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Perspective

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Towards a public policy of cities and human settlements in the 21st century

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Cities and other human settlements are major contributors to climate change and are highly vulnerable to its impacts. They are also uniquely positioned to reduce greenhouse gas emissions and lead adaptation efforts. These compound challenges and opportunities require a comprehensive perspective on the public policy of human settlements. Drawing on core literature that has driven debate around cities and climate over recent decades, we put forward a set of boundary objects that can be applied to connect the knowledge of epistemic communities and support an integrated urbanism. We then use these boundary objects to develop the Goals-Intervention-Stakeholder-Enablers (GISE) framework for a public policy of human settlements that is both place-specific and provides insights and tools useful for climate action in cities and other human settlements worldwide. Using examples from Berlin, we apply this framework to show that climate mitigation and adaptation, public health, and well-being goals are closely linked and mutually supportive when a comprehensive approach to urban public policy is applied.

Climate action is commonly considered to be designed and coordinated at the global or national level. However, the discourse increasingly points towards the downscaling of climate action, with the local level and its actors as crucial points of intervention. Action will affect everyone, and everyone will need to contribute to it: climate action is by and for people. Over half the world's population (and growing) live in cities[1], making urban-scale policy, research and practice central to progress on climate change. Still, many solutions for the design, building, retrofit, and use of urban environments often overlook the perspective of people, lack interdisciplinary integration, and fail to coalesce into comprehensive policies. Additionally, there is a notable absence of robust models for extrapolating solutions. When one city successfully implements a climate solution, how best can insights and procedures be transferred to other locations in different legal, geographic, ecological, socio-economic, and cultural contexts? Many cities lack capacity for research and planning and would benefit from tools and knowledge already available in other cities, while still matching the local setting. To advance climate action, societies need a coherent public policy of cities and human settlements that takes into account local context through a case-by-case approach while nonetheless being scalable and transferable[2,3].

Such an endeavor is supported by strong insights from different literatures and assessments. The Intergovernmental Panel on Climate Change (IPCC), for example, has considered the urban perspective in the last two assessment cycles[4,5]. Calls for an integrated urban sustainability science have been repeated[6–8], and the contribution of various disciplines have been identified[9]. As a result, insights into mitigation and adaptation in cities have been accumulated and synthesized. The World Health Organization has been increasingly engaging with health in cities since Habitat III[10] and recently published a joint guide with UN-Habitat focusing on many health and climate co-benefits indicating how public health practitioners at national and city level can act locally[11]. However, what is still lacking is guidance on how to integrate these insights into a public policy[12].

A public policy of cities and human settlements that brings a social perspective to technical solutions should consistently integrate climate action, public health, well-being, and digitalization goals[13]. The Covid-19

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pandemic demonstrated the relevance of urban-scale action for dealing with the public health crisis while at the same time acting in accordance with climate mitigation and adaptation goals[14–16]. The recent UN World Cities Report calls for a "new social contract" with universal basic income, health coverage, housing, and basic services to make cities more resilient[17]. However, climate action often takes a backseat to pressing development and growth needs, especially in cities worldwide. This is particularly prevalent in the Global South, where urban growth is largest and where climate action is mostly seen as a co-benefit of development and equity, aligning with the overarching goal of achieving well-being for all[18,19].

The aim of this perspective is to develop a transdisciplinary framework for urban public policy in the context of climate change and connected sustainability challenges. We use 'urban' here to include other human settlements. With this framework, we aim to bring all relevant and concerned disciplines together, specifically motivated by making both technical, social and scientific knowledge directly relevant to municipal policies. For this, we set out why the goal of urban public policy, while concerned with climate change, should be to enable a wide array of functions that support well-being ('for people'), including access to health, education, clean water, sanitation, recreation, social belonging and community, and also to foster agency ('by people'). This multi-layered complexity requires different disciplinary perspectives bound by a transdisciplinary process[20] that includes: orientation knowledge (state of urban governance and greenhouse gas emissions, and normative goals such as carbon neutrality); systems knowledge (empirical evidence and understanding of how urban systems work); transformation knowledge (understanding of interventions that realize the goals); and process knowledge (methods and procedures of transdisciplinary research) (Fig. 1)[21,22]. We adapt this transdisciplinary framework for urban public policy research and implementation by first confronting the challenge of delineating proper boundaries of analysis. We then explore the role of pragmatic mayors and policy experimentation for resolving the challenging or even 'wicked' problems of urban sustainability, before applying the adapted framework in detail, drawing on three case studies from Berlin.

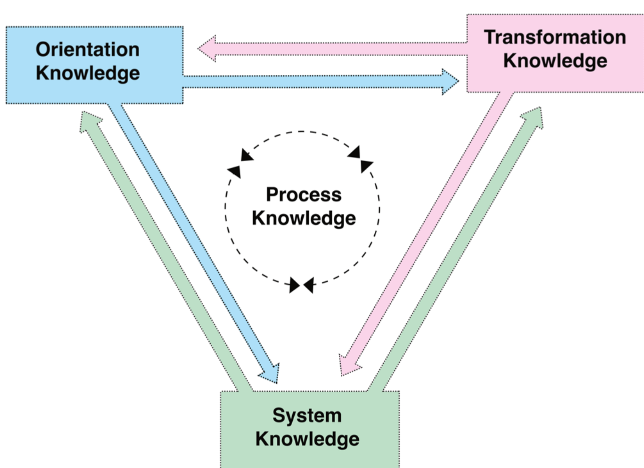

Fig. 1 | Systems, orientation, transformation, and process knowledge are generated and applied in transdisciplinary processes. Transdisciplinary research builds on interdisciplinary and multidisciplinary research. Systems knowledge involves empirical and theoretical studies spanning the spectrum from the specific, disciplinary understanding of a single phenomenon to an integrative, interdisciplinary perspective on complex relationships between phenomena. Orientation knowledge is the formulation and justification of the goals and objectives of social change processes. Transformation knowledge involves the understanding and development of technical, economic, legal, social, and cultural means to reach the desired goals or objectives. Process knowledge consists of the methodologies and procedures needed to design and carry out transdisciplinary research. Motivated by[21].

Realizing trandisciplinarity in the context of epistemic diversity

A public policy of human settlements requires and is characterized by high complexity arising from diverse, and often contested goals, interests, values and models of stakeholder collaboration[23]. While climate change has been described as a wicked problem, the intellectual origin of the conceptualization of a 'wicked problem' can be traced to experiences with the complex interrelationships between various social and environmental aspects of city planning[24]. The urban spatial dimension adds two additional levels of complexity. First, it is difficult to appropriately identify and address the relevant scale of analysis when implementing policy at anything larger than the building scale, i.e., street, neighborhood, district, town, city, city-region. Second, character and location vary widely in settings from city center, suburban, peri-urban, mixed-use, single-use, tele-connected areas. It matters *how* stakeholders, analysts and participants handle this complexity, *which* issues academics investigate in their research, and *how* municipal agencies integrate climate action in their administrations and coordinate it with other governance levels, and *which* procedures they follow when doing so.

The complexity of making decisions on environmental issues has been understood and lucidly analyzed more than 50 years ago, exemplified by the case study of the Tocks Island Dam[13] led by Robert Socolow. This demonstrated that various perspectives need to be considered to develop a comprehensive picture of what sustainability means. By necessity this transcends the evaluation framework of any specific discipline. Since then, a body of literature has evolved around the concept of transdisciplinary research, outlining key characteristics of wicked problems and procedures, and the knowledge categories needed to resolve wicked problems.

Examples of advanced water and sanitation engineering[25], urban planning and architecture[26], and advanced scholarly and religious installations[27] point to sophisticated urban governance dating back to antiquity. However, the contemporary urban disciplines on which a public policy of settlements depends merged in the first half of the 20th century.

The foundations of urban ecology and its core tenets can be traced to the work of sociologists at the University of Chicago in the 1920s[28]. Applying concepts from ecology and sociology to the study of cities, authors including Burgess, Park, and McKenzie seeded the concepts that are now socio-ecological resilience, ecosystem services, complex adaptive systems, and social-ecological systems[29,30].

Snow's pioneering epidemiological work deciphering an outbreak of cholera in Victorian era London dates to the mid 19th century[31]. Empirical methods developed most rapidly, however, following the 'avalanche of printed numbers' in the years after WWII[32]. The legacy of this work can be seen in contemporary quantitative geography (e.g.[33],) and in economists' work on 'New Economic Geography' (e.g.[34],). The statistical physics of the urban that has developed in the last 20 years can be seen as extending the epistemological frameworks and methodological practices developed by urban economists and geographers[35,36].

Engaging with the new structures of government and governance emerging in urban areas, authors including Dahl, Jacobs, Stone and Castells were key contributors in the middle of the 20th century to the development of concepts and ideas at the core of contemporary urban geography and politics literatures. Castell's "Network Society"[37], for example, develops ideas around coordination and communication between actors, differentiated capacities, fragmented authority, and political and legal contexts that can be seen today in authors applying multi-level[38,39], adaptive[40], and polycentric governance framings[41].

Socio-technical and environmental transitions authors (e.g.[42–45],) can trace foundational ideas in their work to the sociology of technology, systems theory, and evolutionary economics. Urban ecology and sustainability science has increasingly embraced a holistic social-ecological-technological systems (SETS) conceptual framework for urban systems[46,47].

This cursory exploration of the fields that developed an urban focus in the 20th century provides insight into the siloing of knowledge and practice in urban research, created by the arrival of arrived established academic disciplines. Even as urban areas shifted from being the setting to being the subject of research, each discipline brought with it certain cultures of knowledge generation[48].

The urban field has thus had long-established practices, concepts, and methodologies built into its subject from a range of epistemic communities. These foundations helped accelerate its development but the same epistemic diversity served as a barrier to the integration of knowledge across the intersection of concepts, approaches and methods. This is evidenced by the "exclusionary discourse" that has been applied to differentiate new from old contributions to urban literature[49].

A framework that enables constructive communication between these different epistemic communities is still missing. Such a framework can be utilized critical for urban transformation in the context of transformations climate action. Here we set out how boundary objects in our novel Goals-Intervention-Stakeholder-Enablers (GISE) framework fill this gap.

A boundary object approach to an urban public policy of the 21st Century: The GISE framework

Boundary objects are, i.e., concepts that can bridge gaps between social worlds or communities of practice. They can facilitate cooperation without necessitating consensus on every aspect of knowledge or methodology[50]. In essence, boundary objects are flexible enough to be interpreted differently by various communities but possess enough immutable content to maintain integrity.

Boundary objects are already widely applied in urban environmental and climate analysis. For example, climate models and projections function as tools for synthesizing complex data into actionable insights for urban planners and policymakers. Geospatial data and Geographic Information Systems (GIS) visualize spatial impacts of climate change, facilitating a shared understanding among diverse stakeholders of infrastructure vulnerabilities and adaptation needs. Frameworks for urban resilience and adaptation emerge as conceptual boundary objects, offering a common language for developing strategies that enhance the capacity of urban systems to withstand climate disturbances.

Here we suggest four domains of crosscutting knowledge that can serve as boundary objects. Orientation knowledge provides a normative frame, delineating the overarching goals and values that guide public policy and urban planning efforts towards sustainability and resilience. Orientation knowledge acts as a boundary object by encapsulating shared objectives such as carbon neutrality, enhanced urban livability, and climate adaptation. This knowledge fosters alignment across stakeholders from various disciplines—ranging from environmental science to urban sociology—by offering a common vision that informs and motivates specific action plans and policy designs.

Systems knowledge brings together the empirical and theoretical understanding of how urban systems operate. As a boundary object, systems knowledge includes data and models that describe urban metabolism, energy flows, and urban heat island effects. By providing a common factual basis, systems knowledge enables collaboration between engineers, urban planners, ecologists, and policymakers. It helps translate complex urban-climate dynamics into actionable insights, facilitating the identification of vulnerabilities and opportunities for intervention.

Transformation knowledge focuses on the strategies, technologies, and practices that can realize the goals set forth by orientation knowledge within the constraints and opportunities identified through systems knowledge. As a boundary object, transformation knowledge bridges the gap between theoretical understanding and practical application. It encompasses case studies, best practices, and innovative solutions for climate mitigation and adaptation in urban settings. By offering a kind of knowledge for validating approaches for transforming urban systems it enables practitioners and researchers from fields such as architecture, transportation planning, and environmental science to devise and implement effective climate actions grounded in interdisciplinarity.

Finally, process knowledge concerns the methodologies and procedures for engaging in transdisciplinary research and action, including stakeholder engagement, policy development, and project implementation strategies. Process knowledge acts as a boundary object by outlining the mechanisms through which interdisciplinary teams can collaborate effectively, navigate institutional landscapes, and engage with communities. This knowledge includes frameworks for participatory planning, collaborative decision-making models, and governance structures that support urban climate initiatives. By providing a blueprint for action, process knowledge enables the diverse actors involved in urban climate action to coordinate their efforts, ensuring that the process of addressing climate challenges is inclusive, equitable, and effective.

These four types of knowledge provide a structured approach for bridging disciplinary divides, fostering mutual understanding, and facilitating collective action towards sustainable urban development in the face of climate change. These domains also imply the importance of assessing: (i) co-alignment of multiple goals, targets, and pathways across policy domains such as climate, transport, and health[51]; (ii) enabling and constraining contexts, including legal frameworks and regulations, infrastructure, digitalization, education, and finance, that shape the outcomes of policy implementation[52]; (iii) governance systems managing diverse actors, interests, and capacities; (iv) interventions, policy experimentation and coalition building in support of change. To capture these elements Fig. 2 presents the Goals-Intervention-Stakeholder-Enablers (GISE) framework.

The recent IPCC reports on adaptation and mitigation placed people at the center of a newly developed Climate Resilient Development framework[53,54]. We adapt this people-centric perspective for the urban setting. People are not only stakeholders but also agents of change in shaping enabling conditions and implementing interventions towards goals that include well-being and agency, in addition to climate action. Well-being implies outcome-based justice in seeking to guarantee universal access to service provisioning systems that reduce GHG emissions and have the resources and capacity to adapt to climate extremes (cf. relevant IPCC chapters for both adaptation and mitigation[55,56]). In turn, agency implies the active involvement of citizens in contributing to climate resilient and low-carbon cities. This includes vulnerable people being empowered to exert influence on decision-making processes and decisions.

Our transdisciplinary GISE framework contributes to the long-standing debate about urban climate governance in three ways. First, in contrast to other frameworks or agenda setting pieces about global urban science[57–59], we directly address public policy of cities. Second, our framework is based on a state-of-the-art understanding of transdisciplinarity[21], thus going beyond the challenges outlined in the literature on urban climate governance[60]. Third, our contributions differ from other frameworks on urban governance and transitions[61], through our focus on people, and by clarifying the four different components of public policy (Goals, Interventions, Stakeholders, Enablers). Other frameworks[62] have similar intentions but a different focus and ignore the role of people in public policy. Our GISE framework provides practical guidance for active engagement in public policy of cities in the context of climate change.

Applying the GISE framework to urban public policy on climate change

An epistemic community on the public policy of human settlements should work on four interrelated topics: (1) co-creating context-specific goals of public policy; (2) studying interventions and pathways for reaching these goals including where possible distributional impacts; (3) understanding and addressing enabling factors and barriers in the wider institutional and infrastructural context; (4) involving a wide array of stakeholders and actors in urban governance (Fig. 2). This approach requires bridging research across urban-relevant disciplines in ways not yet foreseen.

Co-creating goals

Contributing to the ambition of the Paris Climate Agreement of staying well below 2 °C warming is an important overarching goal for municipalities. By 2021, net-zero emission targets had been adopted by at least 826 cities and 103 regions[54] worldwide. Improved adaptation and resilience to extreme

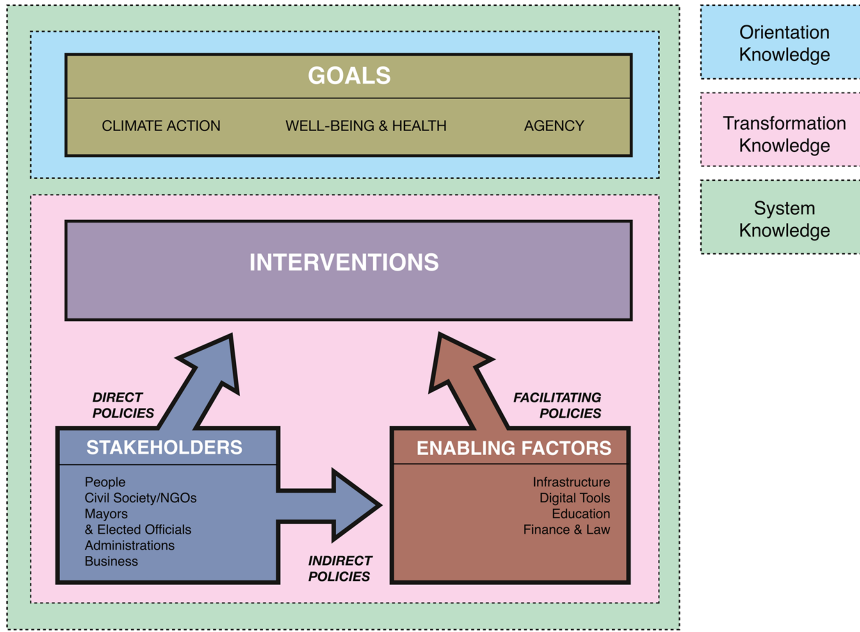

Fig. 2 | The Goals-Intervention-Stakeholder-Enablers (GISE) framework as an architecture for the study of public policy of human settlements in the context of climate change, embedded in transdisciplinary research. Public policy of human settlements builds on system knowledge, orientation knowledge, and transformation knowledge and relies on and aims to provide process knowledge. Knowledge creation (downward arrow) starts with system knowledge and understanding as well as orientation knowledge, which then induces the search for goal specific transformation knowledge. Action (upward arrow) starts the other way around, first aligning relevant actors and designing contextual enabling factors that lead to interventions that aim to achieve the desired goals.

weather are also important goals of urban climate governance to ensure the health and well-being of urban populations. These overarching climate change mitigation and adaptation goals in cities are strongly related to both material infrastructures and the digital environment, emphasizing goals related to digital sovereignty and the governance of urban data. Moreover, to be effective on the municipal level, climate action goals must be specified and worked out for the local context in a co-creative process, including local actors from politics, civil society, economy and science and following the principles of transdisciplinarity (see also the section on Stakeholders below)[63].

Goals set ambition; targets guide action and monitor progress. Figure 3 provides three illustrative examples of how climate action goals can be supported with specific targets. If relevant stakeholders are involved in the goal-setting process, the probability is high that they also actively support the actual implementation of those targets. In addition, this facilitates the provision of enabling structures. The three examples in Fig. 3 draw on experiences in Berlin and are not representative of cities worldwide; we discuss the scalability of case-specific solutions further below.

First, for decarbonizing heat in buildings, a key target is to rapidly deploy heat pumps as an energy-efficient heating technology that can be powered by electricity from renewables. Interventions include regulations (prohibition of new oil and gas heating) and co-alignment of policies (retrofitting to improve the thermal efficiency of buildings as a precondition for effective use of heat pumps). Furthermore, an essential element of reducing urban GHG emissions in the heat sector is to ensure collaborative efforts between major stakeholders, in addition to encouraging the businesses and organizations operating in Berlin to pursue more strategies to cut emissions (via tax breaks and incentive programs) (Fig. 3A).

Second, for decarbonizing transport while promoting public health, a specific target is the modal shift away from low-occupancy private cars towards active, shared, public, and micro-mobility. Interventions include the provision of safe cycling infrastructure, public spaces for people, and restrictions or banning of on-street parking (Fig. 3B).

Third, to improve urban climate resilience and reduce peak temperatures, urban planning and government entities must adopt policies and set targets that increase urban green coverage (e.g., street trees, urban parks, green roofs) and reduce impervious surfaces. This results in reduced heat stress and an increase in effective cooling via shadowing and evaporation. Interventions include city-scale land-use optimization and community awareness while addressing equity concerns in vulnerable city locations and among vulnerable populations. Accounting for urban green accessibility and constraining green gentrification (i.e. increasing housing prices from greening projects) are crucial (Fig. 3C).

Co-creating goals on 'what to do' also requires critical reflection on 'what *not* to do'. Dismantling resistant elements of incumbent systems is a critical feature of sustainability transitions[64]. Negative trends receive less attention than promising developments, but tackling these trends is key[65]. An illustration is the '*SUV-isation*' of cities: rising market shares of big heavy private vehicles counteract efficiency gains in engines and electric motors. A ban on SUVs may be an integral part of safe, just urban transport policies that enhance wellbeing. Tourism and airports are other examples: both are often considered to be outside the realm of urban climate policies, despite being a major driver of rising emissions and urban inequalities (Box 1).

Climate action and resilience goals for cities require wide boundaries of analysis, as is the case for a public policy of human settlements more generally. Asking cities to be net-zero or resilient means little if the substantial needs of city dwellers are not considered in the form of services for sanitation, housing and shelter, education, jobs, health, political participation, social security, recreation, and social interaction. Similarly for climate adaptation, it is essential to consider wider societal benefits of actions, as well as trade-offs and conflicts with other societal goals[66]. While there can be conflicts with other goals, sound urban strategies should target specific co-benefits between adaptation and mitigation[67]. In addition, giving citizens agency during the policy-making process can foster ideation and allows for a more holistic assessment of proposed policies and reduces conflicts by securing societal support for policy interventions.

Well-being has many different constituents, but one dimension above all has consistently high, beneficial and quantifiable effects—health[68]. For both climate mitigation and adaptation pathways, health effects will be considerable[69]. A few examples: modal shifts to cycling encourage active mobility, and building and urban design reduces heat stress during heat waves. The design of green spaces and streets as places for activities results in urban ecological health that benefits people's health. Nonetheless, beyond health there are broader metrics of well-being that provide a basis for evaluating climate solutions involving infrastructure, social context and urban living[55,56]. Demand-side strategies for climate solutions and service provision in urban contexts have multiple benefits for wellbeing[68]. Integrating health and climate goals can also help broaden the coalition of actors and political support for ambitious climate action.

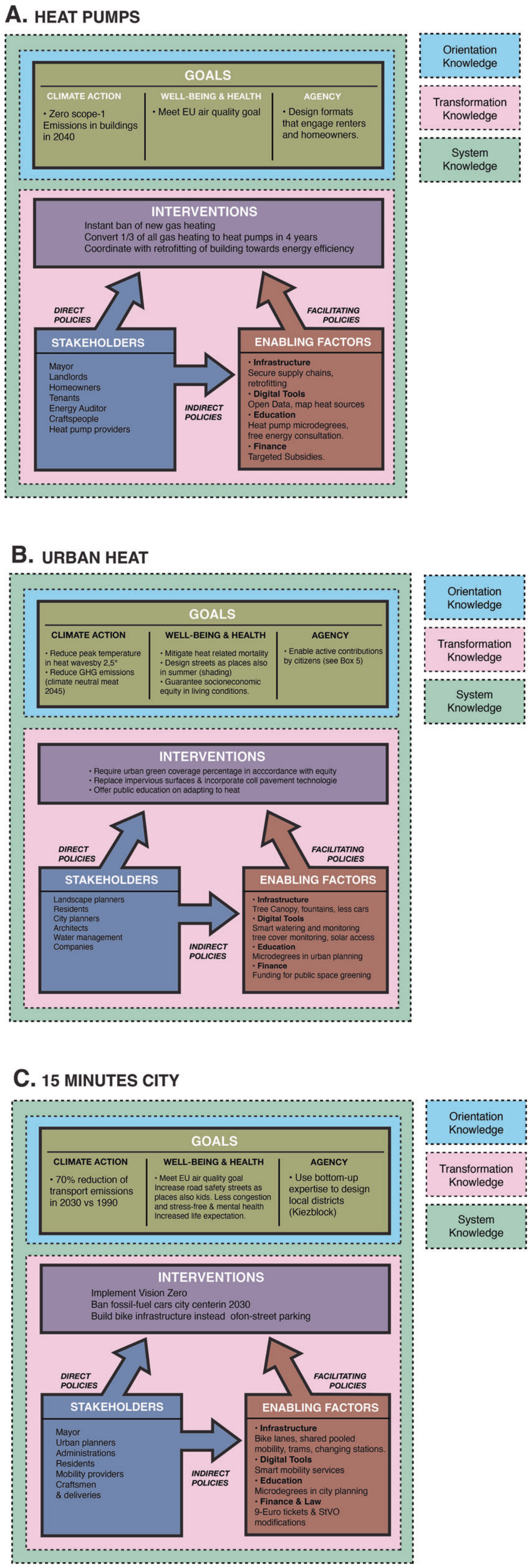

Fig. 3 | Case studies of the GISE framework in Berlin, Germany. A Roll-out of heat pumps. The share of new residential unit permits in Germany with fossil-based heating systems dropped from 90% in 2000 to around 26% in 2021, while the share with heat pumps grew from 1% to 44%[138]. However, only 2% of homes in Berlin use electric heat pumps[139]; mostly in single-family homes[140]. Further, one quarter of residential heating systems in Berlin are aged 25 years or older, and the average age is 18 years[139]. This presents an important opportunity to rapidly replace old fossil heating systems and increase the use of heat pumps for residential heating. This needs to be fostered by respective incentives for owners and legislation. While Germany's Building Energy Act[141] forbids installation of new oil boilers in new and renovated buildings from 2026, and all newly installed heating systems from 2024 must integrate at least 65% renewable energy where possible, gas heaters may still be installed as secondary systems or in replacements where heat pumps or district heat are considered infeasible. Policies and strategies must explicitly exclude oil and gas from all new buildings and replacements. If fossil heating systems are installed today, they will become stranded assets, needing replaced long before their technical end-of-life (e.g. a gas boiler installed in 2025 with a lifetime of 25 years would normally remain in use until 2050) if climate targets in the building sector are to be met. **B** 15 min City. A positive urban vision is the 15-minute city that enables citizens to meet their daily needs within a short walk or bicycle ride from their homes. Interventions to reach this goal include phasing out fossil-fuel cars, provide affordable and good public transport, radically reduced on-street parking, which also provides the opportunity for high-quality active travel infrastructure. This can be facilitated by changes in the taxation and legal framework at a national level, as well as providing street space to smart, electric, and active mobility (services) and the infrastructure these require. This requires the alignment of a multitude of stakeholders; some obvious (e.g. residents, urban planners, etc.), other perhaps less so (e.g. local businesses; urban logistics providers). These steps also lead to co-benefits for well-being and public health in terms of e.g. cleaner air and safer urban space. **C** Heat Wave Resilience. Urban communities and infrastructure play an important role in combating heat stress through representing the enabling factors to reach the desired climate protection targets. This requires a collaborative effort and interventions of stakeholders at all levels of society (e.g., urban planners, residents, utilities, housing sector, and various public corporations). Interventions to reach milestones towards heat mitigation goals require: (i) Combination of increased urban green coverage (e.g., street trees, local urban parks, green roofs) and a reduction in the impervious surfaces cover; either through replacement with vegetation cover or high albedo material (e.g., car parks and sidewalks) (ii) Identification of city vulnerable spots and population, which are most susceptible to adverse health impacts during heat waves (iii) Promotion of environmental transport modes (e.g., cycling) along with investments in providing the required infrastructure (iv) Investments in community awareness and R&D. Resulting co-benefits will reflect on both climate and public health sector and can support equity in living conditions and accessibility to green public spaces.

Agency addresses the procedural justice dimension of climate resilient development ('by people'). While climate change is a complex problem which partially requires technological solutions, agency calls for the genuine involvement of affected populations in the policy-making process. Rights-based approaches focus on capacity-building, meaningful participation in the policy- and decision-making process—especially for the most vulnerable groups—and their access to key resources, including financing, to reduce risk and adapt to climate change[53]. There is a strong relationship between well-being for all and agency in that service provisioning systems and infrastructures that underpin well-being (e.g., health, education, air quality, etc.) provide capacities for people to act. For example, the IPCC specifies that "investing in universal basic infrastructure, including sanitation, clean drinking water, drainage, electricity, and land-rights, can transform development opportunities, increase adaptive capacity, and reduce vulnerability to climate-related risks"[55]. The IPCC assessment also makes clear that social inclusion for the urban poor relies on process design by local (municipal) governments[55]. Agency of people, and in particular of those most affected by climate change, is a key procedural goal that closely co-aligns with well-being and health as outcome goals.

Agency not only directly relates to climate governance but also to indirect governance layers. A particularly important and rapidly emerging field is urban data governance. Digitalization can enable and foster citizen participation, increase trust by facilitating public audits, and allow for advanced data-driven policy-making. It serves as the foundation for comparing climate risks and policies between cities and for sharing policy evidence. Digital tools are particularly important for developing solutions that are spatially explicit and adaptable to local conditions, while being scalable

Box 1 | Limit urban airport capacity

Aviation emissions have soared, and now account for around 2% of global greenhouse gas emissions. Technological solutions to providing low-carbon flight remain distant promises[142]. Although air travel mostly happens outside cities, much of it has cities as origin or destination. Residents of large cities have comparatively high emissions from air travel after controlling for socio-economic factors. The reasons for this are multiple but likely include an induced demand effect from better accessibility to large airports[143,144]. City tourism is one of the fastest-growing tourism segments and its climate impact, though typically overlooked, can be substantial. Locally adverse impacts are not distributed equitably[145]. In 'international' cities like Brussels and Barcelona, the estimated climate footprint of inbound air travel for city tourism is as high or even higher than the official climate footprint of local residents *for all purposes*[145,146]. This could be substantially higher in developing country cities. Many cities actively contribute to these trends by promoting airport expansion through 'city-marketing' strategies that are reliant on tourism inflows from distant locations. An effective policy for climate mitigation requires a rethinking of aviation, e.g. via limiting airport capacity expansion. To make these initiatives economically viable, marketing campaigns and tourism strategies—often enthusiastically endorsed by city mayors—could move from short-stay tourism to slow travel concepts and an expansion of night-train capacity in regions with enabling railway networks.

and transferable to other cities[9]. However, the data used are often held by private actors who restrict public access to data and exploit it for commercial reasons, which are not always consistent with the public good. Here, civil society and public institutions are key actors in democratizing data governance and redistributing the value generated by citizens' personal data[70]. If public institutions do not take action, the dependence on private companies will continue to grow, with progressing lock-in effects, making it increasingly difficult to shape use of data towards public good, strengthen data sovereignty of citizens, and limit risks associated with unethical data practices.

Interventions: Pathways Analysis

Pathways analysis is an important means of identifying robust and effective interventions at given points in time while maintaining the flexibility to switch to alternative pathways in the future if required. Robustness is achieved by designing options that: are adapted to local conditions; incorporate a social-learning approach that engages citizens; are co-aligned with other goals such as health and well-being; are strategic rather than reactive. Robustness also requires adaptive decision making through an unfolding series of fuzzy moments requiring interpretation and decision-making under uncertainty[42]. But this should not be used to sideline critical technological knowledge. For example, technological analysis reveals that repeated evocations of hydrogen as a future-proof low-carbo means of heating homes home is a thermodynamic pipe dream[71]. Such insights are crucial to usefully limit the space of reasonable options and so enable directed action.

Climate mitigation pathways informed by simulation of technological options and economic costs are numerous[72–75] and have emphasized robust sectoral strategies applicable to cities: retrofitting, heat pumps, district heating, and floor space reduction in buildings; vehicle electrification, mode shifting, and car-free urban planning in transportation. However, while pathway development is expert-driven and based on scientific state of the art, the translation of these pathways into the policy arena requires the involvement of affected citizens ('by the people' and not just 'for the people'). Climate adaptation pathways are more limited, applied largely to water and land management problems[76–79], large infrastructure projects, and at national scales[80]. More locally-scaled adaptation pathways have promoted vulnerability-based thinking, but with a tendency to justify static solutions due to legal or other constraints[81].

A fine-grained understanding of such pathways needs to involve perspectives from a diverse set of stakeholders with a focus on key practitioners, as well as different tools, and disciplines ('by people')[82]. For buildings, this includes architects and designers, landscape planners, urban development professionals, building engineers and real estate analysts as well as households and citizens. Cross-disciplinary tools include bottom-up studies[83] that inform context-based, empirically-rooted agent-based modeling[84] for understanding behavioral and lifestyle changes in the context of social dynamics and other contextual enablers and barriers. Specific disciplines further contribute detailed insights. For example, urban economics reveals the interplay between marginal prices and urban form, and the relationship between transport infrastructure and settlement patterns[85].

Sectoral or disciplinary investigations must be supported by integrated urban planning, and by social studies that inform pathways with insights on distributional effects, cultural constraints, and value conflicts. Pathways explicitly allow dynamic interaction effects between implementation strategies towards specific or sectoral targets to be considered (e.g., the efficiency of heat pumps improves with more energy-efficient housing stock).

Pathways analysis also helps to evaluate the well-being co-benefits of climate action ('for people). For public health, health equity is an important concern. Pathways also need to consider possible adverse consequences for some groups, e.g., considering the accessibility of 'fuel poor' (those dependent on cars but with little income), and liquidity constraints of homeowners transitioning to heat pumps. Adverse outcomes for health equity can arise in several ways, including through population displacement due to gentrification following area-based urban greening investments[86,87]. However, well-designed and allocated green space in the city can help avoid traffic for recreation outside cities, provide space for interaction and exchange, and reduce social inequality if accessible to citizens disadvantaged through age, health or income[88].

Pathways of digitalization and its impact have been conceptualized[89], but not yet investigated at an urban scale. The availability and applicability of data for urban climate governance is an important field for further investigation, as interactions between the digital and material worlds are playing an increasingly influential role in pathways towards climate and other goals. This is especially relevant when it comes to monitoring and evaluating the implementation of climate action interventions towards established sustainability goals.

Stakeholders

Urban governance is multi-level, multi-actor and polycentric[90]. Typically, governance of cities starts with national legal frameworks, may involve region-specific regulation, has mayoral decisions at its center, includes district management, and involves various forms of direct citizen, civil society, and business participation. The agency and coordination of stakeholders, and in particular urban citizens, are therefore integral to a public policy of human settlements ('by people').

Municipal leadership and municipal executive bodies are paramount for urban action (Box 2). Although cities are more limited in legislative scope than national or regional bodies, they have certain governance advantages. For example, cities can more easily run policy experiments[91] while acting at an intermediary level to generate trust among citizens and firms in support of collective action[92].

Civil society plays an important role in urban climate action due to spatial proximity and shared experiences ('by people'). Cities tend to be the

Box 2 | Pragmatic mayors and experimenting as action

Mayors and municipal leaders can make the difference in advancing urban goals. In Bogotá, mayors Antanas Mockus and Enrique Peñalosa transformed the city by opening public spaces, increasing accessibility with bus rapid transit, and improving safety. In Copenhagen, the dedicated 'bike mayor' Ayfer Baykal led the transformation of urban transport infrastructure. In Paris, Anne Hidalgo transformed the urban environment by providing space for people. These mayoral leadership examples were enabled by focusing on specific places - a considerable advantage in urban climate action. By knowing and experiencing the concrete issues of a place, municipal stakeholders can better work towards viable solutions. Urban policy-making is pragmatic, not ideological, and mayors need to deliver on the ground, not by winning sophisticated political arguments. Their constituents care more about their daily infrastructure functioning, and less about positions along an ideological spectrum. By working on the nuts and bolts of physical infrastructure, it is possible to make progress in the 'thick' context of conflicting values, diverging lifestyles and urban living[147].

Experimentation and iterative learning are good ways to make nimble decisions that can be adaptive to changing circumstances[148]. Research on urban governance on climate change points towards lived experiences as a key means to deal with the open-ended process of resolving the wicked problem of urban climate change mitigation and adaptation[149]. Trying things out is also a way to improve the social acceptability of policies, including climate policies. An example is the Stockholm congestion charge[150], initially implemented for a 6-months trial and then permanently reintroduced. Through large observed benefits from the policy, positive media coverage, and familiarity of households with the policy and its impacts, the 6-months trial led to a change in public opinion from hostile *ex ante* to favorable *ex post*. During the Covid-19 pandemic, cities experimented with pop-up bicycle infrastructures, providing an effective niche innovation[151]. Similar shifts in public opinion from initial scepticism towards a new policy to a subsequent embracing of the policy only months later have been shown in many other contexts. Examples range from public health (a smoking ban in public places in New York City) to climate change mitigation (one of the first carbon taxes in British Columbia) to air pollution and traffic management (congestion charging in London). Numerous psychological theories including status quo biases and endowment effects predict such reversals[152]. Providing opt-out clauses allowing contentious policies or commitments to subsequently be rejected is another good design feature of experimental policy changes[148] to avoid ex ante concerns blocking change[153]. Conceptualizing changes in policies and behaviors as temporary and reversible experiments helps allay ex ante concerns and allow for positive ex post experiences of improved results.

Box 3 | Barriers for urban climate governance inside municipal administrations

City administrations are complex organizations that have a key role in any transformation process towards more sustainable living. Often processes are hindered by four factors:

A. A general culture of risk aversion leads to negative or slow decision processes. Decisions must be escalated to the highest levels, which often means the politicians[154].
B. Conflicting directives must be balanced. For instance, cities often strive to create new affordable housing, which contradicts the mandate to reduce emissions in the construction sector. Resolving these conflicts is difficult and again requires escalation.
C. City administrations need to cover all areas of urban life, making it important to interact with many different internal stakeholders. This makes processes lengthy, and requires a range of governance capacities that may be lacking[155].
D. Resources and competences can be limiting. Cities dependent on central government allocation of general taxation are exposed to major political and budgetary risks outside their control. In the UK, for example, fiscal austerity imposed by national government following the 2007–2008 global financial crisis has seen local authority budgets cut by 40% on average[156].

sites of protest, resistance, and demonstrations as manifestations of social opinion, and activism. This characteristic strengthens the link between who (citizens) and how (support desirable decisions and resist undesirable decisions). Examples of such resistance include globally networked social movements such as *Fridays for Future*, which are organized into sub-groups across various cities and have developed site-specific demands. For example, the channeling of civic frustration about missing safe bicycle infrastructure in Berlin led to a referendum and then a new mobility law at city-regional level[93].

Administrations particularly in countries that operate under civil law, are tasked with following rules, regulations, and processes that may cause tension with the emerging imperative of climate action, which has only started to be codified into law and procedures. In Germany, administrative rules governing street spaces mandate lengthy procedures and protocols for even small modifications towards sustainable transport modes or livable neighborhoods. In the US, the California Environmental Quality Act is misused to prevent low-carbon housing projects, including in-fill developments and multi-unit residential buildings. Hesitant administrations can use codification to block climate action endorsed by municipal leaders (Box 3). In other cases, municipal administrations have been hollowed out by national centralizing tendencies leaving municipal entities with insufficient powers, human resources, and financial capacity to undertake independent action.

Businesses, service providers, and skilled trades are other important stakeholders. For example, business operatives can both sell and supply the most resource-efficient products and services by default[94]. Trades people are required to implement technological solutions such as heat pumps (Fig. 3A). Associations and unions are central to promoting (re-)education and upskilling of workforces to exploit the opportunities inherent to net-zero transitions.

Coordination and collaboration between departments and government levels are essential for good urban governance. Given the complexity of administrations themselves, effective governance is therefore a multidimensional process, in which top-down, bottom-up and 'middle-out' processes mutually inform and nourish each other[95]. For example, countries with national legislation that requires cities to develop climate plans foster urban climate planning and action[96] particularly when national or supranational framework documents provide guidelines for action at lower levels of government[97]. National sectoral policies, e.g., on vehicle fleet electrification, have an outsized impact on urban GHG emission pathways. In the

Box 4 | Data governance in cities

Data governance plays an increasingly important role for climate action in cities. Currently, there are unequal data sharing arrangements between the public and the private sector. For example, the public sector openly shares schedules and occupancy profiles of public transport services with private companies. But very few private mobility operators transfer any data back to city authorities on their services. Countering this requires strong public institutions that have the expertise to recognize data related risks and the necessary resources to initiate change, for example, by mandating data sharing arrangements across various urban sectors. As an example, the city of Munich has implemented data sharing arrangements that allow all e-scooter providers to operate on city infrastructure as long as they share their data on where the e-scooters are parked and what trips are made during the day[157]. This helps the city effectively govern where e-scooters can be used and supports future urban micro-mobility strategies. Scaling such examples is constrained by inadequate data-related expertise and funding in public institutions. This results in a strong reliance on external consulting that in turn undermines in-house knowledge in the context of a fast-changing digital landscape. To effectively wrest back control from large, resource-rich data monopolies like Google or Microsoft, increased collaboration across many cities is required to generate sufficient leverage. Alongside the public sector, citizens have a crucial role to play, as in many cases it is their personal data that is powering novel digital solutions. However, current market norms are that personal data are massively collected, analyzed, shared, and monetized, with the individual having little understanding or control over the process. To counter this, a public policy of human settlements should define an alternative approach for handling citizens' data. It should embrace digital agency, enable data subjects to control their digital footprint, and engage in the governance of data to preserve political agency in society, as successfully practiced in the case of Estonia[89].

Box 5 | Barriers of scalability of citizen science to a coherent governance concept

Urban trees are increasingly exposed to climate change, suffering from droughts and heat stress. City authorities need to adapt urban strategies to such climate-induced changes by monitoring the trees' need for water and sufficiently coordinating maintenance. This responsibility does not remain at the administration level, but also residents want to actively participate and care for their lived surrounding, and can successfully contribute to their vitality. Therefore, local initiatives for community tree watering are emerging. In Berlin, the digital platform 'Gieß den Kiez'—Water your district—of the *CityLAB* intends to connect and coordinate such local watering communities. The platform maps open data on city trees and provides a prediction of their need for water to actively engage the citizens in tree maintenance through a gamified approach. Citizens can observe tree-specific information, coordinate as a community, and mark a tree as watered. Despite the positive feedback of the community and extensive media coverage, the citizen-led approach at present remains insufficient to scalability. Specific legal barriers on IT-infrastructure as well as absent human capacity and digital competence such as inadequate data-related expertise hinder the local city government from taking it up to a government-led initiative. The *CityLAB* functions as a successful intermediary platform provider, taking advantage of the E-Government law (*E-Government-Gesetz Berlin - EGovG Bln*) by using open data and providing it to the public in a visualized platform approach. This once again outlines the reliance on external intermediaries to bypass legal and educational scaling constraints and the relevance of explicit human capacity to provide interfacing. It also stresses the importance of context and stakeholder considerations in urban settings.

absence of national frameworks, international climate networks are frequently used as knowledge and information tools in a more horizontal, city-to-city approach, supporting cities and other settlements in developing local climate plans[98]. Cities in multiple networks perceive themselves, and are perceived by others, as leading actors of change towards a climate-resilient future. The 100 cities of the EU Mission on "Climate-Neutral and Smart Cities" is a good example. The Climate Emergency Declaration movement is a bottom-up form of collaboration driven by cities and local municipalities as a call for action to higher levels of government to accelerate climate action[99].

Urban data governance is an increasingly important domain for urban climate governance. It provides new opportunities for co-design between urban planners and software engineers (Box 4). With the availability of big data on infrastructures and their usage, how urban data are collected, shared, and applied to advance climate action in cities requires effective data governance and regulation in the climate-friendly configuration of spaces and places (e.g., Box 5). This is a new layer of governance in the urban realm which for millennia has been focused on the governance of physical spaces of buildings, transport, and utility networks through which services of housing, mobility, and sanitation have been provided.

Enabling factors

Climate action is not a direct consequence of decisions made by an optimizing 'social planner' but rather depends on a multi-actor decision environment and circumstances that advance or hinder implementation. People in their diverse roles, for example as professionals (urban and transport planners) and as citizens, play a central role in shaping enabling factors ('by people'). These contextual enablers and barriers can be categorized into infrastructure, data, education, finance and law.

Physical infrastructure is particularly relevant for urban governance in a spatially explicit action arena. In a city of spaces and spatial structures, decisions are not made in the abstract, but always concern one or more specific sites such as a neighborhood, street or building. Infrastructures also play a key role in urban transport. For example, a modal shift away from private vehicles to cycling requires safe cycling infrastructures (Fig. 3B). Addressing protection from heat waves with green and blue infrastructures requires a spatial consideration of parks and tree provision as well as their design to address both climate and just well-being outcomes (Fig. 3C). For example, parks designed around cultural and social activities are empirically associated with less gentrification and more just outcomes than those designed around recreation and aesthetics[100].

Digital infrastructure is rapidly emerging as a complement to physical infrastructure. For cities, big data tools support the identification of locations for individual housing units to be retrofitted with the most climate mitigation benefits at least cost[9]. Combined with social data, digital tools can also help identify where urban greening and community development can best combat distributional inequity in housing. Digital twins that create virtual simulations of physical systems enable optimal resource allocations and safe innovations to be tested '*in virtual vivo*' before being applied to physical infrastructure[101]. Remote sensing data combined with ground-truth data (including through distributed citizen science initiatives) feed high-resolution maps of urban form and movement that inform agile urban planning of location-specific changes to reduce car dependency. In turn, geo-localized social media data can reveal actions people are taking to deal with everyday challenges in the urban environment[102]. Agent-based models can then combine the big data resolution with insights on the behavior and choices of city dwellers, informing strategies on where and how to change mobility systems. Digitalization creates powerful tools for reducing greenhouse gas emissions, exemplified by novel data-driven urban planning strategies[103], or by smart and shared mobility options that reduce reliance on private cars[104,105]. An increasing collection of new data further amplifies this potential[106]. Mature and established data governance capabilities are a prerequisite for public actors who seek to utilize sensitive data to inform policy-making[107]. To democratize data governance and increase trust in data-driven decisions, open, transparent and privacy-forward processes are key. Important design principles include data separation, stewardship, and citizens' control[108,109]. It is also key to recognize that digital transformations can often lead to exclusionary impacts for impoverished citizens[110–112]. Digital infrastructure should be built and accessed in ways that reflect different groups' perspectives and needs. Those lacking the financial capacities or skills to use or engage with new technologies should not be marginalized.

Education is another contextual field that can be either enabler or barrier if it's a limited resource. Inter alia, skills and training in support of net-zero goals is a complex, multi-faceted challenge[113,114]. Berlin, for example, is lacking the skilled tradespeople, electricians, and construction workers required for heat pump installation, and the transport planners and urban designers competent in cycle infrastructure planning. Micro-degrees and the engagement of the private sector and unions are central to remove this barrier.

Finance is typically considered a national-level domain but is central to urban transitions. Cost-efficient low-carbon technologies such as heat pumps require up-front investments that are prohibitive for many households. Targeted credit programs are helpful, but climate action interventions by municipal governments require funding that largely surpasses their budgetary capacities. This means sustained national financial support for urban mitigation and adaptation policy implementation.

At the legal level, interdependencies between national and city-scale governance require alignment between regulations at both levels. District transport planners in Berlin are hindered by an arcane street regulation framework that prioritizes car transport over everything else and restricts interventions to change how street space is allocated and used in alignment with zero-carbon mobility goals.

Integrating knowledge creation and climate action

Here we tie these public policy elements back in to our transdisciplinary GISE framework (Figs. 1 and 2). At its core, knowledge creation and advancing climate action are intrinsically interwoven (vertical arrows in Fig. 2). Stakeholders and professionals involved in realizing the enabling factors are creating transformation knowledge. For example, information and global and national mitigation discussions do not always trickle down to urban professionals on the ground. Academic actors involved in public climate advisory boards not only communicate scientific insights but also serve as impartial agents that can bring other stakeholders with specific political or economic interests to the table.

Formats of knowledge creation and co-design processes, such as decision theaters and experimental games, are simultaneously required to define goals and to create both orientation and system knowledge. These formats advance climate action while simultaneously providing agency to people. The potential of co-design processes lies in their capacity to integrate stakeholders as epistemic partners to create policy solutions and plan their implementation based on situated knowledge. These processes can facilitate a way towards publicly acceptable agreements particularly if structured less around positioning within power systems and more around finding solutions that work.

Partnerships for developing shared, place-based cases for climate action provide promising examples that can be followed. Ahmedabad city's heat action plan stands out as a unique climate plan in South Asia for various reasons. The plan co-produced by the Ahmedabad Municipal corporation in partnership with several actors including academia, international partners, research organizations, and civil society emphasizes an effective early warning system, capacity building of health professionals, coordination across key government agencies and awareness initiatives. Over time, the plan has been well-adopted by the city, reduced heat related deaths and morbidities and its success led to its replication in several other Indian cities[115]. Ahmedabad and other cities, however, face challenges to mainstreaming and scaling up at the city scale such as through climate resilient housing or mandating climate actions as part of building codes. As another example, Graz is revolutionizing its climate governance through the implementation of the Climate Information System Graz. This interactive platform integrates a wealth of urban climate data sourced from simulations, measurements, thermal flights, and drone surveys. Serving as a dynamic hub, the portal not only informs urban planning but also drives organizational and political decisions. It fosters synergies with existing policy frameworks, facilitates networking among diverse stakeholders across disciplines, and promotes novel avenues for cooperation and collaboration. Climate Commissions bringing together public, private, community and private sector actors have been developed over the last several years in Durban, Surat, Edinburgh, Leeds, Belfast, Berlin and other cities. They offer avenues for collaborative climate action[116] and experimental governance[117]. Climate Commissions may also be able to develop new capacities and demand for action.

On the other hand, in extreme cases, cities work in an autocratic mode where top-down imposition plans leads to complete lack of buy-in and disconnect with the needs of people. Co-design of processes also needs to involve actors whose primary focus is not climate change. Understanding cities as a vital human habit for health at individual and population levels necessarily involves the public health profession. Health practitioners often have vital data on local health needs and trends and much-needed skills for wielding the evidence base through political advocacy, tied to a professional ethical position which encompasses health equity. Co-design of processes involving health and climate actors can thus improve decision-making on climate-resilient cities.

Scaling solutions

Dating back as far as the development of statistical physics in the nineteenth century[118], scaling urban knowledge has posed a challenge for disciplines focused on the urban[28,119–121]. Along one dimension, the challenge of scaling is the challenge of understanding the extent to which urban knowledge from one context can be applied in another (the generalizability challenge). Along a second dimension, the scaling challenge contends with the extent to which urban concepts, such as urban capacity, civic pride and the quality of governance, can be operationalized in ways that are valuable for urban research and practice (the replication challenge)[122].

Foregrounding people and communities can play an important role engaging with both these dimensions. The involvement of people and communities through citizens assemblies[123], Climate Commissions[124], climate juries[125], and by other means, is critical to the development of a better understanding of the heterogeneity of cities, to develop urban capacities, and to realize the social license needed for the rapid scaling of urban-scale climate action. People and community-centered research practices and methodologies are therefore critical for addressing the generalizability challenge. At the same time, the involvement of people and communities via citizen science movements[126], urban labs[127], participatory games[128], or other means, can help with the development of place based understanding of urban concepts, and address the challenge of replicability. Pairing the information drawn from these analyses with advances in computational social science[129], including the application of deep learning and neural networks and boosting[103], stacking and Bayesian model averaging[130], may be key to unlocking rapid advances in urban learning.

Millions of cities exist worldwide, yet only a small minority possess the capabilities to systematically explore climate solutions. Numerous cities lack the technical proficiency and financial means required for data collection, developing emissions inventories, climate scenarios downscaling, vulnerability mapping, and the formulation of climate strategies in alignment with global and national targets. Furthermore, these cities often face financial constraints, relying primarily on funding from superior government bodies or international sources. A major challenge is how solutions that are identified and implemented in some cities can be adapted and adopted by others with low transaction costs. There are broadly four approaches in research and practice for tackling this challenge.

First, comparative analysis, meta-analysis, and synthesis across case studies allow shared insights and strategies to be drawn out of many different rich and contextually grounded examples. The recent IPCC Sixth Assessment Report, for example, has a dedicated chapter synthesizing evidence on effective climate action from cities across both Global North and South[4].

Second, data-based investigations across cities use econometric or statistical techniques to identify generalizable predictors of effective urban climate action. For example, a study of 'smart local energy systems' in the UK for locally balancing renewable energy supply with flexible demand and storage resources used spatial econometric techniques to identify the skills, housing stock characteristics, and local authority competencies associated with successful implementation[131].

Third, generalized learning (machine learning) of spatially-explicit solutions across geography apply big data techniques to identify intervention priorities across large areas. Non-linear machine learning-based clustering approaches enable the identification of similar cities or districts at the country level[132] or globally[2,3,133]. Learning approaches also enable the identification of energy-relevant properties of the building stock at the scale of individual buildings for specific regions[103], and potentially for full continents[134].

Fourth, functional international climate networks of cities foster knowledge exchange and mutual learning on what works, and can accelerate transfers of local innovations and policy experiments[9]. Examples of this horizontal governance among cities include various mayoral networks, ICLEI - Local Governments for Sustainability, and the C40 Cities initiative. Also regional climate networks help support capacity-limited municipalities to exchange learning on successful interventions or to collaborate on sourcing common project finance.

Despite progress on all four of these approaches for scalability, a critical role for future urban research lies in furthering our understanding of the contexts and conditions that allow for approaches that were successful in one place to be applied in others. Future research must tackle the twin challenges of reproducibility and variability. Reproducibility challenges arise from the contested and qualitative nature of many urban concepts such as capacity, resilience, sustainability, and accountability. This makes conflicting findings between studies hard to reconcile, and the studies themselves hard to reproduce. Variability challenges are due to the complexity of urban areas, their dynamism, diversity, and histories. These challenges impede broadly applicable patterns and processes that can provide insights across a wide range of cities. Big data-driven approaches may help tackle both challenges in generalizing solutions across cities while respecting city-specific idiosyncrasies. Here, urban researchers can benefit from advances in data applications and advanced statistical approaches in other fields including sociology, psychology, and the medical sciences that have similarly faced reproducibility challenges[135,136].

Towards a public policy of human settlements in the 21st century

Jane Jacobs wrote, "*Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody.*" This is also true for cities in the 21st century. A public policy of human settlements can support climate action and the substantial sustainability challenge cities face, if stakeholders and all parts of urban societies co-create goals and contribute in their various to implementation.

With the ambition to make the substantial task actionable, we suggest the following three-fold structure to a multi- and transdisciplinary community advancing a public policy of cities and human settlements in the context of climate change. First, coordination and cooperation between planning, engineering, economic, humanities, health and social sciences and other disciplines is an integral element of a public policy of human settlements. Only a joint understanding of the challenges, as identified from starkly different perspectives, can enable resolving problems and hurdles. Being conscious of the paradigm shift in the context of the climate and energy crisis, an understanding of reduced energy and material demand and its implications for policies and urban development, will enable the identification of interventions concordant with climate and well-being goals[137]. Second, while each city is different, it is nonetheless important to scale solutions by adapting procedures across municipalities, and by learning horizontally (collaboration, networking, comparing) and vertically (big data pattern analysis). This requires adequate networking institutions and data governance structures for cities that operate in the public interest. Third, researchers and practitioners benefit from coordinating urban climate action, public health, social inclusion and agency. These domains are dynamically co-developing. Exchange can support the co-alignments of goals. Here, too, Jane Jacobs' "*everybody*" has a key role to play in engaging in social, political, and economic arenas to develop trusted data, housing, transport, health, and other infrastructures and optimizing their use and coordination. The "*everybody*" is needed in the 21st century to put urban societies onto a pathway that is in line with reaching global climate goals and fosters urban experimentation as climate action: the quintessence of our public policy of human settlements in the 21st century.

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