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A modular framework for management of complexity in international forest-carbon policy

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Complex and variable ecological and social settings make the programme on reducing emissions through avoided deforestation, forest degradation and other forestry activities in developing countries (REDD+) a challenging policy to design. The total value to society of each type of REDD+ outcome is dependent on the fundamentally different risk profiles of alternative forest-management approaches and their scope and potential for co-benefits. We suggest a modular policy framework for REDD+ that distinguishes and differentially compensates the distinct outcomes. This could represent an improved framework to promote and manage incentives for effective forest-carbon initiatives, offer better scope to find common ground in policy negotiations and allow faster adaptation of policy to an uncertain future.

Parties to the United Nations Framework Convention on Climate Change (UNFCCC) now have an agreement to implement REDD+ (ref. 1). This decision will change finance mechanisms for environmental protection and monitoring and alter the landscape of opportunity costs for biodiversity conservation and development[2,3]. Substantial finance has already been directed or pledged through both the UNFCCC and parallel REDD+ programmes and agreements, including project-based demonstration activities run by non-governmental organizations (for example, the Noel Kempff Mercado Climate Action Project in Bolivia)[4], subnational collaborations such as the Governors' Climate and Forest Task Force (www.gcftaskforce.org) and fund-based, intergovernmental agreements such as the bilateral Indonesia–Norway Forest and Peat Carbon Agreement[5], the multilateral Oslo Climate and Forest Conference Interim REDD+ Partnership[6], and the Global Environment Facility. REDD+ might secure the protection of some of the world's most biologically diverse areas and provide a framework for holistic policies to address deforestation[7]. However, such optimism obscures substantial risks such as the perverse incentive to convert natural forests to plantations (under the guise of carbon enhancement) and the displacement rather than abatement of land-conversion activities, particularly to non-forest ecosystems (inter-ecosystem leakage)[3,8–10]. The challenge for scientists and policy negotiators now is to guide the implementation of REDD+ so that it maximizes the benefits of reducing emissions through forest-carbon protection and enhancement activities, while minimizing the potential negative impacts[10] and risk of policy failure[11].

REDD+ under the UNFCCC is rapidly developing towards wide-scale implementation, but it is difficult to anticipate the combined effects on carbon and other co-benefits owing to the disparity between the activities available under the programme, the many policy options and requirements to address these objectives, and the diverse contexts in which they may be implemented[12]. Research on drivers of deforestation[13] clearly indicates REDD+ is a complex venture that will require the support of a large variety of international and national policies, owing to interdependencies of deforestation with, for example, agriculture, forestry and economic development. Despite the varied options for the implementation of REDD+, compensation will be based on how these achieve a number of fundamentally different objectives[12], from emissions avoidance through reducing deforestation and degradation of relatively intact forest, to emissions reduction through modification of forestry practices, emissions sequestration through carbon enhancement of forest, and the support of mitigation activities for forest-carbon emissions with protection of forest areas. The present emphasis is on performance-based compensation, aggregating forest emissions mitigation on national scales (Fig. 1, left-hand side).

We are concerned that the inherent complexity of the present REDD+ mechanism (in terms of the numerous objectives and outcomes) renders it too cumbersome and 'black box' to negotiate and evaluate effectively. This complexity will inhibit the establishment of effective, equitable and manageable REDD+ schemes, particularly if emphasis on market incentives remains.

REDD+ discussions have consistently been accompanied by a strong desire to take this opportunity not only to mitigate emissions, but also to promote social and ecological outcomes[2,8,14], or at least ensure no impingement on human rights, or social or environmental capital. However, experiences in extant carbon markets[15,16] suggest that these outcomes need to be regulated or otherwise incentivized to occur, as the transaction costs involved in ensuring these social outcomes can act as a disincentive[17,18]. Present methods are quite regulation heavy and incentive poor. For example, the Kyoto Protocol Clean Development Mechanism (CDM) attempts to regulate the production of social benefits through sustainable development directives that are evaluated by the host country[19], as well as methodological guidelines on how projects should be developed. Voluntary carbon markets aim to differentiate themselves from the CDM based on provision of environmental and social co-benefits, and have a corresponding emphasis on socio-environmental evaluation criteria[20]. This distinction can provide a positive incentive akin to certification, but delivery of social or environmental outcomes remains rooted in the regulatory approach[21]. Following the precedent of the CDM, the present REDD+ has trended towards a 'safeguards' approach[20].

Though regulations, methodologies and safeguards provide reasonable mission objectives, many question the effectiveness in

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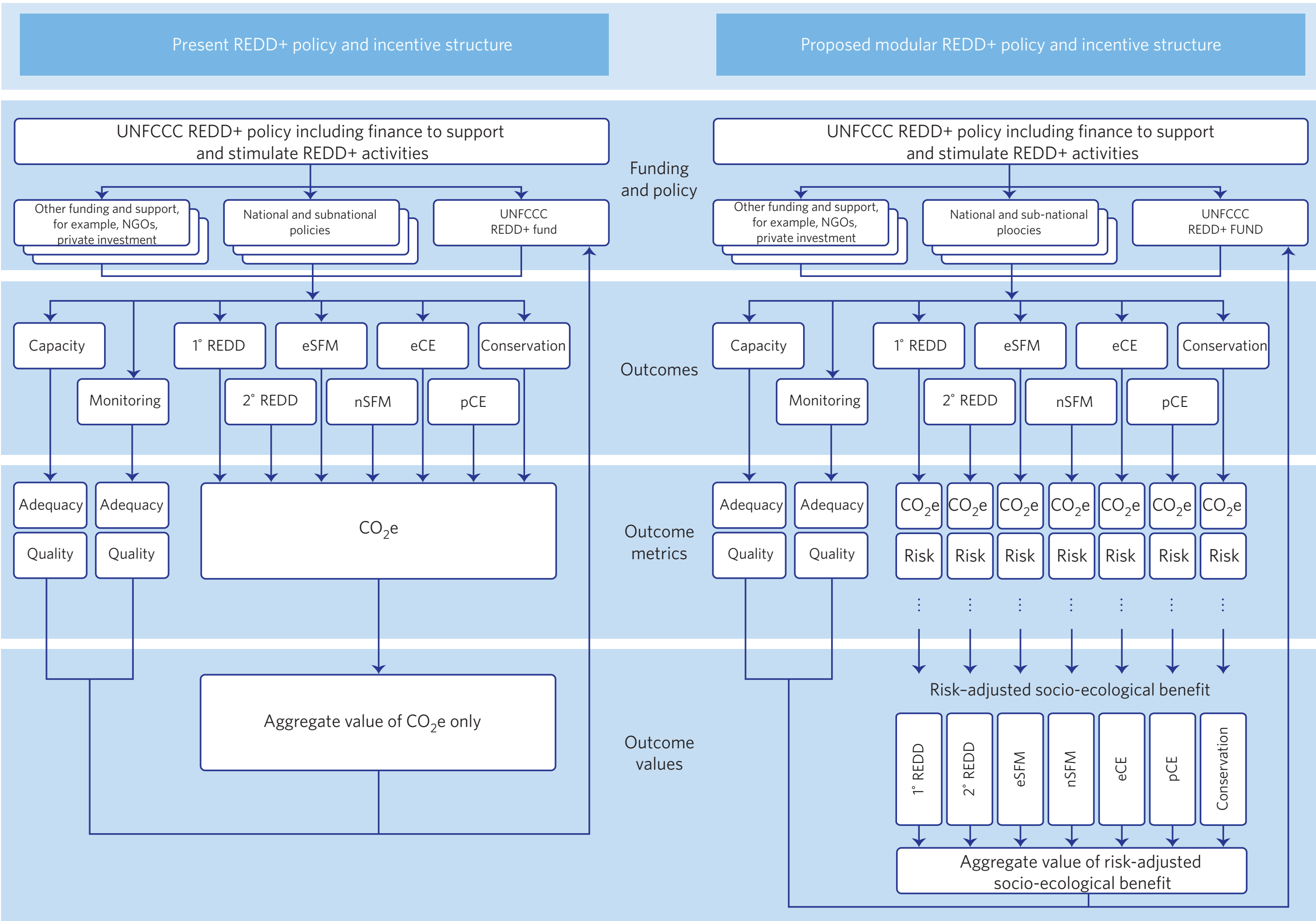

Figure 1 | REDD+ conceptual design under present policy (left-hand side) and a proposed modular framework based on separation of REDD+ outcomes (right-hand side). Policy and funding set desired objectives and result in realized outcomes in each category: capacity development; monitoring of outcomes; 1° REDD; 2° REDD; eSFM; nSFM; eCE; pCE; and conservation of forest areas. Present policy, however, does not provide adequate scope to distinguish these fundamentally different outcomes when calculating appropriate compensation. Explicit differentiation of outcome metrics including, for example, the volume of carbon dioxide equivalents (CO_2e), risk and other potential metrics, such as biodiversity indices, between modules allows a better approximation of total economic value, rather than basing compensation on CO_2e alone. NGOs, non-governmental organizations.

practice for both environmental and social outcomes[15,16,22]. Some call for stricter assessment and regulation[23], yet this still fails to provide certainty in how these measures can be effectively implemented, monitored, validated or enforced[20]. There has been little emphasis on providing a 'carrot' for socio-ecological outcomes, although there are present schemes that provide product differentiation through biodiversity accreditation (for example, the CDM 'Gold Standard' or the climate, community and biodiversity (CCB) standards[24,25]) or forest certification[26], and proposed frameworks that aim to compensate dually both for biodiversity and carbon[14,27]. Other methods could include rent extraction (for example, taxation) of carbon credits to correct market distortions[28] or to raise revenue for redistribution to social or environmental activities, and preferential pricing of preferred projects (as suggested for CDM[29] and the Australian Carbon Farming Initiative[30]).

The management of risk and uncertainty has received much attention, as these factors affect the fundamental efficacy of emission reductions. The risk and uncertainty involved in forest-carbon initiatives can take many forms. First, as forests are spatially variable and naturally stochastic systems, there is uncertainty in how much carbon is stored or will be sequestered under any given scenario, and the time frame involved (including permanence[31]). Second, there is the lingering uncertainty as to whether we can reliably determine if mitigated emissions can be considered additional, or whether leakage may occur. Third, there is a risk that severe weather or catastrophic events may result in reduced or negligible carbon emission reductions. These events may be predictable, avoidable or able to be managed, such as fire, or may be unavoidable and unexpected, such as cyclones or emerging pests and disease. Risks and uncertainty are not limited to physical factors, thus a fourth category of risk may be that of financial failure of forest-carbon investments, potentially as a result of changing economic conditions[32] or governance, and possibly leading to inadequate support for the continuation of the project management. Fifth, a lack of societal or community support may also reduce project effectiveness. Sixth, as outcomes are not limited to emission reductions, but also extend to environmental and social co-benefits, there is inherent uncertainty in terms of the value of these (which, like the forests themselves, may also vary in time and space)[33–36] and certainly a risk that they might not be delivered as expected[33]. Finally, there is the uncertainty involved in monitoring and verification: whether these processes can be accurately accomplished, or if they can be politically subverted.

Proposals for methods to reduce the risk and uncertainty in forest-carbon initiatives have been varied. One of the simplest

Table 1 | The five activities proposed for UNFCCC REDD+ differ in concept, permanence and risk, and should be distinguished in accordance with our modular policy approach.

UNFCCC activity	Concept of emissions mitigation	Permanence of main emissions mitigation (intentional)	Risk of unintentional carbon loss (aside from leakage)	Proposed module(s) based on outcomes
Reduced deforestation and degradation of forests	Avoided emissions (also net sequestration[60], particularly in secondary forests).	Permanent avoidance.	Relatively resilient in primary forests, but increased risk at least initially in secondary forests[43,45].	1° REDD 2° REDD
Sustainable forest management	Reduced emissions.	Permanent reduction, but ongoing release of emissions owing to timber extraction.	Greater risk owing to higher levels of human activity and disturbance[43], and uncertainty regarding the economic viability of ecologically sustainable forest management.	eSFM nSFM
Forest-carbon enhancement	Emission sequestration.	Relatively permanent if forest conserved, but temporary if subsequently harvested.	Greater risk as a new ecosystem (*sensu*[61]), particularly if a monoculture plantation. Risk of carbon loss from ecological restoration may decrease over time.	eCE pCE
Forest conservation	Supporting forest-carbon emissions mitigation activities (also potential for some ongoing sequestration[60]).	NA	Assuming conservation is within least disturbed areas, relatively resilient[43,45].	Conservation of forest areas; management with the primary aim of biodiversity and cultural preservation.
Capacity building and ongoing monitoring	Supporting forest-carbon emissions mitigation activities.	NA	NA	Capacity building. Monitoring of outcomes.

Each UNFCCC REDD+ activity is designed to stimulate certain policy outcomes. It therefore comprises distinct concepts of carbon-emissions mitigation, including different scales of permanence and risk: they will vary in terms of volume and value of carbon, and total socio-ecological value. Hence, we propose international carbon-policy works towards a modular framework based on policy outcomes. NA, not applicable.

possibilities is to avoid the issue. For example, the CDM largely excludes potential forest-carbon activities because of these complex issues[37,38]. Where forest carbon was included in the CDM, strong restrictions and limitations on methodology were employed as an attempt to minimize the uncertainty involved[39,40]. REDD+, however, does not have the luxury of using this approach. Although much improvement in the measuring and estimation of carbon in forests has been made, stochasticity necessitates more direct mechanisms to manage risk and account for uncertainty in emissions abatement. Often this has involved proposals to provide compensation at the lower end of the expected value, with or without the creation of an insurance pool or buffer of mitigated emissions. Insurance could also be financial, used to purchase extra carbon credits in times of poor performance[41], and it may be voluntary or independent from carbon trading, or required and funded through a levy or tax on carbon credits. Important considerations involved in risk management include how the scheme can address the different types of risk, who bears the liability and financial costs of the risks, and how it may perversely affect the attractiveness of different project types. For example, restrictions placed on the forest-carbon sector in the CDM have been identified as a large contributor to the poor uptake of afforestation/reforestation projects[40,41].

In this Perspective, we suggest REDD+ policy works towards a modular framework in which compensation given to participating host parties is calculated based on a function of their performance in individual modules distinguished by specific outcomes (Fig. 1, right-hand side). We recommend that the modules should be structured around the outcomes of: (1) reduced deforestation and degradation in relatively undisturbed primary forest (1° REDD); (2) reduced deforestation and degradation in modified and degraded secondary forest (2° REDD); (3) sustainable forest management (SFM) in existing forestry areas (eSFM); (4) SFM in new forestry areas (those not previously used for forestry activities; nSFM); (5) carbon enhancement through ecological restoration (eCE); (6) carbon enhancement in plantations (pCE); and (7) conservation of forest areas (for example, though exclusion of forestry). Owing to leakage potential (in which emissions are displaced rather than mitigated), accounting and compensation based on overall performance on national scales will be required. However, as improvements are made in performance monitoring, policy evaluation and estimation of total economic value (comprising both economic and non-monetary social and environmental values), modules could become increasingly independent and even potentially develop towards different incentive mechanisms.

This categorical modularity based on outcomes would complement the existing hierarchical or nested institutions already embedded in climate mitigation policy in response to numerous scales of governance. The categorization based on outcomes can be seen as both similar and complementary to the three-fund approach (in which finance is directed through streams based on actors: government, forest-dependent people and private land stewards)[42], as well as the wildlife-premium concept (in which further value, and thus payment, is attached to areas high in particular biodiversity features)[27]. We believe a modular framework based on outcomes provides many desirable attributes for new forest-carbon policy. These include: a default differentiation of concepts and risks through separated submechanisms; an improved ability to capture non-monetary values through defined additional metrics; and the potential for adaptation to change.

Why a modular approach?

Differentiation of concepts, risks and opportunities. Investments and returns are valued in economics with respect to their nature, the time that they are expected to occur (discounting for time preferences) and accounting for risk and uncertainty. Under a modular REDD+, outcomes would be differentiated as each module engenders fundamentally different concepts of emissions abatement, different concepts and applications of additionality, and involves different scales of volume, permanence and risk of unintentional carbon loss (Table 1)[3,9,43]. Thus, documented differences in the biodiversity[34,44], carbon dynamics and resilience of primary or least disturbed forests[36,43,45,46] should be reflected in a higher value placed on emissions mitigation in these areas compared with, for example, mitigation in plantations. Under the proposed modular framework, REDD+ outcomes would be measured through the use of numerous metrics, including the volume of avoided carbon emissions derived, the risk and other relevant parameters such as an index of biodiversity value (Fig. 1, right-hand side). This would transform the crude measure of static carbon value into one of aggregate risk-adjusted socio-ecological benefit — a value more reflective of total economic value. Targets, limits and safeguards could be set for each module to allow for a more specific and controlled result than that achievable under an unspecified programme of activities.

The specific opportunities of each policy objective for REDD+ can be managed more directly under a modular approach. Modularity could enable a greater variety of agents to manage and implement actions, providing valuable scope both for centralized and decentralized activities[11]. In particular, there could be the option for some sectors to work towards separate finance mechanisms, at least on national scales under which leakage can still be managed through national accounting. Market-linked options might be suitable for activities such as SFM, where alternative revenue streams support operations and entrepreneurs have scope for innovation. Alternatively, fund-based sources may be more appropriate for less-charismatic, larger-scale or lower-(carbon)-return objectives such as capacity building (as is occurring at present), ongoing national monitoring and protected-area conservation. Integrating market capacity into UNFCCC REDD+ design is important to consider: it is clear that markets are an available policy option in REDD+ host countries at present and international REDD+ markets are possible in the future[12]. The present emphasis on performance-based compensation is arguably necessary to deliver quantifiable results; however, it still captures some of the perverse incentives that a market mechanism may entail (for example, the direction of investment to activities of high financial return, but not necessarily high co-benefits, including subsidization of extractive activities) and does not capitalize on possible benefits (for example, the provision of private finance).

Modularity would also allow specific issues, such as peatland management, to be distinguished from other mechanism components. Peat swamps and mangroves store and sequester significant amounts of carbon[47,48] and exhibit considerably different volumes, permanence and risk profiles than comparable (dryland) terrestrial areas[38]. As demonstrated by peat fires in Borneo, these areas can also be significant sources of emissions[49]. They provide many other clearly demonstrable ecosystem services, such as flood, drought and storm-damage mitigation, food provision (for example, nurseries for fish) and water purification and are considered highly valuable in terms of species biodiversity[50,51]. While not always having the highest site-level species biodiversity in a regional context[52], these areas may be important when considering complementarity in biodiversity conservation. The importance, influence and strong regional nature of these benefits (and impacts of degradation) suggest that restoration and conservation of these areas would make optimal nationally appropriate mitigation actions. In any case, the risk of price distortion is undesirable in an undifferentiated carbon market[52], as is the potential to focus on peatland systems at the expense of other areas highly valuable for co-benefits[52].

Capturing non-monetary values. Differentiated modules would promote competition between forest-carbon mitigation options, which could reduce information asymmetries[33] and create conditions better suited to capture values (for example, co-benefits) that are otherwise invisible in markets. Individual modules would benefit from advertising their own values and co-benefits (and possibly also the risks of others). Such promotion of co-benefits is a more positive approach to the mitigation of climate change[53] and reduces the emphasis on forest conservation for carbon alone[11]. Product differentiation allows the liberation of consumer choice, encourages users to be informed[33] and is a fundamental requirement to facilitate demand-side management. Information, a key criterion of the theoretical perfect market, allows demand to set prices for otherwise invisible values, as demonstrated by the higher preference towards forest-carbon projects[54] and the popularity of projects certified under the CCB standard in the voluntary carbon market[24]. Under the CDM there is little encouragement for buyers to be informed regarding the environmental and social credentials of the emission-offset units, beyond their own moral drive or publicity requirements. Scandals such as the HFC-23 loophole[55] can have significant price-distortion impacts and tarnish the reputation of the entire mechanism. Optional certification, for example the CDM 'Gold Standard', theoretically provides some information transfer, and trades at higher prices. However, the low adoption rates[25] imply that it is being treated as a luxury good, rather than providing adequate (default) differentiation. The voluntary carbon market shows similar symptoms: it is fairly small, at less than 1% of the regulatory market, and the value of the market is rather sensitive to external economic conditions (decreasing by almost 50% from 2008 to 2009)[24].

Adaptation to uncertain futures. A modular system may be more robust, flexible and amenable to modification given an uncertain future. Modularity encourages participation by many agents and many levels of governance and coordination that may prove more resilient to unexpected perturbations[56]. There will always be unknown unknowns, particularly in the design of an unprecedented policy and in the face of global change. To think we can design a perfect policy in response to this is overconfident[57]. The ability to separately modify incentives for different outcomes is valuable: until we develop techniques to accurately measure the total social value of different REDD+ outcomes it is unlikely that we will be able to incentivize the socially optimal distribution of investment and effort under an undifferentiated programme. Furthermore, social values of outcomes may change over time.

An adaptive regulatory policy is an essential, but relatively unexplored, aspect of REDD+ design[12]. Policies can be adaptive in terms of both proactively encouraging experimentation (providing a structure for hypotheses testing) and having the flexibility for rapid modification given changes in the knowledge environment (being robust to a range of future scenarios)[58]. The institutional and political reform required to implement an international forest-carbon policy is uncertain, complex and challenging, but most importantly variable across different sectors and situations[11]. This is clearly shown by the long and protracted negotiations and the plethora of pilot projects. Many problems can be anticipated as potential, but until we test a new approach we are unlikely to be able to determine which of these problems are most important and discover unanticipated issues. Under an outcome-based modular REDD+ design each module could have the capacity for modification, for example, through caps, premiums or other incentives to encourage or discourage activity in the sector. These could be negotiated more rapidly under a modular policy owing to the reduced stakeholder complexity and scope for conflicting interests.

Managing leakage. Avoiding leakage, a situation where emissions are displaced rather than mitigated, has been a key challenge in the design of REDD+ (ref. 59). Leakage can be spatial and temporal, and can cross both administrative and sectoral boundaries[59]. We argue that some amount of leakage is inevitable: it is an integral component of economic adjustment to a possibly significantly altered policy and economic environment. Therefore, attention should be focussed on identifying and managing leakage rather than avoidance *per se*. Present REDD+ policy addresses leakage through the use of national accounting and compensation. Yet only weak regulations, in the form of safeguards, are in place at present to reduce perverse cross-sectoral leakage: emissions displacement from areas of low to high total economic value, for example, transitions from sustainably managed forests to monoculture plantations. This is effectively a 'black box' approach to managing leakage, where the true effects of REDD+ are hidden in the aggregated outcome (Fig. 1, left-hand side). Working towards a modular REDD+ could more directly and transparently monitor leakage by clearly separating performance in the different sectors, and expands opportunities to manage leakage by incentive, as well as regulation.

Towards successful REDD+ policy

For REDD+ to be successful it will need to satisfy the policy objectives of environmental effectiveness, economic efficiency, equitable distribution of benefits and costs between stakeholders, and be politically feasible. REDD+ will require effective, long-term policy actions. However, REDD+ policy is unavoidably complex, involving disparate concepts, uncertainties and stakeholders. Working towards the development and implementation of forest-carbon policy through a modular framework based on outcomes capitalizes on the benefits offered by a competitive market while addressing the fundamental differences between strategic policy initiatives. In this Perspective we have described a modular REDD+ that could provide an improved framework to deliver mitigation, encouraging more accurate and complete economic and social valuation of activities, while still retaining flexibility to adapt to new information, experience and changing conditions. This is a new policy proposal and as such will require further study to quantify the potential benefits and costs. It is, however, an approach that we believe deserves further attention in international forest-carbon policy, if only to cast the spotlight on the present 'black box' of forest-carbon accounting, and to increase the incentives for activities that are likely to contribute positively to total economic value, rather than degrade it.

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Additional information

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