Building a methodological foundation for impactful urban planetary health science

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Abstract

Anthropogenic environmental change will heavily impact cities, yet associated health risks will depend significantly on decisions made by urban leaders across a wide range of non-health sectors, including transport, energy, housing, basic urban services, and others. A subset of planetary health researchers focus on understanding the urban health impacts of global environmental change, and how these vary globally and within cities. Such researchers increasingly adopt collaborative transdisciplinary approaches to engage policy-makers, private citizens and other actors in identifying and evaluating potential policy solutions that will reduce environmental impacts in ways that simultaneously promote health, equity and/or local economies—in other words, maximising 'co-benefits'. This report presents observations from a participatory workshop focused on challenges and opportunities for urban planetary health research. The workshop, held at the 16th International Conference on Urban Health (ICUH) in Xiamen, China in November, 2019, brought together 49 participants, and covered topics related to collaboration, data and research impact. It featured research projects funded by the Wellcome Trust's Our Planet Our Health (OPOH) programme. This report aims to concisely summarise and disseminate participants' collective contributions to current methodological practice in urban planetary health research.

1. Introduction

Cities are critical to the planetary health agenda as primary contributors to global environmental change, sites of high vulnerability, and centres for leadership in mitigating or adapting to such change.[1–3] City leaders and decision-makers grapple with the difficult challenge of achieving sustainable development objectives for current and future generations in the context of growing populations, widening inequalities, increasing resource scarcity, and other issues.[4] The Sustainable Development Goals (SDGs)[5] provide a broad structure to guide urban policies that will promote human health alongside environmental sustainability, including by addressing climate change; yet the SDGs require local interpretation to guide implementation in differing economic, social, cultural and environmental circumstances.[6,7] The policy mechanisms and interventions that cities should apply to tackle society's most pressing health and environmental problems are the focus of ongoing research and debate. This paper reports on the discussion and activities of a group of international urban and planetary health researchers, policymakers and built environment professionals who convened to discuss opportunities and challenges in urban planetary health research.

Planetary health has emerged over the last decade as a new field of enquiry focused on the health impacts of anthropogenic environmental change.[8] It overlaps and builds upon the related fields of ecological public health, One health and Ecohealth (among others) with regard to its general focus and methods, yet each field can be defined by slightly different emphases.[9] Rather than conceptualise these related fields as sequential and separate, Buse and colleagues recognise that they co-exist and overlap.[8] The *Rockefeller Foundation–Lancet Commission on planetary health* set the agenda for planetary health as follows: understanding the interlinkages between human health, civilisation and unprecedented environmental degradation; taking transformative action that confronts the complexity of the challenge; changing governance systems to integrate social, economic and environmental policy by using interdisciplinary knowledge; and adopting solutions that redress inequities.[10] Others have emphasized the role of solutions that involve changing behaviour among individuals, corporations and other societal actors.[11] There are clear synergies across research fields that investigate human health and environmental change, and

methods, theories and skills from many disciplines (e.g., public health, meteorology and social sciences) are key to addressing these critical challenges.

In addition to health risks arising from the climate crisis and other aspects of environmental degradation, many other characteristics of urban settings contribute to today's most urgent health challenges.[10,12] Population health challenges in cities emerge from rapid unplanned urban growth, a growing burden of non-communicable diseases, ageing populations, widening inequalities, and environmental change. Ettman et al. draw on multi-level and eco-social conceptual frameworks of health determinants that position urban factors (such as living conditions and communities) within a nested structure of complex forces that interact to affect health.[13,14] Krieger's eco-social constructs of embodiment, cumulative interplay, accountability and agency introduced critical concepts for urban and environmental health.[15] Through these multi-level and eco-social frameworks the complexity of urban planetary health research becomes apparent, as does the necessity for systems thinking and transdisciplinary approaches for research that will lead to action.

The complexity of urban and planetary health challenges is regularly emphasised, leading to calls for systems approaches and inter- or transdisciplinary approaches for both research and policymaking.[11,16] Systems thinking involves taking a holistic view of challenges using diverse sources of knowledge.[17] Such approaches seek to understand the many interconnected parts of a problem and how they are interrelated in reinforcing or balancing feedback loops that account for system behaviour over time.[18] Systems thinkers are attuned to decision-makers' proclivity toward short-term and reductionist perspectives, which often result in unintended consequences or policy failures.[12,17,19]

Inter- and trans-disciplinary research have varying (and contested) meanings and these terms are sometimes used interchangeably. Stokols et al. define interdisciplinary approaches as the 'integration of perspectives, concepts, theories, and methods from two or more disciplines or fields to address a problem' which they distinguish from a transdisciplinary approach that goes further to create 'fundamentally new conceptual frameworks, hypotheses, and research strategies that synthesize diverse approaches and ultimately extend beyond them'.[20] Some definitions of transdisciplinarity argue that it requires the involvement of 'actors from both the scientific community and other sectors of civil society (non-governmental organizations, community associations, and the private sector) in order to tackle real-world problems'.[21] In this paper we discuss research approaches that use both systems thinking (and modelling) and transdisciplinary approaches with non-academic partners to investigate and improve urban and planetary health.

This report focuses on planetary health in the urban context, in alignment with the research agenda of the Wellcome Trust's *Our Planet Our Health* (OPOH) programme, which comprises three domains as they relate to human health: climate change, global food systems and urban environments.[22] We co-organised a pre-conference workshop at the 16th International Conference on Urban Health (ICUH) on 4 November 2019 in Xiamen, China with participation from OPOH project teams involved in urban research and a wider urban health audience. This report aims to concisely summarise and disseminate participants' collective contributions to current methodological practice in urban planetary health research. We have organized the report by themes which represent key activities critical to developing, leading and managing large-scale research projects in urban planetary health, and to maximizing their real-world

impact. This report reflects upon workshop discussions in the context of wider literature, thereby contributing to ongoing discourse about the role of planetary health research in contributing to transformative change to improve health.

2. Workshop participants

Table 1 describes the six participating OPOH research projects and briefly describes their aims. Collectively, these projects span much of the globe, featuring transdisciplinary research conducted in partnership with local government, civil society, private enterprises and local communities. In addition to OPOH researchers, Wellcome supported a set of participants from low- and middle-income countries in attending and contributing to the workshop.

The workshop included a total of 49 participants, primarily urban health researchers or students, in countries including: Australia, Bangladesh, Canada, China, Colombia, Indonesia, Germany, Ghana, Mexico, UK, USA, Switzerland, Singapore and New Zealand. A broad range of disciplines and research areas were represented, including sustainable housing, mental health, agriculture, air pollution, community development, built environment and vector-borne diseases, urban food environments, water and sanitation, urban planning, public health/epidemiology, and environmental science. We gathered data throughout the workshop about participants' views and experiences. All participants received information about this research and provided written informed consent.

Table 1 Research projects funded by Wellcome Trust's Our Planet Our Health programme involved in convening the workshop

Project	Aims and Website
Complex Urban Systems for Sustainability and Health (CUSSH)	To conduct research and improve capacity to guide transformational changes in cities to meet environmental imperatives and improve the health and wellbeing of current and future populations by harnessing the benefits of sustainable policies and minimizing potential adverse consequences of global technological, environmental and social change. https://www.ucl.ac.uk/complex-urban-systems/
Pathways to equitable healthy cities (PATHWAYS)	To improve population health, enhance health equity and ensure environmental sustainability in cities around the world through co-production of rigorous evidence with policy and civil society partners in cities in six countries. http://equitablehealthycities.org/
Revitalising Informal Settlements and their Environments (RISE)	To provide the research-based evidence that a localised, water-sensitive approach to revitalising informal settlements in the Asia-Pacific can deliver sustainable, cost-effective improvements in health and the environment, paving the way for further deployments in the region and globally. https://www.rise-program.org
Salud Urbana en América Latina (SALURBAL), Urban Health in Latin America	To quantify the contributions of city and neighborhood-level factors to differences in levels of health and health inequalities among and within cities; to evaluate the health and environmental impact of city and neighborhood-level policies and interventions; to employ systems thinking to better understand the dynamic relations between urban environment, health and sustainability; and to engage with the scientific community, the public and policy makers to disseminate findings and translate them into policies and interventions. https://drexel.edu/lac/salurbal/overview/
Sustainable Healthy Urban Environments (SHUE)	To test the feasibility and methods of assembling data about the characteristics of a globally-distributed sample of cities and the populations within them for comparative analyses, and to use such data to assess how policies may contribute to sustainable urban development and human health. SHUE database available at: https://figshare.com/articles/SHUE_Database/7399094/1
Moving health upstream in urban development decision-making (UPSTREAM)	To conduct economic valuation of the scale of impact of the built environment on human health; and to investigate, in collaboration with those who control the development of our towns and cities, how we can minimise health costs. https://urban-health-upstream.info/

3. Fostering collaborative planetary health research

Tackling multifaceted, complex challenges such as planetary health in cities requires tools, expertise and knowledge from across different disciplines and sectors. Recent planetary health research has demonstrated the value of situated knowledge to identify locally appropriate solutions to adapt to the health-related impacts of climate change.[23,24] Integrating such diverse types of knowledge poses pointed challenges to effective collaboration.[16,25,26] The projects presented here have devised solutions to achieving such collaboration in practice; this section offers their practical and theoretical insights.

Many collaboration challenges were common across workshop participants. These included:

- *agreeing* upon the problem(s) to address;
- ensuring that contributions from all disciplines and perspectives were *valued*;
- *understanding* different views in light of differences in domain-specific knowledge, jargon and cross-national differences;
- *integrating* knowledge and perspectives across discipline and geography; and
- *satisfying* diverse disciplinary requirements while maintaining efficient project functioning and feasibility.

For example, the data collection in transdisciplinary studies, particularly in the context of longitudinal research designs, may pose challenges beyond those seen in single discipline studies. The need to maximise resource effiency while maintaining quality and incorporating principles from different disciplines involves ongoing negotiation and compromise. Such approaches also require greater time, logistical resources, and effort during day-to-day implementation, which in turn requires thoughtful planning and management. Each disciplinary facet of a study (e.g., those examining environmental quality, human health, or social responses) implies a distinct set of sampling time points, which in combination translate into frequent visits and sampling among study subjects. Researchers must ensure that the intensity of data collection is not burdensome for the subject, while continuing to convey thorough information on the purpose of each individual activity and the study as a whole. Furthermore, differences in language, research cultures, social norms and broader cultural context may impact on the way people are able to communicate with each other and build trust. These differences can significantly hinder collaboration if the initial key step of creating common ground is not given enough time or depth early in the project.

Participants identified three critical principles and associated sets of activities to foster effective collaboration across and beyond disciplines: capacity-building, knowledge sharing, and trust-building. *Capacity-building* in research was seen as a mechanism to support new understanding and tolerance of diverse perspectives, leading to potential improvements in integration. In the context of transdisciplinary projects, capacity-building refers especially to changes in the way researchers and different actors tackle working across disciplines, contexts and sectors. It focuses on efforts made to recognise diverse knowledge systems as equal and building common ground as the base for collaborative work. Mechanisms identified as effective for capacity-building included: co-authorship of outputs among project stakeholders of different levels of seniority; training activities; dedicated workshops; and

mentoring. Extensive *knowledge-sharing* was seen as critical, especially across income and geographic strata, and amongst academics, practitioners and policy-makers. Mechanisms include 'face to face' and virtual interactions, in addition to traditional, published, academic outputs or policy briefs. Finally, projects highlighted the necessity of *building trust* and establishing good rapport between actors from different sectors and disciplines in order to bridge diverse backgrounds, experience and knowledge. This requires continuous effort at project meetings and the use of facilitated team-building sessions (see box 1). Each of these principles requires dedicated project governance and administration structures, ideally co-designed, approved and maintained by representatives from all involved stakeholder domains.

Box 1: Temperature Check: a boundary-bridging simulation game to foster collaboration among diverse partners

At the workshop, participants trialed an interactive game ("Temperature Check") that aims to foster collaboration through discussion of planetary health among diverse project partners. Communicating uncertainty and building trust across different expertise areas and backgrounds often requires alternate forms of communication.[27,28] The concept of 'bridging boundaries' between scientists from different disciplines, policy professionals, and decision-makers at different levels offers communication insights for planetary health researchers.[29] 'Boundary objects', in this case, are concepts or information easily recognized by stakeholders from various domains—though used differently by each—that can form common ground for exploring differences and creating common understanding. They can connect conceptual borders between knowledge systems and they exist in many forms, including interactive games. Simulation games allow for reflection and the creation of a new, shared language that helps build trust between different actors. Playing such games requires participants to confront real problems by combining information from different disciplines and acknowledging local or tacit forms of knowledge. By highlighting the effects of decision-making, the game can also stimulate thinking about short- and long-term consequences of different options and serve as an introduction to systems thinking.

"Temperature Check" was commissioned by the Wellcome Trust and developed by Coney, a game-making company, to explore challenges of urban governance in the face of climate uncertainties and spark changes in thinking about planetary health.[30] The game puts players in the seat of political power, giving them the responsibility to make decisions that can both mitigate climate impacts and improve citizens' health. Players are confronted with scenarios and decisions that explore planetary health concepts such as: the relationships between environmental change and health, the challenges of decision-making in the context of budgeting constraints, and the criticality of local leadership in fostering effective collaboration for the greater good. The simulation deepens players' understanding of these issues and prompts consideration of whether and under which circumstances it is possible to adopt 'win-win' solutions. Workshop participants played for an hour in five groups. Players found the game highly useful in fostering discussion about implications, co-benefits and indirect consequences of decisions. It sparked debate over the role of uncertainty and other factors in making decisions for urban health in a climate change context. Participants from different disciplines, countries, institutions and projects were able to discuss challenges and opportunities in a low-risk setting that stimulated collaboration. Temperature Check could be particularly interesting to play with mixed audiences of decision-makers including policy professionals, researchers and urban citizens affected by changes in climate. It—and other games like it—can be useful in the initial stages of transdisciplinary research projects that seek to identify real-world solutions for more equitable and healthy cities.

4. Planetary health research data sources

The breadth and diverse forms of disciplinary and transdisciplinary data pose challenges for urban planetary health research projects. Research questions may be addressed by methods from many disciplines (e.g. epidemiology, policy studies and psychology) using quantitative, qualitative or mixed-methods data analysis approaches. To adequately explore research questions, data may be required across a range of topics and spatial levels, including, in some cases, individual-level health data[31] (see table 2 for a list of data types relevant to planetary urban health research). We used small group discussions to identify challenges related to data acquisition and use for urban planetary health research and to leverage the extensive experience of participants across different contexts to propose solution to these challenges.

Table 2 Examples of data sources for planetary urban health research

Health data	**Urban environment data**
Vital statistics Census data Population projections Surveys Cohort studies Disease registers Health service records (e.g. hospital admissions, insurance claims) Community-led enumeration	Census data Satellite imagery Open source data e.g. WorldPop[49], Global Urban Footprint[50], World Map Service layers[51], Global Human Settlement[52] Air quality monitoring stations Maps produced by local governments (e.g. administrative boundaries) and/or communities (community enumerations) Big data (e.g. to identify food stores from Google Maps or traffic from Waze) OpenStreetMap Global Bus Rapid Transit Data[53]

A range of challeges related to data acquisition and use were identified by OPOH projects and explored in the session (Table 3). Specifically for quantitative data, key challenges include: limited *availability* (including where data are unavailable at the required spatial scales or levels of disaggregation); limited *access* to existing data; lack of *standardization*, both within and between countries; variable data *quality;* and the potentially prohibitive *cost* of data. Data *management* can also be challenging, especially for urban planetary health research projects collecting primary data or samples, as the nature of the research implies the production and management of different categories of data, at times in large amounts. Data management systems must be accessibile to researchers from different countries and disciplines who may use different jargon or operational language related to data (or speak different languages), or who have significantly different ways of interpreting and interacting with data. For international collaborative research projects, regulations on data and sample sharing can be different for each country and although the premise of a collaborative research project is to work together, regulations in each country must be respected, especially in the case of sensitive data, such as biological samples.

Table 3 Challenges and solutions in acquiring and using data for urban health research. LMIC: Low- and middle-income settings

Theme	Challenges	Potential solutions
Spatial scale	Data are only available at regional or national level (not city or sub-city level) Data are only available at aggregate level (not individual level) Lack of expertise to handle and analyze geospatial data	Design studies and use data for the levels available Expand GIS training and make it accessible to LMIC
Accessibility	Data are owned by the private sector and are not shared with public/research sector Special permissions or contacts are needed to access data, including both 'official and unofficial processes'	Sign data sharing agreements Build trust and working relationships with data 'owners'
Standardization	Indicators are not harmonized across countries or across cities within countries Difficulties in linking across datasets because identifiers or definitions of geographic areas are not consistent	Promote standard definitions for key indicators and data collected Probabilistic data linkage Develop crosswalk datasets to ensure transparent and consistent linkages between datasets[32]
Quality	Undercounting in datasets (e.g. mortality, population) Cause of death not always properly registered in mortality data Data are not representative at the level of interest Measurement error in data e.g. green space from satellite imagery "Missingness" Manipulation of data for political reasons Gender-blind data	Use multiple data sources, when available When collecting primary data, use technology to improve recording Utilize correction methods for mortality data, see[34]
Cost	Data costs may be prohibitive (data that are not open source may be inaccessible for researchers in LMIC)	Exploit open source datasets (see Table 1)

Availability	Data of interest have not been collected Data are out of date	Crowd-sourced data Utilize citizen science to collect information about underrepresented populations Collect primary data for research, if feasible Develop machine learning methods to create new indicators from existing datasets/maps (e.g. street-view images) Exploit big data, including routinely collected data from health services Exploit global data sources, including those created by OPOH funded projects[32,54]

Multiple creative solutions were proposed for sourcing, managing, and appropriate use of data for urban planetary health research (Table 3). These include: data sharing agreements between public and private institutions; exploitation of open source data (see Table 2); exploration of big data (including routinely collected health data); use of methodologies such as data mining or machine learning to create new indicators from existing datasets; more extensive sharing and use of global datasets produced by large-scale urban health research projects, and collecting primary data on exposures and outcomes of interest (although this is not always feasible). This session demonstrated that, although existing data are never perfect, creative use can nonetheless enable progress on crucial issues in urban planetary health research. For example, the SALURBAL project created a data platform and system that integrates health outcomes with physical and social environment data to examine multi-level aspects of health across cities in 11 Latin American countries. Data were first compiled at city, sub-city and individual levels from a range of sources. They were then harmonized to allow for between country comparisons.[32] The system facilitates linkages of data across different levels. Data are now being used to answer a range of research questions related to urban health in Latin America (see[33,34]).

One important mechanism for data generation and management in urban planetary health research is the application of systems approaches. Indeed, methods from systems science can be applied to elicit and integrate quantitative and qualitative data from a wide range of stakeholders. Group model building and other participatory systems methods offer stakeholders an opportunity to hear diverse perspectives related to a problem and to explore the consequences of complexity, thereby increasing their own understanding (or 'mental model', see box 2) of the problem and potential solutions, whilst improving communication across disciplinary, sectoral and cultural boundaries.[35,36] For example, system dynamics modelling is being used in the CUSSH project to investigate household air pollution in Nairobi, combining qualitative data from participatory workshops with quantitative population and mortality data from the Nairobi Urban Health and Demographic Surveillance System (NUHDSS).[37,38] A subsequent workshop session explored the value of systems approaches for eliciting and using knowledge from diverse urban actors (Box 2).

Box 2: Mind mapping: exploring the value of participatory methods to understand complex problems

An interactive workshop session on 'mind mapping' was designed to encourage participants to think outside of their disciplinary lenses and embrace diverse knowledge forms. The exercise aimed to integrate different definitions of a given concept into a unified mind map, while allowing individuals to expand their own 'mental model' of the topic. A mental model is a 'psychological core of understanding'[39] – as distinguished from a 'mind map', which is a 'participant-centric visual representations of experience'[40] that graphically shows how participants link concepts. In this session, participants labelled themselves with their own discipline, and were divided into groups encompassing different disciplines. Each group was assigned a concept (for example, "safety," "standards," "wellbeing," "sustainability," "natural systems," "human systems," "modelling") and asked to draw a collective mind map. Participants explained the concepts from their own perspectives, identifying related terms and drawing relevant linkages (particularly cause and effect relations). After 15 minutes, some team members rotated to other groups, continuing the exercise with a new team. Over time, participants observed the expansion and eventual completion of the various mind maps. Sharing and learning about each other's definitions whilst seeing the visual mind maps expand helps foster the emergence of a common language among disciplines. This technique can be used to construct a more comprehensive view of a concept than is held by individual participants. At the end of the session, participants shared mind maps with the full group. Participants reported expanding their own mental models and learning new ways to think about other people's perspectives – valuable outcomes in the context of complex planetary health challenges.

5. Achieving planetary health impact

Transdisciplinary urban planetary health research is fundamentally solutions-oriented, with real-world impact of central importance. However, achieving impact poses significant challenges that vary across contexts. Indeed, what it means to achieve 'impact' is highly contested, and depends on individuals' knowledge, background and mental model of how research influences or should influence society.[41] One recent consensus definition adopted by research councils in the UK states that impact is 'the demonstrable contribution that excellent research makes to society and the economy.'[42] By virtue of directly connecting researchers with non-academic stakeholders within formal research structures and processes, transdisciplinary research may better avoid the pitfalls of traditional research, where evidence often fails to be meaningfully translated into action.[43,44] For urban planetary health research, emerging scientific evidence may be more impactful where researchers design research agendas in conjunction with non-academic partners to reflect real-world needs and priorities, build trusting relationships with decision-makers[25] and integrate non-academic team members into the strategic management of projects.[26]

In the current context, a workshop session addressed how urban planetary health research could influence 'upstream' urban policies and decisions that appear likely to improve health and sustainability.[45] Small-group discussion focused on urban development (i.e., construction of new housing and infrastructure), exploring the dominant factors controlling urban development across geographic, political and cultural contexts. Challenges associated with integrating health into urban development could be grouped into three broad categories: political dynamics (e.g. neoliberalism, short-termism, poor public awareness, corruption), private sector priorities (e.g. entrenched business-as-usual approaches, lobbying) and lack of

regulatory control (e.g. lack of resources/enforcement, established bureaucracy). Though all participants described challenges to achieving impact related to land, finance and delivery, the relative importance of each factor and locus of control varied strongly for different geographies. Indeed, primary control varied, with participants attributing it to national government (e.g. China, Singapore), large private-sector companies (e.g. UK, USA, Canada), or a combination of public and private ownership models and semi-informal settlements (e.g. Ghana, Indonesia).

While some participants seemed to be very familiar with the factors affecting research impact in urban development, there was an overall sense that these 'upstream' issues (i.e. control of key assets and processes in urban development) are outside the knowledge base of many researchers, not least those working in urban health. The discussion indicated key challenges that could inform future research, such as the wide variation in dominant factors of control across settings and, in line with previous work,[46] the corresponding need for context-specific approaches to engagement. There is an urgent need for planetary health researchers to engage more strongly with political and regulatory issues, in order to achieve impact, as noted in the UPSTREAM project.[26,45] Urban health researchers may need further support to engage with powerful private and public sector actors to influence change. The type of support required is likely to vary across economies and political systems in rapidly urbanising nations.

6. Conclusion

This article reports on a workshop to share learning about urban planetary health research across diverse disciplines, geographies and policy sectors. We acknowledged the challenges associated with investigating complex urban and planetary health topics, whilst proposing and learning about creative solutions. This report provides the wider research community with a summary of our collective contributions to current global methodological practice on urban health and sustainability.

We end this report noting that planetary health is not a hopeless research pursuit, but one that requires optimism, courage to work outside of our comfort zones and willingness to try new ways of working. However, those being trained to carry forward the field of planetary health face challenges in bridging evidence to action.[47] Communication to audiences including policy-makers requires tailoring the level of complexity to the audience, such that clear messages can be used to guide action even as specialists seek to understand nuanced and interdependent causal processes. When distilling evidence through economic valuation, we should recognize the limits of existing methods to incorporate long-term social and environmental outcomes. In addition to the disciplines and partners represented in the workshop, engagement with public relations and communications experts may help to tailor research findings that will reach people on an emotional level to catalyse change.[48]

Contributions

JS proposed the workshop contents and structure, which were further developed by all authors. All authors participated in preparing and running the workshop. HP wrote the introduction, workshop participants, and conclusion sections and edited the paper. CA wrote the section on collaboration. CPF and JM wrote the data section. DB, EG and YN wrote the impact section. All authors commented on drafts.

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Conflict of interest
None declared.

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