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Beyond choice architecture: a building code for structuring climate risk management decisions

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Abstract: Although the need for urgent climate change action is clear, insights about how to make better climate risk management decisions are limited. While significant attention from behavioral researchers has focused on choice architecture, we argue that many of the contexts for addressing climate risks require increased attention to the needs of a deliberative and dynamic choice environment. A key facet of this kind of decision is the need for decision-makers and stakeholders to identify and balance conflicting economic, social and environmental objectives. This recognition of difficult, context-specific trade-offs highlights the need for structuring the decision-making process so that objectives are clearly articulated and prioritized. Equally, policy analyses and deliberations must effectively link priorities with climate risk management options. This restructuring of decision-making about climate change calls for more than a nudge. Scientific and technical efforts must be redirected to help stakeholders and decision-makers better understand the diverse implications of climate change management alternatives and to become better equipped to take actions commensurate with the urgency of the problem.

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Introduction

Against the backdrop of the science underlying climatic change, citizens and policymakers have been on the receiving end of a barrage of research and media reporting about its current and projected consequences. The most prominent source of climate change information is the Intergovernmental Panel on Climate Change (IPCC), but its work has been buttressed by a raft of studies by government agencies, national laboratories and individual scientists. Their work, in turn, has been amplified by news and social media outlets. The main takeaways from this research and reportage is that climate change is bad and if left unchecked is going to get worse, but that hope exists for a positive future if we undertake urgently needed climate action.

Indeed, the *need* for urgent climate action has been made crystal clear. Similarly, opinions regarding *what kinds* of risk management actions (encompassing mitigation and adaptation) are most needed are also in abundant supply; they range from decarbonizing the global economy (e.g., in energy, mobility and manufacturing) and eating more plant-based foods, to investing in geo-engineering (e.g., for sequestering CO_2 or reflecting solar radiation) to relocating the most vulnerable species and human settlements to save them from extinction.

From opinions to decisions

Unfortunately, relative to information about causes and consequences or the range of risk management options to choose from, insights about *how* to make better climate risk management decisions have been scant.

As researchers – and also frequent advisors to governments, businesses and communities – about multi-stakeholder and multi-objective decision-making, we have become increasingly concerned about the nature and tenor of the conversation among those who are calling for climate action. News and social media channels, along with individual scientists and commentators, have raised the alarm that climate change poses a threat and requires urgent action. And, collectively, these groups have offered a long list of climate risk management options that are available to consumers and policymakers.

However, the history of the climate debate has shown us that expressions of alarm and lists of options are insufficient for sustained and meaningful change. Largely missing are strategies for organizing decision-making about climate change actions in a manner that accounts for the multiple dimensions of their effects and, equally, the objectives of a diversity of people – both victims and beneficiaries – who feel they have a legitimate stake in choices about which actions to take. In sum, it has been difficult in our experience to find individuals or organizations talking about – and, more importantly, working on – science-based processes that can bring diverse and reasoned people together to make defensible, high-quality decisions about climate change that both accurately reflect their concerns and create a pathway to meaningful action.

A 'high-quality' decision is characterized by internal consistency, which is the degree to which selected options reflect people's prioritized objectives; this, in turn, is based on the inclusion during decision-making of scientific insights about the manifold consequences of the available options *and* an explicit focus on addressing key tradeoffs. This perspective on decision quality is based on foundational insights from operations research and the decision sciences (Edwards, 1954; Edwards & Newman, 1982; Keeney & Raiffa, 1993). Equally, it is based on a healthy dose of common sense: a "good" decision is good because it leads decision-makers to consider and select alternatives that align with their priorities (Hammond *et al.*, 1999).

The notion of decision quality as a function of internal consistency addresses the misconception – common among highly trained individuals such as scientists and policymakers – that experience and expertise coupled with access to reliable information (e.g., in the form of scientific or policy insights) are the inevitable precursors to high-quality decision-making. This same set of expectations about the connections between information, knowledge, experience and judgment underlies the misguided 'deficit model' approach to communication and decision-making about risk (Árvai, 2014; Simis *et al.*, 2016). Yes, more and better expertise, experience and information are preferable to less, but, these ingredients alone do not necessarily lead people to more internally consistent choices (Keeney, 1992; Bessette *et al.*, 2019).

The reasons behind this observation are well known to readers of this journal. Research on judgment and decision-making has revealed several obstacles to internal consistency (e.g., see Gilovich *et al.*, 2002) that, when taken together, point in the same direction: people are not strict optimizers. Rather than evaluating options by thoughtfully evaluating and prioritizing their pluses and minuses across objectives, people take shortcuts. And, while taking shortcuts is commonplace, most decision-makers fail to recognize the systematic biases that accompany them and – importantly – the need for (and value of) more structured deliberation (Lichtenstein & Slovic, 2006).

Over the past 15 years, behavioral economists and psychologists have responded to this challenge by advancing a series of initiatives aimed at facilitating higher-quality judgments and decisions. Among the best known of these approaches is choice architecture, which turns the tables on predictable biases. Here, decision-makers – typically individuals – are 'nudged' (Thaler & Sunstein, 2008) in the direction of their preferences without limiting the freedom to make choices *not* in line with them. Rather than focusing on debiasing decisions, choice architecture takes the position that it is more efficient to reengineer the environment in which people make their choices, thereby exploiting judgmental heuristics to yield desirable outcomes. Choice architecture has quickly manifested itself in a wide range of businesses and – until recently – dedicated government offices in the USA and the UK.

With respect to climate risk management, choice architecture is responsible for several important policy inroads. For example, some localities and organizations have adopted energy-efficient defaults in building codes (Delgado & Shealy, 2018), food service providers have explored nudging people in the direction of lower-emissions meal options (Campbell-Árvai *et al.*, 2014) and companies have developed efficiency-focused, set-and-forget home energy management systems. These examples are predicated on a large set of robust research findings on the power of 'climate-friendly' defaults (Sunstein & Reisch, 2014) that harness the influence of endowment effects and loss aversion (Kahneman *et al.*, 1991) to keep people from making changes that would result in higher levels of energy use and related greenhouse gas (GHG) emissions.

A second soft behavioral policy response, focused directly on improving an individual's decision-making competencies, is a 'boost' (Hertwig, 2017; Hertwig & Grüne-Yanoff, 2017). Unlike choice architecture, boosts seek to improve decision-making by teaching people to utilize the most appropriate heuristics in light of the decision at hand (Reijula *et al.*, 2018). A typical boost intervention can be either quite simple, involving limited time or effort, or it can require significant training. Either way, a boost is a progressive addition of deficit thinking applied to the science of judgment and decision-making itself: the more people can learn about (1) how their minds process information during judgment and decision-making, (2) the information that can aid in evaluation (like conditional probabilities) and (3) the heuristics that stand in the way or lead to ecologically rational choices under different circumstances, the better they will be at selecting appropriate courses of action.

We appreciate the intent of nudges and boosts and find it hard to disagree with a general desire to improve the quality of people's decision-making processes. However, in our experience, the contexts where either nudges or boosts provide an effective means for addressing climate risks are limited. Consider examples such as adaptation to sea-level rise (Weaver *et al.*, 2017), endangered species management (Gregory *et al.*, 2013) or large-scale energy-generation transitions (Árvai *et al.*, 2012). These contexts are complex and dynamic, involve multiple stakeholders and decision-makers and involve analyses that require high accuracy and high effort (Johnson & Payne, 1985); adding to the challenge, decision-makers must balance conflicting economic, social and environmental objectives. In other words, these are multi-party and multi-dimensional decisions that require 'active' (Campbell-Árvai *et al.*, 2018) decision structuring wherein analysts work with decision-makers and stakeholders to fundamentally change the information they consider and the approach they would otherwise instinctively take when making climate risk management choices.

Unlike choice architecture, these more active types of climate change decision-making are not designed to exploit obstacles to high-quality decisions, and, unlike boosts, they are not designed to simply educate people to select appropriate rules of thumb or to better understand concepts like risk and probability (Reijula *et al.*, 2018). Rather, the goal is to help decision-makers work with legitimate stakeholders to identify and respond to the decision challenge through the adoption of decision aids that focus on the identification of a comprehensive set of objectives, the generation of creative alternatives and learning that is achieved through deliberative analysis (Bessette *et al.*, 2014; Corner *et al.*, 2014). The intent is less to prescribe a specific course of action or to teach a specific skill than it is to organize the decision-making process so that informed dialogue can take place and the resulting choices are broadly defensible.

At its core, decision structuring involves breaking complex, multi-attribute decisions down into more cognitively manageable parts (Gregory *et al.*, 2005). As in choice architecture, doing decision structuring well in the context of climate risk management hinges upon linking values-based objectives to science-based insights, where values refer to what matters to stakeholders and decision-makers – their interests or concerns – in the context of the issue at hand; once specified and provided with a preferred policy direction (e.g., more or less), then they can be expressed as objectives (see Keeney, 1992).

However, in contrast to a boost, empirical research (Bond *et al.*, 2008) convincingly demonstrates that most individuals (including senior managers and experienced decision-makers) fail to identify many of the objectives acknowledged as important after completion of a structured or deliberative process. In line with extensive work on constructed preferences (Lichtenstein & Slovic, 2006), these findings raise questions about the efficacy of boosts in the context of problems – like climate change – that are novel and complex. In these cases, beyond learning concepts, individuals often need help in order to clearly articulate and operationalize their own values. They also will need help keeping in mind the multiple dimensions of a problem as they work toward solutions; research on the prominence effect, for example, emphasizes the importance of not undermining or forgetting about *seemingly* less important (because they are less prominent) dimensions of a problem when generating or selecting alternatives (Slovic, 2015).

A general framework for structuring decisions – whether conducted as part of small groups or embedded in the design of large-scale surveys – is composed of six basic elements, each supporting the others in ways dictated by a specific decision context (Gregory *et al.*, 2012). These include: (1) clarifying the central decision problem(s) and any relevant bounds and constraints; (2) helping individuals to accurately articulate and define the objectives guiding the decision-making process, including the natural, proxy or constructed performance measures (Keeney & Gregory, 2005) used to gauge success or failure in achieving them; (3) constructing logical and creative risk management alternatives that directly or indirectly address the stated objectives; (4) identifying the predicted consequences associated with these alternative courses of action, including key sources of uncertainty; (5) confronting the inevitable value tradeoffs that arise when selecting from among alternatives; and (6) implementing decisions, including ongoing monitoring of outcomes (as measured by the achievement of objectives) and adapting policies to new information or changing conditions (Figure 1).

This process is both sequential (e.g., identifying objectives prior to constructing alternatives) and transparent. Both qualities are especially important in the context of developing broadly acceptable public policies for issues such as climate change where stakeholders are often poorly informed about consequences and polarized in their perspectives. These differences may at first appear both irreconcilable and inflexible, with strong taboos blocking many of the actions that policymakers might choose to consider. Because structured approaches emphasize dialogue and deliberation, starting with open discussions about what matters to people (rather than the alternatives-focused 'what should be done?') and encouraging information sharing – which facilitates learning (Bessette *et al.*, 2016) – the process has proven to be very effective in breaking down barriers and finding areas of common agreement among seemingly intransigent perspectives.

Structuring climate risk management decisions

As noted above, many climate researchers, policymakers and activists seem to neglect the need for a more structured evaluation of problems and alternatives, and they leap straight from perceived problem to proposed solutions. This tendency follows from the emphasis placed in climate change debates on the results of scientific studies and the predictions of modeled consequences rather than on affected people and communities; after all, it is *people* who provide insights about the values that will be affected and the difficulties inherent in making tradeoffs across conflicting objectives.

However, what we do find to be in short supply is a working understanding of climate change decision-making – and decision-making in general – and the challenges it poses: the concerns a climate action plan should address,

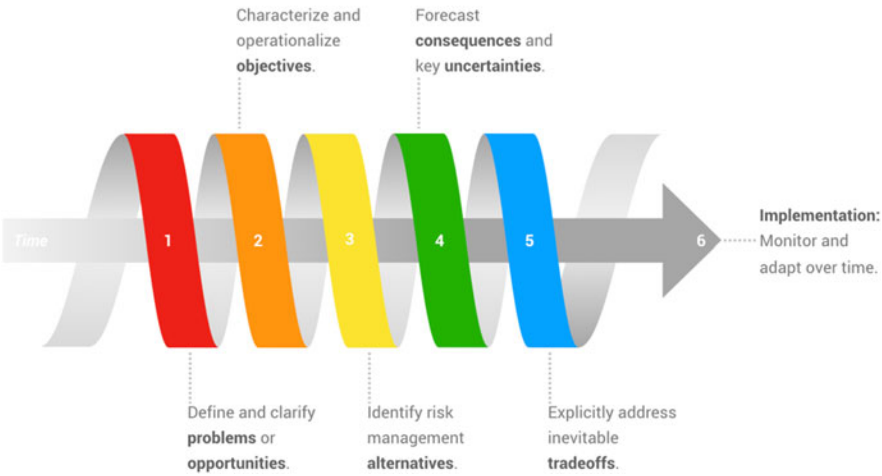

Figure 1. A framework for structuring climate risk management decisions.

providing a clear accounting and prioritization of the myriad objectives that guide choices, ensuring creativity when developing a range of possible solutions, defensibly addressing tradeoffs over time and across objectives characterized by complexity and uncertainty and working with key stakeholders in a deliberative environment to identify policies that will achieve a sufficient level of support. The net result of this lack of 'structure' to decision-making (Árvai *et al.*, 2001; Gregory *et al.*, 2001, 2012) about climate risk management is the manifestation of a broad range of judgmental and deliberative obstacles that too often results in attenuated dialogue, myopic decisions and a lack of meaningful implementation concerning climate change policies.

In our own research, for example, we have observed that people instinctively make choices about climate risk management that reflect an extreme version of tradeoff avoidance (Lichtenstein *et al.*, 2007) and satisficing (Simon, 1955) in that they do not reflect a more comprehensive accounting of the wide range of problem-relevant objectives. When directly faced with multiple objectives (e.g., the desire to reduce GHG emissions and improve environmental and human health while at the same time reducing the capital and operating costs of new infrastructure), participants naturally gravitate toward alternatives that are strongest on a single, most prominent dimension, typically cost or other economic considerations that can easily be justified to others (Slovic, 1975; Bessette & Árvai, 2018). There is also ample evidence of climate risk perceptions and management preferences being driven primarily by motivated reasoning (van der Linden *et al.*, 2015; Shi *et al.*, 2016), psychological distance (Spence *et al.*, 2011; Brügger *et al.*, 2015), the availability heuristic (Demski

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et al., 2017; Tanner & Árvai, 2017), affect and imagery (Leiserowitz, 2006; Marx *et al.*, 2007; van der Linden, 2014), psychic numbing (Lu & Schuldt, 2016) – and the list goes on.

As shown by the lack of strong climate change action, which is persistent in the face of recent dire warnings about current and near-term consequences (Intergovernmental Panel on Climate Change, 2018; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2019), these responses by decision-makers are not likely to be altered in a fundamental way by a simple nudge. Instead, the need is to shift citizens and decision-makers from automatic thinking to reflective thinking, and from debates about singular aspects of problems or alternatives to the consideration of tradeoffs across multiple objectives. This restructuring of the climate change conversation calls for a heavier lift, one that is able to break the shackles of motivated reasoning and that leads to the recognition that deeper, more shared thinking is required to stimulate effective action. Yet this call for more active structure, dialogue and decision support for climate change management raises an obvious question: What should the analytical side of deeper, more thoughtful action look like?

In the following section, we briefly highlight two case examples – energy system transitions and adaptation to sea-level rise – that used structured decision-aiding processes to encourage a better understanding of the connection between risk management objectives and alternatives, a more complete consideration of climate change outcomes and a more open, informed dialogue concerning the scope and range of the most important tradeoffs. A key step in both cases was to recognize that decision-makers and stakeholders would need outside help from facilitators of a structured decision-making approach; this work entailed structuring the decision-making process by posing questions and providing tools to stakeholders and decision-makers that helped them to identify the key values and objectives at play and permitted them to be more proactive in searching for means of achieving them. This also permitted redirecting scientific and technical efforts so that they were better able to provide data that could enable the evaluation of the consequences of leading risk management options in terms being both understandable and meaningful to stakeholders and decision-makers. In these (and other) examples, participating stakeholders and the technical experts and decision-makers ultimately responsible for the policy choice expressed satisfaction with the outcome, considered it technically sound and cost-effective, and in terms of the structured decision-making process itself, they saw it achieving a high level of community acceptance and facilitating near-term implementation without the costly delays brought about by court action.

Case examples

Energy transitions

A major focus of our climate-related work over the past decade has been the topic of energy transitions (e.g., see Árvai *et al.*, 2012; Bessette *et al.*, 2014, 2016, 2019; Kenney *et al.*, 2015; Bessette & Árvai 2018). Underlying this work is the recognition of a fundamental link between use of fossil fuels to generate electricity and climate change (Intergovernmental Panel on Climate Change, 2011) and the desire to help establish new policies that could mitigate climate risks through decarbonization of the energy system.

In our experience, the problem (or *opportunity*) posed by energy transitions is best addressed by adopting a portfolio-based approach deployed at a regional level rather than search for a one-size-fits-all solution (Árvai *et al.*, 2012; Bessette *et al.*, 2014). Thus, decisions about energy transitions are ideally suited to the type of structured analysis we outline above.

In the previous section, we noted the importance of ensuring that the problem frame posed to stakeholders and decision-makers is appropriate. If the problem frame is too narrow, then people run the risk of overlooking alternatives that are more internally consistent. If the problem frame is too broad, then it is easy to fall into the trap of paralysis by analysis; that is, creating a problem that involves too many stakeholders, objectives, risk management options and data to consider effectively and efficiently. In our opinion, many prior attempts at developing a comprehensive 'energy policy' have failed because they scope the opportunity at a national level, which is too broad. In reality, energy strategies generally unfold on a regional level, with different geographic areas being more or less well suited to the deployment of specific technologies.

All of our work on structuring decisions about energy transitions has focused heavily on identifying the range of objectives that will help to guide choices. Just as choice architects invest significant time and energy into determining what constitutes the self-interests of the nudged, we have invested weeks and months into identifying and characterizing stakeholders' and decision-makers' objectives. This has been time-consuming work because, in order for these objectives to be useful, they must be comprehensive, meaning that they encompass all of the specific outcomes (e.g., economic, environmental and social) that may be affected. Likewise, they must be understandable (i.e., concise and free of ambiguity), independent (i.e., not influenced by other objectives) and directional (i.e., *lower* levels of some things like carbon emissions and uncertainty and *higher* levels of other things like employment or flexibility). In addition, objectives are not targets; reducing GHG emissions as a result of a new energy strategy is an objective, while net-zero GHG emissions by 2050 is a target.

In our experience, operationalizing some of these objectives, like reducing the GHG emissions from different generation sources, has proven easy. Operationalizing other objectives, such as increasing levels of employment, has proven more difficult. An objective related to increasing employment opportunities, for example, requires reconciling questions about the type (construction versus operational), duration (part-time versus full-time) and quality (unskilled versus skilled) of work.

In decisions about energy transitions, a wide range of climate change risk management options typically come under scrutiny. This includes the range of energy sources (e.g., wind, solar, nuclear, natural gas, etc.), as well as other strategies that help to achieve stated objectives (e.g., investing in building and infrastructure retrofits, CO_2 capture technologies or behavioral interventions aimed at increasing energy efficiency). What makes decisions about energy transitions especially unique and interesting is the fact that few of these options are mutually exclusive, which means that different portfolios of options can be assembled at a regional level such that they may play a role in reducing global climate change risks.

We have found in our work that allowing stakeholders and decision-makers to have a hand in the process of developing portfolios helps to fulfill public expectations regarding the legitimacy of decision-making processes; this approach also alleviates concerns raised about many decision-making processes – including those that rely on choice architecture – that stakeholder engagement is merely the façade behind which the real decisions are being made (Renn *et al.*, 2013).

In addition, we have found that asking people to develop their own portfolios requires them to engage with objectives and alternatives in a more meaningful way. For example, they must identify and select measures tracking the more important changes in objectives, which helps them to compare the risks, benefits and limitations associated with different generation alternatives more thoroughly. In the end, they learn more about energy (and climate) systems and, importantly, they learn more about their own preferences and priorities (Bessette *et al.*, 2014, 2016).

Even when we have operationalized objectives and portfolios of energy options in hand, it has seldom been easy to draw on existing data that explain the connection between the two. Data, as they relate to many of the objectives being considered in the decision, often do not exist or are difficult to access. For example, data that characterize objectives related to GHG emissions and costs are readily available, whereas data that characterize other relevant objectives such as the impacts of specific portfolios of generation methods on employment or innovation are often missing. As a result, we have often been faced with the need to collect these data ourselves on a case-by-case basis and with the assistance of utilities or large engineering or consulting firms (Bessette *et al.*, 2014).

A final key element in our work on decision support for energy transitions is to provide decision-makers with guidance about the specific climate risk management options that are most in line with their prioritized objectives. To do so, we have worked with consultants with experience in both planning and software development who have built project-specific tools to help people set priorities and compare competing portfolios, each representing markedly different priorities and future directions.

These tools effectively pose a series of questions that ask stakeholders and decision-makers to quantify the pros and cons of each portfolio under consideration (Bessette *et al.*, 2014). For example, individuals might be asked how much additional cost they are willing to incur in exchange for reduced GHG emissions or for the financial and personal benefits that come with being at the cutting edge of innovation. Conversely, decision-makers might be queried about their willingness to compromise on air-quality standards or regional employment levels as a means of keeping cost increases at sufficiently low levels so that consumers remain supportive. By incorporating the resulting weights in utility functions, people can be shown a small subset (typically consisting of between five and seven portfolios) of risk management options that address key objectives and, therefore, are likely to be broadly accepted.

The end goal of such a process is to create a decision-making environment that visibly accounts for people's values and provides stakeholders – members of the public, business leaders, elected decision-makers, etc. – with an opportunity to help shape the course of dialogue. Rather than passively receiving information – in the form of opinions or data – and then being asked to provide input to a single option or two, participants are encouraged to think about and express their objectives and then to use this information as part of a process to develop and evaluate several creative portfolios. The deliberative process is structured so that people learn about both the energy (and climate) system and how proposed changes to it will affect what matters most to them.

Sea-level rise

Sea-level rise is one of the most frequently noted adverse effects of climate change. Reasons include the high concentration of people in many countries (including the USA and Canada) who live near coastlines and the notable increase in hurricanes and coastal flooding – including Katrina in New

Orleans and Sandy in New York City – over the past two decades. Hazards associated with climate change-induced sea-level rise are particularly challenging for decision-makers because they result from several different components (e.g., melting at the icecaps, storm surges, antiquated berms and dams, etc.); adding to the challenge, sea-level rise frequently involves a wide range of impacts that include human health and safety, homes and structures, infrastructure, environmental considerations and agricultural production.

From a climate action and behavioral policy standpoint, several aspects of mitigation or adaptation policies related to sea-level rise are particularly vexing. One is the contrast between the slow rate of sea-level rise (roughly 3.5 mm per year) and predictions that many coastlines are likely to experience rates many times higher than historical averages over the next 50–75 years. Another is the unequal distribution of effects from flooding: residents living in low-lying areas often bank on the government picking up the tab after a flood event, whereas residents living elsewhere ask, "Why should I pay for the bad choices of my neighbors?" In addition, both the rate of change in sea-level rise and the locations of greatest vulnerability are usually subject to substantial uncertainty; these factors complicate public incentives for action and often encourage motivated reasoning in that parties on both sides of a predicted impact range can draw on factual information upon which to base competing claims.

The case study discussed here is based on a project recently completed in a large west-coast city as part of a strategy to 'help make our coastal communities more resilient'. The 2-year study outlined potential future impacts of climate change, with sea-level rise a particular concern, and presented decision-makers with insights about the pros and cons of various adaptation strategies over the short, medium and long term. The structured decision-aiding process involved multiple stakeholders (residents, community and environmental organizations, business associations, an active agricultural sector and Indigenous communities) and a diverse range of (sometimes conflicting) objectives. The project also involved an active collaboration among different levels of government, technical support from project and consulting engineers and landscape architects, input through partnerships with a local university and extensive community consultation.

The first steps included extensive meetings with community stakeholders to frame the problem and to identify potentially impacted values. These varied in importance across different portions of the study area but included protection of residents' housing, environmental concerns, infrastructure safety (important because the study site links a large metropolitan area with key shipping, auto, truck and train routes), economic considerations (including a significant agricultural sector), recreation and culture (including historical and tribal values). Work with representatives of these interests identified the extent to which performance indicators associated with each objective were likely to change in the short, medium and long term. Results were described in quantitative and qualitative terms (using evaluative measures such as 'slightly worse' or 'moderately better') as well as visually (using color-coded scales and sliders to show how different policy options affected the likely outcomes).

An important focus was the identification, description and comparison of adaptation alternatives with the goal of encouraging more open and informed dialogue. This focus on active deliberation was critical to the project's success because many stakeholders entered the process with strong but incorrect views about the cost, technical feasibility and effectiveness of different adaptation strategies. These options included expanding beaches in front of the existing shoreline (to reduce wave run-up), creating an artificial barrier island (to reduce onshore wave action), building a dike across portions of the bay (to reduce the impacts of high tides and storm surges) and a managed retreat (in which the beach area would be restored to its original natural state, with residents and businesses receiving support to relocate). Each alternative had vocal supporters and opponents; advocates for the barrier island, for example, considered it an effective and more natural form of protection, whereas opponents worried about the loss of ocean views, key intertidal habitats and the stability of an artificial spit built in an active earthquake zone. Discussions among city staff, consultants and analysts and public stakeholders provided numerous suggestions for helping participants to understand the varied consequences of these different options. For example, photographs of individuals holding placards were taken in different parts of the city; each individual's placard depicted in stark terms what changes in sea-level rise would mean for the area where the photograph was taken. These photographs were shared among participants. And, to help overcome polarization among participants, facilitators were encouraged to shift people's focus from a single, readily justifiable objective to the full range of multiple values likely to be affected by the different adaptation alternatives. To help overcome polarization among participants, facilitators were encouraged to shift people's focus from a single, readily justifiable objective to the full range of multiple values likely to be affected by the different adaptation alternatives.

All of this information came together in a series of region-specific consequence tables (Keeney, 1992; Gregory *et al.*, 2012) that showed the values criteria in rows and the major alternatives (including a no adaptation baseline) in columns; these were color-coded to distinguish differences in the expected level of change. Summary rankings, again color-coded, were also included for anticipated levels of overall risk, capital and maintenance costs and several other leading considerations. Computer-adjusted photographs of familiar areas showing the anticipated changes over time were also included in the materials prepared for public meetings and in the information brochures sent to residents. Residents were encouraged to review preliminary versions of these impact evaluation tables, to ask questions of clarification and to seek revisions where they felt that the representation was not fully accurate.

This approach represents a sharp departure from the climate adaptation descriptions presented in many other cities on four levels. First, it explicitly combines values information with factual information about the anticipated consequences of actions. Second, it readily permits the comparison of different alternatives in terms of how well they are predicted to achieve the different expressed objectives. This type of approach encourages dialogue and increased understanding among stakeholders, with disagreements being referred back to a common information base; Individual 1 prefers Alternative C because it scores well on the objectives most important to her, whereas Individual 2 prefers Alternative A because it scores well on the objectives most important to him. Third, the adoption of a structured approach facilitates sensitivity analyses and the close examination of tradeoffs because (by looking behind the summary evaluations shown in the table) it calls into question the amounts by which the different values-based scores need to change before shifts occur in the order of preferred alternatives. Finally, the process encourages residents to view themselves as participants with agency, actively helping to shape the process and information base through both formal and informal input at public meetings, rather than as passive responders to an overall technical process run by bureaucrats.

Temporal considerations presented one of the most difficult challenges faced when designing the decision-making process and in presenting information. For study designers, there was tension between the desire for residents to recognize the urgency associated with undertaking climate adaptation actions and the need to proceed sufficiently slowly to permit meaningfully collaborations with each other as well as with policymakers and analysts. Temporal considerations also influenced the confidence of technical experts when making predictions; the longer the timeframe (e.g., 2080 versus 2030) when estimating sea-level rise, the more uncertainty typically assigned to estimates of sea-level rise.

Affective considerations were also important: analysts and project consultants sought to design materials that would encourage residents to care enough to pay attention and come to meetings, but they also wanted to avoid unduly frightening the residents or causing anxiety. Common obstacles to multi-attribute evaluation such as satisficing (Simon, 1955), the sunk cost bias (Arkes & Blumer, 1985) and the status-quo bias (Kahneman *et al.*, 1991) were introduced at public meetings and discussed in terms of their implications for the timing and acceptance of different climate adaptation strategies (Meyer & Kunreuther, 2017).

We also wanted to avoid polarization in two major respects. One is obvious: that of polarization between coastal and more inland residents, because at least one of the options ('managed retreat', whereby some homes and structures would be abandoned) clearly will have very different impacts on residents depending on where they live and on how compensation is determined. The other source of polarization is less obvious: neighboring cities were also considering climate adaptation policies at the same time, so there was a natural tension between the desire to lead (and perhaps be first in line for federal funds) and the tendency to wait and see and, perhaps, to learn from the experience of other communities.

Conclusion

Decision-making that optimizes across a comprehensive spectrum of prioritized objectives and carefully crafted alternatives is challenging; some (Simon, 1972; Kahneman, 2003) might say that doing so as a matter of intuitive course is practically impossible. Research on choice architecture has shown that, at least in some cases, it is possible to structure the decision environment so that individuals' expressed interests become more closely aligned with societal goals (Thaler & Sunstein, 2008), and research on boosts to decision skills suggests that education has the potential to lead to higher-quality choices (Hertwig, 2017). Decision structuring expands the range of behaviorally responsive policy contexts to environments where people are required to more actively construct their preferences in light of multiple objectives (Lichtenstein & Slovic, 2006). The goal of a structured decision-aiding process is to offer the best possible context, via attention to the organization and sequencing of both values and facts, to inform defensible choices. In this sense, the process of decision structuring – defining the problem or opportunity, eliciting and operationalizing objectives, identifying and characterizing alternative courses of action and being explicit about the need to confront tradeoffs – serves as a possible 'building code' for aiding policy deliberations and encouraging the selection of higher-quality alternatives (Gregory *et al.*, 1993).

Our intent with this paper is not to suggest that structuring decision-making for climate risk management is a magic wand that makes shortcomings in judgment and decision-making suddenly disappear. Judgmental obstacles and demanding problems are omnipresent when it comes to making sound choices about climate change policies. Instead, the goal is to recognize and account for these obstacles and biases and identify courses of action that are both internally consistent (in that they reflect decision-makers' and stakeholders' considered objectives) and adaptive (in that they lend themselves to learning and flexibility).

The deliberative underpinnings of a facilitated, structured approach to climate decisions, which – in contrast to Delphi techniques, for example – uses sequential decision steps to organize dialogue among participants, can also help in overcoming the polarization that so often paralyzes group decision-making efforts. As noted two decades ago, "What is necessary is not to allow every view to be heard, but to ensure that no single view is so widely heard, and reinforced, that people are unable to engage in critical evaluation of the reasonable competitors" (Sunstein, 2000, p. 115).

Our recommendation of the more widespread adoption of decision structuring for consequential climate change choices can learn from similar initiatives in other environments. Decision-making within medicine is perhaps the most well-known example of a trend toward more careful, deliberative decision-making. Whereas 'doctor knows best' was once common practice in medicine, it is increasingly the case that physicians guide their patients through decision-aiding processes aimed at establishing partnerships for making treatment choices. As with energy transitions and adaptation to sea-level rise, shared decision-making in medicine typically combines several related goals: helping to clarify treatment and health-related objectives; providing accurate factual information about likely consequences; identifying alternatives; and informing difficult tradeoffs (Fagerlin *et al.*, 2011; Lin & Fagerlin, 2014).

Getting to a point where shared decision-making is now increasingly common required several fundamental shifts within the field of medicine. Chief among them was a cultural shift whereby physicians ceded some control over treatment decisions to those who would be most directly affected by them: their patients. Once patients had the opportunity to play a meaningful role in deliberations about treatment, treatment objectives – including how they were operationalized – had to be recast to account for values-based (alongside technical) concerns. And, importantly, what is tantamount to decision structuring became a more frequent part of both primary and continuing education for physicians and other health care professionals.

The results from this cultural shift in medicine have been positive. Research on a wide range of medical and treatment contexts (e.g., coronary artery disease, breast and prostate cancers, contraceptive choice, knee and hip replacement) have shown that shared and structured decision approaches increase participants' knowledge, improve communication about risks, decrease conflict between physicians and patients and increase the internal consistency of treatment choices (Lin & Fagerlin, 2014; Stacey *et al.*, 2017).

If we are to treat climate risk management with the level of seriousness it deserves, then similar fundamental shifts in our collective approach are needed. For example, just as 'nudge units' have found their way into government and business, there is a need for more attention to be given to capacity building around the broader issue of decision aiding within these same entities. Similarly, the behavioral aspects of structuring stakeholder-based deliberative choices about climate change strategies need to be given more attention. It is not sufficient to boast about the number of meetings held or the amount of money spent; instead, participants need to work through a behaviorally sound process that clearly defines the problem and articulates clear objectives that are then used to generate a responsive suite of alternatives (Gregory *et al.*, 2012). Despite the magnitude of recent investments in financial and human resources within government and business, the adoption of techniques from the behavioral decision sciences to encourage better individual or group decision-making processes and more internally consistent, broadly defensible policy and strategic choices has lagged far behind.

Likewise, structured decision-making is only as good as the decision frame and supporting data upon which it is built. While we appreciate the reasons why the IPCC has largely steered clear of providing advice that is directly 'policy prescriptive', we encourage them – and organizations with missions similar to theirs – to take a more stakeholder- and values-based approach to their analyses. Climate risks and climate risk management reflect a socially constructed set of values. Giving more attention to stakeholders' decision-making processes could have a positive effect on both the scope and speed of citizens' acceptance of climate change policies. Yet getting there, within the IPCC and elsewhere, will require rethinking the target of research and the personnel involved in conducting it.

We began this paper by pointing to the wealth of research now at our fingertips concerning the likely consequences of climate change. It tells us that the problems we face are dire, that if we do not act quickly climate change will get worse *and* that a glimmer of hope still remains with respect to our ability to stem the most alarming and hazardous consequences. We agree strongly with all three points. But even if decision-makers were to fully embrace the first two points, there are no quick fixes or clever new policy frames that will achieve the third and, collectively, get us to 1.5°C in time. The best bet, in our view, is continued emphasis on choice architecture for individual choices that can serve as behavioral wedges to reduce GHG emissions (Dietz *et al.*, 2009) and – *equally* – a much greater commitment to structured decision aids as a means for making smarter, more values-based and more defensible climate risk management choices.

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