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# Aeromobilities' extra-sectoral costs: a methodological reorientation

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**ABSTRACT**

For over a decade, scholars have graced a number of aeromobilities' socio-cultural dimensions, from being in an airport to commanding an aeroplane. Yet, while this work has heightened appreciations of the political nature of aerial worlds, the propensity has been to focus on the immediate arrangements and politics related to flight. Using civil aviation as an example, this article offers a methodological reorientation and conceptual rethink of how aeromobilities' (re)production invokes far-reaching political economies in excess of the core activity of aerial conveyances. It seeks to open up worldly webs of iniquitous movements and relations that make aerial life – rather than flying per se – possible in the first place. Interspersing a selection of our research with extant literature, reports and statistics, the article outlines, in coincidence with our earlier findings, two ways in which civil aviation has thus incurred extensive extra-sectoral costs: the material mobilisation of resources for air infrastructures, and the mobilisation of populations and labour for aeromobile development. The discussion aims ultimately to promote a more nuanced understanding of the constituents, and costs, of moving in the present age.

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## Introduction

More than a decade has passed since mobilities scholars first began taking aviation seriously as a fertile site of social, cultural and political interrogation. Recognising the limits of treating air transport studies as a matter of routes and networks, Adey, Budd, and Hubbard (2007, 774) arguably led the charge to (re)cognise this travel mode as 'not some asocial realm or "non-place", but a space whose embodied, emotional and practised geographies' deserved greater scrutiny. Soon after, a number of texts emerged in quick succession to delineate the inner workings of aviation, including Cwerner, Kesselring, and Urry's (2009) pioneering book on *Aeromobilities*. This book not only coined a neologism around which a variety of meanings, practices, feelings and aesthetics would become synonymous with aviation; it also spurred growing attention to the political ways in which global aerial flows are splintered to benefit some more than others (Martin 2011; Sheller 2016). As Cwerner (2009) summed up in the book's introduction, the academy was due to make a case for 'establishing aeromobilities as both a distinctive field of research and a key issue in the future development of social theory'. As air travel extends its reach across the globe, the need to understand how mobile lives are organised through aviation has only become more acute.

Aeromobilities research has matured since these incipient debates, and now features prominently in multiple disciplines, including anthropology, geography, history, political science and sociology. Scholars in these domains have helped to deepen knowledge on the subject, gracing such issues as

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airport design and its surveillant qualities (Bissell, Hynes, and Sharpe 2012; Shilon and Shamir 2016), the aircraft cabin and its subjectivities (Bissell, Hynes, and Sharpe 2012; Lin 2015), and, recently, drones and their killing potentials (Allinson 2015; Birtchnell 2017). Yet, while these expositions have heightened scholarly appreciations of the political nature of aerial worlds, the preponderant stance has been to focus on the immediate arrangements and costs related to flight, suggesting that aviation's negativities can be clearly delimited and contained within the realm of literal aerial movements. More explicitly, there is a tendency within extant scholarship to concentrate on the 'real-time' performances and operation of flight, omitting, in the process, larger systemic – often pernicious – processes in the production and re-production of, not just a movement, but an entire mobility regime. In some senses, this fixation on only the immediate fails to fully grasp Adey's (2010, 2) assertion that 'aeromobilities are responsible for our current and modern condition'. If aeromobilities have introduced new worldviews, new meanings and new relationships in modern life, these social ruptures cannot be merely restricted to only those moments that appear to be manifestly aerial.

Desiring an optic that treats aeromobilities as a composite outcome of multiple stretched-out relations (Lin 2018), this article offers, by way of discussion, a methodological intervention that seeks to unearth the myriad political economies within which aviation is ensconced. Such a positionality reorients aeromobilities from a clearly demarcated 'product' in aerial conveyance, to part and parcel of a total system entangled in worldly webs of iniquitous movements and relations that make aerial life possible in the first place. As Urry (2000, 188) writes, social processes 'have to be re-thought as involving multiple mobilities with novel spaces and temporalities', rather than discrete phenomena that are kept separate for analysis (see Cidell 2017). This viewpoint is able to add to global value chain or global production network analyses of transport systems (see Niewiadomski 2017), by taking their 'chains' and 'networks' beyond assigned sectoral categories to countenance far more complex sociotechnical and socioecological interdependencies in mobilities. Interrogating these interlocking mobilisations of people and things happening alongside aeromobilities can shed important light on an industry that often has spill-over effects in other seemingly unrelated action spaces. It reveals other 'rough touch[es] of power' (Adey 2010, 15) – of exploitations, disruptions and oppressions – that may rarely be associated with air travel, but are central to becoming airborne.

This article does not seek to empirically present a case study, but aims to conceptually scope out the potentiality of such extra-sectoral costs, and contemplate their implications. Being both researchers of civil aviation, our respective research – one on the material infrastructures of aviation, and the other on social transformations caused by aviation – provides a roadmap for this intellectual exercise. Although not the only form of air travel, civil aviation takes precedence in aeromobilities discourses because of its growing prevalence and visibility in everyday life, and, as such, will form the basis of our arguments. The remainder of the article will proceed as follows. In section two, we establish how scholars have commonly understood the politics of aeromobilities. The third section then outlines an alternative framework that consciously extends civil aviation to a wider politico-economic networks of (re)production. Sections four and five operationalise this framework by turning to two clusters of circulations entrained/entailed by civil aviation, namely a) the material mobilisation of ecological resources for air infrastructural investments; and b) the mobilisation of populations and labour both for and to sustain aeromobile development. By attuning to these nonhuman and human metabolisms, we underscore how aeromobilities are umbilically tied to a gamut of economic, ecological and labour processes not usually associated with flying. The final section concludes by reiterating the need for a methodological reorientation in (aero)mobilities research, to garner a more nuanced understanding of the constituents, and costs, of moving in the present age.

## Recounting aeromobilities

A hallmark of the recent rise in aeromobilities research has been its attention to the sociality of flying. This contrasts starkly with earlier caricatures of aviation as being made up of a series of superficial

'non-places', or maps showing 'the expansive global reach of air routes' (Adey, Budd, and Hubbard 2007, 786). Given the impetus to move away from such staid portrayals, it is perhaps unsurprising that the first – and arguably chief – part of this historiographical turn was to focus on clarifying the inner workings of the aviation sector, both in terms of its experiences as well as its logics. While some authors contemplated the distinctive views, sensations and practices entailed in aerial inhabitation (Budd 2009; Bissell 2015), others ruminated on how modern airports constitute sites replete with techniques and technologies designed to organise movements before and after flight. In particular, the latter group of scholars have observed how airports often utilise a blend of rules (e.g. logs, manifests and signs), materialities (e.g. carpets, lighting) and architectural fixtures (e.g. railings, seats) to ensure that passengers and goods are circulated through in a timely manner (Adey 2008; Budd 2012). Such a focus has allowed for the accentuation of the liveliness of aeromobilities, which, rather than a Cartesian plot of lines and nodes, are veritably human endeavours with significance and meaning.

Corollary to this valorisation of aeromobilities' human nature is a recognition of the inevitability of politics. One of the earliest threads took aim at the bifurcation of air passengers into non-elite and elite streams, kept separate by silent boundaries that only entrench social inequalities. Notably, this literature has uncovered how airport planners and operators often deliberately incorporate a 'politics of speed' in airport procedures and terminal architecture (Adey 2006). Indeed, many of the airport's design functions are geared toward accelerating the travels of kinetic business classes at immigration, security checkpoints and other strategic nodes, even as it simultaneously imposes enhanced (read: slower and more tedious) screening for tourists, immigrants and refugees on the pretext of heightened security and health risks (Bissell, Hynes, and Sharpe 2012; Budd, Bell, and Brown 2009).

These observations of discrepant air travel experiences were later extended to how civil aviation as a whole is assembled as a series of 'open skies' and 'closed gates' for different socioeconomic classes. While some segments of the population (often white, male and affluent subjects) can easily gain access to the air transport system, others are assigned the lot of 'low motility' due to their exclusion from vital financial, diplomatic and technical 'fields of possibilities' (Sheller 2010, 279; see also Hirsh 2016, 2017). Consequent to these denials, persons without the necessary network capital have, at times, had to resort to what Martin (2011) calls 'desperate passages' – in cargo holds and aircraft wheel wells – in order to participate, illicitly, in global air travel, or, upon arrival, be subject to deportation through the very mobilities they seek to attain (Walters 2015). Seen as such, civil aviation categorically comes with untold injustices, as well as personal costs to those refused its vaunted mobilities.

Passengers are not the only ones subject to the politics of aeromobilities; aviation employees are similarly regimented and controlled to fulfil certain disciplinary standards. On this register, a growing body of literature has begun expounding on the work that cabin crew members do. These writings problematise the ways in which airlines have historically capitalised on flight attendants' bodies and demeanours to differentiate and create legible identities for themselves. In the Global South, female/feminised cabin crew members continue to perform a labour of care and hospitality till today, as flag carriers attempt to showcase their country's culture and win passengers through the human touch (Ferguson and Ayuttacorn 2019; Forseth 2017). This not only comes with company expectations that flight attendants should suppress their emotions in the face of unruly passengers, but also portends a manner of affective manipulation and gendered commodification coinciding with service cultures (Lin 2015). At the other end of the spectrum, pilots are trained to become another kind of idealised subject – the ultra-vigilant and skillful guardian of safety who is intimate with 'his' machine (Adey et al. 2012). Through practices that date back to the interwar period, trainers have sought to understand, correct, and eventually eradicate the susceptibility of pilots to lapses and mistakes. This tactic of creating resilient – often masculine – bodies unfazed by the risks of flight harnesses another aspect of human emotions, raising similar questions about the politics of subjectification.

Other scholars have elucidated aeromobilities' politics beyond the remit of people, offering a perspective that stresses its nonhuman or ecological fallouts. In this regard, aviation's pollutive

effects take centre-stage, as scholars resurrect a longstanding concern that has animated air transport studies since the advent of mass air travel. While aeromobilities research now intertwines the issue of aircraft noise with novel conceptions of verticality and urban spatial governance (Peterson 2017), it is the cynosure of air transport's unsustainable contribution to greenhouse gas emissions and climate change that has captured the lion's share of academic attention. Not least, aeromobilities scholars are insistent on the need to understand the social, cultural and political underpinnings of modern society's addiction to flying, in order to explain why reversing the trend of aviation growth proves such an intractable challenge. Citing the globalising nature of employment (Bissell, Vannini, and Jensen 2017), consumerist aspirations of tourism (Cohen, Higham, and Cavaliere 2011), and marketing gimmicks like frequent flier programmes (Zook and Graham 2018), these studies highlight how the ecological costs of air travel are bound up with people's dreams, desires and personal ambitions, which cannot be easily dismantled through taxation on frequent flying or consumption caps (Higham, Cohen, and Cavaliere 2014). Not only does this work expound on the reasons behind aeromobilities' entrenchment in society, it also raises critical questions about how climate responsibilities ought to be (re) distributed.

A final vein of work worthy of note here concerns growing research on drones, a burgeoning mode of aeromobility that overlaps with, and has important implications for, civil aviation. Initially, studies on this subject have focused on the utility of drones in waging war against enemy targets on the ground. In its starkest form, military users invoke the 'top-down' view to gain a vertical vantage point from which to unleash ordnance on populations below (Adey, Whitehead, and Williams 2011), activating an automated method of killing (Birtchnell 2017; Elliott 2019), and a 'necropolitics' that abrogates the humanity of people through distance (Allinson 2015). More recently, there is increasing awareness of how drones fold into the civil realm also. Mentes (2019) work, for instance, notes how recreational drones productively occupy and disrupt the safe flow of passenger air traffic, necessitating a counter-surveillance on drone users through compulsory drone registers in certain territorial jurisdictions. Feminist and media scholars have further pointed to the possible (mis)use of these craft in the arena of crowd control and protest suppression (Kaplan 2020). Here, the drone is seen as a technique for governing the publics, as it lends its surveillant power for the purposes of policing and constructing 'official' televisual knowledge (LaFlamme 2017; Parks 2013). While still a nascent field, these insights have underscored the complex interactions between multiple forms of competing aeromobilities and their users. They highlight, again, how the aerial has a distinct capability of altering 'our current and modern condition' (Adey 2010, 2), in a new struggle for rights and visions of citizenship.

## Aeromobilities' (re)production

These expositions have uncovered the once-neglected socio-cultural dimensions and politics of aeromobilities. However, we argue that the current focus on the immediate arrangements surrounding flight only tells part of the story. Explicitly, it delineates the contours of aviation predominantly within its own sector, omitting a multitude of other components and consequences that surround, but are not often attributed to aeromobilities. To be sure, some scholars have begun to unpack the vertically integrated chains of resources and ancillary functions needed to sustain civil aviation as a transport mode. While Cidell (2017) advocates analysing air travel in tandem with automobility choices and behaviours, Niewiadomski (2017) employs a global production network perspective to foreground 'the array of additional services … such as handling, security, air navigation and ground transport, and various complementary services such as food outlets, retail, accommodation, meeting facilities and car hire' that support passenger air travel. This detailed attention to aviation's value chains – both forward and backward – is helpful, but we argue that more can be said about the sector's excesses beyond its patent role of conveyance. Indeed, given how diffuse and transnational its services are, civil aviation is not easily reducible to a product with a clearly demarcated life cycle.

Instead, it must be seen as a mobility regime requiring diffuse actions and inputs that contingently emerge according to the system's needs.

In this context, a methodological reorientation that traces civil aviation's relational webs beyond its conspicuous moment of dispensation becomes imperative. It can help locate the industry within a much thicker network of technological, ecological, demographic and social relations, involving not just flying, or the commodity of air travel, but a panoply of seemingly detached pursuits that quietly (re)produce aviation in its current shape and scale. When refracted through such an understanding, civil aviation is, then, recognised not as a ready form but as an extra-sectorally assembled *formation* (Lin 2018). It not only includes the most visible circulations that envelop each flight – from jet fuel shipments to inflight catering; it is also tethered to large systemic arrangements – straddling even so-called 'non-aviation' activities – that enable particular modalities of (civil) aerial life to unfold. It is this far-reaching political economy, along with aviation's impact beyond its most apparent utility, that warrants greater reflection.

Attuning mobilities to these extended processes is in fact not new. Few writings in political ecology, albeit niche, have animated how transport systems are often derived from complex skeins of capital's resource appropriations and metabolisms. Carse and Lewis's (2017) exposition on the regularisation of shipping procedures for trans-continental navigation is a case in point. Specifically, their work examines international adherences to paradigmatic standards in canal construction in order to enable globally operable systems in maritime transport. Referring to the Panama Canal, they argue that leading waterways like the aforementioned have had profound impacts on the (re) organisation of secondary waterways elsewhere (e.g. the Lower Mississippi River). These standards not only set 'environmental benchmarks' across the world, but also precipitate further rounds of resource circulations and a slew of 'intentional and unexpected ecological change' to align the periphery with the centre (Carse and Lewis 2017, 12). Herein lies a potent instance of mobilities' entanglements with various other cognate flows and maintenance considerations. To build up an international shipping system, capital must invoke socio-natures at increasingly far-flung (and immobile) sites. From the dredging of riverbeds to the deposition of toxic sediments, the fashioning of a networked milieu for global shipping comes on the backs of untold resource consumption and environmental costs that often elude calculations of product or sectoral life cycles.

Carse and Lewis (2017) illuminating account of international shipping's extra-sectoral expenditures is articulated more pointedly by a pair of theoretical reflections by Ekers and Prudham (2017, 2018). Aimed at explaining the development of particular economic landscapes, the authors posit that the establishment of mobility infrastructures – and one might add technologies, territories, and transnational labour regimes – is capital's attempt at a 'socioecological fix'. To elaborate, they write that socioecological fixes refer to capital's investments in particular assets and resources so as to (re) produce the social relations of, and conditions conducive toward, accumulation. These milieus are, for them, not built up in the aftermath of capital's arrival, but are conditional means by which capital 'remake[s] the environments … of commodity circulation and everyday life' (Ekers and Prudham 2017, 1373). Like Carse and Lewis (2017), Ekers and Prudham contend that these constructions are 'a dynamic and ideologically charged' process, involving the mobilisation of particular spaces and natures; of nonhumans and humans (Ekers and Prudham 2017, 1374). These same 'material processes and throughputs' are what empowers capital to move, switch locations and resolve its internal crises (Ekers and Prudham 2018, 18), giving rise to further permutations of movement of their own.

Focusing on such broad political economies of mobilities – or, better, mobility regimes – arguably opens the door to a methodological reorientation that valorises the extra-sectoral excesses of organised movement. Transposed to civil aviation, it can help identify a fuller range of politics associated with air travel – not just the injustices suffered by those who are overtly excluded from, slowed down in, and controlled through its architectures, but also those who/which foot the cost from a distance via their indirect connections to the total enterprise of flight. Acknowledging that these externalities can be equally onerous, such a stance allows for the capturing of a wider range of

exploitations, disruptions and oppressions emanating from aeromobilities, while offering a more responsible account of the latent violences that subtly work through hidden layers of mobilities' creation and enablement. If aeromobilities have indeed altered modern living, then a comprehensive stock-take of what lays the groundwork to their conditions of possibility also deserves serious contemplation.

In the following, we want to outline two broad ways in which civil aviation has thus established multiple relations with other segments of the political economy. We refer to snippets of our respective research to guide this conceptual rethink. While Lin has studied various artefacts and infrastructures requisite to civil aviation, Harris's work has looked more closely at the socio-economic dynamics and inequalities spurred by the increase in air mobility. These two themes constitute an interesting contrast that is able to bring out some surprising shades of aeromobilities' formative processes. Specifically, the first is able to cast into relief the material and technological expenditures of a resource-demanding industry, whereas the second uncovers the labour ramifications and human costs of a globalising force often discoursed in macro terms. Based on this roadmap, we intersperse a few empirical examples from our work with analogously oriented scholarly literature (on infrastructure and labour), as well as supporting evidences from relevant industry reports, government statistics and news articles, to construct a synecdocical picture of civil aviation's extra-sectoral costs. Framed around these foci, the article serves as a starting point by which further conversations about (aero)mobilities' extensive nonhuman and human toll can be sparked.

## *Moving materials*

Far from a seamless operation conjured out of thin air, civil aviation, in reality, entails a highly arduous process of infrastructural preparation and construction, involving numerous support sites, industries and material movements. Indeed, its most basic infrastructures – i.e. aircraft and airports – depend on an intensive, *and* extensive, constellation of ancillary activities and resource expenditures to become realised. With the advent of new traffic flows like those of low-cost air passenger services (which compete for airspace through high-frequency, narrow-body aircraft) or of sensitive cargo conveyances (e.g. biomedical products, livestock and Formula One racing cars), the demand for new kinds of air infrastructures has only become more acute, requiring investments in an ever-expanding array of advanced air navigation technologies, specialised storage facilities, and even artificially formed land (Graham 2016). Intimately intertwined with these infrastructures, civil aviation thus indirectly generates an assortment of hidden metabolisms that lie far beyond the immediacy of flight; or to paraphrase Lauren Berlant, '[air] infrastructure … keeps the world practically bound to itself' (Berlant 2016, 394), by mobilising a vast assemblage of materials in excess of the core activity of flying.

Consider the business of aircraft manufacturing – a multi-billion-dollar industry that has accelerated with rising air traffic demand in, especially, the Global South. As the International Air Transport Association (2018) estimates, global air passenger numbers are expected to double to 8.2 billion by 2037, with the Asian region – particularly China, India and Indonesia – anticipated to drive over half of that growth. Though expected to be crimped by the COVID-19 pandemic, the number of new aircraft needed in the next two decades has the potential to top over 42,000.

These rising demands certainly augment overall resource needs, but it is the particular ways in which the air transport industry normalises a particular culture of mass, speedy travel, and mobilises a whole materials economy (with roots in military experimentations) behind it, that deepen aviation's extra-sectoral costs. Coining the term 'light modernity' to denote an economic shift away from 'heavy' and 'slow' forms of movement, Sheller (2014) traces the historical importance of the discovery of aluminium to aviation; notably, the lightweight element is a crucial ingredient in the forging of high-strength alloys – when combined with copper, magnesium, zinc and other metals – to build aircraft structures. As Sheller (2014, 66) writes, '[t]he allure of aluminium begins with the dream of flight and the conquest of space', sparking a whole new generation of rigid frame civil and

military aircraft in the 1910s, and a concurrent expansion in bauxite mining in the United States. While the geographies of aluminium production have since shifted to Australia, China and Russia, the absolute consumption of the metal in civil aviation has only continued to grow, standing at 351,000 tonnes in 2015, and set to rise even further over the next twenty years (Djukanovic 2016). Indeed, financial markets are reporting a 20 to 30 percent increase in aluminium prices in 2018, driven chiefly by increasing 'demand for aerospace-grade aluminium … due to [Original Equipment Manufacturers'] production increases' (Catchpole 2018).

These figures signal an entire aluminium industry on which civil aviation's light modernity depends. Problematically, the circulation of this resource, from its raw state as bauxite ore, to smelting plants, to aircraft manufacturers like Airbus and Boeing, is hardly a clean process, exacerbated by the concentration of most of its effects in the Global South. Beginning with bauxite mining, Sheller (2014, 17) describes the extraction process as a harmful 'open pit process that leads to deforestation and leaves behind toxic "red mud" lakes that can overflow and pollute local ground water'. Even the act of aluminium smelting is a highly pollutive activity, which can leave behind long-lasting greenhouse gases and toxic particulates in the atmosphere. With the exception of Australia, all top ten bauxite exporters are now located in the Global South, with China (incidentally also one of the largest markets for new aircraft) taking the top spot, alongside countries like Brazil, Guinea, and Indonesia. At the industrial level, the activities of the world's largest aluminium producer, Hongqiao Group, have not only laden its home province of Shandong, China with disproportionate air and water pollution (Ng 2016), but also caused widespread 'environmental damage detrimental to agriculture and water resources' through the tentacles of its growing offshore-mining network (Aluminium Insider 2019). While aircraft manufacturing is certainly not the sole reason for Hongqiao's or the Global South's aluminium woes, these material circuits nonetheless form a crucial part of the multiplicitous relations that civil aviation has entered into. Without these stealth sectors supporting aircraft manufacturing, aviation's vision of lightness could never have been fulfilled.

Besides aircraft manufacturing, the production of fixed infrastructures like airports constitutes another instance of civil aviation's latent externalities. Returning to China again as one of the world's fastest growing air markets, as many as 74 new civil airports are slated to be built, and a further 139 to undergo expansion by 2020 (CAAC 2017a). Likewise, India has seen sizable airport investments, including one new civil airport per year since 2014, and an approved plan to construct 15 new 'greenfield' aerodromes (Lok Sabha 2014). What is remarkable is not just the pace at which these new airports are sprouting up across the Global South, but also their massive scales. Built as citadels of progress, these mega-infrastructures tend to require large amounts of raw materials (including aluminium), occupy huge swathes of land, and are prone to displace existing ecologies.

Of these ecological displacements, land reclamation for airport construction incurs some of their most significant hidden costs of aviation. Artificial islands are becoming increasingly popular infrastructures for hosting large airports, built out to sea in response to competition for land and noise complaints at shore. While many of these projects first appeared in Japan, more and more coastal cities in the Global South – including Dalian and Sanya in China, and Ordu and Rize in Turkey – are beginning to turn to such seaborne platforms to situate their mega-airports. Prior experiences in Asia, such as in Hong Kong and Singapore, have proved that such terraforming, while delivering an infrastructural boost for mass passenger air travel and air cargo, augurs deleterious effects on the environment – ranging from permanent biodiversity losses to catastrophic terrain transformations (Lin 2019). More contemporarily in Dalian Jinzhouwan, where the world's largest offshore airport (covering an area of 21 square-kilometre) is currently being built, issues such as water pollution, coastal degradation, and wildlife and fishery loss are reported to be marring the project's environmental record, so much so that engineers in the country are urging against the use of explosives for excavation (Yan et al. 2013).

Land reclamation for airport construction also exacts grievous harm on distant places where sand is being mined and imported. Hong Kong airport's new 650-hectare reclamation plan for a third runway, for example, will see the importation of 90 million cubic metres of marine sand from Qingzhou, Guangxi, some 1,650 kilometres away. Through the flow of sand from one of China's less developed autonomous regions to a leading global city, the fortunes of Hong Kong – a city hoping to propel itself forward through increased aeromobilities – effectively become intertwined with the (mis)fortunes of its poorer hinterland. As Graham (2016, 261) avers, because of the vast amounts of sand required for reclamation, infrastructures like mega-airports and artificial islands grow on the back of ground literally 'flowing from poor to rich countries and from rural areas to cities'. Indeed, these infrastructures thrive on economic regimes of sand exploitation, both legal and illegal, that have not only obliterated livelihoods in the places where the sand originates, but also instigated 'the rise of violent "sand mafias" in Malaysia, Cambodia, Vietnam, India, Indonesia and Italy, Tunisia, Morocco, Senegal' (Sim and Tribillon 2019, n.p.) engaging in these transactions. Framed in this way, the cause of disappearing islands and receding coastlines at these locales (Comaroff 2014) has, in part, a genesis in aviation development, whose voracious appetite for land is silently mobilising material transfers of the most basal and tectonic kind. As such methods of 'ground manufacture' proliferate (Graham 2016), civil aviation's burdens on far-flung ecologies are only set to rise, built upon a network of inequitable geographies and peripheral socio-natures elsewhere (Carse and Lewis 2017).

Consider next the sizeable energy uptake of airports as another form of extra-sectoral excess. Unlike minimalistic prototypes of the past, airports today have morphed into spectacular landscapes of oversized proportions. As Airports Council International sums up this trend, global airports now 'focus on an improved customer experience, … looking beyond and outside of the box' (Smith 2018, n.p.) to (re)create affectively pleasing quasi-urban environments. Not accounting for its newly opened sister airport, Daxing, Beijing's Capital International Airport (BCIA), the busiest air hub in the developing world, fits this bill perfectly, sporting an iconic dragon-shaped terminal three then-built as the largest terminal building in the world. But the cavernous halls of this inspiring terminal also hides hefty energy demands and associated ecological costs. For instance, in 2017, the complex cost over 604 million Chinese yuan (US$90 million) to operate, or, in energy terms, over 19 million kilowatt hour of electricity for non-aeronautical purposes such as interior lighting and terminal services (BCIA 2017, 23). Taking into account the city's energy sources, this demand renders the airport complicit in the unsustainable generation of power in Beijing, where coal remains a crucial source of energy. While there is no doubt that energy consumption at airports like BCIA is miniscule compared to the rest of their cities, the energy intensiveness by which modern aeromobilities function, infrastructurally alone, ought to give pause to the kinds of (wasteful) metabolisms that the industry promotes even before flight.

Indeed, civil aviation today is simultaneously a transport mode *and* a cultural disposition, made possible through intricate infrastructural relations that solidify particular profligacies and consumerist tendencies. This is most symbolically encapsulated in the way the aviation industry has made use of air-conditioning to enact 'hospitable' landscapes at every turn. As Otter (2017) argues, air-conditioning has normatively changed humans' interactions with the outdoors, and cultivated a predilection for 'increasingly sealed, climate controlled spaces', of which airports are epitomic. In much of the tropical and sub-tropical Global South, these facilities borrow liberally from Eurocentric discourses about the favourability, health benefits and productive comforts of temperate climates, making artificial cooling an aspirational goal amid paradoxical structures of steel and glass (Chang and Winter 2015).

Layer on top of this the technology of industrial-grade refrigeration, which has, in the last decade, enabled the transport of perishables and once-exotic food products by air. At Singapore Changi, undertaking perishables logistics in the tropics has meant that some 736 USD,000 or 16.4 million mega-joules of energy – enough to power 13,500 homes in the city-state – is spent every month to cool 'just one cold room … because the facility is on 24 hours, and we have three back-up

generators' (interview, ground handler, 9 February 2017). Seeing that Singapore possesses no hydrocarbon reserves, these operations entail the importation of energy resources from afar, spawning more traffic (and carbon emissions) between the air hub and natural gas exporters such as Qatar, and Trinidad and Tobago. Here, civil aviation not only directly consumes energy through flight; it also now begets – and necessitates – new power generation to run its energy-intensive infrastructures. Through another round of resource trade, this time, in energy, these untold mobilisations reinforce the primacy of a multi-stranded political economy by which civil aviation and air-enabled worlds are (re)produced. Only by surfacing these extended sectors, activities and metabolisms in the infrastructuring of civil aviation can the latter's footprint be more comprehensively measured, and its costs duly counted.

## *Displacing people*

The growing demand for materials for infrastructure's creation and maintenance is directly related to another extra-aerial facet of aeromobility: the human labour needed to build, service, or expand upon infrastructures in far-flung territories. Social and economic displacement is a key feature of these human 'resource' circulations, which assist and abet air travel, and are profoundly uneven in their geographical scope. For instance, shrinking agricultural sectors and expanding gaps between the urban and rural drive young men from farming villages in Bangladesh, India, and Nepal to fly to the Gulf States to build mega-construction projects such as airports and tourism facilities (e.g. the football stadium for the 2022 FIFA World Cup in Doha), themselves made salient by air travel. Furthermore, aviation development forums are now heavily focused on the growing market for Chinese investments to fuel the Belt and Road Initiative, of which aviation is an increasingly important part. This is reflected in the Civil Aviation Administration of China's (CAAC) plan in 2015 to build an 'Air Silk Road' to foster increased trade and tourism between itself and the world; as a result, CAAC (2017b) has signed bilateral air transportation agreements with 62 Belt and Road countries. As energy-intensive materials such as fossil fuels continue to be sourced from afar and drawn further into the circulatory systems of aeromobility, likewise are the human resources needed to construct and sustain these various aviation-linked projects. Investments in new airports, stadia, and free trade zones – often premised on the displacement of people – are examples of socio-ecological fixes built in response to crises in capital, entirely dependent on moving labour to where capital needs it most (Ekers and Prudham 2018, 26).

Yet labour mobilisation occurs both before *and* after aeromobility systems are established, forming part of a dynamic, metabolic circuit involving not only the labourers themselves, but community networks, families, and employers. For example, scholars have highlighted the relationship between the growth of labour migration and the low-cost carrier (LCC) industry, where affordable flights on budget airlines increasingly support new flows and directions of contemporary labour migration, and contribute to the rise in smaller, regional airports (Bowen 2010; Burrell 2011). LCCs enable people both to live abroad, and to maintain transnational and material ties to home and family, such as in the case of the 600,000 Polish migrants travelling to the UK between 2004 and 2009, bringing back potatoes from their home village every few months (Burrell 2011, 1029). These travellers which include tourists, pilgrims, and migrant labour for tourism are being mobilised in this way as part of a recursive, multiplicitous circuit, and are in fact the main force behind the massive growth in aviation infrastructures over the past few decades – both as labour supporting aviation development itself, and as mobility outputs entrained by that aviation development (Hirsh 2017). In many cities, parallel transport networks – considerably different from modes of transport for the elite – enable domestic workers and lower middle class travellers to travel back and forth from their places of employment to their home towns, but often through slower means and more complicated connections, such as minivans and buses in Hong Kong (Hirsh 2016, 2017). This kind of temporary labour migration contributes to the types of formations of new aeromobile circuits that are not perceived as tied to aviation, such as the transnational flows of remittances.

Take Nepal for example; currently the third-highest remittance-receiving country in the world relative to its GDP, where remittances make up approximately 25 percent of its current GDP (Adhikari 2014). Following years of civil war and political upheaval, dwindling agricultural sustainability in rural areas, significant property and livelihood loss due to the 2015 earthquake, and a lack of domestic employment opportunities, young rural men (as well as some women) have steadily left the country over the past two decades for jobs elsewhere (Malla and Rosenbaum 2017). While opportunities for work can be found in neighbouring India, a riskier but more lucrative option is employment in construction in expanding high-tech metropolises with labour shortages such as in Malaysia and the Gulf States. In many cases, it is now easier for rural Nepalis to travel by air to Sharjah, Kuala Lumpur, Bangkok, and Doha than it is to travel to another village within their own country due to relatively poorer road infrastructure, infrastructure under repair, or no roads at all in high-altitude areas. Every day, young men travel to Qatar, UAE, and Malaysia from Tribhuvan International Airport in Kathmandu, prompting flydubai and Malindo Air aviation personnel to make remarks like: 'not a single seat is empty, you know. All are occupied.' Much of the increase in air traffic is due to these intensified labour circulations entangled in the possibilities of air-enabled economies; for instance, international passenger movement increased by nearly twelve percent between 2017 and 2018, and is expected to continue to grow (CAAN 2018). As a result, Nepal's only international airport is struggling under full capacity. One representative from the Civil Aviation Authority of Nepal (CAAN) related the overwhelming demand for more Air Services Agreements (ASAs) with Nepal not to increased global interconnectivity, but with the circulation of remittances from migrant labour that drive displacement and loss.

The current pace of air travel significantly alters the demographic makeup of rural villages left behind; many now consist of the elderly, women, and young children. A better understanding of the scale and pace of aeromobilities that fuel the global capitalist economy involves paying closer attention to these wider social, temporal, and even emotional horizons that unfold at a different tempo and scope from the self-contained phenomenon of the flight itself. Repercussions of loss reverberate long after a villager has departed, both materially (empty houses, fewer people to till the fields) and in more affective ways. Take for instance several contemporary Nepali folk songs that detail the emotional consequences of labour migration, such as 'Saudi Qatar Jane Dai' ('the man who goes to Saudi Arabia and Qatar'), which are sung in popular clubs and always improvised differently depending on the singers' own experiences. If the demise of the extended family can be tied to the emergence of the steamship and the train (Bowker 2015), labour mobilisation is tied to aeromobility in similar, fragmentary ways, profoundly impacting the shape and makeup of family structures in places far away from aviation's gleaming hubs.

Visceral experiences that may initially be seen as far removed from the world of flight – the normalisation of loss, as well as restructuring at the community, kin, or family levels – are part and parcel of the growth of aeromobilities at their current scale. Violence also forms a significant part of this narrative. Construction work in places like the Gulf States can be risky; the mobility of labour migrants is often tied to opaque brokerage companies who control the visa and hiring processes, employers that exploit workers, labour laws that are fuzzy at best, and ill health due to poor working conditions and heat exhaustion. Daily conversations in Bangladesh and Nepal are peppered with stories of friends or relatives who fly to the Gulf for six months and discover that they are not getting paid, or stories about people who don't return at all. At the airport in Kathmandu, an average of three migrant labourer coffins arrive every single day by air, coffins that flight attendants and airport workers must spend extra time to deliver to bereaved families waiting at the arrivals terminal (Dixit 2018). To get a sense of how pervasive these incidents are, during a conversation with Nepali flight attendants about how they are viewed by the public, one flight attendant said quietly, 'some people do not respect our work; they feel like our work is just to collect the body bags.' In order to fully understand the processes of injustices of aeromobilities in the contemporary era, concentrating on the experience of flight or the industry itself does not begin to capture the spatial and temporal reach of air-enabled socioeconomic transformations. To exemplify further, an operations manager

for a low-cost Southeast Asian-based carrier, critically commenting on increased operations and the enormous amount of remittances brought back from labour migration asked forlornly, 'does it [remittances] bring infrastructure development *here*?' In cases like this, increases in air connectivity are a response to the need for building *other* kinds of societies and structures – often far removed from where they are needed most.

While more efficient routes and quicker connections are being forged by new air infrastructures, the spatial and temporal patterns of mobility on the ground take on a considerably different form. Today, the majority of the world's airports currently under construction are located in Asia. While the building of Beijing's Daxing Airport has culminated in the forced eviction of over 20,000 people (Johnson 2018), the ongoing construction of Mumbai's 1,160-hectare Navi airport has displaced 3,200 families and is expected to destroy '400 acres of mangroves, 1,000 acres of mud flats and about 300 acres of forest land' in entirely new districts (The Times of India 2017). These recently incorporated lands matter as silent costs of aeromobilities in the Global South. Rather than blank slates, they constitute the erased geographies of air-enabled futures, often at the expense of marginalised populations living on land earmarked for airport construction.

Since the 1970 s, displaced populations, made to move or alter their livelihoods for the sake of the aeromobility of others, have incited significant demonstrations against the building of airports. Consider Narita Airport, where numerous protests by thousands of demonstrators were led by local farmers and their supporters (Pascoe 2004, 106). In India today, some airport workers must travel even *farther* than before to get to their places of work due to new airports, airport expansion projects, and land acquisition for soon-to-be privatised airports such as Guwahati in northeast India. Farmers must now travel around the land set aside for airports in order to get to their fields and pastures (Harris and van der Veen 2015). On another register, some airports such as Caticlan and Dumaguete in the Philippines have had to extend their operating hours due to substantial increases in air traffic. The broader impacts of the temporal extension of air-enabled mobility affect other peoples' everyday experiences of time, for instance lengthening the working hours of local public transport drivers, or the availability of taxis for women who return from the airport alone at night. This temporal stretching is akin to Cindi Katz's (2001) observation of time-space expansion – a critique of Harvey's time-space compression – while some connections are made easier for some, they create farther, more time-consuming, but less secure journeys for others.

These compressions and expansions of space and time are also evident in the aviation labour market directly. The current global pilot shortage manifests in particular ways in the Global South; in China and India for instance, foreign pilots are hired because of what is seen as a lack of local training and skills (IATA 2018). But perhaps it is not so much a lack of local training academies with the right resources and technology, but because civil aviation training takes *time* (not to mention adequate finances). The quicker way to sustain the pace of aeromobility at its current speed is to hire pilots who have *already* been trained; often those who come from the Global North and receive considerably higher salaries than local pilots as a result of this urgency to maintain the flow of air traffic at the capacity that is needed. Take for instance the twenty-five Nepal Airlines pilots who have threatened resignation unless their employer begins to pay their salaries, benefits, and taxes on par with the twelve expat pilots who receive two-thirds more, or about 13 USD,000 per month (The Himalayan Times 2020). Here, the reproduction of wider global inequalities forms a constituent part of the very labour needed for sustaining aeromobility.

Thus, loss is linked to aeromobile lives in two ways: the loss of money within the aviation industry is tied to the *disruption* of the current pace of aeromobility, but also the displacement and loss of *people* – whether they are workers departing rural villages in Nepal to build stadia in Doha, or Chinese pilots moving from Chengdu to work with a Bangladesh-based carrier, or more literally, those who arrive home in body bags tied more broadly to the *expansion* of air mobilities. These are serious societal shifts that are not apparent in the politics of flight itself, but that in some ways warrant more urgent attention. There is of course nothing new about aeromobility enabling the efficiency of access to certain corridors and connections, while others fall by the wayside. However, if

we can spur further 'questions about the interface between bodies and the world' by using the broader lens of extra-sectoral costs and metabolisms, paying attention to the injustices of air-enabled mobility is arguably now more acute (Solomon 2016, 11).

## Conclusions

The rapid growth of air travel in recent years has instilled much academic interest in the social, cultural and political dimensions of civil aviation. While certainly not the only form of aeromobility, the sector's increasing prevalence and banality, not least in the Global South, have rendered it a particularly salient focal point in the literature. As represented in Cwerner, Kesselring, and Urry's (2009) book, *Aeromobilities*, civil aviation has today been widely researched for its distinctive cultures, and interrogated for the politics it engenders for life in the air and on the ground. Yet, despite the merits of this work, current fixations on the immediacy of flight have masked the wider political economy in which these aeromobilities thrive – not just as a set of internal logics tethered to the service of flying, but also as a pervasive regime of exacting infrastructural arrangements, resource supply chains and (non)human mobilisations. Even with the added complication of the COVID-19 pandemic, these types of circulations are expected to persist, if in reconfigured forms to sustain an evolved aeromobile sphere that may now demand new resources, lay waste former jobs and equipment, and enrol new labour and infrastructures. Without attending to these systemic relations, civil aviation risks being mischaracterised as a self-contained phenomenon that is circularly referenced to its main endeavour of flying, or, at most, ancillary services that support its transport business (Niewiadomski 2017).

This desire to expound deeply on civil aviation's complex extra-sectoral linkages not only affirms longstanding calls within mobilities studies to view movements as resolutely multiple in nature (Urry 2000); it also offers an optic by which scholars can re-conceptualise aeromobilities' pernicious effects beyond aerial occupation. By attuning to the circumstance of its (re)production, it becomes possible to trace backward and forward the constitutive pathways, as well as costs, that allow air transport systems to thrive, expand, reconfigure and come into *formation* each time (Lin 2018). Tracing a selective set of nonhuman and human mobilisations across wide-ranging politico-economic terrains, this article has provided a glimpse of how a panoply of hidden metabolisms vitally underpin the conditions of possibility of these systems. From bauxite mining to land reclamation to labour mobilisations of various kinds, we have demonstrated how aerial lives are dependent on a whole slew of socioecological exploitations, livelihood disruptions and population displacements stretching across untold fields of production. These extra-sectoral costs unveil a multiplicitous, cross-cutting politics not often captured in aeromobilities studies, promoting a different methodological approach for studying the fallouts of aerial life. Indeed, what this article has sought to highlight is not, again, the same asymmetrical practices, visions, and experiences that envelop flight, but the injustices and violence wrought by the enterprise of aeromobility-making.

Our focus on these diffuse production scapes of civil aviation should not, however, be mistaken as a parochial interest in only aeromobile forms of production. To be sure, as a global industry with elaborate material, human, ecological and technological inputs and repercussions, civil aviation may just be an obvious candidate for tracing such connections. Yet, the methodological reorientation this article advocates really has the potential to find resonance with a limitless number of organised mobility systems – from air to land, civil to military – so long as they depend on similarly stretched relations to become viable. This approach is to some extent, alluded to in discussions on the high fuel consumption of automobility (Dennis and Urry 2009), but we contend that such extra-sectoral linkages need to be made in bolder ways, to countenance a far larger, perhaps more haphazard, milieu of supply chain interdependencies beyond the powering of movement. Whether it be the relationship between shipbuilding and landscape transformations (Carse and Lewis 2017), or the social change wrought by the displacement of drivers with autonomous vehicles (Bissell et al. 2020), the genealogies of mobilities should not begin and end at conspicuous moments of travel

consumption, but be allowed to unfurl across myriad topologies and unexpected terrains that have, in one way or another, become co-opted into complex networks of mobility (re)production. Such methodological promiscuity potentially bolsters recent debates about climate crises and mobility transitions, encouraging a more holistic view of the true socioecological footprints of transport systems.

Finally, pursuing such a stance has the added benefit of pinpointing the structural forces behind the creation of mobility orders. In this article, we have emphasised the importance of taking a politico-economic stance in understanding both the demand for and means of creating economically vital conveyance systems like civil aviation. Integrating these disparate productive logics within a single structural space provides an alternative framework that does not take ostensible mobility forms as *a priori* starting points for analysis, but, rather, conscientiously seeks out a confederacy of flows converging upon particular capitalist impulses, accumulative strategies and attempts at socio-ecological fixes (Ekers and Prudham 2017, 2018). Such a recognition allows for the entire value chain of movement to become visible at once, leading to a fuller appreciation of how larger orders of rule stoke and unite various unsuspecting sectors and vectors. In an era characterised not just by accelerated movement but increasingly segmented circulations, developing a lens sensitive to the ways in which the political economy forges mobilities out of a network of interrelated flows can foster structurally more holistic perspectives. It aids in looking past what is discrete to valorise larger architectures by which the world *becomes*, rather than is, on the move.

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