palmer et al., 2006; Chazdon, 2008; Stanturf et al., 2014; McDonald et al., 2016). Scale mismatches occur between the social and ecological systems considered in FLR (Cumming et al., 2006). Further, the emphasis has been on western scientific knowledge and associated priorities, with limited attention paid to integrating the knowledge, experience and aspirations of indigenous peoples and local communities into restoration efforts (Berkes & Davidson-Hunt, 2006; Egan et al., 2011; Hill et al., 2013; Lake et al., 2017).

Linkages across the science-practice-policy interface remain limited for restoration (Suding 2011) and while FLR has significant political leverage, policies in support of FLR remain insufficient and often disconnected from both science and practice (Baker et al., 2014). This is reflected, for example, in the ambitious targets set by governments for restoration forest landscapes which go beyond the available scientific and technical capacity required to meet them (Aronson et al., 2010).

4. Integration lessons for FLR from related approaches

In this section we review some of the key lessons from the four approaches investigated as well as related enabling conditions that can support FLR planning and implementation (also see Table 1).

4.1 Lessons from social-ecological systems

From the social-ecological system (SES) literature, we learned that understanding the roles of multiple stakeholders at different spatial scales is essential (Ostrom, 2009; Yang et al., 2018). Within the landscape to be restored, multiple stakeholders interact and are influenced by others within a series of social and ecological nested scales (Holling 2001). Influences are exerted from above (e.g. national level) and below (e.g. village level) and feedback loops exist that transform the system. Seeking to integrate these influences into FLR implementation requires mechanisms that can bring different stakeholders together in a non-threatening, participatory and transparent decision-making process (Ananda, 2007). For example, in the Crown of the Continent landscape in North America, Canadian and American NGOs and government agencies connect through social networks in a

roundtable process that results in a net gain in accountability (Jedd and Bixler, 2015). Additionally, in northern California, the Western Klamath Restoration Partnership (WKRP) brings together tribal, federal, and non-governmental stakeholders to define priority restoration actions on different parts of the landscape using multiple cultural values associated with the landscape and its use (Lake et al., 2018). Polycentric governance further enables objectives to be tailored to, and responsive to, local landscape dynamics while still contributing to broader landscape scale objectives (Bixler et al., 2018).

Recognising and understanding these linkages and interactions can help to map the whole network of stakeholders and their relationships (Buckingham et al., 2018), and identify the ways in which they impact on or are affected by the restoration process~~,~~. ~~as well as~~ It will also help to identify the ways in which resilience and adaptive capacity of both social and ecological systems can be enhanced through FLR projects.

Embracing complexity, as exemplified in SES approaches, shines a light on trade-offs between ecological integrity and people's livelihoods and wellbeing (Erbaugh & Oldekop, 2018). Acknowledging that addressing trade offs in land use is necessary in order to accommodate both the demand for food and the essential biodiversity conservation priorities to maintain our life-support system (Lewis et al., 2018), what such trade-offs entail will depend on the context and the needs and interests of stakeholders, particularly those that live in the landscape (Yang et al. 2018). Forest landscape restoration inherently transcends both social and ecological systems; if it is to be successful in the long term, it must take both into account to maximise opportunities and resilience. The SES literature can inform resource users and other stakeholders on appropriate restoration strategies by increasing their awareness of the balance between risk, resilience and benefits associated with different interventions. Informing and preparing stakeholders for the potential outcomes of FLR interventions will be key to achieving success.

Resilience, which is relevant to both social and ecological systems, will be affected by restoration, which modifies both the social and the ecological "landscape". A balance must be sought between the resilience of human and ecological system components (Yang et al., 2018). While the desired relationship is a positive one for both human and ecological components, restoration may also negatively affect social and/or ecological resilience. For example, returning trees to the landscape that are not valued by or useful to local communities may actually decrease overall resilience of the SES (Yang et al., 2018). Furthermore, a cascade of impacts on the resilience of these systems may be generated across spatial and temporal scales. This happens because processes occurring along smaller spatial and temporal scales can influence those happening over longer spatial and temporal scales and vice versa (Holling, 2001). Ultimately, the intention in an FLR process is to aim for resilience, adaptability and sustainability of the entire social-ecological system.

4.2. Lessons from the landscape approach

From the landscape approach we have learned that landscapes evolve continuously, both socially and ecologically, necessitating a flexible approach to planning for the long-term. Adaptive management (a structured, iterative process of robust decision-making informed by system monitoring with an aim to reduce uncertainty over time) is a key component of FLR implementation, allowing~~s~~ for periodic adjustments to meet longer term objectives and secure landscape resilience (Larson et al., 2013; Sayer and Boedhihartono, 2018). Periodic re-appraisals of progress towards long term restoration objectives – and any necessary modification of management actions –need to be informed by monitoring of appropriate biophysical and socioeconomic indicators.

Influences from other spatial scales signify that decision-makers and practitioners must look *beyond* the landscape (Arts et al., 2017- acknowledging that the 'landscape' can be both a fuzzy spatial scale, as well as a means of integrating social and ecological dimensions). Although the landscape is the unit of interest, it is itself a contested space (Sgard, 2010) and is impacted by processes occurring at other spatial scales (Cumming et al., 2006). A narrow approach focusing on the landscape (even with all its inherent complexities) risks losing sight of important influences that may need to be incorporated for FLR to be successful (Bixler et al., 2018). At the same time, local priorities and uses also need to be addressed; many restoration projects have failed to consider locally-valued species. For example, in Morocco's Béni Boufrah valley residents opposed large scale reforestation with pine species, while they embraced projects that used locally valued species such as barbary red cedar (*Tetraclinis articulata*) and mastic (*Pistacia lentiscus*) which resulted in higher success rates (Derak et al., 2017). Thus, different stakeholders within and beyond the landscape will have different objectives for restoration and these need to be negotiated and reconciled as part of the FLR implementation plan if the effort is to be sustainable.

We found that tenure security and property rights associated with land, forest, trees, goods and services from the trees are critical enabling factors for FLR that need to be considered. However, tenure relations in forest landscapes are more nuanced than the relationship between ownership, rights and investments. Tenure security provides stakeholders with an incentive to invest in land management such as restoration (McLain et al., 2018). Tenure security and formality however, are not equivalent. While land tenure is important from a land rights perspective and often politically contentious, different property rights (e.g. the right to manage forests or the right to use them) may be secured in many instances without the formality of tenure (de Jong et al., 2018). Further, expecting legality of tenure to be a prerequisite for FLR may lead to numerous missed opportunities. Instead, in reality there is a continuum of measures and rights that are not necessarily formal which may be applicable given specific contexts and may serve to promote FLR. For example, in Changting County in China's western Fujian Province, a combination of tenure reforms that gave individuals or legal entities far-reaching land use rights and incentives under the Conversion of Cropland to Forest Programme (CCFP) have led to a 20% increase in forest cover and an increase in average annual farm income from USD 60 to USD 1,110 over a 30-year period (de Jong et al., 2018).

The diversity of stakeholders engaged in FLR leads to an equally diverse set of perceptions and understandings concerning the causes of forest loss and degradation (Mansourian, 2018). Progress is hampered by a lack of common understanding among stakeholders concerning causes and importance of forest loss and degradation, objectives for FLR and priority implementation actions (Buckingham et al., 2018). These divergent understandings reduce the likelihood of agreement on a common vision and plan of action for restoring the landscape (Erbaugh & Oldekop, 2018). Also, divergent economic impacts of forest conversion and degradation on stakeholders lead to competing priorities for forest restoration, and different views of the benefits and burdens of forests, as well as different aspirations for the landscape. Priorities may be shaped by politically powerful actors with particular interests in trajectories of land use change, rather than representing a common understanding of what should be done (Baker et al., 2014). As a result, existing power dynamics may be reinforced and FLR, like other large-scale land use interventions, may exacerbate inequalities through exaggerating the position of both "winners" and "losers" (Rai et al., 2018).

The landscape approach acknowledges that landscape level solutions should recognise the value of diversity (Sayer & Boedhihartono, 2018). There is no -one-size-fits-all- solution for FLR. Socio-political and economic circumstances vary greatly across and within landscapes dictating the viable and acceptable options for FLR. Furthermore, over the timescales necessary for forest landscape restoration, landscapes will change, stakeholders may change and their needs may evolve or have to adapt to changing environmental and socio-political conditions. This calls for a regular re-appraisal of the context, priorities, objectives and management actions based on sound monitoring data.

4.3. Lessons from land sparing/sharing

From the land-sparing/land-sharing literature we learned that broad priorities for the landscape can integrate multiple objectives (Latawiec et al., 2018). It can be argued that land sparing/land sharing has contributed to a false dichotomy between ecological and human wellbeing objectives (e.g. see Bennett, 2017), while in reality in most circumstances a mix of approaches will be needed (Latawiec et al., 2018). Quantifying the various benefits provided by restored forest landscapes for different stakeholders can help to define suitable restoration strategies.

Choices about land use are made in the landscape by different stakeholders with divergent priorities and facing different constraints (McLain et al., 2018). Landscape interventions need to take these choices into consideration and understand the diverse motivations driving them (Mansourian, 2018) which may help to reconcile trade-offs for FLR by working across stakeholder groups to reach common agreement. For example, in Madagascar's Fandriana-Marolambo landscape, communities were initially wary of the State forest service who historically had encouraged them to plant exotic species, only to later punish them for doing so, and as a result, engaging both parties in FLR required an understanding of these divergent starting points, concerns and motivations (Mansourian et al., 2016).

Adaptive management is a core lesson emerging from the land sparing/land sharing debate, recognising that a mixture of both might provide the optimal solutions to deliver on "nature's contributions to people". Tensions between planning at the 'landscape' scale and implementing flexible local actions need to be acknowledged and addressed. FLR seeks to achieve a wider, landscape-level plan, vision or overarching series of long-term objectives, through local or site-based interventions that are frequently associated with short term imperatives. However, as landscapes evolve, so will approaches and objectives. Restoration itself modifies feedback loops, for example, potentially influencing natural evolution (e.g. Raimundo et al., 2018) or transforming indigenous knowledge on restoration (e.g. Hartmann et al., 2016) within the social-ecological system, thereby also necessitating adaptive management (Larson et al., 2015). Provisions need to be made for this flexibility, whilst also acknowledging the need for planning and measuring progress that provides lessons to better inform future phases (Evans et al., 2018). Gross and Hoffmann-Riem (2005), referring to a participatory restoration project in Montrose Point (USA), call this "recursive design" whereby the long-term restoration project has repeatedly had to change in response to changing ecological and social realities.

To date, many large-scale land use interventions, such as land-sparing or land-sharing are hampered by a lack of reliable evidence on their impact (Latawiec et al., 2018; Rasmussen et al, 2018). FLR, as many other large-scale interventions (e.g. REDD+[1] - Duchelle et al., 2018) and conservation more broadly (Ferraro et al., 2006), has suffered from a lack of effective and useful monitoring systems to evaluate attainment of management objectives and inform further action. The results of regular monitoring, if effectively fed back into decision-making processes, can inform these and influence changes in approaches (Larson et al., 2013). Decisions about what to monitor, and who should monitor are also important, since setting targets and indicators dictates the direction of change, enhancing some views while potentially marginalising others (Jacobs et al., 2018).

4.4. Lessons from agroecological approaches

[1] Reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.

Agroecological and agroforestry science and methods combine indigenous and local knowledge with the intention to restore the productive, ecological, social and political fabric of landscapes to provide a range of services and valued resources (van Dexter & Visseren-Hamakers, 2018). Such approaches can provide an alternative pathway to FLR based on local needs and values, and may be a means of reconciling multiple objectives such as water security, food production and biodiversity conservation. FLR interventions that promoted agroforestry systems, with mixtures of native and exotic species, have also been acknowledged via the lens of SES, as providing both moderate to high ecological and social resilience and also offering higher socio-economic opportunities for land managers (Yang et al. 2018).

The historical trajectory of a landscape and its inhabitants provides valuable insights into suitable FLR strategies (Davidson-Hunt & O'Flaherty, 2007; Lake et al., 2018). Locally-rooted strategies are more likely to persist over time and reflect both local knowledge and practices. Yet frequently there is a disconnect between national policies and local practices which generate land use conflict and contribute to failed restoration projects (Pistorius & Freiberg, 2014).

More generally, Boedhihartono et al. (2012) have raised the question of "restoring what and for whom", yet many restoration efforts proceed without giving serious consideration to this question. For example, many project brokers (e.g. Reforestaction, EcoTrees or Plantons pour l'Avenir) sell tree planting projects – often for carbon offsetting - with limited information on who benefits from these projects, who is involved and whether those involved have had any say in the choice and location of tree planting.

There is evidence that local level organizations may not have the technical capacity, political power or financial resources to achieve results and objectives frequently defined by remote stakeholders via mechanisms such as REDD+ or the Bonn Challenge (Phelps et al., 2010). For example, lessons emerging from related land use interventions, such as REDD+, have raised concerns that they could lead to more centralized forest management to the detriment of local communities (Phelps et al., 2010; Sandbrook et al., 2010). Informal and traditional mechanisms or institutions, and those that depend on them, stand to lose the most as recentralization could erase decades of progress in community empowerment and polycentric governance. Forest restoration can become a tool to wrest power from local stakeholders who are most dependent on the landscape. For example, through the 2016 Compensatory Afforestation Fund Management Fund Act in India, the state forest department defined the species and chose the land on which to re-plant, at the expense of local practices and preferences (Rai et al., 2018). Similar evidence has been found in Vietnam (McElwee, 2009).

5. Integration for improved FLR decision-making

Polycentric governance analysis and pursuit can improve legitimacy and outcomes in FLR planning and implementation (Bixler et al., 2018). Recognising the multiple biophysical, climatic, political and socio-economic influences on FLR over space and time, polycentric governance can bring different actors together in loose modes of collaboration across spatial scales and sectors (Bixler et al., 2018). An example of this type of governance which allowed for more flexible and integrative forms ~~– where top-down rules, policies and legislation were replaced with more flexible forms~~ of funding allocations in line with the rapidly evolving dynamics of landscapes, ~~–~~ is the U.S. Collaborative Forest Landscape Restoration Program (Schultz et al., 2012). Polycentric governance enables the inclusion of broader societal goals, leading to more sustainable approaches to landscape interventions such as FLR.

Broadening the knowledge base can support greater equity in FLR, but this requires a greater openness to diverse knowledge systems than is currently the case**.** Forest landscape restoration has

tended to rely heavily on Western science and related priorities, often at the expense of the traditional knowledge, aspirations and values of indigenous and local communities (Lake et al., 2018). Yet, in many landscapes, these ancient (yet dynamic) knowledge systems are of direct relevance to land use and to FLR, and may therefore be instrumental in determining the course of an FLR intervention. For example, the Western Klamath Restoration Partnership established in California between Tribal, Federal and non-governmental organisations builds on the fire management strategies refined over countless generations by the Karuk Tribe to maximize forest landscape diversity, resiliency and resource production (Lake et al., 2018). Ignoring such traditional knowledge is not only detrimental to restoration interventions, but also further disempowers and disenfranchises many key stakeholders in the landscape. The integration of diverse knowledge systems seeks more holistic methods to achieve sustainability of resource use through shared stewardship, and offers the opportunity to enhance equity though the use of locally-relevant and legitimate approaches whilst incorporating other (i.e., western) scientific methods.

Spatial planning approaches involving diverse stakeholders can facilitate local level integration. Tools such as participatory historical recordings or three-dimensional *papier maché* models (Hardcastle et al., 2004) can help bring stakeholders together around FLR planning. Rather than emphasising restoration techniques per se, spatial planning tools that are participatory are about visualisation of different alternatives, agreement, negotiation, consensus, and recognizing trade-offs across landscape-level stakeholders (Sayer & Boedhihartono, 2018; Carmenta & Vira, 2018). They can serve as an integrative tool to bring stakeholders together in dialogue around a common problem and to determine acceptable, sustainable, and lasting solutions.

Thus, three important lessons emerge: Active and equitable collaboration across geographic, administrative and generational scales can lead to improved FLR implementation. As actions taken at difference scales by different stakeholders affect the landscape, decision-making processes for FLR need to be broader, more flexible and inclusive, and require innovative governance structures that can resolve differences. Secondly, stakeholder motivations and objectives vary, and evolve over time. While planning is necessary, regular re-appraisals are also necessary over the course of FLR interventions to take into account new stakeholders, as well as changes in stakeholder interests and priorities. Thirdly, operating in a complex SES, FLR interventions must negotiate a fine line between long term planning and flexible short-term actions if they are to achieve resilience of both human and ecological systems.

[insert Table 1]

Table 1: Relevant integration lessons for FLR from related approaches

SES aApproaches	• Interactions exist across multiple spatial and temporal scales which influence the FLR process • Recognising the non-linearity of the landscape signifies that feedback loops in FLR interventions should be considered for adaptive management • Complex interactions, feedbacks and holism between ecological and social aspects in landscapes to be restored require further research • Compromises between social and ecological objectives, and thus outcomes, in FLR, are inevitable. • Social and ecological resilience of the system can best be achieved through a mix of actual restoration approaches in the landscape
Landscape Aapproaches	• Landscapes evolve continuously, which has an impact on any FLR planning process • The needs of a landscape's population change over time, and the FLR process should also adjust to this • With many different stakeholders and differing spatial scales influencing the landscape, governance is important • Power inequalities plague the landscape and require attention in any FLR process • Tenure conflict negatively impacts on FLR • The knowledge and interest of local actors (including through citizen science) represent an untapped opportunity for FLR • Monitoring FLR requires measuring process, outputs and outcome given the dynamic nature of landscapes • Adaptation to evolving biophysical and socioeconomic conditions and stakeholder priorities should characterise FLR • There is a need to reconcile the impacts of restoration measures on different stakeholders
Lland sSparing/lLand Ssharing aApproaches	• Landscape interventions such as FLR are expected to reconcile food production with biodiversity conservation • Recognising the multiple values of landscapes helps to design appropriate interventions • Quantifying biophysical, economic and social benefits of landscapes to be restored can help define suitable strategies
aAgroecological Aapproaches	• Policy coordination across agriculture, forestry and other natural resources sectors can be improved. • Understanding the history and power relations in landscapes helps to address land rights issues that may influence achievement of FLR objectives • Restoring landscapes should account for multiple objectives including biodiversity, cultural values, ecosystem services etc. • Agroecological approaches are rooted in local knowledge and history which represents the long term interest of rural populations but are often ignored or marginalised by powerful decision-makers • There is frequently a clash between national policies and local knowledge, values, land use practices, traditional institutions

6. Conclusions

Forest landscape restoration is a relatively young field. While integration of sectors and interests is at its core, this integration has proved difficult to achieve in practice. Yet integrating multiple disciplines, sectors and visions, and considering diverse interests, priorities and preferences can support the adoption of the diverse and complex strategies necessary to achieve the multiple objectives implicit in FLR. Any landscape to be restored is by definition a social-ecological system and integration takes place across disciplines, sectors, knowledge systems, governance contexts and spatial and temporal scales.

Decision-makers and practitioners have many urgent priorities as they seek to significantly scale up restoration efforts in order to respond to our planetary challenges and contribute to the Sustainable Development Goals, Land Degradation Neutrality targets and other international commitments such as the Aichi Biodiversity Targets and the Paris Agreement on climate change. Without effective and durable consideration of local needs and external pressures on forest landscapes, such interventions are likely to be unsustainable as evidenced by comparable forest/natural resource management challenges that we have considered in our analysis.

Yet integrating multiple disciplines, sectors and visions, and considering diverse interests, priorities and preferences can support the adoption of the diverse and complex strategies necessary to achieve the multiple objectives implicit in FLR. Stakeholder motivations and objectives vary and evolve over time, and FLR interventions must take this fact into account. Operating in a complex SES, FLR interventions must negotiate a fine line between long term planning and flexible short-term actions if they are to achieve resilience; adaptive management approaches informed by appropriate monitoring can greatly facilitate this. Decision-making processes for FLR need to be broader, more flexible and require innovative governance structures that can help to resolve differences. In the end, improving integration across sectors, disciplines, space and time can support the development and implementation of a more sustainable and equitable FLR implementation and contribute to achieving the ambitious restoration targets committed by governments, private donor organizations, corporation sustainability campaigns, NGOs, and the global community at large.

Acknowledgments; This article is based on a multi-authored book published by Routledge in 2018 (Mansourian, S. and Parrotta, J. eds., 2018. *Forest Landscape Restoration: Integrated approaches for effective implementation.* London: Routledge) and distils emerging lessons from this research. We thank all the authors for their contributions to the book. We would also like to thank four anonymous reviewers for their useful suggestions on an earlier draft of this article.

References

Adams, C., Rodrigues, S.T., Calmon, M. & Kumar, C., (2016). Impacts of large-scale forest restoration on socioeconomic status and local livelihoods: what we know and do not know. *Biotropica*, *48*, 731-744. https://doi.org/10.1111/btp.12385

Ananda, J., (2007). Implementing Participatory Decision Making in Forest Planning. Environmental Management, *39*, 534. https://doi.org/10.1007/s00267-006-0031-2

Anderies, J., Janssen, M. & Ostrom, E. (2004). A framework to analyze the robustness of social-ecological systems from an institutional perspective. *Ecology and Society*, 9. http://www.ecologyandsociety.org/vol9/iss1/art18/

Aronson, J. & Alexander, S. (2013). Ecosystem Restoration is Now a Global Priority: Time to Roll up our Sleeves. *Restoration Ecology, 21*, 293-296. https://doi.org/10.1111/rec.12011

Aronson, J., Blignaut, J.N., Milton, S.J., Le Maitre, D., Esler, K.J., Limouzin, A., Fontaine, C., De Wit, M.P., Mugido, W., Prinsloo, P. & Van Der Elst, L. (2010). Are Socioeconomic Benefits of Restoration Adequately Quantified? A Meta-analysis of Recent Papers (2000–2008) in Restoration Ecology and 12 Other Scientific Journals, *Restoration Ecology*, *18*, 143-154. https://doi.org/10.1111/j.1526-100X.2009.00638.x

Arts, B., Buizer, M., Horlings, L., Ingram, V., Van Oosten, C. & Opdam, P., (2017). Landscape approaches: a state-of-the-art review. *Annual Review of Environment and Resources*, *42*, 439-463. https://doi.org/10.1146/annurev-environ-102016-060932

Baker, S., Eckerberg, K. and Zachrisson, A., (2014). Political science and ecological restoration. *Environmental Politics*, *23*, 509-524. https://doi.org/10.1080/09644016.2013.835201

Bennett, E. M. (2017). Changing the agriculture and environment conversation. *Nature Ecology and Evolution*, 1, 1-2. https://doi.org/10.1038/s41559-016-0018

Berkes, F. & Davidson-Hunt, I.J. (2006). Biodiversity, traditional management systems, and cultural landscapes: examples from the boreal forest of Canada, *International Social Science Journal, 187*, 35-47. https://doi.org/10.1111/j.1468-2451.2006.00605.x

Bixler, R.P., Jedd, T. & Wyborn, C. (2018). Polycentric governance and forest landscape restoration: considering local needs, knowledge types, and democratic principles. In: *Forest Landscape Restoration*, (edited by S. Mansourian and J. Parrotta) pp. 192-213. London: Routledge.

Boedhihartono, A.K. & Sayer, J.A. (2012). Forest landscape restoration: restoring what and for whom? In: *Forest landscape restoration* (edited by J. Stanturf, D. Lamb and P. Madsen). Pp. 309-323. Dordrecht: Springer. https://doi.org/10.1007/978-94-007-5326-6_16

Brancalion, P.H. & Chazdon, R.L. (2017). Beyond hectares: four principles to guide reforestation in the context of tropical forest and landscape restoration. *Restoration* Ecology, *25*, 491-496. https://doi.org/10.1111/rec.12519

Buckingham, K., Ray, S., Arakwiye, B., Morales, A.G., Singh, R., Maneerattana, D., Wicaksono, S. & Chrysolite, H., (2018). *Mapping social landscapes: A guide to restoration opportunities mapping.* Washington DC: WRI.

Carmenta, R. & Vira, B. (2018). Integration for restoration: reflecting on lessons learned from the silos of the past In: *Forest Landscape Restoration*, (edited by S. Mansourian and J. Parrotta) pp. 32-52. London: Routledge.

Carmenta, R., Zabala, A., Daeli, W., & Phelps, J. (2017). Perceptions across scales of governance and the Indonesian peatland fires. *Global Environmental Change, 46*, 50-59. https://doi.org/10.1016/j.gloenvcha.2017.08.001

Caughlin, T., Graves, S.J., Asner, G.P., Tarbox, B.C. & Bohlman, S.A., (2019). High-Resolution Remote Sensing Data as a Boundary Object to Facilitate Interdisciplinary Collaboration. In: *Collaboration Across Boundaries for Social-Ecological Systems Science* (edited by S.G. Perz) pp. 295-326. London; Palgrave Macmillan.

Chazdon R. (2008). Beyond deforestation: restoring forests and ecosystem services on degraded lands. *Science*, *320*, 1458-1460. DOI: 10.1126/science.1155365

Chazdon, R., & Guariguata, M. (2018). *Decision support tools for forest landscape restoration. Current status and future outlook.* Bogor: CIFOR.

Cumming, G., Cumming, D.H. & Redman, C., (2006). Scale mismatches in social-ecological systems: causes, consequences, and solutions. *Ecology and society*, *11*, 14. http://www.ecologyandsociety.org/vol11/iss1/art14/.

Derak, M., Cortina, J., Taiqui, L. & Aledo, A., (2018). A proposed framework for participatory forest restoration in semiarid areas of North Africa. *Restoration Ecology*, *26*, S18-S25. https://doi.org/10.1111/rec.12486

Duchelle, A. E., Simonet, G., Sunderlin, W. D., & Wunder, S. (2018). What is REDD+ achieving on the ground? *Current Opinion in Environmental Sustainability*, 32, 134-140. https://doi.org/10.1016/j.cosust.2018.07.001

Egan, D., Hjerpe, E.E. & Abrams, J., eds., (2011). *Human Dimensions of Ecological Restoration: Integrating Science, Nature, and Culture.* Washington, DC: Island Press.

Erbaugh, J.T. & Oldekop, J.A., (2018). Forest landscape restoration for livelihoods and well-being. *Current Opinion in Environmental Sustainability*, *32*, 76-83. https://doi.org/10.1016/j.cosust.2018.05.007

Evans, K., Guariguata, M.R. & Brancalion, P.H., (2018). Participatory monitoring to connect local and global priorities for forest restoration. *Conservation biology*, *32*, 525-534. https://doi.org/10.1111/cobi.13110

FAO (2016). *Forest Resources Assessment*. Rome: FAO.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C.S. & Walker, B., (2002). Resilience and sustainable development: building adaptive capacity in a world of transformations. *AMBIO*, *31*, 437-440. https://doi.org/10.1579/0044-7447-31.5.437

Gross, M. & Hoffmann-Riem, H., (2005). Ecological restoration as a real-world experiment: designing robust implementation strategies in an urban environment. *Public Understanding of Science*, *14*, 269-284. https://doi.org/10.1177/0963662505050791

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S., Tyukavina, A., ... & Kommareddy, A. (2013). High-resolution global maps of 21st-century forest cover change. *Science*, *342*, 850-853. DOI: 10.1126/science.1244693

Hardcastle, J., Rambaldi, G., Long, B., Van Lanh, L., & Son, D. Q. (2004). The use of participatory three-dimensional modelling in community-based planning in Quang Nam province, Vietnam. *PLA Notes*, *49*, 70-76.

Hartman, B.D., Cleveland, D.A. & Chadwick, O.A., (2016). Linking changes in knowledge and attitudes with successful land restoration in indigenous communities. *Restoration ecology*, *24*, 749-760. https://doi.org/10.1111/rec.12347

Higgs, E. S. (1997). What is good ecological restoration? *Conservation biology, 11*, 338-348. https://doi.org/10.1046/j.1523-1739.1997.95311.x

Hill, R., Pert, P., Davies, J., Robinson, C.J., Walsh, F. & Falco-Mammone, F. (2013). *Indigenous Land Management in Australia: Extent, Scope, Diversity, Barriers and Success Factors*. Cairns: CSIRO Ecosystem Sciences.

Hobbs, R.J. & Norton, D.A. (1996). Towards a conceptual framework for restoration ecology. *Restoration ecology, 4,* 93-110. https://doi.org/10.1111/j.1526-100X.1996.tb00112.x

Holling, C. S. (2001). Understanding the complexity of economic, ecological, and social systems. *Ecosystems*, *4*, 390-405. https://doi.org/10.1007/s10021-001-0101-5

Hosonuma, N., Herold, M., De Sy, V., De Fries, R.S., Brockhaus, M., Verchot, L., Angelsen, A. & Romijn, E. (2012). An assessment of deforestation and forest degradation drivers in developing countries, *Environmental Research Letters*, *7*, 044009. https://doi.org/10.1088/1748-9326/7/4/044009

IPBES (2018). Summary for policymakers of the thematic assessment report on land degradation and restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. R. Scholes, L. Montanarella, A. Brainich, N. Barger, B. ten Brink, M. Cantele, B. Erasmus, J. Fisher, T. Gardner, T.G. Holland, F. Kohler, J.S. Kotiaho, G. Von Maltitz, G. Nangendo, R. Pandit, J. Parrotta, M.D. Potts, S. Prince, M. Sankaran and L. Willemen (eds.). Bonn: IPBES Secretariat.

Jacobs, S., Martín-López, B., Barton, D.N., Dunford, R., Harrison, P.A., Kelemen, E., Saarikoski, H., Termansen, M., García-Llorente, M., Gómez-Baggethun, E. & Kopperoinen, L., 2018. The means determine the end–Pursuing integrated valuation in practice. *Ecosystem Services, 29*, 515-528. https://doi.org/10.1016/j.ecoser.2017.07.011

Jedd, T. & Bixler, R.P. (2015). Accountability in Networked Governance: Learning from a case of landscape-scale forest conservation. *Environmental Policy and Governance*, *25,* 172-187. https://doi.org/10.1002/eet.1670

Kissinger, G., Herold, M. & De Sy V. (2012). *Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers*. Vancouver: Lexeme Consulting.

Lake, F.K., Wright, V., Morgan, P., McFadzen, M., McWethy, D. & Stevens-Rumann, C., (2017). Returning fire to the land: celebrating traditional knowledge and fire. *Journal of Forestry 115*, 343-353. https://doi.org/10.5849/jof.2016-043R2

Lake, F., Parrotta, J., Giardina, C., Hunt-Davidson, I., & Uprety, Y. (2018). Integration of Traditional and Western knowledge in forest landscape restoration. In: *Forest Landscape Restoration*, (edited by S . Mansourian and J. Parrotta) pp 198-226. London: Routledge.

Lamb, D., Erskine, P.D. & Parrotta, J.A. (2005). Restoration of degraded tropical forest landscapes. *Science, 310*,1628-1632. DOI: 10.1126/science.1111773

Lambin, E.F. & Meyfroidt, P. (2011). Global land use change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences, 108*, 3465-3472. https://doi.org/10.1073/pnas.1100480108

Larson, A.J., Belote, R.T., Williamson, M.A. & Aplet, G.H., (2013). Making monitoring count: Project design for active adaptive management. *Journal of Forestry*, *111*, 348-356. https://doi.org/10.5849/jof.13-021

Latawiec, A.E., Silveira dos Santos, J., Maioli,V., Junqueira, A.B., Crouzeilles, R., Jakovac, C.C., Tubenchlak, F. & Strassburg, B.N., (2018). Forest landscape restoration and land sparing–sharing Shifting the focus towards nature's contributions to people. In: *Forest Landscape Restoration*, (edited by S Mansourian and J Parrotta) Pp 100-118. London: Routledge.

Lewis, S.L., Wheeler, C.E., Mitchard, E.T.A. & Koch, A., (2019). Regenerate natural forests to store carbon. *Nature, 568,* 25-28.

Maginnis, S. & Jackson, W. (2005). What is FLR and how does it differ from current approaches. *Restoring forest landscape: An introduction to the art and science of forest landscape restoration*. Yokohama: ITTO.

Mansourian, S. (2018). Understanding Stakeholders, In: *Forest Landscape Restoration*, (edited by S Mansourian and J Parrotta) pp 139-157. London: Routledge.

Mansourian, S. (2018b). In the eye of the beholder: Reconciling interpretations of forest landscape restoration. *Land Degradation & Development*, *29,* 2888-2898. https://doi.org/10.1002/ldr.3014

Mansourian, S. & Parrotta, J., (2018). The need for integrated approaches to forest landscape restoration. In: *Forest Landscape Restoration* (pp. 19-31). London: Routledge.

Mansourian, S., Stanturf, J.A., Derkyi, M.A.A. & Engel, V.L. (2017). Forest Landscape Restoration: increasing the positive impacts of forest restoration or simply the area under tree cover? *Restoration Ecology*, *25*, 178-183. https://doi.org/10.1111/rec.12489

Mansourian, S., Razafimahatratra, A., Ranjatson, P. & Rambeloarisao, G. (2016). Novel governance for forest landscape restoration in Fandriana Marolambo, Madagascar. *World Development Perspectives*, *3*, 28-31. https://doi.org/10.1016/j.wdp.2016.11.009

Mansourian, S., Vallauri, D. & Dudley, N. (eds) (2005). *Forest restoration in landscapes: beyond planting trees*. Dordrecht: Springer Science & Business Media.

McDonald, T., Gann, G.D., Jonson, J. & Dixon, K.W. (2016). *International standards for the practice of ecological restoration – including principles and key concepts*. Washington DC: Society for Ecological Restoration.

McElwee, P., (2009). Reforesting" Bare Hills" in Vietnam: Social and Environmental Consequences of the 5 Million Hectare Reforestation Program. *Ambio*, 325-333. https://www.jstor.org/stable/40390243

McNeill, D., Garcia Godos, J. & Gjerdåker, A. (2001). *Interdisciplinary research on development and the environment.* Centre for Development and Environment. Oslo: University of Oslo.

McLain, R., Lawry, S., Guariguata, M.R. & Reed, J. (2018). Toward a tenure-responsive approach to forest landscape restoration: A proposed tenure diagnostic for assessing restoration opportunities. *Land Use Policy*. https://doi.org/10.1016/j.landusepol.2018.11.053

MEA (2005) *Ecosystems and human well-being: synthesis.* Washington, DC: Island Press.

Ostrom, E., (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, 325(5939), 419-422. DOI: 10.1126/science.1172133

Ostrom, E. (1999). Coping with Tragedies of the Commons. *Annual Review of Political Science, 2*, 493–535. https://doi.org/10.1146/annurev.polisci.2.1.493

Palmer, M.A., Falk, D.A. & Zedler, J.B. (2006). Ecological Theory and Restoration Ecology In: Foundations of Restoration Ecology (eds Falk, D A , Palmer, M A & Zedler, J B) Pp 3-26. Washington DC : Island Press

Perring, M.P., Erickson, T.E. & Brancalion, P.H. (2018). Rocketing restoration: enabling the upscaling of ecological restoration in the Anthropocene. *Restoration Ecology*, *26*, 1017-1023. https://doi.org/10.1111/rec.12871

Phalan, B., Onial, M., Balmford, A. & Green, R.E., (2011). Reconciling food production and biodiversity conservation: land sharing and land sparing compared. *Science*, *333*(6047), 1289-1291. DOI: 10.1126/science.1208742

Phelps, J., Webb, E.L. & Agrawal, A., (2010). Does REDD+ threaten to recentralize forest governance?. *Science*, 328(5976), 312-313. DOI: 10.1126/science.1187774

Pistorius, T. & Freiberg, H., (2014). From target to implementation: perspectives for the international governance of forest landscape restoration. *Forests, 5*, 482-497. https://doi.org/10.3390/f5030482

Rai, N.D., Bhasme, S. & Balaji, P. (2018). Power, inequality and rights: a political ecology of forest restoration' In: *Forest Landscape Restoration*, (edited by S Mansourian and J Parrotta) pp 63-78. London: Routledge.

Raimundo, R.L., Guimarães Jr, P.R. & Evans, D.M., (2018). Adaptive networks for restoration ecology. *Trends in ecology & evolution*, *33*, 664-675. https://doi.org/10.1016/j.tree.2018.06.002

Rasmussen, L. V., Coolsaet, B., Martin, A., Mertz, O., Pascual, U., Corbera, E., ... & Ryan, C. M. (2018). Social-ecological outcomes of agricultural intensification. *Nature Sustainability*, *1,* 275. https://doi.org/10.1038/s41893-018-0070-8

Reed, J., van Vianen, J., Barlow, J. & Sunderland, T., (2017) . 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

Reinecke, S. & Blum, M., (2018). Discourses across scales on forest landscape restoration. *Sustainability*, *10*, 613. https://doi.org/10.3390/su10030613

Rietbergen-McCracken, J. S., Maginnis, S. & Sarre, A. (eds.) (2007). *The Forest Landscape Restoration Handbook.* London: Earthscan,.

Riggs, R., Langston, J., Margules, C., Boedhihartono, A., Lim, H., Sari, D., Sururi, Y. & Sayer, J., (2018). Governance Challenges in an Eastern Indonesian Forest Landscape. *Sustainability*, *10*, 169. https://doi.org/10.3390/su10010169

Sandbrook, C., Nelson, F., Adams, W.M. & Agrawal, A., (2010). Carbon, forests and the REDD paradox. *Oryx, 44*, 330-334. https://doi.org/10.1017/S0030605310000475

Sayer, J. & Klintuni Boedhihartono, A. (2018). Integrated landscape approaches to forest restoration. In: *Forest Landscape Restoration*, (edited by S Mansourian and J Parrotta) pp 83-99. London: Routledge.

Schultz, C.A., Jedd, T. & Beam, R.D. (2012). The Collaborative Forest Landscape Restoration program: A history and overview of the first projects. *Journal of Forestry, 110*. https://doi.org/10.5849/jof.11-082.

Sgard, A., (2010). Le paysage dans l'action publique: du patrimoine au bien commun. Développement durable et territoires. *Économie, géographie, politique, droit, sociologie, 1*, . DOI : 10.4000/developpementdurable.8565

Stanturf, J.A., Palik,, B.J., Williams, M.I., Dumroese, R.K. & Madsen, P. (2014). Forest Restoration Paradigms. *Journal of Sustainable Forestry,* 33, S161-S194. https://doi.org/10.1080/10549811.2014.884004

Suding, K.N., (2011). Toward an era of restoration in ecology: successes, failures, and opportunities ahead. *Annual review of ecology, evolution, and systematics*, *42*, 465-487. https://doi.org/10.1146/annurev-ecolsys-102710-145115.

Tress, B., Tress, G. & Fry, G. (2005). Defining concepts and the process of knowledge production in integrative research. In: *From landscape research to landscape planning: Aspects of integration, education and application (*edited by B. Tress, G, Tress, G. Fry and P. Opdam*)* pp 13-26. Dordrecht: Springer.

Van Dexter, K. & Visseren-Hamakers, I., (2018). Linking forest conservation and food security through agroecology: insights for forest landscape restoration. In: *Forest Landscape Restoration*, (edited by S Mansourian and J Parrotta) pp. 119-136. London: Routledge.

WWF and IUCN (2000). *Minutes of the Forests Reborn Workshop*, Segovia (unpublished).

Yang, A., Bellwood-Howard, I. & Lippe, M. (2018). Social-Ecological Systems and Forest Landscape Restoration. In: *Forest Landscape Restoration*, (edited by S Mansourian and J Parrotta) pp 65-82 . London: Routledge.