# The number and spatial distribution of forest-proximate people globally

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*Title*: **The number and spatial distribution of forest-proximate people globally**

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**SUMMARY**

Forest landscapes are complex socio-environmental systems. The degree to which forests support human livelihoods, and humans affect forest ecology, depends in part on the spatial relationship between people and forests. Here, we estimate the number of people who live in and around forests globally. We combined forest cover and human population density data to map the spatial relationship between people and forests on a global scale in 2000 and 2012. Globally, 1.6 billion rural people lived within 5km of a forest in 2012. Of these, 64.5% lived in tropical countries and 71.3% lived in low-income, lower-middle-income, or upper-middle-income countries. We propose the term 'forest-proximate people' to refer to people who live in and around forests. Forest proximity is related to, but not synonymous with, forest dependency. Our findings have implications for researchers and decision-makers interested in forest conservation, forest livelihoods, and sustainable socio-economic development in communities in and around forests.

**KEYWORDS**

forests; forest-dependent; land use change; livelihoods; policy; sustainability

## INTRODUCTION

Forest landscapes are complex socio-environmental systems[1]. They are important for carbon storage, carbon sequestration, and biodiversity conservation, among other environmental benefits[2]. They also make a range of important socio-economic contributions, including health benefits and support for subsistence and income-generating livelihoods of many people living in and around forests[3,4]. Given these values, forest conservation, governance, and restoration are global priorities, as is the sustainable socio-economic development of people and communities in and near forests[5].

The degree to which forests support human livelihoods, and the degree to which humans affect forest ecology, depends in part on the spatial association between people and forests. Mapping the spatial relationship between forests and the people that live in and around them is therefore an important part of understanding the nature of these relationships between forests and people[6]. Doing so has theoretical and practical utility.

From a theoretical perspective, mapping the spatial relationships between humans and natural resources contributes to understanding how people and their environment relate and interact, and how these relationships vary and change over space and time[6]. An improved understanding of the scale and magnitude of the interactions between environmental and human components can also help socio-environmental systems scholars to better understand the dynamics and outcomes related to forest landscapes[7].

From a more pragmatic perspective, quantification of the spatial relationships between humans and natural resources can help decision-makers develop spatially-explicit conservation and sustainable development indicators and policies to target priority areas [6,8,9,10]. Numerous development agencies, NGOs, and donors concerned with forest conservation and development policies have launched initiatives with the stated aim of improving livelihoods of people living in and around forests, changing how people use forests, and strengthening forest conservation. Examples include payments for environmental services programs that aim to reduce deforestation by land-owners and forest-users[11]; initiatives to commercialize non-timber forest products[12]; creation of new protected areas to conserve biodiversity, and shifts in tenure and forest governance to improve the livelihoods of forest users[13].

In addition to a policy and programmatic focus on forest livelihoods, donors and project implementers concerned with conservation and development increasingly seek to quantify the impacts of projects designed to support the livelihoods of people living within intervention areas[14]. Systematic evidence on the number and spatial distribution of people living within or near forests within a project area, country, or region is important to help decision-makers target projects in priority areas. It is also necessary for efforts to estimate the numbers of people that will be affected - directly or indirectly, positively or negatively – as a result of a new intervention. Reliable estimates of numbers of people affected by new interventions lies at the core of attempts to measure the livelihood effects of policy interventions.

When targeting priority areas for policies and programs, and when evaluating the impact of those interventions, actors in many cases identify 'forest-dependent people' as the population of people to whom their efforts apply. While forest dependence has been defined according to a number of different criteria, proximity to forests is often considered a necessary (although not sufficient) criterion for a person or community to be forest-dependent[4]. However, several important knowledge gaps on the interactions between forests and people remain. Few quantitative analyses examine the spatial relationships between people and forests, whether globally or at national levels, and there are few empirical estimates of the number of people that live in and around forests globally. Some estimates of the number of forest-dependent people have been generated (e.g. [15,16,17]) but these are dated and were not based on systematic quantitative data or analyses. We address consequent research needs in this paper by answering the question: "How many people live in and around forests globally?" Our response includes quantification of the spatial relationship between people and forests at a global scale using publicly-available data that can be used to assess changes in the numbers of people in forest landscapes over time.

## RESULTS

Our results are both empirical and conceptual. Empirically, we quantify the number and spatial distribution of people living in and around forests globally. Conceptually, we propose precise terminology to refer to people living in and around forests.

### The number of people living in and around forests

Globally, 1.93 billion, 1.60 billion, and 0.78 billion rural people lived within 10km, 5km, and 1km of a forest in 2012 (Fig. 1, Fig.2, Table S1). The distribution of these people by country is indicated in Table S1. For brevity, from hereon we report results only for our estimates of forest-proximate people (FPP) living within 5km of a forest. The countries that accounted for the largest proportions of the global total of FPP in 2012 were China (272m FPP; 17% of all FPP), United States (169m; 11%), Indonesia (103m; 6%), India (88m; 5%), and Brazil (55m; 3%). We provide maps to show the spatial location and relationship of forests and FPP globally (Fig. 1) and for two countries with large forest areas (Brazil and Indonesia) (Figs. 3 & 4).

In 2012, 1.03 billion FPP (64.5% of all FPP) lived in tropical countries (defined here as countries that have any part of their land mass within the tropics); the remaining 569 million (35.5%) lived in non-tropical countries (defined here as countries that are entirely outside the tropics). A total of 1.14 billion FPP (71.3% of all FPP) lived in countries classified as low-income, lower-middle-income, or upper-middle-income countries by the World Bank; the remaining 460 million (28.7%) lived in countries classified as high-income.

Across all countries, an average of 28% of each country's population was forest proximate in 2012. Values ranged from 0% of some countries' population being forest proximate (e.g. Greenland, Kuwait) to very high proportions of some countries' population being forest proximate (e.g. Bhutan: 75%, Norway: 76%). In Brazil, 24% of the population were FPP in 2012; in Indonesia, 35% were FPP in 2012 (Figs. 3 & 4).

At the global level, the number of FPP increased slightly between 2000 and 2012: there were 10.5 million more FPP in 2012 than 2000 (Table S1). The number of FPP increased in some countries over this time period (the largest increase was in Bangladesh, with 14 million more FPP in 2012 than 2000). It also declined in others during the same time period (the largest decrease was in China, with 48 million fewer FPP in 2012 than 2000) (Table S1).

Changes in population were the principal driver of decreases in the number of FPP in Brazil and Indonesia, and of an increase in the number of FPP in India (Fig. 5). In Nigeria, a decrease in the number of FPP was driven by a combination of changes in population and tree cover (Fig. 5).

**New terminology**

We propose the term 'forest-proximate people' to reference people who live in and around forests. The term captures the spatial relationship between people and forests precisely, without presuming anything additional about the nature of the relationship between them. The term is a conceptual cousin of the frequently-used but less precise term 'forest-dependent people'. The term 'forest-dependent people' is widely deployed to refer to people who derive some benefit from forests. However, whereas 'forest-dependent people' can imply many things about the nature of the relationship between forests and people, including – frequently – signifying a degree of reliance on one or more forest resources, the term 'forest-proximate people' merely references the fact that someone lives near to a forest, regardless of the degree to which they utilize, rely on, or derive value from that forest.

## DISCUSSION

We mapped the spatial relationship between people and forests globally and for all countries. Our results lead to conclusions that have important implications for researchers and decision-makers interested in the interactions between people and forests, and those concerned with policies and programs that affect forest conservation as well as sustainable socio-economic development in communities in and around forests.

**Why proximity?**

Proximity is a necessary condition for many, although certainly not all, common interactions between people and forests in which researchers and decision-makers are interested. Inhabited forests (i.e. those that are occupied by people living in and around them) may be better protected through the stewardship of their occupants relative to unoccupied forest areas[18,19,20]. People living near forests may be more likely to interact directly with forests, harvest forest products, benefit from forest-based ecosystem services, and derive livelihoods from forest-based activities in comparison to people living farther from forests[4]. Exceptions include cases where people process and add value to timber harvested in distant forests.

Proximity is a relatively more straightforward concept to apprehend and operationalize in comparison to terms such as dependence. As we show in this paper, it can be measured precisely and quantified at a global scale using publicly available global forest cover and population datasets at a relatively fine spatial resolution.

However, proximity as measured by physical Euclidean distance – as we define and operationalize it here – may not always be a good indicator of whether or not a person is likely to actually use forest resources. Proximity is indeed often used as a proxy for accessibility, and proximity certainly can affect accessibility. But other important factors also condition access. For example, a person may be proximate to a forest but not have legal or physical access to its resources (e.g. if the forest is within a strictly protected area or is topographically difficult to reach). Alternatively, a person may live further from a forest but a favorable road or river network may enable them to access the forest just as quickly and easily as someone living closer to a forest but with less favorable access. Nonetheless, in the absence of global forest accessibility data that accounts for such institutional and physical barriers and enabling factors, proximity as measured by physical Euclidean distance serves as a first approximation for accessibility.

**Implications of the patterns of forest proximity**

In some countries that have been the focus of forest conservation and development efforts, a large proportion of the total population is forest-proximate. For example, 24% of Brazil's population and 35% of Indonesia's population lived within 5km of a forest in 2012. This finding has implications for the role of forests in development, including for making progress towards the sustainable development goals.

Forest-proximate people are more abundant in some countries and places than others. Our maps and data may therefore be a useful starting point to determine priority countries and sub-national areas for targeted policies and project interventions. For example, decision-makers may wish to prioritize helping larger numbers of forest-proximate people, or conserving forested areas with the greatest pressures from adjacent human populations. Alternatively, forest-proximate people living in more intact, remote forested areas may be more likely to meet agencies' additional criteria for aid and support, and may thus constitute a higher priority for targeted interventions. In either case, our spatial analysis can help guide some decisions that affect people proximate to forests.

Decision-makers' priorities to target support may in many cases also be based on additional social, economic, environmental, or political criteria. Few consistent global datasets reflecting such priorities are available to superimpose over the maps of forest-proximate people we present. But our maps provide baseline information that governments, researchers, NGOs, and development agencies can use at the national or sub-national level based on more local or national level data availability for additional variables of interest. For example, a researcher or decision-maker in a given area could generate more refined estimates of the number of people who have a particular relationship with, or reliance on, a forest resource (e.g. fuelwood) by combining our data with information on variables to which they may have privileged access. Alternatively, a researcher or decision-maker might be interested in the number of forest-proximate people who are living in poverty[21]. In such a case, for a country or region of interest they could overlay our maps with spatially explicit national or local poverty indicators. The Food and Agriculture Organization of the U.N. has defined a set of Global Core Set of Forest-related indicators, including the "number of forest-dependent people in extreme poverty": our analysis is a first step towards the construction of such an indicator.

## Forest-proximity and forest-dependence

'Forest-dependent people' is a term widely used by researchers and decision-makers to refer to people whose livelihoods rely to some degree on forests[4,22]. Definitions of forest-dependent people vary widely[4], and forest dependency can be measured in different ways[23]. Many claims have been made about the number of forest-dependent people in the world[16], including a commonly-cited but empirically unsupported claim from the World Bank that 1.6 billion people depend on forests for their livelihoods[17]. Variability among definitions and an absence of global datasets that measure dependence consistently or systematically mean that reliable, consistent, and replicable estimates of the number of forest-dependent people globally remains only an aspiration[15]. Our estimates of the number of forest-proximate people does not directly estimate the number of people whose livelihoods are directly supported by forests. However, our estimates offer some useful insights about the number of forest-dependent people in the world, depending on the definitions used. To this end, we identify below a number of sets of relationships between forest-dependence and forest-proximity.

Many definitions of 'forest-dependent people' include criteria reflecting a spatial relationship between people and forests, often with respect to indigenous, traditional, and other people in rural areas in and around forests[4,22]. This subset of 'forest-proximate people' typically derive direct subsistence and/or income-generating livelihood benefits from forests. Indeed, people living in and around forests are more likely to derive such benefits compared to those living in locations distant from forests. It is likely also the demographic often targeted by agencies invested in poverty alleviation and/or sustainable socio-economic development within forested regions. Forest proximity is therefore often a necessary (if insufficient) criterion for forest dependence; in such cases, forest proximity could be a useful partial proxy for forest dependence.

However, not all forest-proximate people are forest-dependent: some people live near a forest, but do not meet additional criteria for dependence. For example, many common interpretations of forest dependence do not include people living in relatively densely-populated areas (e.g. on the periphery of densely-populated urban areas), nor those living in higher-income countries, nor those living in non-tropical countries. Rather, many common interpretations of forest dependence instead refer to indigenous, traditional, and other people living in relatively remote forested regions in tropical low-income, lower-middle-income, or upper-middle-income countries[22,24]. In relation to such interpretations, only a subset of the 1.6 billion forest-proximate people are also forest dependent. Our data enable us to partially identify this subset: for example, by subtracting the number of forest-proximate people living in higher-income countries and/or non-tropical countries. However, our data do not enable us to fully quantify this subset, since consistent global or country level datasets on key additional dimensions of forest dependence remain to be developed.

Finally, some authors have used definitions of forest dependence that explicitly do not include forest proximity as a necessary condition for forest dependence. That is, some authors identify forest-dependent people that do not live near forests (e.g. some people that work in the timber sector). Of course, our analyses do not reveal anything about the number or spatial distribution of forest-dependent people in cases where forest proximity is not a condition of forest dependence.

### Conclusion

Our novel analysis of the spatial relationship between forests and people leads to one major empirical and one major conceptual contribution. Empirically, we found that 1.60 billion people in rural areas lived within 5 km of a forest in 2012. Conceptually, we propose the term 'forest-proximate people' as an appropriate means of referring to people who live in and around forests. While our estimate of 1.60 billion forest-*proximate* people coincidentally matches the commonly-cited estimates (originating with the World Bank[17]) of 1.6 billion forest-*dependent* people, we note that while the two constituencies overlap, dependency and proximity are not always synonymous in this context.

Our findings are relevant to researchers studying forests as socio-environmental systems, including those interested in the spatial relationships between natural and human systems. They also have implications for decision-makers who wish to understand the impacts of forest-sector policies and programs on people, and/or who wish to more precisely target funding or policies with conservation and/or sustainable development objectives towards geographies where they might be expected to have the greatest impact. One interesting avenue for future research exploration would be to more formally quantify the number of forest-proximate people living in relatively densely populated areas, since our maps suggest that that could be a large proportion of such people.

## EXPERIMENTAL PROCEDURES

### Resource Availability

#### *Lead Contact*

Further information and requests for data should be directed to the Lead Contact, Peter Newton (peter.newton@colorado.edu).

#### *Materials Availability*

This study did not generate new unique materials.

#### *Data and Code Availability*

Table S1 and source data for this study are available at: https://doi.org/10.7910/DVN/XZRUYC

**Methods**

We combined forest cover and human population density data to map the spatial relationship between people and forests on a global scale. We used 1km resolution global population density data[25] and 30m resolution global tree cover data from Landsat[26] to generate spatial overlays that identified population subsets living in or close to forests in 2000 and 2012.

We first created a global tree cover map by mosaicking the tree cover tiles from Hansen et al.[26] into a global raster image. Because these data did not include a tree cover estimate for the year 2012, we generated this by calculating baseline global tree cover in 2000 and using tree cover gain and tree cover loss datasets for the subsequent twelve years to generate a final tree cover estimate for the year 2012. We used Hansen et al.'s[26] definition of tree cover (50% canopy cover), and defined a forest as any area of tree cover ≥ 2 ha. We resampled the tree cover raster dataset from 30m to 1km resolution using the nearest neighbor function to match the resolution of the global population density dataset and to improve computing viability. We projected both datasets into the Mollweide equal-area projection[27] so that kilometers could be used for a buffer zone distance.

We used a Euclidian distance measure to create a 10km, 5km, and 1km buffer zone around each tree cover pixel and then calculated the population living within those buffers and summed the total for each country (list of countries from World Bank[28]). There is no established definition of forest proximity, so we took precedence from the methodology deployed in hundreds of sites globally by the International Forestry Resources and Institutions (IFRI) research network, which records the number of people who "reside in or very close to the forest(s) (within 5km)"[29]. We included estimates for 10km and 1km also, as sensitivity analyses.

We excluded urban areas from our analysis, defining them as areas with population densities equal to or greater than 1,500 people per $km^2$ [30]. Brezzi et al.[30] also consider 1,000 people per $km^2$ as an alternative metric for urban areas; we chose the higher population density to generate the most liberal estimates of the number of people living in and around forests.

We used population data from 2000 and 2012 in conjunction with the tree cover layers from 2000 and 2012, respectively, to generate estimates of the number of people living in or near forests at these two different time periods.

We calculated changes in the number of FPP in each country by comparing these two estimates (Table S1). For four countries (Brazil, India, Indonesia, and Nigeria), we evaluated whether these changes were primarily associated with changes in tree cover (e.g. deforestation could reduce the number of FPP; reforestation could increase the number of FPP) or in population changes (e.g. rural-urban migration could reduce the number of FPP; population growth could increase the number of FPP). We did so by plotting the observed changes in the number of FPP (Fig. S1A) against modelled changes in the number of FPP while holding tree cover constant at 2000 values (Fig. S1B) and while holding population constant at 2000 values (Fig. S1C). This enabled us to evaluate whether changes in the number of FPP was more likely to be driven by changes in population (Fig. S1B) or tree cover (Fig. S1C), or by a combination of the two (Fig. S1D).

Three caveats should inform the interpretation and use of our analysis. These concern the buffer distance that we used to define proximity; and some specific clauses of both the tree cover data and population data that we used. We briefly discuss each of these caveats here.

First, we principally report results here based on a 5km buffer to indicate proximity, but this choice of distance was somewhat arbitrary and our estimates are inevitably sensitive to the buffer distance used. We conducted sensitivity analyses using alternative buffer distances: a larger buffer (10 km) inevitably resulted in higher estimates (global total: 1.93 billion FPP); a smaller buffer (1 km) resulted in lower estimates (0.78 billion FPP) (Table S1). Indeed, distance is serving in many cases as a proxy for accessibility. Since accessibility itself is determined by transportation routes (e.g. roads, rivers), as well as by institutional prohibitions (e.g. protected areas), it may be that more refined metrics of accessibility would be preferable; even as data for such metrics are less commonly available, particularly at a global scale.

Second, the Hansen et al. (2013) data of tree cover has been widely used as a measure of, or proxy for, forest cover and forest cover change. However, the dataset has a couple of relevant caveats and limitations.

One limitation is that Hansen et al. (2013) use a threshold value of 50% tree cover as a measure of forest, which may not satisfy all stakeholders. Definitions of forests vary between individuals and agencies and the Hansen et al. (2013) data may not be a good fit for all definitions (Chazdon et al., 2016). For example, these data may be more likely to exclude dryland forests that are characterized by low tree cover. This consideration could mean that our estimates are conservative, and that the number of forest-proximate people would be higher in some places if a lower threshold of tree cover were used to define a forest.

A second limitation is that the Hansen data represent tree cover, not forests. Plantations (e.g. of oil palm) that have intact tree cover may be counted as 'forests' within this dataset. In such cases, people living near a plantation but not near a forest would still be counted as forest proximate. We use tree cover as a proxy for forests, but note that these data do not distinguish primary forest, secondary forest, plantations, and other tree cover types.

A final limitation is that the Hansen data do not enable comparisons of the number of FPP between different forest biomes. A researcher interested in these questions could calculate the number of FPP using MODIS tree cover data, since these data are pre-classified into different forest types (e.g. open shrublands, deciduous broadleaf forest, evergreen needleleaf forest). Calculating the number of FPP using MODIS data would also enable a comparison of the degree to which estimates vary depending on the source of the tree cover data used.

Third, the distributors of LandScan caution against relying on those data as a change detection tool[31]. We acknowledge this limitation, while noting that these were the best available data for us to use for the temporal analysis. Further, these concerns do not apply to using LandScan data for a cross-sectional analysis of a single year (which is how we generated the estimates of the number of FPP in 2012).

More broadly, our analysis was intended largely to demonstrate the potential utility of considering forest proximity in estimating relationships between people and forests, but depending on the function of the estimate and the interests of the stakeholder, as well as the specific system being analyzed, it may make sense to define proximity using a different buffer distance, and/or an alternative definition of forest or urban area. We caution against claims that there is a single 'correct' estimate of the number of people that live near, or who depend on, forests.


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## AUTHOR CONTRIBUTIONS

Conceptualization: A.A., J.O., and P.N.; Methodology: A.K. and J.O.; Formal Analysis: A.K.; Resources: A.A.; Writing – Original Draft: P.N.; Writing – Review & Editing: A.A., A.K., J.O., D.C.M., and P.N.; Visualization: A.K. and J.O.; Supervision: A.A.; Funding Acquisition: A.A., D.C.M.. J.O, and P.N.

## DECLARATION OF INTERESTS

The authors declare no competing interests.

## REFERENCES


[1] Chazdon, R.L., Brancalion, P.H.S., Laestadius, L., Bennett-Curry, A., Buckingham, K., Kumar, C., Moll-Rocek, J., Vieira, I.C.G., and Wilson, S.J. (2016). When is a forest a forest? Forest concepts and definitions in the era of forest and landscape restoration. Ambio 45, 538–550.

[2] Sullivan, M.J.P., Talbot, J., Lewis, S.L., Phillips, O.L., Qie, L., Begne, S.K., Chave, J., Cuni-Sanchez, A., Hubau, W., Lopez-Gonzalez, G., Miles, L., Monteagudo-Mendoza, A., Sonké, B., Sunderland, T., Ter Steege, H., White, L.J.T., Affum-Baffoe, K., Aiba, S.I., De Almeida, E.C., De Oliveira, E.A., Alvarez-Loayza, P., Dávila, E.Á., Andrade, A., Aragão, L.E.O.C., Ashton, P., Aymard, G.A., Baker, T.R., Balinga, M., Banin, L.F., Baraloto, C., Bastin, J.F., Berry, N., Bogaert, J., Bonal, D., Bongers, F., Brienen, R., Camargo, J.L.C., Cerón, C., Moscoso, V.C., Chezeaux, E., Clark, C.J., Pacheco, Á.C., Comiskey, J.A.,

Valverde, F.C., Coronado, E.N.H., Dargie, G., Davies, S.J., De Canniere, C., Djuikouo, M.N., Doucet, J.L., Erwin, T.L., Espejo, J.S., Ewango, C.E.N., Fauset, S., Feldpausch, T.R., Herrera, R., Gilpin, M., Gloor, E., Hall, J.S., Harris, D.J., Hart, T.B., Kartawinata, K., Kho, L.K., Kitayama, K., Laurance, S.G.W., Laurance, W.F., Leal, M.E., Lovejoy, T., Lovett, J.C., Lukasu, F.M., Makana, J.R., Malhi, Y., Maracahipes, L., Marimon, B.S., Junior, B.H.M., Marshall, A.R., Morandi, P.S., Mukendi, J.T., Mukinzi, J., Nilus, R., Vargas, P.N., Camacho, N.C.P., Pardo, G., Peña-Claros, M., Pétronelli, P., Pickavance, G.C., Poulsen, A.D., Poulsen, J.R., Primack, R.B., Priyadi, H., Quesada, C.A., Reitsma, J., Réjou-Méchain, M., Restrepo, Z., Rutishauser, E., Salim, K.A., Salomão, R.P., Samsoedin, I., Sheil, D., Sierra, R., Silveira, M., Slik, J.W.F., Steel, L., Taedoumg, H., Tan, S., Terborgh, J.W., Thomas, S.C., Toledo, M., Umunay, P.M., Gamarra, L.V., Vieira, I.C.G., Vos, V.A., Wang, O., Willcock, S., and Zemagho, L. (2017). Diversity and carbon storage across the tropical forest biome. Sci. Rep. 7, 1–12.

[3] Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N.J., Bauch, S., Börner, J., Smith-Hall, C., and Wunder, S. (2014). Environmental income and rural livelihoods: A global-comparative analysis. World Dev. 64, S12–S28.

[4] Newton, P., Miller, D.C., Byenkya, M.A.A., and Agrawal, A. (2016). Who are forest-dependent people? A taxonomy to aid livelihood and land use decision-making in forested regions. Land Use Policy 57, 388–395.

[5] Seymour, F., and Busch, J. (2016). Why forests? Why now? The science, economics, and politics of tropical forests and climate change (Brookings Institution Press).

[6] Ellis, E.C., and Ramankutty, N. (2008). Putting people in the map: anthropogenic biomes of the world. Front. Ecol. Environ. 6, 439–447.

[7] Iwamura, T., Lambin, E.F., Silvius, K.M., Luzar, J.B., and Fragoso, J.M. (2016). Socio-environmental sustainability of indigenous lands: simulating coupled human-natural systems in the Amazon. Front. Ecol. Environ. 14, 77–83.

[8] Miller, D.C. (2014). Explaining global patterns of international aid for linked biodiversity conservation and development. World Dev. 59, 341–359.

[9] Miller, D.C., Agrawal, A., and Roberts, J.T. (2013). Biodiversity, governance, and the allocation of international aid for conservation. Conserv. Lett. 6, 12–20.

[10] Waldron, A., Mooers, A.O., Miller, D.C., Nibbelink, N., Redding, D., Kuhn, T.S., Roberts, J.T., and Gittleman, J.L. (2013). Targeting global conservation funding to limit immediate biodiversity declines. Proc. Natl. Acad. Sci. U. S. A. 110, 12144–12148.

[11] Zhang, D. (2016). Payments for forest-based environmental services: A close look. For. Policy Econ. 72, 78–84.

[12] Belcher, B., and Schreckenberg, K. (2007). Commercialisation of non-timber forest products: a reality check. Dev. Policy Rev. 25, 355–377.

[13] Hajjar, R., and Oldekop, J.A. (2018). Research frontiers in community forest management. Curr. Opin. Environ. Sustain.

[14] Miller, D.C., Rana, P., and Benson Wahlén, C. (2017). A crystal ball for forests?: Analyzing the social-ecological impacts of forest conservation and management over the long term.

Environ. Soc. 8.

[15] Calibre Consultants (2012). Numbers of forest dependent people: a feasibility study. Calibre Consultants and the Statistical Services Centre (SSC), University of Reading, Reading.

[16] Chao, S. (2012). Forest peoples: numbers across the world. Forest Peoples Programme.

[17] World Bank (2002). A revised forest strategy for the World Bank Group_31 October 2002. World Bank, Washington, D.C.

[18] Agrawal, A., and Yadama, G. (1997). How do local institutions mediate market and population pressures on resources? Forest panchayats in Kumaon, India. Dev. Change 28, 435–465.

[19] Nolte, C., Agrawal, A., Silvius, K.M., and Britaldo, S.S.F. (2013). Governance regime and location influence avoided deforestation success of protected areas in the Brazilian Amazon. Proc. Natl. Acad. Sci.. 110, 4956–4961.

[20] Oldekop, J.A., Sims, K.R.E., Karna, B.K., Whittingham, M.J., and Agrawal, A. (2019). Reductions in deforestation and poverty from decentralized forest management in Nepal. Nature Sustainability 2, 421–428.

[21] Sunderlin, W.D., Angelsen, A., and Wunder, S. (2003). Forests and poverty alleviation, State of the World's Forests. Rome.

[22] Byron, N., and Arnold, M. (1999). What futures for the people of the tropical forests? World Dev. 27, 789–805.

[23] Nerfa, L., Rhemtulla, J.M., and Zerriffi, H. (2020). Forest dependence is more than forest income: Development of a new index of forest product collection and livelihood resources. World Dev. 125, 104689.

[24] Shepherd, G. (2012). Rethinking forest reliance: findings about poverty, livelihood resilience and forests from IUCN's "livelihoods and landscapes" strategy. Gland.

[25] Landscan (2012). LandScan 2012: High resolution global population data set [WWW Document]. URL https://landscan.ornl.gov/

[26] Hansen, M.C., Potapov, P. V, Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S. V, Goetz, S.J., and Loveland, T.R. (2013). High-resolution global maps of 21st-century forest cover change. Science 342, 850–853.

[27] Usery, L.E., and Seong, J.C. (2001). All equal-area map projections are created equal, but some are more equal than others. Cartogr. Geogr. Inf. Sci. 28, 183–194.

[28] World Bank (2014). World Bank Official Boundaries. Available at: https://datacatalog.worldbank.org/dataset/world-bank-official-boundaries.

[29] IFRI (2011). International Forestry Resources and Institutions (IFRI) research program. Field Manual. Version 14. Revised December 2011. Available at: http://ifri.forgov.org/wp-content/uploads/2012/09/IFRI_Manual.pdf

[30] Brezzi, M., Piacentini, M., Rosina, K., and Sanchez, D. (2012). Redefining urban areas in OECD countries, in: Redefining "urban": A new way to measure metropolitan areas. Paris, pp. 19–58. https://doi.org/10.1787/9789264174108-en

[31] Oak Ridge National Laboratory (2020). LandScan Frequently Asked Questions. [WWW

Document]. URL https://landscan.ornl.gov/frequently-asked-questions

FIGURE LEGENDS

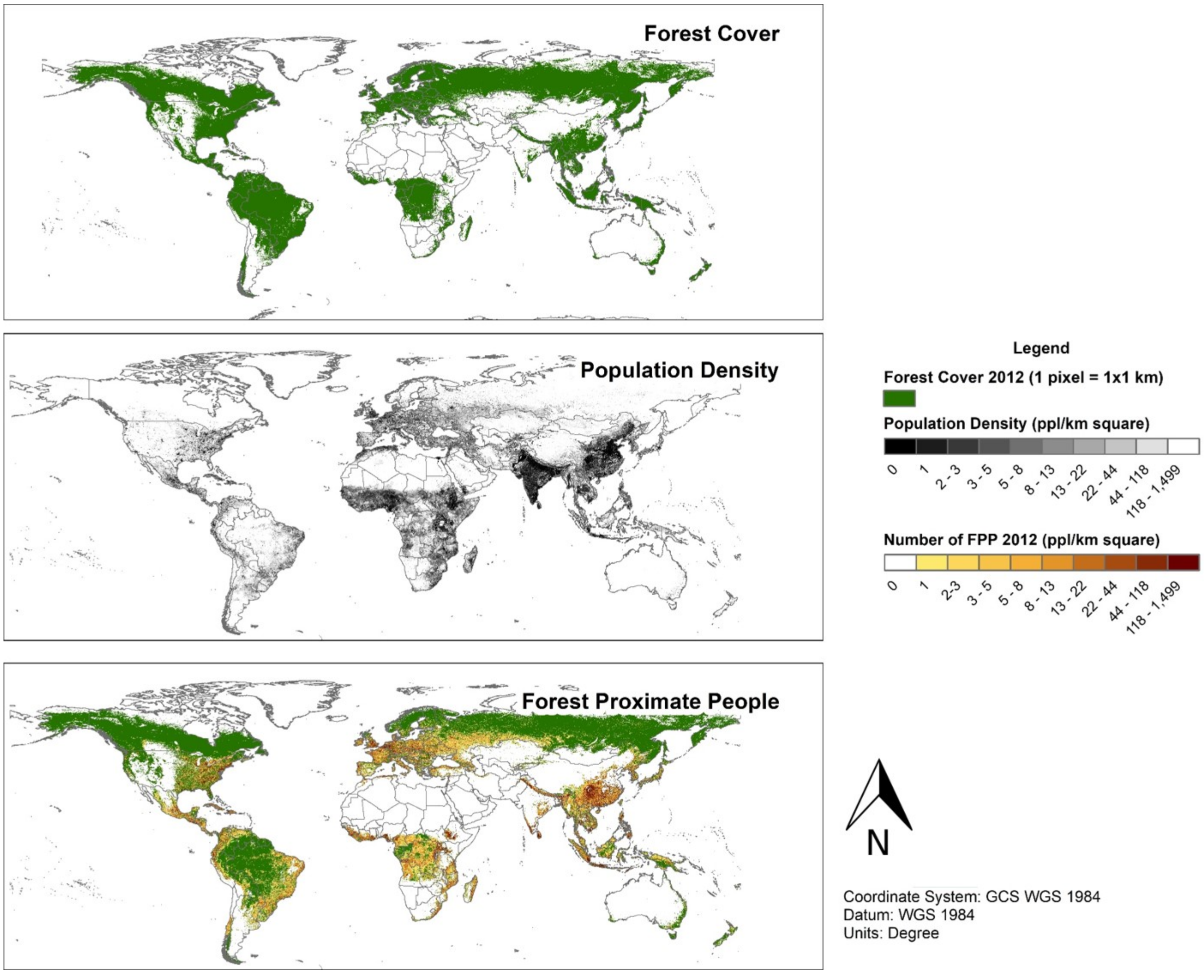


**Figure 1**. The distribution of forest-proximate people (rural people living within 5km of a forest) globally, in 2012.

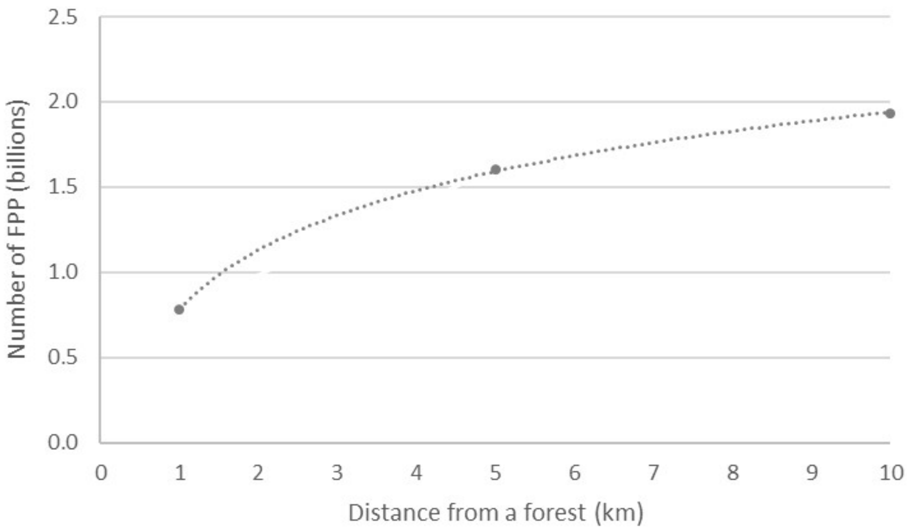


**Figure 2.** The number of forest proximate people (FPP) living within different distances (1km, 5km, 10km) of a forest in 2012**,** globally

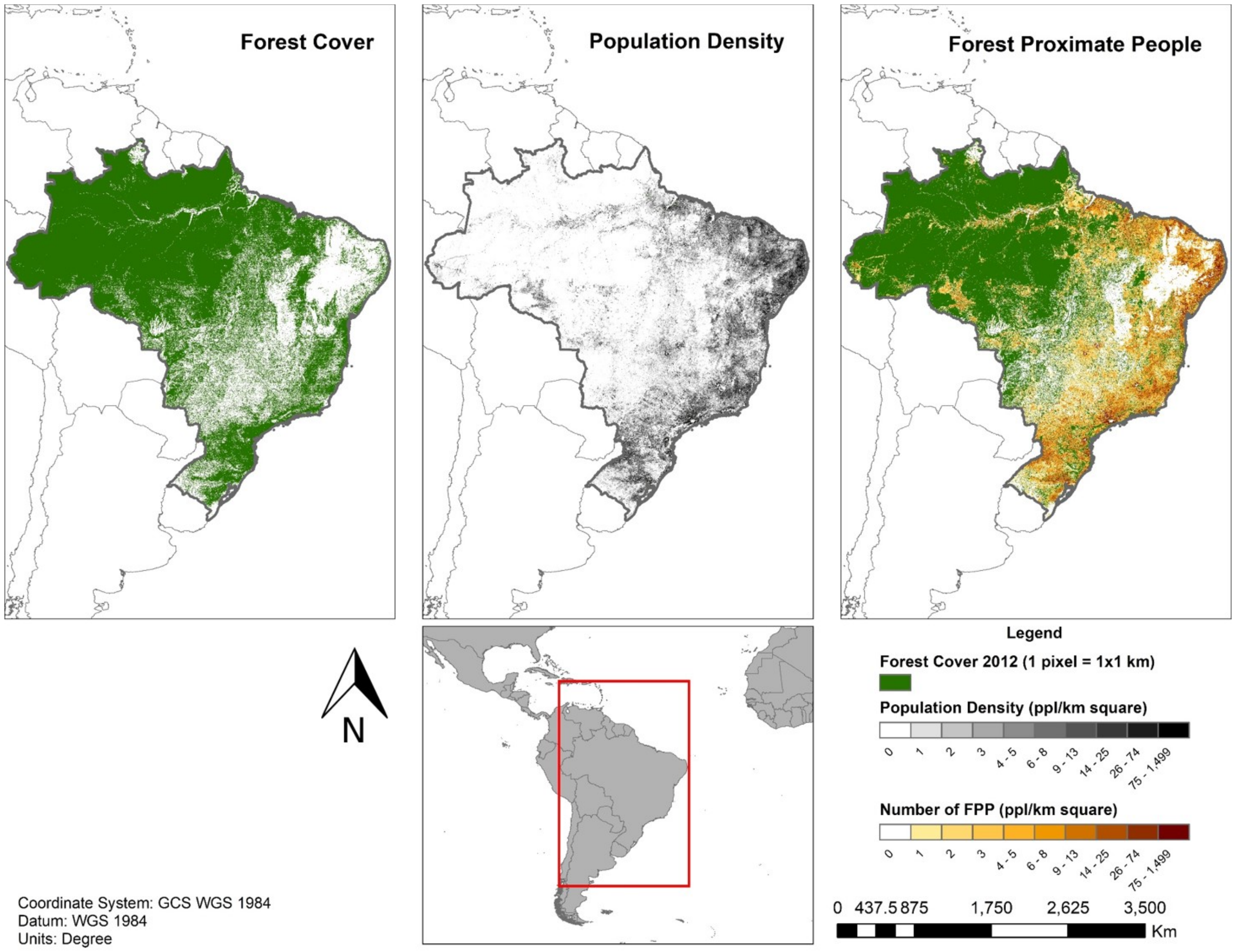


**Figure 3**. The distribution of forest-proximate people (rural people living within 5km of a forest) in Brazil in 2012

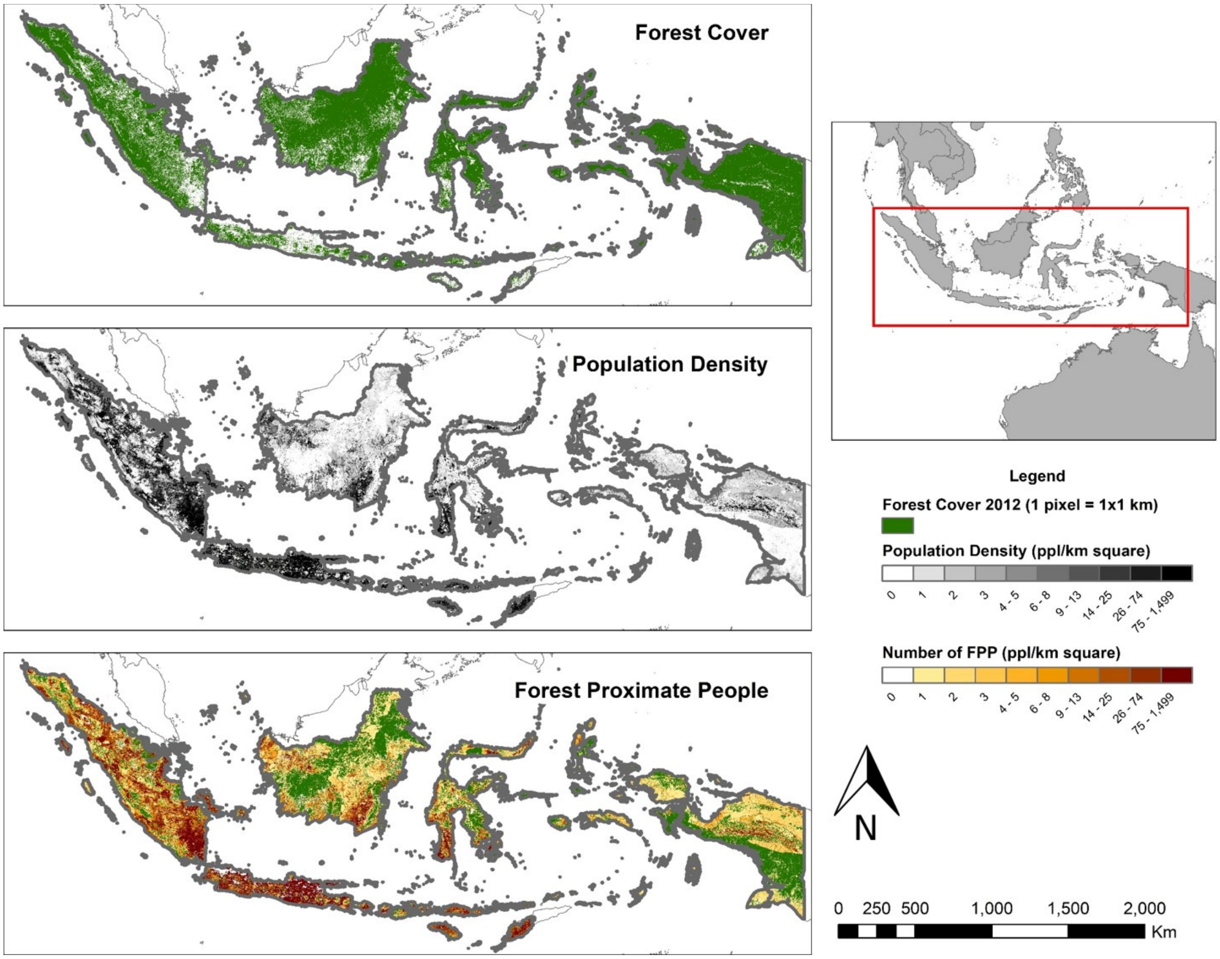


**Figure 4**. The distribution of forest-proximate people (rural people living within 5km of a forest) in Indonesia in 2012

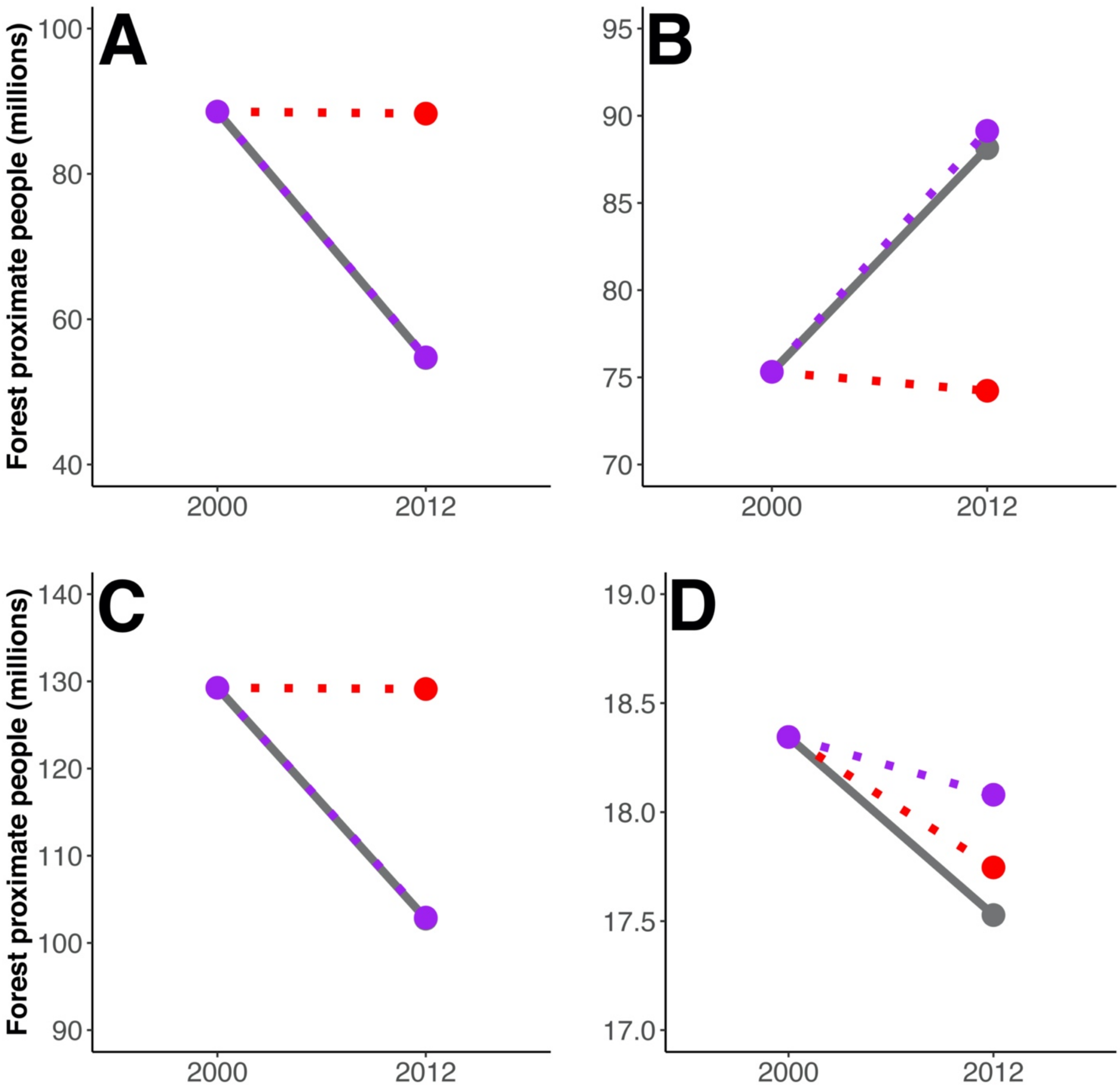


**Figure 5.** Drivers of changes in the number of forest proximate people (FPP) in each of (A) Brazil, (B) India, (C) Indonesia, and (D) Nigeria between 2000 and 2012. Black/grey solid lines denote the observed change in the number of FPP; red-dashed lines denote the change in the number of FPP when population was held constant at 2000 values; purple-dashed lines denote the change in the number of FPP when tree cover was held constant at 2000 values. See Figure S1 for a conceptual explanation of the methodology.

**SUPPLEMENTAL INFORMATION**

**Figure S1.** A conceptual schematic of the methodology used to evaluate the relative role of changes in tree cover (TC) and population (PP) as drivers of (A) an observed increase in the number of forest proximate people (FPP) between 2000 and 2012 (black/grey solid lines). In (B) the observed increase in the number of FPP was closely associated with the modelled increase in the number of FPP when tree cover was held constant at 2000 values (purple-dashed lines). This suggests that the principal driver of change in the number of FPP was changes in population. In (C) the observed increase in the number of FPP was closely associated with the modelled increase in the number of FPP when population was held constant at 2000 values (red-dashed lines). This suggests that the principal driver of change in the number of FPP was changes in tree cover. In (D), the observed increase in the number of FPP exceeded both the modelled increase in the number of FPP when tree cover was held constant at 2000 values and the modelled increase in the number of FPP when population was held constant at 2000 values. This suggests that both tree cover and population were drivers of change in the number of FPP. Related to Experimental Procedures.