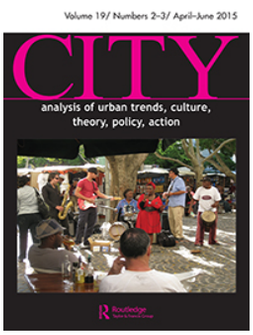

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Life support
The political ecology of urban air

Stephen Graham

Humans, increasingly, manufacture their own air. In and around the three-dimensional aerial environments within and above urban regions, this manufacture of air reaches particular levels of intensity. For a species that expires without air in two or three minutes, this anthropogenic manufacture of air is of incalculable importance. Curiously, however, urban air remains remarkably neglected within the political–ecological literatures. Accordingly, this paper suggests a range of key themes, which a political ecology of urban air needs to address. These touch upon the links between global warming, urban heat-island effects and killer urban heatwaves; urban pollution crises; the paradoxes of urban pollution; horizontal movements of polluted air; the vertical politics of urban air; the construction of vertical condominium structures for elites; the vicious circles that characterise air-conditioned urbanism; heat-related deaths of workers building air-conditioned structures in increasingly hot climates; the growth of large-scale air-conditioned environments; and, finally, the manipulation of urban air through political violence.

Key words: urban air, political ecology, heat islands, air conditioning, air pollution

Introduction: manufactured air and the 'defencelessness of breathing'

> **'At first we feel nothing, we are insensitive, we are naturalized. And then suddenly we feel not something, but the absence of something we did not know before could possibly be lacking. Think of the poor soldiers on the front line, deep in their trenches, the 22nd of April 1915 near Ypres (Figure 1). They knew everything about bullets, shells, rats, death, mud, and fear—but air, they did not feel air, they just breathed it.**
>
> **And then, from this ugly, slow-moving, greenish cloud lingering over them, air is being removed. They begin to suffocate. Air has entered the list of what could be withdrawn from us. In the terms of the great German thinker Peter Sloterdijk, air has been made explicit; air has been reconfigured; it is now part of an air-conditioning system that makes our life possible.' (Bruno Latour 2005, 104)**

Humans, increasingly, manufacture their own air. For a species which expires without air in two or three minutes—what Elias Canetti (1987, 930) has called 'defenselessness of breathing'—this anthropogenic manufacture of air is of incalculable importance. Inescapably, 'air constitutes an implicit condition of existence' (Sloterdijk 2009, 32).

The process of machinic manufacture happens in a variety of related ways. On a planetary scale, the earth's atmospheric temperature and composition is now so radically different from what it was a few centuries

Figure 1 'The insidious and deadly gas that creeps noiselessly down toward the foe.' Contemporary depiction of a German gas attack on the Russian front in the First World War (Source: The Library of Congress 'The War of the Nations: Portfolio in Rotogravure Etchings: Compiled from the Mid-Week Pictorial' [New York: New York Times, 1919], 210. Public domain. At https://www.flickr.com/photos/library_of_congress/6332015472/)

ago that geologists are now pushing for the contemporary period to carry an appropriately anthropomorphic moniker—the 'Anthropocene'—rather than the previous 'Holocene' (the period since the retreat of the ice sheets around 12,000 years ago—see Boschman 2014). Global climate change is a product of three centuries of rampant urban-industrial growth: between 70 and 80% of all greenhouse gases now emanate from the world's urban areas (Hodson and Marvin 2010).

In and around the three-dimensional aerial environments within and above these urban regions, this manufacture of air reaches even greater levels of intensity. Here, giant, warmed-up domes or 'heat islands', warmed by the city's release of energy, the extra-high concentration of greenhouse gases (and other pollutants) that linger above cities, and the tendency of concrete and asphalt to heavily absorb the sun's heat, are systematically filled with complex 'cocktails' of pollutants. These emerge from the energy-intensive activities that concentrate in and around cities: power generation; industry; oil-based transportation, building use and so on.

As urbanisation intensifies and spreads, a wide range of global health organisations are asserting that these domes filled with warmed-up cocktails of gases are becoming one of humanity's greatest killers (see OECD 2014; World Health Organization 2014).

Startlingly, however, the politics and geographies of bad or lethal air in cities remain remarkably peripheral to the huge growth of political–ecological work on the social and technological productions of nature in urban environments that has in other ways been so productive in human geography and

critical urbanism over the past two decades (see Heynen, Kaika, and Swyngedouw 2006). This body of work, linked closely to wider post-humanist and materialist shifts in social theory and philosophy (Bennett 2010), has successfully challenged conventional conceptions of the urban, and of the Society/Nature binary. This literature posits urban processes as complex multi-scaled metabolisms fundamentally integrating social, organic, 'natural' and technological agents into strung-out 'cyborgian', 'socioecological' or 'techno-natural' complexes, assemblages or hybrids (with the latter concepts and terms varying between different strands of theorisation) (see Swyngedouw 2006).

Resulting studies of such urban metabolisations of nature have successfully addressed, amongst other themes, water and sanitation (Kaika 2005); the politics of food (Heynen 2006); the production of green space (Heynen, Perkins, and Roy 2006); the violent political ecologies of oil and other resources (Peluso and Watts 2001); or the collapse of urban infrastructures (Graham 2009) (for a recent review, see Heynen 2013).

It is notable, however, that despite the wider public discourses of air emergency in the world's cities, beyond a few initial analyses, the political ecologies of urban air remain underdeveloped. 'Technical', depoliticised, medicalised, positivist, physical geographic and public health policy discourses still overwhelmingly dominate the field. 'Urban political ecology research has so far been focused on natural resources for consumption, production, and recreation, rather than on environmental pollution' (Véron 2006, 2094). Raymond Bryant's (1998, 89) diagnoses over 15 years ago that 'the existing literature [on changing air quality] is largely devoid of political analysis'—a problem which inevitably works to obfuscate the ways in which 'unequal power relations are "inscribed" in the air'—retain power today.[1]

A few innovative interventions, motivated by this wider neglect, have made useful starts. Michael Buzzelli (2008) developed a political–ecological discussion of the challenges of the multi-scaled nature of air pollution for air pollution monitoring in Vancouver. Janice Harper (2004) blended political–ecological theory with medical anthropological ideas to present a searing ethnography of the stark air pollution and asthma crises in Houston. In addition, Réne Véron (2006) built an innovative analysis exploring the growing power of elites' bourgeois-environmentalist ideas emphasising the beautification of Delhi as a 'world city', in shaping pollution monitoring in the city. Ostensible efforts by governmental elites to 'clean up' urban air in Delhi, Véron shows, thus amount to a deeply revanchist programme to remove the poor, along with their vehicles and informal communities, which they deem not to befit to 'purified' environments of this sanitised urban vision.

Such analyses, however, remain sporadic and occasional; the contrast with the burgeoning literatures on the political ecologies of urban water is sharp. Erik Swyngedouw and Nik Heynen's emphasis over a decade ago on major metropolitan regions as socio-natural and techno-natural complexes within multi-scaled political ecologies through which dangerous and bad air is produced and shifted, has yet to move such processes to the centre of critical geographic analysis. 'The cars burning fuels from distant oil-deposits and pumping CO2 into the air, affecting people, forests, climates, and geopolitical conditions around the globe,' they wrote, 'further complete the global geographic mappings and traces that flow through the urban and "produce" London as a palimpsest of densely layered bodily, local, national and global—but depressingly uneven geographically—socioecological processes' (Swyngedouw and Heynen 2003, 899).

More broadly, whilst the innovative work of German philosopher Peter Sloterdijk (2005, 2009) on the histories of deadly air in warfare, climate change and geoengineering is having a major influence, environmental anthropologist Tim Choy asserts that air

still remains peripheral to social theorisation. 'Air matters too little in social theory', he writes.

> 'Aside from signifying a loss of grounding, air is as taken for granted in theory as it is in most of our daily breaths. [. . .] Air is left to drift [. . .] neither theorized nor examined, taken simply as solidity's lack. There seems at first to be no reason not to let it.' (Choy 2010, 9–11)

Such a neglect seems especially paradoxical given wider recent shifts in the social theorisation of urbanism and urbanisation towards an emphasis on a Lefebvrian process of planetary urbanisation (Brenner 2013); a preoccupation with the urban dimensions of global climate change and the unsurprisingly huge contribution of urban-industrial centres to greenhouse gas emissions (Hodson and Marvin 2010); a growing recognition of the volumetric and vertical aspects of politics and geopolitics (Elden 2013); and the wider cultural geographies, affective atmospheres and histories of urban air (Anderson and Holden 2008; Martin 2011; Adey 2013).

Much work thus remains to be done to explicate the political ecologies and politics of the materiality of urban air in the context of rapid urbanisation and global climate change. Such a project needs to make explicit the systematic anthropogenic and machinic manufacture and material conditioning of both 'good' and 'bad' air, through design, technoscience, capitalist industrialism, militarism, warfare, commodification, consumerism and so forth. In a context of planetary urbanisation, unprecedented pollution and public health crises, rising social inequalities and rapid anthropogenic climate change, air, in other words, needs to be wrenched finally and fully from any lingering post-Enlightenment categories of its givenness as a 'public' good within a 'Nature' that is external to the socio-technical worlds and processes of urban life. As Bruno Latour has emphasised so elegantly, Sloterdijk's work hammers home the enormous stakes that surround the essential technopolitics of a species inhabiting environments of increasingly manufactured and 'conditioned' air. 'This is Sloterdijk's explicitness', he writes:

> 'You are on life support, it's fragile, it's technical, it's public, it's political, it could break down—it is breaking down—it's being fixed, you are not too confident of those who fix it. Our current condition merely relies on our more explicit understanding that this tentative technological system, this "life support", entails the whole planet—even its atmosphere.' (Latour 2005, 104)

With such an apparent gap between global public heath crises and analytical neglect, this unusually broad review paper seeks to help shift the politics and political–ecological materialities of urban air from the margins to the centre of critical urban social science. To achieve this, it undertakes an international and multi-scaled review of the multiple dimensions of the politics of contemporary urban air, discussions of which tend conventionally to be separated within the highly 'siloed' discourses of separated academic and policy communities. Through an interdisciplinary synthesis, the paper's aim is to blend insights from recent research in human geography, urban studies, urban design, architecture, environmental sociology, climatology, social policy, public heath, epidemiology, political theory and philosophy around a series of key, cross-cutting thematic vignettes. The aim here, then, is to use such a synthesis to add momentum to an already discernible 'turn' towards the critical social scientific and architectural analysis of air (see Adey 2013, 2014; Gissen 2013) and to further the incorporation of urban air (and its politics) into urban social theory.

Accordingly, what follows is structured around 10 suggested themes, to which, I feel, a political ecology of urban air should attend. These address, in turn, the links between global warming, urban heat-island effects and killer urban heatwaves; urban pollution crises; the paradoxes of urban pollution; horizontal movements of polluted

air; the vertical politics of urban air; the construction of vertical condominium structures for elites; the vicious circles that characterise air-conditioned urbanism; heat-related deaths of workers building air-conditioned structures in increasingly hot climates; the growth of large-scale air-conditioned environments; and, finally, the manipulation of urban air through the actions of state militaries and security forces through what Jacob Hamblin (2013) calls 'catastrophic environmentalism'.

Heat islands and killer heatwaves

> 'The U.S. Environmental Protection Agency estimates that, between 1979 and 2003, heat exposure has caused more than the number of mortalities resulting from hurricanes, lightning, tornadoes, floods, and earthquakes combined.' (NASA 2010)

Turning to our first vignette, the well-known 'urban heat-island' effect already mentioned (see Lee 1984; Gartland 2010) means that the raised ambient air temperature at the core of large urban areas is usually at its highest during clear, still nights, reaching temperatures which are between 3 and 10°C higher than those in surrounding areas (Figure 2). Such effects are important contributors to global warming as a whole. Although their precise contribution remains controversial amongst climatologists, the best recent evidence suggests that the extra heat given off by urban areas has contributed something between 15 and 21% of global warming as a whole over the past 150 years (as opposed to greenhouse gas emissions and other changes) (Hausfather and Menne 2013).

Recent research using remote sensing shows that urban heat islands can have even greater effects than recent thought suggests: one major study in the USA in 2010 showed that summer temperatures in the main cities in the north-east—Boston, New York, Philadelphia and Washington,

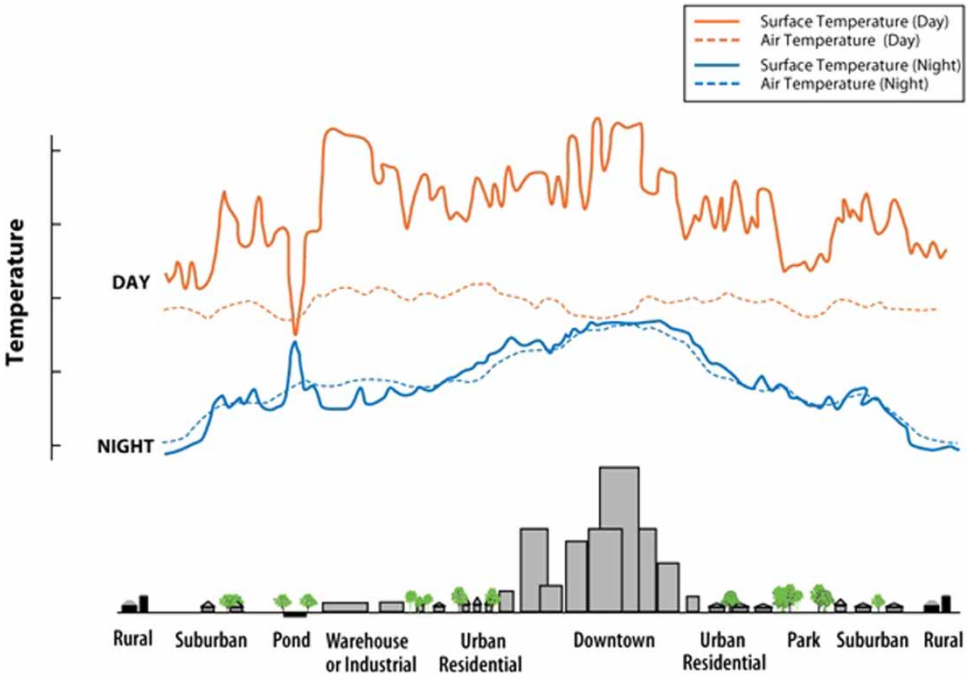

Figure 2 Typical urban heat-island effects in a US city by day and night (Source: NASA 2010).

DC—were an average of 7–9°C (13–16°F) warmer than surrounding rural areas over a three-year period (NASA 2010).

As well as ameliorating cold winters, urban heat islands can dramatically accentuate the lethal effects of hot summers within a context of a warming planetary climate. Emergencies such as the Chicago heatwave in 1995 and the European heatwave of 2003 (which killed around 70,000 largely elderly people) have dramatically revealed the ways in which systematic inequality, housing policies, poor urban design and hopelessly inadequate emergency response arrangements can combine together to allow urban heatwaves to become mass killers of the poor, the lonely, the old, the weak and the vulnerable. Epidemiological studies have shown that there is a 'significantly increased risk of hospitalization for multiple diseases, including cardiovascular disease, ischemic heart disease, ischemic stroke, respiratory disease, pneumonia, dehydration, heatstroke, diabetes, and acute renal failure, with a 10°F increase in same-day apparent temperature' due to urban heatwaves (Ostro et al. 2010, 1053).

Current estimates suggest that average planetary temperatures rose between 0.5 and 1.3°C between 1951 and 2000 due to anthropogenic greenhouse gas emissions. These temperatures, moreover, will inevitably rise further by the end of the century by between 1.7 and 4.8°C (depending on the degree to which greenhouse gas emissions can be reduced) (Johnson 2013). Given that, by 2100, the United Nations estimates that the world's population will be between 11 billion and 15 billion, and that fully 65–85% of that population will inhabit heat-island cities, primarily in tropical or semitropical locations, the future threat of major urban heat emergencies seems an especially daunting one.

Worrying precedents already exist. In the 1995 heatwave in Chicago, after a 48-hour period of daytime temperatures between 41 and 43°C, those without air conditioning, living near the black, bitumined roofs of the city's notorious public housing 'projects' on the South Side, quite literally baked. Many were too worried about the possibilities of crime to open their windows. Many who did have air conditioning could not afford to turn it on because of high electricity costs (power outages were also a major problem). By Friday, 14 July, as Eric Klinenberg (2002a) recounts:

> 'thousands of Chicagoans had developed severe heat-related illnesses. Paramedics couldn't keep up with emergency calls, and city hospitals were overwhelmed. Twenty-three hospitals—most on the South and Southwest Sides—went on bypass status, closing the doors of their emergency rooms to new patients. Some ambulance crews drove around the city for miles looking for an open bed. Hundreds of victims never made it to a hospital. The most overcrowded place in the city was the Cook County Medical Examiner's Office, where police transported hundreds of bodies for autopsies.' (see Klinenberg 2002b)

By the end of the week, 739 people had died because of the extreme heat (especially the lack of cooling at night). The pattern mapped perfectly on to the geography of poverty: most victims were old, poor, isolated and male—they died alone. Elderly African-American men were statistically the most likely to die (Klinenberg 2002a).

The heat catastrophe across Europe in 2003, which prematurely killed around 70,000 people, similarly overly affected the old, the ill and the lonely living isolated lives in major cities like Paris (where 4800 such people, labelled the 'Forgotten' in the French media, lost their lives) (NASA 2010). As in Chicago, the most lethal spaces were marginal, poor quality apartments high up in the tenements beneath the dark, baking slate and bitumen of roofs. 'Many of these forgotten victims lived in *chambres de bonne*,' Richard Keller (2013, 302) writes, 'the former domestic servants' quarters under the roofs of many of Paris's buildings that are a legacy of Prefect Georges-Eugène Haussmann's reconstruction of the city in the nineteenth century.'

Indeed, the deaths of the isolated, poor and old helped to expose the Janus-faced vertical architectures and geographies of Paris: a sumptuous and burnished street-level face for the bourgeoisie hiding an invisible, decrepit (and dangerous) world of attic-living for the poor. Richard Keller (2013, 302) explored the personal residences of the isolated and old people who died in the heatwave (many of whom were buried, like victims of the Chicago heatwave, in unattended funerals). Entering the street-level front door of the apparently wealthy East Side Haussmannian block where one of the heatwave's victims lived, he discovered that 'it is actually two buildings in one. A marble-lined entryway gives access to the building concierge's apartment, the elevator, a wide stair-case leading to the main building's apartments, and the courtyard.'

The rear-side of the block, Keller (2013, 307) found, by contrast, was 'accessible only by a serpentine and decrepit service staircase. This side of the building houses the *chambres de bonne*, seven or eight such apartments with a common toilet and sink at one end of the hall.' These apartments, hidden away high up from view, raised up to the sun, were the killing zones in Paris's 2003 heatwave. They illustrated profoundly how heightening social inequalities, embodied through the vertical complexities of physical urban form, can dramatically affect the vulnerabilities of marginalised populations during urban heat emergencies.

Urban heat islands have a further crucial element: they dramatically increase the energy available for violent weather events within cities. Indeed, as cities sprawl into megalopolitan urban regions, so weather events which derive from such energy are becoming apparent.

A spate of violent tornadoes on the fringes of Istanbul in the hot summer of 2014, for example, were judged by meteorologists as being the results of rapid urbanisation. Virtually unknown previously in the region, they were generated by flows of hot air surrounding Istanbul's extending and intensifying heat island. 'What weird old gods of weather have Istanbul's architects accidentally awoken?', Geoff Manaugh (2014) wonders:

> 'This conjures up frankly outrageous images of a city so sprawling—and so thermally ill-conceived—that huge masses of air at different temperatures are now rising into the sky to do battle, violently colliding like mythological titans above the city to generate the surreal tornadoes now ripping through the neighborhoods below. Weather might be the future of urban design.'

Toxic domes

> 'Air … from Johannesburg to Tehran, to Delhi to Jakarta, isn't about aesthetics, or even possible climate change at some point in the future: it's about life and death now.' (Doyle and Risely 2008, 246)

As well as unliveable heat—and this is our second vignette—processes of urban-industrialisation systematically manufacture whole environments where the ambient air is a basically toxic environment which kills millions of people a year. Le Corbusier (1967) called the air of industrial cities, 'devil's air'—and for good reason. The statistics here are even more startling than those surrounding urban heat emergencies: urban air is killing urbanites at alarming rates.

Iconic episodes show that this is not new, of course. Indeed, deadly air pollution, rather than some simple 'externality', has long been constitutive of modern urban-industrialism and its machinic landscapes (Horvath 1974; Véron 2006, 2096). Deadly air is as old as urbanism itself (see Brimblecombe 2012), with coal-based urban energy often creating the worst mortality. In 1952, in one iconic example, 13,000 people died in a three-month smog episode in London. The complex technoscience of weather forecasting and pollution management, in fact, has been a major element within the emerging governmentalities of science, technology and

the environment in modern states (see Whitehead 2011).

Recent studies within the epidemiological traditions of positivist science estimate that global death rates from air pollution are rising exponentially; toxic air now provides the world's biggest public health crisis. In 2014, following new evidence that the stresses of polluted air are responsible for many deaths through strokes and heart diseases amongst physiologically stressed urbanites, the World Health Organization estimated that 7 million people were killed by air pollution globally in 2012. 'The risks from air pollution are now far greater than previously thought or understood, particularly for heart disease and strokes', argued Dr Maria Neira, Director of the World Health Organization's Department for Public Health, Environmental and Social Determinants of Health. 'Few risks have a greater impact on global health today than air pollution; the evidence signals the need for concerted action to clean up the air we all breathe' (World Health Organization 2014). A total of 4.3 million of the estimated deaths were due to indoor air pollution (mainly from lit stoves); 3.7 million were due to bad external air.

When analysis takes into account the secondary deaths through cardiovascular and pulmonary mortalities (especially emphysema and chronic bronchitis), one in eight of all human deaths were caused by bad air inside and outside (World Health Organization 2014). Children, the elderly, the poor and those with respiratory and heart problems are dramatically over-represented in this annual figure.

In China alone, air pollution, largely from the cars and industries in and around cities, is estimated to kill over 1.2 million people prematurely per year. (The combination of mass automobilisation, extreme reliance on coal and particulate-producing diesel fuel, and rapid industrialisation make Chinese cities the most polluted in the world.) (Environmental Technology 2013).

In India, meanwhile, epidemiologists estimate that 620,000 people die prematurely each year through the effects of urban air pollution (*Economic Times* 2013). This figure is growing rapidly as the country urbanises and automobilises at very fast rates. Of 180 Indian cities monitored for sulphur dioxide, nitrogen dioxide and suspended particle matter, only two—Malappuram and Pattanamthitta in Kerala—met the World Health Organization's rather generous criteria of 'acceptable' pollution in 2012.[2]

Atmospheric dust thrown up by diesel engines, coal-burning power stations and industry—'particulate matter'—is the single biggest killer within the toxic domes above cities: this literally asphyxiates urbanites through cancers, lung disease and asthma. (The widespread shift to diesel engines, ostensibly driven by 'green' agendas, has often been catastrophic for public health.) 'By 2050, there could be 3.6 million premature deaths a year from exposure to particulate matter, most of them in China and India', a recent report by the OECD (2014) estimates. Chilling epidemiological records and surprises are continually emerging here: in November 2013, an eight-year-old girl living adjacent to one of Beijing's massive flyovers became the youngest person ever to be diagnosed with lung cancer (Duggan 2013; for wider research on air pollution and asthma crises in urban neighbourhoods, see Corburn, Osleeb, and Porter 2006).

Toxic urban atmospheres are especially lethal in cities that are hemmed-in by mountains or other natural features; where concentrations of particularly dirty polluters are most intense; and during stable anticyclonic episodes where air fails to rise or get blown away and lingers for days and even weeks. It is now common for health authorities in major cities—Beijing, Lagos, Santiago, Mexico City, Kathmandu, São Paulo, Cairo, Jakarta, Athens are only some of the most notorious examples—to declare states of emergency during such situations. Millions of vehicles are forced off the roads; the most polluting industries are shut down; populations, especially the most vulnerable, are urged to stay indoors until the smog clears.

Architect Albert Pope (2013), invoking Peter Sloterdijk's (2009) work on the weaponisation of air through lethal gas attacks in war and terrorism, wonders if such crises, in effect, work as what Sloterdijk calls 'air-quakes'. 'Can a set of ontological rights—such as breathing—actually challenge or even displace economic hegemony?', he asks. To him, the unbearable urban air within many Chinese cities works to 'brings the elements of our life-world out of a background of neglect and foregrounds them as the ontological preconditions of human existence'.

Pollution paradoxes

> 'Smouldering away, the megacity's atmospheres lend a definite aura.' (Adey 2013, 2)

Third, toxic urban air works to interrupt the efforts of city agencies to entrepreneurially brand and market their cities as blue-skied and fragrant-aired destinations for tourists, conferences, film locations, investment flows and, above all, sporting mega-events.

The authoritarian regime in Beijing—a city that pumps out more particulate matter than Portugal (Adey 2013, 7) and adds 400,000 cars to its roads every year—worked especially hard to re-engineer the city's air for the 2008 Olympics by forcing traffic off the road and closing factories. Whilst the population's health dramatically improved, the reversion to previous levels of transport, energy generation and industrial production immediately after the Games reintroduced the downward spiral.

Indeed, by the end of 2013, the extreme pollution in Beijing and other big Chinese cities meant that airline pilots were being instructed on how to land in smog. The crisis was so bad that the country's official media was reduced to releasing bizarre platitudes that the pollution meant that the people's 'knowledge of meteorology, geography, physics, chemistry and history [had] progressed'. Blankets of killer smog were also invoked as a geopolitical, defensive shield against the prying weapons of unknown enemies. 'Smog may affect people's health and daily lives', the announcer admitted. 'But on the battlefield it can serve as a defensive advantage in military operations' (Kalman 2013).

Pollution paradoxes can sometimes interrupt apparently inexorable logics of urban warming. In a particularly prolonged smog event in February 2014, Chinese scientists warned that the smog blanketing the Beijing region was becoming so bad that its effects were starting to resemble those of nuclear winters, creating a city almost 'uninhabitable for human beings'. Densities of suspended particles hit concentrations over 20 times maximum limits recommended by the World Health Organization. Photosynthesis rates in agricultural crops in the greenhouse-based systems within Beijing's hinterland were halved. Architectures to boost food production for teeming cities at the local, ground-level scale will always prove to be no match for the human manufacture of toxic, and increasingly opaque, urban atmospheres (Kalman 2014).

In Hong Kong, meanwhile, in the year 2000, a priority of economic development authorities was to tempt the Walt Disney Corporation to build a theme park there. They were nearly unsuccessful because the Corporation felt that the city's notoriously bad winter air pollution 'did not mesh particularly well with the family image that Disney so prided itself on cultivating' (Choy 2010, 6). (Deep ironies lurk here of course: Los Angeles, the location of Disney's headquarters, has suffered episodes of catastrophic smog for decades.)

Echoing the complex simulations of pollution-free urbanism choreographed 2000 miles further north in Beijing, tourist managers in Hong Kong now routinely erect blue-skied panoramas next to the iconic city viewpoints when pollution episodes obscure the skyline and harbour with what the *International Business Times* called a 'steamy sauna of humidity and noxious air' (FlorCruz 2013) (see Figure 3).

Figure 3 Smog and simulacrum: the fake skyline erected for tourist use in Hong Kong in 2013 (Source: http://imgur.com/VaZU3lU. Photo: Pirapira Pelar [Attribution licence]).

Not surprisingly, urban tourism economies are especially vulnerable to toxic urban air. Urban pollution crises in China in late 2013 saw domestic and international visitor numbers to iconic sites such as Beijing's Forbidden City drop by 75%. Chinese insurance companies even introduced travel insurance packages covering smog events to try and bolster bookings (Coldwell 2014).

However, immersion in megacity air leads to more than health hazards, environmental injustice and problems for place marketers and tourists. As in the smoke-filled industrial cities of 19th-century Europe, these airs also inevitably shape the atmospheric, aesthetic and affective experiences of place (see Adey 2014). These relationships, too, are often paradoxical: as Turner found when painting the startling sunsets generated by major global volcanic events in the 1880s, toxic air can generate its own sublime urban beauty.

In cities like Shanghai (Figure 4), the combination of rising vertical towers and the worsening state of city air creates its own aesthetic connection: the view of the smog-filled lower atmospheres from tower residents above. Giuditata Vendrame, an Italian who lived for 11 months on the 17th floor of a gleaming new tower in central Shanghai, recalls that the thickening haze of the city's polluted air 'often imbue[d] the city with a particular sense of lightness, suspension and fragility'. The foggy air, in turn, softened her view of the city's burgeoning forest of concrete, skyscraping towers. 'The city gains visual and architectural qualities', she writes. 'The light of the sunbeams penetrates this foggy layer, giving the city a magic and fairytale colour. However, this "magical haze" is harmful. It is smog, air pollution' (Vendrame 2012).

Downwind

Fourth, the uneven distribution of bad air works horizontally, too. Less urbanised areas downwind of major metropolitan formations breathe the filth of the city they may never visit. Such downwind vulnerabilities are especially lethal after chemical spills (as at Bhopal in 1984 which has killed up to 16,000 people) or when they become radioactive due to atmospheric nuclear testing or nuclear catastrophes like those at Chernobyl and Fukushima. Less often, it is cities that are downwind from bad air generated by rural conflagrations: 'Singapore frequently complains of the extreme haze caused by Sumatran forest fires in Indonesia' (Adey 2013, 10).

Figure 4 Air pollution in Shanghai, 2013 (Source: http://www.everystockphoto.com/photo.php?imageId=12866901&searchId=3aab0a4b8063f9a9a1d8039a05475e22&npos=27. Photo: Fung Leo [Attribution licence]).

At a planetary scale, the relative (although often chimerical) cleaning up of the airscapes above European, Japanese or North American cities has been achieved partly through a massive geo-economic shift across the horizontal terrain of the earth's surface: the huge and filthy extractive and manufacturing complexes that sustain these cities' places within global divisions of labour are now strung out across China, East and South-east Asia, Africa, Latin America and even Australia.

A major report of the Intergovernmental Panel on Climate Change in 2013 concluded that such wholesale offshoring between the West and East Asia was the key reason that global emissions of carbon dioxide and the other greenhouse gases increased twice as fast between 2000 and 2010 as they did during the previous three decades. This was because of the huge growth of manufacturing capacity powered by electricity generated from dirty coal-burning power stations. 'A growing share of CO2 emissions from fossil fuel combustion in developing countries,' the report concluded, 'is released in the production of goods and services exported, notably from upper-middle-income countries to high-income countries' (cited in Goldenberg 2014).

The circulations of the global atmosphere, however, mean that even horizontal outsourcing and the offspring of bad air across transcontinental horizontal scales fails to offer a complete insulation from bad air: a recent study found that between 12 and 24% of the sulphur pollutants in the western USA had been blown there from industrial and urban sites in China by atmospheric wind systems (Walker 2014).

Airy refuges, human sinks

> 'One can [. . .] discern a political–economic geography of air.' (Choy 2010, 26)

Fifth, in all cities, the impacts of toxic and warmed-up aerial domes are distributed extremely unevenly and unjustly. Whilst atmospheric pollution can be a great leveller in terms of wealth and class, generally, wealthy and elite groups are able to insulate themselves from its effects more effectively than are poor or marginalised ones. Here a three-dimensional cat and mouse game of

environmental injustice is wrought out as systems of linked, 'capsular' spaces such as condominiums and penthouses, malls, office complexes and upmarket cars are constructed which offer air conditioning (whilst pumping their heat straight to hose immediately outside) (see De Cauter 2005). Air-conditioned cars, often flitting across the cityscape on raised flyovers, dump their heat, noise and carcinogens straight onto the relatively impoverished communities that such so often structures bisect. (At the same time, their cool interiors make worsening traffic more bearable for their occupants.) Communities adjacent to highways and flyovers have been shown to have dramatically higher death rates due to asthma and other pollution-related diseases than those further away from highways. 'Residential proximity to freeways is associated with uncontrolled asthma' (Huynh et al. 2010).

The damaging impacts of auto exhaust emissions were one of the motivations of modernist architects like Le Corbusier to advocate the destruction of traditional streets and the mass housing of urban populations into raised towers (see Gissen 2013, 3). Cars, meanwhile, would traverse the city on freeways surrounded by buffer zones of pollution-absorbing greenery. These days, however, mass modernist housing programmes are mostly in abeyance—with occasional exceptions such as Singapore. The colonisation of (air-conditioned) vertical space is now largely an elite programme—a three-dimensional rising up of the powerful and wealthy bound up with the neo-liberal and revanchist re-engineering of entire cityscapes largely for their needs. As elites in many cities literally rise up into gated, air-conditioned, vertical communities and tall, climate-controlled workplace towers, so they work to escape both the din of urban life and the pressing heat and pollution of the hotter urban surface.

Such vertical geographies of environmental injustice tend to be exaggerated where cities are built on mountainous terrain. Ascending up the proliferating skyscrapers in the world's most vertical city—Hong Kong—anthropologist Tim Choy (2010, 29) is struck that 'the rich have access to good air while the poor are relegated to the dregs, to the smog and dust under flyovers or on the streets'.

Elite expatriates, for example, can seek refuge from bad air, noise, heat and humidity by colonising what he calls Hong Kong's 'airy refuges'—in skyscraper penthouses located in the topographic heights of the Peak or Midlevels. Just above the teeming street, meanwhile, covered, extending, air-conditioned escalator systems snake to connect archipelagos of elite spaces of consumption, work and leisure. 'Much of Hong Kong seems designed to get off the ground—into the air, and out of it' (Choy 2010, 12). These dynamics add to and layer over the long-standing traditions of elites to inhabit exurban or mountainous locations to escape the worst of the environmental toxins, pollutions and temperatures within the toxic domes above cities. (Classic urban geography also dictates that, often, such processes of elite exurbanisation were often orchestrated upwind of the main metropolitan centre.)

Hong Kong offers a startling system of vertically raised walkways snaking between the huge, raised podium structures at the bases of upmarket hotels, residential blocks and malls and corporate enclaves (Figure 5). Such systems can literally allow those who have access, to inhabit the kind of raised-up, premium accommodation and mobility systems so beloved of science-fiction writers.

Continuing his discussions of walking in Hong Kong, Choy (2010, 12) talks of a day spent in the company of an executive from the Tsing Tao beer company as he 'wends his way expertly through Wenchai, a government and nightlife district on Hong Kong Island, without ever touching the ground'. Because the city's deep, canyon-like streets and long podium structures at the base of towers act to channel and contain relatively heavy polluted air, this has crucial impacts on the relative health of the vertically stratified population. 'In the typical street canyons of Hong Kong, air pollutants tend

Figure 5 Raised walkway systems, Central, Hong Kong (Photo: Stephen Graham).

to be trapped in the bottom 15 m' (Wong, Ng, and Yau 2012, 14). Moreover, the massive podium blocks between the streets and the raised walkways in Hong Kong 'not only block most of the wind to pedestrians (affecting comfort and air quality), but also minimise the "air volume" near the pedestrian level (affecting air quality)' (Ng 2009).

Splintering air: vertical architectures as 'spatialised immune systems'

> 'An analysis of air reveals who belongs and who does not, who is deserving and who is not in a constellation of megacity inequality.' (Adey 2013, 4)
>
> 'One could [. . .] lament the splintering of the atmosphere.' (Canetti 1987, 10)

Political ecologies of urban air thus need to address the conditioning of air within interior spaces (for recent progress here, see Biehler and Simon 2011). The layered politics of

Figure 6 'The higher you go, the cooler you get!' Placards around the Indiabulls 'Sky' residential tower in downtown Mumbai, 2011 (Photo: Adam Cooper, reproduced with permission).

urban atmospheres—our sixth theme—is not lost on real estate agents and developers who build, design and market the world's vertical gated communities. 'The Higher You Go, the Cooler You Get!' screams the advertising hoarding at the elite Indiabulls Sky Complex in Mumbai's central business district (Figure 6).

Perhaps the ultimate capsular or 'splintered' living environment (Graham and Marvin 2001; De Cauter 2005), the building—marketed under the banner 'way, way above the rest'—offers a litany of elite, luxury services, a suite of pools, spas and restaurants (all in the relatively cool air above the 12th floor; below these is a tall podium of stacked parking garages). In addition, there is private rooftop helipad, and a complex system of air conditioning and pollution filtering. In effect, the Sky Complex, like other elite residential towers, works to offer what philosopher Peter Sloterdijk (2009) has termed as a 'spatialized immune system' lifting elites above the bad air and heat—as well as the dense populations of poorer people—of the grounded city below.

Exploiting the deep etymological and cosmographic connections between height, status and power, the developer of Indiabulls, moreover, urges its customers to 'soar higher' to embrace 'a lifestyle unprecedented and

elevated up to the sky'. On the placard around the corner, vertical height is equated not just with premium atmosphere but with a direct invocation of theological supremacy for the elites lucky enough to ascend the tower. 'Consider it a blessing', it shouts, 'to share the same address as God.' 'Where the heavens extend an invitation' is the strapline of the development's brochure.

Fragmenting atmospheres: vicious circles of the air-con city

> 'But where is Utopia, where the weather is 64.4°F … ?' (Le Corbusier 1967, 42)
> 'Air conditioning [is] now considered as natural as the air itself.' (Cox 2010, xi)

Seventh, an urban political ecology of air must address the widening and increasingly ambitious processes through which air is deliberately manufactured and conditioned. Expected to almost double between 2012 and 2018—from USD 98.2 billion to 178.4 billion in 2018—the global air-conditioning industry is in bonanza mode (Transparency Market Research 2013). Urbanisation, urban heat-island effects and the very warming of the planet, combined with the ubiquity of consumer capitalism, provide a perfect market environment for an industry which offers the promise of manufacturing what Peter Sloterdijk (2009, 94) has called 'thematized' or 'designed air'. 'The breaking up of the social world into spaces of moral interdependence inaccessible to one another,' he suggests, 'is analogous to the micro-climatic fragmenting of the atmosphere' (Sloterdijk 2009, 99).

The widespread normalisation of expectations amongst middle-class and wealthy urbanites in warmer cities that urban life must consist of a continuous experience of chilled air manufactured to cover every building or transport choice, adds further to the 10% per annum market global growth rate (Transparency Market Research 2013). The growing normalisation of air-con urbanism in hot climates like the southern USA has been paralleled by major architectural, social and geo-economic shifts: the iconic 'rustbelt' to 'sunbelt' transformation (see Cox 2010). 'By 1960, 20 per cent of homes in the South owned an air conditioner', writes Pete Adey (2014):

> 'by 1973 80 per cent of [US] cars had air conditioning, as it became felt as an almost legal right. However, this also contributed to a massive shift in population density [in the southern states] which almost doubled from between 1930 to 1980 due to declining mortality, and, interestingly, new routines of travel and migration to the "sun belt". The 1970 census was dubbed the "air conditioned census" by the New York Times because it captured the evolving effect of the technology in creating attractive and comfortable climates in the South, even in the summer.' (156)

Many other nations have followed the US path towards mass air-con use. Overwhelmingly, such processes are organised through individualised market forces distributing personal machines as consumer durables. Such transformations are reflected strikingly in urban landscapes in many megacities where large buildings gradually become strewn with walls of individual air conditioners (Figure 7).

The laws of physics, of course, mean that heat removed from the cooled, bubble-like, air-conned enclosures for the more privileged cannot disappear. It must, instead, be dumped beyond the walls. The proliferation of air-conditioned environments thus leads to greater amounts of heat dumping via the heat exchangers on the frontages of the buildings. (Anyone who has stood next to the extracted air next to the air-con outlet of a major mall, hotel or office complex in a hot city can testify to the fan oven-like experience.) Stan Cox (2010, 31) observes that:

> 'on hot summer days in the cities and towns of southern Europe, heat exhausted from room air conditioners becomes trapped between the multistory buildings that line the region's narrow, picturesque streets. The air-

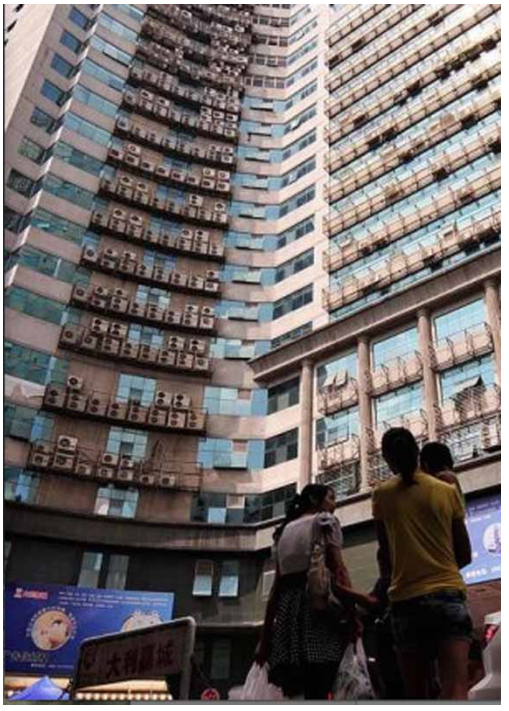

Figure 7 The new Great Wall of China? Individual air-con units cover this tower in Fuzhou, China, so densely that it has become one of the most famous structures in the city and is even a tourist attraction (Source: http://www.chinasmack.com/2011/pictures/most-awesome-wall-of-air-conditioners-in-fuzhou.html. Photo: Steve Levenstein).

> conditioning units raise the temperature of the already-hot outdoor air surrounding them by 10°(F), forcing compressors and fans to run almost constantly, consuming even more electricity in order to flush heat out of homes and shops.'

Such external heat dumping further exacerbates both urban heat-island effects (Figure 8) and the intolerable temperatures of the wider street environment. This, in turn, adds to the increasingly desperate urge by those who can afford it to find refuge within an air-conditioned environment. And so the cycle goes on: more air con, more heat dumping on streets, and ever-greater temperature disjunctures between the street and building interiors, etc. And all to produce 'building-machines' which, as the widespread problems of 'sick building' syndrome demonstrate, themselves often prove profoundly unhealthy (Murphy 2006).

Research on the 2003 heat emergency in Paris by Cecile de Munck, of the French Centre for Meteorological Research, suggests that ramped up air-con use in the city exacerbated the problem. Here 'modeling experiments show that excess heat expelled onto the streets because of increased air conditioner usage during heat waves can elevate outside street temperatures significantly' (see Figure 8). Notably, this exacerbation of heat-island effects is most powerful in the densely built and largely affluent districts within the centre of Paris—places where air con has been most widely installed and where running costs are not a problem (quoted in NASA 2010).

A second vicious circle for air-con cities involves the pressure of the peaks of electricity demand created by urban air-con systems leading to major power blackouts (see Graham 2009). Behind the unprecedented blackout across the megalopolitan north-eastern USA on 14 August 2003—the most powerful example thus far—'lay a power system overloaded by summer energy use, and in particular, dragged down by the burden of air conditioning' (Grabar 2013).

In 2013, air con accounted for 10% of global electricity demand—a figure that, with 38 of the world's 50 biggest cities being in the tropics, is rising fast (Grabar 2013). Such growth rates force the use of extra fossil fuels for electricity generation, related threats to energy security, the release of more particulate matter and greenhouse gases, and the increased risk of major power outages.

Again, the vicious circle here seems inexorable: more air conditioning, exaggerated climate-change-related temperature rises, increasingly intolerable urban heat islands, further demands for air-con environments and so on. 'Turning buildings into refrigerators burns fossil fuels, which emits greenhouse gases, which raises global temperatures, which creates a need for—you

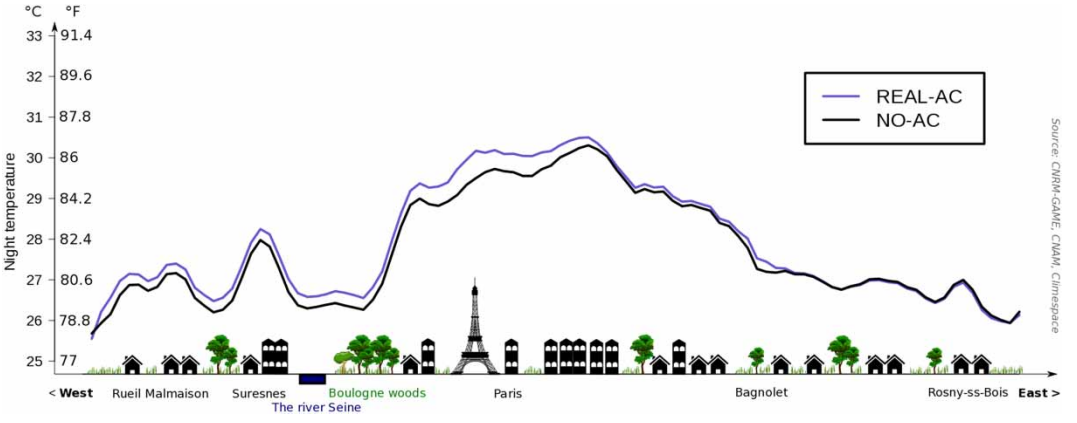

Figure 8 Calculations of the effect of heat dumping from air conditioning on the killer heatwave and heat island during the 2003 emergency in Paris. The 'Real AC' graph shows the actual heat-island profile for the city with air conditioning, the 'No AC' graph is an estimated profile of the city were there to be no air conditioning at all (Source: NASA 2010).

guessed it—more air-conditioning' (Hutchinson 2010).

Such feedback loops add further to the vulnerabilities that marginalised urban groups, who have no choice but to endure urban heat islands without air conditioning, face. Detailed research of heat emergencies demonstrates clearly that 'ownership and usage of air-conditioners significantly reduce[s] the effects of temperature' on the wide range of conditions, diseases and ailments that can become killers during urban heatwaves (Ostro et al. 2010, 1053).

The lessons of the killer heat emergencies in Chicago in 1995 and across Europe in 2003 discussed above are again deeply relevant here. There remains a startling absence of public policies to systematically organise the delivery of adequately cool environments for the city's poor within rapidly warming cities faced by dramatic rises in consumer electricity costs (on the Australian case, see Farbotko and Waitt 2011).

In such a situation, market-based distribution of life-saving bubbles of coolness can only work to kill increasing numbers of the old, the poor, the weak and the ill. Many are now arguing that the inevitable failure of markets to deliver socially just cooling mirror the failure of markets for many other 'public' goods. Learning from cities like Hartford, Connecticut, for example, Henry Grabar (2013) argues that public, municipal infrastructures for cooling air are essential to tackle both urban heat crises and the contribution of individualised air-con markets to toxic air (after all, many North American cities have long traditions of organising collective heat, steam and electricity infrastructures).

Many designers are also calling for a rediscovery of design-based solutions to cooling buildings and for a return to altering the choreographies of everyday and business lives to deal with hot weather (see, e.g. Gandy 2010).

Hot bodies, cooled bodies: citadels of death and apartheid atmospheres

> 'As many people are killed on construction sites throughout the world each year as die as a result of armed conflict.' (National Examination Board in Occupational Safety and Health, n.d.)

If the increasingly hot, urban world can be starkly divided between those who are inside air-con environments and those who are outside, the massive construction of a whole suite of vast air-conditioned hotels, malls, leisure attractions and even football stadia by armies of near-slave labourers within the

50-degree temperatures of Qatar—our eighth theme—is the lethal apogee of such injustice.

Two million indentured labourers from Nepal, Pakistan, India and the rest of South and South-east Asia, are constructing these edifices in a $140 billion programme to ready to enclave for the 2022 World Cup. The International Trade Union Confederation has warned that 4000 construction workers are likely to die before the start of the tournament; at least 185 Nepalis—who make up a sixth of the migrant workforce—died in 2013 alone (Gibson and Pattison 2014). Over 500 Indian workers—between 20 and 30 a month—died between 2012 and 2014 (Gibson 2014).

Heatstroke and dehydration are the main killers, especially during the summer months (although fatal 'accidents' and suicides are also routine). Most death certificates are marked with the catchall of 'natural' 'cardiac arrest' by Qatari doctors. This deflects attention from the lethal working environment that is the real cause of such huge death rates. The dark irony is that, when opened, the entire archipelago of bubble-like visitor spaces—including, the Qatari government claim, five new and one extended stadia—will be air-conditioned.

The Qatar example, however, is only the most visible of many: the wider construction of a series of what Davis and Monk (2009) termed 'dreamworld of neoliberalism'—in Dubai and Bahrain, most notably—have been achieved at the expense of unknowable numbers of heat-related deaths amongst near-slave migrant workers. After the UK's shadow sports minister, Clive Efford, expressed revulsion at the latest revelations of worker deaths in Qatar, Maher Mughrabi (2013) wondered:

> 'Where exactly has this man been? Dubai, Qatar and Bahrain have been hosting the stars of golf, tennis, snooker, formula one and, of course, horse racing for decades now. And all those holidaymakers in Dubai who have sampled the shopping festival, the mall with the indoor ski slope or zooming up in the lift of the world's tallest building should also know that all this was built through the same system of labour that is suddenly so appalling.'

'During the summer, temperatures soar above 45 Celsius (113 Fahrenheit), and visitors are advised to walk outdoors only in the evening, and drink water continually', writes Richard Abernethy (2010). 'Heat stroke is a killer for workers doing heavy physical labour for shifts of 12 hours or longer.' Human Rights Watch (2006) (Figure 9) cite a report from the journal *Construction Week* that found that 880 migrant construction workers died in the UAE (United Arab Emirates) in 2004 alone. The Indian consulate, moreover, registered the deaths of 971 Indian citizens in 2005. Sixty-one of these were registered as site accidents; many were of heatstroke and heat exhaustion; suicides made up the remainder. The report found that 'as many as 5000 construction workers per month were brought into the accident and emergency department of Rashid Hospital in Dubai during July and August 2004' (Human Rights Watch 2006).

Journalist Nesrine Malik (2011), visiting Dubai to research the deaths of migrant workers, found that conditions for Indian workers building Dubai's air-conditioned skyscrapers and megaprojects were so appalling that two committed suicide each week. (The first suicide from the world's tallest tower, the Burj Khalifa, another Indian migrant worker, happened when she was there. Locals joked callously that the death had 'inaugurated the building' as a suicide platform, such is the frequency of suicide leaps [Malik 2011].)

Climate capsules: echoes of Buckminster Fuller

> 'The air starts to become private.' (Vendrame 2012)
>
> 'Let us not forget that today's so-called consumer society was invented in a

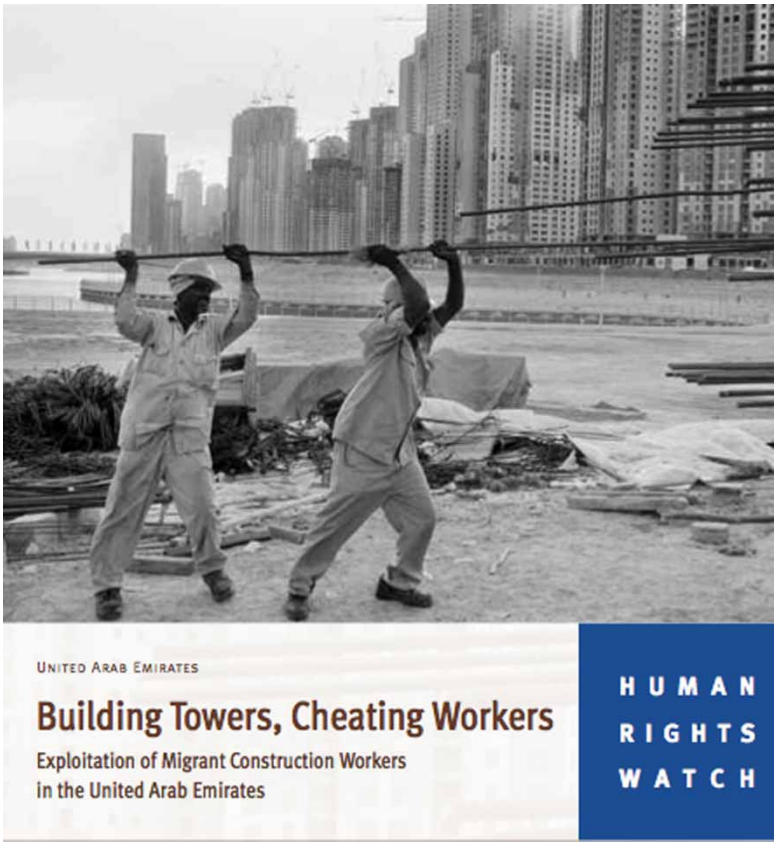

Figure 9 Human Rights Watch's 2006 report of worker deaths building air-conditioned complexes in the USA (Source: Human Rights Watch 2006).

> greenhouse—in the very same glass-canopied, nineteenth century arcades in which the first generation of "experience customers" learned to breathe the intoxicating scent of an enclosed, interior-world full of commodities.' (Dorrian 2012, 27)

Relatedly, an urban political ecology of air must attend, penultimately, to the proliferation of air-conditioned environments at the macro scale. Increasingly megalomaniacal use of air-conditioned interiors has been central, for example, to Dubai's spectacular emergence as the ultimate dreamworld of neo-liberalism. Reaching its extreme with the conceit of a complete, indoor, skiing environment, with real snow, in the middle of one of the world's hottest deserts (Figure 10), Dubai's archipelago of air-conditioned interior 'experiences' each enjoys a wholly manufactured climate (a project for a much larger, so far unbuilt, 'Arctic experience', is to include real polar bears) (Dorrian 2012).

Dubai's interior ski spaces—the ultimate interiorisation of 'nature'—echoes architect Buckminster Fuller's influential ruminations between the 1940s and 1960s on the possibilities of dome-like constructions at various scales within which urban air could be precisely controlled. (Famously, Fuller even suggested a giant dome encompassing midtown Manhattan which would permanently sustain what he called a 'Garden of Eden climate'—see Krausse and Kichtenstein 2001.)

Figure 10 Oil and ice: the world's largest freezer. Ski-Dubai's 400-metre slopes are maintained at a constant −2°C even when summer temperatures beyond the walls soar past 50°C (Source: http://www.everystockphoto.com/photo.php?imageId=10559969&searchId=cd5bce6e1eebc4a6502d9334b77d79c7&npos=22. Attribution licence: Jon Rawlinson)

To Mark Dorrian (2012, 26), Dubai's capsular, air-conditioned interiors echo Fuller's geodesic domes, with their 'complex connotations of autonomy, encapsulation, and world imagery'. Here, though, the techno-utopia of constructing bubbles for the precise manipulation of urban air—what he calls a 'renovated atmosphere' (Dorrian 2012)—rests, with deep paradox, of the bodies of unknowable labourers who expired through heat exhaustion in their efforts to project the façade.

The juxtaposition of interiorised simulacra of 'nature' unleashes less lethal paradoxes. The interior condition within 'bubble' environments like Dubai ski-dome emerges 'more pure, less polluted, and hence more "itself" than in the world beyond, albeit now as commodity' (Dorrian 2012, 26).

Crises of air pollution are also driving urban elites to engineer capsules of filtered, good-quality air from the wider urban environment. In the most powerful example so far, governors of Beijing's International School for elite, expat children have spent $5 million housing their previously outdoor playgrounds and sports spaces within a giant dome. This allows the air breathed by the school's children to be filtered to a very high standard by powerful industrial air filters that control the interior's relationship to the urban outside. Much larger urban domes, Fuller-style, have also been proposed as ways to create climate-controlled urban air spaces within central Houston and in Dubai's huge, 4.5 million square metre 'mall of the world' project.

Atmo-terror: authored air, weaponised weather

> '[State and non-state] terrorism, from an environmental perspective, voids the distinction between violence against people and violence against things: it comprises a form of violence against the very human-ambient "things" without which people cannot remain people.' (Sloterdijk 2009, 25)

A final theme for a political ecology of urban air surrounds the long and complex history of the deliberate manufacture or manipulation of bad or lethal air as a form of warfare or coercion, or what Jacob Hamblin (2013) calls in his crucial book *Arming Mother Nature*, 'catastrophic environmentalism'.

As the smog-induced 'nuclear winter' in the agricultural regions around Beijing in late 2013 showed, a rapidly urbanising world experiencing tumultuous climate and sea-level changes is especially vulnerable to the malign manipulation of climate for political ends, whether from states or non-states.

As already noted, Peter Sloterdijk has done much to excavate the political history of what he calls 'atmo-terror': the deliberate manipulation of air, weather and climate as an ultimate means of destroying an enemy Other. Modelled on the gas attacks of the First World War with which we started this paper, he shows how such ideas shaped the gas chambers of the Holocaust, techniques of strategic fire and atomic bombing, the use of hot and cold climates as means of inflicting pain on detainees, and Cold War experiments in military weather modification

and biological and chemical warfare. (The latter, at least, has been widely practised since the Second World War.)

Such techniques, to Sloterdijk, involve the upscaling of ideas of air conditioning of small, local 'bubbles' to larger urban, regional or planetary scales. Indeed, Evans and Reid (2013, 126) remind us that 'it is no coincidence that we may trace the origin of climatic conditioning to warfare'. It is inevitable, then, that debates about weaponising weather—and the wider militarisation of nature—overlap with those concerned with using similar geo-engineering techniques to address crises of climate change, intensifying extreme weather events and resource exhaustion.

Such a history, though, struggles to overcome the long-standing myth that meteorology and climate are entirely 'natural', drawing only on other-than-human forces. 'So long as meteorology presents itself as a natural science and nothing else', Sloterdijk (2009) writes, 'it can pass in silence over the question of the weather's possible author' (86–87). Whilst the International Panel on Climate Change is coming fully to grips with unintentional effects of urban-industrialism on the earth's atmosphere, it has so far failed completely to address real or potential acts of climatic warfare (see Hamblin 2013).

Such a shift is long overdue. 'In the United States,' one major US military study in 1996 predicted, 'weather-modification will likely become a part of national security policy with both domestic and international applications' (House et al. 1996). Intensifying storms, shaping cloud cover, denying rain and water, instigating severe heatwaves: the authors predicted that a deeply hubristic military menu might be available by 2025 whereby controllable airs might be deployed mechanically against 'future adversaries'. Like a bad sci-fi film, they suggest that the USA's global meteorological stations and research centres simply be re-programmed to help control such events. This, however, is not science fiction: the US military widely used cloud seeding in the Vietnam War to try and bog down the Viet Cong.

Unlike such 'weather warfare', Jamais Cascio (2008) writes, 'geoengineering would be subtle and long term, more a strategic project than a tactical weapon'. Future offensive geoengineering on a larger scale could take a wide variety of terrifying, and deeply unpredictable, forms:

> 'Over-productive algae blooms can actually sterilize large stretches of ocean over time, effectively destroying fisheries and local ecosystems. Sulfur dioxide carries health risks when it cycles out of the stratosphere. One proposal would pull cooler water from the deep oceans to the surface in an explicit attempt to shift the trajectories of hurricanes …'

Full circle: urban atmo-terror

To finish our wide-ranging discussions, it is apposite to consider the ways in which authored and weaponised air has become a central tactic of state security forces within innumerable contemporary struggles over the right to the city (Figure 11). Here a century-long history of tear gas emerges which connects us back to the gas attacks of the Somme and elsewhere in the early 20th century.

Figure 11 Riot police using tear gas against protestors near Taksim Gezi Park demonstrating against the destruction of the park by a shopping mall development (Source: http://www.everystockphoto.com/photo.php?imageId=22820617&searchId=cedd6d67ec62c830c46e65c7ada4acd1&npos=12. Attribution licence: Alan Hilditch).

As Anna Feigenbaum (2014) has shown, the standard practice of tear-gassing protestors on city streets involved transmuting chemical weaponry from war to routine pacification (with often fatal consequences). So widespread are images of tear-gassed protestors in contemporary news reports, she writes that, 'desensitized to these images, people often forget that tear gas is a chemical weapon, designed for physical and psychological torture'.

As urban police forces become more militarised, so they deploy counter-insurgency doctrine against domestic urban populations in which pacification through exploiting the defencelessness of breathing mutates into a major industry in its own right (known, in the parlance, as 'non-lethal' or 'less-lethal' weaponry). Here, within the hybrid category of peace-war, we confront the most insistent moments where the right to air and the right to the city are one and the same. 'While tear gas remains banned from warfare under the Chemical Weapons Convention,' Feigenbaum emphasises:

> 'its use in civilian policing grows. Tear gas remains as effective today at demoralizing and dispersing crowds as it was a century ago, turning the street from a place of protest into toxic chaos. It clogs the air, the one communication channel that even the most powerless can use to voice their grievances. . . . As those who signed declarations [against chemical weapons] at the Hague back in 1899 knew, peace cannot be made through poison.'

With airspaces deliberately modified into toxic and lethal devices as a standard atmo-terrorism means of undermining protest against the extremes of urban neo-liberalism, we confront a final example of where the politics of the urban becomes a politics of air. Marijn Nieuwenhuis (2013), observing the mass tear-gassing of 2013 protests against the evictions of public parks from Istanbul, argues that 'the ongoing struggle over Gezi Park and other spaces around Turkey (and beyond) are no longer primarily being fought on the ground. They are instead increasingly taking place in the air.'

As in the trenches of 1915, the gas mask becomes a primary instrument of survival. 'Means of air conditioning (e.g. gas masks) have instead turned into the primary instruments of resilience', Nieuwenhuis continues. 'Any form of effective resistance against atmo-terrorism should, therefore, start by securing the air from which life springs.'

Disclosure statement

No potential conflict of interest was reported by the author.

Note

1 Although it must be noted that more progress has been made exposing the environmental injustices and epidemiologies of air-pollution-related ill health in cities—see Corburn, Osleeb, and Porter (2006), Morello-Frosch, Pastor, and Sadd (2001), and Pearce, Kingham, and Zawar-Reza (2006).
2 These standards are as follows; for sulphur dioxide – 20 micrograms per cubic metre of air on average over 24-hours or 500 micrograms per cubic metre of air on average over a 10-minute period; for nitrogen dioxide – 40 micrograms per cubic metre of air on average over a year or 200 micrograms per cubic metre of air on average over a 1-hour period; for 2.5 micron diameter suspended particle matter – 10 micrograms per cubic metre of air on average over a year or 25 micrograms per cubic metre of air on average over a 24-hour period; and for 10 micron diameter suspended particle matter – 20 micrograms per cubic metre of air on average over a year or 55 micrograms per cubic metre of air on average over a 24-hour period. See World Health Organization (2005).

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