

2019 **SCIENTISTS URGE ENDORSEMENT** Aug **OF CALIFORNIA TROPICAL FOREST** **STANDARD**

Daniel Nepstad | Executive Director & President

*Earth Innovation Institute is coordinating this letter from **Scientists in Support of the California Tropical Forest Standard**. It will be submitted to the California Air Resources Board in advance of a September 19 [public meeting](#) to consider endorsement of the California Tropical Forest Standard.*

Are you a scientist interested in joining this Letter? Write to Dan Nepstad (dnepstad@earthinnovation.org) and Jonah Busch (jbusch@earthinnovation.org). If you're not a scientist but still support the California Tropical Forest Standard you can submit a public comment to Air Resources Board [here](#) or [here](#).

We are scientists—ecologists, economists, anthropologists, geographers, and climatologists. We are all directly involved with research to better understand climate change and to identify the best ways to avoid its most dangerous impacts. Many of us have spent decades working in the Tropics.

We include 10 lead authors of the Intergovernmental Panel on Climate Change; 7 members of the United States National Academy of Sciences; 7 Fellows of the California Academy of Sciences; 1 member of the European Academy of Sciences; 1 member of the Australia National Academy of Sciences; 4 current or former Directors General of the Center for International Forestry Research; and 2 MacArthur “Genius Grant” fellows. We have collectively authored hundreds of articles in *Science*, *Nature*, and other top scientific journals.

We are writing to strongly urge the California Air Resources Board to endorse the California Tropical Forest Standard (CTFS). We believe that California has a unique opportunity to leverage its global leadership on climate policy to advance a broad and inclusive agenda to address climate change by protecting tropical forests at scale.

The message we convey is this: slowing the loss and speeding the recovery of tropical forests is a critical part of any successful global strategy for minimizing the negative impacts of climate change. The CTFS is an important step towards unlocking this potential.

1. The best science shows us that tropical forests could help avoid the most dangerous impacts of climate change.¹⁻³

These carbon- and species-rich ecosystems could deliver 25 to 30% of the carbon emissions reductions needed by 2030 to avoid dangerous climate change.³ Slowing the deforestation and degradation of tropical forests, the source of as much as one fifth of global emissions,⁴⁻¹⁵ while allowing damaged forests to recover¹⁶⁻¹⁹ is one of the most cost-effective, near-term steps towards a zero net carbon budget globally.²⁰⁻²⁷

2. The CTFS could help unlock this potential.

The CTFS would establish a very high bar of methodological rigor, transparency and accountability for tropical forest jurisdictions—states, provinces, counties and even nations—that are taking steps to reduce deforestation and advance low-emission development. Given California’s global leadership on climate change solutions and the depth of the analyses and public consultation that went into developing the Standard, we believe that the CTFS would be adopted by other programs under development by governments and industries to support the transition of tropical forest jurisdictions to equitable low-emission development. The Standard is also likely to be used by tropical forest jurisdictions themselves.

3. The importance of the CTFS goes beyond offsets and REDD+.

The CTFS was deliberately developed as an alternative to project-based REDD+ and it reflects a recognition that one of the most promising pathways to achieve emissions reductions at scale in tropical forest regions is to encourage the governments of jurisdictions to partner with civil society, the private sector, and indigenous peoples and local communities to develop durable programs for low emissions development. While the standard could eventually inform efforts to recognize the emissions reductions achieved by tropical forest jurisdictions in existing and emerging “pay-for-performance” programs, including implementation of California’s international offset provision, its value goes beyond this purpose.

The Standard is focused on *jurisdictional*²⁸⁻³¹, or “sector-wide”, strategies for slowing the loss of tropical forests while improving the livelihoods and participation of forest communities within a broader transition to low-emission development. Jurisdictional strategies seek systemic solutions to deforestation, inadequate recognition of land rights, and other issues across entire political geographies—states and provinces—and are much less susceptible to leakage and dubious carbon accounting than some of the project-based examples that have been cited by others.

4. The CTFS already reflects important progress made in fostering stronger partnerships between tropical forest governments and Indigenous Peoples.

One of the highlights of the Global Climate Action Summit in San Francisco last September was the announcement of “[Guiding Principles for Collaboration and Partnership between Subnational Governments, Indigenous Peoples and Local Communities](#).” State and provincial governments that are members of the Governors’ Climate and Forests Task Force endorsed these principles and shook hands with the democratically-elected leaders of key Indigenous Peoples organizations in Indonesia (AMAN), Central America and Mexico (AMPB) and the Amazon (COICA). In all, 35 governments, 18 Indigenous Peoples organizations, and 17 environmental NGOs endorsed these Principles, which have now been included in the CTFS.

These partnerships are already happening, as has been [documented](#) for the State of Acre, in the Brazilian Amazon, which has a 20-year partnership between the state government and the Indigenous Peoples who reside in the state.³²

Conclusion: To unlock the potential of tropical forests as a climate change solution, it is urgent that the California Tropical Forest Standard be endorsed. If endorsement is postponed, an important opportunity will be lost to send the signal that California, in its role as a global leader of climate change solutions, recognizes and supports bold efforts to address climate change by slowing the loss and speeding the recovery of tropical forests.

Signatories as of Aug. 26, 2019

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References Cited in the Letter

- 1. Houghton, R.A., Byers, B., Nassikas, A.A., 2015. A role for tropical forests in stabilizing atmospheric CO₂. *Nature Climate Change* 5, 1022–1023. <https://doi.org/10.1038/nclimate2869>
- 2. Seymour, F., Busch, J., 2016. Why forests? Why now? The science, economics, and politics of tropical forests and climate change. Center for Global Development, Washington DC.
- 3. Griscom, B.W., Adams, J., Ellis, P.W., Houghton, R.A., Lomax, G., Miteva, D.A., Schlesinger, W.H., Shoch, D., Siikamäki, J.V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R.T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M.R., Herrero, M., Kiesecker, J., Landis, E., Laestadius, L., Leavitt, S.M., Minnemeyer, S., Polasky, S., Potapov, P., Putz, F.E., Sanderman, J., Silvius, M., Wollenberg, E., Fargione, J., 2017. Natural climate solutions. *Proceedings of the National Academy of Sciences* 114, 11645–11650. <https://doi.org/10.1073/pnas.1710465114>
- 4. Pan, Y., Birdsey, R.A., Fang, J., Houghton, R., Kauppi, P.E., Kurz, W.A., Phillips, O.L., Shvidenko, A., Lewis, S.L., Canadell, J.G., Ciais, P., Jackson, R.B., Pacala, S.W., McGuire, A.D., Piao, S., Rautiainen, A., Sitch, S., Hayes, D., 2011. A Large and Persistent Carbon Sink in the World's Forests. *Science* 333, 988–993. <https://doi.org/10.1126/science.1201609>
- 5. Baccini, A., Goetz, S.J., Walker, W.S., Laporte, N.T., Sun, M., Sulla-Menashe, D., Hackler, J., Beck, P.S.A., Dubayah, R., Friedl, M.A., Samanta, S., Houghton, R.A., 2012. Estimated carbon dioxide emissions

from tropical deforestation improved by carbon-density maps. *Nature Climate Change* 2, 182–185. <https://doi.org/10.1038/nclimate1354>

- 6. Harris, N.L., Brown, S., Hagen, S.C., Saatchi, S.S., Petrova, S., Salas, W., Hansen, M.C., Potapov, P.V., Lotsch, A., 2012. Baseline Map of Carbon Emissions from Deforestation in Tropical Regions. *Science* 336, 1573–1576. <https://doi.org/10.1126/science.1217962>
- 7. Achard, F., Beuchle, R., Mayaux, P., Stibig, H.-J., Bodart, C., Brink, A., Carboni, S., Desclée, B., Donnay, F., Eva, H.D., Lupi, A., Raši, R., Seliger, R., Simonetti, D., 2014. Determination of tropical deforestation rates and related carbon losses from 1990 to 2010. *Global Change Biology* 20, 2540–2554. <https://doi.org/10.1111/gcb.12605>
- 8. Grace, J., Mitchard, E., Gloor, E., 2014. Perturbations in the carbon budget of the tropics. *Global Change Biology* 20, 3238–3255. <https://doi.org/10.1111/gcb.12600>
- 9. Tubiello, F.N., Salvatore, M., Ferrara, A.F., House, J., Federici, S., Rossi, S., Biancalani, R., Condor Golec, R.D., Jacobs, H., Flammini, A., Prospero, P., Cardenas-Galindo, P., Schmidhuber, J., Sanz Sanchez, M.J., Srivastava, N., Smith, P., 2015. The Contribution of Agriculture, Forestry and other Land Use activities to Global Warming, 1990-2012. *Global Change Biology* 21, 2655–2660. <https://doi.org/10.1111/gcb.12865>
- 10. Liu, Y.Y., van Dijk, A.I.J.M., de Jeu, R.A.M., Canadell, J.G., McCabe, M.F., Evans, J.P., Wang, G., 2015. Recent reversal in loss of global terrestrial biomass. *Nature Climate Change* 5, 470–474. <https://doi.org/10.1038/nclimate2581>
- 11. Zarin, D.J., Harris, N.L., Baccini, A., Aksenov, D., Hansen, M.C., Azevedo-Ramos, C., Azevedo, T., Margono, B.A., Alencar, A.C., Gabris, C., Allegretti, A., Potapov, P., Farina, M., Walker, W.S., Shevade, V.S., Loboda, T.V., Turubanova, S., Tyukavina, A., 2016. Can carbon emissions from tropical deforestation drop by 50% in 5 years? *Global Change Biology* 22, 1336–1347. <https://doi.org/10.1111/gcb.13153>
- 12. Smith, P., Bustamante, M., Ahammad, H., Clark, H., Dong, H., Elsidig, E.A., Haberl, H., Harper, R., House, J., Jafari, M., Masera, O., Mbow, C., Ravindranath, N.H., Rice, C.W., Robledo Abad, C., Romanovskaya, A., Sperling, F., Tubiello, F., 2014. Agriculture, Forestry and Other Land Use (AFOLU), in: Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T., Minx, J.C. (Eds.), *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York,

NY, USA.

- 13. Silver, W.L., Ostertag, R., Lugo, A.E., 2000. The Potential for Carbon Sequestration Through Reforestation of Abandoned Tropical Agricultural and Pasture Lands. *Restoration Ecology* 8, 394–407.
<https://doi.org/10.1046/j.1526-100x.2000.80054.x>
- 14. Gilroy, J.J., Woodcock, P., Edwards, F.A., Wheeler, C., Baptiste, B.L.G., Medina Uribe, C.A., Haugaasen, T., Edwards, D.P., 2014. Cheap carbon and biodiversity co-benefits from forest regeneration in a hotspot of endemism. *Nature Climate Change* 4, 503–507.
<https://doi.org/10.1038/nclimate2200>
- 15. Olsson, L., Barbosa, H., et al. 2019. IPCC Special Report on Climate Change and Land. Chapter 4: Land Degradation. Intergovernmental Panel on Climate Change, Geneva, Switzerland.
- 16. Chazdon, R.L., Guariguata, M.R., 2016. Natural regeneration as a tool for large-scale forest restoration in the tropics: prospects and challenges. *Biotropica* 48, 716–730. <https://doi.org/10.1111/btp.12381>
- 17. Hawes, M., 2018. Planting carbon storage. *Nature Climate Change* 8, 556–558. <https://doi.org/10.1038/s41558-018-0214-x>
- 18. Bastin, J.F., Finegold, Y., Garcia, C., Mollicone, D., Rezende, M., Routh, D., Zohner, C.M., Crowther, T.W. 2019. The global tree restoration potential. *Science* 365, 76-79.
- 19. Brancalion, P.H.S., et al. 2019. Global restoration opportunities in tropical rainforest landscapes. *Science Advances*, 5 DOI: 10.1126/sciadv.aav3223
- 20. Kindermann, G., Obersteiner, M., Sohngen, B., Sathaye, J., Andrasko, K., Rametsteiner, E., Schlamadinger, B., Wunder, S., Beach, R., 2008. Global cost estimates of reducing carbon emissions through avoided deforestation. *Proceedings of the National Academy of Sciences* 105, 10302–10307. <https://doi.org/10.1073/pnas.0710616105>
- 21. Strassburg, B., Turner, R.K., Fisher, B., Schaeffer, R., Lovett, A., 2009. Reducing emissions from deforestation—The “combined incentives” mechanism and empirical simulations. *Global Environmental Change* 19, 265–278. <https://doi.org/10.1016/j.gloenvcha.2008.11.004>
- 22. Coren, M.J., Streck, C., Madeira, E.M., 2011. Estimated supply of RED credits 2011–2035. *Climate Policy* 11, 1272–1288.
<https://doi.org/10.1080/14693062.2011.579318>
- 23. Busch, J., Engelmann, J., 2017. Cost-effectiveness of reducing emissions from tropical deforestation, 2016–2050. *Environmental Research Letters* 13, 015001. <https://doi.org/10.1088/1748-9326/aa907c>
- 24. Busch, J.B., Engelmann, J., Cook-Patton, S., Griscom, B., Kroeger, T., Possingham, H., Shyamsundar, P. (2019). “Low-Cost Opportunities for

Carbon Dioxide Removal Through Tropical Reforestation" *Nature Climate Change*, 9:463-466.

- 25. Busch J et al.2012. Structuring economic incentives to reduce emissions from deforestation within Indonesia. *Proceedings of the National Academy of Sciences* 109(4):1062-1067.
- 26. Fuss, S., Lamb, W.F., Callaghan, M.W., Hilaire, J., Creutzig, F., Amann, T., Beringer, T., de Oliveira Garcia, W., Hartmann, J., Khanna, T., Luderer, G., Nemet, G.F., Rogelj, J., Smith, P., Vicente, J.L.V., Wilcox, J., del Mar Zamora Dominguez, M., Minx, J.C., 2018. Negative emissions—Part 2: Costs, potentials and side effects. *Environmental Research Letters* 13, 063002. <https://doi.org/10.1088/1748-9326/aabf9f>
- 27. Edwards, D.P., Fisher, B., Boyd, E., 2010. Protecting degraded rainforests: enhancement of forest carbon stocks under REDD+: Enhancing forest carbon with REDD+. *Conservation Letters* 3, 313–316. <https://doi.org/10.1111/j.1755-263X.2010.00143.x>
- 28. Nepstad, D., Irawan, S., Bezerra, T., Boyd, W., Stickler, C., Shimada, J., Carvalho, O., MacIntyre, K., Dohong, A., Alencar, A., Azevedo, A., Tepper, D., Lowery, S., 2013. More food, more forests, fewer emissions, better livelihoods: linking REDD+, sustainable supply chains and domestic policy in Brazil, Indonesia and Colombia. *Carbon Management* 4, 639–658. <https://doi.org/10.4155/cmt.13.65>
- 29. Nepstad, D., McGrath, D., Stickler, C., Alencar, A., Azevedo, A., Swette, B., Bezerra, T., DiGiano, M., Shimada, J., Seroa da Motta, R., Armijo, E., Castello, L., Brando, P., Hansen, M.C., McGrath-Horn, M., Carvalho, O., Hess, L., 2014. Slowing Amazon deforestation through public policy and interventions in beef and soy supply chains. *Science* 344, 1118–1123. <https://doi.org/10.1126/science.1248525>
- 30. Boyd, W., Stickler, C., Duchelle, A.E., Seymour, F., Nepstad, D., Bahar, N.H.A., Rodriguez WArD, D., 2018. Jurisdictional Approaches to REDD+ and Low Emissions Development: Progress and Prospects. Working Paper. Presented at the Oslo Tropical Forest Forum, Oslo, World Resources Institute, Washington, DC.
- 31. Stickler, CM et al. 2018. The State of Jurisdictional Sustainability. San Francisco, USA: Earth Innovation Institute/Bogor, Indonesia: Center for International Forestry Research/Boulder, USA: Governors' Climate and Forests Task Force Secretariat.
- 32. DiGiano, M., Mendoza, E., Ochoa, M.L., Ardila, J, Olivieria de Lima, F., Nepstad, D. 2018. The twenty –year-old partnership between indigenous peoples and the Government of Acre, Brazil. Earth Innovation Institute, Collaboration for Climate series, San Francisco USA.