Simple REDD+: a new compensation mechanism without reference levels based on net carbon sequestration services

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Abstract

Deforestation in tropical regions causes 15% of global anthropogenic carbon emissions. REDD+ – United Nations program for reduction of emissions from deforestation and forest degradation – is intended to curb emissions due to deforestation by offering compensation for reductions with respect to historical or future deforestation reference levels. Compensation based on reference levels of deforestation has been shown to be politically controversial and unfair to countries with low historical deforestation rates. New mechanisms able to incentivise countries in all phases of the forest transition are necessary. We propose a reference-free, assumption-free and international leakage-immune mechanism based on balancing compensations for carbon sequestration services with capped penalizations for annual deforestation emissions. Using the new mechanism, we estimate that countries with high deforestation rates like Brazil and Indonesia would forgo respectively $7.5 and $1.4 billion annually in terms of compensation for carbon sequestration. Countries with low deforestation rates and high forest stocks like Angola and Colombia would receive net annual payments of $860 and $740 million respectively. Because of its simplicity and transparency the mechanism could contribute to reach international consensus over the implementation of REDD+ compensation mechanisms.

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Introduction

Deforestation in tropical regions causes 15% of global anthropogenic carbon emissions (Van der Werf et al. 2009). Reduction of deforestation related emissions has been identified as one of the most cost-effective interventions to mitigate climate change (Stern 2007). At the eleventh Conference of the Parties (COP) in Montreal in 2005 a mechanism for reducing emissions from deforestation in developing countries (REDD) was proposed and widely supported. REDD was subsequently expanded to REDD+ to denote the inclusion of activities that on top of addressing climate change could provide the enhancement of carbon stocks, sustainable management of forests and conservation (Peskett 2008).

The initial intuition behind REDD was that countries willing and able to reduce emissions from deforestation should be compensated for that (Parker et al. 2008). This seemingly simple intuition was based on the climate change mitigation keystone principle of additionality by which an intervention is allocated carbon credits if it produces a reduction of emissions that would not have taken place in the absence of the intervention (Parker et al. 2008). To be able to prove that an intervention offers additional emissions reductions when it comes to deforestation involves the comparison with historical deforestation levels and/or assumptions of future deforestation levels. These levels are then used to set a reference level of deforestation upon which current levels are compared and compensations are calculated. Setting reference levels for deforestation that are transparent and universally accepted has proven to be very challenging. Compensations based on historical rates unfairly penalize countries that have preserved their forests and favour countries with high deforestation rates, potentially leading to leaking of deforestation to countries not incentivized by REDD+ (Eliasch 2008). On the other hand, countries with high historical deforestation rates and low forest area left would naturally observe reductions in deforestation rates in the near future. In these cases, the decrease in deforestation would not be caused by REDD+ interventions, leading to countries unfairly benefiting from compensations (Grondard et al. 2008). Predicting future deforestation rates able to generate international consensus is not any easier, even though projections based on sophisticated econometric methods and macroeconomic covariates have been proposed (Parker et al. 2008). The covariates needed to make predictions present themselves high uncertainty and the models involve further assumptions that reduce the transparency of the reference levels adopted. Problems can arise for example if the socioeconomic conditions of a country might suddenly change leading to very different deforestation patterns, as was the case of Indonesia after the expansion of oil palm cultivation (Venter and Koh 2012). These caveats are worrying because an adequate choice of reference levels has been shown to be fundamental to achieve adequate climate mitigation results and biodiversity conservation (Busch et al. 2011).

The technical limitations of historical and projected reference levels and their inability to prevent international leakage made these methods controversial in the UNFCCC negotiations and unfortunately contributed to prevent REDD+ from joining other clean development mechanism (CDM) projects – such as introduction of renewable energies – in the recognition of certified emission reduction credits (Grondard et al. 2008).

Despite the shortcomings inherent to reference level setting, several compensation mechanisms attempting to overcome the technical difficulties of REDD+, and the policy discussions on the implementation of REDD+, continue focusing on how to set the deforestation reference levels and proving that emissions reductions occur with respect to them (Angelsen 2008a). Pioneering approaches based on historical rates and setting the basis of REDD were compensated reductions (Coalition for Rainforest Nations 2005, Santilli et al. 2005) and mechanisms proposed by the Joint Research Center (Mollicone et al. 2007). In the compensated reductions proposal compensations are based on comparisons with at least a 5-year historical reference levels of deforestation that could be negotiated and updated periodically to reflect the reality of each country (Coalition for Rainforest Nations 2005, Santilli et al. 2005). The Joint Research Center proposal expanded upon the compensated reduction approach by categorizing countries between high and low forest conversion rates – where low conversion rates corresponded to rates lower than half of the global average deforestation levels (Mollicone et al. 2007). Because these approaches would fail to incentivise countries with low deforestation rates and large forest stocks, and this could potentially lead to international leakage, alternative mechanisms have also been proposed, *inter alia*: an approach from the Terrestrial Carbon Group, combined incentives and stock flow mechanisms (Griscom et al. 2009). The Terrestrial Carbon Group proposed a compensation mechanism that considered that all forests outside protected areas were at risk of deforestation within 50 years; using that assumption to establish a global reference deforestation level that could be used to create tradable credits (Terrestrial Carbon Group 2008). The combined incentives compensation mechanism consists on payments based on the basic historical deforestation levels that are complemented with compensations derived from a comparison between global deforestation rates and country deforestation modelled as a proportion of national forest stocks (Strassburg et al. 2009). A weighting factor is then proposed to allow countries to choose which component of the compensation mechanisms would be more attractive for them. Related to the spirit of the combined incentives mechanism, the stock flow approach proposes to withhold a percentage of the payment for emissions reductions to fund payments related to forest stocks (Cattaneo 2009).

Combined incentives type mechanisms present a substantial improvement over mechanisms solely based on historical reference rates regarding potential international leakage minimization and incentivising of a wide range of countries. Despite the advances, there is not yet an established mechanism that has permeated to the policy agreements. One reason might be that new mechanisms still rely on historical rates and introduce further assumptions regarding the relationship between carbon stocks and global deforestation rates.

Given the inherent difficulties when trying to reach consensus over historical and projected reference levels, a mechanism that is not based on reference levels whilst remaining international-leakage free and capable of incentivizing all countries, would be highly desirable. Because any exogenous modelling assumption has the potential to be very controversial in international REDD+ compensation mechanisms discussions, we attempted to elaborate an intuitive, assumption-free mechanism based on the net value of services due to carbon sequestration.

The rationale of our mechanism goes beyond incentives that can eventually lead to climate change mitigation; it is rooted on the direct moral obligation of high-income countries paying for the services that forests in low-income countries do actually provide. Because carbon sequestration is a nonrivalrous in consumption and nonexcludable good, it is a public good (Stone 1994). Public goods are associated to market failures – the market cannot capture their real value – leading to an undesirable shortage of their supply (deforestation). Regulatory interventions are then legitimate to correct such market failure on the grounds of justice and equity within current and future generations (Kaul et al. 1999).

Considering the moral duty of correcting the market failure for carbon sequestration is important if we consider that combined incentives and stock flow related mechanisms have been criticised as economic inefficient because of suggesting payments for forests that are not immediately at risk of deforestation (Angelsen 2008b). This rightful concern might be applicable to emissions from forests that will not be immediately deforested but does not apply to the legitimate payment for carbon sequestration services that all the forest stocks provide. This is precisely how our mechanism both departs and attempts to contribute to the advancements introduced by combined incentives related mechanisms. Whereas in other mechanisms the inclusion of the compensations for the stock is a mean to incentivise all countries to obtain the end of emissions reduction, we incorporate the compensation to the stock as the rightful payment for the service that it provides – i.e. the compensation is an end in itself. Performing an emissions-sequestration balance, we further tie together emissions reductions and carbon sequestration, thus incentivising countries in all forest transition stages.

Methods

A simple compensation mechanism based on net carbon sequestration services

The payment mechanism consists on a mass balance of CO_2 sequestered from the forest stock and emitted from deforestation and degradation activities. If the country presents net sequestration of carbon, compensation is calculated by multiplying the net sequestration by the price of carbon sequestered, i.e. the country is paid for the actual services provided in a given period of time and such payment is conditional on the services of carbon sequestration being greater than the disservices from emissions due to deforestation. If the country is a net emitter of carbon, neither compensation nor penalty is received. The mechanism can be expressed as:

$$REDD_i = \max\left\{0, \left(S_i - \alpha E_i\right) P\right\}$$

where $REDD_i$ is the REDD+ payment to country i (\$/year); P is the carbon price (\$/ton of CO_2 emitted or sequestered); E_i is the annual emission from deforestation for country i (ton of CO_2 emitted); S_i is the annual sequestration from forests for country i (ton CO_2 sequestered); and α is a weighting factor that increases the flexibility of the scheme by allowing the relative penalization for emissions with respect to carbon sequestration. $\alpha = 1$ indicates that the service due to a ton of sequestered carbon is of the same magnitude that the externality due to a ton emitted. $\alpha = 0$ would lead to payment for carbon sequestration regardless of emissions and $0 < \alpha < 1$ can be used to increase incentives for countries with current high rates of deforestation.

The estimated compensations are conceived to be updated yearly or according to a time span compatible with the availability to produce updated remote sensing maps for each country.

Illustration of the method with the Global Forest Resource Assessment 2010

For simplicity, we employ data on past deforestation and national forest stocks from the Global Forest Resource Assessment 2010 (FAO 2010) to illustrate the application of the mechanism. To estimate the average CO_2 emissions per hectare and country in the areas deforested we overlaid geographic information system maps of above ground carbon content in forests (Ruesch and Gibbs 2008) with countries distributions of tropical forests (Hansen et al. 2010) and calculated the average aboveground carbon per hectare in the tropical forests in each country. Because the exact size and location of carbon sinks is uncertain (Pan et al. 2011) we assumed instead a constant range of carbon sequestration by intact tropical forests. This assumption seems reasonable given the similarity of the estimates obtained for carbon sequestration in intact African forests (0.63 Mg C/ha·year (95% CI 0.22–0.94)) (Lewis et al. 2009) and intact forests in the Amazon (0.62 ± 0.23 Mg C/ha·year) (Baker et al. 2004). We employed as the price of carbon the certainty equivalent of the median of peer-reviewed estimates with a 3% of pure rate of time preference, without equity weights and a risk premium ($25/tC) (Tol 2010). The calculations were applied to 61 countries that included those that contain tropical forests.

Results

If the relative penalization for emissions with respect to carbon sequestration α is set to one (tons emitted carry the same externality magnitude that the service provided by tons sequestered), very few countries would receive net payments from the proposed mechanism according to the current state of affairs (Table 1 column titled “Net compensate C sequest.” where the value is positive). The most benefited countries are those with relatively large forest stocks that produce notable carbon sequestration services and that have low deforestation rates. For instance, for forest stocks corresponding to 2005 compensation would be received by countries like Angola ($863 million of annual compensation), Colombia ($743 million), Democratic Republic of Congo ($670 million), India ($1.2 billion) and Vietnam ($890 million) (Table 1 column title “Net compensat. C sequest.”). If the mechanism attained a complete cessation of deforestation in the 61 countries or if α were set to zero (no penalization from emissions from deforestation), the value of the carbon sequestration services to be paid for forest areas corresponding to 2005 could increase up to $26.6 billion annually (sum of column “annual C sequestrat. service” in Table 1).

Setting α to one is remarkably conservative because many more hectares of forest stock are needed to compensate for the emissions produced by one hectare deforested (*ca*. 300 hectares would be needed to sequester the equivalent to the emissions of aboveground carbon of 1 ha deforested in Indonesia). For countries to realize the payments for carbon sequestration, they would need to dramatically reduce their deforestation rates. The potential incentives for countries effectively reducing deforestation are far from negligible. For instance Indonesia could receive annually up to $1.4 billion and Brazil $7.5 billion.

Because carbon sequestration is a service that would generate payments through time and deforestation motivated by timber logging is a one off payment, countries have a strong incentive to preserve forests if payments can be guaranteed. Past deforestation would effectively forgo a stream of benefits. For instance, if the mechanism were implemented, Indonesia would forgo $8.8 billion of missed compensation from carbon sequestration services as a result of deforestation from 2000 to 2005 for a time horizon of 30 years and 6% discount rate (Table 1, column “annual loss service emissions ($ mill) 2000-5”).

Discussion

Our estimate of total potential incentives for halted deforestation of $26.6 billion is close to other estimates in the literature whereby $30 billion would be sufficient to reduce 90% of deforestation when using a combined incentives mechanism (Strassburg et al. 2009). The similar magnitude of our estimate confirms that payment for carbon sequestration offers sufficient incentives to pay for most opportunity costs of land use alternatives that replace forests.

Low-income countries with large forest stocks and small deforestation rates would perceive immediate payments for carbon sequestration services, allowing them to develop whilst preserving their natural capital. This could lead to countries developing economically whilst specializing in the provision of ecosystem services. Because our scheme is based on the correction of market failures regarding one ecosystem service – carbon sequestration – natural extensions of the proposed mechanism would be payment for other ecosystem services of global relevance, such as biodiversity conservation. The valuation of these ecosystem services is however less established than the valuation of carbon sequestration and it might be overambitious to include other ecosystem services in the mechanism at this early stage.

Although our mechanism is centred on services provided by forest stocks, it can also be regarded as additional because, for countries to be able to receive payments, substantial reduction of deforestation with additional emissions reductions needs to occur. This departure from the standard additionality criterion is certainly a price to pay for eluding problems with historical reference levels.

It might be argued that, due to the stringency of the mechanism in terms of necessary deforestation reductions, countries with high deforestation rates will be discouraged from attempting progressive reductions that would not receive compensation in their beginnings. This problem could be alleviated modifying the weighting factor α to fine-tune the relative importance of sequestration over emissions. This would allow increasing the incentives for countries with high rates of forest conversion. Although this would increase the flexibility of the mechanism, it might distort the actual value of the services and disservices provided by each country and could lead to controversy. On the other hand, the stringency of the mechanism might be positive since payments will be conditioned on the production and maintenance of substantial results. This would both avoid payments being facilitated easily for "hot air" – reductions that were to occur without the intervention and countries holding "carbon hostage" – high levels of deforestation before REDD+ implementation (Venter et al. 2010).

There exists concern over the permanence of REDD+ credits; i.e. projects producing emission reductions are maintained through time. This problem can be solved since the mechanism is based on a "get-paid-as-you-go" strategy: programs that only produce a temporal delay for deforestation would only receive a short compensation for the services provided. On the other hand, a "get-paid-as-you-go" strategy and the fact that most of the countries would not be able to obtain REDD credits at the current state of affairs – but credit number could increase substantially as their deforestation policies change –

which might present technical difficulties if the mechanism were to be included in carbon credit markets. Difficulties would arise because the volume of carbon credits available would fluctuate over time, which might be at odds with the principle of permanence. This is certainly another price to pay for the flexibility of the system. Some solution would be to associate the credits with an expiry date consistent with the updating time for the remote sensing maps. After the expiry date, the number of credits offered by each country would need to be revised. In addition, because numerous credits from the mechanism could swamp the credit market, a re-scaling of the objectives of emissions reductions of the countries would be necessary as the number of carbon sequestration credits available fluctuate.

A "get-paid-as-you-go" strategy is also consistent with the principle of sovereignty of the countries. Countries do not need to sign contracts that would constraint decisions regarding their economic development in the future and can flexibly decide on their land use allocations through time.

Our mechanism presents some caveats. The estimation of carbon emissions and sequestration presents some technical difficulties such as not having spatially explicit maps of carbon sequestration or not knowing what will be the destination of the timber and how rapidly it will be emitted as carbon dioxide. Also, because there is no momentary penalization for emissions exceeding sequestration, countries might strategize periods of high deforestation rates followed by no deforestation to receive payments for carbon sequestration. Possible solutions would be to cumulatively account for the emissions in the past to prevent these countries from receiving payments for carbon sequestration in the future. This would be a rather unforgiving strategy that would dissuade countries to reduce deforestation if the cumulative emissions debt is too high. We believe that this would not be needed, since uncontrolled deforestation in short periods of time would actually reduce the forest stock and the stream of payments that carbon sequestration would generate, representing itself a strong penalization for deforesting countries.

$26 billion annually in payment of carbon sequestration services is certainly a bargain if we get in exchange a reduction of anthropogenic carbon emissions close to 15% and a comprehensive conservation of biodiversity in the tropics. If we further consider that $26 billion is indeed less than a thousandth part of the estimated value ($33 trillion) of ecosystem services annually (Costanza et al. 1997), we realize that we have a strong moral duty with future generations to implement REDD+ as soon as possible. It would be a shame that REDD+ would eventually not gain recognition as certified emission reduction credits because of controversies due to historical deforestation reference levels. We hope that our alternative reference level-free mechanism would be able to facilitate discussions and contribute to break the *impasse* that keeps REDD+ away from carbon credit markets.

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Table 1. Countries annual value of carbon sequestration services in 1990, 2000 and 2005. Annual value of losses due to deforestation. Net present value (NPV) of carbon sequestration services and net compensation using the proposed scheme where α = 1.

Country/area	annual C sequestrat service ($ million) 1990	annual C sequestrat service ($ million) 2000	annual C sequestrat service ($ million) 2005	annual loss service emissions ($ mill) 90-2000	annual loss service emissions ($ mill) 2000-5	NPV service C sequest ($ million) 1990	NPV service C sequest ($ million) 2000	NPV service C sequest ($ million) 2005	Net compensat C sequest ($ million) 1990	Net compensat C sequest ($ million) 2000
Angola	960	941	931	-78	-78	13219	12949	12814	882	863
Antigua and Barbuda	0	0	0	0	0	2	2	2	0	0
Argentina	555	532	520	-445	-448	7645	7321	7159	111	84
Bangladesh	14	14	14	–	-1	191	192	189	–	13
Belize	26	26	26	0	0	358	358	358	26	26
Benin	52	42	37	-41	-41	720	580	510	12	2
Bhutan	48	49	50	25	25	658	681	693	73	75
Bolivia	989	946	925	-952	-952	13614	13027	12735	37	-5
Brazil	8190	7768	7524	-11997	-13886	112740	106927	103563	-3807	-6118
Brunei	5	5	4	-10	-10	68	62	60	-5	-5
Cambodia	204	182	165	-480	-750	2807	2502	2265	-276	-568
Cameroon	387	352	335	-1007	-1007	5321	4844	4606	-620	-655
Central African Republic	365	361	358	-137	-137	5030	4965	4933	229	224
Chile	240	249	254	58	58	3309	3433	3495	299	308
Colombia	968	960	956	-222	-217	13320	13217	13166	746	743
Congo	358	355	354	-80	-80	4927	4890	4872	278	275
CostaRica	40	37	38	-62	10	556	515	518	-21	47
Cuba	32	38	43	25	36	446	528	588	57	75
Democratic Republic of the Congo	2213	2130	2104	-2434	-1459	30467	29312	28966	-221	670
Dominican Republic	22	22	22	0	0	298	298	298	22	22
Ecuador	218	186	171	-757	-757	2995	2567	2353	-540	-571
Ethiopia	238	216	205	-88	-88	3277	2971	2818	150	128
Gabon	345	344	343	-48	-48	4754	4732	4721	298	296
Ghana	117	96	87	-446	-380	1615	1321	1196	-328	-284
Guatemala	75	66	62	-180	-180	1029	912	854	-105	-113
Guinea	117	109	106	-229	-165	1606	1497	1458	-112	-56
Guyana	238	238	238	–	0	3274	3274	3274	–	238
Haiti	2	2	2	-1	-1	25	24	23	1	1
Honduras	116	86	73	-902	-718	1601	1177	1008	-785	-632
India	1007	1064	1066	1412	113	13862	14645	14677	2419	1177
Indonesia	1836	1541	1394	-8798	-8794	25271	21214	19185	-6962	-7253
Ivory Coast	161	163	164	44	60	2216	2239	2256	205	223
Jamaica	5	5	5	–	–	75	74	73	–	–
Kenya	58	56	55	-22	-20	804	777	764	36	36
Laos	273	260	254	-164	-164	3754	3584	3500	109	97
Liberia	64	54	50	-218	-218	880	749	684	-154	-163
Madagascar	216	205	202	-188	-104	2968	2823	2783	28	102
Malaysia	352	340	329	-345	-620	4851	4681	4529	7	-279

Martinique	1	1	1	–	–	10	10	10	–	–
Mexico	1087	1032	1012	-992	-741	14962	14209	13927	95	291
Mongolia	181	168	161	–	–	2491	2312	2223	–	–
Myanmar	618	544	507	-1433	-1433	8503	7491	6986	-815	-889
Nepal	76	61	57	-237	-136	1044	846	788	-161	-75
Nicaragua	103	87	82	-363	-254	1417	1201	1125	-260	-167
Nigeria	271	207	175	-1927	-1927	3736	2848	2404	-1656	-1720
Pakistan	40	33	30	-26	-27	548	459	412	14	6
Panama	69	68	68	-25	-11	949	934	931	44	57
Papua New Guinea	496	475	464	-598	-598	6834	6532	6382	-101	-123
Paraguay	333	305	291	-403	-403	4587	4199	4005	-70	-98
Peru	1105	1090	1083	-385	-385	15210	15005	14903	720	705
Philippines	167	125	113	-1100	-659	2292	1723	1553	-934	-534
Sierra Leone	48	45	43	-48	-48	660	618	597	0	-3
Solomon Islands	44	37	34	-90	-90	600	514	471	-46	-53
Sudan	1203	1110	1064	-368	-368	16559	15282	14644	835	742
Suriname	233	233	233	0	0	3203	3203	3203	233	233
Thailand	251	233	229	-190	-97	3461	3212	3148	62	136
Trinidad and Tobago	4	4	4	-3	–	51	49	49	1	–
United Republic of Tanzania	653	588	555	-258	-258	8984	8090	7644	395	330
Venezuela	819	774	751	-1138	-1138	11279	10656	10344	-318	-363
Vietnam	147	185	204	690	705	2030	2542	2803	838	890
Zambia	774	704	669	-278	-278	10650	9686	9203	496	426