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Article

Options for a National Framework for Benefit Distribution and Their Relation to Community-Based and National REDD+ Monitoring

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Abstract: Monitoring is a central element in the implementation of national REDD+ and may be essential in providing the data needed to support benefit distribution. We discuss the options for benefit sharing systems in terms of technical feasibility and political acceptability in respect of equity considerations, and the kind of data that would be needed for the different options. We contrast output-based distribution systems, in which rewards are distributed according to performance measured in terms of carbon impacts, with input-based systems in which performance is measured in term of compliance with prescribed REDD+ activities. Output-based systems, which would require regular community

carbon inventories to produce Tier 3 data locally, face various challenges particularly for the case of assessing avoided deforestation, and they may not be perceived as equitable. Input-based systems would require data on activities undertaken rather than change in stocks; this information could come from community-acquired data. We also consider how community monitored data could support national forest monitoring systems and the further development of national REDD+.

Keywords: benefit sharing; input-based distribution; output based distribution; equity; community monitoring; link to national MRV

1. Introduction

International debate on the design of an international policy for Reducing Emissions from Deforestation and forest Degradation (REDD+) has been going on since 2003. A three-phased approach was adopted at the 15th Conferences of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in 2009. Under such an approach, countries would first receive assistance to build up their capacities, then to experiment with strategies to reduce deforestation and degradation before moving on to a fully fledged system under which they could expect financial rewards tied to performance compared to agreed baselines or reference levels [1–3]. With financial support from the UN-REDD programme (UN-REDD+), the Forest Carbon Partnership Facility (FCPF) and various bilateral donors, a number of countries are well into phase 1 or starting phase 2, and the formal adoption of a REDD+ framework by the Parties at COP19 in Warsaw is a major step forwards in turning the idea into reality. A major role for communities has been foreseen, not only in managing forests, but also in monitoring tasks related to this [4], and there have been many projects promoting methods that could be used for community based monitoring (CBM) for REDD+ [5,6]. However, with all these positive advances, some of the challenges of implementing this complex policy at national and local level are also becoming more evident [7]. As countries move from the basic capacity development phase into Phase 2 of REDD+ and start to envisage how performance-based activities could be built into national programmes, several important questions arise relating to CBM, benefit sharing and how the related data will tie into national REDD+ data systems.

We start from the position that CBM is likely to be promoted in national REDD+ programmes, even though it is not yet clear what form it will take and what data it will provide. While CBM protocols could focus on carbon stock changes in community forests, they could also be designed to gather data on activities undertaken rather than on results. Either way, the use of CBM may be very important in increasing both the accuracy and the transparency of monitoring processes, but the choice of data to be included would have direct bearing on the suitability of such monitoring with respect to benefit sharing.

In this paper, we present and discuss a range of feasible options for benefit distribution systems that governments could select from. We use the term "benefit" here to refer to the direct rewards that participants within a national REDD+ system would receive in Phase 3 as an inducement, and we assume that the main source of these benefits is the finance raised as a result of international trading of the carbon credits, whether this is through a fund or a market; these inducements might be transferred to the stakeholders in the form of cash or in kind. We do not consider funds relating to preparatory phases, e.g., for capacity building, to be "benefits" in this sense, and in this paper we are not considering co-benefits (such improved micro-climates, water supply *etc.*) that may also accrue to participating communities.

An important question is how the financial benefits of future carbon credits and/or other REDD+ payments will be distributed within national programmes or initiatives started at the level of sub-national jurisdictions, since although UNFCCCC REDD+ was conceived as a scheme to operate at the national level, it has been agreed that in some cases, particularly where national governments do not have full authority over some jurisdictions, sub-national programmes will be accepted (e.g., province or state level REDD+ programmes). For simplicity, we talk in terms of national programmes for the purposes of this article [8]. These benefits may be the main incentives for the participation of individual stakeholders in REDD+ activities within national programmes; before opting in, potential participants will want clarity on what rewards they could expect, and under what conditions they will be eligible to receive them. Not only will they need information relating to their own opportunities under REDD+, it is clear that at societal level there will be need for transparency and a legitimate rationale to justify how the financial benefits from REDD+ are to be distributed between the different participants. These might for example be individuals or communities whose territory includes forest areas and who might contribute to REDD+ by improving their forest management approach or by making changes in other ways (e.g., management of cattle) to reduce pressure on the forest. However, given that community monitoring of such REDD+ activities will in many cases accompany these activities, the question arises of whether, and how, this will be used in assessing the relative contribution of different participants, and therefore whether it could and should be used as a basis for the distribution of benefits. A further question concerns how such community monitored data might be integrated with the data systems at national level which will be used by countries in reporting to UNFCCC on their national achievements relative to reference levels.

The assumption is often implicitly made that within national programmes the financial benefits that accrue from international sources should simply be shared between participating stakeholders according to the performance of each participant, calculated in terms of the tons of carbon each participant saves, a model which we refer to as an "output-based benefit distribution system". However, although a carbon-performance metric based on output (amount of carbon saved through REDD+ activities) may be appropriate for distribution of benefits at the international level [9], there are a number of reasons why it is less suitable for the distribution of benefits *within* countries or jurisdictions. There are alternative metrics for distribution of REDD+ benefits that could be considered, using subsidies which are tied to performance in terms of inputs and effort, rather than in terms of (carbon) outputs. We refer to models of this type as "input-based benefit distribution systems". The distinction between input-based and output-based models is well known in literature on Payment for Environmental Services (PES) [10–12], where the terms "action based" and "results-based" are

sometimes used [13]. Input-based systems are much more common in PES systems, that is, payments are made on a per hectare basis for changes in management which are assumed to bring about improvements in the flow of environmental services, rather than for the delivery of the services themselves, partly because capacity to observe and measure the environmental services themselves is limited [11].

The choice between these different types of benefit distribution model needs to be based on careful comparison of their implications with regard to three critical characteristics: (a) technical feasibility, particularly as regards baselines; (b) political acceptability, particularly as regards equity and who could be included as a participant; and (c) data requirements, particularly with regard to data that could be gathered by CBM. We start by describing the two models for benefit distribution, including some variations on the input-based approach, in Section 2, before going on to compare them in terms of these three critical issues in Section 3. In Section 4, we consider whether and how systems of data collection to support benefit distribution at the local level might be linked to national systems for REDD+ monitoring and Measuring, Reporting and Verification (MRV). Conclusions are summarized in Section 5.

2. The Difference between Output-Based and Input-Based Systems for REDD+ Benefit Distribution

International REDD+ as proposed under the UNFCCC is in the long run predicated on an output-based benefit distribution system in the sense that by Phase 3, countries are to be rewarded on the basis of reduced emissions or increased removals of carbon dioxide from the atmosphere, as assessed using a baseline or reference level. Countries will only be rewarded for carbon savings which are additional in terms of this baseline, and they will be rewarded proportionally to the quantities involved. As noted above, many observers have assumed that within countries, the same principle should hold: benefits should flow to those who participate in reducing the emissions, on the basis of their individual achievements in reducing emissions through reduced rates of deforestation and/or degradation or though increasing removals of carbon from the atmosphere through forest enhancement [14–16]. This follows the idea of market based incentives [3,9] or a "payment by output" approach that has come into vogue in various domains of public policy and public management, including the environment [17], and this principle will be followed regardless of whether international finance for REDD+ comes from a true carbon market based on off-sets, or from a fund. It reflects a model of economic incentives in which the underlying assumption is that people will try harder if they are rewarded proportionally to their achievements; in terms of UNFCCC policy the underlying rationale is that it will lead to the most cost-efficient mitigation of emissions. Interestingly, many (though not all) REDD+ type projects which pre-date UNFCCC and national approaches to REDD+ and which sell their carbon credits on the Voluntary Carbon Market (VCM) are also rewarded in this way; their funds are, as might be expected, directly related to their carbon performance. However, in those where credits are issued for reductions in deforestation (rather than for tree planting and other forest enhancement activities, which have different characteristics in terms of accounting [18]) the *internal* distribution of benefits among the project participants (say, between the members of participating communities at the local level) is not generally carried out according to individual performance [19,20]. There are important reasons for this. Firstly, a system in which payment is tied

to individual achievement would require a baseline for each and every participant, against which performance could be assessed. Secondly, it may in practice be difficult to identify and define who should receive the benefits (*i.e.*, which participants have not deforested, but would have done in the absence of the REDD+ project). Thirdly, a system based on individual achievement may offend basic principles of equity [18]. As we will demonstrate and explain in this paper, exactly the same kinds of challenges arise in the distribution of benefits among participants within national level REDD+ programmes (say, between different participating rural communities).

The alternative to the output-based benefit distribution model is one that distributes rewards on the basis of effort or input in the implementation of REDD+ activities. As noted above, in most Payment for Environmental Services (PES) systems, landowners are offered a flat rate payment per hectare if they agree not to deforest, or to carry out a set of prescribed activities for sustainable use which are assumed to conserve forest and retain or increase carbon stocks or biodiversity (see for example [21] for the case of Mexico; [22] for the case of Costa Rica; and [23] for the case of Ecuador). Though called a "payment for environmental services", in these programmes the payment is in fact a subsidy, and it is paid on the assumption that the actions undertaken will have positive effects on the quantity and quality of the services. The improvement in the supply of environmental services is not directly measured, although payments are usually made after checking that the activities have indeed been carried out, to ensure conditionality. However, additionality is not usually assessed; it is clear that in many cases payments do not result in additional effects, since many of the participants would not have deforested anyway [21,23] (for an extended discussion of the efficiency of payments in this respect under PES, see [24,25]). In input-based systems, potential participants are free to decide if it is worth their while to participate, based on the size of the incentive offered. Payments may be higher in areas with particularly important ecological characteristics ("graded flat rates"), and may be restricted to areas which are genuinely under threat of deforestation. This input-based system of distribution of benefits relies on calculation of overall carbon achievements of a large area (state or national level), the financial value of which form the basis of the fund to be distributed. It is therefore fundamentally different from the output-based one which pays each participant on the basis of the direct measurement *ex-post* of carbon achievements.

A sophisticated variation on the input-based model is payment by opportunity cost, in which the level of the reward or benefit is set based on an estimate of what the landowner/community would have to sacrifice financially by conserving the forest or managing it in a sustainable way rather than deforesting or degrading it for personal economic gain (note that here we are considering opportunity costs only in the sense of how these might vary within any one country. It is of course true that the opportunity costs of REDD+ vary between countries, an issue that leads to inequalities in the extent to which different countries could potentially participate, but this is beyond the scope of this paper.). This is based on the idea that implementation costs are not uniform, and that scaling of payments to reflect this will enable more people to participate. There are two ways to estimate opportunity costs: (1) payment levels could be set centrally for each type of likely land use change in given regions; the per hectare rates of payment in areas threatened by avocado or palm oil plantations, for example, would be much higher than rates of payment in areas threatened by less profitable commodities such as maize; (2) payment levels are fixed through an auction system, in which potential participants bid, proposing the level of payment they consider would match their costs; a central organization would

then select which bids to accept, *i.e.*, choosing the most cost effective bids on offer. The knowledge that selection will be made in this way should encourage potential participants to put in their lowest possible bids. Opportunity costs models, particularly the second type, are considered by some economists to offer the most efficient form of incentives as in theory at least they should result in carbon savings at lowest costs. Many observers of PES however dispute this, noting that opportunity costs do not reflect the full costs of the environmental service delivered since they do not include transaction costs [26,27]. Transaction costs (for example, the cost of acquiring the necessary data), may vary considerably between the different models, as we show below. It has also been noted that opportunity costs vary greatly over space and are usually highest for large landowners in areas of greatest deforestation threat [24,28,29], which raises the question of social equity in targeting. Borrego and Skutsch [30] have shown that the opportunity costs of shifting cultivation vary by a factor of 5 within one community, as richer individuals with larger parcels invest more and get much higher returns. A policy of paying the poorer members of the community at a lower rate than the richer members is not likely to be popular. Moreover, experience indicates that the suppliers of the environmental service prefer fixed payments [31].

3. Critical Comparison of Output- and Input-Based Benefit Distribution Systems

In order to make sound choices in the design of a benefit distribution system, the characteristics of the different possible systems needs to be considered. Here, we consider three important sets of characteristics. We first look at the different technical challenges associated with baselines for output- and input-based systems, secondly at their respective political and equity implications, and finally at their data requirements, including the cost of gathering the data that would be needed to implement them.

3.1. Technical Considerations

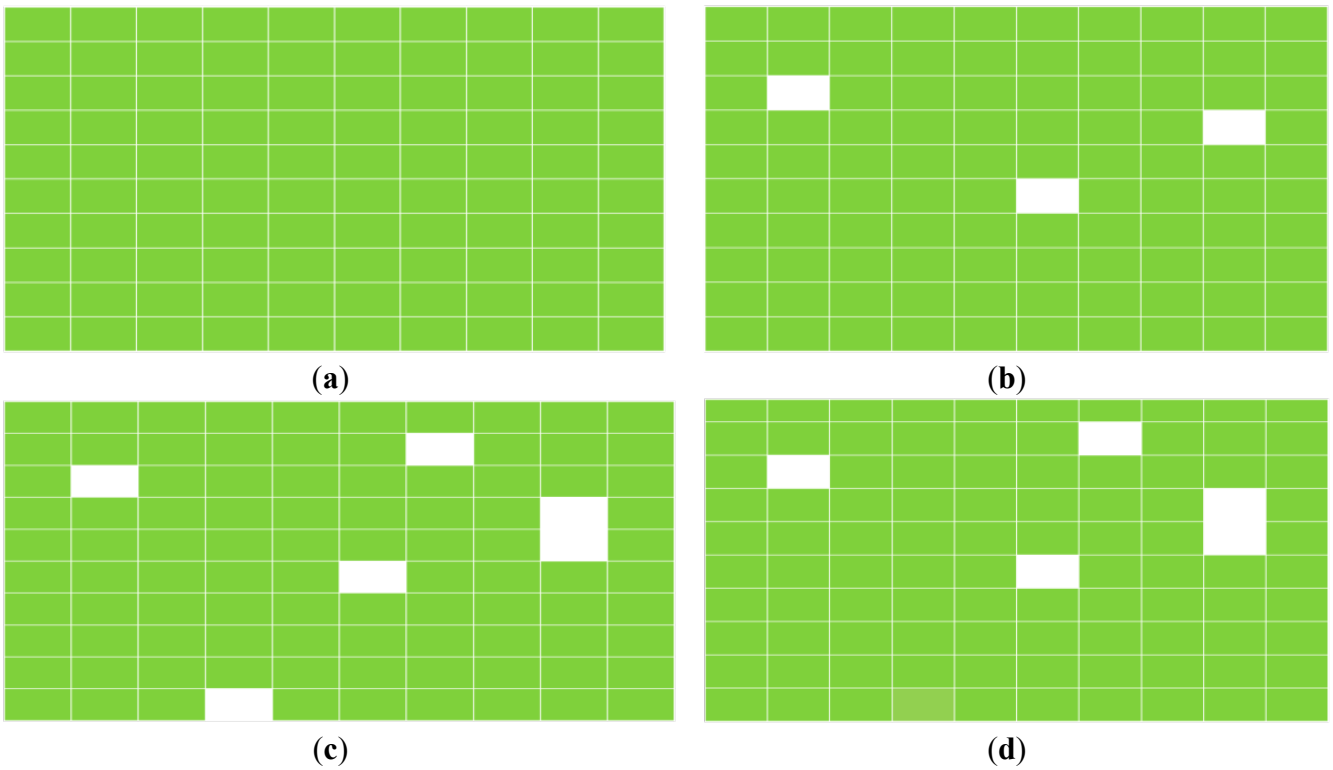
3.1.1. Baselines for Output-Based Benefit Distribution

Payment by output requires a baseline against which performance can be assessed; the baseline represents "business as usual", *i.e.*, it is a projection of what the carbon losses from the forest stock would have been if no action were to be taken under REDD+. It is usually based on historical trends, and it is in essence hypothetical or counterfactual. The national level baseline is called the reference emission level or reference level depending on whether or not it includes forest enhancements. Baselines can also be set up for smaller areas within a national territory: for example, REDD+ type projects in the VCM have baselines which usually cover the project area and a zone surrounding this area, to ensure that any local project leakage will be included. Such projects however are usually made up of multiple forest owners or forest owning communities.

We consider first the case of reduction of emissions (from deforestation) for which REDD+ activities are stimulated over a given area, and are successful (the case of emissions from degradation raises even more challenges, since lack of historical forest inventory data in most countries means that it is not possible to construct a baseline for these carbon losses.) At the end of the period during which REDD+ activities have been undertaken, it is possible to compare the actual deforestation rate of the whole area against the baseline, but it is very difficult to know which of the many

individuals/communities would have deforested in the absence of the project, but did not [18]. For example, if a region is made up of 100 forest parcels of equal size, and has had a historical deforestation rate of 3%, it would, under a business as usual scenario, be expected to lose the equivalent of three parcels of forest every year in the future. If as a result of REDD+ activity, the rate of loss is reduced to two parcels per year, the region would receive credits equivalent to one parcel. The difficulty, however, is to know which of the many parcels that did not deforest in that year should receive these credits. As Figure 1 shows, in year 3, there would be 95 parcels that are not deforested, but the credits available for distribution are equivalent to the forest stock of only one parcel. Since most deforestation is unplanned, it is impossible to know to which of the 95 owners or communities the credits should be attributed. In practice, this means that it is impossible to relate the "avoided deforestation" to individual owners/communities, and thus to determine who should be rewarded.

Figure 1. Example showing the difficulty of identifying who should receive benefits relating to the reduction of deforestation within a large geographical area. (**a**) Year 1: Region has 100 intact forest parcels; (**b**) Year 2: before REDD+ 3 parcels are cleared: rate of loss 3%; (**c**) Year 3: without REDD+ Continuing at 3% loss, 6 parcels would be cleared by the following year; (**d**) Year 3: with REDD+ However, with REDD+, the rate of loss is reduced to 2%. One parcel is "saved", but it is impossible to determine *which* one.



This is a major dilemma facing national REDD+ programmes, in which the intention is to enroll communities and landowners as participants. Credits will be calculated at national level, based on overall losses and gains against the reference emission level. Many communities will not deforest, but it will not be possible to ascertain which ones *would have* deforested in the *absence* of REDD+. This difficulty is a direct outcome of the requirement under REDD+ that carbon savings should be

additional; credits are not issued for all forest that is not deforested, but only for that amount of forest that would have been deforested but was not.

The apparent solution to this problem would be to create a baseline for every individual property, showing their individual past deforestation trends and making individual forward predictions for their "business as usual" situations. However, apart from the huge transaction costs that would be involved in developing so many baselines, there are difficulties in applying deforestation baselines to each and every small property, since the temporary clearances associated with cyclical harvesting and certain agricultural practices (e.g., shifting cultivation) would average out in time at broader geographical scale. Moreover, a benefit distribution system based on individual baselines would risk presenting perverse incentives. Those responsible for a parcel which has never been deforested in the past will be at a disadvantage compared to those who have considerably deforested their forests in the past, since the latter will be able to claim more credits when they start to improve their management [32]. This kind of metric is unlikely to be considered legitimate by the general public, as it does not reward those who have always maintained their forest well, a point that we will discuss in more detail below in the section on political and equity considerations.

Secondly, we consider the case of increased removals of carbon dioxide from the atmosphere through forest enhancement, which is technically different in terms of baselines from reduced deforestation and degradation. It presents other possibilities, and could be credited in a different manner. For example, if through improved management, the owners or managers of forest parcels are able to increase forest cover, or to increase the density of biomass within the existing forest areas, these increases in stock can readily be measured on site [5,33] and could therefore, unlike reductions in deforestation and degradation, be attributed directly to the owners or managers [18]. For example, in the Scolel Té programme in Chiapas, Mexico, which follows the Plan Vivo system and sells credits on the voluntary carbon market, farmers are encouraged to increase tree cover in their coffee plantations; increases in tree biomass are measured on their fields, and they receive a payment which is directly proportional to the increment [34]. The same strategy has been used in a number of projects in Tanzania which involve tree planting [35]. This strategy can also work at the community level: in a REDD+ pilot project in Nepal, for example, communities are rewarded for increases in stock in the communal forests [36], partly on the basis of their performance. This is also the methodology used in afforestation and re-forestation projects under the Clean Development Mechanism (CDM). The measurement of increases in stock in these forests does not rely on counterfactual assessments, which are inherent in the assessment of avoided deforestation/degradation. Although a baseline will be required to check that the forest was not growing of its own accord before the project began (*i.e.*, to satisfy the requirement of additionality), such baselines are relatively simple to develop and there is considerable experience in this from CDM projects and in the Voluntary Carbon Sector. It might also be possible to develop a methodology that uses independent expert judgment.

3.1.2. Baselines for Input-Based Benefit Distribution

In benefit distribution systems based on inputs, on the other hand, all landowners participating in the REDD+ programme would receive benefits, provided they carry out the prescribed activities and do not deforest, as is the practice in most PES schemes in developing countries and e.g., in Europe

for the case of some agri-environmental grants. It is also the principle behind most forest certification systems [37]. Although a reference emission level would be necessary at national level to gauge the overall national achievements in REDD+, no carbon baselines would be needed to measure carbon performance of the participants. Instead, benefits could be based on simple flat rate payments, graded flat rates, or opportunity costs, as described above. All that would be needed would be some proof that participants had complied with the programme requirements. The challenge, however, is that if the financial benefits were to be sourced only from the carbon credits, the money would have to be shared between a very large number of participants, meaning that each participant would receive a very small amount. Alternatively, the money could be used for community infrastructure and facilities; nevertheless it would involve small amounts since it would have to be shared between all participants in compliance. In the case illustrated in Figure 1, the profits from the carbon credits issued as a result of the reduced deforestation equivalent to one holding would have to be shared between all 95 owners who had not deforested. It is also clear that paying everyone, every year, when in reality only a few would have deforested in any one year, is not very efficient from an economic perspective; this strategy has been heavily criticized for example in the case of the programme Bolsa Floresta in Brazil [38]. Moreover, there would be no incentive for extra effort in forest management, as everyone would get an equal payment for the same minimum set of activities, even if they voluntarily implement additional activities.

Given the technical difficulties with output-based payments related to the impossibility of determining who should be paid and the apparent economic "inefficiencies" of input-based systems (which pay a large number of people who would not have deforested anyway), plus the fact that input-based systems will never be able to generate sufficient funds to pay all participants a significant subsidy, Balderas Torres and Skutsch [18] proposed a dual system of payments. In this system, communities/landowners could receive input-related payments for participation in a REDD+ programme in connection with reductions in deforestation and forest degradation measured at the jurisdictional or national level, and financed from the fund derived at national or state level from sale of aggregate credits calculated at that level. In addition, they could receive an output payment for any measured increases of stock which they could demonstrate on their own property. The input-related payments to each participant would necessarily be small, given that the fund would pay out to all participants, not merely those that are responsible for additionality. However, the output payments would vary according to real achievements, and, as explained above, these are much easier to measure than counterfactual reductions in deforestation, and require no real baseline since increments would be physically measured at intervals throughout the crediting period; any increases above the starting value would be rewarded. This could stimulate the better management of large areas of degraded forest through relatively simple means such as restricting off-take to levels which are sustainable. Since claiming credits for such growth would require local data, communities could be required to include monitoring as part of their management strategy. As we will discuss in Section 3.3, there would of course have to be third party checks, or the threat of them, to ensure that growth rates are not exaggerated.

3.2. Political and Equity Considerations

We now turn to the second critical issue: how output- and input-based distribution systems compare when considered from the point of view of political acceptability and particularly as regards equity, which is a major concern of many REDD+ observers. There have been a number of literature reviews around the issue of equity in benefit distribution for REDD+ [39–41] and these demonstrate that the vast majority of articles on benefit distribution in REDD+ take the line that the key issues are social equity and rights [19,42–46]. This reflects the heavy engagement of NGOs and civil society organizations in REDD+, representing in particular the rights of indigenous peoples.

A recent article [47] makes it clear that "equity" in REDD+ can be interpreted in many different ways. It suggests that equity in benefit distribution could be understood as (a) "merit-based", *i.e.*, benefits go only to those who have achieved carbon savings (which would result from what we have called "output-based" benefit distribution; systems of this kind may be considered "equitable" because those who receive payments are the ones who have "earned" the benefits). Equity may alternatively be understood as (b) rights-based, *i.e.*, benefits going (only) to those who have rights over the resources; or (c) needs-based, *i.e.*, benefits should be distributed to favor groups that are marginalized and vulnerable, as in pro-poor approaches. Needs-based here refers to needs in the general societal sense, not to needs as regards e.g., capacity building for REDD+.

The choice between these different equity principles can be hotly debated on ideological grounds, but it is important also to understand the extent to which output- and input-based distribution mechanisms can provide for equity in each of these forms [48–50]. Most obviously, communities or landowners with a history of good forest conservation will have flat baselines and would therefore not receive benefits under a merit or output-based system, because they can hardly improve on what they have been doing in the past, a situation which would be considered highly inequitable in most societies, and which is quite likely to act as a perverse incentive, as discussed above. An input-based system which would reward all those who carry out good practices, whether they started this earlier or as a result of the REDD+ project, is therefore likely to be perceived by the general public as much "fairer" [31], and should be preferred in this sense. If, however, the system is based on inputs payments which vary to reflect opportunity costs, this could easily be perceived as "unfair", as it raises questions about procedural equity in terms of who calculates the appropriate opportunity cost for each participant, and how; and it increases the chances of collusion and corrupt practice in this regard.

A rights-based approach to equity raises problems in that rights over forest are frequently not formalized. Tenure or rights would first have to be established, a process that could delay implementation of REDD+ for many years. However, even in countries where rights to forest land are legally in the hands of clearly defined agrarian communities, as in Mexico, a rights-based approach could be controversial, as there are increasing numbers of people within these communities who are not formally members of the community and who do not have a vote in community decision making or rights to the common property, either because they did not inherit these rights or because they have sold them. Many individuals may be excluded from financial benefits if the rights-based principle is applied *within* the communities participating, and this would be a problem, regardless of whether an output-based or an input-based distribution system was to be selected.

There are, however, other rights issues which are less discussed and which may have different outcomes under output- and input-based systems. This arises when we consider that people or communities other than those who own forests might have rights to a share of REDD+ benefits. It is well known that many of the drivers of deforestation have their origins outside the forests, in particular the expansion of agricultural and grazing land, which may be stimulated by population growth, in-migration, increases in prices of crops and meat, or increased external demand. It is clear that to succeed, REDD+ will have to tackle such drivers directly. A national government might for example choose to stimulate agricultural practices that reduce pressure on forests. It would therefore be quite reasonable if some of the financial benefits derived from international sales of REDD+ credits or carbon funds were to be invested in the promotion of these practices, if it can be shown that this is an effective way of conserving forests. The underlying principle here is that it is not only the owners or managers of forests who could be eligible for benefits, but also actors outside the forest ([51]; see also [52] for the case of agroforestry). There could also be many stakeholders, such as intermediary agencies, who might legitimately claim a share of the financial rewards from REDD+, if they are implicated in generating participation of forest users, farmers, *etc.* in REDD+ activities which result in decreased emissions or increased sequestration of carbon in forests. The case has also been made that part of the financial benefit of REDD+ should be allowed to flow to agricultural research institutes that are carrying out research to minimize the impacts of drivers (R. Mathews, p.c).

It would however be very difficult to make direct quantitative assessments of the impact of any such action (whether by a farmer or by a supporting agency) on the rate of reduction of deforestation in a given area, with a view to rewarding individuals on the basis of deforestation avoided. It is clear that an output-based accounting mechanism would not work here. Some kind of input-based system would be needed to establish both the legitimacy of the claims, and the size of the benefits to be assigned to them.

Finally, there have been many calls for "pro-poor" approaches to REDD+ that approach equity of benefit distribution in terms of needs [43,53,54]. The underlying problem here is that in general, it is probably not the most marginalized and poverty stricken members of society who are responsible for most deforestation or even for degradation. Although the role of poverty in deforestation is contested, and evidence is mixed [55–57], if we consider first the problem at the level of the individual, the really poor in rural settings are generally laborers working for other farmers, without their own land or cattle, or having very small holdings. Those who clear forest for expansion of agriculture need capital, and those responsible for large-scale degradation (through logging, forest grazing, *etc.*) tend to be those with more resources at their disposal. It may therefore be difficult to achieve carbon savings by directing output-based benefits towards the poorest in society; in fact, it may be a contradiction in terms. Apart from the problem that the needs-based approach directs benefits to those individuals who are not responsible for deforestation (and may thus be an inefficient strategy in terms of reducing emissions), it may also in practice be very difficult to direct benefits to the poorest individuals who have no land resources of their own, even in an input-based system, as they may not have the land resources to participate at all.

If the distribution of benefits happens between communities rather than between individuals, as will often be the case in national REDD+ programmes, the question arises of whether poorer communities deforest more than richer communities. If this were true, output-based distribution systems would be unlikely to reach the poor. One way to overcome these problems at the community level might be to design hybrid approaches to achieve equity in benefit sharing. Among the few publications on this, the three watershed pilot REDD programmes in Nepal [36] uses a weighting mechanism such that 60% of the financial reward is allocated on the basis of needs (using a set of social indicators describing each community), 24% on the basis of existing forest stock, and only 16% on the basis of output, which is measured as increase in stock in the forest (forest enhancement). In Vietnam, an even more complicated weighted index has been developed (the "K" index), which involves both input and output indicators [58]. However, both of these innovative approaches are in pilot phase and it is not yet clear whether they can be considered successful.

3.3. Data Considerations

It is clear that benefit distribution systems crucially depend on data, and this includes not just data on carbon fluxes but also data on how REDD+ activities are undertaken and what they consist of. At the national level, countries will have to produce robust data on carbon stock changes in order to claim carbon credits and bring in the funds necessary to support REDD+ activities. Increasing the accuracy and level of confidence of the data; for example, moving from Tier 1 to Tier 3, should in principle increase the number of credits that could potentially be claimed. In order to achieve greater data certainty, governments may need to monitor change at the local level using local inventories which feed into and support the national forest monitoring system. Whether these same data should be used as the basis for benefit distribution is, as we have shown, open to question, although it is clear that the choice of monitoring and measuring parameters and indicators will inevitably shape and constitute what REDD+ will be [59]. Given the important political implications of data, it is crucial to assess possible differences in data requirements between input- and output-based systems.

Output-based benefit systems require very accurate data on carbon outputs at the level of each participant, which would necessitate ground level inventories (Tier 3 data). Input-based payment systems on the other hand would be associated with regional or national estimates of carbon stock change, carried out using remote sensing and Tier 1 or 2 carbon data, and with local information on the nature of the activities that are being carried out. The generation of detailed information about changing carbon stocks at the local level, which output-based systems would need, is an expensive undertaking [60], particularly if carried out by professional staff. Transaction costs of measuring carbon stock change at the local level may be reduced if the forest owners or REDD+ actors/implementers themselves are involved in this monitoring, but despite the fact that such measurements may be as accurate as those carried out by professionals [5,6,61,62], this does not resolve underlying data uncertainties. Although the monitoring of changes in forest carbon stocks through measurement of key parameters, such as diameter at breast height in a set of permanent sampling plots, is often presented as a scientific procedure which can be perfected [59,63], in reality there are significant uncertainties involved. Efforts to bring down these uncertainties are inherently costly [64,65], even though in most cases only above-ground carbon stocks are measured, ignoring the complexities of the other carbon

pools. In addition to measurement errors, the use of tree parameters to calculate carbon stocks relies on allometric equations which give, at best, rough approximations, as it is rare to find equations to match all the kinds of trees in the sample and default equations are needed. To deal with these kinds of uncertainties, conservative estimates are used. This might cause participants to feel cheated, although such conservatism is essential to maintain the integrity of the programme. This problem has been discussed by Sommerville *et al.* 2011 [66] for the case of biodiversity, and although the differences between carbon and biodiversity assessment are considerable, it is clear that in both cases the cost of administering reward or benefit distribution systems based on performance as ascertained through local measurements would likely be high, not least because systems which link payments directly to outputs in terms of tons of carbon would encourage participants to over-estimate their achievements and might even encourage fraud [67,68]. To counteract this, strict regimes of verification would be required, with associated costs. This would itself entail the need for a grievances office for participants. Basically, any benefit distribution system based on outputs would be costly to administer. On the other hand, it would yield very detailed data at the local level that could be a valuable input to national carbon accounting, enabling densification of data on carbon stock changes in areas where REDD+ activities are being undertaken.

In contrast, input-based systems only require data verifying that the agreed REDD+ activities have been undertaken and maintained successfully, as is the practice in forest certification. The estimates of carbon stock change for input-based systems (carried out at the state or national level using remote sensing and Tier 1 or 2 data) would inevitably be less secure, and therefore command less confidence in international markets, *i.e.*, would result in conservative payments. However, though such systems would also necessitate the involvement of some external third party for checks and balances, the reporting process would be much easier, cheaper and less burdensome. It would certainly be possible to require participants to make regular inventories of their forest-related activities and even their carbon stocks as part of their management agreement, even if payments are not based on the change in stocks. There would be much less temptation to exaggerate the carbon impacts of the programme if the payments were decoupled from these, and thus there would be less need for very careful verification of data. An additional benefit would be that since reporting focuses mainly on the activities carried out, it would be possible to link activities to changes in carbon stock levels, in other words, to use the data for an assessment of the effectiveness of different management strategies, which would be very helpful in improving public policy on REDD+.

A summary of the issues discussed in Section 3, showing the strengths and weakness of output- and input-based distribution systems is presented in Table 1.

Table 1. Strengths and weaknesses on output- and input-based benefit distribution systems under national REDD+.

Criteria			Output-Based Benefit Distributions Systems		Input-Based Benefit Distribution Systems	
			Strengths	Weaknesses	Strengths	Weaknesses
Technical issues	Baselines		Simple, parcel-based baselines are needed to measure increments in forest stocks. It is easy to identify which individual or communities have increased their stocks and base rewards on this	Not possible to determine who deserves avoided deforestation credits unless individual baselines are constructed	Baselines not required	
	Economic efficiency		Only the additional carbon savings will be rewarded	Construction of individual baselines would be very costly		All participants receive rewards, even those who would not have deforested in absence of REDD+. Payments will therefore be very small per participant
Political acceptability and equity	Ability to deliver merit-based equity		Would deliver merit-based equity			Would not deliver merit-based equity
	Ability to deliver rights—based equity	Rights of forest owners	Rights to forest are weak in many countries and it is well known that they need to be strengthened if REDD+ is to succeed. In this respect it makes no difference whether an output-based or an input-based benefit distribution system is selected			
		Rights of REDD+ actors outside forest		Would not permit actors outside the forest to receive benefits, as their actions cannot be quantitatively related to stock changes in the forest	Would permit a division of benefits to include actors outside the forest	
	Ability to deliver needs/poverty based equity			Not likely to benefit poor people as in general the poor are not the main actors behind deforestation	Could be used to benefit poorer individuals and communities	
Data requirements	Accuracy of data required			Very high, and needs strict verification	Data requirements low, though higher if opportunity costs model is used	
	Transaction costs			High	Low	

4. Relating Data for Benefit Sharing to National Forest Monitoring Systems

Many national governments are already setting up national forest monitoring systems, which will be used among other things to support national measuring, reporting and verification (MRV) of their REDD+ activities as required by UNFCCC and international carbon funds. These MRV requirements are fixed by UNFCCC and need to be fulfilled by the national monitoring system, which has to capture the carbon impacts of the sum of all the REDD+, and other activities over the whole national forest area. These national forest monitoring systems will need to include information on drivers of deforestation and on the effectiveness of different programmes and policies in dealing with these drivers and in reducing emissions. They will be essential in providing feedback to the country on what works and what does not work under REDD+, to justify and prioritize REDD+ activities addressing key drivers [69,70]. In addition to these international requirements, the national monitoring system should cater for the needs of the national REDD+ programme implementation, including benefit distribution. A link could be established between data needed to support the benefit distribution system, focusing on activities and change in management practice, and data that is already being systematized in the national monitoring system. The fact that many REDD+ activities may address actions and actors that are outside forests implies that monitoring should include other areas in addition to forests [70]. The national system would need to be able to track and monitor REDD+ activities by the multiple actors involved both inside and outside the forest and could provide the basis and verification for the input-based benefit distribution mechanism. In this way, national forest monitoring systems would evolve to underpin and stimulate strategies and priorities for REDD+ implementation, to track REDD+ activities and their impacts (both carbon and non-carbon), and to support the generation and sharing of benefits for the multiple REDD+ actors involved, as well as providing data for reporting on REDD+ performance in terms of greenhouse gas emissions to the international community. They could be used to link the success and failure of different types of incentives and rewards to the activities undertaken in different parts of the country and, at a broad scale (though not at the level of the individual parcel) to achievements in reducing emissions at the national level.

Moreover, if a dual benefit distribution (*i.e.*, payments based on both outputs and inputs) were to be introduced, with output-based payments for increases in stock, there would be locally generated data on changing stock levels in the forests, as a result of community biomass stock monitoring. This would of course only exist for those parts of the forest where these activities take place, *i.e.*, it would be patchy, but it would represent an important source of data, additional to national forest inventories, providing information on stock levels which could validate and densify data in the national system.

5. Conclusions

In this paper, we have argued that a transparent, legitimate and easy to understand benefit distribution system will be essential to the success of REDD+ as countries move into Phase 2 and start to implement activities at the local level, initially on a pilot scale but with a view to fully-fledged performance-based REDD+ in the near future. We argue that there are advantages and disadvantages to both output- and input-based benefit distribution systems. Benefit distribution systems based on output metrics (calculations relating to reductions of emissions of carbon associated with reductions in

deforestation and degradation) are difficult, if not impossible, to implement at the level of individual forest parcels, such as forests owned and managed by communities or small landowners, since it is not possible to identify who, out of the many land owners who have not deforested in any given time period, would have deforested in the absence of REDD+, and thus deserve the rewards (a technical problem). In reality, and to ensure public and political acceptability of the programme, all forest owners who carry out sustainable forest management practices may need to be rewarded, at least in areas where there is a clear risk of deforestation, whether or not they would have engaged in unsustainable practices in the absence of REDD+. It is very doubtful that output-based benefit distribution systems would be considered equitable by the general public, because this would not reward those who have always conserved their forests. Moreover, output-based payments are based on measurements which involve considerable uncertainty at the local level, and which involve heavy transaction costs and risk of the REDD+ mechanism becoming too complex to be effectively implemented [7].

Input-based benefit distribution systems, in which stakeholders receive benefits according to their participation in the REDD+ activities such as conservation or sustainable management of forests or sustainable agricultural practices, are in many ways preferable to output-based systems. We argue that they are technically more feasible, more politically acceptable and easier to administer, with associated lower costs, partly because of lower requirements for detailed carbon monitoring. One option is to distribute benefits according to opportunity costs, either through a centrally fixed payment level for each type of likely land use change (which corresponds with different opportunity costs) or through a system of bidding by interested actors. However, though in theory more economically efficient, opportunity cost models will involve considerable transaction costs because appropriate payments levels would have to be calculated for each participant, and this would raise procedural equity issues and increase the potential for corrupt practice. Another option, which is more transparent and simple in administrative terms, is that a central agency pays flat rates per hectare in return for good forest management or agricultural practice, either using a universal rate or different rates to account for varying land use activities, which is in fact the payment method used in most PES schemes including some agri-environmental subsidies within the European Union. This, however, would mean that many participants would be paid for activities which are not additional in carbon accounting terms, meaning that this system will not be very cost-effective.

As we have shown in this article, both input-based and output-based models have advantages and disadvantages in terms of efficiency, legitimacy and political feasibility. We suggest that the best solution might be a hybrid system in which stock increases (forest enhancements) are rewarded on an output basis at the level of the individual forest parcel, while the financial returns from reductions in emissions from deforestation and degradation (assessed at regional level) would be used to fund input-based incentives. This would imply that only increases in stock should be rewarded on the basis of local measurements of stock change over the REDD+ period (as ascertained by CBM), while avoided deforestation and degradation would be monitored at a regional scale. The fund derived from sale of the resulting carbon credits could be used to encourage activities both within and outside the forest, reaching a broader range of actors; it would therefore not be restricted to forest owners. This mixed system would result in a higher level of economic efficiency than a purely input-based system because at least the rewards for stock increments would only be paid to those who actually produce such increments.

Whatever benefit distribution system is chosen, it is important to recognize that if countries wish to promote CBM as part of the monitoring for REDD+ as recommended by UNFCCC, they should think carefully about what the function of these data will be with regard to the way that benefits are to be distributed, and to provide protocols for the CBM that meet these requirements.

Finally, we suggest that data associated with input-based benefit distribution systems at the local level could usefully supplement national monitoring systems, as in addition to carbon data, these will require information on the success of different public policies or programmes in reducing emissions. In this sense, the requirements for national forest monitoring systems are evolving to more than simply accounting for carbon. Data systems are needed to underpin and stimulate strategies and priorities for REDD+ implementation, by tracking REDD+ activities and their impacts (both carbon and non-carbon), and supporting the generation and sharing of benefits for the multiple REDD+ actors involved, in addition to their obligatory role in the reporting of REDD+ performance in terms of green house gas emissions to the international community. A dual system of benefit sharing as proposed in this paper would certainly require CBM at the local level, which could feed important information both on carbon and on the range of interventions undertaken at that level into an improved national data system.

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Author Contributions

Margaret Skutsch prepared the first draft; Esther Turnhout, Marjanneke Vijge, Martin Herold, Tjeerd Wits, Jan Willem den Besten and Arturo Balderas Torres then contributed sections and improved the text. Margaret Skutsch responded to the reviewers´ comments in the first instance.

Conflicts of Interest

The authors declare no conflict of interest.

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