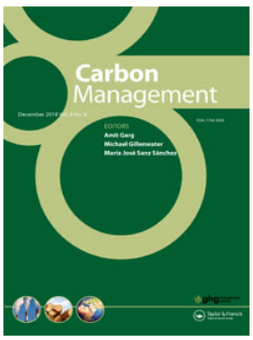

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CASE REPORT

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Adaptive management of jurisdictional REDD + programs: a methodology illustrated for Ecuador

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ABSTRACT

Jurisdictional REDD+ (JR) is based on the premise that results-based flows of finance can drive changes in complex land-use systems across entire nations or subnational jurisdictions to achieve large-scale reductions in carbon emissions from deforestation and forest degradation. The early JR experiments demonstrate that the promise of payments is, alone, insufficient to drive a jurisdictional land-use system transition. Effective JR strategies are needed that translate finance – or the prospect of finance – into forest-friendly changes in the land-use system that are embedded in public policies and programs aligned to achieve that end. Adaptive management has yet to be incorporated into JR programs and could potentially improve the performance of JR. To address this gap, we present a methodology for adaptively managing JR programs that features (a) a "living" mechanistic model of the jurisdictional land-use system, (b) an operational theory of change that describes how the JR strategy will intervene in this system to lower emissions, (c) an annual or biennial assessment process that revisits the theory of change through an independent group of experts and quantitative analysis of spatially-explicit components of the strategy, and (d) a decision-making body for adaptively refining the strategy based on the assessment. The methodology is illustrated for Ecuador's national JR program, the "REDD + Action Plan" (AP), that has secured commitments of results-based payments and international cooperation funds totaling ~US $120 million.

KEYWORDS

Environmental impact evaluation; adaptive management; REDD+; deforestation; rural development

Introduction

Net carbon emissions from tropical deforestation represent approximately one tenth of global emissions from human activities [1]. Slowing and reversing tropical forest loss and degradation could be a fifth or more of the emissions reduction needed by 2030 to avoid a 1.5 deg C increase in average global temperature [2,3]. One of the major innovations created over the last decade to unlock the potential of tropical forests as a climate change solution is REDD+, the acronym for "Reductions in Emissions from Deforestation and Forest Degradation," with the "+" referring to carbon enhancement in forests [4,5].

There are two major categories of REDD+. REDD+ "projects" are designed to reduce emissions from private landholdings, parks, forest concessions, indigenous peoples' territories, or other land units with little or no government engagement. These projects are usually financed by private sector entities seeking offsets within the voluntary carbon market [6].

Jurisdictional REDD + programs (JR) are designed to reduce emissions across entire political jurisdictions–nations, state or provinces–with a prominent role for governments [5]. JR has been financed thus far through "results-based-payments" (RBD) contracts with government donors, in which the jurisdiction's payment is tied to verified emissions reductions measured against a jurisdiction-wide baseline. With the completion of jurisdictional REDD + standards (e.g. ART/TREES [7] and California Tropical Forest Standard [8]), the market for verified JR emissions reduction credits could create a new source of funding for tropical forest jurisdictions that are making the transition to forest-friendly development.

The performance of JR thus far has been uneven [9]. The largest and most advanced experiment in

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JR–the Brazilian Amazon Fund launched in 2009 [10] – has received nearly two billion US dollars in payments in compensation for Brazil's success in slowing Amazon deforestation; roughly $1.4 billion US dollars have been disbursed to Amazon state governments and projects to support further progress [11]. The steep decline in Amazon deforestation resulting from Brazil's 2004 plan to prevent and control Amazon deforestation (PPCDAm) extended through 2012 [12]. The Amazon Fund, launched in 2009 and initiating financial disbursements in 2010, was not able to secure this slowdown. Since 2012, deforestation has been rising [13].

The Brazilian experience and other JR RBD contracts in Indonesia, Guyana, Colombia and elsewhere demonstrate that neither the prospect of finance nor the flow of payments from RBD contracts are sufficient to drive large-scale transitions in a regional land-use system if the strategy for translating payments into land-use interventions is inadequate [14–16]. It has been suggested that successful JR strategies have clear goals, public policies and programs that are aligned to achieve those goals across the relevant sectors, and the capacity to implement these policies and programs [12,17].

We are unaware of any efforts thus far to incorporate the lessons or best practices of "adaptive management" to improve the effectiveness of JR strategies. Adaptive management is a body of principles, practices and approaches designed to increase the effectiveness of strategies that seek to intervene in complex systems to achieve a set of goals [18,19].

Here, we present a methodology for adaptively managing JR strategies, illustrating its application through the Ecuador national REDD+ "Action Plan" (AP) [20] that will soon begin implementation. Ecuador has secured commitments of results-based payments and international cooperation funds totaling ~US $120 million to implement the AP, and is well-positioned to adopt this methodology (Supplemental material).

An adaptive management methodology for jurisdictional REDD + programs

Strategies for managing natural resources that are focused on maximizing impacts within short time frames often fail because of insufficient consideration of complex interactions [7]. Adaptive management is a goal-oriented, iterative, and structured approach to natural resource management that involves representation of a complex system, development of hypotheses for how to achieve desired system responses, and development of flexible interventions that are monitored and adjusted as new information becomes available [8].

We propose an adaptive management methodology for jurisdictional REDD + programs with the following core elements: (a) an operational, mechanistic model that represents the major causal relationships in the land-use system, (b) a theory of change that describes how interventions in the system will achieve the desired results, (c) a process for periodically assessing the theory of change to identify alterations that could improve its performance, and (d) a governance framework for deciding how to adjust the strategy based upon assessment findings.

The mechanistic model of the land-use system integrates information from both scholarly research and expert opinion from scholars and practitioners (in the topical areas of farm systems, finance, markets, infrastructure, social movements) and should emphasize conceptual coherence and accuracy. This model becomes operational if it informs the implementation of the JR strategy.

The theory of change is a set of hypotheses or predictions that describe how interventions in the land-use system will promote forest-friendly responses. Hypotheses are needed at the scale of individual innovations and for integrated sets of interventions.

The assessment should draw on both the opinion of experts and quantitative analyses of the effect of those interventions that are amenable to such analysis. It should be independent, free of influence from those who have a vested interest in the success or failure of the JR strategy.

Finally, the governance framework should secure the independence of the assessment process and make alterations to the JR strategy based upon the recommendations that flow from the assessment.

The Ecuador REDD + action plan

Ecuador recently completed its REDD + Action Plan (AP), the nation's main policy for achieving forest-based climate change mitigation [21]. The AP is part of Ecuador's National Climate Change Strategy and represents up to one third of the projected national total emission reductions by 2025 under Ecuador's Nationally Determined

Contribution to the Paris Agreement. MAE leads the AP through its Subsecretary of Climate Change. The implementation of the AP is currently carried out by MAE with support from the United Nations Development Programme (UNDP), the KfW Development Bank, as well as other strategic partners such as MAG. In addition, a National REDD + Roundtable with advisory powers was created to facilitate the participation of key stakeholders from academia, indigenous peoples, the private sector and civil society. To implement the AP, Ecuador has lined up approximately US$120 million in potential results-based payments and cooperative agreements with the GCF, the Global Environment Facility (GEF) [22], and the REDD + for Early Movers (REM) program [23].

The AP has two principal targets: (i) to reduce gross emissions from deforestation by at least 20% by 2025 relative to a national deforestation reference level for the 2000-2008 period and (ii) to reduce the rate of net deforestation by 2025. The AP aims to achieve these goals through four strategic interventions (Figure S3, Supplemental Online Information). First, it aims to mainstream climate change mitigation and REDD + in national public policies both across the main sectors that influence land-use change and through the regional territorial planning process. Second, it supports the transition of farms to sustainable, deforestation-free production systems working on the supply chain to engage producers and consumers as part of sustainable businesses. Third, it promotes the adoption of sustainable forest management practices and commercialization of non-timber forest products through bio-enterprises. Finally, it promotes forest conservation and regeneration of degraded forests.

The AP also defines five cross-cutting components, including: a) management of the AP measures and actions to ensure effective implementation and coordination among different partners, sectors, and government levels; b) implementation of a Monitoring, Reporting and Verification System (MRV) of land use change and emissions; c) adoption of the Cancun Safeguards to reduce risk and maximize the environmental and social benefits of the AP implementation; d) development of local capacities to implement AP activities and manage local/traditional knowledge; and e) maintenance of communication and collaboration with key sectors, actors and stakeholders (Figure S3, Supplemental Online Information).

The AP is anchored in three main interventions to address deforestation that have been designed and tested, including (a) the Ministry of Environment's (MAA) nation-wide "Socio Bosque" program, which provides payments to landholders who forgo their right to clear forests [21]; (b) three separate water funds for protecting and restoring forests in key watersheds [24]; and (c) the Ministry of Agriculture and Livestock's (MAG) Amazon Productive Transformation Agenda (ATPA) program, which supports farmers to make the transition to sustainable agroforestry and forest-friendly farm systems [25].

The AP has defined thus far about 20 implementation plans (IP) aligned with the plan's M&A. These IPs include a broad set of actions like efficient and environmentally friendly production of cacao and coffee, jurisdictional RSPO certification, traceability and certification of wood production, sustainable forest management, sustainable livestock, support of biocommerce and watershed conservation (Table S1, Supplemental Online Information).

Ecuador's AP also faces some challenges that could be addressed *via* adaptive management, as proposed below. The main challenge is to broaden the base of support for a rural development model that values, preserves, and recovers forests. This means deepening progress already made in extending institutional "ownership" of the AP beyond the MAE to achieve broader participation of the public sectors and institutions that are shaping the future path of rural development in Ecuador: agriculture, infrastructure, mining, energy, finance and planning. This integration with other sectors, especially agriculture, could provide opportunities to multiply some of the AP's farm-level interventions more broadly and to link the AP more effectively to agricultural finance. Similarly, integration with the mining, transportation infrastructure and energy sectors is necessary to minimize the negative environmental and social impacts that these sectors can cause when they make interventions in forested landscapes with insufficient planning.

There are also opportunities to increase the positive impacts of the AP. The on-going jurisdictional palm oil certification initiative under the RSPO could become the basis for certifying other Ecuadorian products as sustainable, opening new markets. Many of the principles and criteria of the RSPO standard are the same or similar to the standard for cocoa (Rainforest Alliance), for example. The AP could also be strengthened through stronger linkages with provincial or local initiatives that are aligned with AP goals, such as the Pastaza Province low-emission rural

development strategy process and the Amazonian Indigenous REDD + network [26]. Finally, the long-term financial sustainability of the AP's successes is currently largely dependent on the results-based payment agreements with the GCF and REM. These contracts are relatively slow and bureaucratic in their implementation, and their long term status is uncertain. Alternative sources of financial revenue for Ecuador's AP, including linkages with the rapidly expanding voluntary market for forest carbon offsets, could increase the scale and efficiency of future AP financing [15].

Results from an analysis of the impact of the Socio Bosque program, which pays landowners for forest conservation, highlight the importance of optimizing existing mechanisms for creating positive incentives for the protection of forests. A recent counterfactual impact analysis found that the additionality of Socio Bosque at the province level (one administrative level below the national) ranges from 1% to 15%; the aggregate additionality of the entire program was 1.65%. In other words, for every one hundred hectares that farmers are paid to conserve, between 1 to 15 hectares of forest clearing is avoided [27]. The sustainability of the program is also precarious because of its dependence upon the federal budget, which is currently diminished because of the decline in oil revenues [28]. Socio Bosque has evolved since its inception, adjusting its target(s) and scope, including adding new incentive strategies, focusing on different ecosystems, and partnering with settlers and indigenous communities in different ways. However, continuous critical thinking and adaptation is required to improve its effectiveness.

The periodic evaluation of AP interventions will depend upon timely, accurate data on trends in the land use land change sector. Important progress has been made in providing these data, but gaps remain. Forest cover and mapping of deforestation are reported by MAE on a biennial basis since 2015 based on the analysis of LandSat images; an annual assessment would facilitate program monitoring and adaptive management. The most recent and detailed land cover maps were published by MAG in 2014; more recent maps are urgently needed. The rural cadastral mapping project has been implemented in about 25% of the country and the last national population census survey was implemented in 2010.

Adaptively managing the REDD + action plan

The Ecuador REDD + AP is a strategy for intervening in the land-use decision-making of many farmers, communities and businesses to slow the loss and speed the recovery of forests nation-wide. These land-use decisions are a response to myriad factors and influences that are interconnected within a complex system (Text S1, Supplemental Online Information).

An initial step in adaptively managing the AP is to establish an operational, mechanistic model of the land-use system and a theory of change for intervening in this system to achieve the desired goals. We present the mechanistic model of land-use and AP theory of change based on previous analyses [23–26] and interviews of experts, summarized in Figure 1 and described more thoroughly in Figure S2 [29–32]. Ecuador's forests are cut down primarily for conversion to subsistence and market-oriented crop and livestock production [29,30,33]. Forest degradation is driven largely by logging that is conducted without using sustainable forest management practices. The AP is designed to intervene in this system to reduce deforestation and forest degradation principally by addressing (a) extensive cattle ranching, (b) inappropriate agricultural practices, (c) predatory logging, and (d) zoning (Figure 1, Figure S2).

Critical components of the proposed AP adaptive management strategy include: (a) a recurrent, annual or biennial assessment of the program that includes the latest information on trends in deforestation, forest degradation, forest regeneration, and other information that could help to interpret these trends, (b) identification of the most likely causes of the trends, (c) an evaluation of the role of AP interventions in these trends, (d) a statistical evaluation of the AP interventions that can be evaluated statistically, (e) identification of options for updating the AP to improve its effectiveness, and (f) a decision regarding the AP elements to be updated.

The proposed AP assessment features two complementary approaches: a holistic, regional and integrated assessment of policies and interventions (Level 1) and a quantitative experimental or quasi-experimental analysis focused on particular interventions (Level 2) (Figure 2).

Given current data availability and frequency, we propose a biennial, semi-quantitative assessment of the main causes of deforestation, degradation and their trends. This assessment shall be based upon the understanding of economic and public policy determinants of land-use decision making, including market prices, the demand for agricultural and forest products associated with

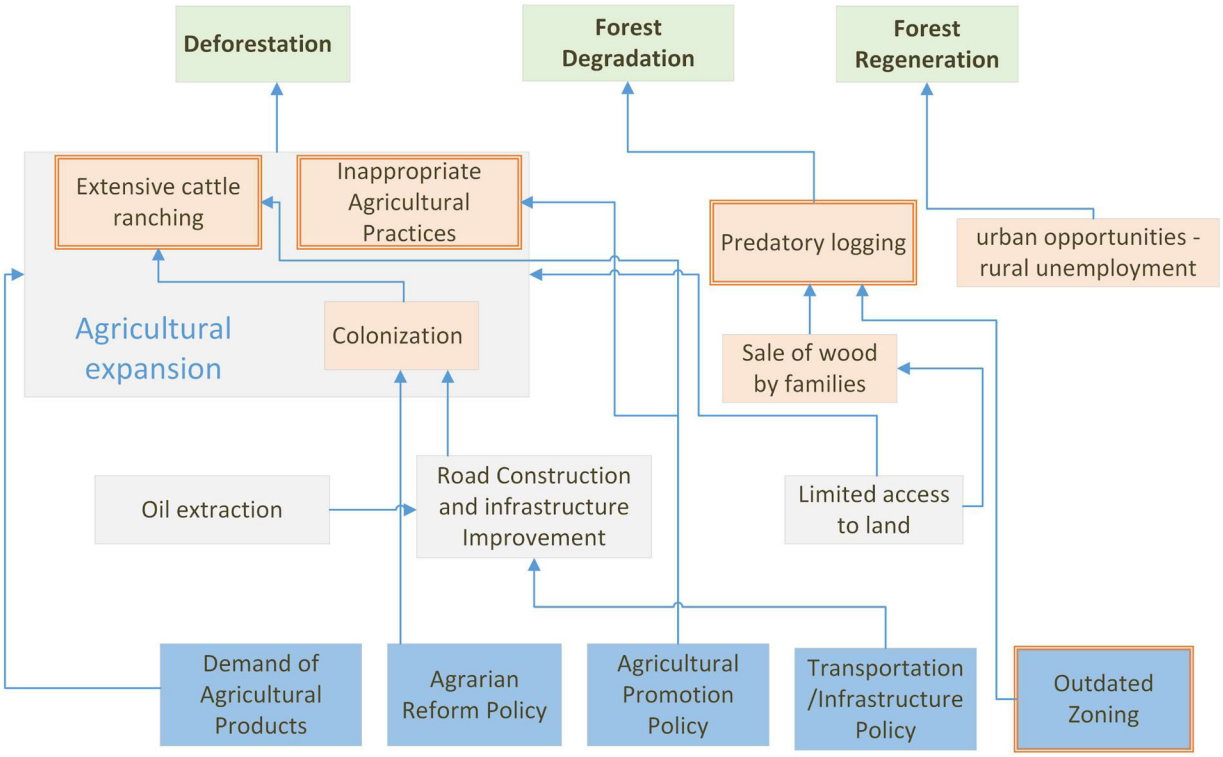

Figure 1. Simplified, conceptual summary of the Ecuador land-use system with a focus on the primary and secondary drivers of deforestation, forest degradation and forest regeneration. Drivers that are addressed by the AP are highlighted with double borders, orange boxes are direct drivers of forest change, gray boxes are secondary drivers and blue boxes are policy and economic dimensions of forest change.

forest clearing or logging, and land-use regulations or financial instruments that have been created or implemented to shape land-use decisions .

The assessment committee's work will also depend upon spatial analysis that identifies simple correlations between the hotspots of forest change and events or interventions that may have caused those hotspots, such as the paving of a road, the opening of a new mine, or the development of a new settlement. Armed with the latest subnational data on agricultural and forest output, transportation, commercialization, infra-structure investments, climate, prices, and the spatial distribution of AP interventions, the assessment committee should be able to attribute the causes of observed trends in forest clearing and degradation with a relatively high level of certainty.

This integrated assessment should be supplemented by formal analyses of spatially-explicit interventions of the AP (Level 1; Figure 2). Data intensive and quantitative methods that represent the state of the art of project impact evaluation [34–36], like randomized control trials, counterfactual matching experiments, and longitudinal panel analysis could be applied to evaluate interventions with a spatially explicit implementation in the territory and a tangible transference of incentives to specific actors (e.g. Socio Bosque Program or ATPA). This data-intensive and analytical impact evaluation could be prioritized for specific interventions whose evaluation thoroughly determines how to maximize project implementation regarding, for instance, disbursed economic incentives, targeting of beneficiaries or definition of implementation areas.

Studies of the statistical impact of a given intervention often assess physical variables related to the transformation of the territory, for instance, the additional forest area that was protected due to the implementation of a program. However, this needs to be complemented with an evaluation of indicators measuring the efficacy and effectiveness of policies and actions. The impact evaluation needs to be documented through regional studies to identify if programs are administered as planned and to understand with local communities how the theory of change of the program and distributed benefits address community needs and driving forces of landscape management. To achieve this, techniques such as surveys with the community, indigenous communities and local leaders are required.

The proposed evaluation needs to address distinctively the ecological and cultural megadiversity of Ecuador. Communities have very different occupation and land-use management of forest resources as reflected by Ecuador's regional deforestation rates [29,33] (Figure S1). This is

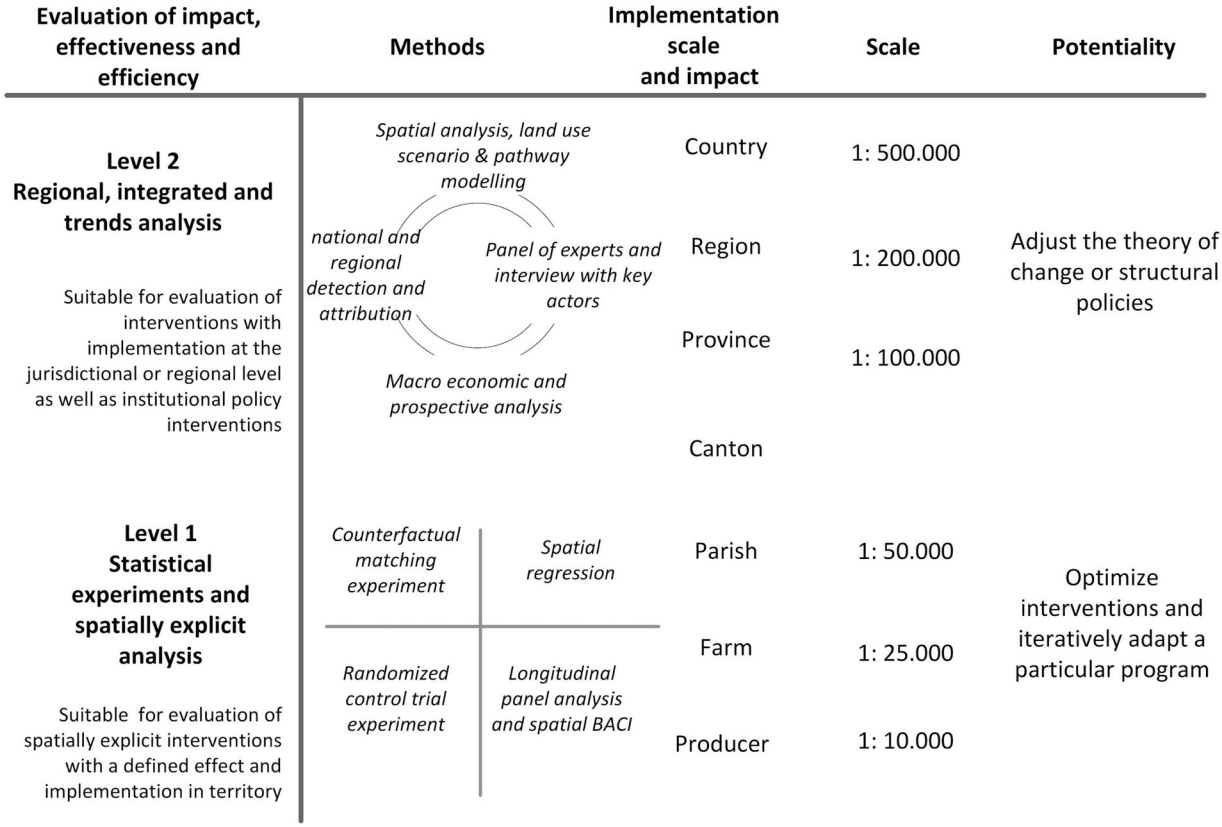

Figure 2. Proposed two-level evaluation of Ecuador REDD + AP, summarizing the methods, scale, scope, and potential application in terms of varying characteristics of AP interventions.

positively reflected for instance in the implementation of the Socio Bosque program, which considered a focalization and payments structure that distinguishes between Amazon forest, coastal areas and high mountain paramos while distinguishing between indigenous and farmer communities. As such, impact assessments need to account for this heterogeneity when designing statistical sampling, regional spatio-temporal analysis or focal interviews.

Governance of the evaluation process

Under the proposed methodology, the periodic AP evaluation would be the responsibility of a REDD + Evaluation and Learning Unit (ELU) and an Adaptive Management Committee (AMC), both nested within the current REDD + institutional framework in Ecuador (Figure 3). The ability of these bodies to do their job will depend upon the independence of its members from any vested interests in the outcomes of the assessment, and the knowledge and skill sets of the committee members.

The ELU is envisioned as a group of independent experts working in parallel to the AP implementation unit. The ELU, using both qualitative assessment (Level 1) and statistical and spatial techniques (Level 2), would evaluate and communicate the impact and effectiveness of the measures, actions and implementation of the AP. The ELU would be tasked with a comprehensive assessment of Ecuador's AP, identifying potential points for course corrections and adaptive management of the AP strategy.

The AMC would then build on the program evaluation to improve AP interventions and would provide observations that facilitate the evaluation process in an adaptive management context. This committee is proposed to comprise technical representatives of the REDD + Roundtable, the ELU, and the REDD + technical-operational committees. The AMC would receive results and recommendations from the ELU and then communicate and discuss these with the decision-making bodies of the Interinstitutional Committee on Climate Change (CICC), MAE, and MAG to facilitate adjustments to the design, finance and implementation of the AP.

Ecuador has been enhancing its technical and institutional capacity to support information-based processes. In addition to having an appropriate governance structure, the availability of accurate, up-to-date information of all independent and dependent variables of the land change system will be of utmost importance to enable comprehensive and accurate assessment. With several

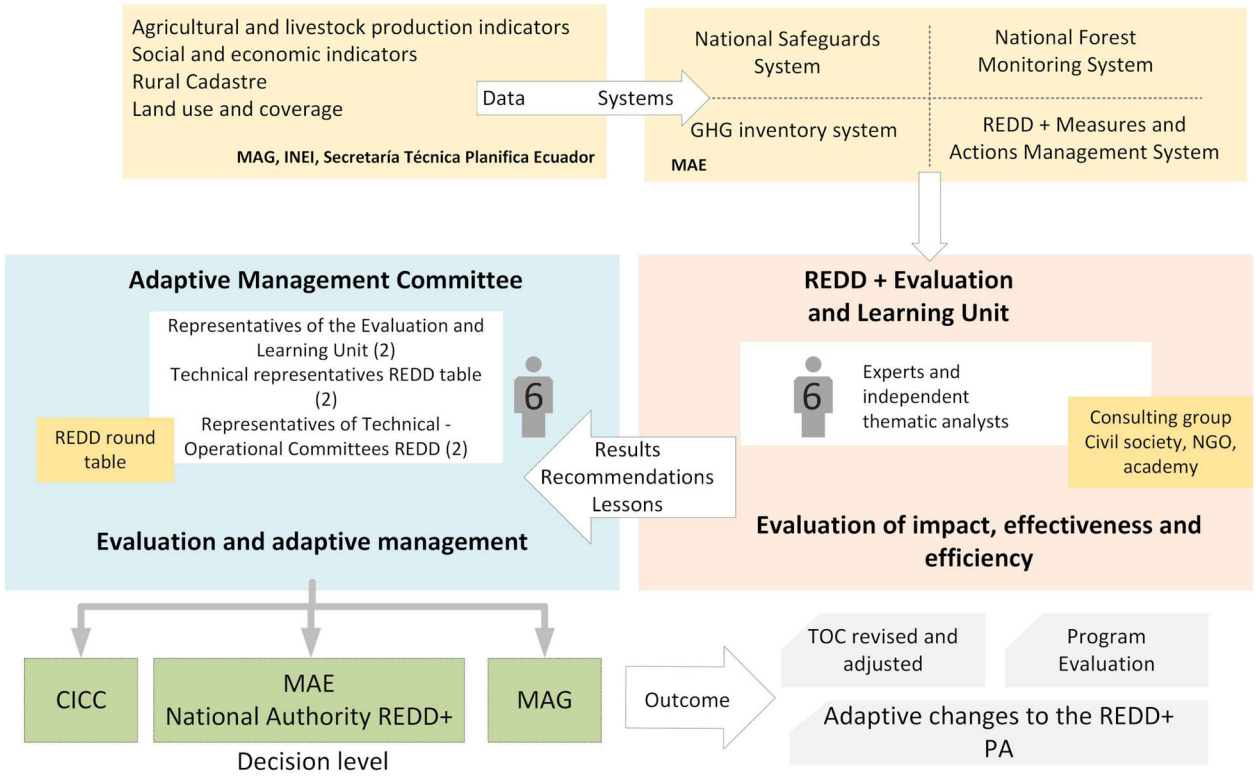

Figure 3. Governance structure of the proposed evaluation system together with main evaluation methods and articulation with existing information systems and data sources. Evaluation outcomes are shown in gray boxes.

systems already operational and institutionally embedded, the country is currently aiming to produce yearly deforestation and land use- land cover maps, a complete rural cadastral system and socio economic information for individual smallholders that would be key to facilitate the AP evaluation. A successful enhancement of information products will require agile coordination across institutions and support for–and revision of–existing data collection and dissemination systems.

Discussion

REDD + was first conceived as a mechanism for compensating nation-wide reductions in emissions from tropical deforestation, and was initially called "compensated reduction" [37]. The Ecuador REDD + AP puts that vision into practice, demonstrating both the potential and the challenge of results-based payment agreements for unlocking tropical forests as natural climate solutions. The observed decline in deforestation relative to historical levels, and the cohesive formulation of climate change mitigation policies based on its natural resources has allowed the country to become a regional leader in the REDD + process. Despite the success in slowing deforestation in recent years, however, deforestation rates are still very high, in particular in Andean and coastal ecosystems where the pressure of agriculture and colonization have led to the clearing of large tracts of montane and dry forest (Supplemental Online Information).

Like any attempt to intervene in a national rural development model, the Ecuador AP must overcome the resistance of sectors to integrated approaches, as it addresses economic interests that are vested in the current rural development model. It must also be responsive to changes in external conditions that influence land-use decision-making. For example, given the dependence of Ecuador's economy on oil, oscillations in oil prices can affect the government's ability to fund programs such as Socio Bosque [28]. The decline in oil prices in the last several years has forced the government to reduce the scope of the program. Changes in labor pools, migration, the costs of commodities, the construction of new roads and infrastructure, or the emergence of new markets for forest carbon emissions reductions are all examples of variables that can influence deforestation and forest degradation independently of the REDD + AP.

The Ecuador REDD + AP is best viewed as a very ambitious, dynamic strategy that must be periodically assessed and adjusted to respond to: (a) changes in market conditions and public policies that influence land-use decisions and (b) evidence that certain components are not working as well as envisioned. The approach described here for adaptively managing the REDD + AP provides the

necessary outputs to adjust the theory of change underpinning the formulation of the AP and the specific optimization of territorial measurements and actions working with rural production units.

Although it is difficult to quantify the effectiveness of different management types for landscape conservation, the case for adaptive management is grounded in solid principles and experiences working in complex and changing settings with diverse communities [18]. In Ecuador, concrete evidence of effective applied adaptive management can be found in the water fund of Quito (FONAG), a financial and technical institution created in 2010 to preserve key water resources of the Quito watershed. The fund has successfully reached financial stability, dealt with political transitions, developed technical capacity and has served as the basis for the implementation of other funds in Ecuador [24,38,39]. Evaluated positively by a recent study implemented by the authors and the MAA, FONAG has critically adapted to changing context and challenges while shaping its strategy and technical capacity towards more ambitious goals.

A critical component of this evaluation is the availability of accurate, timely information on (a) the primary program targets, including deforestation, forest degradation, and forest regeneration, and a decrease in associated net emissions, (b) on secondary targets such as the increase in cocoa productivity, agroforestry farm interventions or the adoption of sustainable forest management practices (Supplemental Online Information), and, (c) key indicators that provide information on effectiveness of the AP components–such as demand for RSPO-certified palm oil. The additional information needed to evaluate and adapt the AP will require improvements in the monitoring, reporting and verification of environmental and socio economic indicators in the country. Of particular importance is the strengthening and institutionalization of MRV systems for forests, land-use/land-cover, the rural cadaster and socio demographic and economic surveys.

Experimental or quasi experimental evaluations are proposed here to assess the impact and fine-tune the targeting strategy of spatially explicit interventions. However, this approach would be limited to a few AP interventions in Ecuador, as not all actions are spatially explicit (e.g. providing tangible incentives, working with farms or smallholder families). Furthermore, for some explicit interventions, like the cacao and coffee smallholder initiatives, informational gaps at the necessary scale or frequency would need to be addressed to permit quantitative and statistical group comparison evaluations.

The structured and holistic approach proposed here to iteratively manage the Ecuador REDD + AP can be refined and applied to a wider set of both explicit (e.g. Socio Bosque) and non-explicit interventions (e.g. responsible purchase of agricultural products). It could then also be used for adaptively managing other REDD + programs for entire jurisdictions (national or sub-national), increasing the likelihood that natural climate solutions can be unlocked to slow climate change.

More importantly, the Government of Ecuador has already partnered with multidisciplinary teams to carry out studies to improve understanding of landscape change dynamics and which led to the formulation of the REDD + AP and a first evaluation of its implementation. Sierra [29] identified causes of deforestation on a regional level, looking at macro and spatio temporal dynamics. Another study [40] conducted about 1,000 interviews with indigenous and local communities to understand the effect of REDD + AP programs. Ardilla *et al.* (2019) carried out a counter-factual study to identify the additionality of specific programs in conserving forest while evaluating efficiency through focal interviews with stakeholders. If Ecuador manages to strengthen its national capacity, information systems and governance model, this effort could be scaled and applied continuously to allow for a truly adaptive management of its environmental policies.

Ecuador has already built an institutional framework to support and drive its climate change strategy and REDD + policy. The adaptive management and assessment governance structure proposed here recognizes established structures like the REDD + Roundtable, the CICC, MAE and MAG. The REDD + AP is an opportunity to strengthen this governance structure and allow Ecuador to achieve a higher level of intersectoral planning and integration with its NDC strategy. The Government of Ecuador has been working on a more modern and participatory process of coordination which includes support and development of the government and public society. The implementation of this structure should enable the alignment of agricultural credit programs and tax incentives with the objectives of the plan.

The adaptive management approach proposed here would imply new costs for Ecuador's REDD + AP. We estimate that these costs would

represent a small share of the overall AP budget. One of the main costs would likely be for an independent secretariat to manage the ELU. Also, some of the more intensive assessments and analyses would have higher costs, primarily to hire additional experts. However, potentially much of the expert participation could be considered pro bono work, as is the case for the Intergovernmental Panel on Climate Change [IPCC], which provides scientific input to UNFCCC.

Conclusions

As the urgency of achieving large-scale reductions in greenhouse gas emissions grows, it is becoming imperative to "learn as we go"–identifying important strategy course corrections as early as possible instead of waiting until the experiment is completed. Ecuador has made important progress in developing a nation-wide program for slowing the loss and speeding the recovery of its tropical forests. It is poised to lead now in another important dimension: the assessment and adaptive management of its national REDD + Action Plan. The methodology proposed here could be tested, refined and applied to other jurisdictional REDD + programs.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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