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The transdisciplinary knowledge journey: a suggested framework for research at the water-health nexus

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The water-health nexus represents the intersection at which issues of water, sanitation, and human health collide. This collision is of crisis proportions at present. This paper will briefly outline the crisis, discuss some theoretical lenses through which we might view the crisis with an aim to action, review the importance of the knowledge journey with respect to linking evidence with action, and conclude with some reflections and next steps. In essence, if we do not adopt a contextualized theoretical lens through which to address the transdisciplinary nature of the problems requiring action at the water-health nexus, we will never succeed — from a scientific or moral imperative — of meeting global human needs.

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Introduction

Access to safe water, considered a basic human right by many, is far from reality. Almost one billion people lack access to safe water while 2.5 billion lack access to adequate sanitation [1]. Estimates indicate that water borne diseases account for approximately 10% of the global burden of illness; for example, 1.4 million children die each year as a result of diarrhea and one in five children born in the developing world will not reach their fifth birthday due to mortality from water borne diseases [2]. Chronic diarrhea and resulting malnutrition in childhood results in cognitive impairment that further affects educational attainment and hence subsequent economic and earning potential [3]. These impacts will be severely increased in the face of global climate change. However, it is widely recognized that inadequate access to safe water, especially in poorer countries, is the prime cause of premature mortality and '. . .this human and environmental cost outweighs massively the predicted negative human consequences of global climate change' [4].

Issues of water and sanitation are inextricably linked; without access to adequate sanitation, many communities practice open defecation. The result is the contamination of what precious water resource may be available. The impacts of practicing open defecation also relate to access to education for girls once they reach the age of menstruation; with no place for dignity, they end up missing school entirely. There are also other dangers for girls and women who practice open defecation; in searching for privacy in dark, remote areas they leave themselves open to violent and sexual attacks.

In 2007, the *British Medical Journal* declared the Sanitary Movement of the 19th century as the single most important medical advancement in the last 150 years resulting in dramatic drops in rates of cholera, typhoid, and other infectious diseases leading to substantially increased educational and economic activity in otherwise marginalized communities [5]. And yet, 2.5 million people in the world — one-third of the world's population — continue to go without.

In the year 2000, the member states of the United Nations came together to establish eight millennium development goals (http://www.un.org/millenniumgoals/) to be reached by the year 2015. The eight goals relate to: ending poverty and hunger, provision of universal education, gender equity, etc. With respect to water and sanitation, the target is to cut in half, by 2015, the number of people in the world without access to safe water and adequate sanitation. While we are close to meeting the target with respect to water, we are far behind on the sanitation target. It is obvious, then, that meeting the water target is not attainable nor sustainable; without adequate sanitation, water supplies will continue to be recontaminated and the cycle of illness and poverty will continue.

Indeed, even if there was any possibility of meeting the Millennium Development Goals (MDGs) for water and sanitation, fully one half of the population in need will still be underserved.

Theorizing water-health and well-being

A tripartite theorization of this crisis is necessary to reflect its fundamental multidisciplinary nature. As such, I draw on embodied epidemiologies [6], systems theory/ecosystems health [7•,8], and understanding the hydrosocial cycle [4,9•].

Krieger [6,10] writes on the notion of *embodiment* and its importance to understanding the determinants of health

and well-being. She postulates, quite rightly, that we are concomitantly social beings as well as biological organisms, the recognition of which provides the foundation for her three critical claims. The first of these is that bodies tell stories about — and cannot be studied divorced from — the conditions of our existence. The second is that bodies tell stories that often — but not always — match peoples stated accounts. Finally, bodies tell stories that people cannot or will not tell either because they are unable, they are forbidden, or they choose not to. For example, food insecurity, inadequate sanitation, lack of safe water, inadequate access to health care, all leave their marks on the body. As do adequate access to health care, the security of a living wage, or societal support for childcare. As a result, she concludes, from the conditions of our bodies one can gain insight into and understanding of the workings of the body politic (who has access to safe water and sanitation; under what conditions; at what cost). In short,

the ecosocial premise is that clues to current and changing population patterns of health, including social disparities, are to be found chiefly in the dynamic social, material, and ecological contexts into which we are born, develop, interact, and endeavor to lead meaningful lives [10, p. 350].

This ecosocial approach to understanding health (inequalities) postulated by Krieger [11] is actually grounded in general systems theory [7] which has long provided a foundation for ecosystems research [8]. Essentially, systems theory tells us that everything is related to everything else and in order to understand how the world works, we need to understand each component part of the system and the interactions between them. These notions translate nicely into the practice of ecosystems research, wherein a healthy ecosystem is defined as:

a comprehensive, multiscale, dynamic, hierarchical measure of system resilience, organization and vigor. These concepts are embodied in the term 'sustainability', which implies the system's ability to maintain its structure (organization) and function (vigor) over time in the face of external stress (resilience). A healthy system must be defined in light of both its context (the larger system of which it is a part) and its components (the smaller systems that make it up) [12, p. 3].

As is the case with embodied epidemiologies, it is essential therefore to understand the contexts within which health occurs in order to understand its determinants, change human behavior and sustain health and well-being, particularly in the face of challenges to the system (e.g., cultural norms related to gender roles; political strife; climate change). So, for example, the use of an ecosystem approach allowed Forget and Lebel [13] to illustrate that mercury poisoning of fish and impending health risks for humans in the Amazon basin were not due to gold mining (occurring up stream) but rather to soil erosion, following deforestation in the area.

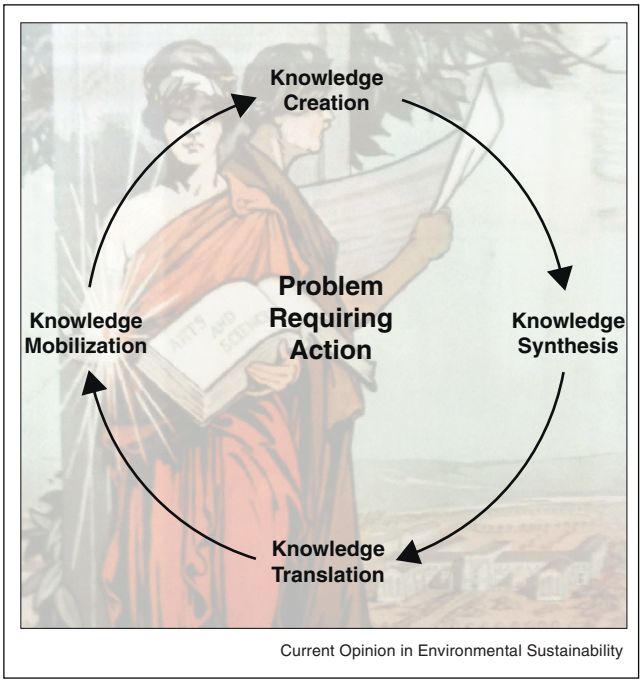
The concept of the hydrosocial cycle is relatively new to the literature [e.g., 9•,14] despite the fact that it makes such intuitive sense to our understanding of the water-health nexus. That is, the hydrologic cycle — familiar to many — explains the circulation of water and moisture through our physical world, enjoining the processes of precipitation, evapotranspiration, condensation, run off, stream flow, etc. In contrast, the hydrosocial cycle builds on the foundation of the hydrologic cycle of course, but accounts for the social, political, cultural, and economic systems that govern the flow of water through societies; who has access? To how much? At what cost? Answers to these questions will provide essential input to the design and success of intervention strategies in the context of linking evidence to action. For example, Budds [9•] uses this approach to explore inequalities in access to water in Chile.

The transdisciplinary knowledge journey

The theoretical lenses outlined above, through which we can view the crisis at the water-health nexus, underscores the need for multiple sciences and multiple scientists to address the problem. It is not just how much water there is, but who has access? What are the power relations in the society through which this water flows? And how is this range of sciences (both human and natural) going to be able to adapt/incorporate a changing corporeal world in the face of global environmental change? Finally, and perhaps most importantly, how do we translate evidence into action?

Many have suggested that we use a *multidisciplinary* approach to the crisis. Herein, we have — for example — natural scientists working on aspects of access and water quality, engineers working on developing new technologies, and social scientists addressing issues of gender and culture vis-à-vis provision of water at the local level. But they do not talk to each other in any meaningful manner; so, for example, the natural scientists are not aware of the fact that the women may continue to use contaminated water supplies located closer to home to address their household needs, because traveling an extra few kilometers each day to fetch water just adds so much more to their burden, they do not see the advantage. We also sometimes talk about using an *interdisciplinary* perspective, where the same set of scientists may be coming together around the same water issue, but there is actually on-going communication — they do talk to each other. But that talk does not inform the nature of the (research) questions being asked; this is the fundamental tenet of a *transdisciplinary* approach, where a wide range of scientists work with community to develop and design appropriate research initiatives that inform problem solving and serve to link evidence to action. There are relatively few examples of such an approach in the water-health literature (see [15] for an exception).

Figure 1



The Transdisciplinary Knowledge Journey.

This does not always involve starting from scratch; knowledge is a journey (Figure 1). *Knowledge creation* activities involve the discovery of new information. For example, a transdisciplinary team of researchers embarked on an exploration of knowledge, attitudes, and practices related to the water-health nexus in a rural village in Kenya, on the shores of Lake Victoria. This team of natural, clinical, and social scientists — working together in a transdisciplinary manner — discovered that although issues at the water-health nexus are at the center of the community's health status, the greatest problem — and most substantial barrier to achieving access to safe water and sanitation — is lack of social capital [16•]. These results implicitly shape the intervention stage of this activity, away from the provision of new/accessible technologies to community trust building activities.

Knowledge synthesis involves taking existing knowledge that is fractured, disparate, and unorganized and synthesizing it in such a way that it becomes *useful* to policy and decision makers, as well as researchers who are designing the next steps in a long-term research program. A quintessential example here involves the very useful policy briefs produced by the United Nations University Institute for Water, Environment and Health (available at http://www.inweh.unu.edu/). Herein, disparate knowledge is brought together in a coherent whole in order to inform the evidence-action link. In one particular case, this included the knowledge of voices from the field, not available in any other fora [3]. *Knowledge translation* occurs as part of the development of an evidence-to-policy framework. Herein, knowledge creators (i.e., researchers, sometimes with the help of knowledge brokers, and always with the help and support of receptor groups) translate knowledge to user and/or receptor groups in meaningful ways. For example, a knowledge translation initiative in India has women working with NGOs in the provision and maintenance of community and household, as well as child-friendly, toilets. As a result, open defecation has been virtually eliminated in this area (Truchhappall) [17]. We ultimately strive to achieve *knowledge mobilization* as part of this knowledge continuum. Herein, we see an evidence based initiative that mobilizes knowledge from receptor to receptor, essentially incorporating an active as opposed to passive form of knowledge movement. For example, a World Bank evaluation of over 100 water projects found that project effectiveness was increased by more than six times when women were involved in spreading the knowledge directly to other women [17].

Where we find ourselves in this iterative loop on the knowledge journey is defined by the problem requiring action and, *vis-à-vis* the theoretical lenses discussed above, the ecosocial context within which we find ourselves. It is also essential to point out that regardless of the stage we are in with respect to the knowledge journey, one must also review one's epistemology to discern what constitutes 'knowledge'. In all cases, this should include — often privilege — indigenous knowledge of those affected by the problem requiring action [18,19].

Conclusions

The knowledge journey is a continuous one (Figure 1); we will never quite reach our destination, as new and emerging issues and concerns confront us at the water-health nexus. For instance, we may indeed reach the MDG target for water; but where does that leave the underserved population remaining?

Further, the knowledge journey is continually impacted by changing secular conditions; on our plate, at present, is global environmental change. This could represent climate change, demographic change/movement, economic change — the array is endless. As this wider 'context' evolves, so too will the problems requiring action, and the knowledge steps we need to take to link evidence to action.

There is no question, further, that the approach we need to take is a transdisciplinary one; we must at the very least do four things: first communicate as scientists (natural, clinical, and social) about the importance of the problems, the need for knowledge, and the need for action; second ensure that our investigations are theoretically informed; third broadly contextualize our investigations; and, fourth privilege local/indigenous knowledge. If we do not, we will not be solving problems but simply spinning our wheels.

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