Networking Cities after Paris: Weighing the Ambition of Urban Climate Change Experimentation

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Abstract

Over the past few decades, cities have repeatedly demonstrated high levels of ambition with regard to climate action. Global environmental governance has been marked by a proliferation of policy actions taken by local governments around the world to demonstrate their potential to advance climate change mitigation and adaptation. Leading 'by example' and demonstrating the extent of action that it is possible to deliver, cities have aspired to raise the ambition of national and international climate governance and put action into practice via a growing number of 'climate change experiments' delivered on the ground. Yet accounts of the potential of cities in global environmental governance have often stopped short of a systematic valuation of the nature and impact of the networked dimension of this action. This article addresses this by assessing the nature, and challenges faced by, urban climate governance in the post-Paris era, focusing on the 'experimentation' undertaken in cities and the city networks shaping this type of governance. First, we unpack the concept of 'urban climate change experimentation', the ways in which it is networked, and the forces driving it. In the second and third parts of the article, we discuss two main pitfalls of networked urban experimentation in its current form, focusing on issues of scaling experiments and the nature of experimentation. We call for increased attention to 'scaling up' experiments beyond urban levels of governance, and to transformative experimentation with governance and politics by and in cities. Finally, we consider how these pitfalls allow us to weigh the potential of urban climate ambition, and consider the pathways available for supporting urban climate change experimentation.

Policy Implications

- Urban climate change governance in the post-Paris era is increasingly about experimentation, or testing innovative technologies and policies 'on the ground'. This is associated with increasingly complex patterns of city networking, and driven by priorities going beyond those of the UNFCCC regime. Understanding this new mode of governance as distinct from conventional local climate policy is necessary in order to harness its potential for global climate change governance.
- Cities cannot 'save the planet' alone. There needs to be an increasing focus on vertical 'scaling up' urban climate change experiments to change regional, national and global policy, as a complement to 'scaling out' as horizontal replication of experiments between cities.
- Vertical linkages, including flows of knowledge and finance, between actors at different governance levels need to be built to create pathways for 'scaling up' urban experiments, e.g. through the National Urban Policies framework of the UN New Urban Agenda. IFIs could enable direct access to climate finance for cities to support experimentation and scaling.
- Beyond a preoccupation with technical 'solutions' to climate change, the social justice implications of the types of urban environments shaped by experimentation must be more systematically considered. Experimentation with urban governance and politics holds great potential for reconfiguring urban systems to deliver climate change mitigation and adaptation, which should be harnessed by city leaders.

The potential of urban climate ambition

Over the past decades, cities have repeatedly demonstrated high levels of ambition with regard to climate action. Dating back at least to the early 1990s, global climate governance has been marked by a distinct proliferation in the range and scale of actions taken by local governments around the world to demonstrate their potential to advance climate change mitigation and adaptation. Much of this action has been facilitated by a sprawling genus of city networks (Acuto, 2013; Bouteligier, 2013). Arguably, within the last five years, and especially around the time of the 21st Conference

of the Parties of the UNFCCC, much of the critical ambition for climate change governance has increasingly emerged from cities. If this was blatant around the multilateral failures of Copenhagen in 2009, where networks like the C40 Climate Leadership Group made clear strides towards 'alternative' solutions for global action, at COP21 in Paris, cities stole even more of the spotlight as Paris mayor Anne Hidalgo and former New York mayor Michael Bloomberg convened some of the most visible conference statements and gatherings. The United Nations formally recognised the key role of urban actors by appointing Bloomberg as the first ever UN Special Envoy on Cities and Climate Change. The reactions of city leaders to the Trump administration's withdrawal from the Paris agreement were a visible statement of the willingness of cities to take ambitious action even in a hostile policy environment. The recited mantra of 'nations talk, cities act' (Curtis, 2016a, 2016b) and the continuous reiteration of a growing track record of urban climate actions delivered 'on the ground' (C40 and ARUP, 2015a), put forward by C40 and many others, thus now echo loudly in many environmental governance venues (Davidson and Gleeson, 2015).

The prevailing discourse regarding urban climate action in the media and policy-making is that it holds much promise: by means of bypassing national and intergovernmental governance, cities can independently take climate policy action, with city networks allowing for peer learning and replication of 'best practice' (Bloomberg and Pope, 2017). By 'leading by example' and demonstrating the extent of action that it is possible to deliver, cities have aspired to raise the ambition levels of national and international climate governance (Bloomberg, 2015). Indeed, post-Paris, the focus of urban climate ambition has moved on from simply demonstrating action has been delivered to 'scaling up' action, with the Paris Agreement also reflecting that this is the critical promise that sub-state actors must deliver. Although the COP21 Decision mentions cities only twice within its text, cities are as non-party stakeholders called to 'scale up their efforts and support actions to reduce emissions' (UNFCCC 2015, p. 19). Yet does this networked urban action on climate change have the potential to realise its underlying ambition? Our goal is to look beyond the rhetoric of how cities can 'save the planet' (Barber, 2017; Bloomberg and Pope, 2017). Taking cue not just from the academic literature but from policy research we developed in collaboration with city networks (C40 in particular),[1] the contribution we wish to make is to unpack the nature of urban climate action after Paris as 'networked experimentation', and point to both the promises and challenges this poses.

While it is encouraging that the literature on global climate governance is beginning to engage with the role of cities in a more substantive sense (Gordon, 2016; Johnson, 2017), our motivation is to push this debate further. As the climate change governance literature is beginning to grapple with new debates about governing climate change in cities, including notions of 'experimentation' and 'scaling' experiments, we wish to contribute with a timely discussion of existing empirical research on these phenomena, and

some critical reflections, in order to enable nuance in these debates and generate a productive research agenda.

This article is divided in four main parts. In the first, we unpack the nature of 'networked experimentation' to outline the ways in which this differs from existing conceptualisations of the urban climate governance. In doing so, we argue that networks are central to shaping urban experimentation in increasingly complex ways, and that experimentation is not primarily driven by urban responses to the UNFCCC regime, but instead by a range of political and economic objectives and pressures that motivate local governments to retrofit urban infrastructures through experimentation. In the second and third sections, we go discuss two pitfalls that could cause networked experimentation to fail to meet its ambition for climate action. We examine the latest manifestation of urban climate ambition as 'scaling' of experiments and argue that current networked urban experimentation has largely resulted in 'scaling out' rather than 'scaling up' – horizontal replication of experiments between cities, rather than vertical scaling from urban to higher governance levels – and link this to existing evidence on the challenges of scaling up. We point to the lack of attention to the nature, as opposed to scaling, of urban experiments, arguing that the transformative potential of governance experimentation has not yet been fully harnessed in comparison to the focus on experimentation with technology. Finally, we consider how this more nuanced understanding of networked urban climate change experimentation encourages scholars and practitioners to weigh the potential of urban climate ambition more pragmatically, and the pathways available for realising this potential.

Networked urban experimentation

Unpacking experimentation

Urban climate governance is no longer confined only to lofty ambitions on paper: the 'second generation' of urban climate governance (Kern and Bulkeley, 2009) has seen a substantial number of policy interventions delivered 'on the ground' in hundreds of localities over the world. Urban climate governance has thus permeated most policy areas and manifested in interventions such as energy-efficient buildings, bike-sharing systems and behaviour change campaigns. In what is perhaps the most popular work on this new form of urban climate governance, Bulkeley and Castán Broto (2013) have characterised the proliferation of such interventions as 'urban climate change experiments'. The authors argue that experiments 'serve as a means through which the governing of climate change in the city takes place' through 'multiple sites and forms of intervention' (Bulkeley and Castán Broto, 2013, p. 362)), and thus that understanding urban climate governance 'is not only a matter of analysing the development of strategy, discourse and policy' (Bulkeley and Castán Broto, 2013, p. 363). Whereas early research focused on analysing climate policy commitments and frameworks put in place by local governments, understanding urban climate governance in the post-Paris era requires a broader conceptualisation of governance that

unpacks how a multiplicity of urban experiments are governed in the city. We strongly agree with Bulkeley and Castán Broto (2013) in that it is crucial to distinguish experiments from conventional urban climate policy, and, indeed, from urban planning. The other defining feature of urban experiments as 'purposive interventions' to address climate change is that they are attempts to 'try out new ideas and methods . . . in new contexts where they are thought of as innovative' and 'explicitly seek to capture new forms of learning' (Castán Broto and Bulkeley, 2013, p. 93). For example, the city of Stockholm first implemented its congestion charging scheme through a six-month pilot, which only later was made permanent and expanded. Experiments are thus different from conventional urban policy in that they are tentative, 'pilot' type interventions that are 'novel' in a particular city, rather than widely-used policy instruments implemented through established processes of urban policy, planning and procurement.

Bulkeley and Castán Broto (2013) outline three different conceptual strands for thinking about urban climate change experimentation: governance experiments, socio-technical experiments, and strategic experiments. In this paper, we are concerned with the two former strands. Discussing the first, we draw among others on Hoffmann (2011), who has argued that networked urban climate action can be understood as a form of 'governance experimentation' in governing climate change at the global scale, driven by disillusionment with international climate negotiations. Others have defined sustainability governance experimentation as 'experimentation in governance approach' that alters 'the configuration of decision-making' (Bos and Brown, 2012, p. 1341). Discussing the second, Bulkeley and Castán Broto (2013) point to the sustainability transitions literature, which conceptualises experimentation with sustainable, radically innovative technologies within the context of socio-technical systems (Schot and Geels, 2008; Sengers et al., 2016), and has begun to examine this also within urban contexts (Frantzeskaki et al., 2017). Indeed, the work on urban climate change experimentation represents only one strand of research on urban experimentation with mitigation or adaptation-relevant technologies.

Among the wealth of typologies, we find it most helpful to distinguish between socio-technical experiments, as material interventions in urban socio-technical systems aimed at testing new types of interventions (in line with Bulkeley and Castán Broto, 2013 and Sengers et al., 2016), and governance experiments as interventions that seek to test new approaches to governing those systems (loosely in line with Bos and Brown, 2012). By systems, we refer to concrete urban sectors and infrastructures: energy, transport, waste, water, etc. With reference to transport, for example, a socio-technical experiment could involve piloting a bike-sharing scheme, whereas a governance experiment could involve giving the Mayor of London power over suburban commuter trains on a trial basis. The distinction here is between 'on the ground' intervention and interventions reconfiguring governance itself, which corresponds to the basic distinction drawn by McGuirk et al.

(2015) between 'practical' experiments and 'institutional' experiments. The conceptualisation of governance experiments as concrete interventions in cities – rather than as urban responses to global governance dynamics (Hoffmann, 2011) – is still very broad in the literature and there is a need for typologies of governance experimentation within the context of urban climate governance. We return to the concept of governance experimentation in the third section of this paper.

Networking and experimentation

Following this unpacking of experimentation, the second point we would like to emphasise is that city networks are central to urban experimentation and should thus form an integral part of the research agenda. It is well-established that urban climate governance grew from the early 1990s as a result of urban policy entrepreneurs and the establishment of city networks (Bulkeley, 2010), and that cities collectively organise in networks to have a voice in global governance arenas. However, more research is needed on the role of networks in urban *experimentation*, specifically. The relative absence of networks in the experimentation literature constitutes a conceptual gap, since it is clear that networks have facilitated experimentation and raised the level of ambition among cities learning from and competing with each other with regard to the deployment of low-carbon technologies and policies (Gordon and Acuto, 2015; Davidson and Gleeson, 2017). In recent research with ARUP and C40 cities, we have shown that between 2011–2015, the growing number of 'climate actions'[2] in C40 members has been accompanied by a growth in the importance of city-to-city collaboration: in 2015, 30 per cent of all climate actions in (66) C40 cities were being delivered through city-to-city collaboration, of which 44 per cent involve collaboration via a specific C40 network (C40 and ARUP, 2015a). This is confirmed in a survey of 100 cities globally by Castán Broto and Bulkeley (2013), who found that city network membership is more strongly correlated with the number of climate change experiments in a city compared to other variables such as population and GDP per capita.

For local governments, networking is based on the need to facilitate knowledge-sharing and learning, potentially giving political leaders ideas and confidence to conduct experiments. In this sense, London can learn from the experience of Stockholm, either through informal networks between mayors and local government professionals, or via formal networks such as C40. This is a commonly told story. However, more comparative research is also necessary to understand the ways in which networks influence the type of climate change experimentation undertaken in cities and the governance processes and structures associated with experimentation. For decades, especially during the Cold War, cities' international relations were mostly limited to peer-to-peer cooperation. Today we see the return (just as with pre-modern city-states) of more explicitly entrepreneurial and public-private 'hybrid' urban governance (Haselmayer, 2018). Through networks, many cities have been

exploring forms of joint procurement and engaged in new private-public partnerships (Roman, 2010). Traditional city twinning organisations, such as Sister Cities International (SCI), have themselves stepped from more specific 'city-to-city cooperation' (Bontenbal and van Lindert, 2009; Cremer et al., 2001) to a wider 'city diplomacy' between cities, and between cities and other non-municipal actors (Acuto, 2016; Gutiérrez-Camps, 2013). Networks are shifting, as with SCI, from an emphasis on the importance of twinning to an emphasis on the importance of strategic implementation and trans-national alliances. This more complex form of networking has been constructed in partnership with actors beyond local governments, such as the UN, the World Bank or the EU. These actors are also increasingly intertwined with the cross-national action of the private sector, as with large private philanthropies, that are in some cases even initiators of city networking efforts, for example the Rockefeller 100 Resilient Cities initiative.

Thus, whilst the number and variety of city networks grows steadily (Acuto and Rayner, 2016), the variety of networked actors initiating experiments is also expanding beyond city halls. The implications of these trends in networking for urban climate change experimentation, and global climate change governance more broadly, should be explored. This echoes the call of Hodson et al. (2017) to understand urban sustainability experimentation in the context of multi-level governance and global economic restructuring.

Drivers of networked experimentation

The third argument we wish to make is that, at this juncture, networked urban experimentation is not driven predominately by a desire to make up for the shortcomings of, or compete with, the multilateral climate regime. Hoffmann (2011) argues that networked urban experimentation is emerging in response to disillusionment with the slow progress of UNFCCC treaty negotiations.

We disagree with this argument. As we have discussed above, much of (networked) urban climate governance will indeed have been established as a response to developments in multilateral environmental governance, including Agenda 21. However, we would argue that the direct influence of the multilateral climate regime on networked urban experimentation has gradually and significantly diminished since the 1990s and early 2000s. In the post-Paris era, local governments are undertaking climate change experimentation linked to a variety of strategic pressures and incentives, such as experiencing tangible vulnerabilities from climatic events and responding to demands for better air quality, housing and transport services by urban electorates; but also by desires to brand cities as progressive and liveable, and foster economic competitiveness spinning out from low-carbon and 'smart' urban development (Bulkeley et al., 2012; Hodson and Marvin, 2007). Cities are keen to engage and be seen to be engaged in 'innovation', and networked urban experimentation is increasingly driven by a broader set of circulating policy ideas and agendas surrounding innovation in

cities (McCann, 2017), rather than policy 'cascading' from the UNFCCC regime.

It is well-established that cities, through city networks, assert their comparative advantages for addressing climate change (acting quickly and delivering more concrete action, compared to national governments) and use climate change as a basis for political contestation with other levels of government (Hodson and Marvin, 2010a). However, direct positioning by city networks vis-à-vis the UNFCCC regime is largely limited to the bigger networks such as C40. Beyond the discourse of 'cities saving the planet', networked urban experimentation is not driven by Hoffmann's (2011) idea of networked cities constituting a competing regime to that of the UNFCCC in governing climate change globally. Arguments have been made that transnational coalitions of sub-state actors are assuming increasing influence in relation to, if not compared with, nation states (Mamadouh et al., 2016; Setzer, 2015), and as such, networked cities clearly matter for climate governance. However, since networked urban experimentation is not in reality about seeking to eclipse the UNFCCC regime, it would be more productive if the debate between the 'transnationalists' and 'multilateralists' in climate change governance research (Betsill et al., 2015) focused less on 'competition' and more on understanding linkages between networked urban experimentation and other processes and actors of climate governance – as exemplified by this special issue. Conceptual and empirical work is thus needed to understand the interactions between experimentation as a process of purposive governance attempting to push cities towards sustainability, driven by priorities beyond climate change and involving increasingly complex networked actor constellations, and the priorities and architecture of global climate governance.

Scaling urban experiments

Ambition as 'scaling'

In the post-Paris era, urban climate ambition has evolved to focus on 'scaling' action, which is of course directly relevant to the idea of 'linkages' between scales and actors of climate governance. The COP21 Decision calls for cities as 'non-party stakeholders' to 'scale up their efforts and support actions to reduce emissions' (UNFCCC, 2015, p. 19), and, similarly, in outlining six research priorities for cities and climate change, Bai et al. (2018) have recently argued that scaling of 'successful local innovations' – or experiments – is key. The scale of action has also become one of the key strategic foci of C40, and gradually other city networks too.[3] The idea that climate action by sub-state actors is too limited in its jurisdictional extent to produce significant mitigation or adaptation outcomes seems to be the implicit backdrop for the call to 'scale', however, what is meant by scaling is often vague and not defined. We unpack the idea of 'scaling' below and critically reflect on the challenges of this process, in order to then highlight what type of thinking is needed to build effective actor 'linkages' in climate governance.

The question of what happens 'beyond' experiments, that is, when an experiment is over – is a core element of the literature on urban climate change experimentation (Turnheim et al., 2018). This is because, as discussed in the first section, experiments are by definition understood to be limited in spatial or temporal scope, as in the common concrete form of experiments as pilot projects. An intervention that has never been implemented in London before, for example, a particular type of sustainable urban drainage, is likely to first be 'piloted' before becoming a fully-fledged part of London's climate change adaptation strategy. The longer-term impact of experiments is thus a central concern for policy and research. The predominant conceptualisation of how experiments can have broader impact originates from the sustainability transitions literature, where 'deepening', 'broadening' and 'scaling up' are theorised as processes through which experiments can eventually transform a 'socio-technical regime' (van den Bosch and Rotmans, 2008). While this framework is drawn upon by many researchers working on urban sustainability experimentation (Bai et al., 2010; Williams, 2016; Kivimaa et al., 2017), it has been developed with reference to the multi-level perspective on sustainability transitions that conceptualises the evolution of socio-technical systems over many decades (Geels et al., 2017), and is not yet well articulated with respect to geography and governance scales (Coenen et al., 2012).

For the purposes of this paper, which is intended for a multidisciplinary and policy-oriented audience, we find that an accessible starting point for thinking about 'scaling' experiments is to draw a distinction between horizontal and vertical varieties of scaling. Here, the basic typology provided by Luederitz et al. (2016, p. 6) is useful for distinguishing between '"scaling out" which refers to repeating the experiment in the same context' and '"scaling up" which refers to integrating and applying the experiment at a higher system level'. To clarify on the vague uses of 'context' and 'system level' here, 'scaling out' refers to horizontal scaling: replication of an experiment in the same or another city. 'Scaling up' can, in turn, be thought of as vertical scaling: integration of particular elements of the experiment (e.g. a technology or policy intervention) into policy at urban, regional, national and global levels of governance. Scaling out thus corresponds to the commonly understood idea of cities learning from and emulating each other through replicating similar interventions, whereas scaling up entails interventions causing policy change and attracting investment to gradually be implemented city-wide, regionally, nationally or globally.

To elaborate on scaling up, the first 'stage' of scaling up an experiment would be scaling *within* a particular city. Research by C40 on experiments (referred to as 'actions') in its member cities provides a clear illustration: each action is classed on a four-tier typology of (spatial) scale: proposed, pilot, significant and city-wide (C40 and ARUP 2015a). For example, in the transport sector, scaling up would entail expanding a Bus Rapid Transit system from one or a few lines (pilot or significant scale) to a city-wide network of lines. While the C40 typology refers to spatial scales within a

city, we think attention to whether experiments scale up to result in urban *policy* change that reconfigures urban systems (transport, energy, waste, etc.) at a city-wide scale is more important. The second 'stage' of scaling up would be in the context of multi-level governance: from the urban level to regional, national and global levels of governance. An example of scaling up from the urban level is the Green Building Programme in the US city of Portland, where experiments with different LEED green building technologies scaled up to the state level, with state-wide investment and institution-building by the State of Oregon (Corfee-Morlot et al., 2009).

The theory of change attached to urban experimentation is that it allows for low-carbon technologies and policies to be tested rapidly 'on the ground', with lessons drawn from such experiments creating learning processes at multiple scales, thus facilitating scaling through implementation by other actors. While this is hope-inducing indeed, considering the boom in networked urban experimentation during the last decade, it is important to critically reflect on potential pitfalls. Clearly, for networked urban experimentation to contribute to addressing climate change, scaling up from pilot-type interventions is needed. In the following section, we argue that to date, networked urban experimentation has largely fostered scaling out, rather than scaling up, and explain this by discussing the challenges of scaling up as a process.

Scaling 'up' or 'out'?

Data from C40 member cities again provide a useful starting point from which to examine the scaling dynamics of networked urban climate change experimentation. Based on our research on, and practical engagement with, the C40 network we would argue that networked experimentation undertaken by C40 member cities reaches its limit in scaling up to city-wide urban policy. Our argument is that, on the whole, this networked urban experimentation materially results in 'scaling out' of experiments globally, rather than 'scaling up' beyond the urban level of governance. This is in our view the first potential pitfall of current networked urban climate change experimentation.

C40 data seems to point to the fact that a large number of experiments have scaled up within its member cities over time. In 2015, 51 per cent of C40 member actions were being undertaken at a city-wide scale, representing an increase of 11 per cent compared to 2011 (C40 and ARUP, 2015a) and an increase of 260 per cent since 2009 (C40 and ARUP, 2015b). This trend is consistent across most of the 11 sectors for climate action (transport, energy, water, etc.) that C40 uses for analysis, with 'a decline in the proportion of pilot and proposed actions with time and a corresponding increase in significant and city-wide actions' (C40 and ARUP, 2015a, p. 28). As cited above, 30 per cent of all climate actions in 66 C40 cities were being delivered through city-to-city collaboration, of which 44 per cent involve collaboration via a policy-specific C40 sub-network (C40 and ARUP, 2015a). Despite this 'success', the C40 network shows no sign of plateauing ambition, with the current strategy of

C40 focused on scaling up actions in member cities to city-wide scale.

However, we argue that this is the extent to which the potential of current networked urban experimentation extends. Networked experiments do not necessarily scale further 'upwards' to become embedded in regional, national or international policy. Instead, specific climate change experiments are being replicated across member cities through the C40 network facilitating 'scaling out'. The potential of scaling up beyond the urban level of governance is limited, while scaling out is prolific. This is unsurprising when one considers the fact that local governments have jurisdictional powers to scale up experiments within city boundaries, and can share knowledge about experiments through networks, allowing for scaling out to other cities. However, neither cities nor city networks have substantive powers to influence national-level policy-making nor international actors such as treaty secretariats or technology standard-setting agencies. Cities and city networks still have very limited channels to effectively lobby national and multilateral policy frameworks. C40 has been active in campaigning internationally, especially alongside the UNFCCC, but also increasingly through side events and 'track II' processes associated with a variety of multilateral initiatives like the Habitat III UN New Urban Agenda or the Sustainable Development Goals. Equally, at national levels, through C40 mayors and especially C40 chairs (Bloomberg in New York, Paes in Rio de Janeiro, Hidalgo in Paris), the network has put public and media pressure on (and informally engaged with) national ministries and leaders. Yet even as a highly-visible and well-funded network, C40 is still not 'at the table' of multilateral negotiations and national policymaking, and its peer networks (ICLEI, UCLG and many others) are certainly not better placed.

Cities and city networks can, to some extent, 'bypass' states by undertaking climate change experimentation independently of their national governments (Bouteligier, 2014). However, currently this networked experimentation predominately results in 'scaling out' rather than 'scaling up'. Experiments are being replicated between cities but scaling up of urban climate change experiments beyond local government to result in policy change at other levels of governance is much more rare. Simply, it is far more common that climate change experiments in London are replicated in Melbourne, Paris and Santiago, than that these are taken up and mainstreamed via the UK government, the European Union, or state governments in Australia. This argument is in line with the evidence already gathered by Williams (2016) in tracing the scaling of low-carbon experiments undertaken in three European cities: Freiburg, Stockholm and London. Here, Williams argues that the importance of 'scaling out' has been overstated and may very well generate a multiplication of replicated experiments without producing upward 'scaling up'. While some technologies, such as solar energy and eco-cycling were 'scaled out' in other cities globally (e.g. in China), this remained limited to the city level, with 'scaling up' to other levels of governance hampered by differing political and cultural contexts across cities and countries. Sustainable urban development in Sweden, specifically the Hammarby Sjöstad and Stockholm Royal Seaport eco-district experiments in Stockholm, provides a further illustrative example. Hammarby Sjöstad was planned since the early 1990s with construction beginning in 2004, and featured environmental technologies that were radically novel at the time. The more recent Stockholm Royal Seaport district, still under construction, has largely replicated the technologies and planning approach of the Hammarby experiment (Högström et al., 2013; Wangel, 2013), and the Hammarby approach has also been 'scaled out' and applied in other eco-districts in Swedish cities. 'Scaling out' also continued globally: the integrated Swedish eco-district concept was branded as 'SymbioCity', which has been marketed and exported by Swedish government as an international exemplar, for example, to cities in Kenya under the umbrella of broader development cooperation (SymbioCity, 2017). Networks also play a role in this scaling: Stockholm Royal Seaport won a C40 Cities Award for its high ambition with regard to sustainability (C40, 2015), thus potentially spurring further replication of this 'best practice' to other C40 cities. However, despite all of this 'scaling out', as argued by Williams (2016), sustainable urban development in Sweden has not resulted in 'scaling up'. After more than a decade of experimentation, plenty of unsustainable urban development is still planned and built in Sweden: national urban planning frameworks have not been overhauled, due to an absence of 'scaling up'. At large, climate-proof urban development remains limited to innovative, but isolated, eco-districts, rather than infrastructural systems in Swedish cities having been reconfigured as a result of significant urban or national policy change.

The Swedish example illustrates the limits of 'scaling out' experiments, which may not go far enough in generating mitigation and adaptation impact. Focusing attention on the track record of networked cities in 'scaling out' and 'bypassing' national governments detracts from the importance of 'scaling up' in terms of embedding climate-relevant technologies and policy interventions in national policy frameworks. This presents a significant pitfall for realising the potential of networked urban experimentation for global climate governance. Reforming national policy and regulation is crucial in order for significant emissions reductions to be realised, and can also reinforce and support experimentation undertaken by cities. For example, in relation to the energy efficiency of buildings, reforming national building standards may be crucial, without which single experiments with low-carbon buildings in specific urban eco-neighbourhoods will be doomed to limited impact. The track record of city networks, including C40, to lobby national governments to make such changes to national policy has yet to be evidenced systematically.

Thus, while 'scaling out' of experiments appears to be occurring with varied impacts, and has been the focus of attention, the pathways through which 'scaling up' occurs in cities, or could ideally occur, remains relatively unclear with limited systematic analysis within city networks or academia. The world is littered by innovation projects that have fizzled

and dried out – 'pilotitis' and the difficulty of scaling is also prominent debate in international development (Huang et al., 2017), for example. Existing empirical evidence on climate change experiments points to the fact that scaling up, particularly 'upwards' from the urban level, is challenging and rare (Hoogma et al., 2002; Bouteligier, 2014; Kivimaa et al., 2017). While experiments arguably provide 'space' for innovation by existing on the fringes of urban policymaking, they are often relatively isolated interventions that are poorly embedded in existing urban or national policy frameworks. This poses challenges for scaling up, for example, as discussed by van Buuren et al. (2018) in the case of Dutch climate adaptation projects. Experiments may be undertaken by fairly small teams within local governments, who need to raise interest in the experiment by involving different actors and disseminate experiment lessons through policy networks, in order to convince urban and national decision-makers that investment for scaling up is warranted (van Doren et al., 2016). Linkages between local climate experiments and policy at other levels are unlikely to exist without significant effort and resources. Indeed, a meta-evaluation of seven EU funding programmes for sustainable mobility experimentation between 2002 and 2013 found that urban beneficiaries felt that the impact of experiments was often stifled by a lack of funding opportunities for scaling up (Tomassini et al., 2016, p. 12).

For effective climate governance at every scale, it is crucial that the challenges associated with scaling up experiments are not underestimated but instead addressed head on. In a welcome contribution to such a research agenda on scaling, Fuhr et al. (2017) propose a new tripartite typology of 'embedded upscaling': horizontal upscaling (between actors at the same level, e.g. between cities), vertical upscaling ('upwards' from city level to a national level, national to the global level, and directly between city and global level bypassing the national) and hierarchical upscaling (from the global level 'downwards' to the national and city level). The different forms of upscaling appear to refer to processes of emulation and 'catching up' between actors, however the authors do not define 'upscaling' itself as a term, which leaves the reader to interpret this as referring to 'more' urban climate action in general terms. Thus, while this framework identifies horizontal and vertical actor linkages, it does not help us understand how urban climate change experiments could be scaled up in practice, from the perspective of policy change and institutional frameworks.

Understanding how experiments can scale up is perhaps best advanced from through empirically grounded analysis. For example, in a review of 30 case studies on sustainability experiments in Asian cities, Bai et al. (2010) find that at least nine resulted in 'upscaling'. Such case studies should be examined both in-depth and comparatively, to understand how linkages between urban, national and global actors can be built to establish scaling up pathways. Institution- and capacity-building are needed at both urban and national levels of governance to build linkages to support undertaking and scaling up experiments, which the focus on 'scaling out' experiments through networks does not contribute to.

Frameworks conceptualising the interactions and flows (knowledge, financial) between actors at different levels that are necessary to achieve scaling up should crucially be built through multi-actor policy processes to establish new frameworks at national levels. A recent case study by Peng and Bai (2018) of low-carbon experimentation in Shanghai attributes success to precisely such a framework of nested experimentation linking national and local actors and initiatives through policy and funding. This work exemplifies a promising future direction for research, through which frameworks for 'vertical' linkages to support scaling up pathways can be built based on empirical cases.

Encouraging transformative experimentation

The second key pitfall that we see in current networked urban experimentation is the lack of diversity in the type of experimentation that is undertaken, and the limited ambition in experimenting with governance and local politics, not just with climate-proofing technologies. Our observations from working with and on cities and city networks is that, with reference to the basic typology outlined in the first section of this paper, the majority of networked urban experimentation tends to be of a socio-technical nature, rather than experimentation with different approaches to governance itself. This supports the findings of Castán Broto and Bulkeley's (2013) survey of climate change experimentation in 100 cities globally, which found that 'technical' innovation was the most prevalent type of innovation. While we would not disagree that technologies and policy approaches with benefits for climate change mitigation and adaptation should be scaled up, it is also crucial that attention is paid not only to the scale and scaling of experiments, but also the *nature* of experiments. Crucially, it is important to recognise that all of this experimental action, and all of the urban ambition behind it, can in fact be transformative in the types, processes and logics of politics in the cities engaged in these activities. Centrally, then, we argue that what global networked urban experimentation needs is not solely scaling up, but also experimentation of a more diverse nature, namely more governance experimentation, not just governance *by* socio-technical experiments. The difference here is subtle but critical: whilst experimentation has been deployed to govern the city to achieve sustainability gains, few experiments in the form, nature and purpose of urban governance itself are present at the heart of this networked form of urban climate governance. However, we argue that to be *politically* transformative, urban climate ambition would need to translate into experimentation with urban politics. Highly networked cities such as the C40 member cities are ripe for this, as they have an inherent cosmopolitan basis of urban dwellers as their constituents, and generally outward-looking 'international' leadership at their helm.

Governance experimentation could include setting up new institutions, such as experimentation units and programmes within local and national governments, which could institutionalise experimentation as a mode of governance, boost funding and facilitate learning, capacity and

network-building. Cities such as London, Los Angeles, New York, Bristol and Mexico City have already done this to some degree, and the Finnish government has set up a national policy programme on experimentation.[4] Governance experimentation could, additionally, involve further experimenting with the logics of urban development, for example, with the definition of 'financial viability' in contractual arrangements between municipalities and real estate developers, which could open up a host of opportunities for experimenting with different climate-friendly technologies that may have been regarded as prohibitively costly. It could also involve local governments engaging even more ambitiously with their cosmopolitan citizenry, beyond the straightjacket of national interests and politics, and entertaining the possibilities that joint policy-making across local jurisdictional boundaries would afford local government. Even more profoundly, networked urban governance could afford cities and other international actors unique possibilities to think through the way core tenets of the international system, from citizenship to sovereignty and territory, are conceived of and deployed for the global commons.

Without rejecting the importance of socio-technical experimentation, we argue that the transformative potential of governance experimentation should be harnessed. Governance experiments could be transformative enough to engender the type of structural political changes that may be needed to avoid and adapt to the risks posed by climate change. The current ambition for networked urban experimentation may have thus an ambiguous effect: whilst it can raise ambition around shared goals and messages, break institutional inertia in climate governance and broaden the toolset available to cities in tackling climate change, it can also limit the 'transformative' ambitions of urban climate action. Cities and city networks have arguably made solid strides towards breaking the 'gridlock' (Hale et al., 2013) of climate change governance by materialising climate action on the ground. However, networked urban experimentation, if overwhelmingly focused on technical 'solutions' and little experimentation with governance itself, could practically both be breaking *and* forging 'lock-ins' in global (climate) governance (Acuto and Rayner, 2016). 'Lock-ins' are in this context both political as much as material: on the one hand we see clear success and visibility of groups like C40 or ICLEI, but on the other hand questions remain as to whether these in fact break away from the *modus operandi* typical of neoliberal international stances (Bernstein, 2012) which have created governance gridlocks in the first place (Curtis, 2018). As such, it is problematic that only 26 per cent of urban climate change experiments in the 100 cities surveyed by Castán Broto and Bulkeley (2013) featured considerations of environmental justice. Urban climate action in the form of experimentation translates directly into tangible material changes to cities and the people who live in them, at a global scale. If the nature of experiments is not in line with democratic or just modes of climate action, risks thus run high. Experimentation could in fact result in green 'enclaves' in cities reserved for the affluent (Hodson and Marvin, 2010b) and aggravate climate risks faced by vulnerable

urban populations (Wachsmuth et al., 2016). It must be recognised that networked urban experimentation is fuelling extensive physical retrofits to cities the world over, resulting in material infrastructures that are very often far more long-lived than the political interests that created them. With limited experimentation on the ways we govern this material embodiment of climate action, infrastructures could further stabilise conditions for uneven development that make the 'urban age' a fundamentally socio-economically polarised epoch (Gordon and Acuto, 2015; McGuirk et al., 2015).

A more pragmatic ambition

Judged on certain metrics, the track record of cities such as those of the C40 Climate Leadership Group in delivering action 'on the ground' is impressive. Even though many cities lack formal powers and cannot always take policy action unilaterally, cities have demonstrated ahead of the Paris Agreement that such barriers can be circumvented by working through partnerships (C40 and ARUP, 2015c). Yet, cities cannot 'save the planet' alone. Our assessment is that the current nature of networked urban climate change experimentation is characterised by some limits to which we have sought to draw attention. Networked experimentation that is producing 'scaling out' arguably holds limited potential for achieving 'scaling up' of experiments beyond the urban level of governance, or realising more transformative outcomes that could be achieved through experimentation with processes and structures of urban governance and politics. Thus while networked urban experimentation has perhaps raised the ambition of global climate governance and started delivering mitigation and adaptation impacts, the logics by which this experimentation currently operates also represent pitfalls which may cause urban climate action to ultimately fail to meet its ambition. Weighing the ambition of networked urban climate change experimentation, it can be said that to tackle climate change, ambition must be ever evolving, and the nature of urban climate action subject to critical reflection. With reference to the two pitfalls we have discussed, we suggest ways in which these can potentially be addressed and networked urban experimentation catalysed, with an eye to offering suggestions to practitioners and cities, but also to the type of engaged academics whose work straddles policy and theory.

First, more attention should be given to 'scaling up' experiments, as complementary to currently dominant 'scaling out' processes. Identifying scaling up pathways for urban climate change experimentation is a crucial research and policy agenda. As it is recognised that cities cannot address climate change in isolation, scholarly attempts to disprove the efficacy or potential of urban climate action are unproductive. The reality of climate change governance today is arguably polycentric: cities are experimenting at the scale of urban governance, whereas experimentation is also needed on other scales (Ostrom, 2010). Despite this, striving for an effective global climate governance architecture in the institutional sense is still important. The research agenda on linkages between climate governance scales and actors

could in the future fruitfully focus on identifying pathways for 'scaling up' of experiments from urban to national and global levels. Vertical linkages to support scaling up pathways could be created through the National Urban Policies frameworks recently encouraged in the UN New Urban Agenda and the Sustainable Development Goals. These frameworks should seek to map out the knowledge and financial flows between actors at different levels that would support scaling up of urban climate change experiments in different sectors and policy areas. In order for effective linkages between such international fora and urban experimentation, it is imperative that cities have direct access to the international sphere and a seat at the table in major international frameworks.

Second, the potential of cities acting as policy and governance 'laboratories' of future climate-proof society could be more ambitiously realised by focusing not just on technical solutions, but also experimenting with governance, institutions, political logics, if not building blocks of the international system like citizenship and sovereignty. This type of experimentation is arguably the most challenging and would require further internationally-oriented capacity-building to be fully capitalised on by local governments. City leaders are rarely trained in international networking, diplomacy or politics, and more could be done on that front by both universities and major philanthropic investors, if not by the United Nations.

Having pointed to ways in which the experimental agency of cities could be supported, pragmatism is nevertheless needed in the realm of everyday urban governance that cities present international affairs with. Often the constraining impact of national and global politics on the agency of cities for climate action is absent from the debate. The ebb-and-flow of neoliberal ideology has periodically caused national governments to drastically reduce public spending, which can have a major impact on climate change experimentation by local government. The UK is a stark example of this, where local government councils in England and Wales – formally in control of a number of climate-relevant policy domains such as transport, housing and waste – have had their central government funding cut by 40 per cent between 2010 and 2015 as part of the public austerity programme of the Conservative government (Bounds and Tighe, 2017), and which is set to reduce by a further 77 per cent from 2015 to 2020 (Bounds, 2017). With these kinds of national policy shifts occurring in the background, much of the debate regarding the potential of cities for climate action is empty if politics is not part of the discussion. Weighing the potential of urban climate action thus requires not only considering forms of intervention and actor linkages, but also broader politics not typically discussed in relation to climate change governance. International financial institutions could have an important role to play in enabling direct access to climate finance for cities within adverse political climates. More fundamentally, the constraining influence of national governments in some cases also raises the question of enhanced urban autonomy as a new political project for cities to strengthen capacity for sustainable and just urban development (Bulkeley et al., 2016).

We conclude with some recommendations for future research on urban climate governance, with reference to the conceptual unpacking in the first part of this article. We have argued that networked experimentation can be understood as an urban governance process driven by priorities that go beyond concerns of climate change or priorities of the UNFCCC regime. This evolution of drivers is not problematic per se, and indeed may only reflect the mainstreaming of climate change as a cross-cutting priority within urban governance. However, we argue that there is a need for further work on the synergies and tensions between emerging priorities and forms of urbanism driving urban experimentation, and the priorities of global climate governance. For example, bibliometric analysis indicates that 'in 2012, the "smart city" surpassed the "sustainable city" in frequency of occurrence in academic discourse' (de Jong et al., 2015, p. 36), but it remains unclear to what extent 'smart' urban experimentation delivers co-benefits for climate change mitigation and adaptation. We have also argued that the role of city networking in shaping urban climate change experimentation should be a core part of the agenda. This goes beyond a focus on transnational actors in climate governance, to consider the agency of local governments in networking in diverse ways: strategically choosing to participate in different city networks through membership, but also networking with a range of other actors such as international organisations, international financial institutions, private sector actors and philanthropic organisations. Research on the role of these networked actor constellations in shaping experiments 'on the ground' is needed.

Finally, while the analytical conflation of sub-state and non-state actors is understandable in the context of the traditional focus of global governance research on nation states, we would like to gently point out that to scholars working on urban governance, equating a city with a non-state actor such as a multinational corporation is incomprehensible and analytically useless. To push forward the research agenda, future work on climate governance should make clear distinctions between local governments and other actors from the outset. In the post-Paris era, cities deserve conceptual lenses befitting their importance as key players in global climate governance.

Notes

1. We have been collaborating closely with C40 for a number of years (cf. C40 and ARUP 2015a,b,c). Our discussion of the network is thus not simply an external appraisal, but built on several years of engagement and a desire to support the network to develop in addressing climate change effectively, recognising that C40 has made important progress in this direction since its inception in 2005. This is a similar engaged (or co-produced) research approach to that we have already discussed in *Global Policy* in relation to collaborating with the World Health Organization (see Acuto et al., 2017).
2. Climate actions are defined as 'the measures and initiatives cities take to reduce the severity of climate change (mitigation), or their exposure to the effects of climate change (adaptation)' (as per C40 and ARUP, 2015a, p. 18). Based on our experience with the workings of the C40 network we would argue that these qualify as urban

climate change experiments in the sense of Bulkeley and Castán Broto (2013).

3. Other major networks like United Cities and Local Governments or Metropolis have, for instance, called for their members to scale up action on Sustainable Development Goals and good governance respectively.

4. For instance the Futures Cities Catapult and Sharing Cities Programme in London, the Los Angeles Innovation and Performance Commission and Innovation Fund, Laboratorio para la Ciudad in Mexico City and the Finnish government experimentation platform.

References

Acuto, M. (2013). *Global Cities, Governance and Diplomacy: The Urban Link*. London: Routledge.

Acuto, M. (2016) 'Give Cities a Seat at the Top Table', *Nature*, 537 (7622), pp. 611–613.

Acuto, M., Morissette, M., and Tsouros, A. (2017) 'City Diplomacy: Towards More Strategic Networking? Learning with WHO Healthy Cities', *Global Policy*, 8 (1), pp. 14–22.

Acuto, M. and Rayner, S. (2016) 'City Networks: Breaking Gridlocks or Forging (New) Lock-ins?' *International Affairs*, 92 (5), pp. 1147–1166.

Bai, X., Roberts, B. and Chen, J. (2010) 'Urban Sustainability Experiments in Asia: Patterns and Pathways', *Environmental Science and Policy*, 13 (4), pp. 312–325.

Bai, X., Dawson, R. J., Ürge-Vorsatz, D., Delgado, G. C., Barau, A. S., Dhakal, S. et al. (2018) 'Six Research Priorities for Cities and Climate Change', *Nature*, 555 (7694), pp. 23–25.

Barber, B. R. (2017) *Cool Cities: Urban Sovereignty and the Fix for Global Warming*. New Haven, CT: Yale University Press.

Bernstein, S. (2012) *The Compromise of Liberal Environmentalism*. New York: Columbia University Press.

Betsill, M., Dubash, N. K., Paterson, M., van Asselt, H., Vihma, A., Winkler, H. (2015) 'Building Productive Links between the UNFCCC and the Broader Global Climate Governance Landscape', *Global Environmental Politics*, 15 (2), pp. 1–10.

Bloomberg, M. (2015) 'City Century: Why Municipalities are the Key to Fighting Climate Change', *Foreign Affairs*, 94 (5), pp. 116–124.

Bloomberg, M. and Pope, C. (2017) *Climate of Hope: How Cities, Businesses and Citizens Can Save the Planet*. New York: St Martin's Press.

Bontenbal, M. and van Lindert, P. (2009) 'Transnational city-to-city Cooperation: Issues Arising from Theory and Practice', *Habitat International*, 2 (33), pp. 131–133.

Bos, J. J. and Brown, R. R. (2012) 'Governance Experimentation and Factors of Success in Socio-technical Transitions in the Urban Water Sector', *Technological Forecasting & Social Change*, 79 (7), pp. 1340–1353.

Bounds, A. (2017). 'Local Councils to see Central Funding Fall by 77% by 2020', *Financial Times*, July 4. [online]. Available from: https://www.ft.com/content/9c6b5284-6000-11e7-91a7-502f7ee26895 [Accessed 31 July 2018].

Bounds, A. and Tighe, C. (2017). 'Austerity Pushes Local Authorities into Great British Sell-off' *Financial Times*, January 19. [online]. Available from: https://www.ft.com/content/cf4b4a26-d8b8-11e6-944b-e7eb37a6aa8e [Accessed 31 July 2018].

Bouteligier, S. (2013) *Cities, Networks, and Global Environmental Governance: Spaces of Innovation, Places of Leadership*. London: Routledge.

Bouteligier, S. (2014) 'Urban Sustainability Pilot Projects: Fit or Misfit between Challenge and Solution?' in F. Padt, P. Opdam, N. Polman and C. Termeer et al. (eds.). *Scale-sensitive Governance of the Environment*. Chichester: Wiley Blackwell, pp. 188–202.

Bulkeley, H. (2010) 'Cities and the Governing of Climate Change', *Annual Review of Environment and Resources*, 35 (1), pp. 229–253.

Bulkeley, H. and Castán Broto, V. (2013) 'Government by Experiment? Global Cities and the Governing of Climate Change', *Transactions of the Institute of British Geographers*, 38 (3), pp. 361–375.

Bulkeley, H., Castán Broto, V. and Edwards, G. (2012) 'Bringing Climate Change to the City: Towards Low Carbon Urbanism?' *Local Environment*, 17 (5), pp. 545–551.

Bulkeley, H. Luque-Ayala, A., McFarlane, C. and MacLeod, G. (2016) 'Enhancing Urban Autonomy: Towards a New Political Project for Cities', *Urban Studies*, 55 (4), pp. 702–719.

C40. (2015). '2015 Awards, Stockholm – Stockholm Royal Seaport', C40 Climate Cities Leadership Group [online]. Available from: http://www.c40.org/awards/2015-awards/profiles/70 [Accessed March 14, 2017].

C40 and ARUP. (2015a). *Climate Action in Megacities 3.0*. London: C40 Cities Climate Leadership Group and ARUP.

C40 and ARUP. (2015b). *Potential for Climate Action*. London: C40 Cities Climate Leadership Group and ARUP.

C40 and ARUP. (2015c). *Powering Climate Action: Cities as Global Changemakers*. London: C40 Cities Climate Leadership Group and ARUP.

Castán Broto, V. and Bulkeley, H. (2013) 'A Survey of Urban Climate Change Experiments in 100 cities', *Global Environmental Change*, 23 (1), pp. 92–102.

Coenen, L., Benneworth, P. and Truffer, B. (2012) 'Toward a Spatial Perspective on Sustainability Transitions', *Research Policy*, 41 (6), pp. 968–979.

Corfee-Morlot, J. Kamal-Chaoui, L., Donovan, M. G., Cochran, I., Robert, A. and Teasdale, P. J. (2009). *Cities, Climate Change and Multilevel Governance*. OECD Environment Working Papers No 14. Paris: OECD Publishing.

Cremer, R. D., De Bruin, A. and Dupuis, A. (2001) 'International Sister-cities: Bridging the Global-local Divide', *American Journal of Economics and Sociology*, 60 (1), pp. 377–401.

Curtis, S. (2016a) *Global Cities and Global Order*. Oxford: Oxford University Press.

Curtis, S. (2016b) 'Cities and Global Governance: State Failure or a New Global Order?' *Millennium*, 44 (3), pp. 455–477.

Curtis, S. (2018) 'Global Cities and the Ends of Globalism', *New Global Studies*, 12 (1), pp. 75–90.

Davidson, K. and Gleeson, B. (2015) 'Interrogating Urban Climate Leadership: Toward a Political Ecology of the C40 Network', *Global Environmental Politics*, 15 (4), pp. 21–38.

Frantzeskaki, N., Castán Broto, V., Coenen, L. and Loorbach, D. (2017) *Urban Sustainability Transitions*. London: Routledge.

Fuhr, H., Hickmann, T. and Kern, K. (2017) 'The Role of Cities in Multi-level Climate Governance: Local Climate Policies and the 1.5C Target', *Current Opinion in Environmental Sustainability*, 30 (1), pp. 1–6.

Geels, F. W., Sovacool, B. K., Schwanen, T. and Sorrell, S. (2017) 'Sociotechnical Transitions for Deep Decarbonization', *Science*, 357 (6357), pp. 1242–1244.

Gordon, D. J. (2016) 'Lament for a Network? Cities and Networked Climate Governance in Canada', *Environment and Planning C: Government and Policy*, 34 (3), pp. 529–545.

Gordon, D. and Acuto, M. (2015) 'If Cities are the Solution, What are the Problems? The Promise and Perils of Urban Climate Leadership', in C. Johnson, N. Toly, and H. Schroeder (Eds.), *The Urban Climate Challenge: Rethinking the Role of Cities in the Global Climate Regime*. London: Routledge, pp. 63–81.

Gutiérrez-Camps, A. (2013) 'Local Efforts and Global Impacts: A City-Diplomacy Initiative on Decentralisation', *Perspectives*, 21 (2), pp. 49–61.

Hale, T., Held, D. and Young, K. (2013) *Gridlock: Why Global Cooperation is Failing When We Need It Most*. Cambridge: Polity.

Haselmayer, S. (2018) 'The De-globalized City', *New Global Studies*, 12 (1), pp. 65–73.

Hodson, M. and Marvin, S. (2007) 'Understanding the Role of the National Exemplar in Constructing "Strategic Glurbanization"', *International Journal of Urban and Regional Research*, 31 (2), pp. 303–325.

Hodson, M. and Marvin, S. (2010a) 'Can Cities Shape Socio-technical Transitions and How Would We Know if They Were?' *Research Policy*, 39, pp. 477–485.

Hodson, M. and Marvin, S. (2010b) 'Urbanism in the Anthropocene: Ecological Urbanism or Premium Ecological Enclaves?' *City*, 14 (3), pp. 298–313.

Hodson, M., Geels, F. and McMeekin, A. (2017) 'Reconfiguring Urban Sustainability Transitions, Analysing Multiplicity', *Sustainability*, 9 (2), pp. 299–20.

Hoffmann, M. J. (2011) *Climate Governance at the Crossroads*. New York: Oxford University Press.

Högström, E., Wangel, J. and Henriksson, G. (2013) 'Performing Sustainability: Institutions, Inertia, and the Practices of Everyday Life', in J. Metzger and A. Rader Olsson (Eds.), *Sustainable Stockholm: Exploring Urban Sustainability in Europe's Greenest City*. London: Routledge pp. 147–167.

Hoogma, R., Kemp, R., Schot, J. and Truffer, B. (2002) *Experimenting for Sustainable Transport: The Approach of Strategic Niche Management*. London: Routledge.

Huang, F., Blaschke, S. and Lucas, H. (2017) 'Beyond Pilotitis: Taking Digital Health Interventions to the National Level in China and Uganda', *Globalization and Health*, 13 (49), https://doi.org/10.1186/s12992-017-0275-z.

Johnson, C. A. (2017) *The Power of Cities in Global Climate Politics: Saviours, Supplicants or Agents of Change?* London: Palgrave Macmillan.

de Jong, M., Joss, S., Schraven, D., Zhan, C. and Weijnen, M. (2015) 'Sustainable-Smart-Resilient-Low Carbon-Eco-Knowledge Cities; Making Sense of a Multitude of Concepts Promoting Sustainable Urbanization', *Journal of Cleaner Production*, 109 (C), pp. 25–38.

Kern, K. and Bulkeley, H. (2009) 'Cities, Europeanization and Multi-Level Governance: Governing Climate Change through Transnational Municipal Networks', *Journal of Common Market Studies*, 47 (2), pp. 309–332.

Kivimaa, P., Hildén, M., Huitema, D., Jordan, A. and Newig, J. (2017) 'Experiments in Climate Governance – A Systematic Review of Research on Energy and Built Environment Transitions', *Journal of Cleaner Production*, 169 (1), pp. 17–29.

Luederitz, C., Schäpke, N., Wiek, A., Lang, D. J., Bergmann, N. and Bos, J. J. et al. (2016) 'Learning Through Evaluation–A Tentative Evaluative Scheme for Sustainability Transition Experiments', *Journal of Cleaner Production*, 169 (1), pp. 61–76.

Mamadouh, V., van der Wusten, H., Dittmer, J. and McConnell, F. (2016) 'The Paradiplomacy of Cities and Regions: Transnational Relations between Sub-State Political Entities', in J. Dittmer and F. McConnell (Eds.), *Diplomatic Cultures and International Politics: Translations, Spaces and Alternatives*. London: Routledge, pp. 135–153.

McCann, E. (2017) 'Mobilities, Politics, and the Future: Critical Geographies of Green Urbanism', *Environment and Planning A*, 49 (8), pp. 1816–1823.

McGuirk, P., Dowling, R., Brennan, C. and Bulkeley, H. (2015) 'Urban Carbon Governance Experiments: The Role of Australian Local Governments', *Geographical Research*, 53 (1), pp. 39–52.

Ostrom, E. (2010) 'Polycentric Systems for Coping with Collective Action and Global Environmental Change', *Global Environmental Change*, 20 (4), pp. 550–557.

Peng, Y. and Bai, X. (2018) 'Experimenting Towards a Low-carbon City: Policy Evolution and Nested Structure of Innovation', *Journal of Cleaner Production*, 174, pp. 201–212.

Schot, J. and Geels, F. W. (2008) 'Strategic Niche Management and Sustainable Innovation Journeys: Theory, Findings, Research Agenda, and Policy', *Technology Analysis & Strategic Management*, 20 (5), pp. 537–554.

Sengers, F., Wieczorek, A. J. and Raven, R. (2016) 'Experimenting for Sustainability Transitions: A Systematic Literature Review', *Technological Forecasting & Social Change*. Available from: https://doi.org/10.1016/j.techfore.2016.08.031.

Setzer, J. (2015) 'Testing the Boundaries of Subnational Diplomacy: The International Climate Action of Local and Regional Governments', *Transnational Environmental Law*, 4 (2), 319–337.

SymbioCity (2017) *Kenya SymbioCity Programme* [online]. Available from: http://www.symbiocity.org/Templates/Pages/Page.aspx?id=415&epslanguage=en#subpageanchor [Accessed 14 March 2017].

Tomassini, M., Gaggi, S., Enei, R., Pietroni, F., Poppeliers, R., Rodrigues, M. et al. (2016) *EU Financial Support to Sustainable Urban Mobility and to the Use of Alternative Fuels in EU Urban Areas*. Directorate-General for Mobility and Transport, Unit MOVE B4 - Sustainable & Intelligent Transport. Brussels: European Commission.

Turnheim, B., Kivimaa, P. and Berkhout, F. (2018) *Innovating Climate Governance: Moving Beyond Experiments*. Cambridge: Cambridge University Press.

UNFCCC. (2015). *Adoption of the Paris Agreement, Draft Decision CP.21*. COP21, Paris. United Nations Framework Convention on Climate Change.

van Buuren, A., Vreugdenhil, H., Van Popering-Verkerk, J., Ellen, G., Van Leeuwen, C. and Breman, B. (2018) 'The Pilot Paradox', in B. Turnheim, P. Kivimaa and F. Berkhout (eds.). *Innovating Climate Governance: Moving Beyond Experiments*. Cambridge: Cambridge University Press, pp. 145–165.

van den Bosch, S. and Rotmans, J. (2008) *Deepening, Broadening and Scaling up: A Framework for Steering Transition Experiments*. Knowledge Centre for Sustainable System Innovations and Transitions (KCT), TNO Strategy and Policy, Kenniscentrum.

van Doren, D., Driessen, P. P. J., Runhaar, H. and Glezen, M. (2018) 'Scaling-up low-carbon urban initiatives: Towards a better understanding', *Urban Studies*, 55 (1), pp. 175–194.

Wachsmuth, D., Cohen, D. A. and Angelo, H. (2016) 'Expand the Frontiers of Urban Sustainability', *Nature*, 536 (7617), pp. 391–393.

Wangel, J. (2013) 'Hur Hållbara är Hammarby Sjöstad och Norra Djurgårdsstaden?' in H. Teleman, C. Caldenby, E. Ullstad, and F. von Platen (eds). *Hållbarhetens villkor*. Malmö: Arena, pp. 1–19.

Williams, J. (2016) 'Can Low Carbon City Experiments Transform the Development Regime?' *Futures*, 77 (1), pp. 80–96.

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