

Roadmap towards justice in urban climate adaptation research

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The 2015 United Nations Climate Change Conference in Paris (COP21) highlighted the importance of cities to climate action, as well as the unjust burdens borne by the world's most disadvantaged peoples in addressing climate impacts. Few studies have documented the barriers to redressing the drivers of social vulnerability as part of urban local climate change adaptation efforts, or evaluated how emerging adaptation plans impact marginalized groups. Here, we present a roadmap to reorient research on the social dimensions of urban climate adaptation around four issues of equity and justice: (1) broadening participation in adaptation planning; (2) expanding adaptation to rapidly growing cities and those with low financial or institutional capacity; (3) adopting a multilevel and multi-scalar approach to adaptation planning; and (4) integrating justice into infrastructure and urban design processes. Responding to these empirical and theoretical research needs is the first step towards identifying pathways to more transformative adaptation policies.

Climate change unjustly impacts the poorest and most marginalized groups of society who have contributed minimally to global emissions, but are among the most affected^{1,2}. Early research and policies on this issue in urban areas catalysed adaptation action by identifying the conditions that enable cities to undertake risk and vulnerability assessments, draft adaptation plans, and evaluate implementation options^{3,4}. Many initiatives recognized the importance of promoting procedural justice by including residents, non-governmental organizations and other civil society actors in adaptation planning processes⁵. As more cities begin to plan for climate change adaptation, the outcomes of these interventions need to enhance marginalized communities' access to the services, infrastructure and livelihoods required to sustain their wellbeing and potential for improvement, rather than exacerbating their vulnerability.

Researchers and decision-makers supporting these objectives have opportunities to more critically assess how the unevenness of existing development affects urban adaptation plans and projects, and how these in turn shape the socio-spatial distribution of risks, vulnerabilities and adaptive capacity. So far, efforts to promote urban adaptation planning have focused on the municipal level⁶. However, placing the burden of responsibility on local governments without strengthening their financial and technical capacity accentuates the differences between the ability of different cities to adapt⁷. This can disadvantage many poorer and less capable cities that are unable to launch adaptation planning, much less engage their disadvantaged communities in this process. Focusing

on the municipal scale hinders the systematic evaluation of how variations in socio-economic conditions, political voice and governance capacity across cities affect the cumulative adaptation of urban regions. It also obscures needs for complementary actions across multiple levels of government and sectors to redress inequities in the responses to climate change⁷.

In response to such challenges, we propose a roadmap for research focused on four interrelated opportunities to advance equitable socio-spatial adaptation:

- Broadening participation in adaptation planning across municipal and civil society actors.
- Expanding adaptation support to rapidly growing cities and to those with low financial or institutional capacity.
- Adopting multilevel and multi-scalar approaches to plan, fund and implement adaptation actions.
- Integrating justice criteria into infrastructure systems and urban design processes to catalyse equitable adaptation on the ground.

This builds on the scholarship of JoAnn Carmin (1957–2014), Associate Professor in the Department of Urban Studies and Planning at the Massachusetts Institute of Technology (MIT) and pioneering scholar of environmental and civil society movements and urban climate governance. We distil these themes from contributions of participants at the Carmin Memorial Symposium on Urban Climate Adaptation, hosted at MIT in December 2014, as well as a literature review of current research, theory and practice in

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urban adaptation. Researchers from diverse disciplines can continue Professor Carmin's legacy by examining how urban adaptation planning redresses, creates or exacerbates socio-spatial inequality.

Theories of justice in urban climate adaptation

These theories build on existing understandings of justice as the fair distribution of social and material advantages among people over time and space⁸. However, ideas of what is fair or just are deeply contested and context-dependent^{9–12}. For example, scholars of race and class argue that Rawls' classic definition of justice — that of allocating resources so that they provide the greatest benefits to the most disadvantaged⁶ — does not go far enough. Rather, the pursuit of justice first requires acknowledging that societal institutions disproportionately benefit some while denying rights and resources to others, and that the cumulative history of institutionalized oppression creates a highly uneven playing field¹⁰. Justice therefore entails not only the fair distribution of goods, but also recognizing cultural differences and removing procedural obstacles that prevent marginalized groups from meaningfully participating in decisions that affect their property, wellbeing and risk^{13–15}. More recently, scholars have argued that all people have the right to a minimum level of capabilities and opportunities in order to accomplish the goals they set for themselves^{16,17}.

Adaptation to climate change is intrinsically spatial. Ideas of spatial justice posit that socially valued resources, such as jobs, income, political voice and power, cultural acceptance, social services and environmental goods, as well as the opportunities to make use of these resources, should be equitably allocated across space^{18,19}. Although the goal is to achieve justice, most spatial justice scholars investigate the ways geographic determinants and differences shape diverse forms of spatial inequality. Neo-Marxist theorists argue that unequal distribution of urban assets, such as land, infrastructure and housing, is an inherent feature of contemporary modes of global economic production, which concentrate resources among urban elites and reproduce social structures that perpetuate uneven development^{18,20,21}. Research on urban environmental justice supports these claims by documenting how prevailing practices in development place undesirable, polluting or hazardous facilities in poor, minority neighbourhoods, or relegate disadvantaged residents to low-quality areas where land is cheap²².

Existing patterns of development have profound effects on the vulnerability to climate change experienced by different communities. Many low-income residents have no choice but to live in informal settlements, public housing, or hazardous and high-risk locations; suffer from pre-existing health conditions²³; and have few resources to prepare for, cope with and recover from stresses and shocks²⁴. These conditions of poverty can compound individual characteristics (such as age, gender and disability), as well as forms of social marginalization (such as ethnic and racial exclusion, and cultural, religious and linguistic isolation), to make disadvantaged residents especially susceptible to climate change impacts²⁵. Distributive impacts of climate change can also exacerbate procedural injustices when they lead to political disenfranchisement^{26,27}. For example, following disasters, disadvantaged communities — whether in New Orleans or Manila — are more likely to be displaced, which can lead to the loss of social and political networks, and a voice in decisions about where and how to rebuild²⁸.

Cities increasingly recognize the need to reduce social vulnerability by improving access to infrastructure, public services and awareness of climate impacts among these groups^{24,25}. In particular, some early adopter cities made a concerted effort to develop representational and participatory processes with non-governmental organizations and urban residents that place justice and equity at the centre of local adaptation efforts^{29,30}. Such consultative and collaborative learning processes raise local awareness of climate risks, identify community needs, help residents develop priority response

options, and integrate community feedback into planning processes and programme implementation^{31,32}. Innovations in participatory tools, such as using games, scenarios and community dialogues to facilitate anticipatory learning, help stakeholders assess communities' vulnerabilities while building trust and mutual understanding^{33–34}. These inclusive planning processes can improve immediate climate equity outcomes and enhance long-term stability of adaptation programmes by conveying relevant and culturally accessible climate information to socially and environmentally vulnerable groups, respecting existing cultural knowledge and values, and engaging communities from the beginning⁵. Nevertheless, participatory processes in the absence of broader reforms are not a panacea, as individuals tend to privilege short-term interests over long-term processes with uncertain outcomes, and may advocate for measures that reinforce inequalities³⁵.

Beyond participatory planning processes, efforts to adapt should, at a minimum, avoid maladaptive strategies that worsen existing social, racial, class, gender or ethnic injustices³⁶. Scholars increasingly argue that adaptation should promote more transformative social contracts that challenge or redress underlying drivers of inequality and vulnerability^{37,38}, and should prioritize the improvement of social services and protective infrastructure for marginalized groups³⁹. To this end, asset-based frameworks have been developed to help practitioners identify the most socially vulnerable populations and raise the capacity of households and communities to reduce and respond to extreme climate impacts²⁴. The capability framework^{16,17} is also applied to highlight the varying capabilities of different social groups to continue to thrive economically and culturally under climate change⁴⁰.

However, very little research has examined the actual distributive outcomes of ongoing and proposed adaptation interventions on the ground^{29,41}. Adaptation projects can, for example, entrench unequal power distribution by taking advantage of disasters to relocate disadvantaged populations from urban centres or investing scarce public resources in areas of high economic value without giving commensurate attention to historically neglected neighborhoods³⁹. Furthermore, despite the increasing popularity of 'resilience' in theory and practice, scholars of climate justice critique the concept for sidestepping politically difficult choices around the redistribution of risks, resources and power^{42,43}. Rather than advocating resiliency planning projects that purport to be politically neutral and universally beneficial, policymakers must pay more explicit attention to distributive and procedural justice implications of adaptation outcomes on the ground. In addition, they must advocate transformative approaches that redress structural risks and vulnerabilities experienced by marginalized communities.

With these challenges in mind, we present a roadmap to reorient urban climate adaptation research and practice around four interrelated research needs. These lines of research seek to empirically assess whether, when and how adaptation actions preserve the interests of urban elites or demonstrate a potential to address long-standing development needs of marginalized communities, prevent maladaptive responses, and tackle the drivers of socio-economic vulnerability^{44,45}. Future research on how scalar and spatial dimensions of adaptation planning entrench or redress social inequality is a first step towards identifying pathways to more transformative adaptation policies.

Broadening participation in urban adaptation planning

Climate adaptation is a cross-cutting challenge requiring multi-sector and multi-stakeholder participation and commitment. However, the dominant actors in urban adaptation planning at present remain "confined to the environmental wing of local authorities and disjointed from other areas of policy making"^{29,46,47}. A 2014 survey of early adopters worldwide found that a majority of cities identify only two sectors — departments of environment and

land-use planning — as actively engaged in adaptation planning and implementation. Agencies responsible for water, wastewater and solid waste management are actively engaged in only a minority of cities, while those responsible for economic development and health are rarely engaged^{48,49}.

Similarly, municipal adaptation often does not engage community or social justice advocacy groups, or it takes place in isolation from community-based adaptation planning processes^{30,50}. Only in Canada and some countries in Asia and Latin America were more than 20% of cities that planned for adaptation working with non-governmental organizations, most of which were likely to be environmental rather than community groups, according to a 2012 survey⁵¹. Although some cities do make meaningful efforts to work with community groups^{29,30}, adaptation planners too often only engage community groups on joint fact-finding for vulnerability assessments and education about climate risks, and not for the framing and identification of adaptation strategies⁵⁵.

This uneven participation by municipal departments and civil society limits the potential for adaptation to be systematically mainstreamed into local development and management policies, and stifles attention to the particular needs of disadvantaged groups. Roads, energy networks and waste management systems that function under unpredictable and extreme conditions can benefit rich and poor communities alike, and mainstreaming adaptation into land-use planning and infrastructure departments can complement socially equitable adaptation. However, socially vulnerable groups and individuals often need specific kinds of additional support, such as evacuation assistance during disasters, livelihood protection, management of chronic health risks, and help address the compound effects of multiple vulnerabilities. The lack of meaningful participation by key actors responsible for health and advancing the economic status of the marginalized suggests that adaptation plans may not adequately account for these needs.

Scholars and policymakers argue that adaptation planning should shift from sectoral plans to more integrated management, and from purely technical changes to more social and institutional approaches^{52,53}. Accordingly, effective and equitable adaptation must engage diverse actors to institutionalize the agenda within local governance⁴⁷. However, existing studies have yet to investigate how the procedural justice of adaptation planning processes shapes distributive implications of adaptation outcomes. As such, empirical research is needed to address the following questions:

- What policies have local municipal agencies developed that specifically benefit disadvantaged communities, and under what conditions do they develop and implement these proposals?
- To what extent do adaptation plans advanced by environmental and land-use planning departments prioritize redressing social vulnerability? How has participation of a broader set of municipal agencies and community groups early in adaptation planning affected strategies and outcomes, especially for socially vulnerable groups?
- When and how have community groups and social and environmental justice advocates contributed to coalitions that successfully overcame political resistance to or lack of concern for climate adaptation? What are the trade-offs between building broader coalitions and achieving consensus on shared adaptation goals?

This research would help to illuminate the strategies that cities have developed to benefit disadvantaged groups, the agencies likely to advance these proposals and the conditions under which these policies gain currency. Such work would also identify opportunities for non-traditional partnerships with stronger coalitions and strategies more likely to benefit these communities⁵⁴.

Catalysing adaptation planning across cities

Many early leaders in urban climate adaptation are national capitals, global centres of finance, or have progressive political leaders and past engagement with environmental sustainability and carbon mitigation⁵⁵. Research has focused on these cities' experiences, and has found that proactive adaptation champions in local departments, political leadership and vision⁴⁷, institutional capacity, and greater financial resources allowed these cities to engage in adaptation planning and implementation⁵⁶. However, it is equally important to assess which cities are not adapting. For most of the three million municipalities worldwide, the complexity of risk and vulnerability assessments, the demands for data and technical expertise, and the costs of implementation exceed their existing capacities⁴. Furthermore, small and medium municipalities — most with far fewer than one million residents — have less political autonomy than first-tier cities. The global urban population is expected to increase by 2.5 billion people over the next 35 years, with most growth taking place in smaller, less resourced cities in the Global South. Adaptation will need to be a priority for many of these cities, given that climate impacts are estimated to cost cities in the Global South as much as US\$109 billion annually in infrastructure investments alone^{57,58}.

To help overcome these challenges, local governments and foundations (among others) have established networks such as the C40 Cities Climate Leadership Group, 100 Resilient Cities, World Mayor's Council on Climate Change, and the Durban Adaptation Charter. These global forums provide opportunities for peer-to-peer learning, technical expertise, and platforms for policy development and transfer^{59–62}. Nevertheless, research finds that these networks are limited because most cities lack the resources to join and participate^{30,55,63}. As a result, global adaptation networks may contribute to, rather than reduce, the inequitable distribution of adaptive capacities and resources across cities and nations.

The lack of adaptation by cities with fewer resources represents a fundamental form of spatial injustice, as future resilience to climate impacts will exacerbate existing developmental gaps between large, wealthy cities and 'the rest'. These gaps point to the important — often structural — local barriers to adaptation, such as funding for implementation, competition with other cities for investments and development, political incentives for action and organizational capacity and authority^{49,51,64,65}. Although financial, institutional and human resources are in short supply even among wealthier cities and can slow their progress, such constraints are magnified in cities with lower staff and resource capacities, preventing them from initiating adaptation action⁵¹.

Identifying ways to expand adaptation to most of the world's municipalities is sorely needed, including by reconsidering the scale and level at which adaptation planning is conducted and leveraging new transnational networks to facilitate institution building and capacity diffusion among cities of all sizes⁶⁶.

- What tools (such as big data, open data and crowd sourcing), planning scales (such communities, regions, states) or modes of engagement (such as transnational municipal networks reflecting the diversity of cities and urban conditions) enable a broader range of municipalities worldwide to take steps to adapt to climate impacts?
- What lessons learned from climate adaptation advances of early adopters are relevant to small and medium cities that are rapidly growing or have limited financial and institutional capacity, given that climate impacts, vulnerability and adaptive capacity are contextually specific?

These questions help reorient the literature around bridging capacity gaps across cities of different sizes and levels of development as a prerequisite to institutionalizing synergistic, effective and

equitable urban adaptation policies. This is particularly important for poorly resourced cities trying to emulate early adopters, as many are weakly positioned to operationalize broad social justice objectives in their adaptation plans in the absence of dedicated financial resources, internal capacities for agenda coordination, and supportive intergovernmental policy mandates⁶¹.

Scales of governance for adaptation justice

Academic literature, policies, guidance documents and networks often argue that all adaptation is local because of the geographic specificity of climate impacts and vulnerabilities, and local government's control over land-use planning and development^{7,67}. A recent review found nearly 130 academic and grey documents adopting this heuristic, with 59% endorsing the concept and only 8% critiquing it⁶. However, this local framing overlooks the multilevel and multi-scalar context in which local adaptation planning takes place, and neglects emerging examples of regional or metropolitan adaptation initiatives worldwide, such as the Regional Adaptation Collaborative programme in Canada, regional climate adaptation planning (KLIMZUG) in Germany, the Southeast Florida Climate Change Compact, and the United Nations Environmental Programme's Territorial Approaches to Climate Adaptation.

Recent scholarship on multilevel governance, primarily from Europe, Canada and Australia, highlights how local climate adaptation is embedded within a complex set of tensions between local and national governments over regulatory authority and revenue assignment^{7,46,68}. Despite these advances, scholarship has yet to examine how the effects of policymaking at multiple levels of government influence the social equity of adaptation plans and implementation. Local governments in many countries lack control over key areas central to urban adaptation, including transportation, energy and water infrastructure systems, as well as social services such as public housing, welfare, risk insurance, and building codes. Long-term infrastructure upgrades and policies with potential to enhance social equity often require national or state leadership, funding and coordination⁶⁹. As a result, municipal adaptation planning tends to focus more on short-term activities that strengthen disaster-risk-preparedness systems, build neighbourhoods' adaptive and coping capacities and integrate climate considerations into land-use plans^{7,70,71}. In theory, this last element has potential to transform long-term developmental trajectories, but in practice is often overtaken by local economic development priorities⁷².

Furthermore, few studies examine the multi-scalar impacts of adaptation interventions across metropolitan regions, or the cumulative justice implications of disconnected adaptation plans. Unevenly distributed municipal adaptive capacity across cities can result in pockets of higher exposure or areas of relative protection⁷³. Adaptation interventions can produce negative spill-over effects across municipal boundaries in a metropolitan region, or transfer risks from one locale to another^{67,74,75}. For example, upstream river embankment and flood retention areas can exacerbate downstream flooding; shoreline armoring in one community can increase erosion elsewhere; and the resettlement of poor residents from central waterways to similarly vulnerable urban peripheries may weaken the adaptive capacity of already disadvantaged groups. Decision-makers' choices about the appropriate scale of adaptation and of evaluating the impacts of specific interventions influence the perceived justice of outcomes. These choices of scale are socially and politically constructed, and reflect the political rationalities that are often at the root of larger patterns of urban injustice^{18,76}.

Evaluation of how the scale of adaptation planning influences the ability of policymakers to address drivers of unequal vulnerability is needed, as is increased understanding of how interventions at multiple levels of government and across different administrative jurisdictions can facilitate or constrain equitable

adaptation outcomes⁷⁷. Future research can help identify ways to support adaptation at multiple scales and levels by addressing these key questions⁷⁸:

- How does the reliance of low-income groups on natural resources for their livelihoods make them particularly vulnerable to climate impacts at the bioregional scale?
- What are the most effective policy and planning tools for rectifying spatial and socio-economic spill-over effects of particular adaptation interventions? To what extent do emerging regional or metropolitan initiatives to plan for climate adaptation redress social vulnerability and equity challenges?
- What are the scales and metrics by which to evaluate justice and equity outcomes within dynamic multilevel and multi-scalar adaptation governance systems?
- How do values that prioritize adaptation and vulnerability reduction for marginalized communities diffuse between levels of government to become institutionalized?

Such empirical research would shed light on the policies at different levels of government that can promote equitable adaptation to climate change. It would broaden the theoretical basis for multi-scalar adaptation from socio-ecological systems and resilience^{44,45}, connecting it to existing literatures on spatial justice and regional planning^{18,79}.

Designing for spatial justice

A final limitation in efforts to advance equitable outcomes is the division between physical-infrastructure and social-institutional approaches to adaptation research, planning and implementation. Governments, designers and funders have focused on reinforcing or retrofitting infrastructure, buildings and open space as practical ways to protect cities from worsening climate disasters. Meanwhile, researchers, critical theorists and activists argue that these responses overemphasize physical and infrastructural solutions at the expense of social, economic and political reforms^{80,81}, are expensive and inflexible, and are often inappropriate given the uncertainties of climate change projections⁴.

This division seems to be shifting as researchers develop new frameworks for adaptation that aspire to be comprehensive and based on urban systems^{82,83}, and as cities, national governments and non-governmental entities worldwide propose increasingly large-scale projects. Examples of such interventions include: raised sea walls and demountable barriers in New York and New Orleans; floating districts to protect cities from rising sea levels in Rotterdam and Hamburg; retention ponds and 'floodable' zones to deal with stronger and more unpredictable storms in Rotterdam; and entirely new sections of cities designed to address multiple climate threats in Lagos and Jakarta. These projects are not simply engineering moves to 'climate proof' particular pieces of infrastructure. They reflect efforts to systemically alter the development trajectories of urban environments.

As cities envision and build more large-scale infrastructure projects, there is a need to understand who is conceiving, developing and implementing these solutions, and to what effect. Cities often undertake climate-change-oriented projects as strategic decisions to protect existing centres of global investment, economic growth and infrastructure expansion, and not towards broader environmental or social justice goals. Such interventions for 'urban ecological security' may result in 'ecological enclaves' that are touted as climate-safe zones but exclude and displace marginalized populations⁷³. This is particularly concerning because large-scale projects (for adaptation or otherwise) historically have problematic impacts on and limited social and economic benefits for urban poor communities^{84,85}. In the absence of major state funding for adaptation, public-private partnerships are financing and governing

Table 1 | Summary of four major research needs for urban adaptation justice.

Research roadmap	Key characteristics of unjust adaptation planning	Proposed research questions
Broadening participation in urban adaptation planning	<ul style="list-style-type: none"> Adaptation planning does not involve sectors key to reducing social vulnerability. Social justice advocacy and community groups are often not involved (or involved upfront) in shaping adaptation planning strategies. 	<ul style="list-style-type: none"> Under what conditions do cities prioritize the needs of marginalized populations in climate adaptation plans and projects? When and how have community groups and social and environmental justice advocates contributed to coalitions that successfully overcame political resistance to or lack of concern for climate adaptation? What are the trade-offs between building broader coalitions and needing to achieve consensus on shared adaptation goals?
Catalysing adaptation planning across cities	<ul style="list-style-type: none"> Lack of financial and human resources in rapidly growing and poorer municipalities. Support of networks limited to larger and wealthier cities. Uneven uptake of adaptation may exacerbate the developmental gap between cities. 	<ul style="list-style-type: none"> What tools, planning scales or modes of engagement enable a broader range of municipalities worldwide to adapt to climate impacts in ways that reduce the vulnerability of the disadvantaged? What lessons learned from early adopters can be relevant to small cities or those with limited capacity? How can adaptation planning at other scales of governance facilitate more widespread adaptation across all cities?
Scaling adaptation justice through multilevel and multi-scalar governance	<ul style="list-style-type: none"> Local framing of adaptation limits the potential to address justice and equity. Spill-over effects of adaptation interventions across scales and jurisdictions. Scalar mismatches between adaptation needs and existing regulations and financial schemes. 	<ul style="list-style-type: none"> What are the most effective policy and planning tools for rectifying spatial and socio-economic spill-over effects of particular adaptation interventions? What are the scales and metrics by which to evaluate justice and equity outcomes within dynamic multilevel and multi-scalar adaptation governance systems? How do values that prioritize equitable adaptation and vulnerability reduction diffuse between levels of government to become institutionalized?
Designing for spatial justice	<ul style="list-style-type: none"> Division between physical-infrastructure and social-institutional approaches to adaptation planning and implementation. Limitations of large-scale urban master plans. Adaptation priorities that exacerbate existing socio-spatial inequality. 	<ul style="list-style-type: none"> To what extent are urban and infrastructural design decisions for climate adaptation creating new waves of displacement or other forms of maladaptation? What are the responsibilities, barriers and opportunities for urban, landscape and infrastructural designers to facilitate equitable adaptation planning and outcomes? Is the traditional model of large-scale master planning adequate for tackling urban climate adaptation, especially given the concentrated risks and exposures in megacities of the Global South? What are the alternatives?

these projects⁸⁶, some of which now bundle or ‘splinter’ previously common-good infrastructures so that only paying customers benefit⁸⁷. These adaptation mechanisms need to be closely examined for transparency, accountability and equity impacts⁸⁷.

Adaptation projects will not confront issues of justice and equality, nor address the needs of the most socially vulnerable groups, if there is little interaction between adaptation researchers engaged in theorizing the spatial injustice of climate vulnerabilities and designers and engineers involved in implementing physical adaptation interventions. Ecological urban designers, concerned with integrating ecological systems and urban form^{88,89} or hybridizing natural and engineered infrastructural systems^{89,90}, are well positioned to address urban environmental change. The following questions help to integrate justice into efforts to investigate relationships between the design of physical and ecological infrastructure and social outcomes of climate change adaptation:

- To what extent are urban and infrastructural design decisions for climate adaptation creating new waves of displacement or other forms of maladaptation? Conversely, under what conditions do infrastructure projects for climate adaptation prioritize or complement efforts to address the needs of the disadvantaged?
- What criteria for social justice would be appropriate in ecosystems valuation and adaptation measures, given the growing push to monetize and commercialize these services?
- What are the responsibilities, barriers and opportunities for urban, landscape and infrastructural designers to facilitate equitable adaptation planning and outcomes?
- Is the traditional model of large-scale master planning adequate for tackling urban climate adaptation, especially given the concentrated risks and exposures in megacities of the Global South? What are the alternatives?

These questions call for empirical research examining how urban design, landscape and engineering professionals translate goals of municipal and private clients and feedback from community meetings into buildable visions for the urban environment. Bridging the divide between adaptation theory and professional planning and design practice represents a step toward envisioning a new kind of comprehensive planning that is simultaneously big enough to deal with the scale of climate impacts and small enough to respond to on-the-ground struggles of the disadvantaged.

Towards a research agenda for just adaptation

The magnitude of projected climate impacts necessitates radical and systemic changes to the design and function of cities, and relationships between the environment and society^{37,91}. Paradoxically, the need for cities to adapt is taking place in an era of austerity, decentralization and opposition to major urban interventions that can fundamentally undercut the capacity of states to carry out these changes. We identify four ways that adaptation planning approaches can exacerbate existing urban inequality and injustice: (1) the absence of key participants in adaptation planning processes to advocate for the interests of disadvantaged communities; (2) the lack of adaptation planning capacities in many cities that most need it; (3) the lack of intergovernmental frameworks that support adaptation planning at the regional and metropolitan scales; and (4) the divide between theorizing justice in academia and implementing adaptation interventions across physical designs and infrastructure systems on the ground. Table 1 summarizes these unjust planning practices and the research questions associated with each of these areas.

As a first step, this research agenda calls for empirically measuring and assessing outcomes related to justice and equity of recent and ongoing adaptation planning efforts. This involves identifying cases

where adaptation planning results in maladaptive and inequitable outcomes for marginalized groups, and those cases where planners and designers overcome existing structural limitations to advance equitable adaptation. This research will contribute to the development of a set of guiding principles, processes, models and tools for local and other governance entities to adopt in their climate adaptation policies.

This roadmap also points to opportunities to reconceive procedural justice as more than consultation with affected communities. Systemically changing key institutions shaping public health and economic wellbeing requires such public agencies to be at the table in adaptation planning. Framing adaptation as a social justice issue can also initiate dialogue between non-traditional partners — such as environment and planning departments, low-income and ethnic minority communities, and social and environmental justice advocacy groups — that can result in new coalitions promoting equitable adaptation. Similarly, opportunities exist to foster dialogue between these groups, critical theorists and urban designers to transform the way people talk about and design equitable adaptation.

Finally, this research agenda highlights the importance of evaluating the roles of different levels of government in advancing adaptation planning, and whether just adaptation approaches require rescaling state institutions and government–society relationships to cope with and manage the climate transition⁹². Past approaches to adaptation often privileged local scales of intervention based on motivated leaders, voluntary networks and non-governmental or global support frameworks. Moving forward, planners, policymakers and researchers must evaluate the justice implications of adaptation at all scales. A critical understanding of cities' roles within intergovernmental governance systems, metropolitan and ecological regions, and global market dynamics are prerequisites for just adaptation actions.

Central to Professor Carmin's legacy is dedication to environmental justice and the pursuit of empirically rigorous research to guide policy development and theorization in the fields of urban climate adaptation and environmental governance. Informed by her work and that of others, communities, cities and metropolitan regions around the world are increasingly integrating climate considerations into development and land-use plans, and engaging low-income and other marginalized communities in prioritizing and operationalizing adaptation interventions^{25,48}. It is time to evaluate the impacts of these efforts in transforming social vulnerability to climate impacts³⁸, and to identify pathways facilitating more just adaptation actions across different types of cities and actors, geographies and governance scales⁹³.

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Author contributions

L.S. led the organization of the Carmin Memorial Symposium, the development of the paper, and together with E.C. drafted the introduction, third roadmap section and conclusion; I.A., J.D., and T.S. drafted the literature review; A.A. drafted the first roadmap section; K.C.S. drafted the second; K.G. drafted the fourth; all authors, especially D.D., D.R., J.T.R. and S.V., reviewed and edited the paper.

Additional information

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Competing financial interests

The authors declare no competing financial interests.

Corrigendum: Roadmap towards justice in urban climate adaptation research

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In the version of this Perspective originally published, it was not acknowledged that this work was contributing to the ICTA 'Unit of Excellence'. This correction has been made to the online version.