

**Improved spatial decision support for REDD+**

**Scoping for tool development and implementation**

UN-REDD PROGRAMME

**Feasibility Report**: xx/xx/2016

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**Improved spatial decision support for REDD+**

***Aim:***

*Explore how implementing countries can improve spatial analyses of REDD+ options in order to identify solutions that would maximize country economic gain, whilst also considering the additional benefits delivered by forests to local and national populations.*

**Executive Summary**

A general aim of governments in most countries is to improve overall economic prosperity and social well-being. For such improvements to be lasting they need to be ecologically sustainable, since well-functioning ecosystems underpin many basic processes upon which humans rely, to various extents, for survival. Whilst the need to protect their forests is widely recognized, governments often wish to do so in a way that provides financial returns, creates jobs, and brings social benefits. A case for the value of REDD+ still has to be made despite its potential to deliver on all of these objectives. REDD+ has a clear role in the evolution towards a Green Economy, and, as such, implementing countries will aim to maximize the financial gains to the economy whilst also securing additional bio-physically-derived socio-economic benefits (i.e. forest ecosystem services that underpin the livelihoods and well-being of both the local and national population). In order to facilitate this process a useful REDD+ decision-support tool would be one which helps prioritize which land areas might be included in REDD+ based on the resulting overall financial/socio-economic gain. As well as identifying locations for gain from REDD+, the analysis should also identify the extra costs that result from securing additional benefits.

A number of REDD+ countries may wish to trial this approach to REDD+ analysis, with the intention to refine it during the process. This may lead to the development of a new tool, though the word tool is used loosely here, as it may entail using a number of existing tools in a series of analytical processes. The processes involved in performing the analysis would necessitate the following:

* Develop or draw on existing scenarios describing the context for REDD+ actions, making use of the country reference scenario for emissions
* Identify (and map) viable areas for different REDD+ actions
* Produce a spatial cost layer (using data on opportunity costs as well as implementation and transaction costs) associated with a potential REDD+ action
* Using carbon maps and carbon price scenarios, calculate a net carbon value layer
* Account for “overhead” costs (those implementation and transaction costs that are required in order to undertake REDD+, but are not specific to a site/location)
* Undertake spatial economic maximization, identifying in descending order the most ‘profitable’ REDD+ land areas, where carbon value exceeds costs
* Calculate changes in financial gain when the choice of areas for inclusion is modified to protect or enhance the delivery of additional benefits (it may be possible to monetize some of these benefits)

Since mapping would be required, a GIS-based tool is likely to be the preferred platform for the analysis.

**Scoping tool development and implementation**

1. **Introduction**

Broad economic analysis can indicate whether there are potential gains to be made from a country engaging in REDD+. In order to make a case with decision-makers about the value of implementing REDD+ at specific locations in a country, though, there is a need to demonstrate that the economic costs and benefits for these areas have been considered. Therefore REDD+ planners will require various decision-support tools, some of which will need to be spatial. An important consideration (especially for finance ministries) when deciding which land areas should be prioritized for REDD+ is the overall financial gain[[1]](#footnote-1) that would be delivered to the nation or sub-national region.

It appears that the existing spatial planning tools could be improved for this function. Not only do they need to be able to calculate what lands could be most cost-effectively protected from carbon stock loss, but they should also be able to take into account the additional benefits generated (and specifically to provide the means to identify any costs as a result of including these benefits). The maps may also help local stakeholders to judge whether they do wish to engage with REDD+ activities. Therefore, the next step is to develop an analytical approach suited to the task.

1. **How would it work?**
2. *Scenarios:* As with any approach that uses modelling the bounds of the analysis that is to be undertaken must be agreed at the outset in order to determine the data that will be required. The purpose of the scenarios in this instance is to identify areas at risk of deforestation or forest degradation, as well as identify prices for carbon and the main alternative land-use products. The scenarios require a narrative description as well as quantitative data. The scenario will build on a country’s (‘business as usual’) reference scenario for emissions (which will need to be developed if it doesn’t already exist). Some basic assumptions will need to be made in order to provide values for key variables (these are external to the modelling process and various sources can be referenced). A carbon price must be chosen, as well as a time period (e.g. to 2040 or 2050), and a discount rate, along with forecasts about whether costs and prices will stay constant (i.e. the same relatively). Some background assumptions for a scenario will also be implicit, such as that actions are taken to tackle the drivers of deforestation and minimise leakage (costs of these are included in ‘overheads’).
3. *Area identification:* In terms of defining the geographic area under consideration, the first step is to develop or draw on an earlier analysis on potential areas for specific REDD+ activities (e.g. Ravilious et al 2011). These make use of information on historic trends in land-cover change, land-use designations, existing carbon stocks etc. The diagram below (Figure 1) shows a stylised indication of a map identifying the area to be included in the economic gain analysis for reducing emissions from deforestation.

Figure 1. Area to be included in the analysis - forest at risk and suitable for REDD:



Note: in a scenario of reforestation actions, the grey area would be analyzed

1. *Spatial cost layer:* The next step in the process is to map a cost layer covering the area to be analysed, which will require existing data (though where existing cost layers are coarse these can be modified). All location-specific costs should be included.
   1. In order to estimate opportunity costs, spatial data on potential land-use (crop or livestock) profitability is needed (working within the adopted timeframe). This will be on the basis of the expected average enterprise yield multiplied by the local market prices for the product; with production[[2]](#footnote-2) and marketing costs deducted in order to determine the ‘net margin’ (i.e. profit), which is the direct on-site opportunity cost. If the indirect costs are to be assessed as well, for instance lost income of agricultural input suppliers and employed farm labourers, then their relevant net income should also be estimated. Other income from converting the land, namely the timber (or charcoal/firewood) value, should also be considered where applicable. The value of lost sustainably harvested timber and Non-Timber Forest Products as a result of land use change should be deducted from the opportunity cost. The Net Present Value of money amounts should be used (i.e. future values brought back to a current amount using the discount rate). Existing tools can carry out the above calculations, and therefore it is their output which would be utilized as an input to the model.
   2. The implementation and transaction costs include addressing any negative employment impacts[[3]](#footnote-3) of REDD+, e.g. training for alternative activities, although not lost incomes where these have been included in opportunity costs (otherwise this would be double counting). They also include the cost of enforcement of policies adopted to deliver REDD+ as well as the on-the-ground conservation and management actions. Many of these costs would likely fall on the governing authority (though some costs could fall on landowners, e.g. tree planting), but may be redistributed to different individuals or sectors within society (various administrative approaches might be adopted). At this stage of the analytical process only the location-specific implementation and transaction costs are taken into consideration (the non-location-specific costs are included later as ‘overhead’ costs). Implementation and transaction cost data can be sourced from existing literature such as pilot project reports.
   3. It is also possible to estimate the socio-cultural costs of REDD+ actions (e.g. through a community survey), which are a form of opportunity cost[[4]](#footnote-4). However, since this is a challenging task (and given relative cost magnitudes and the instability of preferences as circumstances change), including such costs is an aspiration rather than a priority.

The diagrams below show the opportunity costs[[5]](#footnote-5) mapped (Figure 2), as well as the location-specific implementation and transaction costs (Figure 3).

Figure 2. Opportunity costs of land parcels: Figure 3. Implementation & Transaction costs: (note: includes socio-cultural costs) (note: location-specific only[[6]](#footnote-6))  

1. *Carbon layer:* net carbon quantities (based on emissions reduction and/or sequestration potential) would be mapped (Figure 4). Note that REDD+ compensation is based on CO2e, so tonnes of C must be transformed by a conversion factor, 3.667. This can then be converted into a carbon value layer, however as carbon prices will be crucial to the values obtained, this step of the process will have to be repeated a number of times to determine the output under different carbon price scenarios (i.e. a sensitivity analysis). An initial comparison of REDD+ income against all location-specific costs (opportunity costs as well as implementation and transaction) will allow a number of areas to be excluded where REDD+ income is less than costs, even before the overhead costs have been included (the non-green areas in Figure 5). The exact nature of the calculations will depend upon which REDD+ action has been chosen for examination (e.g. reforestation, sustainable forest management, etc).

An important and often overlooked value is the option value at the end of the period under REDD+ (possibly 20 years as the minimum). One approach is that of the Verified Carbon Standard[[7]](#footnote-7), where crediting can be renewed a number of times up to a period of 100 years (considered permanent). Therefore, leaving the forest standing for the first period of REDD+ may offer the opportunity to enrol in the next period of REDD+ (at a possibly higher carbon price). In order to account for this, the time chosen for an analysis could be extended to 100 years (permanence) and model future crop and carbon prices over the remainder of the century (though this opens a non-trivial degree of uncertainty in the calculations). An alternative approach may be to at least include the timber value of the standing forest at the end of the first period, as a minimum option value.

Figure 4. REDD+ income for carbon: Figure 5. REDD+ profit/loss: (note: before overhead costs)

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1. *Overhead costs:* Finally, the ‘overhead’[[8]](#footnote-8) costs need to be allocated. These could include national administration including monitoring systems and enforcement, and (most critically) the costs of preventing leakage. Economics recognizes the concept of ‘economies of scale’ whereby some overheads (known as fixed costs) form a diminishing part of total costs when spread across a larger number of units[[9]](#footnote-9). However, some costs may rise with the area in a scheme (such as on-the-ground enforcement costs), yet even here these costs may not increase uniformly. Therefore, if significant, non-location-specific overhead costs that change with area may need to be included in the earlier costs layer. Otherwise, for the analysis these overhead costs could be evenly spread across the land units identified in a solution.

If certain areas are identified as providing a net profit at the chosen carbon price without taking account of overhead costs but do not appear profitable when these costs are included, then this suggests that REDD+ in these areas will need additional (national) subsidies (or international payments for other ecosystem services), or a higher carbon price, or be cross-subsidized by the more profitable areas (if any). In order to speed the process of identifying where value is maximized there may need to be some simplifying assumptions made in terms of overhead costs. Figure 6 (below) shows the results once the overhead costs have been considered. It is envisaged that the tool may present the spatial cost-effectiveness (US$ per tCO2e) of areas by a colour gradation. Note that the most cost-effective areas (indicated here by medium-dark green) would be chosen first, whilst the areas with negative values (red-brown) are initially excluded, since they would require a much higher carbon price. A number of net gain areas may be identified; however a contiguous solution[[10]](#footnote-10) is selected below.

Figure 6. Cost effectiveness of possible REDD+ areas: (includes overhead costs)

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Selected area = \* Net value of area = US$ 72,000 Carbon saving = 22,000 t CO2e

1. *Additional benefits:* Further maps of specific examples of the potential additional benefits (such as water quality) of the REDD+ action being considered, could then be overlaid in order to identify whether REDD+ deemed cost-effective based on carbon coincides with other benefits. It may also be useful to be able to present these benefits in a monetary valuation layer (especially eco-tourism and reduced dam sedimentation values), though the absence of reliable data may preclude this.

These benefit maps would cover not just the most cost-effective areas. Figure 7 below shows a map layer of biodiversity hotspots with the selected area for REDD+ based on cost-effectiveness. It will then be possible to observe the economic implications of modifying the area boundary in order to include more biodiversity benefits. Finally, as part of the process of considering specific areas for REDD+ inclusion, the identified areas on the map might be further grouped together into sensible management units (and the change in economic gain presented). It is worthwhile noting that the above steps (i-vi) would need to be repeated for each scenario (as well as region) investigated.

Figure 7. Map overlay of biodiversity benefits:

*The planner may wish to extend the area on the top left which has biodiversity benefits (the impacts of doing so would then be calculated)*

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1. **Implementation of the approach**

The above has laid out in reasonable detail the steps that would need to be followed in order to undertake a spatial REDD+ analysis that provides guidance on enhancing country economic gain, and any costs associated with securing additional environmental benefits. The approach appears to be feasible. However, the detail of the data requirements, calculation processes, and mapping practicability still requires further work. As envisaged it requires extensive input information, most of which will rely on the outputs from other existing tools / processes. Whilst in theory it would be possible to automate much of the work involved in each of these various processes, the software development required to do so means that it would be an inflexible option (as well as prohibitively expensive and possibly unwieldy).

There are likely to be complications adapting existing non-REDD+ land use and economic analysis models for REDD+ use, since the context has some significant differences with that for which they were developed (and may be at odds with existing deforestation risk models). So, whilst it is worth exploring the possibilities of various current models, it may well be the case that none are easily adaptable.

In terms of delivering a bespoke tool for the spatial economic analysis, the most realistic way forward is to build a GIS model. Cost data would be generated outside of the model using already available tools. This could be further enhanced spatially by modifying cost values using other spatial datasets, for example: soil agricultural suitability classification and distance from markets. Previous work by UNEP-WCMC on mapping multiple benefits provides a useful basis for the additional benefits analysis.

Working to a limited budget and timescale, there is likely to be some trade-off in accuracy in order to deliver an operational product. However, it would most likely be a clear improvement over the current situation.

1. **Conclusions**

The above has briefly outlined the features required of a REDD+ spatial tool to support economic decision-making. Whilst the ambition is always to deliver a ‘perfect’ tool, there is also a need to be pragmatic about what can be achieved (the perfect should not become the enemy of the sufficient). There is a clear desire amongst at least some REDD+ planners to be able to identify preferable spatial options for implementing REDD+ that consider cost-effectiveness (i.e. attempting to maximize country net income)[[11]](#footnote-11). Whilst this is a laudable aim for land-use planning, it is important not to lose sight of the additional benefits that REDD+ can offer as a result of the various ecosystem services that forests deliver. Therefore, the spatial analysis of additional benefits (both existing and potential) must be a key element of the tool.

As well as the value maps produced, any resulting output which is presented in a tabular form (for example by administrative units) may also be important for the decision-maker. For instance it could present the total quantities of biodiversity and ecosystem service benefits (beyond carbon values) along with budget implications associated with different scenarios / spatial options, so that the implications of different choices can be more easily assessed.

Whatever the nature of the output, it is important that the underlying assumptions are clearly flagged. Whilst this analysis will form only one component in a complex REDD+ decision-making process, it may nevertheless be a high profile element. Because of this, it is imperative that the analysis is as reliable as possible, being based on high quality data (without the data identified above it may be that an alternative approach is preferable).

With regard to next steps, if the outlined approach is deemed worthwhile pursuing then further work could be undertaken in 2015 in the following areas:

1. Explore how existing tools might be modified to accommodate the required analysis or feed data into the analysis;
2. Scope where/how data might be sourced;
3. Produce trial map layers for one or two regions in one or more case study countries to feed into the model;
4. Undertake the economic maximization of REDD+ analysis, as well as additional benefits analysis;
5. Evaluate the reliability and unforeseen issues of the approach, and refine as required.

**Annex**

Possible steps for analyzing economic gains from REDD+ (note that the steps would have to be repeated for different broad categories of action, such as reduced emissions from deforestation, or reforestation actions).

Area identification

Carbon price

Scenario

Overhead costs

Additional benefits maps

**Additional benefits consideration**

Location-specific costs

**‘Maximization’ (spatial)**

**Mapping of net carbon value**

Economic sensitivity analysis could take place

**References**

Ravilious, C., Bertzky, M., Miles, L. 2011. Identifying and mapping the biodiversity and ecosystem-based multiple benefits of REDD+. A manual for the Exploring Multiple Benefits tool. Multiple Benefits Series 8. Prepared on behalf of the UN-REDD Programme. UNEP World Conservation Monitoring Centre, Cambridge, UK.

Shoch, D., Eaton, J., Settelmyer, S. 2011. Project Developer’s Guidebook to Verified Carbon Standard REDD Methodologies. Conservation International.

World Bank 2011. Estimating the opportunity costs of REDD+ A training manual. World Bank, Washington DC.

1. A different approach considers the perspective of the private sector, in which case it would be important to spatially map revenues of commodities being produced and overlaid with a map of the costs to produce these outputs in a sustainable, low carbon way, and the carbon savings/values associated with this. [↑](#footnote-ref-1)
2. But not implicit wages, or wages paid to land user household members. [↑](#footnote-ref-2)
3. *Ibid.* [↑](#footnote-ref-3)
4. World Bank (2011) Estimating the opportunity costs of REDD+ A training manual. [↑](#footnote-ref-4)
5. The numbers are illustrative and all in US$/ha, within each land parcel (though it can also be convenient to express costs in terms of US$/tonne CO2 equivalent). [↑](#footnote-ref-5)
6. Whilst general administration costs of REDD+, including preventing leakage, are overhead costs that might be spread across areas, there may also be spatial variations. Areas with low cost, i.e. 1, may be in an area where conservation projects are already underway, whilst high cost areas, i.e. 5, could be in a peri-urban area where high monitoring and governance costs would be incurred in preventing illegal fuelwood collection. [↑](#footnote-ref-6)
7. Shoch et al (2011) Project Developer’s Guidebook to Verified Carbon Standard REDD Methodologies [↑](#footnote-ref-7)
8. Non-location-specific implementation and transaction costs [↑](#footnote-ref-8)
9. For example, developing a software system to make electronic payments to 100 landowners will cost the same as one that can process 1 000 payments. [↑](#footnote-ref-9)
10. A contiguous solution may be important for enhancing biodiversity and ecosystem service functions as well as reducing the costs of enforcing forest protection (the latter might possibly be included in the calculations). [↑](#footnote-ref-10)
11. This could be perceived to be in opposition to the aims of the Financial Incentives Benchmark, which aims to identify where there is a landowner surplus (i.e. excess profit resulting from a fixed carbon price but variable marginal cost of REDD+). Thus a higher carbon price can be paid for greater reductions, but with countries required to pay for the lowest cost emissions savings (which might be recouped from the land owner surplus). [↑](#footnote-ref-11)