Journal of Sustainable Development; Vol. 15, No. 6; 2022
ISSN 1913-9063 E-ISSN 1913-9071
Published by Canadian Center of Science and Education

EIDs and the Intersectional Health/Livelihoods Paradox in the Rural Global South

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Received: September 30, 2022 Accepted: November 3, 2022 Online Published: November 4, 2022

doi:10.5539/jsd.v15n6p66 URL: https://doi.org/10.5539/jsd.v15n6p66

Abstract

This article presents the framework of the intersectional health/livelihoods paradox to analyse how political economic processes incur land use change to create vulnerability to infectious disease, but that in contending with these risks rural people negotiate conflicts with livelihoods. The conflicts and trade-offs people make in deliberating over health and livelihood outcomes because of ecological degradation are distributed unevenly through lines of social difference, such as gender and class. While the health/livelihoods paradox is evident within contexts of vulnerability to infectious disease, it is poignant when considering the impacts of interventions and containment strategies to control outbreaks in rural settings. Despite considerable attention on the urban context of disease surveillance, spread and containment due to the Covid-19 pandemic, this article refocuses analysis of the impacts of emerging infectious disease (EID) in rural contexts. The article shifts attention away from analysis of the problematic practices of rural households that undertake livelihood activities such as harvesting of wildlife for consumption, to a nexus between land use change, ecologies, livelihoods and health. The literature is fragmented in terms of the landscapes explored, developmental processes, species dynamics, diseases and social contexts. Therefore, this article presents a framework that enables complex dynamics such as these, that lead people to make compromises between competing health and livelihood outcomes to be examined.

Keywords: ecology, emerging infectious disease, gender, livelihoods, paradox, political economy

1. Introduction

A rich body of literature has emerged in response to the Covid-19 pandemic with analysis insightful in identifying the economic, social and health impacts of the disease and containment strategies, particularly in urban settings. In general, the pandemic has exacerbated inequalities in health and socioeconomic status amongst urban populations as spread of infection and containment strategies are applied with uneven effects (Ho & Maddrell, 2021). The Covid-19 pandemic has focused attention on the risks of zoonotic disease spread, given trade of wild animals and the lack of regulation and control of wet markets in the global South. Zoonotic diseases such as Covid-19 that originate in animals account for at least 60% of all emerging infectious diseases (EID) (Jones et al., 2008). Tropical regions such as South East Asia are global hotspots for EIDs due to biodiversity richness that is often threatened by land use change (Allen et al., 2017). While rural areas are described as the source of EIDs and that processes of urbanisation are vectors for spread (Nwankwo & Ayadiuno, 2021), this article reviews the literature on the dynamic relationship between political economic restructuring, land use change, ecological disturbance, disruptions to livelihoods and risk of illness within rural landscapes. The article identifies the gendered nature of risk and the need to incorporate social difference in analysis of dynamic relationships.

To capture dynamic relationships, this article presents an analytical frame that highlights the contradictions and dilemmas rural people face in confronting risks to illness and livelihoods. Political ecology of health provides a broad frame for analysing how political economic processes, such as economic liberalisation and structural adjustment incur land use change to compromise rural ecologies, livelihoods and health (King, 2010). This article presents the framework of the intersectional health/livelihoods paradox to unpack the trade-offs people make as they weigh up sometimes competing risks to health and livelihoods due to land use change and subsequent ecological disturbance. These conflicts and trade-offs are unevenly distributed as social structures such as gender, class, age and geography intersect to shape the experience of marginalisation and hence compromise health and livelihood outcomes for different groups of people (Hopkins, 2019). Paradoxical dynamics exist during the

creation of vulnerability but also when interventions to contain outbreaks place pressure on rural people to choose between competing interests and outcomes. If risk mitigation and containment strategies are to be effective, then the processes through which people calculate various health and livelihood risks and make decisions regarding desired outcomes needs to be understood.

While this article presents evidence of a cross section of articles that explore these themes, what is evident is the fragmented nature of the literature and the need for a contextual understanding of infectious disease, given the array of diseases, developmental processes and ecological and social contexts. Indeed, paradoxes unfold through economic and health issues but also social structures and cultural values. In engaging paradoxical thinking, this article confronts the dominant discourse that infectious disease emerges out of rural people's problematic practices such as harvesting wildlife or poor animal husbandry practices. The article proceeds through the following four sections. Section two explores the paradoxes that exemplify scales of political economic restructuring and the impacts this has on EID. Section three explores how ecological disturbance leads to vulnerability to disease through intersecting lines of social difference such as gender and class, drawing on a handful of developmental and ecological contexts. Section four presents the evidence of the health/livelihoods paradox with respect to interventions and containment strategies for outbreaks. The journal article concludes with the case for applying the intersectional health/livelihoods paradox to examine the nexus between land use change, species dynamics, livelihoods and health.

2. Political Economic Restructuring and EIDs

In light of the Covid-19 pandemic, there has been considerable discussion of the drivers and context within which infectious disease emerges. Brooks, Hoberg, Boeger, and Trivellone (2022) describe spillover of disease from one species to another as a rare event involving parasite mutation and host switching. The 'parasite paradox' is the disconnect between the increasing numbers of EIDs despite the stated unlikeliness of mutation occurring. Discussion has turned to the economic, political and environmental causes and processes that lead to vulnerability to EID. A common argument is that EIDs emerge out of wilderness areas of the global South (Davis & Sharp, 2020). African or Asian rainforests are configured as breeding grounds for viral ontogenesis and stigmatised as sites of emergence (Keck & Lynteris, 2018). Forests are often portrayed as spaces of increased risk, such as during the harvest of bush meat for consumption or the illegal wildlife trade (Akem & Pemunta, 2020; Brooks et al., 2022). People living in landscapes amongst livestock and wildlife undertake problematic food and water practices that should be rectified with education based interventions to mitigate risk of infection (Kamau et al., 2021). However, political economic change in these landscapes is leading to contradictory and paradoxical outcomes for people living in these environments. These paradoxes reveal scaler impacts of structural adjustment, such as through urbanisation and agricultural liberalisation that incur risk of infection for certain people, animals and environments.

Global capitalist industrialisation, urbanisation and neoliberal restructuring (including the privatisation, marketisation and financialisaton of nature) co-create the conditions for EID (Sparke & Anguelov, 2020). The liberalising of agri-food systems to enhance competitive advantage between the global North and South is a significant contributor to this trend as it incurs, as Austin (2021) explains, a consumption – degradation paradox or ecologically unequal exchange. Within this frame, the global North has an extractivist relationship with the global South and externalises their consumption-based environmental costs through unequal trade relations. Agrarian restructuring compromises smallholder livelihoods and fragments forests in the interests of export oriented intensive monocropping, commodification and infrastructure development (Brenner & Ghosh, 2022). In this unequal exchange, intensive capitalist agriculture degrades landscapes and undermines local immunity, while labour migration, global commodity circuits and urbanisation increase the spread of infection (Matthewman & Huppatz, 2020). The 2013-14 ebola virus in Guinea, is an example of structural adjustment-driven economic liberalisation that led to agroecological transformations and the outbreak (Brenner & Ghosh, 2022; Sparke & Anguelov, 2020).

Regionally, urbanisation and land use planning disturb landscapes in which pathogens emerge, which in turn disturb the integrity of the socio-ecological system. Connolly, Keil, and Ali (2021) analyse the impacts of extended urbanisation (peri-urbanisation or urban sprawl etc) as a driver of EID. In their view, urban extension disturbs peripheral ecologies leading to risk i.e., by building on flood-prone land that waterlogs after rainfall, increasing sites where vectors and water-borne diseases grow (Ahmed et al. 2019). Similar to Austin (2021), Brenner and Ghosh (2022) explore a dialectical relationship between rural extractivism and urban development that increases risk of EID. A dialectical relationship between expanding enclosure and degradation of land for commercial and industrial agriculture or plantations, at ever greater distances from the concentration of resources into urbanisation is leading to risk. Enclosure of land for intensively farmed livestock decreases forms of smallholder food

production and associated regenerative agroecologies, while releasing pathogens into transmission pathways such as migration of surplus rural labour to urban areas. This growing surge in urbanisation is leading to greater concentrations of people living with inadequate infrastructure such as water and sanitation, increasing risk of spread of infection (Nwankwo & Ayadiuno, 2021; Rose-Redwood et al., 2020). In informal settlements poverty, poor building design and overcrowding is leading to spread of infectious disease such as tuberculosis (Pardeshi et al., 2020; Tosam, Ambe, & Chi, 2019). In addition, privatisation and the dismantling of government health services under neoliberalism has increased vulnerability to infectious disease as it undermines access to treatment for lower socioeconomic groups (Cleaveland et al., 2017; Connolly et al., 2021; Navarro, 2020; Sparke & Williams, 2022). The impacts of these failings are evident in the high death rates amongst poor communities and the negative impacts of social distancing on slums, homelessness and migrants during the Covid-19 pandemic (Ho & Maddrell, 2021).

Indeed, the literature on Covid-19 identifies the impacts of the pandemic as mainly an urban phenomenon. This is evident in the research that discusses the impacts of policies such as the integration of technology into surveillance and containment strategies to control exposure to risk (Bengtsson, Borg, & Rhinard, 2019; Langenohl & Westermeier, 2021; Martins, Lavallee, & Silkoset, 2021). Analysis reveals concerns over the unethical use of technologies that lead to technology creep and mass surveillance (Martins et al., 2021; Tréguer, 2021). Monitoring and surveillance that is expanded through digital technology can promote racial or ethnic bias through segregation and over-policing of various social groups (D'Ignazio & Klein, 2020; Figueroa, Luo, Aguilera, & Lyles, 2021; Hendl, Chung, & Wild, 2020; Ingram, 2009; Lal, Erondu, Heymann, Gitahi, & Yates, 2021; Peron, Duarte, Simoes-Gomes, & Nery, 2021; Storeng & de Bengy Puyvallée, 2021). D'Ignazio and Klein (2020) have termed this risk the 'paradox of exposure' in which marginalised groups such as undocumented migrants avoid surveillance to mitigate spread of infection out of fear of discrimination and deportation.

In response to the literature on the impacts of infectious disease in urban areas, this article addresses the impacts political economic restructuring and land use change have on disease in rural communities and the paradoxes they face as they contend with disruptions to livelihoods. Development has led to economic and physical displacement in response to logging, construction of infrastructure and industrialised agriculture, the consequences of which has been loss of livelihoods and social networks leading to poverty and a disease burden (Cernea, 2000; van der Ploeg & Vanclay, 2017; Vaz-Jones, 2018). In addition, events such as war, historical conflict or a legacy of colonialism, have long lasting impacts on health (Ahmed et al., 2019). The unregulated movement of the displaced (many of which squat on marginalised land) are commonly described as a vector for pathogens (Sparke & Anguelov, 2020; Tasker & Braam, 2021). Vulnerable groups such as refugees lack legal status and are unable to safely access essential services (Décobert, 2016; Suwanvanichkij, 2008). In addition, health care in remote rural areas is limited with services not adequately connected to the broader health system and are under resourced (Agarwal, Perry, Long, & Labrique, 2015). The dilemmas rural people face in confronting economic and ecological disturbances as they balance health and livelihood needs is discussed in the next section.

3. Ecological Disturbance and the Intersectionality of Risk of Infection

The impacts of land use change are felt differently by different genders, socioeconomic classes, ages and geographies, amongst other lines of social difference (Nightingale, 2011; Rocheleau, 1995). Intersectional studies have been productive in examining how social difference shapes the experience of marginalisation for certain groups of people (Hopkins, 2019). Political ecology of health provides a broad frame for analysing the implications of social difference and environmental degradation on health (King, 2010). The health impacts of ecological and landscape disturbance are distributed unevenly due to these social inequalities.

It is the spatial and dynamic nature of perturbations on ecosystems that increase the risk of EIDs (Cunningham, Daszak, & Wood, 2017). Land use change can alter habitat architecture, microclimate, and resource abundance for vectors, hosts or pathogens; change host/vector community composition; change the spatial distribution of species, their behaviour or movement; or contaminate their environment with pollution (Gottdenker, Streicker, Faust, & Carroll, 2014). In Shah, Huxley, Elmes, and Murray (2019), vector and host number and dynamics respond to changes in vegetation cover, surface moisture, topography and soil type. Less complex landscapes such as plantations and monocultures have reduced species richness increasing the risk of EID. For example, in Kaup (2021), the aedes aegypti mosquito that carries the zika virus prefers peri-urban and agriculturally developed environments, where there are fewer predators and competitive pressures from other mosquito species. Ecological disturbances can lead to increases or decreases of predators that control reservoirs of pathogens and biodiversity loss may reduce ecological niches that support some diseases but create alternative niches for other vectors and pathogens (Ellwanger et al., 2020). The impacts of land use change on infectious disease are complex and context specific (Gottdenker et al., 2014).

Deforestation is a key driver of land use change which has contradictory impacts on infectious diseases such as malaria, depending on mosquito species (Guegan, Ayouba, Cappelle, & de Thoisy, 2020). Deforestation can reduce mosquito habitat, decreasing the number of vectors, but in Brazil, Olson, Gangnon, Silveira, and Patz (2010) observed that deforestation leads to increased risk of malaria as the shrubs that grow as secondary growth are habitat of mosquitoes, as are the fish farms that replaced primary forest. Deforestation brings communities and loggers to forest fringes where they live amongst hosts such as primates (Gottdenker et al., 2014). The risk of infection is often gendered, as in Cambodia where men (particularly poor farmers) travel deeper into forests and for longer on logging trips than do women (Bannister-Tyrrell et al., 2019). On deforested land in Indonesia, workers sleep in temporary shelters on construction sites where they encounter monkeys and malaria (Naserrudin et al., 2022). Sleeping in forests for work is also common practice in Vietnam where young men sleep in huts without walls and without bed nets (Canavati et al., 2019).

Land use change increases conflicts between people and wildlife over resources such as land and water leading to destroyed crops and livestock losses (Garnier et al., 2020), but also between people, leading to further encroachment of poor households into wildlife areas (Harrison et al., 2020). Bats are hosts to various diseases such as coronaviruses, ebola and dengue amongst others, but provide important ecosystem services by aiding seed dispersal and pollination, prey on pests and form an important source of protein in diets (Bonilla-Aldana et al., 2021; Leach et al., 2017). Plowright et al. (2021) explains that habitat destruction and fragmentation causes nutritional and physiological stress in animals such as bats, as resources are diminished and behaviours for feeding change. Animals are more likely to become ill under these conditions and shed pathogens into the environment while simultaneously concentrating into anthropogenic landscapes. In West Africa, deforestation from mining decreased vegetation, concentrating bats into 20% of tree cover near villages which led to the ebola outbreak (Tosam et al., 2019). Bats are hunted and consumed by men, roost around the house where women perform domestic chores but interact with men and women during the gendered division of labour such as farming, fruit collection and animal husbandry (Leach et al., 2017). The connectivity paradox, therefore, balances the need for intact nature and landscape change for human livelihoods (Plowright et al., 2021).

Political economic and land use change can impact livelihood dynamics within a mosaic of landscapes which has implications for risk of neglected tropical diseases in communities. In Africa, Leach et al. (2017) discusses interspersed landscapes of villages, crop land and kitchen gardens (habitat of rodents and lassa fever), wetlands for rice and forests harvested for various uses (habitat of tsetse flies and trypanosomiasis). Social difference shapes risk of infection in these landscapes. Poor women and children living in mud homes are exposed to rodents and disease during domestic work more so than wealthier women that live in concrete homes (Dzingirai et al., 2016). Exposure to lassa fever through contact with rodent urine/faecal contaminated food, water and surfaces is most prevalent for men clearing crop land and for women and children collecting firewood and preparing vegetable mounds (Leach et al., 2017). In West Africa, war and development have led to displacement and the establishment of smaller household units cultivating marginalised land, increasing the number of comfortable niches for rodents and lassa fever (Dzingirai V et al., 2017).

Informal markets such as wet markets are often sites of contention for risk of infectious disease as regulations, infrastructure (roads, water, sanitation) and storage (refrigeration) are poor or absent (Ahmed et al. 2019). However, informal markets are the primary source of cheap animal sourced foods, and fresh, local produce for many people in Africa and Asia, through which social relations of trust and credit support relations between buyers and sellers (Ahmed et al., 2019). Local practices and adaptations provide a clearer profile of risk, such as female food vendors that ration meat products to sell each day, leaving less leftovers for the following day (Ahmed et al., 2019). However, within the household rural women are often responsible for jobs such as livestock shed cleaning, manure use, fodder harvesting and feeding, treating sick animals, milking and feeding young animals which puts them at risk of infection (Kimani et al., 2012). Women also often lack formal education and are marginalised from information and training on animal health and infection control (Alhajia, Babalobib, & Isolab, 2018; Hu Suk Lee, 2020; Kelly et al., 2018; Pal, Yawongsa, Bhusal, Bashyal, & Rukkwamsuk, 2021; Thys et al., 2019). A gendered (as opposed to sex) approach to exposure and response to risk of infection, particularly for zoonosis such as brucellosis, are still limited in public health interventions (Garnier et al., 2020).

The strategies of households in response to ecological and livelihood disturbances such as through mining incurs gendered risks of exposure. In Zimbabwe, male squatters from abandoned mining towns cleared woodlands for tobacco farming which increased exposure to tsetse flies (Leach et al., 2017). In Ghana, risks from mining disproportionately impacted women, as in Ferring and Hausermann (2019) where abandoned mines filled with water increased mosquito numbers and incidence of malaria, particularly in children. Poor women, who gain livelihoods mining risk illness but also compromised cropping systems and water quality, the psychological stress

of which further compromises women's immunity in addition to physical ill health. In Tanzania, conflict over resources was the result of the institutionalisation of a national park which regulated that women must collect fuelwood at dawn when mosquitoes are most active and travel further for water, exposing them to malaria for prolonged periods each day (Dunn, Le Mare, & Makungu, 2011). In India too, women that fetched water from tube wells were exposed to malaria as sites were poorly drained with pools of stagnant, polluted water (Sharma et al., 2021). Economic and physical displacement leads to marginalisation increasing the risk of exposure, creating tension between competing health and livelihood outcomes and forcing people to make trade-offs as they deliberate desired strategies.

4. Containment Strategies and the Health/Livelihoods Paradox

The health/livelihoods paradox describes conflicts and trade-offs that are not only evident in the effects of social difference on exposure to risk but are especially poignant when examining the outcomes of interventions and containment strategies for infectious disease. Interventions to control disease can make poverty worse with the impacts on livelihoods overshadowing the impact of the disease itself (Cunningham, Scoones, & Wood, 2017). In addition, social and cultural factors shape how people experience risk and beliefs shape understandings of health and wellbeing that underpin the construction of knowledge regarding disease (MacGregor & Waldman, 2017). Complicating these factors is the political nature of containment strategies which make visible specific risks and vulnerable populations, while negating others that are themselves embedded within specific socio-geographic spatial frames (Brown, Craddock, & Ingram, 2012).

The health/livelihoods paradox arises due to tension between traditional practices and development interventions and containment strategies. Containment strategies such as fencing and border restrictions constrain pastoralists who lose their seasonal and informal movements to capitalise on grazing, fodder, water or escape from disease or conflict (Davis & Sharp, 2020; Khbou, Htira, Harabech, & Benzarti, 2018). In addition, in Kenya, constrained mobility from the institutionalisation of private property undermined social relations that enabled labour sharing, animal gifting and herd risk pooling (Unks, King, German, Wachira, & Nelson, 2019). However, exposure to infection is high after rainfall when herders and animals are concentrated to capitalise on good grazing and women manage young and sick animals exposing them to disease (Dzingirai et al., 2016). In the case of refugee camps, Braam, Jephcott, and Wood (2021) discuss livestock bans in response to fears herds grazed amongst host communities' livestock or wildlife habitat increase the risk of disease spread. Camps are often established on land with little vegetation and poor agriculture leading to malnutrition, therefore the loss of animals can undermine capacity for livelihood rehabilitation, nutrition, and psychosocial health increasing vulnerability to disease. These few examples reveal the importance of understanding the spatialised dynamics of exposure to risk but also the tensions that the health/livelihood paradox illicit for the most marginalised that fear they will lose their ability to forage in forests or graze after rainfall if they report illness.

The health/livelihood paradox emerges when interventions have counterintuitive effects on disease spread. Bardosh et al. (2017) identify the relevance of understanding local practices for containing infection, as in Nigeria where Fulani nomad husbandry practices were found to mitigate the risk of brucellosis spread instead of facilitating it. In Ethiopia, Kloos (1990) found that pastoralists migrated seasonally to avoid vectors such as mosquitoes during inundation but that irrigation, poor sanitation and higher population densities in resettled communities led to increased rates of transmission amongst settlers and migrant labourers. Muslim, Mohd Sofian, Shaari, Hoh, and Lim (2019) made similar conclusions about the impacts of resettlement in Malaysia, where the replacement of customary livelihood activities (such as fishing, hunting and gathering) with cash crops reduced exposure to a diversity of parasites but increased concentration of exposure to alternative parasites during repetitive contact with contaminated soil, food and water.

Knowledge of transmission pathways between humans and livestock can be limited or contested, therefore ill-designed policies for containment will incur resistance from farmers (Klous, Huss, Heederik, & Coutinho, 2016). Pastoralists unable to act on health advise experience stigmatisation and may continue with risky practices as they prefer their own knowledge of diseases (Davis & Sharp, 2020). Farmers' response to the avian influenza outbreak in Vietnam exemplified this trend. Porter (2013) documents farmers' unwillingness to report illness due to culls of sometimes entire flocks of healthy birds based on a few poultry deaths. Historically, local farmers rarely consulted state veterinarians due to confidence in their own experience and advice from friends and neighbours regarding diagnoses and treatment. As a result, farmers contested problematisations of local chicken farming practices. In their calculation of risk, farmers rationalise economic loss, illness and relations to the state, such as in Southern China where avian influenza has two names: qinliugan (disease that incurs mass culling) or liugan (ordinary duck disease) (Keck & Lynteris, 2018).

The literature discusses the contextual environment within which the avian influenza outbreak emerged therefore the spatial frame within which the health/livelihoods paradox unfolds. Lakoff (2016) describes failings in vaccine production coupled with patchy surveillance of certain strains in countries with lots of birds but poor infrastructure. Increasing wealth is increasing demand for industrialised meat, exacerbating concentration of birds in unhygienic conditions and aggravating spread of infection (Spencer, Finucane, Fox, Saksena, & Sultana, 2020). On farm practices and their impacts on the environment such as shifts from extensive to intensive cropping, use of fertilisers, irrigation and monocultures degrade habitats for birds (wild and domestic) which can have feedback effects for pathogens in integrated wetland-crop-bird landscapes (Cumming et al., 2015). However, Hinchliffe (2015) challenges this spatial frame, claiming technological problematisations and solutions mask the social and informal relations through which farmers and consumers weigh up avian influenza as just one risk amongst many livelihood risks. He identifies market relations, such as when middlemen pool birds during transportation, or when consumers prefer live birds to freshly killed birds due to freshness and flavour, as points of tension where trade-offs are made. Containment strategies need to be sensitive to multifaceted points of risk that include technical solutions as well as social relations and cultural preferences that guide behaviour.

The sociocultural dimensions of the health/livelihoods paradox are most evident in the case of the ebola outbreak in West Africa. In Sierra Leone, O'Kane and Boswell (2018) describe conflicts over how culturally sensitive care was to be given to patients. Hospitals became hotspots for ebola as poor hygiene practices and the concentration of sick people created the conditions for the disease to spread (van Loon, 2005). The sick are the most contagious before and after death, therefore the division of labour distributed risk amongst men and women differently. Men hunted infected primates but also carried the dead and prepared burials, while women, particularly older women, cared for the sick and cleansed the bodies of the deceased, often to protect the younger women from exposure (Bagnol, Alders, & McConchie, 2015; Scoones et al., 2017). The public health response to the outbreak was to replace traditional funerals with safe burials but this was met with resistance by family and community (Scoones et al., 2017). Hierarchical power differentials emerged between global health organisations and local actors over meanings of concepts such as heritage and human dignity through which different actors weighed up the trade-offs between spread of infection and preserving the dignity of their loved ones through traditional burials (O'Kane and Boswell, 2018). Conflict led to mistrust on the part of local people who withheld reports of infection and death in their villages (O'Kane & Boswell, 2018). Behaviour change was derived from engagement with communities that built trust, social solidarity and were sensitive to local political dynamics (Cunningham, Scoones, et al., 2017). Obeng-Odoom and Bockarie (2018) conclude response strategies to infectious disease must build social resilience through social medicine, collective self-reliance, empowered social ties, social protection and socially inclusive development.

The intersectional dimensions of the health/livelihoods paradox with respect to containment strategies is little explored outside a few studies of the ebola or zika outbreaks which discuss the gendered impacts of the pandemics (Davies & Bennett, 2016). These shortcomings are echoed in recent literature that calls for greater attention to intersectionality to examine the impacts of the Covid-19 pandemic (Figueroa et al., 2021; Ho & Maddrell, 2021; Ryan & El Ayadi, 2020). While the sexual and reproductive health aspects of vulnerability and impact of the zika outbreak are comprehensively discussed, limited research explores how social difference shapes the health/livelihoods paradox in terms of containment strategies for the disease (Forero-Martínez, Murad, Calderón-Jaramillo, & Rivillas-García, 2020; Gurman et al., 2020). In Brazil, gender and class intersected with poor water storage infrastructure to produce breeding habitats for mosquitoes leading to the spread of zika (Camargo, 2020; Davies & Bennett, 2016). Camargo (2020) provides insightful analysis of how multi-scalar surveillance from the intimate to the international was configured around relations between women, water, mosquitoes and the climate to configure the household as a space of securitisation to control zika spread. Within this frame, zika enabled an assemblage of forms of security and control of women's bodies, mosquitoes and water environments through which marginalised women were blamed for the outbreak. Poor women's access to the resources required for health such as water was compromised due to a geopolitical storm over control of the disease.

5. Conclusion

This article has demonstrated a framework for examining how political economic transformations and subsequent land use change lead to risk of infectious disease, but that this risk is distributed unevenly amongst different social groups within rural society. The risk posed to rural communities is two-fold in that land use change poses risks to livelihoods and that securing dual goals of health and livelihoods may be in conflict. The article thus poses the framework of the intersectional health/livelihoods paradox to examine how these conflicts and trade-offs unfold for various social groups in different ecological contexts. In making everyday decisions over health and livelihoods, rural people weigh up countervailing factors with health, including social and cultural norms and behaviours that

shape the experience of ecological and human ill/health and livelihood security.

The dominant discourse characterises the emergence of infectious disease as derived from wilderness areas in the global South such as forests, but that this risk migrates to urban settings where people are concentrated, infrastructure is poor and the risk of spread is high (Nwankwo & Ayadiuno, 2021). This article has demonstrated how the paradoxes of political economic transformations and rural land use change from agricultural industrialisation, mining, forestry and settlement development lead to environmental degradation and dilemmas for people living in these rural landscapes. The article has also identified some specific ecological dynamics with respect to species such as bats, mosquitoes and rodents of land use change and their role in risks to health for people deriving their livelihoods in particular ecological contexts. Further research will benefit from a more robust analysis of the nexus between ecological disturbance, changes in species dynamics, livelihoods and health in particular landscapes. Studies of this nature would further enrich insight into the paradoxical nature of the health/livelihoods trade-off, in which interactions with specific species encompass more dimensions than income or food to include social and cultural values and more dimensions of health than infectious disease such as psychosocial health and nutrition.

This article demonstrates the salience of intersecting lines of gender, class, age and geography for understanding the distribution of risk of EID due to land use change and disturbances to ecological integrity. The evidence presented in this article highlights the necessity of understanding the gendered division of labour for disaggregating exposure to disease, but that the paradoxical nature of health/livelihood risks is also gendered. Gender intersects with class when poor men and women are forced to seek livelihoods in disturbed landscapes such as forests or crop land in which vectors such as mosquitoes or rodents are abundant (Bannister-Tyrrell et al., 2019; Leach et al., 2017). Gender intersects with age when women and their children risk infection with malaria when seeking livelihoods near abandoned mines filled with water (Ferring & Hausermann, 2019). Stressed bats adapting to ecological disturbance cohabit with men and women in various landscapes as they engage in livelihood activities (Leach et al., 2017; Plowright et al., 2021). However, how these relations intersect with socioeconomic or ethnic dimensions to produce the health/livelihoods paradox requires more attention. A robust examination of the impacts of intersecting social structures such as gender, class, ethnicity, race and religion etc would make for compelling analysis of the distribution of power and politics in this nexus of ecology, species dynamics, livelihoods and health.

This article also identifies the lack of intersectional engagement in analysis of the health/livelihoods paradox that emerges from surveillance and containment strategies. While the literature engages transdisciplinary themes to explore the sociocultural dimensions of farmers' perceptions of risk and disease management behaviour, they fall short in explicitly disaggregating these trends by lines of social difference. With the Covid-19 pandemic igniting interest in surveillance and containment of EIDs, particularly for zoonoses, the power and politics of how risk is managed and controlled will be ever more pertinent if efforts to secure health do not infringe on social justice and equity. Policy makers designing strategies to manage risk of infectious disease and its spread will benefit from a participatory process with rural communities to identify the countervailing forces that prevent them from adhering to health advice. Participatory epidemiology (PE) is one such approach for engaging local communities in project planning and design to identify appropriate methods of surveillance and containment that suit any give context (Alders et al., 2020; Ebata et al., 2020). Methods of PE such as maps, calendars, interviews and focus groups can be used to gather data that is sensitive to social and power dynamics within communities but also between communities and researchers or political actors so that strategies designed reflect differing vulnerabilities (Ebata et al., 2020). PE enables local knowledge of diseases and practices to be incorporated into policy (Alders et al., 2020) but also people's knowledge of local ecologies and how changes in these are leading to changes in the disease dynamics they are familiar with. Indeed, policies for rehabilitation of impacted communities of development would benefit from incorporating the intersectional health/livelihoods paradox into their project planning as a framework to better capture the impacts of environmental degradation on people's health and livelihoods and design strategies to mitigate these.

Conflict of interest statement: There are no conflicts of interest.

Acknowledgement

I would like to thank Melanie Banister-Tyrrell, Clare Strachan, Anna Okello and Barbara McPake for comments on previous drafts of this article.

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