Why Forests? Why Now?
The Science, Economics, and Politics of Tropical Forests and Climate Change

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**Who’s hurt by climate change?**

- United States
- European Union
- Japan
- Russia
- Eurasia
- Other high income
- China
- India
- Middle East
- North Africa
- Sub-Saharan Africa
- Latin America
- Other developing Asia

**Who caused climate change historically?**

- United States
- European Union
- Japan
- Russia
- Eurasia
- Other high income
- China
- India
- Middle East
- North Africa
- Sub-Saharan Africa
- Latin America
- Other developing Asia

**Who’s causing climate change now?**

- United States
- European Union
- Japan
- Russia
- Eurasia
- Other developing Asia
- China
- India
- Middle East
- North Africa
- Sub-Saharan Africa
- Latin America
- Other developing Asia

Deforestation remains a significant contributor to climate change even as emissions from other sectors have grown faster.

Total annual greenhouse gas emissions 1970–2010

- CO$_2$ FROM FOSSIL FUELS
- CO$_2$ FROM DEFORESTATION (NET)
- NON-CO$_2$ GREENHOUSE GASES

- INDONESIA FOREST FIRES, 1997–1998

Billions of tons of greenhouse gas emissions (GtCO$_2$eq/yr)

Source: Edenhofer et al. (2014)

Deforestation represents net emissions from gross forest cover loss and degradation less removals by forest regrowth.
Goals:

- Synthesize knowledge on tropical deforestation and climate change authoritatively
- Make findings accessible to non-specialists (i.e. international development finance professionals)
- Make a persuasive case for increased funding from rich countries for tropical forest conservation
By the numbers:

• 2 Authors
• 6 Research Assistants
• 23 Background Papers
• 40 Background Paper Authors
• 100+ Reviewers
• More than 2 years in the making
• Published December, 2016
Key messages:

- Tropical forests are undervalued as a contributor to climate stability and sustainable development

- Science, economics, and politics are now aligned to support action on tropical forests

- Results-based payments for reducing emissions from deforestation (i.e. REDD+) have great potential for success
Introduction
1. Tropical forests for climate and development

Science
2. Forests and Climate
3. Forests and Water, Energy, Agriculture, Health, Safety, Adaptation
4. Advances in satellite monitoring

Economics
5. More, cheaper, faster mitigation
6. Forest services are undervalued
7. How to stop deforestation: Brazil and beyond
8. Deforestation for globally traded commodities

Politics
9. International forest politics
10. Forest politics in developing countries
11. Forest politics in rich countries
12. Finance for tropical forests

Conclusion
13. A closing window of opportunity
Natural forests capture CO₂; deforestation releases CO₂

**Intact Forest Ecosystems**
- Capture carbon in vegetation and soil

**Clearing and Burning Forests**
- Releases carbon that had been stored in vegetation and soil

**Regrowing Forests**
- Capture and accumulate carbon slowly over decades

**Conversion**
- To pasture, agriculture, and urban areas produces ongoing emissions
Conversion of peat forests releases large volumes of carbon from below ground.

UPLAND FOREST, BRAZIL
(source: Malhi et al, 2009)

- Trees and leaf litter: 200 t/ha
- Roots and soil: 200 t/ha

PEAT FOREST, INDONESIA
(source: Jayneck et al, 2008)

- Trees and leaf litter: 10 t/ha
- Roots and soil: 2,500 t/ha
Nine countries produced 77% of emissions from deforestation, 2001-2012

Billions of tons of greenhouse gas emissions (GtCO₂eq/yr)

Source: Busch and Engelmann 2015
Emissions from deforestation refers to gross emissions from tropical forest cover loss and peat conversion
If tropical deforestation were a country, its emissions would be greater than those of the European Union.

**ANNUAL GREENHOUSE GAS EMISSIONS, 2012**

- **China**: 11.0
- **United States**: 5.5
- **Tropical Deforestation**: 5.0
- **European Union**: 3.8
- **India**: 2.5
- **Russia**: 2.0

Billions of tons (GtCO₂eq/yr)

Source: CAIT v2.0, Busch and Engelmann 2015

Emissions from deforestation refers to gross emissions from tropical forest cover loss and peat conversion.
Net tropical deforestation produces 8% of net emissions, but halting and reversing tropical deforestation would reduce total net emissions by up to 24–30%.
Forest landscapes provide services; deforestation puts lives at risk

**INTACT FOREST**
- Cool, clean air
- Natural foods and medicines
- Local rainfall for crops
- Freshwater for irrigation and drinking
- Sediment-free water for hydropower
- Birds and bats pollinate crops and eat pest insects
- Nurseries for coastal fishing

**DEFORESTATION**
- Forest fires cause respiratory illness
- Landslides destroy villages
- More severe floods wash away homes
- Erosion leads to sedimentation
- Malarial mosquitoes breed in warm standing water
- Mangrove removal exposes coastal towns to storms and tsunamis
Forest Loss in Riau, Indonesia, 2000-2012.

Source: Hansen, Potapov, Moore, Hancher, et al. (Science, 2013).
Forest carbon stocks (Saatchi et al., 2011)

Forest carbon stock change (Goetz and Dubayah, 2011)

Forest carbon stocks (Baccini et al., 2011)

Natural forest vs. plantation (Miettenen et al., 2010)

Natural forest vs. plantation (Digital Globe, 2015)
Technology for monitoring tropical forests is rapidly advancing
(Goetz et al, Environmental Research Letters, 2015)

<table>
<thead>
<tr>
<th>Aspect of REDD+</th>
<th>Monitoring need</th>
<th>SUB-NATIONAL SCALE</th>
<th>NATIONAL SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMISSIONS FROM DEFORESTATION</td>
<td>loss of forest cover</td>
<td>• field plots • aircraft • satellite</td>
<td>• field plots • aircraft • satellite</td>
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<td>EMISSIONS FROM DEGRADATION</td>
<td>aboveground carbon stock</td>
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<td>SEQUESTRATION BY REGROWTH</td>
<td>belowground carbon stock</td>
<td>• • •</td>
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<td>ENVIRONMENTAL SAFEGUARDS</td>
<td>loss of forest carbon stock</td>
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<td>LAW ENFORCEMENT AND GOVERNANCE</td>
<td>gain in forest carbon stock</td>
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<td>distinguishing natural forests vs. plantations</td>
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<td>biodiversity</td>
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<td>near-real time alerts</td>
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Status of Technology
- • currently operational
- • approaching operational
- • further advances required
- • unlikely to become operational

Source: Adapted from Goetz et al. (2014).

Notes: Sub-national scale: tens or hundreds of square kilometers. National scale: thousands of square kilometers. Field plots: field measurements without the use of remote sensing. Aircraft: synergistic use of airborne sensors and field measurements. Satellite: synergistic use of satellite-borne sensors and field measurements. National-scale degradation refers to an approach based largely on fine-scale forest-cover change while sub-national scale degradation refers to a stock-change approach. National-scale regrowth refers to an approach based largely on mapping afforestation and reforestation while sub-national scale regrowth refers to a stock-change approach. Biodiversity refers to plant and animal species richness and diversity.
Earth is on track to lose an India-sized chunk of its tropical forests by mid-century.
Reducing tropical deforestation is a relatively low cost mitigation option
(Busch and Engelmann, in review)

Sources: Busch and Engelmann (2015); GCAM
Reducing deforestation offers nearly half the potential low-cost emission reductions in developing countries.

Gross emissions and emission reductions refer to greenhouse gases excluding agriculture. Low-cost emission reductions refer to emission reductions available below a carbon price of $20/ton CO₂.

Reducing tropical deforestation would let the world achieve a cooler climate more cheaply.

Curves represent the theoretically minimum global cost of achieving a temperature target.
Source: Busch, Engelmann, and Lépissier, 2016
By reducing tropical deforestation, a cooler climate can be achieved cheaper and faster.

**COOLER**

GLOBAL TEMPERATURE INCREASE

- Without Forests: 2.5°C
- With Forests: 2°C

**CHEAPER**

COST OF ACHIEVING 2 °C

- Without Forests: $1,200 billion/year
- With Forests: $800 billion/year

**FASTER**

YEAR OF PEAK EMISSIONS

- Without Forests: 2028
- With Forests: 2026

Source: Busch and Engelmann 2015
Factors associated with less or more deforestation

- Less deforestation
  - Law enforcement
  - Protected area
  - Payments (PES)
  - Presence of indigenous peoples
  - Greater poverty
  - Higher timber price
  - Community forestry
  - More secure land tenure

- More deforestation
  - Neighbors to roads
  - Neighbors to urban area
  - Greater population
  - Rural income support
  - Higher agricultural price

Source: Busch and Ferretti-Gallon, CGD Brief, 2014.
Brazil reduced deforestation and increased agricultural production at the same time
Emissions from deforestation are embodied in globally traded commodities

(Persson et al., *Environmental Research Letters*, 2015)
Nations Unies
Conférence sur les Changements Climatiques 2015
COP21/CMP11
Paris, France

Diagram:
- **GREENHOUSE GAS EMISSIONS (GtCO₂e/yr)**
- **HISTORICAL EMISSIONS**
- **REFERENCE LEVEL**
- **EMISSION REDUCTIONS**
- **PAST**
- **FUTURE**

Note: Reference level depicted is an illustrative example; reference levels could be above, equal to, or below historical emissions.
Tropical forests’ share of climate finance is small relative to their mitigation potential

FAST-START FINANCE PLEDGES BY DONOR (2010-2012) with portion focused on forests (REDD+)

Note: Fast-start finance commitments include both grants and loans.
Less than half of pledged finance for REDD+ is results-based

INPUT-BASED FINANCE
$5.1 BILLION

- $617M OTHER INPUT-BASED FINANCE
- $186M CONGO BASIN FOREST FUND
- $266M UN-REDD
- $358M FCPF READINESS FUND
- $603M FOREST INVESTMENT PROGRAM (FIP)
- $3,138M BILATERAL FUNDING

RESULTS-BASED FINANCE
$4.6 BILLION

- $1,000M VOLUNTARY CARBON MARKET
- $1,000M INDONESIA-NORWAY PARTNERSHIP
- $1,034M AMAZON FUND
- $470M FCPF CARBON FUND
- $311M FCPF BIOCARBON FUND
- $250M GUYANA-NORWAY PARTNERSHIP
- $141M GERMANY REM
- $300M BILATERAL PBP NORWAY-PERU
- $150M BILATERAL PBP NORWAY-LIBERIA

Source: Norman and Nakhooda, updated 2016
More than 50 countries have initiated REDD+ programs, but only a few have access to performance-based finance.

- COUNTRIES THAT HAVE INITIATED REDD+ PROGRAMS
- COUNTRIES WITH PERFORMANCE-BASED FINANCE AGREEMENTS IN PLACE

"Countries that have initiated REDD+ programs" refers to countries that have received readiness funding from the World Bank Forest Carbon Partnership Facility, the UN-REDD Program, and/or implementation finance from the Forest Investment Program, but did not yet have a payment-for-performance agreement in place as of April 2015. "Countries with performance-based finance agreements in place" refers to countries that had a payment-for-performance agreement in place as of April 2015.
Where should we go from here?

• Private commodity suppliers: Implement zero-deforestation commitments

• Public finance: Expand major donors beyond Norway, Germany, UK

• Market finance: Move ahead on tropical forest offsets in ICAO, California

• Green Climate Fund: Results-Based Payments for REDD+
Thank you!

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Funding: Norwegian Agency for Development Cooperation

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Poor people are most at risk from climate change

**Loss of livelihoods** due to water scarcity, particularly for farmers and pastoralists

**Loss of goods and services** from marine and coastal ecosystems, especially for fishing communities in the tropics

**Risk of food insecurity** and the breakdown of food systems, particularly for poorer populations

**Increases in food prices,** particularly affecting poor households dependent on wage labor

**Heat stress,** particularly for vulnerable urban populations and outdoor workers

**Increases in ill-health,** especially in low-income developing countries, due to food-, water-, and vector-borne diseases

**Impacts of extreme weather events,** especially for households living in poor-quality housing

**Death or injury** from storm surges, coastal flooding, and sea level rise for people living in low-lying coastal zones and islands

Source: IPCC Fifth Assessment Report “Impacts, Adaptation, and Vulnerability” (2014)
Since 1750, deforestation has been responsible for one-third of emissions; forests have been responsible for half of natural uptake.

Source: Clais et al, 2013
The carbon released immediately from deforestation can take a century to recapture through forest growth.
Figure SPM.2. Total anthropogenic GHG emissions (GtCO₂eq/yr) by economic sectors. Inner circle shows direct GHG emission shares (in % of total anthropogenic GHG emissions) of five economic sectors in 2010. Pull-out shows how indirect CO₂ emission shares (in % of total anthropogenic GHG emissions) from electricity and heat production are attributed to sectors of final energy use. "Other Energy" refers to all GHG emission sources in the energy sector as defined in Annex II other than electricity and heat production [A.II.9.1]. The emissions data from Agriculture, Forestry and Other Land Use (AFOLU) includes land-based CO₂ emissions from forest fires, peat fires and peat decay that approximate to net CO₂ flux from the Forestry and Other Land Use (FOLU) sub-sector as described in Chapter 11 of this report. Emissions are converted into CO₂-equivalents based on GWP100 from the IPCC Second Assessment Report. Sector definitions are provided in Annex II.9. [Figure 1.3a, Figure TS.3 a/b] [Subject to final quality check and copy edit.]

Figure 11.8. Breakdown of mean annual CO₂ fluxes from deforestation and forest management in tropical countries (GtCO₂/yr). Pan et al. (2011) estimates are based on FAO data and the Houghton bookkeeping model (Houghton, 2003). Baccini et al. (2012) estimates are based on satellite land cover change and biomass data with FAO data, and the Houghton (2003) bookkeeping model, with the detailed breakdown of these results shown in Houghton, (2013). Harris et al. (2012) estimates are based on satellite land cover change and biomass data.
Table 2.1. Gross annual pan-tropical emissions during the 2000s, by study

<table>
<thead>
<tr>
<th>Study</th>
<th>Gross emissions (GtCO₂eq/yr)</th>
<th>Time period</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zarin et al. 2015</td>
<td>2.3</td>
<td>2001-2013</td>
<td>Selected deforestation</td>
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<tr>
<td>Harris et al. 2012</td>
<td>3.0</td>
<td>2000-2005</td>
<td>Deforestation</td>
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<tr>
<td>Achard et al. 2014</td>
<td>3.2</td>
<td>2000-2010</td>
<td>Deforestation</td>
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<tr>
<td>Liu et al. 2015</td>
<td>3.6</td>
<td>2000-2005</td>
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<tr>
<td>Tyukavina et al. 2015</td>
<td>3.7</td>
<td>2000-2012</td>
<td>Deforestation, degradation</td>
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<tr>
<td>Busch &amp; Engelmann 2015</td>
<td>3.9</td>
<td>2001-2012</td>
<td>Deforestation, peat</td>
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<tr>
<td>Tubiello et al. 2014 (FAOSTAT)</td>
<td>4.9</td>
<td>2000-2009</td>
<td>Deforestation, degradation</td>
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<tr>
<td>Tubiello et al. 2014 (Houghton)</td>
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<td>van der Werf et al. 2009</td>
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<td>Deforestation, degradation, peat</td>
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<td>Tubiello et al. 2014 (EDGAR)</td>
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<table>
<thead>
<tr>
<th>Study</th>
<th>Removals (GtCO₂eq/yr)</th>
<th>Time period</th>
<th>Scope</th>
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</thead>
<tbody>
<tr>
<td>Baccini et al. 2012</td>
<td>-4.3</td>
<td>2000-2010</td>
<td>Reforestation and regrowth of secondary forests</td>
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<tr>
<td>Grace et al. 2014</td>
<td>-4.8</td>
<td>2000-2010</td>
<td>Reforestation and regrowth of secondary forests</td>
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<tr>
<td>Pan et al. 2011</td>
<td>-6.2</td>
<td>2000-2007</td>
<td>Reforestation and regrowth of secondary forests</td>
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</tbody>
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Tropical forests’ goods and services contribute to development

**GOODS & SERVICES**

- **INCOME**
  - timber
  - non-timber products
  - tourism

- **FOOD**
  - wild foods, bush meat
  - freshwater and coastal fish
  - forage and fodder
  - erosion control
  - irrigation
  - rainfall patterns
  - pollination

- **ENERGY**
  - less dam siltation
  - fuelwood and charcoal

- **HEALTH**
  - clean drinking water
  - clean air
  - medicine
  - mosquito control
  - fire control
  - recreation

- **SAFETY**
  - landslide prevention
  - flood control
  - tsunami mitigation

- **GLOBAL PUBLIC GOODS**
  - carbon storage
  - biodiversity

**DEVELOPMENT**
Multiple studies have estimated the cost-effective potential of reducing emissions from tropical deforestation.
European Union biofuel policy increased demand for palm oil, a driver of deforestation.
The bulk of American environmental groups have seen REDD+ as an opportunity.

Source: Climate Advisers analysis, adapted from Wolosin and Lee, 2014

Disbursement of multilateral REDD+ funding has lagged far behind pledges.

**STATUS OF FINANCE PLEDGED THROUGH DEDICATED MULTILATERAL FUNDS, 2006-2014 (MILLIONS OF DOLLARS)**

- **PLEDGED**: $2.193
- **DEPOSITED**: $1.532
- **COMMITTED**: $909
- **APPROVED**: $634
- **DISBURSED**: $247

Source: Adapted from Norman and Nkhood (2014, updated 2015) based on data for the Forest Investment Program, the FCPF Carbon Fund, the FCPF Carbon Fund, the Congo Basin Forest Fund, the BioCarbon Fund, and the UNREDD Programme as of December 31, 2014.