

Zoonotic urbanisation: multispecies urbanism and the rescaling of urban epidemiology

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Abstract

A focus on zoonotic urbanisation challenges existing conceptions of global urbanism. In this article I consider how a modified urban political ecology framework might help to illuminate emerging landscapes of epidemiological risk. I show how a multi-scalar perspective on urban epidemiology, including the impact of colonialism, global capitalism, and changing relations with non-human others, unsettles existing analytical approaches. I contrast resilience-oriented public health paradigms, focused on the malleability of nature, with a historically grounded set of insights into global environmental change. I suggest that the conceptual field of zoonotic urbanisation provides an analytical entry point for understanding an emergent ‘triple crisis’ spanning climate change, biodiversity loss, and global health threats.

Keywords

accelerator landscapes, ecological decay, multispecies urbanism, urban epidemiology, urban political ecology, zoonotic urbanisation

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摘要

对人畜共患病城市化的关注，让人们在全球城市化的现有概念提出了质疑。在本文中，我们考查了变革后的城市政治生态学框架如何有助于阐明流行病学风险的新情况。我们展示了城市流行病学的多标量视角如何颠覆现有的分析方法，这个多标量视角包括殖民主义的影响、全球资本主义的影响，以及其它非人类因素与其不断变化的关系对其造成的影响。本研究对比了以抗御力为导向的各种公共卫生范式，重点关注自然的可塑性，并基于历史提出了一系列关于全球环境变化的见解。本文认为人畜共患病城市化的概念场提供了一个分析切入点，使人们得以理解新出现的“三重危机”：气候变化、生物多样性丧失以及全球健康威胁。

关键词

加速图景、生态衰退、多物种城市化、城市流行病学、城市政治生态学、人畜共患病城市化

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In the wake of the Covid-19 pandemic the precise relationship between cities, urbanisation, and infectious disease has come under renewed scrutiny.¹ In particular, there are efforts to extend the field of urban epidemiology to encompass new kinds of spaces, processes, and co-evolutionary dynamics. The status of Covid-19 as a zoonotic disease of animal origin has illuminated complex chains of causality and connectivity that exceed the analytical capacity of the biomedical sciences (see, for example, Fearnley, 2022; Goldstein et al., 2022; Kirksey, 2020).² A pervasive search for origins, often couched in terms of cultural alterity, fails to engage with the structural dimensions to heightened levels of zoonotic threat (Zhang, 2021). The scale of the analytical task has engendered metaphors of epistemological monstrosity, pushing existing theoretical frameworks to their limit, and upending conventional conceptions of urban space (Brenner and Ghosh, 2022). New approaches to urban epidemiology, drawing on a variety of insights from political economy and political ecology, have begun to develop multi-scalar approaches to the study of animal-human relations that include an

array of extractive frontiers, infrastructure networks, and urban topographies.³ The anthropologist Meike Wolf (2016), for instance, in a path-breaking contribution, highlights the need to develop a double conceptualisation of ‘the urban’ that encompasses not only multiple processes, scales, and heuristic vantage points but also the need for ethnographic engagement with the complexities of highly varied local epidemiological contexts.

It is difficult to underplay the zoonotic dimensions to human history since most diseases are of animal origin. The place of animals within cities has been a compelling strand within urban research encompassing themes such as the development of abattoirs, the regularisation of street life, and affective dimensions to human-animal relations (Brantz, 2008; Philo, 1995; Wolch, 2002). A zoonotic reading of urban space adds another layer of complexity, illuminating different facets of modernity at a global scale, along with specific biopolitical interventions in fields such as veterinary science and public health. The Covid-19 pandemic has brought these epidemiological questions into sharp focus as part of a wider set of

late-modern vulnerabilities, unsettling existing conceptions of preparedness and the institutional framing of public health.

In this article I look beyond the specific case of Covid-19 to consider the wider implications of what I term ‘zoonotic urbanisation’. A focus on zoonotic urbanisation highlights a series of intersecting temporalities: the on-going influence of pre-modern intersections with zoonotic disease; the emergence of the ‘bacteriological city’ and attempts to rationalise urban space; the entangled epigenetic and evolutionary pathways of hosts, vectors, and pathogens; and the global destruction of ecosystems, including the impact of accelerator landscapes on epidemiological risk. The spatial dimensions to zoonotic urbanisation are similarly multifaceted, extending from various types of architectonic spaces or even the claustrophobic interior of hazmat suits to large-scale infrastructure systems, agro-industrial landscapes, and more distant viral reservoirs.

In the period since the spread of Covid-19 a number of new zoonotic threats have come into focus. In May 2022, for instance, the World Health Organization declared a ‘public health emergency of international concern’ in relation to the rapid spread of the monkey pox virus to more than 70 countries, extending far beyond its known occurrence in parts of West and Central Africa. At the time of writing a series of further zoonotic threats including Crimean-Congo haemorrhagic fever, H5N1 avian flu, Langya henipavirus (LayV), Marburg virus, MERS and Nipah virus are being actively monitored by the WHO and other health agencies. And in the sphere of capitalist agriculture there are a series of unprecedented global emergencies spanning foot-and-mouth disease, swine fever, and other livestock diseases that signal wider public health threats.

The relationship between urbanisation and emerging zoonotic diseases raises a series of pressing questions. To what extent

is urbanisation a fundamental element in a new epidemiological transition or simply a socio-ecological terrain within which specific corporeal vulnerabilities become manifest? How can we analytically combine disparate locales ranging from dense metropolitan spaces to more distant types of settlements, facilities, or infrastructure networks? And how should we interpret specific dimensions to urbanisation that are driven by the epidemiological dynamics of late modernity such as bio-tech related agglomerations or new approaches to landscape design?

In this article I explore a series of specific challenges for urban epidemiology. I begin by delineating the current epidemiological transition and its relationship to global patterns of urbanisation. I then look in more detail at a series of distinctive spaces and processes that have contributed to the growing impact of zoonotic disease including landscapes of ecological decay. In the next section I examine affective dimensions to zoonotic urbanisation including different kinds of human–animal relations under multispecies urbanism. I then turn to the theme of pandemic governmentalities and changing conceptions of urban form. Finally, I consider some of the possibilities offered by a modified urban political ecology framework for the analysis of emerging landscapes of epidemiological risk.

Patterns and periodicities

We can delineate at least three zoonotic transitions in human history. In a first phase, associated with early human settlements, animal domestication, and the expansion of trade routes, we see the spread of zoonotic diseases such as plague, rabies, and tuberculosis. A second phase is associated with the growth of industrial cities and subsequent improvements in nutrition, public health, and other fields but needs to be set in a broader context marked by the

development of global capitalism, Indigenous dispossession, and the colonial dynamics of global environmental change. The spread of cholera, for example, is closely related to European colonialism *and* the environmental conditions experienced in fast-growing cities. And in recent decades, a third phase is marked by the increasing prevalence of new and emerging diseases in response to agro-industrial intensification, climate change, proliferating zoonotic contact zones, unprecedented degrees of global mobility, mass displacement, the growing resistance of many diseases to existing treatments or control measures, and the persistence of extreme poverty and inequality.

The history of disease has been closely tied with the urban arena even if the underlying epidemiological dynamics have not necessarily been directly produced by urbanisation. A particular focus of contestation is the degree to which specific public health interventions or wider improvements in nutrition led to the gradual enhancement of life expectancy in 19th-century European and North American cities. A global vantage point illuminates how conditions in many colonial cities continued to decline as capital derived from overseas territories was siphoned into elaborate public works within the metropole. The status of cities as a leading cause of ill health has been a recurring focus of contestation within the field of 'disease ecology' as part of a wider critique of modernity and reductionist tendencies within the biological sciences (Anderson, 2004). Although the characterisation of cities as 'incubators' for infectious disease remains prominent within the bio-medical literature (see, for example, Alirol et al., 2011) there is now wider recognition of the diversity of urban spaces and processes that produce divergent epidemiological landscapes. The existence of an 'urban penalty' has become far more variegated in terms of its intra-urban expression, including

persistent health disparities in terms of income, ethnicity, and other factors along with forms of enclave urbanism that shield wealthy elites from many forms of epidemiological risk.

For many commentators the Covid-19 pandemic serves as an indicator for the Anthropocene. Bruno Latour, for example, stresses the symbolic singularity of Covid-19 as a precedent for large-scale environmental disruption, suggesting that 'the health crisis prepares, induces, and incites us to prepare for climate change' (Latour, 2021: S27). In contrast, Manuel Arias-Maldonado (2023: 50) suggests that Covid-19 is 'the product of a zoonotic spillover that reproduces a well-known human vulnerability in a contemporary context'. For Arias-Maldonado (2023: 51), the threat of zoonotic disease is better interpreted as 'a danger of the Holocene that is amplified in the Anthropocene'. Similarly, Eva Horn (2021: 124) stresses the significance of 'tipping points' marked by 'slow latency periods with sudden rapid escalations', a dynamic that is shared by zoonotic pandemics and many other environmental phenomena. Horn (2021: 131) highlights an 'epistemic similarity' with the Anthropocene rather than a causal relationship, notwithstanding the accelerated rates of global mobility and ecological destruction that have occurred over recent decades (see also Arias-Maldonado, 2023).

Even if Covid-19 has been widely characterised as an indicator for the Anthropocene, this term of geological origin, with its emphasis on globally synchronous starting points, does not provide a cogent entry point into the zoonotic dimensions to the global health crisis. The alternative concept of the Plantationocene offers a more precise heuristic device to illuminate specific dimensions to the evolution of zoonotic space, including the global mobility of pathogens, changing modes of food production, colonial patterns of environmental degradation, and the rise

of multiple extractive frontiers (Barua, 2023; Wolford, 2021). The Plantationocene also highlights changing patterns of diet and nutrition, including the shift from local or regional plant-based diets towards meat-oriented modes of global consumption (Otter, 2020).⁴

Global environmental history can be conceptualised in terms of successive extractive frontiers for food, timber, and other commodities. The historian Sven Beckert and his colleagues suggest that the modern era has been marked by a series of distinctive ‘commodity regimes’ shaped by the spatial and organisational dimensions to global capitalism. Under the current commodity regime, emerging in the wake of the 2008 financial crisis, there has been an intensification of agro-capitalism marked by increasingly monopolistic patterns of ownership along with new forms of automation, logistics, and data control (Beckert et al., 2021: 444). Modes of intensification include the development of vast industrialised facilities for chickens, pigs, and other animals (Lander et al., 2020). The epidemiological danger from poultry farms, for example, has steadily grown as chicken has become the main global source of meat for human consumption with many millions of almost genetically identical birds kept in close confinement (Davis, 2005; Vidal, 2021). The number of chickens being raised worldwide has more than doubled since 1990 to reach over 33 billion birds by 2020 (FAO, 2022). The global epicentre for the emergence of H5N1 and H7N9 avian influenza has been in southern China, in a landscape that includes significant wetlands for migratory birds as well as zones of rapid urban expansion, to produce a vast potential interface with natural reservoirs of infection (Fearnley, 2020; Keck, 2020). The anthropologist Frédéric Keck (2019), writing in the context of zoonotic threats emerging from the ‘livestock revolution’, refers to ‘a feral reversal of the

Anthropocene’ (p. S251). Yet significant outbreaks of avian influenza have also been recorded in more bio-secure zones of industrialised poultry production in Canada, France, the Netherlands, the UK, and the USA (Gilbert et al., 2017). The model for large-scale intensification of production originated in the US ‘broiler belt’ and was subsequently exported to Brazil, China, Mexico, South Africa and elsewhere from the 1970s and 1980s onwards (Keck, 2019).⁵ Similarly, the industrialisation of pig farming, with the large-scale confinement of animals, dates from the 1970s in the USA, and is a model that has subsequently been adopted in Brazil, China, France, Germany, Russia, Spain, Vietnam and other countries but often on an even greater scale: the world’s largest pig farm opened near the Chinese city of Nanyang in late 2020, housing over 100,000 animals in 21 six-storey buildings, while a still larger facility has recently opened near the Chinese city of Ezhou that will slaughter over one million animals a year. Zoonotic transfer zones involve multiple intersections between the biosphere and the technosphere, including not only extractive frontiers and new forms of agro-industrial intensification but also the development of elaborate infrastructure systems for the transport of live animals.

The question of periodicity touches on divergent conceptions of human agency. There is a striking contrast between the idea of the ‘bacteriological city’ as an idealised field of spatial rationalisation at the leading edge of scientific knowledge and the looming significance of the ‘zoonotic city’ as a field of proliferating uncertainties (Gandy, 2006, 2022b). An emphasis on zoonotic urbanisation clearly lies in tension with the adaptive Anthropocene paradigm since it questions the efficacy of techno-managerial responses to epidemiological threat. New and emerging diseases, along with multiple feedback loops, are indicative of the limits to human

agency (Lynteris, 2020). For the geographer Stephanie Wakefield and her colleagues there is a need to recalibrate our understanding of human agency in the face of two contrasting positions: firstly, the emphasis on harnessing ecological processes within a resilience-oriented framework in the service of capitalist urbanisation; and second, the adoption of a new materialist stance in relation to the radical asymmetry between human and non-human capacities (Wakefield et al., 2022). The implications of either overestimating human ability to influence bio-physical systems or effectively abandoning efforts to make strategic biopolitical interventions have far reaching consequences. A more critically nuanced reading of political agency à la Wakefield provides a compelling alternative to either an exaggerated faith in eco-modernist resilience paradigms or the blurring of human agency within new materialist ontologies.

Ecological decay and accelerator landscapes

Increasing levels of zoonotic risk are related to a range of factors including climate change, habitat destruction, industrialised agriculture, multiple extractive frontiers, and increased global mobility. If we take the impact of habitat destruction this encompasses not just the elimination of existing ecosystems but also the uncertain dynamics of what remains. The epidemiological impact of global biodiversity loss includes specific forms of ecological disequilibria emerging within simplified, polluted, or fragmented ecosystems. The global dimensions to ecological decay span a series of amplifier effects since warmer, disrupted, or denuded ecosystems can create conditions within which many pathogens can flourish (Haddad et al., 2015; Morris et al., 2016). The fragmentation or pollution of water bodies, for example, can enable vast

numbers of mosquito larvae to develop in the absence of fish or other natural predators. Other forms of ecological disruption and heightened epidemiological risk include urban expansion into biodiversity hotspots (Allen et al., 2017). A recent study of peri-urban landscapes in the Brazilian state of Recife, for instance, revealed the increased prevalence of insect vectors for disease, including mosquito species associated with the remnants of tropical rainforest such as *Culex nigripalpus*, responsible for the transmission of Saint Louis encephalitis, West Nile virus, and Venezuelan equine encephalitis (Paiva et al., 2019).

An emphasis on ecological decay unsettles recent developments in urban ecology, especially in the global North, that have emphasised ‘recombinant ecologies’ or ‘novel ecosystems’ as a form of benign abundance. The reconceptualisation of global nature as a ‘rambunctious garden’, as elaborated by the ecologist Emma Marris (2013), is more context specific in its epidemiological implications than her upbeat assessment allows. Furthermore, the emphasis on novel ecosystems finds resonance with strands of resilience discourse that have stressed the malleable dimensions to urban nature. From a global perspective, however, many of these new ecological landscapes are anything but benign. Landscapes in proximity to industrialised agriculture can become ‘hypertoxified environments’ affecting existing ecosystems and water resources over vast areas (Brenner and Ghosh, 2022: 897). In the Murcia region of southern Spain, for example, nitrogenous waste released from pig farms has led to the ecological collapse of one of Europe’s largest salt water lagoons and mass die-offs of fish (Hekman et al., 2021). Similarly, in North Carolina, the poorly regulated expansion of pig farming has produced a regional landscape soaked in manure that has been likened to the smell of a decomposing corpse (Yeoman, 2019).

These ‘necrotic landscapes’ exhibit a series of thano-metabolic pathways that have multiple implications for human health, as these damaged and denuded ecosystems become sites of heightened epidemiological risk. In parts of south Asia, for example, environmental degradation in the vicinity of pig farms has facilitated the bat–pig zoonotic interface for the transfer of Nipah virus to the human population (Jones et al., 2013; Pulliam et al., 2012).

Urban topographies perform a kind of ecological mimicry. The city can be conceptualised as a kind of forest ecosystem but not in the classic sense of a biomass model as developed by the Brussels school of urban ecology in the 1970s.⁶ From an epidemiological perspective the urban landscape resembles a series of ecological niches: small bodies of water can play the role of saproxylic tree-hole ecologies or water-filled leaf axils. Urban landscapes contain a diversity of water-related threats that reflect the changing distribution and ecological dynamics of different insect vectors for disease.⁷ Dysfunctional water supply systems necessitate temporary storage measures, especially in poorer neighbourhoods, thereby providing ideal habitats for mosquitoes, including the *Aedes* vectors for chikungunya, dengue, Zika virus, yellow fever and other diseases. Uncollected garbage such as old tyres can similarly host large numbers of mosquito larvae. Open sewers, blocked drains, and standing water, exacerbated by flood events, provide further breeding opportunities for the *Anopheles* vectors for malaria and the *Culex* vectors for West Nile virus, Japanese encephalitis, filariasis and other diseases (Acevedo-Guerrero, 2022; Borre et al., 2022).⁸

With the growing resistance of mosquitoes to insecticides there is increasing interest in the use of natural predators to control their larvae. In some cases, however, introduced species of fish can attack so many

organisms that they contribute to increased numbers of mosquitoes as a result of wider forms of ecological disturbance (Dambach, 2020). In these and other instances invasive ecologies can undermine the epidemiological objectives of species introductions. For the *Aedes* vectors that breed in temporary water bodies to avoid predators there has been attention on the role of small crustaceans such as copepods or the introduction of other mosquito species that are specialised predators of mosquito larvae such as the harmless *Toxorhynchites* genus. Yet another approach has been the release of transgenic mosquitoes to render offspring infertile, opening up a new field of entomological experimentation and biotech profitability (Beisel and Boëte, 2013; Reis-Castro, 2021). In practice, however, these biological control programmes have often proved complex and expensive to sustain over longer periods, and if these measures are interrupted or funding runs out the numbers of dangerous insect vectors quickly recover.

It has long been recognised that urban environments produce intensified evolutionary pressures yet the epidemiological consequences remain only partially explored. The spatial isolation of underground infrastructure networks has enabled the accelerated evolution of mosquitoes in London, New York, and other cities (Byrne and Nichols, 1999). There is evidence that the rapid spread of West Nile virus in North America may be partly due to the evolutionary adaptation of the pathogen to urban environments (Hadfield et al., 2019). Similarly, the global mixing of the four dengue serotypes has facilitated the emergence of more dangerous strains of the virus (Ooi and Gubler, 2009).

Specific aspects of urban environments can raise levels of epidemiological risk. Although the negative impacts of light pollution are best known in relation to nocturnal ecology, circadian rhythms, and

migratory birds there are under-researched zoonotic implications. Light pollution is known to weaken the immune system of birds thereby making them more likely to serve as hosts for West Nile virus and other diseases (Kernbach et al., 2019). Artificial light is also believed to increase the biting activity of mosquitoes, including day-flying *Aedes* species (Fyie et al., 2021). Other little studied sources of epidemiological risk include the interior environments of infrastructure networks. Plumbing and heating systems provide ‘tubular ecologies’ in which specific pathogens can flourish such as the thermotolerant amoeba *Vermamoeba vermiformis* and the *Legionella* genus of Gram-negative bacteria. Water supply networks can contain diverse zoonotic threats such as the protozoan parasites *Giardia* and *Cryptosporidium*. Different stages of decay or neglect produce further micro niches such as biofilms that can support a variety of pathogens, including parasitic worms.

The circulatory dynamics of infection between human and non-human reservoirs of disease is another source of epidemiological uncertainty. The prevalence of Covid-19 among animals such as white-tailed deer (*Odocoileus virginianus*) in suburban areas of North America has revealed additional complexities in the assessment of zoonotic risk and the emergence of new variants that can re-infect human populations (Chandler et al., 2021). Similarly, the infection of farmed mink with Covid-19 in Denmark in 2020 led to a controversial cull of over 17 million animals driven by fears of new variants being transmitted back into the human population (Fenollar et al., 2021).

Individual human bodies can serve as incubators for the emergence of new strains of existing pathogens. From late 2020 onwards a series of Covid-19 mutations emerged in regions with high rates of infection including the UK (alpha), South Africa (beta), India (delta and kappa), Brazil

(gamma and zeta), Peru (lambda), Colombia (mu) and most recently Botswana and South Africa (omicron). The bodies of people with compromised immune systems can facilitate the emergence of new strains of existing diseases. The prevalence of co-infection with Covid-19 and HIV in South Africa, for example, contributed towards the emergence of the omicron variant (Freer and Mudaly, 2022). Concern with zoonotic co-morbidities and the incubation of more dangerous viral strains has re-inscribed existing forms of public health stigma.

Urban density has been a recurring epidemiological motif, especially for diseases with respiratory modes of transmission. Specific metropolitan milieus such as prisons, hostels, or other kinds of confined spaces have long been sources of transmission for diseases such as tuberculosis, and more recently Covid-19. Similarly, crowded social venues such as nightclubs or bars can serve as high-risk environments for respiratory transmission: in early 2022, for example, a major new outbreak of the BA.5 variant of the Covid-19 virus in Shanghai was traced to a single bar. Yet a narrowly topographic reading of urban density must be offset by other factors such as household structure, degrees of overcrowding, and existing health disparities (McFarlane, 2021). Additionally, the cities of East Asia and the global South have been entrained in specific kinds of cultural projections as part of a Euro-American pandemic imaginary that is oriented towards topographic origins rather than structural relations.

Zoonotic affects

The affective realm of the zoonotic city spans human relationships with animals, the psychological aspects of contact with nature, microbial influences on human moods or behaviour, and cultural dimensions to heightened levels of risk and anxiety. The impact

of social isolation during the Covid-19 pandemic led to intensified interactions with urban nature, ranging from the increased use of parks to the building of affective relations with individual animals. There has been a significant increase in the ownership of dogs and other companion species, especially where the 'knowledge class' has benefited from home working opportunities. The animal geographies of the post-Covid city reflect an intensification of existing patterns of higher pet ownership in wealthy neighbourhoods (Hubbard and Brooks, 2021). Similarly, the surge of demand for urban green space has accentuated existing disparities in the provision of parks in different neighbourhoods, along with the re-inscription of existing modes of social and racial exclusion (see, for example, Apostolopoulou and Liodaki, 2021; Hoover and Lim, 2021).

The affective resonance of zoonotic urbanisation has led to greater interest in specific aspects of food production including the treatment of animals in industrialised agriculture. We see here the operation of context specific ethics in relation to animals across different facets of urban space ranging from the human home to more distant sites of food production (Blanchette, 2020; Palmer, 2010). Posthuman contributions to ethical debates have stressed the significance of 'speciesism' for lack of empathy towards non-human others (Chiew, 2014). The new generation of large-scale 'protein factories' such as multi-storey 'pig hotels' or vast poultry installations is a focal point for both ethical and epidemiological concern. Disruption to agriculture in the wake of the Covid-19 pandemic led to the temporary closure of many slaughterhouses in North America and elsewhere and the mass culling of animals. The more recent spread of avian flu has led to the mass killing of chickens using cruel methods such as heat, steam, or suffocating foam since it is unprofitable to dispose of birds in

a more humane way (Collins and Torgerson-White, 2022). Similarly, in response to the swine fever pandemic, that has already killed a quarter of the global pig population, animals in industrialised facilities have in some instances been disposed of as cheaply as possible by crowding, heatstroke, and the switching off of ventilation systems as documented by animal rights organisations (Bolotnikova, 2022). The ethical lacunae in relation to non-human others, and the wider dynamics of human interaction with nature, have been a driving force behind new kinds of zoonotic threats to global health.

There is a longstanding interest in behavioural ecologies associated with zoonotic infections. Rabies, for example, is spread through the bites of infected animals; the increase in aggression is the mode of transmission. The theme of deadly viruses that induce some kind of behavioural change is a recurring trope in recent cultural representations of the zoonotic city. In the Venezuelan film *Infección* (Dir.: Flavio Pedota, 2019), made during the Zika epidemic, a mutated rabies virus threatens to destroy society (the film was banned in Venezuela on the grounds that it might be interpreted as a political satire). In the Korean TV drama *All of us are dead* (Dir.: Lee Jay-koo and Kim Nam-su, 2022) we are presented with a virally transmitted 'zombie apocalypse' that begins with a bite from an infected rat in a school laboratory. Similarly, in the film *28 days later* (Dir.: Danny Boyle, 2002) a highly infectious virus called 'rage' is caused by the release of an infected monkey from a research laboratory by animal rights activists, with the disease quickly spreading through society to leave only a few beleaguered survivors in its wake. Set in an uncomfortably near future of 2024, the critically panned film *Songbird* (Dir.: Adam Mason, 2020) depicts a largely deserted Los Angeles under a violently enforced lockdown in the wake of Covid-23 that has killed some

eight million Americans (compared with the real figure of over one million at the time of writing). The film builds on the ‘imagination of disaster’ trope, within which LA has played a prominent role, but the zoonotic origins of the epidemic are obscured by a narrative emphasis on the use of militarised public health agencies and the forced removal of people to squalid quarantine zones. In these and other representations the zoonotic city is represented in apocalyptic terms as a harbinger for wider societal collapse.

The existence of mood-altering microorganisms within the human body is well established (Dinan et al., 2013). The behavioural dimensions to zoonotic infection are now the focus of sustained scientific interest. It has been shown, for example, that the protozoan organism *Toxoplasma gondii*, that originated in cats, can directly affect human behaviour. *Toxoplasma* is now estimated to infect 30% of the global human population and is regarded as a paradigmatic example of ‘parasitic adaptive manipulation’ since the infection of the brain and nervous system induces specific behavioural changes. From an evolutionary standpoint the transmission of the ‘cat virus’ serves to reduce fear among potential prey but the impact on human societies remains little explored. A specific area of speculation is the role of *Toxoplasma* infection in the rise of global capitalism and forms of risk-taking human behaviour. Latent human infection is also considered to be a risk factor in the development of Alzheimer’s disease, bipolar disorder, Parkinson’s disease and schizophrenia (Fabiani et al., 2015; Webster et al., 2006). The impact of *Toxoplasma* and other pathogens that influence mood or behaviour poses important questions for affect theory in an urban context. In particular, an understanding of affect as partly related to bio-physical processes lies in tension with much of the existing literature. A more nuanced theory

of affect would build on emerging interest in the chemosphere and the porosity of the body, as elaborated by Alaimo (2010), Brennan (2004), and others, by incorporating less explored dimensions to urban epidemiology. A greater emphasis on the affective characteristics of the virosphere and other fields of zoonotic concern contributes to a multi-subjectival reading of urban space. The affective dimensions to the multispecies city thus extend from more visible aspects of human–non-human relations to a series of more diffuse dimensions.

Pandemic governmentalities

The global response to the Covid-19 pandemic has been highly fractured, marked by lack of universal access to vaccines, especially in the global South, along with widespread scepticism or even hostility towards public health measures. Distrust in science forms part of a political economy of media manipulation that is closely associated with authoritarian ideologies, although disparate political coalitions have emerged in Europe and elsewhere that extend to anti-modern forms of environmental mobilisation (Bennhold, 2022; Stein et al., 2021). We should note, however, that scepticism towards public health policy, including the use of vaccines, also has roots in colonial or discriminatory modes of governmentality (see, for example, Patchin, 2020).⁹ In Brazilian cities, for example, aspects of suspicion towards public health interventions are connected with the experience of racism, persistent socio-economic inequalities, and dysfunctional public services where lack of trust in the state has cultural and structural origins (Borre et al., 2022).

The global failure to eradicate or even contain the Covid-19 virus poses uncertain consequences including the longevity of vaccine efficacy, the virulence of new variants, and the impact of long-Covid on a

significant proportion of the population.¹⁰ The shifting parameters of the state–capital nexus under ‘pandemic capitalism’ can be illustrated through surging profits for the manufacture of masks, protective clothing, vaccines, and other medical equipment. One of the outcomes of the Covid-19 pandemic has been the consolidation of biotech driven patterns of urbanisation. The German city of Mainz, for example, where BioNTech was founded in 2008, has been transformed into ‘the world’s pharmacy’ with a huge windfall in local tax revenue (Miller, 2021). BioNTech in turn is now expanding operations worldwide with new plants under construction in Rwanda, Senegal, and Singapore. Globally, the largest producer of vaccines remains the Serum Institute of India based in Pune, which manufactures around 1.5 billion vaccine doses per annum for not only Covid-19 but also polio, rabies, tetanus, and a number of other diseases and health threats (including snake venom). Each new zoonotic threat is associated with a distinctive configuration of biotech urbanisation: the surge in demands for the monkey pox vaccine in the summer of 2022, for example, focused attention on the one global supplier, Bavarian Nordic, with its headquarters and manufacturing plant based north of Copenhagen. The vast expansion in the global production of vaccines has also required the development of new cold storage networks for worldwide delivery marked by increased monopolies in the global logistics sector. The ‘low tech’ side to pandemic capitalism has also produced its own geographies: the manufacture of gloves, masks, and other components of personal protective equipment (PPE) has been widely associated with sweatshop conditions at a series of manufacturing plants in China, India, Malaysia, the UK, the USA and elsewhere.

The global response to the Covid-19 pandemic has expanded aspects of state

intervention. Yet this enhanced role for the state lies in conflict with ideological attempts to not only reduce the size of the state but also diminish public expectations about what governments or health authorities can be expected to do. There are dimensions to post-pandemic public policy that are indicative of the strategic use of epidemiological risk to achieve existing political and economic objectives such as the increased flexibilisation of work, the use of algorithmic governmentalities, and the extension of monopolistic control into distressed economic sectors (see, for example, Avlijaš, 2021; Madden, 2020). An ‘atmosphere of crisis’ can serve as a pretext to accelerate or intensify the underlying dynamics of urban policy making (Madden, 2020: 679). In Puerto Rico, for example, the Covid-19 pandemic provided an opportunity to extend existing forms of state sanctioned corruption, human rights violations, and rule by exception (Atiles-Osoria, 2021). While in the UK the suspension of procurement protocols saw an upsurge of various kinds of fraud and political nepotism in relation to the disbursement of lucrative public contracts (Transparency International UK, 2021).

The scale of state intervention in relation to the Covid-19 pandemic has been driven by its perception as a global rather than merely regional threat, with significant mortality experienced within the global North unlike other on-going health threats that are concentrated in the global South such as dengue and malaria. Dengue in particular has seen an eight-fold increase in cases worldwide over the last 20 years with ‘hyper-endemicity’ now reported for many urban areas in the global South (WHO, 2022: 3). With climate change, however, the epidemiological dynamics of cities in the global South are now becoming more pervasive in the global North. Intermittent or poorly coordinated vector control programmes, along

with cutbacks in primary health care provision, have made outbreaks more likely. In 2009 dengue made its first appearance in southern Florida since 1946 and has been the focus of on-going control efforts in the face of repeated further outbreaks (Bouri et al., 2012; Butterworth, 2022).¹¹ And in the cities of the Global South, the scale and severity of dengue outbreaks have been steadily growing: in the case of Dhaka, for example, the Covid-19 pandemic both masked and exacerbated an unprecedented city-wide outbreak of dengue, pushing health care systems to the brink of collapse (Hossain et al., 2022).

There are tensions between ecological and epidemiological conceptions of urban space. Urban resilience discourse has adopted a narrow focus on climate adaptation strategies based on ‘generic ecologies’ that are poorly aligned with the socio-ecological characteristics of specific sites. The epidemiological consequences of generic ecologies can be observed in the case of design features that might be innocuous in their original setting but emerge as problematic in another context.¹² The emerging emphasis on natural floodplains and the capacity of cities to store or intercept rainwater forms part of the ‘ecologisation’ of urban policy discourse.¹³ Yet the presence of standing water holds markedly different epidemiological implications depending on local context, including the multi-scalar dynamics of pathogenic ecologies. A sustained engagement with zoonotic urbanisation clearly holds significant implications for ‘ecological urbanism’ and related fields where the material and metaphorical dimensions to urban ecology have been extensively elided.

The development of post-Covid planning scenarios has been marked by attempts to ‘future proof’ cities in the face of a proliferating range of environmental, economic, and epidemiological threats (OECD, 2020). Yet most conceptions of the post-Covid city

remain design-oriented and are analytically congruent with the ecomodernist emphasis on resilience under the adaptive Anthropocene. As Covid-19 becomes an endemic global disease the aspiration to create the post-Covid city as an urban pathway towards a more sustainable future appears to be an increasingly chimeric policy goal.

New kinds of corporeal precarity are emerging under techno-feudal landscapes of risk (Gandy, 2022b). In particular, the socio-economic inequalities underlying different levels of viral exposure reflect the growing polarisation of the labour market between a ‘knowledge class’, who can take advantage of various forms of home working, and a new ‘service class’ marked by multiple forms of corporeal vulnerability and economic precarity (Reckwitz, 2021). The operation of racial capitalism is reflected in divergent mortalities driven by systemic inequalities in the labour market along with restricted access to housing, health care, education, and other services. In Brazil’s largest cities, for example, poorer residents living in peripheral zones must not only travel long distances for work but also use crowded public transport for longer periods (Borre et al., 2022). The impact of public health measures such as lockdowns and other restrictions on movement has had a disproportionate effect on the urban poor, especially within cities of the global South, where a majority of the population are either unemployed or reliant on informal employment opportunities (Bhan et al., 2020; Chirisa et al., 2022).

The long-term implications of the Covid-19 pandemic remain uncertain. Has the impact of Covid-19 revealed the ultimate limits to pandemic governmentalities? Or has the aftermath of the pandemic set in train a series of bio-political precedents for the 21st century? The lockdown of Shanghai in April 2022, a city of over 20 million inhabitants, marks one of the largest lockdowns yet imposed by state health authorities.

Anxious residents, many of whom were left short of food following the speed of implementation, had to contend with drones and robot dogs patrolling the streets in one of the most intensively surveilled cities in the world (McMorrow and Li, 2022). In addition, individual residential complexes with high infections rates were sealed off, effectively creating local quarantines within a regional quarantine. In Shanghai and other Chinese cities, we encounter the limits of what Xufei Ren (2020: 426) refers to as 'grid governance' marked by multiple intersecting spheres of state control. Above all, it appears that even the most stringently enforced public health measures have ultimately failed to contain a rapidly mutating and highly infectious source of epidemiological risk: a fresh surge of Covid-19 cases across China in the autumn of 2022 led to a series of new lockdowns in Chengdu, Dalian, Guangzhou, Shenzhen, Shijiazhuang and other cities.¹⁴ Following a deadly fire in a residential complex under strict lockdown in the city of Ürümqi, however, widespread street protests morphed into the most serious challenge to the authority of the Chinese state in decades, forcing significant changes in Covid-19 containment policies.

Other large-scale public health interventions include the aerial spraying of whole neighbourhoods with insecticides to control mosquito vectors for the Zika virus. In Brazil, for example, poorer urban neighbourhoods have experienced mass fumigation with toxic chemicals, a governmental response that was intensified in the runup to the 2016 Olympics (Borre et al., 2022). Yet these high-profile forms of biopolitical performativity lie in tension with the structural and topographic determinants of epidemiological risk (Gandy, 2022c). Given the proclivity of the *Aedes* vector for domestic interiors, the aerial spraying of whole neighbourhoods can have little long-term effect (WHO, 2022). Furthermore, as the surge of

dengue in Florida reveals, the sub-division of neighbourhoods into private lots makes the elimination of breeding opportunities for *Aedes* mosquitoes all but impossible (Butterworth, 2022).

Extending urban political ecology

There is clearly scope for a closer conceptual synthesis between elements of urban political ecology and the neo-Lefebvrian analysis of global urbanism that goes beyond the scalar recalibration of urban theory. A consistent analytical thread is the relationship between a variety of different kinds of spaces, including ostensibly non-urban or ex-urban spaces that are nevertheless integral to the urban process as a whole. The neo-Lefebvrian scrutiny of diverse urban topographies has highlighted different kinds of relations, landscapes, and processes that might be gathered together under an extended conceptualisation of urban space (Brenner, 2013). Similarly, an expanded reading of urban metabolism has enabled reflections on urbanisation from multiple vantage points, including historical intersections between extractive frontiers and capitalist urbanisation that have radically altered landscapes of epidemiological risk (Kaup, 2021; Treffers et al., 2022; Wallace et al., 2020).¹⁵

In a wide-ranging intervention Neil Brenner and Swarnabh Ghosh (2022) suggest that earlier iterations of extended urbanisation within an urban political ecology framework, especially the contributions of Roger Keil and his colleagues, have been based on 'a predominantly zonal and morphological conception' (p. 868) of urban space that externalises significant developments in relation to extractive frontiers and the global transformation of capitalist agriculture. Brenner and Ghosh characterise their own interpretation of extended urbanisation as 'relational-dialectical' (p. 878) and focus on three specific developments: the

'mega infrastructures of agro-industrial production and circulation' involving 'large-scale patterns of territorial enclosure'; the emergence of the 'global industrial feedlot matrix' to service vast numbers of livestock; and the rise of 'multispecies virospheres' (p. 897). Brenner and Ghosh's call for a 'heterodox synthesis' (p. 867) between insights drawn from urban political ecology and neo-Marxian studies of global agriculture suggests a promising line of conceptual dialogue. Yet they appear to elide existing work within urban political ecology with what they refer to as 'mainstream urban theory' (p. 880) even though the dominant paradigm within urban environmental discourse is the systems-based approach that can be clearly differentiated from both urban political ecology à la Keil and a variety of neo-Lefebvrian insights developed by Brenner and others. In 2007, for example, Roger Keil and Harris Ali emphasised the significance of increased global connectivity, agro-capitalist intensification, and large-scale ecological disruption. In the context of the recent SARS outbreak, Keil and Ali noted how heightened levels of urban epidemiological risk were being driven by 'larger processes of metabolism' that form part of 'the global city system' (Keil and Ali, 2007: 850).

Increasing levels of epidemiological risk are clearly marked by multiple scales of causality. Brenner and Ghosh refer to 'the simultaneously planetary and microbiological dimensions of emergent forms of extended urbanization' (2022: 31) but how can these elements be held together analytically? Implicit here is the need for a conceptual synthesis between the structural and molecular realms of global health. The emergence of what Brenner and Ghosh term 'multispecies virospheres' at a global scale has significant implications, not least through the potential emergence of new viral strains. By implication, the current epidemiological transition can be read as the socio-ecological

outcome of capitalist restructuring across multiple scales and temporalities since the emerging virosphere is itself a marker of this wider geo-historical transition. A conceptual synthesis between urban political ecology and related neo-Marxian perspectives raises a series of further questions. Is there a 'bio-medical fix' discernible in parallel with the search for a 'socio-ecological fix' under the adaptive Anthropocene? Can a 'heterodox synthesis' à la Brenner and Ghosh extend to insights from the biophysical sciences? And what kind of spatial forms might develop in response to incessant and increasing levels of epidemiological risk?

Conclusions

The intensified threat of new and emerging diseases is a significant marker for what the sociologist Andreas Reckwitz defines as 'late modernity'. More broadly, following Reckwitz, we must contend with a cultural and political landscape that is no longer anchored to a narrative of progress, with multiple indicators suggesting increased levels of precarity and insecurity for a majority of the global population. The epidemiological sphere, like that of climate change, is increasingly characterised by isolated technical advances (such as vaccine development) within a wider systemic context of heightened and potentially uncontrollable risk.

A zoonotic framing of capitalist urbanisation denotes multiple scales, topographies, and constellations of agency, thereby transcending atomistic, bounded, or systems-based conceptualisations of urban space. A multi-scalar analysis of epidemiological risk illuminates diverse extractive frontiers, zoonotic transfer zones, and accelerator landscapes for new or emerging diseases. The global biodiversity crisis is recast as far more than a question of loss or extinction since it is the unpredictable ecological dynamics emerging within what remains that serves as

a primary driver for new landscapes of epidemiological risk. In the popular science imagination the techno-managerial response to zoonotic threats has been framed as a scientific ‘arms race’ between viral mutations and new vaccines. Yet the epistemological vantage point of the laboratory is at odds with the multiple spatial dynamics of global epidemiological risk. Conversely, a culicid vantage point, as refracted through the lens of multispecies urbanism, emphasises forms of evolutionary dynamism or topographic complexity that elude the scope of existing biopolitical interventions. The zoonotic dimensions to urbanisation highlight the limitations to ‘generic ecologies’ in urban design discourse that ignore the geographical specificities of epidemiological risk.

What heuristic devices might help us to make sense of the shifting contours of epidemiological risk under modernity? A dual conceptual emphasis on the ‘bacteriological city’ and the ‘zoonotic city’ highlights an interrelated set of developments. The bacteriological city represents an ideal type under the aegis of modernity whereas the zoonotic city serves as a signifier for the limits of human control over nature; the bacteriological city aligns with the attempted rationalisation of urban space whilst the zoonotic city highlights the extent of uncertainty over urban environmental futures. Or as Andrew Lakoff emphasises, there has been a shift of emphasis towards attempts to manage the future in the present.¹⁶

A focus on zoonotic urbanisation underlines the scale of an emerging ‘triple crisis’ encompassing climate, biodiversity, and health. Yet making sense of these threats is also hampered by a scientific funding crisis running in parallel with the global health crisis that is marked by significant cutbacks for research into biodiversity, especially within the most biodiverse regions that form the likely epicentre for future zoonotic threats (Bitencourt and Bezerra, 2022). The

expansion of bio-medical research programmes in the wake of Covid-19 is not matched by a concomitant emphasis on biodiversity research. Indeed, the molecular orientation of most scientific research projects emerging from the Covid-19 pandemic has restricted possibilities for a wider understanding of the global health crisis and its origins (Fearnley, 2022).

Zoonotic dimensions to urban epidemiology span biophysical, material, and relational dimensions to public health as well as emergent cultural and geopolitical discourses of risk and preparedness. Zoonotic urbanisation represents the epidemiological outcome of the cumulative violence towards nature under colonialism, modernity, and global capitalism (see, for example, Osterhammel, 2009). This is why the concept of the Plantationocene is especially apposite for placing zoonoses in a wider historical and geographical context. The conceptual field of the Plantationocene – which can be read alongside the related concept of the Capitalocene – generates a productive conceptual dissonance with the adaptive Anthropocene and its associated emphasis on systems-based conceptions of urban space.

Urban political ecology is not yet in a position to give a full analysis of zoonotic urbanisation since there are significant uncertainties extending to relations with the bio-physical sciences, the critical salience of affect theory, and the cultural dimensions to heightened levels of epidemiological risk. Each of these conceptual lacunae – science, affect, and risk – can be briefly considered in turn. First, a structural analysis of urban epidemiology must contend with the scientific impetus towards molecular rather than relational dimensions to environmental risk. A greater emphasis on the epigenetic and evolutionary dimensions to zoonotic urbanisation has the potential to illuminate multiple causalities and intersecting temporalities. Second, and relatedly, urban political

ecology needs a theory of affect that can contest the blurring of human agency within posthuman and new materialist ontologies. An affect theory that insists on political agency would form a natural counterpart to a relational theory of urban space. A more nuanced reading of corporeality would necessarily be multi-subjectival, extending to the virosphere, the chemosphere, and other late-modern socio-ecological constellations. And third, the cultural dimensions to fear and anxiety under late modernity have only been tangentially incorporated into the analysis of disparate ecological imaginaries.

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Notes

1. The Covid-19 pandemic has led to a series of critical interventions at the interface between epidemiology and urban studies. See, for example, Acuto et al. (2020) and Ruszczyk et al. (2022).
2. The post-Covid epidemiological debate marks an elaboration of existing efforts to understand the complexities of zoonotic disease. See, for example, Ahmed et al. (2019), Brown and Kelly (2014), Dzingirai et al. (2017), Hirschfeld (2020), Lowe (2010), Van Loon (2005) and Wolf (2016).
3. A multiscalar approach to urban epidemiology extends across urban political ecology, political economy, and related fields. See, for example, Ali et al. (2022), Connolly et al. (2021), Gandy (2022a, 2022b), Kaup (2021) and Wallace et al. (2016, 2020).
4. Urbanisation itself has been associated with cultural shifts towards higher levels of meat consumption along with the intensification of agro-capitalism and the development of longer regional or global supply chains.
5. Zones of agricultural intensification also intersect with racial capitalism, the imposition of draconian labour regimes, and new landscapes of viral exposure so that forms of mistreatment extend to both people and the non-human realm. See, for example, Freshour (2020), Silbergeld (2016) and Stoddard and Hovorka (2019).
6. The Brussels school of urban ecology is especially associated with metabolic models of urban space developed by Paul Duvigneaud. See Gandy (2022c).
7. These micro ecologies have been the focus of digital surveillance systems as part of what Rehman (2022) refers to as 'epidemic infrastructures'. See also Nading (2014).
8. Fragile public health care systems, especially in the global South, have been subjected to price gouging and racketeering as evidenced by the desperate scenes in India over the purchase of dwindling oxygen supplies for dying relatives.
9. The World Health Organization, for example, founded in 1948, represents significant continuities with the colonial state apparatus, including the transfer of personnel and expertise during the early stages of its formation.

10. In the UK alone some 2 million people are estimated to be affected by long-Covid illnesses.
11. In recent years the USA has experienced a series of further dengue outbreaks in Florida (2013, 2020), Hawaii (2015) and Texas (2013).
12. A recent example of 'generic ecologies' gone wrong is the recreation of a prize-winning architectural design for housing in Milan in the southern Chinese city of Chengdu that led to the spread of dengue fever.
13. These 'soft engineering' approaches to flood risk, reliant on complex urban ecologies, are now the focus of intense epidemiological debate.
14. By July 2022 eleven Chinese cities were under full or partial lockdowns affecting nearly 115 million people. See Alim (2022).
15. A multiscalar analytical framework is conceptually aligned with an emphasis on the simultaneous universality and heterogeneity of capital. See Chibber (2014) and Mezzadra and Neilson (2019).
16. Presentation made to the 'Contagious futures' event held at CRASSH, Cambridge, on 22 November 2022. See also Lakoff (2017).

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