VMD0037

GLOBAL COMMODITY LEAKAGE MODULE: PRODUCTION APPROACH (LM-P)

Version 1.0

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Sectoral Scope 14

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1 SOURCES

The following have informed the development of the module:

- VCS JNR Leakage Working Group
- VCS document *AFOLU Requirements*
- VCS document *JNR Requirements*
- VCS document *Program Definitions*

2 SUMMARY DESCRIPTION OF THE MODULE

This module estimates the global commodity leakage value that is expected to result from REDD+ activities within the jurisdiction. The global commodity leakage value, expressed as a percentage, is used to determine the global commodity leakage deduction within the VCS *JNR Leakage Tool* (ie, a 4 percent global commodity leakage value results in a leakage deduction of 4 for the global commodity leakage category in the tool).

This module assesses a number of factors that impact the amount of leakage emissions that will occur outside the jurisdiction as a result of the jurisdictional program. This approach focuses on the volumes of foregone commodity production as a result of jurisdictional program activities. The module uses commodity yield data to estimate the amount of production (considering the commodities driving deforestation and/or degradation) that may have occurred on the area where deforestation and/or degradation was prevented within the jurisdiction. The module allows the jurisdictional program to mitigate the impacts of leakage by increasing production within the jurisdiction through agricultural intensification, increasing commodity yields, production on marginal lands and decreasing demand for commodities resulting in deforestation (and degradation, where relevant).[1] The additional production from such activities is subtracted from the production that would have been expected from the area where deforestation (or degradation) is avoided to determine the amount of production subject to leakage. The amount of production subject to leakage is used to estimate the leakage emissions resulting from displaced deforestation (and degradation) outside the jurisdiction but within the country. The module applies an econometric factor to estimate how much of the foregone production will result in increased supply outside of the jurisdiction due to market effects. Based on the estimated increase, the amount of supply that will be made up by bringing new land into production is calculated. After applying commodity yields to covert the amount of production to the area of production the tool determines how much of the new land brought into production is likely to result in deforestation.

[1] For the purposes of this module, degradation is relevant where the jurisdictional program scope includes accounting for reducing emissions from forest degradation. All “(and degradation)” references throughout the document should be read as, “(and degradation, where relevant)”.

Since global commodities are linked to international markets, this method assumes that such commodity production will shift to areas outside the jurisdiction both domestically and internationally. The final step of the leakage module is to estimate how much of this deforestation (and degradation) will occur within the country but outside any other jurisdictions accounting for deforestation. This follows UNFCCC policy that a country is only responsible for accounting for GHG emissions occurring within the country. The module determines the share of leakage that remains in the country based on either the share of recent global deforestation (and degradation) emissions occurring within the country, or the share of global forest carbon stocks at-risk of deforestation (and degradation) existing within the country whichever is greater. These factors are then applied to estimate the percentage of the area of deforestation (and degradation) that would result in leakage emissions to other forests within the country. The amount of deforestation (and degradation) already accounted for by other jurisdictional REDD+ programs within the country is also considered. Finally this approach applies the average carbon stocks of forests within the country to estimate the global commodity leakage value. This global commodity leakage value can then be used in coordination with the VCS *JNR Leakage Tool*.

This module was developed with a working group composed of leading practitioners and experts on jurisdictional REDD+ and has undergone peer review and public consultation, including review and testing by jurisdictional governments that are applying the VCS JNR framework.[2]

3 DEFINITIONS

See the VCS documents *Program Definitions, JNR Requirements* and *AFOLU Requirements,* and VCS *JNR Leakage Tool,* for further specification on terms and definitions used within this document.

4 APPLICABILITY CONDITIONS

This module is applicable to jurisdictional programs seeking to estimate a global commodity leakage value as referenced by the VCS *JNR Leakage Tool*.

This module is applicable under the following conditions:

- The jurisdictional program applies a Scenario 2 or Scenario 3 approach (see VCS document *JNR Requirements* for a description of the scenarios).
- The jurisdictional program is subnational in scope, or the jurisdictional program is national and the tool is being used to estimate and address leakage within the country.
- The jurisdictional program affects the production of relevant global commodities.

[2] VCS JNR Leakage Working Group members can be found at: http://www.v-c-s.org/node/620

5 PROCEDURES

Where the jurisdictional program only includes activities that reduce emissions from deforestation, estimate the leakage emissions from commodities driving deforestation. Where the jurisdictional program includes activities that reduce emissions from deforestation and degradation, estimate the leakage emissions from both deforestation and degradation. Unless otherwise noted, when applying this module to calculate a global commodity leakage value for degradation, deforestation should be read this as degradation. The module must be applied separately for leakage resulting from deforestation and for leakage resulting from avoided degradation (where relevant). This will result in one global commodity leakage value for deforestation and one for degradation for each year in the monitoring period.

Where this module is applied to determine a global commodity leakage value for both deforestation and degradation, the degradation analysis must consider whether relevant global commodities drive deforestation and/or degradation. For example, forest or plantation crops driving degradation (eg, palm oil or coffee production) that degrade forest lands but maintain a forest land use must be considered in the analysis of degradation. Agricultural crops and livestock driving deforestation (ie, that maintain a non-forest land use) should be considered during the deforestation analysis. Where a relevant global commodity drives both deforestation and degradation, such commodity must conservatively be included in the analysis for both deforestation and degradation.

5.1 Amount of Production Subject to Leakage

This section evaluates whether, and to what extent, the jurisdiction has experienced a net decline in the amount of global commodity production as a result of the jurisdictional program. This is achieved by monitoring the amount of increased production of global commodities or decreased demand for global commodities generated through strategies, policies or measures designed to maintain commodity production (ie, leakage mitigation) as described in Section 5.1.4. This amount of leakage mitigation is then subtracted from the amount of foregone production, which is calculated based on applying commodity yields to the area of avoided deforestation as described in Section 5.1.3, to determine the amount of production subject to leakage in Section 5.1.5.

This analysis must be conducted for, at minimum, each relevant global commodity *j* associated with driving deforestation within the jurisdiction, identified using the procedures in the VCS *JNR Leakage Tool*. Global commodities include agricultural products, forest product and livestock products that are linked to international markets. A commodity is considered linked to international markets where a significant amount of the country's production of that commodity is traded on international commodities markets, given as more than 5 percent of the country's total production of a given commodity is traded on international commodities markets. Other global commodities that may be substituted for relevant global commodities should also be considered. Illegal commodities (eg, coca) must not be included within this analysis, as set out in the VCS *JNR Leakage Tool*. The total leakage caused by all commodities included in this analysis is

determined using the proportion of deforestation set out in Section 5.1.1 and by considering the overlaps between commodities, as set out in Section 5.2.2.

5.1.1 Proportion of Deforestation

The proportion of deforestation from each driver of deforestation described in the jurisdictional program description, PD_j, must be estimated. For all areas where deforestation was avoided as reported in the jurisdictional program description or most recent monitoring report, consider what land uses would have occurred, and what commodities would have been produced. At minimum, all relevant global commodities identified using the procedures in the VCS *JNR Leakage Tool* must be included in this analysis. Other global commodities that do not cause significant deforestation within the jurisdiction or may be substituted for relevant global commodities may also be included in this analysis.

Where livestock from cattle grazing is identified as a relevant global commodity, commodity yield data for livestock must be included. However, these data should only be assessed for grazing cattle that contribute to deforestation. Commodity yield data on cattle that do not directly contribute to deforestation (eg, feedlot-grown cattle which do not directly contribute to deforestation) need not be included. Calculate the percentage of the area that would have been used for each relevant global commodity (ie, the proportion of deforestation, PD_j). Where the area of each non-forest land use of deforested land is specified in the jurisdictional program description this may be used to calculate the proportion of deforestation for each relevant global commodity. Where the specific area of each non-forest land use is unknown or not specified for each relevant global commodity, use the existing areas of production for each relevant global commodity within the jurisdiction compared to the total area of agricultural land within the jurisdiction to calculate these percentages. Where jurisdictional data is not available, use country-wide data to calculate these percentages and justify that such data is appropriate. Typically, when calculating the percentage of the area used for each commodity, the total across all commodities will be 100 percent. However, justification may be provided that less than 100 percent of the area is subject to deforestation from agricultural production (ie, there may be select regions not suitable for agricultural production that are only subject to deforestation from timber harvesting).

All lands that would have been deforested must be attributed a non-forest use, unless otherwise justified. Justification may be provided that some of the lands that would have been deforested would not be subject to global commodity production. Identify the proportion of deforestation driven by the production of relevant global commodities and the proportion of deforestation not driven by the production of relevant global commodities (ie, area where deforestation is only driven by subsistence activities or production of domestically traded products). For example, a jurisdictional proponent may have evidence to show that relevant global commodities (eg, soy, corn and livestock production) only drive 50 percent of the deforestation within the jurisdiction and the remaining 50 percent of deforestation is caused by subsistence activities or production of domestically traded products (as determined in accordance with the VCS *JNR Leakage Tool*). Where data is not available to support such analysis, conservatively assume that 100 percent of the deforestation comes from relevant global commodities.

The proportion of deforestation must be determined for each relevant global commodity. The sum of the proportion of deforestation across each relevant global commodity must be equal to or greater than the proportion of deforestation driven by the production of all relevant global commodities. For example, where 50 percent of deforestation is driven by the production of global commodities, then the sum of the proportion of deforestation across each relevant global commodity must be 50 percent or greater than 50 percent (eg, 20 percent may be driven by soy, 20 percent by corn and 10 percent by cattle rangelands). There may be significant overlap between agricultural commodities driving deforestation (eg, soy, corn, rice or livestock) and forest products driving deforestation (eg, saw logs or pulp wood). Such overlap between relevant global commodities is accounted for in Section 5.2.2.

Because land uses can overlap, the total proportion of deforestation across agricultural commodities may be more than the proportion of deforestation of relevant global commodities. Where crops overlap seasonally, it may be appropriate for the total value for the proportion of deforestation driven by all such crops to be greater than the proportion of deforestation driven by the production of relevant global commodities.

Production of pulpwood and saw logs are expected to overlap. These forest uses are often relevant to degradation. Where the production of forests products is identified as a driver of deforestation, such relevant global commodities must be included in the analysis for the global commodity leakage value for deforestation. Where they are identified as drivers of degradation and degradation is being accounted for, they must be included in the analysis for the global commodity leakage value for degradation.

Fuelwood is not considered a relevant global commodity as it is not traded on international commodities markets. Leakage from fuelwood collection must be accounted for as a domestic market or subsistence activity in accordance with the VCS *JNR Leakage Tool*.

5.1.2 Baseline Commodity Yields

This section calculates the baseline commodity yields for the jurisdiction based on an analysis of the historical commodity yields. The baseline commodity yields are used to calculate amounts of forgone production caused by avoiding deforestation in Section 5.1.3. The baseline commodity yields must be determined per-hectare for each relevant global commodity included in the analysis.

The baseline commodity values must be determined by monitoring commodity yields prior to the implementation of the jurisdictional program, or be collected from regional studies conducted according to methods that are publicly available from a recognized, credible source and must be reviewed for publication by an appropriately qualified, independent organization or appropriate peer review group, or be published by a government agency. Apply annual data from each year included in the historical reference period used to develop the jurisdictional baseline to determine a baseline commodity yields. Where annual data is not available throughout the historical

reference period, provide justification that the years in which data is available are representative of such period.

For livestock, use cattle head slaughtered per hectare per year as the default unit. Typically this number will have to be calculated by dividing the number of head slaughtered per year in the jurisdiction, divided by the area of pasture in the jurisdiction.

Historical commodity yield data is used to estimate baseline commodity yields. The method to estimate baseline commodity yields depends on the method applied by the jurisdictional program to develop the most plausible jurisdictional baseline scenario. The baseline scenario may be developed based on a historical annual average or a historical trend of GHG emissions or removals and the baseline may include modeled adjustments (as set out in VCS document *JNR Requirements).*

Where the jurisdictional baseline is developed using the historical annual average GHG emissions or removals (without modeled adjustments), estimate the commodity yields required to maintain existing production within the jurisdiction using either the historical annual average of commodity yields, or the historical trend in commodity yields (as set out in VCS *JNR Leakage Tool*). Procedures for conducting the historical annual average analysis are provided in the corresponding sub-section below.

Where the jurisdictional baseline is developed using the historical annual average with modeled adjustments or historical trend of GHG emissions or removals, estimate the commodity yields required to maintain the existing trend of production within the jurisdiction using the historical trend in commodity yields (as set out in the VCS *JNR Leakage Tool*). Procedures for conducting the historical trend analysis are provided in the corresponding sub-section below.

<u>Historical Annual Average Analysis</u>

Where the jurisdictional baseline is developed using the historical annual average GHG emissions or removals, the historical annual average commodity yield for each relevant global commodity *j* may be applied to calculate baseline commodity yields, based on a historical record of commodity yields within the jurisdiction. The baseline commodity yield for each commodity *j* in year *t* is defined in equation 1 below. This baseline commodity yield will be the same for every year during the program crediting period.

$$y_{j,t} = \frac{\sum_{h=1}^{H}(\bar{y}_{j,h})}{H} \tag{1}$$

Where:

$y_{j,t}$ = Baseline commodity yield for commodity *j* in year *t* (tonnes / ha)

$\bar{y}_{j,h}$ = Commodity yield for commodity *j* in year *h* of the historical reference period (tonnes / ha)

H = Number of historical reference years

The baseline commodity yield must be calculated using data from the same historical reference period used to develop the jurisdictional baseline.

Historical Trend Analysis

Where the jurisdictional baseline is developed using the historical annual average with modeled adjustments or historical trend of GHG emissions or removals, a trend in commodity yields for each relevant global commodity *j* must be applied to calculate baseline commodity yields, based on the historical annual average commodity yield within the jurisdiction and a growth rate. Where the jurisdictional baseline is developed using the historical annual average GHG emissions or removals, a historical trend analysis may also be applied to calculate baseline commodity yields. The baseline commodity yields for each relevant global commodity *j* at time *t* is calculated by applying an annual growth rate r_j to the historical commodity yields as set out in equation 2 below.

$$y_{j,t} = \frac{\sum_{h=1}^{H}(\bar{y}_{j,h})}{H} * \left(1 + r_j\right)^t \tag{2}$$

Where:

$y_{j,t}$ = Baseline commodity yield for commodity *j* in year *t* (tonnes / ha)

$\bar{y}_{j,h}$ = Commodity yield for commodity *j*, in year *h* of the historical reference period (tonnes / ha)

H = Number of historical reference years

r_j = Growth rate of commodity yields for commodity *j* (percent), or the default value (2.5 percent)

t = Years since program crediting period start date

The baseline commodity yield must be calculated using data from the same historical reference period used to develop the jurisdictional baseline.

This module uses a conservative default growth rate of commodities of 2.5 percent, based on peer-reviewed agricultural studies.[3] Apply the default growth rate, or where data on trends in commodity yield within the jurisdiction are available, justify a more accurate jurisdiction-specific growth rate for commodity *j* based on government approved or peer-reviewed studies on growth trends within the jurisdiction. Where a jurisdiction-specific growth rate is applied, the growth rate must be calculated using data from the same historical reference period used to develop the jurisdictional baseline. Growth rates are expected to increase over time with technological improvements in agriculture.

[3] See Appendix 2 for additional background information.

5.1.3 Forgone Production

The amount of foregone production is calculated as the area of avoided deforestation by the jurisdictional program multiplied by the baseline commodity yield (as calculated in Section 5.1.2) and proportion of deforestation (as determined in Section 5.1.3) for each relevant global commodity as follows:

$$FP_{j,t} = d_t * y_{j,t} * PD_j \quad (3)$$

Where:

$FP_{j,t}$ = Foregone production for commodity *j* in year *t* (tonnes)

d_t = Area of avoided deforestation by the jurisdictional program in year *t* (ha)

$y_{j,t}$ = Baseline commodity yield for commodity *j* in year *t* (tonnes / ha)

PD_j = Proportion of deforestation driven by commodity *j* (percent)

The area of avoided deforestation, d_t, includes the total area of deforestation prevented as reported in the monitoring report. In reality, land being deforested may have lower productivity than average land in the jurisdiction used for agriculture, however this module assumes that productivity on land being deforested is equal to the average land within the jurisdiction.

5.1.4 Leakage Mitigation

Strategies, policies or measures may be implemented as part of the broader REDD+ strategy that help prevent commodity displacement and are referred to here as leakage mitigation activities. Leakage mitigation activities can avoid leakage by increasing production elsewhere within the jurisdiction, without associated deforestation or degradation, to replace production forgone by the jurisdictional program. Leakage mitigation activities can reduce demand for the forgone goods and services. An example of replacing forgone supply is a program that helps farmers increase crop productivity thereby increasing the total amount of crops produced without increasing the area farmed. An example of reducing demand is an activity that assists local people to convert to efficient cookstoves and allowing the same amount of food to be cooked with substantially less consumption of fuelwood.

Where leakage mitigation activities are implemented, the increase in production or decrease in the production demanded must be monitored and reported. Achievements must be demonstrated through amounts of production increased or consumption decreased, not effort or activity. For example, a jurisdictional proponent could provide technical assistance to farmers or access to high yielding seeds, and measure increases in crop yields on farms that are assisted.

Where leakage mitigation activities have not been implemented, the value for leakage mitigation is zero. Evidence must be provided that leakage mitigation activities will be (at validation), or have been (at verification), implemented.

5.1.5 Amount of Production Subject to Leakage

Calculate the amount of production of each type of commodity that is subject to market leakage, net of mitigation. The amount of production subject to market leakage is the amount of foregone production (as calculated in Section 5.1.3), minus the amount of leakage mitigation (as determined in Section 5.1.4). If no leakage mitigation occurs, the potential amount of leakage will be the same as the amount of foregone production calculated in Section 5.1.3.

$$l_{j,t} = FP_{j,t} - LM_{j,t} \tag{4}$$

Where:

$l_{j,t}$ = Amount of production subject to leakage for commodity *j* in year *t* (tonnes)

$FP_{j,t}$ = Forgone production of commodity *j* in year *t* (tonnes)

$LM_{j,t}$ = Leakage mitigation of commodity *j* in year *t* (tonnes)

5.2 Deforestation Caused by Leakage

5.2.1 Area of New Land Brought into Production

Where the global commodities are linked to international markets and the amount of production subject to leakage for commodity *j* in year *t* (as calculated in Section 5.1.5) is greater than zero (ie, $l_{j,t} > 0$), estimate the total area of new land brought into production outside the jurisdiction in year *t* by applying the baseline commodity yields (as calculated in Section 5.1.2) in the following equation:

$$INL_{j,t} = \frac{l_{j,t} * IS * NL}{y_{j,t}} \tag{5}$$

Where:

$INL_{j,t}$ = Area of new land brought into production in year *t* (ha)

$l_{j,t}$ = Amount of production subject to leakage for commodity *j* in year *t* (tonnes)

IS = 75 percent; Proportion of leakage resulting in increased supply outside the jurisdiction

NL = Proportion of increased supply coming from new land brought into production; or the default value (40 percent)

$y_{j,t}$ = Baseline commodity yield for commodity *j* in year *t* (tonnes / ha)

A brief summary of the default values and the procedures for applying alternative values is provided below. Appendix 2 contains additional background information regarding how the default values were developed.

<u>Amount of Increased Supply</u>

A fundamental premise of market leakage is that where production is decreased by one unit, then production in other locations will replace some, but not all, of the forgone production. This module

uses a conservative default value of 75 percent for *IS* which assumes that 75 percent of the production lost due to the jurisdictional program is made up through increases in supply outside the jurisdiction.

Amount from New Land Brought into Production

The increases in supply of these global commodities due to the jurisdictional program may or may not result in deforestation. Supply increases from bringing new land into production may result in deforestation, while supply increases from agricultural intensification and increases in yields will not lead to deforestation. This module uses a conservative default value of 40 percent for *NL* which assumes that 40 percent of the increase in supply outside the jurisdictional program is made up through bringing new land into production.

Where the default value is not applied for *NL*, provide evidence justifying the use of a different value for the percent of supply increase coming from new land brought into production within the country. Such evidence may include government approved or peer reviewed studies of the amount of production increases coming from new land brought into production.

5.2.2 Area Resulting in Deforestation

The total increase in deforestation as a result of the area of new land brought into production across all relevant global commodities must be calculated using equation 6.

$$ID_t = max\left(NLD * \sum_{j=1}^{A} INL_{j,t} \ , \sum_{j=1}^{FP} INL_{j,t}\right) \tag{6}$$

Where:

ID_t = Increase in deforestation outside the jurisdiction in year *t* (ha)

NLD = Proportion of new land brought into agricultural production resulting in deforestation; or the default value (100 percent)

$INL_{j,t}$ = Area of new land brought into production in year *t* (ha)

A = Total number of relevant global commodities that are agricultural commodities

FP = Total number of relevant global commodities that are forest products

Of the area of new land brought into production for agricultural crops and livestock, some of this land will be forested land while some will be marginal land with low carbon stocks. This module uses a conservative default value of 100 percent for *NLD* which assumes that all of the new land brought into agricultural production will result in deforestation.[4]

[4] See Appendix 2 for additional background information.

Where the default value is not applied for *NLD*, provide evidence to justify using a different value for the percent of new land brought into agricultural production that will result in deforestation within the country. Such evidence may include government approved or peer reviewed studies of the amount of production increases that result in deforestation within the country.

When summing across commodities consider overlaps in the land use to produce different commodities as described below. Where the relevant global commodities driving deforestation only include agricultural commodities, the area of new land brought into production must be summed across all agricultural commodities, *A*, to determine the total increase in deforestation.

Where agricultural commodities and forest products are included as relevant global commodities, the area of new land brought into production must be summed across all relevant global commodities that are agricultural commodities, *A*, and also summed across all relevant global commodities that are forest products, *FP*, to determine the total increase in deforestation outside the jurisdiction. For the calculation of the increase in deforestation outside the jurisdiction resulting from the production of forest products, the proportion of new land brought into agricultural production resulting in deforestation does not apply, as these commodities are conservatively assumed to always be produced on forested land. The increase in deforestation from agricultural commodities and forest products must then be compared and the highest value must be selected as the total increase in deforestation due to the jurisdictional program.[5]

5.3 Domestic Share of Leakage

5.3.1 Domestic Share of At-Risk Forests

After determining the total area of leakage resulting in deforestation, the next step is to estimate how much of this deforestation is likely to occur outside the jurisdiction but within the country. UNFCCC policy establishes that countries are only responsible for their own GHG emissions. As such, a jurisdiction or country reporting GHG emission reductions or removals does not report emission increases that may occur in other countries as a result of the activities of the reporting country. Therefore the jurisdictional program must estimate the domestic share of at-risk forests to determine how much of this global deforestation is likely to occur within the country. The share of at-risk forests can be calculated using one of the following approaches:

1) The percentage of global deforestation during the historical reference period that occurred in the country, as a proxy for historical at-risk forests (equation 8); or

2) The percentage of global at-risk forest carbon stocks during the historical reference period that are located within the country, as a proxy for future at-risk forests (equation 9).

[5] Production of agricultural commodities driving deforestation will often overlap in land use with production of wood products. Such land may first be deforested for its wood resources then used for agricultural production. Therefore such overlaps must be considered and the land use resulting in the highest level of increased deforestation due to jurisdictional program must conservatively be selected to determine leakage.

Conservatively select the metric that yields the highest percentage, as set out in equation 7 (and expanded upon in equations 8 and 9) below:

$$s = max(s_d, s_{cs}) \tag{7}$$

$$s_d = \frac{d_d}{g_d} \tag{8}$$

$$s_{cs} = \frac{d_{cs}}{g_{cs}} \tag{9}$$

Where:

s = Country's share of global leakage (percent)
s_d = Country's share of global deforestation (percent)
s_{cs} = Country's share of global at-risk forest carbon stocks (percent)
d_d = Area of deforestation within the country (ha)
g_d = Area of deforestation globally (ha)
d_{cs} = At-risk forest carbon stocks within the country (tonnes C)
g_{cs} = At-risk forest carbon stocks globally (tonnes C)

5.3.2 Other REDD+ Programs

Next estimate the share of leakage resulting in deforestation within the country that is outside any other jurisdictional REDD+ program that monitors and accounts for GHG emissions (ie, to estimate unaccounted leakage within the country). This share is evaluated using either the percentage of global deforestation during the historical reference period or the percentage of global at-risk forest carbon stocks, as described above. Where the country does not include any other jurisdictional REDD+ programs or data is not available, the share of unaccounted leakage within the country must be set conservatively as 100 percent.

Conservatively select the metric that yields the highest percentage, as set out in equation 10 (and expanded upon in equations 11 and 12) below:

$$u = max(u_d, u_{cs}) \tag{10}$$

$$u_d = \frac{d_d - R_d}{d_d} \tag{11}$$

$$u_{cs} = \frac{d_{cs} - R_{cs}}{d_{cs}} \tag{12}$$

Where:

u = Share of unaccounted leakage within the country (percent)
u_d = Share of unaccounted deforestation within the country (percent)
u_{cs} = Share of unaccounted at-risk forest carbon stocks within the country (percent)
d_d = Area of deforestation within the country (ha)
R_d = Area of deforestation accounted for under other jurisdictional programs within the country (ha)
d_{cs} = At-risk forest carbon stocks within the country (tonnes C)
R_{cs} = At-risk forest carbon stocks accounted for under other jurisdictional programs within the country (tonnes C)

5.3.3 Domestic Deforestation Caused by the Jurisdictional Program

Using the country's share of global leakage and the share of unaccounted leakage within the country, calculate the increase in domestic deforestation caused by the jurisdictional program following equation 13 below.

$$IDD_t = ID_t * s * u \tag{13}$$

Where:
IDD_t = Increase in domestic deforestation outside the jurisdiction in year *t* (ha)
ID_t = Increase in deforestation outside the jurisdiction in year *t* (ha)
s = Country's share of global leakage (percent)
u = Share of unaccounted leakage within the country (percent)

5.4 Leakage Emissions

Finally, calculate the global commodity leakage value expected to result from deforestation occurring outside the jurisdiction (but within the country) due to forgone production of goods within the jurisdiction.

The global commodity leakage value, expressed as a percent, is calculated using the increase in domestic deforestation outside the jurisdiction in year *t* (as calculated in Section 5.3.3), and the area of avoided deforestation by the jurisdictional program as shown in equation 14.

$$X_t = \frac{IDD_t}{d_t} \tag{14}$$

Where:
X_t = Global commodity leakage value for deforestation in year *t*
IDD_t = Increase in domestic deforestation outside the jurisdiction in year *t*
d_t = Area of avoided deforestation by the jurisdictional program in year *t*

This module assumes that the carbon stocks per hectare within the jurisdiction are equivalent to the carbon stocks per hectare in forests subject to deforestation outside the jurisdiction but within the country.[6] The global commodity leakage value, X_t, is expressed as a percentage and may be used to determine the global commodity leakage deduction as set out in the VCS *JNR Leakage Tool*. Where the monitoring period includes multiple years, the global commodity leakage must be determined for each year included within the jurisdictional monitoring period.

6 PARAMETERS

6.1 Parameters Available at Validation

Data Unit / Parameter	$\bar{y}_{j,h}$
Data unit	Tonnes / hectare
Description	Historical commodity yield within the jurisdiction for commodity *j* in year *h* of the historical reference period
Equations	1 and 2
Source of data	Officially published agricultural data by the jurisdiction, or peer-reviewed studies.
Value to be applied	
Justification of choice of data or description of measurement methods and procedures applied	The data must report on the commodity yield for commodity *j* within the jurisdiction and be sourced from the same time period used to develop the jurisdictional baseline. Where direct commodity yield data is not available, use data on the production divided by the area of production for each commodity within the jurisdiction and justify that such data is appropriate. Where jurisdictional data on commodity yields, production and area of production are not available, use country-wide commodity yield data and justify that such data is appropriate.
Purpose of data	Calculation of leakage

[6] Areas selected for REDD+ activities are usually selected for high biodiversity, carbon stock and/or customary value, and often have higher carbon stocks than on other forested lands within the country. As a result, it is generally conservative to assume that the carbon stocks will be equivalent because it is likely that carbon stocks where deforestation would shift to will be lower. This method also addresses the challenges of determining the average change in carbon stock due to deforestation outside the jurisdiction. Such data is often unavailable or difficult to determine throughout the entire country.

Any comment	Where data is not available for every year during the time period used to develop the jurisdictional baseline, provide justification that the years in which data is available are representative of such period. Apply the data from the historical reference period determined at validation until the program crediting period is renewed (ie, where the baseline is updated more frequently than every 10 years, the data from the historical reference period should still be applied until the crediting period is renewed). Apply the data provided at validation throughout the program crediting period to ensure that such historical reference period represents commodity yields within the jurisdiction before the implementation of jurisdictional activities. Once the crediting period is renewed, use newly calculated data based on an updated historical reference period.

Data Unit / Parameter	H
Data unit	Number
Description	Number of historical reference years
Equations	1 and 2
Source of data	Jurisdictional program description or based on data availability
Value to be applied	
Justification of choice of data or description of measurement methods and procedures applied	The number of historical reference years should include the same number of years in the historical reference period used to develop the jurisdictional baseline. Where data is not available for every year during the historical reference period used to develop the jurisdictional baseline, provide justification that the years for which data is available are representative of such period. Where such justification is provided, the number of historical reference years, *H*, is the number of years for which data has been provided (eg, if the jurisdictional baseline was developed from 2005 to 2015 but commodity yield data was only available in 2006, 2008, 2010, 2012 and 2014 and this is justified, then the jurisdictional program's number of historical reference years, *H*, is five years).
Purpose of data	Calculation of leakage
Any comment	

Data Unit / Parameter	r_j
Data unit	Percent
Description	Growth rate of commodity yields for commodity *j*
Equations	2
Source of data	For jurisdiction-specific growth rates, data from government approved or publicly available peer-reviewed studies on growth trends within the jurisdiction.
Value to be applied	Default value of 2.5 percent or justify a jurisdiction-specific growth rate
Justification of choice of data or description of measurement methods and procedures applied:	For background information on the default value see Appendix 2. For jurisdiction-specific values, data from government approved or publicly available peer-reviewed studies on growth trends for individual commodities within the jurisdiction must be used to justify jurisdiction-specific values for individual commodities. Where jurisdictional data is not available, use studies on growth trends for individual commodities within the country and justify that such data is representative of the jurisdiction.
Purpose of data	Calculation of leakage
Any comment:	

Data Unit / Parameter	PD_j
Data unit	Percent
Description	Proportion of the area of deforestation driven by commodity *j*
Equations	3
Source of data	Analysis of commodities driving the deforestation based on recognized, credible sources reviewed for publication by an appropriately qualified, independent organization or appropriate peer review group, or published by a government agency.
Value to be applied	

Justification of choice of data or description of measurement methods and procedures applied:	Conduct an analysis based on agricultural production or deforestation data from recognized, credible sources reviewed for publication by an appropriately qualified, independent organization or appropriate peer review group, or published by a government agency. Consider the area of land within the jurisdictional baseline where each relevant global commodity would have been produced. Calculate the proportion of deforestation, based on the percentage of the area within the jurisdictional baseline, subject to each driver. When available, use data regarding each relevant global commodity. Where data is not available for each relevant global commodity, use data on the proportion of total agricultural production within the jurisdiction for each relevant commodity as a proxy for the proportion of deforestation from agricultural commodities and justify that such data is an appropriate proxy. Where jurisdictional data is not available, use country-wide data to calculate these percentages and justify such data is appropriate. Average the production data over a period covering the most recent 10 years for which data is available or justify a different time period that is representative of trends in production.
Purpose of data	Calculation of leakage
Any comment:	The proportion of deforestation must be calculated for all relevant global commodities driving deforestation. The proportion of degradation must be calculated for all relevant global commodities driving degradation. Where wood products are considered drivers of both degradation and deforestation they must conservatively be included in the analysis for both deforestation and degradation.

Data Unit / Parameter:	IS
Data unit:	Percent
Description:	Proportion of leakage resulting in increased supply outside the jurisdiction
Equations	5
Source of data:	
Value to be applied	Default value of 75 percent

Justification of choice of data or description of measurement methods and procedures applied:	For background information on the default value see Appendix 2.
Purpose of data	Calculation of leakage
Any comment:	

Data Unit / Parameter:	NL
Data unit:	Percent
Description:	Proportion of increased supply coming from new land brought into production
Equations	5
Source of data:	For country-specific values, data from government approved or publicly available peer-reviewed studies.
Value to be applied	Default value of 40 percent or justify a country-specific value
Justification of choice of data or description of measurement methods and procedures applied:	For background information on the default value see Appendix 2. For country-specific values, the data from government approved or publicly available peer-reviewed studies on the proportion of increased supply coming from new land brought into production within the country must be used to justify a country-specific value. Such studies should distinguish between the increase in supply coming from bringing new land into production and the increase in supply coming from increased commodity yields or agricultural intensification.
Purpose of data	Calculation of leakage
Any comment:	

Data Unit / Parameter:	NLD
Data unit:	Percent
Description:	Proportion of new land brought into agricultural production resulting in deforestation
Equations	6
Source of data:	For country-specific values, data from government approved or publicly available peer-reviewed studies
Value to be applied	Default value of 100 percent or justify a country-specific value

Justification of choice of data or description of measurement methods and procedures applied:	For background information on the default value see Appendix 2. For country-specific values, data from government approved or publicly available peer-reviewed studies on the proportion of new land brought into agricultural production coming from forest land within the country must be used to justify a country-specific value. Such studies should distinguish between the new land brought into agricultural production that was previously forest land and such land that was previously grassland or marginal land with lower carbon stocks.
Purpose of data	Calculation of leakage
Any comment:	

Data Unit / Parameter	d_d
Data unit	Hectares
Description	Area of deforestation within the country
Equations	8 and 11
Source of data	Data from recognized, credible sources that have been reviewed by an appropriately qualified, independent organization (eg, IPCC, FAO) or appropriate peer review group, or been published by a government agency
Value to be applied	
Justification of choice of data or description of measurement methods and procedures applied	When available, apply nationally monitored or estimated data. The at-risk forest carbon stocks data must be sourced from a time period within five years of the program crediting period start date, or justification must be provided for use of older data.
Purpose of data	Calculation of leakage
Any comment	

Data Unit / Parameter	g_d
Data unit	Hectares
Description	Area of deforestation globally
Equations	8
Source of data	Data from recognized, credible sources that have been reviewed by an appropriately qualified, independent organization (eg, IPCC, FAO) or appropriate peer review group,

	or been published by a government agency
Value to be applied	
Justification of choice of data or description of measurement methods and procedures applied	Studies on global deforestation must use comparable methods to estimate global deforestation as those used to determine the area of deforestation within the country.
Purpose of data	Calculation of leakage
Any comment	

Data Unit / Parameter	d_{cs}
Data unit	Tonnes C
Description	At-risk forest carbon stocks within the country
Equations	9 and 12
Source of data	Data from recognized, credible sources that have been reviewed by an appropriately qualified, independent organization (eg, IPCC, FAO) or appropriate peer review group, or been published by a government agency
Value to be applied	
Justification of choice of data or description of measurement methods and procedures applied	When available, apply nationally monitored or estimated data. The at-risk forest carbon stocks data must be sourced from a time period within five years of the program crediting period start date, or justification must be provided for use of older data. Where data on at-risk forest carbon stocks is not available, data on the area of at-risk forest land may be used. Where studies regarding at-risk forest carbon stocks or areas are not available, justify the use of proxies such as the tropical forest carbon stocks as an indicator of the at-risk forest carbon stocks. The same metric (eg, tonnes C or hectares) or proxy must be used to calculate at-risk forest carbon stocks globally.
Purpose of data	Calculation of leakage
Any comment	

Data Unit / Parameter	g_{cs}
Data unit	Tonnes C
Description	At-risk forest carbon stocks globally
Equations	9

Source of data	Data from recognized, credible sources that have been reviewed by an appropriately qualified, independent organization (eg, IPCC, FAO) or appropriate peer review group, or been published by a government agency
Value to be applied	
Justification of choice of data or description of measurement methods and procedures applied	Studies on global deforestation must use comparable methods to estimate global deforestation as those used to determine the area of deforestation within the country.
Purpose of data	Calculation of leakage
Any comment	

Data Unit / Parameter	R_d
Data unit	Hectares
Description	Area of deforestation accounted for under any other jurisdictional REDD+ programs with GHG emissions monitoring and accounting outside the jurisdiction and within the country
Equations	11
Source of data	Reports by other jurisdictional REDD+ programs with GHG emissions monitoring and accounting outside the jurisdiction but within the country
Value to be applied	
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of data	Calculation of leakage
Any comment	Where data from other jurisdictions is not available, then the share of unaccounted leakage within the country should be set at 1.

Data Unit / Parameter	R_{cs}
Data unit	Tonnes C
Description	At-risk forest carbon stocks accounted for under any other jurisdictional REDD+ programs with GHG emissions monitoring and accounting outside the jurisdiction and within the country
Equations	12

Source of data	Reports by other jurisdictional REDD+ programs with GHG emissions monitoring and accounting outside the jurisdiction but within the country
Value to be applied	
Justification of choice of data or description of measurement methods and procedures applied	Determine at-risk forest carbon stocks based on the jurisdictional baseline or reference levels reported by other jurisdictional programs. Where the at-risk forest carbon stock within the country uses a different metric (ie, area of at-risk forests) such metric must also be applied based on data from the jurisdictional baseline or reference levels.
Purpose of data	Calculation of leakage
Any comment	Where data from other jurisdictions is not available, then the share of unaccounted leakage within the country should be set at 1.

6.2 Parameters Monitored

Data Unit / Parameter	d_t
Data unit	Hectares
Description	Area of avoided deforested by the jurisdictional program
Equations	3 and 14
Source of data	Jurisdictional monitoring report
Description of measurement methods and procedures to be applied	As reported with the jurisdictional monitoring report
Frequency of monitoring/recording	The data may be monitored once at the end of the monitoring period but should be reported on an annual basis.
QA/QC procedures to be applied	
Purpose of data	Calculation of leakage
Any comment	

Data Unit / Parameter	LM
Data unit	Tonnes
Description	Leakage mitigation achieved by the jurisdictional program in terms of production of a given commodity
Equations	4

Source of data:	Agricultural production data from leakage mitigation projects implemented by the jurisdictional program or data on the reduction in the production demanded as generated by the jurisdictional program.
Description of measurement methods and procedures to be applied:	A jurisdictional program should measure the volume of production through agricultural records.
Frequency of monitoring/recording:	The data may be monitored once at the end of the monitoring period but should be reported on an annual basis.
QA/QC procedures to be applied:	
Purpose of data	Calculation of leakage
Any comment:	

7 REFERENCES

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APPENDIX 1: DOCUMENT HISTORY

Version	Date	Comment
v1.0	4 Feb 2014	Initial version released.

APPENDIX 2: BACKGROUND INFORMATION ON DEFAULT VALUES

Growth Rate

The default value for growth rates of production has been developed based on reports from the International Food Policy Research Institute (IFPRI) and Food and Agriculture Organization (FAO). This default value based on the growth rates of production has been applied within this module to serve as proxy for growth rates in yields. Analysis from the IFPRI indicates that the average agricultural growth rates in developing countries over the past 40 years have remained less than 2.5 percent for each decade with values ranging from 2.08 percent to 2.42 percent (Fuglie and Nin-Pratt, 2012). Reports from FAO confirm that this is a conservative default value for growth rates. They predict that agricultural growth rates within developing countries will decrease in the coming decades with an average value of 1.6 percent for developing countries from 2007 to 2030 and an average value of 0.9 percent for developing countries from 2030 to 2050 (Alexandratos and Bruinsma, 2012). Therefore 2.5 percent has been selected as a conservative default value for commodity production and jurisdictions are eligible to justify using jurisdiction or country-specific values where such data is relevant and available.

Proportion of Leakage Resulting in Increased Supply

The default value for the proportion of leakage resulting in increased supply outside the jurisdiction was developed using the methods for estimating leakage from Murray, McCall and Lee (2004). This method considers the elasticity of supply and the elasticity of demand to estimate leakage for a given commodity. The analysis for developing the conservative default value used data on elasticity of supply and demand across commodities and countries from peer-reviewed economic studies and the Food and Agricultural Policy Research Institute's Elasticity Database. The elasticity data on agricultural commodities and forest products indicated that no commodities experienced perfectly inelastic supply or demand. Averaging across countries, most commodities losses occurring within the jurisdiction would result in a 40 to 75 percent increase is supply elsewhere. Therefore 75 percent was selected as a conservative default value.

Proportion of Increased Supply coming from New Land Brought into Production

The default value for the increased supply coming from new land brought into production was developed based on data and reports from the FAO. Such studies indicate that globally only 10 percent of the increases in production globally will come from new land being brought into production (Alexandratos and Bruinsma, 2012). Some sub-regions such as Latin America and the Caribbean may experience 40 percent of future supply coming from new land being brought into production. While these studies provide predictions regarding the long-term trends in production other studies on short-term trends result in other conclusions. Roberts and Schlenker (2013) provide evidence that shorter-term price shocks do not follow these longer-term trends and the increase in production is primarily made up by bringing new land into production.

The default value has been developed based on the assumption that jurisdictional programs will have longer-term impacts on commodity markets. Based on the FAO data, 40 percent was selected as a

conservative threshold for the default value. Such default value could be updated in the future if jurisdictional REDD+ programs are shown to have shorter-term impacts on commodity markets.

Proportion of New Land brought into Agricultural Production Resulting in Deforestation

The default value for the new land brought into agricultural production resulting in deforestation was developed based on data and reports from FAO and Gibbs et al (2010). These studies indicate that some countries have significant areas of forested land that are suitable for agricultural production and much of the new land brought into agricultural production in the 1980s and 1990s was forested land. Therefore a default value of 1 was selected to provide the most conservative assumption that all new land brought into agricultural production will come from forested land. However, a lower value may be justified by using country-specific values where such data is relevant and available.