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Accountability and data-driven urban climate governance

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The use of increasingly large and diverse datasets to guide urban climate action has implications for how, and by whom, local governments are held accountable. This Review focuses on emerging dynamics of accountability in data-driven urban climate change governance. Current understandings of the implications for accountability are examined based on three common rationales for prioritizing data-driven decision-making: standardization, transparency and capacity building. We conclude that the trend toward data-driven urban climate governance can incentivize city governments to prioritize narrowed metrics and external interests, inhibiting the broader transformations required to realize climate change goals. We offer priorities for research at the intersection of data-driven climate governance and the accountability of city governments.

City governments are increasingly developing policies and programmes designed to reduce greenhouse gas (GHG) emissions and adapt to the consequences of climate change. The growing commitments and engagement of city governments in climate governance are generating new dimensions of accountability that have yet to be fully examined. Central among these are the growing importance of data-driven decision-making and new sources and uses for data that are produced and leveraged in urban climate governance. GHG inventories, vulnerability assessments and reporting protocols on global data platforms are some examples of data that are increasingly seen as core components of effective urban climate change policy and planning. Engaging with these new data sources often includes participating in global reporting platforms and requirements like the carbonn Cities Climate Registry (cCCR), joining city networks like the C40 and ICLEI, developing local GHG emissions inventories, implementing energy and water-use benchmarking tools, accessing local and regional climate change projections, completing climate change vulnerability assessments, and developing and implementing climate action strategies. The former chair of the C40 Cities Climate Leadership Group and UN Special Envoy for Cities and Climate Change, Michael Bloomberg, promotes the motto, "you can't manage what you don't measure."

These new sources of, and uses for, data in urban climate governance give accountability renewed importance as city governments face new accountability audiences and expectations. We define accountability as the responsibility of city governments to "render an account of their decisions and actions"[1]. This understanding of accountability is very similar to and builds on its use in broader public accountability research[2–5]. Both data-driven decision-making and accountability are crucial components of the urban response to climate change and the pursuit of a global sustainability transformation. They have the potential to shape and influence the efficacy of decarbonization initiatives and ensure the political feasibility and legitimacy of such efforts as they are undertaken in cities and by city governments. However, there are tensions and trade-offs between data-driven decision-making and accountability that are not well understood in the context of urban climate governance but are nonetheless critical to the pursuit of a global sustainability transformation[6,7].

Accountability for city governments is a central concern in local and multilevel governance scholarship. Local government accountability to the community and to regional and/or national governments has been driven by concern with democratic representation, accountability for performance and citizen participation[1,8,9]. Previous work in the public domain predominantly focuses on the effects of the use of information and communication technologies on specific types of accountability[10] as well as the different accountability relationships within a public setting—including organizational, political, legal and professional accountability[5]. This is a much broader context than the accountability dynamics highlighted in this Review, as this previous work encompasses both the accountability mechanisms that are embedded in institutional structure as well as the accountability embedded in certain actions taken by public and private organizations in addition to citizens. The rise in urban accountability practices at the global level represents a change; an emerging 'cities agenda' in global governance has led to an increased role for city governments in global politics[11]. Data-driven decision-making is embedded in this trend, as the creation of data at the city level is being highlighted as "a prerequisite to the active participation of local governments in the geopolitics of global sustainability"[11]. There are over 200 international city networks, and most are regularly involved in evidence-based reporting[12]. As city governments tackle climate change, they are engaging with both familiar and novel accountability audiences spanning from local to global constituencies.

Our aim in this Review is to provide insight and direction for urban climate governance research that can interrogate and support the accountability of local governments working to address climate change, and to support scholars and practitioners using or creating data to inform urban climate governance. It examines the diverse literatures and perspectives emerging from the rise of data-driven decision-making and its implications for accountability, with a focus on understanding the role that data-driven decision-making plays in shaping who city governments are accountable to and whether they are being held to account as they take up the climate challenge. We organize our Review around three common rationales for prioritizing data-driven decision-making—standardization, transparency and capacity building—and their implications for

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accountability in urban climate governance. We conclude that the shift toward data-driven urban climate governance has the potential to facilitate and incentivize a narrowed focus on metrics that can inhibit the broader transformations required to realize global climate change goals unless metrics and data are collected and applied with consideration for democracy, social justice, accessibility and local context. Key intervention points include shared international reporting frameworks, efforts to increase the usability and accessibility of public data, and building city government capacity for not only processing data, but also embedding social justice considerations into data-driven policymaking.

The promise and perils of data-driven decision-making

The availability of new, big data sources, and the expectation that these data directly inform and improve policymaking by city governments, is not unique to climate change governance[13,14]. New technologies are allowing more data to be collected, such as sensors that have been installed around cities to track the number of cars, passengers or bikes. The online data trail of citizens in location data or social media engagements has also increased. Some of these datasets have been turned into open data, meaning they can be accessed and evaluated by the public. The technology to store these newly collected data has become more sophisticated, and the volume of data that can be held at any time has increased. Finally, there are now faster and cheaper ways of visualizing data. Open-source programs offer simple and easy ways of analysing and visualizing data, sometimes removed from an understanding of the source and structure of the raw data. City governments are increasingly engaging and experimenting with such new, data-rich tools in different policy contexts.

There is also a growing normative emphasis on data-driven and evidence-based policy as a means of increasing the efficiency, effectiveness and equity of local regulations and public service delivery[15]. Data can provide new insights for local policies, such as identifying trends in spatial developments or understanding how residents use space. New online platforms and data collection techniques potentially enhance the opportunities for government to include residents and develop participatory mechanisms for decision-making, and increase the visibility of policy measures in the urban space through open data and concrete metrics for evaluating local policies and decision-makers. Data-driven decision-making provides an opportunity for citizens to evaluate services and other policy outcomes, and therefore be more informed and empowered constituents[16]. The availability of big data may make it possible to collect and disseminate more information and facilitate the creation of new accountability tools[17].

Taken together, a central expectation of advocates of data-driven decision-making is that it will increase the accountability of city governments, or their ability to "render an account of their decisions and actions"[1]. Accountability is a pillar of good governance and is especially salient at the local level, as city governments are often in close contact with residents and face higher accountability expectations from residents than other levels of government. The ability to better hold city governments accountable is often a central rationale for encouraging data-driven decision-making, but is also a key challenge due to the politicization of data generation and use.

The points raised touch on several parallel discussions in the literature. Research into open data and the trust, transparency and democratic value elements accompanied by it[18–20], as well as the development of indicators and benchmarks at national and global levels and how they shape governance[21–24], all highlight questions of who, how and to what end databases are established. These different literatures also look at the role of organizations and institutions that develop indicators and determine the openness of the data—both for underlying indicators and the larger databases. This includes research around how databases are established and the underlying logic of indicators being used, the motivation and logic behind certain indicators and how they come to represent certain values, and to what end the data is accumulated. Research on the politics of urban data has similarly highlighted that the knowledge base for urban sustainability action is grounded in selective (and limited) ways of seeing the urban space because of who is involved in knowledge production and the emphasis on particular kinds of data[11,25].

An important gap in in this literature as it pertains to urban climate change research and practice is a critical examination of the relationship between data-driven decision-making and the accountability of city governments. The focus has often been on the form and quality of data going into the decision-making process (input) or the decisions that follow (output), rather than on the 'black box' of governance (the social and political processes that transform information into policy) that mediates the two[26]. While accountability is shaped by data availability, both are political products, and their relationship is not well understood in urban climate change governance. Decision-makers may have more or less interest in being held accountable and having their actions held up to public scrutiny. Poorly designed accountability tools and measures can also be used to legitimize decisions made without the public's best interest in mind. Creating and maintaining accountability mechanisms and criteria is a highly political exercise, and new models of data-driven decision-making make this rendering more critical.

Our aim in this Review is to examine current understandings of the relationship between data-driven urban climate change governance and the accountability of city governments. This examination is organized around three typical rationales for prioritizing data-driven decision-making: standardization, transparency and capacity building.

Implications for accountability of data standardization

Data-driven urban climate governance often relies on standardized data collection and reporting methods. Standardization can ensure rigor and structure in measuring progress on emissions or vulnerability reductions and enables shared reporting frameworks that establish a common language[27]. The practice of standardizing data collection and reporting efforts can, however, shift the site of accountability away from the means and towards the metrics of climate governance[28]. For example, complying with shared standards for GHG emissions inventories might have the unintended effect of prioritizing the inventory itself as the goal, with potential implications for the accuracy of the data and the amount of resources invested by city governments into contributing to national and global databases[29].

There is a growing consensus around GHG emissions inventory protocols at the global scale reflected in the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories, developed by the World Resources Institute, C40 and ICLEI. For many years, cities were confronted with several available reporting platforms, scattering data across multiple sources and effectively decentralizing tracking and verification[30]. Today, many of these reporting platforms have been absorbed by the Carbon Disclosure Project (CDP), where more than 800 cities now report environmental data.

Another dimension of global benchmarking and the uptake of standardized measurements is the question of 'who counts, how and for whom'[31]. Cities may be incentivized to allocate resources toward meeting certain numeric targets regardless of what these targets mean in their local context and whether they are a good representation of the measures being taken[29]. These resources include financial commitments as well as time invested into data acquisition and analysis. In order to acquire certain technological capacities or expertise, such as advanced high-performance computing or data engineering skills, local governments have to invest in training and tools[32].

The emphasis on the evaluation and comparability of urban governance performance through standardization can lead cities to overlook context-specific information[11]. The literature on indicator development and benchmarking specifically points toward this issue by highlighting that supposedly global indicators are mostly rooted in particular local or national models and make the comparison and benchmarking that follow highly political[22,33]. Focusing on carbon emissions, for example, potentially omits more potent and long-lasting instruments and measurements, and therefore does not capture the complexity of climate change threats or the range of activities city governments might (or should) engage with to address them. Urban GHG inventories often reflect very different characteristics of the urban context, and "different activity data sources, different release dates and different sources for the conversion factors" all result in different numbers[34]. City boundaries also pose a challenge in harmonizing measurements, such as whether cities decide to include estimates of emissions for goods used within the urban area that are produced elsewhere or extra-urban travel behaviour of residents (that is, Scope 3 emissions)[27,35]. While standardized data provide a tool for holding governments accountable, "data lose value as they get decoupled from the situations in which they are produced"[36]. Governments often rely on data coming from the national level or smaller projects and require extra time in terms of collaborative efforts among different teams as well streamlining of data formats[37]. This also includes handling missing data and accounting for the fact that much of this data is selective and not representative of the population living in a city[32]. Local governments often face a trade-off between consistency with the standard in question and the accuracy of the data[29]. Finally, global benchmarks, according to Broome and Quirk[38], suffer from a 'dodgy data' problem, where data might be missing and is replaced by a composition of different benchmarks, "resulting in a proliferation of data that frequently rests on very tenuous foundations"[38].

While urban climate governance has increasingly become standardized, the ability to hold cities accountable has become more complex[39,40]. Climate policies interact directly and indirectly across international, national and local scales[41,42]. Standardized climate reporting may make it harder to derive decision-making chains and actions at the local level. The main criticism arising from this shift is that it suggests that "quantification, standardization, disclosure and transparency operate less as a means of enhancing accountability between cities and external audiences than as a means of providing cities with the symbolic value of seeming 'accountable' without actually being so", such as the World Bank linking city climate change leadership and recognition to the need for quantification, standardization and transparency[40]. Standardized performance indicators are thus not always helpful in enhancing accountability and improving environmental outcomes in urban climate governance.

The trade-off between standardizing measurements and capturing local complexities is one that is inherent to making data comparable and being able to benchmark performance. This trade-off matters for accountability: local nuance can be lost or made invisible in efforts to conform to national or international standards, it can limit and redirect local resources dedicated to addressing climate change, and it can distort the regional understanding of climate change impacts. It further has implications for power relationships among stakeholders, as political debate is replaced with technical expertise[21]. Holding city governments accountable to national or global standards leads to comparability in terms of numbers but can ultimately limit knowledge about local performance addressing climate change and redirect policy attention and resources away from initiatives specific to the local context and toward efforts required to conform with standards determined elsewhere[11]. This emphasis on quantification and standards is useful for comparability but privileges certain types and sources of knowledge about the contributions of cities to global carbon emissions.

Implications for accountability of data transparency

A second rationale for data-driven policymaking is the potential for data to serve as a transparency mechanism in local decision-making processes and service provision[15]. Data are meant to make clear where the costs and benefits of a decision lie, their magnitude and timing, and their distribution. They may help to reveal the criteria that were used in decision-making, the expectations and assumptions of decision-makers, and even who the decision-makers were. Data-driven decision-making has the potential to provide concrete metrics by which voters and stakeholders can evaluate services and, therefore, similarly evaluate and express their satisfaction with municipal leaders and programmes.

Enhanced transparency through data-driven decision-making engages with broader processes and patterns of urban governance and the relationship between city governments, external stakeholders, the private sector and urban residents. Data-driven decision-making can empower the public and watchdogs to hold government and other actors accountable, but potentially marginalizes those issues and stakeholders not captured by relevant datasets[11,35]. The metrics by which decision-makers are held accountable—whether by reductions in GHG emissions, number of new programmes initiated or electricity saved (kWh)—reflect particular logics of accountability and programmatic goals, which can ultimately shape the conduct of cities. The value of transparency is highly contingent on what measures are being tracked and shared, and who is able to interpret and act on these measures[21]. Cities may seek to be externally accountable to higher levels of government, transnational organizations, private investors or financial institutions, or internally accountable to residents or the networks they participate in[40]. Both the design of accountability institutions and the execution of interventions are important, otherwise "authority holders can be held to account for their actions without necessarily mitigating negative environmental impacts"[43]. While data-centred transparency is typically an important tool for accountability[15], the institution building around transparency and reporting schemes determines the extent to which this is true[13]. Issues can be marginalized that are not quantifiable or included in datasets, making it difficult for constituents to hold city governments accountable for the issues they care about[44].

Data interpretation can also be subjective, and data availability can limit the possibility for transparency when prohibitively expensive or not readily available[14]. There is typically little transparency behind the production of urban data, such as the motivations for using certain datasets over others and the goals that are being pursued in doing so. The use of big data and technology-driven 'smart cities' strategies can serve to depoliticize and neutralize contentious and unequal policy spaces in ways that are counterproductive to problem solving[45]. While more information about the sources and trends of CO_2 emissions in cities is readily available, for example, its value for enhancing accountability of the city government for meeting its GHG reduction goals will be determined by the extent to which it is accessible and understandable to the public.

Data-driven transparency can also be used to shift accountability from the public to the private sector, which has implications for what is ultimately prioritized. Many energy-use benchmarking measures leverage the transparency they provide to shift accountability for energy conservation and GHG emissions reductions away from city halls to building owners, buyers and tenants. Programmes like energy-use benchmarking, adopted by more than 20 US cities, help to highlight major energy users in the city, providing an additional pathway for accountability[16]. The programmes make the energy use (both absolute and relative) of the city's commercial and institutional buildings public, but are rarely coupled with stringent requirements on that energy use. Rather, there is an assumption that transparency will facilitate behaviour change, and a real estate market that rewards efficiency and environmental values becomes the agent of accountability.

Transparency can be a means of securing external recognition from investors and higher levels of government (and therefore a tool of governance), and a claim to power by demonstrating the effectiveness and compliance of cities[40]. As cities become more embedded in global climate governance, the 'constituencies' to whom they are holding themselves accountable diversify and expand beyond the local[46], creating the potential for tensions and contradiction in measures meant to enhance transparency. The metrics used in international spheres of urban climate change accountability reflect an interest in demonstrating cities as attractive sites for investment rather than the environmental imperative of reducing GHG emissions. For example, highlighting the efficiencies and demonstrating GHG emissions reductions can help attract investors, exemplified by a recent Price Waterhouse Coopers report that lists transparency as "an essential factor driving the ability of cities to secure access to private capital and much-needed investment"[40]. Such practices reinforce economic over environmental objectives and shape what cities will be held accountable for through enhanced transparency.

Publicly available data and accounting methods can empower the public and other watchdogs to hold governments accountable for their emissions reduction targets and other climate change goals, shining a light on government performance and the behaviours of other actors in the city. Greater transparency can also serve to build or rebuild trust in government, a growing challenge for many cities. The value of increased use and provision of data as a transparency mechanism designed to improve service delivery and build trust is limited by the ability or willingness of the city to provide the data in a useful and relevant way.

Implications for accountability of data for capacity building

A common assumption underlying data-driven urban climate governance is that data can improve the capacity of city governments to act and therefore deliver on their climate change commitments when held to account[47–51]. This section highlights two caveats to this assumption.

First, capacity has to first be created in order to integrate data into the decision-making process. This means data only enables the capacity to act when there is an existing structure to use, share and utilize data in urban climate change governance. As Tomer and Shivaram[52] find, "public agencies simply do not have enough data scientists on staff or senior management experience to navigate a complete transition to big data platforms". Local governments often lack the technical capacity—both in terms of policies, such as in data exchange and hardware—to engage with and incorporate these new types of data. City staff are not always aware of what data is available, where it is stored and which internal and external audiences' data is allowed to be shared with[37]. It can be difficult to link data on the supply side (for example, public transport schedules) with the demand side (for example, travel data generated by smartphones). Furthermore, city governments may not have a large amount of data available if they are small or rely on central governments for environmental data[37]. In order for new data and more information to increase the capacity of local governments to act on climate change, investments must be made in human and technical capacities needed to collect, analyse and use the information.

Second, data can empower government to act, or non-governmental actors to demand, new climate action from the state, but data-driven decision-making can disempower those that are not counted or are without access to data, reducing their capacity to act. New sources and types of data can allow local governments, citizens or other agencies to more efficiently and effectively address the challenges posed by climate change. For example, energy-use benchmarking programmes, such as in San Francisco and New York City, require large building owners to audit energy use and release the data publicly. This new data source can increase the capacity of building owners, the public and governments to demand, require and achieve energy efficiency improvements[53]. Tracking progress in GHG emissions reductions or the implementation of mitigation and adaptation policies can create opportunities for non-state actors (including the public) to hold governments accountable for progress towards declared targets.

Data-driven decision-making can also disempower those not counted or without access to data[35]. A focus on data and metrics can potentially shift control over policymaking away from democratic channels, particularly in contexts of private data collection and dissemination[54]. Data can also fail to capture the variation and disparities in city populations. For example, GHG emissions inventories tend to homogenize the urban population and their contributions to climate change, even though spatial and demographic variation in GHG emissions is well documented[55,56]. Similarly, per capita GHG emission reduction targets are often set at one level across urban populations despite these known spatial and demographic variations[57]. As Rice[58] puts it, "urban carbon governance erases important aspects of social and spatial difference among carbon emitters". Improving urban sustainability metrics means working to "better capture the broader dimensions of ecological sustainability and social equity"[35]. Inventories and carbon footprint analyses also often position the individual as the primary agent responsible for climate action, rather than governments or the private sector[57]. In such cases, it becomes more difficult to hold accountable corporations and governments that have control over structural drivers of urban emissions beyond the reach of the individual.

Rather than a politically benign source of capacity, the effectiveness of data in building capacity depends on decisions about what kinds of data are used and how they are deployed. Enhancing decision-making so that local governments are able to take effective action on climate change means not only creating the capacity to integrate data into the decision-making process, but also increasing policymakers' capacity to integrate social justice considerations into data-driven decision-making. To improve outcomes from data-driven urban climate governance, capacities are needed to allow decision-makers to engage with local data that reflects social and spatial differences and to use data in ways that direct climate action towards powerful actors and structures shaping GHG emissions and climate vulnerability in cities. This is summarized in the 'power paradox' defined by Hansen and Porter[59], who point out that the increased transparency through data can be a tool for the less powerful, but that "the logistic and physical infrastructure that enable big data, the ownership and control over it, and the resources of knowledge produced by big data, together with the continuous cultivation and uneven distribution of relevant technical expertise create an asymmetric relationship between those who collect, store and mine large quantities of data, and those whom data collection targets"[59].

Discussion and concluding remarks

The growing commitment of city governments to respond to climate change is inextricable from the simultaneous rise in data-driven decision-making. Each is shaping the other and raising new questions about the accountability of city governments.

National and international benchmarks as well as reporting frameworks are pushing city governments to standardize climate change data collection and measurement. This facilitates accountability and comparison within and across countries, but can erode local accountability to residents. Meeting (inter)national benchmarks creates goal-oriented policy that is characterized by broad strokes and long-term commitments, shifting accountability away from the means and towards the metrics of climate governance. Standardization can exclude or marginalize small, context-specific projects that have local value but are not readily captured by a GHG emissions inventory. In essence, holding cities accountable to (inter)

national standards can shift policy attention and resources away from the local context.

Data-driven urban climate governance has the potential to provide open and accessible information to voters and stakeholders, help rebuild trust in government and attract investment. However, this also attaches a particular numeric rationality to accountability that requires an educated and engaged public as well as trained public officials. It further creates an imbalance among those designing benchmarks and creating their own accountability forums, and those with less influence to do so. Data only build transparency and capacity when there is a facilitative structure in place to allow data to be used and shared. Data-driven decision-making can be disempowering when data are inaccessible or conceal spatial and demographic variation and inequalities. Decisions made as data are created, transferred, analysed and communicated shape whose capacity is built, who governments are transparent to and the benchmarks city governments seek to reach.

While new sources of, and uses for, data in urban climate governance present exciting opportunities for enhanced accountability, the highly political nature of data use and generation points to the need for critical engagement by the research community. The shift toward data-driven urban climate governance has the potential to motivate and facilitate a technical transition in cities with a narrowed focus on metrics rather than the broad transformation of social, economic and technological systems—"diverse, emergent and unruly political re-alignments"[60]—needed to respond to climate change. However, the shift can also be a starting point for new opportunities for accountability and climate action. Realizing this potential requires that generators and users of climate-related data and information engage with the political context of their work. Consideration of data democracy, data accessibility and local needs and interests must be central. Investments in data collection and generation must be matched by investments in the capacity of decision-makers and the public to use and engage with these data. Experiments with novel strategies for data generation and dissemination, such as Los Angeles' Open Data Portal; localized metrics and standards, including for adaptation[61]; and equity-oriented approaches to urban climate change policy, such as Cleveland's racial equity tool[62], can provide valuable experience and information for climate scholars and practitioners. Key intervention points include shared international reporting frameworks, efforts to increase the usability and accessibility of public data, and building city government capacity for not only processing data but also embedding social justice considerations into data-driven policymaking.

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Author contributions

S.H., S.G. and L.T. contributed to the project planning, analysis, writing and editing of this manuscript.

Competing interests

The authors declare no competing interests.

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