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Climate capacity in medium-sized German cities: (how) do smaller municipalities implement mitigation and adaptation policies?

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Although research has begun to examine local mitigation and adaptation approaches in parallel, it has tended to focus on leading cities and adopt large-N approaches that focus on published climate plans. We know little about whether smaller local governments are able to address these twin challenges simultaneously, or whether and how they are implementing their planned policies. Drawing on analysis of 194 German cities, supplemented by fieldwork interviews in ten of these municipalities, we find that smaller cities are focusing increasingly on both mitigation and adaptation at the institutional level. However, concerns remain about implementation and the long-term development of infrastructure projects. Moreover, there is a risk that our knowledge of local climate policy, much of which is based on climate planning documents, may be distorted because municipalities are incentivised to produce highly ambitious and unrealistic plans, and often rely heavily on external experts to draft these documents.

Recent studies have found that larger cities are generally more active than smaller municipalities in climate mitigation and adaptation[1–4]. In part, this may be because they often benefit from favourable conditions for ambitious climate policy, including wealthier populations, the presence of universities and highly-educated residents, and strong green parties and civil society movements[5].

In addition to these external socioeconomic and political factors, we can also surmise that larger municipalities are more likely to possess the internal capacities to develop and implement effective climate policies[6–8]. Alongside financial resources, many of these capacities are associated with the staff who are responsible for mitigation and/or adaptation. Key issues here relate to whether municipal climate managers possess sufficient skills and knowledge of potential policy solutions, and whether they have access to internal and external funding and networks to navigate local policymaking processes and ensure that measures are implemented[8,9]. *Ceteris paribus*, we would expect larger cities to have more municipal officers, as well as bigger budgets, than smaller municipalities. This could mean that they are more likely to (be able to) appoint highly-skilled, dedicated managers to address climate challenges, and allocate specific funds to related policy initiatives. Since smaller municipalities normally have fewer expert staff and less money, it is probably more difficult for them to identify and implement potential policy solutions[9–11]. They are also less likely to be active in transnational municipal climate networks[12,13], which suggests they may struggle to share information and learn from the experiences of similar cities abroad.

Given these capacity issues, and the huge challenges that climate change presents to some communities, we can see how smaller and/or under-resourced municipalities may struggle to develop and implement ambitious policies for both mitigation and adaptation. This might be particularly the case for the latter, given that many cities have been engaged in mitigation activities since the early 1990s[14,15]. Indeed, although the quality of adaptation planning in European cities appears to have improved[16], smaller local governments in particular have only begun to engage with climate adaptation very recently, if at all[3,9,10]. For example, an assessment of 104 of the largest cities in Germany found that bigger municipalities were often forerunners in both mitigation and adaptation, whereas their smaller counterparts tended to concentrate on only one (or indeed neither) of these dimensions[2]. Additionally, whilst there is some disagreement in the literature as to whether cities that are more exposed to climate threats are more active in adaptation[17–20], such studies have tended to focus on larger cities, which are more likely to possess sufficient capacities to address both areas simultaneously.

Perhaps even more importantly, this research is often based on the contents of municipal climate plans and other documentation, rather than

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(parallel) analyses of whether and how the policies and measures set out in these strategies are being delivered (although see[10] and[21] for exceptions). Based on the literature, we can identify several reasons why such studies are unlikely to present a complete picture of how municipalities are addressing climate change. First, although commitment to a particular policy goal at senior levels may well help to mobilise actors to support appropriate measures, there is always the risk that some cities may publish a plan partly for symbolic reasons. This is particularly the case in the environmental sector, where appropriately ambitious policies may entail high political costs, and politicians are therefore reluctant to introduce them[22]. For example, research into cities that have declared 'climate emergencies' have cautioned that such pronouncements do not always result in substantially more stringent policies[23]. Second, the project management literature has highlighted how public bodies and contractors often have an incentive to exaggerate the level of ambition and estimate unrealistically low costs when bidding for funding[24]. Similar dynamics may well play out in climate funding schemes – particularly if they involve competitive bidding for pots that reward innovation and aspiration. Another concern here relates to the notion of 'projectification' and the problems associated with short-term funding to undertake time-bound, specific initiatives that may not be sustained after the money runs out[25,26]. Finally, given that (smaller) municipalities may lack the staff, money and time to research and develop their own climate policies and plans, we might expect many of them to outsource this work to consultancy companies, research institutes, universities or other external actors, on the assumption that these organisations may be better placed to identify and suggest 'best practice' approaches[27]. Although such advice can undoubtedly help with policy development, previous studies have highlighted how it does not always align with local political priorities or contexts[28,29], and municipal policymakers are less likely to 'buy in' and commit to ideas proposed by external actors, especially over the longer term[30]. As such, we should be sceptical as to whether municipalities (are able to) implement all of the initiatives that external consultancies suggest. More generally, we should not take the contents of climate plans at face value, because cities may be incentivised to set out over-optimistic objectives and measures within them. Underpinning these concerns is the issue of municipal capacity, and whether a city has the financial resources, staff time, expertise, and/or political support for meaningful climate action, both currently and in the coming years.

With this in mind, we examined the current level of mitigation and adaptation activity in German cities, and the views of managers in smaller municipalities around the feasibility of climate policy implementation. We suspected smaller municipalities might find it particularly difficult to address both areas equally (perhaps regardless of whether a single officer is responsible for mitigation and adaptation), and may therefore look elsewhere for sources of funding and support. We also felt that some such cities – particularly those that are highly exposed and vulnerable to climate impacts – might choose to direct their scarce resources towards local adaptation, whereas others would prioritise reducing greenhouse gas emissions. In line with *npj Climate Action's* conventions on structure and format, we detail our methods in section 4, at the end of the manuscript.

Our initial desk-based research identified clear differences between the climate approaches of larger and smaller cities in Germany, even though many smaller municipalities had developed mitigation and adaptation plans in recent years. Subsequent fieldwork interviews in ten smaller cities then revealed various common themes, both in terms of the issues they faced and how climate managers sought to address them. These centred around financial constraints, which contributed towards a lack of long-term staffing and planning for climate action, and a reliance on external advice and funding that called into question their ability to deliver on ambitious mitigation and adaptation plans. We did find evidence that some cities were addressing these constraints (such as by converting the short-term, project-funded employment contracts of climate managers into centrally-financed permanent positions). Nonetheless, concerns remained around: the often time-consuming, complicated and unrealistic nature of funding application processes; a lack of interest in and focus on the implementation of policies and long-term infrastructure projects amongst senior management, politicians and funding bodies; and a lack of integration between mitigation and adaptation initiatives.

Moreover, our fieldwork raised questions about how much we actually know about climate policy implementation at the local level, given that large-N studies often draw on analyses of local climate plans. Our interviewees also pointed out that many funding schemes incentivise cities to set out unrealistic levels of climate ambition in their project bids, because this increases their chances of success. Additionally, since smaller municipalities often lack the capacities to write their own climate plans, they are much more likely to rely on external experts to undertake this task. While this practice provides municipalities with access to broader knowledge and expertise, it may increase the risk that climate plans are not sufficiently aligned with local political priorities and could mean that some municipalities struggle to implement particular solutions. We address each of these concerns in turn below.

Results

Desk-based analysis of climate activities in 194 German cities

Using the schema developed by[2] as an initial heuristic to assess progress, and in line with previous studies[2,4,8], we found that smaller and medium-sized municipalities in Germany – i.e., those with populations ranging from 50,000 to 100,000 – appeared to be more active in the area of climate mitigation than adaptation. Only twelve of the these 114 cities were yet to publish their own climate mitigation plan by our cut-off date of December 2022. Of these twelve, eight were covered by county- or region-wide mitigation plans at a higher level of governance and one (Grevenbroich) was currently developing a strategy. Only three municipalities were neither in the process of developing their own plans, nor covered by strategies at the county or regional level: Bad Kreuznach, Lingen, and Lippstadt. However, far fewer had published an adaptation strategy (or a mitigation plan with a dedicated section focused on adaptation) by that point. Excluding those plans still in development, only 43 had done so by the end of 2022 – although 15 lower-tier municipalities were also covered by higher-tier county or regional plans (see Table 1). Thirty-six cities had neither published a plan nor were developing one. Only one of the cities that had not yet published a municipal mitigation plan – Aschaffenburg – was in the process of developing an adaptation strategy. By way of contrast, every one of the 80 largest cities in Germany had published a mitigation plan by the end of 2022, and more than four-fifths of this group (67 cities) had published stand-alone adaptation strategies or had dedicated a section of their mitigation plans to adaptation. A further seven had adaptation plans currently in development, and we found no evidence of adaptation planning in only five of these 80 cities.

We found similar contrasts between larger and smaller municipalities in terms of other indicators of climate policy activity (see Table 2). Specifically, the 80 biggest cities were much more likely to be involved in transnational climate networks, climate awards and certification schemes than their smaller counterparts, and many more had also set targets for carbon neutrality and declared climate emergencies. These initial descriptive findings chime with two longstanding themes in urban climate scholarship, namely that (a) most cities only became active in adaptation several years after they introduced mitigation policies, and (b) larger cities are more likely to have done something in both areas of climate policy[2–4,7,14,15,18,20,31].

Nonetheless, smaller cities have begun to catch up with their larger counterparts in terms of climate planning in recent years (see Fig. 1, and Annexes A1 and A2). Although smaller municipalities were generally much slower to develop strategies than the biggest cities, planning for mitigation (from 2009) and adaptation (from 2017) has become much more widespread within this group in recent years. This suggests that smaller German cities may be overcoming their capacity constraints and are increasingly able to address mitigation and adaptation together.

However, these high-level commitments to developing policy at a strategic level may not cascade down to the level of implementation[32], particularly if funding programmes are targeted mostly at the initial

Table 1 | Publication of mitigation and adaptation plans in smaller (50,000–100,000 inhabitants) and larger (>100,000 inhabitants) German cities

	Total number of smaller cities (mitigation)	Total number of larger cities (mitigation)	Total number of smaller cities (adaptation)	Total number of larger cities (adaptation)
Municipalities with published climate plans	102 (89.5%)	80 (100%)	43 (37.7%)	67 (83.8%)
Municipalities with plans in development but not yet published by the end of 2022	1 (0.9%)	-	12 (10.5%)	7 (8.8%)
Plan adopted at county or regional level but not developed or in planning by the lower-tier authority	8 (7%)	-	15 (13.2%)	1 (1.3%)
County or regional plan in development but not yet published	-	-	8 (7.0%)	-
Plan neither published nor in development	3 (2.6%)	-	36 (31.6%)	5 (4.4%)
Average year of publishing first plan (municipality and county/regional plans)	2009 (earliest 1990)	2000 (earliest 1986)	2018 (earliest 2008)	2015 (earliest 2007)
Totals	**114 (100%)**	**80 (100%)**	**114 (100%)**	**80 (100%)**

Table 2 | Membership of climate networks and participation in climate awards in smaller and larger German cities (see section 4 and Annex B for further details)

	Total number of smaller cities (mitigation)	Total number of larger cities (mitigation)	Total number of smaller cities (adaptation)	Total number of larger cities (adaptation)
Member of one transnational climate network	58 (50.9%)	28 (35%)	17 (14.9%)	34 (42.5%)
Member of two networks	22 (19.3%)	21 (26.3%)	0	5 (6.3)
Member of at least three networks	1 (0.9%)	22 (27.5%)	N/A	N/A
Not a member of a transnational network	33 (28.9%)	9 (11.3%)	97 (85.1%)	41 (51.2%)
Bid for, but not won, climate awards	11 (9.6%)	7 (8.8%)	10 (8.8%)	13 (16.3%)
Won one climate award	33 (28.9%)	24 (30.0%)	15 (13.2%)	24 (30.0%)
Won two climate awards	10 (8.8%)	22 (27.5%)	1 (0.9%)	8 (10.0%)
Won at least three climate awards	4 (3.5%)	14 (17.5%)	0	0
Not participated in climate awards	56 (49.1%)	13 (16.3%)	88 (77.2%)	35 (43.8)
Set a target for climate neutrality by 2050 or earlier	15 (13.2%)	53 (66.3%)	N/A	N/A
Declared a climate emergency	20 (17.5%)	34 (42.5%)	N/A	N/A
Totals	**114 (100%)**	**80 (100%)**	**114 (100%)**	**80 (100%)**

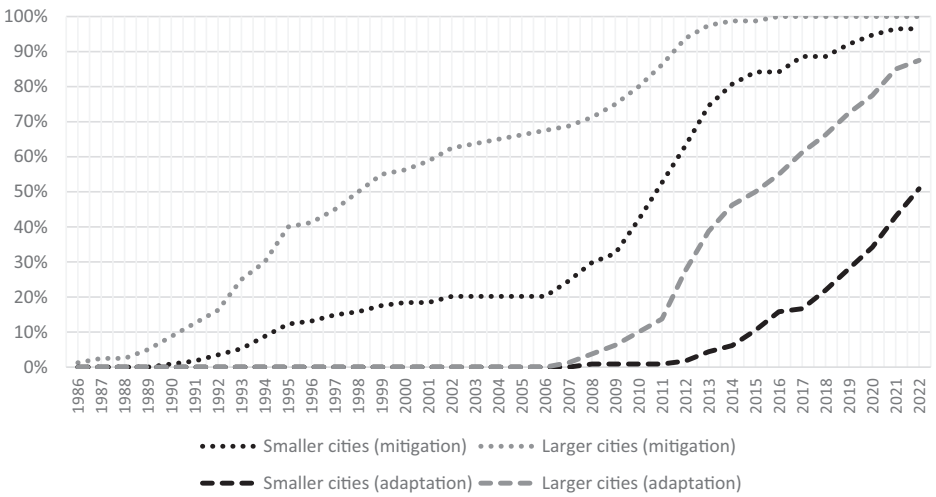

Fig. 1 | Share of larger and smaller German cities adopting mitigation and adaptation plans (cumulative; year of first publication of urban plans and plans at county level).

planning phase. Nearly all of the 114 smaller cities we examined had successfully acquired federal funding through the federal government's National Climate Initiative (NKI), and all of those with populations over 100,000 had done so[29]. Although a large number received NKI grants for specific mitigation initiatives (such as energy-efficient lighting for streets and municipal buildings), many cities only applied for this funding to develop climate plans, or to employ climate managers on fixed-term contracts[33]. In terms of adaptation, the federal government's *Deutsche Anpassungsstrategie* (DAS) scheme only began to offer funds specifically for adaptation plans from 2021 onwards, and the implementation of specific

Table 3 | Smaller and larger cities' reliance on external funding and advice to produce their most recent climate plans (see section 4 for further details)

	Total number of smaller cities (mitigation)	Total number of larger cities (mitigation)	Total number of smaller cities (adaptation)	Total number of larger cities (adaptation)
Received funding to develop most recent climate plan	84 (76.3%)	33 (41.3%)	43 (74.2%)	45 (66.2%)
Received NKI or DAS federal funding	79 (71.8%)	32 (40.0%)	36 (62.1%)	39 (57.4%)
Received other public funding	5 (4.5%)	1 (1.3%)	7 (12.1%)	6 (8.8%)
Funded climate plan internally	26 (23.6%)	47 (58.8%)	15 (25.9%)	23 (33.8%)
Most recent climate plan produced externally	86 (78.3%)	43 (53.8%)	46 (79.3%)	40 (58.8%)
By external private consultancy	72 (65.5%)	38 (47.5%)	42 (72.4%)	34 (50.0%)
By external non-profit organisation (public research institute, environment agency, university)	14 (12.7%)	5 (6.3%)	4 (6.9%)	6 (8.8%)
Most recent climate plan produced in-house by municipality	15 (13.6%)	21 (26.3%)	10 (17.2%)	19 (27.9%)
Most recent climate plan produced by municipality together with external actor(s)	9 (8.2%)	16 (20.0%)	2 (3.4%)	9 (13.2%)
Totals	**110 (100%)**	**80 (100%)**	**58 (100%)**	**68 (100%)**

measures a year later. Earlier adaptation plans were funded mostly through the NKI scheme or other public sources, including state governments and other federal government departments.

More in-depth analysis of cities' most recent climate plans suggests that smaller municipalities relied particularly heavily on federal funding in the production of these documents. Table 3 shows how the vast majority (over 70%) of those with populations ranging from 50,000 to 100,000 used the NKI to produce their most recent mitigation plans. Additionally, more than 60% of these cities' most recent adaptation strategies were also financed through this initiative or, in a handful of cases, the DAS programme. Many also relied on the NKI to fund earlier plans, and/or to pay the salaries of municipal climate managers. Additional schemes, including EU regional development funding, state-level programmes and other federal sources, were also important. In contrast, larger cities were much more likely to fund their most recent strategies internally: nearly six in ten of this group used municipal budgets to produce their mitigation plans, and one-third of these cities' most recent adaptation plans were also wholly self-financed.

Furthermore, around 80% of smaller municipalities relied entirely on external actors to produce their mitigation and adaptation plans, compared to less than 60% of larger cities (see Table 3). The figures here are fairly similar for both mitigation and adaptation, with larger cities also more likely to work with consultancies, research institutes or universities and write their strategies in collaboration with these external experts. Externally-sourced plans also tended to be longer and more detailed than those that were produced in-house.

In-depth analysis of climate policy implementation in ten German cities

With these issues in mind, we set out to identify whether this apparent increased focus on climate planning was being reflected in terms of the implementation of policies and long-term infrastructure projects, by interviewing climate managers and other policy actors in a cross-section of ten smaller and medium-sized German cities. Section 4 provides further information about our rationale for selecting these municipalities, as well as our process for conducting and analysing the interviews. Given the contents of Table 3, it was not particularly surprising that all ten of the climate managers we interviewed emphasised the importance of external funding for developing their climate plans. This was particularly the case for those municipalities that were in financial difficulties (for example, Gera), which would otherwise be unable to generate the funding internally. Our interview findings echoed recent surveys conducted by the German federal environment agency, in which municipalities listed "simpler funding conditions", "stronger municipal budgets", "more staff" and "more funding" as the four most important changes that could help them to improve climate mitigation at the local level[34]. A large majority also responded that a lack of capacities were key barriers to planning and implementing adaptation policies[35]. All ten of the cities where we conducted interviews had received NKI funding to try to address these concerns.

Additionally, it was notable that interviewees in many of the cities we studied (for example, Arnsberg, Elmshorn, Neumünster, Neubrandenburg, and Worms) were keen to address both mitigation and adaptation simultaneously. Against our expectations, the climate managers we spoke to did not suggest that their municipalities had to prioritise one aspect over the other due to capacity constraints. This reflects a widespread realisation of the need to catch up with the leaders in both areas, and perhaps also the increased urgency of adaptation and more recent federal support for this area. For example, the federal government established a national Centre for Climate Adaptation in July 2021 to support municipalities with these challenges, and began to fund local adaptation strategies through its DAS scheme in the following year. Additionally, eight of the ten climate managers we interviewed suggested that their cities were threatened by severe weather events such as heatwaves, storms and flash flooding, and that this exposure to climate impacts might help to increase the importance of adaptation within their municipalities.

Many of the smaller cities we spoke to had used an initial tranche of NKI funding to appoint dedicated officer(s) responsible for mitigation, who often also worked on adaptation. These funded positions had a number of advantages: they meant that cities were much better placed to bid for subsequent grants (because they employed individuals with relevant knowledge and expertise, whose jobs were sometimes dependent on submitting successful funding applications), and they also had individual champions within the municipality who would push for more ambitious policies. Notably, six of the ten climate managers we interviewed had been employed initially through such grants, but were appointed as permanent members of staff once the federal funding expired. This finding concurs with previous studies into 'unlikely pioneers' or 'ordinary cities' that have managed to adopt more ambitious climate policies[36,37].

Since grant funding is often tied to the development of a climate strategy[15], the existence of the NKI programme helps to explain the recent surge in adaptation plans amongst smaller cities. Additionally, according to the funding guidelines that operated before 2021, municipalities had to have a climate plan already in place if they wanted to submit bids to fund the salaries of climate managers. In such cases, we can see how external funding streams may lead to a snowball effect, in which they underpin subsequent

activities that reinforce and extend the initial investment. Such an outcome could help to overcome the capacity constraints so often cited as a reason why smaller municipalities in particular have struggled to address climate mitigation and/or adaptation effectively. However, in order to trigger this self-sustaining process, smaller municipalities need to be able to meet the criteria for the first and subsequent tranches of funding.

Moreover, interviewees argued that climate managers spend too long bidding for external funding, leaving them insufficient time to develop, implement and enforce policy. Crucially, they also expressed scepticism that the development of a climate plan would necessarily result in appropriate or commensurate action. Specifically, one manager highlighted that grants are not available to implement adaptation initiatives (e.g. to increase resilience to severe weather events), and another stressed that issues such as flash flooding, sustainable mobility, land-use planning and energy management cannot be addressed comprehensively on a project-by-project basis anyway. Instead, municipalities need to adopt a long-term approach to address such problems and ensure that the city sustains its initial progress. Similarly, a climate manager in a different city suggested that funded projects are nearly always viewed as being less important than mandatory, everyday functions that the municipality has undertaken for decades. These issues relate to common concerns about the problems of short-termism and 'projectification' within public organisations, especially the risk that much of the work undertaken and knowledge gained from grant-funded initiatives is lost once the funding expires and the staff responsible for the project transfer to other tasks or leave the municipality altogether[25]. Furthermore, although there have been few studies into the topic[38], we might expect this to be a particular risk in situations where external actors are heavily involved in initial knowledge production and strategy development[39]—as is the case with climate policy in many smaller German cities.

More specifically for the German context, our interviewees were highly critical of how the funding landscape for local climate policy operates. Notwithstanding the apparent generosity of the NKI scheme, at least in the past, one interviewee stressed that they often struggled to find the necessary 20% of a project budget internally that is required to submit a NKI application for the remaining 80%. Additionally, several stressed that the NKI programme would not cover many of the measures they had set out in their climate plans, and therefore they would also need to seek out funding from elsewhere to implement them in full. Interviewees in three different cities also felt that forms and processes were quite convoluted and bureaucratic, deadlines for submitting applications were sometimes very short, and applicants can often wait many months before discovering whether their bid was successful.

These hurdles pose particular challenges for smaller municipalities and/or those that have not already made good progress on climate policy. Additionally, some German states provide far more generous funding schemes for local climate policy than others, which also risks exacerbating the gap between leading and laggard municipalities, and between leading and laggard federal states *(Länder)*. Smaller cities also struggled to compete with their bigger counterparts for the best staff, including those with the English language skills necessary to write and submit subsequent bids for EU funding. Finally, one climate manager stated that the existence of different federal funding systems for mitigation and adaptation led to unnecessary complications and duplications – particularly where a single manager was responsible for both areas.

Perhaps even more importantly, competitive funding schemes tend to reward the most ambitious applicants, rather than those who may be most in need of resources. Although nearly all applications for NKI funding are successful[40], our interviewees stressed that other funding bodies often expect bidders to propose highly innovative and stringent policies, such as stretching climate neutrality goals or comprehensive public participation initiatives. This could incentivise municipalities to set unrealistic objectives (both in their applications for external funding and their publicly-available climate plans), to try to increase the chances of receiving grants. Such an eventuality would cast doubt on the veracity and reliability of their mitigation and adaptation plans and therefore also the extent of our knowledge about how cities are tackling climate change. Whilst we did not probe our interviewees in depth about this risk, and would not wish to 'name and shame' any such exaggerations, several climate managers did acknowledge that it represented a genuine problem. This risk is perhaps particularly acute in those cities that did not research and write their climate plans 'in-house'. As discussed earlier, these plans may take less account of local conditions and issues than those produced by municipal staff. This could mean that they are over-ambitious and represent more of a 'wish-list' of desirable policies than a hard-headed assessment of what is realistically achievable in the city in the short-, medium and long-term.

Discussion and conclusion

Overall, our study shows that German cities between 50,000 and 100,000 inhabitants have made substantial progress in institutionalising climate mitigation and adaptation in recent years. Compared to bigger cities, however, they are usually less active and (even) more reliant on external funding for climate policy. Moreover, we can see that the recent surge in smaller municipalities adopting climate adaptation strategies may not necessarily result in the wholesale implementation of those plans. Problems around resourcing and the short-term, project-based nature of many climate activities mean that some cities may struggle to maintain momentum and sustain their progress. Clearly, these issues can affect cities of any size, and could prevent any municipality from implementing all of the initiatives they set out in their mitigation or adaptation plans. However, despite the recent surge in climate plans and more ambitious greenhouse gas reduction targets amongst smaller municipalities in Germany, our analysis of what is actually happening in these places casts doubt on the notion that they are closing the gap between themselves and their larger counterparts. Instead, various factors (both specific to Germany and more generally applicable) may be contributing to a situation in which the production of climate plans is masking sluggish implementation and may well mean that the ambition within mitigation and adaptation plans is unlikely to be realised in practice.

Although our interviewees were all very keen to progress climate policy, most of them were hampered by capacity constraints, and many were sceptical about whether the measures set out in local climate plans would be implemented on schedule. The funding landscape, which encourages applicants to set ambitious and possibly unrealistic targets, and also exacerbates the short-term nature of many climate projects ("projectification"), was at the root of these problems. There are significant risks that some municipalities will not be able to sustain the progress they have made on climate policy in recent years. This is particularly the case for those cities that have not converted NKI-funded climate manager positions into permanent posts upon the expiry of the initial grant, and/or have relied heavily on external actors to develop their mitigation and adaptation strategies.

As such, our study confirms the findings of much previous research, which has argued that smaller municipalities suffer from capacity constraints and struggle to devote sufficient resources to climate policy, and therefore higher levels of government need to intervene to 'upscale' them to the necessary level[31,41]. Notably, those smaller cities that are more active in both adaptation and mitigation (such as Kempten and Worms) have been pioneers for many years. Additionally, not only have these municipalities benefited from the general NKI and DAS funding streams, but they also received grants from the more specific *Masterplan* scheme and other research projects. Cities such as Kempten and Worms have developed core teams of climate managers on permanent employment contracts, which hold them in better stead to keep on track in the future.

These concerns notwithstanding, and in contrast to our initial expectations, we did not find that smaller cities were having to 'choose' between mitigation and adaptation and devote most of their (limited) capacities to one of these areas. Instead, nearly all of our interviewees emphasised the importance of addressing both simultaneously—and the fact that many smaller cities published mitigation and adaptation plans at around the same time (see Annex A1) suggests that this is a broader phenomenon. Given that previous studies have stressed how urban mitigation activities began in the 1990s, and most cities only began to consider adaptation from the 2010s

onwards[2,14,15], this is a notable finding. For our interviewees, both aspects were equally important, perhaps reflecting recent policy developments in adaptation and the increasing urgency of climate change. Indeed, our interviewees did not suggest that their municipality's vulnerability or exposure to climate threats played an important role in setting local climate priorities—and therefore, in line with[18,19,37], we found no clear link between the level of climate risks and adaptation policy. We did only examine ten cities in depth, and our findings may have been skewed by the increased support available to local governments in Germany for climate mitigation and adaptation in recent years. Indeed, any (even smaller) municipalities that have not applied for federal funding, and/or not appointed a full-time, dedicated climate manager, might well struggle to tackle both of these areas. Despite these concerns, however, our findings do suggest that greater awareness of climate threats amongst local governments could mean that cities in other contexts have begun to take mitigation and adaptation equally seriously.

Nonetheless, our study casts doubt on the extent of our knowledge of urban mitigation and adaptation. To date, many large-N studies into local climate policy have relied on the contents of municipal climate plans[1,2,16,17] or large-scale surveys[15,42–45], but we suggest that these analyses may not paint an accurate picture of how cities are tackling mitigation and adaptation. Our interviewees identified various reasons why municipalities are incentivised to provide misleading or unrealistic information when bidding for necessary funding, or to produce ambitious climate plans that may be very difficult to implement. Some literature has highlighted how these risks often play out in project management and external contracting[24], but they have been under-examined in the field of urban climate policy. Although we only examined ten smaller cities in Germany, we suspect that similar dynamics may be in play in other contexts, especially where municipalities need to bid for external grants. Indeed, given that many other countries do not have largely uncompetitive funding schemes like the NKI and DAS, it may well be the case that cities elsewhere face greater incentives to set out over-ambitious or unrealistic policies in their bids for climate funding.

Additionally, we were struck by the extent to which cities relied on external actors to produce their climate plans. We did not come across any previous studies that have examined this issue in depth, but feel that it could have important implications for policy implementation in particular[46]. At one level, we can understand that agreeing a contract with an external provider for this work might be the easiest approach for a municipality to adopt, particularly if the city receives a specific sum to fund precisely this task through a funding scheme. This approach could also mean that cities—both in Germany and elsewhere—are more likely to become aware of supposedly 'best practice' policies, particularly if they have limited access to networks of climate managers from other municipalities. However, it increases the risk that mitigation and adaptation strategies include measures that are neither appropriate nor feasible in the local context[27–29]. Municipal staff and policymakers may also feel less ownership of externally-produced plans, which could mean their policies are less likely to be implemented or sustained over the longer term[30].

Previous studies have emphasised the difficulties associated with analysing or evaluating the implementation of (environmental) policy[47–49], and therefore it will be challenging to undertake a more comprehensive analysis of what is actually happening 'on the ground'. However, research of this nature is essential if we are to gain a fuller understanding of how municipalities are tackling climate change.

With this in mind, we suggest that more studies need to adopt qualitative approaches, perhaps in parallel with surveys and monitoring or evaluation exercises, to examine whether and how specific policy initiatives have been implemented—and to identify causal links between any such measures and subsequent reductions in greenhouse gas (GHG) emissions or improvements in climate adaptation[50]. We would particularly welcome comparative studies of cities that produced their climate plans in-house with those that relied heavily on external experts, to identify whether and how this ownership of policy shapes implementation and effectiveness. In addition, future research should focus not only on transnational municipal networks but also on national and, in particular, regional networks of climate managers in smaller cities and towns, which seem to be far more important for such municipalities than for their larger, internationally-oriented counterparts.

Finally, despite our best efforts, we found it difficult to gather relevant data in those cities that are lagging behind in climate policy: fewer municipal officers are available for interview and public bodies are probably less likely to have conducted any assessment of climate risks or GHG reduction initiatives. As a result, we might expect such municipalities to be less active in mitigation and/or adaptation compared to those cities in which we conducted fieldwork interviews, reinforcing our suspicion that our overall knowledge of urban climate policy remains quite limited. Smaller towns are perhaps less likely to be tackling climate change than larger cities: we restricted our study to municipalities with more than 50,000 inhabitants, which previous large-N studies suggest are likely to be more active than their smaller counterparts[1–4,20]. Although conducting empirical research in smaller towns may be challenging, some of the capacity issues identified in our study are likely to be more acute in these municipalities, particularly if they have struggled to apply for external funding. This would not bode well for societal attempts to tackle major challenges such as the climate crisis.

Methods

Initially, we sought to compare the climate policies of smaller and medium-sized German cities with their larger counterparts, to identify any notable differences in levels of ambition and activity in both mitigation and adaptation. We undertook our analysis in Germany for several reasons. Germany has a long history of decentralised governance, and municipalities have a constitutional right to 'self-administration'[51]. This legacy means that mitigation and adaptation remained a voluntary task for most local governments when we undertook our fieldwork in late 2022. At that point in time, some of the federal states had introduced legislation that required local governments to introduce some climate-related policies (such as the development of plans for low-carbon heating in Baden-Württemberg[52]). However, subsequent federal legislation on renewable heating and adaptation planning only became law in 2024.Within this context of municipal autonomy, however, a supportive political environment, together with funding schemes to tackle climate change (such as the federal government's National Climate Initiative (NKI), and German Adaptation Strategy (DAS)), helps to facilitate and encourage action at the local level[15,31,53]. As such, we would expect many smaller cities to introduce climate mitigation and/or adaptation policies, and recent studies have indeed found this to be the case[2,7,40]. Nevertheless, this research has not examined how smaller municipalities have sought to address potential capacity constraints, nor whether, how and why such constraints may have led to them to rely on external actors or funding, and/or ultimately affected policy implementation.

We adopted some of the indicators in[2]'s ranking schema to map out the initial contrasts between 114 smaller municipalities (those with between 50,000 and 100,000 inhabitants) and 80 larger cities (those with more than 100,000 residents). This included identifying the year of publication of each city's first and subsequent mitigation and adaptation plans, the level of GHG reduction commitments within mitigation plans, and the range of measures included in adaptation plans. We also incorporated each city's membership of various transnational climate networks into our analysis (the Climate Alliance, Covenant of Mayors, Energy Cities, ICLEI, Aalborg Charta, Mayors Adapt, and the EU mission on adaptation to climate change), and took account of their involvement in various awards and certification schemes (the European Energy Award, Climate Star Award, the EU Mission on climate-neutral and smart cities, the European Climate Award, and the German federal government's 'Masterplan', 'Stadtgrün', 'blauer Kompass' and 'Klimaaktive Kommune' initiatives). Alongside the ranking system that features in[2], we also considered additional indicators that have come to light more recently, such as the declaration of a climate emergency, net zero emissions targets, the publication of heat health action plans (*Hitzeaktionspläne*), new certifications and awards, and a city's involvement in research projects. Annex B provides a full list of these indicators.

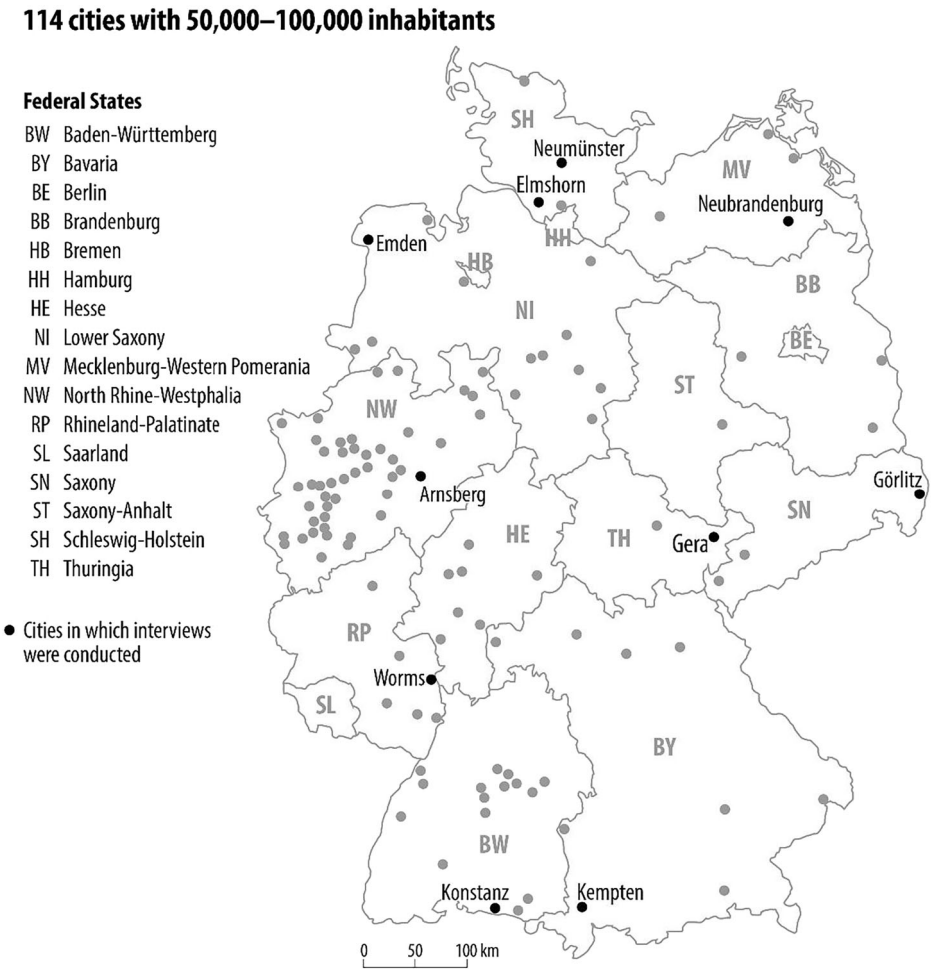

Fig. 2 | Investigated municipalities located on a map of Germany.

We gathered data pertaining to these indicators from local mitigation and adaptation plans (available on municipal websites), the websites of transnational climate networks, and those of certification and award schemes. Based on the information provided in each city's most recent plan, we coded it as being produced by external organisations (either private consultancies or non-profit bodies such as universities), or written 'in-house' by municipal officers. We did the same for the funding of each plan: i.e. whether it was funded by an external grant, or from municipal budgets. Plans that involved outside experts in their production, and/or were funded externally through initiatives such as the NKI scheme, usually stated this quite clearly and included relevant information and logos in the first few pages. Where a plan did not mention any external funding, and/or the involvement of any external actors in its production, we assumed that they had been funded, and/or written by, the municipality and its staff, and coded them accordingly.

We then identified ten smaller municipalities (Arnsberg, Elmshorn, Emden, Gera, Görlitz, Kempten, Konstanz, Neubrandenburg, Neumünster, and Worms) that prioritised mitigation and adaptation in different ways. These ten cities are also located in different parts of Germany (see Fig. 2): indeed, nine of the country's thirteen territorial states (*Flächenländer*) were represented in our sample. In total, they had published eleven mitigation and adaptation plans: seven of these were funded by NKI grants, and the remaining four were funded in-house. Six plans had been written wholly by external bodies, three were produced in-house and the remaining two were the result of collaborations between the municipality and external actors.

Drawing on our desk-based assessment using the indicators in Annex B, as well as further information (e.g. related to their involvement in funded climate research projects), we graded each of these ten cities' progress and activity in terms of both mitigation and adaptation along a four-point scale, ascending from: (1) largely inactive; (ii) becoming active; (iii) active; and (iv) highly active. Table 4 locates each of these cities in a matrix, mapped against their level of activity along both dimensions (for more details see Annex C).

We conducted a total of 18 interviews in these cities to get a broader picture of how smaller municipalities across the country are addressing these issues. We interviewed municipal staff (e.g. climate managers, employees of the environmental and city planning departments or other individuals responsible for climate policy) in each of the ten cities, as well as representatives of civil society (e.g. Fridays for Future activists or representatives of local groups focused on sustainable development) in eight of them. These interviews all took place during autumn 2022 and had an average length of 53 min (60 min for municipal staff and 40 min for civil society actors). We used two different interview guides: one for municipal staff and another for civil society actors. The interview guides for municipal staff included 21 questions that centred on the institutional integration of climate mitigation and adaptation (e.g. the extent to which both topics are considered as cross-departmental tasks), and the political and societal context of the cities (e.g. the level of support for climate action from local political and civil society actors), as well as the municipality's financial capacities. The interview guide for civil society actors included 17 questions and mainly focused on their perception of the municipalities' ambitions and activities (e.g. whether climate change was treated as a priority) and their relationship with local politics and administration (e.g. the extent to which there was conflict and/or forms of collaboration between the municipality and civil society actors). All interviews were voice-recorded, transcribed and analysed using thematic codes. Through the fieldwork, we sought to identify the ways in which the cities sought to address potential capacity constraints, and assess the implications of these strategies for climate policy implementation.

Table 4 | Levels of strategic mitigation and adaptation activity in our ten selected cities according to desk research conducted prior to interviews

	Level of adaptation activity				
Level of mitigation activity		**Highly active**	**Active**	**Becoming active**	**Largely inactive**
	Highly active		Kempten	Emden	Konstanz
	Active	Worms		Neumünster	Gera, Görlitz
	Becoming active			Arnsberg	Neubrandenburg
	Largely inactive				Elmshorn

Data availability

No datasets were generated or analysed during the current study.

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Author contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by all authors. All authors wrote different sections of the first draft of the manuscript, and all authors commented on previous versions of the manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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