Restoring Global Forests: Opportunities & Challenges

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Outline

1. Need for more economic research on forest restoration
2. Financing large-scale restoration
3. Sampler of recent research
Annual Review of Environment and Resources

Forest Restoration in Low- and Middle-Income Countries

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My definition of “forest restoration”

• Reestablishment of *tree-dominated ecosystems that supply forest goods and services* (fuelwood, timber, carbon sequestration, biodiversity habitat, watershed conservation, ...), *in locations where forests naturally occur*

  • Includes planted forests and introduced species: not limited to forests of naturally regenerated native species

  • Excludes perennial tree crops (oil palm, orchards, ...)
LMICs in Africa, Asia & Pacific, Latin America & Caribbean (2000-present)
Principal driver of interest: climate mitigation

Fig. 1. Climate mitigation potential of 20 natural pathways. We estimate maximum climate mitigation potential with safeguards for reference year 2030. Light gray portions of bars represent cost-effective mitigation levels assuming a global ambition to hold warming to <2 °C ($<100 \text{ USD MgCO}_2 \text{e}^{-1} \text{ yr}^{-1}$). Dark gray portions of bars indicate low cost ($<10 \text{ USD MgCO}_2 \text{e}^{-1} \text{ yr}^{-1}$) portions of <2 °C levels. Wider error bars indicate empirical estimates of 95% confidence intervals, while narrower error bars indicate estimates derived from expert elicitation. Ecosystem service benefits linked with each pathway are indicated by colored bars for biodiversity, water (filtration and flood control), soil (enrichment), and air (filtration). Asterisks indicate truncated error bars. See SI Appendix, Tables S1, S2, S4, and S5 for detailed findings and sources.

Source: Griscom et al. (PNAS, 2017)
Panel A - Estimated costs and 2050 potentials

Source: IPCC (Global Warming of 1.5°C, 2018)
<table>
<thead>
<tr>
<th><strong>Afforestation</strong></th>
<th>Regenerating forest on sites where the most recent land cover was not a forest (typically, crops or pasture)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reforestation</strong></td>
<td>Regenerating forest on sites where the most recent land cover was a forest</td>
</tr>
</tbody>
</table>
Great biophysical restoration potential

Where trees can grow: 8.7 Bha

Where no trees currently exist, outside urban areas and cropland: 1.8 Bha

Source: Bastin et al. (Science, 2019)
Where are the economists?

• Search results for “forest restoration” in:
  – Web of Science 2,981 publications
  – EconLit 118 publications

• Search results for “deforestation” in:
  – EconLit 1,549 publications
Why should economists—especially in the Global South—be interested in forest restoration?
1. Evidence of a “forest transition” in many LMICs

Fig. 1. Conceptual framework. See text for explanation. To avoid clutter, potential feedback from land-use transitions (arrows 3, 4) and their effects (arrow 5) to rural outmigration (arrow 1) is not shown.

Source: Vincent & Curran (SESYNC proposal, 2020)
Among LMICs:

- 30%: increasing total forest area
- 85%: increasing planted forest area
- 40%: declining agriculture area
- 40%: declining rural population

Source: Vincent, Curran, and Ashton (ARER, 2021)
Forest transitions are neither automatic nor fully understood.

Figure 1

Net change in total planted forest area in low- and middle-income countries by region and decade, calculated as total area at end of decade minus total area at beginning of decade. Total planted forest area increased in all regions in both decades, but it increased more slowly during the second decade, especially outside of Latin America and the Caribbean. Regional totals include only countries with data on total planted forest area in all three years, 2000, 2010, and 2020. Data from Reference 15.

Source: Vincent, Curran, and Ashton (ARER, 2021)
2. Better data and methods than 20 years ago

Taking stock of agroforestry adoption studies

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3. Restoration is costly ...

We need to get the funding lined up. It will take US$1 trillion to restore 350 million hectares.
... at a time when government budgets are stressed ...
... and little ODA flows to forestry

(UNEP/FAO, Factsheet, 2020; OECD, Aid Focused on Environment, 2019)
Need to use scarce available funds cost-effectively

Source: Strassburg et al. (Nature Ecology and Evolution, 2019)
Need to evaluate potential sources of new financing

Source: Flynn, *Institutional Investment in Forestry* (RISI, 2016)
Source: Binkley et al., *Pension-Fund Investment in Forestry* (World Bank, 2020)
4. People!

Low-cost tree cover restoration sites in the tropics (≤ $20 tCO₂^{-1})

Cropland (284 Mha)
Pastureland (204 Mha)
Degraded forest (58 Mha)

Source: Shyamsundar et al. (“Scaling smallholder tree cover restoration in the tropics,” in prep.)
Where can funding come from to create large-scale financial incentives for landholders to restore forests?
Nationally funded payments for ecosystem services (PES)?


1999 – 2015: US$69 billion, 32 million smallholder farming households, 15 Mha restored forest
Carbon payments?
Spotty government commitment ...

Figure 2.1
Map of carbon taxes and emissions trading systems

The large circles represent cooperation initiatives on carbon pricing between subnational jurisdictions. The small circles represent carbon pricing initiatives in cities. In previous years, Australia was marked as having an ETS in operation. However, the Safeguard Mechanism functions like a baseline-and-capped program, falling outside the scope of the definition of ETS used in this report. Therefore, the system was removed from the map. Rio de Janeiro and Sao Paulo were marked as considering the implementation of an ETS based on scoping work done in 2011 and 2012 respectively. Given there have been no updates since, the these were removed from the map.

Note: Carbon pricing initiatives are considered “scheduled for implementation” once they have been formally adopted through legislation and have an official, planned start date. Carbon pricing initiatives are considered “under consideration” if the government has announced its intention to work towards the implementation of a carbon pricing initiative and this has been formally confirmed by official government sources. The carbon pricing initiatives have been classified in ETSs and carbon taxes according to how they operate technically. ETS not only refers to cap-and-trade systems, but also baseline-and-credit systems as seen in British Columbia. The authors recognize that other classifications are possible.

... with few government programs allowing carbon offsets ...

... slow growth (until recently) in voluntary programs ...

Figure 2. Market Size by Traded Volumes of Voluntary Carbon Offsets, pre-2005 to 31 August 2021

... and low carbon prices

Figure 4: Transacted Voluntary Carbon Market Sizes by Largest Project Types 2019 - August 2021

Wood markets?

Source: https://www.indiamart.com/proddetail/teak-plantation-21452284612.html
World is not running out of wood!

Source: FAO, Global Forest Resources Assessment 2020
Stumpage prices rose for much of the 20th Century ...

Figure 1. Historical trends in real Southern pine stumpage prices ($1967/mbf Scribner). For 1910–1934, the prices in this figure are from sales of second-growth timber on private lands; for 1935–1983, from sales on national forests. Data through 1970 are from US Bureau of the Census (1975); data following 1970 are from Ulrich (1985). The average rates of increase shown in the figure were calculated by regression for the periods before and after World War II. Note that the vertical scale is logarithmic, so that a curve depicting a constant percentage increase plots as a straight line.

Source: Binkley & Vincent (Southern Journal of Applied Forestry, 1988)
... but have shown no trend for last 30-40 years

Source: Forest Research Group, *Forest Research Notes* 6(3), 2010
Of course, local scarcity can exist

Source: FAOSTAT-Forestry
Business as usual in global forest sector: global forest area stabilizes but does not increase

**Table S2. Baseline key GTM estimates, 2010–2100.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Woody Bio-energy (Mm3)</th>
<th>Forest C Stock (GtCO2e)</th>
<th>Total Forest Area (Mha)</th>
<th>Plantation Area (Mha)</th>
<th>Natural Inaccessible/Unmanaged Forest Area (Mha)</th>
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</thead>
<tbody>
<tr>
<td>2010</td>
<td>0</td>
<td>3,336</td>
<td>3,466</td>
<td>72</td>
<td>2,289</td>
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<tr>
<td>2020</td>
<td>0</td>
<td>3,351</td>
<td>3,350</td>
<td>70</td>
<td>2,193</td>
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<td>2030</td>
<td>0</td>
<td>3,351</td>
<td>3,333</td>
<td>68</td>
<td>2,107</td>
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<tr>
<td>2040</td>
<td>0</td>
<td>3,347</td>
<td>3,348</td>
<td>80</td>
<td>2,023</td>
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<tr>
<td>2050</td>
<td>0</td>
<td>3,343</td>
<td>3,356</td>
<td>82</td>
<td>1,938</td>
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<tr>
<td>2060</td>
<td>0</td>
<td>3,336</td>
<td>3,393</td>
<td>84</td>
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<td>2070</td>
<td>0</td>
<td>3,334</td>
<td>3,426</td>
<td>89</td>
<td>1,761</td>
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<tr>
<td>2080</td>
<td>0</td>
<td>3,344</td>
<td>3,469</td>
<td>94</td>
<td>1,671</td>
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<tr>
<td>2090</td>
<td>0</td>
<td>3,361</td>
<td>3,516</td>
<td>97</td>
<td>1,580</td>
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<tr>
<td>2100</td>
<td>0</td>
<td>3,376</td>
<td>3,548</td>
<td>103</td>
<td>1,489</td>
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</tbody>
</table>

Stronger market incentive for forest restoration requires greater demand for wood products
Limiting warming to 1.5°C, with 10% of global energy supply coming from woody biomass

Source: Favero et al. (Science Advances, 2020)
Black line: difference, limiting warming to 1.5°C with 10% of global energy supply coming from woody biomass minus limiting warming to 1.5°C with 0% of global energy supply coming from woody biomass

Source: Favero et al. (Science Advances, 2020)

See also: Daigneault et al., “How the future of the global forest sink depends on timber demand, forest management, and carbon prices” (CENREP Working Paper, 2021)
Policy interventions beyond forest sector needed

<table>
<thead>
<tr>
<th>Country</th>
<th>Restoration potential (km²)</th>
<th>Quantified NDC</th>
<th>Governance index</th>
<th>Tenure security index</th>
<th>Score for enabling business of agriculture</th>
<th>Minutes to market from reforestable areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>843,253</td>
<td></td>
<td>-0.18</td>
<td>74</td>
<td>75</td>
<td>149</td>
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<tr>
<td>Congo, Dem. Rep.</td>
<td>809,997</td>
<td>✓</td>
<td>-1.61</td>
<td>NA</td>
<td>30</td>
<td>175</td>
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<tr>
<td>Indonesia</td>
<td>423,308</td>
<td></td>
<td>-0.17</td>
<td>63</td>
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<tr>
<td>Anoela</td>
<td>305,239</td>
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<td>-0.87</td>
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<td>Colombia</td>
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<td>65</td>
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<td>219</td>
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<td>Tanzania</td>
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<td></td>
<td>-0.56</td>
<td>64</td>
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<td>158</td>
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<td>Mexico</td>
<td>200,519</td>
<td></td>
<td>-0.37</td>
<td>79</td>
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<td>75</td>
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<td>Central African Republic</td>
<td>147,531</td>
<td>✓</td>
<td>-1.58</td>
<td>NA</td>
<td>NA</td>
<td>230</td>
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<tr>
<td>Côte d'Ivoire</td>
<td>130,496</td>
<td></td>
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<td>69</td>
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<td>59</td>
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<td>Myanmar</td>
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<td>75</td>
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<td>196</td>
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<tr>
<td>Venezuela, RB</td>
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<td></td>
<td>-1.78</td>
<td>72</td>
<td>NA</td>
<td>268</td>
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<tr>
<td>Thailand</td>
<td>115,404</td>
<td>✓</td>
<td>-0.20</td>
<td>72</td>
<td>59</td>
<td>63</td>
</tr>
<tr>
<td>Cameroon</td>
<td>107,934</td>
<td></td>
<td>-1.12</td>
<td>55</td>
<td>22</td>
<td>132</td>
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<tr>
<td>Mozambique</td>
<td>106,571</td>
<td></td>
<td>-0.77</td>
<td>57</td>
<td>51</td>
<td>154</td>
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<tr>
<td>China</td>
<td>105,041</td>
<td>✓</td>
<td>-0.36</td>
<td>75</td>
<td>70</td>
<td>108</td>
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<td>Philippines</td>
<td>104,861</td>
<td></td>
<td>-0.31</td>
<td>51</td>
<td>68</td>
<td>89</td>
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<tr>
<td>India</td>
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<td>✓</td>
<td>-0.11</td>
<td>64</td>
<td>62</td>
<td>64</td>
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<tr>
<td>Malaysia</td>
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<td>0.43</td>
<td>54</td>
<td>52</td>
<td>99</td>
</tr>
<tr>
<td>Vietnam</td>
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<td>✓</td>
<td>-0.33</td>
<td>82</td>
<td>61</td>
<td>65</td>
</tr>
<tr>
<td>Zambia</td>
<td>82,834</td>
<td></td>
<td>-0.45</td>
<td>70</td>
<td>64</td>
<td>128</td>
</tr>
</tbody>
</table>

Source: Shyamsundar et al. ("Scaling smallholder tree cover restoration in the tropics," in prep.)
Economic research needs

1. **Retrospective analysis**: evaluate impacts of current or past projects/programs/policies directly or indirectly related to forest restoration

2. **Prospective analysis**: discrete choice experiments (DCEs), field experiments, pilot auctions, and randomized controlled trials (RCTs) to test features of potential forest restoration projects/programs/policies
Fixed effects model on impacts of tenure reform on forest area in China

Converting community forestland to de facto private forestland increased forest cover
Afonso & Miller *(Forest Policy and Economics, 2021)*

Fixed effects model on socioeconomic impacts of commercial wood plantations in Brazil

Increase in plantation area is associated with a reduction in poverty in local communities
Permadi et al. (*Land Use Policy*, 2017)

Discrete choice experiment on hypothetical smallholder pulpwood outgrower scheme in Indonesia

Scheme more likely to succeed if it offered three types of contracts with different primary objectives:
(i) wood production
(ii) livelihood development
(iii) conservation
Randomized controlled trial (RCT) on tree planting in Zambia

Strengthening customary use rights by mapping farmers’ parcels increased perceived land security, but it did not affect tree planting; however, technical assistance did increase tree planting
Jindal et al. *(Land Use Policy, 2013)*
Andeltova et al. *(Ecosystem Services, 2019)*

Distributional impacts of tree-planting PES (via pilot auctions) in Tanzania and Kenya, respectively

Auction outcomes tended **not** to be pro-poor—better-off households were more likely to win them (Tanzania)—but did tend to be pro-female—women were more likely to win them (Kenya)
Randomized controlled trial (RCT) on two-stage PES for tree planting and tree survival in Zambia

Forest restoration via PES entails a budgetary tradeoff: implementing agency can boost landholder participation by allocating more of its budget to subsidize seedling purchases, but boosting tree survival requires allocating more of the budget toward payments linked to survival.
Economics of forest restoration: studies underway

- SANDEE
  - 6 studies underway: Bangladesh, China, India, Nepal, Pakistan
  - 4 studies proposed to IDRC: Bangladesh, Bhutan, Nepal, Pakistan
- Environment for Development Initiative (EfD): study underway in Uganda
- FAO: study underway in Uganda
- US Socio-Environmental Synthesis Center (SESYNC): studies underway in Brazil, China, Guatemala, and Malawi, plus global analysis
Thank you!  

https://time.com/5259602/japanese-forest-bathing/