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Understanding slow progress on urban climate adaptation: An empirical analysis of behavioural dynamics in Dutch policymaking

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ABSTRACT

Urban areas face an increasing urgency to adapt to climate change, yet adaptation efforts remain insufficient. Addressing this adaptation gap requires an understanding of the psychological mechanisms and contextual influences shaping climate adaptation behaviour. Whereas behavioural scientists have explored citizens' climate adaptation behaviours, the decision-making of policymakers is often overlooked despite its importance in closing the adaptation gap.

To address this, we conducted a behavioural systems analysis to uncover behavioural dynamics that shape policymakers' decision-making, based on 32 semi-struct ured interviews and a workshop with Dutch urban climate adaptation policymakers. Combing thematic and content analysis with behavioural system mapping, our results highlight the importance of an integrated, dynamic system approach to understand psychological and contextual influences on policymakers' decision-making. We identified nine central themes reflecting key behavioural dynamics: reliance on precedents; fragmented roles and responsibilities; habitual thinking based on longstanding processes; policy stringency, clarity and process; conflicting political priorities; importance of individuals; externally-motivated action; illusion of local actor engagement; moving from awareness creation to mainstreaming. Furthermore, analysis of behavioural influences using the Theoretical Domains Framework identified policymakers' beliefs about consequences, environmental context and resources, and goals as most influential determinants of behaviour. Behavioural system mapping revealed three impactful levers for interventions, namely supporting precedent identification, stimulating information gathering, and boosting mainstreaming processes, to improve decision-making in urban climate adaptation.

By integrating behavioural insights and systems analysis, this work proposes a novel approach to analyse contextual, dynamic influences and determinants of behaviour that shape adaptation policymaking. Therefore, it aligns with recent calls from behavioural scientists highlighting the need for systemic approaches in behavioural science.

1. Introduction

1.1. Policymakers' behaviour matters

Climate adaptation refers to *'the process of adjustment to actual or expected climate and its effects in order to moderate harm or exploit beneficial opportunities'* (Calvin et al., 2023, p. 120). International and local government bodies across the globe are increasing their adaptation efforts to cope with climate change impacts (Ministry of Infrastructure and the Environment, 2016; UNEP, 2022, 2023). Whereas awareness is increasing, and suitable climate adaptation instruments are often known, considered implementable, and economically cheaper than not adapting in time, present adaptation efforts are slow and remain inadequate (Biesbroek et al., 2015; Calvin et al., 2023; Carter et al., 2015; DARA & Climate Vulnerable Forum, 2012). This 'adaptation puzzle' (Bechtoldt et al., 2021, p. 187) cannot be explained by structural barriers and enablers only; a closer look at psychological factors and other behavioural influences that shape climate adaptation efforts is needed (Ishtiaque et al., 2021; Lee et al., 2023a; Siders & Pierce, 2021).

Psychological research has primarily investigated factors that influence the adaptation behaviours of citizens (e.g., Bateman & O'Connor, 2016; Singh et al., 2017). While citizen action for climate adaptation is

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necessary (Hegger et al., 2017), individual citizens have limited leverage over system-wide effects and are strongly influenced by adaptation policies and the choice architecture these provide (Biesbroek et al., 2018; Petzold et al., 2023; Reisinger et al., 2011). To address the adaptation gap, it is necessary to recognise that urban climate adaptation expands beyond citizen action, as it is a complex multi-actor[1] issue, wherein efforts need to be agreed and implemented by various governmental, non-governmental, and private actors (Cunningham & Hermans, 2018; Kanarp & Westberg, 2023; Vargas López & Flores-García, 2023).

Policymakers are key actors within this system, as their decisions regarding the design and implementation of policies for climate adaptation shape the trajectory in which society adapts. Especially local policymakers are at the core of urban climate adaptation efforts as the localised nature of climate impacts, such as extreme weather events and ecosystem degradation, require local responses. Therefore, local policymakers are often the ones to decide which measures, such as green roofs and water management strategies, are allowed, facilitated, supported, or incentivised in local urban planning (European Commission, 2021; Hallegatte & Corfee-Morlot, 2011; Petzold et al., 2023; Wilbanks, 2011).

Present behavioural research, however, has paid little attention to policymakers' decision-making behaviour. A stronger focus on policymakers is needed to improve the understanding of climate adaptation efforts, as articulated in recent research (Siders & Pierce, 2021; Árvai & Gregory, 2021). Siders and Pierce (2021, p. 5) called for more research on 'how decision-makers are making decisions in practice', arguing that the wicked nature of climate adaptation challenges requires effective decision-support for policymakers. We thus seek to investigate policymakers' decision-making using a behavioural system approach to take into account how behavioural dynamics in the complex system shape their decisions.

1.2. The importance of context in understanding decision-making behaviour

Behavioural insights in decision-making more broadly refer to the *'application of findings from behavioural science to analyse and address practical issues in real-world settings'* (Hallsworth, 2023, p. 311). The main interest is to identify behavioural influences that shape individual-level decision-making processes and appropriate ways to improve them (Dewies et al., 2022; Hallsworth, 2023; Hallsworth & Kirkman, 2020; OECD, 2017).

Despite the largely beneficial effects of behavioural interventions, their effect sizes are often small (Mertens et al., 2022). This has been attributed to the application of individual-level interventions to broad population groups that neither take into account the system context in which the target behaviour takes place, nor any individual-level differences, as observed in numerous policy domains, including health and environmental issues (Chater & Loewenstein, 2023).

Therefore, behavioural scientists emphasise the need to move beyond the individual level and to take into account systemic complexity when investigating behavioural dynamics and designing interventions to address wicked problems, such as climate change (Chater & Loewenstein, 2023; Hallsworth, 2023; Lunetto et al., 2022). Efforts to incorporate a system approach into behavioural science studies have shown promising results in identifying social tipping points (Andreoni et al., 2021), assessing intervention impacts within systems (Hawe et al., 2009), and formulating system-focused behavioural interventions (Guariguata et al., 2020; Hale et al., 2022).

In urban areas, the context within which multiple actors develop policy and the interactions between them shape climate adaptation efforts (Lunetto et al., 2022; Petzold et al., 2023). A system perspective to illuminate contextual influences on policymakers' decision-making can improve the understanding of behavioural dynamics and the identification of ways to improve adaptation decisions through behavioural interventions.

1.3. Analysing the system shaping policymakers' climate adaptation decisions

One valuable starting point for investigating policymakers' decision-making is research on the structural barriers and drivers that affect climate adaptation policy and its outcomes (Bauer et al., 2012; Bauer & Steurer, 2015; Keskitalo, 2010; Phuong et al., 2018). These often result from how urban climate adaptation is governed, affecting the roles, responsibilities, and interests of actors within a specific context, the laws and regulations to consider, and also how public climate adaptation policy is financed. Consequently, the key contextual inhibitors of climate adaptation are attributable to structural influences, such as insufficient financing, a lack of guiding policy documents, and a high number of involved actors (Oberlack, 2017; Phuong et al., 2018; Shi et al., 2015). However, the reductionist focus on individual factors and whether they act as barriers or drivers in the specific circumstances leads to neglecting interaction effects and other complex, dynamic processes that lead to their emergence, wherein factors can moreover function as both barrier and driver (Biesbroek et al., 2014; Ishtiaque et al., 2021; Lee et al., 2023b). With a focus on explaining policy outcomes based on (structural) contextual differences, research on structural barriers tends to treat policymakers' decision-making processes leading to the policies and their implementation as a black box (Biesbroek et al., 2015).

Existing research on the psychological mechanisms underpinning individual-level climate adaptation behaviour provides another valuable starting point by unpacking this behavioural black box. Environmental psychologists have identified multiple behavioural barriers to individual-level climate adaptation. These range from cognitive biases (Grothmann & Patt, 2005; Weber, 2015), risk perception (Houser et al., 2022), social norms (Geiger & Swim, 2016), belief in and perceptions of climate change (Blennow & Persson, 2009), and perceived behavioural control (Zhang et al., 2020) to the ability to process information (Fischer & Glenk, 2011), and psychological distance (Singh et al., 2017). In their meta-analysis of adaptation behaviours, van Valkengoed and Steg (2019a) found that perceived self-efficacy, perceived outcome efficacy, the experience of negative affect, and descriptive, pro-adaptation norms exert the most significant influence. However, this research has yet to consider dynamic contextual and psychological influences on policymakers' decision-making processes within a complex multi-actor system as encountered in urban climate adaptation.

Assessing both contextual and psychological influences requires a system-focused research approach. Causal system mapping is a suitable method for doing so. It has been widely practised in many different disciplines that endorse system thinking, policy and system analysis methods to study complex systems, at times for decades (Repenning, 2003; Wolstenholme & Coyle, 1983). Recently, applied psychologists have proposed to develop 'behavioural system maps', utilising participatory systems mapping to generate causal maps to explore cause-effect relationships explaining complex behavioural dynamics in multi-actor systems (Hale et al., 2022; Lunetto et al., 2022), thereby helping to make *'explicit the people, behaviours and influences on behaviour within a system and the nature of the relationships among these'* (Hale et al., 2022, p. 4).

1.4. Aims and contribution of this study

In this work, we aim to advance the analysis of climate adaptation by focusing on policymakers' decisions and by moving beyond the sole analysis of barriers. Examining the contextual and psychological

[1] In complex systems, individuals and organisations with the power to influence a system of interest through unilateral actions are often referred to as 'actors' (Cunningham & Hermans, 2018).

influences on urban policymakers' decision behaviour (rather than that of citizens), we aim to uncover the behavioural dynamics shaping urban climate adaptation decision-making. Our main research question is: *What are the psychological and contextual factors influencing policymakers' urban climate adaptation decision-making processes according to Dutch policymakers?* We combine methods from behavioural science with policy and system analysis in a novel way to address this challenge and demonstrate it for the case of urban climate adaptation decision-making in the Netherlands.

2. Research methodology

We adopt a qualitative research approach to investigate the decision context and gain an in-depth understanding of various actors' perceptions and experiences of urban climate adaptation decision-making. This approach consists of (i.) an analysis of the actors in Dutch urban climate adaptation governance as a basis for participant identification and selection, followed by (ii.) semi-structured interviews and a validation and reflection workshop for data collection, and then (iii.) qualitative data analysis combining thematic and content analysis of contextual and psychological influences with behavioural system mapping.

2.1. Study area and context

To research urban climate adaptation decision-making processes, we examine the decision-making of policymakers in (the mainland part of) the Kingdom of the Netherlands. A focus on Dutch climate adaptation policymaking is suitable, as the Netherlands are highly urbanised and face high vulnerability to climate change impacts, considering its low-lying topography. In the Netherlands, the awareness of and need for large-scale adaptation is widely accepted. This is reflected by national adaptation policies, such as the Deltaplan Spatial Adaptation and the National Adaptation Strategy developed jointly by three national ministries (Ministerie van Infrastructuur en Waterstaat et al., 2023), next to manifold adaptation strategies at local and regional levels (e.g., Rotterdam Office for Sustainability and Climate Change, 2013; Utrecht Province, 2020). In addition, 45 climate adaptation working regions have been established as regional cooperation platforms by the Dutch national government, provinces, water boards,[2] and municipalities to improve adaptation capacity and foster collaboration (Ministerie van Infrastructuur en Waterstaat et al., 2023).

The governance of climate adaptation spans across four governance levels. The national level sets overarching adaptation guidelines and goals such as being 'climate-robust in 2050', often without specifying what that means. Provinces and working regions translate guidelines and data to regional levels for their local partners. Finally, the municipal level is responsible for developing local adaptation strategies, planning, and implementing measures. Local planning instruments include municipal adaptation implementation programmes, sewer plans, environmental visions, and further adaptation-related plans. These planning instruments are generally updated every few years (e.g., 5 years) and guide municipal budget planning, programming, and implementation efforts. In addition to these planning instruments, municipalities have a range of adaptation actions at their disposal. These include outreach activities to create public awareness, subsidies that incentivise private adaptation, and local infrastructure projects (Hamstead et al., 2021; Ministerie van Infrastructuur en Waterstaat et al., 2023).

2.2. Participant sample identification and selection

We aimed to sample from a broad spectrum of policymakers in urban climate adaptation, reflecting the relevant governance actors at local, regional, and national levels and their interconnected roles. The types of actors to approach were determined through an actor analysis (Cunningham & Hermans, 2018). Based on a review of policy documents and scientific articles on climate adaptation barriers, we listed actors involved in urban climate adaptation decision-making in organisations, such as municipalities, water boards, work regions, provinces, ministries, and consultancies. Using purposive sampling, we selected participants who hold positions in urban climate adaptation planning and implementation.

Based on an initial long list of suitable participants, we sent email invitations to take part in this study, describing the research and its objectives. The long list was compiled from the contact points of the climate adaptation working regions, publicly available information on climate adaptation contacts within the identified actors, and via personal contacts of the authors and their networks. Moreover, we utilised snowball sampling, wherein initial interviewees recommended additional participants who could provide insights into the decision-making processes (Saunders et al., 2019) to broaden the scope of our search both in terms of perspectives as well as geographical distribution of respondents across the country, thereby enriching and validating the initial actor scan. Participants were continuously recruited until saturation was reached, as commonly done to determine the necessary sample size in qualitative research (Lakens, 2022). We operationalised this as reaching theoretical saturation, i.e., the point at which additional interviews do not result in the identification of new themes during axial coding (Wutich et al., 2024). Typical sample size recommendations in qualitative research aiming to develop themes from interview data suggest planning for 30 interviews (Thomson, 2010), which this study exceeded.

In total, 32 of the 133 contacted individuals were available within the foreseen timeframe and agreed to take part in an online interview. They cover a diverse range of functions and perspectives from across the country, as shown in Fig. 1. Most participants held senior-level positions, often as one of the organisation's main climate adaptation advisors or managers. Participant responsibilities included drafting adaptation strategies, supervising adaptation projects, developing outreach initiatives, and managing adaptation programmes. Following the interview series, nine participants took part in a validation and reflection workshop to consolidate the findings. In this workshop, we discussed the results of the thematic analysis and draft behavioural system maps for each theme.

2.3. Data collection and consolidation

We conducted the semi-structured interviews to analyse the dynamics within urban climate adaptation, as recommended for such an in-depth investigation (Adams et al., 2014). All interviews were recorded, taking between 36.39 and 59.05 min (M = 47.41 min). They were conducted as follows: Before starting the recording, we explained the purpose and scope of the research to the participant and addressed any arising questions. After confirming participant consent, we commenced the interview and the recording following the interview guidelines. The data collection approach, informed consent, and data privacy procedures for both the interviews and validation workshop were reviewed and approved by the TU Delft Human Research Ethics Committee (nr. 4367).

The interview covered four topical areas. First, we explored participants' role and goals in urban climate adaptation decision-making. Then, participants elaborated on the actors relevant to their decisions and the factors that shape their decision-making. We used adjusted questions from earlier research investigating barriers to climate adaptation (Lee et al., 2023a, Mees & Surian, 2023) to assess influences on decision-making processes, however, replacing the word "barrier" with "factor". This resulted in questions like, 'Which factors influence your decision-making in urban climate adaptation?'. In addition, we added questions focusing on the decision-making process to investigate when and how the identified influences affect decisions. Finally, we asked a

[2] Water boards are the governmental bodies tasked with the regional management of water levels, water quantity and quality.

Organisation	n
Municipality	14
Water board	5
Province	4
Working region	4
National level	3
Consultancies	2

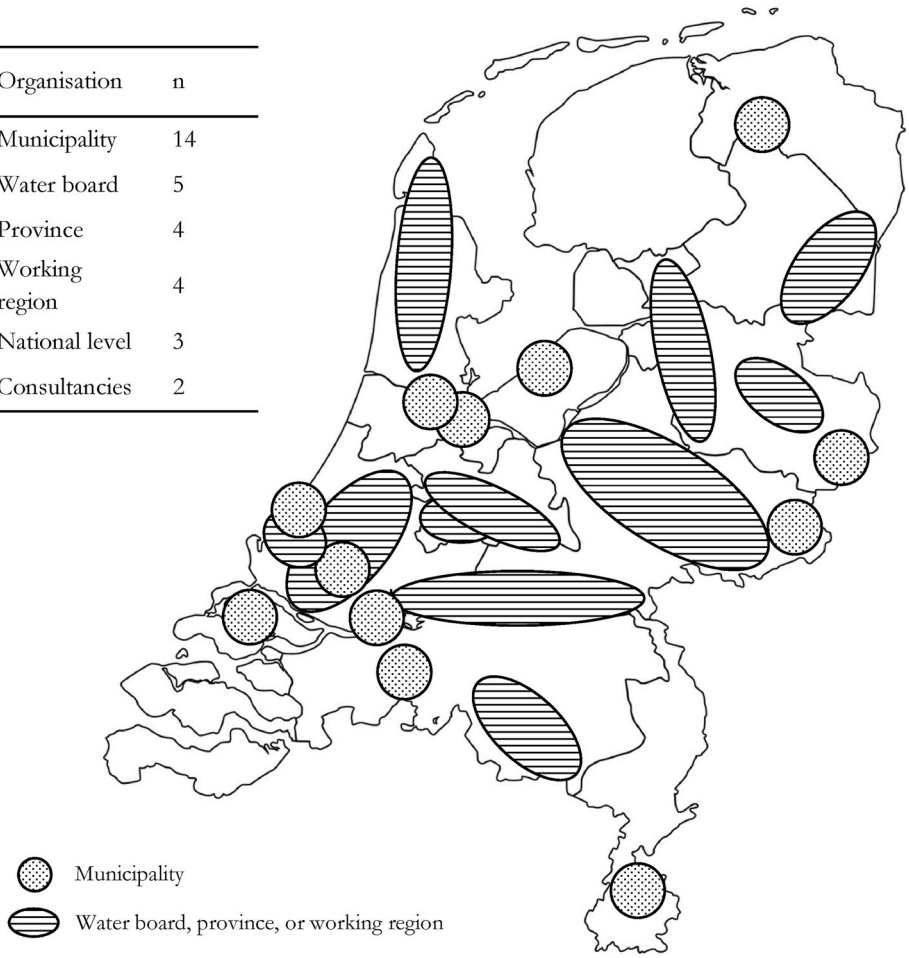

Fig. 1. Sample composition. The map shows the geographical scope of responsibilities covered by the interviewees. Three held multiple climate adaptation-related positions (e.g. role in a working region and at national-level), of which only the focal role considered in the interview is displayed. Interviewees with national-level or other geographical focus (e.g., consultancies, national ministry) are not visualised for readability.

question to identify the underlying determinants of decision-making behaviour considering participants' capabilities, opportunities, and motivation, following the COM-B model of behaviour (Michie et al., 2011). While only one question explicitly asked for decision influences, all interview questions aimed to capture factors and their dynamic interactions that shape decisions, including those that participants might not label as such (e.g., actors, process structure). The semi-structured interviews allowed for further exploration of the mentioned influences through follow-up questions. The interview guideline is provided in Appendix A.

Six weeks after the final interview, we conducted an online 2-h workshop to validate and enrich the themes identified through the thematic analysis and reflect upon initial behavioural system maps. All authors were present and co-facilitated the workshop. First, we presented the data analysis process and the findings of the thematic analysis. Second, we formed two groups, each reflecting in breakout rooms on four or five themes, respectively. This reflection focused on three questions: 1. exploring how the dynamics influence decision-making processes, 2. what its effect is on policy decisions, and 3. how it affects policymakers' personal motivation, capabilities, and opportunities. To support the reflection, we provided behavioural system maps based on the preliminary interview findings to visualise the themes' dynamics for validation, as typically done in participatory system mapping (Barbrook-Johnson & Penn, 2022).

2.4. Data analysis

We analysed the interview data using a three-step qualitative data analysis process using the qualitative data analysis software Atlas.ti, version 24.2.1 (ATLAS.ti Scientific Software Development GmbH, 2024). First, we conducted a thematic analysis using open coding to surface themes that describe how key factors and dynamics shape the decision context. This approach allowed an in-depth examination of the interview data, facilitating the identification of patterns and themes (Braun & Clarke, 2006; Vaismoradi et al., 2013). Based on open codes, we identified internal and external actors that were reported to influence participants' decision-making. We then used axial coding to group the codes and develop (sub)categories (Hawker & Kerr, 2007). This allowed for a systemic understanding of how different factors are interconnected within policymakers' decision context. Finally, we used the developed categories and subcategories to identify themes that capture the dynamics within and between the categories. These themes aggregate the behavioural dynamics captured in the categories and connect multiple (sub)categories.

Second, we conducted a content analysis using deductive coding to uncover the determinants of policymakers' behaviour based on the Theoretical Domains Framework (TDF), which allows the identification of psychological and contextual determinants of behaviour (Atkins et al., 2017). The TDF provides a framework for analysing and categorising behavioural determinants across multiple behavioural domains, such as knowledge, social influences, and beliefs about consequences, that

underlie actors' behaviour (Atkins et al., 2017). Building on the COM-B model (Michie et al., 2011), the TDF allows a more granular analysis of behavioural determinants in 14 domains (Atkins et al., 2017). Inter-rater agreement between two coders was calculated for a sample of four randomly chosen interviews (I7, I15, I17, I21). The average inter-rater agreement for the occurrence of the 14 TDF domains per interview was 80.36 per cent, ranging from 71.42 to 92.86 per cent. All inter-rater disagreements were resolved through deliberation between the coders.

Third, we developed a behavioural system map depicting the perceived causal relationships between the mentioned contextual and psychological influences on policymakers' decision-making. This was done by systematically extracting all mentioned observable behaviours and their interconnections from the open coding, developed themes, and workshop notes into a causal map (Kim & Andersen, 2012). We integrated the underlying determinants of behaviour from the TDF analysis into the behavioural system map. The links between the behaviours and determinants of behaviour were established based on co-occurrence in the interview data. Fig. 2 illustrates the key concepts used to visualise interactions between actors in a behavioural system map.

Finally, we analysed the generated map to derive insights into the behavioural dynamics within the system and to identify levers for change. This was done as follows. (1.) We analysed the maps for the key behavioural dynamics captured in the themes and as derived from the thematic analysis to analyse causal links between the behaviours. (2.) We examined the connections between the themes to identify behavioural dynamics that have a broad effect on the system. By doing this, we identified behaviours that have an impact on the behavioural dynamics of multiple themes and, therefore, behaviours that have a broad influence on the system. The dynamics underlying the levers have also been validated in the reflection workshop. (3.) We identified behaviours of municipal policymakers that could function as a lever for behaviour change due to their impact within the system, presenting a lever for interventions. Following this approach, we identified key levers for interventions that target municipal policymakers' decision-making behaviour.

3. Results

3.1. The multi-actor system in urban climate adaptation

The interview participants named 61 external and 29 internal actors whom they perceive as distinct entities influencing their decision-making (see Appendix B for the list of actors). This large number and diversity highlight the complexity of the multi-actor system characterising urban climate adaptation policymaking. The behaviours of the main actors and their influence on local policymakers are displayed in Fig. 3.

Of the 61 reported external actors, 29 are governmental or quasi-governmental bodies, such as national ministries, water boards, or municipal councils. While the national governmental bodies are primarily seen as influencing decisions through policy frameworks and financial incentives, regional organisations, such as the provinces, working regions, and water boards, are providing knowledge, data, and collaboration opportunities.

Private sector actors constitute a significant proportion of the multi-actor system (n = 17). Especially local private actors, such as local businesses and business associations affect adaptation decisions. Moreover, consultancies are often directly involved in local adapation, as Dutch governmental bodies contract out knowledge and strategy development. These consultancies provide data, access to climate adaptation precedents, networks, and expertise to local decision-makers.

The local community and organisations (n = 8) are also relevant to urban climate adaptation decisions. While participants only perceived limited influence of interest groups, inhabitants are the main community actor perceived to be influencing decisions.

Although participants reported only seven knowledge institutions actors as being relevant to their decision-making, they are perceived as a critical information source. In particular, national knowledge institutions, such as the Royal Netherlands Meteorological Institute, that translate global scientific evidence to the Dutch context shape policymakers' local decision-making. Local universities also shape decisions, as they provide more localised expertise and research collaborations.

The internal actors (n = 29) reported to influence urban climate adaptation decision-making span a wide range of departments, such as spatial planning, and leadership functions. In particular, departments focusing on health, water, and environmental issues are a prevalent influence on adaptation decisions.

3.2. Overarching themes reflecting the decision context

Through the thematic analysis, nine themes were identified from the interviews that shape policymakers' decision context and dynamics influencing climate adaptation (CA) decision-making. The themes are listed in Table 1 and further elaborated hereunder. The theme development involved identifying patterns across the interviews and organising them into themes, synthesising responses of multiple participants (see column 'Dynamics mentioned'). The developed themes represent patterns of behavioural dynamics described by the interviewees. They capture a range of factors and dynamic, causal dependencies between them that affect decision-making processes. A table with interview quotes connected to each theme is provided in Appendix C. All themes were validated in the workshop, in which participants reflected on the behavioural dynamics captured within each theme.

3.2.1. Theme 1: reliance on precedents

The interviews revealed that policymakers' decisions in urban CA are marked by a reliance on precedents to assess and communicate the

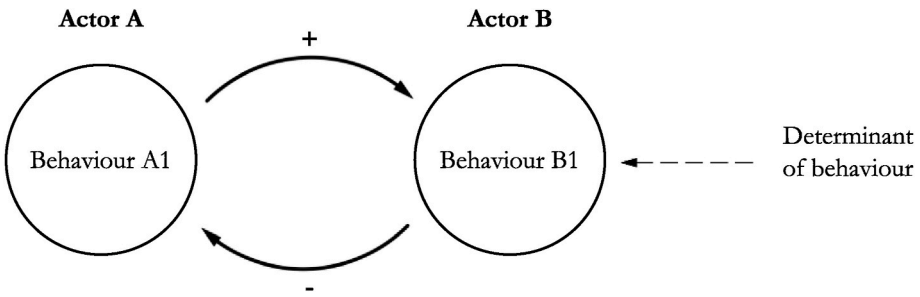

Fig. 2. Schematic illustration of behavioural system mapping concepts. The arrows depict the cause-effect relations between behaviours, which can be positively (+) or negatively (−) correlated, e.g. how the behaviour of one actor A influences the behaviour of another actor B. Causal relations can be uni-directional, mutually balancing, or re-inforcing (depicted by a loop-like structure), reflecting the behavioural dynamics within the (multi-actor) system. The (positively correlated) effects of underlying determinants of behaviour on an observable behaviour in the system are represented through dotted, incoming arrows, with the cause stated at the arrowtail.

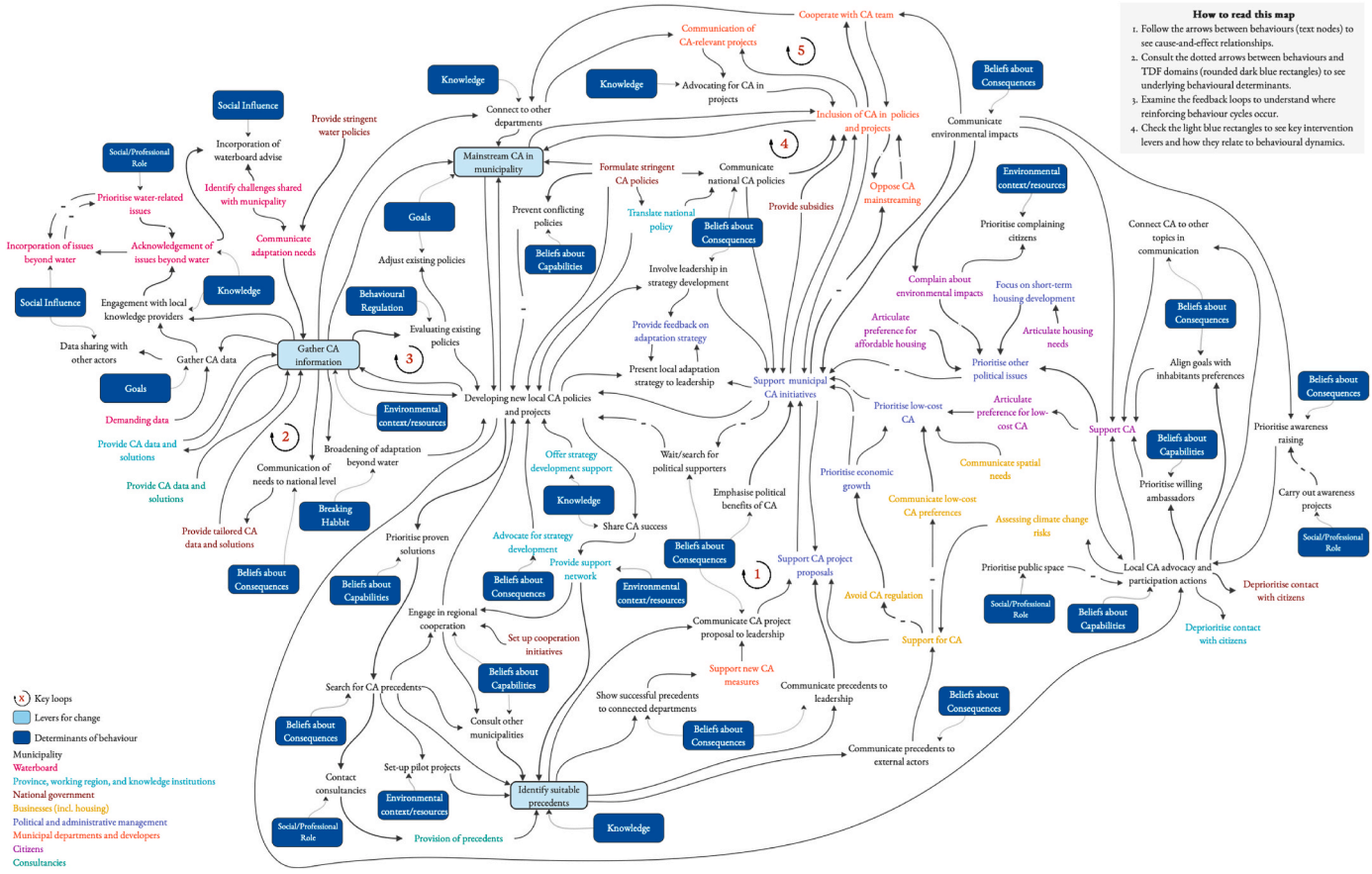

Fig. 3. Behavioural system map of policymaker decision-making in urban climate adaptation in the Netherlands. Behaviours are text nodes. Arrows depict cause-effect relationships between behaviours. Colours refer to different actors. TDF domains underlying behaviours are rounded dark blue rectangles with dotted arrows. Key levers for interventions are rounded light blue rectangles. Provinces, working regions (see Section 2.1) and knowledge institutions have been clustered, as their influence overlaps. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

success prospects of a CA measure to justify the allocation of limited resources. Policymakers perceive a need for precedents as means to convince internal and external actors whose support they need for specific CA measures. Amidst a lack of own precedents, the success probability of a potential measure is often estimated based on examples from other municipalities, especially those that are geographically close. Commenting on the process of minimum rainfall retention in a municipal strategy, one participant described, *"scientifically speaking, we should do 80 mm [per m^2]. However, we're having this like socioeconomic, political argumentation. Why we should or should not do it? So what is the easiest? We're just going to look at what other municipalities in our area are doing."*(I28).

A lack of suitable precedents can cause inertia or challenges in the development of a strategy, as policymakers aim to avoid the uncertainties connected with being a first mover. A small number of big Dutch cities emerged as role models which affect policymakers' decision-making throughout the country.

3.2.2. Theme 2: fragmented roles and responsibilities

Overlapping responsibilities and unclear authority boundaries in CA policymaking increase the complexity for the individuals navigating them, resulting in contradictory actions and inertia. Individual policymakers perceive navigating these fragmented responsibilities as challenging. One described that *"the difference between municipalities and waterboards and provinces is just completely indigestible"*(I2). In expectation of upcoming regulations or actions from other governance levels, policymakers might delay decisions and leave problems unaddressed to prevent time-consuming policy readjustments. Commenting on the fragmented responsibilities in urban CA, one participant explained: *"what happens if everyone is responsible for it, nobody is. You tend to look at each other and think 'ah the other one is probably picking this up'. So it's like a blanket everybody lies under"*(I12).

The interconnectedness between CA and health, urban planning, and social issues exacerbate the fragmentation of responsibilities for project managers. This also affects policymakers" perceived ability to respond to climate change, as slow internal decision processes and extensive coordination needs reduce the speed of CA.

3.2.3. Theme 3: habitual thinking based on longstanding practices

The decision context in urban CA is shaped by the geographic location in the flood-prone delta of three major European rivers, as well as longstanding institutionalised water management practices of the Dutch battling 'water coming from all sides' from as early as the middle-ages, preceding the establishment of the Netherlands as a nation-state in its current form. Due to this, water-related climate impacts are often prioritised in urban CA. One participant outlined that *"we come from a water perspective so everybody's always working on water"*(I9). Traditionally, the Netherlands have controlled their aquatic environment using technological solutions. This inclination toward the technological control of the environment amidst relative environmental stability still shapes current strategies and policymakers' decision context, including how policymakers who do not work directly on adaptation respond to mainstreaming initiatives. The interviewees stated that CA mainstreaming is perceived to interfere with these longstanding decision-making practices, shaping expectations regarding which CA efforts they can propose, as they may be incompatible with longstanding urban

Table 1
Themes shaping policymakers' decision context in climate adaptation (CA).

Theme	Dynamics mentioned (N = 32)	Characteristics
1. Reliance on precedents	26	CA examples from other municipalities are needed to convince actors and manage uncertainties.
2. Fragmented Roles and Responsibilities	31	Unclear roles and responsibilities lead to decision-making inertia, responsibility diffusion, and cooperation challenges.
3. Habitual Thinking Based on Longstanding Practices	28	Habitual thinking and longstanding practices shape CA implementation and resistance expectations.
4. Policy Stringency, Clarity, and Process	32	Policy stringency, clarity, and process spark uncertainty and limit the perceived opportunities to initiate CA.
5. Conflicting Political Priorities	28	Other political priorities affect the ability to convince actors and mobilise internal support for CA.
6. Importance of Indiviudals	25	Individual preferences create bottlenecks in decision-making processes and shape expectations of gatekeeping in collaboration.
7. Externally-Motivated Action	31	External motivations generate room for CA advocacy and reduce resistance.
8. Illusion of Local Actor Engagement	32	Illusions of direct contact with inhabitants shape perceived outreach needs and strategies.
9. Moving from Awareness Creation to Mainstreaming	31	Assumptions about widespread awareness shift priorities towards mainstreaming of CA.

planning and building practices.

3.2.4. Theme 4: policy stringency, clarity, and process

The absence of stringent policy benefits some policymakers, enabling them to tailor CA efforts to local needs, whereas others need stringent policies to convince local actors of CA's necessity. One participant highlighted this by saying, *"we have to do this because of Deltaplan Ruimtelijke Adaptatie [Deltaplan Spatial Planning], we have to keep going"*(I6). Accordingly, the availability of national policies shapes policymakers' expectations of whether they can convince other actors to foster CA. Policymakers' decision context is also shaped by the perceived clarity of climate adaptation goals. The absence of clear goals for CA and the vague ambition to be 'climate-robust in 2050' affect policymakers by sparking uncertainty and lacking clear guidance. For example, one participant elaborating on the 2050 goal said: *"that's really vague. It doesn't really say something"*(I4).

While climate change is perceived to progress at an unexpected speed, rigid policy processes reduce the ability to adjust policy in between regular strategic plan adjustments. This reduces policymakers' perceived ability to incorporate newly attained knowledge into existing policies. One participant stated *"we try to make sure that everything is as recent as possible. But our own policy runs, it's a 5-year plan, so that will be 2027 when it's going to be revised. So then there will be the new influence of whatever is there"*(I21).

3.2.5. Theme 5: conflicting political priorities

Policymakers are often confronted with conflicting political priorities, such as housing needs, climate change mitigation, flood protection, and livability considerations that affect their CA decision-making. These conflicting priorities arise from simultaneously aiming for long-term CA and short-term pressing political issues of municipalities. In particular, the protracted housing shortage and need for new construction conflict with CA efforts, which are perceived to slow down the building process while increasing building costs. One participant, describing the prioritisation of housing within municipal departments, stated, "*they say, oh, it has to be quick. It has to be cheap"*(I19). As CA measures often require physical space, which is limited in densely populated urban environments, trade-offs between housing development and CA arise in spatial planning.

3.2.6. Theme 6: importance of individuals

Individual preferences and efforts have a substantial influence on adapation decisions, often acting as a bottleneck. Emphasising this, one participant stated, "*So I think that's it. It's depending on people"*(I17). This is particularly relevant in municipalities with limited CA capacities, in which CA actions depend on individual initiatives as CA *"is still so small and therefore so person-driven"*(I2). Individual preferences also shape the contact with project managers who supervise building and infrastructure developments, sometimes leading to an active search for CA-favouring individuals for support. One participant outlined that when setting up CA initiatives the CA team explores *"can we get a project manager who is […] more interested in climate adaptation"*(I8). Participants also critically mentioned the resistance of influential individuals when implementing CA into organisational practice, which is perceived to be frustrating.

3.2.7. Theme 7: externally-motivated action

Policymakers' decision context in urban CA is often motivated externally, such as by environmental changes and subsidies. Especially extreme weather events, such as flooding and heatwaves, allow policymakers to showcase vulnerabilities and adaptation needs to leverage support from citizens and political leaders to initiate adaptation efforts. Participant statements included, e.g. *"those are the examples that I use when I'm talking to people who know little about it"*(I26). Similarly, policymakers often prioritise CA measures based on visible local environmental changes, especially when inhabitants approach policymakers demanding adaptation solutions. One participant explained that their focus was *"first on extreme downpour, but we've had a number of heat stress events. We realised we should also focus more on that"*(I16). However, ongoing climate change also creates difficulties in designing CA policies, as policymakers need to adapt their policies to observed changes before the foreseen timeframes.

3.2.8. Theme 8: illusions of local actor engagement

The CA governance system is built on the assumption that municipal policymakers are in regular exchange with citizens, businesses, and other local actors. Policymakers from other governance levels report that they are in indirect contact with citizens through the municipalities. However, this assumption does not align with the reality in local policymaking due to budget and personnel capacity limitations. Regardless of their designated role as contact point, municipal policymakers often struggle to engage with citizens and local actors. Their contact is mainly problem-driven, e.g., via complaints to policymakers about infrastructure functioning and existing public duties, leading to situations wherein *"The people who don't experience problems we don't speak that actively"*(I7), and inhabitants *"come in action when they have big problems, damage because of the climate change"*(I6). Capacity limitations thus lead to a concentration of engagement with citizens who actively complain or are directly affected by an event or redevelopment project.

3.2.9. Theme 9: moving from awareness creation to mainstreaming

Another important theme that shapes policymaking is the perception of being in a transition from raising awareness to implementing and mainstreaming CA. One participant described the focus of the initial CA efforts in the Netherlands by saying, *"the first seven years it was also a lot about raising awareness"*(I24). As policymakers primarily focused on creating awareness, they feel to now be in a phase of mainstreaming and perceive an urge to focus on implementing CA measures. For example,

one participant accentuated that after years of awareness creation efforts, *"now it's on the agenda and we need to make it happen more quickly"*(I26). The transition to a mainstreaming focus also shapes interactions with external actors, which are becoming less frequent and more project-oriented, as described in the previous theme.

3.3. Determinants of policymakers' behaviour

The analysis of the determinants of policymakers' decision-making behaviour revealed the following TDF domains being mentioned most frequently during the interviews (see Table 2).

Three behavioural domains were mentioned across all interviews (n = 32), namely environmental context, goals, and beliefs about consequences, closely followed by social/professional role and identity, social influence, as well as knowledge (n = 31). In contrast, the domains of *optimism* and *intentions* were mentioned by only 7 and 5 participants, respectively. While optimism includes both optimism and pessimism, *intentions* incorporate the stability of intentions as well as intentions and stages of change. The other six domains were mentioned by somewhere between 28 and 14 respondents.

Table 2
Frequency of mentioned determinants of behaviour.

Domain	Description	Frequency (N = 32)
1. Beliefs about consequences	Acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation	32
2. Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence and adaptive behaviour	32
3. Goals	Mental representations of outcomes or end states that an individual wants to achieve	32
4. Social/professional role and identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting	31
5. Social influences	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours	31
6. Knowledge	An awareness of the existence of something	31
7. Beliefs about capabilities	Acceptance of the truth, reality or validity about an ability, talent or facility that a person can put to constructive use	28
8. Skills	An ability or proficiency acquired through practice	23
9. Memory, attention and decision processes	The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives	16
10. Emotion	A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event	16
11. Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus	15
12. Behavioural regulation	Anything aimed at managing or changing objectively observed or measured actions	14
13. Optimism	The confidence that things will happen for the best or that desired goals will be attained	9
14. Intentions	A conscious decision to perform a behaviour or a resolve to act in a certain way	5

See Atkins et al. (2017) *for a full overview of domains and subdomains.*

Connected to the COM-B, the analysis shows that participants' reflective motivation (beliefs about consequences, goals, social/professional role and identity, goals) is the most frequently reported component affecting participants' CA decisions. The other most frequently reported domains are connected to physical capability (environmental context and resources), psychological capability (knowledge), and social opportunity (social influences).

3.4. Behavioural system map of policymakers' decision-making

The behavioural system map in Fig. 3 shows the dynamic cause-effect relationships (arrows) between CA behaviours (text nodes) along with the identified TDF domains that shape actors' behaviour (rounded dark blue rectangles with dotted arrows), together driving the dynamics within the system. The map depicts central loops and behaviours that shape urban climate adaptation decision-making as well as the psychological and contextual factors that underpin them. The analysis of the map surfaced three key levers for interventions to improve local policymakers' decision-making for urban climate adaptation (light blue rectangles). These levers are each connected to the behavioural dynamics in one of the identified themes that shape CA policymaking.

Lever 1: **Supporting precedent identification**. As shown in the lower centre of the map, policymakers' search for precedents (Theme 1) is sparked by beliefs about capabilities and beliefs about consequences, as policymakers have a low perceived capacity to carry out adaptation projects without being able to show successful precedents. As visible on the right side of the map, the identification of precedents is central to convincing other actors in the system. This identification is influenced by policymakers' knowledge and the provision of suitable precedents from consultancies and other actors. Whether policymakers attain precedents from consultancies is influenced by their social and professional role and identity, as their professional confidence and task boundaries shape their outreach to consultancies. Loop 1 shows that the identification of suitable precedents increases political support, which then increases local adaptation efforts and further searches for precedents. The dynamic presents a key lever for change, where the provision of precedent knowledge or the connection to precedent providers can lead to more local adaptation efforts.

Lever 2: Stimulating information gathering. Another central behaviour is policymakers' gathering of information, as can be seen on the top left of the map. The central determinants of this behaviour are policymakers' environmental context and resources. Extreme weather events, national policies, and other external influences (Theme 7) shape the extent to which policymakers gather information, engage with other actors, and initiate local adaptation strategies. The loops in this dynamic show that the gathering of new information results in more tailored national support (loop 2) and the updating of existing strategies (loop 3), which both again increase the gathering of information. It also increases the engagement with local knowledge providers and the incorporation of their advice. Finally, the gathering of information increases the development of new local strategies, which, in turn, leads to more information gathering. Due to these loops, the gathering of information is another central lever within the decision-making system.

Lever 3: Boosting mainstreaming processes. The third lever is connected to the mainstreaming of adaptation by local policymakers. This behaviour is underpinned by goals that prioritise mainstreaming within the organisation. Mainstreaming sparks the adoption of new practices in other departments (Theme 3). The mainstreaming then leads to two loops. First, it increases the political support for adaptation as its internal support grows (loop 4). Second, it strengthens connections to other departments, which, in turn, increases mainstreaming attempts (loop 5). Accordingly, targeting policymakers' goals regarding mainstreaming efforts poses another key lever within the system.

Also visible by looking at the interconnections between the levers and behaviours is that the themes are deeply interconnected,

collectively shaping policymakers' decision context and dynamics within it. For example, the 'reliance on precedents' is linked to 'habitual thinking based on longstanding practices' and 'policy stringency, clarity, and process'. Policymakers' dependence on established precedents can be a result of the lack of stringent guidelines and the influence of longstanding internal management processes that prioritise proven solutions. This reinforces a dynamic in which innovative measures and local experimentation are deprioritised.

3.5. Validation of the findings with policymakers

Participants in the reflection workshop confirmed that all the themes can be observed in their decision-making. The workshop yielded two primary additional insights on urban climate adaptation decision-making. First, participants emphasised the interconnections between the themes, outlining that they jointly shape their decision-making processes. For instance, they emphasised that the uncertainty sparked by a lack of stringent policy documents (Theme 4) is connected to the 'Reliance on Precedents' (Theme 1) and the 'Fragmented Roles and Responsibilities' (Theme 2). Second, participants accentuated that the themes, if navigated successfully by the individual policymaker, can positively influence adaptation decisions. For example, the 'Habitual Thinking Based on Longstanding Practices' can provide a supportive basis for decisions and the limited 'Policy Stringency, Clarity and Process' can lead to more local deliberation processes. Connectedly, participants highlighted the potential of change on the individual level to improve adaptation decision-making.

4. Discussion

The findings enrich existing research on climate adaptation behaviour (Bechtoldt et al., 2021; Gifford, 2011; van Valkengoed, Perlaviciute, & Steg, 2022; van Valkengoed & Steg, 2019b) and on structural barriers to climate adaptation by illuminating individual-level decision-making processes of policymakers and behavioural determinants that underpin them (Ishtiaque et al., 2021; Lee et al., 2023b; Oberlack, 2017; Phuong et al., 2018). The nine themes highlight that policymakers aim to follow the scientific recommendation to mainstream adaptation efforts but that behavioural dynamics in the decision context limit their mainstreaming abilities, leading to slow adaptation progress. The focus on unpacking cause-effect relationships between observable behavioural factors and underlying determinants allowed for a more comprehensive analysis of dynamics in the multi-actor system.

In particular, the results show how a 'barrier' in one municipality can function as a 'driver' of adaptation efforts in another municipality (Theme 4 in section 3.2), also showing the importance of understanding the dynamic interdependencies between behaviours and their determinants to unpack (in)action and identify relevant levers for intervention (section 3.4). This highlights the value of moving past reductionist barrier-focused thinking, as also emphasised by Biesbroek et al. (2014) and Ishtiaque et al. (2021). The findings show that certain actions aiming to remove a barrier, such as establishing national standards, will likely be ineffective as policymakers also need relevant precedents to convince local stakeholders. Shifting the focus to behavioural dynamics can help to improve within existing resource constraints, rather than expending more resources on trying to overcome them.

The overarching influence of individual initiative on adaptation outcomes leads to a situation where individuals become bottlenecks for adaptation progress. Thus, individual-level behavioural interventions tailored to the specific policymaking context may be a promising lever to change system behaviour. The insights concerning the respective determinants of behaviour establish a basis for developing such interventions as recommended by van Valkengoed, Abrahamse, and Steg (2022). Similar to research on citizens' adaptation, our results confirm self-efficacy (beliefs about capabilities) and outcome expectancy (beliefs about consequences) as relevant determinants of adaptation behaviour (van Valkengoed & Steg, 2019a). However, our results assert the importance of taking policymakers' decision context into account, as social norms and place attachment have not been identified as primary behavioural influences prevalent in their decision-making (Bechtoldt et al., 2021; van Valkengoed & Steg, 2019a). Similarly, prior research on citizens suggests no negative correlation between climate adaptation and mitigation behaviours (Urban et al., 2021), whereas our findings suggest that mitigation action, if perceived as a political priority, reduces policymakers' prioritisation and capability beliefs, undermining adaptation (see Theme 5).

The system perspective in this study goes beyond identifying determinants of behaviour. It also discloses how the target behaviour influences other behaviours in the system, enabling the development of individual-level interventions that affect the system through behaviours that function as levers (section 3.4). This suggests a potential route for a more active role of behavioural scientists in climate policy decision-making, as advocated by van der Linden et al. (2021). It emphasises research highlighting the importance of advancing the understanding of policymakers' decision context in climate change policymaking (Siders & Pierce, 2021; Árvai & Gregory, 2021) and proposes a methodology to analyse diverse policymaking and decision contexts.

By illuminating behavioural dynamics, our study corroborates drivers of policy diffusion processes, referring to the processes through which policies spread across multiple jurisdictions, which have been observed in research on climate adaptation. For example, organised diffusion, in which networks established from higher governance levels foster learning, are reflected in the role of working regions as providers of information and precedents (Schulze, 2024). Similarly, the study also provides evidence for an interest-driven policy diffusion mechanism, in which external influences (see Theme 7) spark local adaptation efforts (Schoenefeld et al., 2022).

Methodologically, the study contributes to recent efforts to bridge behavioural science and systems analysis (Chater & Loewenstein, 2023; Hale et al., 2022; Hallsworth, 2023; Kaufman et al., 2021; Lunetto et al., 2022), confirming the added value of behavioural system maps for understanding behaviour in complex systems (Lunetto et al., 2022). To the best of our knowledge, it is the first study that integrates determinants of behaviour, identified based on the Theoretical Domains Framework, in behavioural system maps. This integrated approach allows for a deeper understanding and analysis of the behavioural system as a basis for designing interventions that are sensitive to both the micro-level determinants of behaviour and the macro-level system dynamics, moving beyond solely focusing on either the individual or the system.

5. Conclusion and recommendations

Current behavioural science research tends to focus on the individual-level behaviour of citizens while omitting the critical importance of contextual and psychological influences on policymakers' decision-making in explaining slow progress in urban climate adaptation. This study applied a behavioural systems approach to the investigation of behavioural dynamics in urban climate adaptation processes to improve the understanding of the decision context shaping policymakers' decisions.

The thematic analysis, based on interviews with 32 policymakers and validated by a subset of nine policymakers, surfaced nine central dynamics that shape decision-making processes in urban climate adaptation: 'Reliance on precedents', 'Fragmented Roles and Responsibilities', 'Habitual Thinking Based on Longstanding Practices', 'Policy Stringency, Clarity, and Process', 'Conflicting Political Priorities', 'Importance of Individuals', 'Externally-Motivated Action', 'Illusion of Local Actor Engagement', 'Moving from Awareness Creation to Mainstreaming'. All themes, including the reliance on role models to convince actors and the dependence on individuals acting as adaptation bottlenecks

which overarch the decision context, jointly shape policymakers' decision-making processes.

The content analysis revealed that policymakers' beliefs about consequences, goals, environmental context and resources, social influences, knowledge, and their social and professional role are the most influential determinants underlying their decision-making behaviour. This shows that the observed behavioural dynamics are underpinned by the interaction of determinants of behaviour with the decision context, suggesting that an inclusion of psychological determinants of behaviour in the analysis is imperative to attaining a nuanced understanding of the decision context.

Behavioural systems mapping based on thematic and content analysis allowed to identify the factors and dynamics that influence policymakers the most, exposing numerous causal interdependencies between the themes and individual behaviours. The map reveals a complex and interconnected decision context, characterised by a large number of actors and dynamics influencing policymakers' decisions. The analysis of the behavioural system map surfaced three key behavioural levers for intervention in municipal policymakers' decision-making: 'supporting precedent identification, 'stimulating information gathering', and 'boosting mainstreaming processes'. These offer the potential for impactful interventions that expand beyond individual-level behaviour change.

This study underscores how focusing on policymakers' decision-making and the determinants of their behaviour can increase the understanding of policy outcomes and the development of behavioural interventions to improve decision-making processes. The behavioural system approach facilitated this by illuminating the contextual influences on policy decisions and by disclosing levers for systemic interventions.

Several directions for future research emerge from the limitations of this study. The Theoretical Domains Framework supported the identification of determinants of behaviour of policymakers' decision-making in urban climate adaptation but lacks the capacity for in-depth examination of underlying psychological mechanisms and relations between determinants. Future research should further examine these mechanisms to strengthen understanding of the processes that behavioural interventions could target. A more comprehensive understanding of the underlying psychological determinants, their impacts and interactions, e.g. using psychological questionnaires, and clearer discrimination of determinants of behaviour could aid the purposeful design of more impactful interventions.

While this study uncovered levers that can be targeted by behavioural interventions, it did not identify specific interventions. Future research should investigate applicable interventions under consideration of the presented levers and showcase their impact on urban climate adaptation efforts. Testing different interventions through lab-field experiments could help anticipate system-wide effects of interventions, providing actionable recommendations for policymakers (List, 2007).

As all participants were from the Netherlands, a country with a WEIRD (Western, Educated, Industrialised, Rich, Democratic) population, the representativeness and generalisability of the findings to other populations may be limited (Henrich et al., 2010). As the governance system and cultural context have a major influence on policymakers' decision-making, the decision context in other countries will likely differ (Nutt, 2014). However, cause-effect relations between the behaviours and their determinants may well be similar. Cross-cultural comparative research is a suitable pathway to explore whether the identified levers, themes, and behaviours also apply in countries with other governance and cultural contexts.

Behavioural system maps can support the analysis of behavioural dynamics in complex systems by helping to visualisually analyse complex behavioural dynamics, which would otherwise be challenging to do. This supports the adoption of system-focused approaches in psychological research. However, the accessibility of the maps is affected by readability challenges that arise through the complex dynamics captured within them. Future work could seek to optimise behavioural system mapping and transfer best practices from other fields (Auping et al., 2024) to balance completeness versus tractability of the resulting maps and accessibility of findings, thereby supporting integrated systems analysis and behavioural science.

Addressing the presented limitations and future directions will contribute to a more comprehensive understanding of climate adaptation decision-making and aid analysis of complex system behaviour in other cases. Thereby, researchers can better support policymakers in designing impactful interventions.

CRediT authorship contribution statement

Kai Bellmann: Investigation, Formal analysis, Data curation, Conceptualization, Validation, Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology. **Gerdien de Vries:** Writing – original draft, Methodology, Writing – review & editing, Investigation, Conceptualization, Visualization, Validation, Supervision. **Lisa Scholten:** Conceptualization, Methodology, Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Investigation, Funding acquisition, Formal analysis.

Data availability statement

The data this study analysed consists of interview transcripts and workshop notes with participants who occupy politically exposed and often unique task portfolios or organizational positions in the Netherlands, making the individuals relatively easily recognizeable. To protect their identity and ensure confidentiality of the information shared with us, we refrain from sharing the full data beyond anonymised quotes as this would risk the identification of the participants. Therefore, the data cannot be made publicly available. Upon reasonable request, anonymised excerpts from the interviews are available from the corresponding researcher.

Declaration of interests

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2025.102666.

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