Planetary Health Watch: integrated monitoring in the Anthropocene epoch

Impressive progress in human development has been accompanied by profound shifts in a range of the Earth's natural systems, including climate change, ocean acidification, biodiversity loss, land use change, pollution, and freshwater depletion.[1,2] These pervasive and interconnected changes are primarily driven by a growing—although inequitably distributed—demand for energy, food, and other resources, and will accelerate in future in the absence of decisive action.

These planetary scale shifts, which characterise the Anthropocene epoch,[3] pose major but imperfectly understood threats to humanity (and to life more generally). Through a range of pathways, the shifts can have direct, ecosystem mediated or indirect (often deferred or displaced) effects on health, the latter mediated in general through social systems.[1,3]

To determine how environmental changes, singly or in concert, affect health, a monitoring and forecasting system is needed to link human health and environmental indicators in time and space, and to assess and predict trends. Such a Planetary Health Watch could improve the effectiveness of adaptation and mitigation strategies, assess progress towards nationally and internationally agreed targets, act as an early warning system, and hold decision makers accountable. Indicators for inclusion in the system should be prioritised using transparent criteria, including relevance, sensitivity, sustainability, scalability, accuracy, economic viability, and consistency.[4]

A number of initiatives already monitor different aspects of the planetary health agenda, but they typically address the effects of single environmental states and exposures (eg, climate change[5] or pollution[6]), which makes it difficult to attribute changes in health outcomes to specific exposures. To monitor potential confounding factors (including socioeconomic and health-care trends), integrated monitoring of the three dimensions of sustainable development—social, economic, and environmental—is necessary.

Human populations exhibit different levels of vulnerability to environmental change, which means that information on exposures alone may inadequately predict health outcomes. One example is the effect of heat stress, which can vary depending on age and physical activity patterns of exposed populations, as well as their access to technology (eg, air conditioning). Similarly, natural systems exhibit different levels of vulnerability to human pressures and respond in non-linear ways, resulting in tipping points (eg, the collapse of the Newfoundland cod fisheries).[1]

Integrated monitoring of environmental changes and their effects on natural systems that are relevant to human health is thus essential to identify drivers, trends, and emerging hotspots or risks. This approach is particularly important where the effects of different environmental changes might interact to influence health outcomes. Food systems, for example, are subject to multiple environmental influences (eg, climate change, loss of pollinators, the carbon dioxide fertilisation effect, freshwater scarcity, tropospheric ozone, and soil degradation).[1,2]

An overview of the relevance of existing frameworks[4] for developing indicators for assessing climate change and health identified the DPSEEA framework as the most promising for providing coherence across different environmental drivers, pressures, states, exposures, effects, and actions. This framework however, has been criticised for failing to integrate environmental and health measures adequately, and modifications to incorporate ecosystem services have been proposed.[7] Another weakness of existing frameworks is that they do not convey the dynamic interplay between their various dimensions and imply instead a sequential relationship between them. In practice, there are often interactions within and between dimensions that can amplify or diminish the effects on health and human development. For such reasons, a Planetary Health Watch would need to explicitly consider potential feedbacks, trade-offs and non-linear changes leading to rapid destabilisation of essential planetary life support systems.

The proposed monitoring system could take advantage of a combination of technological innovations that increase data availability, processing, analysis, and communication capabilities. These innovations include remote sensing, crowdsourcing, cloud computing, smartphones, networks, robotics, artificial intelligence, and social media. It is now possible to monitor the Earth in near real time, analyse the resulting data, and share the results directly with decision makers and those in a position to influence them. By capitalising on these advances, the proposed Planetary Health Watch system would allow users to assess direct or indirect exposure to an environmental change responsible for a substantial disease burden. First, the system should monitor trends in health outcomes directly or indirectly (through predefined pathways) related to an exposure of interest. Second, it should consider trends in potential confounding factors (eg, improvements in diet or health-care coverage) which may modify the effects of specific exposures. Third, it should generate data on the funding and implementation of specific adaptation policies and technologies, as well as broader development policies that aim to reduce vulnerability to environmental change. Finally, it should estimate the health and environmental benefits of policies and technologies to reduce the environmental impacts of societies (eg, air pollution co-benefits of reducing greenhouse gas emissions), identifying important feedbacks, trade-offs, and synergies.

A Planetary Health Watch system would need to collect, combine, analyse, visualise, and share health and environmental data at different temporal and spatial scales to assess complex inter-relations, patterns, and trends. This process would require a combination of remote sensing, analysis of big data, and surveillance of vulnerable ecosystems and populations to monitor indicators of health and development in a range of settings. The system should make use of open-data sources as far as possible, including existing health surveillance systems, and cohort studies where available, to capture trends across different populations. The system would employ cutting-edge methods to link and attribute changes in health outcomes to environmental changes, including supercomputing and open-source artificial intelligence (deep learning) algorithms to process and analyse large datasets.

To detect and assess trends in exposures and health outcomes in vulnerable populations, it may be appropriate to collect data in sentinel sites.[8] Examples include populations living on small islands, in the Arctic,[9,10] or in arid or coastal regions that may be especially vulnerable to climate change or freshwater depletion or contamination; people living in or near waste dumps;[5] and rapidly urbanising populations, particularly in informal settlements.

There is a potential to integrate Planetary Health metrics into current health surveillance systems, such as the INDEPTH network that collects data for more than 4 million people living in 53 populations in 20 countries in Africa, Asia, and Oceania. Cause-specific mortality data is available from a range of sites.[11]

Globally, the population is shifting from rural to urban settings. There are a growing number of sources of urban environmental and health data, including the Multi-Country Multi-City Collaborative Research Network that makes use of available temperature and mortality data from more than 450 locations,[12] together with the SHUE database covering more than 250 randomly selected cities.[13]

The proposed system should interact with the Global Burden of Disease programme that has undertaken global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks between 1990 and 2015.[14]

Planetary Health Watch could both contribute to and be informed by efforts to monitor the Sustainable Development Goals, which are made up of 17 goals, 169 targets, and 231 indicators, capitalising on the work to develop a global dashboard and SDG index,[15] which permit monitoring of aggregate progress as well as spill-over effects. Such effects include net imported groundwater depletion, net imported emissions of reactive nitrogen and carbon dioxide, and biodiversity impacts. These indicators show where economic progress is achieved unsustainably.

In April, 2018, World Resources Institute (WRI) will publicly launch Resource Watch, an integrated earth monitoring system that brings together more than 200 datasets on water, food, cities, biodiversity, energy, forests, climate change, and oceans, together with socioeconomic data, to permit exploration and analysis of trends. Planetary Health Watch could build on Resource Watch's open-data architecture, and integrate data for human health. Resource Watch will provide a freely accessible, interactive, open-data, open-source platform for information on the world's most urgent global challenges, leveraging remote sensing, models, ground sensors, national statistics, and eventually crowdsourced data. Data are carefully selected and curated to ensure high quality and usability. Features included in Resource Watch include the following: signals (a regular stream of interactive data blogs at the intersection of environment and human development), planet pulse (real-time monitoring of key indicators of the state of the planet on a map-based interactive globe), dashboards (displays of thematic and geographical key performance indicators), applications (featured online and mobile applications, to help users manage specific risks), explore (where users can overlay, analyse, and share data in a map-based interface), and get engaged (where users can select from a range of activities, including signing up for alerts on hotspot issues or emerging trends).

Planetary Health Watch would need a governance structure to reflect the interests of potential users and contributors of data. It will require scientific input from a range of disciplines and geographical locations to provide advice on methods, reporting, communication, and use of results.

In preparation for Planetary Health Watch, the direct and indirect pathways by which environmental change can affect human health should be systematically assessed to prioritise those that are most relevant. Additional work is needed to identify target users, assess their data needs for decision making, prioritise potential indicators based on transparent criteria, identify an appropriate host institution, and design a fit-for-purpose governance structure. Planetary Health Watch will be indispensable for safeguarding health in the Anthropocene epoch and making it a reality should be an urgent priority.

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