Where ecosystems, people and health meet: academic traditions and emerging fields for research and practice

Onde ecossistemas, pessoas e saúde se encontram: tradições acadêmicas e campos emergentes de pesquisa e prática

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ABSTRACT

Human-driven environmental change has brought attention to the importance of ecosystems in sustaining human health and well-being. There are various schools of thought and fields of inquiry and action that seek to understand health in relation to linked social and ecological phenomena. We

describe 18 such fields and outline common elements and incongruities among them. They converge around the application of systems thinking and crossing disciplinary boundaries, while differences are found in methodologies, research foci and problem framing. Although fields encourage sustainable and equitable pathways for health promotion, depoliticized and ahistorical approaches continue to be standard practice. Future research calls for a deeper commitment to examining ourselves as political actors, making space for conversations around power dynamics, and (re)centering participants in research methodologies.

Keywords: Environmental Health; Ecological Health; Review.

RESUMO

As mudanças ambientais antrópicas despertaram a atenção para a importância dos ecossistemas como fundamentais para sustentar a saúde e o bem-estar humanos. Várias escolas de pensamento e campos de atuação em pesquisa e ação, buscam compreender a saúde e os fenômenos sociais e ecológicos associados. Apresentamos 18 destes campos de atuação destacando seus elementos comuns e divergências. Eles convergem em torno do cruzamento de fronteiras disciplinares e na aplicação do pensamento sistêmico, enquanto as principais diferenças são encontradas nas metodologias, nos enfoques de pesquisa e no enquadramento dos problemas. Embora os campos busquem promover a saúde pelos caminhos sustentáveis e equitativos, as abordagens despolitizadas e a-históricas continuam sendo parte da prática padrão. Pesquisas futuras requerem um compromisso maior na avaliação das nossas próprias condutas como atores políticos e na promoção de novos espaços de discussões sobre a dinâmica de poder, a fim de (re)centralizar os participantes nas metodologias de pesquisa.

Palavras chaves: Saúde ambiental; Saúde Ecológica; Revisão.

1 PEOPLE, ECOSYSTEMS AND HEALTH IN A CHANGING WORLD

Climate change and increasing demands on natural resources continue to put unprecedented pressures on land, water and forests in Latin America and across the globe, raising concerns for our health and the planet (FOLEY, et al. 2011, PATZ, et al. 2005, WHITMEE, et al. 2015). At the same time, industrialization and the global economic system are, by design, degrading the ecosystem services that we depend on to sustain life, including those that regulate the cycling of toxins and pathogens (DEFRIES, et al. 2004, MCMICHAEL 1997, MEA 2005, 2008). he earth's systems have been so ubiquitously and, in many cases, irrevocably transformed that some argue we have entered a new geological epoch referred to as the 'Anthropocene' (STEFFEN, et al. 2007). Ongoing processes such as deforestation, eutrophication, biodiversity loss, desertification, and ocean acidification now define our complex and often destructive relationships with the environment.

Concurrent with these large-scale ecological changes, there is a (re)emergence of diseases and illness, as it is increasingly difficult to manage the transmission of pathogens and exposure to environmental toxins (BALBUS, et al. 2013, JONES, et al. 2008, MCMICHAEL 2014, PATZ, et al. 2004). In Brazil, recent zika, dengue and chikungunya outbreaks are a case-in-point (CARVALHO, et al. 2017), and this is echoed across the globe through examples like avian flu and Ebola (JONES, et al. 2008, WOOLHOUSE 2008). Health and environmental impacts are more acute in poorer and marginalised populations (JOHANSEN, et al. 2016, OTTERSEN, et al. 2014), although ongoing ecological changes will ultimately affect people across borders, economic sectors, and social classes.

Faced with the inevitability of change and uncertainty for our homes, communities and planet, we must plan to adapt to emerging circumstances that will affect the health of ecosystems and the living and non-living entities of which they are comprised. Such 'wicked' problems – defined by incomplete and contradictory knowledge, undefinable boundaries and causes, and complex interconnected

phenomena - pose a significant challenge (BROWN, et al. 2010). To date, conventional public health and ecological approaches, which build on Cartesian science, linear causality and command-and-control strategies, often generate outcomes that compromise ecosystem resilience and the services that regulate disease (DAKUBO 2010, DE SANTANA SILVA, et al. 2017, HOLLING, et al. 1996, WALTNER-TOEWS 2000). Promoting equitable and sustainable outcomes means acknowledging the limitations of existing approaches and radically reworking the fundamentals of conventional scholarship and practice (DE SANTANA SILVA, et al. 2017, FUNTOWICZ, et al. 1994, WALTNER-TOEWS 2017).

As we engage with these challenges, there is growing recognition that humans are deeply interconnected to environments and ecosystems[1], and that those connections are foundational for health and well-being (HORWITZ, et al. 2011). This notion is central to diverse Indigenous knowledge systems, while awareness of these relationships is found in Hippocrates' treatise and 19th century germ theory in western traditions. Nonetheless, the recent mainstreaming of such ideas is forging new opportunities for scholarly inquiry and practical applications.

There are thus a growing number of ways for thinking about and working at the interface between people and environments, focusing on the health of individuals, communities, and social and ecological systems. These are found in both long-standing academic traditions and emerging fields of inquiry and action. Collectively, this comprises a rich body of knowledge and resources that can be tapped into to address complex social-ecological-health problems. However, it can be difficult and even disconcerting to situate ourselves in this terrain given overlapping concepts, varying methodologies, quickly evolving content, and varying political implications.

The objective of this paper is to present a navigation guide to help orient ourselves as students, scholars and professionals interested in linked social-ecological-health problems. We first present a preliminary list of fields that address the interconnections between people, ecosystems and health, broadly outlining the scope and orientation of each. After highlighting the main points of convergence and difference among these fields, we conclude with reflections that encourage critical engagement with future research and action. In building a sense of collective appreciation for the evolution of thinking and practice, this paper is an invitation for readers to add to and continue adapting existing content.

2 A SURVEY OF FIELDS

2.1 METHODOLOGICAL CONSIDERATIONS

At the 2016 One Health-EcoHealth Congress, a group of early career scholars and practitioners developed a conference statement outlining future aspirations for these communities (IAEH 2017). A main topic of discussion was the diversity of approaches and perspectives related to social-ecological-health phenomena and the growing number actors involved in these areas. We also noted that some emerging areas seemed to be gaining momentum in the academic or public arena, while eclipsing other, sometimes older areas that harness less attention or funding. Positioning ourselves in a single perspective was daunting, and we noted a lack of published sources to help orient ourselves, given the variety of approaches occupying similar terrain. As a first step, we developed a glossary that described four areas of research and action relevant to public health practice (see BUSE, et al. 2018). This paper expands on our previous endeavors by broadening our focus to include other areas that consider the relationships among the health of humans, animals and ecosystems.

We engaged in an iterative process of literature reviews and consultations with peers and senior scholars. Drawing on our collective knowledge and experience, we developed an initial list of western scholarly perspectives and approaches related to social-ecological-health phenomena. For each entry, we reviewed foundational and synthesis texts, noting the historical context in which these approaches emerged, associated academic disciplines, main concepts and methodologies, and key actors involved (such as institutions, groups, and researchers). This information was used to map the relationships between entries and, upon consulting with experts, the list was reorganized, refined, or expanded as necessary. The updated list then guided subsequent iterations of reviewing-mapping-consultation.

From this process, we identified 18 different fields. Some fields are rooted in pre-existing academic disciplines or traditions and include subsets of practitioners dealing with health-environment concerns. Others emerging from more recent, cross-disciplinary contexts were considered fields if they had the following: a) an overarching aim/purpose or orienting principles/values; and b) some form of social organization in formalized venues to facilitate communication and knowledge building.

This procedure is not equivalent to a systematic or scoping review, and we acknowledge the subjective selection process. Accordingly, the list is not intended to be comprehensive and may exclude some relevant fields. Given that few publications have endeavored to map this evolving terrain, we consider this an important initial exercise and welcome additional contributions. Recognizing the importance of positioning ourselves as authors and being transparent about influences and biases, it is noted that those involved in the documentation process are primarily affiliated with institutions from Brazil, North America and Oceania.

2.2 OVERVIEW OF FIELDS

Annex 1 outlines the scope and orientation of the 18 fields identified in this exercise. These generalized descriptions naturally obscure the diversity within each field, and thereby overlook the ways that fields have evolved over time. Although this cannot be mapped given the scope of our paper, Table 1 presents fields along a historical timeline and includes orienting references that provide interested readers with further detail.

Public health was identified as a precursor to many fields, so a highly-referenced definition seems appropriate. According to WINSLOW (1920), public health is "the science and art of preventing disease, prolonging life and promoting physical health and efficacy through organized community efforts, [...] the control of communicable infections, the education of the individual, [and] the organization of medical and nursing services [to] ensure every individual in the community a standard of living adequate for the maintenance of health [and to] enable every citizen to realize [their] birthright of health and longevity".

Table 1. The 18 fields identified in this exercise, following an approximate timeline of their emergence. Main disciplines of influence, some orienting references, example journals (including the ISSN of printed versions), and examples of organizations linked to each field are noted.

Emergence	Field	Parent Disciplines*	Orienting References*	Example Journals*
1900s	Occupational and Environmental Health	Medicine; Environmental Science; Toxicology; Public Health	LEVY (2006), SMITH (2009), WILCOCK (2006)	International Journal of Occupational and Environmental Health (ISSN: 1077-3525) Archives of Environmental & Occupational Health (ISSN: 1933-8244)
1950s-1960s	Health and Medical Geography[a]	Human and Physical Geography; Epidemiology; Public Health	JONES, et al. (1993), KEARNS, et al. (2002), MCGLASHAN (1972), MEADE (1977, 2010)	Health & Place (ISSN: 1353-8292)
	Medical Anthropology[a]	Anthropology; Archeology; Linguistics; Human Biology	BROWN, et al. 2016), JORALEMON (2017), MCELROY, et al. (2014)	Medical Anthropology (ISSN: 0145-9740); Anthropology and Medicine (ISSN: 1364-8470)
	One Health[b]	Veterinary medicine; Pathology; Public Health	GIBBS (2014), ZINSSTAG, et al. (2012), ZINSSTAG, et al. (2011), ZINSSTAG, et al. (2015)	One Health (ISSN: 2352-7714)
1960s	Human Ecology and Health[a]	Sociology; Human Geography; Public Health	BRUHN (1970), CROLL, et al. (2013), KARTMAN (1967), LAST (1998), WEISS, et al. (2004)	Human Ecology (ISSN: 0300-7839)
1970s	Medicina social latinoamericana (Latin American Social Medicine)[b]	Sociology; Political Science; Medicine; Epidemiology	BREILH (2008), DE CAMPOS OLIVEIRA, et al. (2000), TAJER (2005)	Medicina Social (ISSN: 1557-7112); Ciência & Saúde Coletiva (ISSN: 1413-8123)

Surgimento (data)	Campo	Disciplinas de Influência*	Referências Orientadoras*	Exemplos de Revistas*
	Worker's Health	Sociology; Psychology; Medicine; Engineering; Public Health	LACAZ (2007, 2010), (MENDES, et al. 1991), TAMBELLINI, et al. (2014)	Ciência & Saúde Coletiva (ISSN: 1413-8123); Revista Brasileira de Saúde Ocupacional (ISSN: 0303-7657)
1970s-1980s	Environmental Justice	Sociology; Anthropology; Environmental Science; Law (Human Rights)	AGYEMAN, et al. (2003), BRULLE, et al. (2006), BULLARD, et al. (2000), LEE (2002)	Environmental Justice (ISSN: 1939-4071)
	Political Ecology of Health[a]	Human Geography; Anthropology; Sociology; Political Science; Environmental History	MAYER (1996), PERREAULT, et al. (2015), PORTO, et al. (2007)	Health & Place (ISSN: 1353-8292); Journal of Political Ecology (ISSN: 1073-0451); Antipode (ISSN: 1467-8330)
1980s	Sustainable Development	Economics; Human Geography; Environmental Science; International Relations	CORVALÁN, et al. (1999), DAHLGREN, et al. (1991), MCMICHAEL, et al. (1999), STEWART, et al. (2005)	Sustainability Science (ISSN: 1862-4065); Environment, Development and Sustainability (ISSN: 1387-585X)
	Healthy Communities and Cities	Public Health; Development Studies	HANCOCK (2009), NORRIS, et al. (2000), OHCC (2011), (PATRICK, et al. 2016), WOLFF (2003)	Health Promotion International (ISSN: 0957-4824)
1990s	Conservation Medicine	Epidemiology; Veterinary Medicine; Pathology; Conservation Biology	AGUIRRE, et al. (2002), DASZAK, et al. (2004), (NORRIS 2001)	Journal of wildlife diseases (ISSN: 0090-3558); EcoHealth (ISSN: 1612-9202)
	EcoHealth	Ecology; Interdisciplinary Social Sciences; Human and Veterinary Medicine	CHARRON (2011), DAKUBO (2010), SAINT-CHARLES, et al. (2014)	EcoHealth (ISSN: 1612-9202)
	Global Health	Epidemiology; Medicine; Political Science; International relations; Public Health	KOPLAN, et al. (2009), PACKARD (2016)	The Lancet: Global Health (ISSN: 2214-109X)
	Ecological Public Health	Sociology; Ecological Economics; Environmental Science	GREEN, et al. (1996), LANG, et al. (2012, 2015)	
2000s	Ecossaúde - Ecosalud	Interdisciplinary Social Sciences; Development Studies; Ecology	BETANCOURT, et al. (2016), GÓMEZ, et al. (2006), WEIHS, et al. (2013)	EcoHealth (ISSN: 1612-9202)
	Indigenous Health[c]	Aboriginal and Indigenous Studies; Anthropology; Public Health	GRACEY, et al. (2009), KING, et al. (2009), STEPHENS, et al. (2006)	International Journal of Indigenous Health (ISSN: 2291-9368)
2010 - present day	Planetary Health	Ecology; Medicine	HORTON, et al. (2014), HORTON, et al. (2015), WHITMEE, et al. (2015)	The Lancet: Planetary Health (ISSN: 2542-5196)

[a] The dates of emergence correspond to approximately when the subset of practitioners in these fields began exploring health and not the emergence of the root field itself.

[b] Since the 2000s there has been a resurgence of interest and practice in Latin American Social Medicine and One Health.

[c] Refers to the emergence of the field, as we have defined it, and not Indigenous health practices and knowledge systems that precede the timeline in this table.

* These are not comprehensive or definitive, but are intended to provide some initial guidance through each field.

Source: Authors.

3 POINTS OF CONVERGENCE AND DIFFERENCES AMONG FIELDS

Although presented as independent and fixed, the fields reviewed (Annex 1; Table 1), in actuality, fluid and permeable. Building on their intellectual predecessors, they have developed in conversation with, and in response to, other areas of scholarship and practice. For example, Medicina Social Latinoamericana (Latin American Social Medicine) and Saúde do Trabalhador e da Trabalhadora (Worker's Health) emerged as critical perspectives in collective health gained momentum in Latin America. Long-standing scholarly traditions in Political Ecology and Human Ecology co-evolved with Health and Medical Geography and Medical Anthropology (BAER 1996, MEADE 2010). The broad

biomedical field of Global Health overlaps and informs several of the smaller fields described (WERNLI, et al. 2016).

In such processes, fields evolve and emerge, bringing new perspectives or refining, adapting, and hybridizing existing ones. Indeed, this is reflected in the diversity of focal points represented among fields. Some are tailored to specific geographic regions (e.g. Ecosaúde/Ecosalud) and groups (e.g. Indigenous Health), while others are oriented to different levels of social organization (e.g. Healthy Communities and Cities versus Planetary Health) or focus more closely on certain interfaces (including human-animal in One Health and Conservation Medicine, or human-society in Medicina Social and Medical Anthropology). Likewise, some prioritize policy and action (such as Environmental Justice and Saúde do Trabalhador e da Trabalhadora) while others are more oriented towards scholarship.

The emergence and evolution of any field is historically situated and reflects the lineage of dominant scientific paradigms and actors involved in their development (ROSENBERG 1979). Fields often positioned themselves in relation to the enduring legacy of public health – a field that originated in the 19th century as Europeans became aware of the links between disease and environmental conditions. In the 1970s, social movements in North and South America contributed to building the fields of Saúde do Trabalhador e da Trabalhadora and Environmental Justice, both of which continue to fight for equity and rights in public institutions. Medicina Social's framing of illness as both a social and political phenomenon builds on European antecedents such as the work of Rudolph Virchow (1821-1902) but has been substantially extended through decades of Latin American work. More recently, multi and bilateral organizations and agencies play decisional roles in field development across the globe. The WHO and UN have been central in building Sustainable Development, Healthy Communities and Cities approaches, and Global Health initiatives. Ultimately, the people, institutions and funding agencies involved in field development, with different political goals and environmental and economic discourses, shape both the scope and orientation of fields.

Health is understood in a number of ways across and within fields. For example, many of the above descriptions deviate from the predominant 'absence of illness' definition and include broader notions of well-being (WHO 1948). This brings attention to the different lenses through which problems are defined, relevant aspects are selected, and solutions are deemed acceptable (OUGHTON, et al. 2009). For fields and practitioners with stronger roots in the social sciences, problems are often framed as economic, psycho-social or cultural. From this view, it is the human-environment relationships occurring within social systems (e.g. communities, neighborhoods, institutions) that give rise to health and illness. Actions informed by such research are often oriented towards governance, social action or human behavior and agency. For fields emerging from ecology or biomedicine, problem framing tends to start with the ecosystem (e.g. watershed), environment (e.g. workplace), or biological system (e.g. an individual). These units comprise the types of interactions and factors that give rise to health outcomes, so solutions tend to target environmental management or clinical treatments (FOLKE, et al. 2016, LANG, et al. 2012).

Problem framing is particularly important in terms of how fields address upstream drivers of disease and ecosystem degradation. This is illustrated in depoliticized and ahistorical framings, whereby environmental-health problems are seemingly divorced from political and economic processes such as neoliberal globalization or the ongoing impacts of colonization. Medicina Social and Saúde do Trabalhador e da Trabalhadora explicitly challenge such depoliticized scholarship, viewing health as 'socially determined' and recognizing that political agendas promoting economic growth often eclipse the health of ecosystems and people (BREILH 2013, LAWINSKY, et al. 2012, TAJER 2005, TAMBELLINI 2012). Environmental Justice and Political Ecology of Health similarly criticize 'apolitical ecologies' (ROBBINS 2011). Through this lens, it is not simply the 'social determinants' of health that are important, but also the structural relationships and processes that support societal inequities and ultimately give rise to health disparities. This includes factors such as the distribution of land and capital, the division of labor and modes of production, or international trade agreements and transnational corporate agendas that are often overlooked in the determinants of health discourse. Taking equity and justice as starting points, more politically engaged framings center the discursive and political economic aspects of ecosystem degradation and illness. As such, actions informed by this research tend to challenge

power structures that underlie environmental health issues, in ways that other framings cannot (ADAMS 2013, BIEHL, et al. 2014, FARMER 2004).

Although fields are united in their recognition of the interconnectedness of people, ecosystems, and health, various models and frameworks were found in the literature. Complex systems theory and ecological principles were common conceptual references, especially in newer fields and literature. These include ecosystems approaches (BETANCOURT, et al. 2016, KAY, et al. 1999, WALTNER-TOEWS, et al. 2008), ecological thinking (LANG, et al. 2015) and more resilience thinking (ARMITAGE, et al. 2012, BERBÉS-BLAZQUEZ, et al. 2014) that are based on notions of scalar dynamics, non-linearity, self-organization, and adaptive responses. Ecosystem health (RAPPORT, et al. 1999, RAPPORT, et al. 1998), which was frequently cited as a precursor concept for many fields, also invokes system organization and resilience, using health as a metaphor to describe the state of an ecosystem. Without being comprehensive, other references include: social-ecological approaches (STOKOLS 1996), eco-social perspectives (KRIEGER 2001), biosocial approaches (FARMER, et al. 2013) and a variety of ecological behavioral health models (SALLIS, et al. 2015). Overall, the models and frameworks we encountered differ in terms of the conceptual hierarchies among social, ecological/environmental, and health phenomena, emphasizing certain spheres of influence and giving importance to specific interactions among them.

Theoretical and conceptual foundations in socio-ecological systems thinking have gained momentum in western thought over the last two decades, in which nature and society are understood as coupled and mutually produced rather than as dualistic opposites (BERKES, et al. 2002, BERKES, et al. 2000b). Researchers and practitioners are increasingly experimenting with holistic, rather than reductionist, approaches to complex problems. With much of this work rooted in natural science traditions, there are a growing number of criticisms from social scientists around the mechanistic and deterministic perspectives that such thinking tends to encourage. In their standard forms, socio-ecological systems approaches do not sufficiently address the discursive and structural aspects of complex problems, such as agency and power (COTE, et al. 2011, DAVIDSON 2010, STONE-JOVICICH 2015). Concurrently, areas such as Political Ecology recognize their lack of engagement with theories and principles in ecology (NYGREN, et al. 2008, WALKER 2005). These distinctions are not absolute, however, as Political Ecology has increasingly engaged with resilience theory (INGALLS, et al. 2016, TURNER 2013, WIDGREN 2012), and scholars of human-animal health relationships have called for a 'Structural One Health' (WALLACE, et al. 2015). Ecohealth researchers are actively seeking to take power dynamics into consideration (BRISBOIS, et al. 2017), with specifically Latin American concentrations being influenced by long-standing scholarship of Medicina Social, Saúde do Trabalhador e da Trabalhadora and related 'collective health' traditions (BETANCOURT, et al. 2016, LAWINSKY, et al. 2012).

Virtually all fields promote some form of collaboration with actors outside academic settings, usually as a tool for conducting more inclusive research and designing more effective interventions and policies (O'FALLON, et al. 2002, WICKSON, et al. 2006). Bridging knowledge and action and engaging in dialogue across sectors, institutions and community groups have long been central tenets in fields emerging from social struggles; however, only recently is participatory action-research being promoted across fields. This process claims to encourage empowerment, social learning, and knowledge sharing among those involved (BAUM, et al. 2006, CLEAVER 1999, MINKLER 2000, O'FALLON, et al. 2002). In practice, however, there are numerous approaches and underlying motivations for engaging with communities, grassroots groups and actors in the public, private and nonprofit sectors (REED 2008). This can range from consultations with stakeholders, with the goal of substantiating or corroborating research or interventions, to more complex processes where participants take an active role in decision-making.

Likewise, there is a shared recognition among fields that multiple disciplines are necessary to deal with complex problems. Most often, there are intentional engagements with the ecological and environmental sciences, veterinary/human medicine and public health, while other scholarly traditions such, as anthropology, tend to be under-represented (Table 1). This demonstrates how post-positivist perspectives, that are common to the natural and biomedical sciences and based largely on ideals of objectivity and empirical evidence, dominate research and practice in this space. Rarely do such perspectives view science and knowledge as socially and politically constructed, as

many social sciences do. Overall, disciplinary boundaries continue to divide fields and practitioners within them, and there are ongoing calls for deeper engagement with and appreciation of diverse scholarly traditions and knowledge systems.

A variety of approaches for integrating knowledge and tools from diverse academic traditions – with distinct epistemological and methodological foundations – were referenced in the literature. Commonly, 'multidisciplinary' or 'interdisciplinary' approaches are promoted, whereby specialists coordinate around a common problem and disciplinary research activities may either run in parallel but remain largely separate, or be integrated at different stages of the research process. Increasingly, more radical 'transdisciplinarity' (HIRSCH HADORN, et al. 2006, MAX-NEEF 2005, WICKSON, et al. 2006) is promoted in fields such as Ecohealth, One Health, Global Health and others (e.g., BOUCHARD, et al. 2014, GÓMEZ, et al. 2006, MIN, et al. 2013, PARKES, et al. 2005). Challenging normative practices of health-related inquiry, these approaches incorporate multiple epistemological perspectives, including those of non-scholars. Local, traditional and Indigenous perspectives are increasingly acknowledged across these and other fields (BERKES, et al. 2000a, PRETTY 2011, REED 2008), although rarely are diverse knowledge systems that exist outside western scientific paradigms meaningfully included in practice.

Such differences are similarly reflected in the main methodologies and tools adopted by fields and practitioners. Some prioritize quantitative inquiry that includes, for example, epidemiological and ecological modeling or causal analysis of the material determinants of health. With interest in complexity on this rise, multi-level, cross-scale analyses are increasingly common. For others, qualitative inquiry is prioritized, which includes studying narratives of illness and wellness and considering the relational and experiential aspects of health that are unique to people, place and time. For critical practitioners, these latter orientations also counterbalance the authority of deterministic causality in science and evidence-based decision-making in public policy (BIEHL, et al. 2014, BRISBOIS, et al. 2017, LACAZ 2007).

Hence, a core commonality across fields is some commitment to epistemological and methodological pluralism, although the extent to which this translates into practice varies. Emerging from these and other fields are new academic and training programs that are rooted in interdisciplinarity and that encourage more holistic, inclusive, and action-oriented approaches. This necessarily involves a diversity of worldviews and value systems as well as (sometimes incommensurable) priorities and methodological orientations. Navigating this nebulous space is, unsurprisingly, a challenge for students, scholars and professionals in any field.

Conversations around 'transdisciplinarity' and, more recently, 'undisciplinarity' in fields such as Ecohealth and Global Health can provide guidance (HAIDER, et al. 2017, MAX-NEEF 2005). Rather than a priori defining the concepts, methodologies, and tools to be used, as is traditionally done, research is instead problem-based, emergent, and reflexive (HAIDER, et al. 2017, WICKSON, et al. 2006). This means fostering individual flexibility and collective pragmatism so that research approaches emerge from the complex problem being examined, rather than from the intellectual comfort zones of the principal investigators. In this way, methodological, theoretical and normative commitments are negotiated, rather than assumed or ignored. Multiple valid approaches are recognized, even if they are seemingly contradictory or irreconcilable. Advances in mixed-method approaches are promising, as they offer practical tools for designing projects that incorporate such thinking (e.g., CRESWELL, et al. 2007, CRESWELL, et al. 2003).

Looking forward, fields will continue to evolve, while approaches for dealing with complex social-ecological-health problems will continue to hybridize and adapt as knowledge is shared and generated. Because this paper provides a synopsis of fields captured within our collective range of knowledge and experience, a scoping review and discourse analysis would be beneficial to systematically and comprehensively map fields and further develop the ideas presented. Beyond the fields listed, we identified climate change and health, resilience-thinking and health, and ecosystem services and health. Although they did not meet our inclusion criteria, they are indicative of developments within and across diverse areas of scholarship and practice.

As students, scholars and professionals, we participate in processes of field development, convergence and divergence, so it is arguably our responsibility to reflect on the future of scholarship and action. There will inevitably be discomfort and unease as we ask deep questions about ourselves and about the institutions in which we operate (BIEHL, et al. 2014, HAIDER, et al. 2017), such as: what worldviews, perspectives, and methods are being excluded or delegitimized in place of more dominant ones? How are decisions being made, by whom, and under what authority? If the transformative potential of fields lies in their multiple meanings, approaches and viewpoints, as some argue (HERRICK, et al. 2017), then these are important future discussions. Without attempting to provide conclusive answers, the following section highlights some avenues for reflection along these lines.

4 FUTURE PERSPECTIVES: CULTIVATING A PRACTICE OF CRITICAL INQUIRY

With unprecedented environmental change, persistent economic disparities, and rising prevalence of related diseases and illness globally, there are a growing number of fields that address the interconnections between people, health and ecosystems. Eighteen of these fields were reviewed here. Together, they paint a rich portrait of applied and scholarly pursuits that seek to embrace complexity and cross disciplinary boundaries with a common goal of improving the health of individuals, communities and social and ecological systems.

There are, however, important distinctions in 'ways of thinking' and 'ways of doing', such that interpretations of central concepts vary within and across fields. The epistemological, methodological, and political influences that give rise to these differences are worthy of consideration, especially if we are to avoid repeating the failures of top-down public health and environmental management strategies that perpetuate inequalities and ecosystem degradation (DAKUBO 2010, HOLLING, et al. 1996, WALTNER-TOEWS 2000). Without presuming intellectual superiority of any one field, it is useful to recognize that some fields have strengths that may add value where others have noted shortcomings. As LERNER, et al. (2017) recently identified when comparing One Health, EcoHealth and Planetary Health, there are important differences to these approaches that need to be acknowledged when applying them.

Fields almost unanimously express concern for equity and sustainability, while transdisciplinarity and participatory action-research are increasingly promoted. While there is ample literature on related tools and concepts, moving beyond tokenistic practices that merely pay lip service to such principles demands more than just new tools. Critical theory streams in Medical Anthropology, Health and Medical Geography, Global Health and similar fields recognize that scientific practices continue to be shaped by colonial and imperialist power structures. Their existence relies on North-South disparities – and other spatial and economic disparities rooted in gender, class and race – and related narratives, such that researcher and subject remain separate (one observes, while the other is observed) and research practices are imbued with skewed power dynamics (***HARDING, 1991***). Fields such as Medicina Social Latinoamericana, Saúde do Trabalhador e da Trabalhadora and Indigenous Health emerged as a direct response to such dynamics.

Despite discourses around shared control of project goals, resources and benefits in fields such as Ecohealth, One Health and other fields with strong medical and natural science influences, power dynamics are sometimes (though not always) neglected and thereby naturalized (BRISBOIS, et al. 2017, DAKUBO 2010, WALLACE, et al. 2015). Practices developed in the global North are frequently imposed on 'partners' and communities around the world, and decision-making authority (in most meaningful senses) largely remains out of their hands (BEHAGUE, et al. 2009, CRANE 2013). In these contexts, research, policies, and interventions may simply further the interests of dominant researchers and organizations rather than those of participating communities and 'partners', even when such actions are cast as empowering or equitable (BEHAGUE, et al. 2009).

Research methodologies led by Indigenous and feminist scholars (e.g. SMITH 2013, SPRAGUE 2016) reposition the observer and the observed, such that relational dynamics are reconfigured as participating communities claim control over the research process. Scholarship from around the world

emphasizes decolonizing practices and methods. In Brazil, work by FREIRE (1970) and BOFF (1986) are important antecedents, making way for Latin American epistemological perspectives that challenge dominant models of economic development and related knowledge production practices (BALLESTRIN 2013, CASTRO-GÓMEZ, et al. 2007, DE SOUSA SANTOS 2007, 2011, TAMBELLINI 2012).

Such scholarship shows that transforming research approaches is as much about cultivating a critical awareness of the political and economic structures that shape the worlds in which we live and work as it is about 'new' tools and approaches. This means re-centering communities and their experiences in the research process, but actively making space so that conversations on power dynamics can actually happen. This can start with accepting that there are multiple, valid ways of knowing that include non-western traditions and worldviews (DURIE 2004, HALL, et al. 2000, PRETTY 2011). It also means acknowledging the narratives that frame research problems and solutions andthe normative assumptions and values that underlie the way we think about and do research. Such reflections and practices are marginal in most fields, projects, and training programs that seek to address social-ecological-health problems. And yet, for decades related discussions have been ongoing, notably in the critical literature in Sustainable Development, Political Ecology, Global Health, and Medicina Social.

Beyond stepping up to the challenge of critical self-reflexivity, research and interventions must also be designed to relinquish decision-making power, cultivate trust among stakeholders, and ensure a two-way, iterative learning process - including researchers learning from communities (ISRAEL, et al. 1998, REED 2008). But these time-consuming processes demand hard work and, as experiences in participatory action-research show, the results are often unpredictable (REED 2008). Traditional academic norms and institutional constraints are direct obstacles, including short funding cycles, pressures to publish and emphasis on 'successful' interventions rather than lessons from failure. Reframing participation so that it is understood as a right, rather than just a normative goal or instrument for community compliance, may help surpass these limitations (RICHARDS, et al. 2004). Yet, underlying the democratization of research, there must also be work to decolonize the paradigms, practices, and institutions that dominate conventional research and action.

From this view, not only are health and environmental issues political, but so too is the scientific process in which we are involved. The power dynamics and narratives that influence disease emergence and ecological degradation are just as relevant as those influencing how scientific knowledge is produced and how science legitimizes policies and action. This means grappling with the effects of neoliberal globalization and persistent colonial legacies that permeate into universities, training programs, governance intuitions and funding organizations. These political economic processes not only influence the upstream drivers of health inequities, but also shape how complex problems are framed and how research and related policy interventions are carried out.

Fields consistently express concern about research falling short when it comes to translating knowledge into action. To these ends, much scholarship advocates partnerships with government agencies, non-profits and community groups, backed by transdisciplinary approaches and epistemological and methodological pluralism. However, deeper commitments to engaging with research as a political process is necessary, as illustrated by developments in Indigenous Health, Environmental Justice and related Latin American fields. Therefore, promoting fairness and equity means going beyond the so called top-down 'abyssal thinking' characteristic of scholarship controlled by and advancing the interests of the global North (DE SOUSA SANTOS 2007). Scholarly and applied research that neglects such critical reflection will continue to operate within existing power structures rather than challenging them, and may thereby reinforce the social-ecological-health problems it sought to address in the first place (ADAMS 2013, BIEHL, et al. 2014, FARMER 2004).

5 CONCLUDING REMARKS

Moving into a new epoch of geological and human history, there is growing recognition that the health of individuals, communities, and ecosystems is being affected by human-driven environmental change. As understandings of these complex interdependencies expands and multiple perspectives are

increasingly valued, the number of fields motivated by interconnected health, social and environmental problems is on the rise. This context engenders unique opportunities for exchange and mutual learning among scholars, professionals and stakeholders. However, it also raises uncomfortable questions about underlying assumptions, dominant narratives, and power dynamics that are inherent to our theoretical and practical approaches. These questions are especially relevant considering the growing number of actors working at the health-society-ecosystem nexus, with diverse and sometimes competing objectives, interests, and resources.

The list of fields presented was developed through a process of documentation that sought to surface past contributions and catalyze new concepts. For future research and action, there are promising perspectives that draw on complexity thinking, accept multiple ways of knowing, and apply pragmatic, problem-driven methodologies. Although the fields reviewed largely originate from western, English-speaking traditions and institutions, the significance of Latin American and Indigenous leadership cannot be overlooked. Such critical perspectives compel us to reflect more deeply, not only on the political and economic relations that underlie illness and disease, but also on the production of knowledge as it operates within the context of neoliberal globalization and capitalism. Sitting at times uncomfortably in these spaces, we are inspired and tasked to reimagine what already exists. New and multiple approaches are needed to better understand the complex relationships between people and ecosystems and continue working towards sustainable futures that are more just and fair.

NOTES

[1] Environments refer to 'settings' or places we live, work and play, while ecosystems are webs of connections between living and non-living system components, including plants, animals and humans.

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ANNEX I – SHORT DESCRIPTION OF THE 18 FIELDS SURVEYED

Occupational and Environmental Health addresses human health risks associated with biological, chemical or physical hazards and toxins in natural and built environments. Concerned with the assessment, monitoring, prevention, and regulation of risks in the workplace, home and community, applied work in this field builds on risk modelling that includes the analysis of hazards, exposure and vulnerability, sometimes with consideration of political and economic contexts. Although ecosystem, plant and animal health are not the focus of this field, it does at times acknowledge the importance of ecological contexts in generating health risks.

Health and Medical Geography is concerned with the spatial patterns of disease and place-based interactions between culture and nature. Through a spatial-relational lens employing both quantitative (geospatial) and qualitative methods, this field seek to understand experiences of human health as well as the causal mechanisms of disease as related to space and place. A broad range of topics are addressed including emergence of epidemiological systems, diffusion of infectious agents in landscapes, the effect of population movement and settlement patterns (of humans and non-human species), and critical interpretations of health care access, clinical practices and health policy.

Medical Anthropology understands human health to be produced by knowledge and social practices as well as the physiological and psychological responses of individuals and communities. It views culture and biology as co-evolving, recognizing that interactions between ecosystems and society are central to the etiology and experience of disease and illness. Concerned with both (pre)historic and contemporary populations, main streams of study include the physical, cognitive or spiritual expressions of wellness and healing, cultural systems and health practices/policy, and the influence of language on embodied experiences of disease and health care services.

Human Ecology and Health focuses on human behavior and patterns of disease in relation to (ecological and built) environments, understanding them as interdependent and co-evolving. Concerned with the psychological, biophysical and socioeconomic aspects of disease, this field applies ecological principles to study human populations through culture, language, technology and social structure. Research topics include agricultural practices and zoonotic disease transmission, risk behaviors and cultural beliefs, as well as migration, urbanization and the spread of disease. It is action-oriented and advocates for individual and community health.

Medicina social latinoamericana (Latin American Social Medicine) focuses on how political economies and social inequities produce health and illness. It rejects the idea that diseases can be studied in isolation from the driving forces that regulate the distribution of health determinants, and understands health and illness not in binary terms, but as a continuous social and political process. The field advocates for human rights, operates in solidarity with marginalized communities, and includes multiple ways of knowing, including Indigenous knowledges. While ecosystems are not a direct topic of study, processes such as neoliberalism and colonialism and related environmental degradation are.

Saúde do Trabalhador e da Trablahora (Worker's Health) has its roots in Brazilian worker's rights movements that grew in response to industrialization, changing modes of production, and the interests of the growing working class. After being inscribed into the National Constitution in 1988, a new field of interdisciplinary and inter-institutional scholarship and practice materialized. The field deals with the relationships between health, environments and production in emerging capitalist economies, shifting the focus away from workplace risks and hazards and instead centering on people and work relationships to understand health and well-being. At its foundation are collaborations between science and policy and the inclusion of workers in decision-making processes.

Environmental Justice began as a social movement in communities of primarily Black, Indigenous and working-class residents who often disproportionately experience health effects related to environmental impacts of nearby industrial activities. This area of scholarship's focus subsequently turned to legal relationships between health and environmental disparities, as well as the social production of inequities. With ties to research, legal practice and grassroots action, this field (which overlaps with work on 'environmental racism') advocates for decision-making that is fair and meaningful, laws that enable positive health and environmental outcomes, and engagement with whole communities, but especially marginalized groups.

Political Ecology of Health focuses on society-nature relationships, power and health, understanding the latter not as the absence of disease or injury, but as encompassing well-being and agency. Taking an explicitly political stance, it critically engages with models and assumptions underpinning research, policy and practice. Themes include tracing the production of knowledge and discourses of health and illness, as well as examining how environmental and health conditions are shaped by political interests, social institutions, and power-laden relationships between humans and non-humans.

Sustainable Development seeks to reconcile health and well-being with economic growth while working within the limits (carrying capacity) of the ecosystem. Most often operating in lower or middle income countries, it promotes research, policy and action that are guided by the principle of sustainability: "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). Although primarily concerned with natural resource use and economic development, policies and interventions that maintain or increase health inequalities are considered to be unsustainable.

Healthy Communities and Cities promotes health and well-being in urbanizing settings around the world through local policies and action-research. It seeks to address the multiple determinants of health and build trust among individuals, communities, public intuitions and organizations. There are different streams led by institutions operating at different levels in the global North and South, ranging from community groups, governmental bodies to multi-lateral organizations. Local research and actions are guided by principles that include ecosystem sustainability, clean and safe environments, community/citizen engagement, multi-sectoral collaboration and political commitment. Overall, these emphasize the importance of governance and leadership in establishing the conditions for health.

Ecohealth promotes the health and well-being of humans, animals and ecosystems, recognizing the connections between the health of all species and their environments. It brings attention to coupled social and ecological complexity as well as economic and political dynamics to understand relationships between ecosystem change and health. The topics addressed in research and practice are wide-ranging and diverse, although they converge around six core principles: systems thinking, transdisciplinary research, stakeholder participation, sustainability, gender and social equity, and knowledge-to-action.

Conservation Medicine grew in response to increasing zoonotic disease outbreaks linked to environmental changes that alter wildlife and human population ecology. The field addresses multiple interactions between species and ecosystems and the related interactions between pathogens and disease. Research focuses on changes in habitat and land use, (re)emergence of infectious agents, parasites, and contaminants, and the maintenance of biodiversity and ecosystems. It aims to support conservation-based solutions that sustain the health of plant and animal communities (including humans).

Global Health emphasizes transnational health issues, recognizing that, with globalization, people and places are increasingly connected, such that diseases can rapidly spread between countries. Diverse topics are addressed in this broad field, generally aiming to improve health through primary prevention and health care services. It promotes policies and systems that rely on cross-border, multi-level collaboration (often along divides such as North-South or so-called developed-developing), with practices converging around principles such as sustainability, innovation, inter/transdisciplinarity. Health is understood as public good to which all people and nations should have access, so human rights and equity are central concerns.

Ecological Public Health was developed in response to critiques of the Social Determinants of Health report (WHO 2008) for omitting environmental/ecological considerations. It focuses on interactions and complexity among the (often compartmentalized) social, cultural, biophysical, and infrastructural determinants of health, and engages with multiple contexts and scales of analysis. It encourages collaboration with actors across levels of influence and action, while promoting health practices that are rooted in collective rather than individualistic efforts.

One Health recognizes the complex interrelationships between the health of people, plants and animals, focusing on interactions between humans and domestic pets, livestock, wildlife, and crops. The field is primarily concerned with the etiology and transmission of zoonotic and communicable diseases, food safety, nutrition and antimicrobial resistance, with links to policy and practice in sanitation, food security, and vaccination programs. As the name implies, One Health emphasizes interdisciplinarity and integration across health and environment-related disciplines.

Ecosaúde/Ecosalud is the Latin American branch of Ecohealth. While it closely follows its predecessor, it emphasizes collective health and is especially cognizant of economic development processes and political contexts that affect health and well-being in marginalized communities. The field builds on the six core principles of Ecohealth, but it especially prioritizes the production and diffusion of transformational knowledge, capacity building of transdisciplinary researchers and leaders, and knowledge exchange among multi-sectoral actors and communities.

Indigenous Health recognizes that the health and well-being of Indigenous peoples are shaped by their cultural practices and knowledge systems that are profoundly rooted in and connected to land and place. It seeks to address the enormous health disparities among Indigenous peoples across the globe through policies and actions that acknowledge complex colonial dynamics, are committed to including Indigenous perspectives and

relationships to the land, and promote self-determination of communities. As such, standard determinants of health and public health strategies are superseded by those that better reflect indigenous contexts, are respectful of diverse epistemologies and ways of life, and are grounded in community participation and control of research and interventions.

Planetary Health seeks to understand threats to human systems (i.e., civilization) and the state of earth's natural systems upon which humanity depends. As a relatively new field, emerging research tends to focus on earth processes (e.g. atmospheric, biogeochemical cycles, etc.) and global population indicators. It aims to enhance the integrity of natural systems as well as health, well-being, and equity worldwide. It calls for better governance, integrated policies, interdisciplinarity, and collective public health action at all levels of society.