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The dawn of Structural One Health: A new science tracking disease emergence along circuits of capital

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ABSTRACT

The One Health approach integrates health investigations across the tree of life, including, but not limited to, wildlife, livestock, crops, and humans. It redresses an epistemological alienation at the heart of much modern population health, which has long segregated studies by species. Up to this point, however, One Health research has also omitted addressing fundamental structural causes underlying collapsing health ecologies. In this critical review we unpack the relationship between One Health science and its political economy, particularly the conceptual and methodological trajectories by which it fails to incorporate social determinants of epizootic spillover. We also introduce a Structural One Health that addresses the research gap. The new science, open to incorporating developments across the social sciences, addresses foundational processes underlying multispecies health, including the place-specific deep-time histories, cultural infrastructure, and economic geographies driving disease emergence. We introduce an ongoing project on avian influenza to illustrate Structural One Health's scope and ambition. For the first time researchers are quantifying the relationships among transnational circuits of capital, associated shifts in agroecological landscapes, and the genetic evolution and spatial spread of a xenospecific pathogen.

1. One Health and the social sciences

The new 'One World-One Health' approach integrates investigations of wildlife, livestock, crop, and human health in an ecosystemic context (Zinsstag, 2012; van Helden et al., 2013; Barrett and Osofsky, 2013). The approach convenes medical doctors, veterinarians, and ecological scientists under the rubric many species share infectious, chronic and environmental illnesses (Hueston et al., 2013). The approach is not without precedence. Calvin Schwabe's (1984) 'One Medicine,' the 'Disease in Evolution' conference at Woods Hole, and investigators as far back as social medicine founder Rudolf Virchow and 18th century veterinarian Félix Vicq-d'Azyr connected human and animal health within varying degrees of social and ecological contextualization (Wilson et al.,. 1994; Saunders, 2000; Morens, 2003). The renewed interest appears driven as much by practical matters as by theoretical development in related fields such as ecohealth (Webb et al., 2010) and complexity science (Carpenter et al., 2009). The complications associated with the surprising spillover of highly pathogenic influenza A (H5N1) ('bird flu') from poultry to humans at century's end galvanized international health agencies to gather scientists across disciplines to address influenza and other emergent diseases (Anderson et al., 2010).

The new One Health has been presented as a crucible in which to test combinations of specialist approaches in population health (Kahn et al., 2012). The animal and human diseases into which it is now most difficult to intervene arise from and spread by a multitude of causes interacting at multiple scales and across biocultural domains. A variety of epistemologies are required to address such

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infections. Indeed, retrospectively many of today's most common human infections first arose in ancient civilizations by way of such synergies (McNeill, 1977/2010). Domesticated stock served as sources for human diphtheria, influenza, measles, mumps, plague, pertussis, rotavirus A, tuberculosis, sleeping sickness, and visceral leishmaniasis (Pearce-Duvet, 2006; Wolfe et al., 2007). Ecological changes brought upon landscapes by human intervention selected for spillovers of cholera from algae, malaria from birds, and HIV/AIDS, dengue fever, malaria, and yellow fever from wild primates.

The new pathogens stimulated innovations in medicine and public health, including individual treatment and prophylaxes, land and marine quarantines, compulsory burial, isolation wards, water treatment, and subsidies for the sick and the unemployed (Watts, 1997; Colgrove, 2002). Each of the series of agricultural and industrial inventions to follow accelerated demographic shifts and new settlement and rejuxtaposed potential host populations, prompting additional rounds of novel spillover (Kock et al., 2012). Environmental impacts, climate change among them, have since scaled geological (Ding et al., 2013). While producing an unprecedented array of commodities, attendant increases in resource extraction, producing material and conceptual rifts between economy and ecology, have degraded habitats, biodiversity, ecosystem function, resource bases, waterways, soil nutrients, and oceanic stock (McMichael, 2009; Foster et al., 2010). The impacts have together promoted disease emergence across multiple host taxa (Jones et al., 2013).

In particular, the 'Livestock Revolution,' in which the breeding, processing and distribution of fast-growth livestock are vertically integrated under a few large agribusinesses, makes repeated appearances across these latest impacts (Magdoff and Tokar, 2010). Industrial stockbreeding drives as much as services a new demand in meat protein, particularly in so-called developing countries, where, like its Neolithic predecessors, it promotes pathogen spillover (Jones et al., 2013; Liverani et al., 2013). Livestock effects are indirect as well. While the sector's growth presents economic opportunities, competition from integrated producers marginalizes smallholders out of markets (de Haan et al., 2010; McMichael, 2012). In turn, the resulting food insecurity, environmental destruction, and perceptions thereof serve as rationales for a particular capital-securitized science tied into spreading the very agrifood model precipitating cycles of economy and disease (Davis, 2007; Wallace and Kock, 2012; Sparke, 2014).

Social scientists have begun to help catalog the mechanisms by which such disease spillover is socially mediated. Anthropologists Goldberg et al. (2012) describe the Kibale EcoHealth Project in Kibale National Park in western Uganda, testing for the area-specific connections among human health, animal health and the surrounding landscape, including population growth, forest fragmentation, rural poverty, cultural beliefs, and shifts in agriculture. Multispecies infection dynamics there, including for *E. coli,* appear as connected to higher-level agroecological changes as to behavioral practices directly related to transmission. For instance, humans tending livestock proved at elevated risk of carrying *E. coli* strains specific to local wild primates increasingly marginalized to dwindling forests. Red-tailed guenons raiding crops out of said forests tended to carry *E. coli* characteristic of humans and livestock.

Other studies have investigated disease pathways appropriate to more industrialized contexts. For example, Paul et al. (2013) apply a value chain analysis to traditional poultry production in Phitsanoulok, Thailand. The team found across 28 poultry collectors, slaughterhouses and market retailers that collectors—intermediaries between farmers and slaughterhouses—played an unrecognized role in spreading HPAI H5N1 in Phitsanoulok. The rapid destocking of poultry upon an outbreak facilitated H5N1 spread and appeared influenced by risk perception, economic margins, and compensation for the players along the commodity chain.

Other social science has positioned One Health within local and global political economies. Giles-Vernick et al. (2010), for instance, review the historical roots of a number of pandemics with the expectation comparative studies should help divulge unexpected differences and similarities across outbreaks. Such work aims to draw out the complexities inherent to societal responses that single site studies routinely miss, including "the unequal burdens of suffering … subsumed under the rubric of globalization." Sparke and Anguelov (2012) situate the politics of epidemiological knowledge within such a socioeconomic divide between the global North and South, specifically within risk management, access to medicines, media portrayals of risk, and the emergence of new diseases in the first place. Forster and Charnoz (2013) find these inequalities also arise out of a coercive "global health diplomacy"—both governmental and philanthropic—ostensibly undertaken to bridge the divide. Keck (2010) describes such power dynamics as an extension of colonial medicine. The contests are part and parcel of higher-order struggles over the political course of economically developing "sentinel borderlands" where new epizootics arise and at the epistemological junctures where disciplines meet.

Research gaps remain, however. In this paper we first critically review One Health as conceived to this point, suggesting additional points of departure for social scientists of a variety of stripes, including in medical anthropology (Kleinman et al., 2008; Lowe, 2010), ecosocial epidemiology (Krieger, 2001), biopolitics (Braun, 2007), and the political ecology of health (Rayner and Lang, 2012), all of which have addressed various aspects of the relationship between social science and epidemiology. As integral as these approaches are to understanding the social context of population health, none to date has pursued statistical tests of what Krieger (2001) and others (*e.g.,* Bond, 2012; Collard and Dempsey, 2013; Hinchliffe et al., 2013) have hypothesized are the likely connections between global capital accumulation and determinants of ecosystemic health.

To that aim we also introduce here an approach that seeks to model the mechanisms by which the broader socioeconomic context largely missing from One Health helps select for xenospecific spillover. Specifically, for the first time in any field we introduce ongoing research *quantifying* the relationship between the circuits of capital out of which many new diseases emerge and their subsequent dynamics, including, from the vantage point of pathogens, their genetic evolution and sociospatial spread. That is, we propose a Structural One Health that empirically formalizes the connections among capital-led changes in the landscape and shifts in wildlife, agricultural, and human health. Should such efforts eventually succeed, researchers will be able to identify the statistically supported combinations of local agroecological circumstances and economic relations that—extending out beyond specific epicenters—drive disease spillover across species.

2. The science and political economy of One Health

Integrating health studies across species appears a step forward for disease prediction and control. A literature search by Rabinowitz et al. (2013) showed a series of studies offering evidence for the feasibility of intersectoral cooperation, including the xenospecific benefits of animal vaccination. Rabinowitz et al. review other studies showing improvement in predicting site-specific disease dynamics and in implementing successful intervention. As presented so far, however, the One Health approach also misses key sources of causality, an omission that for some of its analyses may reverse initial conclusions. For instance, descriptions of efforts in