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Enhancing the resilience of midsize cities to climate extremes: A tool for practitioners to assess their governance context

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ABSTRACT

With increasing awareness and impacts of climate change, many cities strive for resilience to absorb and recover from shocks and disruptions from climate extremes. Working towards making a city climate resilient implies the design and adjustment of strategies, which often involve water-related projects and require cross-sectoral collaboration. Various tools and approaches exist to support cities in assessing and improving their climate resilience. However, they often address the characteristics of large cities, and few of them consider how the governance context, including social, institutional and political circumstances, affects the implementation of strategies and projects. Tailor-made tools are needed for midsize cities to address their specific characteristics and assess their governance context. This paper presents such a governance assessment tool for practitioners in midsize cities. Building on an existing governance assessment tool, we co-designed and applied a practitioners' tool in collaboration with seven mid-size cities in the North Sea Region. The tool guides the practitioners in midsize cities to assess how the governance context affects the realization of strategies and projects towards urban climate resilience. Experience of the practitioners that applied the tool indicate that it is easy to use and provides insights into supportive and restrictive aspects of governance, with room for improvement regarding formulation of the assessment questions and answers. While the tool is relevant for other policy fields, its application would require re-tailoring the questions and answers to the specific context of those fields.

1. Introduction

Impacts of climate change threaten human wellbeing and natural resources in urban areas, but the governmental authorities often lack the capacity to cope with these impacts (WWAP: World Water Assessment Programme, 2017; Leal Filho et al., 2019). Adaptation to climate change poses a particular challenge in Europe, where the increased frequency and intensity of droughts, precipitation and heatwaves are attributed to climate change (Smaniotto Costa et al., 2015; Guerreiro et al., 2018). Climate change also negatively affects the quantity and quality of urban water resources in many European countries (Georgi et al., 2016). In the North Sea Region, more frequent and extended droughts and heatwaves are expected to endanger the quality of urban waters and increase fluctuations in groundwater levels, which can damage buildings and ecosystems (Quante and Colijn, 2016).

Impacts of climate change make cities vulnerable in intersecting social, economic and environmental dimensions. The number of people and urban land area and the resulting damage from floods are projected to increase with sea level rise, and more frequent extreme rainfall and heatwaves. With a higher probability of coastal city flooding, more than a billion people in low-lying cities and settlements are expected to be at risk from coastal-specific climate hazards by 2050 (Dodman et al., 2022). As droughts and heatwaves are likely to increase, water shortages are forecasted to worsen in many areas (UNDRR: United Nations Office for Disaster Risk Reduction, 2021). Under the 1.5 °C global warming scenario, it is estimated that an additional 350 million people living in urban areas will be exposed to water scarcity from severe droughts (Dodman et al., 2022).

About 25% of all cities, with an approximately $4.8 trillion economic activity, are water-stressed due to geographical and financial limitations (McDonald et al., 2014). At the same time, urban populations are the main consumer of energy, generating about 70% of global greenhouse gas emissions (Vandecasteele et al., 2019). They are also a main consumer and polluter of water globally (WWAP, 2017), and in Europe (Georgi et al., 2016). Since the effects of climate change are unevenly distributed, cities face the challenge to protect all sections of their communities, particularly vulnerable groups, such as the elderly, children and women (Carter, 2011; Foster et al., 2019). Although European

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climate adaptation policies recognize the importance of protecting vulnerable groups (EEA: European Environment Agency, 2019), the financial burden is often put on individual citizens, for instance through private insurance schemes (O'Hare et al., 2016).

Starting from the early 2010s, resilience has become a prominent concept for addressing climate change in urban areas (Leichenko, 2011; Brown et al., 2012; Meerow et al., 2016; Ribeiro and Pena Jardim Gonçalves, 2019). In the context of climate change, resilient cities can be described in terms of multiple attributes. Leichenko (2011) categorizes these attributes under three main themes: 1) Cities should deal with climate change as one of the many stresses that they experience, such as population growth and migration; 2) Cities should demonstrate multiple resilience-oriented characteristics, such as flexibility, diversity, adaptive governance, and capacity for innovation and learning; 3) Cities should integrate their climate resilience efforts with broader development plans. Tyler and Moench (2012) describe urban climate resilience with a focus on systems, agents, and institutions. A climate resilient urban system is flexible to function under varying conditions and absorb sudden shocks and failures. Agents (re)organize themselves, access to resources, and learn from experiences. Institutions link the systems and agents, providing information on property and use rights, vulnerabilities and risks, and facilitating knowledge creation and exchange. Assessing urban climate resilience requires considering governance factors, such as the capacities and roles of multiple actors and institutions, which affect the implementation of resilience actions (Mehryar et al., 2022).

As reviewed in the next section, various tools and approaches support cities in enhancing their climate resilience, while few of them pay attention to governance factors. They also often focus on large cities, and not midsize cities, which have a population of 20,000 to 200,000 (Kunzmann, 2009), less resources for strategic processes and more connection with their surrounding region and partners (Gonzalez, 2012). Regarding climate resilience, midsize cities face specific challenges that distinguish them from large cities (Birkmann et al., 2016; Özerol et al., 2020): limited expertise in addressing challenges in an integrated manner; lacking human resources to implement a comprehensive strategy; low budget and few opportunities for large investments; limited benefit from research and funding; dependency on or limitations by regional or national governments. Considering these specific characteristics of midsize cities, the applicability and effectiveness of existing approaches for such cities is questionable (Brown et al., 2012; Junghans et al., 2018; van der Heijden, 2019). Tailor-made tools for midsize cities are needed to assess their governance context towards improving their climate resilience. Such tools should be both easy to use and appealing to create awareness and dialogue among stakeholders (Özerol et al., 2020). With this paper, we aim to demonstrate the design and application of a tailored-made governance assessment tool (GAT) for midsize cities. The tool guides the practitioners in midsize cities to assess how governance factors can support or restrict the realization of strategies and projects towards urban climate resilience. We build on an existing GAT (Bressers et al., 2013) to co-design and apply a practitioners' version of it in collaboration with seven mid-size cities in the North Sea Region.

The remaining sections of the paper are organised as follows: Section 2 reviews the literature on the assessment of climate resilience, and introduces the theoretical and methodological foundations of the GAT. In section 3, we describe the project and methodology through which the practitioners' version of the GAT was co-designed. Section 4 presents the practitioners' GAT, followed by section 5 on the results from applying it in seven midsize cities. Section 6 provides reflections on the co-design and application process, and possible improvements. Finally, in section 7, we draw conclusions and identify future research directions.

2. Assessing the governance context of urban climate adaptation and resilience

Transforming the cityscape into climate resilience requires a multiplicity of rather complex interventions. Moreover, these interventions need not only a large extent and a wide palette of infrastructural and communal measures, but also to be well-integrated into a coherent set in which the measures reinforce each other's effectiveness. Implementation of such a package will likely require a substantial number of years. This adds to the complex and dynamic character of the implementation process.

Scientific and grey literature is rich with multiple tools and approaches to support cities in assessing their strengths and weaknesses from a water management and governance perspective. Some of these approaches build on more comprehensive existing concepts, such as Integrated Water Resources Management (IWRM), Integrated Urban Water Management (IUWM) and Water Sensitive Urban Design (WSUD). For instance, the 'City Blueprint' approach by Koop and van Leeuwen (2015) provides insights into the implementation of IWRM and IUWM in practice based on three sub-frameworks: 1) The trends and pressures framework 2) The city blueprint framework 3) The governance capacity framework. The Water Sensitive Cities (WSC) framework builds on IUWM and WSUD to integrate political, hydrological and ecological aspects of urban design and resilience (Wong and Brown, 2009; Brown et al., 2016). The framework proposes three pillars of action: 1) Cities as water sensitive communities and networks 2) Cities as water catchments 3) Cities as ecosystem service providers. Finally, the 'Water-Wise Cities' approach builds on WSUD and the pillars of the WSC framework, which are merged into four levels of action (IWA: International Water Association, 2016): 1) Regenerative water services for everyone 2) Integration of urban planning with the water cycle 3) Basin-connected cities 4) Water-wise communities.

Various decision support tools (DSTs) have been developed and applied to support cities in making better decisions for climate adaptation and resilience. Effective DSTs address both the implementation and evaluation processes, facilitating both awareness raising and knowledge exchange as well as the creation of transformative capacities (Mehryar et al., 2022). Palutikof et al. (2019) propose guidelines for climate adaptation DSTs, grouping them in three categories: foundations to ensure cooperation with users and to match the decision support with user needs; co-design of the DST considering the needs and capabilities of potential users to ensure policy relevance and uptake by users, supporting the sustainability of the DST by evaluating, comparing and documenting the application results and lessons. Regarding the uptake and sustainability of the DSTs, Fünfgeld et al. (2019) suggest that collaborative and discursive processes to make the DST helpful for organisations that have limited resources and capacities.

As the conceptual frameworks and principles of the above approaches and tools demonstrate, urban climate resilience is not a status or goal to be achieved. Instead, it is a co-production process that involves various stakeholders from public and private sectors, civil society and academia that operate at the local, regional and national levels. (Muñoz-Erickson et al., 2017). This multi-stakeholder and multi-level character of urban climate resilience requires paying attention to the broader governance context that consists of the institutional structure underlying the use and management of water and other natural resources. A common way for cities to put urban climate resilience into practice is to design and implement water-related strategies and projects. To ensure that water-related strategies and projects contribute to climate resilience, it is essential for cities to understand and assess how the governance context affects the design and implementation of such strategies and projects.

In Contextual Interaction Theory (CIT), implementation processes are nested in layers of context (Bressers, 2009), as shown in Fig. 1. Apart from the specific case context (like geographical circumstances and previous interventions and decisions), and the 'wider contexts' (like

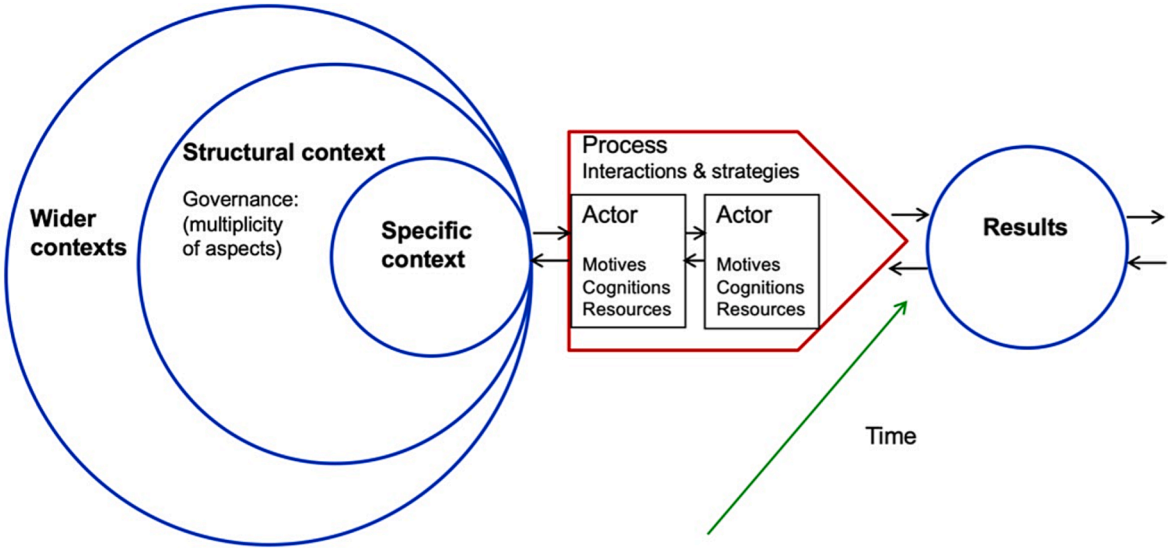

Fig. 1. Interaction processes influenced simultaneously by various layers of context.
Source: Bressers et al. (2016).

technological developments, the political system and economic growth or decline), there is the 'structural context' that consists of the joint governance conditions in the policy field and sectors of society that are relevant for the implementation of the measures. This governance context can be to some degree supportive and to some degree restrictive for the ability to implement the measures. The GAT provides systematic guidance to assess the degree of supportiveness.

The concept of governance that is used in the CIT and GAT was developed from the concept of policy as "the pursuit of an actor to attain certain goals with certain means". It recognizes that there are five dimensions of governance: 1) multiple levels and scales with 2) multiple actors in networked relationships over, and that 3) multiple problem perceptions form the basis of socially constructed goals, and that means are not just 4) instruments of change, but also 5) the responsibilities and resources for their implementation (Bressers and Kuks, 2003). In the Euwareness project on integrated water management in six European countries, these five dimensions of governance were assessed in terms of *extent* (completeness) and *coherence*, criteria that were introduced by Knoepfel et al. (2001). They were first applied to dimensions of governance, where they were demonstrated to positively relate to the development of more sustainability in the water bodies studied (Bressers and Kuks, 2004). Later in the New Rurality project, long-term implementation of river restoration was studied in which the "complex and dynamic" nature of such processes led to the addition of two extra criteria for determining the degree of supportiveness of the governance context: *flexibility*, allowing for adaptive strategies of dealing with obstacles and chances during the process and *intensity* (later renamed to *pressure for change*), the combined pressures to move into a more sustainable direction (De Boer and Bressers, 2011). On this basis, the first version of the GAT was developed (Kuks et al., 2012) and applied in a pilot study on a Dutch project about the Meuse River.

A further developed version of the GAT was applied extensively in the DROP project on drought resilience in northwest Europe (Bressers et al., 2013). Apart from qualitative judgments made for each cell (i.e., the governance context being restrictive, neutral or supportive), in many cases the results were also illustrated in graphs in a 4x5 matrix form with "traffic light" colours. In the DROP project, international scientific assessment teams visited the six case regions twice and discussed the relevant governance issues with many practitioners from governmental and societal organisations, leading to well-informed assessments (Bressers et al., 2016). Among others, this led to the ambition to develop the GAT in such a way that practitioners would no longer be just informants for research, but could be involved in making the assessments or even enabled to make them themselves.

Since its development in 2011, the GAT has been applied extensively by researchers in more than 20 countries. These applications resulted in dozens of journal articles and book chapters, such as Casiano Flores et al. (2023) on urban water transition in the Netherlands; Casiano Flores et al. (2017) on wastewater governance in Mexico; Mirnezami et al. (2019) on water conservation in Iran; Judeh et al. (2017) on water governance in Palestine; Al-Khatib et al. (2017) on the reuse of treated wastewater in Palestine; and Vikolainen et al. (2017) on coastal innovations in the United Kingdom, next to 11 doctoral theses. While most of the applications are in the field of water policy and governance, several recent studies applied the GAT in other fields, such as the adoption of energy efficient appliances by households in Nigeria (Gana and Hoppe, 2017). As the empirical evidence builds up, the added value of comparative water governance analyses has become prominent (Özerol et al., 2018). This trend is reflected in the applications of GAT that compare multiple cases, such as Casiano Flores et al. (2019) on three sub-national cases of wastewater treatment policy implementation in Mexico; Rouillard et al. (2016) on urban water management innovations in Denmark, Germany, and Spain; and Özerol (2019) on the national and local actors of drought governance in Belgium, France, Germany, the Netherlands and the United Kingdom.

The applicability of the GAT is not limited to a specific policy field. Whenever policies involve measures in a complex and dynamic setting, the GAT matrix with its 20 cells offers a structure to assess the degree to which the governance context is supportive or restrictive for implementation. However, this broad applicability comes at a price: the users need to have a good understanding of the essence of the multiple questions in each cell regarding their impact on the supportiveness of governance. The questions that fill the cells in the original GAT refer to various terms, such as the dependency of actors and levels, the monitoring and enforcement of instruments, or the accountability and transparency of responsibilities. These terms are both too conceptual and not specific enough to be recognizable by practitioners. This makes the GAT essentially a "researchers' tool", rendering it inaccessible for practitioners.

3. Methodology for transforming the GAT into a tool for practitioners

3.1. Background of the CATCH project

CATCH (water sensitive Cities: the Answer To Challenges of extreme weather events) is an international collaboration project implemented between 2017 and 2022 within the scope of the EU Interreg North Sea Region Programme. The project focuses on the specific context and needs of midsize cities for climate resilience. It brings together a transdisciplinary team of 'practice' and 'knowledge' partners from six countries (Belgium, Denmark, Germany, the Netherlands, Sweden, and the United Kingdom). The practice partners are five local authorities (Zwolle Municipality, Enschede Municipality, Arvika Municipality, Vejle Municipality, Norfolk County Council) and five regional authorities (Värmland County, Province of Overijssel, Water Authority Vechtstromen, Flanders Environmental Agency, Oldenburg and East Frisian Water Association), whereas the knowledge partners include two universities (Jade University of Applied Sciences from Germany and the University of Twente from the Netherlands) and a consultancy firm (Royal HaskoningDHV).

The overall objective of CATCH is to demonstrate and accelerate the redesign of urban water management of midsize cities to become climate resilient by following the principles of the WSC framework. For this purpose, the project team co-designed an online DST (www.catch-tool.com), and the practice partners implemented pilot measures, with the goal of developing a climate adaptation strategy for each partner city. The DST includes four components: a self-assessment tool for midsize cities (Özerol et al., 2020) that adjusts the WSC index (Chesterfield et al., 2016) to the North Sea Region conditions; a climate adaptation cycle (Bormann et al., 2015) guiding the midsize cities through the phases of the management cycle; a stepwise method for identifying and assessing urban ecosystem services (Lulofs et al., 2022); and the practitioners' version of GAT.

Over the last decade, all CATCH partner cities have experienced one or several impacts of climate change, such as heavy rainfalls, more frequent and intense floods, water quality degradation and heat stress. These shared experiences motivate the partner cities to implement the pilot measures that can provide insights into the feasibility and effectiveness of climate adaptation strategies and projects. As shown in Table 1, seven pilot measures have been implemented within the scope of the CATCH project.

Table 1
CATCH partner cities and pilot measures.

City	Country	Population	Pilot measure
Herentals	Belgium	27.000	Designing a green–blue area in a city development area
Vejle	Denmark	55.000	Redesign of a playing field for water storage during heavy rainfall
Oldenburg	Germany	164.000	Traffic information for road users during heavy rainfall
Enschede	The Netherlands	158.000	'Pinkeltjes Square' that created a multifunctional playground
Zwolle	The Netherlands	124.000	Developing a community building strategy and serious game
Arvika	Sweden	14.000	Constructed wetlands to reduce the effect of climate change on water quality
Norwich	UK	140.000	Community-led technological solutions for flood protection in the city

Source: Özerol et al. (2020).

3.2. Co-design of the practitioners' version of GAT within the CATCH project

To develop the DST, the CATCH team adopted a transdisciplinary research approach by involving academic and non-academic participants in the knowledge co-production and co-design processes. As the GAT is one of the four elements of the DST, its design within the CATCH project followed the same approach. To increase the likelihood of achieving the project objectives, the knowledge co-production processes focused on the understandability and applicability of knowledge (Bracken et al., 2015; Brugnach and Özerol, 2019). For this purpose, the research process was adjusted to the practitioners' needs and realities. Practitioners were encouraged to question the ideas or concepts that were raised during the project and to promote their own knowledge. An iterative process was followed so that all partners could learn from each other and develop a common understanding and shared "language". The midsize cities in the North Sea Region are located in high-income and politically stable countries, but they differ in social, climatic and geographic conditions. Taking these similarities and differences into account, the CATCH project team thrived to develop the DST in a way that it would be simple and appealing on the one hand, and relevant and detailed on the other.

Two main collaborative approaches contributed to co-designing the practitioners' GAT: partner visits and partner meetings. At least two team members from each partner participated in the planning and conducting of the partner visits and partner meetings. From January until September 2018, the team members responsible for developing the online DST (University of Twente, Jade University and Royal HaskoningDHV) visited the seven partner cities to understand their water management and climate adaptation practices, collect data about their specific characteristics and governance context, and familiarise with the pilot measures. The visits took 2–3 days each, and consisted of interviews and pilot site visits. Standard guidelines were used to shape the agenda of visits and the scope of interviews. A total of 49 respondents were interviewed, including both CATCH partners, who are experts in water urban management and/or climate adaptation, and their stakeholders, such as other local and regional authorities, non-governmental organisations and housing corporations.

Throughout the five-year period of the CATCH project, more than 20 partner meetings were organised, including several online meetings during the Covid-19 pandemic. As well as discussing project management and sharing updates about the progress of pilot measures, these meetings served the purpose of co-designing the four components of the CATCH DST through interactive sessions. The first session for the GAT took place during the third partner meeting in June 2018. We presented the original GAT to the partners and received their input regarding the relevance, clarity and completeness of the questions included in the matrix. This session improved the awareness of partners about the dimensions and criteria of the GAT. It also showed that some questions were too complicated, with terms that were not familiar, and some of them too abstract, requiring practice-oriented examples. Therefore, we made modifications for enabling practitioners to use the GAT independently and focusing their internal debate on the feasibility of measures and their options to improve such feasibility. The main step in this direction was formulating one question each to assess the status of the 20 cells of the matrix, and five short answers for each question. The questions also included practice-oriented specifications about urban water management and climate adaptation.

During the partner meetings in 2019 and 2020, several feedback and testing sessions were conducted to tailor the GAT by paying attention to multiple aspects, such as structure, user friendliness, accessibility of text and images, and the provision of examples. The inputs of partners were collected both verbally through interactive (online) sessions and using feedback forms. The DST team also met regularly to discuss the inputs provided for each component of the DST, including the GAT, and to design the outline and content of the report that is created after the

application of all four DST components. In April-May 2021, each practice partner applied the DST and produced their reports, including the GAT results and recommendations. They also shared their reflection on the application process in terms of by whom and how the questions were answered, and whether the assessment focus was on the city-level climate adaptation strategy or a specific project, i.e., the CATCH pilot measure.

Transforming a scientific framework into a practical tool, which can be used widely without the need to understand the underlying theory, proved a challenge. There is a trade-off in terms of streamlining and simplification requiring a further narrowing down of the topic of application. Only in this way it is possible to translate the topics of the 20-cell matrix of the GAT into more "real-life" questions that can serve as indicators for assessment. The CATCH project follows the concepts from the water sensitive cities framework as a form of urban climate adaptation. These concepts were kept in mind while "translating" the scientific meaning of the elements of GAT into questions and answers that are recognizable for municipal civil servants as well as local and regional administrators working on the subject.

4. The GAT for the practitioners of urban climate resilience

The practitioners' GAT discerns five dimensions of governance and uses four evaluative criteria. **Completeness** is the first criterion, which focuses on the representation of all elements in the governance structure of climate adaptation and resilience. The second criterion is **coherence**. When the strategies and projects to become a resilient city have long time horizons, complex interactions among actors, and interplay among scales, their realization in practice often becomes more dynamic and less predictable. Not only will the strategies need to be adaptive and regularly adjusted to new situations and insights, but also projects will likely meet obstacles at some point and hopefully also unexpected opportunities. Avoiding the obstacles in time and using the opportunities fully as they arise requires adaptive management. That is why **flexibility** is included as the third criterion, allowing the assessment of for such adaptiveness. Lastly, long time horizons and dynamic circumstances create the need for a stable and strong **pressure for change** towards moving in the direction of a water-sensitive and climate resilient city. These four evaluative criteria are applied to the five governance dimensions as described below. Before starting with the application of the GAT, the user is offered with brief descriptions of these dimensions.

Levels and scales: Sustainable and resilient city strategies and projects not only have a scale of their own but also need to be adjusted to other scales. Each project fulfils a role at a larger scale than its own. For instance, for water management strategies the scale of the surrounding catchment area is often important. When it comes to the feasibility of strategies and projects it is not so much the hydrological or geographical scales, but the social and administrative levels. The municipal level sits in a structure of higher-level authorities, such as provinces, federal states, regional and national authorities, and even non-governmental organisations (NGOs), from which it can receive support, but also to which it often needs to adjust.

Actors and networks: The success of sustainable and resilient city strategies and projects rarely depends only on municipal actors. It is often essential to involve multiple actors, such as community organizations, private companies, universities, water authorities, housing corporations and environmental NGOs. It is also probably not the first time that the municipality cooperates with those stakeholders. On water and other subjects, previous contacts and perhaps even stable network relations have been established on different occasions, such as consultative committees, regular meetings and thematic platforms.

Problem perceptions and goal ambitions: Cities are almost by definition quite dense. This implies that sustainable and resilient city projects and the strategies leading to them always interact with several existing uses of the space, buildings and infrastructure, and with other problems and ambitions, such as transport, energy transition, housing, and job creation. Some organisations might see a different scope of problems when looking at the city or the project site than sustainability or resilience. That will also be the case among the project partners and even among the different departments of the municipality. Thus, sustainability and resilience need to be continuously balanced with, and where possible, integrated into other ambitions.

Policy styles and instruments: City strategies and projects often reflect certain policy implementation styles. Such styles can be consensual or in the form of directives or incentives. They can concentrate on infrastructure or aim more at behavioural changes. They can be short-term or long-term oriented, and imply much or little communication with the community. Various options might be available to the water sector or the collaborating sectors involved in the strategy or project, provided for instance by laws and regulations. Some policy sectors or budget providers might require the use of certain instruments, procedures or timelines regardless of whether this makes the realization of the strategy or the project easier.

Responsibilities and resources: To realize strategies and projects in practice, there should be clarity about who is responsible for what part. That is even more important when the implementation cannot be done by the municipality alone but needs collaboration between several partners in more than one sector, as will often be the case. The other side of the coin is that responsibilities should come with resources that enable their fulfilment. These resources include not only financial means but also administrative rights, professional expertise and political support. When collaborating with partners, the resources of the municipality may be combined with those of others.

As listed in Appendix A, the 20 questions of the practitioners' GAT takes the user stepwise through the five dimensions and four criteria of governance. When answering the questions, the user is advised to focus either on a project or a strategy, and choose one of the five answers. Table 2 presents the five answer categories and their basic interpretation, which is further elaborated below.

After all the questions are answered, the user is presented with a summary of the answers in the form the colour-coded GAT matrix. An example matrix with dummy results is shown in Table 3.

In addition to the GAT matrix, the user is also presented with the justification of the assessment results and a set of recommendations to move forward. **Supportive** answers (*green cells*) refer to situations where governance supports the successful implementation of the strategy/project. Dealing with the supportiveness of the governance context is not only a matter of looking where the user can improve the "red" cells, but also of protecting the "green" ones. **Neutral** answers (*yellow cells*) represent situations in which the practitioner doesn't feel supported by the context, but not hindered, either. It is good to think about whether this situation is likely to worsen or better in the near future. Additional exploration can be made to find out if there are ongoing developments that can make the situation better or worse in the near future, and to explore actions to prevent the situation from getting worse. **Restrictive** answers (*red cells*) need extra attention, as they indicate that the governance context restricts the successful implementation of the strategy/project. These items can be improved by taking actions to improve the aspect over the upcoming period, for instance platforms that facilitate the interaction of stakeholders and their problem perceptions. If it is not possible to change a restrictive situation, the user can explore whether supportive items can compensate for this. Table 4

Table 2
Answer categories and their interpretation.

Answer	Colour coding	Interpretation
Answers a	Green	Supportive
Answers b	Yellow	Neutral
Answers c	Red	Restrictive
Answers d	White	More information is needed.
Answers e	Grey	Awareness and/or capacity is low.

Table 3
Results that the user sees after answering all the questions (*dummy only*).

	Criteria			
Dimensions	Completeness	Coherence	Flexibility	Pressure for change
Levels and scales				
Actors and networks				
Problem perspectives and goal ambitions				
Policy styles and instruments				
Responsibilities and resources				

Table 4
Compensations for restrictive governance aspects.

Restrictive aspect	Possible compensation
Completeness	Other dimension within completeness
Coherence	Other dimension within coherence
Flexibility	Other dimension within flexibility
Pressure for change	Other dimension within pressure for change
Completeness of actors is low	High flexibility to involve them in the process later on Open-minded problem perception and goal ambition

shows illustrative examples that can compensate for governance aspects that are assessed as restrictive.

To change the "**We don't know**" answers (*white cells*), the user has three options: 1) think about the consequences of this specific situation and whether they will be restrictive, neutral or supportive, 2) gather more information, or 3) consult colleagues or the designer of the tool. Finally, the user should be self-critical when the "**This is not important**" (*grey cells*) answer is given too often. This might indicate that possible problems are overlooked, and that the organization is not as capable to perform on its own as one would like to think. The user should evaluate the risks that come with this aspect to understand the consequence in case this subject is restrictive, and to question whether it is really not important to take this governance aspect into account.

5. Application of the practitioners' GAT in CATCH partner cities

In this section, we present the results from the application of the practitioners' GAT for the seven CATCH partner cities and their experiences with using the tool. The practice partners prefer not to highlight results that can be interpreted as performance comparisons. They do not want to publish the specific recommendations for their city that were made based on the assessment results, either. While this restricts the result-oriented insights presented below, we respect the preferences of practice partners and focus on illustrative examples.

Arvika, Sweden: The DST, including the GAT, was applied by Teknik I Vast, which represented the Arvika Municipality in the CATCH project. While there are limitations of being a small city, it also brought advantages, such as the easiness of applying the tool at the city level and reaching out to citizens. However, when applying the GAT, Teknik I Vast had a small team available to answer questions and did not feel confident in answering some questions on behalf of the municipality. This has led to an assessment with several "neutral" or "don't know" answers, for instance regarding the availability of funding. With regards to problem perceptions and ambitions, the Arvika pilot measure focuses on water quality, which is not a commonly addressed climate change challenge, such as rainfall and floods. The city of Arvika has made progress on flood management, such as the recent flood barrier, whereas water quality has been emerging as a new priority. But floods are still perceived as the biggest climate change threat, and they are high on the agenda.

Enschede, The Netherlands: Several staff members from the municipality were involved during the development of the DST, but the final version was applied by a single team member. A reflection was made that this resulted in mostly neutral and possibly too modest answers. Concerning the resources and responsibilities dimension, some restriction is observed due to limited funds and the key focus on water. Climate adaptation in Enschede is mostly associated with water management, also in terms of budget. This results from the fact that in many Dutch cities, climate adaptation plans are often derived from sewer management plans. Another restriction related to problem perceptions and ambition results from the need to use private space for climate adaptation, which needs improving the awareness and willingness of private property owners and involving them in climate adaptation actions.

Herentals, Belgium: Most components of the DST, including the GAT, were applied by the Flanders Environmental Agency (VMM) for the pilot level. This is explained by the fact that VMM, as a regional authority, doesn't have the detailed overview at the city level, which calls for engaging representatives from the city level during the application of the GAT. The scope of the Herentals pilot is different from other CATCH pilots, involving only a design, which has not been implemented within the CATCH project. Therefore, a different perspective had to be applied for answering many questions in the GAT. Similar to several other cities, limitations are experienced in Herentals regarding the responsibilities and resources dimension. While all actors supported the pilot, the financing and payment of the costs was a limiting factor. On the other hand, since Kleine Neete, the pilot area, is important for many actors, the actors and levels dimensions were mostly supportive. In 2020, separately from the application by practitioners, also researchers that worked before with GAT analysed the situation and prospects (Casiano Flores et al., 2021). They also derived the conclusion that the four main criteria were met as "moderately supportive".

Norfolk, UK: Most of the answers to GAT questions were given by the Norfolk City Council (NCC) for the pilot level. Similar to several other CATCH partners, this is explained by the focus on the scope and emphasis of the pilot. With regards to problem perceptions, floods and water management put increasing pressure towards taking actions for climate adaptation. This relates to the "pressure for change" criteria of the GAT. It shows supportiveness in terms of the initiatives to improve the current status and the actors that contribute to them. For instance, a new large-scale project on 'holistic flood management' is being designed from an integrated perspective. Some regional actors, such as Anglian Water, support this approach since it fits their agenda. There is also increased awareness among citizens. Compared to other partner cities, the GAT results for Norfolk have many more "neutral" answers (12 out of 20). This indicates a need to pay attention to possible changes in the governance structure towards a supportive or restrictive context. For instance, the "responsibilities and resources" dimension was scored with

"neutral" for all four criteria. This dimension includes, among others, the funding for climate adaptation actions and the distribution of tasks among different stakeholders, both of which have the potential for improvement in the future.

Oldenburg, Germany: The DST, including the GAT, was applied by the members of the project team from the Oldenburg-East Frisian Water Association. Partly because this organisation is not the local authority at the city level, it was necessary to answer some questions for the city level and others for the pilot level. For GAT this also implied that the answers to several questions were not entirely known. Through the overall experience with the project, the added value of communicating with different stakeholders was demonstrated. These gains could result in a more comprehensive application of the GAT in future occasions.

Vejle, Denmark: The whole DST, including the GAT, was applied at the city level. This was enabled by the fact that the CATCH partner that applied the GAT is the Vejle municipality. Of all the seven CATCH partner cities, Vejle has the most positive answers to the GAT questions, with only 4 answers that indicate "neutral" context and 16 answers that indicate "supportive" context. These can be explained by the broader focus of Vejle on climate adaptation and climate resilience. Many climate adaptation activities are being implemented in the city and accordingly they score high in most of the DST components. They are still critical of themselves, seeking out ways for improvement, such as reaching out to citizens more often. At the same time, Vejle is known as a frontrunner city, which is not only because of CATCH but also due to its membership in the global "100 Resilient Cities" programme.

Zwolle, The Netherlands: The municipality has been implementing various climate adaptation actions. While the CATCH pilot was about raising awareness and although it took place in multiple neighbourhoods, it was not measurable with the tools. Therefore, the whole DST, including the GAT, was not applied for the project level but for the city strategy level. Building on this experience, the GAT and other components of the DST can be used in the future to assess specific projects or programmes. This also aligns with the intention of Zwolle to tailor the CATCH tools to its climate adaptation strategy. While the overall GAT results are very positive for the city of Zwolle, they still have the ambition to realize significant changes with the climate adaptation strategy. Therefore, the only restrictive aspect was seen as the "pressure for change" of the "problem perception and ambitions" dimension.

6. Discussion

The co-design process of the simplified and specified version of the GAT was a mutual learning process. At the start, the researchers tried to explain the original GAT to the practitioners, to find out quickly that these explanations raised more questions than answers. Application of the tool requires from the practitioners to understand the various dimensions of governance and the relevance of the four main criteria for the circumstances under which they had to fulfil their job. At the same time, the researchers had to grasp the practical requirements that were essential governance factors for the success of the climate adaptation plans and projects. The dialogue unfolded in a few rounds until the researchers could develop the practitioner's tool for midsized city climate adaptation, using wordings that are familiar and resonate among the practitioners involved.

As shown in the previous section, the CATCH cities vary regarding the way in which they applied the tool. When the researchers apply the GAT, they collect data through stakeholder interviews and workshops, and review policy and practice documents from all relevant sectors, which enable them to make well-informed assessments. In some instances, the cities followed a similar approach by bringing representatives from multiple sectors together when using the tool. In fact, that approach can work even better, as it allows the practitioners to learn from not only the results of the application, but also their mutual discussion on the assessment of the 20 cells. In some other cases, the application of the tool was left to one practitioner. Though such a person might be a well-informed "insider", it is likely that not all relevant aspects were taken into account. The practitioners' GAT accounts for such limitations by including a "*We don't know*" answer option, rather than forcing an ill-informed positive or negative answer, or a neutral one that might mislead the assessment in the absence of knowledge. Such an application can still be relevant. Even when it just represents "the world according to practitioner X", it makes the situation explicit for both these practitioners and their colleagues.

In the CATCH project, there was no attempt to steer the application of the practitioners' tool. Hence the variation in the way it was used. There can be several middle grounds between leaving it entirely to the practitioners and having it done by the researchers. Giving further guidance by training or written manuals could be considered, as well as a fully interactive participatory assessment. Depending on the purpose of the assessment, both of these might be sensible steps to enhance the application. In the case of CATCH, the purpose was to see whether it was possible to specify the GAT in such a way that it can be used independently by practitioners in the realm of climate adaptation and resilience in midsize cities.

7. Conclusions

In this paper, we presented insights and lessons from the co-design and application of a practitioners' version of the GAT, which was initially developed in 2011 as a researchers' tool, and widely applied thereafter in various countries and policy fields. The co-design of the practitioners' version took place within the scope of the CATCH project, which aimed to support the midsize cities in the North Sea Region to become climate resilient and water sensitive. Having such a specific empirical scope made it possible to tailor the GAT to the needs and priorities of the partner cities. At the same time, it required further specifications moving away from a generic tool.

Based on the results of the application of the GAT by the seven CATCH partner cities, we can conclude that the co-design process for tailoring the tool to a specific context is as important as the results of the assessment. The knowledge co-production process, which involved extensive discussions on the meanings and implications of each dimension and criteria, also raised the awareness and ownership of the partners. Each partner was able to critically reflect on the tool, drawing on its relevance and applicability to their context, while also bringing in their practical situation to conduct the assessment. This experience still leaves room for improving the GAT, mainly in terms of the formulation of the questions and answers. Significant progress was made in the simplification of the academic language, which was dominant in the original GAT.

Both the co-design of the specified GAT and its application by the practitioners involved considering each item in a systematic way that raises the awareness among the practitioners of the governance context in which they have to do their work. Therefore, it is not only the results from the tool that can contribute to practice, but also the discussions during its application. Future research can pay attention to the implications of incorporating knowledge and perspectives from multiple users through such discussions to reach a joint answer for the assessment questions.

The practitioners' version of the GAT cannot be used as-it-is in other related policy fields, such as nature conservation. While it proved possible to turn an academic tool into a simplified and specified tool, this was at the expense of the wideness of its applicability. The assessment questions were tailored to address the specific focus on climate adaptation and resilience in midsize cities. However, this does not mean that the tool is irrelevant for other policy fields. The co-design approach with which the original GAT was simplified and tailored can be repeated for other sectors. This would imply that the wording of the 20 questions has to be adjusted according to the specific issues relevant in the given policy field. As the experience in the CATCH project showed, it would be a missed opportunity to do this just as a researchers' exercise. The co-

design with practitioners is a mutual learning process that not only leads to a better newly specified tool, but also raises awareness about the relevant governance context of the given conditions of the given field with both practitioners and researchers.

CRediT authorship contribution statement

Gül Özerol: Conceptualization, Methodology, Data curation, Writing – original draft, Writing – review & editing, Funding acquisition, Project administration. **Hans Bressers:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Visualization, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. . Questions included in the practitioners' version of the GAT

Completeness

Think about: Are there stakeholders missing that are needed to get things done? Or are there any unassigned responsibilities or missing resources?

1. Are all relevant higher-level authorities involved in the strategy/project?
   a. Yes.
   b. No, but it is not a problem.
   c. No, and it is a problem.
   d. We don't know.
   e. This is not important.
2. Are all actors that could contribute to the strategy/project involved?
   a. Yes.
   b. No, but it is not a problem.
   c. No, and it is a problem.
   d. We don't know.
   e. This is not important.
3. Are all other problem perceptions and ambitions that relate to the same urban space taken into account?
   a. Yes.
   b. No, but we expect that it will not be a problem.
   c. No, we focus on water goals.
   d. We don't know.
   e. This is not important.
4. Are the different options for implementation styles and combinations of instruments taken into consideration during the design of the strategy/project?
   a. Yes.
   b. No, but we considered most of the familiar options.
   c. No, we left options out to focus on the construction of water works.
   d. We don't know.
   e. This is not important.
5. Are the responsibilities for different parts of the strategy/project clearly assigned and facilitated with the necessary resources to fulfil them?
   a. Yes.
   b. No, not all of them.
   c. No, not at all.
   d. We don't know.
   e. This is not important.

Coherence

Think about: Aren't the problem perceptions so divergent that a common basis for agreements is missing? Do different policy sectors like spatial planning, energy transition, health and flood protection demand contradictory requirements?

1. Is your strategy/project well aligned with those of higher-level authorities?
   a. Yes.
   b. No, but it is not conflicting either.
   c. No, it conflicts with the principles of higher-level authorities.
   d. We don't know.
   e. This is not important.
2. Does the municipality have collegial relationships with the other actors involved?
   a. Yes, we are working like a team.
   b. Not with all actors, but with some there is.
   c. No, for some of these actors our strategy/project is really controversial.
   d. We don't know.
   e. This is not important.
3. Does your strategy/project create synergy and contribute to the ambitions of other sectors?
   a. Yes.
   b. No, but it does not conflict with other ambitions either.
   c. No, it contains choices that clearly deviate from competing ambitions.
   d. We don't know.
   e. This is not important.
4. Does the combination of instruments create synergy and make their realization easier?
   a. Yes.
   b. No, but we could exclude aspects that might conflict with other parts.
   c. No, we had to include aspects that might easily conflict with one another.
   d. We don't know.
   e. This is not important.
5. Are the responsibilities and resources of the actors involved supportive to one another, and do they facilitate cooperative activities to realize the strategy/project?
   a. Yes.
   b. Some responsibilities might compete with those of others, and there is probably going to be discussion about the distribution of input of resources.
   c. No, we continuously debate about the division of responsibilities and resources.
   d. We don't know.
   e. This is not important.

Flexibility

Think about: Is it possible to change plans later in the project? Can stakeholders or authorities be added to the project in a later stage?

1. Can higher-level authorities be used in the implementation of your strategy/project or to help solve problems?
   a. Yes.
   b. Not really, all we can do is to make use of the actions they take anyway.
   c. No.
   d. We don't know.
   e. This is not important.
2. Is it possible to include new stakeholders if this would be worth it?
   a. Yes.
   b. We can, after consultation with the partners.
   c. No.
   d. We don't know.
   e. This is not important.
3. Can the ambitions of the strategy/project be changed when (new) opportunities or problems arise over time?
   a. Yes.
   b. Yes, but we need new political decision-making.
   c. No.
   d. We don't know.
   e. This is not important.
4. Can the combination of instruments be changed when (new) opportunities or problems arise over time?
   a. Yes.
   b. Yes, but we will need new political decision-making.
   c. No, we should follow the original plan as much as possible.
   d. We don't know.
   e. This is not important.
5. Is it possible to combine the resources from various sectors of the municipality and other partners to realise tasks that no one could do on their own?
   a. Yes.
   b. Yes, but we are careful to invest in other's tasks.
   c. No.
   d. We don't know.
   e. This is not important.

Pressure for change

Think about: Do authorities or stakeholders push you in the direction of a water sensitive city? Does the project demand big changes?

1. Is there enough stable pressure from higher-level authorities to move in the direction of a water sensitive city?
   a. Yes.
   b. Not really, if we would do nothing, they wouldn't care.
   c. No.
   d. We don't know.
   e. This is not important.

Is there enough stable pressure from other stakeholder(s) to move in the direction of a water sensitive city?

a. Yes.
b. Not really, if we would do nothing, they wouldn't care.
c. No.
d. We don't know.
e. This is not important.

2. Are the ambitions of your strategy/project very different from the current situation?

a. Yes.
b. Not very much, but it is a first step in the right direction.
c. No.
d. We don't know.
e. This is not important.

3. Are the instruments demanding more adaptation from the citizens or other stakeholders than the current situation?

a. Yes.
b. Not really, it is not much different from the familiar.
c. No.
d. We don't know.
e. This is not important.

4. Is the total amount of resources enough to implement the strategy/project in the long term?

a. Yes.
b. Yes, but only for now.
c. No.
d. We don't know.
e. This is not important.

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