



Urban Infrastructuring

Document Version
Submitted manuscript

[Link to publication record in Manchester Research Explorer](#)

Citation for published version (APA):

Iossifova, D., Zavos, S., Gasparatos, A., Gamal, Y., & Long, Y. (2022). Urban Infrastructuring: trajectories of infrastructural entanglement in cities of the Global South: Introduction. In D. Iossifova, A. Gasparatos, S. Zavos, Y. Gamal, & Y. Long (Eds.), *Urban Infrastructuring: reconfigurations, transformations and sustainability in the Global South* (pp. 1-12). (Sustainable Development Goals). Springer Nature.

Published in:
Urban Infrastructuring

Citing this paper

Please note that where the full-text provided on Manchester Research Explorer is the Author Accepted Manuscript or Proof version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version.

General rights

Copyright and moral rights for the publications made accessible in the Research Explorer are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Takedown policy

If you believe that this document breaches copyright please refer to the University of Manchester's Takedown Procedures [<http://man.ac.uk/04Y6Bo>] or contact openresearch@manchester.ac.uk providing relevant details, so we can investigate your claim.



1 Urban infrastructuring: trajectories of infrastructural entanglement in cities of the Global South

Deljana Iossifova, Stylianos Zavos, Alexandros Gasparatos, Yahya Gamal, Yin Long

Abstract

In this chapter, we introduce the notion of *infrastructural entanglement* to denote the close relationships and correlations that develop between components of infrastructural configurations and other social, ecological, political, or otherwise defined systems as part of urbanisation and globalisation in countries of the Global South. We employ the notion of *infrastructuring* as engendering complex infrastructural entanglements that have severe implications for sustainability. We argue that infrastructuring is essential to urbanisation; that it is entangled with socio-spatio-ecological transformations that often have negative outcomes over time; and that it requires an ethical positioning in research and practice in order to enhance infrastructural sustainability in the face of intersecting environmental, social and economic crises. Building on these assumptions, the chapter introduces the overall argument of the edited volume, which is developed in three parts. First, the volume identifies infrastructural entanglements across various urban and urbanising settings in the Global South. Second, it highlights some of the damaging processes and outcomes of urban infrastructuring and argues that the absence, presence and transformation of infrastructure in the Global South (re-)produces socioecological injustice in the short- and long term. Third, the volume argues for a shift of infrastructuring agendas towards more just and sustainable interventions.

1.1 Introduction

The rapid urbanisation observed in many parts of the world during the past decades implies the transition from rural to urban configurations of spatial, social and ecological systems (Grove, 2009; Young et al., 2006). This transition is largely associated with the shift towards urban ways of life (e.g., from agrarian livelihoods to waged work in manufacturing or services) that are commonly supported by different kinds of infrastructures (Iossifova et al., 2018). Indeed, some argue that infrastructure is the defining component of the city, which in turn could be defined as ‘an infrastructural entanglement’ (Amin & Thrift, 2016, p. 33).

We use the notion of *infrastructural entanglement* to denote the close relationships and correlations that develop between components of infrastructural configurations and other social, ecological, political, or otherwise defined systems. We draw on Star’s (1999) well-rehearsed conceptualisation of infrastructure as material, practised and relational. As such, infrastructures are the (invisible) configurations that sustain or improve human life. They are essential to cater for multiple human needs, ranging from clean water to the movement of people and goods. Especially in rapidly transforming geographical contexts, overlapping and complementary infrastructures may serve the supply and delivery of the same resources, services and goods (e.g., multiple sanitation systems may co-exist) (Lawhon et al., 2018; Smiley, 2020). Different infrastructural systems may interact with each other as well as with their socioecological environment, including multiple social, economic and environmental systems (Frantzeskaki & Loorbach, 2010; Graham & McFarlane, 2014; Simone, 2014; Thacker et al., 2019).

Thinking about sociomaterial and socioecological events and configurations through a processual lens, we also employ the notion of *infrastructuring*: in the words of Bossen and Markussen (2010, p. 618, emphasis in original), ‘[d]iscussing “infrastructure” as a *noun* ... suppresses the variety of

material and non-material components of which it consists, the efforts required for their integration, and the ongoing work required to maintain it'. Thus, infrastructuring as a concept encompasses the acts of conceptualising, planning, making, maintaining and intervening in heterogeneous infrastructural configurations (see following section for more details). As such, *urban infrastructuring* refers to the transformative agency of complex and dynamic urban infrastructural configurations.

Infrastructural transformations do not happen with the same speed, do not have the same characteristics, and certainly do not have the same outcomes everywhere. For example, the slow and paced transformation of infrastructural technology in the Global North in recent decades has centred around the introduction of digital technologies and the implementation of smart urbanism (Furlong, 2021; Safransky, 2020). This stands in contrast to the more profound technological transitions of the Global South, where the 'violence of urbanization' is transforming existing socioecological landscapes rapidly and radically (Pedrazzini et al., 2014, p. 419). Expressions of such transformation can be found in the replacement of century-old infrastructural technologies, practice and systems with the networked infrastructures associated with modernity, growth and development (Coutard & Rutherford, 2015). In many regions, such profound and violent infrastructural transformations¹ have ruptured the spatial form and social structure at unprecedented scales by dismantling existing sociomaterial and human-environment relationships (Cirolia et al., 2021; Iossifova, 2020; Schramm & Monstadt, 2015). A key mechanism in this process is the introduction of infrastructure mega-projects into socio-spatial environments, thereby expelling and marginalising already disadvantaged populations and destroying fragile ecosystems (Pedrazzini et al., 2014; Sassen, 2014). Such examples abound, ranging from the demolition of a single block to make space for a metro station to the disappearance of entire neighbourhoods for the sake of highway connectivity (Duhl & Powell, 1963; Shao, 2013).

The concept of sustainability challenges this approach to infrastructural development. On the one hand, infrastructure is instrumental to (participation in) economic development and to the improvement of public health and human wellbeing. On the other hand, it often entails substantial resource use and pollution that come with detrimental impacts on the environment, society and economy (Federici, 2019; Mehta, 2010). This suggests that infrastructural systems can generate significant trade-offs among different aspects of sustainability (Rigon & Broto, 2021a; Thacker et al., 2019). Furthermore, and while intra- and inter-generational equity are central tenets of sustainability, we often observe the unequal access of different social groups to infrastructure, especially in parts of the Global South (Hardoy et al., 2001; Rigon & Broto, 2021a). This raises important questions about the intersections between infrastructural transitions and sustainability in the Global South.

It is through the above considerations that the main themes of this edited volume converge: infrastructuring is essential to urbanisation; it is entangled with socio-spatio-ecological transformations that often have negative outcomes over time; and it requires an ethical positioning in research and practice in order to enhance infrastructural sustainability in the face of intersecting environmental, social and economic crises. We argue that it is possible to shift towards more sustainable trajectories through practices of careful intervening (e.g., conceptualising, planning, making, maintaining) in heterogeneous infrastructural configurations in the Global South.

¹ Violence in the context of this chapter refers primarily to 'concrete forms of structural violence' experienced as and embodied in the lack of critical infrastructure (Tyner & Inwood, 2014, p. 780). Structural violence is the social injustice that results from the withholding of resources (Galtung, 1969).

The overall aim of *Urban Infrastructuring* is to work through notions of infrastructural entanglement and processes of infrastructuring in order to identify potential future pathways for transformative development. To achieve this, contributions examine the mechanisms of infrastructuring and how they intervene in infrastructural configurations in the Global South. In the following sections, we provide a brief overview of the infrastructural turn in the social sciences and recent approaches to thinking about infrastructure, with a particular focus on the Global South. We then discuss the infrastructural paradox through the two simultaneous functions of infrastructural reconfigurations: as a medium for development *and* an instrument for exploitation. Finally, we highlight the need for interdisciplinary approaches to the study of infrastructuring before providing, in the concluding section, an overview of the overall aim, driving questions and structure of this edited volume.

1.2 The infrastructural turn in the social sciences: configuring infrastructural inversions

The infrastructural configurations discussed in this volume include material objects, various kinds of resources, services, people and ecological systems across different scales. For example, such configurations related to sanitation encompass the different inanimate objects of the sanitation system (e.g., night pots, pipes, sewage tanks); resources, such as the water and energy needed for operation; sanitation services offered by actors such as local governments or businesses; human-infrastructure interactions; and the ecosystems that provide necessary services (such as composting or treatment) or receive wastewater (Tilley et al., 2014). Such infrastructural configurations are dynamic in that changes in one element is likely to trigger and result in changes in another, and across the wider system. As Larkin (2013, p. 382) suggests, infrastructures are 'built networks that facilitate the flow of goods, people, or ideas and allow for their exchange over space. As physical forms they shape the nature of a network, the speed and direction of its movement, its temporalities, and its vulnerability to breakdown. They comprise the architecture for circulation, literally providing the undergirding of modern societies, and they generate the ambient environment of everyday life'. This view of infrastructure makes a strong case for using inter- and transdisciplinary lenses for the study of infrastructuring processes (Larkin, 2013; Niewöhner, 2014, 2015).

Contributions to *Urban Infrastructuring* echo the above insights by advocating the integration of systems thinking into disciplines such as anthropology in order to generate ethnographies of infrastructure (e.g., see Shtanov & Iossifova, this volume): looking at the wider system, rather than infrastructural technology alone, can shift and enrich our understanding. That said, any analysis of infrastructural configurations and/or infrastructuring processes still needs to consider the elements of the broader system including the technology, the social ordering that governs it, and how wider social, ecological, economic and cultural systems are affected by that very technology (Machlis et al., 1997). In this sense, we join Gupta (2018, p. 62) and others in conceptualising infrastructure as *infrastructuring*, which is essentially 'a process, not a thing: a thing-in-motion, ephemeral, shifting, elusive, decaying, degrading, becoming a ruin but for the routines of repair, replacement, and restoration (or in spite of them)'. The notion of infrastructuring suitably takes into account the interrelatedness of actors, technologies and other aspects of the interrelation between infrastructure and everyday practices (Niewöhner, 2014, 2015). We think infrastructuring not only as heterogeneous and multi-local – or even translocal – but also across and through multiple temporalities, ranging from inception through implementation over maintenance and abandonment, and actualised through multiple and overlapping processes of material, social, spatial and ecological transformation. As such, we acknowledge that infrastructural configurations underpin, facilitate and shape urban form, everyday life and future trajectories: they have structuring agency. They are

political in influencing, if not determining, 'how socio-economic disparities are maintained and perpetuated' (Latham & Layton, 2019, pp. 2-3).

Contributions to this volume align with the recent infrastructural turn in the social sciences (Amin, 2014; Cass et al., 2018; Coutard & Rutherford, 2015), which is arguably situated within a broader ontological and epistemological shift questioning already established divides within western scholarship. In this emerging paradigm, infrastructures can be examined as technological objects, yet it is now clear that their systemic operation demands that they are not examined as objects alone (Larkin, 2013). Critically, the very 'act of defining an infrastructure is a categorizing moment ... that highlights the epistemological and political commitments involved in selecting what one sees as infrastructural (and thus causal) and what one leaves out' (Larkin, 2013, p. 330). This infrastructural turn has challenged the previously assumed technical purity of infrastructure in offering conceptualisations of sociotechnical hybridity (e.g., Latour, 2005; Latour & Hermant, 2006; Swyngedouw, 2006). In so doing, this recent shift problematises the overarching distinction between categories in the study of infrastructure, such as nature, culture and technology, and calls for a reworking and renegotiation of the position of humans in relation to infrastructural things and concerns, to materialities and immaterialities considered exterior, other, or subordinate to them (Anand et al., 2018).

The infrastructural turn has already produced a significant body of work that foregrounds what is traditionally considered as the background to social transactions (Lampland & Star, 2009; Star, 1999; Star & Lampland, 2009; Star & Ruhleder, 1996). When infrastructures are invisible, analytical tools have been employed to render them visible, and focus on situations and events that are not usually explored (Harvey et al., 2017). Through the tactics of infrastructural inversion (i.e., rendering visible infrastructural forms, formations and networks), infrastructure is now considered an analytical instrument capable of assembling and narrating the stories of multiple actors within disparate spatiotemporal settings (Bowker, 1994). In such configurations, the researcher assumes a central role in that the research becomes instrumental to infrastructural visibility. Infrastructural inversion implies a courteous sensibility in relation to infrastructure. Indeed, as we discuss in the concluding chapter to this edited volume (Chapter 19), infrastructural inversion demands an ethico-politics of care (Puig de la Bellacasa, 2017).

Beyond the social sciences, there has also been a recent turn in the humanities that utilises Bowker's (1994) infrastructural inversion to foreground infrastructure and its entanglements. The movement of infrastructuralism, for instance, is interested in 'literary fictions that try to make infrastructure, as well as its absence, visible' (Rubenstein et al., 2015, p. 576). In this way, infrastructuralism 'registers the urgency of defending public infrastructures both from neglect and from privatization' (Rubenstein et al., 2015, p. 578). Signalling parallels to transitions in the social sciences, infrastructuralism also refers to a method, 'the practice of attending closely to the jostling, colliding, and overlapping of social, cultural, and technological forms' (Levine, 2010, location 59). In this respect, some of the main questions underpinning several of the contributions to this volume are closely aligned with those asked by the movement of infrastructuralism: 'What is the proper amount of scepticism with which to consider the infrastructures that shape our lives? When are we justified in decrying the intrusions of infrastructure' – or the lack thereof – 'and when ought we to defend the progress it does, sometimes, represent? When is it necessary to demand the extension of infrastructure to those whom it does not presently reach?' (Rubenstein et al., 2015, p. 579/580).

1.3 The infrastructural paradox: balancing promises, inequalities, sustainability and decay

The proposition for infrastructural inversion discussed above follows from empirical investigations that have exposed the importance of studying the transformative agency of infrastructural reconfigurations. For example, tracing infrastructural networks can reveal patterns of uneven sociospatial development (Graham & Marvin, 2001). Rodgers and O'Neill (2012, p. 404) highlight that 'infrastructure is not just a material embodiment of violence (structural or otherwise), but often its instrumental medium, insofar as the material organization and form of a landscape not only reflect but also reinforce social orders, thereby becoming a contributing factor to reoccurring forms of harm'. In this way, 'broader processes of marginalization, abjection and disconnection often become operational and sustainable in contemporary cities through infrastructure' (Rodgers & O'Neill, 2012, p. 403). Infrastructure poses a paradox: on the one hand, it is conceived as the medium of development – on the other, it works as an instrument for control, exploitation and exclusion. The infrastructural paradox manifests in the simultaneous need to adapt urban infrastructure to support the shifting and expanding economic activity demanded by the principles of rapid urbanisation and globalisation, *and* at the same time to achieve the goals of sustainable urban development in the face of environmental change and degradation (Fisch, 2018; Star, 1999). Below, we unpack some of the main aspects of this paradox.

Most countries in the Global South have been undergoing profound transformations through urbanisation and globalisation (Bhan, 2019; Rigon & Broto, 2021a; Shin, 2021). Some of the main processes underpinning urbanisation include land use change, the production of novel built environments and transitions from rural to urban lifestyles (Brenner, 2014; Brenner & Schmid, 2015; Burdett & Sudjic, 2006; Iossifova et al., 2018). Accordingly, becoming urban involves significant shifts in the division of labour and access to goods and services, the fundamental redefinition of relationships with nature, and transformed patterns of everyday life and interpersonal relations (Angelo, 2021; Gandy & Jasper, 2020; Kaika & Swyngedouw, 2000).

As a starting point, it is necessary to highlight the dominant infrastructural aspiration at the heart of the infrastructural paradox. What connects infrastructural narratives in the Global North and South is perhaps the paradigm of development towards better, less unequal futures (Anand et al., 2018; Mehta, 2010; Yapa et al., 1995). Arguably, the paradigm of capitalist development is fuelled by the ideal of modern life and its conveniences, which is made possible by the continuous and faultless working of infrastructures in the background (López-García, this volume). Through complex articulations, this development paradigm renders sociotechnical arrangements (e.g. roads and highways, pipes, cables and wires, sewage systems and waste management) into sites showcasing that 'life will change for the better' (Harvey & Knox, 2012, p. 534). Infrastructures are thus designed, engineered and implemented on the promise of making (urban) life *better* (Graham & Marvin, 2001). Some may argue that *better* entails improving human social development (including dimensions such as better education and improved health, largely aligned with the UN Sustainable Development Goals (SDGs) (United Nations, 2015). Others may argue that *better* simply means more efficient, i.e. by enabling the smooth and convenient participation and integration of urban populations in processes of production and consumption under the principles of continued and globally networked economic growth (Brenner & Schmid, 2015; Santos, 1975; Sassen, 1991).

However, despite these aspirations, infrastructural development does not always lead to the desired outcomes. For example, some of the current approaches to urban infrastructuring have major ramifications for sustainability. Urbanisation-driven changes in the patterns of everyday life are invariably linked with greater reliance on larger-scale infrastructural configurations designed and

implemented to distribute resources (e.g. energy, clean water), enhance connectivity (e.g. transportation, communications), or treat waste from urban activity (e.g. solid waste, wastewater) (Graham & Marvin, 2001). To function in a coordinated and interlinked manner, urbanites require infrastructures across multiple scales to connect them to an increasingly globalised economy (Anand et al., 2018; Larkin, 2013). The rapid transformation of everyday infrastructural needs as a result of urbanisation is embedded in the machinations of a capitalist global economy that may work to engender urban inequalities which manifest through familiar channels, most notably the improvised urban slum (where access to infrastructural services may be limited) or the gated suburban community (where access to infrastructural services may result in wasteful resource use) (Angotti, 2013; Iossifova, 2015; Monstadt & Schramm, 2013).

Besides various social, economic and environmental systems at different spatial scales, infrastructures are intimately linked with most facets of everyday life in cities. As a result, the ongoing transitions in infrastructure and infrastructural practices may lead to major changes with potentially unknown consequences (Ainger & Fenner, 2014; Pearsall et al., 2021; Thacker et al., 2019; United Nations, 2015). For example, many contributions to this volume examine the processes through which infrastructural reconfigurations in the Global South – from toilet provision in Mumbai’s slums (Dewoolkar, this volume) to the construction of new urban districts in Lekki (Shtanov & Iossifova, this volume) – have been leading to the (re-)production or exacerbation of social inequalities and injustices. However, the processes of infrastructuring may also contribute to or result in major environmental impacts, such as (unsustainable) resource extraction, disruption of critical ecological processes and essential resource depletion, biodiversity loss, climate change, and overall environmental degradation (Goodbun et al., 2012; Mehta, 2010).

Urbanisation renders infrastructure visible in making it accessible to some, but not to others; operational for some, but not for others; sustainable for some, but not for others. Similarly, it is now commonly observed that infrastructures in the Global South engender a much higher degree of provisionality in that responsibilities for the operation and maintenance of infrastructural systems are not as neatly divided as is common in most of the advanced economies. Everyday life in much of the South is entangled with creating, upholding and maintaining infrastructure, claiming a variety of knowledges, (gendered) labour and corporeal experiences to a much greater extent than common in the North (Andueza et al., 2021; Graham, 2010; Truelove & Ruszczyk, 2021). Where and how infrastructure is implemented has important distributional and equity implications, as it essentially determines who is included or excluded, who may or may not lay claim to the resources and services that constitute infrastructural citizenship (Anand, 2011, 2012; Lemanski, 2020).

As part of the promise of infrastructure, well-functioning infrastructural networks and services are expected to remain unseen in the background. Scholars have argued that it is only through instances of breakdown that the presence of infrastructural networks and configurations can be grasped empirically (Bowker, 1994, 1995). Arguably, infrastructures are the often invisible structures that remain unnoticed if functioning well – and that become highly visible when they break down (Star, 1999). However, infrastructural ruptures, failures, breakdowns and disjunctions are also the starting points through which many of the negative sustainability impacts outlined above emerge. Where these failures are the norm, infrastructure is never finished, and conceptualising it requires working and thinking outside the binaries of failure/success or breakdown/stable operation. It requires addressing the multitude of relations taking place in the areas between such opposites, and on the ground.

Many of the infrastructural aspirations, impacts and failures that are part of the infrastructural paradox outlined above are highly visible in urban contexts of the Global South. Many of these

settings are characterised by the heightened intensity of everyday events mingling with aspirations for ordered and planned development (and the good outcomes it would bring) through infrastructuring endeavours. Yet, at the same time, the failures, breakdowns, violent displacements and precarious technologies that do not afford squeezing into predefined categories are folded into the processes of infrastructuring. The notion of breakdown, in particular, has become central in studies of infrastructure, triggering a body of work on infrastructural failure, repair and maintenance that examines some of the violences and injustices produced through such events beyond the categories of provision and access (Cirolia et al., 2021; Davis et al., 2019; Guma, 2020).

1.4 Beyond singular infrastructural approaches

Some of the rapid 'development' taking place in the Global South becomes visible in the kind of transitional events that render infrastructure multiple through the coexistence of different infrastructural technologies (such as the pit latrine and the sewage network). During the last decades, the scholarly re-focus from the North to the South in the literature concerned with infrastructure has provided much-needed insights on the heterogeneous character of infrastructural formations (Anand et al., 2018; Furlong, 2014; Lawhon et al., 2018). Moving beyond infrastructure as an indivisible part of the networked city (Coutard & Rutherford, 2015), alternative configurations and alliances between plans and negotiated realities on the ground make inquiries on infrastructuring more complex and less universal (Simone, 2004). As Furlong (2014) rightly contends, infrastructural formations can inform more constructive and realistic domains of inquiry if approached through the lens of coexistence, rather than uniformity, of sociotechnical systems.

Two decades ago, Graham and Marvin (2001) posed that a centralised, most often state-managed and homogenising modern infrastructural ideal has given way to a decentralised, liberal and market oriented, fragmented and splintered urbanism characterised by the realities of uncertainty and difference. The notion of development, however, remains at its ontological core. Notions of sustainability challenge infrastructural development in that, on the one hand, infrastructure is instrumental to (participation in) the processes of capitalist economic development, while on the other, it allows the kind of resource use and pollution that is detrimental to sustainability (Federici, 2019; Puig de la Bellacasa, 2017). The collapse of critical ecological systems has an immediate impact on sustainable development, here understood through the notions of health and wellbeing now and in the future (Bai et al., 2016). Research on sustainability transitions is motivated by these processes as recognised societal challenges (Köhler et al., 2019). Technological solutions or other types of incremental fixes are no longer considered appropriate in response to such challenges; therefore, 'radical shifts to new kinds of socio-technical systems' are required in order to shift current trajectories towards pathways for sustainable development (Köhler et al., 2019, p. 2).

Interventions in physical infrastructures inevitably lead to changes in spatial patterns *and* patterns of everyday life, thus altering social relations and human-environment relationships and possibly (re-)instituting injustices. We work with the notion of intervention as 'intentional action aimed at shaping urban development towards a more desirable direction. To intervene is to take active part in something to change the course of events' (Rigon & Broto, 2021b, p. 2). Even though Larkin (2013, p. 330) reminds us that 'discussing infrastructure is a categorical act', this kind of reminder is not to be taken as a moment when infrastructure, the visions entailed in it, its 'promises' and 'failures' are to be defined a priori. This categorical act of discussing infrastructure can imply, besides an epistemological position, a political stance on behalf of the researcher (Larkin, 2013). It can imply a commitment towards addressing the multifaceted nature of infrastructuring as processes always in the making, always in transition, as processes of heterogeneous coexistence rather than unity. Even though transdisciplinarity has already been argued to facilitate more holistic frameworks for the

relation between infrastructure and the urban (Graham & Marvin, 2001), infrastructure as projection and infrastructure in transition – i.e. infrastructure as lived and negotiated – are still interrogated separately. Studying them together requires not only an analytical shift, but also an ethico-political one. In the conclusions to this volume, we argue therefore that an ethical positioning with the life-sustaining ethics of care is critical for *sustainable* infrastructuring as research and practice.

1.5 Aims, structure and content of the book: urban infrastructural entanglements, injustices and trajectories

1.5.1 Aims and structure

A key point of departure in this edited volume is that urban infrastructuring engenders complex infrastructural entanglements that have severe implications for sustainability. Thus, the book's argument is developed in three parts that reflect the following underlying questions:

- (1) How are infrastructures in the Global South entangled with social, ecological or economic systems at various scales?
- (2) What are the modes of infrastructuring and how do they act to entrench social and ecological injustices in cities of the Global South? How do the absence, presence and transformation of infrastructure impact on human health and wellbeing, social justice and (urban) inequality?
- (3) What can be done to understand and transform infrastructuring agendas towards future sustainability in the Global South?

First, the volume identifies infrastructural entanglements across various urban and urbanising settings in the Global South that range from the fragmented infrasystems of Ulaanbaatar (Karte et al, this volume) over theatre infrastructures in Beijing (Stecher, this volume) to municipal solid waste management infrastructures in Bolivia (Lozano Lazo & Gasparatos, this volume).

Second, it highlights some of the damaging processes and outcomes of urban infrastructuring and argues that the absence, presence and transformation of infrastructure in the Global South (re-)produces socioecological injustice in the short- and long term. Inequality, a central element of sustainability as discussed at the beginning of this chapter, is a key theme that runs through many chapters in this book. For instance, Shtanov and Iossifova (this volume) present how inequalities are produced through the production of the built environment in Lekki, Nigeria. Dewoolkar (this volume) highlights the flawed mechanisms of producing open defecation free cities under India's Swachh Bharat Mission (SBM).

Third, the volume argues for a shift of infrastructuring agendas towards more just and sustainable interventions. Here, contributions highlight ways of thinking through (Chattopadhyay, this volume), intervening in (Greed, this volume) or designing out (Iossifova et al., this volume) urban inequalities.

Overall, the contributions to this volume show the breadth of complementary methodological approaches that can be used to generate knowledge in infrastructural research. This echoes the assertion of Larkin (2013, p. 338) that infrastructure 'can be analyzed in so many different ways' that the choice of methodology, as becomes abundantly clear from the contributions to this volume, 'is a theoretical question'.

1.5.2 Contents of the edited volume

Urban Infrastructuring is structured in three parts that reflect the main themes and questions discussed above. In Part I, *Infrastructural Entanglements*, contributions are concerned with the interactions and resulting correlations between infrastructural and other systems. Infrastructural

entanglements are here the close relationships that develop between components of infrastructural formations, and other social, ecological, political or otherwise defined systems.

In Chapter 2, Karthe, Lee and Ganbat look at Mongolia's capital, Ulaanbaatar, to demonstrate how population growth and urban sprawl transform water, energy and transport infrastructures in ways that, in turn, trigger environmental problems with implications for public health and ecological degradation. In Chapter 3, Valencio, Valencio and Baptista examine the role of infrastructural systems in amplifying or reducing the impact of natural disasters and subsequent decrees of state of emergency in Brazil. Stecher (Chapter 4) employs an infrastructural lens to demonstrate how theatre (as art form) is entangled with place, architecture and shifts in the social and cultural life of China's capital, Beijing. In Chapter 5, Salia and Iossifova identify some of the challenges for planned development in urban Ghana that arise from the co-existence of statutory and customary infrastructures as frameworks for the administration of land in urbanising Ghana. Here, the infrastructures that support the documentation and governance of land ownership, transactions and development are entangled with complementary and contradicting social orders. Gamal (Chapter 6) questions whether market processes can affect residential infrastructure through land choice. He applies an observational approach to market preferences, applied to the case of Greater Cairo, highlighting the importance of procedural preferences for individuals. Lozano Lazo and Gasparatos (Chapter 7) identify sustainability challenges, opportunities and responses in the municipal waste management systems in Bolivian cities through the perspectives of different stakeholders. They point to the common expectation of accelerating paradigm shifts in these systems, and they identify implications for the ongoing transitions, as well as urban health and wellbeing.

In Part II, *Infrastructuring (Unequal) Relationships*, contributions are concerned with the processes and effects of infrastructuring as the transformation of sociomaterial infrastructurally entangled configurations. They demonstrate that infrastructuring can intervene in the relational fabric of the city to transform social, spatial and resource flow relationships.

López-García (Chapter 8) puts forward an analytical framework for the study of the distributional effects of infrastructural policies and transitions and the production of urban inequality. He argues that urban infrastructure supports urban-based activities and requires profound transformation to meet sustainable development goals. In Chapter 9, Makore draws on fieldwork in two informal settlements in Harare (Zimbabwe) to shed light on older people's lives in such settings. She argues that a move towards more sustainable and inclusive urban futures can only result if age-friendliness is reimagined to include older people living in informality. Chakrabarti (Chapter 10) discusses the role of infrastructure in the livelihoods and everyday lives of Kolkata's idol-making community, Kumartuli. She highlights how the social and material infrastructures that are fundamental to idol-making are woven into the built form of the city, and how their transformations take place hand-in-hand with shifts in social practices. In Chapter 11, Shtanov and Iossifova present some of the concrete mechanisms through which space and architecture are produced in Lekki, Nigeria. They identify where and how synergetic and exploitative relationships reinstate some of the structural injustices engendered through knowledges, practices and infrastructures. In Chapter 12, Ren et al draw on fieldwork in Shanghai (China) and the analysis of sanitation transformation programmes in two older under-serviced inner-city neighbourhoods. They argue for the identification of tailored sanitation transformation solutions based on the consideration of local urban morphology, architecture and socio-cultural specificities in rapidly transforming cities of the Global South. Dewoolkar (Chapter 13) draws on fieldwork in Mumbai to demonstrate how embodied experiences of accessing sanitation infrastructure can be read as instances of infrastructural violence in the

context of India's Swachh Bharat Mission (SBM) and its target of making cities open defecation free. She argues that the implementation of SBM acts to exacerbate existing socioeconomic inequalities.

In Part III, *Infrastructuring Just Trajectories*, contributors develop interventions along two lines: on the one hand, they examine or work with methodological approaches that acknowledge the entanglement of infrastructuring with processes marked by high levels of unpredictability and uncertainty. On the other hand, they highlight the relevance of ethical (normative) frameworks in and for a professional practice that could shift development trajectories towards futures that are more socially and ecologically just.

Zhou et al. (Chapter 14) present a Bayesian approach to estimate Chinese urban residential building lifetime, which is currently associated with a number of uncertainties and characterise overall stock turnover dynamics. Their modelling framework can provide the basis for the analysis of policy trade-offs of embodied-versus-operational energy consumption and carbon emissions. In Chapter 15, Solomou et al. present a computational tool that enables strategic planners to explore how the sequence of implementing urban development projects may influence longer-term sustainability outcomes. Greed (Chapter 16) highlights the need to provide social infrastructure to support and enable all citizens to benefit from physical infrastructural projects and urban planning initiatives. She discusses the importance of toilet provision that takes into account biological differences and gendered practices. In Chapter 17, Iossifova et al. argue for a re-engagement of architectural theory and practice with the design of sanitation facilities in the Global South. They provide an overview of COVID-19 transmission pathways and their relevance for the design of shared sanitation facilities in the context of Accra, Ghana. Finally, Chattopadhyay (Chapter 18) draws from select Future Fictions within contemporary transmedial Futurism from the Global South to highlight infrastructures in the context of imagined future urban spaces. He explores how Global South narratives can be studied through distinct worldbuilding design toolkits, namely science fiction, architecture fiction and future fiction.

In the concluding chapter, we argue that the project of infrastructuring requires systemic approaches to account for the complexity of dynamic infrastructural configurations and entanglements. We suggest that to become *sustainable*, infrastructuring, as transformative through research and practice must adopt a systems lens and be aligned with an ethico-politics of *care*.

References

- Ainger, C. M., & Fenner, R. A. (2014). *Sustainable infrastructure: principles into practice*. ICE publishing
- Amin, A. (2014). Lively Infrastructure. *Theory, Culture & Society*, 31(7-8), 137-161.
- Amin, A., & Thrift, N. (2016). *Seeing like a city*. Polity Press.
- Anand, N. (2011). PRESSURE: The PoliTechnics of Water Supply in Mumbai. *Cultural Anthropology*, 26(4), 542-564. <https://doi.org/https://doi.org/10.1111/j.1548-1360.2011.01111.x>
- Anand, N. (2012). Municipal disconnect: On abject water and its urban infrastructures. *Ethnography*, 13(4), 487-509. <https://doi.org/10.1177/1466138111435743>
- Anand, N., Gupta, A., & Appel, H. (Eds.). (2018). *The Promise of Infrastructure*. Duke University Press.
- Andueza, L., Davies, A., Loftus, A., & Schling, H. (2021). The body as infrastructure. *Environment and Planning E: Nature and Space*, 4(3), 799-817. <https://doi.org/10.1177/2514848620937231>
- Angelo, H. (2021). *How Green Became Good: Urbanized Nature and the Making of Cities and Citizens*. University of Chicago Press. <https://books.google.co.uk/books?id=Y3oWEAAAQBAJ>
- Angotti, T. (2013). *The new century of the metropolis: urban enclaves and orientalism*. Routledge.
- Bai, X., Surveyer, A., Elmqvist, T., Gatzweiler, F. W., Güneralp, B., Parnell, S., Prieur-Richard, A.-H., Shrivastava, P., Siri, J. G., Stafford-Smith, M., Toussaint, J.-P., & Webb, R. (2016). Defining

- and advancing a systems approach for sustainable cities. *Current Opinion in Environmental Sustainability*, 23, 69-78. <https://doi.org/https://doi.org/10.1016/j.cosust.2016.11.010>
- Bhan, G. (2019). Notes on a Southern urban practice. *Environment and Urbanization*, 31(2), 639-654. <https://doi.org/10.1177/0956247818815792>
- Bossen, C., & Markussen, R. (2010). Infrastructuring and Ordering Devices in Health Care: Medication Plans and Practices on a Hospital Ward. *Computer Supported Cooperative Work (CSCW)*, 19(6), 615-637. <https://doi.org/10.1007/s10606-010-9131-x>
- Bowker, G. C. (1994). Information Mythology: The world of/as information. In L. Bud-Frierman (Ed.), *Information Acumen: the understanding and use of knowledge in modern business*. Routledge.
- Bowker, G. C. (1995). Second Nature once Removed: Time, Space and Representations. *Time & Society*, 4(1), 47-66. <https://doi.org/10.1177/0961463x95004001003>
- Brenner, N. (Ed.). (2014). *Implosions/Explosions: Towards a Study of Planetary Urbanization*. Jovis.
- Brenner, N., & Schmid, C. (2015). Towards a new epistemology of the urban? *City*, 19(2-3), 151-182. <https://doi.org/10.1080/13604813.2015.1014712>
- Burdett, R., & Sudjic, D. (Eds.). (2006). *The Endless City*. Phaidon
- Cass, N., Schwanen, T., & Shove, E. (2018). Infrastructures, intersections and societal transformations. *Technological Forecasting and Social Change*, 137, 160-167. <https://doi.org/https://doi.org/10.1016/j.techfore.2018.07.039>
- Cirolia, L. R., Hailu, T., King, J., da Cruz, N. F., & Beall, J. (2021). Infrastructure governance in the post-networked city: State-led, high-tech sanitation in Addis Ababa's condominium housing. *Environment and Planning C: Politics and Space*, 23996544211037063. <https://doi.org/10.1177/23996544211037063>
- Coutard, O., & Rutherford, J. (2015). *Beyond the Networked City: Infrastructure reconfigurations and urban change in the North and South*. Routledge.
- Davis, A., Javernick-Will, A., & Cook, S. M. (2019). The use of qualitative comparative analysis to identify pathways to successful and failed sanitation systems. *Science of the Total Environment*, 663, 507-517. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2019.01.291>
- Duhl, L. J., & Powell, J. (Eds.). (1963). *The Urban Condition: People and Policy in the Metropolis*. Basic Books.
- Federici, S. (2019). *Re-enchanting the World: Feminism and the Politics of the Commons*. PM Press.
- Fisch, M. (2018). *An Anthropology of the Machine: Tokyo's Commuter Train Network*. University of Chicago Press. <https://books.google.co.uk/books?id=d4lZDwAAQBAJ>
- Frantzeskaki, N., & Loorbach, D. (2010). Towards governing infrasystem transitions: Reinforcing lock-in or facilitating change? *Technological Forecasting and Social Change*, 77(8), 1292-1301. <https://doi.org/https://doi.org/10.1016/j.techfore.2010.05.004>
- Furlong, K. (2014). STS beyond the "modern infrastructure ideal": Extending theory by engaging with infrastructure challenges in the South. *Technology in Society*, 38, 139-147. <https://doi.org/https://doi.org/10.1016/j.techsoc.2014.04.001>
- Furlong, K. (2021). Geographies of infrastructure II: Concrete, cloud and layered (in)visibilities. *Progress in Human Geography*, 45(1), 190-198. <https://doi.org/10.1177/0309132520923098>
- Gandy, M., & Jasper, S. (Eds.). (2020). *The Botanical City*. Jovis.
- Goodbun, J., Till, J., & Iossifova, D. (Eds.). (2012). *Scarcity: architecture in an age of depleting resources*. Wiley.
- Graham, S. (Ed.). (2010). *Disrupted Cities: When Infrastructure Fails*. Taylor & Francis. <https://books.google.co.uk/books?id=OxGRAGAAQBAJ>.
- Graham, S., & Marvin, S. (2001). *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition*. Routledge.
- Graham, S., & McFarlane, C. (Eds.). (2014). *Infrastructural Lives: Urban Infrastructure in Context*. Routledge.

- Grove, J. M. (2009). Cities: managing densely settled social-ecological systems. In *Principles of ecosystem stewardship* (pp. 281-294). Springer.
- Guma, P. K. (2020). Incompleteness of urban infrastructures in transition: Scenarios from the mobile age in Nairobi. *Social Studies of Science*, 50(5), 728-750.
<https://doi.org/10.1177/0306312720927088>
- Gupta, A. (2018). The Future in Ruins: Thoughts on the Temporality of Infrastructure. In N. Anand, A. Gupta, & H. Appel (Eds.), *The Promise of Infrastructure* (pp. 62-79). Duke University Press.
- Hardoy, J. E., Mitlin, D., & Satterthwaite, D. (2001). *Environmental Problems in an Urbanizing World: Finding Solutions in Africa, Asia, and Latin America*. Earthscan.
- Harvey, P., Jensen, C. B., & Morita, A. (2017). Introduction: Infrastructural Complications. In P. Harvey, C. B. Jensen, & A. Morita (Eds.), *Infrastructures and Social Complexity: A companion* (pp. 1-22). Routledge.
- Harvey, P., & Knox, H. (2012). The Enchantments of Infrastructure. *Mobilities*, 7(4), 521-536.
<https://doi.org/10.1080/17450101.2012.718935>
- Iossifova, D. (2015). Borderland Urbanism: seeing between enclaves. *Urban Geography*, 36(1), 90-108. <https://doi.org/10.1080/02723638.2014.961365>
- Iossifova, D. (2020). Urban (Sanitation) Transformation in China: a Toilet Revolution and its socio-eco-technical entanglements. In M. Keith & A. A. d. S. Santos (Eds.), *Urban transformations and public health in the emergent city* (pp. 102-122). Manchester University Press.
- Iossifova, D., Doll, C., & Gasparatos, A. (Eds.). (2018). *Defining the Urban: Interdisciplinary and professional perspectives*. Routledge.
- Kaika, M., & Swyngedouw, E. (2000). Fetishizing the modern city: the phantasmagoria of urban technological networks. *International Journal of Urban and Regional Research*, 24(1), 120-138.
- Köhler, J., Geels, F. W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M. S., Nykvist, B., Pel, B., Raven, R., Rohracher, H., Sandén, B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., & Wells, P. (2019). An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions*, 31, 1-32.
<https://doi.org/https://doi.org/10.1016/j.eist.2019.01.004>
- Lampland, M., & Star, S. L. (Eds.). (2009). *Standards and their stories: How quantifying, classifying, and formalizing practices shape everyday life*. Cornell University Press.
- Larkin, B. (2013). The Politics and Poetics of Infrastructure. *Annual Review of Anthropology*, 42(1), 327-343. <https://doi.org/10.1146/annurev-anthro-092412-155522>
- Latham, A., & Layton, J. (2019). Social infrastructure and the public life of cities: Studying urban sociality and public spaces. *Geography Compass*, 13(7), e12444.
<https://doi.org/https://doi.org/10.1111/gec3.12444>
- Latour, B. (2005). *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford University Press.
- Latour, B., & Hermant, E. (2006). Paris: Invisible City [Paris ville invisible]. Retrieved 22 January 2010, from <http://www.bruno-latour.fr/virtual/PARIS-INVISIBLE-GB.pdf>
- Lawhon, M., Nilsson, D., Silver, J., Ernstson, H., & Lwasa, S. (2018). Thinking through heterogeneous infrastructure configurations. *Urban Studies*, 55(4), 720-732.
<https://doi.org/10.1177/0042098017720149>
- Lemanski, C. (2020). Infrastructural citizenship: The everyday citizenships of adapting and/or destroying public infrastructure in Cape Town, South Africa. *Transactions of the Institute of British Geographers*, 45(3), 589-605. <https://doi.org/https://doi.org/10.1111/tran.12370>
- Levine, C. (2010). Infrastructuralism, or the Tempo of Institutions. In V. Jackson (Ed.), *On periodization: selected essays from the English Institute*. The English Institute.
<https://www.fulcrum.org/concern/monographs/tb09j696k#toc>

- Machlis, G. E., Force, J. E., & Burch, W. R. (1997). The human ecosystem Part I: The human ecosystem as an organizing concept in ecosystem management. *Society & Natural Resources: An International Journal*, 10(4), 347-367.
- Mehta, L. (Ed.). (2010). *The Limits to Scarcity: Contesting the Politics of Allocation*. Earthscan.
- Monstadt, J., & Schramm, S. (2013). Beyond the networked city? Suburban constellations in water and sanitation. In R. Keil (Ed.), *Suburban Constellations: Governance, Land and Infrastructure in the 21st Century* (pp. 85-94). Jovis.
- Niewöhner, J. (2014). Perspektiven der Infrastrukturforschung: care-full, relational, ko-laborativ. In D. Lengersdorf & M. Wieser (Eds.), *Schlüsselwerke der Science & Technology Studies* (pp. 341-352). Springer.
- Niewöhner, J. (2015). Anthropology of Infrastructures of Society. In J. D. Wright (Ed.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 119-125). Elsevier.
- Pearsall, H., Gutierrez-Velez, V. H., Gilbert, M. R., Hoque, S., Eakin, H., Brondizio, E. S., Solecki, W., Toran, L., Baka, J. E., Behm, J. E., Brelsford, C., Hinrichs, C., Henry, K. A., Mennis, J., Roman, L. A., Rosan, C., South, E. C., & Valletta, R. D. (2021). Advancing equitable health and well-being across urban–rural sustainable infrastructure systems. *npj Urban Sustainability*, 1(1), 26. <https://doi.org/10.1038/s42949-021-00028-8>
- Pedrazzini, Y., Vincent-Geslin, S., & Thorer, A. (2014). Violence of Urbanization, Poor Neighbourhoods and Large-Scale Projects: Lessons from Addis Ababa, Ethiopia. *Built Environment*, 40(3), 394-407. <https://doi.org/10.2148/benv.40.3.394>
- Puig de la Bellacasa, M. (2017). *Matters of Care: Speculative Ethics in More than Human Worlds*. University of Minnesota Press.
- Rigon, A., & Broto, V. C. (Eds.). (2021a). *Inclusive Urban Development in the Global South: Intersectionality, Inequalities, and Community*. Routledge.
- Rigon, A., & Broto, V. C. (2021b). Introduction. In A. Rigon & V. C. Broto (Eds.), *Inclusive Urban Development in the Global South: Intersectionality, Inequalities, and Community* (pp. 1-14). Routledge.
- Rodgers, D., & O'Neill, B. (2012). Infrastructural violence: Introduction to the special issue. *Ethnography*, 13(4), 401-412. <https://doi.org/10.1177/1466138111435738>
- Rubenstein, M., Robbins, B., & Beal, S. (2015). Infrastructuralism: An Introduction. *MFS Modern Fiction Studies*, 61(4), 575-586.
- Safransky, S. (2020). Geographies of Algorithmic Violence: Redlining the Smart City. *International Journal of Urban and Regional Research*, 44(2), 200-218. <https://doi.org/https://doi.org/10.1111/1468-2427.12833>
- Santos, M. (1975). Space and Domination--A Marxist Approach. *International Social Science Journal*, 27(2), 346-363.
- Sassen, S. (1991). *The global city: New York, London, Tokyo*. Princeton University Press.
- Sassen, S. (2014). *Expulsions: Brutality and Complexity in the Global Economy*. Harvard University Press.
- Schramm, S., & Monstadt, J. (2015). Changing sanitation infrastructure in Hanoi: hybrid topologies and the networked city. In *Beyond the Networked City* (pp. 44-68). Routledge.
- Shao, Q. (2013). *Shanghai gone: domicile and defiance in a Chinese megacity*. Rowman & Littlefield.
- Shin, H. B. (2021). Theorising from where? Reflections on De-centring Global (Southern) Urbanism. In M. Lancione & C. McFarlane (Eds.), *Global Urbanism: Knowledge, Power and the City*. Routledge.
- Simone, A. (2004). People as infrastructure: Intersecting fragments in Johannesburg. *Public Culture*, 16(3), 407-429.
- Simone, A. (2014). Relational infrastructures in postcolonial urban worlds. In S. Graham & C. McFarlane (Eds.), *Infrastructural Lives: Urban Infrastructure in Context* (pp. 17-38). Routledge.

- Smiley, S. L. (2020). Heterogeneous water provision in Dar es Salaam: The role of networked infrastructures and alternative systems in informal areas. *Environment and Planning E: Nature and Space*, 3(4), 1215-1231. <https://doi.org/10.1177/2514848620908194>
- Star, S. L. (1999). The Ethnography of Infrastructure. *American Behavioral Scientist*, 43(3), 377-391. <https://doi.org/10.1177/00027649921955326>
- Star, S. L., & Lampland, M. (2009). Reckoning with Standards. In M. Lampland & S. L. Star (Eds.), *Standards and their stories: How quantifying, classifying, and formalizing practices shape everyday life* (pp. 3-34). Cornell University Press.
- Star, S. L., & Ruhleder, K. (1996). Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Information Systems Research*, 7(1), 111-134. <https://doi.org/10.1287/isre.7.1.111>
- Swyngedouw, E. (2006). Circulations and metabolisms: (Hybrid) Natures and (Cyborg) cities [10.1080/09505430600707970]. *Science as Culture*, 15(2), 105-121. <http://www.informaworld.com/openurl?genre=article&doi=10.1080/09505430600707970&magic=crossref> | D404A21C5BB053405B1A640AFFD44AE3
- Thacker, S., Adshead, D., Fay, M., Hallegatte, S., Harvey, M., Meller, H., O'Regan, N., Rozenberg, J., Watkins, G., & Hall, J. W. (2019). Infrastructure for sustainable development. *Nature Sustainability*, 2(4), 324.
- Tilley, E., Ulrich, L., Lüthi, C., Reymond, P., & Zurbrügg, C. (2014). *Compendium of Sanitation Systems and Technologies* (2nd revised ed.). EAWAG.
- Truelove, Y., & Ruszczyk, H. A. (2021). Bodies as urban infrastructure: Gender, intimate infrastructures and slow infrastructural violence. *Political Geography*, 102492. <https://doi.org/https://doi.org/10.1016/j.polgeo.2021.102492>
- United Nations. (2015). *Transforming Our World: the 2030 Agenda for sustainable development*. <https://sustainabledevelopment.un.org/content/documents/7891TRANSFORMING%20OUR%20WORLD.pdf>
- Yapa, L., Wisner, B., & Luce, H. R. (1995). Building a case against economic development. *GeoJournal*, 35(2), 105-118. <https://doi.org/10.1007/bf00814057>
- Young, O. R., Berkhout, F., Gallopin, G. C., Janssen, M. A., Ostrom, E., & Van der Leeuw, S. J. G. e. c. (2006). The globalization of socio-ecological systems: an agenda for scientific research. 16(3), 304-316.