**UCS Report**

***Halfway There? What the Land Sector Can Contribute to Closing the Emissions Gap***

**Detailed Description of Methods**

# Key Words

To identify candidate studies for inclusion in our database, we used search engines (Web of Science, Proquest, EBSO E-Journals Database, Zanran, Google, and Google Scholar) and browsed websites (McKinsey, UNFCCC, IPCC) for articles containing the combinations of terms related to our subject (e.g. AFOLU; LUCF; EMISSION\*), concept (e.g. ABATE\*+ POTENTIAL) and popular mitigation policies (e.g. REFOR\*; AGRI\* + INTENS\*) (Table 1). In addition to the keyword search we also identified candidate studies from colleagues and news sources identifying newly published reports.

# Criteria

We included studies in the database only if they met the following criteria:

1. Studies must be publicly available, including both grey and peer-reviewed published literature.
2. Estimates in studies must either be country specific or region specific. Studies that give global estimates without breaking estimates down by region or country are therefore not included.
3. Estimates in studies must be final. Estimates are excluded if authors indicate these numbers are preliminary and not to be cited.
4. Studies must have explicit reference and projection estimates for years 2020 and 2030, *OR*,
5. If reference and/or projection estimates are not given explicitly for 2020 and/or 2030, the study-period must allow estimates for 2020 and 2030 to be interpolated.
6. Reference scenarios must be reasonably attainable, scenarios are excluded if their estimation is based on scenarios that do not account for economic and political constraint (ie. Masera 1995).

# Yields

Our literature search and inclusion criteria resulted in the inclusion of 13 studies in the database (Global n=1, Brazil n=3, China n=1, Democratic Republic of the Congo n=1, European Union n=1, India n=1, Indonesia n=2, Mexico n=2, United States n=1) (Table 2). Of the 13 studies, 1 study was global, with estimates broken into regions. GHG reference and scenario estimates for this study were then divided by ratio of population of the country to that of the entire region.

# Interpretation

## Quality of Studies

The estimates we used varied in quality, which we then coded into three categories of “very good”, “good”, and “poor” (Table 3). We identified published studies and reports whose estimates are explicit for both 2020 and 2030 and are available in either text or table as “very good”. We identified published studies whose estimates are not explicit for either/both 2020 and 2030, but encompass the given time period, are available in the text or a table and, therefore, can facilitate interpolation for those years as “good”. We identified published studies whose data are neither explicit for 2020 or 2030, nor are available in text or table, but must be interpolated based visual graphs as “poor”.

## Unit Conversion

GHG gas estimates were given in units that differed across studies; most studies used tons of carbon dioxide (TCO2) or carbon dioxide equivalent (TCO2e), megatons of carbon dioxide (MtCO2) or carbon dioxide equivalent (MtCO2e), or gigatons of carbon dioxide (GtCO2) or carbon dioxide equivalent (GtCO2e). Sometimes, estimates were given in tons, megatons or gigatons of carbon (TC, MtC, or GtC), which we then converted to carbon dioxide using the molecular ratio of carbon to carbon dioxide (12/44). To enable consistent comparison we converted all units to Gigatons of Carbon Dioxide Equivalent (GTCO2e).

## Averaging

When two estimates of emissions where used under a particular scenario, these estimates were averaged to a single estimate. For instance, Masera 1995 contained reference scenarios based on both High Emissions (0.5 GtC) and Low Emissions (1.1 GtC) projections. These estimates were then averaged to a single estimate (0.8 Gtonnes of Carbon).

## Interpolation

As discussed above, when estimates were not given for both 2020 and 2030, we had to interpolate for these years based on the given information. For instance, Creyts et al 2007 did not present explicit numbers for either year, but interpolation was possible based on the given annual percentage change rate for both reference and abatement scenarios. In cases where only numbers for 2030 were given (eg. Woetzel et al 2009) we identified 2020 estimates as not available (“N/A”).

# Limitations

Our estimates are limited by availability, scope, and quality. Literature for GHG emission abatement exists for some sectors more than for others. Land sector abatement is particularly complicated. While energy and transportation sectors track a one-way flow, trees’ ability to sequester carbon means the flow of carbon between forests and the atmosphere runs both ways. National datasets for land sector emissions, therefore, are less likely to be reported on than for other sectors.

Studies that do estimate land sector GHG abatement potential sometimes focus on specific land emissions sources, and do not report comprehensively. For instance, Wesselink et al 2009 only reported emissions from agriculture, where soils and fermentation are the main emissions sources, leaving emissions from forests and deforestation out of the reported results. This provides one part of a larger possibility for a country’s land sector emissions abatement.

As previously discussed the quality of our estimates vary depending on whether estimates are given or must be interpolated, and whether the numbers that need to be interpolated are explicit in the text or whether they are roughly presented a graph, and therefore have to be visually determined.

# Tables

Table 1 Keywords searched\*

|  |  |
| --- | --- |
| **Subject**Greenhouse Gas Emissions (GHG)EmissionsCarbonClimateLow-CarbonLand UseLand CoverForestAgricultureLUC (F)LULUC(F)AFOLU[Country under investigation] | **Concept**PathwaysModelAbatementMitigationReductionPotentialProjectionsScenario20202030**Popular Mitigation Policies**ReforestationAfforestationDeforestation (Reduction/Mitigation/Abatement)Forest ManagementAgriculture (Intensification)Cattle (Intensification) |

* Where possible, roots of words were truncated to generate wider results.

Table 2. Studies included

|  |
| --- |
| Bajželj et al, *Nature Climate Change*, 2014: 924-929.Creyts et al, *McKinsey & Company*, 2007.De Gouvello, *Clean Energy Solutions Center*, 2010Gupta et al, *McKinsey & Company*, 2009.Indonesian national Council on Climate Change, 2010.Johnson et al, *The World Bank*, 2009.Masera, *Intercencia*, 1995McKinsey & Company, 2009.The Ministry of the Environment, Nature Conservation and Tourism, 2009.National Council on Climate Change, 2009.Strassburg et al, *Global Environmental Change*, 2014Wesselink and Deng, *ECOFYS*, 2009.Woetzel et al, *McKinsey & Company*, 2009. |

Table 3. Estimate Quality Matrix

|  |  |  |  |
| --- | --- | --- | --- |
|  | Very Good | Good | Poor |
| Estimates are stated for 2020 and2030 (no need for interpolation) | X |  |  |
| Estimates not stated for 2020 and 2030, but available information can facilitate interpolation |  | X | X |
| Estimates explicit in text or table (not graph) | X | X |  |
| Estimates not explicit in text or table, but 2020 and 2030 numbers can be interpolated from visual graphs |  |  | X |

# References

Bajželj, Bojana, et al. "Importance of food-demand management for climate mitigation." *Nature Climate Change* (2014): 924-929.

Creyts, Jon, Anton Derkach and Scott Nyquist. "Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost? U.S. Greenhouse Gas Abatement Mapping Initiative." Executive Report. 2007.

de Gouvello, Christophe. "Brazil Low-Carbon Country Case Study." 2010. *Clean Energy Solutions Center.* Report. 21 November 2014.

Dewan Nasional Perubahan Iklim. "Indonsia's Greenhouse Gas Abatement Cost Curve." 2010.

Gupta, Rajat, Shirish Sankhe and Sahana Sarma. *Environmental and Energy Sustainability: An Approach for India*. New Delhi: McKinsey & Company, 2009.

Johnson, Todd M., et al. *Low Carbon Development for Mexico*. Conference Edition. Washington, DC: The World Bank, 2009.

Masera, O.R. "Carbon Mitigation Scenarios for Mexican Forests: Methodological Considerations and Results." *Intercencia* 1995: 388-395.

McKinsey. *Pathways to a Low-Carbon Economy for Brazil*. Sao Paulo: McKinsey & Company, 2009.

National Council on Climate Change. "National Economic, Environment and Development Study (NEEDS) for Climate Change: Indonesia Country Study." 2009.

Strassburg, Bernardo B. N., et al. "When enough should be enough: Improving the use of current agricultural lands could meet production demands and spare natural habitats in Brazil." *Global Environmental Change* (2014): 84-97.

The Ministry of the Environment, Nature Conservation and Tourism. "The Democratic Republic of congo's REDD+ Potential." 2009.

Wesselink, Bart and Yvonne Deng. "Sectoral Emission Reduction Potentials and Economic Costs for Climate Change." 2009.

Woetzel, Jonathan, Martin Joerss and R. Bradley. "China's green revolution: prioritizing Technologies to achieve energy and environmental sustainability." 2009.