

Fall 2012

Planning for Sea Level Rise in Portland, Maine using Robust Decision Making as a Guide

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Planning for Sea Level Rise in Portland, Maine using Robust Decision Making as a Guide

Sadie Lloyd

Capstone

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This paper would not have been possible without the on-going support and guidance of Sam Merrill, Director of the New England Environmental Finance Center and Associate Research Professor at the Muskie School of Public Service at the University of Southern Maine. I would also like to thank those at the City of Portland who provided me with important perspectives and considerations that enabled me to critically consider the challenges a city like theirs faces. Lastly, I thank my family and friends for their continuous understanding and encouragement over the previous three years.

I believe in this City's ability to remain vibrant and to maintain resilient communities long past 2100. Here's to that vision.

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ABSTRACT

This paper evaluates the potential for Robust Decision Making (RDM) to guide communities preparing for the impacts of climate change, using sea level rise planning in Portland, Maine as a case study. RDM is a problem solving process that considers multiple outcomes and an uncertain future, and focuses on decisions that provide benefits regardless of which future scenarios develop, allowing for the adjustment of decisions over time to accommodate changes in the future. The flexibility of RDM makes it an appropriate model for decision makers and stakeholders unsure how to address impacts of climate change, an issue complicated by numerous uncertainties. Investigation shows that stakeholders want municipalities to follow an RDM-like process in planning for the impacts of climate change. This study examines how RDM is specifically applicable to challenges decision makers face when attempting to address climate change impacts, explains how stakeholders in Portland were engaged, and analyzes how that engagement shows support for RDM. This paper also provides guidance for Portland going forward and makes recommendations for communities that may want to do something similar.

INTRODUCTION

Planning for the impacts of climate change is a challenge due to the numerous uncertainties involved. There is uncertainty about future output of greenhouse gas (GHG) emissions, which will depend in part on population, human behavior, economic growth, and advances in energy technology. There is no definitive understanding about the severity of impacts communities will experience from climate change, and difficulty in estimating the future value of impacted assets. Climate science and climate modeling, including impact modeling, are works in progress.

Uncertainty can prevent climate change mitigation and adaptation efforts from moving forward, even when stakeholders believe some impact will occur (Mahrenholz 2008). Communities and regions are faced with the choice between preparing sooner or waiting until more precise information is available. Delay action and impacts could be more severe with less time to address them; however, immediate action risks the possibility that impacts are less severe. In fact, unnecessary, costly precautions may have already been put in place (Ingham et al. 2007). The multiple interdependent forms of uncertainty increase the difficulty of deciding whether to act, and in which way. It is unknown what a changing climate means in economic terms (Heal and Kristrom 2002), and there is no way to know how adaptation strategies and economic values will be affected by climate change, or how much mitigation adaptation efforts will provide (Ingham et al. 2007).

Traditional problem solving models can deteriorate in the face of complex futures. Organizations and communities with different agendas and a variety of interests only hasten this deterioration. In response, the best strategy to address uncertainty is one that provides options under a variety of potential outcomes and can be adjusted over time with emerging information. Robust Decision Making (RDM) is a tool to help policy makers and stakeholders make decisions amidst uncertain circumstances. It has potential to be directly applicable to planning processes that have the goal of reducing climate change impacts (Lempert et al. 2010).

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While RDM is often used in computer modeling, its basic principles can be applied to many decision making processes. The RDM process 1) determines which alternatives should be considered, 2) specifies the weaknesses of each alternative, and 3) suggests new or adjusted methods that might better resist vulnerabilities (Lempert et al. 2010). Solutions should focus on multiple approaches that are adaptable over time, account for numerous possible scenarios, and provide benefits regardless of which scenario develops (Lempert and McKay 2011). This approach is seen as working backwards from a traditional model. Instead of predicting the future it considers present actions that could shape the future to the stakeholders' and decision makers' liking.

Strengths of RDM include flexibility, more effective policy discussions (because decisions consider multiple futures instead of one future to formulate plans around), and solutions that are helpful in any scenario. Agreement is more likely to be reached when parties with different expectations and values can focus on actions that will provide benefits regardless of future events (Lempert et al. 2010).

While RDM is a promising model to guide climate change planning, its utility will be determined in practice. The purpose of this paper is to evaluate whether RDM has practical application for a community beginning to plan for the impacts of climate change, in this case, sea level rise (SLR), in Portland, Maine. The results and discussion sections assess the outcome of public stakeholder discussions in Portland to consider whether RDM is an appropriate planning model for the City to follow as they continue planning for SLR, and for other communities that may want to begin a similar process.

METHODS

On July 18, 2011, the Portland City Council unanimously passed a resolution in support of creating a sea level rise adaptation plan (City of Portland 2012a), publicly identifying sea level rise as an

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important issue requiring attention. The resolution states that, according to the data, sea level rise is occurring off the coast of Portland and is expected to continue and accelerate on a global scale, resulting in negative impacts. Additionally, it highlights the vulnerabilities in low-lying areas of Portland, the potential economic, cultural, and social loss from sea level rise, and the interest of the local community to address the issue (City of Portland 2012b).

As part of the work plan ordered by the resolution (City of Portland 2012c), a study was to be conducted by the New England Environmental Finance Center (NEEFC) that would model a no-action scenario (i.e., no adaptation response) and possible actions (adaptation responses). The assessment would model the Bayside neighborhood specifically, looking only at loss of private property from SLR impacts, including storm surge. It would also model costs and benefits of a surge barrier and levee complex in protecting vulnerable real estate in one part of the City (Merrill et al. 2012).

Scenario modeling is one tool that can be used to frame potential impacts from climate change. In Portland, Maine, the Coastal Adaptation to Sea Level Rise Tool (COAST) was used to begin a public discussion about SLR and potential impacts the City faces. COAST mapped lost real estate value from SLR and storm surge (SS) in 2050 and 2100, which could then be compared to lost real estate value if two adaptation strategies were implemented (in this case a hurricane barrier prior to 2050 and a levee shortly after 2050). Model results were not an endorsement of structural approaches, but rather highlighted the need and benefit of considering a range of approaches to protect a variety of assets in the City. Model results included 3D extrusions of lost real estate value to frame the issue, along with an analysis of cumulative expected damage under each adaptation scenario (Merrill et al. 2012).

Inputs for the model were created with base layer data and property values that NEEFC gathered from the City. The COAST model produced visual and numeric results that were then presented to the City and public stakeholders. NEEFC organized the public participation process and conducted the public meeting to discuss findings.

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Representatives from three stakeholder groups planned the public event that would present the results of the COAST modeling and inform the public discussion: NEEFC; Portland Society of Architects (PSA), which hosted an event the year before to examine mitigation, infrastructure, and economic and policy issues (Mainebiz 2011); and the City of Portland.

It was important to the City to review all materials being dispersed to the public if they were going to be involved in the event. A Senior Planner for the City, along with the Planning Division Director, had a large role in shaping questions that would be posed to the public during breakout sessions. They were concerned that if worded incorrectly, the questions would imply the City was solely responsible for taking certain adaptation actions. They also wanted to be clear that at that stage the City was only looking to gather information about the community's perspective and how the public wanted the issue to be approached.

Additionally, a Professor of Planning at the Muskie School of Public Service at the University of Southern Maine, consulted with the group about how to lead the breakout sessions so that discussions would be productive. The goal was to keep people on task, manage conflict (all parties were sensitive to the underlying controversial nature of the topic), and have a meaningful discussion. The group established a list of ground rules every participant would receive and the facilitator could use to keep the group on track if necessary. Four facilitated breakout rooms were arranged.

Flyers were distributed around the Bayside neighborhood to a large number of commercial and industrial locations as well as residential associations, and PSA also distributed it through their networks. The City approved the flyer before allowing their logo to be used, which ultimately distinguished them as supporting the process, and a representative of the City reached out to local papers.

The public event on February 24th, 2012 began with a brief welcome address from the Mayor who voiced his support for protecting the City from the impacts of sea level rise. Peter Slovinsky of the Maine Geologic Survey presented an overview of SLR along with findings from a Back Cove study he had

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recently completed and presented to the City Council. Sam Merrill, Director of the NEEFC, who had overseen and managed the COAST modeling, then described the modeling process and explained the findings. Before breaking into discussion groups, participants were then given time to view and absorb the models (which had been printed and posted in large format) and cost-benefit tables. The purpose behind allocating this was to provide participants with a baseline understanding of the potential impacts, adaptation responses, and financial implications. The models used extruded polygons to show amount of damage (in dollars) caused by SLR and/or SS and helped to frame the topic for the discussion of adaptation alternatives.

Those who attended were not climate scientists or policy experts but members of the community: City officials, Councilors, architects, planners, engineers, non-profit representatives, and citizens-at-large. While some participants may have been familiar with the topic, for others it was the first time thinking through the problem. Participants were broken up evenly into four groups. Each person was given a sheet with breakout group discussion questions. It also listed ground rules for participating in the discussion:

1. This is not a debate about climate change
2. Let one person speak at a time
3. Stick to the questions at hand
4. Be concise and specific
5. Don't debate others' points
6. Maintain adaptation focus

Given the controversial nature of the topic, rule one was especially important. Each group also learned about the four adaptation approaches available to those concerned about impacts of SLR and SS on real estate. These options are:

1. Fortify assets (hard structures)
2. Accommodate more water (soft approaches)
3. Relocate assets (many approaches)
4. Do nothing

Each group also received three questions to discuss:

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1. *Which* of the four approaches should we take in response to sea level rise/storm surge regarding private property in Back Cove?
2. *Who* is responsible for implementing a response to sea level rise/storm surge regarding private property in Back Cove?
3. *How* should a response be implemented (financial, regulated, managed)?

A time limit for the discussion of each question was established and detailed notes were taken. After the public forum the facilitators met to discuss trends, subtleties, and important points that arose in the discussions they led.

To determine whether public response indicated RDM would be an appropriate guide for future SLR planning in Portland, a literature review on RDM was conducted. Themes from the public discussion were compared to themes that define RDM to identify similarities and make recommendations.

RESULTS

The COAST model showed that the City will be at risk in 2050 and 2100 and is currently vulnerable to severe storms. Significant damage from SS is expected even if no SLR were to occur, increasing when SLR was included in the 2050 and 2100 scenarios. Higher sea levels and more intense storms resulted in more projected damages. COAST projected that nearly all damage would be avoided if the adaptation actions modeled were taken (Merrill et al. 2012).

COAST was an effective tool for starting the public discussion; after the presentations, participants were able to consider the adaptation questions. Despite the groups being separated and having a mix of stakeholder types in each room, similarities in the discussions emerged (Appendix A).

In the discussion of question one (“which of the four approaches should be taken?”), two major themes appeared across groups. All groups felt a response to SLR/SS would require multiple approaches, and that timing would determine which approach to take. For example, group one felt that accommodation might make more sense in the near-term, but that longer-term and closer to 2100,

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relocation was reasonable. Group two felt the City's planning approach needed to be long-term and agreed that accommodation was a near-term strategy, but unlike group one, felt relocation was better sooner in the process rather than later. Group four strongly favored fortification and accommodation to relocation or doing nothing. While there may have been differing opinions on which approach was best, all participants thought any plan should consider multiple approaches over time.

Other common themes from question one included the need for plans and strategies to be adaptable (especially when better or more information is available), the role of regulation and policy changes (zoning, building codes, etc.), and education being an on-going part of the process.

Across all groups there was general consensus that multiple parties should be involved in planning a response to SLR/SS. Several groups recommended partnerships between stakeholders. All thought municipal government had an important role in managing a response. Group one thought City government was responsible for infrastructure, and private owners were responsible for their own properties, and saw a need for public/private/community partnerships. Group two thought City government was responsible for developing and implementing the adaptation plan, and the public was responsible for public health and welfare. Group three thought City government would not become involved until the local community had started the process themselves, but agreed this would lead to a partnership.

All groups discussed the role of insurers and banks, which many thought would "drive the ship" because of their role in development, but some in group three wondered whether current requirements in the insurance industry were aggressive enough and what their long term interests were. Group four thought cooperation would be required between the City, developers, and insurance industries, and some thought that along with the City, financial and insurance companies had a role to force developers to bear adaptation costs.

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Two of the groups identified the responsibility of developers, suggesting the development community has some responsibility for creating resilient public infrastructure, and that infrastructure costs be balanced between the developer and the City. Group four thought engagement with the development community would inform planning and regulations.

Three groups identified that SLR/SS would affect more than just the City because it is a regional and even international issue. People thought it would be appropriate for the State and/or Federal government to have a role in planning and even cost-sharing on adaptation action, but most thought it was unlikely that either would participate. It was the opinion of some that FEMA had responsibility because they manage flood hazard mapping, but that if left up to FEMA, there would be no response. There was widespread distrust of upper levels of government to help communities grapple with and plan for these issues.

Much like responses to question one, all groups thought a response to SLR/SS would require a mix of strategies (most groups felt that building regulations would be part of the equation). Even those groups unable to detail each strategy thought a single approach (for example, just financing, or just regulation) would not be sufficient, and ultimately, while group four was unable to reach agreement on how accommodation and fortification would be implemented, they thought a combination of regulations would be needed, along with financing from Federal, State, local, and private parties. They envisioned an investment strategy that would evolve over time based on what the community valued. One group concluded it would take a mix of strategies for how to respond and that a response would need to be incremental, allowing the City to adapt over time. This would help the City be less vulnerable to unfavorable consequences of certain adaptation responses that could arise as climate conditions continue to change.

Group three determined that certain hazards would require specific regulatory responses, but that any response should integrate financial, regulatory, and managed approaches. However, they

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thought the uncertainty around risk was an important issue to address before creating a plan; it was their opinion that hazard levels would need to be identified and mapped more thoroughly than has been done to date so that better decisions are possible.

Participants overwhelmingly agreed that the selected mix of approaches would need to change over time, based on estimated damages and changing conditions. They thought no party was singularly responsible for action but that everyone affected would have a role, and a response should be implemented by multiple parties working together. They thought that an adequate response would take financial, regulatory, and managed approaches, and that the City of Portland would need to lead and coordinate the adaptation planning process and response (Appendix A). Participants understood that SLR and SS projections were not perfect and many of the participants considered this during the discussions.

None of the participants were presented with the concept of RDM or a similar process, but their question responses mirrored the RDM process. Notably, in the first question, groups thought it was important to not focus on just one approach, but a mix of adaptation approaches, a key aspect of RDM. They thought the approaches would be determined by how far into the future one looked (presumably the situation would be more extreme further from the present). Groups were more in favor of accommodation in the near term, but thought that as a long-term strategy it was not as sound as relocation. Also, the farther into the future they looked the more likely they were to consider what were perceived as more extreme approaches.

Focusing on more than one approach allows for adaptability of a sea level rise response plan over time. Adaptability is another key aspect of RDM, and it was a common theme throughout each of the discussion questions. Participants were focused on timing. Model results showed that potential major impacts from SLR/SS were not going to occur in the next few years, and those that would occur by 2050 were going to be considerably less severe than those that would occur by 2100. Their potential

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solutions took this into account. By allowing approaches and strategies to be implemented over time it allows for both the plan and the response to change if outcomes turn out to be different than what was predicted (or information used in predictions changes and becomes more precise). Group one, for example, thought it would be less of a commitment with fewer consequences to “accommodate” in the short-term, but when the situation worsened in later years, it would be safer and more cost effective to relocate. Should actual scenarios turn out differently, policy and decision makers can adjust the plan before costly or prohibitive responses have been put in place, as well as consider new responses that may not have been available in the past.

Groups chose not to select one approach to implement because it is unknown which scenarios will develop, and they wanted a response that would be helpful in a number of possible scenarios. This mirrors the third important factor that defines RDM, that decisions should consider multiple potential scenarios.

Comparing conclusions that emerged from the public discussion to RDM theory illustrates that stakeholders want the City to lead an RDM-like process. This provides preliminary evidence that RDM can be a useful tool to guide climate change planning.

DISCUSSION

Determining how the community wanted a SLR adaptation response to be structured would not have been possible without a public involvement process. Developing sustainable responses to the impacts of climate change involves all societal stakeholders (Lorenzoni et al. 2007). It is important to include public participation in any climate change planning effort because climate change is an issue that affects quality of life of those now, as well as that of future generations. Effective participation processes empower stakeholders and encourage community leadership, while decision making

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processes that foster public participation are more transparent (Braun 2010). However, governments have, at times, been reluctant to involve the public in the climate change discussion because of fear of political resistance, a close relationship with industries who support the status quo, a history of valuing development and prioritizing economic growth, and the lack of responsibility taken by those with short elected terms (Lorenzoni et al. 2007).

Participation should be explored as a way to guide decision making, not just garner support for existing practices and decisions. Ultimately, inclusion can lead to greater consent from everyone involved, and can help define community priorities. More recently, a call has been made to include participation in climate change planning because, at least for now, a majority of adaptation efforts are happening on a relatively local scale. This is because approaches are usually place-based and centered around local needs and implications that require a local knowledge base (Few et al. 2007).

In Portland the COAST modeling tool was effective in starting a discussion with the public, which was the City's goal. Using a model that presents relative damage and avoided costs, especially with impactful visual aids, is helpful to start the conversation, despite uncertainty, which has been a significant roadblock. It also provided information that was not apparent before (such as the role of SS in no SLR scenarios; see Merrill et al. 2012). For example, even if SLR does not occur and sea levels do not change SS will impact low-lying areas of the City, resulting in some economic loss if no response is implemented. Because storms are projected to increase in frequency (Borenstein 2011), SS will be a problem the City faces. That Portland is already experiencing flood events helps convey the reality of the situation.

It is helpful to examine the public forum process to determine whether it was effective in gathering public opinion. Prior to holding the forum the planning group determined it would be best for facilitators to manage the discussion so that it stayed on the topic of private property in Bayside, rather than considering all vulnerable assets and all low-lying areas. This was to simplify the discussion and

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provide information the City could use to inform adaptation planning, keeping in mind that it was the first time most people were approaching the topic. However, it turned out that discussions run with less structure, allowing participants to talk on a larger scale (City-wide and including all types of vulnerabilities and assets), enabled participants to consider the topic more thoroughly and come up with clearer answers. These discussions did not become unproductive as had been feared. Conversely, rooms that were restricted to talking only about the parameters that were modeled had a harder time thinking beyond basic responses.

While a concerted effort was made to vary stakeholder types in each room, some had a greater variety than others. Those with more variety had more productive discussions. It may be worthwhile to examine this further, and explore possibilities for ensuring highly mixed stakeholder groups in future discussions.

Once the City evaluates conclusions from the public discussion it will need to communicate to stakeholders (those already involved and those that would like to be involved going forward) about where Portland is in the planning process. If they have not pursued the topic further since the public meeting they should indicate as much. They should also communicate to stakeholders what information from the public discussion they will use to inform the adaptation plan, what opportunities will exist for the public to get involved in the future, and whom the public may contact if they have questions or want to get involved.

Based on public response, and using RDM as a framework, the City of Portland now has useful information to help them begin a SLR adaptation plan. The plan should include multiple approaches. In this case, the majority of breakout groups favored accommodation in the near term. This includes building requirements like putting parking on the first level of a building or adding fill to raise a building lot. Parking on the first level allows for some flooding without compromising homes or businesses. Raising a lot avoids flooding altogether. This is a robust solution because it will provide benefits even if

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SLR does not occur or does not rise to projected levels, and because certain low-lying areas are already experiencing flooding during high tide events.

Some groups encouraged the City to consider relocation at a later date. Together with accommodation, these mixed approaches increase flexibility and adaptability over time without prematurely committing extensive resources. Accommodation will protect public and private assets now and for a moderate amount of time into the future, which will allow the City to consider options for more extreme storms and inundation (engineering will also be advancing and new adaptation responses developed). Should it become clear that relocation is not necessary, costly measures will have been avoided and homes, businesses, and other community spaces spared. If it becomes clear that future impacts are more severe, however, the plan will already allow for a more drastic response.

Stakeholders in Portland want to see the adaptation planning and response include a mix of stakeholder types. There was little private business representation at the forum and none at the event held by PSA the previous year. Several businesses along marginal way are vulnerable to the threat of SLR/SS; this is a group has a stake in the future of Bayside and therefore a responsibility. Other important stakeholders include banks and insurers (because of their current roles in leading and underwriting adaptation responses to potential flooding) and the development community (because of their role in shaping new development). It could be argued the development community has a responsibility to build resilient homes and businesses. The City should invite these important groups to be a part of a planning process that will capitalize on their knowledge and practices, and to advocate for resilient, responsible development.

Portland should follow the format they used to engage stakeholders in stormwater financing issues in 2011 and 2012 as a model to collectively work with numerous interests in SLR adaptation planning. To address how the City would finance required stormwater infrastructure improvements, they formed the Sustainable Stormwater Funding Task Force made up of City Council representation,

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property managers, neighborhood association representation, residential and non-profit property owners, advocacy groups, local citizens-at-large, City and State officials responsible for public infrastructure, and business owners. This group met once a month and talked about how potential solutions would affect the different interests in the room and how they would be perceived by the general public (City of Portland 2012d).

A Sea Level Rise Adaptation Task Force would include the same stakeholder types as well as City Planners, engineers, and architects (many of whom are already engaged as a result of the forum) and follow the same schedule, meeting once a month. This would provide a mechanism to involve regional and State stakeholders, a priority many groups highlighted during discussions. A line item for adaptation planning will need to be created in the City budget. One aspect of the task force's role (aside from helping to form the adaptation plan) would be to make the case for funding, how funds would be used, and the efficient use of those funds (for example combining relevant adaptation and stormwater infrastructure improvement projects). This group will need to operate under the assumption that decisions be flexible, adaptable, sensitive to time, and robust (they will provide benefits regardless of amounts of SLR/SS). The flexibility of considering multiple approaches at the same time, numerous possible outcomes, and the value of a solution that provides benefits regardless of what occurs will facilitate agreement, because multiple considerations and concerns are reflected in decisions, as opposed to debate over one decision stalling the process because of differences in values and expectations (Lempert et al. 2010).

The adaptation plan to be produced should include both regulatory and financial tools. A combination of regulations, such as more restrictive permitting, building codes, and site planning to avoid or deliberately allow for minimal flooding, will help protect new development, while financing from Federal, State, local, and private resources may be directed towards existing infrastructure (including public) adaptations.

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Stakeholder discussion groups at the forum were in agreement that the City needs to lead and manage adaptation planning rather than advise it. This is in part because the City needs to be sensitive to all stakeholder interests and because of the underlying responsibility of a municipality for the communities within its jurisdiction, whereas no other stakeholder inherently carries this City-wide umbrella status.

While one public meeting does not provide enough information to create an adaptation plan, it did provide areas of focus and specific approaches to consider. It is a positive outcome that the public supports a flexible, adaptable process rather than expecting policy makers to find one solution. Public support for an RDM-like process not only highlights the tool's potential value, but provides the opportunity to begin adaptation planning with support for decisions that are meant to account for uncertainty by allowing them to change over time. City officials now have information about the relative costs and benefits of several adaptive responses to SLR/SS, and how the community would like to see the response structured. City staff should act on these results while momentum is present in the community.

RDM and lessons from the public process in Portland have application on a global scale as well. The modeling process, combined with organized public participation, helps address a number of issues that have historically prevented communities and municipalities from addressing SLR, issues that can be applied to many climate change planning challenges. Because the problem has been narrowed to the local scale that matters to them, communities can begin to discuss which assets they value and what types of responses they think are the best fit. Even though we do not know the future value of private property, economic loss to those properties from SLR/SS events, or the future cost of implementing adaptation strategies that may be chosen in the future, the COAST approach provides a clear picture of where the largest losses would occur and whether the adaptation strategies would significantly reduce the impacts. This type of modeling (different from simple 2D inundation mapping, which does not frame

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impacts in economic terms, but shows only the amount of flooding), enables stakeholders and policy makers to begin discussions *despite* present uncertainties, *and* in light of them. It enables communities to begin RDM. Low-lying communities facing impacts from SLR and SS (or on a broader scale, other types of climate change impacts such as high heat days) that have previously been crippled by the numerous uncertainties inherent to climate can use COAST or a similar model to begin a public discussion.

In starting these discussions jurisdictions can use a similar approach to frame a public discussion and gather the same type of information. Questions and guidelines that the forum planners used provide a reference for other municipalities to work with.

The process in Portland presents preliminary evidence that RDM is a good planning method in practice and will help other communities make decisions about how to address the impacts of climate change. Stakeholders can use RDM to structure their decision making process by requiring that adaptation strategies incorporate a mix of approaches; select approaches that provide benefit regardless of severity or occurrence of impacts; and identify solutions that take multiple outcomes into account.

CONCLUSION

Planning for climate change is a complex task with multiple uncertainties. Uncertainty can produce a lack of confidence in decision makers who might refrain from irreversible decisions because of the prospect of information becoming available later. The belief that there will be greater knowledge over time may lead to less action now. Some uncertainty will be eliminated through further research (Ingham et al. 2007), and planners and stakeholders will need to measure adaptation options against assessed climate change impacts and potential risks (Mahrenholz 2008). Also important is that

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estimated damages in 2100 are unlikely to occur on account of ongoing adaptation: as the risk grows and inundation events increase, property owners and City government will likely take adaptive measures (Merrill et al. 2012).

RDM is a problem solving framework that allows decision makers to determine strategies that are right for their communities despite uncertainties. Because of uncertainty, plans need to be continuously adjusted over time to account for better information and changing scenarios. In many ways the factors defining RDM are similar because they emphasize creation of adaptive capacity, best determined by flexibility in the face of unexpected outcomes (Pelling 2010). Places are less able to adapt when solutions are measured against current conditions or a predicted future that is inherently uncertain. Being able to transition over time indicates a greater resiliency and adaptive capacity. Communities that use RDM principles are likely to create a flexible response system and augment their adaptive capacity, whereas those that create responses based on rigid predictions are likely to have more difficulty adapting should the future be different than expected.

Adaptation planning is a complex process. Stakeholders bring different values to the table and represent a range of agendas. Monetary concerns, the relatively brief length of political terms, and a lack of certainty about the future all contribute to decisions not to take action. Fear of the most severe consequences from climate change, evolving science that slowly becomes more certain, and the desire to save money in the long-term with comprehensive planning motivates decision makers to consider actions that are most likely to provide some level of benefits to their communities. Uncertainty cannot be a reason for delaying decision making, but should incite policy makers to look at ways to make robust decisions (Celino and Concilio 2011).

Preliminary investigation shows that RDM has practical application, and may be a useful tool to guide jurisdictions through adaptation planning. RDM is a different way of approaching problem solving that encourages all parties to focus on common goals rather than opposing factors. This process will

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provide a framework moving forward, and accommodates continued learning over time, leading to stronger, more thoughtful solutions. When the impacts from SLR and SS become apparent over time, the need for communities to address them grows more urgent.

The case of sea level rise planning in Portland, Maine presents evidence that involving the public can provide useful information for municipalities that may want to create an adaptation plan, and that the public wants to see an RDM-like process. Results from the Portland COAST study emphasize the potential for RDM to guide plan making, policies, and decision making. They provide a framework for groups to address a complex, seemingly unsolvable problem, even if some parties come to the table with opposing opinions, and to do so in a way that not only considers the needs and constraints of current society, but allows decisions to be changed in the future, encouraging ones that provide benefit regardless of which future scenario emerges. This case study illustrates a method that can not only start the planning process, but guide it through discussing uncertainty and complex scenarios.

Appendix A

Sea Level Rise Public Discussion in Portland, Maine held February 24, 2012

Summary from break out groups

Prepared by Sadie Lloyd

April 26, 2012

Group 1, Room 205, question 1

Initially there was a lot of uncertainty among the participants in group 1. There was preliminary discussion about what the four approaches to addressing sea level and storm surge inundation were that some of the other groups did not require. There was also a fairly high level of resistance to answering the questions at first because of the challenge the group had with understanding the concepts. It was clear that this was the first time many of the group members had been introduced to the information that had been presented prior to the break-out sessions. It may have been helpful for them to have been part of a preliminary conversation where they could have asked more broad questions about the data and implications of sea level rise and storm surge. Eventually, the group was able to move on to the first question.

The discussion for question 1 included a wide range of opinions. All of the approaches were suggested as potential responses to sea level rise/storm surge in the Bayside neighborhood, with the exception of “do nothing”. The approaches most commonly brought up were accommodate (soft approaches), followed by fortify, and then abandon/relocate. Some people felt certain approaches should not be up for consideration, like abandonment. There was some agreement that going forward there should be no new development in Bayside. Twice it was brought up that regulations would have to be used to direct development, and that current regulations would need to be adapted. Someone pointed out the need to address infrastructure, and multiple people talked about the need for adaptability over time.

Collectively the group landed on a mixture of approaches. They felt that timing was an important factor, and which approach taken would be dependent on a timeline; not all approaches would be appropriate at any given time. For example, accommodation might make more sense in the immediate to near-term, but as 2100 gets closer, when storm inundation is more severe, relocating could be the reasonable response.

Group 1, Room 205, question 2

The discussion about who was responsible for implementing a response was similar to question 1. The ideas that came out included a diverse group of stakeholders. Some felt that FEMA had responsibility because of their current role in flood hazard planning, but that if left up to them there would be no approach. Other people suggested city government was responsible as well as insurance companies and banks because of their role in enabling development to happen, the private sector operating and developing in the Bayside neighborhood, and even the community and general public. The group then talked through what the current role of each of these groups was.

This question led the group to discuss some bigger issues they were thinking about. In particular, they talked about education and that local government should use events that have already happened (like the Patriots Day Storm) to highlight the need for action. This might include something like a media campaign. It was suggested that the City/community could not afford to stay and fortify, so which

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approach was taken might affect responsibility. One of the group members made the point that who they *wanted* to be responsible was not necessarily the most effective solution. Some felt that the variability of the data had an impact on what to do and who was responsible; the most extreme situation would potentially call for a different set of actions and players than the least extreme.

Ultimately, the group decided that responding to sea level rise/storm surge would take a public/private/community partnership in part because a group approach would save money, and because those who had a stake should have responsibility. The City had a responsibility for infrastructure and private owners were responsible for their own properties. While it was unclear what the community was responsible for specifically, the group felt they should have some role because it is their neighborhood.

Group 1, Room 205, question 3

The discussion moved to how a response should be implemented and someone suggested having a TIF district in Bayside that would apply to vulnerable properties. Some implementation required a government response, which might include regulations on buildings. It was the opinion of some that the government wouldn't pay and so the community needed to push for policy to be formulated and for the funds to implement the chosen response. Discussion then moved to management of utilities and infrastructure and the responsibility of relevant parties to manage those. The group questioned whether the saved properties would generate enough income to justify protecting them (the issue of affordability), which led to tax equity and beneficiary questions.

Some felt, because of the role insurance companies are already playing in building accommodations, that they would be the leader in implementing approaches. Some felt it was difficult to determine how implementation should occur before an approach was selected and who was responsible had been established. Despite the range of topics that came up the group did conclude that the City should lead and manage any implementation but with local collaboration of public and private stakeholders (including tax payers and utilities).

Group 2, Room 203, question 1

This group felt that private property should not be looked at separately from other assets like infrastructure, and that the City should look at all of the vulnerable assets together because they are connected. As an example, it was pointed out that the new stormwater storage tanks that will be installed under Baxter Boulevard could be inundated by sea level rise and/or storm surge, which could potentially impact homeowners.

Someone voiced support for a "Portland of the future" and the need to approach this as a long-term planning project that considers 25, 50, and 100 years out, acknowledging that what will be important at those times may differ. Down the line the City and community may look back and wish they had made decisions now.

There was a lot of discussion in this break out room about relocation. They felt that now was the time to identify properties most at risk and the possibility of incentivizing relocation for those property owners. In this buy out/financial incentive to retreat model the best financial deals would be given to those who left earlier. This was seen as a short-term model. Additionally, it was suggested that zoning be adjusted to prohibit new construction in the flood zone.

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One person saw Maine (and even Portland) as a place that still had a lot of space to build on in non-vulnerable areas, further justifying retreating and relocating. In regards to property/assets with the highest value (historic, aesthetic, recreational) the group thought fortification was appropriate to consider. Accommodation was considered for recreational purposes only around Back Cove, where a landscape like wetlands could absorb sea water, and Baxter Boulevard re-engineered to allow recreation but not motorists. There was skepticism about hard fortification and a preference to avoid it. They discussed elevated construction and the possibility, as well as the consequences, of building on stilts. They came back to the point about infrastructure though, and that despite different building standards there were still things like sewer and roads that would need to be considered.

In summary, for the question of which of the four approaches should be considered, group 2 generally agreed that a mix of approaches was needed depending on the time frame. Which asset was being looked at would determine which approach would be taken. They felt relocation was key in the short term with soft fortification (especially of most valuable and vulnerable assets) also playing a role. They felt strongly that the City needed to take a long-term planning approach.

Group 2, Room 203, question 2

While discussing who was responsible for implementing a response, group 2 specifically called out private citizens, municipal government, and the local community. The municipal government would be interested in protecting its tax base, and the State will have a strong interest in protecting the City. They pointed out that certain responses (like building a hurricane barrier under Tukey's Bridge) will involve substantial regulatory review at the local, state, and federal level (including players like DEP, Army Corps, and FEMA). While they felt it was unlikely the City could get money from the State or Feds, they believed that cost-sharing should be part of adaptation planning and response. It was pointed out that bankers and insurers would have an influence whether they were asked to or not.

Group 2 felt that ultimately the public was responsible for public health and welfare, and that the City (with public input) was responsible for developing and implementing an adaptation plan. They thought that banks and insurance companies would "drive the ship", and because help from the State and Feds was unlikely, it would take local action.

Group 2, Room 203, question 3

In order for the City to implement a response the group concluded that the City needed to first do an overall adaptation plan because of the numerous variables at play. They again pointed out the need for mixed approaches as well as incremental approaches that would allow the City to adapt over time, because things would keep changing. Similarly to question two, this group felt that banks and insurers would lead the way and beat government planning to a response. They questioned whether the state could help somehow. Part of the implementation would be regulatory (like having building restrictions in flood zones) as well as incentives for things like elevating structures and relocation. Someone commented that there was not currently money in the City planning budget for adaptation planning or implementing responses, and so the first step was to develop line items. They also talked about the problem of people not seeing sea level rise as an issue.

In summary the group wanted to see mixed approaches incrementally implemented. Public process should determine specific implementation steps. Implementation would likely include financial and other incentives, regulation, and education, with possible cost-sharing strategies with State and Federal funds.

Group 3, Room 211, question 1

Right away group 3 established their belief that sea level rise trends would continue past 2100, and acknowledged the possibility of learning in a year or two that future sea level would be higher than expected. They questioned whether there was a single correct response or if it would take an array of strategies. They felt there were a number of needs that once addressed would better inform which approach to take. They felt hazard maps that clearly showed where and what the risks were would be important going forward. These maps would hopefully be developed with the Feds and FEMA. Once an agreement was reached on the risks then the maps could be developed and the planning process started.

There were differing opinions on which approach to take. They indicated the possibility that zoning and land use changes were needed. Someone questioned if bayside should just be filled again, and some wondered if any action should be taken at all but instead let people do what they want and abandon when the time comes. Those representing the design community were much more passive to hard engineering approaches. The group felt fortification was appropriate in the short-term, with the possibility of including accommodation, although appropriate timing was questioned. Specific responses were suggested, like raising the trail around Back Cove and prohibiting certain land uses and creating adaptation tools through ordinances and regulation. The importance of flexibility and adaptability came up numerous times. While softer approaches were considered to be ok in the short term, continued adaptation would be key in the long-term. Likewise, ongoing education while land is developed and redeveloped would inform a continual learning process.

Some of the concerns this group discussed were whether it was possible to defend filled land (due to the geological uncertainty of filled land) and what types of engineering challenges this might pose, as well as unintended consequences that could result from blocking water in one place. They wondered if the private sector would have expectations of the public sector in terms of protection.

In summary, the group agreed that the correct approach would be multi-faceted and iterative to accommodate a range of sea level rise/ storm surge events over time, involving education, policy, and infrastructure.

Group 3, Room 211, question 2

The group grappled with some big questions during this part of the discussion. A lot revolved around the question of who was responsible in general, and whether the City was responsible for protecting private development in Bayside, and who can make the decision that land cannot be further developed (who champions public good over public interest). More overarching questions were: who are we as a community? How do we choose what to protect in that context?

Delving further into the question of who is responsible there was agreement that those receiving the benefits of any approach taken, like those developing in low lying areas, should contribute towards protection costs, such as having a premium to build in a hazard zone. There was a fair amount of discussion about the insurance industry and whether current requirements are aggressive enough. They saw that insurance companies are already requiring development to adapt, but wondered what their long-term interest was and if they are involved in addressing the risks with 20, 40, 60 year models.

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Group 3 felt the City should take the lead but that there would be some public/private relationship involved. They felt that because regulation had not caught up with science, the government was responsible for the education needed and that it could be a mechanism to keep a dialogue going as decisions are made now. They believed that current regulations were based on information that was no longer accurate, and people with knowledge needed to go into neighborhoods.

This group summarized that the local community would be the driver at the grass roots level to begin the process and the government would follow and be a part of a mixed partnership. They felt that education and knowledge sharing was important among private development firms, the design community, higher education and research institutions, and all levels of government. Lastly, they added that the development community has a responsibility for the development of resilient public infrastructure because it protects or enhances their resilient public investment.

Group 3, Room 211, question 3

In addressing how a response should be implemented the group voiced concern that because the development community is not looking long-term there is a disconnect with development and what the sea level/storm surge data is telling us. They felt that hazards such as unstable soils may need a regulatory approach and that any response should be implemented carefully by various entities depending on which approach is taken. Any response would take a synthesis of financial, regulatory, and managed approaches.

The group then talked about risk. They believed that gradations of hazard would need to be identified, and then information created and disseminated about risk levels so that they could be better understood. Additionally they felt a hazard map should be created for educational purposes, assuming that better information would lead to better decisions. In summary, group 3 saw the first step to implementing a response as developing and disseminating hazard maps.

Group 4, question 1

This group was less concerned about education and information regarding sea level rise and were more politically oriented. They talked through and saw room for various approaches, but felt that fortifying assets and accommodating more water were the most practical, where as doing nothing and relocating were more problematic. It was suggested that there is the desire and purpose in developing urban spaces like Bayside. Some in group 4 felt that 75% of the problem Bayside is now (and would be) facing was poor planning, and when considering doing nothing as an approach wondered whether neighborhoods could survive without taking action. Seeing abandonment of Bayside as a poor option, accommodation was preferred through actions like elevating roadways (and other infrastructure) and buildings. The engineers' perspective was seen as preference for fortification, like a surge gate. They acknowledged this appeal but felt accommodation would be a better long-term approach. They felt it was important to consider infrastructure across entire communities rather than by individual properties.

The tipping point was a concept of discussion that would necessitate the needs for strategies that would change over time. This group came to the conclusion that a dynamic approach would focus on fortification and accommodation because they were the most amenable. They believed relocation to be inconsistent with other policy goals and doing nothing was not "smart". Fortification and accommodation would need to happen at various times and be location specific.

Group 4, question 2

Determining who was responsible for implementing a response brought up a number of ideas. Some felt the City had a role, with the help of financial and insurance institutions, to force developers to bear adaptation costs. Others felt that zoning needed to be consistent and address infrastructure needs, where costs would be balanced between the developer and the City. This led to the suggestion of a private/public partnership and the notion that joint responsibility was critical. They questioned whose responsibility it was to initiate a cooperative relationship and/or dialogue. Regardless, cooperation would be required of the City, developers, and insurance companies. More broadly, they thought cooperation should include parties that can provide expertise and perspective, including architects, engineers, the real estate industry, and neighbors.

They saw the potential for planning and regulations to be informed through engagement with the development community to assess economic/market feasibility to absorb costs on a per project (or building) basis, versus fortifying public infrastructure on an area basis. It was acknowledged however, that meshing project by project accommodation strategies with existing conditions was a complex problem. The group questioned how evaluative judgments would be made, by whom, with whose input and engagement, thinking ultimately that it would be a complex decision process to reflect dynamic response strategies.

On a less specific scale someone brought up the fact that people are resistant to change/relocating and prefer to be on the coast and in urban areas. More specifically, there was concern for who would help those already in vulnerable areas. Some felt it was time to revisit planning costs for Bayside and Back Cove through a community engagement process like the Bayside charrette held in 2000. One participant thought that Bayside already had a TIF district and perhaps it could be targeted to adaptation costs for infrastructure or building costs.

Lastly, many felt Bayside should be seen as a super-regional resource with its importance to the state as a whole considered. They saw the possibility to put responsibility in the hands of a voluntary cooperative group that would include all levels of government. Some, but not all, felt that the City had a role in structuring a regional financial framework to capture a broad range of beneficiaries.

Group 4, question 3

Group 4 felt that any implemented response needed to consider the appropriate scale (regional, watershed, or estuarine systems, for example). Suggestions for implementation included:

- a tool kit with the combination of a TIF program and zoning to set physical building parameters, restrictions, and design implications
- an overlay district with a form based code approach to provide clarity to developers with costs offset by a TIF
- zoning to phase out buildings (and begin relocation) over time
- form based codes to allow buildings to accommodate sea level rise over time
- statewide financing mechanism (like a transfer or gas tax) for multiple communities to draw from
- not using form based code, but other, less rigid regulatory programs

One participant talked about the high percentage of Maine's economy generated by the Greater Portland region, and if this area experiences substantial economic loss (including development

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potential), there will be economic impacts to the State as a whole. That being said, it was mentioned that a statewide effort would not sell if it was perceived as only benefiting Portland.

While the group could not reach consensus on how accommodation and fortification would be implemented, they felt it would take some combination of regulations, with financing from Federal, State, local, and private parties. They saw a dynamic investment strategy that would evolve based on the value of economic assets (over time) with justification for investment based on derived community wide value.

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