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Understanding national biodiversity targets in a REDD+ context

Brian Alan Johnson*, Rajarshi Dasgupta, André Derek Mader, Henry Scheyvens

Natural Resources and Ecosystem Services Area, Institute for Global Environmental Strategies, 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115, Japan

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ABSTRACT

Forest conservation is a key component of multilateral environmental agreements related to biodiversity conservation (Convention on Biological Diversity; CBD)) and climate change (UN Framework Convention on Climate Change; UNFCCC), and ambitious national commitments are essential to the implementation of these agreements. To understand the relationships between developing countries' different forest conservation commitments/policies made under the CBD and UNFCCC, here we proposed a policy screening scenario analysis approach. Two alternative scenarios of future forest changes are generated at the national scale: one based on a country's national biodiversity targets developed for the CBD, and another based on the country's REDD + forest reference level (FRL) developed for the UNFCCC. The proposed scenario analysis allows for estimation of the climate change mitigation and natural forest conservation benefits of selected national biodiversity targets in terms directly relevant to REDD+ (i.e. in relation to the "baseline" scenario of the FRL). From a literature review of national submissions to the CBD and UNFCCC, we found this scenario analysis is currently feasible for 16 countries.

As case studies, we performed the scenario analysis for one country with a deforestation-related target (Cambodia) and one country with a reforestation-related target (Lao PDR) to illustrate the methodology in detail. We found that achieving Cambodia's NBT of reducing natural forest losses by 50% would lead to a reduction of net natural forest losses by 145,767 ha./year and net CO_2 emissions by 39,742,511 tons/year (considering above-ground and below-ground biomass), while the achievement of Lao PDR's NBT of increasing forest cover to 70% of the national land area would result in a total of 3,216,588 ha. of net natural forest gains and a total of 836,386,724 tons of avoided CO_2 emissions (considering above-ground and below-ground biomass).

1. Introduction

Loss of natural forests is a major cause of biodiversity loss (Jha and Bawa, 2005; Sodhi et al., 2004), climate change (Betts et al., 2008; Pan et al., 2011), soil erosion (Karamage et al., 2016; Ochoa-Cueva et al., 2015); air and water quality deterioration (Betts et al., 2008; Sweeney et al., 2004); and increased vulnerability to natural hazards (Bradshaw et al., 2007). This problem has already received significant global attention, as can be seen in the Convention on Biological Diversity's[1] (CBD) inclusion of targets related to natural forest conservation in the Aichi Biodiversity Targets; 20 Targets developed to help achieve the CBD's goals of mainstreaming biodiversity across government and society, reducing direct pressures on biodiversity, safeguarding ecosystems/species/genetic diversity, enhancing the benefits of biodiversity to all, and enhancing biodiversity policy implementation (e.g. through participatory planning, knowledge sharing, and capacity building processes) (CBD, 2010). As one example of a deforestation-related target, Aichi Target 5 aims to "reduce the rate of natural habitat (including forest) losses by at least 50% by 2020, while also significantly reducing forest degradation and fragmentation" (CBD, 2010). Many countries have also recognized the consequences of natural forest loss, and formulated their own national biodiversity targets (NBTs) for reducing deforestation and/or increasing reforestation. These NBTs represent countries' voluntary commitments towards achieving the global Aichi Biodiversity Targets, and make up an important part of their "national biodiversity strategy and action plan" (NBSAP; a biodiversity plan submitted to the CBD as a national obligation to the convention) (CBD, 2018).

International initiatives are also underway to assist developing countries with their forest conservation efforts, and some of this assistance comes in the form of payment for ecosystem services (PES) (Gómez-Baggethun et al., 2010). PES schemes involve providing

* Corresponding author: 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115, Japan.
E-mail addresses: johnson@iges.or.jp (B.A. Johnson), dasgupta@iges.or.jp (R. Dasgupta), mader@iges.or.jp (A.D. Mader), scheyvens@iges.or.jp (H. Scheyvens).

[1] The Convention on Biological Diversity is an international environmental convention focused on the conservation and sustainable use of biodiversity.

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financial or non-financial incentives to a party (e.g. a household, a community, or country) for the environmental benefits given by the land that they own or manage, e.g. the watershed protection, wildlife conservation, or C sequestration benefits of the land (Gómez-Baggethun et al., 2010). PES schemes can operate at local to global levels, and REDD + is perhaps the largest international PES mechanism. Through REDD+, international financial support is provided to developing countries for global climate change mitigation benefits associated with five activities: reducing deforestation, reducing forest degradation, conservation of forest C stocks, enhancement of forest C stocks, and sustainable management of forests (UNFCCC, 2010). REDD + payments are already being made at the subnational level through bilateral voluntary carbon trading markets (Pettenella and Brotto, 2012), and progress is being made towards the establishment of a multilateral REDD + payment mechanism at the national level under the UN Framework Convention on Climate Change (UNFCCC). Here, we focus on national-level REDD + because its scale matches that of NBTs.

To evaluate a country's performance under the national REDD + system, its actual (gross or net) emissions/removals related to one or more REDD + activities are compared against the emissions/removals projected in the country's forest reference level (FRL) (UNFCCC, 2011). An FRL is calculated based on the historical rate of forest change in a country and the corresponding GHG emissions/removals (UNFCCC, 2009), and it can be generally interpreted as a baseline future scenario. The UNFCCC gives countries a great deal of flexibility in how they can project their FRL from the historical data so-as to allow them to take into account specific national circumstances. However, there is much ongoing debate as to how national FRLs can be projected in a scientific and unbiased manner, taking into account the different national capacities, data availability, and national circumstances of countries eligible for REDD + funding (Brockhaus and Angelsen, 2012; Hargita et al., 2016; Herold et al., 2012; Huettner et al., 2009). To date, simple averaging of historical emissions has been the most commonly used approach for projecting national-level FRLs, followed by linear extrapolation (Johnson et al., 2017) (Fig. 1). This indicates that, currently, countries are using very simple approaches to project their FRLs. However, it is envisioned that the methods used to project FRLs will improve over time as national capacities and data availability improve (GOFC-GOLD, 2013; Herold et al., 2012; UNFCCC, 2013).

From the discussion above it is evident that, despite the ongoing challenges related to projecting FRLs, REDD + financing has the potential to aid countries in achieving their NBTs related to forest conservation, which can also help the global community to achieve the related Aichi Target(s). Thus, in addition to improving the scientific basis of the FRL projections (e.g. through use of improved data quality/quantity and capacity building), it is important to establish a strong connection between countries' FRLs and their NBTs. We are, however, unaware of any previous studies that have quantitatively compared countries' NBTs with their FRL. "Policy screening scenario analysis", a type of scenario analysis for evaluating the effectiveness of different management policies, was recently recognized by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) for its utility in estimating the biodiversity and ecosystem service impacts of different policy interventions (IPBES, 2016). This kind of scenario analysis could be used to quantify the benefits of NBT(s) in terms relevant to REDD+, i.e. their climate change mitigation benefits compared to the FRL scenario.

In this study, we illustrate how the potential climate change mitigation benefits of NBTs related to deforestation and reforestation (two common types of NBT) can be calculated in a transparent manner using the information provided in national submissions to the UNFCCC (FRLs) and the CBD (NBTs). Specifically, we calculate the climate change mitigation benefits of an NBT as the difference between the net GHG emissions estimated under an "NBT scenario" (i.e. a scenario in which an NBT is achieved) and the net emissions estimated under an FRL scenario. This policy screening scenario analysis also allows us to project the future extent of different natural forest types under the NBT and FRL scenarios, which can have important implications for biodiversity conservation. As case studies, we selected two Southeast Asian countries: Cambodia, which has a target of halving its rate of natural forest loss by the year 2020 (a deforestation-related NBT) (National Council for Sustainable Development, Ministry of Environment, 2016); and Laos PDR, which has a target of achieving 70% national forest cover by the year 2020 (a reforestation-related NBT) (Ministry of Natural Resources and the Environment, 2016). These two countries were selected for the case studies because all of the information required for the scenario analysis is readily available in their FRL submissions, allowing for a clear illustration of the methodology. For some other countries, the calculations require the use of external datasets and software (e.g. georeferenced "Carbon maps" and GIS software in the case of Brazil (Ministry of the Environment, 2018)), making it more difficult to explain the methodology here in simple terms.

2. Methods and materials

2.1. Review of countries' NBTs and FRLs

To identify countries with NBTs for which the climate change mitigation benefits can be calculated (as of July 2018), we first performed a web search to identify all countries that had submitted both their FRL (at (UNFCCC, 2018)) and NBSAP (at (CBD, 2018)). We then reviewed the NBTs of these countries to identify those with specific quantitative targets (i.e. numerical targets) related to deforestation or reforestation,

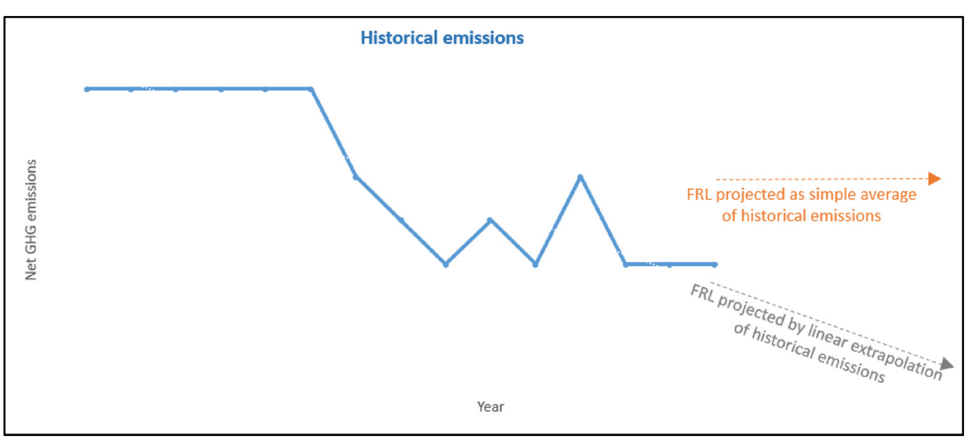

Fig. 1. Examples of how a FRL can be projected from a country's historical emissions using simple averaging or linear extrapolation, the most commonly used approaches.

as a numerical target is required for the scenario analysis. For the purpose of our study, numerical NBTs related to deforestation were defined as targets for reducing forest loss rates by a specific amount or percentage, and numerical NBTs related to reforestation were defined as targets for increasing the national forested area to a specific amount (e.g. number of ha.) or a specific percentage of the national land area. Finally, we reviewed the FRLs of countries with numerical NBTs related to deforestation or reforestation to ensure that the relevant REDD + activity ("deforestation" or "enhancement of forest C stocks", respectively) was also included in the country's FRL.

2.2. Scenario analysis

The FRL scenario of future changes in natural forest extent and C stocks was calculated for each country by applying the projection method specified in the country's FRL submission (e.g. simple averaging or linear extrapolation) to each natural forest class assessed in the submission. Total net changes in natural forest extent and C stocks were then obtained by summing the calculations for each natural forest class.

For countries with deforestation-related NBTs, the NBT scenario was calculated assuming: (1) forest losses for would be reduced by the amount specified in the country's NBT (in relation to the FRL scenario) for all natural forest types currently experiencing net losses in area; and (2) no additional conservation of the natural forest types currently experiencing net gains in area (i.e. applying the same projection as the FRL scenario for these forest types). For countries with reforestation-related NBTs, the NBT scenario was calculated assuming: (1) no further losses for the natural forest classes currently experiencing net losses in area; and (2) allocation of the remaining amount of land needed to reach the target to the forest types already experiencing gains in area (from the non-forest class(es) that were most frequently being converted to these forest types).

It should be noted that our approach for generating the FRL and NBT scenarios is based on the historical trends of forest change for each forest type, so it does not assume increased conservation of either high biomass forests (to maximize REDD + payments) or high biodiversity forests (to maximize biodiversity conservation benefits).

2.3. Cambodia case study

Cambodia was one of 12 countries with a numerical NBT related to deforestation, as reported in Section 3.1. In its most recent NBSAP, Cambodia set an NBT of reducing the rate of natural forest loss by at least half by the year 2020 (National Council for Sustainable Development, Ministry of Environment, 2016). The reference time period for comparison with the 2020 rate of natural forest loss was not specified, so for consistency here we assumed it to be the same as the base period over which historical forest changes were monitored in the country's FRL submission; 2006–2014.

Cambodia's FRL submission shows that five out of nine types of natural forest experienced losses in area from 2006 to 2014, while four experienced slight gains (Table 2) (Ministry of Environment, 2016). The FRL projects that the future GHG (specifically CO_2) emissions/removals due to changes in forest C stocks (specifically above-ground biomass (AGB) and below-ground biomass (BGB) stocks) will be equivalent to the average annual rate of CO_2 emissions/removals over the 2006–2014 period (i.e. simple averaging approach).

From the information in the NBSAP and FRL, the future annual forest losses/gains (and corresponding C stocks) were calculated for each type of natural forest under the NBT and FRL scenarios. The NBT does not specify the rate at which forest losses should be reduced prior to 2020, so our calculations are mainly valid for the year 2020 and beyond. For the FRL scenario, the annual losses/gains in area and C stocks for each type of natural forest were calculated as the average of the 2006–2014 changes. For the NBT scenario, we assumed: (1) half the rate of forest losses (compared to the 2006–2014 rate) for the five natural forest types experiencing losses in area, and (2) forest gains matching the 2006–2014 rates for the four natural forest types experiencing gains in area (i.e. equivalent to the FRL scenario).

2.4. Lao PDR case study

Lao PDR is one of five countries with a numerical NBT related to reforestation, as reported in Section 3.1. In its most recent NBSAP submitted in 2016, Lao PDR set an NBT of achieving 70% forest cover by the year 2020 (Ministry of Natural Resources and the Environment, 2016), which corresponds to 16,137,981 ha. of forest cover. Recognizing the importance of natural forests, the NBSAP also specifies that tree plantations should make up only a small part (~500,000 ha. or about 2.2%) of the 70% national forest cover.

The country's FRL submission (Ministry of Agriculture and Forestry, 2018), however, shows that the national forest extent actually decreased from 2005–2015. In the FRL submission, the change in forest extent between 2005–2015 was assessed for four "forest strata" with different levels of C stocks (only AGB and BGB C stocks were reported), as shown in Table 3. Strata 1–3 represent different types of natural forests. Stratum 4 consists of forest plantations (~200,000 ha.), bamboo, and regenerating vegetation, with the vast majority being regenerating vegetation (Ministry of Agriculture and Forestry, 2018). The large area of regenerating vegetation in the country is reportedly due to the widespread practice of shifting cultivation, which results in large tracts of land shifting between upland crops, regenerating vegetation, and mixed deciduous forest (Ministry of Agriculture and Forestry, 2018). The country's FRL projects that the future rates of change for each stratum of natural forest (and the related CO2 emissions) will be equivalent to their average rates of change between 2005–2015 (i.e. simple averaging approach).

From the information in the FRL and NBSAP, we calculated the forest extent for each stratum and the related C stocks for the year 2020 under the FRL and NBT scenarios. For the FRL scenario, we applied the historical rates of change for forest strata 1–4 to the year 2020. For the NBT scenario, we assumed that the country's forest area would reach the target of 16,137,981 ha. through: (1) preventing further losses of natural forests (i.e. strata 1–3); and (2) reforestation of the remaining amount of land needed to reach the target through the transitioning of land in stratum 4 (mainly regenerating vegetation) to stratum 2. This transition of land from stratum 4 to stratum 2 represented nearly all of the reforestation/forest restoration that occurred in the country between 2005–2015, and is mainly attributed to the government's efforts to transition agricultural practices in the country from shifting cultivation to sedentary agriculture (Ministry of Agriculture and Forestry, 2018).

3. Results

3.1. Countries' NBTs and FRLs

We found that 16 countries currently have NBTs for which our scenario analysis approach can be performed. Thirty-two countries have already submitted both their FRL and NBTs (Fig. 2), and 21 of these countries also had quantitative deforestation- or reforestation-related NBTs (Table 1). As seen in Table 1, 16 of the 21 countries had specific numerical NBTs (e.g. "reduce the rate of deforestation by 50%"), while the remaining five had more vague targets of "reducing" or "significantly reducing" their rates of forest losses (without stating the amount of the intended reduction). Notably, all countries with deforestation-related NBTs had included the REDD + activity "deforestation" in their FRL, and all countries with reforestation-related NBTs have included the REDD + activity "enhancement of forest C stocks" (which generally corresponds to reforestation/forest restoration/afforestation) in their FRL.

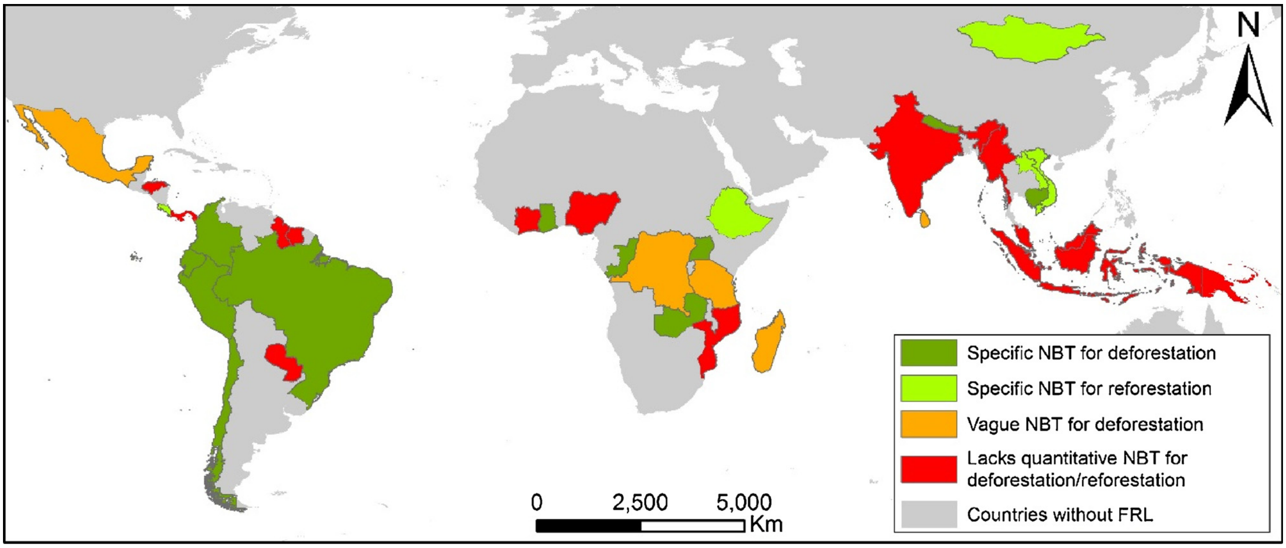

Fig. 2. Countries that have submitted their forest reference levels and national biodiversity targets to the UNFCCC and CBD, respectively. See Table 1 for the full list of countries.

Table 1

NBTs related to deforestation or reforestation, and REDD + activities included in countries' FRLs. DF, deforestation; FD, forest degradation; EFCS, enhancement of forest C stocks; CFCS, conservation of forest C stocks; SMF, sustainable management of forests. *Peru's NBT was interpreted as "reduce deforestation by 5% by 2021″.

Country	Relevant National Biodiversity Target	REDD + activities evaluated in FRL
Brazil	Reduce rate of natural habitat (including forests) loss by at least 50% by 2020 (compared to 2009 rate)	DF
Cambodia	Reduce rate of natural forest loss by at least half by 2020	DF, FD, EFCS
Chile	Reduce rate of ecosystem (including forests) loss by 75% (and to zero in prioritized areas)	DF, FD, EFCS, CFCS
Colombia	Reduce deforestation rate from 120,000 ha./year to 50,000 ha./year by 2020 (in hotspots identified by the national government)	DF
	Reduce deforestation rate to 25,000 ha./year by 2025 (in hotspots identified by the national government)	
	Reduce deforestation rate to 10,000 ha./year by 2030 (in hotspots identified by the national government)	
Congo	Reduce rate of natural forest loss by at least half by 2020	DF, FD
Costa Rica	Recover 1,000,000 ha. of forest by 2020	DF, EFCS
Côte d'Ivoire	No target for reducing forest loss/increasing forest cover	DF, EFCS
Democratic Republic of the Congo	Reduce deforestation rate by 2020	DF
Ecuador	Reduce deforestation rate by at least 5% by 2021	DF
Ethiopia	Increase forest cover to 20% of national area by 2020	DF, EFCS
Ghana	Reduce rate of natural forest loss by at least half by 2020	DF, FD, EFCS
Guyana	No target for reducing forest loss/increasing forest cover	DF, FD
Honduras	No target for reducing forest loss/increasing forest cover	DF
India	No target for reducing forest loss/increasing forest cover	SMF
Indonesia	No target for reducing forest loss/increasing forest cover	DF, FD
Laos PDR	Increase forest cover to 70% of national area by 2020	DF, FD, EFCS
Madagascar	Reduce rate of habitat (including forests) loss, degradation, and fragmentation by 2025	DF
Malaysia	No target for reducing forest loss/increasing forest cover	DF, SMF
Mexico	Maintain the trend of decreasing rates of natural habitat (including forests) loss to 2020	DF
Mongolia	Increase forest cover to 9% of national area by 2025	DF, FD, EFCS
Mozambique	No target for reducing forest loss/increasing forest cover	DF
Myanmar	No target for reducing forest loss/increasing forest cover	DF
Nepal	Reduce rates of forest loss and degradation by at least 75% by 2020	DF, FD, EFCS
Nigeria	No target for reducing forest loss/increasing forest cover	DF
Panama	National biodiversity targets not yet finalized	DF, FD, EFCS, CFCS, SMF
Papua New Guinea	National biodiversity targets not yet finalized	DF, FD, EFCS
Paraguay	No target for reducing forest loss/increasing forest cover	DF
Peru	Reduce rate of ecosystem degradation by 5% by 2021, with an emphasis on forests and fragile ecosystems*	DF
Sri Lanka	Significantly reduce the rates of habitat (including forests) loss, degradation, and fragmentation significantly by 2022	DF, EFCS
Suriname	No target for reducing forest loss/increasing forest cover	DF, FD
Tanzania, United Republic of	Significantly reduce the rate of habitat (including forests) loss by 2020	DF
Uganda	Reduce rate of loss of natural habitats (including forests) by at least half by 2020	DF, FD, CFCS, SMF
Vietnam	Increase forest cover to 45% of national area, maintain primary forest at 0.57 million hectares	DF, FD, EFCS, CFCS, SMF
Zambia	Reduce deforestation rate by at least 25% by 2020.	DF

Table 2
Annual changes in forest extent and C stocks in Cambodia under the FRL and NBT scenarios, 2020- (bold text). Historical data for the years 2006–2014 was derived from the country's FRL submission.

Forest type	tC/ha	2006	2010	2014	Annual change (2020-), FRL scenario	Annual change (2020-), NBT scenario
Evergreen forest, ha.	91	3,710,271	3,573,925	2,973,903	−92,046	−46,023
Semi-evergreen, ha.	135	1,453,441	1,391,117	1,108,320	−43,140	−21,570
Deciduous, ha.	48	4,613,417	4,498,397	3,480,532	−141,611	−70,805
Flooded, ha.	40	597,355	524,005	481,078	−14,535	−7,267
Rear mangrove, ha.	92	27,519	27,371	25,906	−202	−101
Bamboo, ha.	0	129,837	130,930	130,678	+105	+105
Forest Regrowth, ha.	43	216,123	249,341	228,560	+1555	+1555
Mangrove, ha.	84	32,060	31,443	33,002	+118	+118
Pine forest, ha.	57	8,157	8,157	8,196	+5	+5
Total natural forest, ha.		10,788,180	10,434,686	8,470,175	−289,751	−143,984
C stocks (tC) as AGB and BGB		796,282,410	768,295,117	623,629,905	−21,581,563	−10,752,539

3.2. Cambodia case study

Under the FRL scenario, natural forest losses in Cambodia are projected to occur at a rate of 289,751 ha./year, resulting in a loss of 21,581,561 tC stocks per year (Table 2). Under the NBT scenario, natural forest losses are projected to occur at a rate of 143,984 ha./year, resulting in a loss of 10,752,539 tC stocks per year. The climate change mitigation benefits of the NBT scenario can thus be estimated as 39,742,511 tons of avoided CO_2 emissions per year [(21,581,561 - 10,752,539) x 3.67]. The NBT scenario also results in a reduction of natural forest losses by 145,767 ha./year as compared to the FRL scenario, with deciduous forest, evergreen forest, and semi-evergreen forest experiencing the highest reductions (Table 2).

3.3. Laos PDR case study

Under the FRL scenario (2015–2020), the area of natural forests in Lao PDR is projected to decrease from 13,231,443 ha. (57.4% of the national land area) to 12,921,393 ha. (56.0% of the national land area), and forest C stocks are projected to decrease by 23,859,322 tons (Table 3). Under the NBT scenario (2015–2020), the area of natural forests is projected to increase from 13,231,443 ha. to 16,137,981 ha. (70% of the national land area), and forest C stocks are projected to increase by 204,038,968 tons. From this, the climate change mitigation benefits of the NBT scenario can be estimated as 836,386,724 tCO_2 of avoided emissions [(-23.859.322 - 204,038,968) x 3.67] compared to the FRL scenario. The NBT scenario also results in an additional 3,216,588 ha. (14.0% of the national land area) of natural forest cover in comparison to the FRL scenario. The forest stratum 2 experiences the highest gains in area under the NBT scenario, while stratum 4 and 5 experience the greatest losses in area.

4. Discussion and conclusion

In this study, we presented a policy screening scenario analysis approach for estimating the climate change mitigation benefits and natural forest conservation benefits of countries' national biodiversity targets in the context of REDD+ (i.e. as compared to a REDD + FRL "baseline"scenario). From our review of all of the submitted FRLs and NBSAPs, we found that the proposed scenario analysis was currently possible for relatively few (16) countries. However, as many developing countries that are eligible for REDD + financing have not yet submitted their FRLs (but have submitted NBSAPs), this number will likely increase in the future as more countries submit FRLs. The proposed scenario analysis approach (or a similar one) may be helpful for countries to include in their initial (or revised) FRLs submitted in future years, so-as to strengthen the connection between national climate change mitigation and biodiversity conservation targets/policies. The scenario analysis can also help countries and other stakeholders to visualize potential environmental or social problems that might arise due to these policies. For example, in Cambodia's case, of the forest types with significant area losses, the C stocks of deciduous forest (48 tC/ha) and flooded forest (40 tC/ha) are much lower than those of semi-evergreen forest (138 tC/ha) and evergreen forest (91 tC/ha). Therefore, if

Table 3
Projected changes in forest extent and forest C stocks in Lao PDR under the FRL and NBT scenarios, 2015–2020 (bold text). Historical data for the years 2005–2015 was derived from the country's FRL submission.

Forest type	tC/ha	2005	2010	2015	2020, FRL scenario	2020, NBT scenario
Stratum 1 (Evergreen), ha.	200	2,618,169	2,613,226	2,605,557	2,599,251	2,605,557
Stratum 2 (Mixed Deciduous, Coniferous, Mixed Coniferous and Broadleaf), ha.	88	9,961,368	9,721,635	9,437,688	9,175,848	12,344,226
Stratum 3 (Dry Dipterocarp), ha.	43	1,272,006	1,215,712	1,188,198	1,146,294	1,188,198
Stratum 4 (Forest Plantations, Bamboo, Regenerating vegetation), ha.	18	6,183,370	6,042,075	6,300,445	6,358,983	3,393,907
Stratum 5 (NF), ha.	5	3,019,344	3,461,610	3,522,370	3,773,883	3,522,370
Total, natural forest (i.e. Strata 1-3), ha.		13,851,543	13,550,573	13,231,443	12,921,393	16,137,981
Total C stocks (tC) as AGB and BGB		1,581,658,089	1,556,755,033	1,533,939,445	1,510,080,123	1,737,978,413

Cambodia is attempting to achieve its NBT while also maximizing its eligibility for REDD + payments, it would appear to make sense to prioritize the conservation of these semi-evergreen and evergreen forests. Although this may not necessarily be negative for the purpose of biodiversity conservation, it could potentially lead to regional variations in the rates of deforestation and biodiversity loss within the country. For example, flooded forests in Cambodia are mainly distributed around Tonlé Sap Lake (the largest lake in the country), so prioritizing the conservation of high C stock forests could potentially lead to neglecting deforestation around this economically and culturally important lake. In the case of Lao PDR, a potential implication of the country's further reduction in the area of non-forest land (stratum 5) and regenerating vegetation (stratum 4) (to meet its NBT and increase GHG removals) is that the amount of land under shifting cultivation would be significantly reduced in the future. This represents a continuation of the current national trend of transitioning from shifting cultivation to sedentary agriculture (Ministry of Natural Resources and the Environment, 2016), and could potentially affect the livelihoods of communities that rely on this traditional agricultural practice. However, this seems unavoidable if the country is to achieve its target of 70% forest cover.

Here it should also be pointed out that countries' NBTs are generally intended to be ambitious in nature, so in some cases a NBT scenario(s) may not be achievable even with international financial support through REDD + . On the other hand, countries' FRLs have generally been quite conservative in terms of their projected future GHG emissions/removals (Hargita et al., 2016; Johnson et al., 2017), possibly because they hope to maximize the REDD + payments they are eligible to receive (Brockhaus and Angelsen, 2012). For example, most countries with decreasing rates of forest-related GHG emissions have projected their FRL as the simple average of their historical emissions (Johnson et al., 2017), which is known to result in overestimation of future emissions (Köthke et al., 2014). If FRLs are too conservative, there is a concern that REDD + payments may not actually lead to lower rates of natural forest losses. This supports the need for including an additional, more ambitious scenario for comparison with FRLs, to allow stakeholders to better understand how natural forest extent and GHG emissions/removals would likely change under conservative and ambitious conservation scenarios. Although REDD + payments would not necessarily need to be based on this more ambitious NBT scenario, its inclusion could potentially attract REDD + donors concerned with biodiversity conservation. Aside from NBTs and FRLs, many countries have also included non-binding climate change mitigation commitments related to the forest sector in their Nationally Determined Contributions (NDCs) to the UNFCCC "Paris Agreement". While several developing countries have mentioned REDD + as a means to achieving their NDCs, until now there has been a lack of consistency in how REDD + is discussed and integrated into the NDCs (Petersen and Varela, 2015). Our scenario analysis approach could also potentially facilitate integration of REDD + in developing countries' NDCs (e.g. by treating an NDC commitment as another scenario). One caveat is that, for a scenario analysis to be meaningful, a consistent definition of (natural) forest should be used for a country's different biodiversity and climate change targets and policies. Neither the UNFCCC nor CBD provide a universal definition for the term "forest", leaving countries to use their own forest definitions to develop their FRLs and NBTs. Forests (and different natural forest types) can be defined in numerous ways, and the choice of definition can result in large differences in the past/future forest area change estimates (Romijn et al., 2013). We do not argue for the use of a specific definition of forest here, but the use of a consistent definition among national policies/targets is needed. The definition of forest used in countries' FRLs was typically explained very clearly (indeed, this transparency is a major requirement for REDD+), but we found that there was often no specific definition of forest provided in countries' NBSAPs and NBTs. Greater guidance from the CBD may be needed on this aspect of the NBSAPs/NBTs, e.g. a requirement that (natural) forest be defined.

Finally, it is important to note that post-2020 global biodiversity targets are expected to be formulated and decided upon at the 15th meeting of the Conference of Parties to the CBD in 2020, and they will replace the Aichi Biodiversity Targets. This is significant in that countries will soon need to develop new NBTs linked to these post-2020 biodiversity targets. Some implications of our study are that countries interested in acquiring REDD + funding for biodiversity conservation post-2020 should strive to: (1) adopt specific quantitate NBTs related to the post-2020 global Biodiversity Targets (to allow for scenario analysis), and (2) include an analysis of NBT scenario(s) and FRL scenario(s) in their future submissions to the CBD and UNFCCC. Our case studies of Cambodia and Lao PDR provide examples of how this scenario analysis could be conducted in a transparent and relatively simple manner for NBTs related to deforestation and reforestation.

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