# Can nature deliver on the sustainable development goals?

In 2015, the UN adopted 17 Sustainable Development Goals (SDGs), aiming to "protect the planet from degradation…so that it can support the needs of the present and future generations".[1] Through the SDGs, the UN recognises that conservation directly supports human health and wellbeing by providing goods like water and fibre, and global public goods like habitat for species and mitigation of climate change.[1,2] Although trade-offs can indeed arise between conservation and economic development, the Rockefeller Foundation–Lancet Commission on planetary health[3] states unequivocally that "the environment has been the foundation of human flourishing", suggesting that if environmental degradation persists then ongoing improvements in human health are likely to be reversed.

The increasing availability of data and improved analytical techniques now enable better understanding of where environmental conditions and human health are tightly linked, and where investing in nature can deliver net benefits for people—especially with respect to the most vulnerable populations in developing countries. These advances bring more opportunities for interventions that can advance multiple SDGs at once. We have harmonised a suite of global datasets to explore the essential nexus of forests, poverty, and human health, an overlap of SDG numbers 1, 2, 3, 6, and 15. Our study combined demographic and health surveys for 297 112 children in 35 developing countries with data describing the local environmental conditions for each child (appendix).[4] This allowed us to estimate the effect forests might have in supporting human health, while controlling for the influence of important socio-economic differences.[4] We extended this work to look at how forests affect three childhood health concerns of global significance for the world's poorest people: stunting, anaemia, and diarrhoeal disease.

We found that, for the poorest households in these 35 countries, forest cover is associated with reduced prevalence of all three childhood maladies, after controlling for potential confounding variables (eg, education, and rainfall; figure). Among children in the two lowest wealth quintiles, those who live in areas with more forest cover were significantly less likely to have these diseases than those living in areas with less forest cover. For children in the two highest wealth quintiles, in contrast, we found no relation between forest cover and any of these health outcomes. We also found that as the amount of upstream forest cover increases, the benefits for the poor increase, particularly for those poor households without access to improved water sources (appendix). These findings suggest that the poorest populations are least capable of replacing natural capital with technology or infrastructure, and are therefore disproportionately affected by the degradation of natural ecosystems.

See Online for appendix

The particular mechanisms through which forest cover can positively affect health outcomes appear to vary among contexts and diseases,[5–7] and gaining a deeper understanding of these causal mechanisms will be critical in making effective environmental or health interventions.[2,3] Nonetheless, the positive signal we get from forests in these analyses is notable, given that the combined global effects of diarrhoea, anaemia, and stunting on the world's children are devastating and the world's forests are steadily disappearing. Diarrhoeal disease is the second leading cause of childhood mortality globally, killing more children than malaria, AIDS, and measles combined.[8] Iron-deficiency anaemia, the most common form of anaemia, has a role in 20% of maternal deaths.[7] Childhood stunting affects over 160 million children worldwide, often limiting physical and cognitive growth for life.[8] Investing in

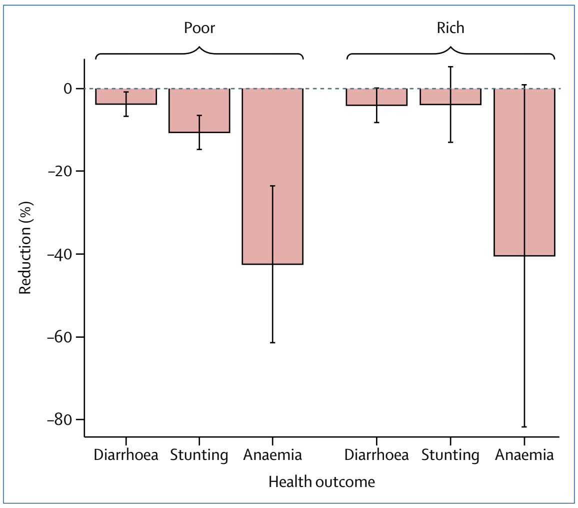


***Figure:*** **Reduction in the probability of diarrhoea, stunting, and anaemia given a 30% increase in tree cover variables**
Error bars are 95% CIs. Model predicts reductions for the poorest two, but not the richest two quintiles.

ecosystem conservation, restoration, or both, might not only improve childhood health outcomes across much of the developing world where forests are in decline, but also help to weaken the poverty-health trap in which many of the world's poorest people find themselves.

The forest–human health connection described here is only one example of the relation among nature, poverty, and human health. Other empirical studies have quantified relations between fisheries decline and nutrient deficiencies,[9] between deforestation and malaria,[9] and between bushmeat availability and anaemia.[10] Given the strong associations among well-functioning ecological systems, poverty, and human health, a critical area of research is understanding how natural resource management and conservation can advance multiple SDGs.

Clearly understanding these relations is not an easy task. The database we built took over 3 years to build, clean, and operationalise. The complexity of the nature–human health relationship necessitated deep thinking around our theoretical models to control for factors that confound these relations and reflect the differentiated effects of local versus regional environmental processes. Nonetheless, it must become a routine for governments, aid agencies, and other organisations investing in economic development to use the data now available to minimise trade-offs, and to seek co-benefits among environmental health, human health, and equity outcomes.

*Brendan Fisher, Diego Herrera, Diane Adams, Helen E Fox, Louise Gallagher, Drew Gerkey, David Gill, Christopher D Golden, David Hole, Kiersten Johnson, Mark Mulligan, Samuel S Myers, Robin Naidoo, Alexander Pfaff, Ranaivo Rasolofoson, Elizabeth R Selig, David Tickner, Timothy Treuer, Taylor Ricketts*

Rubenstein School of Environment and Natural Resources (BF, TR), and Gund Institute for Environment (BF, DH, RR, TR, TT, RN), University of Vermont, Burlington, VT, USA; Environmental Defence Fund, Washington, DC, USA (DH); Department of Marine and Coastal Sciences, School of Environmental and Biological Sciences, Rutgers University, New Brunswick, NJ, USA (DA); National Geographic Society, Washington, DC, USA (HEF); Institute for Sciences of the Environment, University of Geneva, Switzerland (LG); School of Language, Culture and Society, Oregon State University, Corvalis, OR, USA (DGe); National Socio-Environmental Synthesis Center, Annapolis, MD, USA (DGi); Department of Nutrition (CDG), and Department of Environmental Health (SSM), Harvard T H Chan School of Public Health, Boston, MA, USA; Harvard University Center for the Environment, Harvard University, Cambridge, MA, USA (CDG, SSM); Betty and Gordon Moore Center for Science, Conservation International, Crystal City, VA, USA (DH); United States Agency for International Development, Bureau for Food Security Washington, DC, USA (KJ); United States Department of Agriculture Foreign Agricultural Service, Washington, DC, USA (KJ); Department of Geography, King's College, London, UK (MM); World Wildlife Fund, Washington, DC, USA (RN); Sanford School of Public Policy, Duke University, Durham, NC, USA (AP); Centre for Ocean Solutions, Stanford University, Stanford, CA, USA (ERS); World Wide Fund for Nature UK, Woking, UK (DT); and Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, USA (TT)

bfisher@uvm.edu

This work was supported by the National Socio-Environmental Synthesis Center (SESYNC) under funding from the National Science Foundation DBI-1052875; The Gordon and Betty Moore Foundation and The Rockefeller Foundation as part of the Health and Ecosystems: Analysis of Linkages (HEAL) programme. CDG was supported by the Wellcome Trust's Our Planet, Our Health program [106964MA] and the National Science Foundation Coupled Natural Human Systems grant 1826668.

In memory of Diane Adams.

We declare no competing interests.



1 UN. Transforming our world: the 2030 agenda for sustainable development. New York: United Nations; 2015.

2 Myers SS, Gaffikin L, Golden CD, et al. Human health impacts of ecosystem alteration. *Proc Natl Acad Sci USA* 2013; **110:** 18753–60.

3 Whitmee S, Haines A, Beyrer C, et al. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation-Lancet Commission on planetary health. *Lancet* 2015; **386:** 1973–2028.

4 Herrera D, Ellis A, Fisher B, et al. Upstream watershed condition predicts rural children's health across 35 developing countries. *Nat Commun* 2017; **8:** 811.

5 Pattanayak S, Wendland K. Nature's Care: diarrhea, watershed protection, and biodiversity conservation in Flores, Indonesia. *Biodivers Conservation* 2007; **16:** 2801–19.

6 Trask JR, Kalita PK, Kuhlenschmidt MS, Smith RD, Funk TL. Overland and near-surface transport of *Cryptosporidium parvum* from vegetated and nonvegetated surfaces. *J Environ Qual* 2004; **33:** 984–93.

7 Bauch SC, Birkenbach AM, Pattanayak SK, Sills EO. Public health impacts of ecosystem change in the Brazilian Amazon. *Proc Natl Acad Sci USA* 2015; **112:** 7414–19.

8 WHO. The Countdown to 2015: maternal, newborn, and child survival. Geneva: World Health Organization; 2010.

9 Golden CD, Allison EH, Cheung WW, et al. Fall in fish catch threatens human health. *Nature* 2016; **534:** 317–20.

10 Golden CD, Fernald LCH, Brashares JS, Rasolofoniaina BJR, Kremen C. Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. *Proc Natl Acad Sci USA* 2011; **108:** 19653–56.