PRACTICAL ARTICLE

A diagnostic for collaborative monitoring in forest landscape restoration

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Monitoring is crucial to meet the goals of the major global forest landscape restoration (FLR) initiatives that are underway. If members of the global FLR community are going to learn from one another, a multi-scalar, multi-site monitoring approach is needed to generate information that can provide the basis for social learning and adaptive management, both of which are essential processes for FLR. This requires reframing and expanding the perspective of monitoring so that compliance monitoring is just one component of a multidimensional approach where collaborative monitoring and compliance-oriented monitoring are complementary. However, FLR planners and implementers often lack experience in applying collaborative approaches in multi-stakeholder settings, and there are few tools that show how to implement FLR or to engage in collaborative monitoring in FLR. Through a literature review, we identified the factors that contribute to successful collaborative monitoring in FLR and synthesized them into a diagnostic that was vetted by 20 global experts. The result is a checklist of 42 core success factors to be assessed at local, subnational, and national levels at different stages in the planning and implementation of FLR. The tool has practical application by providing guidance on best practices: specifically, how to start collaborative monitoring, and more generally, how to plan, prepare for, and evaluate FLR activities. This diagnostic complements other diagnostics, such as those used to identify FLR sites, as it can identify preexisting strengths and weaknesses in new initiatives, or pinpoint problems with ongoing implementation. The diagnostic explicitly addresses issues of scale, including multiple sites, governance levels, and changes over time.

Key words: Bonn Challenge, ecological restoration, local monitoring, multi-scalar, network governance, participatory monitoring

Implications for Practice

- Forest landscape restoration (FLR) monitoring systems need to be learning-focused, collaborative, and cross-scalar in order to encourage adaptive management and help FLR projects achieve their goals.
- Before a FLR project is ready to start collaborative monitoring, specific "success factors" need to be in place.
- FLR implementers and planners can assess readiness for collaborative monitoring and for implementing FLR by evaluating their project using the collaborative monitoring diagnostic. They can then address shortcomings and gauge progress toward strengthening their monitoring systems.

Introduction

There is widespread agreement that monitoring is fundamental to successful forest restoration (Holl & Cairns 2002; Clewell & Aronson 2013; Sayer et al. 2013; Dey & Schweitzer 2014). In a broad context, forest landscape restoration (FLR) is defined as "a planned process that aims to regain ecological integrity and enhance human well-being in deforested or degraded landscapes" (Besseau et al. 2018; Mansourian et al. 2005), recognizing that there will be trade-offs to solve in order to meet a diverse set of management goals and societal aspirations. FLR includes a suite of different land uses—from protection of natural forests to establishment of commercial tree plantations—which in a given landscape are intended to generate various ecological and

socioeconomic benefits. To this end, monitoring generates the information that provides the basis for social learning and adaptive management (Le et al. 2012), both of which are essential processes for FLR (Stanturf et al. 2019).

Global monitoring to track progress of national FLR commitments in response to various international initiatives is largely piloted through the application of output indicators and related guidelines (e.g. AFR100 2018; Dave et al. 2019). For example, in the case of the Bonn Barometer (Dave et al. 2017), site-based numbers aggregated at the national level provide information on e.g. carbon storage, number of "restored" hectares, and number of jobs created. Yet solely focusing on compliance monitoring may not provide insights into why FLR interventions are effective or ineffective, nor does it

help scale up efforts because such indicators cannot identify management problems either within or across landscapes, or pinpoint cross-scale bottlenecks in information flows (e.g. from on-the-ground initiatives to national reporting; Scarlett & McKinney 2016; Sayer et al. 2017). Further, definitions of success in FLR are bound to shift as stakeholders continuously evolve their views of desirable outcomes, and as legal and normative contexts change (Sayer et al. 2017). Thus the above-mentioned efforts need to be complemented with tools and approaches (Evans & Guariguata 2016; Evans et al. 2018) for catalyzing reflection, learning (Fernandez-Gimenez et al. 2008; Schultz et al. 2014; Demeo et al. 2015), and multi-scalar thinking, all of which are necessary in complex socioecological systems like landscapes (Ostrom 2007; Scarlett & McKinney 2016). One metaphor for conceptualizing multi-scalar thinking across landscapes is as a lens that views knowledge at various resolutions, that is the lens can focus on fine resolution information that is specific and granular enough for local decision-making; the lens can then be focused out to generate bigger pictures that are useful for global discussion and decision-making (e.g. Cash et al. 2006).

In light of the unprecedented efforts to restore ecosystem functionality encapsulated in the United Nations 2021–2030 Decade on Ecosystem Restoration, a multi-scalar, multi-site monitoring approach that works beyond the individual project is warranted if members of the global FLR community are to learn from one another. This requires reframing and expanding the perspective of monitoring so that compliance monitoring becomes just one component of a multidimensional program. Here we intentionally use the term "collaborative monitoring" rather than the more widely used "participatory monitoring" because "collaborative monitoring" recognizes the diversity of actors and interests—sometimes in disagreement—that share a forest landscape and are linked to restoration efforts, and it refers to the crucial importance of learning among those groups (Demeo et al. 2015; US Forest Service 2017). While participatory monitoring refers to a "continuum of engagement" from local people to professional researchers in the collection and use of information for decision-making, primarily at the local level (Danielsen et al. 2009), collaborative monitoring includes the same types of multi-party monitoring activities, while also embracing cross-scale, multi-level actors and interactions that are networked to share information and influence change (Cash et al. 2006; Newig et al. 2010; Edwards et al. 2017; Mansourian et al. 2017; US Forest Service 2017). Potential benefits of collaborative monitoring include catalyzing learning and adaptation, engaging people, gauging progress toward goals, and providing accountability.

At the project level, many publicly funded FLR projects still regard monitoring as an extra cost and not as an integral investment, as Coppus et al. (2019) recently found in Latin America. There is a widespread need to build local capacity in the skills, judgment, and ethos of trial-and-error that are central to adaptive management (Reed et al. 2016; Sayer et al. 2017). It is equally important to create "learning networks" for the "community of practice," or the people, groups, and interests

that are connected to FLR efforts at the local, subnational, national, and global levels (van Oosten et al. 2014). However, government agencies, nongovernmental organizations, and planners and implementers often lack experience in applying participatory and collaborative approaches in multi-stakeholder settings (Sayer et al. 2008; Colfer et al. 2011; Meli et al. 2019) and in initiating collaborative monitoring (Guijt 2007; Colfer et al. 2011; Murcia et al. 2016). Here we present a diagnostic tool to assess the conditions or success factors that need to be in place to launch collaborative monitoring and promote multi-scalar thinking, and we discuss its potential applications and contributions for the global FLR effort.

Methods

Our first step was to review the literature to identify the success factors, or the contextual conditions, structural features, actors, attitudes, and activities, that help a collaborative monitoring effort achieve its goals. While what constitutes "success" naturally varies from context to context, there are common ingredients that lead to what any given project defines as success. Our goal was to extrapolate those ingredients using a process of synthesis and induction. The term "success factor" does not suggest causation but implies a role in contributing to restoration objectives (Hanson et al. 2015). Those factors that present a barrier or negative impact are termed "constraints." Constraints in this context may include either permanent structural impediments or barriers that can be overcome with intervention (Moser & Ekstrom 2010; Devisscher et al. 2016).

We built the tool based on literature reviews that were performed first in 2016 and then again in 2018, when we surveyed existing knowledge and lessons learned to broaden and deepen understanding of the potentials of participatory monitoring (Evans & Guariguata 2016; Evans et al. 2018). We then updated the literature search to identify cases of collaborative monitoring in FLR specifically and in natural resource management generally. Databases searched included Science Citation Index Expanded, Social Sciences Citation Index, Environment Complete, AGRIS, GreenFILE, ScienceDirect, OAIster, MEDLINE, Networked Digital Library of Theses and Dissertations, JSTOR, GeoRef, BioOne, and SciTech Premium Collection. Relevant keyword combinations included: *forest landscape restoration*, *forest restoration*, *reforestation*, *rehabilitation*, *ecosystem restoration*, *collaborative monitoring*, *participatory monitoring*, *community-based monitoring*, *local monitoring*, *community monitoring*, *farmer-managed natural regeneration*, *agroforestry*, *forest*, *landscape*, *watershed*, *soil erosion*, *ecosystem services*, *governance*, *networked governance*, *governance networks*, *scale*, *social network analysis*, *socio-ecological systems*.

Based on the literature search described above, and from the bibliographies of articles found in the searches, we identified 80 articles that discussed the conditions surrounding collaborative monitoring or related activities. The following questions were used to screen for success factors:
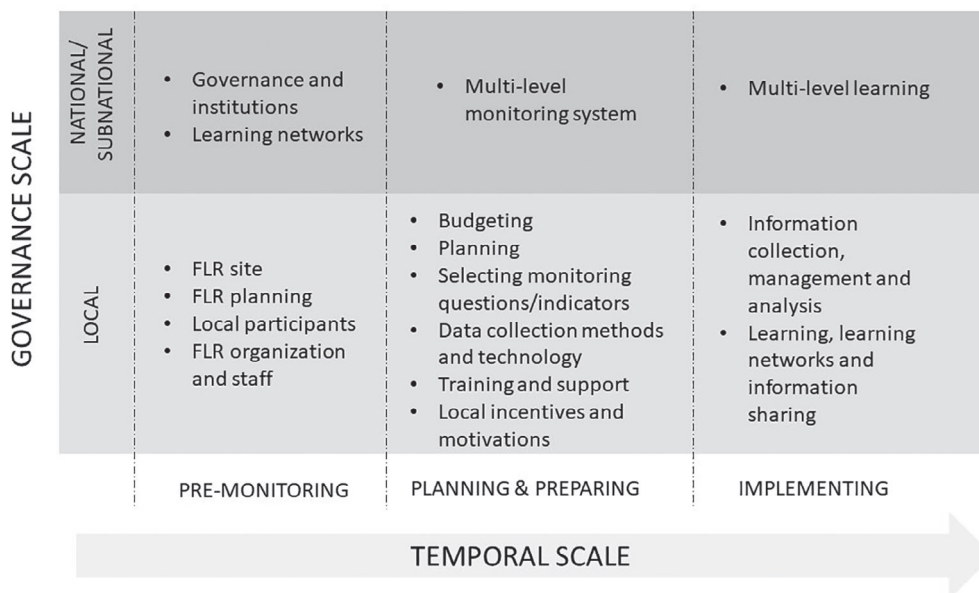
Figure 1. Roadmap to success factors for collaborative monitoring in FLR. Success factors in the matrix (Table 1) are organized under the bulleted items.

● What were the biophysical, social, and institutional conditions of the sites or cases described that contributed to (or constrained) successful collaborative monitoring?

● Who was involved (local people, subnational, national, global actors, institutions, charismatic leaders, champions), what were their roles, and what were the characteristics of their successful (or unsuccessful) participation?

● What were the other factors that contributed to (or constrained) success, including (but not limited to) governance structures, organizations, networks, resources, technology, events, funding, information flows, and scale dynamics?

Success factors and constraints were identified, listed, and synthesized into a series of statements, initially totaling 106. The list of success factors was then formatted into a matrix, organized by temporal and governance scales.

The second step was to have this initial list of success factors independently evaluated by a group of 20 global experts in order to rank and validate them. The experts individually scored each success factor on a Likert scale of 1 ("not important or useful at all") to 5 ("very important, useful, and necessary"). "Important" was defined as "can affect the outcome of the collaborative monitoring, is essential" and "useful" was defined as "will help or contribute to carrying out collaborative monitoring, but may not be essential." For the final step, the combined scores were averaged, and the success factors that scored an average of 4 and above were refined into a list of 42 "core" success factors.

Results

The resulting core success factors are organized by governance and temporal scales (see Fig. 1 for a schematic of how they were organized). Table 1 presents the 42 success factors ranked highest by the expert reviewers and thus considered to be

essential. The complete list of the initial 106 factors with their corresponding references is found in Table S1.

The success factor matrix is designed to serve as the "score card" for assessment activities (which could involve a combination of interviews, surveys, and/or workshops) to score the status of the success factors. There are several possible approaches to the scoring: for instance, the "stoplight" approach, that is marking progress with red/yellow/green depending on the status (Stanturf et al. 2015, p. 53), or assigning Likert scale values (e.g. 1 to 5) to represent more variation and provide a basis for basic calculations of the values. The scores can then be shared or graphically illustrated for dissemination across cultures and education levels (see e.g. Evans & Guariguata 2016). It may also be desirable to accompany the results with a more contextualized explanation in a report format.

The nature of the success factors will dictate the methods used to collect the information. These might include stakeholder analysis, participatory mapping, or values scoring (Evans et al. 2006; Lynam et al. 2007). Understanding the nature of governance institutions and relationships among stakeholders may require the application of techniques borrowed from social network analysis (Newig et al. 2010; Devisscher et al. 2016; Fischer & Jasny 2017). The matrix is not conceived to provide a static pass/fail grade but rather as a tool for recognizing strengths and shortcomings; if a reasonable change in approach is feasible to improve the status of a success factor, then the diagnostic can provide insight into prioritizing issues for improvement.

Discussion

The diagnostic serves as a conceptual framework based on literature and expert input, similar to other restoration diagnostics that are case-based (e.g. Hanson et al. 2015). The tool has

Table 1. Matrix of core success factors for collaborative monitoring in FLR.

Premonitoring

Success factors at the initial phases of the FLR planning, prior to collaborative monitoring

Local

FLR site

1. The entire geographical area expected to be impacted from FLR is defined.

FLR planning

2. All relevant stakeholders are involved in FLR planning and help decide what constitutes FLR, FLR success, and FLR goals.
3. The FLR goals are simple, and stakeholders generally agree on them.
4. FLR goals have been transformed into feasible objectives and (insofar as possible) measurable targets.
5. Monitoring is considered essential to FLR success.
6. There are specific strategies to involve women and marginalized groups in all phases.

Local participants

7. Local people have access rights to the land and natural resources, and there are relatively few conflicts about access rights.
8. The FLR effort is a broad-based coalition of all relevant landscape users, who are involved in meaningful ways, whether they are marginalized groups/castes, women, young people, local leaders, local smallholders, large landholders, nongovernmental organizations, companies, or governments.
9. There are strong local intrinsic motivations to participate in the FLR, and local stakeholders perceive that there is a benefit to their participation.
10. Participants are involved in elements of benefit sharing or activities related to the FLR (e.g. tourism, reforestation, etc.)

Local implementing organization and staff

11. There are skilled, motivated, and appropriately compensated FLR staff to support collaborative monitoring.
12. FLR staff recognize that time, negotiation, and training are necessary parts of the monitoring process, and they embrace an ethos of learning, experimentation, and participation.
13. FLR staff have training in a diverse toolbox of relevant monitoring techniques that are locally appropriate.
14. FLR staff are motivated and knowledgable about facilitating participatory approaches to data collection, data analysis, information sharing, and learning.
15. Collaborative monitoring is written into FLR staff work plans, so that monitoring continues even when there is a staffing change.

National/Subnational

Governance and institutions

16. There is a concerted, long-term commitment by stakeholders at the national and subnational level to get the collaborative monitoring system off the ground and see it through.
17. There are strong formal institutions and cooperation among informal institutions, transparent decision-making, equitable distribution of power, and low levels of corruption.

Learning networks

18. The "community of practice"—the group of people or organizations concerned about the FLR—is identified, and they create opportunities for exchanging information and ideas regularly through organizations, websites, meetings, workshops, and conferences.

Planning and Preparing

Success factors during the design and planning of the monitoring activities, including budgeting, training for local people and FLR staff, and building systems for information sharing

Local

Budgeting

19. Investments in training, capacity-building, and follow-up are included in the costs of collaborative monitoring.
20. Resources are dedicated to data analysis and social-learning activities (meetings, workshops, trainings, field trips) that support decision-making and adaptive management cycles.
21. Costs related to quality control, data management, and data storage are included in the budget.
22. A specific portion of the FLR budget has been dedicated to monitoring for the length of the FLR period (e.g. 10% of total FLR budget).

Planning for monitoring and selecting questions and indicators

23. Monitoring plans are made early in FLR planning stages, are closely matched to FLR goals, and involve a range of stakeholders.
24. Monitoring indicators are closely aligned with management objectives in the short, medium, and long term.
25. The process of defining monitoring questions/indicators, including natural resource use, well-being, and others, is collaborative and emphasizes mutual learning.
26. The indicators are not too technical and do not involve a lot of mathematical knowledge.
27. The indicators are not too time-consuming or too expensive to monitor, they are not too numerous, and they are easy to interpret.

Table 1. Continued

Planning and Preparing	

	Data collection methods and technology
	28. Data collection forms and protocols are designed together with local monitors, researchers, and government staff and are not developed in isolation.
	29. The data collection tools and methods are geared toward quick and local processing and analysis without complicated calculations.
	30. The data collection tools and methods provide for sharing information with stakeholders at multiple levels and for application in future FLR efforts.
	Training and support
	31. Substantial regular training is provided to local people in the use of tools, forms, and technology to collect data, and in interpreting the data to build understanding and answer questions.
	32. Training is simple and adapted to the technical capacity of the participants.
	Local incentives and motivations
	33. Participants feel that their needs are considered in the monitoring system, and the activities focus on attributes that are relevant to them rather than only fulfilling scientifically complete criteria.
	34. Data needs and goals of local stakeholders are considered early on and are matched with those of scientists and natural resource managers.
	35. Monitoring results—both of the local project and of the bigger picture—are regularly shared to motivate participation.
National/Subnational	**Multi-level monitoring system**
	36. To scale up to a national monitoring system, there is infrastructure in place for data registration, storage, and processing.
	37. To scale up to a national monitoring system, there are standard procedures for monitoring processes to be consistent and transparent.
	38. There is a managing organization that is responsible for organizing and overseeing the monitoring and balancing of local needs with national and global needs.

Implementing	

Success factors during the monitoring activities, including data collection, analysis, information sharing, and learning. As adaptive management is inherent to FLR, these processes would be continued indefinitely throughout the life cycles of the project and beyond.

Local	**Information collection, analysis, and learning**
	39. Data are collected at the beginning of the project, at regular intervals throughout the project, and well beyond project implementation to assess whether long-term goals have been met.
	40. Information on progress and desired endpoints is represented in a way that is visually understandable to stakeholders and is discussed in ways that local people can both interpret and apply.
	41. Local people feel comfortable with sharing their own impressions and what they learned in spite of differences in power with officials, and they feel empowered to effect changes.
National/Subnational	42. To encourage learning and adaptation, build trust, build respect for diverse opinions, and increase transparency, there are repeated learning events, interactions, meetings, and field trips to the FLR sites among diverse stakeholders.

practical application to provide guidance on best practices for initiating collaborative monitoring specifically, and for FLR activity planning and preparing more generally. It can identify preexisting strengths and weaknesses for new initiatives, or pinpoint problems with ongoing implementation. It provides a checklist so that implementers, particularly those who are new to collaborative monitoring, know what essential pieces need to be in place at the outset and throughout the project. However we recognize that many of the factors included in the diagnostic also relate to implementation of various FLR activities and toward operationalizing FLR principles (Besseau et al. 2018).

Importantly, the diagnostic explicitly addresses multiple sites, issues of scale, and changes over time. While difficult to project the multi-scalar nature of complex systems into a two-dimensional format, the diagnostic is intended to represent a nested framework with implicit linkages between scales (Ostrom 2007). For instance, whether local people are motivated to participate or else implement FLR activities will depend on various issues regarding access to resources, tenure issues, local staff attitudes, level of training, governance, and other issues not included in the matrix, such as cultural tendencies and external political influences. These motivations may also change over time (Sayer et al. 2017), and the diagnostic may be used to assess changes across the temporal scale. These key issues are discussed below.

Bridging Multiple Sites and Governance Scales

Understanding governance contexts is crucial to identifying the capacities and constraints of a multi-level FLR collaborative

monitoring system (Pahl-Wostl 2009), since problems related to governance are often the most important stumbling blocks at any FLR site (Mansourian et al. 2017). Further, action at the landscape scale requires collaboration, since no single entity has the power to address all of the relevant issues (Scarlett & McKinney 2016). It is also critically important to collect baseline data at the landscape scale before planning and implementing FLR, let alone before monitoring FLR outcomes. Finally, successful FLR relies on a network of collaborators, where various people and organizations develop informal or formal relationships and commitments, and collaborate and learn together. They overcome disagreements, pool resources, and build trust (US Forest Service 2017). This "network governance" is complementary to formal institutions and other forms of formal governance (Scarlett & McKinney 2016). As such, the diagnostic includes success factors that strengthen network governance and formal governance. For instance, one essential element of network governance is the importance of communities of practice (van Oosten 2013) and learning networks (Newig et al. 2010; Jedd & Bixler 2015) to link FLR projects.

Understanding Cross-Scale Issues

Scale provides a conceptual lens for understanding issues in new ways: temporal, spatial, governance, knowledge-based, and management-based, among others (Cash et al. 2006). Problem solving in natural resource management is often hampered due to mismatches in scale (e.g. funding cycles that define project lifetimes are much shorter than the restoration time frame of a forest) (Brown 2003; Cash et al. 2006; Gallemore et al. 2014). In the case of FLR, issues of jurisdictional scale are the most problematic, requiring coordination, information sharing, and learning among local, regional, national, and global entities, as well as cross-jurisdictional institutions such as treaties or tribal governments (Scarlett & McKinney 2016). FLR collaborative monitoring must map to these complexities, providing cross-site comparability and learning at the national and global level, and responding to multinational and global needs for accountability. For the purpose of simplicity, the diagnostic groups success factors as local or subnational/national in order to address jurisdictional scale. It also provides success factors necessary for "scaling up" a monitoring system from the local to other levels. Organizing variables into a nested framework such as this one is precisely the sort of diagnostic approach that generates cumulative capacities to find solutions to problems in complex, cross-scale, and changing systems (Ostrom 2007).

As a Process Monitoring Tool

FLR is by definition a continuous, iterative process rooted in landscape approaches which rely on adaptive management as one of its principles (Besseau et al. 2018). This means that monitoring must continue well after implementation and over the long term to assess the status of FLR projects over their life cycles. The diagnostic can serve as a type of report card to regularly analyze and reflect on the progress of not only the collaborative monitoring activities, but also the FLR project as a whole at various stages of its development. For instance,

establishing goals and measurable objectives at the outset of the project is crucial; returning to check back on those goals and objectives periodically, and adjusting as needed, is equally important. Revisiting whether local people are motivated to participate, and coming up with solutions if they are not, is an activity that is necessary throughout the life cycle of a FLR initiative. People and agencies change over time, as do societal choices and aspirations, necessitating a systematic approach for addressing that change. This iterative cycle of monitoring, reflection, and learning is central to adaptive management (Colfer 2005; Fernandez-Gimenez et al. 2008). When used over time, the diagnostic complements efforts that seek to embed process monitoring into management as a long-term endeavor (Reed et al. 2016; Sayer et al. 2017).

Further Research and Applications

The diagnostic, like similar efforts in the context of FLR planning (IUCN & WRI 2014; Hanson et al. 2015), is as yet a pilot product. Once applied and validated, it is likely to be further modified. Exploring several of the following key researchable issues would strengthen its real-world applicability:

(1) Test various approaches for collecting information on success factors to determine the most appropriate and cost-effective methods.
(2) Test how use of the diagnostic correlates with collaborative monitoring performance, and how it correlates with FLR performance. Local monitoring is generally thought to contribute to management success (Agrawal & Chhatre 2006; Ostrom & Nagendra 2006). However, some argue that other aspects of governance play a more significant role (Andersson et al. 2014). The diagnostic can serve as a mechanism for further exploring the correlations among monitoring, governance, and management.
(3) Test the extent to which the assumptions of the diagnostic are upheld in practice, that is, how the success factors are linked to performance and compliance monitoring. Applying the diagnostic under diverse conditions will create comparative opportunities to tease out the relevance of the success factors.
(4) Apply a pre- and postanalysis to test whether the application of the tool improved the system in contexts where there is a monitoring system already in place.
(5) Perform a local stakeholder assessment to gauge local perceptions of what constitutes necessary conditions for collaborative monitoring and how these vary from expert-driven monitoring approaches.
(6) Adapt the diagnostic to perform a capacity needs assessment for a given location at a given scale (i.e. the capacity to implement a FLR project).

The diagnostic is intended to fill a gap in the global FLR agenda to help implementers plan for collaborative monitoring, and then strengthen their efforts over time through periodic assessments. The focus of our diagnostic on multi-scalar thinking (across jurisdictions, governance levels, and time) and its emphasis on learning (in the creation of learning networks and

communities of practice, and scaling up the monitoring into systems for multi-scalar learning) is intended to reorient monitoring schemes. It is important to note that there are issues other than monitoring that require guidelines and diagnostics for assessing readiness, such as human capacities, stakeholder engagement, and financial resources.

Global efforts so far may not be fully realizing the learning potential of FLR monitoring across different scales. When monitoring is central to FLR, it becomes a tool for solving problems and a catalyst for improved management. It can break down barriers and build trust among stakeholders (Schultz et al. 2014) and motivate participation (Galabuzi et al. 2014). Although achieving all of this is not easy and may often intimidate FLR implementers, to "engage stakeholders and support participatory governance" is one of the core principles of FLR (Besseau et al. 2018).

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Supporting Information

The following information may be found in the online version of this article:

Table S1. Expanded matrix of success factors.