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WORKING PAPER

Planning For An Uncertain Future: Can Multi-Criteria Analysis Support Better Decision-Making In Climate Planning?

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PLANNING FOR AN UNCERTAIN FUTURE: CAN MULTI-CRITERIA ANALYSIS SUPPORT BETTER DECISION-MAKING IN CLIMATE PLANNING?

Abstract: The realities of climate change demand updated approaches and tools to support decision-making. In this paper, we examine the promise of an emerging tool, multicriteria analysis (MCA) in climate-change planning. We find that MCA has the potential to perform better than cost benefit analysis and working group approaches in supporting decision making processes that are more participatory, transparent, comprehensive, rigorous, and scenario-driven. However, in practice, MCA may not achieve all of these effective planning principles, and it is more likely to fall short in cases where planners have limited resources.

Keywords: Environment, Sustainability, Natural Resources, Citizen Participation

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Introduction

Communities around the world are increasingly considering actions to minimize climate-related vulnerabilities. Yet the realities of climate change demand updated approaches and tools to support decision-making. As we discuss in this paper, shortcomings of current dominant approaches are amplified by the uncertainty and complexity involved in climate resilience planning. For example, cost-benefit analysis requires planners to place monetary values on project costs and benefits, even though many potential costs and benefits are hard to quantify, and all the more so under extreme uncertainty. Meanwhile, the commonly used working group model of decision-making can too easily avoid the rigorous assessment of risk needed for smart resilience planning. The aim of this paper is to explore whether multi-criteria analysis, a decision-making tool used in other contexts, may be better able to facilitate planning processes that follow generally accepted principles of good planning while at the same time addressing the increased complexity brought on by climate change.

Multi-criteria analysis (MCA) is an analytical framework that can help planners systematically compare the merits of potential initiatives based on a set of agreed-upon criteria. The first step is to select initiative evaluation criteria. Criteria may be either qualitative or quantitative, and may reflect social, cultural, economic, and/or environmental priorities—for example, social distribution of benefits, cost effectiveness, or reduction of damage to local ecological habitats. The second step is to assign weights to the selected criteria, which should reflect their importance relative to other criteria (e.g., the final decision will be based 25% on cost effectiveness, 45% on reduction of risk to population centers and vulnerable communities, and 30% on reduction of damage to local ecological habitats). The final step involves scoring each proposed initiative. To do so, planning teams need to decide on a scoring system to evaluate

potential initiatives against the criteria. Generally, planning teams use either a simple binary system (e.g., project does or does not meet criteria) or a more complex ranking system that assigns a score according to where initiatives fall along a designated range (e.g., projects with capital costs of more than $5 million receive a score of 0, while projects costing less than $1 million receive a score of 5 for the cost effectiveness criterion).

Multi-criteria analysis can be helpful when there are competing objectives, stakeholder groups with different priorities, and when success of the desired outcome will be defined in both economic and non-market terms (Hajkowicz and Higgins 2008; Romero and Rehman 2003; Hajkowicz and Collins 2006). Academic literature suggests that MCA can encourage decision-makers to engage a range of stakeholders in decision-making, improve transparency of the process, and elevate non-market considerations (Janssen 2001; Dodgson, et al. 2009). For these reasons, planners have begun to use MCA in climate resilience planning. However, the use of MCA as a tool to inform effective climate resilience planning has yet to be rigorously evaluated.

This paper develops a rubric to assess whether MCA has greater potential to facilitate a climate resilience planning and decision-making process that follows traditional principles of good planning than two commonly used approaches to decision-making—the working group approach and cost-benefit analysis. Our comparison is based on five foundational elements of good planning, which we describe in Section II along with our approach for evaluating the degree to which they have been achieved. In Section III, we discuss the use of working group and cost-benefit analysis in climate resilience planning, and explore their benefits and shortcomings. In Section IV, we use our evaluation criteria to analyze the use of MCA in the case of the Louisiana Coastal Master Plan, assessing the degree to which that process conformed with each of our principles. Finally, we offer conclusions about the potential strengths and limits

of MCA in the practice of resilience planning more generally and make recommendations about how to improve it.

Research Approach & Methodology

To assess the effectiveness of MCA in the resilience-planning context, we first need to define a standard for good planning against which to judge MCA and other decision-making approaches. Drawing on the planning literature, including the Ethical Principles in Planning statement of the American Planning Association (APA 2015) and elements of W.C. Baer's 1997 criteria for general plan evaluation, we identify five commonly accepted principles or norms of effective planning: **participatory, transparent, comprehensive, rigorous,** and **scenario-driven**. Drawing on the academic literature and a set of case studies,[1] we develop a rubric that defines high, moderate, and low performance for each of these principles. We outline the rubric below and describe it in more detail in Appendix B.

Principle #1: Participatory

Participatory decision-making processes support and encourage meaningful community engagement and input. Stakeholder participation in the decision-making process has been shown to improve the quality of decisions, as community stakeholders can contribute new information and ideas that help planners to weigh the merits of potential initiatives (Beierle 2002). A participatory process is one that gives citizens an opportunity to contribute, including disadvantaged groups who "lack formal organization or influence" (APA 2015), and vulnerable

[1] Two of the case studies we reviewed were from New South Wales, Australia, one focusing on planning for drought resilience (Metropolitan Water Directorate, 2014) and the other on land use planning reforms for coastal cities (Preston et al., 2013). Another case from Melbourne, Australia involves managing storm water run-off (Urrutiaguer et al., 2007). A fourth case study from Egypt addresses climate impacts on wheat production in the Nile Delta area (Julius & Scheraga, 2000). The final case, from Burundi, involves creation of a National Adaptation Plan of Action to deal with the effects of climate change (Republic of Burundi, 2007).

populations who are most likely to be harmed first and worst in the case of hazard events, but least likely to be represented in the planning process (Friend and Moench 2013).

To meet this principle, processes should engage a diverse group of community stakeholders, including experts and non-expert stakeholders. Making a distinction between stakeholder *presence* and *impact* (Chandrasekhar et al. 2014), we look specifically for community stakeholder *impact*—meaning engagement around the decision-making and prioritization of initiatives, including an explicit link between community participation and chosen initiatives, as opposed to community *presence*, e.g., engagement to generate buy-in for initiatives that have already been selected.

A **low score** for participatory signifies that there was little to no evidence of stakeholder engagement, or the engagement happened at a time when decisions had already been made. A **moderate score** indicates that stakeholders were engaged, but had limited impact on decisions. A **high score** indicates consistent involvement and impact of experts and non-experts from across relevant sectors. One instructive example is the development of the National Adaptation Plan in Burundi, which was led by a multi-disciplinary Project Steering Committee that brought together stakeholders from areas including energy, environment, health and agriculture. Capacity building activities for Steering Group members ensured all members were able to fully participate. The process also involved extensive community engagement: four engagement sessions were held in each of four regions of the country to discuss the impact of climate change and potential adaption strategies. A two-day national forum brought together stakeholders from across the country to test and refine the draft report (Republic of Burundi 2007).

Principle #2: Transparent

Transparent decision-making processes make public the decision-making criteria used, as well as any supporting analyses. Ideally, the proceedings and processes by which decisions are made will be well documented, and these documents will be made publicly available so that community stakeholders can better understand how and why decisions were made (Stefania, Giuseppina, and Margherita 2014).

A **low score** for transparency indicates that decision-making criteria were not made public, there was a lack of documentation of the process, there was limited or no disclosure of assumptions about the future state of the world, and/or information that was too technical to be assessable to the typical community member. A **moderate score** indicates incomplete public documentation of the criteria, analysis, and final plan. A **high score** indicates that all relevant criteria and the final plan were made public (in accessible language), as well as the analyses that were used to assess recommended options. For example, government officials in New South Wales (NSW), Australia, made public the five criteria used to judge potential interventions and the initiatives under consideration to build drought resilience in NSW's Lower Hunter Valley region. They held public workshops at multiple stages in the modeling and analysis process to explain the criteria to the community, and the final report explains how each option was evaluated. The report outlines assumptions used to construct a "base case" for drought resilience, and how each option changes the jurisdiction's performance against the base case (NSW Government 2014).

Principle #3: Comprehensive

Decision-making processes are comprehensive when they involve experts from a range of systems and policy areas, and when they consider a wide range of relevant factors or criteria in

evaluating different proposals. Currently, climate change adaptation planning is typically led by a single government agency, which often has little to no engagement with other agencies (Baker, et al. 2012). Yet the interconnectedness of environmental, economic, and social systems affected by climate change on the local level demands that experts from a range of substantive areas participate in the decision-making process. In addition, it requires that a range of criteria, including hard-to-quantify social, cultural, and environmental considerations, inform decision-making. To satisfy this principle, there should be evidence of cross-sector collaboration and input into decisions, as well as consideration of initiatives against a range of criteria, including those that are difficult to quantify.

A **low score** for comprehensiveness indicates that the process lacked multidisciplinary input and/or that the criteria used to assess interventions were narrow and ignored important but difficult-to-quantify considerations. A **moderate score** indicate that there was limited engagement from qualified experts or a clear preference for one or two types of criteria for judging interventions. A **high score** indicates that the planning team made deliberate efforts to engage experts from a range of policy areas when developing criteria, and considered a range of benefits or possible outcomes. It also indicates that the decision makers drew on non-quantitative evidence wherever possible, providing a comprehensive assessment. For example, planners working on reducing pollution in the Yarra River in Melbourne, Australia, through urban storm-water management used an MCA analysis that assessed a broad range of project criteria. The planners evaluated performance from multiple domains, including water quality outcomes, as well as more qualitative criteria, such as the contribution of the project to building local government capacity, and the extent of resident involvement in implementation (Urrutiaguer, Lloyd, and Lamshed 2007).

Principle #4: Rigorous

Rigorous decision-making processes promote evidence-based decision-making—that is, fair and objective decisions made on the basis of data and analysis. Typically, rigorous planning requires the use of systematic and consistent analysis to explore options and inform decisions, including the examination of demographic, economic, and land use information as well as data on natural resources and constraints (Berke and Godschalk 2009). In the resilience planning context, a rigorous process should also include identification of the risk, location, and magnitude of potential hazards, and vulnerability analysis to identify places, people, and structures most at risk of being harmed (Tang et al. 2010; Brody 2003). To satisfy this principle, processes should incorporate data, models, and tools to thoroughly evaluate existing conditions and vulnerabilities, as well as potential future hazards. There should also be a clear connection between the results of these analyses and the decisions that were ultimately made.

A **low score** for rigor indicates that there was little or no data, models, or supporting evidence used in the decision-making process. It also indicates that proposed interventions were not measured consistently against each criterion. A **moderate score** indicates that the process was not thorough in its use of data, models, or evidence, and criteria were not applied consistently to all interventions under consideration. A **high score** indicates that the process was comprehensive in its use of data, models, and evidence, and that each intervention was evaluated similarly against each criterion. One example of a planning process that was moderately rigorous is seen in the approach planners used in selecting ways to protect wheat farmers in Egypt. Planners assessed five proposed initiatives through multiple rounds of modeling, consistently using the same models to compare impacts across options (Julius and Scheraga 2000). Yet the study had limited engagement with climate or other experts that could have

supplemented the planning team's knowledge, relying only on a single outside perspective to determine subject values for some assessment criteria (Julius and Scheraga 2000).

Principle #5: Scenario-Driven

Planning for resilience often involves imperfect information and incomplete data (Haque et al. 2010). Scenario-driven decision-making processes address future uncertainty by considering the long-range performance of proposed initiatives under a range of different possible future conditions and events. While all planning deals with uncertainty, the possible range and severity of climate related impacts makes considering alternative scenarios particularly important (Scrieciu et al. 2011). Thus, planners must grapple with a range of climate hazard scenarios, consider how initiatives might perform under a range of potential conditions, and choose those initiatives that perform well under a range of scenarios (Dessai and Hulme 2007; Preston, et al. 2011). To satisfy this principle, processes should use scenario planning techniques. There should be evidence that efforts were made to better understand how initiatives might perform against worst-case future projections, and that initiative selection was informed by high performance under a range of climate scenarios.

A **low score** for scenario-driven planning indicates that no scenario planning was used in the decision-making process. A **moderate score** indicates that scenarios may have been considered, but that initiatives were not well tested under the different scenarios. A **high score** indicates that multiple climate change scenarios were modeled, and that performance of potential initiatives was evaluated in each scenario. The process used by local governments to select adaptation measures to protect the coast line in New South Wales, Australia, against sea level rise is a good example of a moderately scenario-driven process. The planning team in that case evaluated the current risk to coastal assets and each initiative based on a one in 100-year storm

surge and modeled this under three climate scenarios: sea level rise of zero, 40, and 90 centimeters. The analysis also considered performance of possible interventions over multiple time horizons in the near-term, medium-term, and long-term (Preston, Westaway, and Yuen 2011). The analysis did not consider scenarios for all study locations and was not explicit about how different initiatives might perform under these scenarios.

In the remainder of this paper, we use this evaluation rubric to assess general planning approaches as well as the specific case of the Louisiana Coastal Master Plan.

Overview of Commonly Used Decision-Making Approaches

While planning processes can take many different forms, the most commonly used decision-making approaches used by planners are cost-benefit analysis and the working group approach. However, both of these commonly used means of evaluating options and making decisions about government investments or interventions have a number of shortcomings, especially when evaluated along the principles we outline above. MCA is a decision-making tool that has been developed in recent years to try to address some of the perceived shortcomings of these other methods, and we attempt to evaluate the extent to which it succeeds.

Working Group Approach

While not often identified as a formal approach to decision-making, the working group approach is probably the most common method used in planning. The working group approach is relatively informal and relies primarily on the judgment of a selected group or groups. Working groups may include a limited core network of government stakeholders assembled to analyze planning choices and formulate local plans; or they may include a more diverse set of

stakeholders, such as nongovernmental organizations, neighborhood groups, business owners, private sector developers, academics, and others (Brody 2003; Berke, Lyles, and Smith 2014).

In theory, the flexibility of the working group decision-making approach can support participation from community stakeholders (Berke et al. 2014; Bucher et al. 2014). In practice, however, working groups tend to be made up primarily of appointed government officials and expert consultants, and the approach has been criticized for failing to involve community members (Brody 2003; Burby 2007). Further, because there is not a structure or mechanism to systematically capture community input about initiatives, it is not clear if or how community input is considered in decision-making.

The working group approach tends to be less formal, and is often not recognized specifically as a decision-making approach. Because of this, it often lacks transparency. Groups tend to work behind closed doors, and meetings are by invitation only. Criteria against which decisions are evaluated are typically not made public, and there is rarely any record of the conversations that occur during the decision-making process (Linkov et al. 2006). Consequently, the relationship between the ultimate decision reached and the underlying decision-making criteria is often unclear (Rauschmayer and Wittmer 2006).

The flexibility of the working group approach can foster comprehensiveness, allowing for diverse participation across various agencies at the local, state, and federal level (Hamin et al. 2014). However, as working groups are often organized by sectors (e.g., transport, energy, etc.), cross-sector collaboration is often limited in practice and at times, results in departmental competition over resources rather than coordinated and comprehensive planning efforts (Lyles et al. 2014).

Researchers have found working group decision-making less rigorous than other approaches (Berke et al. 2014). The informal nature of the decision-making process can result in participants analyzing data selectively, to make the case for initiatives that are in their interest, rather than supporting a process in which analysis and data are used more consistently and objectively to compare the potential of a range of initiatives. Consequently, working group plans often fail to adequately consider the merits of a wide range of initiatives, and instead prioritize consensus-driven and more easily achievable choices (Berke et al. 2014; Preston 2011).

As working group processes are not well documented, it is not clear whether or how they use scenario planning. As the working group approach is relatively informal, however, it seems unlikely that groups evaluate potential initiatives against a range of climate hazard scenarios in a systematic way. The informal nature of this approach means that working group participants may not have access to information required to understand the diverse range and potential long-term impacts of climate change hazards (Berke et al. 2014).

Cost-Benefit Analysis Approach

Cost-benefit analysis (CBA) is another commonly used approach to decision-making in climate resilience planning. CBA has been used in a wide range of planning contexts, including creating environmental impact statements. CBA is a common requirement for federal funding for flood protection and disaster mitigation, and, as a result, many states require its use for assessing and prioritizing potential projects (Berke, Lyles, and Smith 2014). Yet, while CBA is likely to achieve some of our planning principles, it often falls short on others.

Given the complexity of CBA models, as well as its focus on quantifiable benefits and costs, CBA is not well equipped to support participatory decision-making. Researchers find that cost-benefit analysis often leads to opaque, top-down decision-making, with little accounting for

equity or livability concerns (Bedsworth et al. 2010; UNFCCC 2011). CBA often overlooks hard-to-quantify costs and benefits, which can result in the exclusion of issues about which local residents care most (Messner et al. 2006). Plus, planners may see less need to involve community members if they are only considering a narrow range of quantifiable outcomes.

While often documented, the technical inputs and complex spreadsheets used in CBA can make this approach non-transparent for the general public. Assumptions about risks and the valuation of costs and benefits that are used in the analysis are often hard to decipher, and CBA processes rarely offer a clear record of the assumptions and other elements that go into the underlying calculations (Beukers et al. 2012).

Cost-benefit analysis is typically not comprehensive because of the inherent challenge of including "reliable estimates of things that are valuable but not valued in markets" (UNFCCC 2011, 12). Given the focus on economic costs and benefits, CBA processes often fail to consider hard-to-quantify criteria, or non-quantitative information (Söderbaum 2006). Limiting initiative selection to cost-based criteria may steer planners away from initiatives that have important, non-economic co-benefits (Gamper and Turcanu 2007). While there has been a real push to include social, environmental, and other non-economic costs and benefits into CBA processes, in practice, the approach still heavily favors those considerations that are more easily quantifiable.

Cost-benefit analysis often rigorously evaluates whether a particular project is "economically justified," and can help provide a clear, quantifiable metric to inform decision-making among a diverse set of potential projects (UNFCCC 2011; Feenstra et al. 1998). The standards for quantifying costs and benefits under CBA are relatively well known among experts (Brisley et al. 2012), and can therefore lend rigor to the decision-making process. The tool requires a sound assessment of risks, costs of initiatives, and potential damage avoided. While

the underlying parameters can be arbitrary, the approach is standardized, and CBA requires analysts to use a consistent approach to evaluate alternatives.

Cost-benefit analysis provides a framework for systematic evaluation of initiatives under a range of scenarios. In practice, the challenge of accurately predicting and quantifying costs and benefits in economic terms under varying scenarios may limit the insights that CBA provides decision makers (Feenstra et al. 1998). But, it is not clear that any other decision-making tool performs better along these lines. Estimating the costs and benefits of initiatives in the future against uncertain risk is inherently challenging. Despite these challenges, in practice, CBA appears to increasingly be used to assess initiative performance under various climate hazard scenarios.

Multi-Criteria Analysis

Partly in response to criticisms of the working group and CBA approaches, multi-criteria analysis (MCA) has emerged as an alternative decision-making approach. In theory, MCA appears to offer some advantages over other planning processes, and the potential to deliver on all five of our principles of effective planning.

First, MCA's use of multiple decision criteria can potentially support more meaningful community involvement. By encouraging the use of a broad set of criteria, MCA can elevate the status of considerations that are important to the community, and create a structure to more systematically solicit community input (Gamper and Turcanu 2007). Hajkowicz and Collins (2006) argue that MCA can also be useful for conflict resolution because the process encourages all stakeholders to explicitly state their priorities.

MCA can also potentially encourage transparency because it prompts planners to explicitly identify decision-making criteria (Dixit and McGray 2013; Donaldson 2009; Belton

and Stewart 2002; Hajkowicz and Collins 2006). MCA processes often summarize results in a relatively simple matrix, making process documentation more accessible compared to CBA, which often involves the use of complex spreadsheets and calculations that can be challenging to decipher. MCA processes can still be opaque if technocratic analysis is not translated into terms that can be easily understood by stakeholders (Janssen 2001), but the many stages involved in MCA provides opportunities for planners to document and share information publicly.

As for comprehensiveness, because MCA allows decision makers to consider objectives that are not easily quantified with precision (Darbra et al. 2008) and allows for a more thorough investigation of potential social or environmental co-benefits (Smit and Pilifosova 2001), Romero and Rehman (2003) argue that MCA can provide a framework to help balance competing objectives. The use of a range of criteria in MCA can encourage experts from more technical fields, such as economics or engineering, to consider the social, environmental, or political dimensions of potential initiatives (Gamper and Turcanu 2007). Further, MCA can support cross-sector collaboration because it provides structure and common language for discussion and debate through the identification of evaluation criteria and scoring measures (Belton and Stewart 2002). Because it does not require the prioritization of economic criteria, MCA may be better equipped than CBA to support cross-agency conversation and compromise (Malczewski 2006). While the use of multiple criteria can help to broaden criteria considered, some scholars note that aggregating scores across diverse criteria can be a challenge. MCA often combines a range of scores that have different base units, such as financial scores with numerical ratings, which can create score calculation problems that do not occur with CBA, in which all costs and benefits are considered in economic terms (Dobes and Bennett 2009).

MCA can be rigorous by employing data and analysis to compare potential initiatives according to agreed-upon criteria. And, it does encourage users to adopt a scoring system and apply it consistently to possible interventions. However, the lack of a common evaluation methodology has led to criticism that MCA may be less rigorous than CBA. MCA does not provide clear guidelines for setting criteria and evaluating initiatives, so analyses can be more arbitrary, open to manipulation, or may result in conflicting results for analysis of the same problem (Dobes and Bennett 2009). Reviews of MCA techniques for water management issues noted that more work is needed to help practitioners structure MCA problems, define criteria, and appropriately scope potential interventions (Hajkowicz and Higgins 2008; Janssen 2001).

Finally, researchers note that an MCA framework can explicitly include a criterion for how well alternative options perform under different future scenarios (Dodgson et al. 2009; Malczewski1999). But, there is nothing inherent in the tool, itself, that requires or suggests this step and, as mentioned above, assessing the impact of initiatives in the face of uncertain climate risk is time intensive and inherently challenging.

While MCA, even in theory, is not a perfect decision-making tool when measured using our planning principles, it does appear to provide a better framework than CBA or working group approach to prompt planners to engage in planning consistent with those goals. In the next section, we explore in depth one case study where MCA was used in order to evaluate how it performed in practice.

Multi-Criteria Analysis in Practice

Our review above suggests that MCA has the potential to encourage decision-makers to engage a range of stakeholders in decision-making, improve transparency of the process, and

elevate non-market considerations. To assess whether the potential of MCA to meet effective planning principles is borne out in practice, we closely analyze the case of Louisiana's 2012 Coastal Master Plan (CMP) update. This case merits close study as a rare U.S.-based example of a resilience planning process that attempted to use a range of criteria to systematically rank initiatives—distinguishing factors of an MCA approach. Given the complexity of Louisiana's resilience needs, this case tests the performance of MCA as a decision-making approach in particularly challenging circumstances, with lessons that may apply in many other places.

We base our analysis on a review of the plan itself, written accounts of the planning process, as well as interviews with participants involved directly in the 2012 update (names and affiliations are listed in Appendix A below). We evaluate this planning process against our five principles for effective planning, and find that it was successful in meeting some but not all of the planning principles, as detailed below.

Background: The Louisiana 2012 Coastal Master Plan Update

With its rapidly eroding coastline and frequent hurricanes, Louisiana faces extreme resource management and flood protection challenges. The state's economy is reliant on its tourism, fishing, and oil industries; all of which are threatened by sea-level rise, increasingly frequent and severe storms, and other climate-related phenomena.

Louisiana's Coastal Protection and Restoration Authority (CPRA) is charged with updating the state's Coastal Master Plan every five years. For the 2012 update, CPRA followed an MCA-based approach, using a range of decision criteria to evaluate proposed initiatives, with the aim of creating a plan that balanced technical considerations with community priorities. In contrast to previous planning exercises in the state, which developed long wish lists of potential initiatives without making much effort to prioritize, the 2012 update sought to make difficult

decisions about which of the hundreds of proposed initiatives in state and regional plans should receive funding (Interview 2015). CPRA, along with a core stakeholder group called the Framework Development Team (FDT)— 60 representatives from business, government, non-governmental organizations, and academia—developed a list of decision criteria that reflected local priorities, and then analyzed proposed initiatives against these criteria, narrowing a list of 1,500 options down to a list of 109 initiatives that were recommended in the final updated Coastal Master Plan (CPRA 2012).

The 2012 Master Plan update was an enormous and complex undertaking. Our review focuses on the actions that the CPRA took to select which among many competing proposals would be prioritized for funding. We examine how they selected criteria, how they evaluated potential initiatives against selected criteria (including the role of the Planning Tool, described below), and how they weighted (or prioritized) criteria.

The objectives of the Louisiana planning process (the "master plan objectives"), as identified by CPRA with community input, were to identify initiatives that would help to reduce economic losses from future flooding and to protect and enhance cultural heritage, natural processes (e.g., natural flood protection), coastal habitats, and "the working coast" (e.g., gas industry) (CPRA 2012). These plan objectives guided the broader planning process, and CPRA translated these five objectives into several decision criteria. Decision criteria included distribution of risk across socioeconomic groups, use of natural processes (i.e., green infrastructure), sustainability, operations and maintenance costs (relative to design and construction costs), support of cultural heritage, flood protection of historic properties, support of navigation, flood protection of strategic assets, support of oil and gas, and restoration of critical landforms (Groves et al. 2012).

In addition to the decision criteria, CPRA divided initiatives into two groups: these included initiatives (or sets of initiatives) that "maximized" flood risk reduction (measured by expected annual damage) and initiatives that supported land restoration (measured by area of land) (Groves et al. 2012). The RAND Corporation was hired to work with CPRA to develop an analytical model, dubbed the "Planning Tool," to support rigorous and consistent multi-criteria analysis of initiatives using the above described criteria. Outputs from the Planning Tool informed deliberation and final decision-making (Groves et al. 2012).

Analysis of Case

In assessing the Louisiana decision-making process, we again use our rubric (detailed in Section II and Appendix B) to measure it against our five effective planning principles. Using this rubric, we find the Louisiana process achieves moderate to high scores on all criteria.

Participatory (moderate/high)

To assess whether or not the process was participatory, we look at who was involved in the process and how their involvement affected decisions. We find that the CMP update's performance on participation was strong. We rate it as moderate/high.

The CPRA team created multiple opportunities for public participation. At the beginning of the process, CPRA conducted a "listening tour" to ensure planners had a baseline understanding of community concerns and priorities (CPRA 2012). During the process, the team organized a series of ten regional community meetings as well as a number of meetings with community groups, such as Global Green, United Houma Nation, and the Oyster Task Force (CPRA, 2012). Community stakeholders were then invited to provide feedback on draft initiatives at public meetings or through a website (CPRA 2012).

That said, while the planning team created many opportunities for participation, stakeholders were not involved with selecting decision-making criteria, there was limited representation from grassroots environmental and social justice organizations, and there is little evidence that non-expert participation influenced outcomes (CPRA 2012; Interviews 2015). The heavy reliance on Planning Tool outputs to inform decision-making made the process more rigorous, but may have limited the influence of public input because initiatives and decision criteria needed to be articulated to fit within the technical parameters of the Planning Tool, and so public feedback may have not been fully captured. Although the general public was invited to offer feedback on the list of initiatives proposed in the draft plan, it appears that feedback was only incorporated to make minor adjustments to proposed initiatives (CPRA 2012; Interviews April 2015).

Transparent (high)

To assess whether or not the process was transparent, we look to see if the decision-making criteria, assumptions, and supporting documentation are publicly available and presented in a way that they are accessible to a non-expert audience.

The CMP update process receives high marks on this principle for thoroughly documenting the decision-making process in a range of publications, including the published plan, the website, and supporting documents and appendices that outline more detail. While some of the documents are too technical to be accessible to the general public, CPRA receives high marks for their thoroughness in leaving a paper trail. The plan describes the process through which initiatives were identified and evaluated. Although the Planning Tool itself was not posted online, RAND published a detailed report explaining inputs, calculations, and assumptions used

in the analysis (Groves et al. 2012). Lists of the various experts and community stakeholders consulted as part of the process are available online, including transcripts of public meetings (CPRA 2012). While some of the technical elements of the decision-making process may be challenging for the general public to understand, the careful documentation marked a notable step forward toward improving transparency of decision-making processes. For these reasons, we give this process a high score for transparency.

Comprehensive (moderate/high)

To assess whether or not the process was comprehensive, we look for evidence that criteria included environmental, social, and cultural concerns in addition to economic outcomes. We look for diversity in both decision-making criteria and potential initiatives, and we examine whether social, cultural, and environmental initiatives (e.g., "green infrastructure" or restoration of ecosystem services, described as "nonstructural" in the CMP) received funding. Finally, we also consider if the planning team included or engaged people from different sectors.

We give the CMP update process a moderate/high score on this principle. The Planning Tool included a mix of criteria for weighing the merits of potential initiatives. It contained cost-based criteria (e.g., considering operations and maintenance costs of projects); but also measured initiative performance against non-quantifiable criteria such as equitable distribution of risk, ecosystem restoration, and support of cultural heritage (CPRA 2012; Groves et al. 2012; Interviews, 2015), elevating these to a similar level of import as those criteria that were easier to quantify. Defining these hard-to-quantify criteria, setting up the Planning Tool, and interpreting output from the tool required CPRA to engage experts from a range of sectors. For example,

including criteria around equitable distribution of risks required planners to consult with individuals with expertise in vulnerable populations as well as experts in risk assessment.

While the CPRA took pains to include a range of decision-criteria, flood risk reduction and land preservation were weighted the heaviest in the Planning Tool (Groves et al. 2012), and seem to have skewed the decision process toward large-scale infrastructure projects. Only 20 percent of funding was ultimately dedicated to "nonstructural" initiatives, which include actions that individual homeowners and businesses can take, such as flood-proofing their buildings (CPRA 2012). Even such "nonstructural" initiatives focus on building projects, rather than, for example, community-based disaster preparedness programs. That said, the inclusion of the protection of coastal habitats and the use of natural processes as decision-criteria led to the choice of more nature-based solutions, representing a shift away from the historically dominant preference for floodwalls, levees, and other forms of "gray" infrastructure—which tend to emerge in CBA processes.

Rigorous (high)

To evaluate rigor, we look to see if data, models, and empirical evidence were employed to explore the merits of potential interventions. We consider consultation with appropriate technical experts, and whether or not the process was structured in a way that supported objective analysis.

We give the CMP update a high score for analytical rigor. Technical experts and community groups alike agreed that the use of sophisticated modeling and decision-support tools—namely, the Planning Tool—supported rigorous and consistent prioritization of projects and resulted in initiative selection that was grounded in objective analysis (Interviews, 2015).

Working with the FDT and other experts and modelers, CPRA and RAND spent months gathering data and developing approaches to understand ecosystem services, socioeconomic characteristics of vulnerable communities, economic impacts of environmental changes, among other issues (Peyronnin et al. 2013). The use of the Planning Tool helped organize the data and analysis and allowed CPRA to be consistent in evaluating alternative initiatives.

It is important to note that CPRA's engagement of RAND was instrumental in the development of the Planning Tool and in enabling a rigorous process. The process would be difficult to replicate because the team had the resources, time, and political support to develop a custom model that greatly improved the planning process.

Scenario-Driven (high)

To assess whether or not a plan is scenario-driven, we consider whether the team developed potential future scenarios and compared the performance of initiatives under each. We look specifically for inclusion of climate hazards, and consideration of different time horizons.

We rate the CMP update as high on this metric. The CPRA was highly sophisticated in its use of scenarios to consider the performance of potential initiatives in an uncertain future. Planners relied on seven ecological models to frame the scenarios against which initiative performance was to be considered. For example, one of these tools, the Coastal Louisiana Risk Assessment Model (CLARA), modeled potential flood depths and resulting damage from projected future storms, based on estimated peak storm surge and wave heights, and calculated the risk of these potential storms in dollars of damage caused (Groves et al. 2014). Scenarios were integrated into the Planning Tool, and the ability of proposed initiatives to reduce flood damage or land loss was measured against the variety of potential conditions that emerged from

these model runs, ensuring that decisions about which initiatives to prioritize were based on evidence about their predicted performance (Interviews, 2015).

CPRA made a concerted effort to consider the impacts of climate change and how sea-level rise might exacerbate existing stressors, such as land erosion. The team modeled moderate and worst case sea-level rise and land-loss scenarios, and chose conservative estimates to make sure proposed initiatives would still be effective in high environmental damage scenarios. CPRA and RAND set an ambitious but bounded 50-year time horizon for the scenarios, deciding that beyond 50 years the uncertainties around sea-level rise, project costs, and other factors would be too high for evaluation results to be meaningful. Their analysis focused on the 20-year scenarios, but the plan also identified projects with longer-term benefits (Groves et al. 2012). One member of the modeling work group was specifically tasked with uncertainty analysis. The technical team also ran several funding scenarios and calculated short- and long-term costs and benefits, testing the sensitivity and robustness of the plan.

Discussion & Conclusion

In this paper, we explore whether MCA-based decision-making processes have greater potential to conform with generally accepted principles of effective planning than working group and cost-benefit analysis driven approaches. Our analysis of the Louisiana case study suggests that MCA can achieve at least some of that promise in practice.

Overall, MCA has the potential to support meaningful **participation** among a broad cross-section of community members. By encouraging the use of multiple criteria for assessing interventions and for permitting the inclusion of harder-to-quantify criteria, MCA can more readily engage community stakeholders in shaping the decision-making process. But while MCA

provides a framework that can permit community members to play a part in choosing and weighting the criteria that will shape the MCA analysis, nothing about the process requires that planners include community members. Further, MCA does not necessarily level the field amongst stakeholders. Indeed, some have noted that MCA processes may strengthen the power of groups with access to more information (Dixit and McGray 2013). Just like any other process, planners must be committed to being inclusive.

Perhaps one of the most significant advantages of MCA is that it supports a **transparent** decision-making process. Because it requires decision-makers to clearly articulate the criteria against which initiatives will be judged, and how they are weighted, it helps community members better understand how decision-makers weigh options and make difficult choices. CBA can also be transparent; but, in practice, it is often too technical to be accessible to a broad group of stakeholders. CBA can also involve unstated assumptions that undermine transparency, although this is also true of MCA processes. While planners may choose to be transparent using any one of these methods, nothing about the working group process encourages transparency.

MCA may support a **comprehensive** decision-making process when it elevates the importance of non-economic criteria. In Louisiana, for example, inclusion of multiple criteria resulted in the team recommending several green-infrastructure projects, which tend to have ecosystem service and public space benefits, in addition to flood prevention benefits. By encouraging consideration of multiple criteria, MCA provides a framework for a more comprehensive process than CBA; the working group approach could theoretically be comprehensive, but is often not, for the reasons we discuss in Section II.

Because it provides a structured approach to evaluating alternative options, the use of MCA may support a **rigorous** decision-making process, but it still requires a commitment to

collecting and analyzing extensive data. The Louisiana team drew data from a variety of sources, employed technically sophisticated modeling and analysis, and compared proposed interventions across diverse criteria using the highly sophisticated Planning Tool. While MCA itself does not ensure that data are high quality, it supports a process that draws on and consistently analyzes data to assess alternatives. That said, the use of difficult-to-quantify criteria that is important for supporting the participatory and comprehensive principles, may reduce a process's rigor because scoring difficult-to-quantify criteria will generally involve more subjective judgment.

While MCA can help to facilitate **scenario-driven** planning, in practice, the depth and breadth of uncertainty around climate impacts can make such scenario planning challenging. Although MCA can fairly easily accommodate sensitivity analyses, it does not seem to be any more likely in practice to do so than CBA. However, the structure provided by both MCA and CBA make them both much more helpful tools for evaluating future scenario performance than a working group approach would be.

In short, MCA is a promising tool for climate change planning, but in practice, it may not achieve all of our effective planning principles. It is more likely to fall short in cases where planners have limited resources. The CPRA in Louisiana was very generously funded, and an analysis with that level of rigor and comprehensiveness would not be possible in jurisdictions with more limited resources. Further, because the approach is not as well understood, local jurisdictions may lack the expertise and political support needed to pursue it (Baker et al. 2012).

As with all decision support tools, MCA can only go so far to facilitate specific planning goals if the planners involved are not also committed to expending the resources and effort to achieve those goals. But the approach developed by the RAND Corporation and the planning team in Louisiana is a useful starting point for planners interested in exploring MCA.

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Appendix A

Interviews

Belhadjali, Karim. Deputy Chief at Coastal Protection and Restoration Authority of Louisiana. April 21, 2015.

Buchanan, Jeffrey. Senior Domestic Policy Advisor at Oxfam. April 10, 2015.

Fischbach, Jordan. Co-director of the RAND Corporation Water and Climate Resilience Center. April 21, 2015.

Saucier, Melanie. Coastal Resources Scientist Supervisor at Louisiana Coastal Protection and Restoration Authority of Louisiana. April 21, 2015.

Whitney, Patty. Executive Director at Bayou Interfaith Shared Community Organizing. April 23, 2015.

Appendix B: Evaluation Instrument

Criterion	Low performance	Moderate performance	High performance
Participatory The planning and decision-making process should meaningfully engage expert and non-expert stakeholders. Stakeholders make substantive contributions throughout the process. Areas for stakeholder involvement in the process include: defining the problem and/or planning process objective; defining evaluation criteria and/or setting of the weights; and identifying alternative project options. *Key questions to determine performance:* 1. Who was involved? a) Did the process include opportunities for stakeholders to shape the analysis outcomes? b) Were a range of external stakeholders, including topic experts, citizens and/or local community organizations, involved in the process? 2. What was their impact? a) Were stakeholders able to influence the planning process? b) Is there evidence that stakeholder feedback was a factor in decision-making?	1. No, or few, stakeholders involved in the planning process a) No clear opportunities created for stakeholder involvement b) Limited to no outside involvement. the process was not open to other stakeholders 2. Stakeholder involvement had no impact on the process or outcomes a) To the extent participation occurred, it was at a point in time where decisions had already been taken b) No documented examples of stakeholder feedback influencing outcomes.	1. While some stakeholders involved, they represented limited groups and/or were only sporadically involved a) Process designed to provide *some* opportunities for external stakeholders to engage b) The process did not include range of interested parties, for example because the process focused on experts rather than local community organizations with an interest in the outcome. 2. Stakeholders were engaged in the process, but lack of evidence indicating their input was a factor in decision-making a) Participation sometimes (but not always) occurred at points where there was a genuine opportunity to shape the planning process b) There is documented evidence of stakeholder feedback, but this is not linked to changes in the decisions made.	1. A wide variety of relevant experts and non-experts were involved throughout the process a) Process designed to create opportunities for range of stakeholders to participate. b) Evidence that a range of stakeholders were actively involved throughout 2. Those involved meaningfully impacted the analysis and outcomes of the process a) Participation occurred at points in time where there was a genuine opportunity to shape the analysis outcomes b) There is documented evidence stakeholder participation and evidence that their feedback played a role in decision making.

Criterion	Low performance	Moderate performance	High performance
Transparent Criteria and process used to make decisions should be well documented. There should be evidence of how criteria were selected and weighted, and assumptions should be explicit *Key questions to determine performance:* 1. Are the decision-making criteria and supporting documentation publicly available and accessible? a) Is the decision making criteria used for analyzing options and developing recommendations clear and publicly available? b) Is the analysis of options publicly available? c) Are the assumptions used in future modeling publicly available? d) Is the information made available in a format that the community can understand?	1. Limited public documentation of the criteria, analysis and final plan a) The decision making criteria are either not available, or are non-specific. b) There is no publicly available analysis of each option, or the final plan is not publicly available c) There is no, or limited, disclosure of the assumptions about future states of the world. d) If information is provided, it is not explained with context or is highly technical jargon that makes it inaccessible to the average community member.	1. There is some, but incomplete, public documentation of the criteria, analysis and final plan. a) There is some information on the decision making criteria used, but these are not fully explained. b) There is a brief summary of the analysis of each option and a high-level final plan publicly available c) Assumptions are mentioned but not explained. d) Information is difficult to find and non-experts would find it difficult to fully engage with the material.	1. All relevant criteria and the final plan are public, as well as the analysis that was used to assess recommended options? a) The specific decision making criteria used for analyzing options and developing recommendations are both clear and publicly available b) The analysis of each option and the final plan is publicly available c) Any assumptions about future states of the world are comprehensively outlined and publicly available. d) Information is presented in plain English; any complex criteria, analysis and assumptions are explained with context.

Criterion	Low performance	Moderate performance	High performance
Comprehensive The process should show evidence of cross-sector collaboration in developing initiatives, as well as consideration of initiatives against a range of criteria, including those that are difficult to quantify <u>*Key questions to determine performance:*</u> 1. Did potential initiatives represent a range of potential policy and project approaches? a) Is there evidence that the process considered social, cultural, environmental, and economic initiatives? 2. Do the criteria capture social, cultural, environmental, and economic considerations? a) Is there evidence that the process considered the social, cultural, environmental, and economic implications of potential initiatives? b) Does the analysis measure non-quantitative outcomes where these are relevant?	1. The process focuses on a narrow set of initiatives from one single policy domain, despite important impacts on other domains a) Solutions come primarily from one policy domain and there is no evidence that the process considered solutions from other policy domains. 2. Criteria are primarily quantitative, and important non-quantitative considerations appear to have been ignored or excluded a) No or limited effort is shown in considering other relevant systems and policy areas when developing criteria. b) All or most relevant non-quantitative evidence appears to have been ignored or excluded	1. While most of the process focuses on one domain, there is some consideration of the impact on other domains a) Some solutions come from other systems however only moderate effort was used to identify solutions from other policy domains. 2. Some non-quantitative is included in the analysis, but key areas of evidence were not captured in the analysis because they were not able to be quantified a) Some effort was made to consider other relevant systems and policy areas when developing criteria, however important areas are not included or effort make to engage across sectors was moderate. b) Some relevant non-quantitative evidence appears to have been ignored or excluded	1. The process has a broad range of outcomes from multiple affected policy domains a) Solutions were invited from across policy domains and the analysis included a wide variety of solutions, to the extent relevant for the topic. 2. Non-quantitative evidence is included in the analysis wherever possible, providing a comprehensive assessment a) There were deliberate efforts to engage other relevant systems and policy areas and consider their perspectives when developing criteria b) Relevant non-quantitative evidence is included in the analysis

Criterion	Low performance	Moderate performance	High performance
Rigorous The decision-making process should be evidence-based and systematic. Due to the uncertain nature of climate change, data, models, and empirical evidence should be used to evaluate existing conditions and vulnerabilities, as well as potential future hazards. *Key questions to determine performance:* 1. Are data, models, and empirical evidence used (where appropriate) to objectively assess project or policy options against relevant criteria? a) Are technical assessment methods and tools representative of good practice? Were appropriate experts consulted? b) Is the process structured to support systematic and consistent application of data, models, and evidence?	1. Lack of rigor due to limited or no use of data, models, and/or supporting evidence. Inconsistent assessments against each criterion. a) The technical assessment methods is shallow or narrow, resulting in a superficial assessment that does not provide a rigorous assessment of the options. There is no evidence of external expert review or consultation. b) The criteria have not been consistently applied to all options, resulting in some options appearing more favorable than others due to non-rigorous assessment methods.	1. Limited use of data, models, and evidence and/or areas where process could have been improved through their use. a) Technical assessment incomplete, with important gaps and unanswered questions about the assessment of the options. Some expert consultation but not sufficient given the level of complexity of the analysis. b) While mostly consistent, there are some areas where the criteria could have been more consistently applied to all options.	1. The analysis is rigorous with comprehensive use of data, models, and evidence and a consistent application of assessments against each criterion. a) The technical assessment methods provide a comprehensive assessment of the option, accounting for all relevant factors. Experts were involved in all necessary stages to provide independent and/or technical advice. b) The criteria are always consistently applied to all options with no apparent bias.

Criterion	Low performance	Moderate performance	High performance
Scenario-Driven The decision-making process should include comparison of initiatives performance under a variety of potential future scenarios, in order to account for the high uncertainty of climate change. *Key questions to determine performance:* 1. Does the analysis compare the performance of initiatives under different future scenarios? a) Are different future scenarios identified, and are these representative of future possible scenarios? b) Is each scenario accompanied with an explanation of the assumptions, time horizon and likelihood? c) Is each initiative's performance assessed against these future scenarios?	1. There are no alternative future scenarios identified, and/or the default future scenario is not made explicit. a) The process only envisions one single future scenario. b) There is no explanation of the assumptions, time horizon or likelihood of any future scenario outlined used in the process. c) The performance of each option is not compared based on different future scenarios.	1. The process identifies more than one future scenario, but it does not effectively use alternative scenarios to compare the performance of options. a) The process envisions alternative future scenarios, however these are either unrealistic or fail to include important possible scenarios. b) The explanation of the assumptions, time horizon or likelihood of future scenarios is incomplete and insufficient to fully understand the scenario. c) The performance of some options are compared against each scenario, however this process does not compare all options or the analysis is superficial for important alternative scenarios.	1. Multiple future scenarios are identified and potential initiatives are considered against these scenarios. a) The process envisions plausible future scenarios that change key parameters. b) Each scenario is explained in sufficient detail to understand the assumptions, time horizon and likelihood. c) Each option is fairly and rigorously analyzed under different future scenarios.