Background report:

Cambodia REDD+ costs and benefits spreadsheet tool

UN-REDD PROGRAMME

Version: May 2016

This report presents background to work carried out by the Forestry Administration of Cambodia, the United Nations Environment Programme World Conservation Monitoring Centre and the Cambodia UN-REDD Programme.

The UN-REDD Programme is the United Nations Collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme was launched in September 2008 to assist developing countries prepare and implement national REDD+ strategies, and builds on the convening power and expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP).

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organisation. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.

Copyright: UNEP 2016

Copyright release: This publication may be reproduced for educational or non-profit purposes without special permission, provided acknowledgement to the source is made. Re-use of any figures is subject to permission from the original rights holders. No use of this publication may be made for resale or any other commercial purpose without permission in writing from UNEP. Applications for permission, with a statement of purpose and extent of reproduction, should be sent to the Director, UNEP-WCMC, 219 Huntingdon Road, Cambridge, CB3 0DL, UK.

Disclaimer: The contents of this report do not necessarily reflect the views or policies of UNEP, contributory organisations or editors. The designations employed and the presentations of material in this report do not imply the expression of any opinion whatsoever on the part of UNEP or contributory organisations, editors or publishers concerning the legal status of any country, territory, city area or its authorities, or concerning the delimitation of its frontiers or boundaries or the designation of its name, frontiers or boundaries. The mention of a commercial entity or product in this publication does not imply endorsement by UNEP.

Should readers wish to comment on this document, they are encouraged to get in touch via: ccb@unep-wcmc.org.

Citation: Blaney, R., Vansteelant, N., and Hicks, C. (2016) Background report: Cambodia REDD+ costs and benefits spreadsheet tool. Prepared on behalf of the UN-REDD Programme. UNEP World Conservation Monitoring Centre, Cambridge, UK.

Acknowledgements: Our thanks to Kimhean Hong (National Consultant, Cambodia UN-REDD Programme), Chea Nareth (Consultant, Cambodia UN-REDD Programme), James Vause (UNEP-WCMC) and Lera Miles (UNEP-WCMC) for their inputs into the spreadsheet tool and this report. Thanks also to workshop participants in Phnom Penh, Cambodia, for their comments and suggestions for the spreadsheet tool.

UNEP WCMC

UNEP promotes environmentally sound practices globally and in its own activities. Our distribution policy aims to reduce UNEP's carbon footprint. Consider the environment before printing this publication.

Contents

1. Introduction

By maintaining, enhancing and restoring forests, REDD+ has the potential to help to achieve multiple environmental, social and economic benefits, and play a role in the evolution of a Green Economy. An enhanced understanding of the costs and benefits of different REDD+ options, as well as of the distribution of costs and benefits across a landscape, can help prioritize options and provide a valuable input for discussions on benefit sharing.

Under the Cambodia REDD+ National Programme, economics and spatial analysis work is being carried out in order to support REDD+ planning. This project is a collaboration between the Cambodia Forestry Administration and the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). It aims to provide enhanced understanding of the costs and benefits from different REDD+ options and how these vary spatially, as well as improved capacity to produce, use and apply decision support tools for REDD+ planning.

This background document provides information regarding a national level spreadsheet tool on REDD+ costs and benefits that has been developed through this project. The document includes background information on the economic concepts reflected in the spreadsheet tool, as well as an overview of the assumptions and components of the tool. Spreadsheet tools tailored for two provinces, Mondulkiri and Koh Kong, were also developed, and differ in some ways to the national-level spreadsheet (e.g. different drivers of land use change, different ammounts for particular costs and benefits). However, this background report is relevant to all three spreadsheet tools.

2. Guide to the spreadsheets

What it does and what it doesn't do

The spreadsheets in the Cambodia REDD+ Costs and Benefits Tool allow users to choose an identified driver of land cover change as well as a REDD+ option to respond to this, and then explore what this means in terms of costs and benefits from various perspectives. The REDD+ options and the drivers of land cover change included in the tool were selected through consultation with partners in Cambodia.

In order to compare the costs and benefits, the tool makes bottom-up calculations of costs and benefits related to the REDD+ options and alternative land uses. It is not an economic model *per se*, and is tailored for relatively small-scale analysis. As such, it does not consider inflation, comprehensive ranges in production costs and prices (e.g. all the variations between small-scale and large scale agricultural producers), nor dynamic changes, (i.e. how the chosen REDD+ options might feedback in to other variables over time). Therefore, if estimating the combined costs of REDD+ for significant areas in multiple provinces, additional information

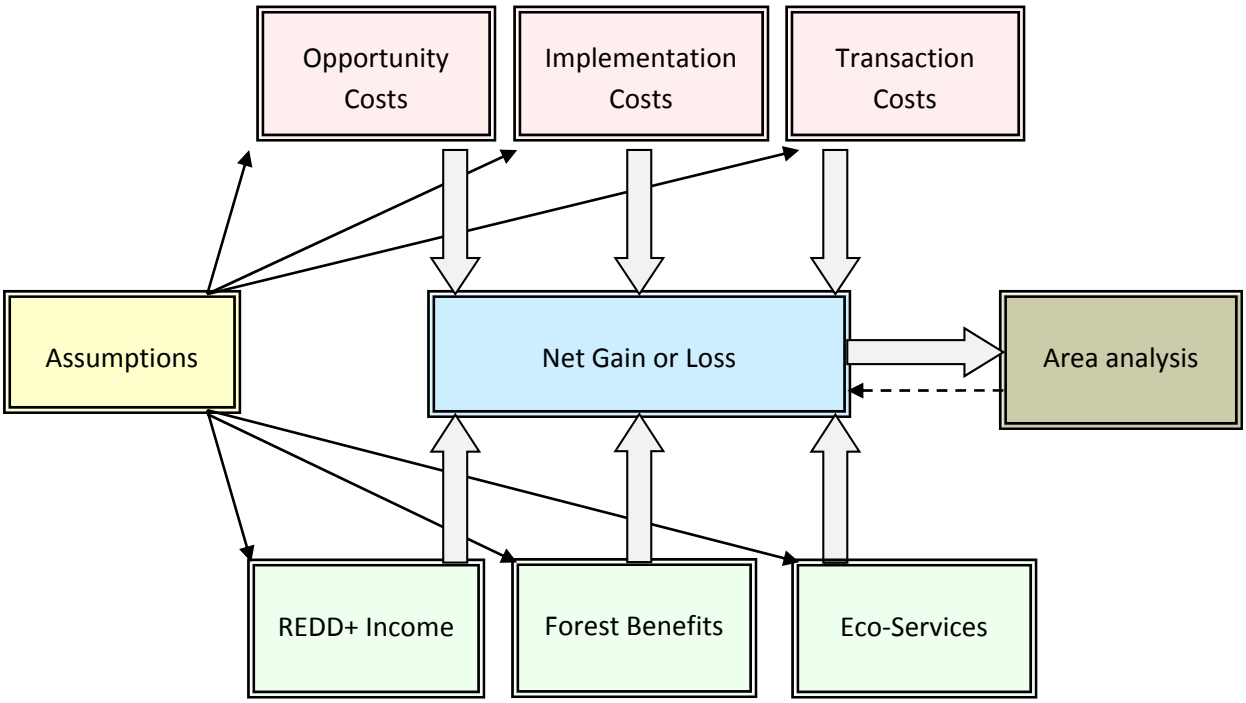
from other models would be required; for example, information on the impact of large-scale changes in agricultural production on agricultural prices. Figures are provided in US dollars, based on 2014 values, and by hectare where possible.

The form of the tool

The tool consists of almost twenty individual MS Excel worksheets, containing data and calculations. It uses a simple interface for the most basic analysis, as well as more detailed Area Analysis sheets which allow users to vary the size of the area and assumptions regarding timber use and conservation status.

The user can also make further changes in the Assumptions worksheet. This contains the key assumptions that underlie the analysis, such as carbon price, yields and prices for the main crops considered, timber stocking volumes, replanting costs, and so on. Changes can also be made in the individual worksheets if required (for instance, changing individual items in cost lines, such as the cost of fertilizer, or costs of training for community based sustainable forest management). An important caveat is to ensure that figures are entered in correct units without making changes to formulae, as this will affect the final output of the analysis.

The broad flow or structure between the main worksheets is as follows (see Annex 2 for definitions of the types of costs):



The Assumptions worksheet

The assumptions, their links to the other worksheets, and their use, are presented below:

Assumption variable:	Link to worksheet:	Used for:
Total area of Protected Forests	Forest Benefits	Calculation of average tourism values per hectare
Economic values:		
Discount rate	Various	Applied to all costs and benefits (for NPV*)
Carbon price	REDD+ Income	Multiply by savings of tons of CO2** for payment
Alternative land uses:		
Large-scale rice yield	Opportunity Costs	Used with price data to estimate revenues
Small-scale rice yield	Opportunity Costs	Used with price data to estimate revenues
Cassava yield	Opportunity Costs	Used with price data to estimate revenues
Rubber yield (max at maturity)	Opportunity Costs	Used with price data to estimate revenues
Oil Palm price	Opportunity Costs	Used with yield data to estimate revenues
Cashew price	Opportunity Costs	Used with yield data to estimate revenues
Rubber price	Opportunity Costs	Used with yield data to estimate revenues
Rice price (plantation)	Opportunity Costs	Used with yield data to estimate revenues
Rice price (small scale)	Opportunity Costs	Used with yield data to estimate revenues
Pepper price	Opportunity Costs	Used with yield data to estimate revenues
Cassava price	Opportunity Costs	Used with yield data to estimate revenues
Charcoal price	Opportunity Costs	Used with yield data to estimate revenues
Standard timber price	Opportunity Costs	Used with yield data to estimate revenues
Luxury timber price	Opportunity Costs	Used with yield data to estimate revenues
Average size of land concession plantation	Opportunity Costs - Government	Required for tax revenue calculations
Average size of small-scale farm	Opportunity Costs - Government	Required for tax revenue calculations
Forests:		
Average carbon in the natural forest area	REDD+ Income	Used in calculations of option value
Official fees on forestry licences	Opportunity Costs - Government & Transaction Costs	Used in conjunction with licence data

Reduction in forest licences due to REDD+	Opportunity Costs - Government & Transaction Costs	Used in conjunction with fees data
Standard logging waste	Opportunity Costs & Forest Benefits	To estimate net wood in timber calculations
Standard clear-felling harvest cost	Opportunity Costs	For standard timber cost calculation
Cost of forest patrols by local community	Implementation Costs & Net Gain or Loss	For implementation cost calculation as well as community income
Cost of forest monitoring/reporting by local community	Implementation Costs & Net Gain or Loss	For implementation cost calculation as well as community income
Cost of boundary demarcation	Implementation Costs	For implementation cost calculation
Cost of reforestation planting	Implementation Costs	For cost calculation of 'Sustainable Forestry'
Cost of establishing agroforestry	Implementation Costs	For cost calculation of 'Sustainable Forestry'
Forest benefits:		
Proportion of forest utilized for NTFP* collection**	Net Gain or Loss	For community income from forest conservation
Price of forest mushrooms	Forest Benefits	Used with yield data to estimate revenues
Price of forest vegetables (average)	Forest Benefits	Used with yield data to estimate revenues
Price of forest medicines (average)	Forest Benefits	Used with yield data to estimate revenues
Price of forest fibres (rattan)	Forest Benefits	Used with yield data to estimate revenues
Sustainable timber price	Forest Benefits	Used with yield data to estimate revenues
Local community share of eco-tourist spending	Forest Benefits	For local community income from tourism
Cost of a tourist visa	Opportunity Costs - Government	Used for tourism tax revenue calculations
Transaction costs:		
Economies of scale (from project to national)	Transaction Costs	To estimate likely national transaction costs
Size of national scheme compared to average pilot	Transaction Costs	To estimate likely national transaction costs
Annual efficiency savings	Transaction Costs	To estimate likely national transaction costs
Ecosystem services:		
Forest area where pollination benefits occur	Eco-Services	To adjust per hectare values for relevant area
Forest area where soil erosion reduction occurs	Eco-Services	To adjust per hectare values for relevant area
Forest area where water regulation occurs	Eco-Services	To adjust per hectare values for relevant area

Forest area where air purification occurs	Eco-Services	To adjust per hectare values for relevant area
Taxes:		
Income tax rates:		
0 - 2,328 US$	Opportunity Costs - Government	Used in tax revenue calculations (agriculture)
2,329 - 3,641 US$	Opportunity Costs - Government	Used in tax revenue calculations (agriculture)
3,642 - 24,760 US$	Opportunity Costs - Government	Used in tax revenue calculations (agriculture)
24,761 - 36,412 US$	Opportunity Costs - Government	Used in tax revenue calculations (agriculture)
36,413 + US$	Opportunity Costs - Government	Used in tax revenue calculations (agriculture)
Government tax rate on profits	Opportunity Costs - Government	Used in tax revenue calculations (timber)
Input tax rate (VAT**)**	Opportunity Costs - Government	Used in tax revenue calculations (all activities)

*NPV: Net Present value

** CO2: Carbon dioxide

*** NTFPs: non-timber forest products

**** VAT: Value added tax

The values of the variables in the Assumptions tab have been chosen based on the figures in the literature that was available (see Annex 1 for main sources), as well as through consultation with stakeholders in Cambodia. But they can be altered in order to explore different cost scenarios, as well as updating variables when new data becomes available.

The Opportunity Costs worksheet

Opportunity costs are the foregone potential income from alternative land or forest uses; for instance, the income from growing cassava on the forestland once it has been cleared, or from charcoal production utilising a forest area (definitions of key terms are also provided in Annex 2: Glossary).

Within the tool, a number of different land uses that are linked to drivers of deforestation and degradation in Cambodia are included, under the following headings:

Economic Land Concessions -

Oil Palm

Cashew Nuts

Rubber

Rice

Small-scale Farming -

Rice

Pepper

Cassava

As well as:

Charcoal

Timber -

Standard Timber Clear-Felling

Luxury Timber Logging

Obviously there are many other crops grown in Cambodia, but this list is not meant to be exhaustive, but rather representative. Similar crops will have similar costs and revenues. Therefore, the deforestation/degradation driver that is most similar to the one of concern should be chosen, if it is not one of the alternative uses identified above.

For each of these alternative uses the profit (meaning the revenues minus the costs) is calculated on an annual basis, over a 25 year period. This is because all of the activities need to be compared, along with REDD+, over a suitable and representative time period. It is likely that REDD+ will require a guaranteed period of carbon retention of between 20-30 years; this is currently the case with pilot projects producing carbon credits for the voluntary off-sets market. In addition to this, industrial plantations (e.g. rubber) operate in a multi-decade cycle, with activities like planting, maximum yields at maturity, then decline and clearing (so that the cycle can begin again with replanting), occurring over a number of decades. Therefore, 25 years is the chosen reference period.

To be able to compare values clearly, a Net Present Value (NPV) in US$ per hectare is calculated. This creates a sum of future costs and benefits at a current value (using a discount rate, i.e. to reflect the lower value that money has in the future compared with having it

available now). The NPV is calculated for all crops/land uses, using a 5% discount rate so that they are comparable.

The data on costs of production, yields and commodity prices have been obtained from various sources, literature, and through data collection by local consultants, and reflect national averages. Nevertheless, this is an area for further refinement, and may be updated in the future.

The costs and prices shown in the spreadsheet tool do not change annually (unless for example the quantity of fertilizer used increases, or the cost of weeding decreases over time). They are given as real prices rather than reflecting increases in inflation. However, some costs and prices may increase in real terms, i.e. by greater than the rate of inflation, and for these items the values increase over the 25 year period. Other costs, such as weeding and security in oil palm plantations, decrease over the 25 year period as the activities become less necessary with time.

The Implementation Costs worksheet

The costs of implementing particular REDD+ options have been assessed in a similar way to the opportunity costs, i.e. calculated on an annual basis over 25 years, discounted back to a present value (using 5%, as for the opportunity costs). Implementation costs for the following REDD+ options have been estimated:

- Protected Area Management (i.e. improved protection of existing designated areas through increased patrolling as well as developing alternative sources of wood fuel).
- Community Based Sustainable Forest Management
- Sustainable Forestry (i.e. not community-based)
- Restoration
- Reforestation (can also include afforestation; also not community-based)
- Community Based Sustainable Wetland Management (i.e. management of wetland/mangrove/flooded forest areas)

For each of these options the interventions and specific tasks to implement them have been identified. The cost estimates are based on information from existing forest projects in Cambodia, compiled using literature and data collection by local consultants. However, since many of these are pilot projects, the cost estimates could be unrealistically high.

Note that some costs do not increase significantly with changes to the area covered by the option (i.e. they are required in order to implement an option, whatever the scale, e.g. developing a management plan). These costs have been transformed into per hectare values by dividing them by the number of hectares being considered in the analysis (which are entered by the user in the Area Analysis sheets).

The Transaction Costs worksheet

National transaction costs are the costs of administering REDD+ across the entire country. It is very difficult to estimate these costs in advance. In order to at least identify the likely magnitude of the cost, the following methodology has been adopted. First, four existing schemes in Cambodia were identified and the project management/administration costs associated with these were listed and an annual cost calculated. Since the annual costs varied greatly (from $25,000 - $135,495) an average of these was taken.

A national REDD+ scheme would cover a larger area than a pilot project, thus the coefficient of the size of the national scheme to the average size of the pilot project is required (which is entered in the Assumptions worksheet). However, the cost is unlikely to increase proportionately with the size of projects; instead, some savings could be gained. For example, some administrative tasks could be automated using computer processing when undertaken on a large scale. Therefore, an 'economies of scale' percentage is required (to be entered in the Assumptions worksheet).

Further to this, it is often the case that through learning and streamlining approaches it is possible to reduce administrative costs over time. Therefore, an efficiency saving over time (annual percentage) is also included in the calculations. The annual costs over 25 years are then estimated and brought back to a present value using the standard discount rate. More accurate estimates of transaction costs are likely when countries begin to roll-out national REDD+ schemes.

The value of lost forestry licence revenues is also included this worksheet (the calculation is undertaken in the Opportunity Costs Government (Opp Costs Gov) worksheet). These are not actually transaction costs and so are not used in the transaction cost estimates. However, it was thought useful to show them here in order to be able to directly compare the value with the transaction costs.

The REDD+ Income worksheet

Payments under REDD+ are expected to be made on the basis of carbon emissions reductions or increased carbon sequestration that occur as a result of actions taken, compared with the Business As Usual (BAU) situation. Some default values based on a review of relevant literature are provided in the spreadsheet tool, allowing a basic estimate of potential carbon emissions reductions. Specifically, the following estimates are used:

1. the carbon content of the land cover following conversion from forest to another land use, and
2. the effectiveness of the REDD+ option (i.e. carbon content at the end of 25 years)

From this information it is possible to calculate the carbon saving compared to the BAU scenario (in tonnes of carbon per hectare). Next, using the carbon price (as set out in the Assumptions sheet), the carbon income (in US$/ha) can be estimated for each combination of driver and response (remembering to adjust for the C to CO_2 conversion factor[1]).

Since the forest will be standing at the end of the 25 year period under REDD+, there may be an option to use it for a further carbon payment (as is the case for voluntary forest carbon schemes). Nevertheless, if a REDD+ payment were made, then this should be estimated for a following 25 year period and compared with the alternative land use. So, although it would be incorrect to include any subsequent, other REDD+ payment now, there should be some recognition that this valuable future asset exists.

Therefore, in order to provide a minimum option value, just the timber value of the forest is included as an 'option value' at the end of the 25 year period - but only in the simple analysis (if an option value is not required then cell B73 in the REDD+ Income worksheet can be set to zero). The Area analysis sheets do not include the option value, but the value in cell B73 can be multiplied by the number of hectares if this is required.

The Forest Benefits worksheet

This worksheet estimates the following forest benefits that may accrue under REDD+ implementation:

- Non-timber forest products (NTFPs) (for local consumption as well as market sales from forests)
- Eco-tourism in Protected Areas
- Sustainable timber harvesting

These are calculated using the same format as opportunity costs (i.e. costs and revenues each year over 25 years, discounted back to a present value). Two sets of figures are presented for each of the three benefits listed above, one set based on REDD+ actions that relate to relatively intact forests, and one set for the restoration and reforestation REDD+ options. This is because where forest needs to re-grow, then the above benefits are likely to be largely absent for most of the time period.

It should be noted that the income from eco-tourism (average US$ per ha) is based on national data for the number of eco-tourists (an increasing trend in Cambodia) multiplied by the average expenditure per head (a declining trend). Average income per hectare is based

[1] The C to CO_2 conversion factor relates to the difference in atomic weight between carbon and carbon dioxide. Carbon weighs 12 atomic mass units, while carbon dioxide weighs 44 atomic mass units, because it includes two oxygen atoms. Therefore one ton of carbon equals 44/12 = 3.67 tons of carbon dioxide.

on the total expenditure divided by the area (hectares) of Protected Areas. Income to the local community is then taken as a percentage of this value (set out in the Assumptions).

The Eco-Services worksheet

While the Forest Benefits worksheet deals with the more tangible economic gains from forest (e.g. income to local communities), forests also deliver other services which benefit the nation. These include:

- Pollination (of crops near forests, increasing yield and quality)
- Reduction of soil erosion (and sedimentation of rivers/dams)
- Water regulation (contributing towards flood and drought mitigation in certain circumstances)
- Air purification (removal of pollutants, especially near industrial areas or towns and cities, or where polluted air is being blown across from neighbouring countries)

In the Eco-Services worksheet, the value of the above services is estimated by multiplying global average values for ecosystem services from tropical forests (taken from relevant literature[2]) by the percentage area of forest where these services occur in Cambodia. This is because not all forests will deliver these benefits; e.g. only forest bordering cropland will deliver pollination benefits. Default values for this percentage are included in the Assumptions, but while these may be relevant for an area of average forest (i.e. across the nation), they may vary according to the specific location of the forest being considered in the analysis. This value can be changed if the proportion of forest where ecosystem services occurs is known for the specific area being analysed.

The Opp Costs Gov worksheet

This worksheet calculates Cambodian government revenues associated with the different land use scenarios. Both income/profit, as well as input taxes, are assessed. In order to calculate taxes for an agricultural activity, the average size of the farm is required (set out in the Assumptions). It should be noted that these are broad estimates (a best-case scenario), which will depend in reality upon both tax structures of individual businesses, as well as the efficiency of tax collection procedures in Cambodia.

[2] Global averages for tropical forests in 'Global estimates of the value of ecosystems and their services in monetary units' by de Groot et al., (2012). These figures can be updated with national and/or local valuation of ecosystem services if the data is available.

The Net Gain or Loss worksheet

The previous worksheets all feed into this worksheet, which collates all calculations, and in some cases undertakes additional calculations, in order to deliver the following estimates (in US$/ha) for each combination of driver and response:

- Surplus for REDD+
- Lost profit from alternative land use
- Lost community income from alternative land use
- Carbon savings in t/CO_2
- Community income from forest conservation/restoration
- Cost of REDD+ Implementation per ha
- REDD+ income per ha
- Value of multiple benefits per ha
- Government revenues foregone from alternative land uses per ha
- Government revenues from REDD+ per ha
- National value of ecosystem services per ha

Area Analysis worksheet

This spreadsheet allows users to analyse different scenarios with regard to an area of land. This worksheet allows the user to input the following:

- The area (in hectares) at risk of land use change (i.e. to be included in REDD+) and the driver of the change (selected from a drop-down list)
- The REDD+ option to address the driver (also from a drop-down list).

There are also two 'yes-no' (Y/N) options presented. First, does the user want to include the timber values from the land being cleared for agriculture, and second, whether the area has a conservation designation.

Depending on the combinations chosen, the relevant cell in the Net Gain or Loss worksheet is then multiplied by the size of the area, and divided by 25 to give an annual NPV. This is presented according to the following perspectives: a) local community perspective, b) government perspective, c) national perspective of the environment. An estimate of transaction costs is also provided. For each of these perspectives, specific values are reported in the summary:

- Annual potential community income foregone from alternative land use (i.e. small-scale farming profits plus labour on plantations/timber)
- Annual community income from forest resources (i.e. share of forest benefits plus income for patrolling and monitoring)

- Annual total revenues from REDD+ for the country (i.e. total REDD+ payments received)
- Annual funds available, e.g. for provision of incentives, or compensation of income foregone, (i.e. REDD+ funds minus implementation costs, but excluding transaction costs)
- Annual value to the nation of forest ecosystem services secured (i.e. forest ecosystem services, including overall benefits from NTFPs, tourism, etc., but excluding carbon/REDD+ payment)
- Total carbon emissions (tonnes CO_2) avoided (i.e. estimated carbon savings compared to BAU)
- Transaction costs; the annual overhead administrative costs of REDD+ (i.e. costs of running a national REDD+ scheme)

Please note that these various figures (all in 2014 US$) cannot be summed together to create one value for gain or loss – the various figures measure different things, and present them according to different perspectives (e.g. community, government, nation).

REDD+ Cost-Benefit worksheet

There is also a basic REDD+ Cost-Benefit analysis worksheet that provides a simple analysis of per hectare values, comparing a driver and a REDD+ responses. The user simply identifies a driver of land use change and a REDD+ option to respond to it, selecting these from drop-down lists. This worksheet shows: carbon savings (tonnes of CO_2 per hectare), the overall value from retaining the forest cover, and the foregone profit from the alternative land use. It presents the latter two in a bar chart.

Area Multidriver worksheets

These worksheets are similar the Area analysis worksheet, but they allow the user to explore the costs-benefits for multiple (up to 4) drivers and responses in a single area. This recognises that a combination of different drivers of land use change and different REDD+ responses may occur across a landscape. For instance, in a particular province, key drivers may be conversion of forest to rubber plantation as well as charcoal production, while responses may include community forestry and protected area management.

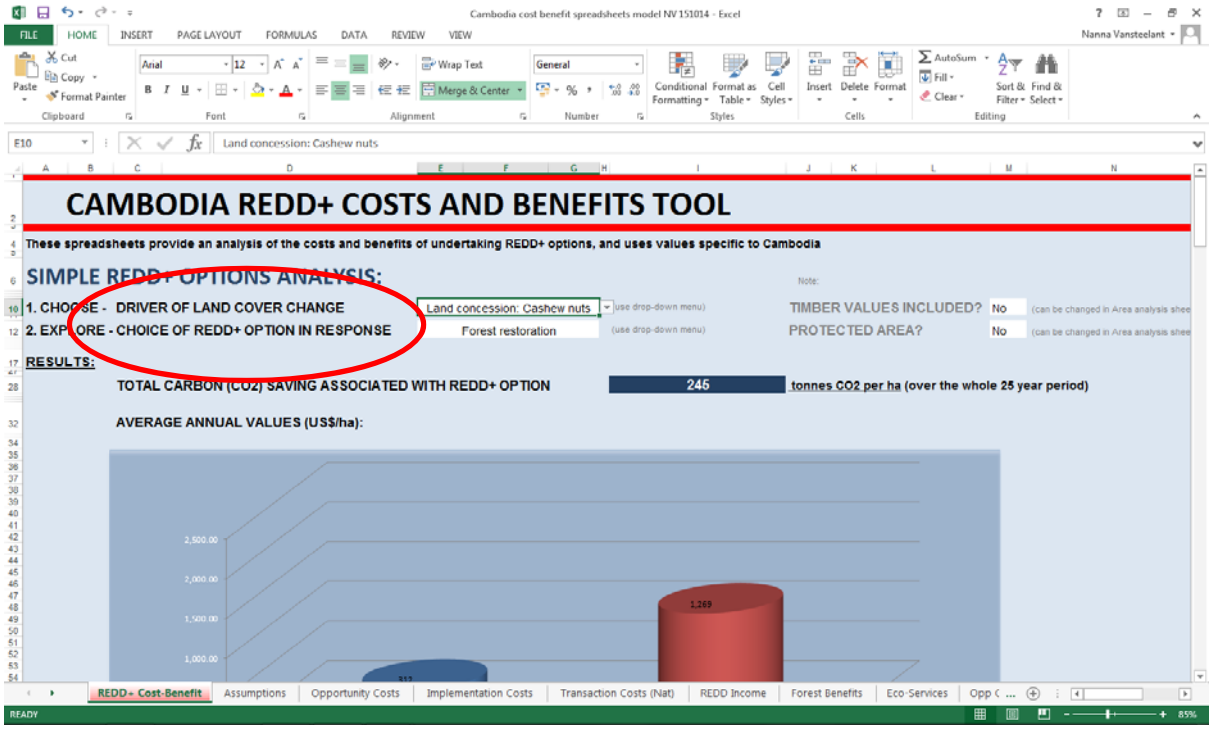
The Area Multidriver worksheet sums the values from worksheets 1 to 4; therefore it is important when undertaking a new analysis to ensure that if any of these four worksheets are not to be used, that the area in them is set to zero. The total area in the summary and the estimated costs and benefits related to this area, are then presented as the sum of the individual areas (as set out in worksheets 1-4).

3. Step-by-step guide on how to use the spreadsheet tool

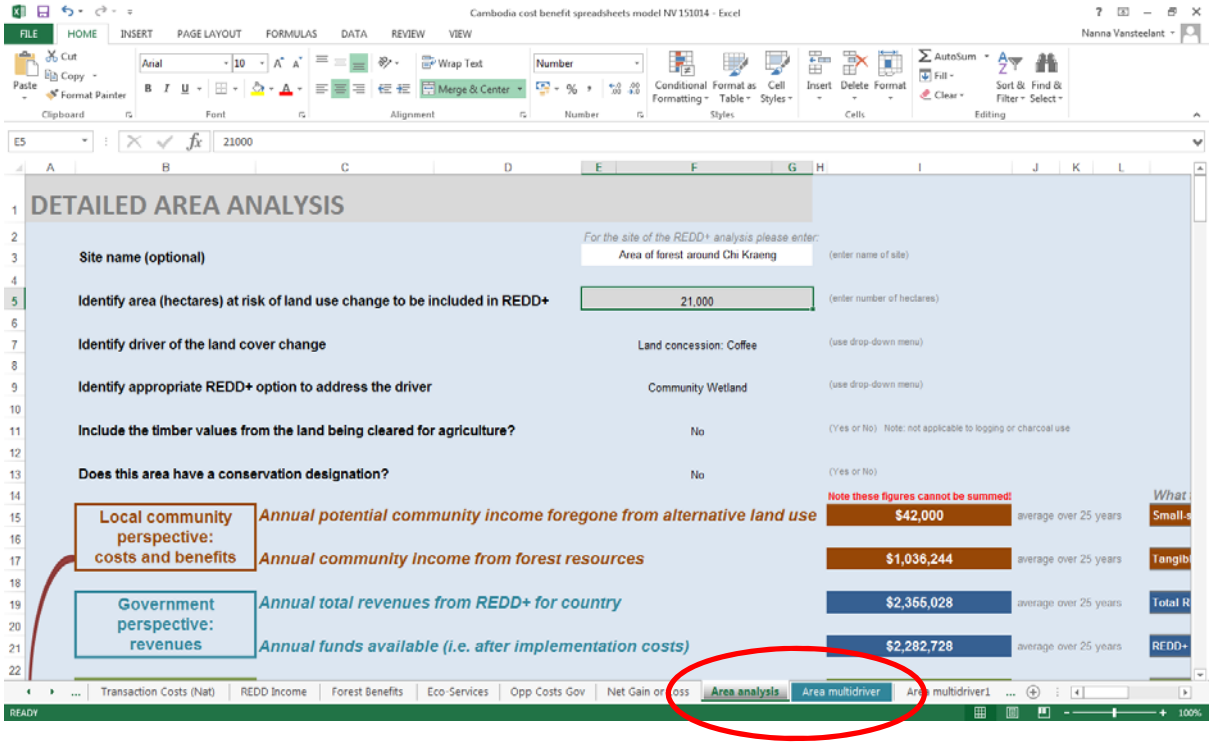
Step 1:

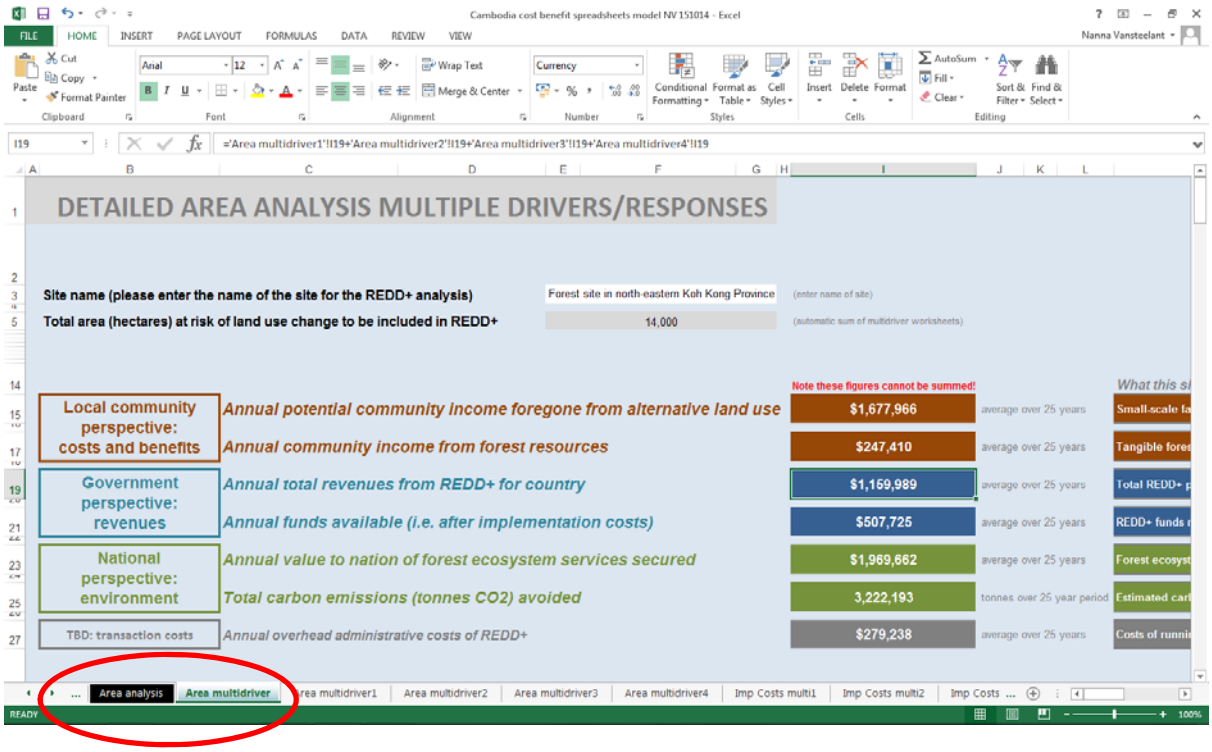
First, decide whether a simple analysis is required (to look at generic per hectare values), or whether an area of specific size is to be examined and whether there is one driver or multiple drivers of land cover change.

If a simple per hectare analysis is required then use the **REDD+ Cost-Benefit** worksheet - choose the relevant **driver of land cover change** and the **choice of REDD+ option in response** in this worksheet and move to step 6.



However, if a specific area is to be examined, then instead either use the **Area analysis** worksheet (if there is one driver and one REDD+ response being considered), or the **Area multidriver** worksheets (if there are multiple drivers and/or responses).





Please note that the three alternative analysis approaches (i.e. simple, one area, area multidriver) are stand-alone worksheets (i.e. they are separate exercises which are not linked), in terms of input of driver and response (though the general assumptions feed in to all of them). It is best to choose one analysis approach at a time, starting with the simple analysis and then proceeding to the more complex analysis options. Proceed to **Step 2.**

Step 2:

The spreadsheet tool is designed for assessing the relative economic costs and benefits of addressing a specific driver of land cover change (namely loss of forest as a result of felling/conversion to agriculture) with a specific response (a REDD+ option), at a relatively small scale (i.e. up to around 100,000 hectares, or 10% of the area of a province). If this is the type of analysis desired, then the user can move to **Step 5**.

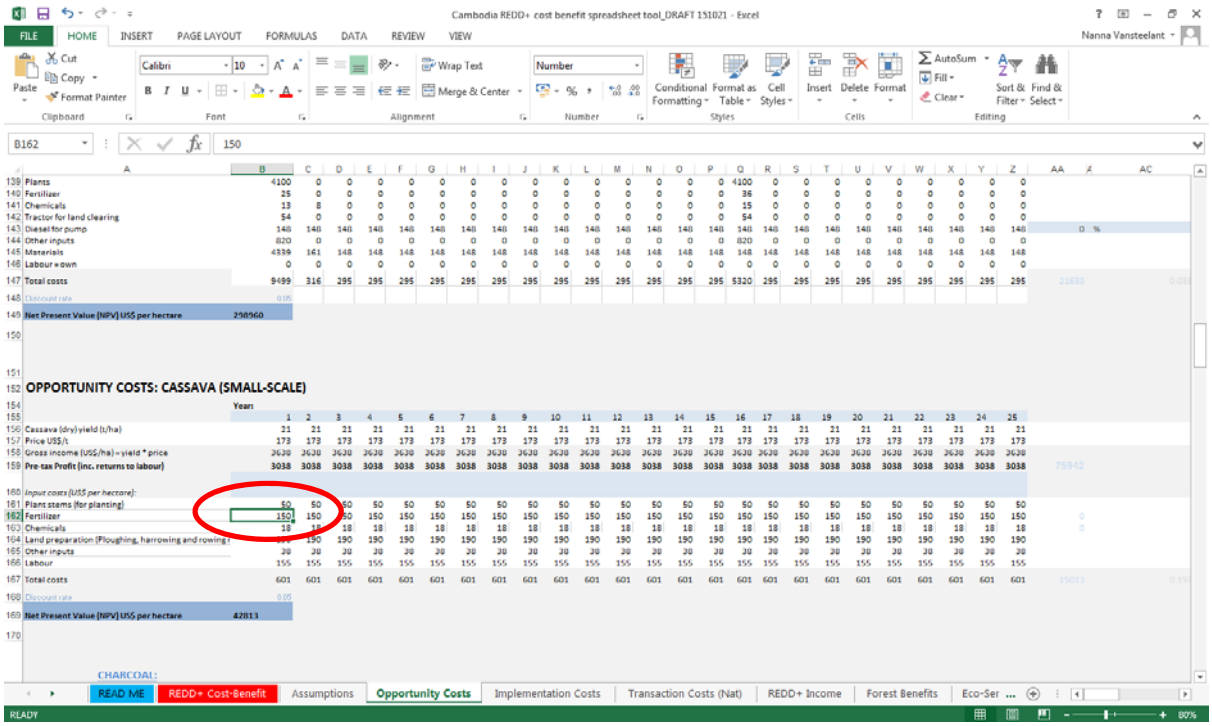
Step 3:

In order to undertake analysis at a larger scale (e.g. when summing values obtained from analyses for multiple provinces to a national result), it is necessary to know the impact that this level of change would have on commodity prices in Cambodia. If the drivers are large-scale plantations of crops for export (e.g. rubber or cashew) then the results should still be valid (i.e. the potential increase or decrease in the commodity may not impact prices, which are influenced by global trends). Therefore, the user can move to **Step 5**; but if the drivers include crops for domestic consumption then proceed to **Step 4.**

Step 4:

Where the drivers include crops for domestic consumption (e.g. rice), then a national level change (e.g. significantly more or less production) would likely have an impact on crop prices within Cambodia. Therefore, how the prices of crops would respond over the 25 year period will need to be estimated so that these adjustments can be made in the spreadsheets. Since the level of price change will vary by the reduction in crop supply (i.e. the total area of cropped land for domestic use), then ideally a dynamic commodity price model would be used in conjunction with the spreadsheet tool.

Alternatively a manual adjustment can be made to prices in the **Opportunity Costs** worksheet, based on available information (e.g. changing the cost of fertilizer for small scale cassava would mean changing the figure in cell B162 in the screengrab below, making sure to use correct units (US$/ha)). If such a change is made, clearly note the assumptions behind these price adjustments (so they can be reported alongside the final results). Once the prices have been adjusted then move to **Step 5**.

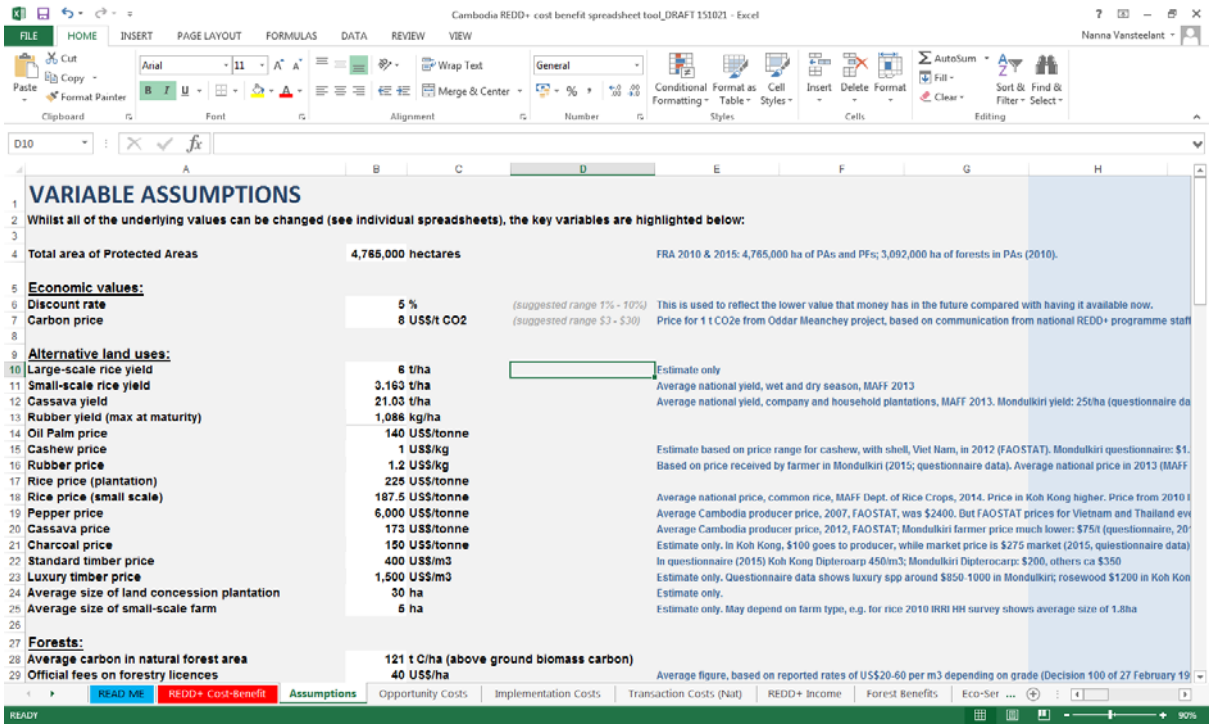


Step 5:

In the analysis worksheet being used (e.g. **REDD+ Cost-Benefit**), select the driver and relevant response. Where there is one of each then the user can proceed to **Step 6**, however, if using the **Area multidriver** worksheets, the number of hectares of forest threatened by each driver must be known (and not have any overlap, i.e. there needs to be one driver per hectare or area of forest). The user should understand which options would likely be used to respond to these drivers in the different areas. Only some options are relevant to certain drivers or certain forest areas; for example, sustainable forestry is unlikely to be implemented in a protected area. Once these drivers and options have been selected proceed to **Step 6**.

Step 6:

Next, review the variables in the **Assumptions** worksheet. All of the worksheets present national average values. Therefore, to improve accuracy, the values in the worksheets can be adjusted with updated data or with data for the specific location - but this will require additional data to be available, or collected and checked. Variables likely to change by specific locations include the crop yields, as well as the proportion of forest that delivers ecosystem services. Another variable subject to change is the carbon price. By varying this value, the user can determine at what carbon price the various REDD+ options become viable.



Step 7:

The spreadsheet then presents the results from various perspectives: community; government; and national environmental perspective[3]. All of the results are in the form of *annual* present values for the period of analysis, in order to allow easy comparability. Note that in the **Area analysis** worksheets these values relate to the total area being considered.

Step 8:

The user can then vary the REDD+ response option, and/or relevant assumptions (such as carbon price and commodity price trends), in order to explore different scenarios. For example, at what carbon price does the implementation of a REDD+ option become viable? Which REDD+ options offer greater potential benefits? What might be a suitable combination of REDD+ options to address multiple drivers in a landscape?

[3] However, please note that that the private profit associated with plantations is only presented in the simple per hectare analysis (i.e. in the **REDD+ Cost-Benefit** worksheet). If the revenues from a large-scale plantations go to the government (i.e. they are State-owned) then the value of this revenue to the government will not be picked up in the disaggregated benefits to the community and government. Tax revenues to government will be picked up, alongside wages to local workers, but profits are assumed to flow to plantation owners elsewhere in the economy.

Annex 1: Main secondary sources consulted to provide data for the spreadsheet

ACI, 2005. Final Report for the Cambodian Agrarian Structure Study. Prepared for the Ministry of Agriculture, Forestry and Fisheries, Royal Government of Cambodia, the World Bank, the Canadian International Development Agency (CIDA) and the Government of Germany/Ges, Bethesda, Maryland: Agrifood Consulting International.

ADHOC, 2014. Land Situation in Cambodia, 2013. Cambodian Human Rights and Development Association. Available from: http://www.adhoc-cambodia.org/wp-content/uploads/2014/05/ADHOC-Land-Report-2013_website_spread2.pdf. [Accessed 16 October 2015].

Asian Development Bank, 2007. Capacity Building for Resettlement Risk Management. Compensation and Valuation in Resettlement: Cambodia, People's Republic of China, and India. Available from: http://www.landesa.org/wp-content/uploads/2011/01/ADB-RDI_Report_on_Land_Taking_Law_and_Practice_in_China_India_Cambodia.pdf. [Accessed 16 October 2015].

Banks, A., Sloth, C., Garcia, D. H., Ra, K., 2014. Forest-Land Conversion and Conversion Timber Estimates: Cambodia Case Study. Prepared on behalf of Forest Trends. Available from: http://www.nepcon.net/sites/default/files/library/NEPCon-ForestTrends-Cambodia-conversion-2014-11.pdf. [Accessed 16 October 2015].

De Groot, R., Brander, L., van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L. C., ten Brink, P., van Beukering, P. (2012). *Global estimates of the value of ecosystems and their services in monetary values*. Ecosystem services 1(1): 50-61.

DFDL, 2015. New Governmental Policies in relation to Economic Land Concessions in Cambodia. DFDL. Available from: < http://www.dfdl.com/resources/legal-and-tax-updates/entry/new-governmental-policies-in-relation-to-economic-land-concessions-in-cambodia>. [Accessed 16 October 2015].

Emerton, L. 2013. The Economic Value of Ecosystem Services in the Mekong Basin: what we know and what we need to know. Report prepared for WWF.

FAO commodity price data: www.fao.org/

Germer, J., Sauerborn, J., 2008. Estimation of the impact of oil palm plantation establishment on greenhouse gas balance. Environ Dev Sustain (2008) 10:697–716.

Grieg-Gran, M., D. de la Harpe, J. McGinley, J. MacGregor, I. Bond (2008), Sustainable financing of protected areas in Cambodia: Phnom Aural and Phnom Samkos Wildlife Sanctuaries, Environmental Economics Programme Discussion Paper 08-01, IIED, London.

Hassan, R., Scholes R., Ash N. (eds) (2005) Millennium Ecosystem Assessment: Ecosystems and Human Wellbeing, Volume 1, Current State and Trends. Island Press, Washington).

MAFF, 2015. Agricultural Sector Strategic Development Plan 2014-2018. MAFF. Available from: <http://www.elc.maff.gov.kh/> [Accessed 16 October 2015].

MAFF, 2015. Principle for Calculating Concession Land Rental Fee. MAFF. Available from: <http://www.elc.maff.gov.kh/index.php/laws/14-principle-for-calculating-concession-land-rental-fee> [Accessed 16 October 2015].

MAFF, 2015. Request to examine and reconsider the principle for collecting concession land rental fee. MAFF. Available from: http://www.elc.maff.gov.kh/index.php/laws/13-request-to-examine-and-reconsider-the-principle-for-collecting-concession-land-rental-fee [Accessed 16 October 2015].

MAFF, 2015. The Fixation of Concession Land Rental Fee. MAFF. Available from: <http://www.elc.maff.gov.kh/index.php/laws/12-the-fixation-of-concession-land-rental-fee> [Accessed 16 October 2015].

McKenney, B., Chea, Y., Tola, P., Evans, T., 2004. Focusing on Cambodia's High Value Forests: Livelihoods and Management. Special Report. November 2004.

MoC, 2012. Rubber Sector Profile. Value Chain Unit, Trade Promotion Department. Ministry of Commerce, Cambodia. July 2012.

NEPCon, 2014. Forest-Land Conversion and Conversion Timber Estimates: Cambodia Case Study, November 2014.

Persson, L., Phirun, N., Ngin, C., Pilgrim, J., Sam, C., and Noel, S., 2010. Ecosystem Services Supporting Livelihoods in Cambodia. SEI.

Sameer Karki. 2002. Community Involvement in and Management of Forest Fires in South East Asia. Prepared for: WWF, IUCN and FireFight South East Asia. FAO. Firebreaks. Available from: http://www.fao.org/ag/againfo/programmes/en/lead/toolbox/Tech/4Firebrk.htm#cost [Accessed 18 April 2012]; Forestry Research Institute of Ghana. 2003. Forest Fire Management in Ghana: Final Technical report. In: Annex 5. Project proposal on Enhancing Climate Change Resilience of Rural Communities living in Protected Area of Cambodia

Soceth, H., 2012. Foreign Investment in Agriculture in Cambodia: A survey of recent trends. Prepared on behalf of the International Institute for Sustainable Development, 2013. Available from: < http://www.iisd.org/tkn/pdf/foreign_investment_ag_cambodia.pdf>. [Accessed 16 October 2015].

Sopheapa, U., Patanothaib, A., Ayec, T.M., 2012. Nutrient balances for cassava cultivation in Kampong Cham province in Northeast Cambodia. International Journal of Plant Production 6 (1), January 2012.

Sopheak, K. 2014. The Study on the Effect of Rice Contract Farming on Smallholder Farmers' Incomes in Kampong Speu Province, Cambodia. Royal University of Phnom Penh. Available from: http://www.chizzolinionlus.it/wp-content/uploads/The-Study-on-the-Effect-of-Rice-Contract-Farming-on-Smallholder-Farmers%E2%80%99-Incomes-in-Kampong-Speu-Province-Cambodia.pdf. [Accessed 16 October 2015].

Soussan J., Sam, C. no date. The Values of Land Resources in the Cardamom Mountains of Cambodia, Final Report.; in partnership with the Ministry of Agriculture, Fisheries and Forests, Cambodia, the Global Mechanism, Conservation International and the Asian Development Bank.

United Nations Development Programme, 2015. 2177 – Establishing Conservation Areas in Landscape Management in the Northern Plains of Cambodia. UNDP. Available from: http://www.undp.org/content/undp/en/home/ourwork/environmentandenergy/focus_areas/ecosystems_and_biodiversity/projects/cambodia_-_establishingconservationareaslandscapemanagement.html [Accessed 16 October 2015].

USAID. Cambodia. Available from: http://usaidlandtenure.net/cambodia. [Accessed 16 October 2015].

World Bank. Estimating the opportunity costs of REDD+. A training manual. Version 1.3.

Annex 2: Glossary

Discount rate

A value used to reflect the lower value that money has in the future compared with having it available now.

Driver

A pressure that exerts an effect on a system, e.g. deforestation is a driver of land-use change, while conversion of forests to agriculture may be a driver of deforestation.

Ecosystem services

Benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits (Hassan et al., 2005)

Forest Benefits

Additional benefits that can be accrued through forest conservation, sustainable management, or enhancement under REDD+ implementation. These may include non-timber forest products (e.g. honey, mushrooms, resin, rattan) for local consumption, as well as market sales from forests, eco-tourism in protected areas, and sustainable timber harvesting.

Implementation Cost

Implementation costs are the financial expenditures for undertaking REDD+ activities on-the-ground. They might include boundary demarcation, patrolling, tree planting, and developing alternative livelihoods for example.

Land concession

In this case, a land concession refers to a land-use type or land-cover that provides economic profit, e.g. oil palm plantations.

NPV

Net Present Value: A sum of future costs and benefits at a current monetary value (e.g. US$ / ha)

Opportunity Cost

Opportunity costs are the foregone financial net revenues from not adopting an alternative land use option. For example, the profits from agricultural land use such as an oil palm plantation (which equates to revenues from selling the oil palm fruit minus the costs of

production, such as labour and fertilizer, and any cost of conversion). These are from the perspective of the land user.

REDD+ options

REDD+ options, in the context of the spreadsheet tool for Cambodia, refer to actions or interventions taken in order to implement REDD+, such as the establishment of community forestry or the enhancement of degraded forest areas.

Transaction Cost

Transaction costs are the financial costs (usually met by the government and donors) for establishing and running a national REDD+ programme. They include the on-going administration costs related to organizing payments and national-level reporting.

Note that these costs can be expressed on a per hectare basis or per tonne of CO_2 basis. In the spreadsheet a hectare basis is used.