Towards a Future Earth Health Research Agenda

Draft for discussion and input to the Belmont Forum

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Background

The purpose of this paper is to synthesize key research areas linking global environmental change and human health that could form the basis of a research agenda for the Future Earth Health KAN and feed into a formal recommendation to the Belmont Forum for a Collaborative Research Action. Further elaboration of the research themes below depends on close involvement with potential users of new knowledge (global, national, sub-national) to identify policy and programmatic applications. The proposed agenda synthesizes critical topic areas identified through a series of scoping meetings and consultative discussions held by the Future Earth Health KAN Development Team[1]. These research themes are a starting point; they will be amended following feedback from additional consultations and further co-design with selected stakeholders.

Research themes / work streams:

1. **Land use change, biodiversity loss and disease risk.** Broad links between health and biodiversity have been identified (Keesing et al., 2010; Lovell et al., 2014; Bernstein, 2014; WHO-CBD 2015; Sandifer et al., 2015; Whitmee et al. 2015). In general, declining biodiversity is associated with increased disease risk. However, the association is complex and variable across settings, and mechanisms and pathways are often not fully understood. Unprecedented land conversion for intensive agriculture, deforestation, and extractive industries (e.g., mining, logging) has led to the spread of known infectious diseases and the emergence of novel pathogens (Loh et al. 2015). These, in turn, can cause significant morbidity and mortality resulting in billions of dollars of economic loss annually (Pike et al. 2014). Linking ecological, epidemiological and economic models to weigh the human health and ecosystem services costs (currently externalities) against the benefits of converting land can directly inform policy on when, where and how to convert or protect land. While infectious diseases are the best studied human health outcomes in this context, other outcomes, such as mental health and non-communicable disease (NCD) risk, have rarely been assessed and could be usefully included in future research. Additionally, nature conservation can result in health benefits through a range of mechanisms e.g. through reduced air pollution, clean water, reduced vector borne disease risk and improving mood but the putative benefits need better quantification in a range of settings. Climate change can accelerate biodiversity loss and also lead to changes in the distribution and incidence of a range of infectious diseases including vector –borne, food and water-related diseases. Better understanding of the relative importance of different environmental drivers and their interactions is essential to inform more effective disease control strategies.

[1] Bellagio Center meeting; online survey; side events (e.g. during the UN General Assembly, United National Environment Assembly, and a conference on "Avoiding Catastrophe – Linking Armed Conflict, Harm to Ecosystems and Public Health")

2. **Food systems and nutrition.** Feeding the world's population remains a pressing challenge (Godfray et al., 2010). Human populations are growing, while globalization is spurring on a nutrition transition in low- and middle-income countries to diets high in fat and sugar, with major effects on global health particularly by increasing the risks of NCDs (Hawkes et al., 2006). The growing demand for food, in particular for animal-based products, are placing pressure on the world's food systems and on the ecosystems that support them. Additionally, climate change will impact on agricultural productivity, with the most negative effects in tropical and sub-tropical regions (Liu et al., 2013; Hertel 2016). There are important health implications, both directly via nutritional pathways, such as increased risks of stunting (Lloyd, Chalabi, Kovats 2011), and indirectly for example by increasing the impoverishment of subsistence farmers. Exposure to heat stress as a result of climate change will also threaten the livelihood of subsistence farmers and other outdoor workers in sub-tropical and tropical regions (Kjellstrom, Holmer, Lemke 2009). Understanding the simultaneous effects of multiple interacting social and environmental changes on nutrition and health is a key priority. Research could entail analyzing environmental and health consequences of the current and projected agri-food systems; developing innovative foods or production methods that optimize both health and environment outcomes; identifying and evaluating dietary changes that are culturally acceptable, economically feasible, healthy, and environmentally sustainable; and assessing combinations of strategies. A particular emphasis on research to address the vulnerability of subsistence agriculture to climate and other environmental stressors is needed.

3. **Urbanization and health.** The majority of the global human population now lives in urban centers. Cities are responsible for 85% of global economic activities and about 75% of greenhouse gas emissions. The effects of urban living on health and wellbeing vary widely, and are affected by wealth, social status, and specific features of the urban environment (WHO, 2016). In high and middle-income countries, urban health threats include air pollution, noise, barriers to physical activity, absence of green space, and in some cases social exclusion and poverty. Cities in low income countries confront all these problems, compounded by critical shortages of infrastructure (potable water, sanitation, electricity, waste management, transport), uncertain land tenure, poor governance, and other challenges (Eckert and Kohler, 2014; Rao & Peters, 2015; Li et al., 2016; Oni et al., 2016). Cities are subject to the urban heat island effect, which will intensify with climate change (Koomen & Diogo, 2017) and the built environment will be an important mediating factor – for example green space can reduce the health island effect and passive and active cooling of buildings may reduce the health effects of heat extremes. Many cities are susceptible to sudden disruptions, for reasons ranging from coastal locations subject to storm surges and sea level rise to precarious infrastructures; an important priority is understanding these vulnerabilities and building resilience. Research on urban health should continue to build on already existing work, utilizing complex systems approaches and innovative tools such as in situ sensors and smartphone-based geocoded personal data collection.

4. **Energy, health, climate change, and air quality.** Despite positive consequences for human development, the energy strategy that has brought us to the Anthropocene - massive combustion of fossil fuels - has created a host of negative health, environmental, and other outcomes (Smith et al., 2012; 2013). Meanwhile, in low- and middle-income countries, many people lack sufficient energy,

and available energy sources such as biomass (particularly when burned indoors in close quarters) bring many ill effects (Wilkinson et al., 2007). Among the most obvious of these ill effects is air pollution, both indoor and ambient, which accounts for substantial mortality (about 7 million deaths annually) and morbidity globally. Eighty-five per cent of fine particulate air pollution is related to energy use (International Energy Agency, 2016). Innovative energy strategies and technologies offer promise for health, equity, and sustainable development (Buonocore et al., 2016; Rosenthal et al., 2017); well-crafted policies can reduce GHG and short lived climate pollutant emissions whilst yielding co-benefits across multiple domains, including health (Haines et al, 2009; Smith et al, 2009). Research at the interface of energy, health, air quality, and climate change could help document the health and socio-economic effects of energy sources including biomass, manufactured biofuels, fossil fuels, and renewables; document the health effects of emerging technologies such as hydraulic fracturing; and analyze the health, socio-economic and environmental effects of strategies to promote clean renewable energy sources. Additionally, detailed scenario modelling for future health risks from a range of climate change projections resulting from different energy choices is warranted, e.g. building on Shared Socioeconomic Pathways (SSPs) (O'Neill et al 2014) to strengthen the representation of health. Results will help inform energy policy decisions in high, middle and low-income country settings.

5. **Disasters and extreme weather and climate events: vulnerability, preparedness, and response.** Global change is increasing the risks of a range of disasters at local to regional scales - some rapid and "kinetic" such as intense storms and floods; others such as heat waves and landscape fires; and still others, which may persist over months and even multiple years, such as droughts and pandemics. Disasters cause acute injuries and deaths, and follow-on impacts, including infectious diseases, mental illness, hunger, conflict, and population migration, can be severe (CRED, 2015). Often these effects are complex and inter-related, as in the outbreak of cholera in East Africa throughout the 2015-2016 El Niño. Research could help advance the science of disaster (impact based) event forecasting, the understanding of disaster impacts on disease dynamics, mental health, food systems, etc. as well as the practice of disaster preparedness and response, and the promotion of disaster resilience. This work could include evaluating the effectiveness of ecosystem-based strategies such as the protection of wetlands, coral reefs and mangroves and the effectiveness of social safety nets, and preparedness efforts, particularly in urban contexts. Climate change is expected to accentuate vulnerability to a wide range of extreme weather and climate related disasters, and increase population exposure to harm in the future. Future modeling and scenarios of future health risks, potential losses and damages to critical health infrastructure, including economic and societal costs of disaster preparedness and response is warranted using SSPs (see above). Such research could also contribute to our understanding of the limits to adaptation beyond which there are threats to habitability of specific locations, as a result for example of exposure to extreme heat stress or sea level rise in low lying regions. Research outputs can be used by local authorities, disaster management and line ministries, private sector, NGOs and other civil society partners involved in vulnerability reduction and resilience building efforts. In particular, vulnerability considerations should identify and address gender, socio-economic status, and other determinants of health that may contribute to inequity.

6. **Health in the Circular economy**. Current patterns of economic development are inherently inefficient and produce large amounts of waste including pollutants affecting human health. Much more efficient use of natural resources and energy together with more effective regulation of the use and disposal of potentially toxic chemicals can result in substantial benefits to health and natural systems. However, the effects of the dispersion of many chemicals in the environment leading to widespread population exposure are still poorly understood. For example, electronic and other waste is exported to low income countries where regulations are lax and many millions of people worldwide work in or live in close proximity to waste dumps (Lancet Commission on Pollution 2017 forthcoming). Contamination of freshwater with agricultural runoff and industrial chemicals is a serious threat to health in some parts of the world. The circular economy aims to promote greater resource productivity to reduce waste and avoid pollution including through reuse, recycling and increased durability of products. Whilst there has been exploration of the economic incentives and promising technologies that would support a circular economy (e.g. EU action plan for the Circular Economy), little is known about the implications for health. Health benefits could accrue from reduced exposure to toxic pollutants including through waste water recycling and reduced occupational exposures but there are also risks to health for example from poorly regulated recycling and trade in waste products. Health impact assessment should be integrated into evaluations of technologies and policies to support progress towards the circular economy.

7. **Supporting research and monitoring of GEC and Health.** There is no current mechanism to monitor planetary health on a global scale. National and regional networks have been set up to monitor different aspects of planetary health. For example, the community-based NDEPTH Network currently collects health and demographic surveillance data through 47 field sites on the life events of over three million people in Africa, Asia and Oceania, with links to local health care systems and universities. Global Disease Detection sites managed by the US CDC evaluate health risks among similarly-selected cohorts in a range of countries. The USAID-Emerging Pandemic Threats Predict project measures emerging zoonotic disease risk in around 30 countries. Other monitoring sites provide detailed data on biodiversity (e.g. Group on Earth Observations Biodiversity Observation Network, GEO-BON), disasters (the Emergency Events Database, or EM-DAT, at the Université Catholique de Louvain Centre for Research on the Epidemiology of Disasters, and the Global Risk Model and Disaster Information Management System "DesInventar"), climate, land use change and other environmental and societal indicators. The Lancet Climate Countdown process aims to monitor the effects of climate change on health, but there are many other environmental changes that affect health and thus a more comprehensive approach is needed. This community (e.g. The Future Earth Health KAN) could play a critical role in 1) development of integrated health metrics, indicators and tools, and 2) assessment of effective ways to integrate these different monitoring platforms to provide the first dedicated monitoring network, which provides publicly accessible data on progress on the protection of natural systems and human health, 3) pioneering how to incorporate data from integrated monitoring systems into future projections of the effects of climate and other environmental changes on health outcomes. Systematic reviews have profoundly influenced the practice of clinical medicine by ensuring that policy and practice recommendations are based on the best available evidence, minimizing bias and providing rigorous estimates of effect size of different interventions. The Cochrane Collaboration includes 37,000 contributors from more than 130 countries – who 'work together to produce credible, accessible health information that is free

from commercial sponsorship and other conflicts of interest '. Smaller initiatives such as Environmental Evidence have started to apply systematic review approaches to environmental issues, yet many more systematic reviews are needed. There is a need to adapt the methods used for systematic reviews in the clinical domain to reflect the complexity of relationships between environmental change and health and the range of effects of policies to promote health and sustainability. Research funders should support collaborative efforts to undertake systematic reviews and develop appropriate methods relevant to planetary health.

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