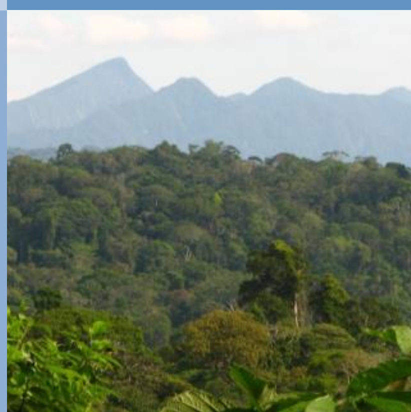

World Bank REDD+ Decision Support Toolbox Methods and Data Sources

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1 INTRODUCTION

The World Bank REDD+ Decision Support Toolbox (REDD+ DST) was developed by Winrock International with the World Bank Group's Forest Carbon Partnership Facility (FCPF) and is a web-based, interactive set of modules that guide users through a series of decisions and considerations related to technical aspects of REDD+ development. It is intended to provide practical guidance to FCPF REDD+ countries as they develop their national forest monitoring systems (NFMS) and reference levels (RLs) by leading users through a set of modules that focus on key areas of REDD+ development. The REDD+ DST provides customized guidance and first-order estimates of emissions by leveraging an advanced built-in database created by coupling a wide range of global datasets with peer-reviewed scientific methods for estimating emissions and sequestration from forests.

The REDD+ DST Modules are briefly described below:

1. REDD+ Design: Provides guidance on setting up a REDD+ program. Users select a FCPF country, scale, activities, carbon pools to include, and GHGs to account for. The REDD+ DST supports decision making by providing country and scale-specific first-order estimates of emissions from deforestation, degradation activities (fire, logging, fuelwood collection) and potential removals by enhancements. This module compares the contribution each activity makes to total emissions to help users decide which activities are most important to include in a REDD+ program. The contribution each carbon pool makes to emissions from deforestation is also explored to help users decide which pools are important to include in a REDD+ program. Interactive, spatially explicit maps are also produced for deforestation, carbon pools, and potential enhancements.

2. Reference Levels: This module provides guidance on developing a reference level based on key decisions made in the REDD+ Design module. Users can interactively change start and end years and explore differences between constructing a reference level using a historical average versus a historical trend.

3. National Forest Monitoring System (NFMS): The NFMS module covers the key components and provides guidance on major considerations of a NFMS including activity data collection and technologies, developing emission factors, a building or aligning an existing national forest inventory, and stratification. This module does not account for decisions made in the first two modules, and is instead formulated to serve as general guidance on key considerations.

4. Reporting and Verification: Much like the NFMS module, the Reporting and Verification module covers important aspects of setting up a reporting and verification system under a REDD+ program, but is not customized based on decisions made in modules 1 and 2.

The REDD+ DST produces first-order estimates at both national and subnational scales of emissions from deforestation, degradation from fire, degradation from timber harvesting, degradation from fuelwood collection, as well as potential removals from enhancements. Relevant UNFCCC, VCS, and FCPF Carbon Fund Methodological Framework requirements are provided throughout the REDD+ REDD+ DST modules as well as suggestions for further reading and links to other relevant resources for further capacity building.

Once all modules are completed, a summary is produced outlining the decisions made by the user in the REDD+ Design module and the Reference Levels module. The first-order estimates of emissions shall also be provided in the summary.

This document describes the sources of data as well as the methods used to render the mostly spatially explicit estimates of emissions or removals the REDD+ DST provides for deforestation, degradation and enhancements REDD+ activities.

2 DEFORESTATION

This section describes the methods used to calculate first-order estimates of area deforested and the resulting emissions from deforestation. Generally, deforestation emissions are calculated by multiplying the area of deforestation (activity data) by an emission factor which represents how much carbon dioxide is emitted per unit area for a given land cover class.

2.1 Activity Data

In the context of deforestation, activity data refers to the spatial location and extent of deforestation.

2.1.1 Forest Area and Forest Loss

In the case of deforestation, which results in a significant change to land cover, it is feasible to use remote sensing products to extract activity data. Hansen et al. (2013)[1] raster layers, which were derived from Landsat 7 ETM+ satellite images, were used for all activity data for deforestation in the REDD+ DST. The tree cover raster, which shows "canopy closure for all vegetation taller than 5 m in height" as a percentage from 0-100, was used to establish area of forest. The REDD+ DST allows users to select either 10%, 20%, or 30% canopy cover as the definition of forest. Cells with values of equal to or greater than each canopy cover threshold were extracted from the original tree cover raster to create forest mask for each canopy cover definition.

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[1] Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

The Hansen et al. (2013) loss year raster was then used to determine areas of deforestation. The loss year raster shows all areas that were deforested, on an annual basis, between 2001-2012. Areas of deforestation for each year between 2001-2012 were clipped to each forest definition threshold used in the REDD+ DST (10%, 20%, and 30% canopy cover) and summed for each subnational administrative unit.

Subnational units used in the WB DST were derived from the Database of Global Administrative Areas (GADM)[2] which provides a data layer of national and subnational political boundaries. Both Level 1 and Level 2 subnational units are available in the WB DST, which represent subnational boundaries at different levels of scale. GADM Level 1 units are typically states, departments, or prefectures whereas Level 2 GADM units subdivide Level 1 units into municipalities or counties. The first order estimates of emissions from deforestation produced by the REDD+ DST are the average deforestation emissions for each year Hansen et al. (2013) activity data are available (2001-2012).

2.1.2 Area of Peatlands

Emissions for deforestation on peatlands were calculated differently than those for other types of land cover due to their unique carbon content. Therefore, it was necessary to compile separate activity data for peatlands. A spatial layer of peatland areas was created using information from the Harmonized World Soil Database (HWSD)[3], which categorizes soil units by their major soil grouping as defined by the Food and Agriculture Organization of the United Nations (FAO) soil map of the world from 1990[4]. All soil units defined as a histosol soil, which is a soil composed of organic matter, were classified as peatland. All areas of deforestation according to the Hansen et al. (2013) layer that occurred on peatland areas were assumed to be peatland deforestation.

2.2 Carbon Stocks

The carbon stocks, or the amount of carbon stored in a forested area, must be known to quantify emissions that result when a given area is deforested. Forest carbon stocks consist of separate pools: aboveground biomass, belowground biomass, deadwood and litter, and soil carbon. All emissions from deforestation except for those from the soil/peat pool are assumed to be committed the year that the deforestation activity occurs. The contribution of emissions from the soil pool are calculated differently as post-deforestation land use and soil type must also be considered, according to Intergovernmental Panel on Climate Change (IPCC) Guidelines. These are further described below.

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[2] Available on-line from: www.gadm.org

[3] FAO/IIASA/ISRIC/ISS-CAS/JRC, 2012. "Harmonized World Soil Database (version 1.2)." FAO, Rome, Italy and IIASA, Laxenburg, Austria.

[4] FAO/Unesco/ISRIC, 1990. "Revised Legend of the Soil Map of the World." World Soil Resources Report, FAO, Rome, Italy.

2.2.1 Aboveground Biomass

Aboveground biomass values were obtained from a spatial layer of carbon stocks in tropical areas developed by Saatchi et al. (2011)[5] which maps aboveground biomass carbon stocks per hectare over Latin America, Africa, and Asia for the early 2000s, providing a useful pre-deforestation benchmark for the REDD+ DST. The biomass map was clipped to three forest mask layers matching the three forest definitions used in the DST (10%, 20%, and 30% canopy cover). Since the forest canopy layer (Hansen et al. 2013) and the biomass layer (Saatchi et al. 2011) use different remote sensing sources and have different spatial resolutions, there were some inevitable mismatches between the two data sources. To prevent counting non-forest biomass pixels that were retained after clipping to the forest masks, all pixels that had less than 40 tons of aboveground carbon per hectare were removed. This biomass threshold has been used to exclude pixels represented as forest in the Hansen dataset but effectively not considered as such in the Saatchi dataset from biasing carbon stocks for a broader deforested area (40t C/ha derived from Dinerstein et al. 2014)[6]. Although this threshold may not be accurate in other forest biomes that exist in countries shown in the REDD+ DST, it provided a conservative estimate of aboveground biomass that could be applied universally across forested areas. The resulting biomass was averaged across subnational units using a zonal statistics function, and then converted from biomass to tons of carbon by dividing in half, as specified in Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance for Land Use, Land-Use Change and Forestry (LULUCF)[7].

Two FCPF countries, Vanuatu and Fiji, were not covered by the Saatchi et al. (2011) map, so an alternative source was used to calculate aboveground biomass. Values of mean carbon stock estimates of permanent sample plots from the Fiji National Forest Carbon Stock Assessment[8] were used for both countries, giving them a flat aboveground biomass value across all subnational units.

2.2.2 Belowground Biomass

An allometric equation derived from Mokany et al. (2006)[9] was used to obtain belowground biomass (BGB) from aboveground biomass (BGB):

$$BGB = 0.489AGB^{0.89}$$

[5] Saatchi, S.S., Harris, N.L., Brown, S., Lefsky, M., Mitchard, E.T.A., Salas, W., Zutta, B.R., Buermann, W., Lewis, S.L., Hagen, S., Petrova, S., White, L., Silman, M., Morel, A. 2011. “Benchmark map of forest carbon stocks in tropical regions across three continents.” Proceedings of the National Academy of Sciences, USA, 108, 9899.

[6] Dinerstein, E., Baccini, A., Anderson, M., Fiske, G., Wikramanayake E., McLauglin, D., Powell, G., Olson, D., Joshi, A. 2014. “Guiding Agricultural Expansion to Spare Tropical Forests.” Conservation Letters, in press.

[7] IPCC. 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. Penman, J., Gytarsky, M., Hiraishi, T., Krug, T., Druger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, T., Tanabe, K., Wagner, F. (eds). Published: IGES, Japan. Available online at http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html.

[8] Payton, I., Weaver, S. Fiji National Forest Carbon Stock Assessment Version 1. February 2011. Compiled by Carbon Partnership Ltd. For SPC/GIZ Regional Programme –Coping with Climate Change in the Pacific Island Region and the Fiji Forestry Department.

[9] Mokany, K., Raison, J.R., Prokushkin, A.S. 2006. Critical analysis of root : shoot ratios in terrestrial biomes. Global Change Biology, 12, 84-84, doi: 10.1111/j.1365-2486.2005.001043.x.

Belowground biomass was then converted to tons of carbon by dividing the value in half, as was aboveground biomass.

2.2.3 Deadwood and Litter

Deadwood and litter biomass amounts were calculated based on a fraction of aboveground biomass as specified by methods under the United Nations Framework on Climate Change's (UNFCCC) Afforestation/Reforestation Clean Development Mechanism (A/R CDM)[10]. This methodology assumes deadwood and litter to be a fraction of aboveground biomass based on an area's elevation and annual precipitation regime (Table 1). Only fractions for tropical biomes were used in the REDD+ DST.

Elevation was obtained from the Global 30 Arc-Second Elevation (GTOPO30)[11] digital elevation model and the annual precipitation from the WorldClim database[12].

Table 1. UNFCCC A/R CDM methodology for determining deadwood and litter biomass stocks from aboveground biomass. Numbers shown are for the tropical biome only.

ELEVATION (m)	ANNUAL PRECIPITATION (mm yr^{-1})	DEADWOOD FRACTION OF AGB	LITTER FRACTION OF AGB
< 2000	< 1000	0.02	0.04
< 2000	1000 – 1600	0.01	0.01
< 2000	> 1600	0.06	0.01
> 2000	All	0.07	0.01

2.2.4 Soil Carbon

[10] UNFCCC. 2012. "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities Version 2.0.0." EB 67 Report Annex 23.

[11] United States Geological Survey. "Global 30 Arc-Second Elevation (GTOPO30). Available online at https://lta.cr.usgs.gov/GTOPO30.

[12] Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. "Very high resolution interpolated climate surfaces for global land areas." International Journal of Climatology 25, 1965-1978.

Through deforestation, most carbon stocks are emitted into the atmosphere. However, in the case of soil carbon, a portion of the carbon remains in the soil after deforestation. Therefore, emissions from soil carbon were calculated differently than other carbon stocks.

2.2.4.1 Mineral Soils

Carbon stocks for mineral soils, or in the scope of the REDD+ DST, non-peat soils, were obtained from the HWSD. For each pixel, the HWSD database contains values for bulk density and carbon content in percent carbon of the topsoil (the top 30 cm of soil, which is the assumed depth affected by deforestation). To estimate tons of carbon per hectare in forested areas, the bulk density was multiplied by the volume of topsoil in one hectare, and then multiplied by the fraction of carbon content. This was done for all pixels within the forest mask, and the weighted average was found for each subnational unit.

To calculate soil emissions from deforestation, land use change factors (F_{LU}) were used. F_{LU}s were obtained from the IPCC Guidelines for National Greenhouse Gas Inventories[13]. Only F_{LU}s for conversion to long-term cultivated crops were used, which varied based on the temperature regime of the subnational unit (tropical or temperate). Although not all land will become long-term cultivated crops, this assumption was made in the absence of a good method of predicting post-deforestation land use on the local level across all FCPF countries. The following formula was used to find deforestation emissions Ems_{SOIL} from soil carbon based on pre-deforestation soil carbon stocks (C_{PRE}):

$$Ems_{SOIL} = C_{PRE} - (C_{PRE} * F_{LU})$$

2.2.4.2 Peat Soils

Most of the emissions from deforestation on peat soils occur slowly over time, as drained organic peat slowly decomposes. The exception is when burning is used to clear the land, as the emissions from burned peat occur immediately. To account for the continuous emissions, an annual emission factor for drained organic soils in forests based on IPCC Wetlands Guidelines[14] was multiplied by ten to estimate more realistic longer-term emissions over ten years. The equation used to calculate total emissions from peat soils in tons of carbon per hectare (Ems_{PEAT}), based on the emissions factor (EF), the activity data (Area), the Initial Burn Depth (BD), the drainage depth (DD), and the peat bulk density (PBD) is as follows:

$$Ems_{PEAT} = Area((EF * DD) + (BD*\text{PBD}*(44/12)))$$

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[13] IPCC. 2006. "2006 IPCC Guidelines for National Greenhouse Gas Inventories." Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan. Volume 4 Agriculture, Forestry and Other Land Use. Paustian, K, Ravindranath, N.H. and Van Amstel, A (coordinating lead authors). Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol1.html.

[14] IPCC. 2013. "2013 Supplement to the 2006 Guidelines: Wetlands." Prepared by the Task Force on National Greenhouse Gas Inventories of the IPCC. Chapter 2: Drained Inland Organic Soils. Drosler, M., Verchot, L.V., Freibauer,A., Pan, G. (coordinating lead authors). Available at: http://www.ipcc.ch/meetings/session37/Doc_8b_Rev_2_Accepted_Report_Wetlands.pdf.

It was assumed that peat is initially drained to a depth of 80 centimeters (Hooijer et al. 2008)[15], and that the top layer of peat (34 cm depth; Couwenberg et al. 2009)[16] is burned. Therefore, the drainage depth was set to 46 cm (34 cm subtracted from 80 cm). A peat bulk density of 0.14 g cm^{-3} was used, as reported as the mean for tropical peat bulk density in Couwenberg et al. (2009).

3 DEGRADATION

This section describes the datasets and methods used to calculate degradation emissions. Degradation activities do not completely remove forest cover, and thus they can be more difficult to detect and quantify by means of remote sensing. Therefore, methods used to calculate deforestation emissions differ considerably from those applied to calculate emissions resulting from degradation activities. Instead, either ground data from various sources are used to tabulate removals of biomass from forests or more complex systems of satellite data analysis are necessary. The REDD+ DST estimates emissions from three major types of degradation: timber harvesting, fuelwood, and forest fires. Different data sources and methods are used to estimate emissions from each of the degradation activities included.

3.1 Timber Harvesting

[15] Hooijer, A., Silvius, M.,, Wosten, H., Page, S. 2006. “PEAT-CO2, Assessment of CO2 emissions from drained peatlands in SE Asia. Delft Hydraulics report Q3943.

[16] Couwenberg, J., Dommain, R., Joosten, H. 2009. “Greenhouse gas fluxes from tropical peatlands in south-east Asia.” Global Change Biology, 16, 1715-1732. DOI: 10.1111/j.1365-2486.2009.02016.x

In the context of the REDD+ DST, timber harvesting refers to commercial selective logging. The methodology described in Pearson et al. (2014)[17] was used to calculate national-level logging emissions for most FCPF countries. This methodology used extraction volumes from the 2010 FAO Global Forest Resources Assessment, and then calculates emissions from extracted logs, damage to the surrounding trees at the logging location, and logging infrastructure.

As emissions were calculated on a national scale, it was necessary to divide emissions among the subnational units represented in the REDD+ DST. The Global Forest Watch database[18] provides logging concessions data for seven FCPF countries: Cameroon, Central African Republic, Democratic Republic of Congo, Republic of Congo, Gabon, Indonesia, and Liberia. For these countries, national-level logging emissions were divided into subnational units according to the proportion of national concessions area within the subnational unit. For all other FCPF countries, national-level logging emissions were divided into subnational units according to the proportion of national forest area within the subnational unit. While the assumption that logging is proportional to amount of forest cover is not without flaws, it provides the best estimate for downscaling national data in the absence of higher resolution extraction or concessions data.

3.1.1 Harvested Wood Products

Some of the volume in extracted logs is stored as harvested wood products (HWP) in the form of lumber, wood panels, or other products that have an in-use lifetime and then may remain sequestered even after disposal especially when in landfills. As such, harvested wood that is manufactured into these products does not immediately contribute to emissions, so the portion of extracted wood that is effectively permanently sequestered in HWP must be subtracted from total logging emissions. Storage at 100 years is used as a simplification for permanent storage reflecting estimations of atmospheric residence of carbon dioxide. Earles et al. (2012)[19] calculated the percentage of aboveground carbon in harvested timber that remains stored in HWP after 100 years by estimating the proportion of national-level extraction volume data that became long lasting end products.

To calculate the amount of aboveground carbon stored in HWP for each subnational unit (AGB_{HWP}), the following equation was used where L_{NAT} is national-level logging extraction volume, Pct_{HWP} is the percent of aboveground biomass stored in HWP after 100 years, BCEF is the biomass conversion and expansion factor, and FArea is the proportion of national forested area within the subnational unit:

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[17] Pearson, T.R.H., Brown, S., Casarim, F.M. 2014. "Carbon emissions from tropical forest degradation caused by logging." Environmental Research Letters, 9, 034017. doi:10.1088/1748-9326/9/3/034017

[18] "Logging." World Resources Institute. Accessed through Global Forest Watch on Oct 7 2014. Available online at www.globalforestwatch.org.

[19] Earles, J.M., Yeh, S., Skog, K.E. 2012. "Timing of carbon emissions from global forest clearance." Nature Climate Change, 2, 682-685. doi:10.1038/nclimate1535

$$AGB_{HWP} = L_{NAT} * Pct_{HWP} * BCEF * FArea$$

Biomass conversion and expansion factors (BCEF) allow for the conversion of merchantable growing stock volume to aboveground biomass. BCEFs for temperate conifer forests and humid tropical natural forests were used from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. For the seven countries that have concessions data available through Global Forest Watch, the proportion of national concessions area within the subnational unit was substituted for the proportion of national forested area within the subnational unit in the above equation.

3.2 Fuelwood

Fuelwood harvesting is often done selectively and not through clear-cutting, so it is considered a major source of degradation. Drigo et al. (2014)[20] conducted a subnational (corresponding to GADM Level 1) spatial analysis of fuelwood demand and supply potential for 86 tropical countries, including all FCPF countries except Fiji. Estimates of non-renewable biomass (NRB) are given along with location of consumption. NRB from land cover change (LCC) by-products was calculated as well, since some wood that is burned as fuelwood comes from deforestation rather than degradation. In an effort to avoid double-counting emissions, in the REDD+ DST, only the fuelwood demand that was satisfied by non-LCC by-products was considered, in order to count only fuelwood collection that resulted in forest degradation.

In order to downscale the values from Drigo et al. (2014) from the subnational GADM Level 1 to Level 2, the proportion of subnational Level 1 unit population within each Level 2 unit was used. Population estimates were taken from the Gridded Population of the World[21] for 2000.

3.3 Forest Fire

Emissions from forest fires are the third source of degradation emissions included in the REDD+ DST. Forest fires refer to fires that degrade the forest through low to high severity burning, but are not the source of fires that cause a land cover change, such as human-induced deforestation. The Global Fire Emissions Database (GFED)[22] provides monthly dry matter emissions that are classified into different sources and land cover types. Within the humid tropical forest biome, deforestation fire emissions are

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[20] Drigo, R. 2014. "Elaboration of the pan-tropical analysis of NRB harvesting (Tier 1 data, version 01 April 2014)." Produced by the Yale-UNAM GACC Project: Geospatial Analysis and Modeling of Non-Renewable Biomass: WISDOM and Beyond for Global Alliance for Clean Cookstoves.

[21] Center for International Earth Science Information Network (CIESIN), Columbia University and Centro Internacional de Agricultura Tropical (CIAT). 2005. "Gridded Population of the World Version 3: Population Grids. Palisades, NY: Socioeconomic Data and Applications Center, Columbia University. Available online at http://sedac.ciesin.columbia.edu/gpw.

[22] van der Werf, G.R., Randerson, J.T., Giglio, L., Collatz, G.J., Mu, M., Kasibhatla, P.S., Morton, D.C., DeFries, R.S., Jin, Y., van Leewen, T.T. 2010. "Global fire emissions and the contribution of deforestation, savannah, forest, agriculture, and peat fires (1997-2009)." Atmospheric Chemistry and Physics, 10, 11707-11735. doi:10.5194/acp-10-11707-2010

decoupled from other emissions based on fire persistence (the length of time for which a fire burns in the same location). Deforestation fires are assumed to have a longer fire persistence in order to achieve complete combustion of fuels, clearing the land completely for a different land cover use.

In order to only count emissions from forest fires that contribute to emissions from degradation (since deforestation fires are already included in the deforestation emissions, Section 2), only emissions from the forest land cover class were tabulated in the REDD+ DST. Furthermore, emissions from three main gases were included: carbon dioxide, methane, and nitrous oxide. Methane and nitrous oxide were converted to carbon dioxide equivalent, and total emissions per hectare were averaged over each subnational unit.

The GFED3 data used in the REDD+ DST is a global dataset generally meant for coarse-scale atmospheric studies. Given the relatively small size of many of the GADM Level 2 units, there is undoubtedly a large source of error in the forest fire emissions numbers reported in the REDD+ DST. However, given that the REDD+ DST reports only first-order estimates and is global in scale, GFED3 was deemed to be the best available data source at the time of implementation.

4 ENHANCEMENTS

This section describes the datasets and methodology used to calculate the potential for enhancements from afforestation/reforestation (A/R) that exists in FCPF countries. Enhancements are inherently different from most emissions in that carbon is accumulated slowly over time by forest vegetation, rather than released all at once in the case of emissions.

4.1 Afforestation/Reforestation

Afforestation is the establishment of forest on non-forest land that had not previously been forest for a long period of time while reforestation is the establishment of forest on recently deforested land. Zomer et al. (2008)[23] created a global layer of land suitable for A/R based on several biophysical suitability variables. These variables excluded lands with high aridity, elevation above tree line, urban areas, water bodies, areas of high agricultural production, and current/recently deforested areas. Forests were defined as above 30% canopy cover according to a Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Continuous Fields (VCF) layer of canopy cover. The MODIS VCF canopy cover used in Zomer et al. (2008) was different than the Hansen et al. (2013) layer used in the REDD+ DST for canopy cover, resulting in a mismatch of forest definitions. Due to this mismatch, the Hansen et al. (2013) forest masks for each forest definition were used to clip the Zomer et al. (2008) A/R layer so that only A/R land on non-forest land was included in enhancements calculations in the REDD+ DST.

Default values for annual average aboveground biomass increments in plantations from the IPCC Good Practice Guidance for LULUCF were used for annual increases in tons of carbon. Subnational units were given a biomass increment based on their precipitation regime (from the WorldClim dataset) and location (Africa, Asia, or the Americas). Biomass increments for tree categories (pine, eucalyptus, etc.) for each location were averaged to create one biomass increment per continent. The tabulated area of eligible land for A/R was multiplied by the biomass increment and converted into emissions in tons of carbon dioxide equivalent, giving each subnational area an annual rate of emissions removals. Since it is not feasible to convert all land eligible for A/R into forest, the REDD+ DST normally assumes a conversion of 20% of eligible A/R land when considering the removals potential of an area.

[23] Zomer, R.J., Trabucco, A., Bossio, D.A., Verchot, L.V. 2008. "Climate Change Mitigation: A spatial analysis of global land suitability for clean development mechanism afforestation and reforestation." International Agricultural Research and Climate Change, 126, 1-2, 67-80.

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