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The political complexity of coastal flood risk reduction: lessons for climate adaptation public works in the U.S.

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Abstract

Coastal climate adaptation public works, such as storm surge barriers and levees, are central elements of several current proposals to limit damages from coastal storms and sea-level rise in the U.S. Academic analysis of these public works projects is dominated by technocratic and engineering-driven frameworks. However, social conflict, laws, political incentives, governance structures, and other political factors have played pivotal roles in determining the fate of government-led coastal flood risk reduction efforts. Here, we review the ways in which politics has enabled or hindered the conception, design, and implementation of coastal risk reduction projects in the U.S. We draw from the literature in natural hazards, infrastructure, political science, and climate adaptation and give supporting examples. Overall, we find that 1) multiple floods are often needed to elicit earnest planning; 2) strong and continuous leadership from elected officials is necessary to advance projects; 3) stakeholder participation during the design stage has improved outcomes; 4) legal challenges to procedural and substantive shortcomings under environmental protection statutes present an enduring obstacle to implementing megastructure proposals.

1. Introduction

Climate adaptation public works (hereafter, adaptation works) are engineered, structural infrastructure projects, initiated, designed, and implemented by governments, with the intention of reducing the economic and social burden of climate change. For example, rising sea levels (Sweet et al., 2017), expanding coastal development (Crossett et al., 2013; Neumann et al., 2015; Titus et al., 2009), and recent hurricane disasters have encouraged several U.S. cities

to investigate strategies for managing coastal floods, including adaptation works such as levees, storm surge barriers and other megastructures (Table 1)(City and County of San Francisco, 2016; City of New York, 2020; GCCPRD, 2018; Sustainable Solutions Lab, 2018a; USACE, 2016, 2018a, 2018b, 2019, 2020b, 2020a). These risk reduction strategies have proven to be technically and economically viable options for densely populated areas to manage sea-level rise and coastal flooding (e.g., the Fox Point Hurricane Barrier in Providence, Rhode Island; Fig. 1) (J. C. J. H. Aerts et al., 2014; Douglas Hill et al., 2012; Jonkman et al., 2013; Kirshen et al., 2020; Merrell et al., 2011; Mooyaart & Jonkman, 2017; Morang, 2016; US National Research Council, 2014). Densely populated regions often lack the space to take advantage of nature-based approaches (e.g., beach widening and wetland restoration) and other coastal adaptation options (e.g., managed retreat, informed land-use planning, building codes, and insurance) can conflict with local development goals. While there are several plans for storm surge barriers, sea walls, and levees in the U.S. (Table 1), few have broken ground, even when technoeconomic analyses by entities such as the U.S. Army Corps of Engineers (USACE) indicate that they are technically feasible and economically beneficial. A better understanding of the political and social factors that determine whether coastal risk reduction efforts succeed or fail could allow future adaptation works to be designed and executed in a more efficacious and less costly manner.

Existing research on why plans for adaptation works ultimately break ground, or not, focuses on identifying complex processes and interactions and classifying them into various adaptation barriers or enablers (Oppenheimer et al., in press). Moser & Ekstrom (2010) define adaptation barriers as "…impediments that can stop, delay, or divert the adaptation process" (Biesbroek et al., 2014; Eisenack et al., 2014; Klein et al., 2014). These barriers have been identified at stages in the project cycle related to conception, design, and implementation (Figure 2) (Moser & Ekstrom, 2010). Among these hinderances are political factors such as those that discourage support from elected officials (Healy & Malhotra, 2009; Jacobs, 2016), environmental laws (Bligh, 2006; Buzbee, 2014; Kagan, 1991; Kysar & McGarity, 2006), governance structures (Lubell, 2017), and social conflict resulting from interactions between diverse groups, organizations, and communities with heterogenous values, beliefs, interests, and influence (Adger et al., 2009, 2013; Dolšak & Prakash, 2018; Eakin et al., 2017; Eriksen et al., 2015; Leiserowitz, 2006; Sovacool & Linnér, 2016). In addition to barriers that can hinder adaptation works, enablers have been put forward as a way to overcome some of these challenges (Dutra et al., 2015; Dyckman et al., 2014). Examples include stakeholder participation (Kirshen et al., 2018; Löschner et al., 2016; Pasquier et al., 2020) and improving coordination between government agencies (Rabe, 1995).

While assessments that identify conceptual barriers and enablers are important, a remaining key challenge is determining which barriers are likely to manifest and under what contexts, as well as ascertaining which enablers would effectively address them. Specificity matters, because the objective and physical size of an adaptation works project are likely to influence which barriers are encountered in the policy process and also determine the ways to overcome them (Moser & Ekstrom, 2010). For example, large infrastructure projects ("megaprojects") inherently have broad scope and thus impact diverse groups of citizens through, for example, urban land-use changes that threaten the environment (Altshuler & Luberoff, 2003; Buzbee, 2014; B Flyvbjerg et al., 2003). While empirically informed literature

reviews exist for different adaptation arenas (Biesbroek et al., 2014, 2015; Bisaro & Hinkel, 2016; Hinkel et al., 2018; Measham et al., 2011; Sieber et al., 2018; A. Wellstead et al., 2014), none are specific to coastal adaptation works in the U.S. This is relevant because federal systems of governing, like the U.S., divide planning authorities in ways different from unitary governments, where planning is the sole responsibility of a central governing body (Austin et al., 2018; Elazar, 1987).

To inform coastal adaptation works in the U.S., we present a select, mini review of the literature on the political and social dimensions of coastal flood risk reduction, with an emphasis on the use of megaprojects. This review is not comprehensive but rather selects articles from the literature in natural hazards, infrastructure, political science, and climate adaptation. Coastal adaptation strategies – especially storm surge barriers, levees, and other engineered coastal defenses – are largely extensions of existing practices to manage flooding outside of a climate change context (IPCC, 2012; Sovacool & Linnér, 2016; Thomalla et al., 2006; US National Research Council, 2014). Thus, several decades of empirical research can provide insights. We highlight where politics plays a role in the conception (Section 2), design (Section 3), and implementation (Section 4) stages of coastal risk reduction project. These stages enable us to organize the literature and are loosely based off those used by Moser and Ekstrom (2010) to delineate adaptation implementation and those devised by Kingdon (2011) to describe the policy process. In reality, the stages of a coastal risk reduction project may not occur in this order, be distinct from each other, or be as clearly defined. Throughout, we give examples of current and past projects to better explain how these factors manifest in the real world. While we focus on the U.S., our findings are relevant to adaptation works in other democracies in which the responsibility for managing natural hazards is split between a central governing body and constituent units (e.g., states/providences or municipalities). We conclude (Section 5) by highlighting four lessons from historical experience with coastal risk reduction with respect to factors that will enable or impede future adaptation works. Focusing on these factors will improve coastal risk reduction efforts so that they are less likely to result in delays, deadlocks, and failures that can waste valuable time and planning resources.

2. The decision to pursue coastal risk reduction

All coastal risk reduction projects begin when the decision to initially explore options appears on a government agenda (a range of problems to which government officials are paying serious attention to at a given time). There are many possible ways in which a coastal risk reduction project can appear on an agenda. For example, the state or local government simply requires action, the federal government offers financial incentives, an extreme weather event highlights a need for adaption works, or groups and/or prominent leaders advocate for action. On the other hand, political incentives have discouraged coastal risk reduction from landing on an agenda or advancing to subsequent stages of planning.

2.1 *Government incentives to put coastal risk reduction on the agenda*

In the U.S., the federal government does not have the authority to coerce states and local communities to meet coastal flood safety standards (US National Research Council, 2014); this

is in contrast to other environmental domains with federal standards, such as water and ambient air quality (Downing & Kimball, 1982). However, Congress has created various federal programs to incentivize local preparedness by 1) making grants available to states and local communities to finance projects they would otherwise not be able to afford through local tax revenues and debt issuances alone and 2) reducing premiums for government-sponsored insurance programs if communities undertake risk-reduction measures (for example, through the National Flood Insurance Program's Community Ratings System) (Carter, N. T. et al., 2019). Federal grants are available either following a natural disaster [e.g., Federal Emergency Management Agency's (FEMA) Hazard Mitigation Program and the Department of Housing and Urban Development's (HUD) Community Development Block Grant (CDBG) Program] or *ex ante* [e.g., FEMA's Mitigation Assistance Program and its Building Resilient Infrastructure and Communities (BRIC) Program – formerly the Pre-Disaster Mitigation Program]. In both cases, recipients are required to have a standing FEMA-approved hazard mitigation plan in order to be eligible. While meager annual budgets (appropriations < $250 million/yr) restrict FEMA support for infrastructure-based coastal risk reduction (Carter, N. T. et al., 2019), some grants through HUD are larger. For example, HUD awarded New York City over $300 million through the Rebuild by Design competition to assist with funding the $1.45 billion East Side Coastal Resiliency Project (City of New York, 2020). But overall, federal funding is 1) often tied to specific disasters, making it inaccessible to communities not impacted and 2) is contingent on annual congressional appropriations, leading to fluctuations in the levels of support. Additionally, annual USACE appropriations are much smaller than the levels needed to fund coastal risk reduction megastructures. For these projects, substantial federal assistance is needed from either Energy and Water Development appropriations acts or emergency supplementation appropriation following disasters (Carter, 2018; Knopman et al., 2017; Kousky & Shabman, 2017, p. 0; Scodari, 2014; Sustainable Solutions Lab, 2018b; US National Research Council, 2014).

2.2 *Flood disasters highlight the need for coastal risk reduction*

A perennial challenge for natural hazard preparedness has been mobilizing support for action. Historically, local governments have tended to view extreme weather events (e.g., floods, hurricanes, tornados) and other rare hazards (e.g., earthquakes, wildfires, pandemics) as minor problems that take a backseat to more frequent and visible issues like unemployment, crime, housing, and education (Birkland, 1996; Burby, 2006; Godschalk et al., 2003; May, 1985; Rossi et al., 1981, 1982), despite acknowledgement of risks (White et al., 2001). For example, acknowledging the risk of a major hurricane hitting New Orleans (Kates et al., 2006) and New York City (Jeroen C. J. H. Aerts & Botzen, 2011; Rosenzweig et al., 2011). However, the salience—or level of perceived importance—of preparedness rises through the occurrence of a disaster and by those who advocate for action (Birkland, 1996). As the salience of risks increase, so does the likelihood of efforts to address them. Indeed, more frequent coastal floods and other extreme weather events often attributed to climate change are increasing support for risk reduction efforts from the public (Cain et al., 2020; Demski et al., 2017; MacInnis & Krosnick, 2020) and elected officials (Yusuf et al., 2014).

In one model of the policy process, floods, hurricanes, and other extreme weather events have been viewed as "focusing events", whereby they refocus the attention of elected officials and publics on an existing problem (Birkland, 1996; Kingdon, 2011; Zahariadis, 2003). During a focusing event, a "policy window" of opportunity opens for a short period, and advocates emerge (Olson, 1971), racing to push their preferred solutions through before the window closes (Birkland, 1996; Christoplos, 2006; Kingdon, 2011). If no viable solutions reach government officials while the window is opened, changes are unlikely (Kingdon, 2011). Cumulative learning helps reinforce lessons (Sadowski & Sutter, 2008). Sometimes, multiple disasters are needed to increase issue salience enough to push a solution through (Birkland, 1996; Kingdon, 2011). For example, despite destructive hurricanes in 1938 and 1944, New England did not begin to address coastal flooding with public works until Hurricane Carol in 1954. This was in part due to exogenous economic and geopolitical events crowding out government-led risk reduction efforts, such as the Great Depression and World War II (Morang, 2016). In another example, the USACE proposed levees and berms for the South Shore of Staten Island following damaging winter storms in December 1992 and March 1993. However, the project ultimately required the advent of Hurricane Sandy in order to stimulate congressional authorization and appropriation, over 20 years after the flood risk initially became apparent (USACE, 2016).

2.3 *Groups and individuals advocate for coastal risk reduction*

Advocacy coalitions are groups whose goal is to increase the perceived importance of a particular policy issue and to encourage the adoption of strategies in order to meet their policy objectives (Sabatier, 1988). Advocacy coalitions for natural hazard risk management have been slow to emerge in part due to the technical nature of the hazards themselves, which has limited their study largely to scientific communities in government and academia (Birkland, 1997; May, 1991b). For instance, few public interest groups focused specifically on hurricanes exist in the U.S. (Birkland, 1997). Such "policies without publics" (May, 1991a) constrain the response following future extreme weather events, or lead to inefficient policies (Birkland, 1997). In the absence of sufficient citizen attention, the federal government has formed and supported groups that promote natural hazard preparedness in the public's interest (e.g., the U.S. National Earthquake Hazards Reduction Program[1] (Birkland, 1997)). However, creating federal advocacy groups has proven to be challenging; an attempt to create a government-sponsored technical group for hurricanes was made but ultimately failed due to a lack of congressional support (the National Hurricane Research Initiative; (National Science Board, 2007)). On the other hand, subnational advocacy groups have emerged for coastal adaptation, such as the Southeast Florida Regional Climate Change Compact (SFRCCC, 2012).

In additional to organized groups, the emergence of high-profile individuals as "policy entrepreneurs" have raised the salience of an issue in order to sustain interest. Policy entrepreneurs who are government executives have pushed their own agendas to address issues that they believe to be important (Kingdon, 2011; Moser et al., 2019; Renner & Meijerink, 2018; J. B. Smith et al., 2009). For example, in the wake of Hurricane Sandy, New

[1] https://www.nehrp.gov/

York City Mayor Michael Bloomberg championed climate adaptation efforts, such as the Special Initiative on Rebuilding and Resiliency and the creation of the Mayor's Office of Resiliency and Recovery[2]. However, subsequent leadership must continue to value adaptation in order to sustain implementation, which has sometimes taken decades (Section 4). Policy entrepreneurs that advocate for adaptation works may leave office and then new leaders might scrap the plans of the previous leadership because the projects do not align with their goals (Kingdon, 2011). For example, President Trump repealed an Obama-era Executive Order amendment requiring consideration of sea-level rise in federal infrastructure decisions (Friedman, 2017). While focusing events, advocacy coalitions, and policy entrepreneurs have all helped to place adaptation works on policy agendas, countervailing political incentives have discouraged their prioritization by governments.

2.4 *Political incentives can hinder coastal risk reduction efforts*

Political incentives can discourage elected officials from reducing exposure and vulnerability to coastal hazards. For instance, the short time scales of election cycles can encourage politicians to focus on contemporary societal welfare at the expense of the future (Jacobs, 2016). If the primary goal of an elected official is to get re-elected (Mayhew, 1974), then it is rational for them to address problems with benefits that are visible to their constituents during their time in office. This includes favoring disaster relief over preparedness (Gasper & Reeves, 2011; Healy & Malhotra, 2009; Posner, 2006). Disaster relief can be distributed in the weeks to months following a disaster, while adaptation projects can take years to plan and implement and may only positively impact a small fraction of the voting population. In some cases, electorates have only come to appreciate the preparedness measures after they successfully mitigate a disaster, years after the incumbent vacates office. The villagers of Fudai, Japan praised a tsunami protection structure following the Tōhoku Earthquake in 2011 after previously labeling it a boondoggle and ridiculing the mayor who championed its construction (Daily Mail, 2011). Ultimately, without the willpower from elected officials to pay upfront political costs in order for publics to receive net returns in the future, the status quo is likely to endure.

The U.S. faces a preparedness dilemma that can inhibit coastal risk reduction efforts: while the federal government seeks to protect citizens from natural disasters, it has limited control over efforts to do so. Both the exposure and vulnerability to a coastal hazard are largely shaped by state and local land use and building codes (Simmons et al., 2018; US National Research Council, 2014). For instance, local jurisdictions may be incentivized by the potential benefits from economic growth to develop lands exposed to flood hazards (e.g., coastlines) (Burby, 2001; Knowles & Kunreuther, 2014; Peterson, 1981; Stone, 1989). At the same time, local jurisdictions bear reduced responsibility for protecting vulnerable and exposed developments, in part due to the expectation of *ex post* federal aid (e.g., disaster relief); the latter takes pressure off local officials to set aside surplus revenue for unexpected events (Rossi et al., 1982). In essence, the rewards of high-risk development accrue to property developers and local and state governments in the form of employment, contracts, profits, and tax revenue,

[2] https://www1.nyc.gov/site/sirr/report/report.page

while the federal government is largely responsible for disaster aid. This misalignment of risk, reward, and responsibility between federal and local governments can suppress local interest in pursuing adaptation and remains an enduring challenge (Burby, 2006; US National Research Council, 2014). In the U.S., some efforts have been made to discourage development on coastal lands (e.g., the Coastal Barrier Resources Act and the Coastal Zone Management Act), but new construction continues in these areas (Climate Central and Zillow, 2018; Crossett et al., 2013; Lazarus et al., 2018).

3. Designing coastal risk reduction strategies

Once governments have decided to reduce flood risks (Section 2), they must determine how to do so. Multiple solutions are often technically feasible, including strategies that reduce the hazard (building surge barriers, levees, and other structural defense measures) and strategies that reduce the consequences of the hazard (elevating structures above extreme water levels, moving populations and the built environment away from the coastline, building codes) (Oppenheimer et al., in press). Either a single strategy (e.g., levee system) or combination of strategies could be employed (e.g., levee system and building codes). We conceptualize selecting a proposal as two steps: 1) producing alternative strategies and 2) choosing among them. These are not merely technical decisions made behind closed doors. Modern approaches to planning seek to create an open, transparent forum for government agencies, elected officials, and the public to deliberate over the best course of action (Davidoff, 1965; Pateman, 1970; UNFCCC, 1992, p. 6). A number of political and social factors are involved, including government agency biases, political power, laws, tension between public participation and technical expertise, and government subsidy schemes.

3.1 *Political and social factors in creating alternative strategies*

Alternatives are the range of potential risk reduction options (sometimes a sequence of options over time) that satisfy a given policy objective (e.g., protection from a 100-year flood). For some projects, proposing alternatives is required by law. The National Environmental Policy Act (NEPA) mandates that government agencies consider more than one solution if a proposed project poses significant harm to the quality of the natural environment (Luther, 2008). Creating a viable risk reduction strategy is not simply a matter of scientific expertise and skillful engineering. Technical experts are able to answer the question of what can be built, but not the normative question of what should be built. Proposed solutions are influenced by their designers' values and beliefs regarding what constitutes "good" options (Gregory & Keeney, 1994; Sovacool & Linnér, 2016) and it is generally impossible to accommodate the diversity of preferences held by stakeholders (Few et al., 2007; Gregory & Keeney, 1994). While project designers forecast net positive social welfare gains, underneath there are likely "winners" and "losers" (Sovacool & Linnér, 2016). Choices inherently entail difficult tradeoffs between the present and the future, and success in the near-term may be maladaptive in the long-run, and vice-versa (Barnett & O'Neill, 2010).

Participatory and collaborative approaches such as iterative design and planning workshops have helped to mitigate disagreements and produce consensus-supported strategies for flood

risk management in East Boston, England, and Austria (Kirshen et al., 2018; Löschner et al., 2016; Pasquier et al., 2020). In the Netherlands, the original Delta Works plan to close off the Eastern Scheldt Estuary with an impermeable dam invoked strong public opposition from yachters, the shellfish industry, and environmental groups (Disco, 2002). In response, engineers and environmental scientists worked together to design an alternative that simultaneously served the interests of safety, the economy, and the local ecology. The result was a storm surge barrier across the Eastern Scheldt with closeable gates wide enough to not significantly impede the natural tidal flow, therefore minimizing the structure's environmental impact (Bijker, 2002; Disco, 2002). However, public interest in natural hazard mitigation is not always strong (Godschalk et al., 2003), and participatory approaches do not always lead to improved outcomes (Bloomfield et al., 2001; Few et al., 2007; Reed, 2008) or technically feasible designs (Araos, 2020). For example, following Hurricane Sandy, the City of New York and HUD worked together through the Rebuild by Design competition to develop the East Side Coastal Resilience Project, a flood protection system integrated into Manhattan's East River Park. After years of public participation through an iterative design process, the final consensus design was thrown out by the City's Department of Design and Construction on the grounds that it was not technically sound from an engineering standpoint. The Department of Parks and Recreation also came to the conclusion that it was not interested in managing a floodable park, as the original design had called for. These conclusions were largely made behind closed doors, upsetting many who had believed their participation would be reflected in the final project design (Araos, 2020). A revised plan was made in place of the original collaborative design. The experience highlights the vulnerability of inclusive, participatory risk reduction efforts to both scientific reevaluation and existing power structures (Bent Flyvbjerg, 1998).

Government agencies tasked with reducing coastal flood risks also have a history of favoring particular approaches, in part due to their statutory missions that lead them to look through different lenses. For example, FEMA's emphasis on individual assistance has focused its disaster mitigation programs largely on private strategies that reduce the consequences of floods, such as property acquisition/buyouts and building-specific measures like flood proofing and structure elevation (CRS, 2009). On the other hand, the USACE has a history of deploying concrete and steel-based projects that impact large regions (Mazmanian & Nienaber, 1979). Many of the USACE's recent coastal risk reduction proposals have continued to favor structural measures over working with nature (Table 1), despite an espoused and to some extent, real interest on the part of USACE in the later (USACE, 2015b).

3.2 *Political and social factors in choosing among alternatives*

Many of the same political and social factors involved in creating a coastal risk reduction strategy play a role when choosing what solutions to employ. This includes accommodating a diversity of values, beliefs, and desires from all stakeholders, government agency biases towards particular strategies, and political power. Additional factors include debate over how to best appraise alternatives, adverse impacts of strategies after implementation, the influence of laws on choosing alternatives, and the impact of government cost sharing. Environmental impact statements (EISs) as required under NEPA and other State or local impact reports (e.g.,

California, New York State, and New York City) are typical examples of appraisal documents (Luther, 2008; Talen, 1996).

Various decision analysis methods have been developed to help appraise large-scale coastal flood risk reduction strategies with respect to chosen objectives (e.g., benefit-cost analysis, robust decision-making and flexible/adaptive decision-making)(Chambwera et al., 2014; Haasnoot et al., 2013, 2019; Lempert et al., 2003; Ranger et al., 2013), but the selection of these objectives, in part, depend on policy goals (Kleindorfer et al., 1993). Even if the objective is agreed upon by all stakeholders (e.g., protection from a 100-yr flood), it does not necessarily encourage consensus for choosing a course of action. For example, all of the USACE's proposed alternatives for flood protection in the New York Metropolitan Area provided protection from a 100-yr flood event (USACE, 2019), but proponents of nature-based flood risk reduction (e.g., dunes and beach nourishment, oyster beds, wetland restoration) loudly objected to the use of storm surge barriers (Elizabeth Royte, 2019; Ong, 2018; Roff & Gallay, 2018; Stringer, 2019). Furthermore, they attacked the USACE's benefit-cost analysis approach on the grounds that it under-valued ecosystem services, biodiversity, and cultural heritage (Ong, 2018). Political motivations have also led to strategic manipulation of decision analyses by planners to obtain desired outcomes (Ferejohn, 1974; Bent Flyvbjerg, 1998; Bent Flyvbjerg et al., 2002; Mazmanian & Nienaber, 1979; Wachs, 1989, 1990).

Anticipated regulatory hurdles and funding subsidies have also influenced choices among presented alternatives. For instance, besides being cheaper, small-scale coastal risk reduction projects that can be implemented quickly have been favored over larger, infrastructure-based measures that have historically taken decades to complete, in part due to lengthy government approval (i.e., multiple Acts of Congress), appropriations processes (Carter & Normand, 2019), and long construction times (Mooyaart & Jonkman, 2017). New York City's Special Initiative for Rebuilding and Resiliency and a University of Massachusetts-Boston study both favored smaller-scale projects over large, engineered projects like levees and surge barriers because they have been implemented faster and have co-benefits that address social justice issues (City of New York, 2013; Kirshen et al., 2020). For example, floodable parks that provide historically marginalized groups access to recreation and green space. Simple, small-scale projects are eligible to be undertaken at the discretion of cities and the USACE, without the need for both approval and appropriations from Congress (Carter & Normand, 2019; Normand, Anna E., 2019). USACE projects like dune building, beach nourishment, and aquatic ecosystem restoration also have local-federal cost sharing schemes that are more favorable to local jurisdictions (Mullin et al., 2018; USACE-IWR, 2003) and are compatible with coastal management strategies that aim to keep future options open (e.g., Haasnoot et al., 2013, 2019). However, numerous small-scale measures taken together may not add up to credible regional protection against rare storms (e.g., a 100-yr flood).

4 Implementing coastal risk reduction

The design and selection of any coastal risk reduction project (Section 3) is not itself sufficient to assure its implementation. Political scientists and planners have long understood the bottleneck that implementation poses to policy making and planning (Bardach, 1977; Mazmanian & Sabatier, 1983; Palumbo & Calista, 1990; Pressman & Wildavsky, 1984; Sabatier,

1986; Talen, 1996; Younis, 1990). Based on past experiences with public works and coastal risk reduction efforts, implementation is likely to be challenged by environmental protection laws, siting-related opposition, institutional complexity (e.g., permitting), and lack of support from elected officials (Fukuyama, 2017; Howard, 2015).

4.1 *Environmental protection laws have challenged coastal risk reduction efforts*

Experience with public works suggests that laws related to environmental protection provide opportunities to challenge the implementation of coastal adaptation works (Bligh, 2006; Buzbee, 2014; Kagan, 1991; Kysar & McGarity, 2006; Luther, 2006; Murchison, 2007). Prior to the passage of contemporary environmental laws in the U.S., by and large the only legal question that proponents of a flood protection project needed to answer was if it impeded maritime navigation (Scarano, 2013). Today, mandatory consideration of environmental impacts has made infrastructure implementation a more complex legal process (Altshuler & Luberoff, 2003; Mazmanian & Nienaber, 1979; Taylor, 1984). For example, under NEPA, all federally funded projects that pose significant harms to the quality of the natural environment must analyze and publicly disclose a proposal's environmental impacts through an environmental impact statement (EIS) and receive public comment on the proposal and its alternatives. Reviews may also be required at the state and local level (e.g., the California Environmental Quality Act, the California equivalent of NEPA, and New York City's City Environmental Quality Review). While this process is not a direct legal barrier to project implementation per se, the transparency of potential environmental harms it provides can trigger lawsuits from neighborhood groups, environmental organizations, and other special interests if they believe the submitted EIS does not sufficiently account for environmental impacts (Luther, 2008).

There are several instances in which environmental laws have led to delays and project failures. In the midst of an effort to implement flood protection in the greater New Orleans region, the USACE was successfully sued in 1977 (*Save Our Wetlands, Inc. v. U.S. Army Corps of Engineers*, 553 F.2d 100 (5th Cir. 1977)). While the *Save Our Wetlands* lawsuit did not completely block the USACE's flood protection efforts, it did lead to a multi-year delay in implementation and an increase in project costs (Bligh, 2006; Kysar & McGarity, 2006). More recently, neighborhood activists in the Lower East Side of Manhattan unsuccessfully sued the City of New York arguing that the new plan for the East Side Resiliency Project needed to go through an extra round of environmental review (Araos, 2020; R. H. Smith, 2020)(*East River Park Action v. City of New York*, docket 151491/2020 (N.Y. Sup. Ct.)). On the other hand, some environmental laws have blocked projects altogether. Under the Clean Water Act, projects cannot be built in coastal waterways unless 1) the sponsoring agency proves they need to be built in the water or 2) the underlying project will not cause "significant degradation" to important aquatic habitats (Copeland, 2016). In New York City, the Sierra Club successfully sued and blocked an effort to issue a landfill permit under the Clean Water Act (*Sierra Club v. U.S. Army Corps of Engineers,* 609 F. Supp. 1052 (S.D.N.Y. 1985)). The permit was needed to break ground on the Westway Project, a proposed Manhattan superhighway (Buzbee, 2014). While there is little doubt that the emergence of the environmental protection movement greatly improved environmental quality, it has led to a number of new laws and lengthy, formalized

processes that have the potential to challenge the implementation of adaptation works, much in the same way it has challenged the deployment of public works in general (Fukuyama, 2017; Howard, 2015; Kagan, 1991).

4.2 *Not in my backyard: siting opposition to coastal risk reduction*

Despite the well-intentioned benefits of adaptation works, the siting of some projects is likely to raise public opposition [e.g., not-in-my-backyard (NIMBY) syndrome (McAvoy, 1999)]. NIMBY syndrome can present problems for governments trying to construct public works that aim to increase the welfare of its citizens broadly, but also imposes direct net costs on some groups given their geographic proximity. These projects are perceived by local citizens to bring few, if any, direct benefits while imposing large immediate costs via eminent domain, decreases in property value, deterioration of the natural environment, and loss of amenities (Aldrich, 2008; Devine-Wright, 2011; McAdam & Boudet, 2012; McAvoy, 1999; Quah & Tan, 2002; E. Smith & Klick, 2007). For example, a 1960s USACE proposal for storm surge barriers across three entrances to Narragansett Bay in Rhode Island was met with strong public opposition, including from recreational boaters who argued the massive structure would induce strong currents and subsequently impede maritime navigation (Evening Bulletin, 1964). Ultimately, the State of Rhode Island asked the USACE to shelve the project believing that the public would not support a bond referendum to pay for the substantial local share of the project cost (Providence Journal, 1965). More recently, neighborhood activists in the Lower East Side of Manhattan expressed opposition to the revised East Side Coastal Resilience Project, in part because of necessary lengthy closures of the East River Park (a key neighborhood amenity) and the removal of nearly a thousand trees (Araos, 2020). Overall, opposition to public works projects is expected to increase over time due to less undeveloped land, rising educational levels that lead to greater access to technical information and legal resources, increased environmental awareness, and declining confidence in government (Aldrich, 2008).

Siting issues can also raise environmental justice concerns if projects with negative externalities (e.g., pollution) are planned near communities with less political and economic power (Aldrich, 2008). In the case of flood risk reduction, these justice concerns largely have centered around who is afforded flood protection and who is left out (Adger et al., 2006; Liao et al., 2019). For example, the East Side Coastal Resilience Project was, in part, designed to provide protection to socially vulnerable populations in the Lower East Side of Manhattan (Araos, 2020; City of New York, 2020; de Sherbinin & Bardy, 2015). However, the revised project plan resulted in dispute between neighborhood activists and those affiliated with low-income public housing (residents and their formal representatives). The former prioritized conservation of the existing park, while the latter supported long-term flood protection (Araos, 2020).

4.3 *Complex governance structures complicate coordination*

The arrangement of government agencies and institutions[3] plays a critical role in the implementation of a coastal risk reduction project. In the U.S., planning authority is divided in a manner that protects the sovereignty of sub-national states (Austin et al., 2018; Elazar, 1987). Fragmented arrangements of government agencies and institutions hinder the implementation of adaptation works by complicating intergovernmental relations and coordination between cities, states, and the federal government (Den Uyl & Russel, 2018; Fukuyama, 2017; Glicksman, 2010; Lubell, 2017; Peterson, 1981). This structure is characterized by fragmented decision-making and a lack of coordination, comprising a "vetocracy" where many diverse interests are involved with strongly held, divergent views (Fukuyama, 2017). Additionally, without reforms and new laws, some long-standing government agencies may not be well equipped to manage coastal flooding and sea-level rise.

In the U.S., there is no federal coordinating body with the sole focus of reducing coastal flood risk (US National Research Council, 2014). Instead, there are at least nine federal agencies with various flood management responsibilities (USACE, 2015a). Each federal agency has a different geographic jurisdiction, regulatory authority, and capacity. In addition, state and local level governments overlap with and often duplicate federal authority. For example, in addition to three federal agencies (Environmental Protection Agency, USACE, and the U.S. Fish & Wildlife Service), the San Francisco Bay and its shorelines are also managed by four state agencies (Bay Conservation and Development Commission, Water Quality Control Board, California Coastal Conservancy, and California Dept. of Fish & Wildlife) and over 100 local governments and special districts. This complex arrangement of authority has hampered efforts to use wetland restoration as a local coastal risk reduction strategy (Pinto et al., 2018). In light of this and other struggles, stakeholders surveyed in the San Francisco Bay area almost unanimously favored more central coordination and integrated planning but disagreed on the preferred governance arrangement (Lubell, 2017). A key question is how to achieve cooperation within complex, multi-level systems. Possible approaches include integration and consolidation of permits (Rabe, 1995), creating new agencies with extensive authority over coastal adaptation issues, and physical climate data centers to minimize duplication in the production of estimates of coastal flood hazards (Lubell, 2017). Task forces have been used to facilitate coordination between federal agencies and local municipalities. For example, following Hurricane Sandy, President Obama formed the Hurricane Sandy Rebuilding Task Force to improve coordination as communities were making decisions about long-term recovery (Hurricane Sandy Rebuilding Task Force, 2013). Although this was not specifically focused on reducing coastal flood risk, its success highlights the potential for similar task forces to help with intergovernmental coordination.

When forced to adapt to a changing climate, some long-standing government agencies may no longer operate effectively. Without fundamental changes and restructuring, these legacy institutions will hinder society's ability to adapt to climate change (Libecap, 2011; Lubell, 2017). For example, in four Southeastern U.S. states, efforts to elevate state highways that become impassible during nuisance or "sunny day" flood events have run into challenges with

[3] Institutions are broadly defined as rules (formal and informal) that structure interactions between groups. They provide important coordination mechanisms and give actors the ability to acquire technical and financial resources that they otherwise would not have access to (Ostrom, 2005).

jurisdictional boundaries (Jones et al., 2019). Flood managers in the Hampton Roads region of southeast Virginia have also cited jurisdictional boundaries as an impediment to regional responses (John & Yusuf, 2019).

4.4 *Support from elected officials is critical for advancing large projects*

Support from congressional delegates is needed to shepherd large USACE projects through Congress. For example, the failed Narragansett Bay storm surge barriers lacked support from both the Governor (Evening Bulletin, 1963) and the Rhode Island congressional delegation (Van Dusen, 1964). On the other hand, the Fox Point Hurricane Barrier received strong, sustained support from both the public and elected officials, including the mayor of Providence, the Governor, and even the President (Providence Journal, 1958, 1959, 1960). More recently, when the USACE's South Shore Staten Island project was in doubt over an issue with encroaching on federal lands, Congressman Max Rose and Senator Chuck Schumer led an effort to pass new legislation that allowed the Corps to access Great Kills Park, part of Gateway National Recreation Area (Michel, 2020). While support from elected officials is necessary, it is not sufficient for large projects to advance. As learned from the Westway experience, legal challenges can trump near unanimous support from elected officials (Buzbee, 2014).

5 Lessons learned: Creating a politically favorable environment for coastal adaptation works

Experience with coastal risk reduction indicates that simply looking good on the drawing board is insufficient to cause a project to materialize. The prospects for breaking ground on storm surge barriers, levees, and other coastal adaptation megaproject in the U.S. are not solely a function of technically feasible and economically justifiable plans. In this non-comprehensive review, we draw from the literature on natural hazards, infrastructure, political science, and climate adaptation to show that large coastal risk reduction projects are deeply embedded in politics and social conflict. We give particular attention to the project phases of conception (Section 2), design (Section 3), and implementation (Section 4).

Despite political challenges, several coastal risk reduction megaprojects have been built in the U.S. (Table 2; Morang, 2016). Projects completed prior to 1970 benefited from preceding modern environmental laws, and in a recent case, some environmental procedures were overridden as a result of the urgent need to protect New Orleans after Hurricane Katrina (CRS, 2006; Luther, 2006). New coastal adaptation works continue to progress (Table 1). For example, the South Shore Staten Island and East Side Coastal Resiliency projects in New York City both await construction after receiving funding and necessary approvals (Cohen, 2019; R. H. Smith, 2020).

From our review of social and political coastal risk reduction factors, we highlight four lessons that reflect factors that will enable or impede future adaptation works:

1. *Multiple floods are often needed to incite interest in coastal risk reduction*

The misalignment of risk, reward, and responsibility between federal and local governments continues to suppress local interest in pursuing coastal risk reduction (Section

2.4). Furthermore, public policy problems that have spatial or temporal immediacy continue to be prioritized over those that may be justified from a long-term strategic perspective such as coastal flood protection, but public support for climate adaptation is increasing (Section 2.2). Flood disasters provide windows of opportunity for interest in coastal risk reduction to greatly increase. However, these windows are, as of yet, rare and are only open for a short period of time (Section 2.2). This highlights the critical importance of taking advantage of these occasions. Particularly, plans are needed in advance so that when a disaster happens, elected officials have specific projects to support, authorize, and fund. Furthermore, past experience suggests that multiple disasters are sometimes needed for coastal risk reduction to receive sufficient attention (Section 2.2).

2. *Participatory planning has helped produce consensus-supported strategies*

Experience suggests that participatory approaches such as iterative design and planning workshops have helped to rectify disagreements between stakeholders and produce consensus-supported strategies (Section 3.1). However, outcomes that offer little improvement over the status quo are still possible. First, the outcome of a consensus in collaborative decision-making has been a solution that, while acceptable to all stakeholders, fails to address the issue at hand (Section 3.2). Second, public apathy has led to a disproportionate representation by special interests (Section 4.2). Third, consensus outcomes are sometimes not technically feasible (Section 3.1).

3. *Strong and continuous leadership is necessary to advance big projects*

USACE megaprojects require multiple acts of Congress to advance from an initial plan to implementation (Section 3.2). This process can take several years. Furthermore, Congress must deal with many policy issues that compete for attention (Section 2.1). The success of USACE megaprojects critically depends on strong and continued support from mayors, local congressional delegations, governors, and even presidents (Section 4.4). However, while it is necessary, support is not always sufficient for projects to advance to implementation. Public opposition and legal challenges have overridden near unanimous support from elected officials (Section 4.1).

4. *Environmental laws and public opposition are enduring challenges*

In the case of large coastal flood protection megaprojects, protecting human safety and the environment are sometimes in direct conflict (Section 4.1). Powerful and organized groups (e.g., environmental NGOs) have exerted a significant influence over the implementation of coastal megastructures (Section 4.2). This influence is usually not countered by lobbying and litigation from other interests who are in favor of projects. Environmental laws provide opportunities for special interests to legally challenge projects if they believe certain environmental impacts have not been properly accounted for. Lengthy litigation has caused project delays, deadlocks, and even failures (Section 4.1).

Breaking ground on a project that is judged by technocratic agencies to be feasible and economically beneficial may not always be desirable. Coastal adaptation works will not solve all problems and they are just one option from a spectrum of possible responses (e.g., protection, accommodation, retreat, advance; M. Oppenheimer et al., in press). Coastal adaptation works may lead to undesirable outcomes not recognized in their analyses such as being maladaptive (Barnett & O'Neill, 2010), inflexible (Arthur, 1989; Corvellec et al., 2013; Markolf et al., 2018; Payo et al., 2016), environmentally harmful (Orton et al., 2019; Swanson et al., 2012), or causing environmental injustices (Adger et al., 2006; Liao et al., 2019; Shi et al., 2016). For these reasons, knowing why projects fail is also useful not only for proponents but also for those who wish for a particular project to fail. Rather than thinking of protection strategies that focus on a single, critical threshold (e.g., the 100-year flood; Rasmussen et al., 2020), a more diverse suite could be used, such as those that are redundant, "safe-to-fail" (Kim et al., 2017), more affordable, combine natural and built infrastructure (Sutton-Grier et al., 2015), and more modular/flexible. These characteristics are the foundation of "resilience"-based approaches (Linkov et al., 2014; National Research Council, 2012; Park et al., 2013; Woods, 2015).

While our review emphasizes the importance of considering political complexities when pursuing adaptation works, it stops short of detailing specific mechanisms that may be necessary to generate effective policy recommendations. Future research could uncover these. For example, examining historical case studies of controversial public works proposals could further open up the "black box" of politics and allow for identification of causal processes (Biesbroek et al., 2014; Elmore, 1979; A. M. Wellstead et al., 2013). Such an approach is also likely to yield practical advice to policy makers on how to intervene, overcome implementation barriers, and obtain favorable outcomes and could also contribute to building political theory. This includes examining how the political forces involved in management of coastal and other environmental risks affect decisions (i.e., political economy). Examples of potential case studies include storm surge barriers and other public works that address societal risks (e.g., renewable energy, drinking water availability, and public transit), earthquake building codes and warning systems, and pandemic planning and response (e.g., COVID-19).

Acknowledgements

The authors acknowledge the helpful comments from two anonymous reviewers and discussions with Robert J. Lempert (RAND), Daniel J. Van Abs (Rutgers), Jeff Gebert (U.S. Army Corps of Engineers), and Megan Mullin (Duke). D. J. R. was supported by the Science, Technology, and Environmental Policy (STEP) Program at Princeton University. R. E. K. was supported by NSF grant ICER-1663807. M. O. thanks the High Meadows Fund.

Data Availability Statement

Data were not used, nor created for this research.

Figures

Figure 1. The completed Fox Point Hurricane Barrier in March 1966 (Providence, Rhode Island). Photo taken by the New England Division of the U.S. Army Corps of Engineers (Waltham, Massachusetts).

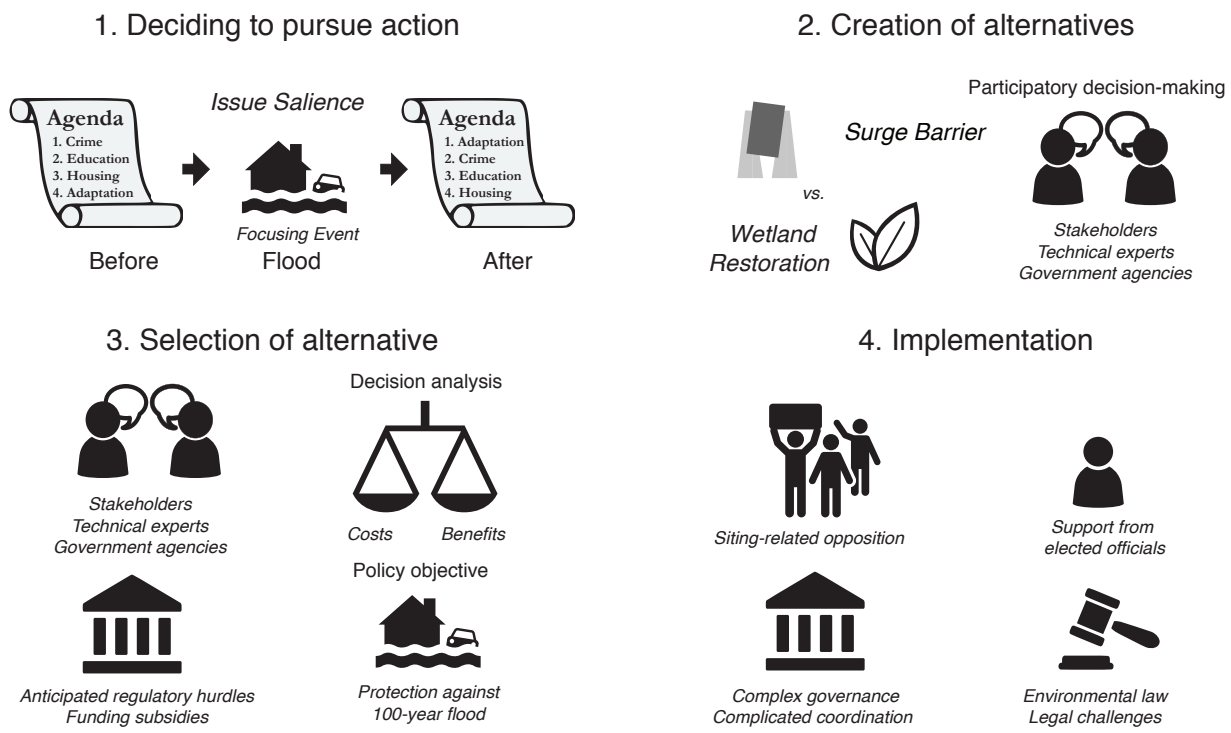

Figure 2. The process leading up to breaking ground on an adaptation works project organized into four different steps: 1) deciding to pursue action (Section 2), creating alternatives (Section 3.1), selecting from alternatives (Section 3.2), and implementation (Section 4).

Table 1. An incomplete list of proposed public works coastal flood protection projects in the U.S. (USACE is the U.S. Army Corps of Engineers; CSRM is Coastal Storm Risk Management; HUD is Department of Housing and Urban Development; NYC is New York City; SSPEED is the Severe Storm Prediction, Education, and Evacuation from Disasters Center)

Project	Location	Strategy	Year Proposed	Lead Agency	Project Cost	Status (as of 2020)
Boston Harbor Surge Barrier	Boston, MA	Levee/Barrier	2018	UMass-Boston	$6.5 to 11.0 billion	Proposed
East Side Coastal Resiliency Project	New York, NY	Levee/Nonstructural	2014	NYC/HUD	$1.5 billion	Approved by the City
Lower Manhattan Climate Resiliency Project	New York, NY	Coastal Advance/Fill	2019	NYC	$10 billion	Proposed
Embarcadero Seawall	San Francisco, CA	Seawall	2018	City of SF	$5 billion	Proposed
Red Hook Integrated Flood Protection System	New York, NY	TBD	2013	NYC	$0.1 billion	Undergoing a redesign
Coastal Texas Protection and Restoration Project	Coastal Texas	Levee/Barrier/Nonstructural	2015	USACE	$23.1 to 31.8 billion	Proposed
Galveston Bay Park	Galveston, TX	Levee/Barrier/Nonstructural	2020	SSPEED	$2.3 to 2.8 billion	Proposed
South Shore of Staten Island CSRM Project	New York, NY	Levee/Nonstructural	1993	USACE	$0.6 billion	Ready to break ground
Charleston Peninsula: A Coastal Flood Risk Management Project	Charleston, SC	Levee/Seawall	2020	USACE	$1.7 billion	Proposed
City of Norfolk CSRM Project	Norfolk, VA	Levee/Barrier/Nonstructural	2015	USACE	$0.9 to 2.3 billion	Awaiting authorization
Miami-Dade Back Bay CSRM Project	Miami, FL	Levee/Barrier/Nonstructural	2020	USACE	$0.9 to 5.2 billion	Proposed
Collier County CSRM Project	Naples, FL	Levee/Barrier/Nonstructural	2020	USACE	$2.2 billion	Proposed
Fairfield and New Haven Counties, CT CSRM Project	Fairfield and New Haven, CT	Levee/Seawall/Pumps	2019	USACE	$0.05 to 0.3 billion	Proposed
New York – New Jersey Harbor and Tributaries Project	New York, NY	Levee/Barrier/Nonstructural	2019	USACE	$15 to 119 billion	Planning suspended

Table 2. An incomplete list of completed public works coastal flood protection projects in the U.S. (USACE is the U.S. Army Corps of Engineers)

Public Works Flood Protection	Location	Completed	Agency	Cost (unadjusted)
Galveston Seawall	Galveston, TX	1904	USACE	$1.5 million
Herbert Hoover Dike	Lake Okeechobee, FL	1938	USACE	Unknown
Pawcatuck Hurricane Protection Barrier	Pawcatuck, CT	1963	USACE	$851,000
New Bedford Hurricane Barrier	New Bedford, MA	1966	USACE	$18.6 million
Fox Point Hurricane Barrier	Providence, RI	1966	USACE	$16.2 million
Stamford Hurricane Protection Barrier	Stamford, CT	1969	USACE	$14.5 million
Charles River Dam	Boston, MA	1978	USACE	$61.3 million
New London Hurricane Protection Barrier	New London, CT	1986	USACE	$12.0 million
Lake Pontchartrain and Vicinity Hurricane Protection (Levee/Dike)	New Orleans, LA	Destroyed during Katrina, 2005	USACE	$760 million
Inner Harbor Navigation Canal Lake Borgne	New Orleans, LA	2013	USACE	$1.1 billion

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