

# 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.

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## 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 <u>not</u> 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:

-		
Accum	ntion	variable
Assum	νισπ	variable:

Link to worksheet: Used for:

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

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

 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<sup>1</sup>).

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

 $<sup>^{1}</sup>$  The C to CO<sub>2</sub> 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<sup>2</sup>) 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 area 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.

<sup>&</sup>lt;sup>2</sup> 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<sub>2</sub>
- 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. smallscale 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<sub>2</sub>) 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).

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D	ETAILED AREA ANALYSIS						
	Site name (optional)	For the site of the REDD+ analysis pl Area of forest around Chi Krae		of site)			
	Identify area (hectares) at risk of land use change to be included in REDD+	21,000	(enter num	er of heclares)			
	Identify driver of the land cover change	Land concession: Coffee	(use drop-o	lown menu)			
	Identify appropriate REDD+ option to address the driver	Community Wetland	(use drop-o	lown menu)			
	Include the timber values from the land being cleared for agriculture?	No	(Yes or No	Note: not applicable to i	ogging or charcoal use		
	Does this area have a conservation designation?	No	(Yes or No				
	Local community Annual potential community income fore perspective:	gone from alternative la		a figures cannot be su \$42,000	mmed: average ove	r 25 years	Wha Small
	costs and benefits Annual community income from forest re	esources		\$1,036,244	average over	r 25 years	Tang
/	Government Annual total revenues from REDD+ for co	ountry		\$2,355,028	average over	r 25 years	Total
	revenues Annual funds available (i.e. after impleme	entation costs)		\$2,282,728	average ove	r 25 years	REDD
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2 3 4	Site name (please enter the	name of the site for the REI	)D+ analysis)	Forest site in nort	ih-eastern Koh K	ong Province	(enter name of	site)				
5	Total area (hectares) at risk	of land use change to be in	cluded in REDD+		14,000		(automatic sun	of multidriver	worksheets)			
14		1							t be summed!		What this	s sl
15	Local community perspective:	Annual potential com	munity income fo	regone from a	alternative	land use		\$1,677,96	6	average over 25 yea	rs Small-scal	le fa
17		Annual community in	come from forest	resources				\$247,410	)	average over 25 yea	rs Tangible fe	fores
19	Government perspective:	Annual total revenues	from REDD+ for	country				\$1,159,98	9	average over 25 yea	rs Total REDL	D+ p
21	revenues	Annual funds availab	le (i.e. after implei	mentation cos	ts)			\$507,725	;	average over 25 yea	rs REDD+ fun	nds r
23	National perspective:	Annual value to natio	n of forest ecosys	tem services	secured			\$1,969,66	2	average over 25 yea	rs Forest eco	syst
25	environment	Total carbon emissio	ns (tonnes CO2) a	voided				3,222,193	3	tonnes over 25 year	period Estimated	carl
27	TBD: transaction costs	Annual overhead administ	ative costs of REDD+					\$279,238		average over 25 yea	rs Costs of ru	unniu
•	• Area analysis Area n	nultidriver	Area multidriver2 Ar	ea multidriver3 A	rea multidriver4	Imp Costs	multi1 In	ip Costs mu	lti2 Imp	Costs 🕀 🕴 [	(	•
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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**.

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## 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.

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VARIABLE ASSUMPTIONS						
Vhilst all of the underlying values can be changed	(see individual spreadsheet	s), the key variables ar	highlighted below:			
fotal area of Protected Areas	4,765,000 hectares		FRA 2010 & 2015: 4,765,000	ha of PAs and PFs; 3,092	,000 ha of forests in PAs (2010).	
Economic values:						
iscount rate	5 %	(europeter/ range 1% - 1	0%) This is used to reflect the lo	ver value that money has	in the future compared with havin	na it available now
arbon price	8 USS/t CO2	(suggested range \$3 - \$			ed on communication from nation	
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Alternative land uses:						
arge-scale rice yield	6 t/ha		Estimate only			
mail-scale rice vield	3.163 t/ha		Average national yield, wet a	nd dry season, MAFF 201	3	
Cassava yield	21.03 t/ha				ations, MAFF 2013. Mondulkiri yiek	d: 25t/ha (questionnaire
tubber yield (max at maturity)	1,086 kg/ha					
Dil Palm price	140 US\$/tonne					
ashew price	1 U\$\$/kg		Estimate based on price ran	je for cashew, with shell	, Viet Nam, in 2012 (FAOSTAT). Mo	ndulkiri questionnaire:
tubber price	1.2 U\$\$/kg		Based on price received by 1	armer in Mondulkiri (201	5; questionnaire data). Average na	tional price in 2013 (MA
tice price (plantation)	225 US\$/tonne					
tice price (small scale)	187.5 US\$/tonne		Average national price, com	non rice, MAFF Dept. of R	tice Crops, 2014. Price in Koh Kon	g higher. Price from 201
epper price	6,000 U\$\$/tonne		Average Cambodia produce	price, 2007, FAOSTAT, v	vas \$2400. But FAOSTAT prices fo	r Vietnam and Thailand
assava price	173 US\$/tonne		Average Cambodia produce	price, 2012, FAOSTAT; N	londulkiri farmer price much lowe	er: \$75/t (questionnaire,
harcoal price	150 USS/tonne		Estimate only. In Koh Kong, S	100 goes to producer, w	hile market price is \$275 market (	2015, quiestionnaire da
tandard timber price	400 US\$/m3				Mondulkiri Dipterocarp: \$200, oth	
uxury timber price	1,500 US\$/m3			data shows luxury spp a	around \$850-1000 in Mondulkiri; ro	osewood \$1200 in Koh H
verage size of land concession plantation	30 ha		Estimate only.			
	6 ha		Estimate only. May depend o	n farm type, e.g. for rice 3	2010 IRRI HH survey shows average	ge size of 1.8ha
verage size of small-scale farm						
-						
orests:						
Forests: werage carbon in natural forest area		ground biomass carbor				
verage size of small-scale farm <u>Forests:</u> verage carbon in natural forest area vfficial fees on forestry licences	121 t C/ha (above ( 40 US\$/ha	ground biomass carbor		orted rates of US\$20-60	per m3 depending on grade (Deci:	sion 100 of 27 February

## Step 7:

The spreadsheet then presents the results from various perspectives: community; government; and national environmental perspective<sup>3</sup>. 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?

<sup>&</sup>lt;sup>3</sup> 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.

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## 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-theground. 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.