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Robust municipal decision making? A pilot study of applying robust decision making in three Swedish municipalities

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The growing understanding of the increased frequency and severity of extreme weather events due to climate change demands action. Locally, measures to adapt must be taken without knowing exactly what will happen, where it will happen or what the consequences will be. To meet this need, a number of decision support tools have been developed and this article investigates how municipalities can implement Robust Decision support in their urban planning. Interviews with respondents from the municipalities were conducted. After this a series of workshops were held, where an RDM method was used on local situations and follow-up interviews assessed the success and potential of the tool. Results suggest that the process addresses uncertainty, encourages bottom-up approaches and provides a tool for creating adaptive pathways in a clear and concise manner. Despite these promising findings, the success of implementation on a broader scale is seen as limited due to organizational factors.

Keywords: climate change adaptation; robust decision models; municipal planning; uncertainty; adaptive pathways

1. Introduction

The growing understanding of the increased frequency and severity of extreme weather events, driven by climate change, demands action. Measures must be taken to adapt, without knowing exactly what will happen, where it will happen or with what consequences. This article seeks to investigate whether and how a specific decision support tool can be used in municipal planning to better meet the challenges of climate change adaptation.

Uncertainties are a challenge for planning for the future, while it is widely recognized that climate adaptation cannot wait. The inclusion of uncertainty in local planning is known to be problematic, particularly in relation to climate change (Woodruff and Stults 2016). The usual "predict-then-act" approach, where forecasts are made and one solution is presented, cannot encompass all of the relevant factors (Weaver *et al*. 2013). New tools need to be developed and adjusted to fit the needs of local planners. To meet these needs, several different decision support tools have been developed to meet the challenges of long-term planning under uncertainty (see Malekpour and Newig 2020 for a review).

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This study examines the Swedish municipal planning context relating to urban development, where decisions have to be made under great uncertainty of how future sea level rise will affect areas. In order to help municipalities with this challenge, we developed a method that builds on three core principles that were identified in the larger literature on Robust Decision Making (RDM). These core principles were applied to specific decision contexts through a series of workshops in three coastal municipalities in Sweden. This contribution presents the results of these workshops.

2. Decision-making under uncertainty

Communicating uncertainty is a longstanding challenge in risk management, regardless of the risk source. The most common approach has been to ignore uncertainties for fear that the receiver will become confused, or will misunderstand (Miles and Frewer 2003, Frewer *et al*. 2003, Dieckmann *et al*. 2017). If uncertainty is communicated, a dual approach has been advocated, which encompasses both numerical and verbal estimations (Budescu, Por, and Broomell 2012), albeit with a slight emphasis on verbal descriptions (Druzdzel 1989). The balance between verbal and numerical expressions of uncertainty can be difficult to grasp. Examples include phrasing such as "very unlikely," to illustrate a less than 10% likelihood of an event occurring, or "likely" to illustrate a likelihood of more than 66% but less than 99% (Budescu, Por, and Broomell 2012, 184). At the same time, factors such as attitudes, emotions and trust affect how uncertainties are perceived, and the reason for the uncertainty in the first place (Johnson 2003, Bar-Anan, Wilson, and Gilbert 2009; Howe *et al*. 2019).

In the specific context of climate change, the role of uncertainty is even more complex. Three reasons have been highlighted: the system is much more complex, which makes relationships between different triggers and consequences difficult to assess; it is impossible to validate assessments; and current decisions cannot be based on future states of the system as they cannot be projected with enough accuracy (Patt and Dessai 2005). Still, decisions need to be made and urban development continues despite an uncertain future. This has led to the development of decision support tools.

2.1. Robust decision making

Many initiatives have focused on how climate change adaptation can become part of mainstream planning processes. In this context, a number of decision support tools have been developed that aim to help local administrators respond to climate change adaptation (Olazabal *et al*. 2019; Marchau *et al.* 2019). This article focuses specifically on Robust Decision Making (RDM) tools. These tools are suitable for climate adaptation because they allow uncertainties to be explored, and a number of alternative decision paths can be developed. Examples include tools such as Decision scaling, Info-Gap, Many-Objective robust decision making, Dynamic adaptive policy pathways and Robust optimization (see Malekpour and Newig 2020 for a review). In our previous work, we have through a literature review of the methods and tools within RDM identified three core principles. Our three core principles represent a condensed version of decision support tools such as Robust Decision Making (Lempert 2019), Information Gap (Ben-Haim 2004), Many-Objective Robust Decision Making (Kasprzyk *et al*. 2013), Decision Scaling (Brown *et al*. 2011) and Dynamic Adaptive Policy Pathways (Haasnoot, Warren, and Kwakkel 2019). The full account for this

process can be found elsewhere (see Carlsson Kanyama, Wikman-Svahn, and Mossberg Sonnek 2019) but a short summary follows below.

2.1.1. *Three core principles*

In our view, many RDM tools for decision support in long-term planning under uncertainty share three core principles:

First, these decision support tools seek to *characterize uncertainties* explicitly. As mentioned earlier, uncertainty can be characterized in a number of ways and terms such as "ambiguity," "severe uncertainty" and "deep uncertainty" are common in the climate adaptation context (Carlsson Kanyama, Wikman-Svahn, and Mossberg Sonnek 2019). When planning for future conditions, attempting to manage uncertainty can be described as managing multiple plausible futures (Maier *et al*. 2016), something that poses a great challenge to managers. As uncertainties are easily ignored by decision-makers (Dessai and Wilby 2011), the first core principle is to make uncertainties explicit by considering relevant types of uncertainties.

Second, it is seen as beneficial to adopt a *bottom-up approach* where local conditions are examined, rather than adjusting to a top-down national guideline. These decision situations can start with "investigating local vulnerabilities, potential solutions and critical tipping-points" (Carlsson Kanyama, Wikman-Svahn, and Mossberg Sonnek 2019, 1342). This process can make decisions better anchored within the community, as they can be seen as more credible to the local community (Weaver *et al*. 2013).

The third core principle is that these decision tools include *adaptive strategies* that are more robust in relation to uncertainty than static solutions (see Dessai and Wilby 2011; Herman *et al*. 2015; Wikman-Svahn 2016). Here, solutions are not fixed but can change depending on the circumstances. This is preferred in situations where uncertainties are high. The Thames barrier is one example of flexible adaptation measures (www.gov.uk/guidance/the-thames-barrier).

However, these principles need to be implemented in a decision context where there are many other factors that can affect the decision-making process.

2.2. *Organizational factors*

It is clear that there is a lack of scientific data that can help to reduce or better describe uncertainties, and that this problem creates a barrier to working with climate adaptation on a local level. However, additional challenges include a lack of leadership, knowledge, competing priorities, inadequate planning processes, a lack of financial resources, and a lack of institutional support (Measham *et al*. 2011; Palutikof *et al*. 2019). These barriers reflect the working environment for local authorities and attempting to introduce a novel decision support tool could simply add insult to injury for already-overworked public servants. One approach focuses on distinguishing between what is useful – and what is valuable. A useful tool is likely to be used but, in order to be valuable, it needs to offer tangible benefits to the user (Daron 2015). In practice, this means that any model needs to go beyond presenting additional data (such as the range of uncertainty) and also provide a method for adopting and using this information.

Turning government requirements into local adaptations can be seen as yet another task for overburdened local authorities. Although municipalities are widely-acknowledged as a key actor in the context of climate adaptation, the literature lacks evidence

that concrete actions have been taken at the local level (Ford, Berrang-Ford, and Paterson 2011). The lack of local adaptation might be a reflection of the particularly difficult position planners find themselves in. These professionals are torn between defining the broader public interest, and accommodating political considerations; in this context, they can be required to act as scientists and advocates who "work in the fishbowl of politics" (Wachs 1989, 476). In addition, local actors usually do not have the same resources or skills, and often rely on decisions requiring consensus among different stakeholders than compared to national actors (Barnett *et al*. 2014). Local authorities are put in a position where decisions have to be made today, while the negative consequences of inadequate planning might not be seen for many years. This makes it extremely difficult to know whether the decisions that are taken are the right ones.

The Swedish decision-making context is characterized by decentralized processes, where municipals have a great deal of autonomy. Despite municipalities having exclusive decision-making rights over the planning process, they are supervised by the County Administrative Boards that can override local decisions if they are seen to go against national guidelines. Sweden has 290 municipalities and 21 Country Administrative Boards.

3. Materials and method

The aim of this study was to investigate to what extent municipal civil servants would find RDM tools useful in their climate change adaptation work. More specifically, we investigated the effect of the introduction of new working practices, which require the planning team to work with the three core principles: embrace uncertainty, adopt a bottom-up approach, and design adaptive measures. Our before-and-after qualitative study aimed to measure the impact of our method.

The study was run with three municipalities – one in the Stockholm region, and two to the north of the capital – and focused on sea level rise. The largest municipality has approximately 100,000 inhabitants and the smallest 25,000. Since all three are coastal municipalities, with future sea level rise an ongoing concern in their urban planning, they were seen as similar enough to enable comparisons. Qualitative data was collected in before-and-after-interviews with all relevant staff in the participating municipalities (Creswell 2007; Gerring 2007).

3.1. Workshops

Each of the three municipalities is engaged in an ongoing project that requires deciding how to develop a specific area that is exposed to sea level rise. In all three cases, the development of residential housing was being explored. Municipalities were asked to identify which of their departments and any other actors (such as a water treatment consortium) would be involved in the project, and invitations to join the workshop were extended to these groups. Participants held many different roles, ranging from environmental strategist to urban planner, traffic planner and landscape architect. After the first and second workshops, the research team examined how the broader issue of sea level rise could be applied to the local context and municipalities' ongoing work.

Each workshop lasted a day, with a few weeks between each one. The first focused on managing uncertainty, our first core principle. Here, the group was encouraged to agree on a common goal for the project or area they were developing. The idea is

illustrated by the question, "How can we plan for, and create, a sustainable and attractive development within the existing and future built environment […] despite our vulnerable coastal location?" This question guided the subsequent process. Participants were then asked to define criteria that would indicate that they had been successful in fulfilling the overall goal. This overarching goal was then broken down into several sub-goals that would indicate the success or failure of the main goal. Next, we asked participants to make the uncertainty connected with these future developments more tangible. Specifically, we asked them to indicate how frequently this sub-goal (or criteria) could fail, without causing the overarching goal to be unsuccessful. For example, one municipality reasoned as follows: if property damage due to flooding did occur once every 100 years (i.e. the event was judged to be rare, but still likely to happen), the overall goal of the project would still be met. However, the failure of rescue services to access the area was estimated to be acceptable only every 1,000 years (i.e. very unlikely to happen and unacceptable if it did happen more often). These indicators made some events acceptable, as it is unrealistic to attempt to mitigate all risks. They were also coupled with the current sea level rise (in centimetres) and resulted in a number of scenarios that illustrated the local consequences of different increases in sea level. After this first workshop, the research team prepared maps to give participants a deeper understanding of how the area of interest would be affected by sea level rise.

The second workshop focused on "failure" as it related to the affected areas, based on the maps we had prepared. It addressed the second principle – using a bottom-up approach. In particular, participants worked with their own local conditions, rather than applying the national guideline to their context. In this way, specific vulnerable areas could be identified and evaluated in relation to the likelihood or probability that they would be negatively affected by sea level rise. Participants were also asked to suggest measures that could be taken to address these issues. One example is the need to reduce the probability of critical societal functions (such as caring for the elderly) being disrupted every 100 years due to flooding. Potential preventive measures included building barriers in front of buildings, evacuating the ground floor, and improving crisis preparedness in care facilities for the elderly (stocking up on dried goods, hygiene supplies, etc.). Measures were identified for all of the situations/circumstances that had been highlighted in the first workshop.

Between workshops two and three, the research team prepared a number of visual illustrations of the measures identified in workshop two. Specifically, maps were generated with the Dynamic Adaptive Policy Pathways (DAPP) map generator software package (www.pathways.deltares.nl). These maps gave an overview of the measures that had been identified by our participating municipalities, in relation to both time and sea level rise (see also Haasnoot, Warren, and Kwakkel 2019 for a richer description).

At the third workshop, participants were presented with these different pathways, and discussed them. Then, each municipality chose the pathway that was perceived as the best solution, and it was studied in greater detail. This final step concluded the third workshop.

3.2. Interviews

All of the municipal officials who participated in our study were interviewed before and after the three workshops. In total, 18 individuals participated, and 32 interviews

were held. With one exception, all interviews were conducted face-to-face, by either the author of this study, or an experienced interviewer, and lasted 30–60 min. They were all recorded and transcribed. Pre-intervention interviews focused on how municipalities were already managing the need for new residential developments in the context of climate change adaptation. They addressed issues such as uncertainty, national guidelines and adaptive measures. The aim was to focus on the three principles that form the basis of the RDM framework. Post-intervention interviews addressed similar questions; here, the aim was to determine whether respondents had changed their attitude, or working practices, based on the three core principles. The first round of interviews took place a few weeks before the intervention, and the second round took place three to five months after the workshops had been conducted. The delay was to ensure that respondents had enough time to apply what they had learned in the workshops in another context.

4. Results

The results are presented under five different sub-headings, where the first describes current ways of working in order to better understand the current situation, followed by the results relating to the three core principles are presented, and finally the perceived usefulness of the method.

4.1. Current versus future processes

The vast majority of respondents clearly understood that climate change adaptation was central to the future of their municipality and were committed to developing a more integrated approach to climate change adaptation. Although climate change was not the main area of responsibility for many, most participants had a good or comprehensive level of knowledge of how climate change would affect their area of expertise.

Nevertheless, this insight and knowledge about future climate change effects was not reflected in municipal planning processes. For example, the current approach to developing a new area was perceived as fragmented. Respondents noted that different municipal divisions, which would benefit from working together more closely, did not. There was no standard process to handle similar processes or projects, such as addressing issues due to climate change in all new urban developments. There was a growing realization that current working practice was unsustainable, given the challenges posed by climate change. Despite this understanding, many stated that their municipality – to a greater-or-lesser extent – lacked a strategy for handling the long-term effects of climate change.

> … then you say 'there are some things that we'll sort out later'. […] what do I think when we talk about the long term … ? My impression is that it's true for almost all of the big challenges related to climate change. There's a rather large lack of long-term planning. (Planning engineer, municipality C)

This lack of long-term planning could be seen as a result of uncertainty surrounding climate change, and its local effects. Furthermore, the current way of working was seen as very traditional, and thinking outside the box was difficult to implement. Although many respondents identified a need to step outside normal routines, they felt

that this would require a new way of thinking – something that would be difficult to introduce in their current setting.

Post-intervention, all participants noted the benefits of having an opportunity for different functions or divisions to sit together and talk about the planned project, rather than following the current, checklist-based form of "collaboration." They observed that although this type of interaction was rare under current conditions, it was a valuable part of the process as it enabled participants to better understand and exchange information about each other's concerns, issues, challenges and solutions. The workshops also highlighted that some services had been overlooked – notably rescue and social services – and would have benefited from participating in the process.

Another positive factor noted by participants was that they (i.e. the municipality) had access to the research team's expertise. They greatly appreciated both the facilitation of the process and the back-office work that was conducted between workshops (notably the preparation of material that explicitly addressed the local context). This highlighted a lack of in-house competence, as municipalities did not have the skills to conduct local analyses of their vulnerabilities and resources. Instead, the task of customizing general information to their specific needs was often left to external consultants. This problem also became apparent when discussing the bottom-up approach.

4.2. First principle – embracing uncertainties

The perceived need for, or usefulness of, national guidelines to manage sea level rise is linked to the concept of knowledge. National guidelines were seen as easy to relate to, and easy to communicate between stakeholders. However, ease of communication does not correspond to ease of implementation. A benefit of leaving an external authority to set the standard is that municipalities do not have to adjust or analyze the local situation. Although this might make the life of civil servants easier (as conducting an analysis of local conditions is difficult), it does not mean that climate adaptation is made easier. Many respondents viewed national guidelines as a blunt instrument that did not really meet the needs of the local community, and were keen to find a different way of working:

> So that's kind of the carrot to participate in this [project], to develop our skills in this area, because we feel that we need to know more. Because it's so easy to talk about the [national authority's] 'one metre' and 'twenty one hundred', period. (Environmental coordinator, municipality B)

However, introducing an alternative perspective, based on local vulnerabilities, was perceived as difficult. One reason is that adjusting climate change adaptation measures to local conditions requires skills and knowledge that municipalities do not currently have – and which they do not need when adjusting to a national strategy. In this context, it is relevant to distinguish between two types of competencies: the first is to be a good facilitator, with sufficient time and resources to be able to organize work based on the use of RDM support. This requires skills in facilitation, back-office work such as producing maps and identifying adaptive pathways, along with the time, resources and a mandate to conduct a series of workshops with relevant participants. It would also require civil servants to be able to interpret the scientific data around climate change, and fit it into the decision-making model:

> It's incredibly difficult to communicate that knowledge and, you might be a bit insecure yourself, in a way, because you almost don't know how to interpret the information that you get. (Environmental specialist, municipality C)

The second challenge is, of course, the uncertain nature of the effects of climate change, and linking this to localized effects. This uncertainty was seen by respondents as omnipresent:

> It's important [to make things concrete], but the uncertainties in the overall prognosis, that's with us all the time, really. (Executive director, municipality C)

This competence (or knowledge) is different from the former, in that it cannot be achieved through training or education. The broader uncertainty surrounding climate change is the very thing that RDM seeks to reduce. Even the best decision support tool seems to be unable to address the underlying the uncertainty that surrounds future developments, regardless of its source.

4.3. Principle two – working bottom-up

Identifying local vulnerabilities was perceived as useful, as it made the abstract exercise of estimating uncertainty about local climate effects more concrete. Although uncertainty remained high, linking different scenarios to the local context made the exercise more practical, as it was built around an environment that participants were very familiar with. It was also an opportunity for people with different competences to make a specific contribution to the discussion, which was seen as very valuable. This helped to identify what really needed to be protected and, thereby, guided priorities. However, the process did not necessarily translate into concrete actions that everyone could agree upon:

> My stand, from the beginning is that there are such great uncertainties we face. At the same time, we've felt … there are great uncertainties, but you always choose a mid-range scenario. Yes, you don't want to assume the worst, so maybe you want to act according to the [low risk] scenario, but you know you should act according to the worst-case scenario. (Environmental specialist, municipality C)

Participants observed that the reason for not adopting the local worst-case scenario, or presenting it to colleagues higher up the decision chain could be that this would not be politically acceptable. Some were concerned that presenting a local worst-case scenario would be seen as overly negative and perceived as scare tactics or a doomsday prophecy.

While this part of the process was seen as positive, the post-intervention interviews indicated that participants found it difficult to remember the distinction between defining local goals/success factors and indicating under what conditions it would be acceptable to fail to fulfill these goals. This observation suggests that how this part of the exercise was defined and operationalized needs improvement.

4.4. Principle three – developing adaptive measures

Adaptive pathways were the last step in the workshop process, and their creation was generally perceived as a good tool. Although most respondents initially found it difficult to recall what the suggested measures were, they were helped when shown a map of the pathways. The interviews indicated that participants considered the pathways to be concrete, clearly illustrated how different solutions could build on each other, and were easy to communicate – if the person communicating could explain the underlying assumptions. Working stepwise, as in the workshops, was perceived as positive, as it made complex issues clearer.

However, pathways were not costed, and this was a dimension that respondents felt was important to address. It was perceived as unreasonable to present a possible solution to the political leadership without giving an estimate of how much it would cost. Although respondents observed that the longer a measure was intended to last – for example, constructing a flexible barrier that could be raised to meet 10,100 and 1000 year floods – the higher the cost, gaining acceptance was seen as unrealistic given the great uncertainty surrounding these frequency estimates:

> I'm doubtful. Because it goes like this: you present measures that will cost money, and then you come to the question of who's going to pay for it. It's not the developer … (Environmental expert, municipality B)

The implication is that the municipality takes on the responsibility – and meets the cost – of implementing a potentially expensive measure, with no guarantee that it will meet future needs, while any future consequences remain its responsibility. It is understandable that this is a challenge to communicate positively.

It was clear that the idea of adaptive pathways was not a particularly useful or memorable tool. Instead, it became apparent that participants had a more restricted view of their position – both in relation to implementing adaptation measures, and the long-term follow-up of measures. They interpreted pathways in terms of what could realistically be implemented in their municipality, and this influenced perceptions:

> Because [current legislation] states that the measures have a reasonable chance of being implemented during the implementation of the entire plan. And that's maybe five, ten years. […] But the way we're organised today, I don't know who … Am I the right person to be responsible for this or should it be … You know? (Environmental specialist, municipality B)

It appears that even if participants found the method valuable, its practical application was evaluated through the eyes of the organization.

4.5. The organizational dimension

Most respondents observed that they worked in a political context. Long-term planning was a challenge, given that consequences might not occur in the next 50 or 100 years, while the organizational context is structured around a four-year political mandate. This also created challenges in communicating uncertainty about future developments. They noted that being unable to present potential consequences and adaptive measures

in a comprehensive manner could have a negative impact on their climate adaptation work as a whole:

> Because often one wants these answers. 'How is it really going to be? Why can't you say how it's going to be'?. And then one chooses, I think, often to "ah, then we can't take that into account because you can't answer how it's going to be anyway and then we can't plan for such a scenario'. (Environmental investigator, municipality C)

Municipal officials knew that they were part of a political organization and felt comfortable navigating it – although some had more experience than others. Many felt that it would have been very useful to have politicians and other decision-makers participate in the workshops, in order for these groups to gain a better understanding of the complexities of climate change adaptation, improve their knowledge, and gain an insight into how civil servants work with such complex issues.

When asked if they thought that the adaptive pathway map could be a useful tool to communicate about climate change adaptation with local politicians, many believed it could be beneficial, but that there were no guarantees. They noted that the bottom line was almost always cost, and that it would be difficult for politicians to commit to an expensive investment in mitigating an event that, in all likelihood, would not occur during their term. Most participants were aware of this, and accepted the rules of the game, although their frustration sometimes showed:

> R: But maybe you can see how this has been taken into account and how seriously they see issues in the long term. But I feel a little bit that there's a … this uncertainty that you talk about, that's there and it's a concern. What we work with, will it really be taken seriously, used in concrete decisions?
>
> I: So, you mean politicians?
>
> R. Yes, it's politicians most of all, but it takes [*inaudible*] that aren't knowledgeable in the same way in [these] issues. If you've worked here for a while then maybe you've experienced that a few times – that you're being overruled – or something that feels like it anyway. There's a slight resignation about that. (Urban planner, municipality C)

Getting politicians and decision-makers to attend similar workshops in the future was seen as unrealistic. In fact, setting aside three days to attend workshops was perceived as too demanding to happen on a regular basis. Participants expressed a preference for a condensed version of our already-streamlined process, from which they would be able to extract the parts they considered useful. Unfortunately, they could not identify relevant aspects. Up to five months had passed between the last workshop and the follow-up interview. It appears that this is either too long for details of the method to be remembered, or not long enough for it become part of indirect routines.

5. Discussion

The need to develop decision support tools for actors working with climate change adaptation is well documented, and the study presented here adds to this growing body of literature. Our results suggest that our model seems to be well-suited to addressing the underlying principles that RDM tools try to capture. Our three principles (Carlsson

Kanyama, Wikman-Svahn, and Mossberg Sonnek 2019) characterize uncertainties; use bottom-up processes; and develop adaptive measures, seem to be relevant in a municipal context. This implies that the method and underlying logic seem to be an appropriate way to address the complex task of climate change adaptation.

The benefits of working with an RDM tool at the municipal level are reflected in a number of ways. The method relies on bringing multiple actors together; the aim is to gather a broad range of views and include as many aspects of the municipality's work as possible. The inclusion of a wide variety of actors, ranging from experts in the overall planning process to more specific functions such as traffic, water treatment and landscape architects, clearly increases the understanding of how different functions will be affected by climate change, and potential adaptation measures. There are benefits from at least two perspectives, one relating to uncertainty, and the other to the role of knowledge.

First, the more perspectives that are brought to bear when a decision must be taken under scientific uncertainty, the better the discussion of that uncertainty. Although drawing upon multiple perspectives, which help to clarify both the problem and its solution, might not reduce uncertainty surrounding the frequency or severity of climate change, it might reduce uncertainty regarding how a complex system, such as a city, will be affected. The joint exercise brings together a number of actors, with in-depth knowledge in their subject area, to define "how much uncertainty is permissible in the system" (Regan *et al*. 2005, 1472) before a decision is taken, and makes best use of the available knowledge from a local perspective.

Second, when multiple competencies are present, there is less need for one (or a few individuals) to act as translators. Viewing "uncertainty" simply as linked to climate change tends to neglect the situation of municipal officials, who are also uncertain or, rather, have reached the limits of their own knowledge. It is reasonable to ask whether civil servants can be expected to act as translators in a highly-complex system where no single actor has full insight? There is a fear of being perceived as unclear or uncertain, with the risk that necessary decisions are not taken. Including people with other competences and different stakeholders in the decision support method might make the decision-making process smoother. Our results show that municipal officials not only need to act as experts in their own field, but also be extraordinary communicators in the dialogue with the political level. This is a challenge for civil servants who can be hesitant to communicate uncertainty, or reluctant to suggest expensive, but well-founded measures out of fear of not being able to present the case in a convincing manner or speaking outside their comfort zone. Although one criticism of the method is that it is resource-heavy, the fact that actors who have decision-making powers are involved throughout the process might prove to save time in the end. We note that crossing departmental boundaries seems to be rare in our municipal context. This is an area of improvement, since other have found that enabling collaboration between multiple stakeholders is essential to successful planning (Malekpour and Newig 2020; Temby *et al*. 2016).

However, the implementation of new decision support tools in the municipal setting seems to be unrealistic, due to a number of constraints. Not all barriers to effective (or successful) climate adaptation are linked to scientific uncertainty about climate change (Measham *et al*. 2011; Palutikof *et al*. 2019). Other factors, such as competing values and priorities, a lack of leadership, a lack of financial resources and institutional support have yet to be addressed. Although these issues lie outside the narrow scope

of RDM tools, they severely hamper the use of the decision support model. The question then becomes – what models or tools can influence these barriers? – if it is even possible. Ultimately, even the worst model – regardless of its focus – can provide us with sufficient data to take a well-balanced and informed decision, but if this decision is not turned into action, no beneficial effects will emerge.

Previous research has indicated the distinction between the usefulness of a model and its value. In other words, the value of the strategy is distinct from the value of the methodology that produces it (Daron 2015). The present study suggests that RDM support has value as a methodology – if it can enhance the inclusion of decision-makers. Engagement in the method could be tailored to the decision-making context of municipalities. Investing time and energy into learning and applying a new decision support tool will remain limited, unless it is likely that the measure or strategies that are produced will have a concrete impact on climate adaptation work. Most actors are aware that climate adaptation is both urgent and necessary; therefore the time might be ripe to address the competing values and goals that municipalities face. If this does not happen, we run the risk of developing useful models that are not valuable in the political landscape where civil servants work, regardless of how well they can integrate scientific uncertainty, or encourage bottom-up strategies.

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