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ORIGINAL ARTICLE

What motivates and hinders municipal adaptation policy? Exploring vertical and horizontal diffusion in Hessen and Finland

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Abstract

Municipalities across the globe are seeking to adapt to increasing climate change impacts, such as heavy rainfall, drought, heat waves, and floods. An important question is how to support the diffusion of innovations in local adaptation policy-making. Responses often lack consideration of the diversity of municipalities and their varying needs and capacities. This article addresses this gap by analysing how internal and external motivations for and barriers to adaptation policy and diffusion vary across municipalities of different sizes in the federal State of Hessen in Germany and in Finland. Hessen and Finland have comparable population sizes and settlement structures, but their municipalities are embedded in different multilevel governance architectures and climatic geographies. The analysis builds on quantitative data from two independent surveys among Hessian and Finnish municipalities. The results show that while there are similarities and some differences among the motivations, with municipalities in Hessen focusing more on extreme weather events and Finnish municipalities more on well-being, the barriers are strikingly similar, focusing on lack of resources as well as unclear responsibilities of different governance levels and within municipalities. Size is an important factor determining the adaptation needs and capacities of municipalities in both surveys. The findings highlight the need for a clearer adaptation governance framework, support from the closest governance level and more resources, but also context-sensitive policy support that has been discussed in theory and practice.

Keywords Climate change adaptation · Policy diffusion · Multilevel governance · Hessen · Germany · Finland · Municipality

Introduction

As the climate continues to change, increasing climate impacts like heavy rainfall, heat, and drought materialise locally (Pörtner et al. 2022). This implies that the local level of governance will be key for advancing adaptation (see Dolšak & Prakash 2018). Municipal adaptation has been the subject of sustained scholarly attention with a particular

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focus on larger cities (Kern and Bulkeley 2009; Otto et al. 2021), although small- and mid-sized municipalities, which contain a considerable portion of the population in all countries, have also begun to act (Bausch and Koziol 2020; Dannevig et al. 2012; Häußler and Haupt 2021; Schulze and Schoenefeld 2022). The diversity of municipalities and the variation of particular adaptation needs and abilities are, however, often overlooked. The size and level of available resources of municipalities may, for example, be important (Schoenefeld et al. 2022). This paper explores this diversity in assessing motivations and barriers that may affect municipal adaptation policy development and implementation as well as the vertical and horizontal diffusion of adaptation policies. Vertical policy diffusion happens when policy-making at one level of governance influences policy-making at another; for example, when local policies influence state or federal policies (bottom-up); or, vice versa, when federal or state policies affect local policy development (top-down). Horizontal diffusion, by contrast, denotes interdependent policy-making among units at the same level of governance, for example, when a municipality's adaptation policies are inspired by the policies of other municipalities, such as those of its neighbours.

Municipalities implement national adaptation policies (Keskitalo et al. 2016), but they typically also have a degree of freedom to develop their own initiatives. That said, many municipalities struggle with significant resource and knowledge constraints (see for example Reckien et al. 2018; but also Araos et al. 2016). This may in turn be one of the motivations to look for solutions in other municipalities or count on other governance levels, that is, engage in policy diffusion, which can be defined as 'the process whereby policy choices in one unit are influenced by policy choices in other units' (Maggetti and Gilardi 2016, p. 89).

As a baseline definition, we understand municipal adaptation policy to be the decisions and the actions taken by municipal, and thus public, actors to cope with the impacts of climate change (see Schoenefeld et al. 2022). We thus focus on adaptation that is intentional and directly focused on reducing vulnerability to climate change impacts and increasing municipal resilience (see Dupuis and Biesbroek 2013). Against this background, this paper investigates the following key research questions: First, what are the internal and external motivations and barriers that affect municipal adaptation policy and how do they relate to vertical and horizontal policy diffusion? Second, how do the motivations and barriers vary with municipality size? And finally, what can we learn about possibilities of advancing municipal adaptation policy diffusion?

Empirically, we focus on municipal adaptation in the German federal state of Hessen, as well as in Finland. In terms of their basic characteristics, Hessen and Finland are both comparatively rich jurisdictions with a similar population size (6.2 and 5.5 million inhabitants, respectively). Both Hessen and Finland contain one large city of more than 600 thousand inhabitants (Frankfurt and Helsinki, respectively), a few mid-sized cities and, crucially for this study, a large number of smaller municipalities below 50.000 inhabitants. However, Hessen and Finland differ in terms of their governance structure and their geography: Hessen is one of sixteen German federal states while Finland is a unitary nation state. In terms of land area, Hessen is only 1/16 the size of Finland. Overall, the climatic conditions, including the effects of climate change, vary considerably less across Hessen than across Finland. Hessen has temperate continental climate conditions with warm summers and mild winters (see Siegmund and Frankenberg n.d.). Finland has arctic conditions in the north and southern boreal and hemi boreal climate zones in the south. Both Hessen/Germany and Finland are part of the multilevel order of the European Union (EU).

With a view to illuminating the conditions of municipal adaptation in Hessen and Finland, the rest of this paper unfolds as follows: The 'Internal and external motivations and barriers affecting adaptation policy' section combines current knowledge on the internal and external motivations and barriers related to municipal adaptation with insights on policy diffusion. The 'Background and methodology' section presents crucial background knowledge of our case studies on the governance context of municipal adaptation in Hessen and in Finland, as well as on the survey methods applied to collect empirical material in both jurisdictions, and the analysis of the survey data. The 'Results' section presents the results of this empirical exploration and these are discussed further in the 'Discussion' section. The 'Conclusion' section concludes with insights on the motivations and barriers related to municipal climate adaptation diffusion, as well as opportunities for future research.

Internal and external motivations and barriers affecting adaptation policy

What motivates and what hinders municipal adaptation policy development has long been of interest to research communities. Motivations may be understood as drivers that propel municipalities to adapt to climate change. Patterson (2021), for example, identified a range of potential drivers of municipal institutional adjustments with a view to climate change adaptation, including extreme weather events or change agents. Juxtaposing the motivations, Biesbroek et al. (2013) define adaptation barriers 'as those factors and conditions that hamper the process of developing and implementing climate change adaptations' (p. 1120–1121). While barriers have often been discussed, Biesbroek et al. (2013) identify a lack of stringent definitional work and argue that many appear to be in the eye of the beholder. However,

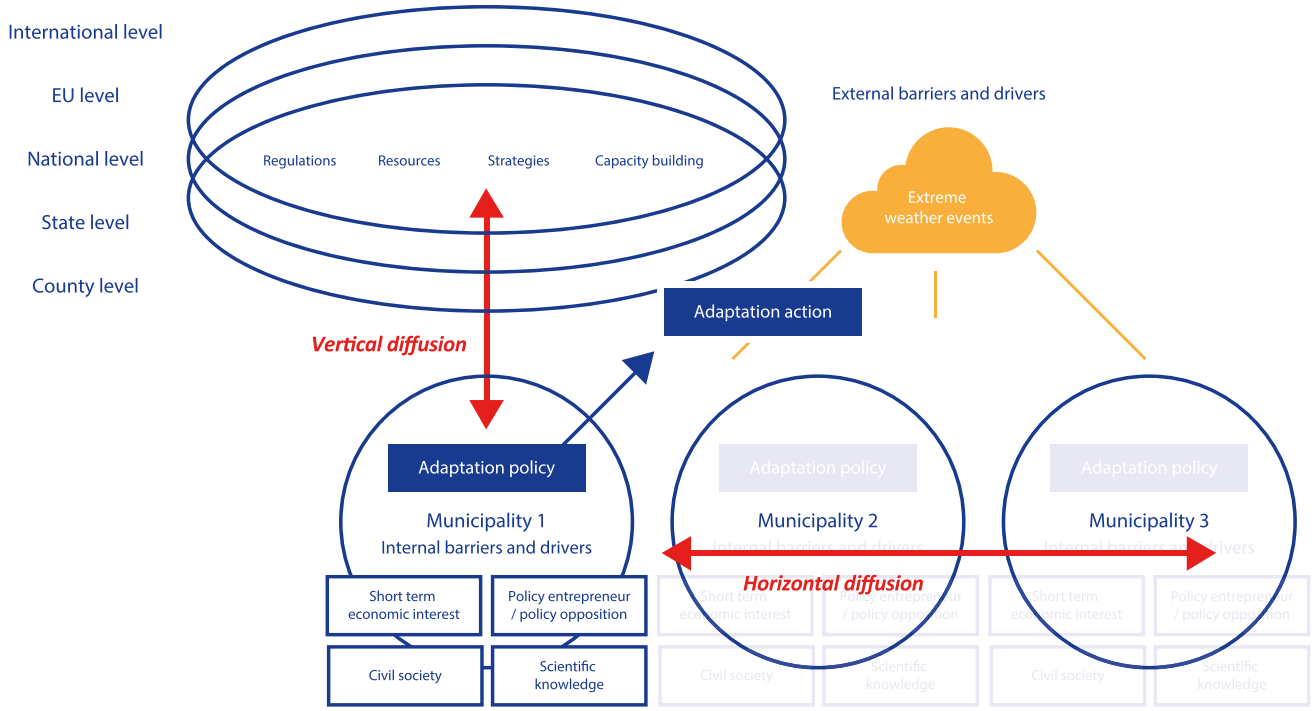

Fig. 1 Horizontal and vertical diffusion with corresponding internal and external motivations and barriers. All municipalities are affected by the same external motivations and barriers and all have their own set of internal motivations and barriers. *Image source: own compilation based on the available scientific literature discussed above and below*

a range of factors undoubtedly impact on municipal or national adaptation, such as lack of resources or awareness or even municipality size (Araos et al. 2016; Simonet and Leseur 2019; Lee et al. 2022; Lesnikowski et al. 2021; Massey et al. 2014; Reckien et al. 2018).

Seeking to systematise such factors, models of government innovation typically distinguish between internal and external motivations and barriers affecting policy development, a perspective that is particularly useful for understanding municipal adaptation policy. According to Berry and Berry (2018), internal determinants include the motivations of policy-makers to act (driven by for example problem severity), the resources they have and the obstacles they face, as well as other policies within the same jurisdiction that may have a bearing on policy adoption. They are thus factors that primarily originate within a municipality, such as for example activities of the municipal administration or of politicians, or activities from local interest groups and citizens. By contrast, external determinants refer to the activities of other jurisdictions and levels of governance, which can be a source of policy diffusion (Berry and Berry 2018).

According to theory, policy diffusion may occur as a consequence of numerous mechanisms and pathways that make actors consider others' policies and actions in their own policy-making, including interests (because actors assess the benefits of a certain policy for them), ideology (where actors decide whether a policy fulfils their ideological values), rights or duties (where policies are put in place because of external rules and pressures), and recognition (where actors put in place policies in pursuit of reputational gains) (Blatter, Portmann and Rausis 2021). Policy diffusion is particularly relevant for municipalities, which typically have a large number of peers, and which are influenced by several higher levels of governance, including county, state, national, international levels (see Kern, 2019).

In order to capture these different external influences, we distinguish between vertical and horizontal motivations and barriers and the relevant processes of diffusion. Vertical external influences span different governance levels, such as from the national level to the local level and vice versa. In this paper, we only examine vertical influence from higher levels of governance to the municipal level. Horizontal diffusion, by contrast, refers to the import or export of policies between municipalities, that is, the transfer of ideas and practices between units at the same governance level. Of course, motivations and barriers affecting adaptation to climate change may also emerge within the municipality. Figure 1 depicts the internal and external motivations and barriers, and vertical and horizontal diffusion, that may influence municipal adaptation policy. The following sections discuss these in greater detail.

Internal motivations and barriers

A wide range of internal motivations and barriers affecting municipal climate change adaptation has been identified. Key et al. (2018), (p. iv) group them into leadership and organisational culture, staffing and technical capacity, stakeholder engagement and partnerships, and operations and institutionalised processes. All of these can also indirectly affect the likelihood of both vertical and horizontal policy diffusion. Some motivations and barriers are strongly context-dependent, for example, natural conditions that make the municipality susceptible to particular climatic extremes. Others, such as the activities of policy entrepreneurs and political initiatives, tend to be important across different contexts (Patterson 2021) because they relate to engagement and partnerships. Likewise, civil society initiatives and environmental interest groups may, for example, drive adaptation. By the same token, municipalities that are already acting on climate change may also be more open to adaptation (but there is no perfect association, see Otto et al. 2021).

Internal barriers relate to issues such as lack of resources (personnel, money) and lack of knowledge and awareness about climate change and its impacts (see Amundsen et al. 2010; Amundsen & Dannevig 2021; Biesbroek et al. 2013; Reckien et al. 2018). Furthermore, institutional path dependencies may make it difficult to advance adaptation action (see Patterson 2021), and competing societal and political priorities may have a similarly hampering effect.

External motivations and barriers

A number of external motivations and barriers can be associated with both vertical and horizontal patterns of policy diffusion (Schoenefeld et al. 2022). For example, climate (adaptation) managers and their networks may contribute to the diffusion of specific policies (see Kenkmann et al. 2021). This paper builds on the premise that these diffusion mechanisms operate both horizontally and vertically and materialise in traceable adaptation policy outputs, attitudes, and courses of action. This section discusses the external motivations and barriers in greater detail.

Vertical diffusion

External vertical motivations and barriers refer to conditions that emerge because of the activities of other governance levels, such as for example the state level, the national level, or the international level. One line of influence may entail funding from higher governance levels, as has been the case for EU-level, national level, and regional level funding. The EU has, for example, put in place funding mechanisms for adaptation (Keskitalo et al. 2013), for example through the structural funds and the life funding instrument.[1] In Germany, national funding through the so-called *Kommunalrichtlinie* has been particularly important for municipalities (Kern et al. 2023; Otto et al. 2021).

Furthermore, there have been a range of approaches towards capacity building through information provision, training, and support. Higher governance levels may organise and/or support municipal networks that focus on adaptation (e.g. the 100 resilient cities network, see Papin 2019). They may also provide strategies and set political priorities for adaptation, implement rules and obligations for municipal adaptation, and they may have similar ideological orientations as a municipality (e.g. same/similar party in power).

Vertical diffusion may also occur through coercion when the national government uses legislation or administrative orders to demand adaptation planning at the local or regional level as in, for example, Ireland, Sweden, Denmark, and Norway (Keskitalo et al. 2016; Reckien et al. 2018; Ulvi et al. 2022). In the EU Member States, there are, for example, regulations of a European origin for specific topics such as flood risk management (The Floods Directive (2007/60/EC)) and a new general requirement for adaptation planning in the European Climate Law (Article 5, Regulation (EU) 2021/1119). Taken together, it becomes clear that the available multilevel structure has the potential to affect the diffusion of adaptation policies in multiple ways (see Keskitalo and Kulyasova 2009).

The external vertical barriers to diffusion are in many instances the inverse of the motivations. Benz (2021) argues that complex, multi-level governance systems may under certain circumstances produce necessary policy innovations to address complex policy problems such as climate change. But they may also constrain the diffusion of such innovations. For example, incongruent societal or political priorities on other governance levels may reduce a municipality's propensity to adopt active climate change policies. For example, a strong interest to exploit valuable land along the coast or rivers may create incentives to accept flood risks. Contradictory legal frameworks at different governance levels may also hamper the diffusion of adaptation policies, and lack of knowledge and understanding on other governance levels may make it difficult to advance adaptation in a municipality. For example, drinking water supply is often a task of the municipal technical maintenance, but the quality of drinking water is also a concern of regional health authorities and the management of aquifers a task for regional and local environmental authorities. Contradictions may arise concerning priorities of appropriate actions when

[1] European Structural and Investment Funds https://ec.europa.eu/regional_policy/en/funding/ and https://eufundingoverview.be/funding/environment-and-climate-action-life

climate change jeopardises both the quality and quantity of drinking water.

Horizontal diffusion

Horizontal motivations and barriers refer to factors that lie outside a municipality, but which operate on the same governance level, thus in our case usually other municipalities. Looking at the motivations, municipalities may interact with one another in networks, which may be anywhere from local (e.g. Häußler and Haupt 2021; Schulze and Schoenefeld 2022) to regional/national or transnational in their extent (e.g. Papin 2019). For example, Hauge, Hanssen, and Flyen (2019) describe the positive role that networks spanning the municipal, the county, and the national level played in advancing municipal adaptation. Several such peer networks have also emerged in the field of climate mitigation (Karhinen et al. 2021). Motivations for diffusion may also arise through similar political conditions, such as party networks.

External horizontal barriers to diffusion may include a lack of examples of (successful) adaptation in other municipalities, a lack of knowledge of what others do, or a lack of communication and network ties among municipalities. The absence of knowledge and information flows likely reduces the probability of municipal adaptation action (see Simonet and Leseur 2019).

Background and methodology

The governance context

To study vertical and horizontal adaptation policy diffusion across different types of municipalities and governance contexts, this study relies on original data from Hessen/Germany and from Finland. As noted above, both Hessen and Finland are similar in that adaptation rules and regulations have been slow to develop, as neither Hessen nor Finland has legal obligations for municipal adaptation planning or action. While both Germany and Finland are embedded in the EU, which provides key reference points for adaptation policies in light of the 2013 Climate Adaptation Strategy (European Commission 2013) and the corresponding update in 2021 (European Commission 2021), the Hessian municipalities, in contrast to Finnish ones, face an additional active climate (adaptation) policy maker at the state level that is not present in the Finnish governance architecture.

This study utilises original data from two independent surveys administered to municipalities in the State of Hessen/Germany (between November 2020 and January 2021) and in Finland (between December 2021 and January 2022). Both surveys included questions on the motivations for and barriers of municipal adaptation policy, including both internal and external factors with a view to vertical and horizontal diffusion. This offers a unique opportunity to compare answers in order to gain better insights into how vertical policy diffusion evolves in different multilevel governance contexts. Moreover, the survey samples are fairly representative including municipalities of many different sizes (see details below), which allows us to explore how motivations and barrier vary with municipality size. Therefore, the motivations and barriers affecting municipal adaptation policy are of particular interest, while the diversity of contexts can shed further light on the prospects for policy diffusion.

Climate change adaptation in Hessen

Located in central Germany, the federal State of Hessen boasts one large city (Frankfurt) and a range of mid-sized and many smaller municipalities. Climate action and adaptation has long been a concern to Hessians. For example, Frankfurt was one of the founding members of Europe's largest municipal climate network, the Climate-Alliance, in 1990 and still houses its headquarters to this day (Climate Alliance 2023). As in most places, adaptation followed mitigation in Hessen, which presented a first adaptation strategy in 2012 (Hessisches Ministerium für Umwelt, Energie, Landwirtschaft und Verbraucherschutz 2012). The 2012 strategy for example highlights the importance of careful zoning in municipalities in order to respond to climate change impacts (p. 64–65), but also emphasises that municipalities depend on a functioning, multi-level structure for successful adaptation (p. 65). This strategy emerged in the context of the German adaptation strategy, which had been agreed at the national level in 2008 (Bundesregierung 2008). Five years after Hessen's first adaptation strategy, the federal state presented a new, integrated climate action plan in March 2017, which addresses both mitigation and adaptation and once again highlights the importance of municipalities as key actors. For advancing municipal climate mitigation and adaptation action, Hessian municipalities can join the so-called Klima-Kommunen, a state-wide network for municipalities that offers opportunities for information, mutual learning as well as enhanced state funding for climate projects (Schulze and Schoenefeld 2022; Klima-Kommunen 2023). In addition, the Hessian municipalities can draw on funding from the state and the national level to support their climate-related activities. They also have their own tax base (mainly property and business taxes — though less than in Finland, see below) and perform a range of mandatory tasks, including for example disaster management through fire departments (together with the counties). However, climate action and adaptation remain de-jure voluntary tasks. In sum, the Hessian municipalities can draw both on

a multi-level, as well as on a horizontal governance architecture to support and finance their adaptation endeavours.

The Hessian survey

Our main source of data is an original survey on climate change adaptation, which builds on previous surveys that had been administered to German municipalities, including for the evaluation of the German adaptation strategy (Hasse et al. 2019). In Hessen, the municipalities could choose between an online and a pencil-and-paper version. The survey returned up to 215 usable questionnaires from the total of 422 Hessian municipalities, producing a response rate of about 51%. The survey sample is fairly representative in terms of its spatial and demographic distribution. A chi-squared test revealed no significant difference between the respondents and the overall distribution of municipalities in Hessen (see Table 1 in the Appendix).

Climate change adaptation in Finland

Finland was one of the forerunners in developing a national level climate change adaptation strategy in 2005 (Ministry of Agriculture and Forestry of Finland 2005). Although Finland experiences a higher-than-average global temperature rise, the societal and economic impacts of climate change have so far been modest. Concerns include flooding, including floods caused by heavy rainfall, impacts on forest resources (storms, wildfires, insect infestations, or droughts), impacts on agriculture (yield loss), and heat waves.

Municipalities are the local administrative units in Finland. They have significant administrative tasks including a large part of the education (primary and secondary schools), health and social welfare, employment, cultural activities, water management, local environmental protection, land use planning, disaster risk management, and support for economic activities. Land use planning is an exclusive municipal task. Municipalities have the right to collect income-based taxes and also land use taxes. Municipal taxes add up to about half of the income of Finnish municipalities (Hottinen 2022). Finnish municipalities have, however, had more limited access to earmarked financial support for adaptation, as there have not been any state funded programmes such as those available in Hessen (see above). Finnish municipalities are entitled to state support for specified activities such as education (on average 22% of the municipal income is based on such state contributions (Hottinen 2022), but adaptation is not among these). Municipalities cannot be ordered to take on new tasks without ensuring a minimum level of funding from the state budget for carrying out the tasks.

The role of the Finnish municipalities in adapting to climate change arises from their comprehensive role as administrative units responsible for the health and welfare of the citizenry and the state of the local environment. The municipalities also aim at ensuring the success of local businesses through, for example, supporting infrastructure, land use planning, and a 'business-friendly' atmosphere. Safeguarding the municipality against climate risks can be one aspect of making the municipality attractive for investments (see Vogel and Henstra 2015). There is a municipal network on climate action offering mainly capacity building and information, which the Association of Finnish Municipalities coordinates and a network ("Hinku") for municipalities aspiring to become carbon neutral (Karhinen et al. 2021).

The Finnish survey

The survey aimed at taking stock of climate action in Finnish municipalities. Similar surveys had been carried out over various time intervals by the Association of Finnish Municipalities (AFM) since 2009 (Mattsson 2021; Savikko 2009). The survey covered both municipal adaptation and mitigation actions focusing on current activities and future needs. It was developed by a research team and tested before sending it to all municipalities in Finland (309) as an e-survey. Responses were obtained from 96 municipalities (i.e. the response rate was about 31%). Because the geographical distribution of the respondents was uneven with few responses from the northern and north-eastern part of the country, the survey was complemented with a non-response phone survey based on regionally stratified random sampling with a sample size of 60 municipalities (see Table 2 in the Appendix). After complementing the data with the non-respondent survey, a chi-squared analysis suggests that the final sample adequately represents the spatial distribution of Finnish municipalities. Considering the size of the municipalities, however, differences are statistically significant. Therefore, the Finnish sample is geographically representative, but still biased towards bigger municipalities (see Table 2 in the Appendix). The comparison of responses from the non-response survey with the original survey responses in corresponding size categories showed that the interview based non-response survey returned a wider range of adaptation actions, suggesting that the survey method has an effect on the results. However, the top actions were the same. The survey data was complemented with census data from Statistics Finland.[2]

[2] For the current analysis, we primarily used the responses to the 10 questions that dealt with adaptation and the general background questions on, for example, climate goals, plans, and resources.

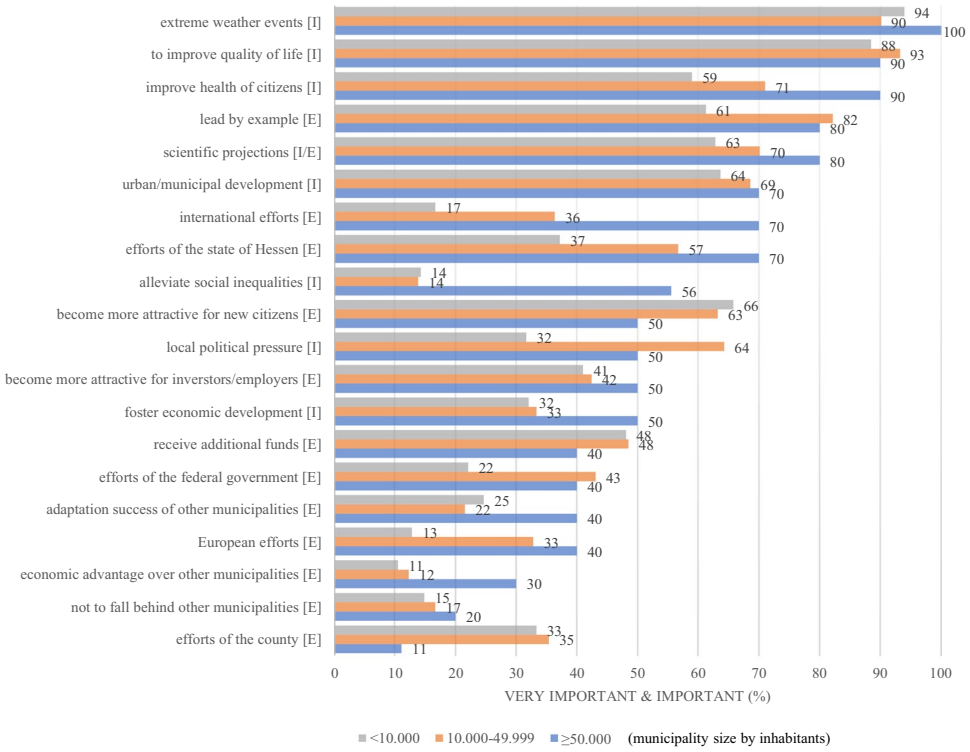

Fig. 2 Motivations for becoming active in adaptation in the Hessian municipalities, percentage of respondents answering 'very important' or 'important' (multiple answers possible). Note: I, internal motivation; EH, external horizontal motivation; EV, external vertical motivation. Extreme weather events may generate characteristics of internal and external effects, depending on their nature

Summary

Taken together, the empirical material was collected independently and the surveys were not exactly the same. We used the collected survey data to explore the potential influence of different motivations and barriers affecting municipal adaptation policy and the extent to which these vary by the population size of the municipalities. As part of the Hessian survey, municipalities were asked to rate predefined lists of motivations for and barriers to adaptation policy on a 5-point scale according to their importance. We report the shares of municipalities, which rated a certain factor at least important. In case of the Finnish survey, respondents were asked to identify the three most important motivations and barriers and we report the shares of municipalities identifying the respective factors. Details on the survey questions can be found in the Appendix. In presenting and interpreting the results, we categorised all answers in terms of whether a motivation/barrier is internal or external to municipalities. Moreover, we differentiate between vertical and horizontal external factors.

Results

Internal and external motivations

The surveys show differences in the importance of internal and external motivations for municipal adaptation efforts (Figs. 2 and 3). According to the Hessian municipalities' own assessment, the experience of extreme weather events was among the most important motivations for becoming active in adaptation policy (Fig. 2). Improving the quality of life and the health of citizens were additional important internal motivations, although health concerns played a stronger role in the larger municipalities. Urban development was also seen as an important issue. A larger discrepancy between differently sized municipalities can be seen with regards to the reduction of social inequalities, which is an important motivation for adaptation policy development in more than half of the large municipalities but only in 14% of the medium- and small-sized municipalities. This may suggest that equity concerns in climate change adaptation, which have increasingly spread across larger cities (see Cannon et al. 2023) may not as easily gain traction in smaller municipalities. About half of the medium-sized and large municipalities also see local political pressures as an important motivation for adaptation activities while this is only the case in about 25% of the small municipalities.

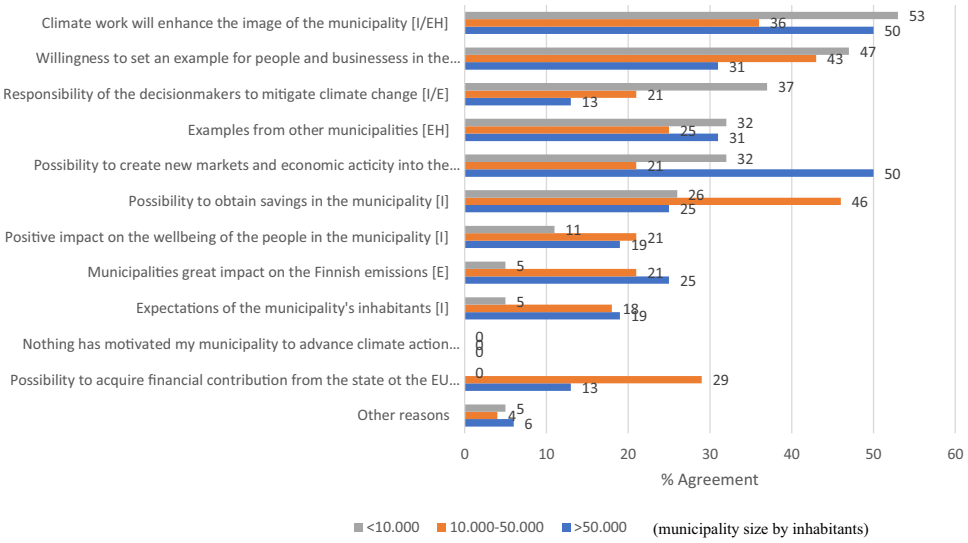

Fig. 3 General motivational factors for climate action in the Finnish municipalities (*N*=64, up to three responses/municipality). Note: I, internal motivation; EH, external horizontal motivation; EV, external vertical motivation

Regarding the external motivations, over 80% of the large- and medium-sized municipalities and over 60% of the small municipalities reported that leading by example was an important motivation to act, making this the overall most important external motivation in Hessen. This suggests that reputational concerns may play an important role in the diffusion of adaptation policy. Another set of horizontal external motivations relate to the attractiveness of the municipality: well over 60% of the smaller and mid-sized municipalities, but only 50% of the large municipalities, indicated becoming more attractive for new citizens as an important motivation for developing adaptation policy. This underscores that municipalities, particularly smaller ones, have realised that adapting to climate change is an important part of their development agenda and potentially of their public image. However, larger municipalities seem to place higher importance on adaptation as a factor in attracting potential investors and employers than smaller municipalities.

Among vertical external motivations in Hessen, international efforts and efforts by the State of Hessen ranked highest. However, larger municipalities are more likely to name the two as an important motivation than smaller ones. Interestingly, the opposite turns out to be the case for the efforts of the counties, whose importance around 35% of the smaller and mid-sized municipalities stressed (very important/important), while counties are rarely considered important by large municipalities. This is not surprising, given that 5 of the 11 largest cities with more than 50,000 inhabitants are not associated with a county in Hessen. Nevertheless, the emerging patterns suggest that, while the state level is the most important higher level of governance for all municipalities, larger municipalities tend to consider developments at the international and national level more important for their own adaptation activities than smaller municipalities. The latter look to the State of Hessen and the county for support in their adaptation efforts. In short, with the exception of the state level, which is important for all municipalities, the smaller the municipality, the more important the closest levels of governance for driving adaptation (see Fig. 2).

The Finnish survey included a question about municipalities' motivations for climate action, but with a different set of possible responses (see Fig. 3). With some reservations, the results can be used for identifying parallels with those for Hessen. Similar to Hessen, reputational aspects were considered important in all municipal size categories. Leading by example also ranked highly, but strongest among the small municipalities. The largest municipalities saw climate action as a potential business opportunity, while the mid-sized municipalities identified opportunities for support from the state and the EU together with obtaining savings as a fairly significant motivator. Impacts on the well-being of the citizenry were felt least important in the smallest municipalities, which mirrors the results in Hessen.

Securing national and EU-funding for the municipality was not regarded as a very significant motivational factor to advance adaptation. This may reflect both the absence of such funding opportunities (an external barrier), or a lack of knowledge of them in the municipalities (an internal barrier). By the same token, municipalities of all sizes considered examples from other municipalities as an important external motivation, pointing to the importance of horizontal diffusion.

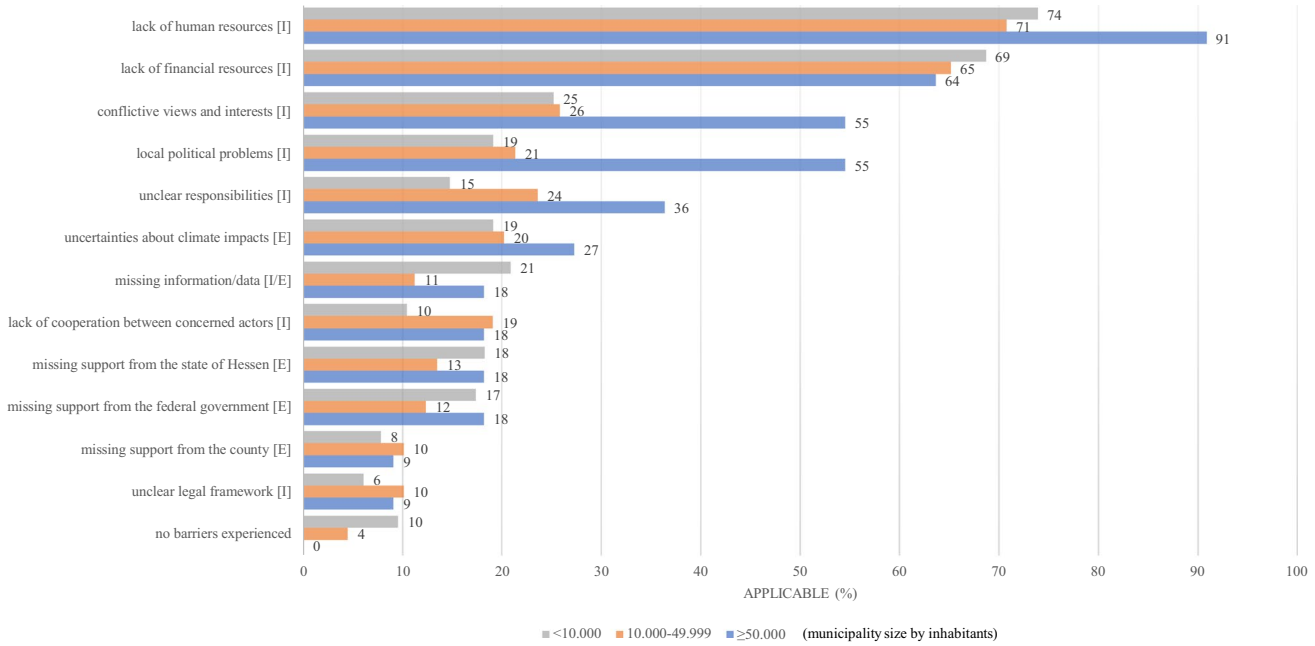

Fig. 4 Barriers to adaptation policy-making in the Hessian municipalities, percentage of respondents answering 'yes' (multiple answers possible). Note: I, internal motivation; EH, external horizontal motivation; EV, external vertical motivation

Internal and external barriers

When it comes to the barriers that may hinder adaptation policy-making in Hessen, the first thing to note is that a lack of human resources, and a lack of financial resources are by far the top two barriers that municipalities of all sizes report (see Fig. 4). While these results are not particularly surprising, they are nevertheless in line with sustained evidence that efforts of stepping up municipal adaptation (including the promotion of policy diffusion) will require additional resources (see, for example, Vogel et al. 2020, who found financial resources as an enabler of municipal adaptation in Nova Scotia, Canada). While these barriers are by and large equally identified by municipalities of all sizes, a lack of human resources is even more often reported as an important barrier by the largest municipalities, which may indicate ongoing difficulties in finding suitable staff for adaptation efforts. Interestingly, internal political factors, such as conflicting views and interests, local political problems, and unclear responsibilities, are the next most often identified barriers in all kinds of municipalities even though they are more often identified in the larger municipalities than in the smaller ones. Assuming that larger municipalities are generally leading local adaptation efforts, this suggests that adaptation is far from being a frictionless process and conflict is likely to accompany adaptation efforts in the future.

Looking towards external barriers, uncertainty about climate impacts, and missing information play a role for about 20% of the municipalities. About the same share reported that a lack of support from the state of Hessen, the federal government, and the county are hindering their adaptation efforts with very small differences in size.

Barriers to municipal adaptation in Finland matched those observed in Hessen. Internal barriers such as the lack of resources at the municipal level and lack of designated responsibilities, plus the external vertical barrier in the form of the lack of legal obligations to plan adaptation, stand out as the most important categories across all municipal sizes (Fig. 5). The lack of resources is felt most acutely in the smallest municipalities, whereas unclear responsibilities came on top in the largest municipalities. While the survey did not directly ask about challenges related to the governance levels, identification of the absence of a legal obligation as a major barrier suggests that vertical governance structures fail to provide clear external direction for adaptation in the Finnish context, which is likely to also limit diffusion. Furthermore, lack of knowledge about how to initiate adaptation is an internal barrier to effective diffusion. It is noteworthy that the need for adaptation in general is not highly contested, and should therefore not be a barrier for diffusion. However, debates over prioritising adaptation relative to other issues in the municipality may limit the search for adaptation action as adaptation to climate change is an optional, not a mandatory, task for municipalities. Finland is currently about to embark on a 'natural experiment' of the difference between mandatory and voluntary planning

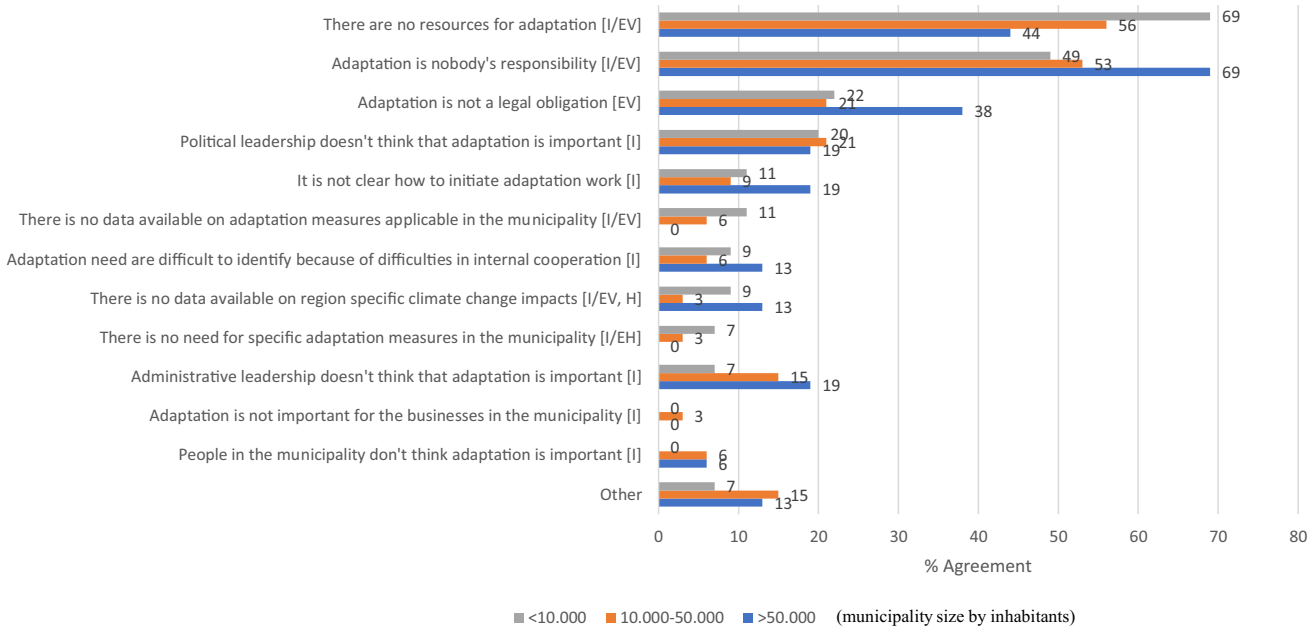

Fig. 5 Barriers to adaptation action in the Finnish municipalities ($N = 96$, up to three most important barriers). Note: I, internal motivation; EH, external horizontal motivation; EV, external vertical motivation

of climate action. A revision of the Climate Act in 2022 (Parliament of Finland 2022) makes municipal planning of climate change mitigation mandatory, whereas planning of adaptation is left optional.

The practice of diffusion

The Hessian survey asked the municipalities explicitly whether they had oriented their adaptation activities on those of others, which is one of the research strategies that has been recommended in the debate on adaptation policy diffusion (Schoenefeld et al. 2022). In total, around 35% of all municipalities reported some direct external orientation in their adaptation policy-making, that is they answered that they had at least modelled some of their adaptation policies on those of others. We would argue that this is a substantial amount given the novelty of the policy area. However, answers vary considerably by municipality size. Around 80% of the largest municipalities reported that they had at least modelled some of their policies on those of others, while the share is 42% for the mid-sized municipalities and 25% for the smallest municipalities. This indicates that larger municipalities may have more resources available for gathering relevant information and looking towards others in their adaptation efforts.

For the municipalities that did orient their own adaptation policies on others, the Hessian survey also asked about relevant motivations and the barriers to doing so. Similar climate impacts and vulnerability profiles turned out to be an important motivator for looking towards others, as well as geographical proximity, that is, looking at what the neighbours do (see Fig. 6 in the Appendix). Other factors include leadership roles of others and successful adaptation roles of others. Interestingly, personal contacts turned out to be much more important for the smallest municipalities (91%) than for the mid-sized municipalities (75%) or the large ones (50%).

The barriers to considering the adaptation efforts of others mainly highlight a lack of administrative capacities to inform oneself about others, which was very important/important for the largest municipalities (70%), as well as for the mid-sized municipalities (61%) and the smallest ones (60%). Other, but less important factors include lack of access to knowledge about others, as well as lack of adaptation experience in the neighbourhood (which turned out to be more important for the small and mid-sized municipalities than for the larger ones). See Fig. 7 in the Appendix.

Ideas for adaptation in the Finnish municipalities appear to originate primarily from networks or neighbouring municipalities (see Fig. 8 in the Appendix), thus supporting the view that networks are very important for enhancing the diffusion of adaptation policies. Regional adaptation work led by the Regional Councils is an especially important source of ideas for the smallest municipalities and own networks for medium-sized ones. Neighbouring municipalities do not inspire the biggest municipalities as much as the others, which is natural, given that many of the largest municipalities are surrounded by smaller ones that have less resources. The large municipalities can actively exploit national and

international sources for ideas and they can also support the smaller municipalities in their neighbourhood. Formal agreements on joint work have been reached by some groups of municipalities, often led by a larger central municipality.

Discussion

Motivations

Despite differences in the specific survey questions applied in Hessen and Finland, the results suggest similar overall patterns of motivations and barriers affecting adaptation policy and its diffusion in Hessen and in Finland. Although the response alternatives were different, both Hessian and Finnish municipalities identified reputational factors as important. The Hessian survey included explicit reference to climate impacts, and identified improving the quality of life or reducing social inequalities (the latter two mainly for larger municipalities) as important motivational factors. In Finland, the well-being of inhabitants was identified as an important motivational factor by about a fifth of larger municipalities, but only a tenth of the smallest. The smallest municipalities probably do not see themselves as having a very active role in safeguarding well-being and may also not consider climate change as a relevant risk to the health and well-being of their citizens.

Barriers

The barriers are strikingly similar across Hessen and Finland, where lack of personnel and monetary resources,[3] as well as unclear responsibilities in the multilevel governance structures, were highlighted in both surveys. Thus, the internal barriers loom large, but since higher governance levels can also provide finance and other resources, multilevel structures contain both a range of barriers and opportunities to unlock municipal adaptation efforts. The lack of resources can be seen to be linked with, for example, conflicting views and interests and the lack of clearly specified responsibilities. This matches the observation of Simonet and Leseur (2019), who also note the interconnectedness of obstacles to adaptation. Some of these barriers can be reduced through legislative change at higher governance levels.

Both surveys suggest that lack of clear responsibilities becomes more serious with size. Municipalities above 50,000 inhabitants report it as a major obstacle. This echoes a long-standing debate on the role of size in governance: size does not necessarily increase efficiency (Slack and Bird 2013). However, one should also note that larger municipalities face a wider array of issues in adapting to climate change and therefore there is a greater need for stronger internal organisation and specific responsibilities; in other words, context matters for policy implementation, an insight which has also built up in other fields of policy studies such as education (e.g. Harris and Jones 2018).

Multilevel governance

The findings reveal that the multilevel governance architecture in which Hessen and Finland are embedded may play somewhat different roles in small and large municipalities. Both in Hessen and Finland the small municipalities typically turn to the closest governance level for support. This is the county level but in Germany also the State of Hessen even though in administrative terms it resembles the national level in Finland. In Finland, however, the small municipalities do not count on the national level. The explanation may be that the physical distances are clearly shorter in Hessen than in Finland. Hessen covers a much smaller land area than Finland (1/16). Thus, the geographical proximity of the state and its institutions and the relative homogeneity of the natural conditions are likely to lower the barrier to make contact also with the (federal) state level and also for the (federal) state level to actively engage in the conditions across the area. The large municipalities are, on the other hand, able to interact with several levels in the governance system both in Hessen and Finland. They may even strive to actively influence the governance by lobbying for resources or legal change.

Large municipalities are clearly better placed when it comes to obtaining resources from other governance levels. This finding emerges from the responses to questions related to the diffusion of adaptation policies. The large municipalities collect their own information (Finland) and are able to follow the successful examples of others (Hessen). While larger municipalities may be able to muster the necessary wherewithal to do so, smaller ones struggle and especially in Finland, give up altogether and do not even apply for funding. This finding was confirmed in the non-response survey in Finland, which provided additional information especially on small municipalities in the periphery, which suffer from depopulation and generally poor economy.

Although resources are key for adaptation, the surveys also highlight the role of unclear multilevel and legal structures. Task and resource allocation across governance levels need to be resolved especially if system transitions that can enable climate resilient development, based on appropriate enabling conditions and inclusive arenas of engagement, are to be achieved (Pörtner et al. 2022, p. 77). The largest municipalities may partly be able to develop 'autonomous transitions' by relying on national and transnational networks

[3] Although the composition of the origin of municipal resources differs for Hessian and Finnish municipalities, see above.

and by developing their own adaptation policies and objectives, but the surveys highlight the need for a functioning multilevel governance structure especially with a view to supporting smaller municipalities. This echoes the findings of Key et al. (2018) and Simonet and Leseur (2019). The small municipalities with less than 10,000 inhabitants are in the greatest need of support, even if their small size may make them agile and somewhat less prone to internal strife over responsibilities (see Figs. 4 and 5). We conclude that new and more effective municipal adaptation policies require that the governance level closest to the municipalities, that is, the Regional Councils and the regional state authorities, devote specific efforts to support the small municipalities in their adaptation efforts. Dedicated services can overcome the barriers that small municipalities face in the form of lack of both resources and skills to benefit from, for example, funds for adaptation that require applications and project management skills.

In regional development, the concept of 'place-sensitive distributed development policies' has been presented in order to adequately respond to the very different needs of regions (Iammarino et al. 2017). This approach stresses that development, which in our case can be interpreted as appropriate adaptation action in the face of climate change, is based on vertical action across governance levels within specialised sectors such as water management, and on horizontal diffusion mechanisms, which bring in peer knowledge (for a related example and findings from fire management, see Butler and Goldstein 2010). We conclude that peer knowledge is particularly important for small municipalities with limited resources. For example, networks such as the Klima-Kommunen in Hessen or the Hinku Network in Finland may provide opportunities for learning and contextually meaningful actions even in the smallest municipalities (Hildén et al. 2022).

The reallocation and clear definition of tasks across the multilevel order is one of the big topics in municipal climate change adaptation, both in Hessen and in Finland. While the Finnish survey directly addressed this question and identified it as a main barrier, the authors are aware of similar ongoing policy discussions in Hessen (though there are also sceptical voices, given that a legal obligation to adapt may reduce municipal independence to develop local solutions). The hope that has typically been articulated is that a legal obligation to adapt at the municipal level would come with the necessary resources to do so. In Finland, this issue was raised in the context of revising the Climate Act. A legal obligation will also require the central government to deliver guidance and support for the tasks that municipalities are expected to undertake, which partly explains why the revised Climate Act maintained municipal planning for adaptation as optional.

Possibilities for adaptation policy diffusion in Hessen and in Finland

It is worth reiterating that the empirical material was collected independently and the surveys were not exactly the same. But while a strict comparison between Hessen and Finland would be inappropriate, the diversity of the insights described above provides a base for reflecting on the generality of some of the motivations and barriers. First, it is noteworthy that the multilevel structure of adaptation governance appears to be perceived less as a challenge in Hessen than in Finland. This is noteworthy, since Hessian municipalities face an additional level of governance compared to Finland. However, both Hessian and Finnish municipalities report unclear responsibilities for adaptation as a barrier. It may reflect unclear internal organisation since larger municipalities see this more often as a problem than the small ones, but also under-developed multi-level governance frameworks, including legislation, may become a barrier by not designating tasks and responsibilities clearly.

When it comes to the motivations, the surveys differ structurally as the Finnish survey included both mitigation and adaptation in the dependent variable 'climate action'. Nevertheless, leading by example, image building and improving the health of the inhabitants are all identified as fairly important. In Finland, the smallest municipalities put greatest emphasis on leading by example, whereas in Hessen, the larger municipalities see this a stronger motivational factor than the small ones. All of these motivations suggest that many municipalities pay attention to their peers, indicating that peer networks could be a relevant diffusion mechanism for municipal adaptation policy.

As for the barriers, the lack of resources loomed large for municipalities both in Hessen and in Finland. However, in Finland, the smallest municipalities do not appear motivated to gain funding through climate action, suggesting that the lack of resources is so fundamental that there are not even resources for applying. This was confirmed in the non-response phone survey that added information on the small municipalities. It may also be because Finnish municipalities have fewer earmarked funding sources from higher governance levels than the Hessian municipalities do.[4] In Hessen, nearly half of the smallest respondents see the possibility of additional funding from the state as a motivation.

[4] We are grateful to Kristine Kern for suggesting this point.

Conclusion

As the climate challenge mounts, adaptation to its effects is becoming an important imperative and complementary strategy to ongoing mitigation efforts. The discussion of how to develop multilevel governance for adaptation, especially with a view to implementation at the lowest administrative level, is particularly important because many of the impacts are felt acutely at the local level. We have shown that there are a wide range of internal and external motivations and barriers that affect municipal adaptation policy and that municipalities have very different capacities to adapt. Policy diffusion is thus not only a question of showcasing 'good practices' that are then presumably automatically adopted. Support for adaptation should be sensitive to context and tailored to fit the specific needs of the municipalities. Large municipalities have capacity to develop their own activities, but may need specific technical guidance, whereas small municipalities also need help in basic planning and risk identification.

We therefore conclude that a key issue for effective diffusion of municipal adaptation policies is the recognition of the diversity of the municipalities with respect to resources, motivations and barriers. As noted above, there are several ways to address this diversity in developing multilevel governance for adaptation. The goal should be to fulfil the 'leave no one behind' credo of the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (United Nations Sustainable Development Group 2023).

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References

Amundsen H, Berglund F, Westskog H (2010) Overcoming barriers to climate change adaption? A question of multilevel governance? Environ Plann C: Gov Policy 28:276–289. https://doi.org/10.1068/c0941

Amundsen H, Dannevig H (2021) Looking back and looking forward—adapting to extreme weather events in municipalities in western Norway. Regional Environmental Change 21:1–11

Araos M, Berrang-Ford L, Ford JD, Austin SE, Biesbroek R, et al (2016) Climate change adaptation planning in large cities: a systematic global assessment. Environ Sci Pol 66:375-382. https://doi.org/10.1016/j.envsci.2016.06.009

Bausch T, Koziol K (2020) New policy approaches for increasing response to climate change in small rural municipalities. Sustainability 12:1894. https://doi.org/10.3390/su12051894

Benz A (2021) Policy change and innovation in multilevel governance, Lansdown, Cheltenham. https://doi.org/10.4337/9781788119177

Berry FS, Berry WD (2018) Innovation and diffusion models in policy research. In: Weible M, Sabatier PA (eds) Theories of the policy process, 4th edn. Routledge, New York

Biesbroek GR, Klostermann JE, Termeer CJ, Kabat P (2013) On the nature of barriers to climate change adaptation. Reg Environ Chang 13:1119–1129. https://doi.org/10.1007/s10113-013-0421-y

Blatter J, Portmann L, Rausis F (2021) Theorizing policy diffusion: from a patchy set of mechanism to a paradigmatic typology. J Eur Publ Policy 29:805–825. https://doi.org/10.1080/13501763.2021.1892801

Bundesregierung (2008) Deutsche Anpassungsstrategie an den Klimawandel. https://www.bmuv.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/das_gesamt_bf.pdf. Accessed 1 Nov 2023

Butler WH, Goldstein BE (2010) The US Fire Learning Network: springing a rigidity trap trough multiscalar collaborative networks. Ecol Soc 15:21. https://doi.org/10.5751/es-03437-150321

Cannon C, Chu E, Natekal A, Waaland G (2023) Translating and embedding equity-hinking into climate adaptation: an analysis of US cities. Regional Environmental Change 23(1):30

Climate Alliance (2023) European municipalities in partnership with indigenous peoples taking local action on global climate change. https://www.climatealliance.org/en/home.html. Accessed 1 Nov 2023

Dannevig H, Rauken T, Hovelsrud G (2012) Implementing adaptation to climate change at the local level. Local Environ 17:597–611. https://doi.org/10.1080/13549839.2012.678317

Dolšak N, Prakash A (2018) The politics of climate change adaptation. Annu Rev Environ Resour 43:317–341. https://doi.org/10.1146/annurev-environ-102017-025739

Dupuis J, Biesbroek RG (2013) Comparing apples and oranges: the dependent variable problem in comparing and evaluating climate change adaptation policies. Glob Environ Chang 23:1476–1487. https://doi.org/10.1016/j.gloenvcha.2013.07.022

European Commission (2013) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0216&from=EN. Accessed 1 Nov 2022

European Commission (2021) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0082&from=EN. Accessed 1 Nov2022

Harris A, Jones M (2018) Why context matters: a comparative perspective on education reform and policy implementation. Educ Res Policy Prac 17:195–207. https://doi.org/10.1007/s10671-018-9231-9

Hasse J, Willen L, Baum N, Bongers-Römer S, Pichl J, et al (2019) Umfrage: Wirkung der Deutschen Anpassungsstrategie (DAS) für die Kommunen. Umweltbundesamt -UBA-, Dessau-Roßlau. https://repository.difu.de/jspui/handle/difu/254722. Accessed 10.01.2023

Hauge AL, Hannsen GS, Flyen C (2019) Multilevel networks for climate change adaptation – what works? Int J Clim Change Strategies Manage 11:215–234. https://doi.org/10.1108/IJCCSM-10-2017-0194

Häußler S, Haupt W (2021) Climate change adaptation networks for small and mediumsized cities. SN Soc Sci 1:262. https://doi.org/10.1007/s43545-021-00267-7

Hessisches Ministerium für Umwelt, Energie, Landwirtschaft und Verbraucherschutz (2012) Strategie zur Anpassung an den Klimawandel in Hessen. https://www.hlnug.de/fileadmin/dokumente/klima/monitor/3-hessische_anpassungsstrategie.pdf. Accessed 11.01.2023

Hildén M, Tikkakoski P, Sorvali J, Mettiäinen I, Kävhkö J et al (2022) Adaptation to climate change in Finland: current state and future prospects, vol 2022. Publications of the Government´s analysis, assessment and research activities, p 61

Hottinen A (2022) Manner-Suomen kuntien ja kuntayhtymien ulkoiset menot ja tulot vuoden 2020 tilinpäätöstietojen mukaan [The costs and incomes of municipalities and association of municipalities according to financial statements for 2020(in Finnish)]. Kuntaliitto. https://www.kuntaliitto.fi/talous/kuntatalouden-tilastot/menot-ja-tulot. Accessed 1 Nov 2022

Iammarino S, Rodríguez-Pose A, Storper M (2017) Why regional development matters for Europe's economic future. Directorate-General for Regional and Urban Policy Working Papers http://projects.mcrit.com/foresightlibrary/attachments/article/1263/Storper,%20M.%20(2017)%20Why%20Regional%20Development%20matters%20for%20Europe's%20Economic%20Future.pdf. Accessed 1 Nov 2023

Karhinen S, Peltomaa J, Riekkinen V, Saikku L (2021) Impact of a climate network: the role of intermediaries in local level climate action. Glob Environ Chang 67:102225. https://doi.org/10.2139/ssrn.3703510

Kenkmann T, Eisenmann L, Muckenfuß L (2021) Municipal climate action managers: evaluating the impact. Öko-Institut https://www.oeko.de//fileadmin/oekodoc/Municipal-climate-action-managers.pdf. Accessed 1 Nov 2022

Kern K (2019) Cities as leaders in EU multilevel climate governance: embedded upscaling of local experiments in Europe. Environ Politics 28:125–145. https://doi.org/10.1080/09644016.2019.1521979

Kern K, Bulkeley H (2009) Cities, Europeanization and multi-level governance: governing climate change through transnational municipal networks. JCMS J Common Mark Stud 47:309–332. https://doi.org/10.1111/j.1468-5965.2009.00806.x

Kern K, Eckersley P, Haupt, W (2023) Diffusion and upscaling of municipal climate mitigation and adaptation strategies in Germany. Regional Environmental Change 23(1) 10.1007/s10113-022-02020-z

Keskitalo ECH, Kulvasova AA (2009) The role of governance in community adaptation to climate change. Polar Res 28:60–70. https://doi.org/10.1111/j.1751-8369.2009.00097.x

Keskitalo ECH, Juhola S, Westerhoff L (2013) Connecting multiple levels of governance for adaptation to climate change in advanced industrial states. In: Edelenbos J, Bressers N (eds) Water governance as connective capacity, 1st edn. Routledge, London, pp 69–88

Keskitalo ECH, Juhola S, Baron N, Fyhn H, Klein J (2016) Implementing local climate change adaptation and mitigation actions: the role of various policy instruments in a multi-level governance context. Climate 4:7. https://doi.org/10.3390/cli4010007

Key R, Scheuer K, Dix B, Bruguera M, Wong A et al (2018) Overcoming organizational barriers to implementing local government adaptation strategies. California Natural Resources Agency https://www.energy.ca.gov/sites/default/files/2019-12/Governance_CCCA4-CNRA-2018-005_ada.pdf. Accessed 1 Oct 2023

Klima-Kommunen (2023) Lernen und Handeln für unsere Zukunft https://www.klima-kommunen-hessen.de/startseite.html. Accessed 1 Nov 2023

Lee S, Paavola J, Dessai S (2022) Towards a deeper understanding of barriers to national climate change adaptation policy: a systematic review. Clim Risk Manag 35. https://doi.org/10.1016/j.crm.2022.100414

Lesnikowski A, Biesbroek R, Ford JD, Berramg-Ford L (2021) Policy implementation styles and local governments: the case of climate change adaptation. Environ Politics 30:753–790. https://doi.org/10.1080/09644016.2020.1814045

Maggetti M, Gilardi F (2016) Problems (and solutions) in the measurement of policy diffusion mechanisms. J Publ Policy 36:87–107. https://doi.org/10.1017/S0143814X1400035X

Massey E, Biesbroek R, Huitema D, Jordan A (2014) Climate policy innovation: the adoption and diffusion of adaptation policies across Europe. Global Environmental Change 29:434–443

Mattsson L (2021) Selvitys kuntien ilmastotyösä [An analysis of climate work in municipalities (in Finnish)]. Kuntaliitto. https://www.kuntaliitto.fi/julkaisut/2012/1480-selvitys-kuntien-ilmastotyosta. Accessed 1 Oct 2023

Ministry of Agriculture and Forestry of Finland (2005) Finland's national strategy for adaptation to climate change. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/80613/2005_1a Finland%27s National Strategy for Adaptation to Climate Change.pdf?sequence=1&isAllowed=y. Accessed 1 Oct 2022

Otto A, Kern K, Haupt W, Eckersley P, Thieken AH (2021) Ranking local climate policy: assessing the mitigation and adaptation activities of 104 German cities. Clim Change 167:1–23. https://doi.org/10.1007/s10584-021-03142-9

Papin M (2019) Transnational municipal networks: Harbringers of innovation for global adaptation governance? Int Environ Agreements-Politics Law Econ 19:467–483. https://doi.org/10.1007/s10784-019-09446-7

Parliament of Finland (2022) Finnish climate law. https://www.eduskunta.fi/FI/vaski/KasittelytiedotValtiopaivaasia/Sivut/HE_239+2022.aspx. Accessed 1 Nov 2023

Patterson JJ (2021) More than planning: diversity and driver of institutional adaptation under climate change in 96 major cities. Glob Environ Chang 68. https://doi.org/10.1016/j.gloenvcha.2021.102279

Pörtner HO, Roberts DC, Adams H, Adelekan I, Adler C et al (2022) Technical summary. In: Pörner HO, Roberts DC, Poloczanska ES, Mintenbeck K, Tignor M et al (eds) Climate change 2022: impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate. Change Cambridge University Press, Cambridge, UK and New York, pp 37–118. https://doi.org/10.1017/9781009325844.002

Reckien D, Salvia M, Heidrich O, Church JM, Pietrapertosa F et al (2018) How are cities planning to respond to climate change? Assessment of local climate plans from 885 cities in the EU-28. J Clean Prod 191:207–219. https://doi.org/10.1016/j.jclepro.2018.03.220

Savikko R (2009) Ilmastopolitiikasta Suomen kunnissa [Climate policies in Finnish municipalities (in Finnish)]. Kuntalitto https://www.kuntaliitto.fi/file/4581/download?token=12wWoilr. Accessed 1 Oct 2023

Schoenefeld JJ, Schulze K, Bruch N (2022) The diffusion of climate change adaptation policy. Wiley Interdiscip Rev: Clim Change 13(3):e775. https://doi.org/10.1002/wcc.775

Schulze K, Schoenefeld JJ (2022) Parteienindifferenz in der lokalen Klimapolitik? Eine empirische Analyse der hessischen Klima-Kommunen: [Do parties matter in local climate politics? An empirical analysis of the Hessian "Klima-Kommunen"]. Z für Vergleichende Politikwissenschaft 15:525–550. https://doi.org/10.1007/s12286-021-00510-8

Siegmund A, Frankenberg P 2023 Klimate der Erde nach Köppen/Geiger. https://diercke.westermann.de/content/klimate-der-erde-nach-k%C3%B6ppengeiger-978-3-14-100700-8-229-3-0. Accessed 1 Nov 2023

Simonet G, Leseur A (2019) Barriers and drivers to adaptation to climate change a field study of ten French local authorities. Clim Chang 155:621–637. https://doi.org/10.1007/s10584-019-02484-9

Slack E, Bird R (2013) Merging municipalities: is bigger better? Institute on Municipal Finance and Governance. https://munkschool.utoronto.ca/imfg/uploads/219/imfg_no_14_slack_birdr3_online_final.pdf. Accessed 1 Oct 2023

Ulvi T, Helonheimo T, Linjama J, Pihlainen S, Riekkinen V, et al (2022) Kunnan ilmastosuunnitelman toteuttamisvaihtoehdot ilmastolaissa [Options for implementing the municipal climate plan in the Climate Act(in Finnish)]. Ympäristoäminstierön julkaisuja 2022:5. http://urn.fi/URN:ISBN:978-952-361-230-3. Accessed 1 Oct 2023

United Nations Sustainable Development Group (2023) Universal values principle two: leave no one behind. https://unsdg.un.org/2030-agenda/universal-values/leave-no-one-behind. Accessed 1 Nov 2023

Vogel B, Henstra D (2015) Studying local climate adaptation: a heuristic research framework for comparative policy analysis. Glob Environ Chang 31:110–120. https://doi.org/10.1016/j.gloenvcha.2015.01.001

Vogel B, Henstra D, McBean G (2020) Sub-national government efforts to activate and motivate local climate change adaptation. Environ Dev Sustain 22:1633–1653. https://doi.org/10.1007/s10668-018-0242-8