Chapter 23

Health in a borderless world: global health complexity

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Abstract

Globalisation affects health through extensive and complex linkages; the way different factors and developments interact is critical to how the system as a whole works. This chapter elaborates on the increasing recognition of systems approaches to global health. One of the first steps in applying a system-based approach to global health entails describing the system involved; here we present a conceptual framework for globalisation and population health. The involvement of interaction and feedback means that the system can be considered as a coherent network which acts as a determinant of global health. This challenges epidemiologists and health scientists to extend their conventional methodological boundaries. We argue that the research paradigms and methodologies applied in sustainability science can provide a promising way forward to address complex global health issues from a systems perspective. The chapter concludes with a brief discussion of possible barriers to adopting a sustainability science approach to health, in an effort to explain the slow progress made so far.

23.1 Introduction

Global health research addresses the ways in which globalisation is impacting on health determinants and health outcomes (Lee, 2003). In the past, globalisation has often been seen as a predominantly economic process characterised by increased deregulated trade, electronic communication and capital mobility. However, it is now increasingly perceived as a more comprehensive phenomenon shaped by a multitude of factors and events, which is rapidly reshaping our society. Based on the work by Scholte (2005), Held et al (2000), and Rennen and Martens (2003), we define globalisation as "a process characterised by a growing intensity, extensity and velocity of institutional, economic, socio-cultural and ecological interactions, resulting in trans-border processes and effects" (Huynen, 2008).

Since globalisation is not happening in a void, neither are its health risks. The dominant Newtonian scientific worldview – characterised by reductionist approaches – might no longer be sufficient. Globalisation affects health through extensive and complex linkages; the way different factors and developments interact is critical to how the whole system works. Global health cannot be disassembled into its constituent elements and then reassembled in order to develop an understanding of the system as a whole. Thus, by taking a traditional reductionist approach, we would miss the bigger picture. Nevertheless, reductionism remains the traditional and dominant epistemological approach in epidemiology[56]. This means that individual health determinants are studied, rather than the system of health determination as a whole; study designs focus on isolating cause–effect relationships, rather than exploring system interactions.

Stressing the need for a system-based approach to global health, this chapter first briefly elaborates on the increasing recognition of the complexity of global health, and subsequently discusses a conceptual model describing multi-causality within the global health system. Accordingly, we argue that research (and policy) in the field of global health requires a systems approach, building on insights and methodologies from sustainability science. The chapter concludes with a brief discussion of possible barriers hampering the adoption of a sustainability science approach to health, in an effort to explain the slow progress made so far.

23.2 The complexity of global health

The recognition that many issues should be studied as a whole has played an important role in the development of complexity theory. Complex systems encompass many

[56] Epidemiology is the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems. (http://www.who.int/topics/epidemiology/en/).

entities interacting with each other, and the variety of these interactions allows the system as a whole to undergo self-organisation. As a result, complex systems have the ability to adapt and co-evolve as they organise through time; they are characterised by emergent system properties, non-determinism, non-linearity, feedback loops, and bifurcation points (Pearce & Merletti, 2006; Waldrop, 1992). Table 1 provides an overview of the most important differences between the (traditional) Newtonian and complexity paradigms. Following its growing influence in the natural sciences, complexity theory has “begun to spill onto the edges of the social sciences as well” (Urry, 2005b), and various scientists studying the processes of globalisation – often implicitly – draw upon concepts and ideas from the field of complexity theory (see e.g., Knorr Cetina (2005), Urry (2003, 2005a), and Castells (1996)).

In line with this development, the past decade has witnessed a growing recognition of the multidimensional and multilevel causation of population health. An ever growing number of health researchers (Albrecht et al., 1998; Colwell, 2004; Huynen, 2008; Huynen et al., 2005; Lang, 2012; McMichael, 2005; Pearce & Merletti, 2006; Wilcox & Colwell, 2005) argue that the health of a population can – or must – be viewed within the broader system of health determinants. Risk factors for disease do not operate in isolation, but occur in a particular population context (Pearce & Merletti, 2006). Upstream or contextual forces play an important role in global health research (Sreenivasan & Benatar, 2006) and may have large impacts, although their effects are non-linear and less predictable (Philippe & Mansi, 1998). As our attention moves upstream in the causal chain of health determinants, there has been an increasing interest in multilevel and systems approaches (McMichael, 1995, 1999; Pearce, 2004; Pearce & Merletti, 2006). Various terms have been used to describe this broader approach to our health, such as eco-epidemiology (Ladd & Soskolne, 2008; Martens, 1998; Soskolne & Broemling, 2002; Susser & Susser, 1996), ecological perspective on health (McLaren & Hawe, 2005), socio-ecological systems perspective on health (McMichael, 1999), ecosystem approach to public health (Arya et al., 2009), ecological public health (Lang, 2012; Morris, 2010) and biocomplexity approach to health (Colwell, 2004; Wilcox & Colwell, 2005). As Soskolne et al. (2007) stated, we “must embrace greater complexity” as “the traditionally used, reductionist, linear approaches are inferior for understanding the interactive webs that are critical for sustainable development and for the health and well-being of future generations.” Similarly, the WHO (2009) argues that systems thinking works to reveal the underlying characteristics and relationships of systems.

Few would deny that globalisation has greatly added to the causal complexity in public health (Morris, 2010) and insights from system-based or complexity approaches have also been increasingly recognised in the field of global health (Huynen, 2008; Huynen et al., 2005; Martens et al., 2011; Soskolne et al., 2007) (see also Table 23.1). As a result, the acknowledged complexity of synergistic global interconnections calls for systems approaches to global health (WHO, 2011).

Table 23.1 Different perspectives on science: the Newtonian paradigm versus the complexity paradigm (Huynen, 2008).

Newtonian paradigm	Complexity paradigm	Implications of complexity in global health
Reductionism: Developing an understanding of a system's constituent parts (and their interactions) is the best way to develop an understanding of the system as a whole.	Holism/contextuality: Complex systems should be studied as a whole; they can have emergent properties that are not explainable from the sum of their (reductionist) parts.	The processes of globalisation and population health are modified by multiple factors, which cannot be studied in isolation from each other. Global health impacts depend on the interplay between many developments, which together form the broader context of population health. Hence, the underlying processes interact at various scales; they are often not fully understood and they might behave in non-linear and unpredictable ways. As a result, system-based or complexity approaches are needed.
Systems respond in a predictable way according to universal laws.	Systems respond in unpredictable ways.	
Linearity: A direct and proportional connection can be established between each cause and effect.	Non-linearity: A small perturbation may cause a large effect. This is often called the "butterfly effect" (see also chaos theory). Tipping points may be reached when the system passes a particular threshold.	
Systems tend towards equilibrium and are driven by negative feedback.	Systems are inherently unstable and positive feedback-driven processes are common.	
Non-historical (time-reversible).	Path-dependence (time-irreversible): complex systems are dynamical systems – they change over time, and prior states may influence present states.	
Uncertainty is a symptom of bad science and needs to be reduced.	Uncertainty is inherent to complex systems and needs to be acknowledged.	Any exploration of health effects of globalisation is surrounded by uncertainty. This uncertainty leads to the introduction of normativity and plurality. As a result, normative choices and transdisciplinary approaches are needed.
Deterministic, one possible future.	Non-deterministic/stochastic, multiple futures are possible.	

23.3 Taking a systems approach: a conceptual framework for globalisation and health

One of the first steps in applying a system-based approach to global health entails trying to describe the system involved. This effort should indicate the importance of studying proximal causes in their broader context. In order to further illustrate this broader context of global health, Figure 23.1 presents the conceptual framework for globalisation and population health developed by Huynen et al. (2005). This framework combines the nature of health determinants and their level of causality into a basic framework that conceptualises the multi-causality of population health.

In order to differentiate between different types of determinants, the customary distinction is made between institutional, socio-cultural, economic, and environmental determinants. These determinants operate at different hierarchical levels of causality. The chain of events leading to a specific health outcome includes both proximal and distal causes: proximal factors act directly to cause disease or health gains, while distal determinants are positioned further back in the causal chain and act via intermediate causes. In addition, contextual determinants play an important role. These can be seen as the upstream macro-level conditions shaping the distal and proximate health determinants; they form the context within which the distal and proximate factors operate and develop. Within this framework, the processes of globalisation (including global environmental changes) operate at the contextual level of health determination, influencing distal health determinants. In turn, the changes in distal factors have the potential to affect the proximal determinants and, subsequently, health. Determinants with different positions in the causal chain probably also differ in their temporal dimensions. Individual-level proximal health risks can be altered relatively quickly, for example by a change in personal behaviour; changing disease rates in whole populations requires slower and more permanent changes in contextual factors, often over the course of a few decades (Huynen, 2008).

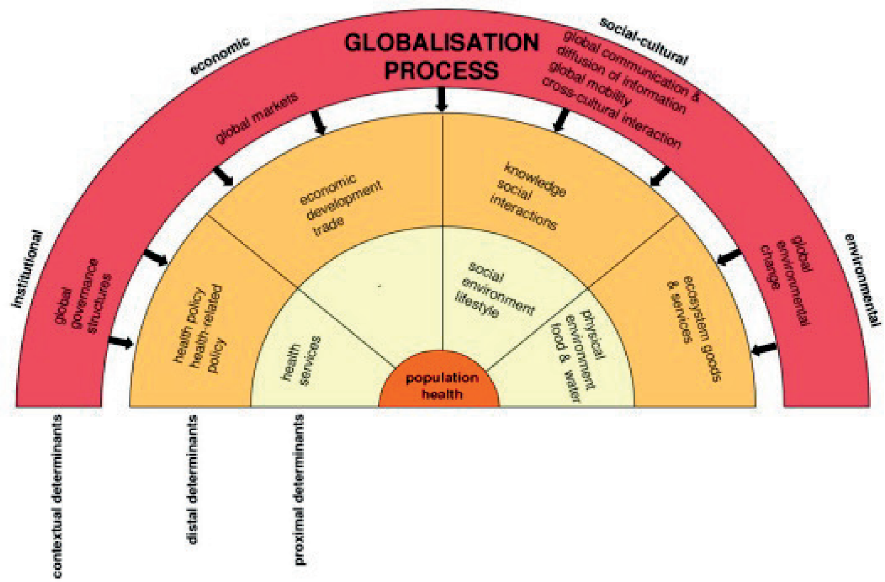

Figure 23.1 The health impacts of globalisation: a conceptual framework (Huynen, 2008; Huynen et al., 2005).

The involvement of interaction and feedback means that the whole can be considered as a coherent network which acts as a determinant of global health; the outcomes of these interactions will vary across geographical locations, but also across different disease outcomes.

23.4 Sustainability science for global health

Although problem framing in order to comprehend all relevant variables within the global health system is an important step forward, it might represent only the tip of the iceberg. Within this system there are dynamic processes and feedback loops, resulting in emergent system properties (i.e. the whole is greater than the sum of its parts), points of bifurcation and possible tipping points. There is little doubt that a system-based approach and related methodologies are needed to underpin research into global health. This challenges health scientists, as well as scientists and practitioners in other disciplines, to extend their conventional methodological boundaries. To date, however, a huge gap is apparent between paradigm and practice. Yet, innovative methods and tools are emerging in other fields, providing examples of what is available and conceivable to advance further systems research exploring future health in order to support decision-making processes (Soskolne et al., 2009).

We argue that the research paradigms and methodologies applied in sustainability science (Kates, 2011; Kates et al., 2001; Kerkhoff, 2014; Martens, 2006; Miller, 2013; National Recource Council, 1999) can provide a promising way forward to address complex health issues from a systems perspective. Over the last decade, sustainability science has emerged as an interdisciplinary and innovative research field conducting problem-driven and problem-solving research that links knowledge to action. Central concepts in sustainability science are systems thinking, complexity, and uncertainty. As a problem- and solution-oriented field, sustainability science is inspired, inter alia, by concepts of Mode-2 science (Gibbons et al., 1994) and post-normal science (Funtowicz & Ravetz, 1993, 1994; Ravetz, 1999). This also requires corresponding research practices, such as transdisciplinary approaches (Lang et al., 2012) and the co-production of knowledge (Kerkhoff, 2014). Hence, a sustainability science approach to global health should account for a number of shared research principles such as transdisciplinarity, participation of non-scientist stakeholders, co-production of knowledge, recognition of uncertainty and system complexity, and the quest for an exploratory science instead of a predictive one.

Box 23.1 Sustainability science for health research: the state of affairs

Scenario analysis of future health: A system-based approach implies less emphasis on prediction, but simultaneously a greater emphasis on understanding the processes involved, acknowledging (inherent) uncertainties, and exploring alternative health futures. In sustainability science, scenarios analysis is used as a tool to assist in the understanding of possible future developments of complex systems, focussing on the interaction between multiple factors according to a set of internally consistent future pathways. Scenarios can be described as plausible but simplified descriptions of how the future may develop, according to a coherent and internally consistent set of assumptions about key driving forces and relationships (Swart et al., 2004). Looking at the main global-scale scenario studies, it can be concluded, however, that the health dimension is largely missing (Huynen, 2008; Martens & Huynen, 2003). Many of the emerging foresight studies and initiatives in health mainly focus on health systems and health care (e.g. European Health Futures Forum).

Modelling the health system: In modelling population health, traditional epidemiological approaches mostly use regression techniques to explore the relations between health determinants and health outcomes (Galea et al., 2010; Soskolne et al., 2009). However, these usually provide only limited insight into the dynamics underlying changing health patterns; a fundamental limitation remains in addressing interacting relationships within the system (Galea et al., 2010). Hence, there is growing interest in adopting innovative model approaches in health research that allow for causal influence at multiple levels, as well as interactions among system variables, feedbacks, and non-linearity (Galea et al., 2010; Mendez, 2010; Sterman, 2006; Trochim et al., 2006). Moreover, health scientists can learn from other fields that have been applying such simulation approaches, such as systems biology, ecology and environmental sciences, and organisational science (Galea et al., 2010).

Transdisciplinary/participatory methods: The use of transdisciplinary/participatory methods is more exclusively linked to the emerging paradigm of post-normal science. The omnipresence of uncertainty in complex systems allows for different valid views on the essence and functioning of these systems, introducing plurality and normativity. As a result, the involvement of an “extended peer community” is considered a superior form of knowledge production and quality control. Hence, the involvement of actors from outside academia in the research process is also seen as a key component of sustainability science; it facilitates the integration of the best available knowledge and co-production of knowledge, the identification and reconciliation of values and preferences, as well as creating ownership of problems and solutions. Although transdisciplinary, community-based, interactive, or participatory approaches have been suggested in order to meet these goals (Lang et al., 2012), transdisciplinary approaches are not yet commonly applied to address complex public health challenges (Haire-Joshu & McBride, 2013).

Box 23.1 provides examples of common sustainability science methods that could be applied to global health in order to advance further research (Soskolne et al., 2009). However, it is important to note that the selection of a specific method and its application to a specific topic or case study are highly dependent on the context of the assessment. Additionally, an integrated assessment is best supported by a combination of tools (see e.g., Valkering (2006) and van Asselt (2001)). For example, participatory processes can contribute to model building by revealing different perspectives on model structure or key components, and to scenario development by revealing different perspectives on vital uncertainties and possible futures. Scenarios can be used as input for simulation models in the face of uncertainty and as input for participatory processes. Finally, simulation models can be used as input for participatory processes and can provide input or validity checks for scenarios by, for example, defining realistic ranges for key aspects of scenarios.

23.5 The need to overcome barriers

Thus, there is a need to broaden the traditional reductionist view on disease causation in order to account for a multilevel understanding of disease aetiology and the interrelations among these multiple health determinants (Galea et al., 2010). Linear, reductionist approaches to research questions – focusing on proximate cause-and-effect relationships – have characterised much of what epidemiology has contributed to public health in the second half of the 20th century (Soskolne et al., 2009). As a result, however, the exploration of long-term and complex risks to human health seems far removed from the tidy examples that abound in textbooks of epidemiology and public health research. System thinking and sustainability science challenge the epidemiological concern with studying single causes of disease in isolation; due to their training, epidemiologists and public health researchers are less accustomed to studying causes within a systems context or addressing far longer time frames than the current boundaries used in the health sciences and the formal health sector (Martens & Huynen, 2003).

A sustainability science approach to global health also implies recognising that there is no single discipline or single operational method for systems thinking (Leishow & Milstein, 2006). Such interdisciplinarity requires health researchers to be particular open to and learn from the contributions of other traditions and approaches. Moving even beyond research collaborations among and across disciplinary boundaries, transdisciplinarity requires the involvement of, and collaborations with, non-academic stakeholders from business, policymaking and/or civil society. However, scientists taking a more conventional research perspective, such as traditionally trained epidemiologists and health researchers, might question the reliability, validity, and other epistemological and methodological aspects of this type of research (Lang et al., 2012).

From a more practical perspective, transdisciplinary research is a relatively new field, still in need of further development in order to overcome its teething problems. Lang et al. (2012) recently published a very elaborate overview of the main challenges (and possible coping strategies) in conducting transdisciplinary research, including difficulties concerning design principles (e.g., lack of joint problem framing, selection of stakeholders/team members), methodological issues (e.g., conflicting methodological standards, discontinuous participation), and problems in the application of co-created knowledge (e.g., lack of transferability of results). They conclude that further development of the practice of transdisciplinary research requires "continuous structural changes in the academic system in order to build capacity for transdisciplinarity among students and researchers". The identified (practical) research challenges, as well as their conclusions about the need for capacity building, seem equally valid as regards conducting transdisciplinary research in the field of health and sustainable development.

Furthermore, the use of complex systems dynamic modelling approaches demands a shift from singling out a single cause as the main research objective to a focus on understanding interactions and interrelations between various causal factors operating at multiple levels, in order to examine how these relationships (and feedbacks) contribute to the emergence of disease patterns within a population (Galea et al., 2010). These models need to be parameterised with observational (epidemiological) data, but this data needs to be applied in a creative way, combining information from disparate sources and allowing for assumptions to be made in order to create simulation models in the face of imperfect data and uncertainty about parameter values, relationships, and future developments. Accounting for a system's complexity and uncertainty will also require a conceptual shift for epidemiology and public health – from statistical association models focused on observed effect estimates to simulations of complex dynamic systems of health determination in which we test scenarios under different conditions (Galea et al., 2010). Thinking critically about "what-if scenarios" entails moving from a predictive science trying to eliminate uncertainty to an exploratory science faced with (inherent) uncertainties.

Hence, as emphasised by Galea et al. (2010), lack of familiarity with methods and limited training in their implementation are probably enough reasons to delay epidemiologists' adoption of system-based approaches. But despite the fact that health scientists might feel comfortable with more reductionist approaches and are consequently slow adopters of systems thinking, we have to face the reality that what is at stake here are complex real-life health risks that need to be understood and addressed in the face of many system interactions within the global health system. However, we emphasise that global health researchers do not have to start from scratch; by building on the expertise already available within the sustainability science community, they might even become pioneers in further applying such a (complex) systems approach to health-related issues.

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