

## Down to Earth: The Emerging Field of Planetary Health

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Human impacts on our planet have become so profound that many researchers now favor a new name for the current epoch: the Anthropocene.<sup>1</sup> The underlying premise of this term is that essentially every Earth system, from the deep oceans to the upper atmosphere, has been significantly modified by human activity.

This idea, and related concepts like the great acceleration, planetary boundaries, and tipping points may be of interest, even grave concern, to ecologists, biologists, and climatologists. Yet viewed through an environmental health lens—which recognizes the critical links between human health and the food we eat, the water we drink, and the air we breathe—humans’ growing influence on the planet threatens the very long-term survival of our species.

“There’s a bit of a paradox that we’re seeing for the last 100 to 150 years,” says Michael Myers, managing director for health at the Rockefeller Foundation. “Exploitation of the environment has contributed to human health. By exploiting Earth resources we have a more comfortable existence, and our life spans have increased considerably. But we’re now at a tipping point in which the exploitation of the environment is beginning to have a negative impact on human health.” The same natural systems that have benefited us for so long, he says, are now beginning to collapse.

From this realization has come another new term: planetary health.<sup>2</sup> There is significant overlap between planetary health and traditional environmental health; both examine the relationship between human health and conditions and exposures originating outside the body, be they extreme temperatures, chemicals and biological agents, vector-borne diseases, or any number of other potential factors. However, planetary health, by definition, explicitly accounts for the importance of natural systems in terms of averted cases of disease and the potential harm that comes from human-caused perturbations of these systems—a consideration that has not necessarily factored into environmental health research to date.

“The size of humanity’s ecological footprint has ballooned so rapidly over the last few decades that we’re impacting the structure and function of natural systems in ways that are now making us vulnerable all over the world,” says Samuel Myers, a principal research scientist in the Department of Environmental Health at the Harvard T.H. Chan School of Public Health. Yet our influence can also be a force for good, he says. Implicit in the planetary health framing is the acknowledgment that sustainable environmental stewardship on a global scale can directly benefit human health.



Planetary health explores how human-caused perturbations of natural systems influence human health. This circle of impacts is exemplified by the shifting ecology of Lyme disease. The vectors that spread Lyme disease are undergoing changes in their habitat and distribution as a result of both warming northern climates and the fragmentation of forest lands into smaller wooded areas.<sup>36</sup> This means the disease is spreading into areas that have never seen it before. Image: © shipfactory/Shutterstock.

Many of the concepts central to planetary health have been around for decades in fields including global health,<sup>3</sup> conservation medicine,<sup>4</sup> OneHealth,<sup>5</sup> and EcoHealth.<sup>6</sup> Similar dynamics play a role within the evolving field of climate change and health. But the framework of planetary health gives these ideas cohesion.

A 2013 paper outlined the core connections and concepts behind planetary health without ever using the term.<sup>7</sup> “Human activity is rapidly transforming most of Earth’s natural systems,” wrote the authors, who were part of a research program called HEAL (Health and Ecosystems: Analysis of Linkages<sup>8</sup>) supported by the environmental organization Wildlife Conservation Society. “How this transformation is impacting human health, whose health is at greatest risk, and the magnitude of the associated disease burden are relatively new subjects within the field of environmental health.”<sup>7</sup>

The paper described an urgently needed new branch of environmental health focused on characterizing the health impacts of anthropogenic alterations in the structure and function of Earth’s natural systems, says senior author Steven Osofsky, a professor at Cornell University and HEAL founder. Osofsky is also science policy director for the Harvard-based Planetary Health Alliance, a consortium of nearly 100 universities, NGOs, government entities, research institutes, and other partners committed to advancing the field.

Richard Horton, editor-in-chief of the journal *The Lancet*, is credited with coining the term “planetary health” in a March 2014 article titled “From Public to Planetary Health: A Manifesto.”<sup>9</sup>

“The harms we continue to inflict on our planetary systems are a threat to our very existence as a species,” Horton wrote. “The gains made in health and well-being over recent centuries, including through public health actions, are not irreversible; they can easily be lost, a lesson we have failed to learn from previous civilisations.”<sup>9</sup>

The following year, *The Lancet* published a second seminal piece in the field, the result of a year-long analysis by the Rockefeller Foundation–*Lancet* Commission on Planetary Health. In a podcast published alongside the report, commission chairman Andy Haines, a professor of public health and primary care at the London School of Hygiene & Tropical Medicine, explained that “the aims of the commission really are to review the many global changes taking place and to outline implications for human health, and also to assess potential ways forward that could both improve environmental sustainability and human health.”<sup>10</sup> The report, titled “Safeguarding Human Health in the Anthropocene Epoch,”<sup>11</sup> served as a simultaneous rallying cry, proof of concept, and literature review for the nascent field.

Later still, at a 2017 conference organized by the Planetary Health Alliance,<sup>12</sup> Howard Frumkin of the University of Washington further rallied the students and researchers in attendance. “This is not just an academic exercise,” he said. “We need planetary health. We need it because our house is on fire. We face urgent threats to our survival, to the health of human civilization, and to the natural systems on which we depend. Planetary health is a radically innovative step forward.”<sup>13</sup>



This Malagasy fisherman caught his octopus by hovering over a hole in the floor of Antongil Bay, waiting for his prey to appear. Ensuring that fisheries remain sustainable typically involves seasonal closures, quota systems, and a greater public understanding of the vulnerability of marine species to overharvesting. Chris Golden is conducting regional case studies in Madagascar and other areas to assess local-level health impacts of human influence over the environment. Image: © Rebecca Gaal.

## Examples of Planetary Health Studies

The easiest way to understand how planetary health differs from yet also encapsulates related fields is through the research itself. Harvard research scientist Christopher Golden, who in 2017 helped teach the world's first course on planetary health at Harvard and who serves as associate director of the Planetary Health Alliance, shares one example.

Golden is leading an investigation on ways that human-caused changes to global fisheries affect diet, nutrition, and thus human health around the planet, especially in low-income nations near the equator.<sup>14</sup> The project involves dozens of researchers with specialties as diverse as ecosystem services, nutritional epidemiology, and fisheries ecology, and is one of 19 funded since 2013 through the Wellcome Trust's expansive new research portfolio, *Our Planet, Our Health*.<sup>15</sup> Wellcome was among five cosponsors of the 2017 Planetary Health Alliance conference, although it has never funded or joined the alliance, says portfolio lead Saskia Heijnen.

A 2016 *Nature* commentary by Golden and colleagues describes how declining numbers of marine fish and changes in their distribution could increase the number of malnourished people in developing nations.<sup>16</sup> The authors estimated that 845 million people (11% of the global population) risk becoming undernourished if they lose access to seafood as a result of declines in fisheries. That's because they already live near a threshold of being deficient in zinc, iron, or vitamin A, and they get more than 10% of their vitamin A or zinc or more than 5% of their iron from wild harvested fish.

Some of these declines are due to the usual suspects of over-fishing, pollution, and human population growth. But Golden's research also considers a less direct factor in fish declines that is far less widely known: the gradual migration of native species toward cooler waters, driven by rising sea temperatures.

Earlier work by a group at the University of British Columbia projected that warming ocean temperatures will drive remaining fish and shellfish stocks toward the poles,<sup>17</sup> reducing fish catch in the tropics by as much as 30% by 2050.<sup>18</sup> In British Columbia,

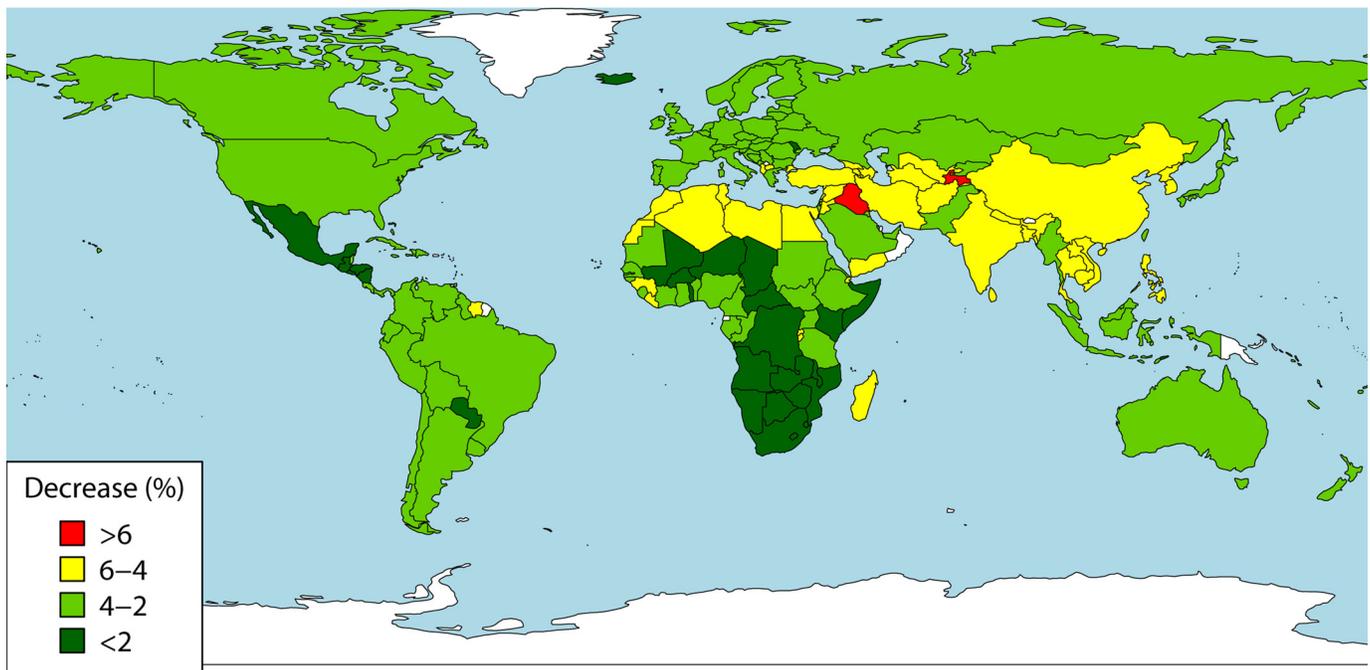
although far from the equator, marine fish and invertebrates of commercial and cultural significance to coastal First Nations will migrate at a median rate of 10–18 km (6–11 mi) per decade by 2050, relative to 2000, the authors estimated.<sup>19</sup> Across all 98 species studied, population cores are projected to shift northward by an average of 50–90 km (31–56 mi) during the first half of the 21st century.

Golden's team is building upon these findings by conducting regional case studies in Bangladesh, Madagascar, the Philippines, the Solomon Islands, and British Columbia. Homing in on each locale individually, the researchers will seek to understand a long chain of reactions linking human influence on natural systems to potentially unexpected health outcomes: climate change and ocean warming causes the migration of fish species, which leads to demand for alternative food sources, contributing to nutritional vulnerabilities and health effects. Whatever replacement foods people might adopt, whether meat, eggs, or local agricultural products and processed foods, Golden says they are likely to be nutritionally inferior to seafood, which he calls "nature's superfood."

According to Golden and coauthors of the 2016 *Nature* commentary, this factor alone could have major implications for human health given the importance of off shore fish stocks to diet and nutrition in low-latitude developing nations. The 2016 commentary concludes with what Golden considers its main point: a call for policy makers and international agencies to pay more attention to human health when deciding how to manage marine environments and fisheries. The team's subsequent case studies are critical if its message is to affect policy at the necessary scales, Golden says.

Sam Myers is exploring another angle of access to nutritious food as a planetary health issue. Myers's research at Harvard has assessed the potential impact of rising carbon dioxide (CO<sub>2</sub>) levels on the nutrient content of staple food crops and the consequent nutritional impact on hundreds of millions of people.<sup>20,21,22,23</sup>

For instance, in a 2017 paper in *EHP*,<sup>20</sup> Myers and colleagues estimated that more than 148 million people could become newly



Even as rising levels of atmospheric CO<sub>2</sub> increase plant growth, they also reduce concentrations of protein and essential minerals in most vascular species, including many staple crops. In a 2017 *EHP* article, Samuel Myers and colleagues estimated that CO<sub>2</sub> emissions at roughly unchanged levels could decrease the mean intake of protein by more than 5% in 18 countries. Source: Medek et al. (2017).<sup>20</sup>

at risk for protein deficiency by midcentury if CO<sub>2</sub> emissions continue at roughly 2010<sup>24</sup> levels. Additional work estimated that declines in insect pollinators could cause up to 1.4 million excess deaths annually.<sup>25</sup> Myers is also investigating the health impacts of fires used for land clearing in Indonesia. Last year, his team estimated that such fires caused around 100,000 excess deaths in 2015 alone.<sup>26</sup>

### Funding the Field

Research so broad in scope as Golden's fisheries work would likely not have been possible without the Wellcome Trust's Our Planet, Our Health program, he says. The project is representative not only of the general ethos of collaboration in the field of planetary health, Golden says, but also of the specific role that funders must play in supporting research.

"The interesting thing is that holistic approaches require interdisciplinary teams, but interdisciplinary teams don't have a lot of funding opportunities," Golden says. "Interdisciplinary research is not something that happens naturally; it's something that you really need to work for. There needs to be money at the table to create and enable that kind of cooperation, because it doesn't happen naturally. Something being intuitive does not mean it is easily executed."

Interestingly, Our Planet, Our Health initially struggled to get off the ground, says Heijnen, because its holistic approach stood in such contrast to the Wellcome Trust's traditional focus on funding biomedical health research. "People were not coming to us with ideas because it was not known that we were interested in it," she says.

Instead of backing down, Wellcome redoubled its efforts, issuing two calls for proposals over 2 years that simply asked researchers to examine links among nutrition, urbanization, climate change, and health. "By casting that net very, very wide, we received many applications," Heijnen says—about 900, in fact. During the initial round, 15 of those projects were funded.

Other projects funded through Our Planet, Our Health explore environmental and nutritional interventions for improving cardiovascular health in rural China; the potential role of insects as a sustainable global food source providing vital nutrients such as protein, iron, and zinc; and ways of better factoring human health into urban planning so that managers can account for acute impacts like heat stress and air pollution as well as long-term factors like altered weather patterns and noncommunicable diseases.<sup>15</sup>

These efforts will incorporate both social science and public interventions. For example, after evaluating region-specific determinants of cardiovascular disease, the team in rural China will study cultural, social, and behavioral factors influencing which interventions may be most successful and where. The "insect farming" team will investigate not only cultivation methods and human uptake of minerals from insects, but also, over the long term, ways to encourage cultural acceptance of insects as a food source.

The Planetary Health Alliance acknowledges the field's breadth and interconnected nature by identifying 15 subareas or themes that may be mixed and matched in research projects, many of which encompass entire academic disciplines. Nine of these deal with health effects of human-driven ecosystem transformations such as pollution, urbanization, and climate change, and six refer to the role of environmental change in public health



A man surveys the damage following a catastrophic 2014 flood in Kelantan, Malaysia, which was widely claimed to have been worsened by deforestation.<sup>37,38</sup> Planetary health focuses on human-driven ecosystem transformations (such as changing land use) and human health outcomes (such as those related to mental health, infectious disease, and civil strife following natural disasters). Image: © muhd fuad abd rahim/Shutterstock.

topics including infectious disease, mental health, and civil strife.<sup>27</sup> The ultimate purpose of such transdisciplinary work, the Planetary Health Alliance emphasizes, is to mitigate the negative human health impacts of global environmental change.

### Spreading the Science

Planetary health now has to its credit three new journals dedicated solely to the emerging discipline: *The Lancet Planetary Health*,<sup>28</sup> the American Geophysical Union's *GeoHealth*,<sup>29</sup> and Nature Publishing Group's *Nature Sustainability*.<sup>30</sup>

In addition, soon after the Rockefeller Foundation–*Lancet* Commission published “Safeguarding Human Health in the Anthropocene Epoch,”<sup>11</sup> the field began making headway into educational and governmental institutions worldwide. “There’s been very rapid penetration and adoption of this framework, I think because it has been compelling to people,” says Myers. “Human activity is disrupting our planet’s natural systems at accelerating rates and driving a very large share of the global burden of disease, and one that is growing.”

The University of California system launched a Planetary Health Center of Expertise in late 2016.<sup>31</sup> Doane University, a private liberal arts college in Nebraska, followed suit in May 2017 by creating its Institute for Human and Planetary Health.<sup>32</sup> Meanwhile, the University of Sydney has appointed the world’s first professor of planetary health, public and environmental health expert Anthony Capon,<sup>33</sup> and the University of Toronto has launched a master’s-level pilot course in planetary health, says Planetary Health Alliance education fellow Sara Stone.

Cornell University has just launched the first master of public health program based on planetary health principles, notes Osofsky.

In all, nearly 20 universities worldwide have introduced planetary health concepts through courses, lectures, seminars, and other formats at the graduate or undergraduate level over the last couple of years, according to Stone. She says new programs are coming all the time.

In 2017, the Rockefeller Foundation launched a second commission on planetary health, this time to investigate the economic rationale for the field. Hosted by the Oxford Martin School at Oxford University and chaired by former Mexican president Ernesto Zedillo, now a professor of economics, politics, and international studies at Yale University, the effort signals the field’s expanding reach and seeks to strengthen its economic and policy case.<sup>34</sup>

Even the United Nations is embracing planetary health as a concept. Together with the Rockefeller Foundation, the United Nations Framework Convention on Climate Change secretariat launched Momentum for Change: Planetary Health in November 2016. This three-year venture is designed to identify new ways of balancing human and ecosystem health in part by highlighting community-level efforts that have produced tangible benefits from applying planetary health principles.<sup>35</sup>

Frumkin—who chairs the funding committee for Our Planet, Our Health, serves on the steering committee of the Planetary Health Alliance, and contributed to the original Rockefeller–*Lancet* report—believes the field’s ongoing success will hinge in part on its ability to impact higher education



Lao People’s Democratic Republic is in the midst of an aggressive push to build hydropower capacity, with more than 50 sites expected to be in operation by 2025.<sup>39</sup> Major development projects like these can improve the quality of life for many people. But Steven Osofsky posits that potential negative impacts on human health caused by the disruption of natural systems should be considered during planning stages as a way to mitigate unintended harm. Image: © Jakkrit kladpu/Shutterstock.

and interrupt disciplinary siloing before it occurs. Myers's undergraduate-level course at Harvard offers a good model because "it sets out its scope not by reference to disciplines, but by reference to big challenges, big problems—a transdisciplinary approach," says Frumkin. "We're seeing young people who combine the insights of different fields very fluidly, and that's exactly what we'll need in this field in coming years."

To achieve its goals, adds Osofsky, the field will also need to play an active and deliberate role in shaping policy and decision-making. For example, he recommends formally including public health considerations in environmental impact assessments for major development projects.

"When we think about large infrastructure projects like a dam on the Mekong, and millions of people are depending on fisheries for micronutrients and protein, that's really important—and yet we don't do robust public health impact assessments," says Osofsky. "If you're building a highway through the Amazon, you need to methodically look at what that means for vector-borne disease. And today, we don't do that. We have to look at the pros and cons of these actions in terms of economic impact, social impact, environmental impact, and public health impact."

Raffaella Bosurgi, editor of *The Lancet Planetary Health*, agrees that the field is inherently political. "We need to build the scientific evidence, and then once we build it, it must help us strengthen the case for policy action," she says. "In that way, we can revise and practically change the way we interact with the environment."

Ultimately, Osofsky says, the field of planetary health is an optimistic one. It makes the case that complex relationships between human modification of the environment and human health outcomes can be understood and thus more thoughtfully and proactively addressed. "If you measure something, then you can really hold people—ourselves—accountable," he says. "The planetary health message gives one prospect for hope."

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